Precipitator and Scrubber Installation Study Holyrood Thermal Generating Station

Prepared for:

Newfoundland and Labrador Hydro

Prepared by:

Stantec Consulting Ltd.
845 Prospect Street
Fredericton, NB E3B 2T7

File No. 133544177/10

November 20, 2008

Executive Summary

Newfoundland and Labrador Hydro own and operate the Holyrood Thermal Generating Station. The station consists of three units firing heavy fuel oil for a combined generating capacity of 500 MW.

Newfoundland and Labrador Hydro are currently exploring the options to reduce the particulate and sulphur dioxide emissions at the station. To meet this objective, electrostatic precipitators (ESP) and a common flue gas desulphurization (FGD) system would need to be installed at the station.

Stantec Consulting Ltd. was retained by Newfoundland and Labrador Hydro to conduct a preliminary study to determine the feasibility of installing this equipment at the station. This report outlines the results of this study and provides Newfoundland and Labrador Hydro with key information in order to evaluate the impact and cost to upgrade the station with new environmental equipment.

It was agreed that the design fuel for the study would be heavy fuel oil with a maximum sulphur content of 2%.

The environmental equipment was selected based on this design fuel case and on the basis of meeting the requirements of Newfoundland and Labrador Regulation 39/04 – Air Pollution Control Regulations, 2004 under the Environmental Protection Act (O.C. 2004 – 232).

The following major conclusions and/or issues have been determined in the course of this study:

- Unitized electrostatic precipitators and a common flue gas desulphurization is the best available control technology (BACT) for reducing particulate and sulphur dioxide emissions at the station.
- Electrostatic precipitators and a flue gas desulphurization system can successfully be retrofitted within the confines of the station property.
- The electrostatic precipitators will remove +95% of the particulate from the flue gas emissions at the design fuel case. Outlet particulate emissions are expected to be 24 mg/Nm^3 at 100% MCR for each unit. Annual particulate emissions from the Holyrood Station are estimated at 189 tonnes based on a 60% station capacity factor at the design fuel case.

- The flue gas desulphurization system will remove +95% of the sulphur dioxide emissions at the design fuel case. Outlet sulphur dioxide emissions are expected to be 29 ng/J (38 ppmdv) at the design fuel case and at 100% MCR on all three units. Annual sulphur dioxide emissions are estimated at 776 tonnes based on a 60% station capacity factor at the design fuel case.

- The cost to install the unitized ESP's and the FGD system at the station is predicted at $ 450,000,000 CDN, or about $900/kW. This cost includes contingency, but excludes escalation, financing during construction (AFUDC) or any of the owner's costs. The prediction is based on budget pricing from equipment vendors, file data and our in-house database. Based on the level of detail and the methodology employed, we would reasonably expect the final project cost to be within ±25% of the above figure.

The following key items and/or issues were identified during the study. Some of these will require additional study by Newfoundland and Labrador Hydro.

- Due to the additional flue gas pressure drop required by the ESP's and FGD, new induced draft (ID) fans will be required for each unit.

- The installation of the new ID fans will change the boiler operation from forced draft to balanced draft. The boiler and breeching will require stiffening to ±35 in. W.G. to meet the NFPA 85 Boiler Code requirements.

- The new precipitators will collect approximately 4400 tonnes/year of particulates (flyash) based on a 60% overall plant capacity factor at the design fuel case. This flyash will be conditioned at the new flyash facility. The conditioned flyash will need to be landfilled. The existing landfill will need to be studied to determine if it can accommodate the additional flyash quantity. A new landfill will more than likely be required.

- The new FGD system will collect approximately 25,000 tonnes of SO_2 emissions per year at the design fuel case and at a 60% annual plant capacity factor.

- The new FGD system will generate approximately 15.0 metric tonnes per hour (MTPH) or 78,000 tonnes annually of gypsum by-product. The annual quantity is based on an overall plant capacity factor of 60% at the design fuel specification. The gypsum by-product can either be sold to the wallboard industry or landfilled.

- The new FGD system will require approximately 8.0 MTPH or 42,500 tonnes annually of limestone based on a 60% plant capacity factor at the design fuel case. The current concept and opinion of probable cost includes an allocation for a truck receiving facility for the delivery of limestone. A limestone stockpile of approximately 30 days has been shown on the preliminary concepts. The report assumes that limestone will be delivered by truck. Newfoundland and Labrador Hydro will need to review the environmental impact of the truck traffic on the community. The results of this study may require Newfoundland and Labrador Hydro to study alternative limestone shipping concepts to mitigate and/or eliminate the truck traffic through the community. Preliminary alternate concepts include unloading the limestone by ship at Long Pond Wharf, the plant's heavy fuel oil (HFO) unloading jetty or at the Ultramar refinery wharf located down the coast from the plant. For the purpose of this study, Stantec has carried a high level opinion of probable cost for unloading the limestone at the existing fuel unloading wharf. It is Stantec's opinion that an additional study should be carried out to further review the potential feasibility of each option and to select the preferred and most economical solution.

- Makeup water requirements for the FGD system will be approximately 31.5 L/s (500 USGPM) at the design conditions. The makeup water is required to replace evaporation losses when the flue gas is saturated in the absorber tower and losses in the blowdown and gypsum dewatering process. The current source of raw water for the plant is from the dam on Quarry Brook. An additional study may be required to ascertain if the current flows from Quarry Brook can sustain the FGD system makeup requirements. An additional source of water may be required if the flow is not sufficient. The opinion of probable cost assumes that water in sufficient quantity will be available to meet the new demand requirements of the FGD system.

- The new FGD system will require a water blowdown stream of 0.63 L/s (10 USGPM) at the design condition to control chloride concentration in the absorber. A separate waste water treatment (WWT) plant has been provided at the FGD building for this purpose.

Table of Contents

Table of Contents

Table of Contents

Table of Contents

LIST OF TABLES

UNITS OF MEASURE

A	Ampere
ACFM	Actual Cubic Feet Per Minute
BHP	Brake Horse Power
°C	Degrees Celsius
°F	Degrees Fahrenheit
in	inches
in w.g.	Inches of Water Gauge
kA	Kilo Ampere
Kg/sec	Kilograms Per Second
Kn/m^3	Kilo Newton Per Cubic Metre
kPa	Kilo Pascals
kV	Kilovolts
kWh	Kilowatt Hour
L/s	Litres Per Second
M	Metres
mg/Nm^3	Milligrams Per Normal Cubic Metre
mm	Millimetres
MMBTU/hr	Million British Thermal Units Per Hour
mmHg	Millimetre of Mercury
MTPH	Metric Tonnes Per Hour
MW	Mega Watt
ng/J	Nanograms Per Joule
Nm^3/sec	Normal Cubic Metres Per Second
Pa	Pascals
ppm	Part Per Million
ppmdv	Part Per Million Dry Volume Basis
psf	Pounds Per Square Foot
RPM	Revolutions Per Minute
USGPM	U.S. Gallons Per Minute

1.0 Introduction

1.1 BACKGROUND

Newfoundland and Labrador Hydro are currently studying options for electricity generation for the Island of Newfoundland. Currently, the Island of Newfoundland relies on the Holyrood Thermal Generating Station to generate and supply electricity during its winter peak load season and shoulder seasons. The Holyrood Station consists of three Heavy Fuel Oil (HFO) boilers for a combined generating capacity of 500 MW. The current boilers do not have any environmental equipment for controlling sulphur dioxide (SO_2) or particulate emissions. Because of this, the station is forced to purchase a low sulphur HFO at a higher cost to meet the Province's environmental regulations. This requirement limits the fuel flexibility for the station and results in a higher cost of power generation.

To improve the current situation, Newfoundland and Labrador Hydro are exploring a couple of options. The first option is to upgrade the Holyrood Station with new state-of-the-art environmental controls. This would allow the Station to burn a variety of fuels and meet its environmental commitment. The second option being considered is installing an underwater transmission cable to bring power to the Island from the potential lower Churchill hydro development. The feasibility and economics of this project are currently being studied and a final decision is expected in mid 2009. Should this project proceed, the Holyrood Station would be relegated to a back up power generating role and see little or no upgrades. However, if the lower Churchill development is delayed or deemed unfeasible, Newfoundland and Labrador Hydro would proceed with a full upgrade of the Holyrood Station which would include life extension work and the installation of state-of-the-art environmental controls. In preparation for this decision, Newfoundland and Labrador Hydro are conducting preliminary studies on the Holyrood Station to determine the scope of the required upgrades and establish a preliminary budget cost for these upgrades.

1.2 STUDY OBJECTIVES

Stantec Consulting Ltd. was awarded a study by Newfoundland and Labrador Hydro to reduce the particulate and sulphur dioxide emissions at the station by the installation of electrostatic precipitators (ESP's) and a Flue Gas Desulphurization (FGD) system. This study will determine what plant upgrades will be required and provide an order of magnitude opinion of probable cost for these upgrades. The study includes the following activities and considerations:

- Prepare preliminary flow sheets.
- Determine modifications to the existing plant.
- Prepare preliminary site layout and general arrangement drawings.

- Determine environment impacts of the projects.
- Determine an order of magnitude opinion of probable cost.
- Determine the Operating and Maintenance costs for the facility.

This report summarizes the findings of the study and presents a complete and detailed description of all the issues associated with installing electrostatic precipitators and a Flue Gas Desulphurization system at the station.

2.0 Project Design Basis

2.1 GENERAL

A project design basis document was produced as part of the study and is meant to outline the key design parameters for the project. A copy of this final document is included in the Appendix.

Two of the major key design factors for the environmental equipment sizing for the project are:

- The design fuel basis and the maximum fuel firing rate for the units at 100% MCR.
- The emissions limits as outlined in the Newfoundland and Labrador Regulation 39/04 – Air Pollution Control Regulations, 2004 under the Environmental Protection Act (O.C. 2004-232).

The first will determine the maximum particulate and SO_2 emissions that can be expected to be generated by the units. The second determines the amount of removal that will be required to satisfy the environmental requirements. These two factors are the main driving force in determining the size of the environmental equipment. In this case, a typical 2% sulphur fuel was selected as the design fuel for the study. A typical fuel specification was provided by Newfoundland and Labrador Hydro which is included in the design basis found in the Appendix. The sulphur content of this fuel formed the basis of design for the FGD system. The corresponding ash content formed the basis of design for the ESP's.

The regulation states that the best available control technology (BACT) shall be used when burning a fuel with this sulphur content. Therefore, BACT for the SO_2 control at a thermal generating station for units of this size is a wet limestone forced oxidation flue gas desulphurization system. A removal efficiency of 95%+ is typical for this technology.

For particulate capture, the dry electrostatic precipitator represents the BACT for removing particulate from flue gas from an oil fired thermal generating facility. Removal efficiencies of 95%+ can be expected for this type of technology.

The preliminary design is based on these two key sizing parameters and all of the required sub systems and infrastructure is based on supporting these design requirements.

3.0 Environmental/Waste Management

3.1 PARTICULATE AND SULPHUR DIOXIDE (SO_2)

As previously discussed, the Holyrood Generating Station currently burns heavy fuel oil (HFO) to generate electricity for the Province of Newfoundland and Labrador. The Holyrood Station consist of three (3) HFO fired boilers. Two (2) of the boiler units were built in the late 1960's and one (1) in the late 1970's. All three (3) boilers currently operate with limited environmental controls. The products of combustion, such as particulate and SO_2, are generated in the boiler's and are emitted directly to atmosphere through the station's existing stacks.

In recent years, environmental regulations have become increasingly more stringent in an effort to reduce and/or minimize the impacts on the environment. Emissions from the burning of fossil fuels are strictly regulated, monitored and enforced to ensure compliance with current standards and permits. Emissions of particulate, NO_x and SO_x have come under greater scrutiny by legislators. Emissions of mercury and even CO_2 have also become environmental issues in the new age of heightened environmental awareness and global warming.

In the Province of Newfoundland and Labrador, the government passed into law strict environmental regulations to limit source emissions from the burning of fossil fuels. The Newfoundland and Labrador Regulation 39/04, "Air Pollution Control Regulation 2004 under the Environmental Protection Act O.C. 2004-232" is the legislation governing emissions for the Province. This legislation, enacted in 2004, serves to govern the allowable emissions and provides penalties for exceedances and non-conformances.

In regards to the pollutants which are the focus of our study, particulate and SO_2, the legislation states the following key points which are extracted below:

> *6.(1) An Owner or operator who installs a new or modified emission source shall employ the best available control technology.*
>
> *7.(1) There is established provincial sulphur dioxide emissions cap which shall be 60,000 tonnes per calendar year.*
>
> *7.(3) The Owner or operator of a facility which releases in excess of 20 tonnes of sulphur dioxide per year in the aggregate, shall submit to the department an annual report on fuel usage, fuel sulphur content, fuel specific gravity and sulphur dioxide emissions, no later than February 28 of each subsequent year.*

9.(1) The Owner or operator of an emission source with a nameplate capacity greater than 100 GJ/hr, or with an annual particulate matter release greater than 100 tonnes shall determine the opacity of a visible emission on a continuous basis.

9.(4) An Owner operator shall not cause or permit to be caused a visible emission having an opacity greater than 20%.

9.(5) Notwithstanding subsection (4), a visible emission may have an opacity exceeding 20%, but not exceeding 25% for one 6 minute period in any one hour period.

9.(14) Commencing January 1, 2005 a person shall not burn, or permit the burning of any fuel, grade number 4, 5 or 6.

(a) where emission sources employ best available control technology.

(i) containing a sulphur content in excess of 3.0%; and

(ii) containing a sulphur content in excess of 2.0% on an annual basis, as calculated by the formula:

$$\frac{(SO_2)\,(100000)}{(1.9579)\,(V_t)}$$

Where:

SO_2 = *Sulphur dioxide emissions in tonnes*

V_t = *Volume of fuel in litres, and*

(b) Where emission sources do not employ best available control technology,

(i) containing a sulphur content in excess of 2.2%, and

(ii) containing a sulphur content in excess of 2.0% on an annual basis, as calculated by the formula:

$$\frac{\sum_{i=1}^{n}(Si)\,(Vi)}{\sum_{i=1}^{n}(Vi)}$$

where:

n	=	*Number of shipments during a calendar year*
Si	=	*Sulphur content of each shipment*
Vi	=	*Volume of each shipment*

In recent years, Newfoundland and Labrador Hydro's Holyrood Station decided to burn a lower sulphur fuel. This has allowed the station to comply with requirements of an emissions source without BACT 9.14(b) and also meet its allocated portion of the provincial SO_2 cap of 25,000 tonnes annually. Currently the plant burns a 1% sulphur fuel and is exploring potentially burning a lower sulphur fuel.

However, burning a low sulphur fuel comes with a penalty of higher fuel costs. The lower sulphur fuel results in an overall higher production cost for electricity and limits the operational flexibility of the station.

The station currently meets its sulphur and particulate emissions requirement without BACT but some excursions do occur which limits the operation of the station. The Holyrood station is subject to ground level concentrations and dispersion modelling. Five (5) gas constituents are monitored at six (6) ambient air monitoring sites and this data along with stack emissions data are used in dispersion modelling. This modelling is used to determine if the station is in or out of compliance which can occur during startup and soot blows. Any excursions are recordable and must be reported to the Newfoundland Department of the Environment. These events can sometimes limit the operation of the units.

Due to the age of the units and the current environmental climate, Newfoundland and Labrador Hydro is exploring a life extension upgrade of the station and installing environmental controls to reduce particulate and SO_2 emissions. This would allow the station to meet or exceed the requirements of the environmental regulations and meet its overall commitment to the environment. It would also provide the station with additional fuel flexibility as well as increased operational flexibility.

Newfoundland and Labrador Hydro identified electrostatic precipitators and wet limestone flue gas desulphurization systems as the BACT to control particulate and SO_2 emissions from an oil fired power plant. These technologies are mature and clearly the best and most reliable technology for this application.

These two technologies form the basis of this study. Also, both of these technologies have been designed and sized based on a 2% sulphur design fuel as previously outlined in the design basis.

Electrostatic precipitators (ESP's) negatively charge the ash particles and collect them on positively charged collecting plates. The plates are rapped and the ash is collected in hoppers where it is then transported to storage. ESP's have also been around for 30+ years or more and are the standard for collecting flyash from a power station's flue gas stream. ESP's have typical collection efficiencies of 95%+ on oil and 99%+ on a coal fired station. The lower collection efficiency on oil is mainly due to the fineness and resistivity of the oil flyash as compared to the larger flyash particles generated by the burning of coal. The ESP's proposed for the Holyrood Station are sized to remove 95%+ of the flyash from the flue gas stream.

Wet flue gas desulphurization systems (FGD) utilize a limestone reagent to capture and neutralize the SO_2 in the flue gas. FGD's have been around for 30+ years and have evolved to be the best and most efficient technology for removing SO_2 from the flue gas stream. Removal efficiencies of 90% are easily attainable and 95%+ removal guarantees are now the current standard. The FGD proposed for the Holyrood Station is based on removing 95%+ of the SO_2 from the flue gas stream.

Based on these requirements, Stantec prepared and issued a design basis document for both the ESP's and FGD system to The Babcock and Wilcox Company (B&W). B&W provided a preliminary equipment sizing and selection to suit these requirements. From this preliminary work, the emissions after the installation of the ESP's and FGD can be expected to be as follows:

Table 3.1: Total Expected Emissions

UNITS @ 100% MCR No. 6 Fuel Oil (2% Sulphur)									
	ESP Design Conditions (Kg/sec)						FGD Design Conditions (Kg/sec)		Emission Summary
	Unit #1		Unit #2		Unit #3		Units 1, 2 & 3 (Combined)		
Species	**In**	**Out**	**In**	**Out**	**In**	**Out**	**In**	**Out**	**% Change**
CO_2	38	38	38	38	30	30	106	107	+ 0.94%
O_2	6	6	6	6	4	4	16	16.9	+ 5.62 %
N_2	140	140	140	140	116	116	396	399	+ 0.75 %
H_2O	11	11	11	11	8	8	30	60	+ 100.0 %
SO_2	0.49	0.49	0.49	0.49	0.40	0.40	1.38	0.041	- 97.0 %
Flyash	0.081	0.0033	0.081	0.0033	0.069	0.0033	0.01	0.01	- 95.8 %
HCL	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0	- 100.0 %
Total	195.58	195.50	195.58	195.50	158.47	158.41	550	583	

UNITS @ 100% MCR No. 6 Fuel Oil (2% Sulphur)									
	ESP Design Conditions (Kg/sec)						FGD Design Conditions (Kg/sec)		Emission Summary
	Unit #1		Unit #2		Unit #3		Units 1, 2 & 3 (Combined)		
Species	In	Out	In	Out	In	Out	In	Out	% Change
SO_3 (ppmv)	18	18	18	18	18	18	18	12	
SO_3 (ppmv) (Note 1)	18	4	18	4	18	4	4	3	
TRONA (Kg/sec)	0.049	.0023	0.049	.0023	0.049	.0023	0.007	0.007	
Temperature (°C)	170	170	170	170	170	170	170	56	
Pressure (mmHg)	701	762	701	762	701	762	762	-	
Flow Rate(Nm^3/sec)	262	262	262	262	156	156	680	561	
Boiler Heat Input (MMBTU/Hr)	1684	1684	1641	1641	1428	1428	4753	4753	
Gross (MW)	175	175	175	175	150	150	500	500	

Notes: 1. Expected SO_3 emissions with TRONA injection installed for SO_3 control.

Fig. 3.1 Emissions Increase/Reductions Summary

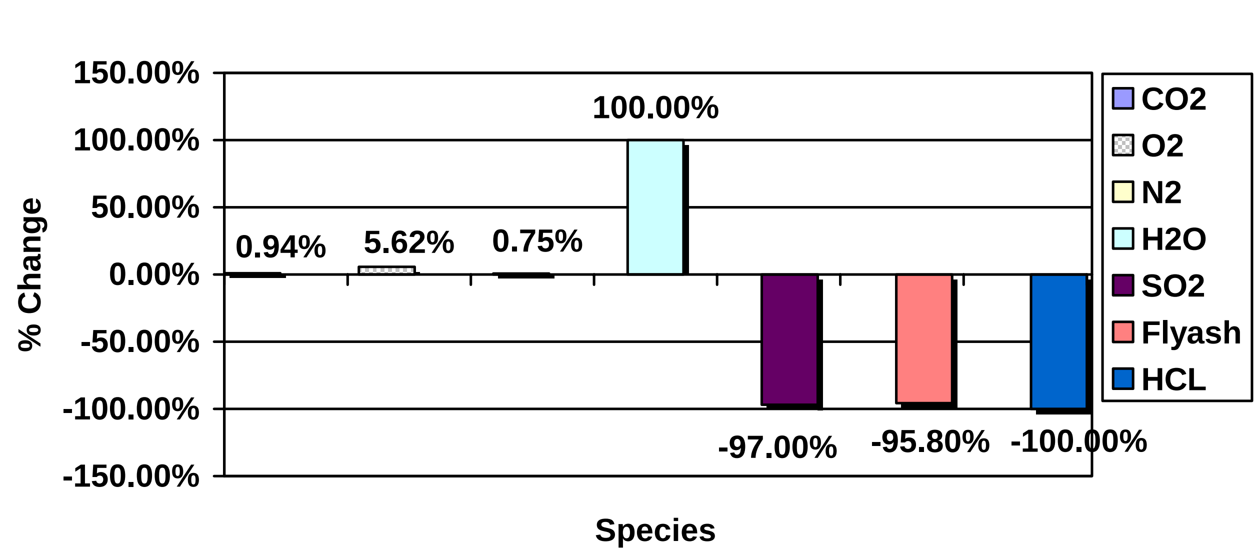


Figure 3.1 clearly indicates the key changes to the emissions at the station resulting from the installation of the individual precipitators and the FGD system. The electrostatic precipitators and the FGD system have both been designed as the BACT in accordance to the regulation of the Province of Newfoundland and Labrador. The installation of the ESP's will result in a 95.8% reduction of particulate emissions from the station at the design conditions. Similarly, we expect to achieve a 97% reduction in SO_2 emissions at the station from the installation of the FGD system. The figure also indicates a slight increase in CO_2 emissions. Water vapour emissions will increase significantly due to the saturation of the flue in the FGD system. The water vapour will manifest itself as a vapour plume from the new stack which will quickly dissipate and disappear. Other emissions shown are not harmful and are insignificant.

The addition of TRONA injection for SO_3 controls is also shown in Table 3.1. If required, TRONA injection will not impact the efficiency of the precipitators or result in any increase in the ESP outlet particulate levels. The ESP's will be designed to maintain the outlet emission levels should TRONA injection be added in the future.

The following table summarizes the annual emissions which are the focus of this study.

Table 3.2: Annual ESP/FGD Emissions Summary

Units @ 100% MCR No. 6 Fuel Oil (2% Sulphur)							
Species	**Emission Concentration**		**Mass Basis (kg/sec)**		**Annual (2) (Tonnes)**		
	In	**Out (1)**	**In**	**Out (1)**	**In**	**Out (1)**	**Removed**
SO_2	1254 ppmvd 957 ng/J	38 ppmvd 29 ng/J	1.38	0.041	26112	776	25336
Flyash	578 mg/Nm^3	24 mg/Nm^3	0.243	0.01	4598	189	4409

Note:
(1) Based on 95.8% removal efficiency for flyash and 97% removal efficiency for SO_2.
(2) Based on an annual plant capacity factor of 60%.

3.2 NO_X AND CO_2

The installation of the electrostatic precipitators and FGD system at the Holyrood Station will have no impact on NO_x emissions at the station. NO_x emissions are a function of the fuel combustion characteristics and boiler operation. NO_x emissions generated in the boiler will essentially remain the same through the precipitators and through the FGD. NO_x emissions will not increase or decrease with the addition of the proposed environmental equipment.

The addition of the FGD system will result in slight increase in the amount of CO_2 emitted from the station. The CO_2 is a result of the dissolution of the limestone in the absorber slurry and from the capture of the SO_2. The CO_2 occurs mostly from the uncontrolled reaction of $CaCO_3$ to $CaSO_3$ in the absorber tower which occurs during times of excessive limestone stoichiometry. In our case, the limestone stoichiometry will be controlled at about 1.03 thus limiting any excessive limestone in the system and keeping the formation of $CaSO_3$ under control. This limits the formation of CO_2. In our case, we can expect a 1 kg/sec increase in CO_2 emissions from the installation of the FGD system at the design gas flow rates. This results in an increase of approximately 19,000 Tonnes per year at the design case which represents less than a 1% increase.

3.3 SULPHUR TRIOXIDE (SO_3)

The following is a brief discussion on sulphur trioxide. Sulphur trioxide (SO_3) is a flue gas constituent that is produced when burning a fossil fuel which includes sulphur as one of its base properties. Sulphur trioxide is not a regulated pollutant nor does it have any harmful or adverse health effects at the expected levels at the Holyrood station. The discussion is provided for information only to make the reader aware of the potential effects on the plume visibility should SO_3 be present.

The burning of HFO results in the formation of SO_2 in the flue gas. The amount of SO_2 generated will be directly proportional to the level of sulphur present in the fuel. Additionally, the amount of SO_3 generated is a direct function of the amount of SO_2 present. Typically, a 1 to 2% conversion of SO_2 to SO_3 can be expected in the boiler. The presence of vanadium in the fuel increases this conversion rate as vanadium is a known catalyst for the formation of SO_3. The vanadium in the fuel exacerbates this conversion which is also dependent on the combustion process. As the gas cools, SO_3 will associate with water vapour to form H_2SO_4 vapour. At the exit of the FGD system, the flue gas is typically 100% saturated and the SO_3 is condensed to H_2SO_4 vapour. This condensed form of SO_3 can, in low concentrations, cause an increased level of plume visibility. Plume visibility is a complex phenomenon. Observer orientation, background sky conditions, meteorological conditions, concentration of aerosols and gases, aerosol size and process operating conditions are all potentially important factors. A typical FGD plume consisting of condensed water vapour will usually dissipate quickly and leave no visible trace. However, it is estimated that sulphur trioxide concentration as low as 5 ppm can lead to a visible plume under certain optical conditions. The FGD causes the SO_3 to condense to an H_2SO_4 aerosol mist with micron size particles in the visible spectrum range. Depending on the amount of SO_3 present this may result in a slight visible plume at the exit of the FGD stack once the condensed water vapour dissipates. This slight plume is not harmful in any way and its visibility will be dependant on the conditions indicated above.

At this preliminary stage of the project, it is important to recognize this phenomenon. Based on the design case, we are anticipating an FGD SO_3 outlet concentration of 12 ppmv. This concentration is quite low and is based on the design fuel case. Actual levels will be greatly dependant on the actual fuel burned in the boilers. The fuel sulphur content, the vanadium levels and the combustion process will all play a role in the final level of SO_3 generated in the flue gas. Therefore, the final plume condition will be very dependant on all of these factors and may not be a concern.

For NLH's information, the following techniques have been employed by the industry to control SO_3. These control techniques focus on controlling the formation of SO_3 in the boiler or by removing SO_3 from the flue gas. The following methods and technologies have been utilized and/or demonstrated to control the SO_3 concentration in the flue gas:

- Combustion process optimization to minimize the formation of SO_3. A small to medium reduction can be achieved with this approach.
- Sorbent injection into the ductwork prior to the precipitator to neutralize the SO_3. The SO_3 is then captured as a solid in the precipitator. Sorbents such as magnesium hydroxide and hydrated lime have been used with various success. These systems can produce a moderate reduction of SO_3 in the flue gas.
- The addition of a wet electrostatic precipitator (WESP) downstream of the FGD to capture the condensed SO_3 aerosol. WESP's were installed at the NB Power Coleson Cove Generating Station and are successfully controlling SO_3 aerosol mist emissions. WESP can achieve high reductions in SO_3 concentrations in the flue gas.

The above technologies have been installed or implemented at designated sites to control extremely high levels of SO_3 which would not be the case at Holyrood. These installations typically burn fuels with extremely high SO_2 and vanadium levels or have SCR's installed for NOx control. SCR's are a know catalyst for the formation of SO_3.

As previously discussed, SO_3 is not a regulated pollutant nor does it have any adverse health effects at low concentration's which is the case at Holyrood. Plume visibility is very dependent on a number of factors and will ultimately depend on the final amount of SO_3 generated and converted to an H_2SO_4 aerosol.

For Newfoundland and Labrador Hydro's information, we have included an order of magnitude optional cost for Newfoundland and Labrador Hydro as an indication of the magnitude of the costs that would be involved with the implementation of the technologies mentioned above.

3.4 WASTE MANAGEMENT

3.4.1 By-Products

The installation of electrostatic precipitators and an FGD system at the Holyrood Generating Station will result in additional waste or by-products being generated at the site.

The dry electrostatic precipitators will collect flyash from the flue gas streams from all three units. The flyash will be collected in the electrostatic precipitator hoppers where it will be transferred by a dense phase transport system to a flyash treatment facility. Here, the flyash will be conditioned with water and transferred to a truck for landfilling.

The flue gas desulphurization system utilizes limestone in slurry form to react and capture sulphur dioxide (SO_2) from the flue gas stream. The calcium carbonate ($CaCO_3$) in the limestone reacts with the SO_2 to form calcium sulphite ($CaSO_3$) in the FGD absorber tower. The calcium sulphite ($CaSO_3$) is oxidized in-situ and forms calcium sulphate ($CaSO_4$), more commonly known as synthetic gypsum. This synthetic gypsum is removed from the process by dewatering a blowdown stream from the FGD system. The dewatered gypsum, with a moisture content of less than 10%, is transferred by conveyor to a short term storage building. At this stage, it is transferred to a truck to be either sold to the wallboard industry or sent to landfill for long term storage.

Another waste stream generated by the FGD system is a blowdown water stream. To control the build-up of chlorides in the FGD process, a small continuous blowdown water flow is required. The FGD reactions and materials are designed for a maximum chloride concentration. Chlorides in the fuel, limestone and the makeup water, if uncontrolled, can build up in the FGD to unacceptable levels. Chloride concentrations of less than 10,000 ppm are typically desirable in FGD applications. The blowdown stream will be sent to the FGD WWT plant where it can be treated and neutralized.

The following table outlines the quantity of waste products that can be anticipated by the installation of electrostatic precipitators and the FGD system at the Holyrood Generating Station.

Table 3.3: Waste By-Products

	Waste Products		
	Flyash	**Gypsum**	**FGD Blowdown Water**
Hourly Basis @ 100% MCR (3 units)	850 kg/hr	14,800 kg/hr	2268 L/hr (0.63 L/s)
Weekly Basis @ 100% MCR (3 units)	143 tonnes	2500 tonnes	381,000 Litres
Annual Production(1)	4400 tonnes	78,000 tonnes	12.0 x 10^6 Litres
Note: (1) Based on 60% Annual Plant Capacity Factor.			

3.4.2 Waste Disposal Landfill

To accommodate these additional solid waste by-products, a new landfill site will need to be developed. This landfill will need to be designed in accordance with current environmental standards. Leachate from the landfill will need to be collected and treated accordingly. It is anticipated that the new landfill will be located near the existing guardhouse on the plant property.

It is recommended that separate landfills be constructed for landfilling ash and gypsum. These landfill sites will need to be equipped with separate independent leachate collection systems. The existing WWT plant solids could be disposed of with the flyash. Leachate from the landfills would be collected in a surge pond which would be constructed near the landfills. The surge pond would act as a buffer during times of heavy rain events. Leachate from the surge pond would be routed to the existing WWT plant. A preliminary review of the existing WWT plant indicates that there would be sufficient capacity to treat the leachate from the new collection pond. The surge pond would assure a gradual and controlled bleed of leachate to the existing WWT plant. The operation of the existing WWT plant will not be impacted by the additional leachate from the surge pond. The operation of the existing WWT will remain the same and no new chemicals or process changes will be required.

It is recommended that the landfill system for both gypsum and flyash be constructed in two to five year cells. At the end of cell life, the cell is capped to prevent leachate generation. On plant closure, recapping will eliminate the need for leachate collection and treatment on a continuous basis. Use of monitoring wells around the perimeter of the cells is also recommended.

Based on the amount of gypsum and ash generated by the installation of the ESP's and FGD, we estimate that a five year cell for the gypsum will require an area of approximately 200m x 200m based on a 10m pile height. The five year cell for the ash disposal will require approximately 40m x 40m based on a 10m pile height. Based on this space requirement Newfoundland and Labrador Hydro will need to assess whether the planned location of the new landfill will provide sufficient space for the construction of the required landfill. An alternate site may be required.

As previously stated, the landfill would presumably be located near the entrance to the facility. Strategic placement of a berm or plants and trees can shield the landfill from view at the entrance to the station. Stantec does not expect any fugitive dusting issues from the landfilling of gypsum or flyash.

A properly designed and maintained landfill will provide years of reliable service and result in no long term impacts to the station or the environment. Off site storage would require a similar landfill construction unless the by-products are sold for further processing.

The opinion of probable cost includes an allowance for the development of a new landfill for the project.

4.0 Civil Requirements

4.1 SITE LAYOUT AND MODIFICATIONS

4.1.1 General

The new precipitators and FGD system, and associated systems and equipment, will be located on the existing Holyrood site to the East of existing Unit 3.

Modifications to the site will be required for both the installation of new equipment and associated systems, and for construction services.

4.1.2 Modifications to the Site

The site, to the east of the Unit 3, will be graded, and access roads and areas for both construction trade trailers and construction offices will be constructed. This includes the relocation and installation of buried services and utilities.

A fence system will be installed along the south side of the plant access road to separate the construction site from the operating plant.

A construction guard house will be constructed on the north side of the plant access road just inside the existing plant gate.

A fenced construction parking area will be constructed on the south side of the plant access road just inside the existing plant gate. This area will be used in the future for a landfill site.

A fenced construction laydown area will be constructed to the south of the plant access road just west of the oil tank farm/wharf access road.

The following buildings and structures will be demolished to make way for the new construction:

.1 Chemical Storage Building
.2 Storage Buildings
.3 Sewage Treatment Plant

The eastern storage building will be retained as a construction stores building. Once construction is complete this building will be demolished.

A Pipe, Meter Shop and Warehouse will be constructed on the north side of the main plant access road just to the north if the switchyard.

A Chemical Storage Building will be constructed to the east of the new Pipe, Meter Shop and Warehouse.

A sewage treatment plant will be constructed to the north of the existing sewage treatment plant.

4.1.3 New Equipment and Systems

The main systems are as follows:

.1 Breeching from the Existing Chimney Inlets to the New Precipitators

The breeching, consisting of two trains per unit, will be located to the north of the existing units. This area is very congested, by both buried services and utilities, and is also the main plant access to the north of the existing units. Design of the breeching trains and associated support structures will take into account the site limitations in this area.

2. Precipitators

The precipitators, one per unit, will be located to the east of existing Unit 3 Boiler House at its northern end. The unit precipitators will be located side by side in an east-west orientation, with the gas paths for each precipitator running in a north south direction.

3. ID Fan Building and Electrical Rooms

The ID Fan Building will be located to the south of the precipitators. The ID Fan Building will house six ID fans, two for each unit. Two electrical rooms will be located above the fans.

4. Breeching from the ID Fan Building to the FGD Building

The breeching, consisting of one train per unit, will run from the ID fan Building to the FGD Building. The elevation of the breeching trains and support structures will provide a minimum 20 foot clearance above the access road. A common plenum will be constructed prior to the absorber tower inlet. Individual unit bypass ducts will be provided. The bypass ducts will tie into to the unit breeching just before the common plenum. The bypass ducts will tie in to the absorber outlet duct.

.5 FGD Building

The FGD Building will be located to the east of the precipitators. The FGD Building will house: 1) the FGD system, including absorber tower and recirculation pumps, 2) the limestone receiving and grinding system, and 3) the gypsum dewatering system.

An auxiliary storage tank will be located to the east of the FGD building.

.6 FGD Chimney

A reinforced concrete chimney will be located on the north side of the FGD Building.

.7 Flyash Facility

The Flyash Facility will be located at the northwest corner of the FGD Building, adjacent to the unit precipitators.

.8 Gypsum Storage Building

The Gypsum Storage Building will be located to the east of the FGD Building. Gypsum will be conveyed from the FGD Building to the Gypsum Storage Building.

.9 Limestone Receiving Building

The Limestone Receiving Building will be located to the east of the FGD Building. The enclosed building, with a truck door located on the south side, will contain a receiving hopper complete with a grizzly and a conveying system. Limestone will be delivered via an access ramp to the receiving hopper by truck or loader. Limestone will be conveyed to the limestone silos located within the FGD Building. Limestone dead storage will be located southeast of the building.

.9 Unit 3 Electrical Room Extension - Station Service Distribution (SSD) Building

The Unit 3 Electrical Room will be extended to the east to provide room for the new electrical equipment. This building will house the new station service distribution equipment and the VFD drives for the new ID Fans.

.10 Truck Scale

The truck scale will be located at the east side of the site adjacent to the main plant access road.

11. Utilidors

Underground utilidors will be constructed for electrical distribution. The utilidors will be run from the Unit 3 Electrical Building extension (SSD) to the ID Fan Building, along the south side of the ID Fan Building, and from the ID Fan Building to the FGD Building.

4.2 DESIGN CRITERIA

4.2.1 Codes and Standards

Buildings and structures will be designed to the following codes:

.1 National Building Code of Canada (NBCC) 2005 edition, except means of egress shall comply with NFPA 101, Life Safety Code.

.2 National Fire Code of Canada (NFCC), 2005 edition.

.3 National Fire Protection Association (NFPA), 101, Life Safety Code 2006 edition.

The Holyrood Generating Station, in accordance with the NBCC 2005, is assigned a post-disaster importance category. This importance category applies to all load conditions.

4.2.2 Climatic Conditions

Climatic and seismic information will be as indicated in Appendix C "Climatic and Seismic Information for Building Design in Canada" of the NBCC 2005 and are as noted hereafter.

Design Element	Design Value
Design Temperatures:	
January 2.5%:	6.8°F (-14°C)
January 1%:	3.2°F (-16°C)
July 2.5% Dry:	75.2°F (24°C)
July 2.5% Wet:	68°F (20°C)
Degree Days Below 18°C:	4800
15 Minute Rain:	0.71 in. (18 mm)
One Day Rain:	4.65 in. (118 mm)
Moist Index:	1.41
Driving Rain Wind Pressure (1/5):	8.35 psf (400P)
Ground Snow Load, Snow Component, Ss (1/50):	60.6 psf (2.9 kPa)
Ground Snow Load, Rain Component, Sr (1/50):	14.6 psf (0.7 kPa)
Ice Accretion Load:	½ inch (12 mm) based on Figure A3.1.4 "Ice Accretion" of CAN/CSA S6-06 "Canadian Highway Bridge Design Code".

Design Element		Design Value
Hourly Wind Pressure (1/50):		16.7 psf (0.80 kPa)
Seismic Data:	Sa(0.2)	0.18
	Sa(0.5)	0.11
	Sa(1.0)	0.060
	Sa(2.0)	0.016
	PGA	0.090

4.2.3 Loads and Load Combinations

.1 Dead Loads

The dead loads will be determined according to Subsection 4.1.4 “Dead Loads” of the NBCC 2005. Dead loads shall include the self-weight of the buildings and structures, and the materials of construction permanently fastened thereto or supported thereby.

.2 Live Loads

Minimum live loads will be determined according to Subsection 4.1.5 “Live Loads Due to Use and Occupancy” of the NBCC 2005.

Slabs-on-grade: 800 psf

Grated Floors, Platforms and Walkways: 100 psf

Stairs: 100 psf

Elevated Concrete Floors : 200 psf

Electrical Rooms: 400 psf

Piping and Electrical Utility Loads: 30 psf

Additionally, all beams will be designed for a miscellaneous concentrated load of 2 kips, all girders 5 kips, and all columns 25 kips. The miscellaneous concentrated loads will not be carried as reactions to the supporting beams and columns.

.3 Operating and Excursion Pressures

Where pressure loads can occur due to operation of the system fans, the breeching will be designed for the fan operating pressure and excursion pressures equal to +/-35 inches w.g. Pressures will be considered as a sustained live load.

4 Ash Loads

Where ash loads can occur, breeching will be design for a load equivalent to 2 feet of ash. For load combinations, ash load will be considered a live load, except for seismic load calculations where the ash load will be included in the weight.

.5 Thermal Loads

Thermal loads due to temperature will be based on the thermal climatic design information for St. John's, NL as published in the NBCC 2005.

For breeching and breeching support steel design, the structures will be designed for the operating and excursion temperatures.

.6 Friction Loads

Breeching and breeching support steel will be designed to resist the friction loads caused by thermal movement of the breeching.

.7 Snow and Rain Loads

Snow and rain loads will be determined according to Subsection 4.1.6 "Loads Due to Snow and Rain" of the NBCC 2005.

.8 Ice Accretion Loads

Where structures allow the accretion of ice, ice accretion loads will be determined in accordance with Subsection 3.12.6 "Ice Accretion" of CAN/CSA-S6-06 "Canadian Highway Bridge Design Code". A unit weight of 62.4 lbs/ft^3 (9.8 kN/m^3) shall be used in calculating ice accretion loads.

.9 Wind Loads

The wind loads will be based on the NBCC 2005 1/50 Hourly Wind Pressure using the exposure factor, Ce, for open terrain.

.10 Seismic Loads

Seismic loads will be based on the NBCC 2005 Section 4.1.8 "Earthquake Load and Effects".

.11 Load Combinations

Load combinations will be in accordance with NBCC 2005 Clause 4.1.3.2 "Strength and Stability" modified to suit the loads above.

4.3 SOILS AND FOUNDATIONS

4.3.1 General

No geotechnical data was available for the study phase. As directed by Newfoundland and Labrador Hydro the geotechnical conditions were assumed to be similar to those of the Unit 2 Boiler Building.

Grade was assumed to be El. +11 feet and bedrock was assumed to be El. +2 feet. The bedrock was assumed to have an allowable bearing pressure of 20,000 psf.

4.3.2 Breeching Foundations – Existing Chimney Inlets to the Precipitators

Due to the existence of numerous buried services in this area the foundation system will consist of reinforced concrete pile caps supported on drilled in place reinforced concrete mini-piles having an allowance capacity of 200 kips, tension or compression. The mini-piles will develop their load capacity from bond between the pile shaft and bedrock. For the study purposes, the mini-piles were assumed to be 30 feet in length of which 15 feet is embedded in the bedrock.

The pile caps will be insulated as required to prevent frost damage.

4.3.3 Precipitator Foundations

The precipitator foundations will be a reinforced concrete mat type foundations founded on either bedrock or on lean concrete founded on bedrock.

The exterior building foundations will consist of reinforced concrete piers and grade walls.

The interior of the building will consist of a slab-on-grade.

Fill material between the mat foundation and slab-on-grade will be compacted engineered fill.

4.3.4 ID Fans and ID Fans Building Foundations

The ID Fans foundations will be individual reinforced concrete foundations founded on either bedrock or on lean concrete founded on bedrock.

The ID Fan building foundations will consist of reinforced concrete spread footings founded on either bedrock or on lean concrete founded on bedrock, and reinforced concrete piers and grade walls.

Fill material between the mat foundation and slab-on-grade will be compacted engineered fill.

A utilidor will run along the south side of the ID Fan Building.

4.3.5 Breeching Foundations – ID Fan Building to the FGD Building

The breeching foundations will be individual reinforced concrete foundations founded on either bedrock or on lean concrete founded on bedrock.

4.3.6 FGD Building Foundations

The FGD Building foundations will consist of reinforced concrete spread footings founded on either bedrock or on lean concrete founded on bedrock, and reinforced concrete piers and grade walls.

Fill material between the mat foundation and slab-on-grade will be compacted engineered fill.

Major equipment, including the Absorber Tower, Recirculation Pumps and Ball Mills, will be founded on individual reinforced concrete foundations founded on either bedrock or on lean concrete founded on bedrock.

Other equipment foundations, including tank foundations, will be reinforced concrete mat type foundations founded on the engineered fill.

4.3.7 FGD Chimney Foundation

The FGD Chimney foundation will be a reinforced concrete mat type foundation founded on bedrock. A reinforced concrete ring wall would extend from the mat foundation to the underside of the reinforced concrete chimney windshield.

Rock anchors will be employed to ensure the foundation is in positive contact with the bedrock for all load cases.

The core of the ring wall will be backfilled with compacted engineered fill. A reinforced concrete slab-on-grade would cap the inner ring.

4.3.8 Limestone and Gypsum Conveyor Foundations

The Limestone and Gypsum Conveyor foundations will be reinforced concrete spread footings founded on bedrock.

4.3.9 Limestone Receiving Structure Foundation

The Limestone Receiving Structure will be a reinforced concrete mat type foundation founded on bedrock. The foundation will be a basement type structure allowing the receiving hopper and conveying system to be below grade. The foundation will be waterproofed as required.

4.3.10 Gypsum Storage Building

The Gypsum Storage Building foundation will be a reinforced concrete mat type foundation founded on engineered fill. The engineered fill will extend down to bedrock.

The foundation will have perimeter push walls and reinforced concrete piers to support the building superstructure.

4.3.11 Unit 3 Electrical Room Extension (SSD Building)

The Unit 3 Electrical Room Extension (SSD) foundations will consist of reinforced concrete spread footings founded on either bedrock or on lean concrete founded on bedrock, and reinforced concrete piers and grade walls.

Fill material between the bedrock and the slab-on-grade will be compacted engineered fill.

4.3.12 Utilidors

Underground utilidors will be provided between the Unit 3 Electrical Room Extension (SSD) and the ID Fan Building, along the south side of the ID Fan Building, and between the ID Fan Building and the FGD Building.

The utilidors would be reinforced concrete rigid box construction and would be waterproofed as required.

4.4 BREECHING AND BREECHING SUPPORT STRUCTURES

Breeching will be designed to resist dead load, operating and excursion pressures, operating and excursion temperatures, ash load, live load, snow load, friction loads, wind loads, and seismic loads.

Breeching sidewalls will be ¼ inch plate with channel or angle stiffeners as required. The breeching would be insulated and would have embossed aluminium exterior lagging on all surfaces.

Expansion joints will be provided where necessary.

Walkway access will be provided along one side of each breeching run.

Breeching support structures will be fabricated from structure steel and where possible would consist of concentrically braced frames.

Access to the breeching will be by stair towers and ladders.

Primary structural steel will receive one coat of inorganic zinc primer and one topcoat.

4.5 STRUCTURAL STEEL

Structural steel for buildings and other structures will be fabricated from structural steel conforming to CSA G40.21 Grade 350W, ASTM A992 and ASTM A572 Grade 50.

Framing, where possible, will consist of concentrically braced frames.

The structural steel framing system will be designed to resist the imposed loads.

Grating will be galvanized welded bar grating. For exterior applications the grating will be serrated.

Handrail will be fabricated from round HSS sections.

Primary structural steel will receive one coat of inorganic zinc primer. For exterior applications a top coat will be applied.

4.6 BUILDING AND BUILDING FINISHES

4.6.1 Roofing System

The roofing system for the various buildings will be a two-ply insulated modified bitumen on steel roof deck. The roofing system will consist of 5/8 inch fire-resistant gypsum board mechanically fastened to the steel roof deck, followed by a two-ply vapour barrier, 2 inches (minimum) of insulation, and a two ply modified bitumen membrane. The top sheet will be torch applied.

The roofing system will be designed and specified to meet the requirements of FM Global 1-28 “Design Wind Loads” and 1-29 “Roof Deck Securement and Above-Deck Roof Components”. Winds affects as dictated by the NBCC 2005 will also be considered.

The roof systems will be sloped (1:48) to the roof drain system by means of either sloping the roof deck or sloped insulation. Primary drainage will be by roof drains. Secondary drainage will be by scuppers through the roof edge parapets.

4.6.2 Wall Cladding

The wall systems for the various building will consist of a double skin insulated wall cladding system supported by a structural steel girt system. The cladding system will be designed to meet the requirements of FM Global 1-28 “Design Wind Loads”. Wind affects dictated by the NBCC 2005 will also be considered.

The double skin insulated wall cladding system will consist of the following:

.1 Exterior sheet having a minimum base metal thickness of 22 gauge (0.030 inch), and having a 12 mil thick Barrier Series finish on the exterior side and a 8 mil thick Barrier Series finish on the interior side.

.2 Galvanized sub-girts having a minimum nominal thickness of 18 gauge (0.048 inch).

.3 Two inches of semi-rigid inorganic glass fibre insulation.

.4 Interior liner sheet having a minimum base metal thickness of 22 gauge (0.030 inch), and having an 8 mil thick Barrier Series on both sides.

4.6.3 Slabs-On-Grade

Slabs-on-grade will be constructed of reinforced concrete and will be sloped to floor trenches and/or sumps as required. Slab-on grade will contain a surface hardener.

4.6.4 Elevated Slabs

Elevated slabs will be reinforced concrete slabs cast on steel deck. The steel deck will act only as formwork. Slabs will be designed to resist the loads specified.

The slabs will be sloped to floor drains as required.

Floor slabs of electrical rooms will be painted to minimize dusting.

4.6.5 Masonry

Reinforced masonry construction will be used in the following locations:

.1 Interior walls of Electrical Rooms

.2 Elevator shaft

.3 Stairwells as required by code

4.7 FGD CHIMNEY

The FGD Chimney used for the purpose of this study is approximately 400 feet in height consisting of a 23 foot diameter flue and a 50 foot diameter windshield. The height of the chimney was not determined using a flue gas dispersion model study, but was dictated by the following criteria to ensure acceptable flue gas flow characteristics at the testing and monitoring ports locations. The monitoring and sampling ports were located approximately ten flue diameters above the top of the chimney inlet flue and approximately two flue diameters below the top of the flue. A flue gas dispersion model should be carried out before finalizing the exact chimney height.

The chimney will consist of a reinforced concrete windshield complete with one carbon steel flue lined with the Pennguard flue lining system consisting of an inorganic borosilicate glass block and an adhesive membrane, C276 stainless steel breeching, gas mixing chamber and ash hopper.

The stack extension above the chimney roof will be clad in C276 stainless steel.

The chimney roof will be reinforced concrete with a two-ply modified bitumen roofing system. The chimney will have roof drains and down comer to grade.

The windshield will extend above the roof to act as a parapet.

Effluent collected in the thimble will be drained via RFP piping to the FGD system.

The chimney will also have instrumentation and monitoring sleeves, aircraft warning lights, CEMS system, access ladders and platforms a man lift from grade to the monitoring level.

During the study phase pricing information for the chimney was obtained from Hamon Custodis-Cottrell Canada, Inc. The pricing information is included in the Appendix.

5.0 Mechanical Requirements

5.1 GENERAL

The following sections will provide an overall description of the major mechanical systems that will be installed as part of the project. It will also provide a description of the existing plant mechanical systems that will require modifications. The mechanical systems that will be discussed include the following:

- Boiler Modifications
- Electrostatic Precipitators (ESP's)
- Flue Gas Desulphurization (FGD)
- Induced Draft (ID) Fans
- Ash Handling System
- Waste Water Treatment
- Balance of Plant System

The description of the systems is intended to be general in nature and include a discussion on the major systems. The information should provide the reader with a good understanding of the scope of the work and of the basis of the opinion of probable cost.

5.2 BOILER MODIFICATIONS

The addition of the electrostatic precipitators and FGD system will add significant pressure drop to the existing boiler draft systems. It is estimated that an additional 2.5 kPa (10" w.g.) of pressure drop will be generated with the addition of the electrostatic precipitators, ductwork and FGD system.

The Holyrood boilers were designed as pressurized boilers and employ forced draft (FD) fans to generate the required boiler draft. A check of the FD fans indicated that these would not be sufficient to generate the additional pressure required to overcome the losses generated by the addition of the precipitators and FGD system.

It was decided that new induced draft (ID) fans would be installed as part of the project. The ID fans would be located on the downstream side of the electrostatic precipitators and be sized to overcome the pressure drop from the new equipment. It was also decided that the installation of the new ID fans would provide an opportune time to convert the boilers to balanced draft from forced draft. Balanced draft boilers would operate under a negative draft condition. This would result in a safer work environment as it would eliminate or minimize any flue gas excursions into the boiler houses.

Therefore, new ID fans have been sized to accommodate the pressure drop for the new equipment and the pressure drop to convert the existing boilers to balanced draft operation.

The installation of the new ID fans and the modification to the boiler drafts results in the boilers having to meet the structural requirements of the most recent edition of NFPA 85 Boiler and Combustion System Hazard Code.

NFPA 85 provides boiler structural design pressure requirements to guard against boiler catastrophic failure from over-pressurization and implosion pressures generated by the FD and ID fans. The NFPA code requirements have changed considerably from when the boilers would have been first built and installed. The existing boilers would have been grandfathered to the old code requirement, but the new codes would apply with the new draft requirements. In this case NFPA 85 Section 4.6.1 Structural Design states:

4.6.1 *Structural Design*

The furnace shall be capable of withstanding a transient design pressure without permanent deformation due to yield or buckling of any support member.

4.6.1.1 *Positive Transient Design Pressure*

For all boiler other than fluidized-bed boilers, the positive transient design pressure shall be at least, but shall not be required to exceed, +8.7 kpa (+35 in. of water).

4.6.1.1.1 *For fluidized-bed boilers, the requirement of 7.4.1.1 shall apply.*

4.6.1.1.2 *For all boilers other than fluidized-bed boilers, if the test block capability of the forced draft fan at ambient temperature is less positive than +8.7 kpa (+35 in. of water), the positive transient design pressure shall be at least, but shall not be required to exceed, the test block capability of the forced draft fan.*

4.6.1.2 *Negative Transient Design Pressure*

4.6.1.2.1 The negative transient design pressure shall be as negative as, but shall not be required to be more negative than -8.7 kpa (-35 in. of water).

4.6.1.2.2 If the test block capability of the induced draft fan at ambient temperature is less negative than -8.7 kpa (-35 in. of water), for example, -6.72 kpa (-27 in. of water), the negative transient design pressure shall be at least as negative as, but not be required to be more negative than, the test block capability of the induced draft fan.

The existing FD fan test block is greater than 8.7 kPa (+35 in. of water) of water and the new ID fan test block will also be close if not larger than -8.7 kPa (-35 in. of water). Therefore, based on these conditions, B&W conducted a structural review of both the B&W and CE boilers in order to satisfy the code requirement of +8.7 kPa/-8.7 kPa (+35 in. of water/-35 in. of water). B&W's report on these findings is provided in the Appendix of this report.

In general, B&W has determined that both the B&W boiler (Unit #3) and the CE boilers (Unit #1 and #2) will need to be structurally reinforced to meet these transient pressure requirements. Additional buckstay reinforcing will be required to satisfy the new design conditions.

The B&W reports included in the Appendix, provide a detailed description of the proposed upgrades. The reports also provide a budgetary opinion of probable cost for these upgrades. Stantec has carried these costs in the main opinion of probable cost. We have also included additional budget allowances to cover costs such as scaffolding, insulation and cladding which were not included in B&W's opinion of probable cost.

5.3 ELECTROSTATIC PRECIPITATORS

5.3.1 General

Three (3) new unitized electrostatic precipitators have been provided as part of the opinion of probable cost. Each precipitator is sized in accordance to the best available control technology (BACT) and to meet the requirements outlined by the Province of Newfoundland and Labrador. The precipitators have also been sized for the design fuel case and the boiler at 100% MCR. An allowance in the precipitator sizing has also been included should a sorbent injection system such as TRONA be required prior to the precipitator to control SO_3. See Section 3.2 for further discussion on this subject.

5.3.2 Equipment Description

For the purpose of this study, all three (3) precipitators will be identical in size and configuration. The following equipment descriptions apply to all three precipitators.

In general, the precipitators will be designed and built with state-of-the-art technology. The ESP's for this project will benefit from many years of technology upgrades and refinements from previous installations. The precipitators use an extremely high voltage electric current to charge and collect the incoming dust particles. Transformer rectifiers and voltage controllers charge the rigid discharge electrodes (RDE). The RDE's are evenly distributed between vertically spaced collection plates. The RDE's charge the incoming particles which are immediately attracted and collected on the collector plates. Magnetic impulse rappers periodically "rap" the collection plates to remove the collected ash. The collected ash dislodges and falls into the collection hoppers where it is removed by the ash handling system.

The Holyrood precipitators have been designed with separate A and B sides complete with 6 TR sets (fields) per side for a total of 12 fields per precipitators. The B&W documentation included in the appendix indicates 9 fields per precipitator. This was subsequently changed to 12 fields to provide additional removal and redundancy. The B&W documentation has not been updated to reflect this change.

The precipitators will include, but not be limited to, the following major equipment:

- Precipitator casing and support frames.
- 12 TR sets and TR controllers.
- RDE's and collection plates.
- Ash hoppers and hopper heaters.
- Insulators and insulator compartment.
- Rappers and rapper controls.
- Weather enclosure.
- Inlet and outlet distribution plates.
- Precipitator controls.
- Insulation and cladding.
- Access stairs, walkways, handrail and ladders.
- Lighting, ventilation, fire alarm, etc.
- Heated insulator compartment.
- Purge air system and control.

Due to the congestion and limited space availability on the North end of the plant, all three new precipitators will be located on the East side of the plant. Breeching will be installed to transport the flue gas from all three boilers to their individual precipitators. The hopper area of the precipitators will be totally enclosed and house the ash transport system components. This area will be heated and ventilated accordingly. The precipitators will be complete with a weather enclosure which will house the TR sets and rapper systems. This area will be totally enclosed and protected from the elements. Access to the weather enclosure will be from individual stairs which will be provided with the precipitators. A walkway has been provided to walk from one weather enclosure to the other.

Separate A and B precipitator electrical rooms have been provided as part of the project. These two new electrical rooms will be located over top of the new ID Fan building and will house all of the electrical equipment required for the proper operation of the precipitators.

5.4 FLUE GAS DESULPHURIZATION

5.4.1 General

The FGD system for the Holyrood station is designed to remove sulphur dioxide (SO_2) from the combined flue gas flow from all three boiler units. The FGD system will have the capacity to remove 95% of the SO_2 in the flue gas when all three boiler units are running at 100% MCR and burning a 2% sulphur content fuel oil.

The FGD system will employ Best Available Control Technology (BACT) and be designed to maximize the removal of SO_2 from the flue gas. The FGD process selected for the Holyrood station is the Limestone Injection Forced Oxidation (LIFO) process. The LIFO process is a mature technology and is the industry standard for removing SO_2 from the flue gas when burning a high sulphur content fuel. Limestone is ground up and injected into an absorber tower as a slurry where it comes into contact with the flue gas. At this point, the calcium carbonate in the limestone reacts with the SO_2 to form calcium sulphite ($CaSO_3$). The calcium sulphite is collected in the absorber reaction tank where the crystals are allowed to grow and then it is oxidized to form calcium sulphate($CaSO_4$). The calcium sulphate, also known as synthetic gypsum, is dewatered and then landfilled or sold to the gypsum wallboard industry. The basic fundamental chemical equations can be represented as follows:

$$SO_{2(g)} + CaCO_{3(s)} \rightarrow CaSO_{3(s)} + CO_{2(g)}$$

$$CaSO_{3(s)} + \tfrac{1}{2}O_{2(g)} + 2H_2O_{(\ell)} \rightarrow CaSO_4 - 2H_2O_{(s)}$$

For the Holyrood project, a single common absorber tower will be used to capture the SO_2 from the flue gas from all three units. The FGD system will consist of three (3) major systems:

- Limestone Receiving, Storage and Preparation
- Absorber System
- Gypsum Dewatering System

5.4.2 Limestone Receiving, Storage and Preparation

5.4.2.1 General

Natural limestone is used as the reagent in the FGD process to capture and neutralize the SO_2 in the flue gas.

For the purpose of this opinion of probable cost it is assumed that limestone will be received at the station in the form of 3/4” minus aggregate.

Based on the SO_2 loading and the capture efficiency, approximately 8.1 tonnes/ hr of limestone will be required. This translates into an annual limestone requirement of approximately 42,500 tonnes based on a 60% plant capacity factor.

5.4.2.2 Limestone Receiving

For the purpose of this study, we have assumed that the limestone will be delivered to the station in dump style trucks from Cornerbrook, Newfoundland. A company from this area currently supplies limestone to NB Power for their Coleson Cove Generating Station. For this purpose, we have included for a limestone receiving facility which includes the following major components:

- Truck Weigh Scale
- Limestone Receiving Building c/w:
  - Limestone Receiving Hopper with Inlet Grizzly
  - Limestone Pan Feeder
  - Limestone Transport Conveyor System

The limestone weigh scale and receiving facility will be located on the east side of the site and include an area for dead pile storage. The intent is for trucks to dump limestone directly into the receiving hopper where the limestone can be hoisted directly to the day silos located inside the plant. Conversely, limestone can be reclaimed by front end loader from the dead storage pile and dumped into the receiving hopper. This method would be employed on the weekends or when truck deliveries to site have been reduced or interrupted such as during the spring road restrictions.

The limestone receiving and conveyor system would be designed such that the limestone day silos in the plant could be filled during a 4 to 5 hour time period on day shift.

During preliminary discussions with Newfoundland and Labrador Hydro, it was noted that the increased limestone truck traffic that would be required could potentially be an issue with the local community. Approximately 9 trucks per day would be required to meet the daily requirements at the design condition. This number is based on full load conditions and no hauling of limestone on the weekend.

Limestone Required @ Full Load:	8.1 MTPH
Daily Requirement (24 Hours):	194 MT
Weekly Requirement (7 days):	1360 MT
Daily Hauling Requirement @ 5 Days:	272 MT
Number of Trucks per Day (30 MT/Truck):	9 Trucks per Day

The impact of this traffic on the local community would need to be studied.

Although outside of the scope of this study, three alterative limestone receiving methods were identified. These include the following:

.1 Long Pond Wharf

Limestone would be unloaded by self unloading ship at the Long Pond Wharf. The limestone could then be trucked to the site through the community or by a new road that would need to be constructed on the former rail bed running along the coast to the station.

.2 Existing Fuel Unloading Wharf

Limestone could be unloaded at the station’s current fuel unloading wharf by self unloading ship. The limestone could be conveyed to shore and then either trucked or directly conveyed to the station.

.3 Ultramar Wharf

Located approximately 5 km from the station, this wharf could accommodate limestone self unloading ships. Here, the limestone could be trucked to the station through the community or by constructing a haul road on the former railway bed which runs along the coast to the station.

An additional study will be required by Newfoundland and Labrador Hydro to determine the best and most efficient method to bring limestone to the station should truck transport directly through the community not be acceptable.

For the purpose of this study, it is Stantec's opinion that landing the limestone at the station's existing unloading wharf would be the most viable and economical option for bringing limestone to the station and minimizing the impact on the community. This option is also favoured because it keeps all of the required upgrades and systems within the confines of the station's boundary and control. The other two options would require additional consultations and negotiations with various stake holders and agencies. Stantec envisions that the limestone would be unloaded at the existing fuel wharf by self unloading ship. A new limestone belt conveyor system would be installed at the wharf to bring the limestone from the ship to the shore. This conveying system would be installed on the existing wharf structures. We have assumed that the existing wharf structures would be suitable for the additional conveyor load. This would have to be confirmed during an additional study. The conveyor would be sized to match the unloading capabilities of the ship self unloading system. Once onto the shore, a new conveyor system would be installed along side the existing fuel unloading piping and bring the limestone directly onto the plant site. The limestone would then be stacked out near the new limestone receiving structure. Stantec has included a preliminary budget opinion of probable cost for this option as part of the overall project cost. An additionally study would be required by NLH to further develop the concept and firm up the cost of such a system.

5.4.2.3 Limestone Storage and Preparation

The limestone storage and preparation system is designed to store and process limestone at the required design rate. Raw limestone is metered from a storage silo into a wet ball mill system. The wet ball mill crushes the limestone aggregate by the tumbling action of steel balls. The crushed limestone in slurry form is pumped up to a classifier. Properly sized limestone is sent to the limestone slurry storage tank. Oversized limestone is sent back to the wet ball mill for further grinding. The ball mill system is sized to deliver 8.1 tonnes/hr of limestone at 95% passing through 325 mesh. Due to the abrasive nature of this process 2 x 100% ball mill trains are provided. Each ball mill system consists of the following major components:

- 1 - 24 hour limestone storage silo
- 1 limestone weigh feeder

- 1 wet ball mill system consisting of:
  - Ball mill and motor
  - Inching drive
  - Bearing lube system
  - Ball mill product tank and agitator
  - 2 x 100% ball mill product pumps
  - Ball mill classifier

The ground limestone slurry is then stored in a tank and then pumped to the absorber tower as required. This common system includes the following components:

- 1-12 hour limestone slurry tank and agitator.
- 2 x 100% limestone slurry pumps.

All of the limestone storage and preparation system will be enclosed in the main FGD Building. Items included in the building and as part of the balance of plant system include but is not limited to such items as:

- Access platforms and walkways for operation and maintenance
- Overhead crane for ball mill maintenance
- Monorails and hoists as required
- Building area sump and pumps
- Service water for make-up and washdowns
- Building heating and ventilation
- Lighting, receptacles, fire alarm
- Fire protection as required
- Mandoors and truck doors

5.4.3 Absorber System

The absorber system includes the main FGD absorber tower which is the primary piece of equipment used to capture the SO_2 from the flue gas. The absorber tower is sized to accept the flue gas flow from all three boiler units. Separate flue gas bypasses have been provided around the tower for each unit for boiler start ups and trips.

Flue gas enters the absorber tower where it is contacted by counter current sprays. The sprays saturate the flue gas and provide intimate liquid to gas contact to absorb and neutralize the SO_2. The clean gas flows up the tower where it passes through two sets of mist eliminators before exiting the tower and entering the stack. The captured SO_2 reacts with the limestone and falls into the absorber tower reaction tank. Here it is oxidized and becomes gypsum. The absorber pH, level and % solids are all controlled as part of the process. Limestone is added to the absorber to control pH, water make-up is added to the absorber to control level and the % solids is controlled by the blowdown to the gypsum dewatering system. All three control parameters will be dependant on the volume of gas flow (i.e. system load) and the % sulphur in the flue gas. Because of the corrosive nature of the process the absorber is constructed of Alloy 2205. Internals are Alloy 2205 or Fibreglass reinforced plastic (FRP).

The absorber system consists of the following major process equipment:

- Absorber Tower c/w:
  - Reaction Tank (26 hours)
  - Reaction Tank Agitators (4)
  - Four (4) Recycle Spray Levels
  - Two (2) Levels of Mist Eliminators
  - Absorber Tray
  - Four (4) - 33% Absorber Recycle Pumps
  - Two (2) - 100% Blowdown Pumps
  - Two (2) - 100% Oxidation Air Compressor Systems
  - Mist Eliminator Wash Tank and Pumps
  - One (1) - Absorber Outlet Damper c/w Seal Air

We have included for the complete absorber system and equipment to be enclosed in the main FGD Building. Items included in the building and as part of the balance of plant systems include such items as the following:

- Access Walkways and Platforms
- Two Main Access Stairways
- Building Elevator
- Monorails and Hoists
- Absorber Area Sump and Pumps
- Main Building Ventilation and Heating Systems
- Service and Instrument Air Systems

- Air Conditioned Electrical Rooms
- Fire Protection
- Service Water Make-up and Washdown
- Lighting, Receptacles, Fire Alarm
- Mandoors and Truck doors

5.4.4 Gypsum Dewatering System

The gypsum dewatering system serves to dewater the absorber reaction tank to maintain a set solids concentration. As SO_2 is absorbed the % solids will build up to a setpoint. Once this setpoint is reached the absorber blowdown pumps will pump some of the reaction tank slurry to the dewatering system where the gypsum will be removed.

When dewatering is required, the blowdown pumps will first pump the slurry to a set of primary hydroclones where centrifugal action will classify the slurry in accordance to particle size. Large particles will be sent to a second stage of dewatering. The smaller particles will be returned to the absorber reaction tank where they will continue to grow.

At the second stage of dewatering, the accepted particles from the hydroclones are collected in a filter feed tank. Here, the solids concentration is about 40% by weight. From the filter feed tank, the slurry is pumped to a vacuum drum filter to be further dewatered to about 90% solids. The dewatered gypsum is sent by conveyor to a small gypsum storage facility. The gypsum storage facility is sized for 3 days of gypsum storage at the design condition. The gypsum storage facility minimizes any fugitive dust emissions from the gypsum until it can be properly landfilled. All of the water collected during the dewatering stage is sent to the reclaim water tank for use as make-up water and for system flushes.

A small bleed stream is removed from the process water returning to the absorber. This blowdown is used to control the system chloride concentration. For the Holyrood FGD, we anticipate that approximately 0.63 L/s (10 USGPM) of blowdown will be required. This water will need to be treated in the FGD WWT plant located in the FGD Building.

The following major process equipment is provided as part of the gypsum dewatering system:

- One (1) Primary Dewatering Hydroclone
- One (1) Filter Feed Tank and Agitator
- Two (2) 100% Filter Feed Pumps

- Two (2) 100% Gypsum Vacuum Drum Filter System c/w:
    - Vacuum Drum Filter
    - Vacuum Pump
    - Cloth Wash Tank and Pump
    - Cake Wash Tank and Pump
    - Vacuum Receiver and Filtrate Pump
    - Vacuum Pump Silencer
- One (1) Reclaim Water Tank and Agitator
- Two (2) 100% Reclaim Water Pumps
- One (1) Auxiliary Hold Tank and Agitator
- Gypsum Collection and Transport Conveyors
- Gypsum Storage Facility (3 days)

The opinion of probable cost includes for the complete dewatering system and equipment to be enclosed in the main FGD Building. Items included as part of the building and as part of the balance of plant systems include such items as the following:

- Access Walkways and Platforms
- Access Stairs
- Monorails and Hoists
- Building Ventilation and Heating System
- Service and Instrument Air Systems
- Service Water Make-up and Washdown
- Fire Protection
- Lighting, Receptacles, Fire Alarm
- Mandoors and Truck Doors

5.5 INDUCED DRAFT FANS

New system Induced Draft (ID) fans have been included as part of the design. The new ID fans are required to overcome the pressure losses resulting from the addition of new electrostatic precipitators, ductwork and the FGD system. Also, as previously discussed in the boiler modification section, the new ID fans have been sized to accommodate the boiler conversion to balanced draft operation.

Two (2) new ID fans have been provided for each unit sized for half the total design gas flow from the unit at 100% MCR conditions. For this study, it was assumed that the ID fans would be identical for all three units.

The new ID fans will be double width double inlet centrifugal fans. The fans include bearing vibration and temperature instrumentation. A bearing lube skid is also provided with each fan. Variable Inlet Vanes (VIV's) and a Variable Frequency Drive (VFD) have been provided for each fan. This combination will provide the fans with a good range of control through all unit operating ranges and also provide for energy savings when the units are operating at part load.

The ID fans have been sized to overcome the existing pressure drop through the boiler and for the pressure drop associated with the new equipment. The design gas flow for the unit at 100% MCR was calculated. Additional margins of 20% for flow and 25% for static pressure were used in the preliminary selection of ID fans for the project. The following table outlines the design conditions for the ID fans for the project.

Table 5.1: ID Fans (100% MCR)

	Flow ACFM	Pressure (In. W.G.)	Temperature (F°)	Speed (RPM)	BHP
Test Block	358,000	34.69	375	1,185	2,490
100% MCR	284,000	27.75	350	1,006	1,544

Based on this preliminary sizing, the individual ID fan will require a 2,700 Hp motor. The Unit #3 ID fan would be run at a lower speed to accommodate the smaller gas flows. A smaller fan could be selected for Unit #3 if so desired.

Because of the change in static requirement, the FD fan will require some modifications. The pressure drop from the boiler to the existing stack previously handled by the FD fans will now be handled by the new ID fans. This will reduce the static pressure requirement on the FD fans by approximately 3.75 to 5 kPa (15 to 20 in. W.G.). Discussion with the original FD fan vendor indicated that there were two options available to reduce the pressure of the fans. The first was to use the fan's existing VIV's and throttle the fan to the new conditions. After review, it was decided that too much throttling would be required. This option would also waste a lot of fan power. The second and selected option is to replace the existing FD fan wheel with a smaller fan wheel. This would allow the fan to run in its optimal and efficient range. The smaller fan wheel would require less power at the revised design conditions. Stantec would expect an energy saving of approximately 450 kw per fan at the new FD fan operating conditions. The opinion of probable cost includes the cost of removing the existing FD fan wheels and replacing them with smaller fan wheels.

The ID fans for all three units will be housed in a new ID fan building which will be located south of the precipitators. The ID fan building will totally enclosed the new ID fans. The opinion of probable cost includes overhead truck doors at each fan for maintenance. Monorails have been provided for ID Fan motor maintenance. The ID Fan buildings will be ventilated to prevent heat build up. The VFD's for the ID Fans will be located in the new Station Service Distribution (SSD) building located next to the existing Unit #3 electrical room. A utilidor has been provided from the SSD building to the ID Fan building and from the ID Fan building to the FGD Building.

5.6 FLYASH HANDLING

Three (3) new electrostatic precipitators (ESP) will be installed as part of the project. The ESP's will remove flyash from the flue gas stream from all three boiler units at the Holyrood Station. The flyash will be collected in the heated hoppers of each individual precipitator.

Based on the capture efficiency of the precipitators, the design fuel and the overall plant capacity factor, it is anticipated that approximately 4400 tonnes/yr of flyash will be collected. This flyash will be transferred from the precipitators and conditioned by a new flyash handling system prior to being disposed in the landfill.

The flyash will be transferred from the precipitator hoppers using individual dense phase ash transport systems. Each flyash hopper is fitted with a pneumatic transport bottle. Flyash is introduced into the bottle. Compressed air charges the bottle until a set pressure. Once this pressure is achieved, an outlet valve opens and the flyash is transported pneumatically to the flyash storage silo. The dense phase flyash transport system includes, but is not limited to the following major equipment.

- 2 – 100% air compressors.
- Desiccant air dryer.
- Air receiver.
- Hopper transport bottles.
- Flyash piping, valves and instrumentation.
- Flyash piping heat tracing.

All of this equipment will be housed in the individual precipitator hopper enclosures. All of the flyash transport piping will be insulated and heat traced to prevent condensation.

The opinion of probable cost includes for a new flyash processing facility. This facility will condition the flyash to make it suitable for landfilling. Flyash is metered from the main storage silo into a conditioner where water is added. The conditioner thoroughly mixes the water and the flyash to a uniform consistency before discharging it to a truck and hauled to the landfill. The new flyash processing facility will be located next to the FGD building and will include the following major pieces.

- One (1) 3 day flyash storage silo.
- Silo outlet feeder.
- Flyash conditioner.
- Piping, valves and instrumentation.
- Chutes.

The flyash equipment will be completely enclosed in a heated flyash building. The flyash facility is designed as a drive-through facility, complete with overhead truck doors. Access is provided by an enclosed stairway to access the main conditioning floor and the top of the flyash silo.

Conditioning water and compressed air will be provided from the FGD building systems.

5.7 WASTEWATER TREATMENT PLANT

The installation of a Flue Gas Desulphurization System (FGD) at the Holyrood Station will result in additional waste water being generated. The FGD system will require a blowdown stream of approximately 0.63 L/s (10 USGPM). This blowdown stream is required to control the level of chlorides in the system to less than 10,000 ppm. Without blowdown, the level of chlorides would continue to build and cause severe process upsets and extensive corrosion of the system components.

Because of the high solids loading in the blowdown stream, it was decided to install a small wastewater treatment (WWT) plant at the FGD building instead of trying to upgrade the existing wastewater treatment plant. This would allow the existing WWT to continue to operate and avoid any disruptions during the course of the project.

Therefore, the FGD WWT plant is based solely on treating the required blowdown stream from the FGD process. The design of the FGD WWT plant is based on meeting the effluent quality requirements outlined in the Newfoundland and Labrador Regulation 65/03, “Environmental Control Water and Sewage Regulations under The Water Resources Act (2003)”.

All of the process equipment for the FGD WWT plant will be fully integrated with the FGD operation and be housed within the FGD building.

The treated wastewater from the FGD WWT plant will be discharged directly to the environment and the solids (mainly gypsum) will be returned to the filter feed tank to be dewatered along with the primary FGD gypsum by-product.

A complete description of the FGD WWT plant can be found in our sub-consultant's report included in the Appendix of this report.

5.8 BALANCE OF PLANT SYSTEMS

5.8.1 Compressed Air Systems

The compressed air required for the new equipment and system will be supplied by new compressed air systems. As previously discussed, compressed air will be required for the flyash transport systems. New unitized air compressors, dryers and receivers will be provided for this system. Compressed air requirements at the ID fan building, flyash treatment facility and at the FGD will be provided by a new instrument/service air system that will be installed as part of the FGD system. The current plant air system will not be impacted by the project.

5.8.2 Fire Protection

The opinion of probable cost includes for the fire protection systems that will be required at the FGD building, ID fan building and precipitators. Some of the existing yard piping will need to be relocated to avoid interferences with new roads and structures. A new fire loop and hydrants will be installed around the FGD building. The FGD building will be protected by a fire hose standpipe system and strategic sprinkler protection as required by the underwriter. The FGD inlet emergency quench system will also be fed from the fire system. The ID fan building and precipitators will also be protected with a standpipe system and strategic sprinklers as required. All of these systems will have separate zones on the existing station fire protection system.

The opinion of probable cost includes for installing a new fire line to the new warehouse/pipe shop/meter shop complex to be built in the location of the old guardhouse parking.

5.8.3 Raw Water Supply (FGD Makeup)

Raw water will be required in the FGD building for makeup water to the FGD process. The majority of the water will be required to offset the following losses:

- Quenching of the inlet flue gas.
- Water losses in the outgoing gypsum.

- FGD blowdown.
- Various tank makeup requirements.

Approximately 31.5 L/s (500 USGPM) of makeup water will be required by the FGD. As previously discussed, Newfoundland and Labrador Hydro will need to conduct a further evaluation of the existing raw water supply and its ability to meet this new requirement. This study will act to confirm the capacity of the existing system and its ability to satisfy the new water demand imposed by the addition of the FGD system. Should the existing raw water makeup system not be sufficient to meet the new demand conditions, Newfoundland and Labrador Hydro will need to conduct a further study to upgrade the existing raw water system. This additional study will need to investigate options to increase the raw water flow to the station which may include such options as:

- Increasing the dam height to increase the water storage capability of the system.
- Building more dams with fish ladders either upstream or downstream of the existing dam.
- Drilling additional wells on the site.
- Stream diversion.
- Tying into an existing additional raw water source nearby and running a new line into the site.

One obvious solution to the problem would be to use raw sea water as the makeup for the FGD system. Unfortunately, raw sea water cannot be used for FGD makeup as the level of chlorides in the seawater is too elevated. The high chloride content of the seawater would cause process chemistry upsets and the level of chlorides in the absorber tower would build up to an unacceptable level. Extremely high chlorides levels would result in extreme corrosion of all equipment in contact with the slurry. The chlorides levels could be controlled by increasing the amount of blowdown to the waste water treatment plant. Unfortunately, this would result in unacceptable volumes of blowdown that would require treatment. Even with the blowdown, the high chloride levels would create unacceptable FGD process chemistry which would be detrimental to the proper operation of the FGD system. The use of seawater as FGD makeup is not a viable option.

To minimize the makeup requirement we would expect to recycle the treated FGD blowdown water back into the FGD process. This is standard operating practice and we have done this in the past on other FGD systems. In our case, FGD blowdown is only 0.63 L/s (10 USGPM) which represents only a fraction of the makeup water demand.

For the purpose of this study, raw water to the FGD building will be supplied by a new 8” line to be connected directly to the relocated 16” diameter raw water line running on the North side of the FGD building. This new line will feed a new raw water tank in the FGD building. The tank will act as a buffer between the FGD system and the existing raw water intake system. This will ensure a smooth and continuous flow of water to the FGD system and avoid or eliminate any surges that could possibly impact the existing raw water system. Two (2) x 100% raw water pumps will supply raw water from this new tank to the FGD process. Water recirculation is provided to maintain a minimum flow on the pumps and maintain pressure in the system under variable demand conditions.

5.8.4 Heating, Ventilating and Air Conditioning (HVAC)

The opinion of probable cost includes an allowance for the HVAC requirements for the project.

.1 FGD Building

The FGD building opinion of probable cost includes the cost to provide the required HVAC systems. The main building will be heated and cooled by natural ventilation. The FGD absorber tower continually radiates heat into the building when it is in operation which is typically in the winter heating season when maximum power production is required. The absorber heats the surrounding air which rises to the top of the FGD building. Here, the building ventilation system will mix the hot air with outside air as required and distribute it throughout the building. In summer, the hot air can be simply exhausted outside by roof exhausters and fresh air brought in at ground level through louvers. The electrical rooms in the FGD building will be mechanically cooled to provide a controlled environment.

.2 ID Fan Building/ESP Electrical Rooms

The ID fan building will be cooled by natural ventilation by the strategic placement of roof ventilators and wall louvers. Mechanical cooling will be provided for the two ESP electrical rooms which are part of this building.

.3 Station Service Distribution Building (SSD)

The new electrical SSD building will be mechanically cooled to maintain a controlled environment. The main ID VFD drives will be located in this building along with the switchgear for a portion of equipment. Because of the heat generated and the criticality of this equipment, two (2) – 100% rooftop A/C units will be provided for this application. This will ensure that cooling is always available to this equipment to minimize any chance of a forced outage due to equipment overheating.

.4 Precipitators, Flyash Handling, Limestone Receiving and Gypsum Storage

The opinions of probable cost include for the natural ventilation of these buildings through strategic placement of rooftop exhaust fans, wall fans and wall louvers.

6.0 Electrical Requirements

6.1 GENERAL

The following sections will provide an overall description of the major electrical distribution system that will be installed to provide electrical power distribution for the new equipment for ID Fans, FGD and ESPs. The electrical distribution systems that will be discussed include the following:

- Station Service Transformers
- Medium Voltage Switchgear
- Low Voltage Switchgear
- Motor Control Centers

The electrical distribution system will provide an 'A' and 'B' distribution system for the FGD and a unitized 'A' and 'B' distribution system for the ESP and ID Fans. The distribution system and cabling system will be arranged and segregated to provide industry standard reliability and risk mitigation. The distribution system will incorporate modern industry standard relaying and protection system c/w communications which will be continuously monitored via the plant DCS. The system will be controlled and monitored via the plant DCS from the main control room. Refer to Drawing SK5702 for the proposed Single Line Diagram for the electrical distribution system.

The description of the systems is intended to be general in nature and include a discussion on the major systems. The information should provide the reader with a good understanding of the scope of the work and of the basis of the opinion of probable cost.

6.2 STATION SERVICES TRANSFORMERS

The addition of the ID Fans, FGD and the ESPs will add significantly to the station service load. As a result, new station service transformers TSSD-A and TSSD-B will be installed to service this load. These new transformers will be supplied from the 230kV switchyard and from new 230kV circuit breakers and associated disconnect switches via new 230kV cable which will be installed in cable tray in a separate 'A' and 'B' pre-cast concrete cable trenches c/w covers. These new station service transformers will feed new 4.16kV switchgear, 5kV-SSDA and 5kV-SSDB. The station service transformers have been sized so that either transformer could carry the entire load related to the new equipment for ID Fans, FGD and ESPs.

Station Service Transformers shall be as follows:

Rated MVA: 15/20
Primary Voltage: 230kV
Secondary Voltage: 4.16kV
Cooling: ONAN/ONAF
Type: 2 winding
Vector: Yy0d2
Impedance: STANDARD
On-load Tap Changer: +5% to -15%, 1.25% tap steps
Maximum temperature rise above 40°C:
 Liquid: 60°C
 Windings: 65°C

Full wave impulse withstand test:
 Primary winding: 1050kV
 Primary Bushing: 1300kV
 Secondary: 95kV

CTs:
 Primary: 3 sets, protection
 Secondary: 1 set, metering
 Neutral: 2 sets, protection

Neutral Resistance Ground

Rated Voltage: 2400V
Insulation Level: 9kV
Continuous Current: 1000A
Resistance: 2.4Ω
Temperature Rise: 385°C
Material: Stainless Steel

6.3 MEDIUM VOLTAGE SWITCHGEAR

The 4.16kV power will be distributed utilizing 5kV switchgear. New 5kV-SSDA and 5kV-SSDB switchgear will be installed on the ground floor of a new Station Service Distribution (SSD) Building. Refer to Drawing E-1202 for proposed electrical room layouts. The new 5kV-SSDA and 5kV-SSDB switchgear will be fed from the station service transformers via 5kV cable bus and will be installed in the new utilidor. In the event that TSSD-A or TSSD-B is taken out of service for maintenance or due to a failure, the kirk-key interlocked tie-breaker between 5kV-SSDA and 5kV-SSDB can be closed and both line-ups can be fed from a single station service transformer.

The 5kV-SSDA and 5kV-SSDB switchgear will supply power directly to the new Unit ID Fans VFDs which will be located on the air conditioned second floor of the new SSD electrical building. 'A' fans will be fed from 5kV-SSDA and 'B' fans will be fed from 5kV-SSDB. The Electrostatic precipitator 600V switchgear 600V-ESP-A and 600V-ESP-B will be fed from this switchgear via close coupled, dry type transformers. This switchgear will be located in the ESP electrical room area. Refer to Drawing E-1101 for proposed SSD and ESP electrical room layouts.

The FGD switchgear 5kV-FGD-A and 5kV-FGD-B will be installed in the FGD building electrical room at elevation 11'-6" and will be also fed from 5kV-SSDA and 5kV-SSDB via 5kV cable bus. All of the FGD related 4.16kV loads will be fed from this switchgear and will include:

- Ball Mills
- Absorber Recycle Pumps
- Oxidation Air Compressors
- Vacuum Pumps
- FGD 600V Switchgear 600V-FGD-A and 600V-FGD-B close coupled, dry type transformers.

Medium Voltage Switchgear shall be as follows:

5KV-SSDA, 5KV-SSDB

Metal clad, arc resistant indoor type, one breaker high construction with a top auxiliary section for relays, controls and metering c/w vacuum electrically-operated breakers, insulated busbars, anti-condensation heaters and remote racking.

Enclosure: Indoor
MVA Class: 500MVA
BIL: 95
Nominal Voltage: 4.16kV, 3 phase, 3 wire
Main Bus Rating: 3000A
Bus Plating: Silver
Ground Bus: 0.5 x 3" copper
Control Voltage: 125VDC

5KV-SSDA

1 x 3000A incoming breaker c/w
- 2 PTs
- 3 CTs, 4000:5, standard accuracy
- Schweitzer SEL-551 overcurrent and recloser relay
- Kirk key interlock
- Lock-Out relay
- Selector switch
- Control Switch
- Test Switch
- MOC and TOC switch
- 3 light LED assembly
- Schweitzer SEL-2020 communications module
- Solid-state meter c/w phase current displays, L-L and L-N voltages, power and energy, %THD.
- Fuse protection for control circuits.
- Terminal strips, mounting hardware, etc.

1 x 3000A tie breaker c/w
- 2 PTs
- 3 CTs, 4000:5, standard accuracy
- 2 x Kirk key interlock
- Schweitzer SEL-551 overcurrent and recloser relay
- Lock-Out relay
- Selector switch
- Control Switch
- Test Switch
- MOC and TOC switch
- 3 light LED assembly
- Fuse protection for control circuits.
- Terminal strips, mounting hardware, etc.

2 x 2000A feeder breakers c/w
- 3 CTs, 4000:5, standard accuracy
- 1 zero-sequence CT, high accuracy
- Schweitzer SEL-551 overcurrent and recloser relay
- Lock-Out relay
- Selector switch
- Control Switch
- Test Switch
- MOC and TOC switch
- 3 light LED assembly
- Fuse protection for control circuits.
- Terminal strips, mounting hardware, etc.

4 x 2000A motor feeder breakers c/w
- 3 CTs, 4000:5, standard accuracy
- 1 zero-sequence CT, high accuracy
- Schweitzer SEL-710 motor protection relay
- Lock-Out relay
- Selector switch
- Control Switch
- Test Switch
- MOC and TOC switch
- 3 light LED assembly
- Fuse protection for control circuits.
- Terminal strips, mounting hardware, etc.

5KV-SSDB

Identical to 5KV-SSDA, but without tie breaker section.

5KV-FGD-A, 5KV-FGD-B

Metal clad, arc resistant indoor type, one breaker high construction with a top auxiliary section for relays, controls and metering c/w vacuum electrically-operated breakers, insulated busbars, anti-condensation heaters and remote racking.

Enclosure: Indoor
MVA Class: 500MVA
BIL: 95
Nominal Voltage: 4.16kV, 3 phase, 3 wire
Main Bus Rating: 2000A
Bus Plating: Silver
Ground Bus: 0.5 x 3” copper
Control Voltage: 125VDC

5KV-FGD-A

1 x 2000A incoming section, main lugs only
- 2 PTs
- 3 CTs, 4000:5, standard accuracy
- Solid-state meter c/w phase current displays, L-L and L-N voltages, power and energy, %THD.
- Schweitzer SEL-2020 communications module
- Terminal strips, mounting hardware, etc.

6 x 1200A motor feeder breakers c/w
- 3 CTs, 2000:5, standard accuracy
- 1 zero-sequence CT, high accuracy
- Schweitzer SEL-710 motor protection relay
- Lock-Out relay
- Selector switch
- Control Switch
- Test Switch
- MOC and TOC switch
- 3 light LED assembly
- Fuse protection for control circuits.
- Terminal strips, mounting hardware, etc.

5KV-FGD-B

Identical to 5KV-SSDA.

6.4 LOW VOLTAGE SWITCHGEAR

Low voltage ‘A’ and ‘B’ 600V switchgear will be utilized in the FGD and ESP areas to distribute power to motor control centers which will service all 600V loads in these areas. Dry type step down transformers will be close coupled and bus connected to the incoming of the low voltage switchgear line-ups.

New low voltage switchgear 600V-FGD-A and 600V-FGD-B will be installed in the FGD Electrical room at elevation 11’-6”. This switchgear will be inter-connected via a kirk-key interlocked tie breaker via bus duct. The close coupled dry type transformers supplying this switchgear have been sized to carry the entire 600V load in the FGD area. In the event that a transformer connected to either the primary of 600V-FGD-A or 600V-FGD-B is taken out of service for maintenance or due to a failure, the kirk-key interlocked tie-breaker between 600V-FGD-A or 600V-FGD-B can be closed and both line-ups can be fed from a single transformer.

New low voltage switchgear 600V-ESP-A and 600V-ESP-B will be installed in the ESP Electrical rooms at elevation 42’-6”. The 600V-ESP-A switchgear will supply unitized ‘A’ MCCs and the 600V-ESP-B will supply unitized ‘B’ MCCs. The Flyash/ESP BOP MCC will be able to be supplied from either 600V-ESP-A or 600V-ESP-B via kirk-key interlocked breakers.

The 600V switchgear will be as follows:

Transformer

Voltage: 4.16kV – 600/347V, Delta-Wye
Rating: 2500MVA, ANN c/w provision for future AFN cooling
Impedance: 12%
Phasing: Dyn1
Off-load tap changer: +5% to -5%, 2.5% tap steps
Insulation: Class 220
Maximum temperature rise over ambient 40°C:
Average temperature rise: 115°C
Hot spot temperature rise: 145°C
Full wave impulse withstand test: 60kV peak
Incoming section: Main lugs only

Neutral Resistance Ground

Rated voltage: 347V
Insulation level: 1.2kV
Dielectric withstand level: 5kV
Continuous current: 25A
Resistance: 13.88Ω
Temperature rise: 385°C:
Material: Stainless steel

600V Switchgear

Metal clad, arc resistant indoor type, three breaker high construction with adjacent auxiliary sections for relays, controls and metering. Breakers to be electrically-operated draw-out LSIG air breakers, insulated busbars and anti-condensation heaters. Unit to have lifting mechanism for breakers:

Enclosure: Indoor
Bus bracing: 100kA
Nominal voltage: 600V, 3 phase, 3 wire
Main bus rating: 2000A
Ground Bus: 0.5 x 2" copper
Control voltage: 125VDC

1 x incoming section, main lugs only.

- 2 PTs
- 3 CTs, 1000:5, standard accuracy
- Solid-state meter c/w phase current displays, L-L and L-N voltages, power and energy, %THD.
- Terminal strips, mounting hardware, etc.

Breakers: 6 x 1200AF/1200AT c/w aux contacts and LSIG trip unit

600V-FGD-B, 600V-ESP-A and 600V-ESP-B Identical to 600V-FGD-A.

6.5 LOW VOLTAGE MOTOR CONTROL CENTERS

600V Motor control centers will generally be utilized to feed all individual 600V process and building services related loads in the FGD and the ESP areas. The following MCCs will be provided:

FGD Area

- Limestone MCC
- Absorber A
- Absorber B
- FGD BOP A
- FGD BOP B
- WWT MCC
- Gypsum MCC

MCCs will be as follows:

The MCC's shall be supplied in accordance with the latest issue of EEMAC standard E14-2, and unless otherwise specified shall be rated as follows:

Rated nominal voltage	600V AC, 3 phase
Rated maximum voltage	635V AC, 3 phase
Rated frequency	60 Hz

60 Hz insulation withstand strength 2200V AC.RMS for 1 minute

Short circuit current carrying capacity:

Momentary (RMS Asymmetrical)	50 kA
0.5 cycle (RMS symmetrical)	35 kA
30 cycle (RMS symmetrical)	35 kA

All circuit breakers, bus stabs, and bus stab-to-breaker connections (direct or cable) shall be capable of withstanding, without damage, the thermal effects and electromagnetic stresses resulting from the available fault currents unless the various components are so designed as to prevent the possibility of a fault occurring, i.e., they shall be fully shrouded and insulated, in which case the components shall be capable of withstanding the maximum let-through current of the circuit breaker. Internal buswork, including all horizontal and vertical buses, shall be capable of withstanding, without damage, the thermal effects and electromagnetic stresses resulting from the available fault currents, as specified, for a time period of 30 cycles.

Maximum altitude	100 M
Maximum ambient temperature	40°C
Relative humidity	10% - 95%
Barometric pressure (nominal)	101.325 kPa
Airborne Contaminants	Dripping water and dirt
Maximum temperature rise (above ambient)	50°C

Bus work continuous current rating:

Vertical bus starter cell feeder bus	600A
Incoming/starter cell feeder bus	1200A
Horizontal bus	1200A
Bus bracing	65kA

6.6 ELECTRICAL BUILDING SERVICES

Electrical building services have been provided and include the following:

- Lighting
- Emergency Lighting

- Communications
- Fire Alarm
- Exit Lighting
- Welding Receptacles
- Convenience receptacles

7.0 Controls Requirements

7.1 GENERAL

The existing plant Foxboro DCS will be expanded with new compatible Foxboro DCS hardware to control and monitor the additional equipment for the VFD ID Fans, FGD and ESPs. The new DCS will include current industry standard redundancy, segregation, unitization and partitioning techniques to provide flexibility and reliability. The DCS configuration for the new equipment will provide control and monitoring from the main control room.

The plant DCS system will at all times control all equipment associated with the ID Fans, FGD and ESP to ensure the safe and efficient operation consistent with the applicable specifications, standards and codes, and performance capabilities of the plant.

The DCS will be designed for stable continuous base load operation, but will also be capable of operating at varying loads typical for the Holyrood station. New DCS Rack rooms will be provided in the FGD and ESP areas which will house the DCS I/O cabinets. The field I/O points will be wired to the DCS I/O cabinets utilizing separate local digital and analog junction boxes. Grounding of equipment will be in accordance with the manufacturer requirements. In general, the ground(s) for the DCS equipment will be run independently and directly to the main ground using insulated wire. However, special grounding requirements may be required as dictated by DCS manufacturer.

In general, PLC's and proprietary controls will not be used. It is, however, recognized that some suppliers of skid mounted packages, such as compressors and ESP T/R sets do not typically offer there equipment to be controlled directly from the plants DCS due to proprietary and/or warranty issues. As a result, in these very limited cases these controls will be integrated into the DCS so that this equipment can be operated and monitored from the main plant control room.

Analog I/O points will be wired to local analog junction boxes with #16 AWG Teck twisted pair shielded cables and wiring from local analog junction boxes to DCS cabinets will utilize #16 AWG Teck multi-pair shielded cables. Ground loops will be avoided. Cables between the rack room and field devices will be grounded at the rack room only.

Digital I/O points will be wired to local digital junction boxes with #14 AWG Teck cables and wiring from local digital junction boxes to DCS cabinets will utilize #14 AWG Teck multi-conductor shielded cables.

Redundant data highway cables will be provided in independent trays where practical to ensure highest reliability.

Where required to satisfy operational and code requirements, safety shut downs or trips and interlocks will be hardwired utilizing electro-mechanical relays.

7.2 PRECIPITATOR CONTROLS

New unitized DCS I/O rack rooms will be provided in the ESP electrical room areas. Separate I/O cabinets and rooms will be provided for Units 1 through 3 and for Common. All of the I/O associated with the ID Fans, ID Fan VFDs, SSD Switchgear and ESPs will be wired and controlled via these DCS I/O cabinets.

ESP proprietary controls will be integrated into the DCS to allow the ESPs to be controlled and monitored from the main control room using both communications and/or hardwired I/O.

7.3 FGD CONTROL

New ‘A’ and ‘B’ DCS I/O rack rooms will be provided in the FGD electrical room areas at elevation 30’-0”. Separate I/O cabinets and rooms will be provided for ‘A’, ‘B’ and for Common. All of the I/O associated with the FGD and related equipment will be wired and controlled via these DCS I/O cabinets.

A remote operator station will be provided in the FGD area to facilitate start-up, commissioning and maintenance activities.

FGD proprietary controls will be integrated into the DCS to allow this equipment to be controlled and monitored from the main control room using both communications and/or hardwired I/O.

7.4 INSTRUMENTATION

Modern electronic instrumentation will be selected where possible to match existing manufacturers and types the plant currently uses. This will limit the amount of new instrumentation and associated parts that need to be introduced into plant stores and reduce the requirement for additional maintenance staff training required to service this instrumentation.

Instrumentation will be selected to be suitable for the process conditions, atmosphere, reliability and accuracy required.

Instrumentation will be installed to meet service conditions and to provide suitable access for installation and service.

Analog instruments will be Hart compatible where possible.

7.5 CEM'S

New continuous emissions monitoring (CEM) will be provided. Modern electronic opacity and NO_x monitoring equipment will be provided between each units ESP outlet and the FGD absorber inlet plenum so that these can be monitored for each boiler. There will also be NO_x and SO_x monitoring equipment provided on the FGD stack. This equipment will be located to facilitate required access and maintenance activities.

8.0 Opinion of Probable Cost

The opinion of probable cost was prepared under the Class 4 guidelines as defined by the Association for the Advancement of Cost Engineering (AACE) which involves a level of project definition of between 1% and 15%. The Class 4 allows an expected accuracy range of -15% to -30% and +20% to +50%. Based on this criteria and the work carried out to date, we believe than an expected accuracy level of ±25% has been achieved.

The opinion of probable cost was developed in consultation with original equipment manufacturer's (OEM's), equipment suppliers and using our in-house database.

A breakdown of the probable cost by major areas of work is summarized in the following table.

Table 8.1 Opinion of Probable Cost

Area	Description	Cost
100	Site Preparation and Site Services	$ 5,823,595
200	Boiler Modifications	$ 5,461,120
300	Breeching and Dampers	$ 40,827,591
400	Precipitators	$ 47,105,798
500	Ash Handling	$ 5,485,378
600	ID Fans	$ 14,325,499
700	FGD System	$ 138,725,197
800	Stack	$ 23,663,581
900	Limestone Receiving and Handling	$ 9,050,721
1000	Gypsum Handling and Landfill	$ 7,757,037
1100	Wastewater Treatment	$ 1,515,000
1200	Power Distribution	$ 19,465,089
1300	DCS	$ 541,550
1400	Construction Indirects	$ 31,015,474
1500	Commissioning	$ 8,671,120
1600	Project Management and Engineering	$ 31,974,716
	Subtotal	**$ 391,408,465**
	Contingency @ 15%	$ 58,711,270
	Total	**$ 450,119,735**
	Use	**$ 450,000,000**

Note: The above does not include overhead cost, AFUDC or other owner's cost.

Stantec Consulting Ltd. does not guarantee the accuracy of this opinion of probable cost. The actual final cost of the project will be determined through the building and construction process.

We have applied a contingency of 15% to the opinion of probable cost to cover items that will be required but are yet not identified. This amount is based on our experience for this level of study and is not to be confused with the level of accuracy of the opinion of probable cost.

The opinion of probable cost does not include escalation, loss of production costs or interest during construction (AFUDC). It also does not include any of the Owner's costs during the life of the project.

8.1 ADDITIONAL PROJECT CONSIDERATIONS

This preliminary study has identified additional project requirements that will need to be considered by Newfoundland and Labrador Hydro if the project was to proceed. These were not part of the original scope of work for this study but will need to be addressed at some point. They have been discussed in this report and can be summarized as follows:

- Cost to mitigate SO_3 emissions.
- Cost to develop a new landfill.
- Raw water study and upgrades if required.
- Limestone shipment to site.

8.1.1 Cost to Mitigate SO_3 Emissions

As previously discussed, the emission of SO_3 may or may not be an issue at the site. SO_3 is not a controlled emission and therefore the decision to install a control system would be based on discussions with Newfoundland and Labrador Hydro and through public consultations. The anticipated levels are not extremely high but are such that a slightly visible plume may be present once the steam plume from the FGD dissipates.

There are two main methods to reduce SO_3 emissions. The first is by the use of injection technology. A sorbent is injected prior to the precipitators. The SO_3 reacts with the sorbent and is captured in the precipitators. The second is by the installation of a WESP. The WESP is installed after the FGD system and captures condensed SO_3. Preliminary discussion's with B&W indicates that a sorbent injection system would have an installed cost of approximately $15 to $20 Million. The predicted cost for the WESP would be in the range of $50 to $60 Million.

Therefore, Stantec Consulting Ltd. Suggests proceeding on the following basis for SO_3 control:

- Allocate funds in the budget for an SO_3 control system based on injection technology.
- Size the precipitators to handle the quantity of injection media that will be required.
- Allocate space on the site and in the design for the injection system.
- Construct the project but do not install the injection system.
- Operate the station and observe the plume visibility.
- If plume visibility is a problem then install the SO_3 injection control system.

This approach would allow Newfoundland and Labrador Hydro to defer the cost of this system until actual plume observations can be made. At this time, Newfoundland and Labrador Hydro can determine if additional corrective measures are required.

If an injection system is required, then it can be installed while the plant is operational. The operational cost of this system would also need to be considered in the decision to proceed.

8.1.2 Landfill Development

The addition of the ESP's and the FGD system will result in additional solid waste by-products at the station. For the purpose of this study, it is assumed that all of the waste by-products will be landfilled. Newfoundland and Labrador Hydro may want to investigate the feasibility of selling the gypsum by-products to a wallboard manufacturer. Synthetic gypsum is typically sought after by the wallboard manufacturers due to its purity and consistency.

Based on the design fuel and the plant capacity factor, it has been determined that 4400 tonnes of flyash and 78,000 tonnes of gypsum will be generated annually. To accommodate these quantities, a new landfill site will need to be developed by Newfoundland and Labrador Hydro.

The development of this landfill was not in the scope of this study. However, based on our in-house database and historical information, it is our opinion that the cost of a new landfill would be in the order of $5 million. This cost has been included in the opinion of probable cost.

8.1.3 Raw Water System Upgrades

As determined by this study, approximately 31.5 L/s (500 USGPM) of makeup water will be required by the FGD system at the design case.

Newfoundland and Labrador Hydro will need to determine if the existing raw water system and Quarry Brook can accommodate this additional demand. An additional study may be required to review this system. Upgrade cost, if required, will need to be determined as part of this additional study and carried in the project budget.

Stantec Consulting Ltd. would be pleased to assist Newfoundland and Labrador Hydro in this undertaking, if so desired.

8.1.4 Limestone Shipment and Receiving

When operating at the design case, approximately 8 MTPH of limestone will be required by the FGD system. This represents approximately 9 trucks per day, based on a 30 tonne truck shipment.

The current preliminary design is based on delivering limestone by truck to the site. However, preliminary discussion with the station indicated that this additional truck traffic through the community of Holyrood may be undesirable. As previously indicated earlier in this report, Stantec outlined three potential solutions to this problem and has carried a rough budget cost in the opinion of probable cost for one of these options.

However, it is Stantec's opinion that NLH should conduct an additional study on the viability of each option and to further develop the opinion of probable costs for these options.

Stantec Consulting Ltd. would be pleased to assist Newfoundland and Labrador Hydro in this additional study if so desired.

9.0 Operation and Maintenance Costs

Operating and Maintenance costs were predicted for the electrostatic precipitators and the FGD system. A summary of the O&M costs are presented in the following section.

9.1 O&M COST PARAMETERS

The following cost parameters were used to predict operating and maintenance costs for the electrostatic precipitators and FGD system.

Table 9.1: O&M Cost Parameters

Parameter	Cost
Plant Capacity Factor	60%
Limestone Cost	$15/tonne
Raw Water Cost	Negl.
Gypsum Landfill	$20/tonne (Note 1)
Ash Landfill	$20/tonne (Note 1)
WWT Cost	Negl.
Power Cost	$0.11/kWh (Note 2)
Full Time Employee (Salary)	(See Table 9.3)
TRONA Cost	$250/tonne (Note 3)

Notes:
1. Predicted Cost (Current sludge disposal cost are approximately $60/Tonne.)
2. Based on fuel costs of $71.60/BBL
3. Optional Cost

9.2 PREDICTED ANNUAL O&M COSTS

The following table summarizes the anticipated additional O&M cost that will be incurred by the station with the installation of the electrostatic precipitators and the FGD system.

Table 9.2: Predicted O&M Cost

	Quantity(Annual)	$/Quantity	Annual Cost
Fixed Costs			
1. Salary (see Section 9.3)			$376,000
Variable Costs			
2. Power Consumption	92,000,000 kWh	$0.11/kWh	$10,120,000
3. FD Fan Energy Saving	14,000,000 kWh	$0.11/kWh	-$1,540,000
4. Limestone Consumption	42,500 tonnes	$15/tonne	$637,500
5. Gypsum Disposal Costs	78,000 tonnes	$20/tonne	$1,560,000

		Quantity(Annual)	$/Quantity	Annual Cost
6.	Ash Disposal Costs	4400 tonnes	$20/tonne	$88,000
7.	Raw Water Cost	6 x 10^8 Litres	Negl.	Negl.
8.	WWT Treatment	12 x 10^6 Litres	Negl.	Negl.
9.	Annual Maintenance, Cost, Parts, Labour and Overhead		$750,000	$750,000
	TOTAL ANNUAL COST			**$11,991,500/Yr**
Optional – TRONA		3,075 tonnes	$250/tonne	$768,750

9.3 ADDITIONAL STAFF REQUIREMENTS

The new equipment installed by the project will add some additional complexity to the operation of the station. Some additional staff will be required to properly operate and maintain the additional equipment. The design of the new equipment is such that additional staff should be kept to a minimum. Modern day controls and a high degree of automation will also play a major role in minimizing any additional staff.

From our experience on projects of a similar nature, we do not anticipate that the precipitators or ID fans will require any additional operating staff. We would expect the individual boiler operators to add this equipment to their normal operating duties. Precipitators are typically a common part of normal boiler train operation in most plants. A dedicated operator for the precipitator operation would be unusual.

The FGD system on the other hand will require some additional staff to properly operate and maintain the equipment. We would expect the following additional staffing requirements:

Table 9.3: Staff Requirements

Position	Qty	Coverage	Annual Salary	Total $
Control Room Operator	1	Day Shift	$90,000	$90,000
Chemical Technician	1	Day Shift	$65,000	$65,000
Maintenance/Instrument Technician	1	Day Shift	$76,000	$76,000
Labourers	2	Day Shift	$45,000	$90,000
Limestone/Gypsum Loader Operator*	1	Day Shift	$55,000	$55,000
			Total	**$376,000**

*If not contracted out.

As can be noted from the table, all of the required staff for the FGD system is for day shift only. The FGD day operator reviews all of the data from the night shifts and troubleshoots any issues with the shift mechanical/instrument technician. The chemical technician performs all of the sampling and testing of the FGD process parameters during day shifts. These include such items as: pH’s, slurry densities, chloride levels, gypsum quality, limestone quality, etc. A couple of day labourers are required to clean up spills and upsets which is a normal occurrence in FGD operation.

The limestone/gypsum operator makes sure that the limestone day silos are topped up and any gypsum produced overnight is loaded into trucks and hauled to the landfill. We have not included the cost of the truck operators as we would assume that these would be contracted out.

The operation of the FGD system during the remainder of the day would be carried out by the existing boiler operators. We would not expect any additional staff requirements other than the daytime requirements outlined above.

9.4 ANNUAL OUTAGE REQUIREMENTS

A 7 to 10 day annual outage will be required for the FGD system. All three units will need to be shutdown in order for the FGD absorber tower to be taken off line (See also discussion on unitized vs. common FGD systems in Section 12.0 of this report). Newfoundland and Labrador Hydro will need to determine if their environmental permit will allow them to keep at least one unit running on bypass if required. A low sulphur fuel could be on hand and used if one unit must be kept running.

During this period, the absorber tower will be drained to the auxiliary storage tank. The absorber will be opened and a complete internal inspection completed. Items that will be checked include such items as; broken or plugged spray nozzles, broken or plugged mist eliminators, agitators, areas of excessive wear, internal piping, etc.

Typically, only very minor repairs will be required.

9.5 SENSITIVITY ANALYSIS

It is important to note that all of the design data and quantities provided in this report are based on the design fuel characteristics and a 60% station capacity factor. Any change to the design fuel specification or the overall station capacity will impact the final quantities of limestome and makeup water requirements as well as the by-products that will be produced such as gypsum and flyash. The following table provides a general overview of the overall system sensitivity at varying load conditions and fuel characteristics.

Table 9.4: By-Product Sensitivity Analysis

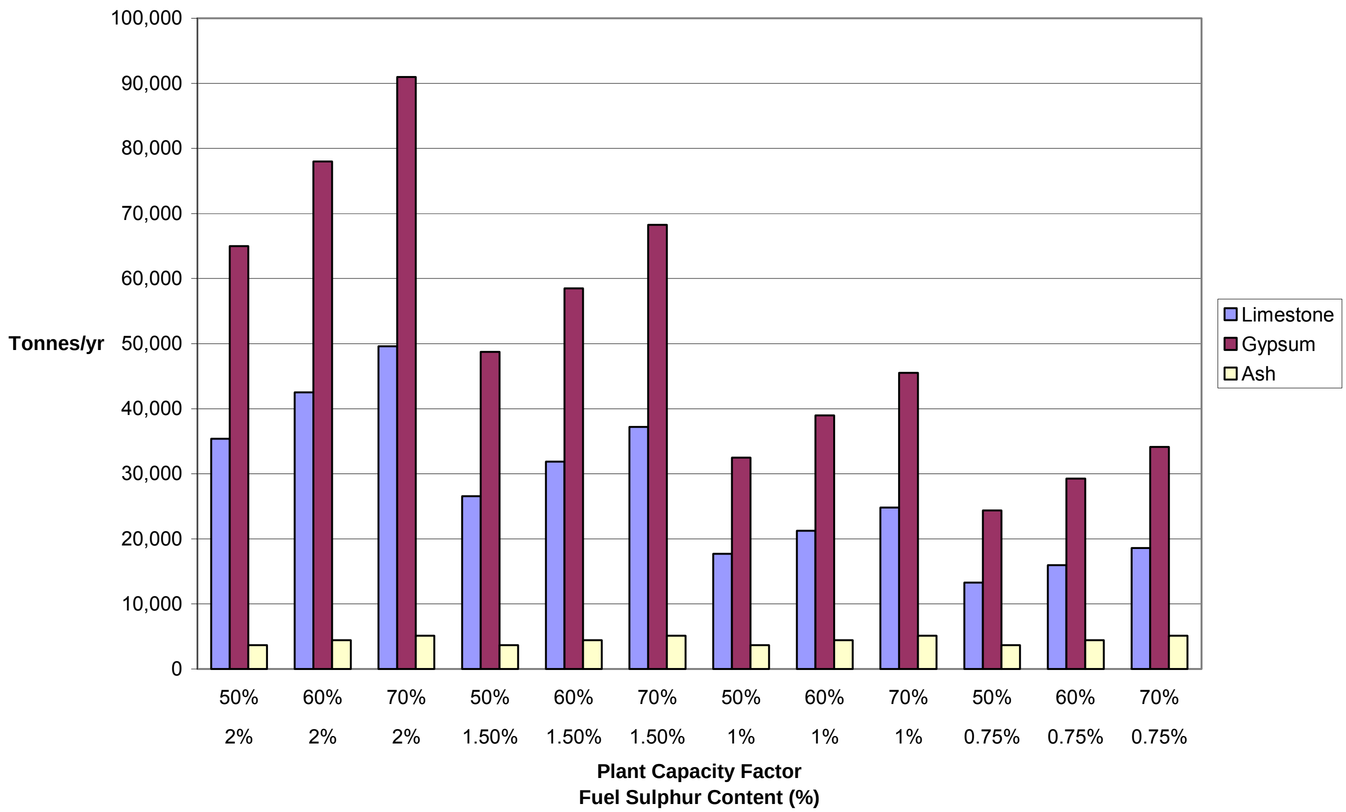
By-Product Sensitivity Analysis

Annual Requirements/Production

Fuel Sulphur Content (%)	Plant Capacity Factor (%)	Limestone (Tonnes/yr)	Gypsum (Tonnes/yr)	Ash (Tonnes/yr) Note 1	Makeup Water (Litres) Note 2	Blowdown (Litres) Note 3
2 %	50%	35,400	65,000	3666	4.96×10^8	10.0×10^6
	60%	**42,500**	**78,000**	**4400**	$\mathbf{5.96 \times 10^8}$	$\mathbf{12.0 \times 10^6}$
	70%	49,600	91,000	5133	6.95×10^8	14.0×10^6
1.5%	50%	26,560	48,750	3666	4.96×10^8	10.0×10^6
	60%	31,875	58,500	4400	5.96×10^8	12.0×10^6
	70%	37,200	68,250	5133	6.95×10^8	14.0×10^6
1 %	50%	17,700	32,500	3666	4.96×10^8	10.0×10^6
	60%	21,250	39,000	4400	5.96×10^8	12.0×10^6
	70%	24,800	45,500	5133	6.95×10^8	14.0×10^6
0.75 %	50%	13,280	24,375	3666	4.96×10^8	10.0×10^6
	60%	15,937	29,250	4400	5.96×10^8	12.0×10^6
	70%	18,600	34,125	5133	6.95×10^8	14.0×10^6

Note:
1. **Ash content in the different sulphur fuels is assumed to be the similar.**
2. **Makeup water requirements are only affected by the unit load.**
3. **It is assumed that blowdown will only be affected by the unit load. However, less limestone usage may result in a lower blowdown requirement than is shown in the table.**

Figure 9.4.1 By-Product Sensitivity Analysis



10.0 Project Execution

Stantec Consulting Ltd. has prepared a preliminary engineering and construction schedule for the project. Based on long lead delivery items and our experience with similar projects, we would anticipate a project duration of between 36 to 42 months. The complete preliminary project schedule is included in the Appendix.

Key to the project would be a timely completion of the environmental impact assessment (EIA) which should be started and completed as early as possible. We have allowed for a 12 month duration for this activity. However, to maintain the schedule we would anticipate starting detailed engineering prior to completion and approval of the EIA. This “Fast Track” approach is required to minimize the overall project schedule but it does expose the owner to some up front risk. Fast tracking would allow for the precipitators and FGD to be bid and awarded in order to permit the start of the engineering for this equipment. The precipitators and the FGD are the long lead items for the project and must be ordered early to maintain the overall project schedule. Key engineering information is required from these vendors early in the project to allow the balance of plant engineering to progress. A certain amount of risk will need to be assumed by the project to allow these activities to commence prior to the final approval of the EIA.

Cancellation clauses and charges can be negotiated with the equipment vendors in the case there would be a delay in the EIA approval.

The construction phase of the project would take approximately 24 – 30 months to accomplish. Stantec has prepared a preliminary site layout to indicate the construction strategy for the site. Such items as construction trailer locations, site access, construction parking and construction laydown areas are indicated. The site lends itself well to the construction as most of the work will be located on the east side of the plant. This area can be fenced off and access controlled through a new construction gate. Access to station for the station staff would continue uninterrupted through the main gate.

The first step in the construction sequence would be to prepare the east side of the station for construction. This would include clearing, grubbing, establishing construction fencing, laydown areas, trailer complexes and relocation of roads and underground services. A new combined pipe shop, meter shop and warehouse would be constructed in the location of the old guardhouse parking. The existing buildings would be demolished to make way for the new FGD and precipitators. The existing warehouse will be kept and used as construction stores for the duration of the project. It would be removed at the end of the project. The chemical storage building will also need to be relocated.

Once this work is completed, the construction of the equipment and building foundations on the east side of the station can commence. Once these are complete, then the equipment and buildings can be installed and/or erected. All of the major construction work on the east side of the station can be undertaken without any disruption to the ongoing operation and activities of the station. Some coordination with the station will be required for the work on the north side of the plant where the main breeching is to be erected.

The schedule also indicates that individual unit outages will be required during the summer season to undertake the boiler stiffening activities. We anticipate that an 8 to 10 week outage would be required for this work.

Final connection of the existing breeching to the new breeching would be accomplished at the end of the project once the ESP's and FGD's are substantially complete. A small one to two week outage will be required for each unit to accomplish the final breeching tie-ins and the FD fan wheel change-out. Commissioning of the ESP's and FGD's will commence once the tie-ins are complete and the units brought back on line.

Stantec anticipates that the commissioning of the ESP's and FGD's will take approximately 8 to 10 weeks.

The schedule currently indicates a March start to construction at the site. This start is required in order to not have the date for commissioning and commercial operation of the units into the winter season. As it is, the commissioning of the units is shown in January which may or may not be acceptable to NLH. To improve on this date, we would recommend starting construction at site as soon as possible after the EIA is complete which would result in a January start to the construction. In this case, commissioning of the units could be accomplished in October or November. Another alternative is to keep the same start date at site and push the final commissioning of the ESP's and FGD into the spring so as to not jeopardize the availability of the units in the cold winter season. The final schedule can be reviewed and adjusted during the detail design phase of the project.

Overall, Stantec is confident in the project duration and that the construction can be carried out in a safe and efficient manner without any major disruptions to the normal plant operations.

11.0 Project Contract Strategy / Cash Flow

It is Stantec Consulting Ltd. opinion that the conventional Owner's engineering method would be the best approach for this project. The Owner's engineer would work closely with Newfoundland and Labrador Hydro through all phases of the project including engineering, construction and commissioning. This approach would provide Newfoundland and Labrador hydro with greatest control over the final budget, schedule and risk for the project. Stantec's recent FGD projects were all successfully executed in this fashion.

Based on this approach, individual contracts would be prepared for various phases of the work. Based on Stantec's experience, we would anticipate the following contracts for this project.

Table 11.1: Typical Contract Strategy

Civil	
C1	Sit Preparation and Construction Services
C5	Breeching Excavation and Foundations
C10	Breeching Structural Steel
C15	ESP and Electrical Building Excavation and Foundations
C20	ESP and Electrical Building Structural Steel
C25	Ash System Excavation and Foundations
C30	Ash System Structural Steel
C35	Ash Building Finishes
C40	ID Fan Equipment and Building Excavation and Foundations
C45	ID Fan Building Structural Steel
C50	ID Fan Building Finishes
C55	FGD Building Excavation and Foundations
C60	FGD Building Structural Steel
C65	FGD Building Roof
C70	FGD Building Cladding
C75	FGD Building Finishes
C80	Stack
C85	Stack Excavation and Foundations
C90	Limestone and Gypsum Excavation and Foundations
C95	Limestone and Gypsum Buildings
C100	Warehouse, Pipe Shop and Meter Shop Pre-Engineered Building
Mechanical	
M1	Boiler Modifications
M5	Breeching and Dampers
M10	Precipitators
M15	Ash Handling Equipment Supply
M20	Ash Handling Equipment Installation
M25	ID Fan Supply

Civil	
M30	ID Fan Installation
M35	FGD Supply and Install
M40	FGD Miscellaneous Mechanical
M45	FGD Elevator
M50	Limestone and Gypsum Equipment Supply
M55	Limestone, Gypsum and Miscellaneous Mechanical Installation
M60	WWTP Equipment Supply
Electrical/Instrumentation	
E1	Station Transformers Supply
E5	Medium Voltage Switchgear Supply
E10	Low Voltage Switchgear Supply
E15	Breeching, Precipitator and ID Fan Electrical
E20	FGD, Stack and WWT Electrical
E25	Limestone and Gypsum Electrical
E30	Miscellaneous Site Electrical
E35	PC's Upgrades Supply
E40	I/O Cabinets Supply
E45	CEM's Supply
E50	Miscellaneous Instrumentation
E55	DCS, CEM's and Controls Installation
Miscellaneous	
51	Site Services Contract

This list provides Newfoundland and Labrador Hydro with a preliminary indication of the expected contracts that would need to be prepared and awarded as part of the project. This list would more than likely change once the project and schedule become more defined. Additional miscellaneous equipment, valves and instruments would be purchased through smaller contracts and material lists as required during the project.

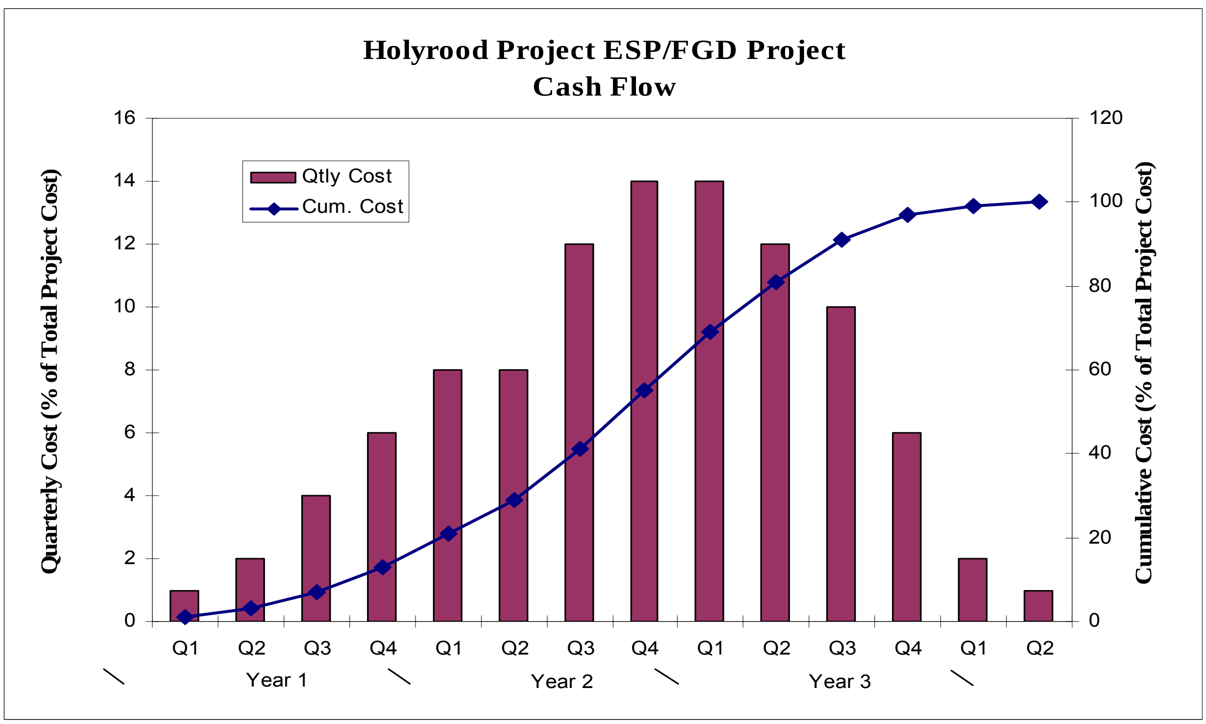
11.1 PROJECT CASH FLOW

The cash flow for the project will follow a typical capital project S-curve capital expenditure. Based on a 38 month project schedule we would anticipate that the overall project cash flow would follow resemble the following table:

Table 11.2: Typical Project Cash Flow (% Total Project Cost)

	Year 1				Year 2				Year 3				Year 4	
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Quarterly	1	2	4	6	8	8	12	14	14	12	10	6	2	1
Cumulative Quarterly	1	3	7	13	21	29	41	55	69	81	91	97	99	100
Yearly	13				42				42				3	
Cumulative Yearly	13				56				97				100	

The above table can be better represented in by the typical s-curve for a project of this nature which would look like:



12.0 Unitized FGD System

As requested by Newfoundland and Labrador Hydro, this section provides some discussion on the pros and cons of installing unitized electrostatic precipitators and unitized FGD systems.

The current study has been focused on installing separate electrostatic precipitators for each unit and a common FGD system. This arrangement was requested by Newfoundland and Labrador Hydro in the original RFP. However, another potential option for the design of the FGD would be a unitized FGD system for each boiler.

Historically, multi-unit electrical generating facilities have been constructed and operated with essentially stand alone capabilities and systems. Some common or shared services do exist but are typically minor and would not impact the operation of the units if these systems were not available.

It is only in recent memory that some environmental equipment such as FGD systems have been installed for multi-unit applications. The decision to install a common FGD for multi-units has typically been driven by costs and possibly site constraints.

A unitized FGD system at the Holyrood Generating Station would have the following key design elements and characteristics:

- Three (3) individual absorber towers complete with individual bypasses.
- Absorber towers would be smaller in diameter.
- Each tower would be equipped with its own:
    - Absorber recycle pumps.
    - Absorber agitators.
    - Absorber oxidation air compressors.
    - Absorber blowdown pumps.
    - Mist eliminator wash system.
    - Instrumentation.
- A single stack would be constructed with three separate flues (i.e. one for each unit).
- Limestone handling, storage and preparation system would be common and be the same size and layout as the common FGD system.
- Gypsum dewatering, transport and storage system would be common and be the same size as the common FGD system.

FGD technology has evolved tremendously in recent years. First generation FGD systems installed in 1970's were notoriously unreliable. In those days, single boiler units were coupled to multi-absorber towers. Spare absorber towers were always installed. This would allow one tower to be down for service or be on standby should it be required.

Plugging, scaling, corrosion and erosion were common problems in the early days of FGD systems. The process chemistry was poorly understood and primitive controls resulted in many problems. Scaling due to uncontrolled natural oxidation of calcium sulphite was commonplace. Corrosion and erosion due to improper material selection was widespread and led to many unscheduled outages.

Since then, much research and development has taken place. The late 80's and early 90's saw the development of second generation FGD systems. Forced oxidation was developed which has minimized or eliminated absorber scaling and plugging problems. Advances in the use of stainless steels and alloys in strategic areas have reduced corrosion and erosion problems. Process chemistry design, modern day controls and key equipment redundancies have also been major factors in improving the reliability of modern day FGD systems.

Today's FGD systems are extremely reliable and forced outages because of a problem with the FGD are rare. Vendors routinely guarantee the reliability of the FGD system and that it will not be the reason for any forced outages. A routine yearly outage is typically the only outage required to inspect the absorber tower and perform minor repairs.

Spare absorber towers are a thing of the past. Single absorber towers on a single boiler unit or on multiple boiler units is commonplace. Stantec has been involved with two major FGD projects with NB Power where a single absorber tower has been installed on multiple boilers. The Dalhousie Generating Station's single absorber tower handles flue gas from two (2) boiler units. The absorber tower is sized to handle the flue gas from Unit #1 (100 MW) and Unit #2 (212 MW) for a combined gas flow of 312 MW.

The Coleson Generating Station is designed with two 525 MW absorber towers to handle the flue gas from three 350 MW boilers. Both of these scrubber systems have operated very successfully with little or any forced outages related to the FGD system.

Based on this experience, and with discussions with FGD vendors, Stantec is very confident in specifying a single common FGD system serving the three boilers for this application. A single absorber tower system will result in a lower capital cost as opposed to building three absorber towers and the infrastructure that would be required. A single absorber tower will also be simpler to operate than multiple towers as the operator will only need to operate a single system instead of three separate systems.

The following table provides a summary of the pros and cons of a common FGD system vs. a unitized FGD system.

Table 12.1: Pros and Cons Between Common FGD and Unitized FGD

	Pros	Cons
Common FGD System		
Construction	• Lower capital cost for equipment • Smaller building volume, smaller building cost • Small overall site footprint. • Lower overall capital cost	
Operations	• Less equipment to operate • Less process chemistry testing and monitoring required • Lower operating cost due to less operating equipment • Less agitators, recycle pumps, oxidation air, blowdown pumps	• Single point of failure with one absorber tower • Added complexity for boiler start-ups, trips and purges
Maintenance	• Less equipment to maintain and service • Reduced costs of spares	• Complete plant outage required for annual absorber maintenance
Unitized FGD System		
Construction		• Higher equipment capital cost • Greater overall building footprint and volume required • Additional stack cost due to three (3) separate flue liners • Higher overall capital cost
Operation	• No single point of failure for entire station • Simplified flue gas path operation for start-ups, trips and purges	• Additional process chemistry testing and monitoring • Additional equipment to operate • Higher operating costs
Maintenance	• Individual unit outage for absorber tower maintenance	• Additional equipment to maintain and service • Additional cost of spares

In summary, a unitized FGD absorber system does provide the station with additional operational flexibility, but at a higher installed capital cost and a higher annual operating cost.

A single common absorber tower system will have a lower installed capital cost and a lower operating cost. However, the major drawback for the common FGD is than an overall outage of 5 to 10 days will be required to perform an annual inspection and routine maintenance. System availability for a single tower is not an issue.

It is Stantec's opinion that the common absorber system FGD will provide Newfoundland and Labrador Hydro with an extremely reliable and efficient system at a lower installed and operating cost.

The only reason to install a unitized FGD system would be if an overall annual plant outage would not be possible or acceptable to Newfoundland and Labrador Hydro. In this case, Newfoundland and Labrador Hydro would need to install unitized FGD systems. This would allow one unit to always be available for service at any time of the year.

It is Stantec's opinion that a unitized system would add 10 to 15% to the overall cost of the project. This cost would be required due to the additional equipment and infrastructure that would be required as stated previously and expanded below:

- Smaller absorber tower but three required instead of one. Additional materials and erection costs.
- Additional equipment associated with each absorber tower including recycle pumps, agitators, oxidation air system, blowdown pumps, mist eliminators, piping, valves and instruments.
- Additional MCC's, cabling etc. to accommodate the additional equipment.
- Additional inlet and outlet ductwork.
- Additional stack flues.
- Larger FGD building required to accommodate three absorber towers. Additional foundations, structural steel, walkways, cladding, roofing. etc.

13.0 Appendices

APPENDIX A.
Opinion of Probable Cost

Client: **Newfoundland and Labrador Hydro**
Project: **HOLYROOD Generating Station - ESP/FGD Installation**
Project No: **133544177**
Currency: **Can. 3 rd Qtr**

STANTEC CONSULTING
Opinion Of Probable Construction Cost
(Without Project Allowances)

Stantec

Prepared by: **Fred Tozer**
Date: **14-Nov-08**
Revision No.: **1**

							Labour					Mat'l/Commodity		Equipment		Sub-Contractor		
Area	SCI	Item	Activity	Description	Qty	Unit	Hrs per Unit	Prod. Factor	Total Hours	Rate	Cost	Unit Cost	Cost	Unit Cost	Cost	Unit Cost	Cost	Total Cost
100				**Site Preparation and Site Services**														$ 5,823,595
200				**Boiler Modifications**														$ 5,461,120
300				**Breeching and Dampers**														$ 40,827,591
400				**Precipitators (unit 1, 2 &3)**														$ 47,105,798
500				**Ash Handling**														$ 5,485,378
600				**ID Fans (Unit 1,2 & 3) , includes equip't, bld'g, & Elect. Rooms**														$ 14,325,499
700				**FGD**														$ 138,725,197
800				**Stack**														$ 23,663,581.0
900				**Limestone Receiving and Handling**														$ 9,050,721
1000				**Gypsum Handling and Landfill**														$ 7,757,037
1100				**Wastewater Treatment Plant**														$ 1,515,000
1200				**Power**														$ 19,465,089
1300				**DCS Console**														$ 541,550
				SUB-TOTAL DIRECT (PROJECT)														**$ 319,747,155**
1400				**Construction Indirects**														$ 31,015,474
1500				**Commissioning**														$ 8,671,120
1600				**Project Management and Engineering**														$ 31,974,716
				TOTAL DIRECT (PROJECT)														**$ 391,408,465**
				Contingency @ 15%														$ 58,711,270
				GRAND TOTAL														**$ 450,119,735**

Client: **Newfoundland and Labrador Hydro**
Project: **HOLYROOD Generating Station - ESP/FGD Installation**
Project No: **133544177**
Currency: **Can. 3 rd Qtr**

STANTEC CONSULTING
Opinion Of Probable Construction Cost
(Without Project Allowances)

Prepared by: **Fred Tozer**
Date: **14-Nov-08**
Revision No.: **1**

Area	SCI	Item	Activity	Description	Qty	Unit	Labour: Hrs per Unit	Labour: Prod. Factor	Labour: Total Hours	Labour: Rate	Labour: Cost	Mat'l/Commodity: Unit Cost	Mat'l/Commodity: Cost	Equipment: Unit Cost	Equipment: Cost	Sub-Contractor: Unit Cost	Sub-Contractor: Cost	Total Cost
100				Site Preparation and Site Services					17,218		$ 1,652,920		$ 1,690,675		$ 240,000		$ 2,190,000	$ 5,823,595
	10000	001		**General**														
			001	Site Survey	1	allow										100,000	100,000	100,000
			002	Geotechnical	1	allow										50,000	50,000	100,000
			003	Compaction Testing	1	allow										75,000	75,000	75,000
	12000	002		**Site Preparation and Reclamation**														
			001	Construction Parking and Misc. Site Development including grubbing, clearing and backfill	5,500	cy	0.06	1.15	379.5	96.00	36,432		0		0		0	36,432
	14000	003		**Site Security and Improvements**														
			001	Fencing	3,500	lft	0.165	1.15	664.1	96.00	63,756	24.85	86,975		0		0	150,731
			002	Construction Guard House and Trades Security System	1	allow										125,000	125,000	125,000
	16000	004		**On Site Roads, Road Bridges and Parking Area**														
			001	Class "A" Gravel	24,000	cy	0.1	1.15	2760.0	96.00	264,960	22.00	528,000		0		0	792,960
			002	Gravel Roads	7,000	cy	0.12	1.15	966.0	96.00	92,736	22.00	154,000		0		0	246,736
			003	Paved Roads	16,500	sy	0.026	1.15	493.4	96.00	47,362	10.36	170,940		0		0	218,302
			004	Construction Parking	2,600	cy	0.12	1.15	358.8	96.00	34,445	22.00	57,200		0		0	91,645
			005	Pit Run Gravel	36,000	cy	0.08	1.15	3312.0	96.00	317,952	9.00	324,000		0		0	641,952
	17000	005		**Building Demolition (3 ea) (Pipe Shop, Warehouse, and Meter Shop)**														
			001	Empty buildings and relocate to temporary location	3	allow	200	1.15	690.0	96.00	66,240		0		0		0	66,240
			002	Demolish 3 Buildings	3	allow	100	1.15	345.0	96.00	33,120		0		0		0	33,120
			003	Relocate Material and Demolish existing Chemical Stores Building	1	allow	100	1.15	115.0	96.00	11,040		0		0		0	11,040
	17000	006		**Relocate Existing Contractor Trailer Complex**														
			001	Relocate Trailers	6	allow	40	1.15	276.0	96.00	26,496		0		0		0	26,496
			002	Relocate U/G electrical	6	allow	20	1.15	138.0	96.00	13,248	2,000.00	12,000		0		0	25,248
			003	Site Preparation and Backfill	6	allow	20	1.15	138.0	96.00	13,248	2,000.00	12,000		0		0	25,248
	28400	007		**Scale House (100mt Truck scale c/w fdn's, scale unit, controls and metering stn.)**	1	pkg	1200	1.15	1380.0	96.00	132,480	12,500.00	12,500	225,000	225,000		0	369,980
	28400	008		**New Plant Buildings**														
			001	New Maintenance Bld'g. (120' x 120' x 20 walls) (divided in 3 equal areas) including site work, foundation, masonry, plumbing, HVAC and electrical	14,400	sf										100.00	1,440,000	1,440,000
			002	New Chemical Storage Building	2,400	sf										75.00	180,000	180,000
	72100	009		**Raw Water**														
			001	Relocate 16" Raw Water line (including excavation & backfill)	1,500	lft	0.61	1.15	1052.3	96.00	101,016	100.00	150,000		0		0	251,016
			002	Raw Water manhole (including excavation & backfill)	2	ea	14	1.15	32.2	96.00	3,091	1,600.00	3,200		0		0	6,291
			003	8" Raw Water Feed to FGD Building (including excavation & backfill)	200	lft	0.32	1.15	73.6	96.00	7,066	35.00	7,000		0		0	14,066
	72700	010		**Domestic Water**														
			001	Relocate Yard Domestic Water Piping 2" (including excavation & backfill)	400	lft	0.26	1.15	119.6	96.00	11,482	29.00	11,600		0		0	23,082
			002	Domestic Water Feed to FGD Building (2")	100	lft	0.26	1.15	29.9	96.00	2,870	29.00	2,900		0		0	5,770
			003	Domestic Water to new Service Bld'g. 2"	120	lft	0.26	1.15	35.9	96.00	3,444	29.00	3,480		0		0	6,924

Client: **Newfoundland and Labrador Hydro**
Project: **HOLYROOD Generating Station - ESP/FGD Installation**
Project No: **133544177**
Currency: **Can. 3 rd Qtr**

STANTEC CONSULTING
Opinion Of Probable Construction Cost
(Without Project Allowances)

Stantec

Prepared by: **Fred Tozer**
Date: **14-Nov-08**
Revision No.: **1**

Area	SCI	Item	Activity	Description	Qty	Unit	Labour: Hrs per Unit	Labour: Prod. Factor	Labour: Total Hours	Labour: Rate	Labour: Cost	Mat'l/Commodity: Unit Cost	Mat'l/Commodity: Cost	Equipment: Unit Cost	Equipment: Cost	Sub-Contractor: Unit Cost	Sub-Contractor: Cost	Total Cost
	78110	011		**Fire Water Piping**														
			001	10" Fire Main and Hydrants on East Side of Plant (including excavation & backfill)	400	lft	0.55	1.15	253.0	96.00	24,288	50.00	20,000		0		0	44,288
			002	New 10" Fire Loop around FGD Building and yard	1,300	lft	0.55	1.15	822.3	96.00	78,936	50.00	65,000		0		0	143,936
			003	New Yard Hydrants around FGD (including excavation & backfill)	8	ea	10	1.15	92.0	96.00	8,832	2,300.00	18,400		0		0	27,232
			004	New 10" Fire Water Feed into FGD Building, ID Fan Building and Ash Building	200	lft	10	1.15	2300.0	96.00	220,800	50.00	10,000		0		0	230,800
			005	10" Gate Valves	8	ea	4	1.15	36.8	96.00	3,533	1,500.00	12,000		0		0	15,533
			006	6" Fire Water Feed to Fire Hydrants	160	lft	0.26	1.15	47.8	96.00	4,593	33.00	5,280		0		0	9,873
	79120	012		**Sewage**														
			001	Demolish existing Sewage Treatment System	1	lot									0	20,000	20,000	20,000
			002	Install New Sewage Treatment System	1	lot									0	200,000	200,000	200,000
			003	Install new 8" dia. Sewer line (including excavation & backfill)	40	lft	0.32	1.15	14.7	96.00	1,413	35.00	1,400		0		0	2,813
			004	Install new 4" sewage line to FGD Building	200	lft	0.32	1.15	73.6	96.00	7,066	32.00	6,400		0		0	13,466
			005	Manholes (including excavation & backfill)	3	ea	14	1.15	48.3	96.00	4,637	1,600.00	4,800		0		0	9,437
			006	Install new 3" dia. Sewer line (force-main) (new Warehouse)	400	lft	0.31	1.15	142.6	96.00	13,690	29.00	11,600		0		0	25,290
			007	Install new 3" dia. Sewer - lift station (New Warehouse)	1	ea	24	1.15	27.6	96.00	2,650		0	15,000	15,000		0	17,650
200	**31000**			**Boiler Modifications**				1.15	8970		$ 861,120		$ 900,000		$ 600,000		$ 3,100,000	$ 5,461,120
	31000	001		**Unit #1,#2 & #3 Boiler**														
			001	Remove Insulation and Lagging on Boiler components (scaffolding and insulation)	3	lot										150,000	450,000	450,000
			002	Allowance for Type 3 Asbestos Abatement on Each Boiler	3	lot										250,000	750,000	750,000
			003	Install stiffening on boiler (2@ $750000 ea plus 1@ $ 400,000= $1,900,000)	1	lot										1,900,000	1,900,000	1,900,000
			004	Reinsulate and Lagging	3	lot	2000	1.15	6900.0	96.00	662,400	300,000.00	900,000		0		0	1,562,400
	32000	002		**FD Fans**														
			001	New Smaller Fan Wheels (Supply)	6	ea								100,000	600,000		0	600,000
			002	Install new Fan Wheels	6	ea	300	1.15	2070.0	96.00	198,720		0		0		0	198,720
	32200	003		**Flue Gas Ducts (Existing)**														
			001	Remove Insulation and lagging on breaching from stack connection to boiler	Included in Boiler pkg													
			002	Install stiffeners on breaching and components as required	Included in Boiler pkg													
			003	Reinsulate and install lagging	Included in Boiler pkg													
300	**32200**			**Breeching and Dampers**				1.15	154384		$ 14,820,891		$ 12,030,800		$ 2,823,400		$ 11,152,500	$ 40,827,591
				From Boiler units to Precipitators														
	23220	001		**Excavation for Flue Duct Supports Units 1,2,3**														
			001	Excavation	10,000	cy	0.06	1.15	690.0	96.00	66,240		0		0		0	66,240
			002	Drilling 9" dia. Holes into rock for piling	4,800	lft	0.28	1.15	1545.6	96.00	148,378		0		0		0	148,378
			003	Supply & install 8" dia CS pipe piles into bedrock (filled with concrete & rebar (320 piles)	9,600	lft	0.14	1.15	1545.6	96.00	148,378	23.00	220,800		0		0	369,178
			004	Anchor for 67 col. Locations. Each Anchor is 1.5" dia and 5 ft long.	270	ea	2.5	1.15	776.3	96.00	74,520	225.00	60,750		0		0	135,270
	23220	002		**Foundations**														

Client: **Newfoundland and Labrador Hydro**
Project: **HOLYROOD Generating Station - ESP/FGD Installation**
Project No: **133544177**
Currency: **Can. 3 rd Qtr**

STANTEC CONSULTING
Opinion Of Probable Construction Cost
(Without Project Allowances)

Stantec

Prepared by: **Fred Tozer**
Date: **14-Nov-08**
Revision No.: **1**

Area	SCI	Item	Activity	Description	Qty	Unit	Labour					Mat'l/Commodity		Equipment		Sub-Contractor		Total Cost
							Hrs per Unit	Prod. Factor	Total Hours	Rate	Cost	Unit Cost	Cost	Unit Cost	Cost	Unit Cost	Cost	
			001	Concrete Foundations (including framework, rebar, & concrete)	450	cy	8.7	1.15	4502.3	96.00	432,216	325.00	146,250		0		0	578,466
			002	Grout for column baseplates for 67 col,s	45	cft	1.8	1.15	93.2	96.00	8,942	95.00	4,275		0		0	13,217
			003	Backfill - Granular	5,000	cy	0.1	1.15	575.0	96.00	55,200	22.00	110,000		0		0	165,200
	23220	003		**Structural Steel**														
			001	Structural Steel for Ducts Support System including grating, handrail & kickplates	1,400	tons										6,000	8,400,000	8,400,000
			002	Stairs systems for 3 stair towers 70 ft rise per stair tower	35	tons										7,500	262,500	262,500
			003	Caged ladder systems	3,600	lft	0.64	1.15	2649.6	96.00	254,362	75.00	270,000		0		0	524,362
	32200	004		**Flue Gas Ducts**														
			001	Ductwork c/w stiffeners, access doors and ports (100,000 sf)	939	tons	25	1.15	26996.3	96.00	2,591,640	4,500.00	4,225,500		0		0	6,817,140
			002	Expansion Joints 8'6" x 8'6"	110	ea	24	1.15	3036.0	96.00	291,456		0	4,500	495,000		0	786,456
			003	Expansion Joints 18' x 8'6"	8	ea	40	1.15	368.0	96.00	35,328		0	7,250	58,000		0	93,328
			004	Insulation and Lagging (6" mineral wool)	126,000	sf	0.261	1.15	37818.9	96.00	3,630,614	10.72	1,350,720		0		0	4,981,334
				From Precipitator Outlet to ID Fans and from ID Fans to FGD Building including Bypasses														
	23220	005		**Excavation for Flue Duct Supports Units 1,2,3**														
			001	Excavation - common	3,000	cy	0.06	1.15	207.0	96.00	19,872		0		0		0	19,872
	23220	006		**Foundations**														
			001	Concrete Foundations (including framework, rebar, & concrete)	400	cy	8.7	1.15	4002.0	96.00	384,192	325.00	130,000		0		0	514,192
			002	Backfill - common	2,600	cy	0.1	1.15	299.0	96.00	28,704	9.00	23,400		0		0	52,104
			003	Backfill - Structural	65	cy	0.12	1.15	9.0	96.00	861	22.00	1,430		0		0	2,291
			004	Walkway foundation (excavation)	1,215	cy	0.16	1.15	223.6	96.00	21,462	13.00	15,795		0		0	37,257
	23220	007		**Structural Steel**														
			001	Structural Steel for Ducts Support System including grating, handrail & kickplates	390	tons							0		0	6,000	2,340,000	2,340,000
			002	Stairs Towers	20	tons							0		0	7,500	150,000	150,000
			003	Caged Ladders	1,000	lft	0.64	1.15	736.0	96.00	70,656	75.00	75,000		0		0	145,656
	32200	008		**Flue Gas Ducts**														
			001	Ductwork c/w stiffeners, access doors and ports (95,000 sf)	892	tons	25	1.15	25645.0	96.00	2,461,920	4,500.00	4,014,000		0		0	6,475,920
			002	Expansion Joints 12' x 12'	42	ea	36	1.15	1738.8	96.00	166,925		0	6,200	260,400		0	427,325
			003	Inlet and by-pass Dampers 12' x 12'	6	ea	240	1.15	1656.0	96.00	158,976		0	300,000	1,800,000		0	1,958,976
			004	Seal Air System	3	ea	160	1.15	552.0	96.00	52,992		0	70,000	210,000		0	262,992
			005	Insulation and Lagging (6" mineral wool)	129,000	sf	0.261	1.15	38719.4	96.00	3,717,058	10.72	1,382,880		0		0	5,099,938
400	**35210**			**Precipitators (unit 1, 2 &3)**				1.15	36519		$ 3,505,796		$ 1,535,347		$ -		$ 42,064,655	$ 47,105,798
				Precipitator and Precipitator Building (Units 1, 2 &3)														
	23521	001		**Excavation for Precipitators Units 1,2,3**														
			001	Excavation - common	4,530	cy	0.06	1.15	312.6	96.00	30,007		0		0		0	30,007
	23521	002		**Foundations**														
			001	Concrete Foundations (including framework, rebar, & concrete)	2,260	cy	8.7	1.15	22611.3	96.00	2,170,685	325.00	734,500		0		0	2,905,185

Client: **Newfoundland and Labrador Hydro**
Project: **HOLYROOD Generating Station - ESP/FGD Installation**
Project No: **133544177**
Currency: **Can. 3 rd Qtr**

STANTEC CONSULTING
Opinion Of Probable Construction Cost
(Without Project Allowances)

Prepared by: **Fred Tozer**
Date: **14-Nov-08**
Revision No.: **1**

Area	SCI	Item	Activity	Description	Qty	Unit	Labour					Mat'l/Commodity		Equipment		Sub-Contractor		Total Cost
							Hrs per Unit	Prod. Factor	Total Hours	Rate	Cost	Unit Cost	Cost	Unit Cost	Cost	Unit Cost	Cost	
			002	Slabs on Grade	260	cy	5.1	1.15	1524.9	96.00	146,390	264.00	68,640		0		0	215,030
			003	Concrete - curbs, walls etc..	120	cy	9	1.15	1242.0	96.00	119,232	390.00	46,800		0		0	166,032
			004	Backfill - Granular	1,065	cy	0.12	1.15	147.0	96.00	14,109	22.00	23,430		0		0	37,539
			005	Lean Concrete	1,975	cy	1.5	1.15	3406.9	96.00	327,060	150.00	296,250		0		0	623,310
	23521	**003**		**Structural Steel (For Stairs and platforms/walkways)**														
			001	Structural Steel	30	tons										6,000	180,000	180,000
	23251	**004**		**Building Finishes and Enclosures (Ash Hopper Area)**														
			001	Exterior Cladding and Liner Sheet	11,000	sf										18	198,000	198,000
			002	Doors and Flashing	12	ea	6.8	1.15	93.8	96.00	9,009	780.00	9,360		0		0	18,369
	23521	**005**		**Building Finishes and Enclosures (Weather Enclosure Area)**														
			001	Exterior Cladding and Liner Sheet	11,000	sf										18	198,000	198,000
			002	Doors and Flashing	12	ea	6.8	1.15	93.8	96.00	9,009	780.00	9,360		0		0	18,369
			003	Steel Decking	11,250	sf	0.01	1.15	129.4	96.00	12,420	2.15	24,188		0		0	36,608
			004	Roofing	11,250	sf										10	112,500	112,500
	35210	**006**		**Precipitator Supply and Install**	1	lot										39,954,600	39,954,600	39,954,600
			001	Precipitators and Ash Hoppers		Incl.												
			002	Structural Steel and Casing		Incl.												
			003	Electrodes and Collection Plates		Incl.												
			004	TR Sets and Controllers		Incl.												
			005	Discharge and Collecting Plate Rappers		Incl.												
			006	Insulators		Incl.												
			007	Penthouse, Hot Floor and Cold Floor		Incl.												
			008	Seal Air Fans and Ductwork		Incl.												
			009	Rapper Controls		Incl.												
			010	Insulation and Cladding		Incl.												
	73600	**007**		**Ash Hopper Area Building HVAC**														
			001	Louvers 4' x 4' (3 ea for each precip.)	9	ea	10	1.15	103.5	96.00	9,936	1,250.00	11,250		0		0	21,186
				Wall Fans (3 per precip)	9	ea	10	1.15	103.5	96.00	9,936	2,000.00	18,000		0		0	27,936
	73600	**008**		**Weather Enclosure Area Building HVAC**														
			001	Louvers 4' x 4' (3 per precip.)	9	ea	10	1.15	103.5	96.00	9,936	1,250.00	11,250		0		0	21,186
			002	Roof Ventilators (3 per precip)	9	ea	10	1.15	103.5	96.00	9,936	2,500.00	22,500		0		0	32,436
				Precipitator and ID Fan Electrical Building (Station Service Distribution Building)														
	23521	**009**		**Excavation for SSD Building**														
			001	Excavation - common	750	cy	0.06	1.15	51.8	96.00	4,968		0		0		0	4,968
	23251	**010**		**Foundations for SSD Building**														
			001	Concrete Foundations (including framework, rebar, & concrete)	230	cy	8.7	1.15	2301.2	96.00	220,910	325.00	74,750		0		0	295,660
			002	Slabs on Grade	60	cy	5.1	1.15	351.9	96.00	33,782	264.00	15,840		0		0	49,622
			003	Concrete - curbs, walls etc..	120	cy	9	1.15	1242.0	96.00	119,232	390.00	46,800		0		0	166,032
			004	Backfill - common	230	cy	0.12	1.15	31.7	96.00	3,047	9.00	2,070		0		0	5,117
			005	Lean Concrete	30	cy	1.5	1.15	51.8	96.00	4,968	150.00	4,500		0		0	9,468

Client: **Newfoundland and Labrador Hydro**
Project: **HOLYROOD Generating Station - ESP/FGD Installation**
Project No: **133544177**
Currency: **Can. 3 rd Qtr**

STANTEC CONSULTING
Opinion Of Probable Construction Cost
(Without Project Allowances)

Stantec

Prepared by: **Fred Tozer**
Date: **14-Nov-08**
Revision No.: **1**

Area	SCI	Item	Activity	Description	Qty	Unit	Labour					Mat'l/Commodity		Equipment		Sub-Contractor		Total Cost
							Hrs per Unit	Prod. Factor	Total Hours	Rate	Cost	Unit Cost	Cost	Unit Cost	Cost	Unit Cost	Cost	
	23251	**011**		**Structural Steel for SSD Building**														
			001	Structural Steel (105402 FT3)	100	tons										6,000	600,000	600,000
			002	Grating	160	sf										35	5,600	5,600
			003	Stairs and Ladders	4	tons										7,500	30,000	30,000
			004	Handrail	100	lft										115	11,500	11,500
			005	Kickplate	100	lft										36	3,600	3,600
	23251	**012**		Building Finishes and Enclosures for SSD Building														
			001	Demolish Exterior Cladding	3,000	sf										10	30,000	30,000
			002	Exterior Cladding	6,800	sf										18	122,400	122,400
			003	Doors	8	ea	6.8	1.15	62.6	96.00	6,006	780.00	6,240		0		0	12,246
			004	Elevated slabs (6")	165	cy	9.66	1.15	1833.0	96.00	175,967	481.00	79,365		0		0	255,332
			005	Slab Decking	4,640	sf	0.008	1.15	42.7	96.00	4,098	2.00	9,280		0		0	13,378
			006	Roof Decking	2,320	sf	0.01	1.15	26.7	96.00	2,561	2.15	4,988		0		0	7,549
			007	Roofing	2,320	sf										10	22,620	22,620
			008	Interior Concrete Block Walls	2,215	sf	0.125	1.15	318.4	96.00	30,567	4.25	9,414		0		0	39,981
			009	Painting	2,215	sf	0.007	1.15	17.8	96.00	1,712	0.71	1,573		0		0	3,284
			010	Flooring	4,630	sf										5	20,835	20,835
			011	Overhead Doors (12' x 14')	1	ea	24	1.15	27.6	96.00	2,650	5,000.00	5,000		0		0	7,650
			012	Sealing and Fire Stopping	1	Lot										25,000	25,000	25,000
	73600	**013**		**SSD Building Mechanical**														
			001	Electrical Room Area Cooling														
			002	VFD Area Cooling **TOP FLOOR** (40 ton capacity each AC units) @ $5,000 per ton installed	2	ea	48	1.15	110.4	96.00	10,598		0		0	200,000	400,000	410,598
			003	Electrical room Cooling **Ground FLOOR** (10 ton capacity each AC units) @ $5,000 per ton installed	2	ea	32	1.15	73.6	96.00	7,066		0		0	50,000	100,000	107,066
	79120		004	Roof Drains	1	Lot										50,000	50,000	50,000
500	**35230**			**Ash Handling**				1.15	13486		$ 1,294,639		$ 260,139		$ 2,800,000		$ 1,130,600	$ 5,485,378
				Ash Handling Building														
	23523	**001**		**Excavation for Ash Handling Building**														
			001	Excavation - common	1,200	cy	0.06	1.15	82.8	96.00	7,949		0		0		0	7,949
	23523	**002**		**Foundations**														
			001	Concrete Foundations	270	cy	8.7	1.15	2701.4	96.00	259,330	325.00	87,750		0		0	347,080
			002	Slabs on Grade	50	cy	5.1	1.15	293.3	96.00	28,152	264.00	13,200		0		0	41,352
			003	Concrete - curbs, walls etc..	130	cy	9	1.15	1345.5	96.00	129,168	428.00	55,640		0		0	184,808
			004	Backfill - granular	800	cy	0.12	1.15	110.4	96.00	10,598	22.00	17,600		0		0	28,198
	23523	**003**		**Structural Steel**														
			001	Structural Steel	100	tons										6,000	600,000	600,000
			002	Grating	450	sf										35	15,750	15,750
			003	Stairs and Ladders	5	tons										7,500	37,500	37,500
			004	Platforms	10	tons										7,500	75,000	75,000

Client: **Newfoundland and Labrador Hydro**
Project: **HOLYROOD Generating Station - ESP/FGD Installation**
Project No: **133544177**
Currency: **Can. 3 rd Qtr**

STANTEC CONSULTING
Opinion Of Probable Construction Cost
(Without Project Allowances)

Stantec

Prepared by: **Fred Tozer**
Date: **14-Nov-08**
Revision No.: **1**

Area	SCI	Item	Activity	Description	Qty	Unit	Labour: Hrs per Unit	Labour: Prod. Factor	Labour: Total Hours	Labour: Rate	Labour: Cost	Mat'l/Commodity: Unit Cost	Mat'l/Commodity: Cost	Equipment: Unit Cost	Equipment: Cost	Sub-Contractor: Unit Cost	Sub-Contractor: Cost	Total Cost
			005	Handrail	650	lft										115	74,750	74,750
			006	Kickplate	350	lft										36	12,600	12,600
	23523	**004**		**Building Finishes and Enclosures**														
			001	Exterior Cladding and Liner Sheet	15,000	sf										18	270,000	270,000
			002	Doors	8	ea	6.8	1.15	62.6	96.00	6,006	780.00	6,240		0		0	12,246
			003	Elevated slabs	16	cy	13.1	1.15	241.0	96.00	23,140	549.00	8,784		0		0	31,924
			004	Slab Decking	850	sf	0.008	1.15	7.8	96.00	751	2.00	1,700		0		0	2,451
			005	Roof Decking	1,500	sf	0.01	1.15	17.3	96.00	1,656	2.15	3,225		0		0	4,881
			006	Roofing	1,500	sf										10	15,000	15,000
			007	Overhead Doors (12' x 14')	1	ea	24	1.15	27.6	96.00	2,650	5,000.00	5,000		0		0	7,650
	73600	**005**		**Ash Handling Building Mechanical**														
			001	Ventilation	1	Lot										30,000	30,000	30,000
	35230	**006**		**Ash Handling System (Supply)**	1	Lot								2,800,000	2,800,000			2,800,000
			001	Precipitator High Pressure Dense Phase Bottles (12 Bottles per precipitator)		Incl.												
			002	Transfer Valves		Incl.												
			003	Bulk Piping		Incl.												
			004	Ash Silo		Incl.												
			005	Ash Silo Dust Collector		Incl.												
			006	Ash Silo Instrumentation		Incl.												
			007	Ash Silo Bottom Fluidizer		Incl.												
			008	Ash Silo Unloading Screw Conveyor		Incl.												
			009	Ash Conditioner		Incl.												
			010	Conditioner Unloading Valve		Incl.												
			011	Air compressors, receivers, dryers, valves, controls		Incl.												
			012	Ash Transport Piping		Incl.												
	70000	**007**		**Miscellaneous Mechanical**														
	35230		001	Ash Handling System Installation	1	lot	5200	1.15	5980.0	96.00	574,080		0		0		0	574,080
	75100		002	Compressed Air Piping 2" dia. c/w fittings & supports / 304 SS / Sch.40 (Headers)	750	lft	1.3	1.15	1121.3	96.00	107,640	44.00	33,000		0		0	140,640
	75100		003	Compressed Air Piping 1" dia. c/w fittings & supports / 304 SS / Sch.40 (Branches)	750	lft	1.3	1.15	1121.3	96.00	107,640	28.00	21,000		0		0	128,640
	72000		004	Service Water Piping 1'"dia. c/w fittings & supports / 304 SS / Sch.40	250	lft	1.3	1.15	373.8	96.00	35,880	28.00	7,000		0		0	42,880
	78000		005	Fire Protection	1	Lot									0	25,000	25,000	25,000
600	**32200**			**ID Fans (Unit 1,2 & 3) , includes equip't, bld'g, & Elect. Rooms**				1.15	27831		$ 2,671,768		$ 754,829		$ 7,696,002		$ 3,202,900	$ 14,325,499
	23220	**001**		**Excavation for ID Fan Buildings**														
			001	Excavation - common	3,500	cy	0.06	1.15	241.5	96.00	23,184		0		0		0	23,184
	23220	**002**		**Foundations for ID fan Building (Including Integral Utilidor)**														
			001	ID Fan Concrete Foundations (including framework, rebar, & concrete)	300	cy	4.8	1.15	1656.0	96.00	158,976	325.00	97,500		0		0	256,476
			002	Building Foundations & Utilidor Foundations	750	cy	8.71	1.15	7512.4	96.00	721,188	325.00	243,750		0		0	964,938
			003	Slabs on Grade	150	cy	5.09	1.15	878.0	96.00	84,290	264.00	39,600		0		0	123,890
			004	Backfill - common	1,300	cy	0.1	1.15	149.5	96.00	14,352	9.00	11,700		0		0	26,052
			005	Backfill - Granular	200	cy	0.12	1.15	27.6	96.00	2,650	22.00	4,400		0		0	7,050
			006	Lean Concrete (For ID Fan Foundations)	480	cy	1.5	1.15	828.0	96.00	79,488	150.00	72,000		0		0	151,488

Client: **Newfoundland and Labrador Hydro**
Project: **HOLYROOD Generating Station - ESP/FGD Installation**
Project No: **133544177**
Currency: **Can. 3 rd Qtr**

STANTEC CONSULTING
Opinion Of Probable Construction Cost
(Without Project Allowances)

Stantec

Prepared by: **Fred Tozer**
Date: **14-Nov-08**
Revision No.: **1**

Area	SCI	Item	Activity	Description	Qty	Unit	Labour					Mat'l/Commodity		Equipment		Sub-Contractor		Total Cost
							Hrs per Unit	Prod. Factor	Total Hours	Rate	Cost	Unit Cost	Cost	Unit Cost	Cost	Unit Cost	Cost	
	23220	**003**		**Structural Steel for ID Fan Building**														
			001	Structural Steel	300	tons										6,000	1,800,000	1,800,000
			002	Monorails	20	tons										6,000	120,000	120,000
			003	Steel Floor Decking	3,000	sf	0.008	1.15	27.6	96.00	2,650	2.00	6,000		0		0	8,650
			004	Stairs and Ladders	35	tons										7,500	262,500	262,500
			005	Handrail	400	lft										115	46,000	46,000
			006	Kickplate	400	lft										36	14,400	14,400
	23220	**004**		**Building Finishes and Enclosures**														
			001	Exterior Cladding	33,000	sf										18	594,000	594,000
			002	Doors	20	ea	6.8	1.15	156.4	96.00	15,014	780.00	15,600		0		0	30,614
			003	Roof Decking	11,000	sf	0.008	1.15	101.2	96.00	9,715	2.00	22,000		0		0	31,715
			004	Roofing	9,100	sf										10	91,000	91,000
			005	Elevated Concrete Slab	75	cy	9.66	1.15	833.2	96.00	79,985	481.00	36,075		0		0	116,060
			006	Interior Concrete Block Walls	7,400	sf	0.125	1.15	1063.8	96.00	102,120	4.25	31,450		0		0	133,570
			007	Painting	7,400	sf	0.007	1.15	59.6	96.00	5,719	0.71	5,254		0		0	10,973
			008	Overhead Doors (12' x 14')	6	ea	24	1.15	165.6	96.00	15,898	5,000.00	30,000		0		0	45,898
	73600	**005**		**ID Fan Building Mechanical**														
			001	Wall louvers and roof ventilators	1	Lot										100,000	100,000	100,000
	78000		002	Fire Protection	1	Lot										75,000	75,000	75,000
	73600		003	Electrical Rooms (2) Cooling - (2 @ 10 Tons per room)	1	Lot										100,000	100,000	100,000
			004	Roof Drains (Use Roof Scuppers)														
	32200	**006**		**ID Fan Systems**														
			001	ID Fans and Motors (Inc. VFD Drive, VIV's, Lube skid, instruments)	6	ea	1200	1.15	8280.0	96.00	794,880		0	1,226,242	7,357,452		0	8,152,332
			002	ID Fan Outlet Dampers	6	ea	40	1.15	276.0	96.00	26,496		0	29,000	174,000		0	200,496
		007		**Miscellaneous Mechanical**														
	75100		001	Compressed Air Piping (from FGD) 1.5" dia, sch 40, 304 ss	700	lft	1.1	1.15	885.5	96.00	85,008	35.00	24,500		0		0	109,508
	77000		002	Lube Oil Piping 3/4" dia, 316ss	400	lft	0.8	1.15	368.0	96.00	35,328	19.00	7,600		0		0	42,928
	76100		003	Hoists 10 ton capacity c/w monorail allowance	6	ea	300	1.15	2070.0	96.00	198,720	4,500.00	27,000	27,425	164,550		0	390,270
			004	Insulation and Lagging for Fans	7,500	sf	0.261	1.15	2251.1	96.00	216,108	10.72	80,400				0	296,508
700	**38000**			**FGD**				1.15	35618		$ 3,419,281		$ 1,792,773		$ 224,700		$ 133,288,443	$ 138,725,197
	23810	**001**		**Excavation for FGD Buildings**														
			001	Excavation - common	10,200	cy	0.06	1.15	703.8	96.00	67,565		0		0		0	67,565
			002	Excavation - Rock	200	cy										40	8,000	8,000
	23810	**002**		**Foundations**														
			001	Ball Mills	275	cy	4.8	1.15	1518.0	96.00	145,728	325.00	89,375		0		0	235,103
			002	Absorber (Rein. Lean)	800	cy	3	1.15	2760.0	96.00	264,960	225.00	180,000		0		0	444,960
			003	Limestone Slurry Tank	75	cy	4.8	1.15	414.0	96.00	39,744	325.00	24,375		0		0	64,119
			004	Reclaim Water Tank	125	cy	4.8	1.15	690.0	96.00	66,240	325.00	40,625		0		0	106,865
			005	Filter Feed Tank	40	cy	4.8	1.15	220.8	96.00	21,197	325.00	13,000		0		0	34,197
			006	Oxidation Air Compressors	385	cy	4.8	1.15	2125.2	96.00	204,019	325.00	125,125		0		0	329,144

Client: **Newfoundland and Labrador Hydro**
Project: **HOLYROOD Generating Station - ESP/FGD Installation**
Project No: **133544177**
Currency: **Can. 3 rd Qtr**

STANTEC CONSULTING
Opinion Of Probable Construction Cost
(Without Project Allowances)

Stantec

Prepared by: **Fred Tozer**
Date: **14-Nov-08**
Revision No.: **1**

Area	SCI	Item	Activity	Description	Qty	Unit	Labour					Mat'l/Commodity		Equipment		Sub-Contractor		Total Cost
							Hrs per Unit	Prod. Factor	Total Hours	Rate	Cost	Unit Cost	Cost	Unit Cost	Cost	Unit Cost	Cost	
			007	Building Foundations	320	cy	8.71	1.15	3205.3	96.00	307,707	325.00	104,000		0		0	411,707
			008	Building Sumps & Trenches	44	cy	13	1.15	657.8	96.00	63,149	460.00	20,240		0		0	83,389
			009	Slabs on Grade	550	cy	5.1	1.15	3225.8	96.00	309,672	264.00	145,200		0		0	454,872
			010	Concrete - curbs, walls etc..	125	cy	9	1.15	1293.8	96.00	124,200	390.00	48,750		0		0	172,950
			011	Backfill - common	1,520	cy	0.1	1.15	174.8	96.00	16,781	9.00	13,680		0		0	30,461
			012	Backfill - Granular	9,500	cy	0.12	1.15	1311.0	96.00	125,856	22.00	209,000		0		0	334,856
			013	Lean Concrete	855	cy	1.5	1.15	1474.9	96.00	141,588	150.00	128,250		0		0	269,838
			014	Utilidor Concrete Foundations	140	cy	20	1.15	3220.0	96.00	309,120	429.00	60,060		0		0	369,180
			015	Auxiliary Storage tank	140	cy	4.8	1.15	772.8	96.00	74,189	325.00	45,500		0		0	119,689
	23815	**003**		**Structural Steel**														
			001	Structural Steel (Supply and Install) (25314555 FT3)	3,365	tons										6,000	20,190,000	20,190,000
			002	Steel Floor Decking	19,000	sf	0.008	1.15	174.8	96.00	16,781	2.00	38,000		0		0	54,781
			003	Steel Roof Decking	22,000	sf	0.01	1.15	253.0	96.00	24,288	2.15	47,300		0		0	71,588
			004	Monorails	20	tons										6,000	120,000	120,000
			005	Grating	60,200	sf										35	2,107,000	2,107,000
			006	Stairs and Ladders	42	tons										7,500	315,000	315,000
			007	Platforms	29	tons										7,500	217,500	217,500
			008	Handrail	8,400	lft										115	966,000	966,000
			009	Kickplate	10,000	lft										36	360,000	360,000
	23816	**004**		**Building Finishes and Enclosures**														
			001	Exterior Cladding and Liner Sheet	141,000	sf										18	2,538,000	2,538,000
			002	Elevated Slabs (6")	355	cy	9.66	1.15	3943.7	96.00	378,595	481.00	170,755		0		0	549,350
			003	Doors	55	ea	6.8	1.15	430.1	96.00	41,290	780.00	42,900		0		0	84,190
			004	Roofing	22,000	sf										10	214,500	214,500
			005	Electrical Rooms Block Walls	19,400	sf	0.125	1.15	2788.8	96.00	267,720	4.25	82,450		0		0	350,170
			006	Elevator Block Walls	4,850	sf	0.125	1.15	697.2	96.00	66,930	4.25	20,613		0		0	87,543
			007	Stairwell Block Walls	17,500	sf	0.125	1.15	2515.6	96.00	241,500	4.25	74,375		0		0	315,875
			008	Painting	20,000	sf	0.007	1.15	161.0	96.00	15,456	0.71	14,200		0		0	29,656
			009	Overhead Doors (12' x 14')	5	ea	24	1.15	138.0	96.00	13,248	5,000.00	25,000		0		0	38,248
			010	Sealing and Fire Stopping	1	Lot									0	75,000	75,000	75,000
	38000	**005**		**FGD Process Mechanical**	1	lot										103,458,443	103,458,443	103,458,443
	38500		**001**	**Limestone Preparation System**		Incl.												
				Day Silos and Feeders		Incl.												
				Ball Mill System		Incl.												
				Ball Mill Product Tank and Pumps		Incl.												
				Ball Mill Classifiers		Incl.												
				Limestone Slurry Tank and Pumps		Incl.												
				Piping, Valves and Fittings		Incl.												
				Instrumentation		Incl.												
	38100		**002**	**Absorber System**		Incl.												
				Absorber Tower		Incl.												
				Recycle Pumps and Internal Sprays		Incl.												
				Absorber Agitators		Incl.												
				Oxidation Air System		Incl.												

Client: **Newfoundland and Labrador Hydro**
Project: **HOLYROOD Generating Station - ESP/FGD Installation**
Project No: **133544177**
Currency: **Can. 3 rd Qtr**

STANTEC CONSULTING
Opinion Of Probable Construction Cost
(Without Project Allowances)

Stantec

Prepared by: **Fred Tozer**
Date: **14-Nov-08**
Revision No.: **1**

Area	SCI	Item	Activity	Description	Qty	Unit	Labour					Mat'l/Commodity		Equipment		Sub-Contractor		Total Cost
							Hrs per Unit	Prod. Factor	Total Hours	Rate	Cost	Unit Cost	Cost	Unit Cost	Cost	Unit Cost	Cost	
				Absorber Outlet Damper and Ductwork		Incl.												
				Mist Eliminators and Sprays		Incl.												
				Mist Eliminator Tank and Pump		Incl.												
				Piping, Valves and Fittings		Incl.												
				Instrumentation		Incl.												
	38200		**003**	**Dewatering System**		Incl.												
				Absorber Blowdown pumps		Incl.												
				Hydroclone		Incl.												
				Vacuum Filters, pumps, cake wash, cloth wash, receivers		Incl.												
				Purge tank and Pumps		Incl.												
				Emergency Hold Tank and Pump		Incl.												
				Filter Feed Tank and Pumps		Incl.												
				Piping, Valves and Fittings		Incl.												
				Instrumentation		Incl.												
				Instrument / Service Air Compressors, Air Dryers and Receivers and piping		Incl.												
				Reclaim Water Tank and Pumps		Incl.												
				Limestone sump, agitators, pumps & piping		Incl.												
				Absorber sump, agitators, pumps & piping		Incl.												
	73600	**006**		**FGD Building Mechanical Ventilation**														
			001	Building HVAC System	1	Lot										1,250,000	1,250,000	1,250,000
			002	Roof Exhaust Fans		Incl.												
			003	Wall Exhaust Fans		Incl.												
			004	Building Louvers		Incl.												
			005	Electrical Room Cooling		Incl.												
			006	Rack Room Cooling		Incl.												
		007		**Miscellaneous Mechanical**														
	72100		001	Service Water Line (8" Dia.)includes pipe,fittings,valve, insulation	200	lft										180	36,000	36,000
	72100		002	Outlet Water Line (6" Dia.)includes pipe,fittings,valve, insulation	300	lft										160	48,000	48,000
	72100		003	60,000 usg , cs tank, epoxy lined and insulated 18' dia. X 38' h (Raw Water)	1	ea											160,000	160,000
	72100		004	Raw water pumps 50 hp	2	ea	100	1.15	230.0	96.00	22,080	6,000.00	12,000	17,500	35,000		0	69,080
	75100		005	Compressed Air Piping (Included in FGD Contractor scope)													0	0
	76100		006	Building and Equipment Hoists	4		50	1.15	230.0	96.00	22,080	4,500.00	18,000	27,425	109,700		0	149,780
	76100		007	Ball Mill Area Overhead Crane (10 Ton)	1	Lot	250	1.15	287.5	96.00	27,600		0	80,000	80,000		0	107,600
	76200		008	Building Elevator	1	Lot										350,000	350,000	350,000
	78000		009	Fire Protection	1	Lot										250,000	250,000	250,000
	79000		010	Roof Drains and Piping	1	Lot										400,000	400,000	400,000
	79120		011	Elevated Slab Process Floor Drains and Piping	1	Lot										150,000	150,000	150,000
	79120		012	Washroom Fixtures, Heater, Piping and Drains	1	Lot										75,000	75,000	75,000
800	**23290**			**Stack**				1.15	18366		1763150		1538431		0		20362000	23,663,581
	23290	**001**		**New Chimney (Supply and Install)**	1	lot									0	18,250,000	18,250,000	18,250,000
			001	Concrete Windshell		Incl.												
			002	Carbon Steel Flue Lined with Borosilicate Block		Incl.												

Client: **Newfoundland and Labrador Hydro**
Project: **HOLYROOD Generating Station - ESP/FGD Installation**
Project No: **133544177**
Currency: **Can. 3 rd Qtr**

STANTEC CONSULTING
Opinion Of Probable Construction Cost
(Without Project Allowances)

Stantec

Prepared by: **Fred Tozer**
Date: **14-Nov-08**
Revision No.: **1**

Area	SCI	Item	Activity	Description	Qty	Unit	Labour					Mat'l/Commodity		Equipment		Sub-Contractor		Total Cost
							Hrs per Unit	Prod. Factor	Total Hours	Rate	Cost	Unit Cost	Cost	Unit Cost	Cost	Unit Cost	Cost	
			003	C-276 Inlet Duct and Thimble		Incl.												
			004	Stainless Steel Outlet Cone		Incl.												
			005	Manlift		Incl.												
			006	Ladders and Platforms		Incl.												
			007	Truck door and mandoor		Incl.												
	23290	002	001	**Concrete Supply for Chimney**	1,900	cy						160.00	304,000		0		0	304,000
	23294	003		**Excavation for Chimney**														
			001	Excavation - common	6,000	cy	0.06	1.15	414.0	96.00	39,744		0		0		0	39,744
	23294	004		**Foundations**														
			001	Stack Foundation (including framework, rebar, & concrete)	2,800	cy	4.41	1.15	14200.2	96.00	1,363,219	325.00	910,000		0		0	2,273,219
			002	Slabs on Grade	50	cy	5.1	1.15	293.3	96.00	28,152	264.00	13,200		0		0	41,352
			003	Misc. Metals	31	tons	25	1.15	891.3	96.00	85,560	6,200.00	192,200		0		0	277,760
			004	Lean Concrete	105	cy	1.5	1.15	181.1	96.00	17,388	150.00	15,750		0		0	33,138
			005	Rock Anchors	32	ea										3,500	112,000	112,000
	38100	005		**Additional Ductwork and Piping**														
			001	Inlet duct extension 21' x 21' (C276 Material)	20	lft										100,000	2,000,000	2,000,000
			002	Insulate 65 lft of 21' x 21' duct & Lagging	5,460	sf	0.261	1.15	1638.8	96.00	157,327	10.72	58,531		0		0	215,858
			003	Drain Piping and Stack to FGD 16" dia. FRP and elevated	125	ft.	5.2	1.15	747.5	96.00	71,760	358.00	44,750		0		0	116,510
900	38400			**Limestone Receiving and Handling**				1.15	13037		$ 1,251,578		$ 980,202		$ 130,000		$ 6,688,940	$ 9,050,721
				Limestone Truck Receiving System														
	23840	001		**Limestone Conveyor Foundations**														
			001	Excavation - Common	2,300	cy	0.06	1.15	158.7	96.00	15,235		0		0		0	15,235
			002	Rock fill (6" max.)	1,600	cy	0.1	1.15	184.0	96.00	17,664	22.00	35,200		0		0	52,864
			003	Gravel fill	470	cy	0.1	1.15	54.1	96.00	5,189	22.00	10,340		0		0	15,529
			004	Pervious fill (3/4" minus)	40	cy	0.1	1.15	4.6	96.00	442	22.00	880		0		0	1,322
			005	Common fill	100	cy	0.1	1.15	11.5	96.00	1,104	9.00	900		0		0	2,004
			006	Cast in place concrete	80	cy	6.5	1.15	598.0	96.00	57,408	325.00	26,000		0		0	83,408
	23840	002		**Limestone Receiving Structure**														
			001	Excavation - Common	4,200	cy	0.06	1.15	289.8	96.00	27,821		0		0		0	27,821
			002	Excavation - Rock	1,400	cy										40	56,000	56,000
			003	Rock fill (6" max.)	350	cy	0.1	1.15	40.3	96.00	3,864	22.00	7,700		0		0	11,564
			004	Gravel fill	250	cy	0.1	1.15	28.8	96.00	2,760	22.00	5,500		0		0	8,260
			005	Pervious fill (3/4" minus)	100	cy	0.1	1.15	11.5	96.00	1,104	22.00	2,200		0		0	3,304
			006	Common fill	100	cy	1	1.15	115.0	96.00	11,040	9.00	900		0		0	11,940
			007	Geotextile	82	sy	0.08	1.15	7.5	96.00	724	3.20	262		0		0	987
			008	Cast in place concrete	416	cy	6.5	1.15	3109.6	96.00	298,522	325.00	135,200		0		0	433,722
			009	Misc. Metals	10	tons	25	1.15	287.5	96.00	27,600	6,200.00	62,000		0		0	89,600

Client: **Newfoundland and Labrador Hydro**
Project: **HOLYROOD Generating Station - ESP/FGD Installation**
Project No: **133544177**
Currency: **Can. 3 rd Qtr**

STANTEC CONSULTING
Opinion Of Probable Construction Cost
(Without Project Allowances)

Stantec

Prepared by: **Fred Tozer**
Date: **14-Nov-08**
Revision No.: **1**

Area	SCI	Item	Activity	Description	Qty	Unit	Labour					Mat'l/Commodity		Equipment		Sub-Contractor		Total Cost
							Hrs per Unit	Prod. Factor	Total Hours	Rate	Cost	Unit Cost	Cost	Unit Cost	Cost	Unit Cost	Cost	
	23840	003		**Structural Steel**														
			001	Structural Steel (Supply and Install)	32	tons										6,000	192,000	192,000
			002	Grating	425	sf										35	14,875	14,875
	23841	004		**Building Finishes and Enclosures**														
			001	Exterior Cladding and Liner Sheet	3,060	sf										18	55,080	55,080
			002	Mandoors	4	ea.	6.8	1.15	31.3	96.00	3,003	780.00	3,120		0		0	6,123
			003	Roofing	630	sf										10	5,985	5,985
			004	Overhead Doors (16' wide x 34.5' High)	1	ea	180	1.15	207.0	96.00	19,872	44,160.00	44,160		0		0	64,032
			005	Miscellaneous Finishes	1	Lot									0	50,000	50,000	50,000
	38400	005		**Limestone Mechanical**														
			001	Limestone Vibratory Feeder	1	ea	64	1.15	73.6	96.00	7,066		0	17,500	17,500		0	24,566
			002	Receiving Hopper and Grizzly	1	Lot										100,000	100,000	100,000
			003	Main Conveyor to FGD Building (50 HP) enclosed in 8' x 8' gallery	300	lft	20.8	1.15	7176.0	96.00	688,896	2,086.00	625,800		0		0	1,314,696
			004	Transfer Conveyor #1 (10 HP)	30	lft	6.8	1.15	234.6	96.00	22,522	668.00	20,040		0		0	42,562
			005	FGD Chutework and Diverter Gate	5	ea	72	1.15	414.0	96.00	39,744		0	22,500	112,500		0	152,244
			006	Front End Loader (3 m3 capacity) approx. wt = 18 tons, std bucket (quote)	1	allow										225,000	225,000	225,000
	73600	006		**Limestone Building Mechanical Ventilation**														
			001	Building Ventilation	1	Lot										15,000	15,000	15,000
				Optional Limestone Receiving System From the Fuel Unloading Jetty														
	23840	001		**Foundations**														
			001	Conveyor Foundations from Fuel Unloading Jetty to the Plant	110	ea.										7,500	825,000	825,000
		002		**Mechanical**														
			001	Conveyor from Jetty to Station	5,500	ft.										800	4,400,000	4,400,000
			002	Limestone Stacker at the Station	1	Lot										750,000	750,000	750,000
1000	**38400**			**Gypsum Handling and Landfill**				1.15	13289		$ 1,275,705		$ 373,612		$ 516,720		$ 5,576,000	$ 7,757,037
	23840	001		**Gypsum Conveyor Foundations**														
			001	Excavation - Common	1,400	cy	0.06	1.15	96.6	96.00	9,274		0		0		0	9,274
			002	Rock fill (6" max.)	980	cy	0.1	1.15	112.7	96.00	10,819	22.00	21,560		0		0	32,379
			003	Gravel fill	280	cy	0.1	1.15	32.2	96.00	3,091	22.00	6,160		0		0	9,251
			004	Pervious fill (3/4" minus)	25	cy	0.1	1.15	2.9	96.00	276	22.00	550		0		0	826
			005	Common fill	60	cy	0.1	1.15	6.9	96.00	662	9.00	540		0		0	1,202
			006	Cast in place concrete	52	cy	6.5	1.15	388.7	96.00	37,315	325.00	16,900		0		0	54,215
	23840	002		**Gypsum Storage Building**														
			001	Excavation - Common	3,800	cy	0.06	1.15	262.2	96.00	25,171		0		0		0	25,171
			002	Rock fill (6" max.)	2,100	cy	0.1	1.15	241.5	96.00	23,184	22.00	46,200		0		0	69,384

Client: **Newfoundland and Labrador Hydro**
Project: **HOLYROOD Generating Station - ESP/FGD Installation**
Project No: **133544177**
Currency: **Can. 3 rd Qtr**

STANTEC CONSULTING
Opinion Of Probable Construction Cost
(Without Project Allowances)

Stantec

Prepared by: **Fred Tozer**
Date: **14-Nov-08**
Revision No.: **1**

Area	SCI	Item	Activity	Description	Qty	Unit	Labour					Mat'l/Commodity		Equipment		Sub-Contractor		Total Cost
							Hrs per Unit	Prod. Factor	Total Hours	Rate	Cost	Unit Cost	Cost	Unit Cost	Cost	Unit Cost	Cost	
			003	Gravel fill	780	cy	0.1	1.15	89.7	96.00	8,611	22.00	17,160		0		0	25,771
			004	Pervious fill (3/4" minus)	390	cy	0.1	1.15	44.9	96.00	4,306	22.00	8,580		0		0	12,886
			005	Common fill	200	cy	0.1	1.15	23.0	96.00	2,208	9.00	1,800		0		0	4,008
	23840	**003**		**Foundations**														
			001	Building Foundations (including framework, rebar, & concrete)	730	cy	8.7	1.15	7303.7	96.00	701,150	325.00	237,250		0		0	938,400
			002	Geotextile	235	sy	0.08	1.15	21.6	96.00	2,076	3.20	752		0		0	2,828
			003	Misc. Metals	2	tons	25	1.15	57.5	96.00	5,520	6,200.00	12,400		0		0	17,920
			004	Bollards	2	ea	8	1.15	18.4	96.00	1,766	400.00	800		0		0	2,566
			005	Catch Basins	2	ea	6	1.15	13.8	96.00	1,325	700.00	1,400		0		0	2,725
	23845	**004**		**Structural Steel**														
			001	Structural Steel (Supply and Install)	70	tons										6,000	420,000	420,000
	23846	**005**		**Building Finishes and Enclosures**														
			001	Exterior Cladding	12,000	sf										13	156,000	156,000
			002	Doors	2	ea	6	1.15	13.8	96.00	1,325	780.00	1,560		0		0	2,885
	38400	**006**		**Gypsum Handling Mechanical**														
			001	Vacuum Filter Collection Conveyor 24" wide	40	lft	5.1	1.15	234.6	96.00	22,522		0	750	30,000		0	52,522
			002	Gypsum Transfer Conveyor 24" wide	40	lft	5.1	1.15	234.6	96.00	22,522		0	750	30,000		0	52,522
			003	Main Gypsum Conveyor to Storage 30' wide , enclosed in 8' x 8' gallery	160	lft	19.1	1.15	3514.4	96.00	337,382		0	1,917	306,720		0	644,102
			004	Conveyor Transfer Chutework	15	tons	25	1.15	431.3	96.00	41,400		0	7,500	112,500		0	153,900
			005	Emergency Dump Chutework	5	tons	25	1.15	143.8	96.00	13,800		0	7,500	37,500		0	51,300
	73600	**007**		**Gypsum Building Mechanical Ventilation**														
			001	Wall Mounted Exhaust Fans (4)	1	Lot												15,000
	38400	**008**		**Gypsum Landfill (Includes Ash Landfill and Leachate Pond)**														
			001	Landfill Development Allowance (Does not include Land cost if required)	1	Lot										5,000,000	5,000,000	5,000,000
1100	**79160**			**Wastewater Treatment Plant**	1	Lot										1,515,000	1,515,000	1,515,000
	79160	**001**		**Wastewater Equipment (Supply and Install)**	1	Lot										1,515,000	1,515,000	1,515,000
			001	Sludge/Lime Mix Tank		Incl.												
			002	Reaction Tanks		Incl.												
			003	Solids Conditioning Tank		Incl.												
			004	Lime Slurry Makeup Tank		Incl.												
			005	Tank Agitators		Incl.												
			006	Wastewater Thickener		Incl.												
			007	Sand Filters		Incl.												
			008	Bulk Bag Discharger		Incl.												
			009	Polymer Preparation System		Incl.												
			010	Lime Slurry Recycle Pumps		Incl.												
			011	Thickener Underflow Pumps		Incl.												
			012	Chemical Metering Pumps		Incl.												

Client: **Newfoundland and Labrador Hydro**
Project: **HOLYROOD Generating Station - ESP/FGD Installation**
Project No: **133544177**
Currency: **Can. 3 rd Qtr**

STANTEC CONSULTING
Opinion Of Probable Construction Cost
(Without Project Allowances)

Stantec

Prepared by: **Fred Tozer**
Date: **14-Nov-08**
Revision No.: **1**

Area	SCI	Item	Activity	Description	Qty	Unit	Labour					Mat'l/Commodity		Equipment		Sub-Contractor		Total Cost
							Hrs per Unit	Prod. Factor	Total Hours	Rate	Cost	Unit Cost	Cost	Unit Cost	Cost	Unit Cost	Cost	
			013	Wastewater Sump and Pumps		Incl.												
			014	Low Pressure Blower		Incl.												
1200	**50000**			**Power**				1.15	63900		$ 6,134,432		$ 6,038,721		$ 7,291,936		$ -	$ 19,465,089
	53000	**001**		**Power Distribution 230 KV Distribution and Substation**														
				Installation of 230kv Swiches in Switchyard														
			001	Install Concrete Pad	9	U	8	1.15	82.8	96.00	7,949	500	4,500		0		0	12,449
			002	Install 230kv Switches in Switchyard	6	U	48	1.15	331.2	96.00	31,795		0	192,000	1,152,000		0	1,183,795
			003	Install 230kv Breakers in Switchyard	3	U	48	1.15	165.6	96.00	15,898		0	360,000	1,080,000		0	1,095,898
			004	Boom Truck	60	U		1.15	0.0	96.00	0	200	12,000		0		0	12,000
			005	Install Tray in Switchyard 230kv Switches to Trench	1	U	153.6	1.15	176.6	96.00	16,957	7,493	7,493		0		0	24,450
			006	Install Pedestrian Trench A	1	U	85	1.15	97.8	96.00	9,384	17,750	17,750		0		0	27,134
			007	Install Pedestrian Trench B	1	U	85	1.15	97.8	96.00	9,384	17,750	17,750		0		0	27,134
			008	Freight to Site	1	U		1.15	0.0	96.00	0	90,000	90,000		0		0	90,000
			009	Install Cable Tray in Trench A	1	U	363	1.15	417.5	96.00	40,075	20,866	20,866		0		0	60,941
			010	Install Cable Tray in Trench B	1	U	363	1.15	417.5	96.00	40,075	20,866	20,866		0		0	60,941
			011	Install Transformers TSSD-A and TSSD- B, Blast Wall, and Basement	2	U	450	1.15	1035.0	96.00	99,360	62,500	125,000	1,100,000	2,200,000		0	2,424,360
			012	Freight to Site	2	U		1.15	0.0	96.00	0	90,000	180,000		0		0	180,000
			013	Install 230kV Cable	1	U	786	1.15	903.9	96.00	86,774	408,636	408,636		0		0	495,410
			014	Install Tray For Control Cabling	1	U	109.5	1.15	125.9	96.00	12,089	9,456	9,456		0		0	21,545
			015	Install and Terminate Control Cabling	1	U	329.1	1.15	378.5	96.00	36,333	26,708	26,708		0		0	63,041
	53000	**002**		**230kV Substation Grounding**														
			001	230kV Substation Grounding	1	U	93.75	1.15	107.8	96.00	10,350	6,058	6,058		0		0	16,408
	53000	**003**		**Power Distribution 4160V Distribution and Substation**														
			001	Install 5kV Switchgear in SSDA (9 Sections)	1	U	216	1.15	248.4	96.00	23,846		0	459,100	459,100		0	482,946
			002	Install 5kV Switchgear in SSDB (7 Sections)	1	U	168	1.15	193.2	96.00	18,547		0	386,136	386,136		0	404,683
			003	Install VFD in SSDA	3	U	80	1.15	276.0	96.00	26,496		0		0		0	26,496
			004	Install VFD in SSDB	3	U	80	1.15	276.0	96.00	26,496		0		0		0	26,496
			005	Boom Truck	40	U		1.15	0.0	96.00	0	200	8,000		0		0	8,000
			006	Cabling from 5kV Switchgear to VFD	1	U	218.7	1.15	251.5	96.00	24,144	44,351	44,351		0		0	68,495
			007	Cabling from 5kV Switchgear to ESP Building	1	U	150.4	1.15	173.0	96.00	16,604	60,376	60,376		0		0	76,981
			008	Install 5kV Switchgear in FGD Building														
				Install FGD A Switchgear	1	U	168	1.15	193.2	96.00	18,547		0	352,247	352,247		0	370,794
				Install FGD B Switchgear	1	U	168	1.15	193.2	96.00	18,547		0	352,247	352,247		0	370,794
				Boom Truck	40	U		1.15	0.0	96.00	0	200	8,000		0		0	8,000
			009	Cabling from 5kV Switchgear to 5kV/600V Switchgear														
				FGD A	1	U	137.85	1.15	158.5	96.00	15,219	26,149	26,149		0		0	41,368
				FGD B	1	U	137.85	1.15	158.5	96.00	15,219	26,149	26,149		0		0	41,368
				Freight for Switchgear	1	U		1.15	0.0	96.00	0	31,000	31,000		0		0	31,000
	53000	**004**		**Power Distribution 600V Distribution**														

Client: **Newfoundland and Labrador Hydro**
Project: **HOLYROOD Generating Station - ESP/FGD Installation**
Project No: **133544177**
Currency: **Can. 3 rd Qtr**

STANTEC CONSULTING
Opinion Of Probable Construction Cost
(Without Project Allowances)

Stantec

Prepared by: **Fred Tozer**
Date: **14-Nov-08**
Revision No.: **1**

Area	SCI	Item	Activity	Description	Qty	Unit	Labour Hrs per Unit	Labour Prod. Factor	Labour Total Hours	Labour Rate	Labour Cost	Mat'l/Commodity Unit Cost	Mat'l/Commodity Cost	Equipment Unit Cost	Equipment Cost	Sub-Contractor Unit Cost	Sub-Contractor Cost	Total Cost
			001	5kV / 600V Transformer and Switchgear FGD														
				Load Break Disconnect	2	U	48	1.15	110.4	96.00	10,598		0	20,000	40,000		0	50,598
				2500kVA Transformer	2	U	80	1.15	184.0	96.00	17,664		0	73,500	147,000		0	164,664
				FGD 600V Switchgear	2	U	60	1.15	138.0	96.00	13,248		0	46,377	92,754		0	106,002
			002	5kV / 600V Transformer and Switchgear ESP														
				Load Break Disconnect	2	U	48	1.15	110.4	96.00	10,598		0	20,000	40,000		0	50,598
				2500kVA Transformer	2	U	80	1.15	184.0	96.00	17,664		0	73,500	147,000		0	164,664
				ESP 600V Switchgear	2	U	60	1.15	138.0	96.00	13,248		0	46,377	92,754		0	106,002
			003	Supply and Install MCC in FGD														
				Limestone	1	U	71.5	1.15	82.2	96.00	7,894		0	59,038	59,038		0	66,932
				Absorber	2	U	55.5	1.15	127.7	96.00	12,254		0	49,545	99,090		0	111,345
				BOP A MCC	1	U	71.5	1.15	82.2	96.00	7,894		0	54,961	54,961		0	62,854
				BOP B MCC	1	U	71.5	1.15	82.2	96.00	7,894		0	54,961	54,961		0	62,854
				Gypsum	1	U	71.5	1.15	82.2	96.00	7,894		0	57,787	57,787		0	65,681
				WWT5	1	U	47.5	1.15	54.6	96.00	5,244		0	38,714	38,714		0	43,958
			004	Supply and Install MCC in ESP														
				ESP	6	U	71.5	1.15	493.4	96.00	47,362		0	57,318	343,908		0	391,270
				ESP/BOP	1	U	55.5	1.15	63.8	96.00	6,127		0	42,240	42,240		0	48,367
				MCC Feeders in FGD	1	U	375.55	1.15	431.9	96.00	41,461	59,045	59,045		0		0	100,506
				MCC Feeders in ESP	1	U	429.2	1.15	493.6	96.00	47,384	67,480	67,480		0		0	114,864
	56000	**005**		**FGD Building Services**														
			001	FGD Building Services	1	U	9909	1.15	11395.4	96.00	1,093,954	618,604	618,604		0		0	1,712,558
	57000	**006**		**FGD Building Tray**														
			001	FGD Building Tray	1	U	6085.85	1.15	6998.7	96.00	671,878	263,332	263,332		0		0	935,210
	57000	**007**		**FGD Building and Stack Grounding**														
			001	FGD Building Grounding	1	U	626.4	1.15	720.4	96.00	69,155	49,213	49,213		0		0	118,367
	57000	**008**		**FGD DC, UPS & Process Power**														
			001	FGD DC, UPS & Process Power	1	U	410.8	1.15	472.4	96.00	45,352	351,395	351,395		0		0	396,747
	56000	**009**		**Fly Ash Building Services**														
			001	Fly Ash Building Services	1	U	264.25	1.15	303.9	96.00	29,173	18,437	18,437		0		0	47,611
	57000	**010**		**Fly Ash Building Tray**														
			001	Fly Ash Building Tray	1	U	365.15	1.15	419.9	96.00	40,313	19,006	19,006		0		0	59,318
	56000	**011**		**Gypsum Storage Building Services**														
			001	Gypsum Storage Building Services	1	U	331.65	1.15	381.4	96.00	36,614	19,973	19,973		0		0	56,588
	57000	**012**		**Gypsum Storage Building Tray**														
			001	Gypsum Storage Building Tray	1	U	163.6	1.15	188.1	96.00	18,061	7,189	7,189		0		0	25,250

Client: **Newfoundland and Labrador Hydro**
Project: **HOLYROOD Generating Station - ESP/FGD Installation**
Project No: **133544177**
Currency: **Can. 3 rd Qtr**

STANTEC CONSULTING
Opinion Of Probable Construction Cost
(Without Project Allowances)

Stantec

Prepared by: **Fred Tozer**
Date: **14-Nov-08**
Revision No.: **1**

Area	SCI	Item	Activity	Description	Qty	Unit	Labour Hrs per Unit	Labour Prod. Factor	Labour Total Hours	Labour Rate	Labour Cost	Mat'l/Commodity Unit Cost	Mat'l/Commodity Cost	Equipment Unit Cost	Equipment Cost	Sub-Contractor Unit Cost	Sub-Contractor Cost	Total Cost
	57000	**013**		**Gypsum Storage Grounding**														
			001	Gypsum Storage Grounding	1	U	74.54	1.15	85.7	96.00	8,229	4,733	4,733		0		0	12,962
	56000	**014**		**Precipitator Building Services**														
			001	Precipitator Building Services	1	U	3985.02	1.15	4582.8	96.00	439,946	219,654	219,654		0		0	659,600
	57000	**015**		**Precipitator Building Tray**														
			001	Precipitator Building Tray	1	U	2475.6	1.15	2846.9	96.00	273,306	112,111	112,111		0		0	385,417
	57000	**016**		**Precipitator Building Grounding**														
			001	Precipitator Building Grounding	1	U	525.88	1.15	604.8	96.00	58,057	31,605	31,605		0		0	89,662
	56000	**017**		**Limestone Gallery Building Services**														
			001	Limestone Gallery Building Services	1	U	194.97	1.15	224.2	96.00	21,525	12,519	12,519		0		0	34,044
	57000	**018**		**Limestone Gallery Tray**														
			001	Limestone Gallery Tray	1	U	365.15	1.15	419.9	96.00	40,313	19,006	19,006		0		0	59,318
	57000	**019**		**Limestone Building Grounding**														
			001	Limestone Building Grounding	1	U	177.5	1.15	204.1	96.00	19,596	8,622	8,622		0		0	28,218
	56000	**020**		**Station Service Distribution Building Services**														
			001	SSD Building Services	1	U	656.5	1.15	755.0	96.00	72,478	43,679	43,679		0		0	116,156
	56000	**021**		**Station Service Distribution Building Tray**														
			001	SSD Building Tray	1	U	643.84	1.15	740.4	96.00	71,080	29,715	29,715		0		0	100,795
	57000	**022**		**Station Service Distribution Building Grounding**														
			001	SSD Building Grounding	1	U	100.06	1.15	115.1	96.00	11,047	7,447	7,447		0		0	18,494
	56000	**023**		**Scale House Building Services**														
			001	Scale House Building Services	1	U	305	1.15	350.8	96.00	33,672	18,435	18,435		0		0	52,107
	56000	**024**		**Transformer Tunnel Building Services**														
			001	Transformer Tunnel Building Services	1	U	418.62	1.15	481.4	96.00	46,216	25,952	25,952		0		0	72,168
	57000	**025**		**Transformer Tunnel Tray and Cable Bus**														
			001	Transformer Tunnel Tray and Cable Bus	1	U	4960.5	1.15	5704.6	96.00	547,639	490,796	490,796		0		0	1,038,436
	57000	**026**		**Cabling from MCC**														
			001	Cabling from Unit 1 Precipitator	1	U	1243.9	1.15	1430.5	96.00	137,326	178,122	178,122		0		0	315,448
			002	Cabling from Unit 2 Precipitator	1	U	1252.58	1.15	1440.5	96.00	138,284	193,901	193,901		0		0	332,185
			003	Cabling from Unit 3 Precipitator	1	U	1271.83	1.15	1462.6	96.00	140,409	208,201	208,201		0		0	348,611
			004	ID Fan Building	1	U	32.72	1.15	37.6	96.00	3,612	1,154	1,154		0		0	4,766
			005	Flyash Handling	1	U	87.28	1.15	100.4	96.00	9,636	8,216	8,216		0		0	17,851
			006	Limestone Receiving	1	U	598.43	1.15	688.2	96.00	66,067	51,854	51,854		0		0	117,920
			007	Absorber System	1	U	725.81	1.15	834.7	96.00	80,129	137,030	137,030		0		0	217,159

Client: **Newfoundland and Labrador Hydro**
Project: **HOLYROOD Generating Station - ESP/FGD Installation**
Project No: **133544177**
Currency: **Can. 3 rd Qtr**

STANTEC CONSULTING
Opinion Of Probable Construction Cost
(Without Project Allowances)

Stantec

Prepared by: **Fred Tozer**
Date: **14-Nov-08**
Revision No.: **1**

Area	SCI	Item	Activity	Description	Qty	Unit	Labour					Mat'l/Commodity		Equipment		Sub-Contractor		Total Cost
							Hrs per Unit	Prod. Factor	Total Hours	Rate	Cost	Unit Cost	Cost	Unit Cost	Cost	Unit Cost	Cost	
			008	Gypsum Dewatering	1	U	467.63	1.15	537.8	96.00	51,626	50,867	50,867		0		0	102,494
			009	FGD Balance of Plant	1	U	538.085	1.15	618.8	96.00	59,405	58,808	58,808		0		0	118,212
			010	Waste Water Treatment	1	U	163.88	1.15	188.5	96.00	18,092	5,917	5,917		0		0	24,009
			011	Control Cabling and JBs	1	U	5979	1.15	6875.9	96.00	660,082	334,803	334,803		0		0	994,885
		027		**Site Work**														
			001	Temporary Construction Power and Relocations	1	Lot						350,000	350,000		0		0	350,000
		028		**Site Lighting**														
			001	Site Lighting	10	U	41	1.15	471.5	96.00	45,264	5,054	50,537		0		0	95,801
	60000	**029**		**Instrumentation**														
			001	CEM System	4	U	313	1.15	1439.8	96.00	138,221	177,564	710,256		0		0	848,477
	60000	**030**		**BOP Instrumentation**	100	U	4	1.15	460.0	96.00	44,160	500	50,000		0		0	94,160
1300				**DCS Console**			200	1.15	288	96.00	27,600		0	513,950	513,950		0	541,550
		001																
			001	DCS Console	1		250	1.15	287.5	96.00	27,600		0	513,950	513,950		0	541,550
				SUB-TOTAL DIRECT (PROJECT)					**402905**		**$ 38,678,880**		**$ 27,895,529**		**$ 22,836,708**		**$ 230,271,038**	**$ 319,747,155**
1400				**Construction Indirects**														31,015,474
			001	Construction Staff including Living Allowance														23,021,795
			002	Construction Field Indirects														7,993,679
1500				**Commissioning**														8,671,120
			001	Commissioning														6,171,120
			002	Capital Spares														2,500,000
1600				**Project Management and Engineering**														31,974,716
			001	Engineering														31,974,716
				TOTAL DIRECT (PROJECT)														**391,408,465**
				Contingency @ 15%														58,711,270
				GRAND TOTAL														**450,119,735**

APPENDIX B.
Design Basis

Stantec Consulting Ltd.
845 Prospect Street
Fredericton, NB E3B 2T7
Tel: (506) 452-7000

NEWFOUNDLAND AND LABRADOR HYDRO
ST.JOHN'S NEWFOUNDLAND

PRECIPITATOR AND FGD STUDY

DESIGN BASIS

Prepared By:

STANTEC CONSULTING
845 PROSPECT STREET
P. O. BOX 713
FREDERICTON, NB E3B 5B4

PROJECT NUMBER: 44177

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Background

Newfoundland and Labrador Hydro (NLH) is evaluating the technical and economic requirements in retrofitting the Holyrood Thermal Generating Station with new precipitators and a Flue Gas Desulphurization(FGD) system.

1.2 Objectives

The objectives of this study are:

- To develop preliminary concepts and sizing's for unitized precipitators and a common FGD system for the station for the removal of particulate and SO_2 based on information provided by NLH and Best Available Control Technology (BACT).
- To develop preliminary layouts and general arrangement drawings showing the integration of the new precipitators and FGD system with the current plant.
- Evaluate the integration requirements and impact of installing the new precipitators and FGD system on the existing Holyrood station.
- Identify all terminal points between the existing Holyrood plant and new facilities.
- Develop capital and operating cost estimates for the precipitators and the FGD system.

1.3 Design Basis Information

The design basis will be used to define the plant physical, technical, operating and cost parameters, and to define the assumptions and approaches used in this study. This document will form the basis of all of Stantec's and their subcontractors' work.

2. DESIGN DATA

2.1 Site Conditions

- Holyrood Thermal Generating Station, Holyrood, Newfoundland.
- Road Access – Assume existing road system is adequate.
- Marine Access – On-site oil receiving Terminal

2.2 Codes

- National Building Code of Canada, 2005 Edition (NBC)
- National Fire Code of Canada, 2005 Edition
- National Fire Protection Association 101, Life Safety Code, 2006 Edition
- Province of Newfoundland and Labrador – Occupational Health and Safety Act and Regulations
- Newfoundland and Labrador Regulation 39/04 – Air Pollution Control Regulation, 2004 under the Environmental Protection Act (O.C. 2004-232).
- Canadian Electrical Code

2.3 Site Design Conditions (NBCC 2005 – St. John's NL)

• Winter Design Temperature (2.5%)	-14 ^{o}C
• Summer Design Temperature (July 2.5%)	+24°C (Dry) +20^{o}C (Wet)
• Degree Days Below 18^{o}	4800
• 15 Minute Rain	18 mm
• One Day Rain (1/50)	118 mm
• Annual Rain	1200 mm
• Annual Total Precipitation	1575 mm
• Driving Wind Pressure	400 Pa
• Snow Load (1/50) (Ss)	2.9 kPa
• Snow Load (1/50) (Sr)	0.7 kPa
• Hourly Wind Pressures (1/10)	0.6 kPa
• Hourly Wind Pressures (1/50)	0.8 kPa
• Seismic Data Sa(0.2)	.18
• Seismic Data Sa(0.5)	.11
• Seismic Data Sa(1.0)	.060
• Seismic Data Sa(2.0)	.016
• Seismic Data (PGA)	.090
• Importance Category	Post Disaster

2.4 Units of Measure

The units of measure for the retrofit will be US units for site development, building and structures. SI units for process measurements.

2.5 Site Equipment Locations and Philosophy

Unitized electrostatic precipitators (ESP) will be installed for each individual boiler unit to remove particulate from the flue gas. A common FGD system will be installed to remove the SO_2 from the flue gas for all three(3) units. Individual bypasses will be provided for each unit around the FGD system.

Due to the congestion on the North side of the plant, the precipitators and the FGD will all be located to the east of the existing Unit #3 boiler house in the location previously reserved for Unit #4.

New ID fans will be required and these will also be located in this area.

The precipitators, ID fans and the FGD will be housed in enclosed and heated buildings. A new stack will also be built to accommodate the saturated gas discharge from the common FGD system.

3. GENERAL

3.1 Plant Operations

The additional equipment added to the Holyrood plant will be designed to not compromise existing plant availability and reliability. The current station annual capacity factor is around 40-50%. A annual capacity factor of 60% will be used for O&M calculations. This reflects possible future operating expectations. The station operates under base load from December through March and is shut down for three summer months. Load varies in the shoulder season months.

The plant design will allow full load operation from all of the Units without compromising availability.

3.2 Plant Design and Equipment Selection

Utility industry standards will be used for design and equipment selection. The following fundamental redundancies will be provided for the major systems:

- Precipitator
  - Individual Unit Precipitator
  - A & B side divided plenums
  - 2 – 50% capacity ID fans to serve two gas trains

- FGD System
  - 100% redundancy on the Ball Mill System
  - Single Absorber Tower with individual unit bypasses
  - Multiple absorber recycle pumps for increased turn down and SO2 removal tuning.
  - 100% redundant Gypsum dewatering system
  - 2 x 100% pump trains for process flows.
  - Common wet stack.

4. ENVIRONMENTAL

4.1 Water Usage

Reducing water usage is to be considered in all technology analysis and selection. Maximizing water recycling and reuse is a design parameter.

The water supply from the existing dam will need to be further investigated by NLH. Current flows may not be sufficient to supply this additional capacity.

4.2 Water Discharge

The water discharge from the new facilities will be kept to a minimum. FGD blowdown waste water will be required to control chloride concentrations in the absorber. The capacity of the existing waste water treatment plant will need to be verified. Upgrades may be required to accommodate the additional liquid and solids stream.

4.3 Gaseous Emissions

The gaseous emissions from the stations will be improved by the addition of the precipitators and the FGD system. Both the emission of particulate and SO_2 will be greatly reduced at the station by the addition of this equipment. The precipitator and FGD efficiencies will be maximized to conform to the Best Available Control Technologies (BACT) requirement outlined in the latest emissions regulations with reference to NEWFOUNDLAND AND LABRADOR REGULATION 39/04 – Air Pollution Control Regulation, 2004 under the Environmental Protection Act (O.C. 2004-232).

4.4 Solid Waste

- Fly ash captured from the three units will transferred to an ash storage silo and conditioned before being land filled in the existing or upgraded NLH landfill site.
- Gypsum production from the FGD will conveyed to a storage area and then transported by truck to the approved landfill area. If saleable grade gypsum is produced, NLH may consider marketing the gypsum to potential wall board suppliers.

5. EXISTING EQUIPMENT

5.1 Holyrood Thermal Generating Station

Full load combustion calculation will be based on the following MCR boiler conditions:

	Unit #1	**Unit #2**	**Unit 3**
Manufacturer	CE	CE	B&W
Year	1970 (1987 Mod's)	1970 (1987 Mod's)	1980
Type of Firing	Tangential	Tangential	Wall
Steam Flow (lbs/hr)	1,167,000	1,167,000	1,070,000
Steam Temperature (Deg. C)	1005	1005	1005
Steam Pressure (Psig)	1955	1955	1890
Gross Plant Output (MW)	175	175	150
Firing Rate at 100% MCR (kg/sec)	11.8	11.5	10

5.2 Design Fuel

The design of the precipitator and FGD system will be based on the station burning a typical 2% sulphur fuel. The following fuel specification was provided by NLH and will be used as the basis of design:

No.6 Fuel Oil		**UNITS**	**VALUES**
Ultimate Analysis	Moisture	% w/w	.55
	Ash	% w/w	.08
	Total Carbon	% w/w	87.69
	Hydrogen	% w/w	9.66
	Nitrogen	% w/w	.43
	Oxygen	% w/w	.04
	Sulphur	% w/w	2.10
Gravity API at 60 F			5.8
Flash Point F		Deg. C	100
Pour Point F		Deg. C	6
Sodium		ppm	37
Viscosity @ 51 C		cSt	647
Viscosity SFS at 122 C		cSt	300

Sulphur % by Weight	% w/w	2
Vanadium	ppm	49.5
BTU's per US Gal.		154,631
BTU's per LB.		17983
Ash by Weight	% w/w	.08
Sediment by Weight	% w/w	.245
Water by Volume		.125
Cleanliness		1
Asphaltenes by Weight	% w/w	7.85
Silica		103
Hydrogen Sulfide	ppm	<1

5.3 Plant Services

The following is the status of plant services for this study:

Service Air	A new service air system will be incorporated into the FGD building to serve the requirements. The dense phase ash handling system will require a separate system for this application.
Instrument Air	A separate instrumentation air system will be incorporated into the design of the FGD system.
Firewater/Service Water	Sufficient capacity for new plant. Will be a separate zone from the existing system.
Fresh Water	An additional water source will need to be investigated as current source may not be sufficient
Wastewater Treatment	To be reviewed as water balance is developed.
Plant Administrative and Maintenance Facilities	No additions or upgrade required.

5.4 Electrical

A new electrical distribution system will be included for the new equipment. Medium voltage will be 5 kV and low voltage will be 600 V or 208/120 V. The new 5 kV switchgear will be connected to the existing plants 5 kV unit and station service boards as required. Low voltage step-down transformers will be provided as required to service the 600V loads and will be connected to the new 5 kV distribution on the primary side.

Motors larger than 200 HP will be 4160 V and 600 V for motors less than or equal to 200 HP. The ID Fans will be driven from medium voltage VFD's. New low voltage MCC's will be used to house feeder breakers, full voltage starters or VFD's as required for the 600V loads.

Power distribution system will be designed on the "A" and "B" bus concepts.

Refurbishment of the existing 5 kV switchgear, if required, will be included in the plant refurbishment estimate and thus, not included in this study.

5.5 Controls

Control of the new equipment will be from the existing control room. The existing control system will be expanded to accommodate this. The FGD building will have a temporary control station installed in one of the I/O rack rooms for commissioning and maintenance purposes.

No refurbishment of the existing DCS is included.

6. PRECIPITATORS

New precipitators will be installed for each unit. The precipitators shall be designed to meet the requirements of BACT and to conform to the NEWFOUNDLAND AND LABRADOR REGULATION 39/04 – Air Pollution Control Regulation, 2004 under the Environmental Protection Act (O.C. 2004-232). As minimum, the particulate removal efficiency of the precipitators shall not be less than 95%.

The precipitators shall include as a minimum the following basic design philosophy and components:

- 2 x 50% Gas Trains (A & B sides)
- Carbon Steel precipitator casing and supports
- Inlet and Outlet Flanged connections c/w gas distribution baffles
- Insulators and insulator plenum
- Insulator heated seal air system
- TR Sets and TR Set Controllers
- Rigid Discharge Electrodes (RTD)
- Collecting Electrodes
- Discharge and Collecting electrode rapping system including controls
- Weather enclosure
- Insulation and Cladding
- Ash hoppers and ash hopper heaters c/w controls
- Complete precipitator state of the art controls

7. FLYASH COLLECTION AND STORAGE

The flyash collected in the precipitators will be transferred to a central flyash storage and conditioning facility located on the site. For the purpose of this study the flyash will be collected and land filled. NLH may decide to re-inject the flyash at a later date. The flyash system will include the following basic design philosophy and components.

- Designed to transfer all of the collected flyash to a central storage and conditioning system
- Use dense phase technology to the transfer the flyash from the precipitators to the storage silo.

- Including the following major equipment:
    - Pneumatic flyash transfer bottles
    - All piping and fittings to transfer the flyash from the precipitators to the silo.
    - Compressed air system for the dense phase transfer
    - Flyash storage silo (3 Days Minimum Storage)
    - Silo unloading and metering system
    - Flyash conditioning equipment
    - Conditioned ash load out facility
    - Complete instrumentation and control system for the flyash transfer, storage and conditioning system.

8. ID FANS

New ID fans will be required to overcome the draft loses from the new breeching, precipitator and FGD system. The new ID Fans will include the following basic design philosophy and components:

- Designed for Unit Boiler operation at 100% MCR
- 2 x 50% capacity ID fans per unit
- Heavy Duty Industrial Grade double inlet centrifugal fan
- Inlet VIV vanes for volume control on low flow conditions
- VFD Control for high load control application
- Insulated and Clad
- TEFC Motor (Motor RTD's, vibration etc.)
- Fan Instrumentation (Bearing Temperatures, Vibration etc..)
- ID Fan enclosure for sound attenuation and maintenance

9. FLUE GAS DESUPHURIZATION (FGD)

The FGD system will be common for all three units and include the following design philosophy and major components:

- 95% minimum SO_2 removal efficiency
- Single absorber tower common to all three units
- Individual flue gas bypasses for each individual units
- Limestone receiving, handling and storage facility
- 2 x 100% Wet ball mill systems
- 2 x 100% Gypsum dewatering system
- Enclosed gypsum storage building for truck load out (3 day minimum storage)
- Emergency Hold Tank

10. NEW WET STACK

A new wet stack will be required to handle the combined flue gas volumes from all three units. The new wet stack will be designed in accordance to the following philosophy and include as a minimum the following design features:

- Designed for the saturated gas flow from all three units at 100% MCR from all three boilers
- Designed for bypass gas flows from all three units at 100% MCR.
- Concrete wind shell with carbon steel liner and acid resistant brick lining.
- Single Flue common to all three units
- C-276 Inlet and stack Thimble c/w drain back top the absorber tower
- C-276 chimney Outlet section
- Stack test ports
- Stack elevator to test port elevation
- CEMS
- Aviation warning lights

11. CAPITAL COST

Capital cost to an accuracy of ±25% will be provided. A contingency will be applied to the total estimate once the estimate is complete. This contingency will be determined in discussions with NLH. The estimate will be as follows:

- Present day 2008 Canadian dollars.

The following costs are not included:

- Newfoundland and Labrador Hydro Owner's costs.
- Environmental permits or licenses
- Insurance.
- Interest during construction.
- Duties and taxes.

The following Fossil Power Plant System Component Index (SCI) structure shall be used for the identifying the work areas. The breakdown to be used is defined in Table 8.1 below.

Table 8.1 System Component Index

WBS	DESCRIPTION
00000	General
10000	Site
20000	General Buildings and Structures
30000	Steam Generation Facilities
40000	Heat Power cycle
50000	Electric power systems
60000	Instrumentation and control
70000	Auxiliary processes and services
80000	Construction indirects
90000	Overhead engineering & administration

The following Work Breakdown Structure(WBS) will also be used in conjunction with the SCI system to breakdown the opinion of probable cost for the project. The following major WBS project breakdown shown in Table 8.2 will be used:

Table 8.2 Project Work Breakdown Structure

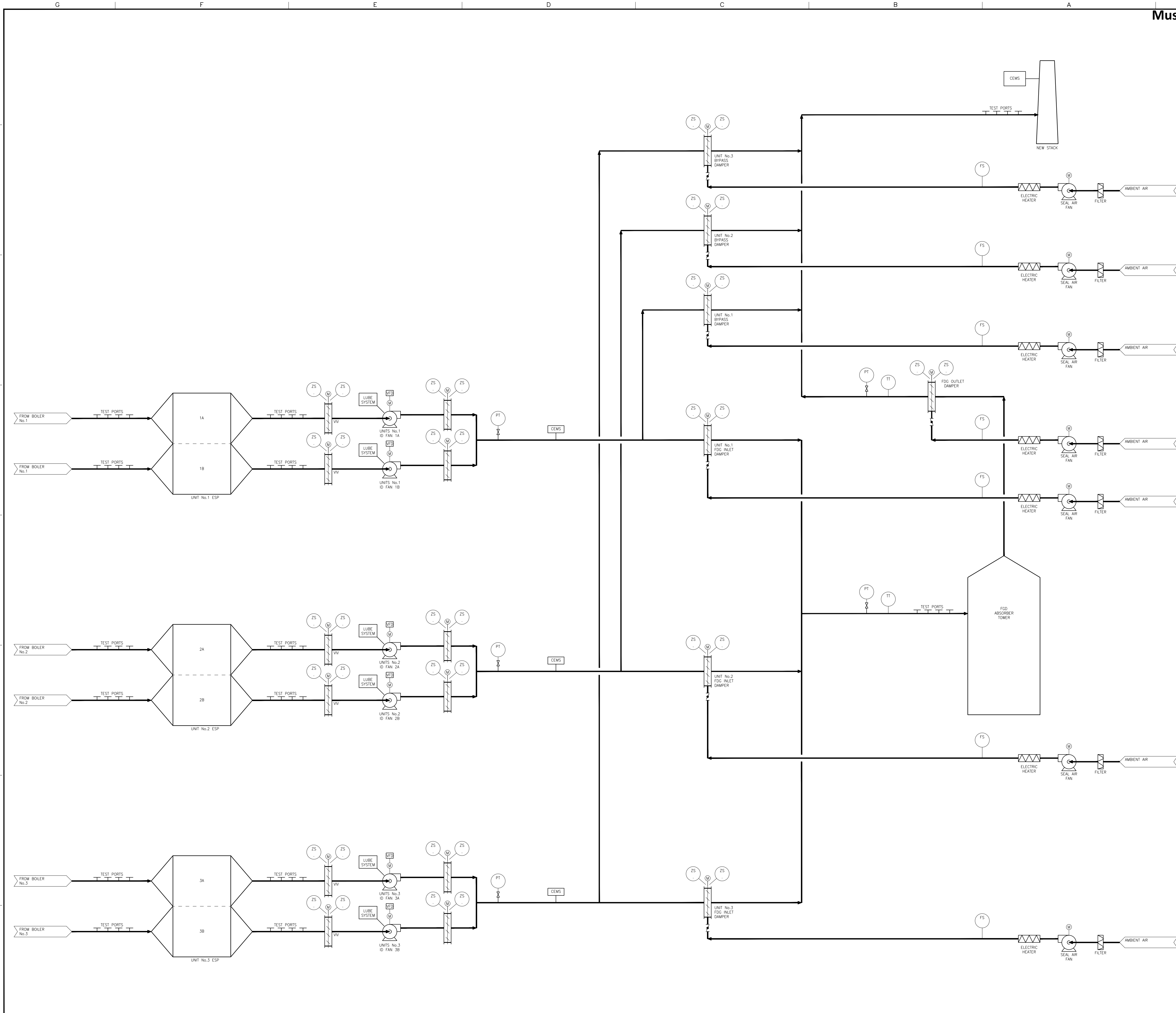
WBS	DESCRIPTION
100	Site Preparation and Site Services
200	Boiler Modifications
300	Breeching and Dampers
400	Precipitators
500	Ash Handling
600	ID Fans
700	Flue Gas Desulphurization(FGD)
800	Stack
900	Limestone Handling
1000	Gypsum Handling
1100	Waste Water Treatment
1200	Power Distribution
1300	DCS
1400	Construction Indirects
1500	Commissioning
1600	Project Management and Engineering

12. OPERATING AND MAINTENANCE COSTS

The additional operating and maintenance costs for the new equipment will be included. Costs will be broken into a fixed and variable component. The following costs are to be used.

O&M Cost Basis	
Full Time Employee	\$90,000 pa - Operator \$76,000 pa – Maintenance \$55,000 pa – Equipment Operator \$45,000 pa - Laborer
Limestone Supply Cost	\$15/10^3 kg
Gypsum Disposal Costs	\$20/10^3 kg
Ash Disposal Costs	\$20/10^3 kg
Fresh Water	Negl.
Waste Treatment	Negl.
Power Costs	\$0.11/kwh

APPENDIX C.
Flow Sheets



PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	AUG. 15, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED | DRAWN TDM
CHECKED (DESIGN, DFTG.) | DATE 08/13/2008
SCALE NTS
APPROVED | SPEC.
P.M. MDV | P.T. DHG

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

PRECIPITATOR AND FGD STUDY

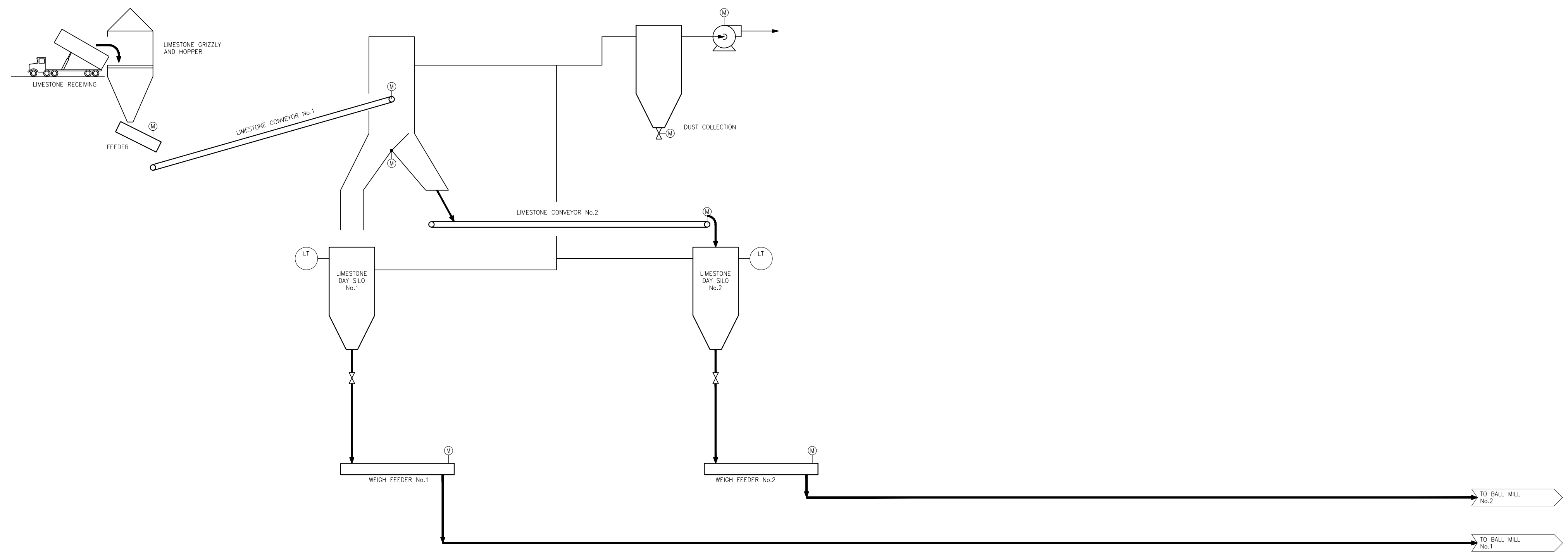
PROCESS FLOW DIAGRAM
UNITS No.1, 2 AND 3
FLUE GAS FLOW

JOB No. 133544177 | DWG. No. E-4021 | REV B

M:\dwg\133544177\133544177E4021.dwg

Nov 18, 2008 1:15pm cboudreau

DWG. No.	TITLE	BY



PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	AUG. 15, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED	DRAWN TDM
CHECKED DESIGN DFTG.	DATE 08/13/2008
	SCALE NTS
APPROVED	SPEC.
P.M. MDV / P.T. DHG	

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

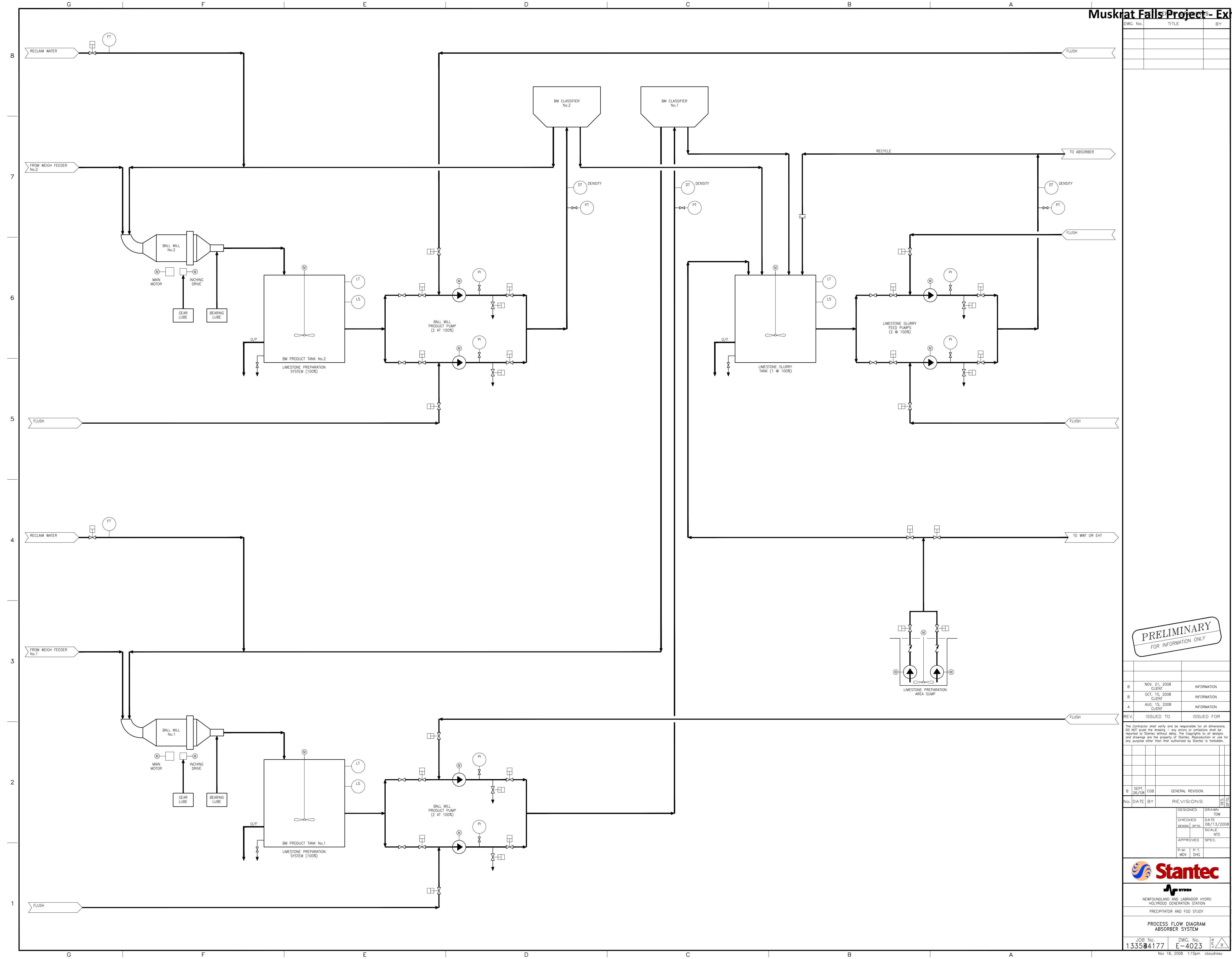
PRECIPITATOR AND FGD STUDY

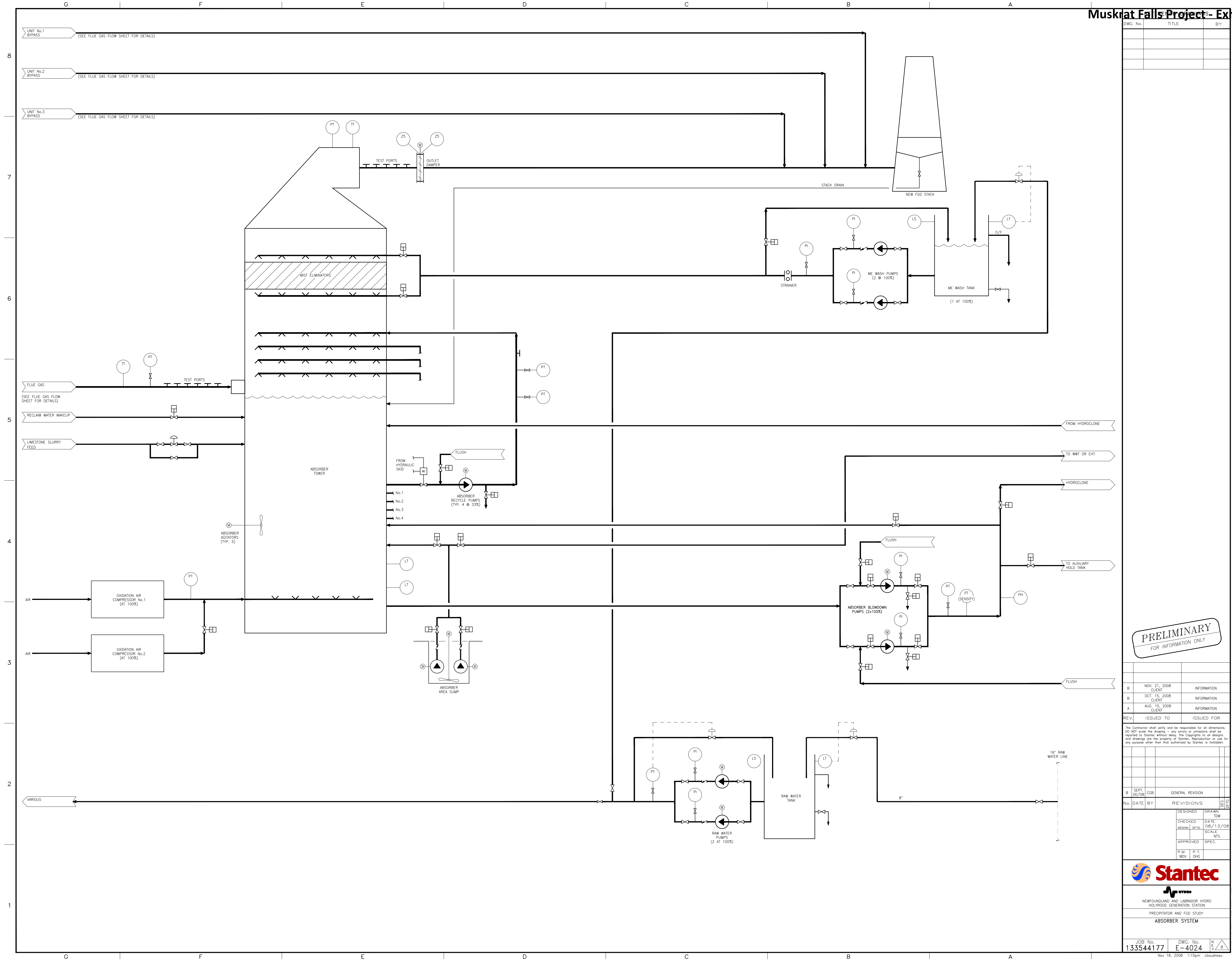
LIMESTONE HANDLING

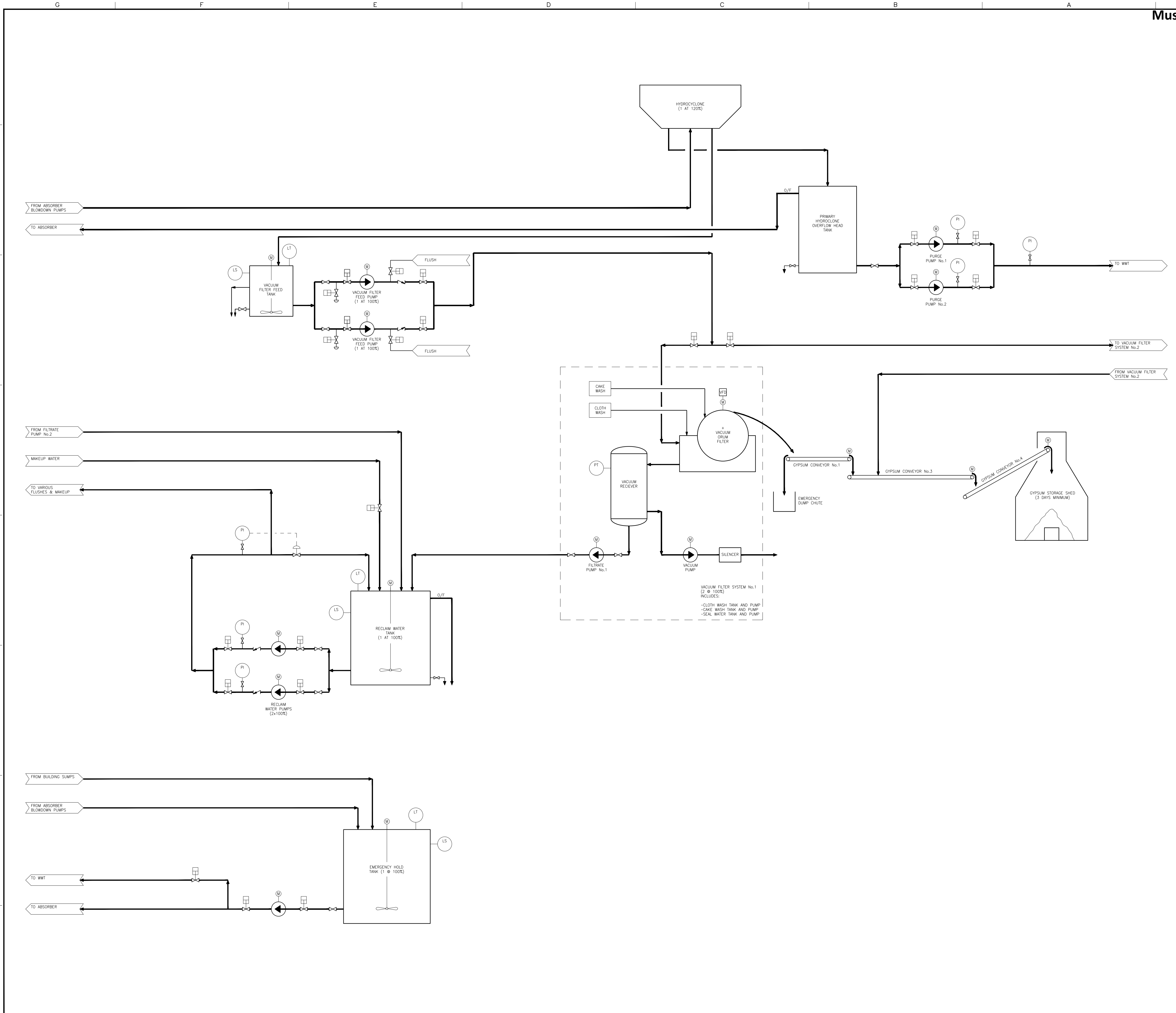
JOB No.	DWG. No.	REV
133544177	E-4022	B

M:\dwg\133544177\133544177E4022.dwg

Nov 18, 2008 1:15pm cboudreau


RECLAIM WATER
FT
FROM WEIGH FEEDER No.2
FLUSH
BM CLASSIFIER No.2
BM CLASSIFIER No.1
RECYCLE
TO ABSORBER
DT DENSITY
PT
BALL MILL No.2
MAIN MOTOR
INCHING DRIVE
GEAR LUBE
BEARING LUBE
LT
LS
O/F
BM PRODUCT TANK No.2
LIMESTONE PREPARATION SYSTEM (100%)
BALL MILL PRODUCT PUMP (2 AT 100%)
PI
LIMESTONE SLURRY TANK (1 @ 100%)
LIMESTONE SLURRY FEED PUMPS (2 @ 100%)
TO WWT OR EHT
LIMESTONE PREPARATION AREA SUMP
FROM WEIGH FEEDER No.1
BALL MILL No.1
BM PRODUCT TANK No.1
PRELIMINARY
FOR INFORMATION ONLY
B NOV. 21, 2008 CLIENT INFORMATION
B OCT. 15, 2008 CLIENT INFORMATION
A AUG. 15, 2008 CLIENT INFORMATION
REV. ISSUED TO ISSUED FOR
The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing – any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than that authorized by Stantec is forbidden.
B SEPT. 26/08 CGB GENERAL REVISION
No. DATE BY REVISIONS DES. DFTG.
DESIGNED
DRAWN TDM
CHECKED DESIGN DFTG.
DATE 08/13/2008
SCALE NTS
APPROVED
SPEC.
P.M. MDV
P.T. DHG
Stantec
HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION
PRECIPITATOR AND FGD STUDY
PROCESS FLOW DIAGRAM
ABSORBER SYSTEM
JOB No. 133544177
DWG. No. E-4023
REV B
Nov 18, 2008 1:15pm cboudreau
M:\dwg\133544177\133544177E4023.dwg


UNIT No.1 BYPASS
(SEE FLUE GAS FLOW SHEET FOR DETAILS)
UNIT No.2 BYPASS
(SEE FLUE GAS FLOW SHEET FOR DETAILS)
UNIT No.3 BYPASS
(SEE FLUE GAS FLOW SHEET FOR DETAILS)
TEST PORTS
OUTLET DAMPER
STACK DRAIN
NEW FGD STACK
MIST ELIMINATORS
STRAINER
ME WASH PUMPS (2 @ 100%)
ME WASH TANK (1 AT 100%)
O/F
FLUE GAS
(SEE FLUE GAS FLOW SHEET FOR DETAILS)
RECLAIM WATER MAKEUP
LIMESTONE SLURRY FEED
FROM HYDROCLONE
TO WWT OR EHT
HYDROCLONE
ABSORBER TOWER
FROM HYDRAULIC SKID
FLUSH
ABSORBER RECYCLE PUMPS (TYP. 4 @ 33%)
No.1
No.2
No.3
No.4
ABSORBER AGITATORS (TYP. 5)
TO AUXILIARY HOLD TANK
ABSORBER BLOWDOWN PUMPS (2x100%)
PT (DENSITY)
PH
AIR
OXIDATION AIR COMPRESSOR No.1 (AT 100%)
OXIDATION AIR COMPRESSOR No.2 (AT 100%)
ABSORBER AREA SUMP
VARIOUS
RAW WATER PUMPS (2 AT 100%)
RAW WATER TANK
16" RAW WATER LINE
8"
PRELIMINARY
FOR INFORMATION ONLY
DWG. No.
TITLE
BY
B NOV. 21, 2008 CLIENT INFORMATION
B OCT. 15, 2008 CLIENT INFORMATION
A AUG. 15, 2008 CLIENT INFORMATION
REV. ISSUED TO ISSUED FOR
The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing – any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than that authorized by Stantec is forbidden.
B SEPT. 26/08 CGB GENERAL REVISION
No. DATE BY REVISIONS DES. DFTG.
DESIGNED
DRAWN TDM
CHECKED DESIGN DFTG.
DATE 08/13/08
SCALE NTS
APPROVED
SPEC.
P.M. MDV
P.T. DHG
Stantec
HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION
PRECIPITATOR AND FGD STUDY
ABSORBER SYSTEM
JOB No. 133544177
DWG. No. E-4024
REV B
M:\dwg\133544177\133544177E4024.dwg
Nov 18, 2008 1:15pm cboudreau



PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
C	NOV. 21, 2008 CLIENT	INFORMATION
C	OCT. 15, 2008 CLIENT	INFORMATION
B	SEPT. 24, 2008 CLIENT	INFORMATION
A	AUG. 15, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
C	SEPT. 30/08	CGB	GENERAL REVISION		
B	SEPT. 24/08	CGB	GENERAL REVISION		

DESIGNED	DRAWN TDM
CHECKED DESIGN DFTG.	DATE 08/13/2008
	SCALE NTS
APPROVED	SPEC.
P.M. MDV	P.T. DHG

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

PRECIPITATOR AND FGD STUDY

PROCESS FLOW DIAGRAM
DEWATERING SYSTEM

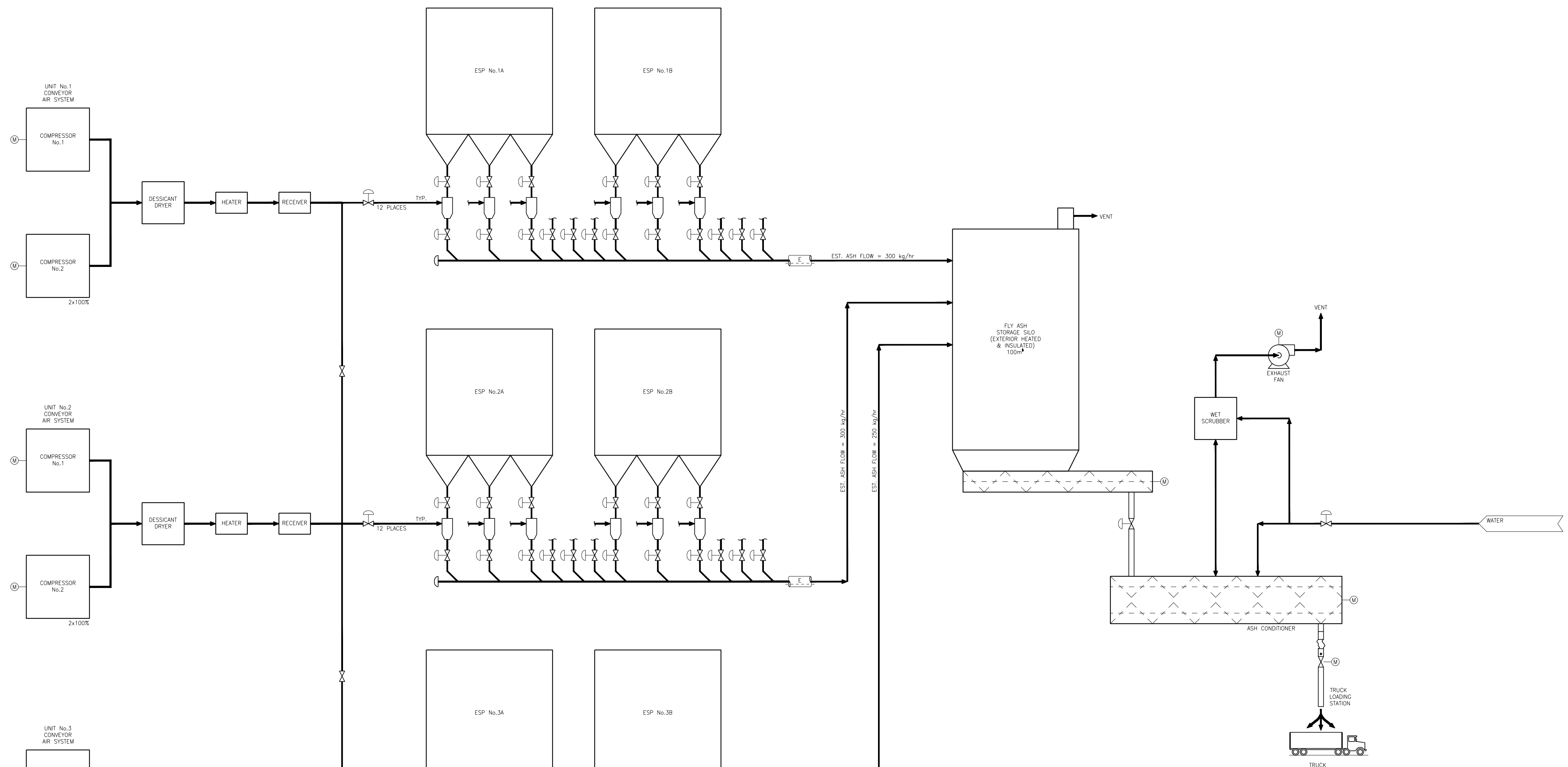
JOB No.	DWG. No.	REV
133544177	E-4025	C

M:\dwg\133544177\133544177E4025.dwg

Nov 18, 2008 1:15pm cboudreau

DWG. No.	TITLE	BY

ASSUMPTIONS:
FLY ASH/BOTTOM ASH SPLIT 75%/25%
FUEL BURN RATE = 100% MCR
PRECIPITATION CAPTURE EFF. = 99.5%
CARBON IN ASH = 30%
FLY ASH BULK DENSITY = 800 kg/m^3



PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	AUG. 15, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED	DRAWN CGB
CHECKED DESIGN DFTG.	DATE 08/13/2008
	SCALE NTS
APPROVED	SPEC.
P.M. MDV / P.T. DHG	

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

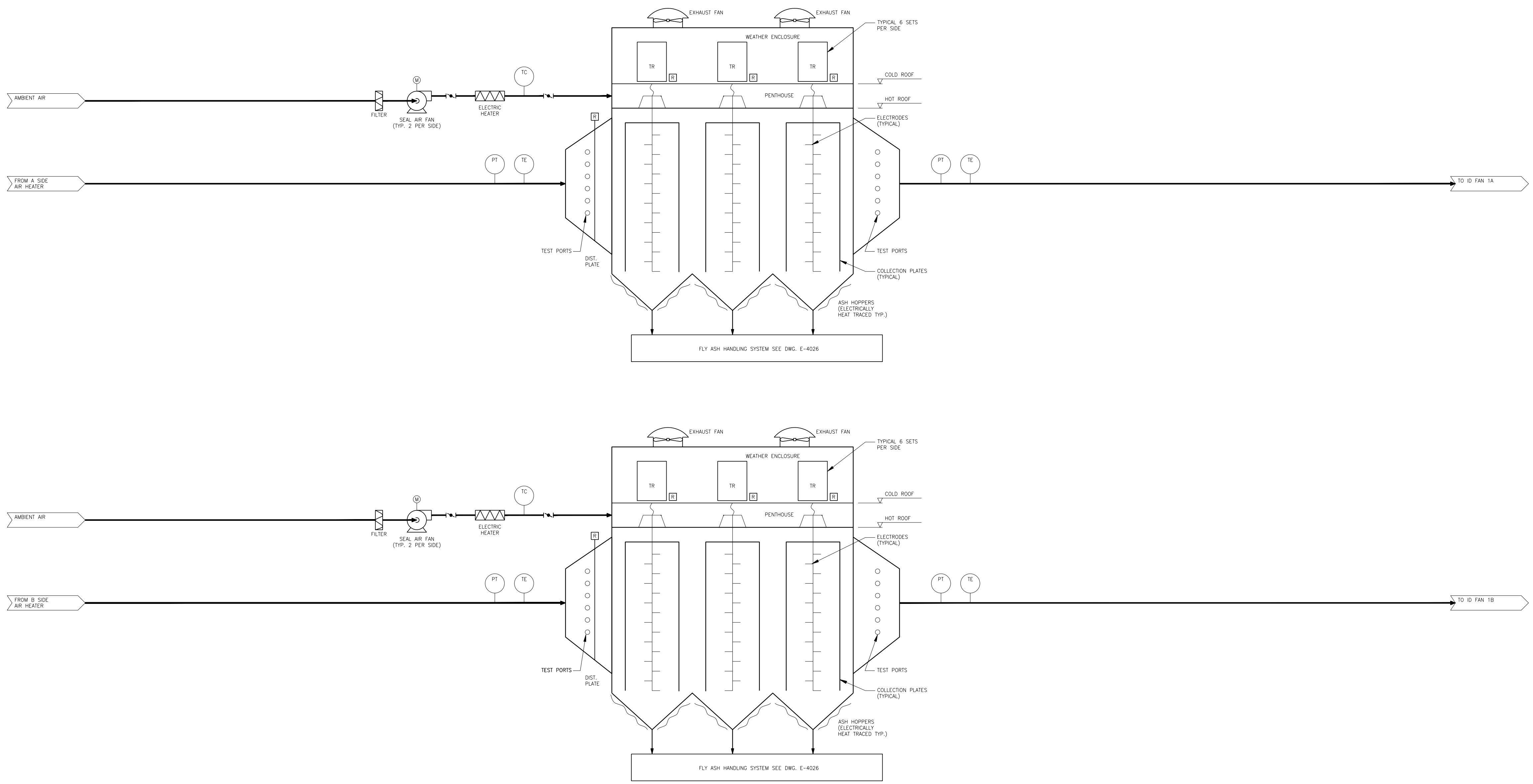
PRECIPITATOR AND FGD STUDY

PROCESS FLOW DIAGRAM
UNITS No.1, 2 AND 3
FLY ASH HANDLING SYSTEM

JOB No.	DWG. No.	REV
133544177	E-4026	B

M:\dwg\133544177\133544177E4026.dwg

Nov 18, 2008 1:15pm cboudreau



REFERENCE DRAWINGS

DWG. No.	TITLE	BY

LEGEND:

TR -TRANSFROMER RECTIFIER SET AND CONTROLLER

R -COLLECTION PLATE AND ELECTRODE RAPPERS AND RAPPER CONTROLS (TYPICAL)

NOTES:

1. UNIT 1 SHOWN, TYPICAL FOR UNIT No.2 AND No.3

PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
B	SEPT. 26, 2008 CLIENT	INFORMATION
A	AUG. 15, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED	DRAWN CGB
CHECKED DESIGN / DFTG.	DATE 08/13/2008
	SCALE NTS
APPROVED	SPEC.
P.M. MDV / P.T. DHG	

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

PRECIPITATOR AND FGD STUDY

FLOW DIAGRAM
UNITS No.1, 2 AND 3
PRECIPITATOR

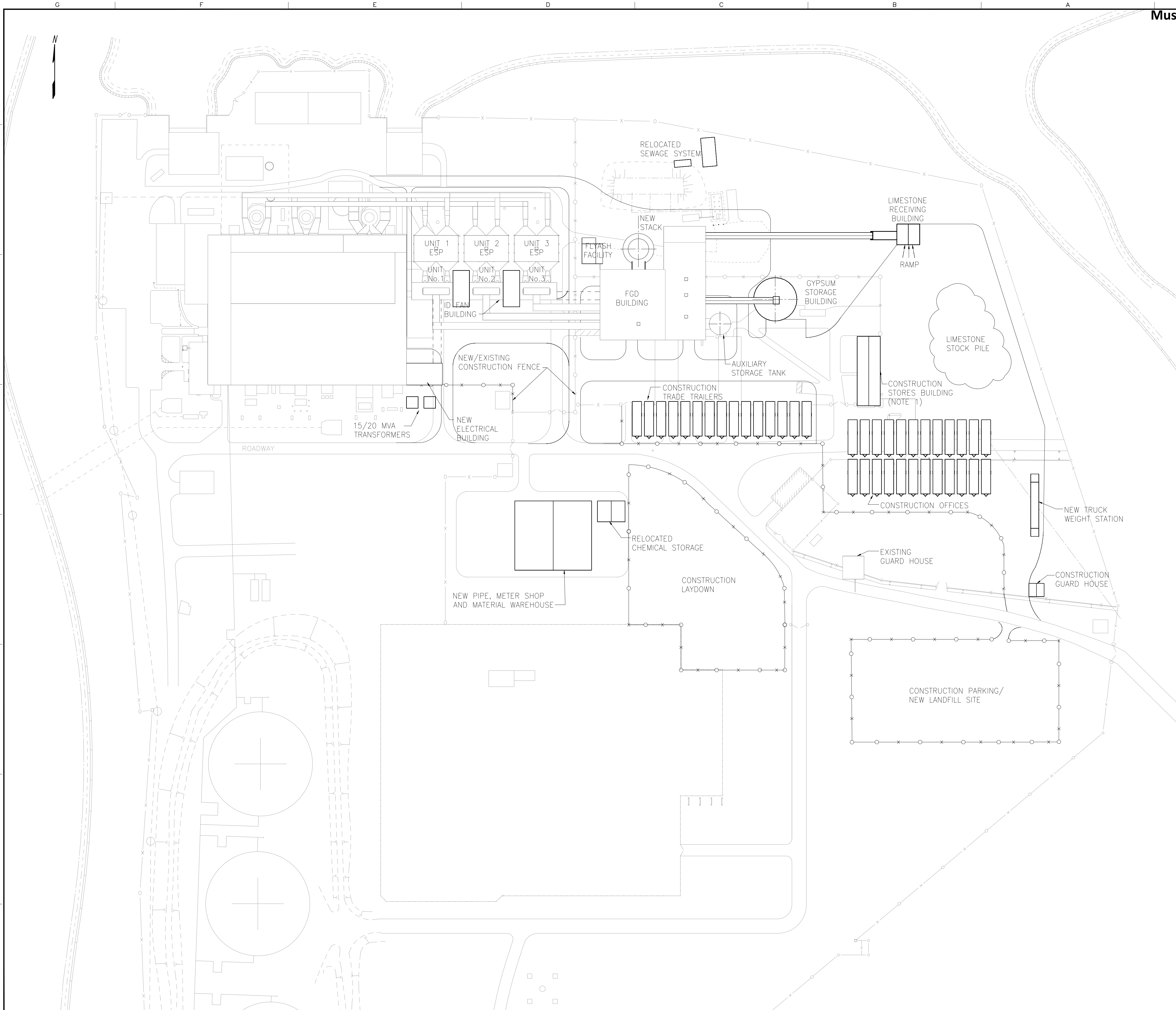
JOB No. 133544177 | DWG. No. E-4027 | REV B

M:\dwg\133544177\133544177E4027.dwg

Nov 18, 2008 1:15pm cboudreau

APPENDIX D.
Site Layout and General Arrangement Drawings

Muskrat Falls Project - Exhibit 5 l) i)



DWG. No.	TITLE	BY

NOTES:

1. (EXISTING MAT WAREHOUSE OR NEW CONSTRUCTION STORES - TO BE REMOVED/RELOCATED AFTER CONSTRUCTION)

PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	AUG. 25, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED	DRAWN CGB
CHECKED DESIGN / DFTG.	DATE 08/13/08
	SCALE NTS
APPROVED	SPEC.
P.M. MDV / P.T. DHG	

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

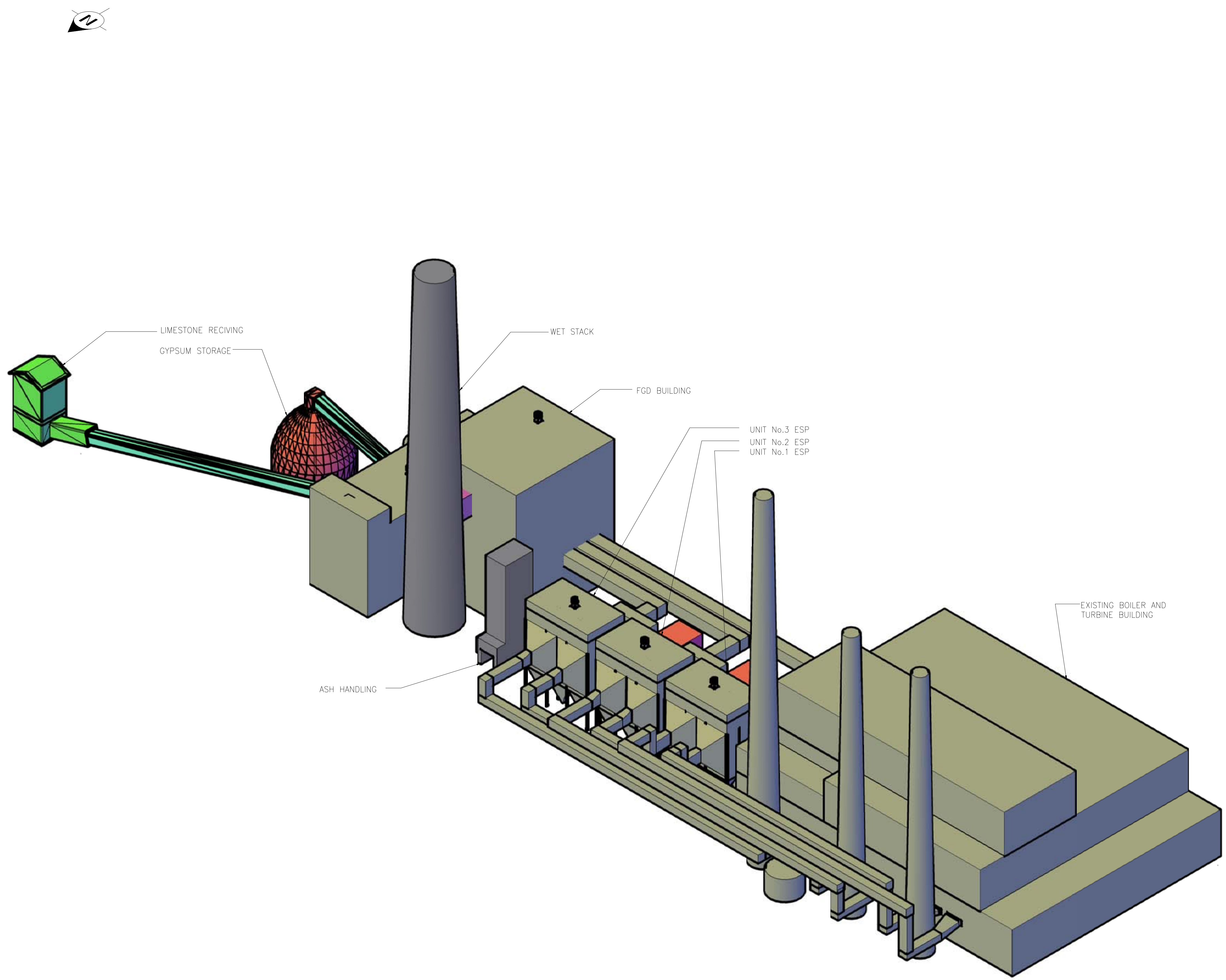
PRECIPITATOR AND FGD STUDY

PROPOSED SITE LAYOUT

JOB No.	DWG. No.	REV
133544177	E-0001	B

M:\dwg\133544177\133544177E0001.dwg

Nov 18, 2008 1:12pm cboudreau



DWG. No.	TITLE	BY

PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	AUG. 25, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	OCT. 15/08	CGB	GENERAL REVISION		

DESIGNED	DRAWN CGB
CHECKED DESIGN DFTG.	DATE 08/13/08
	SCALE NTS
APPROVED	SPEC.
P.M. MDV / P.T. DHG	

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

PRECIPITATOR AND FGD STUDY

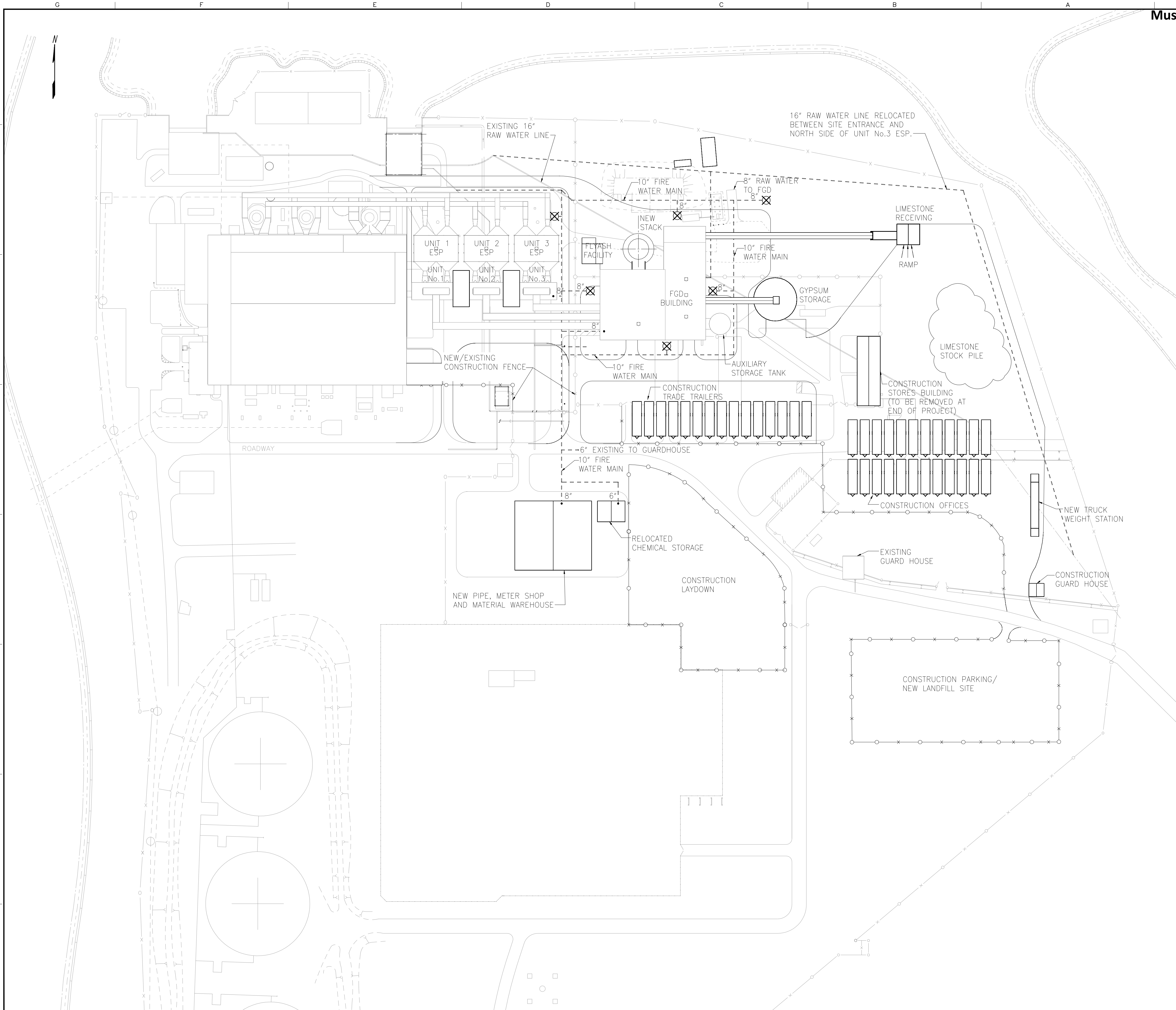
PROPOSED SITE LAYOUT

JOB No.	DWG. No.	REV
133544177	E-0002	B

M:\dwg\133544177\133544177E0002.dwg

Nov 18, 2008 1:13pm cboudreau

Muskrat Falls Project - Exhibit 5 l) i)



LEGEND:

FIRE HYDRANT

NOTES:

1475ft. OF NEW 16" RAW WATER LINE.

193ft. OF NEW 8" RAW WATER LINE.

1660ft. OF NEW 10" PIPE FIRE WATER MAIN.

310ft. OF NEW 8" PIPE FIRE WATER TO HYDRANTS.

40ft. OF NEW 6" PIPE FIRE WATER TO HYDRANTS.

EXISITING UNDERGOUND SERVICES TO BE RELOCATED AS REQUIRED.

PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
C	NOV. 21, 2008 CLIENT	INFORMATION
C	OCT. 15, 2008 CLIENT	INFORMATION
B	SEPT. 05, 2008 CLIENT	INFORMATION
A	AUG. 25, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
C	SEPT. 26/08	CGB	GENERAL REVISION		
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED | DRAWN CGB
CHECKED DESIGN / DFTG. | DATE 08/13/08
SCALE NTS
APPROVED | SPEC.
P.M. MDV | P.T. DHG

Stantec

HYDRO

NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

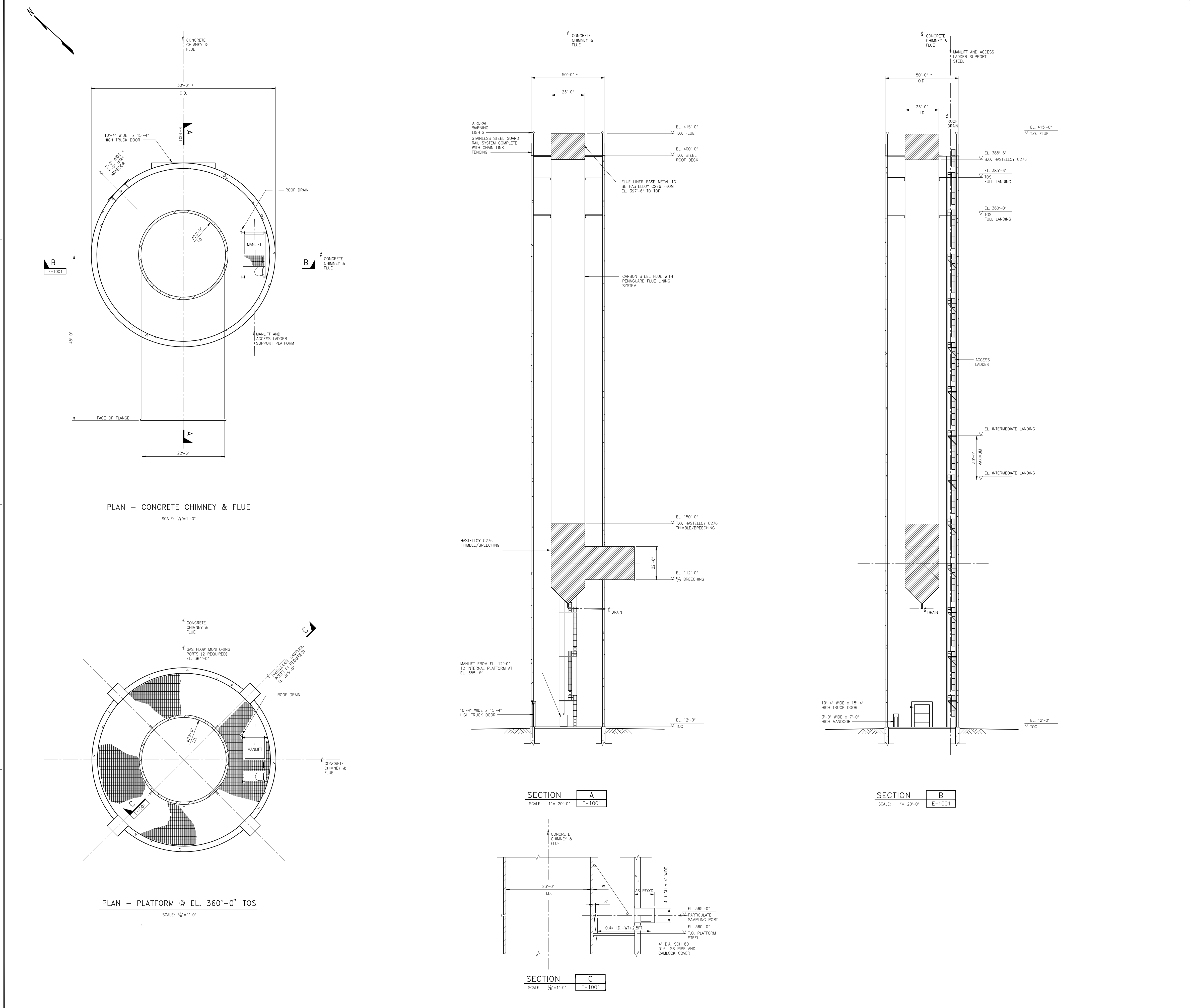
PRECIPITATOR AND FGD STUDY

PROPOSED FIRE AND RAW WATER PIPING AND RELOCATIONS

JOB No. 133544177 | DWG. No. E-0003 | REV C

M:\dwg\133544177\133544177E0003.dwg

Nov 18, 2008 1:13pm cboudreau



DWG. No.	TITLE	BY

NOTES:

1. * DIAMETER OF WINDSHIELD TO BE DETERMINED BY CONTRACTOR.

PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
A	NOV. 21, 2008 CLIENT	INFORMATION
A	OCT. 15, 2008 CLIENT	INFORMATION
A	AUGUST 28, 2008 CONTRACTOR	BUDGET PRICING

No.	DATE	BY	REVISIONS	DES.	DFTG.

DESIGNED RHO	DRAWN KRN
CHECKED DESIGN / DFTG.	DATE 08/25/08
	SCALE AS NOTED
APPROVED	SPEC.
P.M. MDV / P.T. DHG	

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

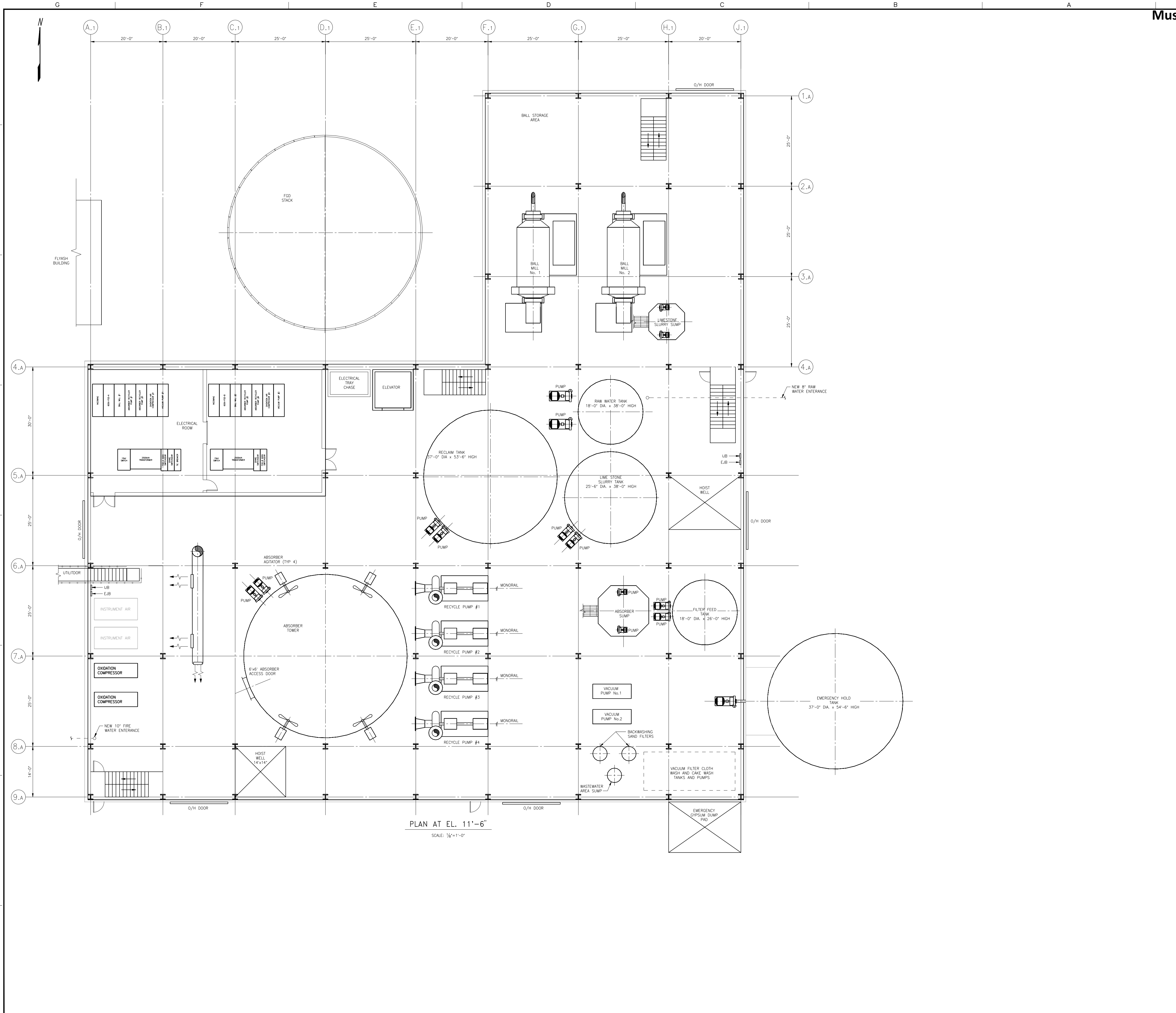
PRECIPITATOR AND FGD STUDY

GENERAL ARRANGEMENT
FGD CHIMNEY
PLANS & SECTIONS

JOB No.	DWG. No.	REV
133544177	E-1001	A

M:\dwg\133544177\133544177E1001.dwg

Nov 18, 2008 1:13pm cboudreau



PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	SEPT. 05, 2008 CLIENT	INFORMATION

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing – any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than that authorized by Stantec is forbidden.

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED MDV | DRAWN DHG | CHECKED DESIGN DFTG. | DATE AUG. 26, 2008 | SCALE 1/8"=1'-0" | APPROVED | SPEC. | P.M. MDV | P.T. DHG

Stantec

NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

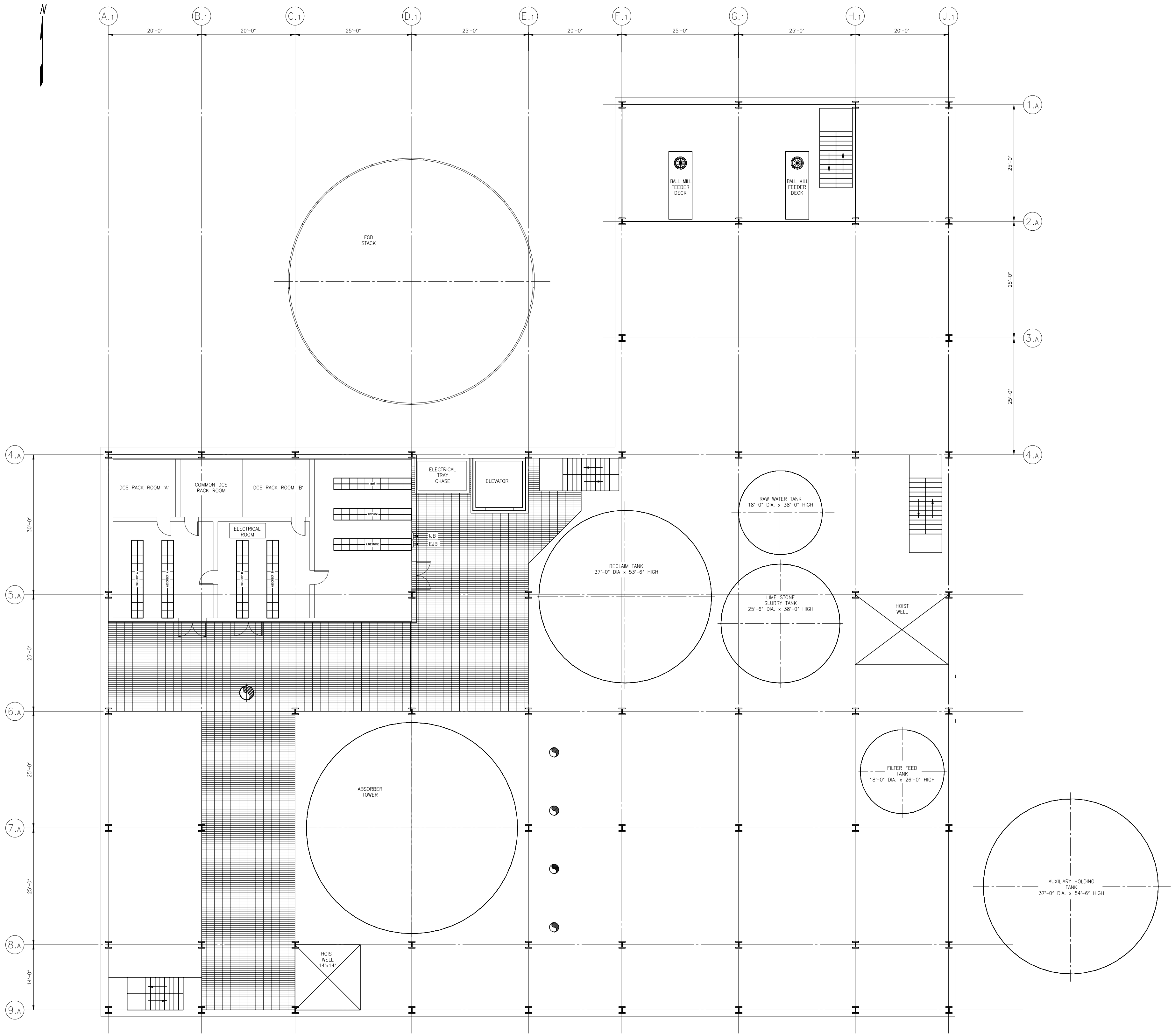
PRECIPITATOR AND FGD STUDY

GENERAL ARRANGEMENT
FGD BUILDING
PLAN AT EL. 11'-6"

JOB No. 133544177 | DWG. No. E-1101 | REV B

M:\dwg\133544177\133544177E1101.dwg

Nov 18, 2008 3:57pm cboudreau



PLAN AT EL. 30'-0"

SCALE: 1/8"=1'-0"

PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	SEPT. 05, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED: MDV | DRAWN: DHG | CHECKED: DESIGN / DFTG. | DATE: AUG. 26, 2008 | SCALE: 1/8"=1'-0" | APPROVED | SPEC. | P.M.: MDV | P.T.: DHG

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

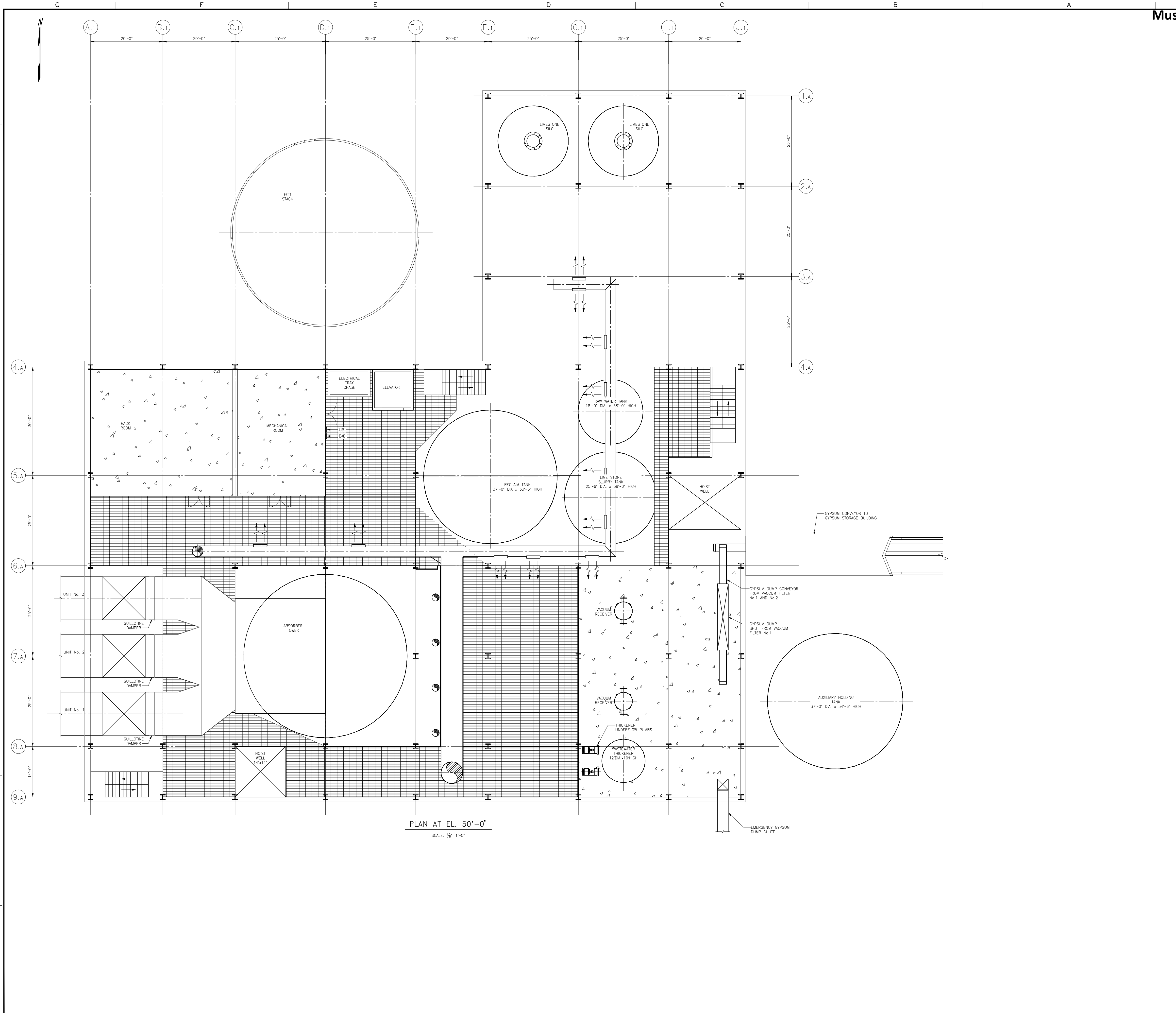
PRECIPITATOR AND FGD STUDY

GENERAL ARRANGEMENT
FGD BUILDING
PLAN AT EL. 30'-0"

JOB No. 133544177 | DWG. No. E-1102 | REV B

M:\dwg\133544177\133544177E1102.dwg

Nov 18, 2008 3:58pm cboudreau



PLAN AT EL. 50'-0"

SCALE: 1/8"=1'-0"

PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	SEPT. 05, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED MDV	DRAWN DHG
CHECKED DESIGN / DFTG.	DATE AUG. 26, 2008
	SCALE 1/8"=1'-0"
APPROVED	SPEC.
P.M. MDV / P.T. DHG	

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

PRECIPITATOR AND FGD STUDY

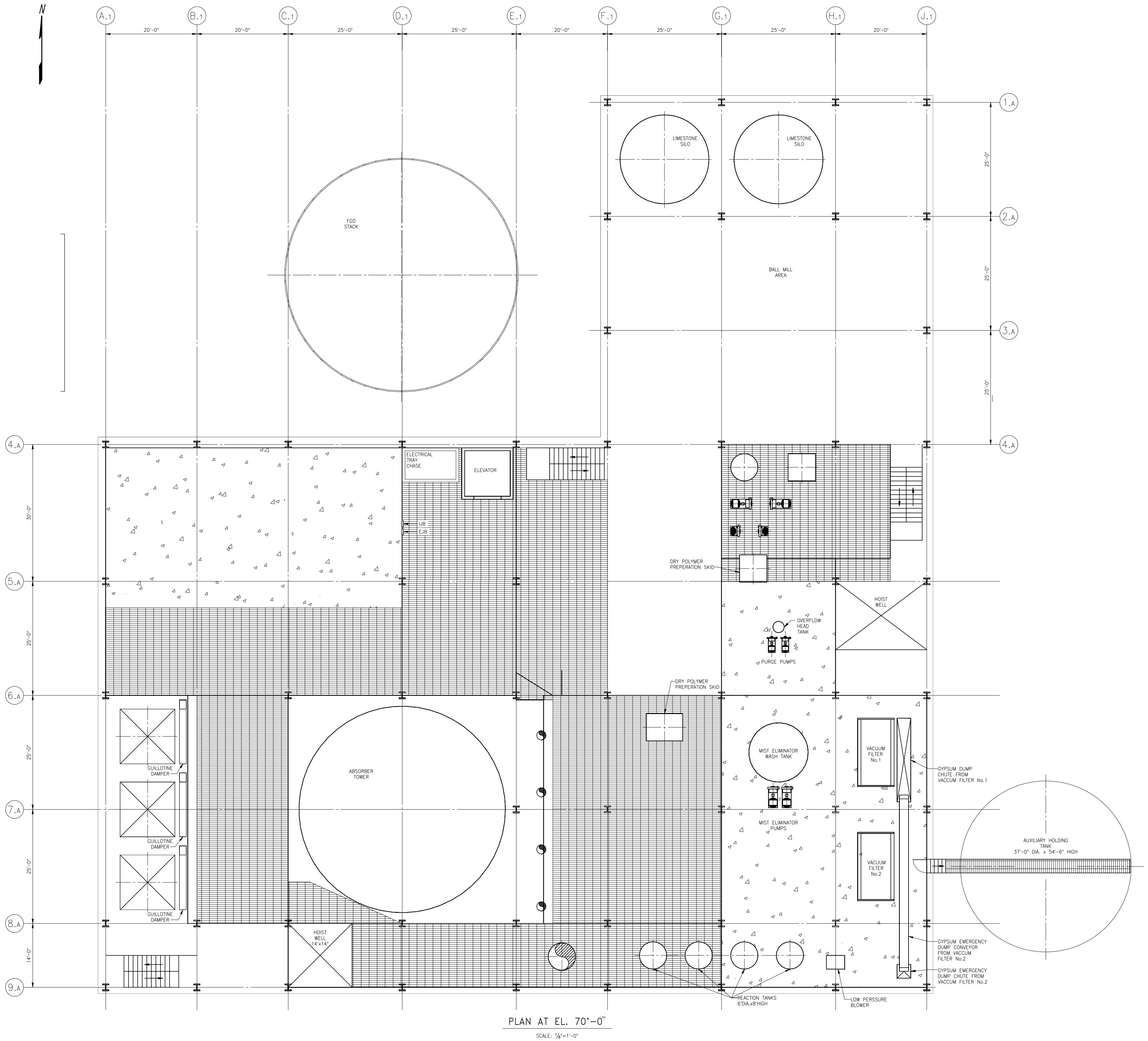
GENERAL ARRANGEMENT
FGD BUILDING
PLAN AT EL. 50'-0"

JOB No. 133544177 | DWG. No. E-1103 | REV B

M:\dwg\133544177\133544177E1103.dwg

Nov 18, 2008 3:58pm cboudreau

Muskrat Falls Project - Exhibit 5 l) i)



PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	SEPT. 05, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED MDV | DRAWN DHG | CHECKED DESIGN DFTG. | DATE AUG. 26, 2008 | SCALE 1/8"=1'-0" | APPROVED | SPEC. | P.M. MDV | P.T. DHG

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

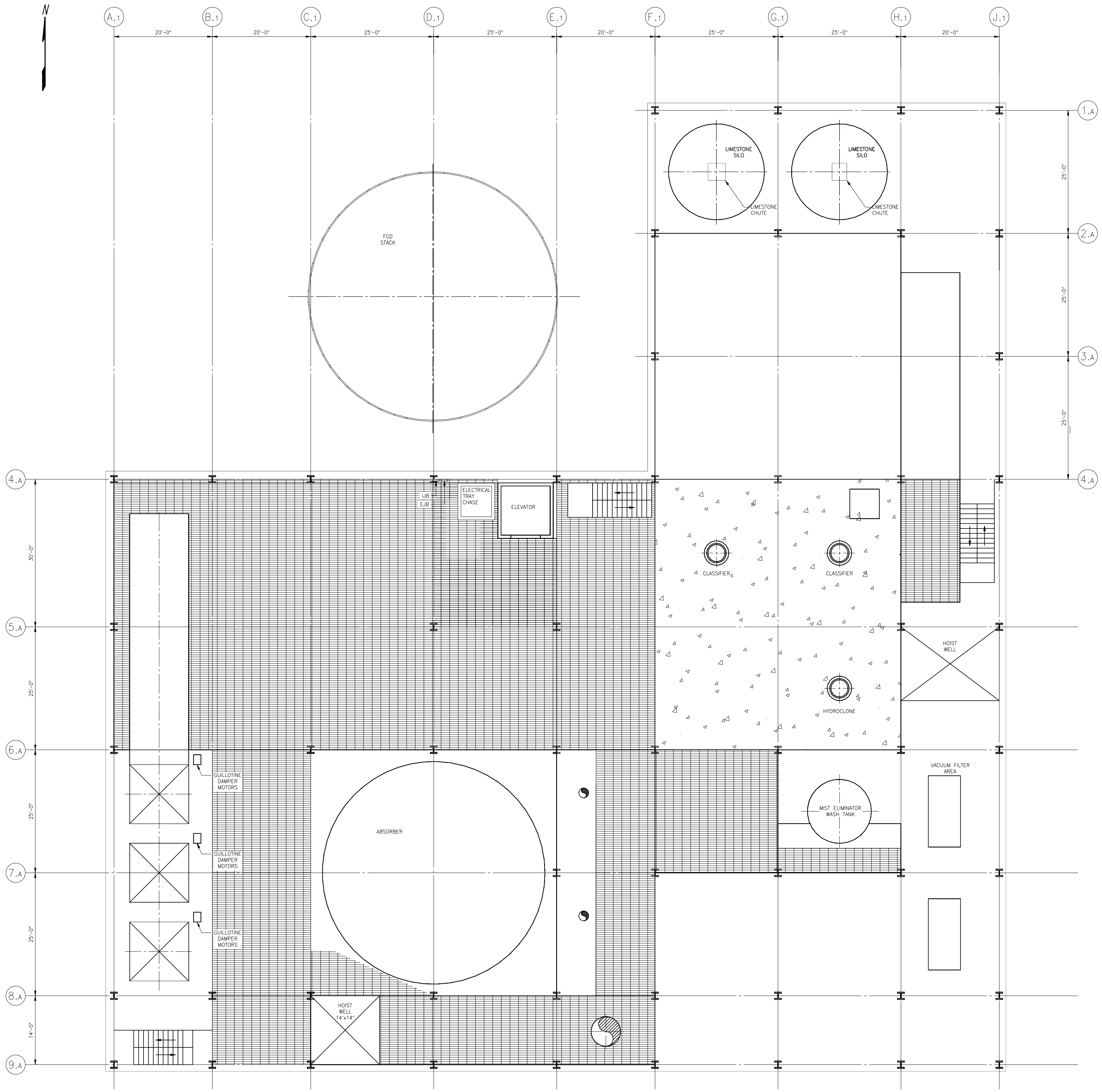
PRECIPITATOR AND FGD STUDY

GENERAL ARRANGEMENT
FGD BUILDING
PLAN AT EL. 70'-0"

JOB No. 133544177 | DWG. No. E-1104 | REV B

M:\dwg\133544177\133544177E1104.dwg

Nov 18, 2008 3:58pm cboudreau



PLAN AT EL. 80'-0"

SCALE: 1/8"=1'-0"

DWG. No.	TITLE	BY

PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	SEPT. 05, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED MDV	DRAWN DHG
CHECKED DESIGN / DFTG.	DATE AUG. 26, 2008
	SCALE 1/8"=1'-0"
APPROVED	SPEC.
P.M. MDV / P.T. DHG	

Stantec

NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

PRECIPITATOR AND FGD STUDY

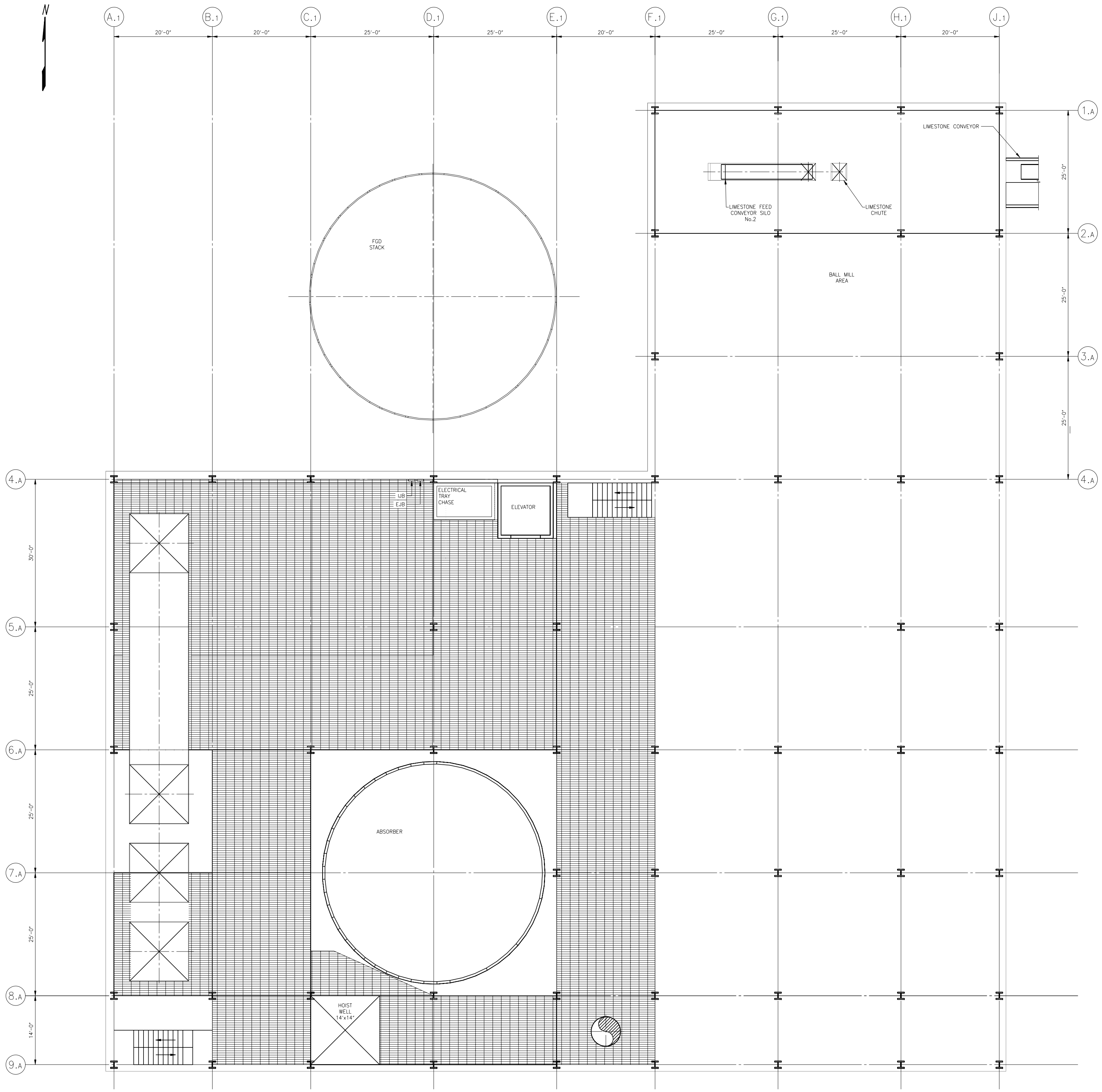
GENERAL ARRANGEMENT
FGD BUILDING
PLAN AT EL. 80'-0"

JOB No.	DWG. No.	REV
133544177	E-1105	B

M:\dwg\133544177\133544177E1105.dwg

Nov 18, 2008 3:58pm cboudreau

Muskrat Falls Project - Exhibit 5 l) i)



PLAN AT EL. 90'-0"

SCALE: 1/8"=1'-0"

DWG. No.	TITLE	BY

PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	SEPT. 05, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED MDV	DRAWN DHG
CHECKED DESIGN / DFTG.	DATE AUG. 26, 2008
	SCALE 1/8"=1'-0"
APPROVED	SPEC.
P.M. MDV / P.T. DHG	

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

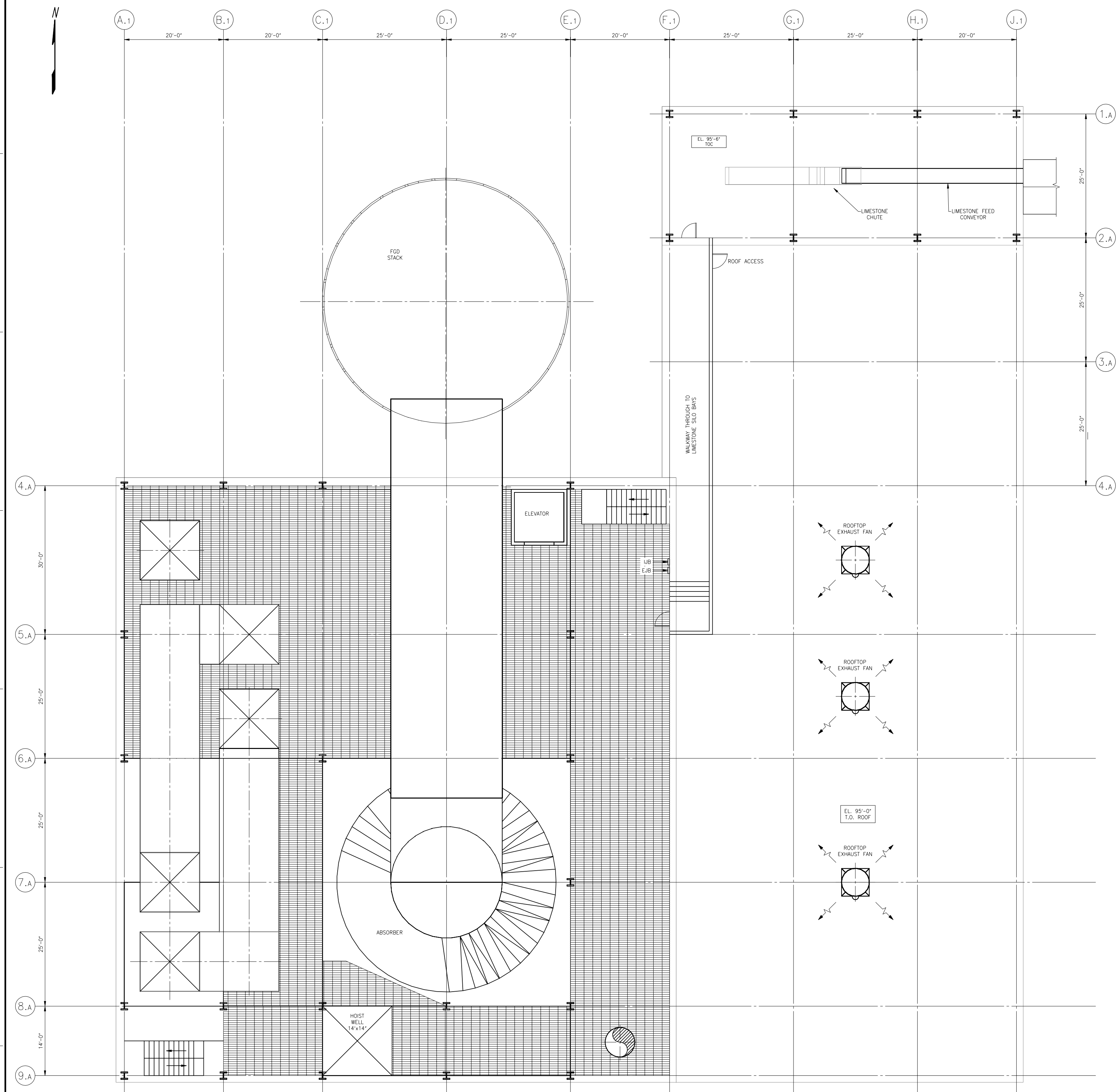
PRECIPITATOR AND FGD STUDY

GENERAL ARRANGEMENT
FGD BUILDING
PLAN AT EL. 90'-0"

JOB No.	DWG. No.	REV
133544177	E-1106	B

M:\dwg\133544177\133544177E1106.dwg

Nov 18, 2008 3:58pm cboudreau



PLAN AT EL. 100'-0"

SCALE: 1/8"=1'-0"

PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	SEPT. 05, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED MDV	DRAWN DHG
CHECKED DESIGN / DFTG.	DATE AUG. 26, 2008
	SCALE 1/8"=1'-0"
APPROVED	SPEC.
P.M. MDV / P.T. DHG	

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

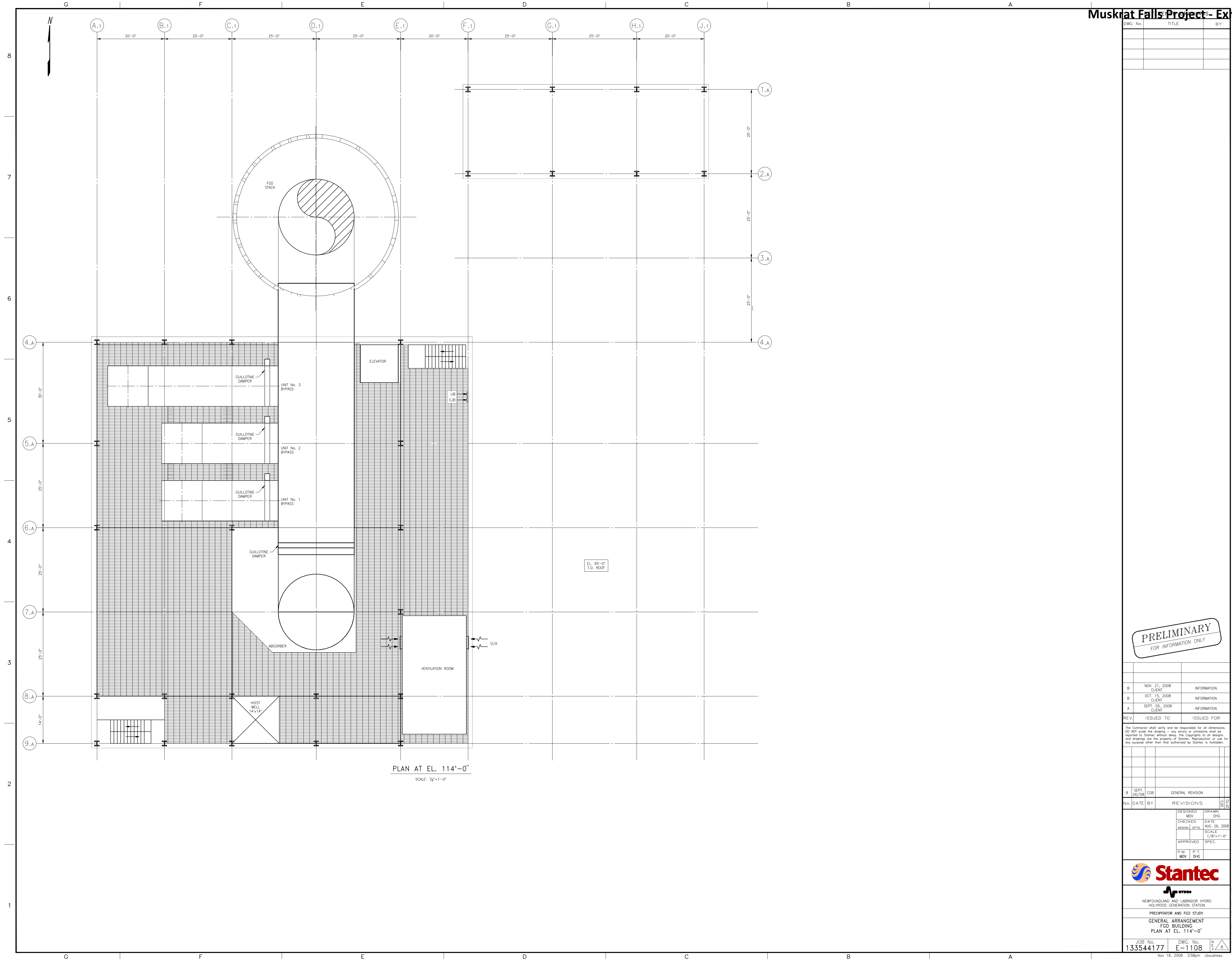
PRECIPITATOR AND FGD STUDY

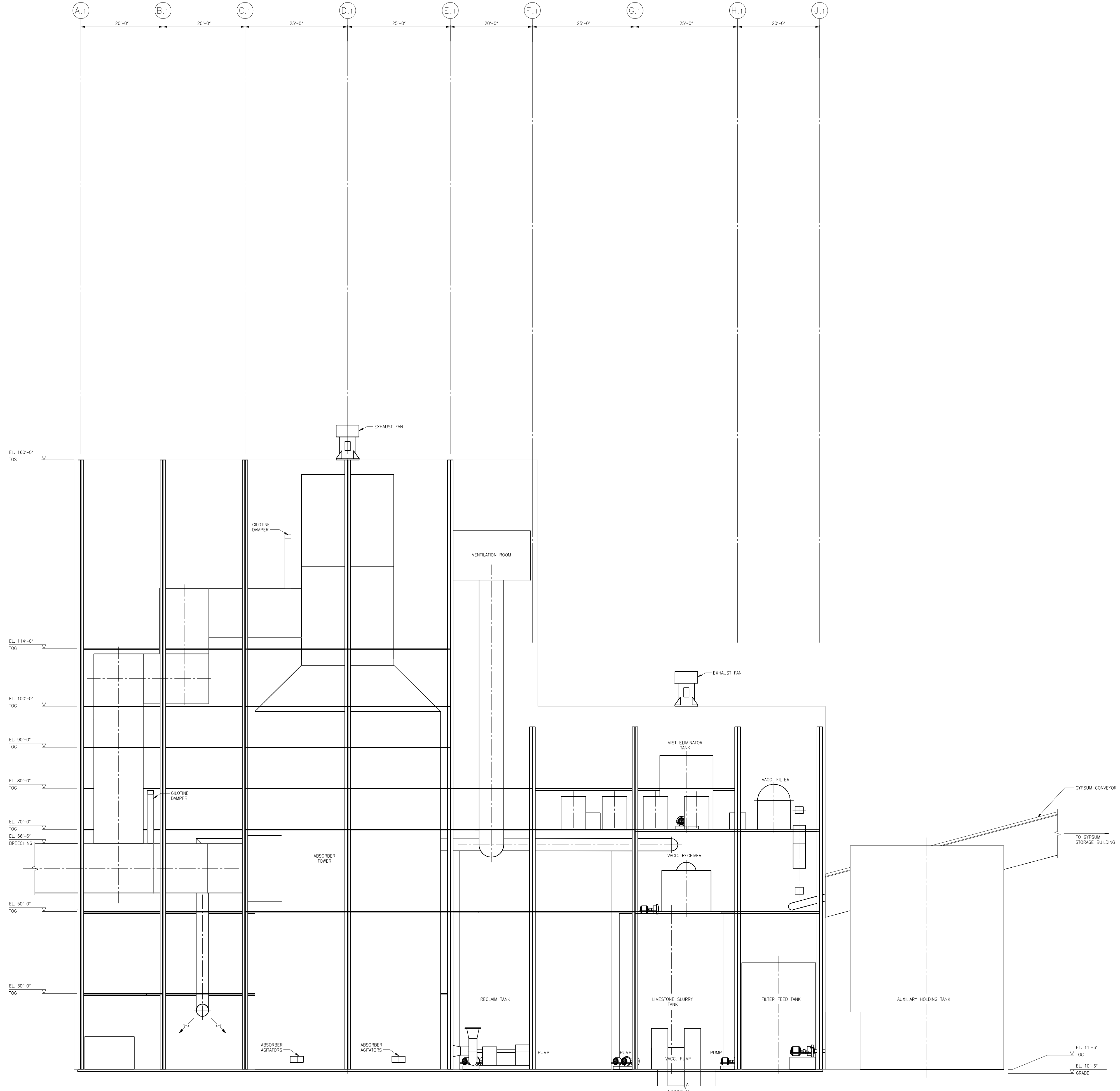
GENERAL ARRANGEMENT
FGD BUILDING
PLAN AT EL. 100'-0"

JOB No. 133544177 | DWG. No. E-1107 | REV B

M:\dwg\133544177\133544177E1107.dwg

Nov 18, 2008 3:58pm cboudreau


FGD STACK
ELEVATOR
GUILLOTINE DAMPER
UNIT No. 3 BYPASS
UNIT No. 2 BYPASS
UNIT No. 1 BYPASS
ABSORBER
HOIST WELL 14'x14'
VENTILATION ROOM
O/A
EL. 95'-0" T.O. ROOF
PLAN AT EL. 114'-0"
SCALE: 1/8"=1'-0"
PRELIMINARY
FOR INFORMATION ONLY
B NOV. 21, 2008 CLIENT INFORMATION
B OCT. 15, 2008 CLIENT INFORMATION
A SEPT. 05, 2008 CLIENT INFORMATION
REV. ISSUED TO ISSUED FOR
The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing – any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than that authorized by Stantec is forbidden.
B SEPT. 26/08 CGB GENERAL REVISION
No. DATE BY REVISIONS DES. DFTG.
DESIGNED MDV
DRAWN DHG
CHECKED DESIGN DFTG.
DATE AUG. 26, 2008
SCALE 1/8"=1'-0"
APPROVED
SPEC.
P.M. MDV
P.T. DHG
Stantec
HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION
PRECIPITATOR AND FGD STUDY
GENERAL ARRANGEMENT
FGD BUILDING
PLAN AT EL. 114'-0"
JOB No. 133544177
DWG. No. E-1108
REV B
M:\dwg\133544177\133544177E1108.dwg
Nov 18, 2008 3:58pm cboudreau



ELEVATION VIEW - LOOKING NORTH

SCALE: 1/8"=1'-0"

PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	SEPT. 05, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED MDV	DRAWN DHG
CHECKED DESIGN / DFTG.	DATE AUG. 26, 2008
	SCALE 1/8"=1'-0"
APPROVED	SPEC.
P.M. MDV / P.T. DHG	

Stantec

HYDRO

NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

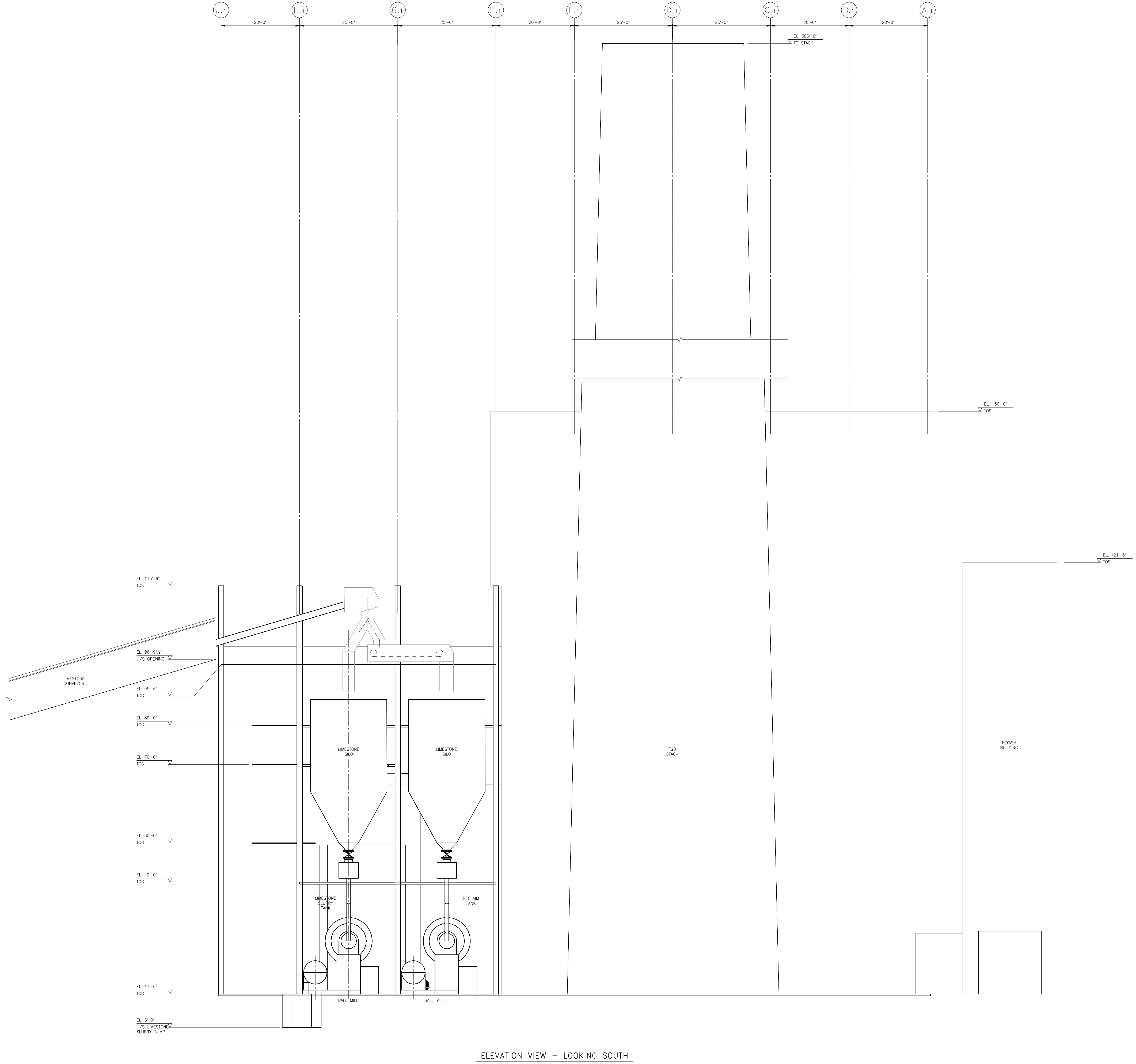
PRECIPITATOR AND FGD STUDY

GENERAL ARRANGEMENT
FGD BUILDING
ELEVATION

JOB No. 133544177 | DWG. No. E-1111 | REV B

M:\dwg\133544177\133544177E1111.dwg

Nov 18, 2008 3:58pm cboudreau



ELEVATION VIEW – LOOKING SOUTH

SCALE: 1/8"=1'-0"

PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	SEPT. 05, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED MDV | DRAWN DHG | CHECKED | DATE AUG. 26, 2008 | SCALE 1/8"=1'-0" | APPROVED | SPEC. | P.M. MDV | P.T. DHG

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

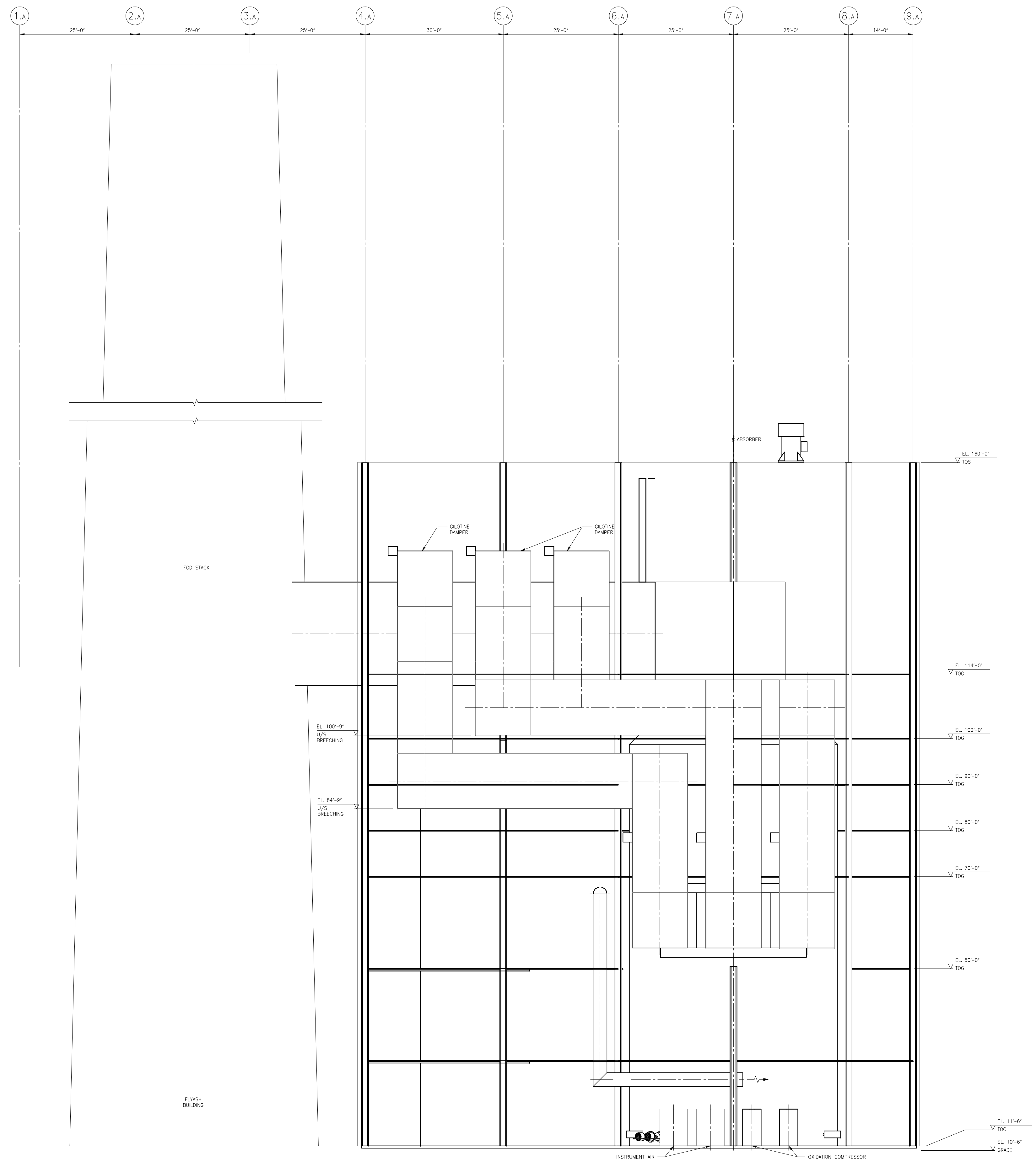
PRECIPITATOR AND FGD STUDY

GENERAL ARRANGEMENT
FGD BUILDING
ELEVATION

JOB No. 133544177 | DWG. No. E-1112 | REV B

M:\dwg\133544177\133544177E1112.dwg

Nov 18, 2008 3:58pm cboudreau



ELEVATION VIEW – LOOKING EAST

SCALE: 1/8"=1'-0"

DWG. No.	TITLE	BY

PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	SEPT. 05, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED MDV	DRAWN DHG
CHECKED DESIGN / DFTG.	DATE AUG. 26, 2008
	SCALE 1/8"=1'-0"
APPROVED	SPEC.
P.M. MDV / P.T. DHG	

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

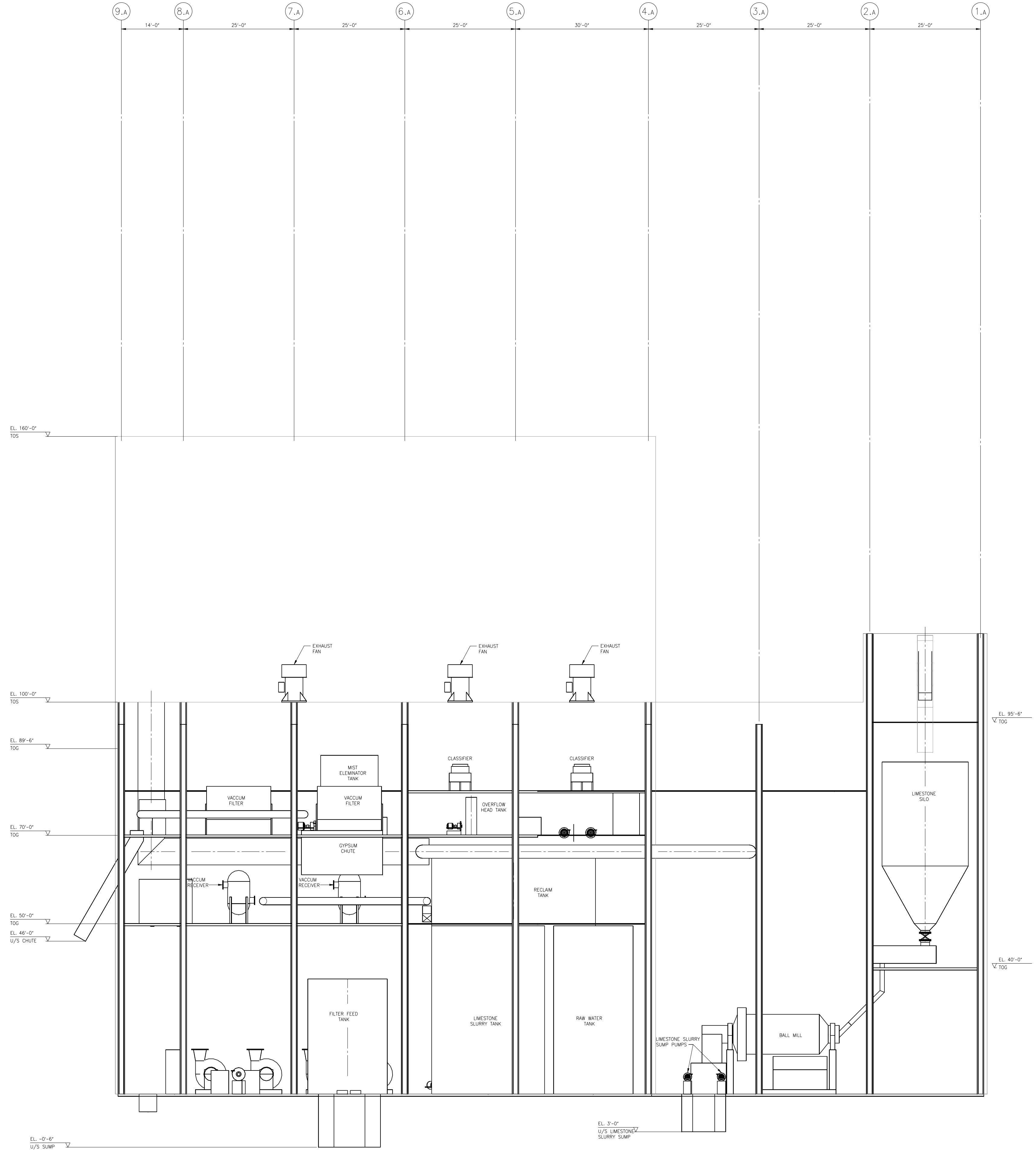
PRECIPITATOR AND FGD STUDY

GENERAL ARRANGEMENT
FGD BUILDING
ELEVATION

JOB No.	DWG. No.	REV
133544177	E-1113	B

M:\dwg\133544177\133544177E1113.dwg

Nov 18, 2008 3:58pm cboudreau



ELEVATION VIEW – LOOKING WEST

SCALE: 1/8"=1'-0"

PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	SEPT. 05, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED MDV	DRAWN DHG
CHECKED DESIGN / DFTG.	DATE AUG. 26, 2008
	SCALE 1/8"=1'-0"
APPROVED	SPEC.
P.M. MDV / P.T. DHG	

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

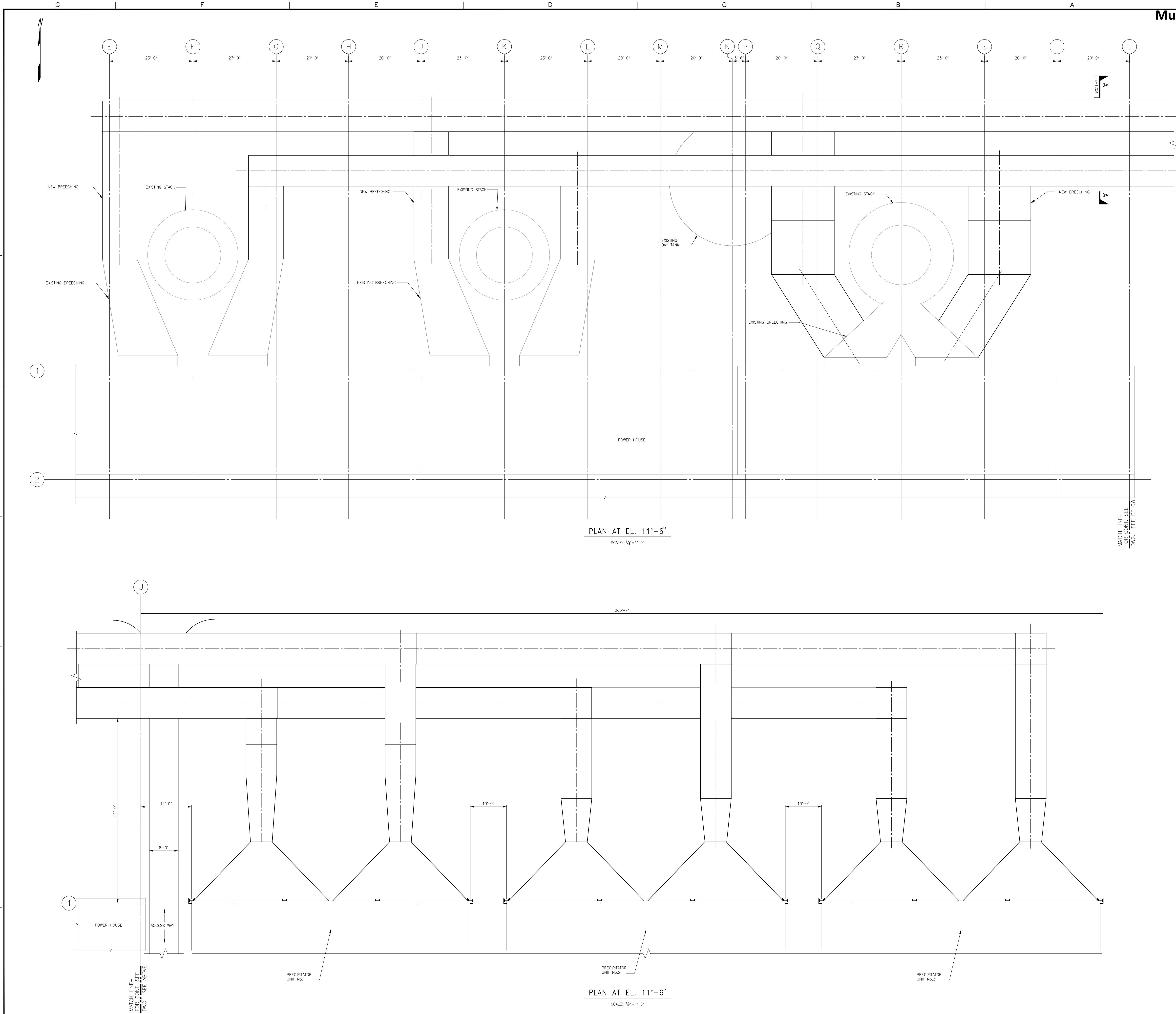
PRECIPITATOR AND FGD STUDY

GENERAL ARRANGEMENT
FGD BUILDING
ELEVATION

JOB No. 133544177 | DWG. No. E-1114 | REV B

M:\dwg\133544177\133544177E1114.dwg

Nov 18, 2008 3:59pm cboudreau



PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	SEPT. 05, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED MDV | DRAWN CGB | CHECKED DESIGN DFTG. | DATE AUG. 26, 2008 | SCALE 1/8"=1'-0" | APPROVED | SPEC. | P.M. MDV | P.T. DHG

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

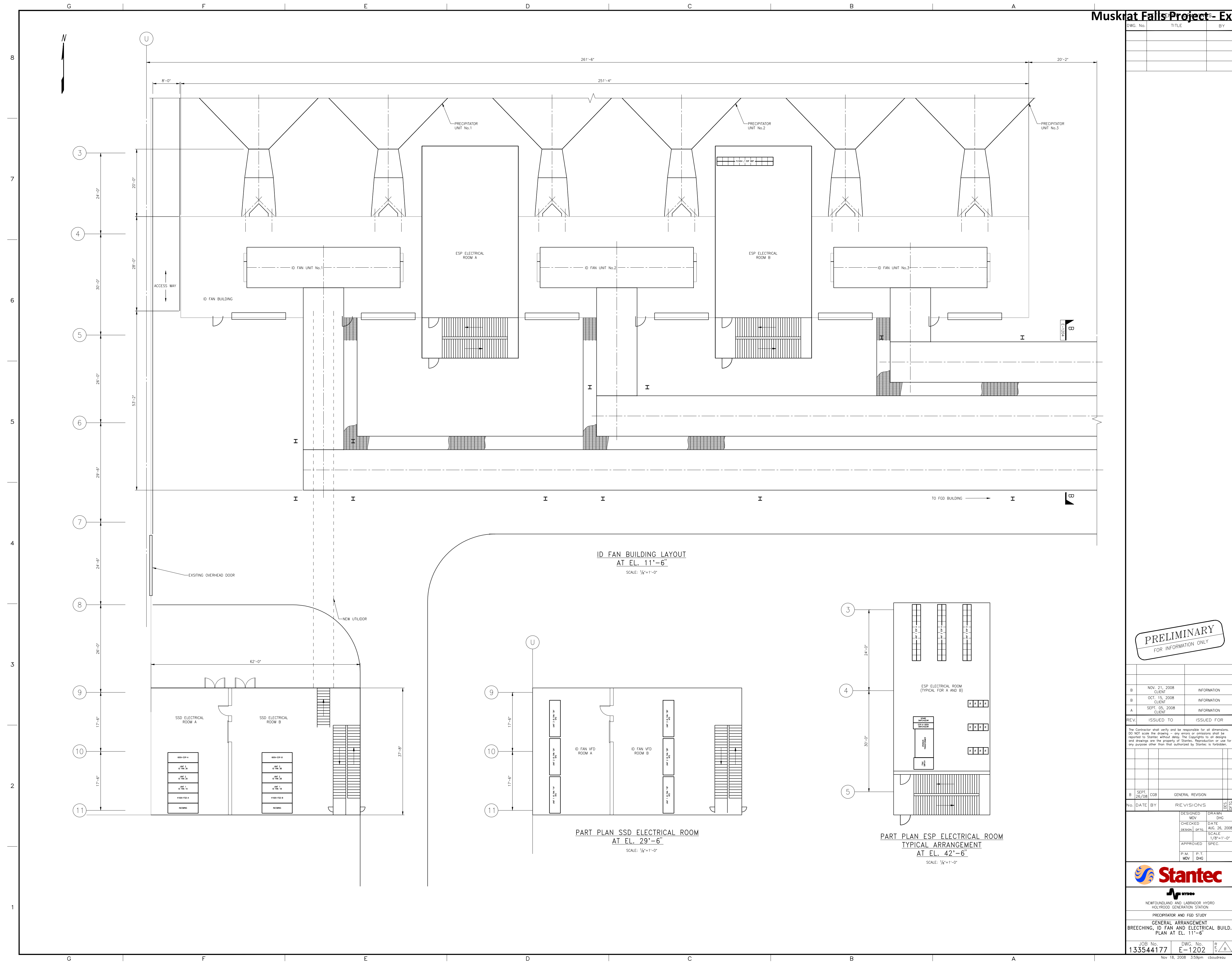
PRECIPITATOR AND FGD STUDY

GENERAL ARRANGEMENT
NEW BREACHING UNITS 1, 2 AND 3
PLAN AT EL. 11'-6"

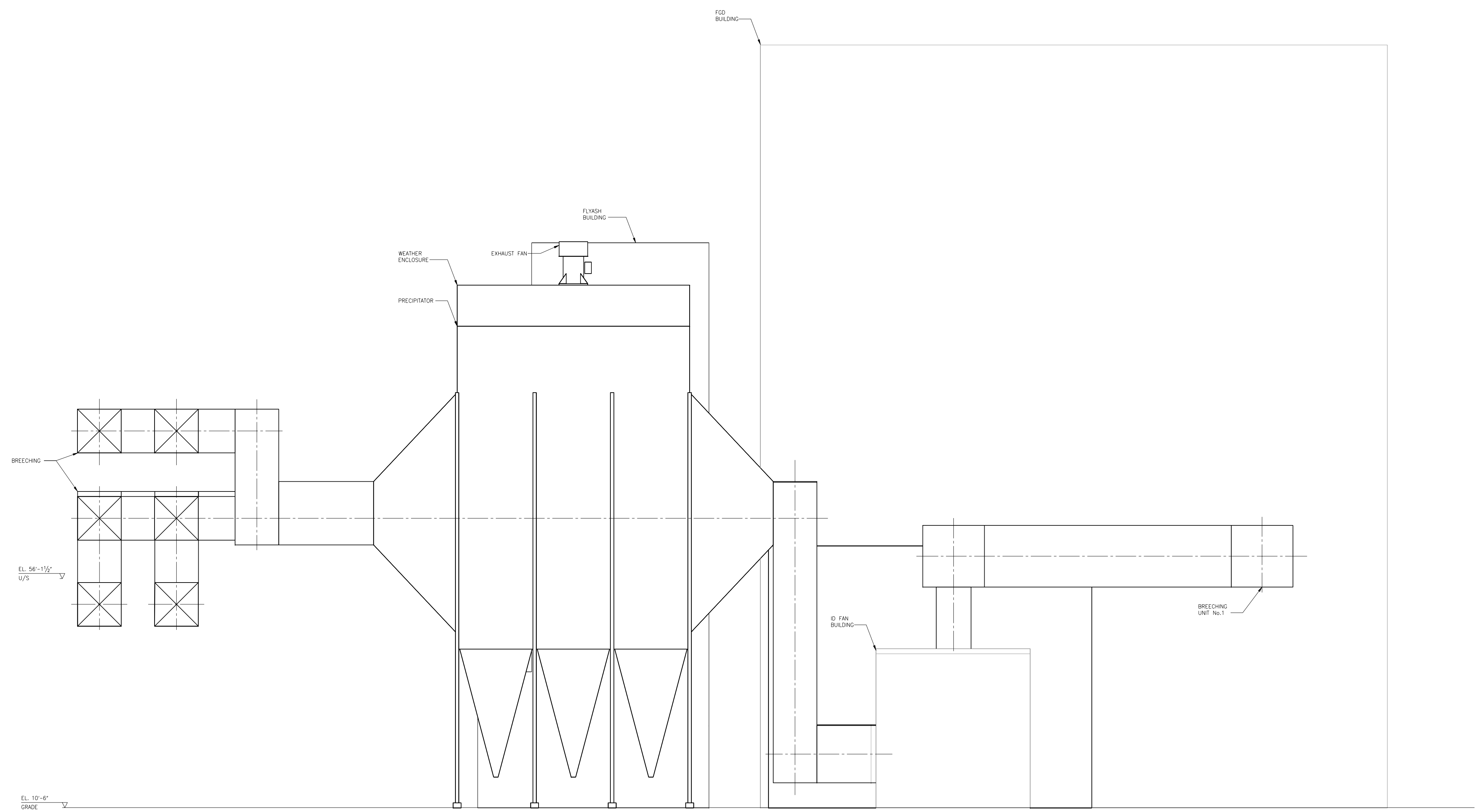
JOB No. 133544177 | DWG. No. E-1201 | REV B

M:\dwg\133544177\133544177E1201.dwg

Nov 18, 2008 3:59pm cboudreau



PRECIPITATOR UNIT No.1
PRECIPITATOR UNIT No.2
PRECIPITATOR UNIT No.3
ID FAN UNIT No.1
ID FAN UNIT No.2
ID FAN UNIT No.3
ESP ELECTRICAL ROOM A
ESP ELECTRICAL ROOM B
ACCESS WAY
ID FAN BUILDING
TO FGD BUILDING
EXSITING OVERHEAD DOOR
NEW UTILIDOR
261'-6"
251'-4"
20'-2"
8'-0"
62'-0"
37'-8"
ID FAN BUILDING LAYOUT
AT EL. 11'-6"
SSD ELECTRICAL ROOM A
SSD ELECTRICAL ROOM B
ID FAN VFD ROOM A
ID FAN VFD ROOM B
PART PLAN SSD ELECTRICAL ROOM
AT EL. 29'-6"
ESP ELECTRICAL ROOM (TYPICAL FOR A AND B)
PART PLAN ESP ELECTRICAL ROOM
TYPICAL ARRANGEMENT
AT EL. 42'-6"
PRELIMINARY
FOR INFORMATION ONLY
B NOV. 21, 2008 CLIENT INFORMATION
B OCT. 15, 2008 CLIENT INFORMATION
A SEPT. 05, 2008 CLIENT INFORMATION
REV. ISSUED TO ISSUED FOR
The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing – any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than that authorized by Stantec is forbidden.
B SEPT. 26/08 CGB GENERAL REVISION
No. DATE BY REVISIONS DES. DFTG.
DESIGNED MDV
DRAWN DHG
CHECKED DESIGN DFTG.
DATE AUG. 26, 2008
SCALE 1/8"=1'-0"
APPROVED
SPEC.
P.M. MDV
P.T. DHG
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION
PRECIPITATOR AND FGD STUDY
GENERAL ARRANGEMENT
BREECHING, ID FAN AND ELECTRICAL BUILD.
PLAN AT EL. 11'-6"
JOB No. 133544177
DWG. No. E-1202
REV B
M:\dwg\133544177\133544177E1202.dwg
Nov 18, 2008 3:59pm cboudreau



ELEVATION LOOKING EAST

SCALE: ⅛"=1'-0"

PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	SEPT. 05, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED MDV	DRAWN DHG
CHECKED DESIGN / DFTG.	DATE AUG. 26, 2008
	SCALE 1/8"=1'-0"
APPROVED	SPEC.
P.M. MDV / P.T. DBB	

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

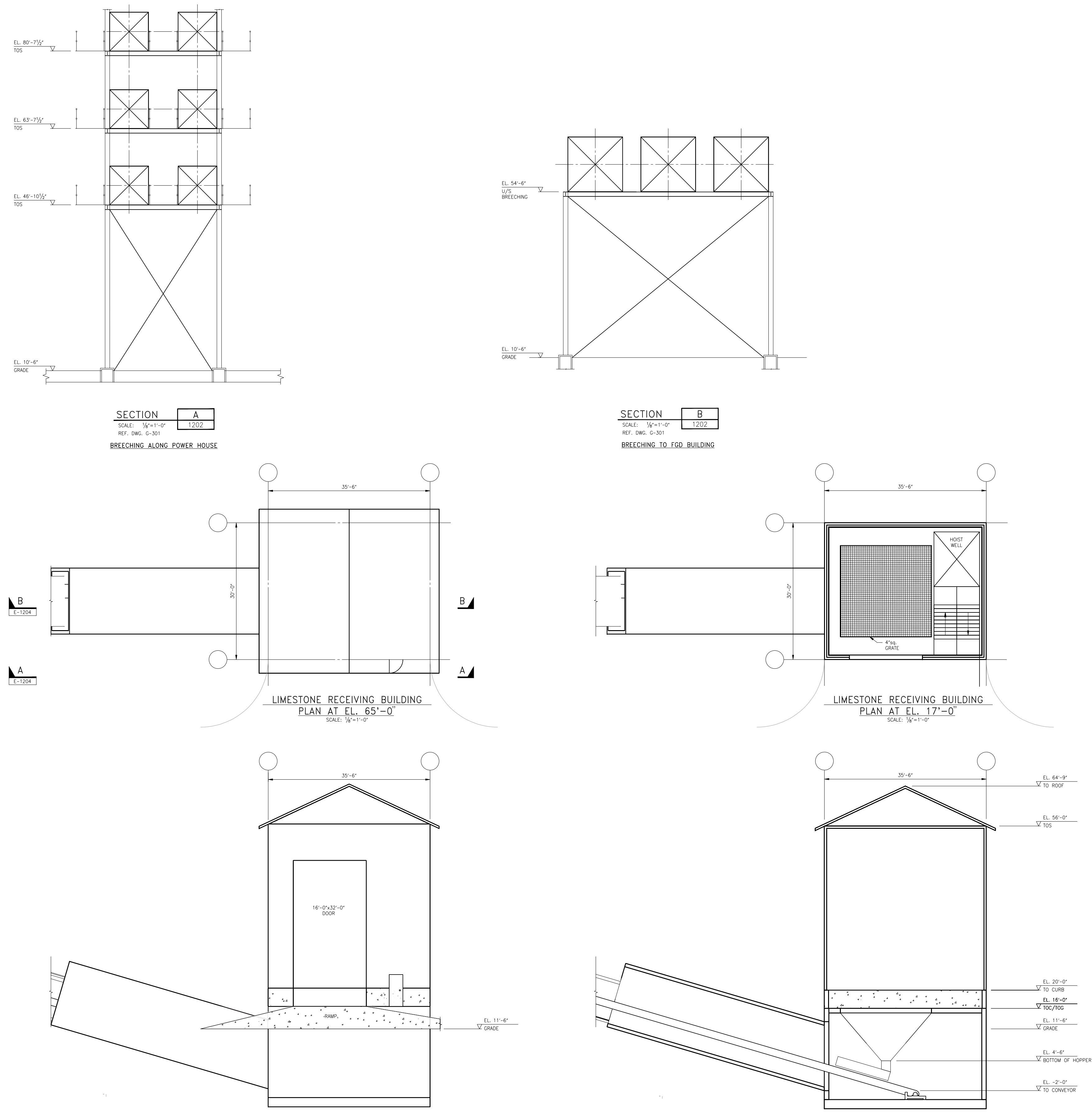
PRECIPITATOR AND FGD STUDY

GENERAL ARRANGEMENT
EAST ELEVATION

JOB No. 133544177 | DWG. No. E-1203 | REV B

M:\dwg\133544177\133544177E1203.dwg

Nov 18, 2008 3:59pm cboudreau



DWG. No.	TITLE	BY

PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	SEPT. 05, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED MDV	DRAWN DHG
CHECKED DESIGN / DFTG.	DATE AUG. 26, 2008
	SCALE 1/8"=1'-0"
APPROVED	SPEC.
P.M. MDV / P.T. DBB	

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

PRECIPITATOR AND FGD STUDY

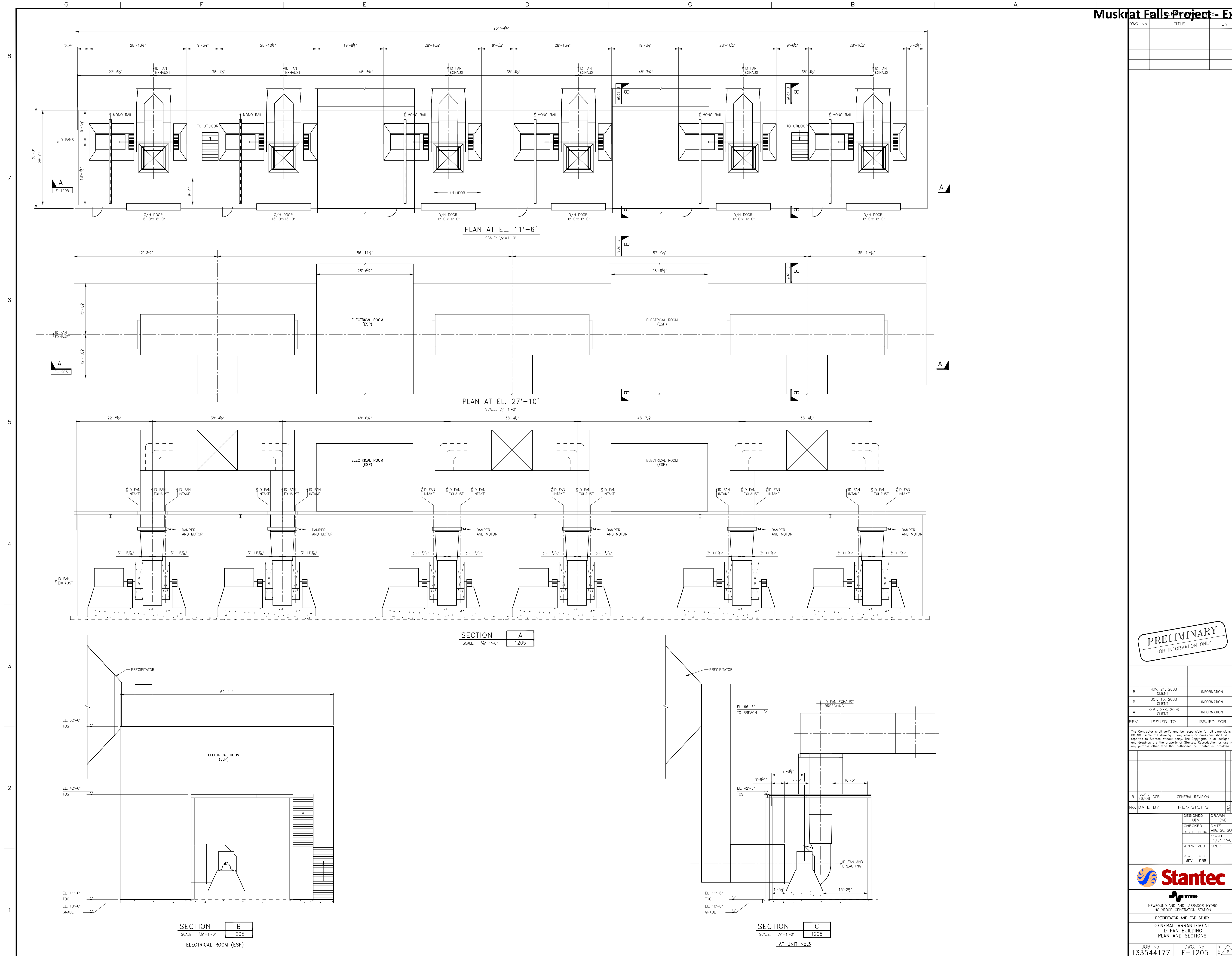
GENERAL ARRANGEMENT
LIMESTONE RECIEVING BUILDING
PLANS AND SECTIONS

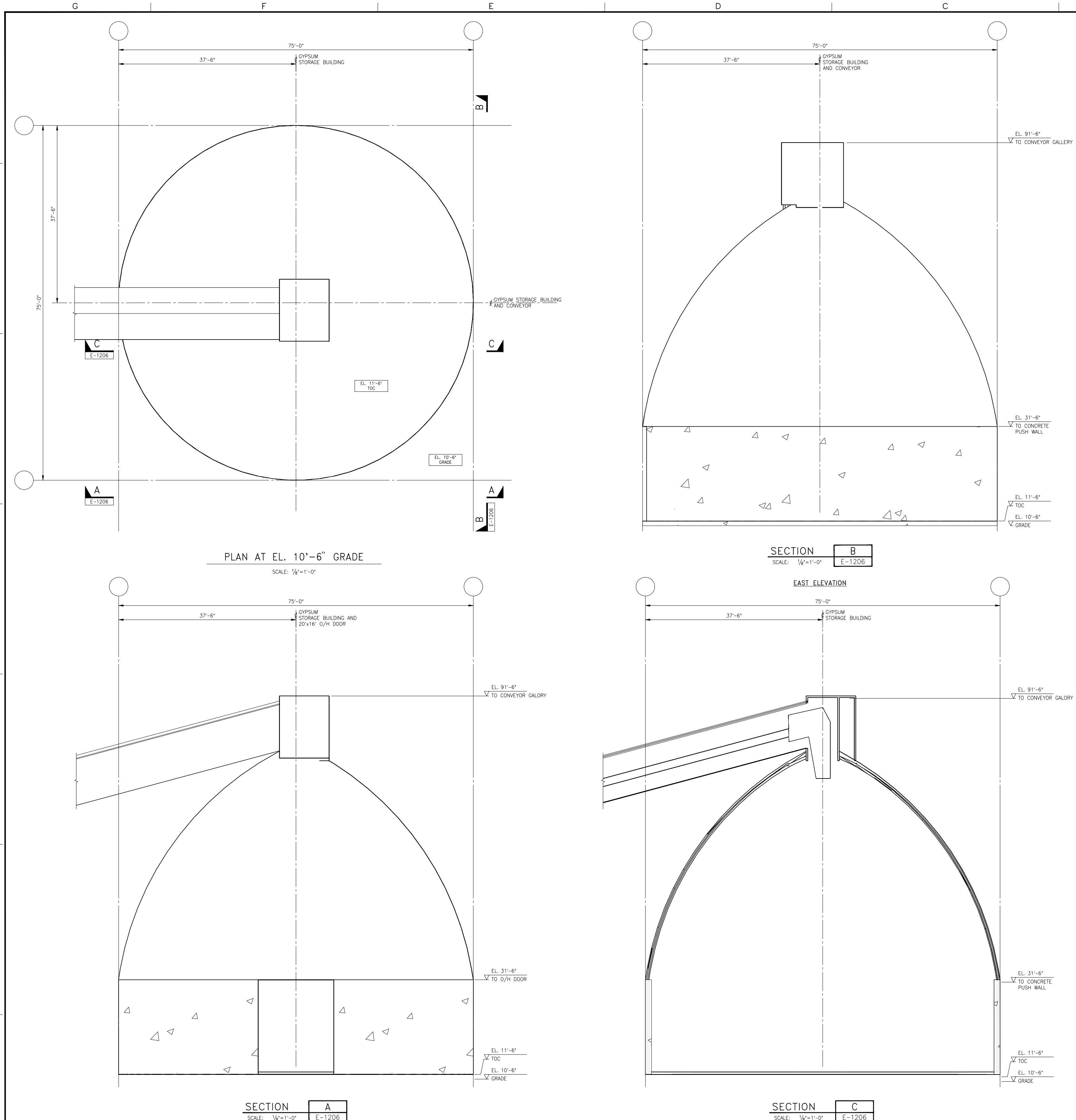
JOB No.	DWG. No.	REV
133544177	E-1204	B

M:\dwg\133544177\133544177E1204.dwg

Nov 18, 2008 3:59pm cboudreau

Muskrat Falls Project - Exhibit 5 l) i)





PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	SEPT. XXX, 2008 CLIENT	INFORMATION

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing – any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than that authorized by Stantec is forbidden.

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED MDV | DRAWN CGB | CHECKED DESIGN DFTG. | DATE AUG. 26, 2008 | SCALE 1/8"=1'-0" | APPROVED | SPEC. | P.M. MDV | P.T. DBB

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

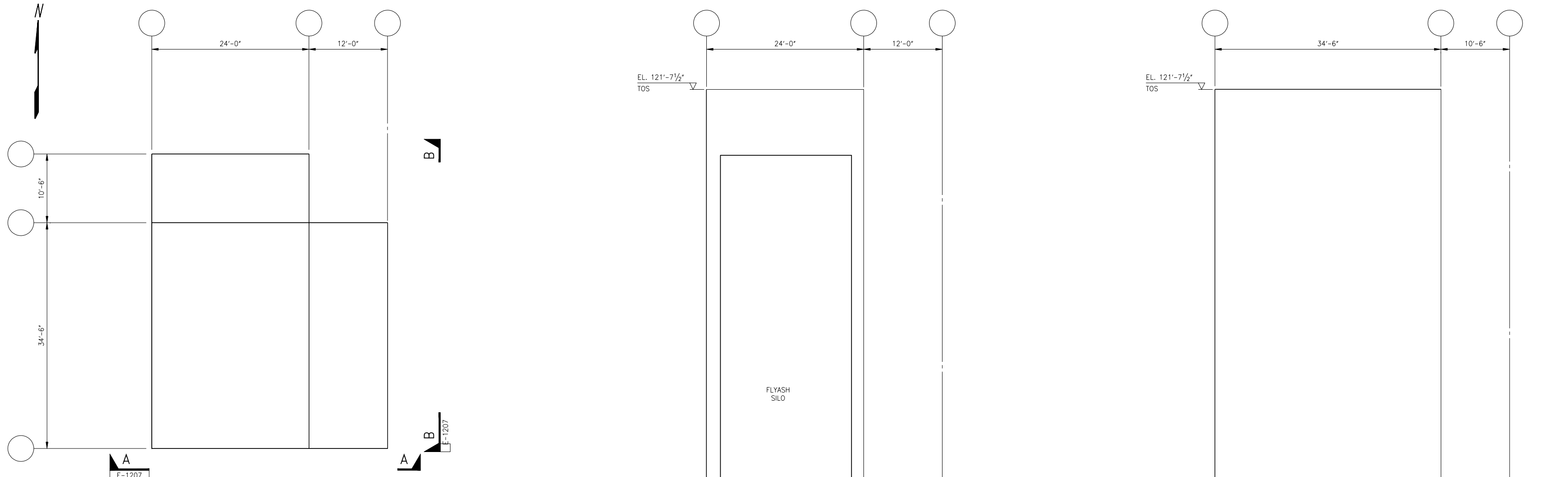
PRECIPITATOR AND FGD STUDY

GENERAL ARRANGEMENT
GYPSUM STORAGE BUILDING
PLAN AND SECTIONS

JOB No. 133544177 | DWG. No. E-1206 | REV B

M:\dwg\133544177\133544177E1206.dwg

Nov 18, 2008 3:59pm cboudreau



PLAN AT EL. 11'-6" TOC
SCALE: 1/8"=1'-0"

SECTION A E-1207
SCALE: 1/8"=1'-0"
ELEVATION LOOKING NORTH

SECTION B E-1207
SCALE: 1/8"=1'-0"
ELEVATION LOOKING EAST

DWG. No.	TITLE	BY

PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
B	NOV. 21, 2008 CLIENT	INFORMATION
B	OCT. 15, 2008 CLIENT	INFORMATION
A	OCT. 15, 2008 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.
B	SEPT. 26/08	CGB	GENERAL REVISION		

DESIGNED MDV	DRAWN CGB
CHECKED DESIGN / DFTG.	DATE AUG. 26, 2008
	SCALE 1/8"=1'-0"
APPROVED	SPEC.
P.M. MDV / P.T. DBB	

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

PRECIPITATOR AND FGD STUDY

GENERAL ARRANGEMENT
FLYASH BUILDING
PLAN AND SECTIONS

JOB No.	DWG. No.	REV
133544177	E-1207	B

M:\dwg\133544177\133544177E1207.dwg

Nov 18, 2008 3:59pm cboudreau

APPENDIX E.
Equipment List and Motor List

NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD PRECIPITATOR AND FGD STUDY

STANTEC JOB No. 44177
STANTEC DWG. No. B-XXXX
DATE: September 11, 2008
REV. G - September 25, 2008
FILE: L:/JOBS/44177/9.1

PRELIMINARY MOTOR LIST

REV NO.	MOTOR NO.	MCC NO.	DESCRIPTION	STR TYPE	HP	KW	Normal Operating	Normal Operating Time	Expected Total Operating KW	ELECTRICAL REMARKS
			Unit No. 1 Precipitator and Flue Gas System							
			Unit No.1 TR Set No.1			66	1	24	53	
			Unit No.1 TR Set No.2			66	1	24	53	
			Unit No.1 TR Set No.3			66	1	24	53	
			Unit No.1 TR Set No.4			66	1	24	53	
			Unit No.1 TR Set No.5			66	1	24	53	
			Unit No.1 TR Set No.6			66	1	24	53	
			Unit No.1 TR Set No.7			66	1	24	53	
			Unit No.1 TR Set No.8			66	1	24	53	
			Unit No.1 TR Set No.9			66	1	24	53	
			Unit No.1 TR Set No.10			66	1	24	53	
			Unit No.1 TR Set No.11			66	1	24	53	
			Unit No.1 TR Set No.12			66	1	24	53	
			Unit No.1 T/R Control No.1			11	1	24	9	
			Unit No.1 T/R Control No.2			11	1	24	9	
			Unit No.1 T/R Control No.3			11	1	24	9	
			Unit No. 1 Rapper Controller Panel No.1			8	1	24	6	
			Unit No. 1 Rapper Controller Panel No.2			8	1	24	6	
			Unit No. 1 Rapper Controller Panel No.3			8	1	24	6	
			Unit No. 1 Rapper Controller Panel No.4			8	1	24	6	
			Unit No. 1 Rapper Controller Panel No.5			8	1	24	6	
			Unit No. 1 Rapper Controller Panel No.6			8	1	24	6	
			Unit No.1 Purge Air Fan No.1		25	19	1	24	15	
			Unit No.1 Purge Air Fan No.2		25	19	1	24	15	
			Unit No. 1 Purge Air Heater No.1			40	1	24	32	
			Unit No. 1 Purge Air Heater No.2			40	1	24	32	
			Unit No.1 Penthouse Exhaust Fan No.1		5	4	1	24	3	
			Unit No.1 Penthouse Exhaust Fan No.2		5	4	1	24	3	
			Unit No.1 Hopper Area Vent Fan No.1		5	4	1	24	3	
			Unit No.1 Hopper Area Vent Fan No.2		5	4	1	24	3	
			Unit No.1 Hopper Heaters (9@10 kw/ea.)		90	67	1	24	54	
			Unit No.1 T/R Hoist		5	4	0	24	0	
			Unit No. 1 ID Fan No. 1		2700	2013	1	24	1611	
			Unit No. 1 ID Fan No. 2		2700	2013	1	24	1611	
			Unit No.1 ID Fan No.1 Bearing Lube Pump No.1		15	11	1	24	9	
			Unit No.1 ID Fan No.1 Bearing Lube Pump No.2		15	11	0	24	0	
			Unit No.1 ID Fan No.2 Bearing Lube Pump No.1		15	11	1	24	9	
			Unit No.1 ID Fan No.2 Bearing Lube Pump No.2		15	11	0	24	0	
			Unit No.1 ID Fan No.1 Bearing Lube Oil Heater			50	1	24	40	
			Unit No.1 ID Fan No.2 Bearing Lube Oil Heater			50	1	24	40	
			Unit No.1 ID Fan No.1 Inlet VIV Motor		3	2	1	24	2	
			Unit No.1 ID Fan No.2 Inlet VIV Motor		3	2	1	24	2	
			Unit No.1 ID Fan No.1 Outlet Damper		7.5	6	0	24	0	

NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD PRECIPITATOR AND FGD STUDY

PRELIMINARY MOTOR LIST

STANTEC JOB No. 44177
STANTEC DWG. No. B-XXXX
DATE: September 11, 2008
REV. G - September 25, 2008
FILE: L:/JOBS/44177/9.1

REV NO.	MOTOR NO.	MCC NO.	DESCRIPTION	STR TYPE	HP	KW	Normal Operating	Normal Operating Time	Expected Total Operating KW	ELECTRICAL REMARKS
			Unit No.1 ID Fan No.2 Outlet Damper		7.5	6	0	24	0	
			Unit No.1 FGD Inlet Damper		10	7	0	24	0	
			Unit No.1 FGD Bypass Damper		10	7	0	24	0	
			Unit No.1 Damper Seal Air Fan No.1		25	19	1	24	15	
			Unit No.1 Damper Seal Air Fan No.2		25	19	0	24	0	
			Unit No.1 Damper Seal Air Heater			250	1	24	200	
			Unit No.1 VFD HVAC Unit Fan		15	11	1	24	9	
			Unit No.1 VFD HVAC Unit Compressor No.1		15	11	1	24	9	
			Unit No.1 VFD HVAC Unit Compressor No.2		15	11	1	24	9	
			Unit No.1 VFD Building Exhaust Fan		5	4	1	24	3	
			Unit No.1 Flyash Handling Air Compressor No. 1		125	93	1	24	75	
			Unit No.1 Flyash Handling Air Compressor No. 2		125	93	0	24	0	
			Unit No.1 Flyash Handling Air Dryer No.1			20	1	24	16	
			Unit No.1 Flyash Handling Air Dryer No.2			20	0	24	0	
			Unit #1 Precipitator Total			**5829.13**			**4516**	

Unit No.2 Precipitator and Flue Gas System

REV NO.	MOTOR NO.	MCC NO.	DESCRIPTION	STR TYPE	HP	KW	Normal Operating	Normal Operating Time	Expected Total Operating KW	ELECTRICAL REMARKS
			Unit No.2 TR Set No.1			66	1	24	53	
			Unit No.2 TR Set No.2			66	1	24	53	
			Unit No.2 TR Set No.3			66	1	24	53	
			Unit No.2 TR Set No.4			66	1	24	53	
			Unit No.2 TR Set No.5			66	1	24	53	
			Unit No.2 TR Set No.6			66	1	24	53	
			Unit No.2 TR Set No.7			66	1	24	53	
			Unit No.2 TR Set No.8			66	1	24	53	
			Unit No.2 TR Set No.9			66	1	24	53	
			Unit No.2 TR Set No.10			66	1	24	53	
			Unit No.2 TR Set No.11			66	1	24	53	
			Unit No.2 TR Set No.12			66	1	24	53	
			Unit No.2 T/R Control No.1			11	1	24	9	
			Unit No.2 T/R Control No.2			11	1	24	9	
			Unit No.2 T/R Control No.3			11	1	24	9	
			Unit No. 2 Rapper Controller Panel No.1			8	1	24	6	
			Unit No. 2 Rapper Controller Panel No.2			8	1	24	6	
			Unit No. 2 Rapper Controller Panel No.3			8	1	24	6	
			Unit No. 2 Rapper Controller Panel No.4			8	1	24	6	
			Unit No. 2 Rapper Controller Panel No.5			8	1	24	6	
			Unit No. 2 Rapper Controller Panel No.6			8	1	24	6	
			Unit No.2 Purge Air Fan No.1		25	19	1	24	15	
			Unit No.2 Purge Air Fan No.2		25	19	1	24	15	
			Unit No. 2 Purge Air Heater No.1			40	1	24	32	
			Unit No. 2 Purge Air Heater No.2			40	1	24	32	
			Unit No.2 Penthouse Exhaust Fan No.1		5	4	1	24	3	
			Unit No.2 Penthouse Exhaust Fan No.2		5	4	1	24	3	
			Unit No.2 Hopper Area Vent Fan No.1		5	4	1	24	3	

NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD PRECIPITATOR AND FGD STUDY

PRELIMINARY MOTOR LIST

STANTEC JOB No. 44177
STANTEC DWG. No. B-XXXX
DATE: September 11, 2008
REV. G - September 25, 2008
FILE: L:/JOBS/44177/9.1

REV NO.	MOTOR NO.	MCC NO.	DESCRIPTION	STR TYPE	HP	KW	Normal Operating	Normal Operating Time	Expected Total Operating KW	ELECTRICAL REMARKS
			Unit No.2 Hopper Area Vent Fan No.2		5	4	1	24	3	
			Unit No.2 Hopper Heaters (9@10 kw/ea.)		90	67	1	24	54	
			Unit No.2 T/R Hoist		5	4	0	24	0	
			Unit No. 2 ID Fan No. 1		2700	2013	1	24	1611	
			Unit No. 2 ID Fan No. 2		2700	2013	1	24	1611	
			Unit No.2 ID Fan No.1 Bearing Lube Pump No.1		15	11	1	24	9	
			Unit No.2 ID Fan No.1 Bearing Lube Pump No.2		15	11	0	24	0	
			Unit No.2 ID Fan No.2 Bearing Lube Pump No.1		15	11	1	24	9	
			Unit No.2 ID Fan No.2 Bearing Lube Pump No.2		15	11	0	24	0	
			Unit No.2 ID Fan No.1 Bearing Lube Oil Heater			50	1	24	40	
			Unit No.2 ID Fan No.2 Bearing Lube Oil Heater			50	1	24	40	
			Unit No.2 ID Fan No.1 Inlet VIV Motor		3	2	1	24	2	
			Unit No.2 ID Fan No.2 Inlet VIV Motor		3	2	1	24	2	
			Unit No.2 ID Fan No.1 Outlet Damper		7.5	6	0	24	0	
			Unit No.2 ID Fan No.2 Outlet Damper		7.5	6	0	24	0	
			Unit No.2 FGD Inlet Damper		10	7	0	24	0	
			Unit No.2 FGD Bypass Damper		10	7	0	24	0	
			Unit No.2 Damper Seal Air Fan No.1		25	19	1	24	15	
			Unit No.2 Damper Seal Air Fan No.2		25	19	0	24	0	
			Unit No.2 Damper Seal Air Heater			250	1	24	200	
			Unit No.2 VFD HVAC Unit Fan		15	11	1	24	9	
			Unit No.2 VFD HVAC Unit Compressor No.1		15	11	1	24	9	
			Unit No.2 VFD HVAC Unit Compressor No.2		15	11	1	24	9	
			Unit No.2 VFD Building Exhaust Fan		5	4	1	24	3	
			Unit No.2 Flyash Handling Air Compressor No. 1		125	93	1	24	75	
			Unit No.2 Flyash Handling Air Compressor No. 2		125	93	0	24	0	
			Unit No.2 Flyash Handling Air Dryer No.1			20	1	24	16	
			Unit No.2 Flyash Handling Air Dryer No.2			20	0	24	0	
			Unit #2 Precipitator Total			**5829.13**			**4516**	

Unit No.3 Precipitator and Flue Gas System

REV NO.	MOTOR NO.	MCC NO.	DESCRIPTION	STR TYPE	HP	KW	Normal Operating	Normal Operating Time	Expected Total Operating KW	ELECTRICAL REMARKS
			Unit No.3 TR Set No.1			66	1	24	53	
			Unit No.3 TR Set No.2			66	1	24	53	
			Unit No3 TR Set No.3			66	1	24	53	
			Unit No.3 TR Set No.4			66	1	24	53	
			Unit No.3 TR Set No.5			66	1	24	53	
			Unit No.3 TR Set No.6			66	1	24	53	
			Unit No.3 TR Set No.7			66	1	24	53	
			Unit No.3 TR Set No.8			66	1	24	53	
			Unit No.3 TR Set No.9			66	1	24	53	
			Unit No.3 TR Set No.10			66	1	24	53	
			Unit No.3 TR Set No.11			66	1	24	53	
			Unit No.3 TR Set No.12			66	1	24	53	
			Unit No.3 T/R Control No.1			11	1	24	9	
			Unit No.3 T/R Control No.2			11	1	24	9	
			Unit No.3 T/R Control No.3			11	1	24	9	

NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD PRECIPITATOR AND FGD STUDY

STANTEC JOB No. 44177
STANTEC DWG. No. B-XXXX
DATE: September 11, 2008
REV. G - September 25, 2008
FILE: L:/JOBS/44177/9.1

PRELIMINARY MOTOR LIST

REV NO.	MOTOR NO.	MCC NO.	DESCRIPTION	STR TYPE	HP	KW	Normal Operating	Normal Operating Time	Expected Total Operating KW	ELECTRICAL REMARKS
			Unit No. 3 Rapper Controller Panel No.1			8	1	24	6	
			Unit No. 3 Rapper Controller Panel No.2			8	1	24	6	
			Unit No. 3 Rapper Controller Panel No.3			8	1	24	6	
			Unit No. 3 Rapper Controller Panel No.4			8	1	24	6	
			Unit No. 3 Rapper Controller Panel No.5			8	1	24	6	
			Unit No. 3 Rapper Controller Panel No.6			8	1	24	6	
			Unit No.3 Purge Air Fan No.1		25	19	1	24	15	
			Unit No.3 Purge Air Fan No.2		25	19	1	24	15	
			Unit No. 3 Purge Air Heater No.1			40	1	24	32	
			Unit No. 3 Purge Air Heater No.2			40	1	24	32	
			Unit No.3 Penthouse Exhaust Fan No.1		5	4	1	24	3	
			Unit No.3 Penthouse Exhaust Fan No.2		5	4	1	24	3	
			Unit No.3 Hopper Area Vent Fan No.1		5	4	1	24	3	
			Unit No.3 Hopper Area Vent Fan No.2		5	4	1	24	3	
			Unit No.3 Hopper Heaters (9@10 kw/ea.)		90	67	1	24	54	
			Unit No.3 T/R Hoist		5	4	0	24	0	
			Unit No. 3 ID Fan No. 1		2700	2013	1	24	1611	
			Unit No. 3 ID Fan No. 2		2700	2013	1	24	1611	
			Unit No.3 ID Fan No.1 Bearing Lube Pump No.1		15	11	1	24	9	
			Unit No.3 ID Fan No.1 Bearing Lube Pump No.2		15	11	0	24	0	
			Unit No.3 ID Fan No.2 Bearing Lube Pump No.1		15	11	1	24	9	
			Unit No.3 ID Fan No.2 Bearing Lube Pump No.2		15	11	0	24	0	
			Unit No.3 ID Fan No.1 Bearing Lube Oil Heater			50	1	24	40	
			Unit No.3 ID Fan No.2 Bearing Lube Oil Heater			50	1	24	40	
			Unit No.3 ID Fan No.1 Inlet VIV Motor		3	2	1	24	2	
			Unit No.3 ID Fan No.2 Inlet VIV Motor		3	2	1	24	2	
			Unit No.3 ID Fan No.1 Outlet Damper		7.5	6	0	24	0	
			Unit No.3 ID Fan No.2 Outlet Damper		7.5	6	0	24	0	
			Unit No.3 FGD Inlet Damper		10	7	0	24	0	
			Unit No.3 FGD Bypass Damper		10	7	0	24	0	
			Unit No.2 Damper Seal Air Fan No.1		25	19	1	24	15	
			Unit No.2 Damper Seal Air Fan No.2		25	19	0	24	0	
			Unit No.2 Damper Seal Air Heater			250	1	24	200	
			Unit No.3 VFD HVAC Unit Fan		15	11	1	24	9	
			Unit No.3 VFD HVAC Unit Compressor No.1		15	11	1	24	9	
			Unit No.3 VFD HVAC Unit Compressor No.2		15	11	1	24	9	
			Unit No.3 VFD Building Exhaust Fan		5	4	1	24	3	
			Unit No.3 Flyash Handling Air Compressor No. 1		125	93	1	24	75	
			Unit No.3 Flyash Handling Air Compressor No. 2		125	93	0	24	0	
			Unit No.3 Flyash Handling Air Dryer No.1			20	1	24	16	
			Unit No.3 Flyash Handling Air Dryer No.2			20	0	24	0	
			Unit #3 Precipitator Total			**5829.13**			**4516**	

ID Fan Building

			ID Fan Building Roof Exhauster No. 1		5	4	1	24	3	
			ID Fan Building Roof Exhauster No. 2		5	4	1	24	3	

Stantec

NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD PRECIPITATOR AND FGD STUDY

PRELIMINARY MOTOR LIST

STANTEC JOB No. 44177
STANTEC DWG. No. B-XXXX
DATE: September 11, 2008
REV. G - September 25, 2008
FILE: L:/JOBS/44177/9.1

REV NO.	MOTOR NO.	MCC NO.	DESCRIPTION	STR TYPE	HP	KW	Normal Operating	Normal Operating Time	Expected Total Operating KW	ELECTRICAL REMARKS
			ID Fan Building Roof Exhauster No. 3		5	4	1	24	3	
			ID Fan Building Roof Exhauster No. 4		5	4	1	24	3	
			ID Fan Building Total			**15**			**12**	
	Flyash Handling									
			Flyash Silo rotary Valve		2	1	1	24	1	
			Flyash Silo Fluidizer Blower		10	7	1	24	6	
			Flyash Silo Fluidizer Heater			100	1	24	80	
			Flyash Mixer		25	19	1	24	15	
			Flyash Building Exhaust Fan No.1		5	4	1	24	3	
			Flyash Building Exhaust Fan No.2		5	4	1	24	3	
			Flyash Handling Total			**135.048**			**108**	
	FGD **Limestone Receiving and Preparation**									
			Limestone Receiving Vibratory Feeder		15	11	1	24	9	
			Limestone Conveyor No.1		50	37	1	24	30	
			Limestone Conveyor No.2		10	7	1	24	6	
			Limestone Dust Filter Fan No.1		5	4	1	24	3	
			Limestone Dust Filter Fan No.2		5	4	0	24	0	
			Limestone Silo Bin Activator No.1		3	2	1	24	2	
			Limestone Silo Bin Activator No.2		3	2	0	24	0	
			Limestone Feeder No.1		5	4	1	24	3	
			Limestone Feeder No.2		5	4	0	24	0	
			Ball Mill No.1 Motor		500	373	1	24	298	
			Ball Mill No.2 Motor		500	373	0	24	0	
			Ball Mill No.1 Inching Drive		10	7	0	24	0	
			Ball Mil No. 2 Inching Drive		10	7	0	24	0	
			Ball Mill No.1 Gear Lube Pump		2	1	1	24	1	
			Ball Mill No. 2 Gear Lube Pump		2	1	0	24	0	
			Ball Mill No.1 Bearing Lube Pump LP		2	1	1	24	1	
			Ball Mill No.1 Bearing Lube Pump HP		2	1	0	24	0	
			Ball Mill No.2 Bearing Lube Pump LP		2	1	0	24	0	
			Ball Mill No.2 Bearing Lube Pump HP		2	1	0	24	0	
			Ball Mill No.1 Jacking Pump		3	2	0	24	0	
			Ball Mill No.2 Jacking Pump		3	2	0	24	0	
			Ball Mill Product Tank No.1 Agitator		5	4	1	24	3	
			Ball Mill Product Tank No.2 Agitator		5	4	1	24	3	

Stantec

NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD PRECIPITATOR AND FGD STUDY

PRELIMINARY MOTOR LIST

STANTEC JOB No. 44177
STANTEC DWG. No. B-XXXX
DATE: September 11, 2008
REV. G - September 25, 2008
FILE: L:/JOBS/44177/9.1

REV NO.	MOTOR NO.	MCC NO.	DESCRIPTION	STR TYPE	HP	KW	Normal Operating	Normal Operating Time	Expected Total Operating KW	ELECTRICAL REMARKS
			Ball Mill Product Pump 1A		40	30	1	24	24	
			Ball Mill Product Pump 1B		40	30	0	24	0	
			Ball Mill Product Pump 2A		40	30	0	24	0	
			Ball Mill Product Pump 2B		40	30	0	24	0	
			Limestone Slurry Tank Agitator		25	19	1	24	15	
			Limestone Slurry Feed Pump No.1		15	11	1	24	9	
			Limestone Slurry Feed Pump No.2		15	11	0	24	0	
			Limestone Receiving and Preparation Total			**1017.13**			**407**	

Absorber System

REV NO.	MOTOR NO.	MCC NO.	DESCRIPTION	STR TYPE	HP	KW	Normal Operating	Normal Operating Time	Expected Total Operating KW	ELECTRICAL REMARKS
			Absorber Recycle Pump No.1		1000	746	1	24	597	
			Absorber Recycle Pump No.2		1000	746	1	24	597	
			Absorber Recycle Pump No.3		1000	746	1	24	597	
			Absorber Recycle Pump No.4		1000	746	0	24	0	
			Absorber Recycle Pump Lube Oil Cooling Fan No.1		1	1	1	24	1	
			Absorber Recycle Pump Lube Oil Cooling Fan No.2		1	1	1	24	1	
			Absorber Recycle Pump Lube Oil Cooling Fan No.3		1	1	1	24	1	
			Absorber Recycle Pump Lube Oil Cooling Fan No.4		1	1	0	24	0	
			Absorber Recycle Pump Inlet Valve Hydraulic Pump No.1		20	15	0	24	0	
			Absorber Recycle Pump Inlet Valve Hydraulic Pump No.2		20	15	0	24	0	
			Absorber Agitator No.1		75	56	1	24	45	
			Absorber Agitator No.2		75	56	1	24	45	
			Absorber Agitator No.3		75	56	1	24	45	
			Absorber Agitator No.4		75	56	1	24	45	
			Absorber Blowdown Pump No. 1		40	30	1	24	24	
			Absorber Blowdown Pump No. 2		40	30	0	24	0	
			Absorber Purge Pump No.1		5	4	1	24	3	
			Absorber Purge Pump No.2		5	4	0	24	0	
			Oxidation Air Compressor No.1		750	559	1	24	447	
			Oxidation Air Compressor No.2		750	559	0	24	0	
			Oxidation Air Compressor No.1 Lube Oil Heater			7.5	1	24	6	
			Oxidation Air Compressor No.2 Lube Oil Heater			7.5	0	24	0	
			Oxidation Air Compressor No.1 Lube Oil Pump		10	7	1	24	6	
			Oxidation Air Compressor No.2 Lube Oil Pump		10	7	0	24	0	
			ME Wash Pump No.1		100	75	1	24	60	
			ME Wash Pump No.2		100	75	0	24	0	
			Absorber Outlet Damper Drive		1	1	0	24	0	
			Absorber Outlet Damper Seal Air Fan No.1		25	19	1	24	15	
			Absorber Outlet Damper Seal Air Fan No.2		25	19	0	24	0	
			Absorber Outlet Damper Seal Air Heater			250	1	24	200	
			Absorber System Total			**4892.07**			**2731**	

NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD PRECIPITATOR AND FGD STUDY

STANTEC JOB No. 44177
STANTEC DWG. No. B-XXXX
DATE: September 11, 2008
REV. G - September 25, 2008
FILE: L:/JOBS/44177/9.1

PRELIMINARY MOTOR LIST

REV NO.	MOTOR NO.	MCC NO.	DESCRIPTION	STR TYPE	HP	KW	Normal Operating	Normal Operating Time	Expected Total Operating KW	ELECTRICAL REMARKS
Gypsum Dewatering										
			Reclaim Water Tank Agitator		15	11	1	24	9	
			Reclaim Water Pump No. 1		40	30	1	24	24	
			Reclaim Water Pump No. 1		40	30	0	24	0	
			Vacuum Drum Filter No.1 Drive		3	2	1	24	2	
			Vacuum Drum Filter No.2 Drive		3	2	0	24	0	
			Vacuum Filter Feed Pump No.1		10	7	1	24	6	
			Vacuum Filter Feed Pump No.2		10	7	0	24	0	
			Vacuum Filter Feed Tank Agitator		5	4	1	24	3	
			Filtrate Pump No.1		5	4	1	24	3	
			Filtrate Pump No.2		5	4	0	24	0	
			Vacuum Pump No. 1		250	186	1	24	149	
			Vacuum Pump No. 2		250	186	0	24	0	
			Cloth Wash Pump No.1		5	4	1	24	3	
			Cloth Wash Pump No.2		5	4	0	24	0	
			Cake Wash Pump No. 1		5	4	1	24	3	
			Cake Wash Pump No. 2		5	4	0	24	0	
			Seal Water Pump No. 1		3	2	1	24	2	
			Seal Water Pump No. 2		3	2	0	24	0	
			Gypsum Conveyor No. 1		10	7	1	24	6	
			Gypsum Conveyor No. 2		10	7	1	24	6	
			Gypsum Conveyor No. 3		15	11	1	24	9	
			Gypsum Conveyor No. 4		25	19	1	24	15	
			Emergency Hold Tank Agitator		50	37	1	24	30	
			Emergency Hold Pump		75	56	0	24	0	
			Blowdown Tank Agitator		5	4	1	24	3	
			Blowdown Tank Pump No. 1		5	4	1	24	3	
			Blowdown Tank Pump No. 2		5	4	0	24	0	
			Gypsum Dewatering Total			**642.793**			**275**	
FGD Balance of Plant										
			Limestone Area Sump Agitator		10	7	1	24	6	
			Limestone Area Sump Pump No. 1		30	22	1	24	18	
			Limestone Area Sump Pump No. 2		30	22	0	24	0	
			Absorber Area Sump Agitator		10	7	1	24	6	
			Absorber Area Sump Pump No. 1		30	22	1	24	18	
			Absorber Area Sump Pump No. 2		30	22	0	24	0	
			Service Air Compressor No. 1		125	93	1	24	75	
			Service Air Compressor No. 2		125	93	0	24	0	
			Instrument Air Compressor No. 1		100	75	1	24	60	
			Instrument Air Compressor No. 2		100	75	0	24	0	
			Instrument Air Dryer No. 1			10	1	24	8	
			Instrument Air Dryer No. 1			10	0	24	0	
			Gypsum Area Roof Exhauster No.1		5	4	1	24	3	
			Gypsum Area Roof Exhauster No.1		5	4	1	24	3	
			Absorber Area Roof Exhauster No. 1		7.5	6	1	24	4	

NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD PRECIPITATOR AND FGD STUDY

PRELIMINARY MOTOR LIST

STANTEC JOB No. 44177
STANTEC DWG. No. B-XXXX
DATE: September 11, 2008
REV. G - September 25, 2008
FILE: L:/JOBS/44177/9.1

REV NO.	MOTOR NO.	MCC NO.	DESCRIPTION	STR TYPE	HP	KW	Normal Operating	Normal Operating Time	Expected Total Operating KW	ELECTRICAL REMARKS
			Absorber Area Roof Exhauster No. 2		7.5	6	1	24	4	
			Absorber Area Roof Exhauster No. 3		7.5	6	1	24	4	
			Absorber Area Roof Exhauster No. 4		7.5	6	1	24	4	
			Electrical Room HVAC Unit #1		5	4	1	24	3	
			Electrical Room HVAC Unit #2		5	4	1	24	3	
			Electrical Room HVAC Unit #3		5	4	1	24	3	
			Electrical Room HVAC Unit #4		5	4	1	24	3	
			Chilled Water Recirculation Pump No. 1		3	2	1	24	2	
			Chilled Water Recirculation Pump No. 2		3	2	0	24	0	
			Chiller Compressor No.1		15	11	1	24	9	
			Chiller Compressor No.2		15	11	0	24	0	
			Rooftop Condenser Fan No.1		15	11	1	24	9	
			Rooftop Condenser Fan No.2		15	11	1	24	9	
			FGD Building Main Ventilation Fan No. 1		125	93	1	24	75	
			FGD Building Main Ventilation Fan No. 2		125	93	0	24	0	
			FGD Building Elevator		50	37	1	24	30	
			FGD Building Elevator Room Exhuast Fan		2	1	1	24	1	
			FGD Raw Water Makeup Pump No.1		50	37.285	1	24	30	
			FGD Raw Water Makeup Pump No.2		50	37.285	0	24	0	
			FGD Balance of Plant Total			**853.693**			**390**	

Waste Water Treatment

REV NO.	MOTOR NO.	MCC NO.	DESCRIPTION	STR TYPE	HP	KW	Normal Operating	Normal Operating Time	Expected Total Operating KW	ELECTRICAL REMARKS
			Sludge/Lime Mix Tank Agitator		5	4	1	24	3	
			Reaction Tank No.1 Agitator		5	4	1	24	3	
			Reaction Tank No.2 Agitator		5	4	1	24	3	
			Solids Conditioning Tank Agitator		5	4	1	24	3	
			Lime Slurry Makeup Tank Agitator		5	4	1	24	3	
			Hydrated lime Buylk Bag Discharge Feeder		0.5	0	1	24	0	
			Lime Slurry Recycle Pump No.1		7.5	6	1	24	4	
			Lime Slurry Recycle Pump No.2		7.5	6	0	24	0	
			Thickner Underflow Pump No.1		7.5	6	1	24	4	
			Thickner Underflow Pump No.2		7.5	6	0	24	0	
			Chemical Metering Pump No.1		1	1	1	24	1	
			Chemical Metering Pump No.2		1	1	1	24	1	
			Chemical Metering Pump No.3		1	1	1	24	1	
			Chemical Metering Pump No.4		1	1	1	24	1	
			Waste Water Area Sump Pump		5	4	1	24	3	
			Low Pressure Blower Tank Sparger		10	7	1	24	6	
			Waste Water Treatment Total			**56**			**35**	

Stantec

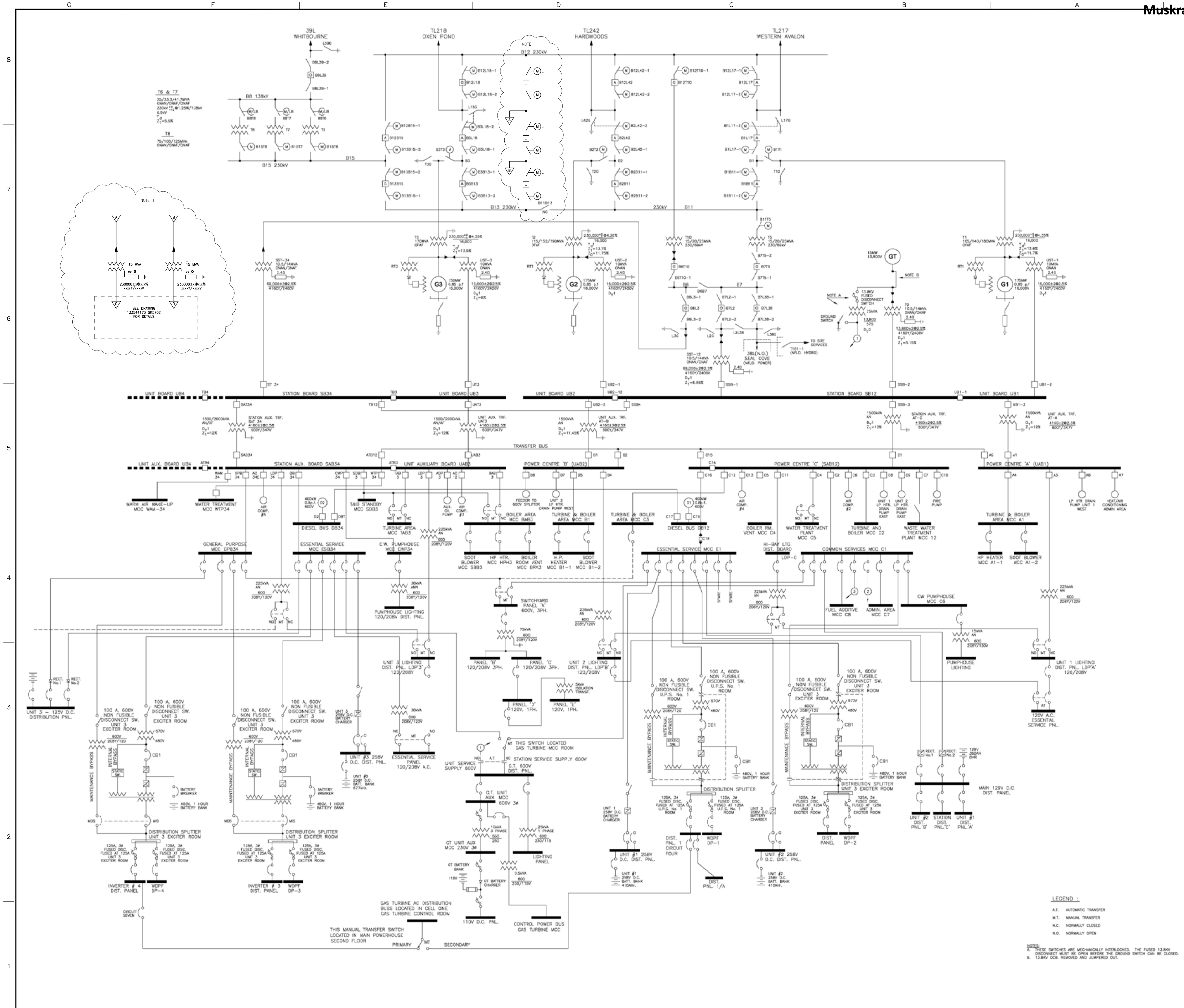
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD PRECIPITATOR AND FGD STUDY

PRELIMINARY MOTOR LIST

STANTEC JOB No. 44177
STANTEC DWG. No. B-XXXX
DATE: September 11, 2008
REV. G - September 25, 2008
FILE: L:/JOBS/44177/9.1

REV NO.	MOTOR NO.	MCC NO.	DESCRIPTION	STR TYPE	HP	KW	Normal Operating	Normal Operating Time	Expected Total Operating KW	ELECTRICAL REMARKS
			TOTAL OPERATING LOAD			**25099**			**17507**	

APPENDIX F.
Single Line Diagrams



REFERENCE DRAWINGS

DWG. No.	TITLE	BY

NOTES:

1. PROPOSED NEW EQUIPMENT FOR FGD/ESP PROJECT

PRELIMINARY
FOR INFORMATION ONLY

REV.	ISSUED TO	ISSUED FOR
A	OCT. 15, 2008 CLIENT	INFORMATION
A	SEPTEMBER 19, 2008 CLIENT	EQUIPMENT BUDGET QUOTATION

No.	DATE	BY	REVISIONS	DES.	DFTG.

DESIGNED HSC | DRAWN DJW
CHECKED (DESIGN / DFTG.) | DATE SEPT. 12, 2008
SCALE NTS
APPROVED | SPEC.
P.M. MDV | P.T. DHG

Stantec

HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

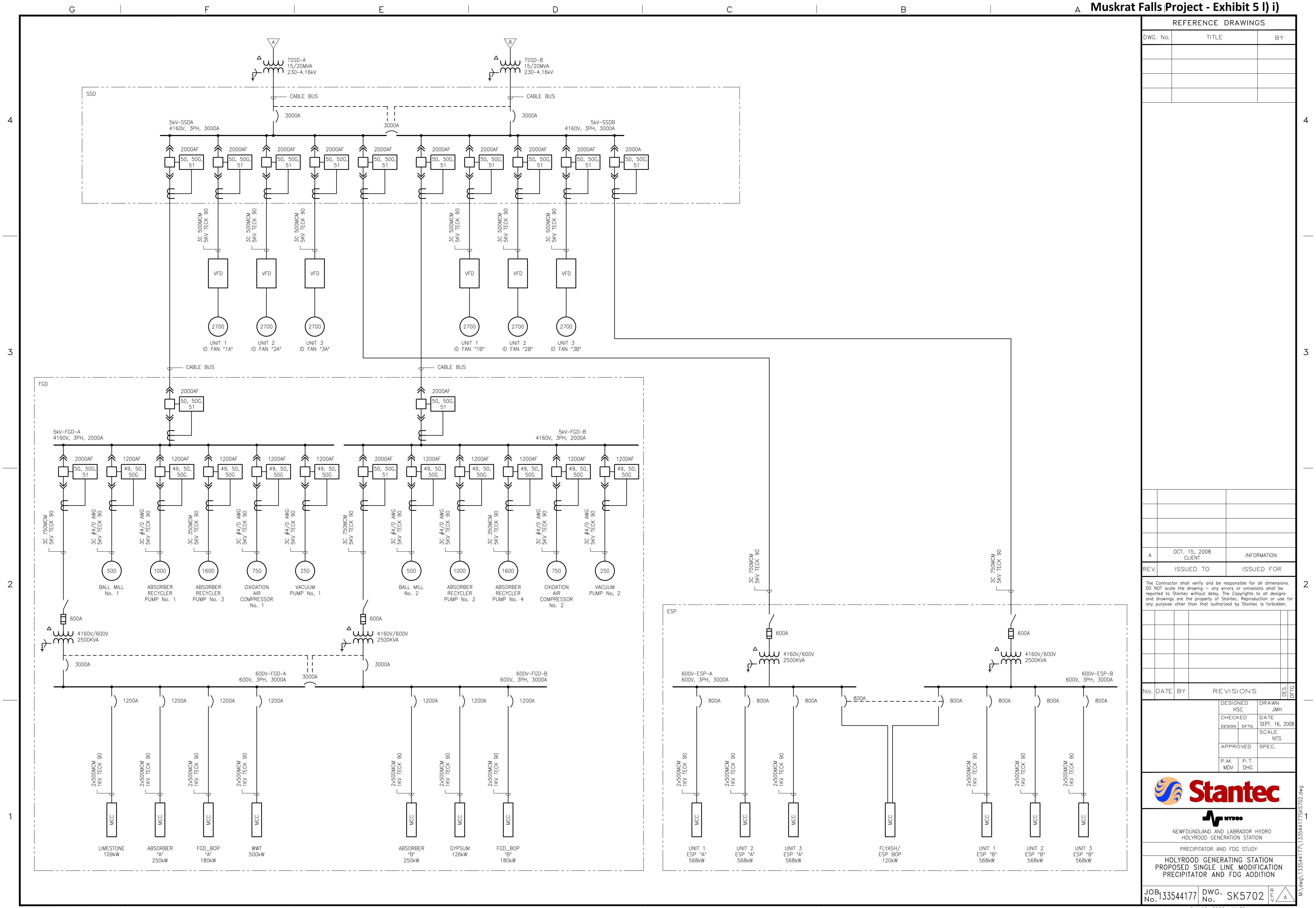
PRECIPITATOR AND FGD STUDY

HOLYROOD GENERATING STATION
PROPOSED SINGLE LINE MODIFICATION
PRECIPITATOR AND FGD ADDITION
SWITCHYARD

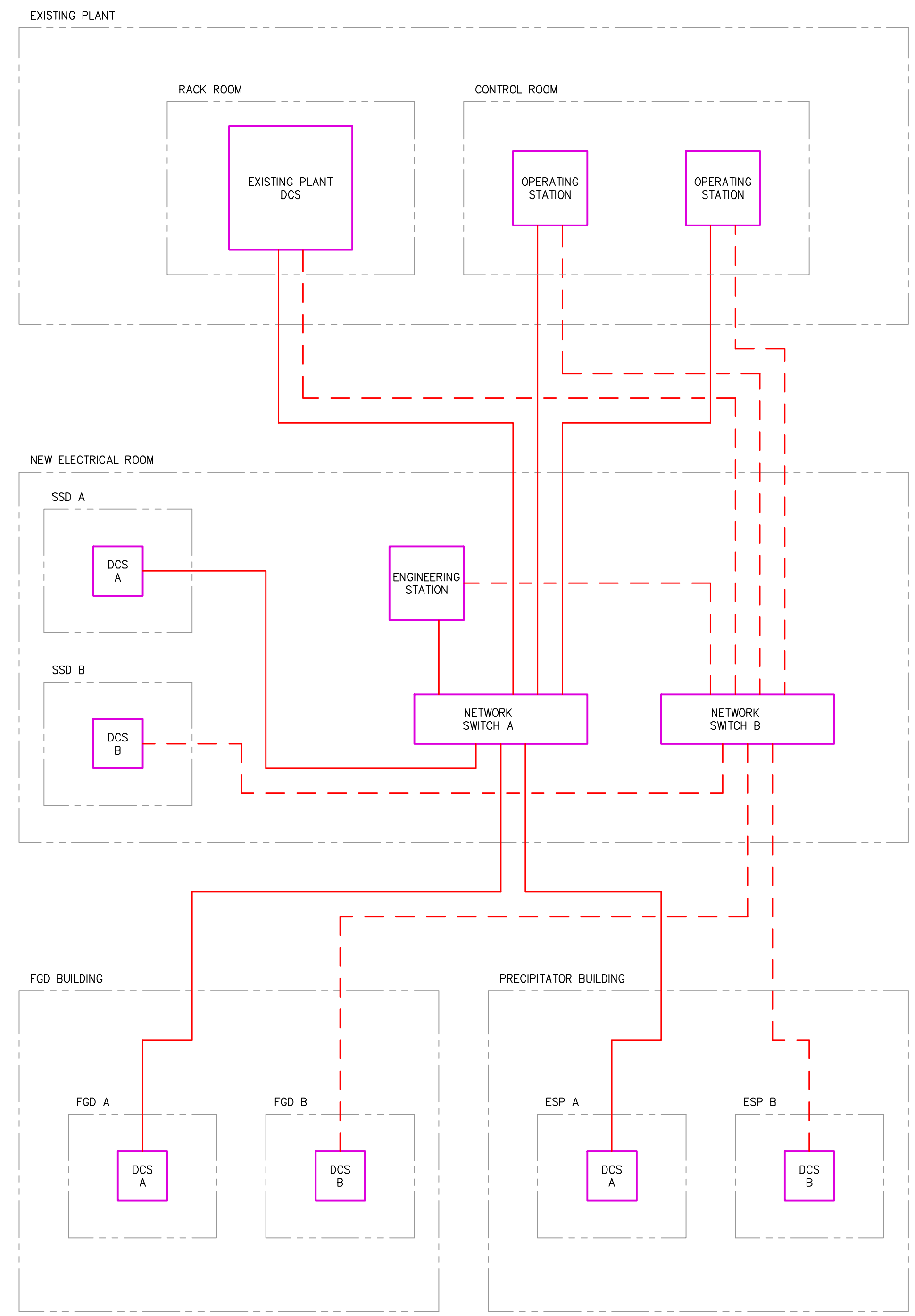
JOB No. 133544177 | DWG. No. SK5701 | REV A

M:\dwg\133544177\133544177SK5701.dwg

Oct 10, 2008 11:37am cboudreau



REFERENCE DRAWINGS
DWG. No.
TITLE
BY
TSSD-A
15/20MVA
230-4.16kV
TSSD-B
15/20MVA
230-4.16kV
SSD
CABLE BUS
3000A
5kV-SSDA
4160V, 3PH, 3000A
5kV-SSDB
4160V, 3PH, 3000A
2000AF
2000A
50, 50G, 51
3C 500MCM
5KV TECK 90
VFD
2700
UNIT 1
ID FAN "1A"
UNIT 2
ID FAN "2A"
UNIT 3
ID FAN "3A"
UNIT 1
ID FAN "1B"
UNIT 2
ID FAN "2B"
UNIT 3
ID FAN "3B"
FGD
5kV-FGD-A
4160V, 3PH, 2000A
5kV-FGD-B
4160V, 3PH, 2000A
1200AF
49, 50, 50G
3C 750MCM
5KV TECK 90
3C #4/0 AWG
5KV TECK 90
3C 350MCM
5KV TECK 90
500
1000
1600
750
250
BALL MILL
No. 1
ABSORBER
RECYCLER
PUMP No. 1
ABSORBER
RECYCLER
PUMP No. 3
OXIDATION
AIR
COMPRESSOR
No. 1
VACUUM
PUMP No. 1
BALL MILL
No. 2
ABSORBER
RECYCLER
PUMP No. 2
ABSORBER
RECYCLER
PUMP No. 4
OXIDATION
AIR
COMPRESSOR
No. 2
VACUUM
PUMP No. 2
600A
4160V/600V
2500KVA
600V-FGD-A
600V, 3PH, 3000A
600V-FGD-B
600V, 3PH, 3000A
1200A
2x500MCM
1KV TECK 90
MCC
LIMESTONE
109kW
ABSORBER
"A"
250kW
FGD_BOP
"A"
180kW
WWT
500kW
ABSORBER
"B"
250kW
GYPSUM
126kW
FGD_BOP
"B"
180kW
ESP
600V-ESP-A
600V, 3PH, 3000A
600V-ESP-B
600V, 3PH, 3000A
800A
UNIT 1
ESP "A"
568kW
UNIT 2
ESP "A"
568kW
UNIT 3
ESP "A"
568kW
FLYASH/
ESP BOP
120kW
UNIT 1
ESP "B"
568kW
UNIT 2
ESP "B"
568kW
UNIT 3
ESP "B"
568kW
A
OCT. 15, 2008
CLIENT
INFORMATION
REV.
ISSUED TO
ISSUED FOR
The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing – any errors or omissions shall be reported to Stantec without delay. The Copyrights to all designs and drawings are the property of Stantec. Reproduction or use for any purpose other than that authorized by Stantec is forbidden.
No. DATE BY REVISIONS
DESIGNED
HSC
DRAWN
JMH
CHECKED
DATE
SEPT. 16, 2008
SCALE
NTS
APPROVED
SPEC.
P.M.
MDV
P.T.
DHG
Stantec
HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION
PRECIPITATOR AND FDG STUDY
HOLYROOD GENERATING STATION
PROPOSED SINGLE LINE MODIFICATION
PRECIPITATOR AND FDG ADDITION
JOB No. 133544177
DWG. No. SK5702
REV A
Oct 10, 2008 11:35am cboudreau



REFERENCE DRAWINGS

DWG. No.	TITLE	BY

NOTES:

1. ALL CABLES ARE SIX CORE FIBER.

"A" SYSTEM CABLING

"B" SYSTEM CABLING

REV.	ISSUED TO	ISSUED FOR

No.	DATE	BY	REVISIONS	DES.	DFTG.

DESIGNED REK | DRAWN DGM
CHECKED DESIGN DFTG. | DATE 12/11/2008
SCALE NTS
APPROVED | SPEC.
P.M. MDV | P.T. DHG

Stantec

HYDRO

NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

PRECIPITATOR AND FGD STUDY

ELECTRICAL BLOCK DIAGRAM
DCS NETWORK
ARCHITECTURE

JOB No. 133544177 | DWG. No. SK5703 | REV A

Nov 28, 2008 10:40am $(GETVAR,??)

$(GETVAR,??) $(GETVAR,??)

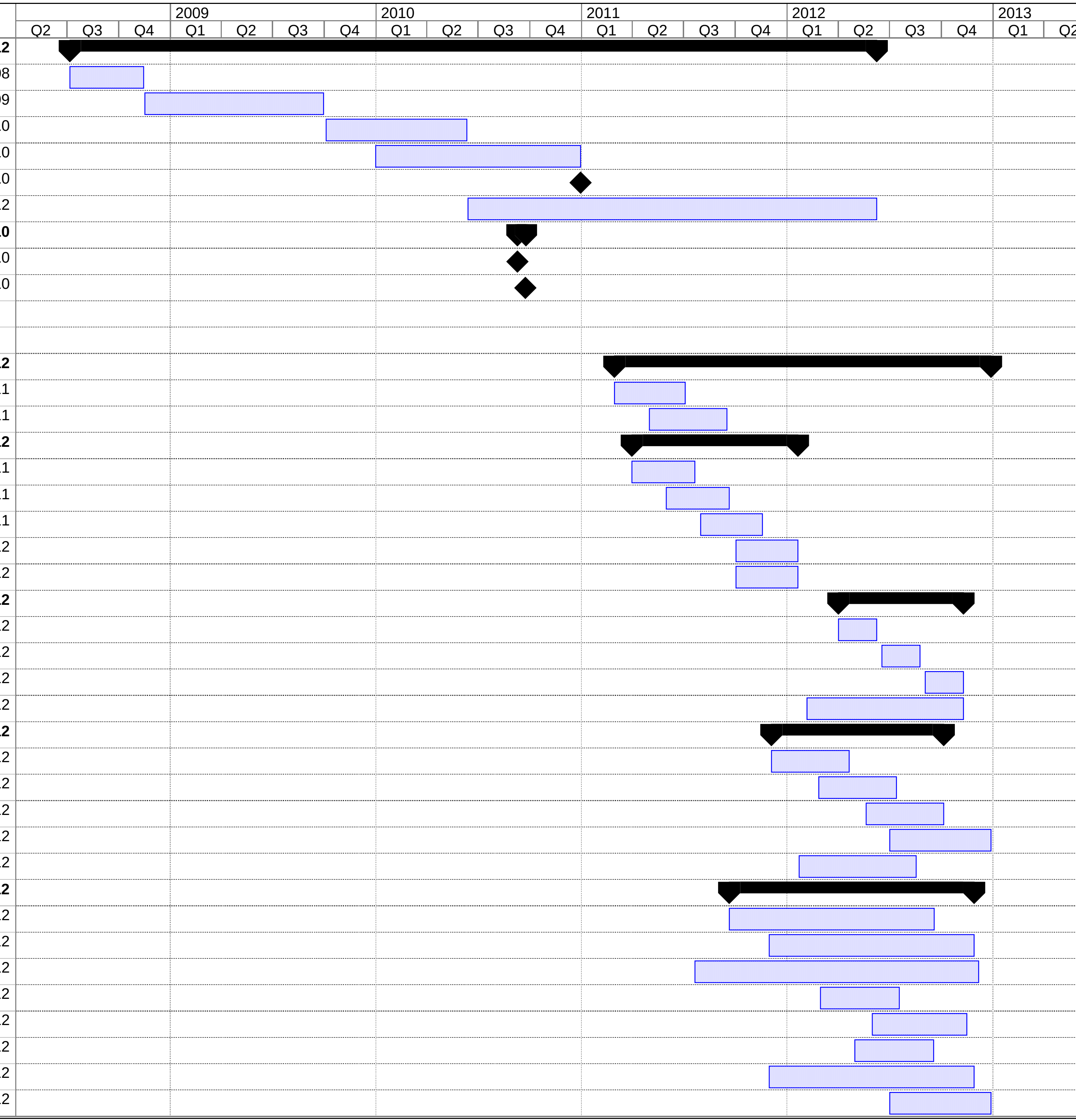
APPENDIX G.
Project Schedule

NEWFOUNDLAND AND LABRADOR HYDRO

PRECIPITATOR AND FGD INSTALLATION

PRELIMINARY PROJECT SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**Engineering and Project Management**	**205 wks?**	**Mon 07/07/08**	**Fri 08/06/12**
2	Preliminary Feasibility Study	19 wks	Mon 07/07/08	Fri 14/11/08
3	Strategic Project Evaluation and Decision Period	45.5 wks	Mon 17/11/08	Wed 30/09/09
4	Preliminary Engineering	36 wks	Mon 05/10/09	Fri 11/06/10
5	EIA	52 wks	Fri 01/01/10	Thu 30/12/10
6	Full Project Approval	0 wks	Thu 30/12/10	Thu 30/12/10
7	Detail Engineering	104 wks	Mon 14/06/10	Fri 08/06/12
8	**Major Contracts**	**2.2 wks?**	**Fri 10/09/10**	**Fri 24/09/10**
9	Award Precipitator Contract	0.2 wks?	Fri 10/09/10	Fri 10/09/10
10	Award FGD Contract	0.2 wks?	Fri 24/09/10	Fri 24/09/10
11				
12				
13	**Construction**	**95.8 wks**	**Tue 01/03/11**	**Fri 28/12/12**
14	**Site Preparation and Construction Services**	90 days	Tue 01/03/11	Mon 04/07/11
15	**Warehouse/ Pipe Shop/ Meter Shop**	20 wks	Mon 02/05/11	Fri 16/09/11
16	**Major Equipment Foundations**	**42.2 wks**	**Fri 01/04/11**	**Fri 20/01/12**
17	Stack	16 wks	Fri 01/04/11	Thu 21/07/11
18	FGD	16 wks	Wed 01/06/11	Tue 20/09/11
19	Precipitators	16 wks	Mon 01/08/11	Fri 18/11/11
20	Breeching	16 wks	Mon 03/10/11	Fri 20/01/12
21	ID Fans	16 wks	Mon 03/10/11	Fri 20/01/12
22	**Boiler Modifications Construction**	**32 wks**	**Mon 02/04/12**	**Fri 09/11/12**
23	Unit #1 Outage	10 wks	Mon 02/04/12	Fri 08/06/12
24	Unit #2 Outage	10 wks	Mon 18/06/12	Fri 24/08/12
25	Unit #3 Outage	10 wks	Mon 03/09/12	Fri 09/11/12
26	**Breaching and Dampers**	40 wks	Mon 06/02/12	Fri 09/11/12
27	**Precipitator Systems**	**44 wks**	**Mon 05/12/11**	**Fri 05/10/12**
28	Unit #1	20 wks	Mon 05/12/11	Fri 20/04/12
29	Unit #2	20 wks	Mon 27/02/12	Fri 13/07/12
30	Unit #3	20 wks	Mon 21/05/12	Fri 05/10/12
31	**Ash Handling System**	26 wks	Mon 02/07/12	Fri 28/12/12
32	**ID Fans System**	30 wks	Mon 23/01/12	Fri 17/08/12
33	**FGD Systems**	**62.2 wks**	**Wed 21/09/11**	**Wed 28/11/12**
34	Building	52 wks	Wed 21/09/11	Tue 18/09/12
35	Process Equipment	52 wks	Thu 01/12/11	Wed 28/11/12
36	**Stack System**	72 wks	Fri 22/07/11	Thu 06/12/12
37	**Limestone Handling System**	20 wks	Thu 01/03/12	Wed 18/07/12
38	**Gypsum Handling System**	24 wks	Fri 01/06/12	Thu 15/11/12
39	**WWTP Systems**	20 wks	Tue 01/05/12	Mon 17/09/12
40	**Power Systems**	52 wks	Thu 01/12/11	Wed 28/11/12
41	**DCS Systems**	26 wks	Mon 02/07/12	Fri 28/12/12



Project: 2008-09-xx-GBW-Project Sch
Date: Wed 01/10/08

Task | Milestone | Rolled Up Task | Rolled Up Progress | External Tasks | Group By Summary
Progress | Summary | Rolled Up Milestone | Split | Project Summary | Deadline

File: 133544177/11

Stantec

NEWFOUNDLAND AND LABRADOR HYDRO

PRECIPITATOR AND FGD INSTALLATION

PRELIMINARY PROJECT SCHEDULE

ID	Task Name	Duration	Start	Finish
42				
43	**Commissioning**	**17.4 wks?**	**Thu 01/11/12**	**Fri 01/03/13**
44	**Breeching and ID Fans**	2 wks	Thu 01/11/12	Wed 14/11/12
45	**Precipitator**	**10 wks**	**Fri 07/12/12**	**Thu 14/02/13**
46	**Unit #1**	**4 wks**	**Fri 07/12/12**	**Thu 03/01/13**
47	Tie-In	2 wks	Fri 07/12/12	Thu 20/12/12
48	Commissioning	2 wks	Fri 21/12/12	Thu 03/01/13
49	**Unit #2**	**4 wks**	**Fri 21/12/12**	**Thu 17/01/13**
50	Tie-In	2 wks	Fri 21/12/12	Thu 03/01/13
51	Commissioning	2 wks	Fri 04/01/13	Thu 17/01/13
52	**Unit #3**	**4 wks**	**Fri 18/01/13**	**Thu 14/02/13**
53	Tie-In	2 wks	Fri 18/01/13	Thu 31/01/13
54	Commissioning	2 wks	Fri 01/02/13	Thu 14/02/13
55	**Ash Handling System**	0.2 wks?	Fri 01/02/13	Fri 01/02/13
56	**FGD System**	8 wks	Tue 01/01/13	Mon 25/02/13
57	**Commercial Operation**	0 wks	Fri 01/03/13	Fri 01/03/13

Project: 2008-09-xx-GBW-Project Sch
Date: Wed 01/10/08

Task | Milestone | Rolled Up Task | Rolled Up Progress | External Tasks | Group By Summary
Progress | Summary | Rolled Up Milestone | Split | Project Summary | Deadline

File: 133544177/11

APPENDIX H.
Waste Water Treatment Plant Report

Thibault & Associates Inc.
Applied Process Chemical Engineering

572 New Maryland Highway, Unit B
New Maryland, New Brunswick
Canada, E3C 1K1
Telephone: (506) 454-2359
Facsimile: (506) 454-2355
Email: thibault@nbnet.nb.ca

Stantec Consulting Ltd.

Holyrood Generating Station
Newfoundland & Labrador Hydro

Flue Gas Desulphurization
Wastewater Treatment Cost Estimate

September 24th, 2008

FINAL REPORT

PROJECT NUMBER 5414-010

REVISION: 01

Prepared By:

Thibault & Associates Inc.

Prepared For:

Stantec Consulting Ltd.
Fredericton, New Brunswick

Stantec Consulting Ltd.

Holyrood Generating Station
Newfoundland & Labrador Hydro

Flue Gas Desulphurization System

Wastewater Treatment Assessment

TABLE OF CONTENTS

LIST OF TABLES

SECTION 1.0 - DESIGN BASIS

The preliminary design and capital cost estimate of a process system for the treatment of the wastewater effluent resulting from flue gas desulphurization (FGD) operations is based on the design criteria as outlined in Table 1. The wastewater system design criteria was developed from the design basis and scope of supply documentation prepared by Stantec Consulting Ltd. and from the subsequent budgetary estimate documentation by Babcock & Wilcox. for the supply and installation of flue gas desulphurization and electrostatic precipitator systems at the Holyrood Generating Station that is owned and operated by Newfoundland and Labrador Hydro.

The preliminary design of the FGD wastewater treatment process is based on the treatment of FGD purge streams and/or blowdown of the gypsum product filter - filtrate as required. The design wastewater load on the FGD wastewater treatment system is based solely on FGD control of impurities and does not account for wastewater from other sources, including the power house wastewater, FGD sump systems, leachate from the proposed gypsum and ash landfill and/or wastewater from other existing areas of the Holyrood Generating Station (such as boiler water treatment, sumps and gas train / fire-side washing). All of the process equipment as required for FGD wastewater treatment will be fully integrated with the FGD operation and will be housed within the FGD building.

The treatment process is designed for a high degree of FGD operational flexibility and is capable of handling twice the design purge flow rate plus an optional blowdown from the drum filter filtrate recycle stream if necessary. A increase in the purge rate will allow for an increased in the fuel chloride content or lower chloride concentrations within the scrubber module. A purge from the filter filtrate steam may be optional for optimum removal of gypsum impurities.

The treated wastewater from the wastewater treatment process is discharged directly to the environment (either direct discharge through a new line or may be tied into an existing treated wastewater discharge line) and the solids, which are mainly comprised of gypsum, are returned to the filter feed tank to be dewatered along with the primary FGD gypsum product. . The treated water quality is designed to meet Newfoundland and Labrador Regulation 65/03, *Environmental Control Water and Sewage Regulations under the Water Resources Act (2003)*.

NOTE A: Under Schedule A of Regulation 65/03, the maximum concentration of total dissolved solids in the treated effluent is 1,000 mg/l. The concentration of dissolved solids within the receiving water and the nominal dissolved solids contained in the FGD purge have are not defined in the project documentation. Any changes to Schedule A that have been previously authorized by the Department of Environment or references to existing Approval to Operate conditions have not been provided. The proposed wastewater treatment process technology provides a cost effective method for lowering dissolved solids concentrations relative to conventional methods based on a higher degree of calcium sulphate precipitation. However, the proposed process technology has not yet been tested to assure compliance with total dissolved solids regulations. Further review is required based on the quality of the receiving water and FGD process chemistry.

NOTE B: The proposed wastewater treatment system is not designed to remove chlorides and effluent chloride limits are not defined. In the event that the effluent of the FGD wastewater system is discharged to the sea or brackish water, the chloride content will not impact on the receiving water.

Table 1: Design Criteria for Holyrood FGD Wastewater Treatment System

DESIGN PARAMETER	UNITS	DESIGN VALUE	
		MAX (CASE A)	NOMINAL (CASE B)
Influent Flow Rate	USGPM	41.6	13.0
Influent Suspended Solids	lb/hr	704	357
Influent Soluble Vanadium	ppm	100	25
Solids Recycle Rate	% of U/F Solids	50	50

Table Notes:

1) **"U/F" refers to the thickener underflow and the recycle rate is a percentage of the total thickener underflow rate.**
2) **All design parameters are based on quality of fuel and an increase in the heavy metal or chloride content of the fuel will impact on the sizing of FGD wastewater treatment system.**

A mass balance simulation of the flowsheet was completed to define the process flow rates and reagent consumption for the proposed FGD wastewater treatment system. The flowsheet and mass balance simulation results for the maximum design (Case A) and nominal operation (Case B) are included in Appendix A. A preliminary equipment layout for the FGD wastewater treatment system is included with FGD system layout drawings.

NOTE C: The maximum loading on the wastewater system has been defined to allow for greater system flexibility to allow for an increase in chloride content of fuel or to reduce the chloride concentration in the scrubber by two fold. In addition to the potential increase in purge flow, the system sizing also allows for blowdown of filtrate to improve on quality of the gypsum (removal of soluble magnesium and heavy metals from filtrate wash stream).

NOTE D: The solids from the FGD wastewater system will not impact on the quality of the gypsum based on heavy metal and sulphur content of the fuel. The maximum content of vanadium in the fuel with 2.0 % sulphur in fuel should be less than 300 ppm V to control the content of vanadium in gypsum at less than 200 ppm V (based on the maximum solids removal efficiency of the proposed electrostatic precipitators).

SECTION 2.0 - PROCESS DESCRIPTION

The proposed FGD wastewater treatment process is based on the recycle of solids for optimized removal of dissolved solids and offers the following benefits:

- ☐ Integrated removal of dissolved heavy metals;
- ☐ Ability to produce a high density solids in the thickener underflow containing between 25% and 40% dry solids that is appropriate for direct return to the filter feed tank (does not require additional thickening prior to being dewatered) and consequently minimizes the volume of sludge generated for disposal, and;
- ☐ Reduced scale formation (gypsum deposition) on equipment surfaces and pipe walls due to improved precipitation and recovery of calcium sulphate crystals in the slurry.

The treatment process is continuous and utilizes four tank reactors to ensure sufficient reaction time for:

- ☐ Conditioning of the recycled solids and hydrated lime slurry in the Lime/Sludge Mix Tank;
- ☐ Influent wastewater neutralization (pH adjustment) and precipitation of dissolved heavy metals in Reaction Tanks No.1 and 2, and;
- ☐ Flocculation of precipitated solids in the Solids Conditioning Tank.

In the Lime/Sludge Mix Tank, the recycled sludge from the thickener underflow is pre-mixed with fresh lime slurry that is added from a recycle loop at a rate controlled by the pH setpoint defined for the reaction. The influent wastewater is pumped into a common header from the FGD purge pumps, the drum filter filtrate stream and from the wastewater area sump. Ferric sulphate reagent is injected in-line in the common influent header and aids in the removal of heavy metals from the wastewater through a mechanism commonly known as co-precipitation. In Reaction Tank No.1, the influent wastewater is combined with the lime-recycled solids mixture at a controlled pH. Reaction Tank No.2 provides additional residence time and mixing to ensure complete precipitation of any dissolved metals. Both reaction tanks are equipped with spargers to provide low pressure aeration of the tank contents, which promotes oxidation of calcium sulphite to sulphate, oxidation of reduced metal species to form metal hydroxide precipitates and aids in the formation of large gypsum crystals that can be more readily dewatered. Flocculent solution is added in the Solids Conditioning Tank with gentle agitation for conditioning of suspended solids in the feed to the thickener.

Suspended solids are separated from the treated wastewater and removed in the underflow from the wastewater thickener. A portion of the thickened solids are recycled to the Lime/Sludge Mix Tank while the remaining portion are pumped to the drum filter feed tank, where they are dewatered and subsequently handled concurrently with the primary FGD gypsum solids.

The overflow from the wastewater thickener is sent to one of two 100% duty continuous backwashing sand filters where any remaining suspended solids are filtered from the final treated effluent prior to discharge. Backwash reject water from the sand filters is directed to the wastewater area sump.

Reagent systems associated with FGD wastewater treatment system include a lime slurry preparation system designed for use with one tonne bulk bags of dry hydrated lime, a ferric sulphate tote tank metering system and a skid-mounted dry polymer preparation system. Other auxiliary equipment required for the FGD wastewater treatment process includes a wastewater area sump complete with sump pump, low pressure air supply (low pressure blower) to Reaction Tanks No.1 and 2, high pressure air supply to the sand filter air lift pumps and process water supply for lime slurry and polymer solution preparation.

SECTION 3.0 - SCOPE OF FGD WASTEWATER EQUIPMENT

The following section provides a listing of the major process equipment for the Holyrood Generating Station FGD wastewater treatment system. General arrangement and proposed layout of major process equipment is illustrated on Stantec Drawings E-1102, E-1103 and E-1104.

Table 2 presents a list of major process equipment, preliminary equipment sizing and selected materials of construction that have been included in the FGD wastewater treatment system budget cost estimate.

Table 2: Summary of Major Process Equipment for FGD Wastewater Treatment System

EQUIPMENT DESCRIPTION	QUANTITY	APPROXIMATE SIZE	MATERIALS OF CONSTRUCTION
Sludge/Lime Mix Tank (Tank No. 1)	1	6 ft diameter x 8ft high	FRP
Reaction Tanks (Tank No. 2 and 3)	2	6 ft diameter x 8ft high	FRP
Solids Conditioning Tank (Tank No. 4)	1	6 ft diameter x 8ft high	FRP
Lime Slurry Makeup Tank	1	6 ft diameter x 8ft high	FRP
Wastewater Area Sump	1	4 ft diameter x 4ft high	FRP
Agitators	5	2 to 5 Hp drives	CSRL
Wastewater Thickener	1	12ft diameter X 10 ft high	Carbon Steel (epoxy coated)
Continuous Backwash Sand Filters	2	4ft diameter x 10 ft high	FRP tank with PP internals
Hydrated Lime Bulk Bag Discharger	1	Feeder 0.5 Hp	Carbon Steel (painted)
Dry Polymer Preparation System	1	260 US gallon batch size	Stainless Steel
Lime Slurry Recycle Pumps	2	25 USGPM @ 30 ft head	CSRL
Thickener Underflow Pumps	2	30 USGPM @ 30 ft head	CSRL
Chemical Metering Pumps (ferric sulfate and polymer, c/w spare)	4	0.85 to 8.50 USGPH	PP
Wastewater Area Sump Pump	1	10 USGPM @ 30 ft head	CSRL
Low Pressure Blower & In-tank Sparger Systems	1	10 SCFM @ 5 to 10 psig	Carbon Steel (painted) & PP

Table Notes:
FRP = Fibreglass Reinforced Plastic
CSRL = Carbon Steel Rubber Lined
PP = Polypropylene (plastic)

All process piping for slurry and lime systems utilize carbon steel rubber lined pipe. Ferric sulphate reagent delivery system piping is carbon steel Teflon or polypropylene lined. Polymer and general (low solids) wastewater piping is polyvinyl chloride (PVC).

All field instrumentation and control valves as required have been included as well as provisions for automated reagent addition and water flush on slurry pumps. Local PLC control panel (floor) mounted with WWT area) with operator interface for reagent preparation and process control have been included. As an alternative, all control functions and operator interface for the FGD wastewater treatment system could be integrated within a plant-wide distributed control system (DCS) or within the main FGD control system with local PLC-based control panels provided for the hydrated lime system, polymer preparation system, sand filters and thickener. Data links to the main DCS will be provided in either case.

All instrumentation and control wiring, power wiring and cable tray are included in capital cost estimate as well as power disconnect and motor control center (MCC). MCC is to be located within main FGD MCC room. All pumps and agitators will be provided with local on/off/auto control boxes. Variable frequency drives (VFDs) have been included for Solids Conditioning Tank agitator and thickener underflow pumps. All process equipment grounding and safety interlock devices will be provided and are included in cost estimate.

All building enclosures, structural supports and foundations are considered part of FGD building design and are not included in capital cost estimate for FGD wastewater treatment system. Interior finishes including floor/wall coatings for chemical resistance are also not included. All overhead cranes as required for bulk bags or tote handling are not included. Lighting and other building amenities common to the main FGD process are not included. Spare parts are not included.

SECTION 4.0 - SCHEDULE AND PRICING

A Class 4 Study or Factored Cost Estimate (as defined by AACE.05.4) was completed for the proposed FGD wastewater system based on a -10% and plus 25% expected accuracy range. The estimate is based on a definitive flowsheet and file cost for vendor supplied process equipment (vendor competitive quotes were not obtained). All installation, piping, instrumentation, wiring and power distribution systems are factored based on previous wastewater treatment system installations by Thibault & Associates Inc.

The total cost for design, equipment procurement, installation, and commissioning is estimated at **CDN$1,515,000** (accuracy range of CDN$1,363,000 to CDN$1,894,000) based on current third quarter 2008 costs. The total estimated cost does not include construction management, which may be incorporated with management of the FGD installation.

The annual operating cost for reagents only (does not included labour, power or maintenance operating costs) is estimated to be **CDN$19,311 at nominal operating conditions (Case B)**. Regent costing is based on file cost for hydrated lime packaged in one tonne bulk bags, ferric sulphate reagent packaged in 260 US gallon tote tanks and CIBA Magnafloc 10 anionic flocculant packaged in 55 lb bags all delivered FOB to site (fuel surcharge on freight and taxes extra).

The estimated time frame for design, equipment procurement and installation is **10 to 12 months** subject to on equipment availability and overall project execution strategy.

APPENDIX A

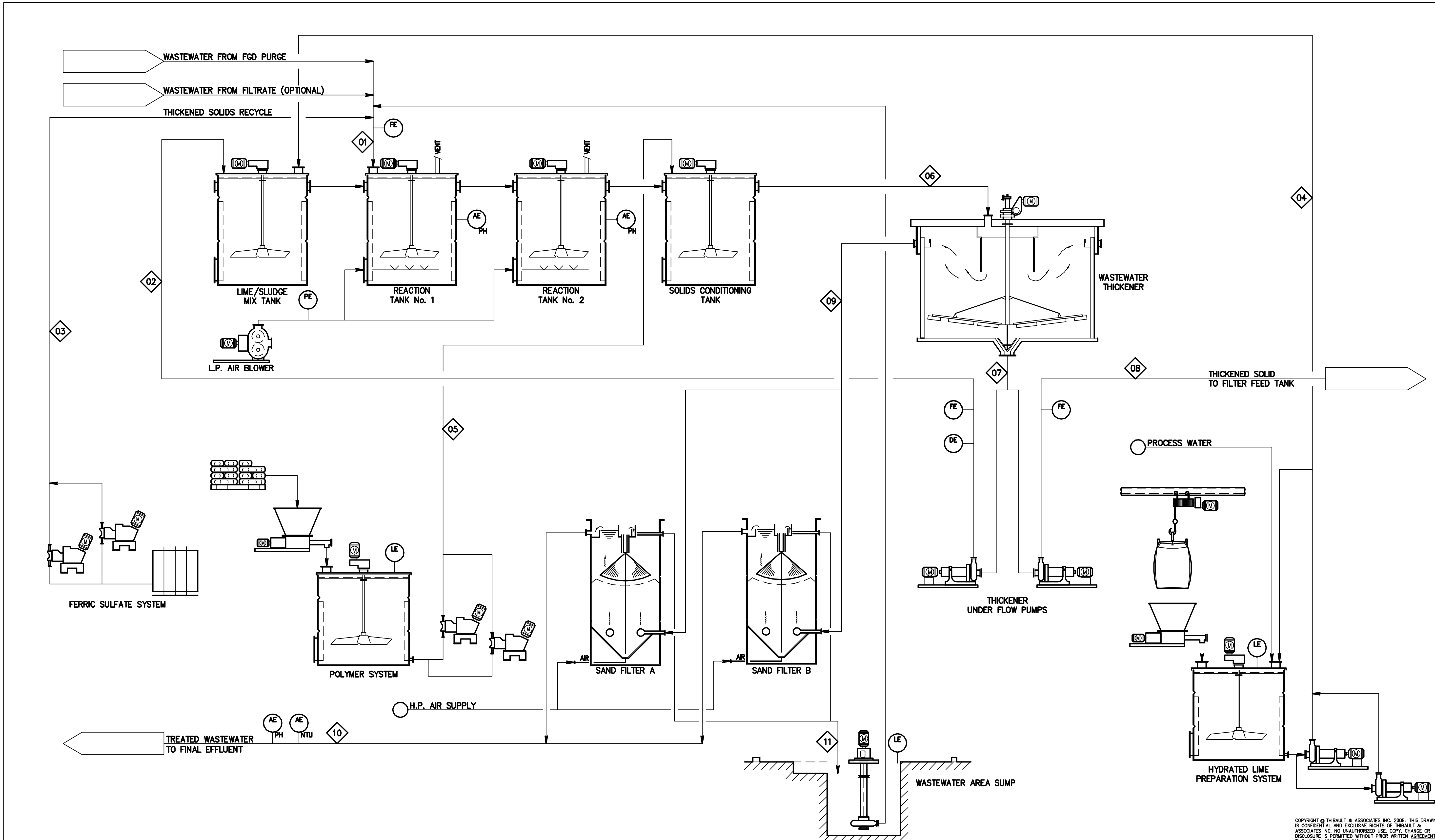
FGD Wastewater Treatment Flowsheet and Mass Balance

Holyrood FGD Wastewater Treatment System
Mass Balance Simulation - Maximum Loading (Case A)

DESCRIPTION	UNITS	STREAM 01	STREAM 02	STREAM 03	STREAM 04	STREAM 05	STREAM 06	STREAM 07	STREAM 08	STREAM 09	STREAM 10	STREAM 11
		Initial Wastewater	Solids Recycle	Iron Addition	Lime Addition	Polymer Addition	Thickener Feed	Thickener Overflow	Thickener Underflow	Solids To Drum Filter	Treated WW To Discharge	Backwash Reject Water
Soluble Vanadium	**ppm**	100.00	0.43	0.00	0.00	0.00	0.43	0.43	0.43	0.43	0.43	0.43
Soluble Iron	**ppm**	100.00	0.00	126,000.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Suspended Solids	**ppm**	33,160.00	200,000.00	0.00	0.00	0.00	60,124.23	164.61	200,000.00	200,000.00	5.32	2,232.68
Soluble Vanadium	**lb/hr**	2.05	0.00	0.00	0.00	0.00	0.01	0.01	0.003	0.001	0.01	0.00
Soluble Iron	**lb/hr**	2.05	0.00	10.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Suspended Solids	**lb/hr**	704.01	743.18	0.00	22.55	0.00	1,489.34	2.98	1,486.36	743.18	0.09	2.89
Water (Sol'n)	**lb/hr**	20,526.67	2,972.72	81.46	428.39	48.24	24,037.87	18,092.43	5,945.44	2,972.72	16,801.21	1,291.21
Total Mass Flow	**lb/hr**	21,230.68	3,715.90	81.46	450.94	48.24	25,527.21	18,095.41	7,431.80	3,715.90	16,801.30	1,294.10
Mass Fr. Solids	**n/a**	0.03	0.20	0.00	5.00	0.00	0.06	0.00	0.20	0.20	0.00	0.00
Slurry Sp. Gr.	**n/a**	1.02	1.13	1.46	1.03	1.00	1.03	1.00	1.13	1.13	1.00	1.00
Volumetric Flow	**USGPM**	41.60	6.58	0.11	0.88	0.10	49.29	36.14	13.15	6.58	33.55	2.58

Holyrood FGD Wastewater Treatment System
Mass Balance Simulation - Nominal Loading (Case B)

DESCRIPTION	UNITS	STREAM 01	STREAM 02	STREAM 03	STREAM 04	STREAM 05	STREAM 06	STREAM 07	STREAM 08	STREAM 09	STREAM 10	STREAM 11
		Initial Wastewater	Solids Recycle	Iron Addition	Lime Addition	Polymer Addition	Thickener Feed	Thickener Overflow	Thickener Underflow	Solids To Drum Filter	Treated WW To Discharge	Backwash Reject Water
Soluble Vanadium	ppm	25.00	0.10	0.00	0.00	0.00	0.10	0.10	0.10	0.10	0.10	0.10
Soluble Iron	ppm	0.00	0.00	126,000.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Suspended Solids	ppm	53,250.00	200,000.00	0.00	0.00	0.00	88,666.12	289.52	200,000.00	200,000.00	9.36	3,923.22
Soluble Vanadium	lb/hr	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Soluble Iron	lb/hr	0.00	0.00	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Suspended Solids	lb/hr	357.46	359.28	0.00	1.75	0.00	720.00	1.44	718.56	359.28	0.04	1.40
Water (Sol'n)	lb/hr	6,355.34	1,437.11	6.30	33.16	16.20	7,846.60	4,972.37	2,874.23	1,437.11	4,617.73	354.64
Total Mass Flow	lb/hr	6,712.79	1,796.39	6.30	34.90	16.20	8,566.60	4,973.81	3,592.79	1,796.39	4,617.78	356.03
Mass Fr. Solids	n/a	0.05	0.20	0.00	5.00	0.00	0.08	0.00	0.20	0.20	0.00	0.00
Slurry Sp. Gr.	n/a	1.03	1.13	1.46	1.03	1.00	1.05	1.00	1.13	1.13	1.00	1.00
Volumetric Flow	USGPM	13.00	3.18	0.01	0.07	0.03	16.29	9.93	6.36	3.18	9.22	0.71



Client / Site:

HYDRO

NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD GENERATION STATION

Drawing Number	Description	Description	Rev.	Date
		For Information Only	00	Sept 19/08

Reference Drawings — Issue / Revision

Designed By	Drawn By	Checked By	Approved By	Scale
SMS	AVP	JDT		NTS

Thibault & Associates Inc.
Applied Process Chemical Engineering

Project: Precipitator and FGD Scrubber Study

Drawing Title: FGD WASTEWATER TREATMENT SYSTEM FLOWSHEET

Project Number	Drawing Number			Revision
5414-010	0503	80	10	00

APPENDIX I.
Boiler Studies

babcock & wilcox canada ltd.

Thermal Power Department
Field Engineering Services

Engineering Study Report

Customer:	**Stantec for Newfoundland and Labrador Hydro Holyrood Generating Station**
Subject:	Buckstay Capacity Engineering Study For B&W Boiler Contract 7391
Ref No:	CM9021628
Page:	1 of 9
Original Date:	Sept. 10, 2008
Prepared By:	Terry Creighton, Project Engineer, Thermal Power
Reviewed By:	Gary Westerveld P. Eng. Manager Field Engineering Services

babcock & wilcox canada ltd.

Equipment Description:

Customer Name		Customer Location	
Holyrood Generating Station		**Holyrood, Newfoundland**	
Project Name / Contract #		**Report Date**	
Buckstay Capacity Engineering Study For B&W Boiler Contract 7391		Aug. 26/08	
Equipment		**Expected Performance at MCR**	
Manufacturer:	Babcock & Wilcox	Capacity	150 MW
Superheater:		Design Pressure, psig:	2200
Economizer:		Steam Temp, °F:	1005 F SH
Air Heater:		Excess Air:	
Firing Equipment:		Primary Fuel:	Oil
Control System:		Auxiliary Fuel:	
Miscellaneous:		In Service Date:	1977
Reason for Service		**Date of Service**	
B&W Service Engineer		**Customer Site Contact**	

babcock & wilcox canada ltd.

TABLE OF CONTENTS

babcock & wilcox canada ltd.

1.0 Introduction

Babcock & Wilcox Canada (B&W) was contracted by Stantec to conduct a buckstay study of the B&W boiler (Unit #3) original contract #7391 at Holyrood Generating Station located in Holyrood, Newfoundland. The boiler was supplied and installed in 1977. The buckstay system was reviewed based on a transient furnace pressure of +/- 35” W.G. furnace pressure.

B&W utilizes proprietary mathematical spread sheets to calculate the expected stresses in the buckstay system. Subsequently, various buckstay elevations were studied in order to determine whether the buckstay system can withstand a transient furnace pressure of +/- 35”W.G.

In the report B&W outlines the results of the buckstay review, and makes recommendations as to the modifications required to satisfy a transient furnace pressure of +/- 35” W.G.

2.0 Buckstay review

In order to comply with NFPA 85 the components of the buckstay system must be analyzed to determine the maximum allowable span between stiffeners (Buckstays) along the furnace wall. If the existing spacing exceeds the value established additional buckstays will have to be added. The factors which influence this spacing are as follows:

- Tube internal design pressure
- Tube material
- Tube design temperature
- Furnace internal pressures, +/- steady state, +/- transient
- Natural frequency of the wall
- Composite wall weight (i.e. existing tension on the tube due to dead load)

Once the spacing is determined the buckstay beam size is reviewed. The factors that influence the beam size are:

- Length of wall being restrained
- Furnace internal pressures, +/- steady state, +/- transient
- Seismic loads
- Natural frequency of buckstay beam

Typically, the negative transient pressures will dominate. Under these conditions the outer flange of the existing buckstay beam may exceed allowable stresses in compression. It is not strictly necessary to replace the beam in these situations as it is sufficient to improve the laterally stability of the beam. Flange stabilizers and/or overturning posts are used to accomplish this.

babcock & wilcox canada ltd.

The tie bar or Tie channel size is reviewed. The factors that influence the tie bar size are:

- Pin spacing (wall attachment spacing)
- Stand-off spacing (tie-bar to buckstay attachment)
- Furnace internal pressures, +/- steady state, +/- transient
- Seismic loads
- Adjacent wall end reaction loads, which impose a compression or tension load on the tie bar

The wall attachment/Pin spacing is reviewed. The factors which influence the spacing are as follows:

- Negative pressure.
- Use of overturning posts vs. Flange stabilizers.
- Tube thickness, internal design pressure and temperature

The Buckstay end connections are reviewed. The factors which influence this design are:

- Buckstay length being restrained
- Adjacent buckstay being restrained
- Maximum –ve or +ve furnace pressure (transient or steady state)
- Seismic loads

2.1 Calculation results

The boiler buckstay system was originally designed for positive pressure. There are three different beam sizes used for the buckstay beams. The front and rear walls use a W24 x 76 or W18 x114. All the sidewall buckstays are W18 x 105. Buckstay material is carbon steel, A36. The buckstay spacing varies from 11’-9” minimum to a maximum spacing of 15’-0”. The buckstay system consists of a beam (W24 x 76, W18 x 114 or W18 x 105) with ¾” thick standoff plates welded to the tie bar and spaced along the buckstay, clips welded to the standoff plate which holds the beam to the standoff plate. A 6” wide x 1” thick carbon steel tie bar and pin assemblies are welded to the waterwall panels. See Fig 1 and Fig. 2.

babcock & wilcox canada ltd.

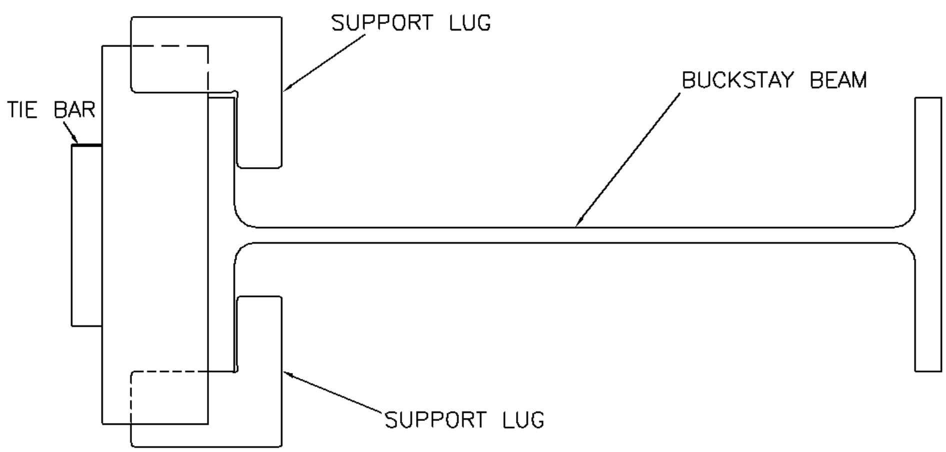


FIG. 1

babcock & wilcox canada ltd.

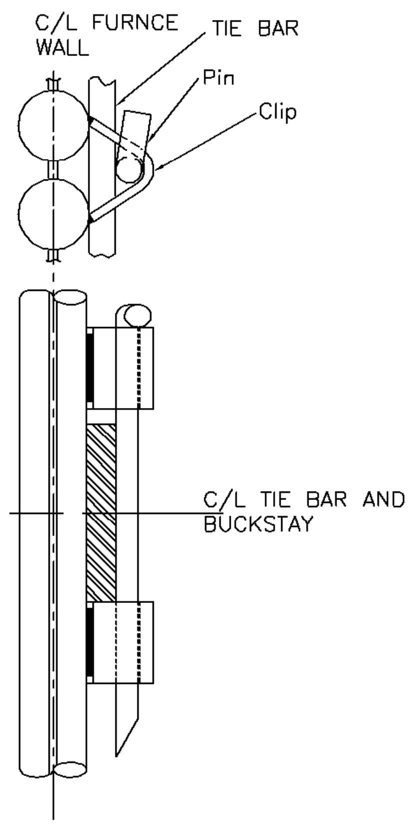


FIG. 2

babcock & wilcox canada ltd.

The buckstay system was analyzed for a +/- 35” transient W.G. furnace pressure. Under positive pressure the buckstay system passes. Under negative pressure, the outside beam compression flange fails and the pins and clips also fail. The compression flange is not fully stabilized and can rotate under negative pressure. The pins and clips are overstressed under negative pressure due to the pin spacing. This applies at all buckstay elevations.

3.0 Recommendations

- To prevent the outside flange from rotating under negative pressure, flange stabilizers are required. Three flange stabilizers are required per beam, one stabilizer at the middle of the beam and a stabilizer equally spaced on each side of the centre stabilizer.

- New pin and clip assemblies are required between the existing pin and clip assemblies such that pin spacing does not exceed 15”.

- The actual condition of the buckstay system including beams, posts, wall connections, end connections and tubes should be inspected to ensure these are in adequate condition.

4.0 Budgetary Estimate

The budgetary estimate to add flange stabilizers and add clips and pins (minimum 15” spacing) to each buckstays level per the calculations above is $0.40M per boiler. This estimate includes supply and construction but does not include other items such as mobilization, scaffolding, insulation and lagging.

THE ABOVE PRICE IS AN ESTIMATED PRICE ONLY AND IS NOT GIVEN BY BABCOCK AND WILCOX AS AN OFFER, OR AS A TERM OF CONTRACT, OR AS AN UNDERSTANDING THAT THE ESTIMATED PRICE SHALL BE A FINAL PRICE. AN OFFER TO SELL IS MADE BY PROPOSAL ONLY, WHICH SHALL INCLUDE BABCOCK AND WILCOX TERMS OF SALE.

5.0 Attachments

- Original Boiler General Arrangement Drawing 663329

6.0 Warranty/Limitation of Liability

B&W warrants that advice and consultation services and engineering studies will

babcock & wilcox canada ltd.

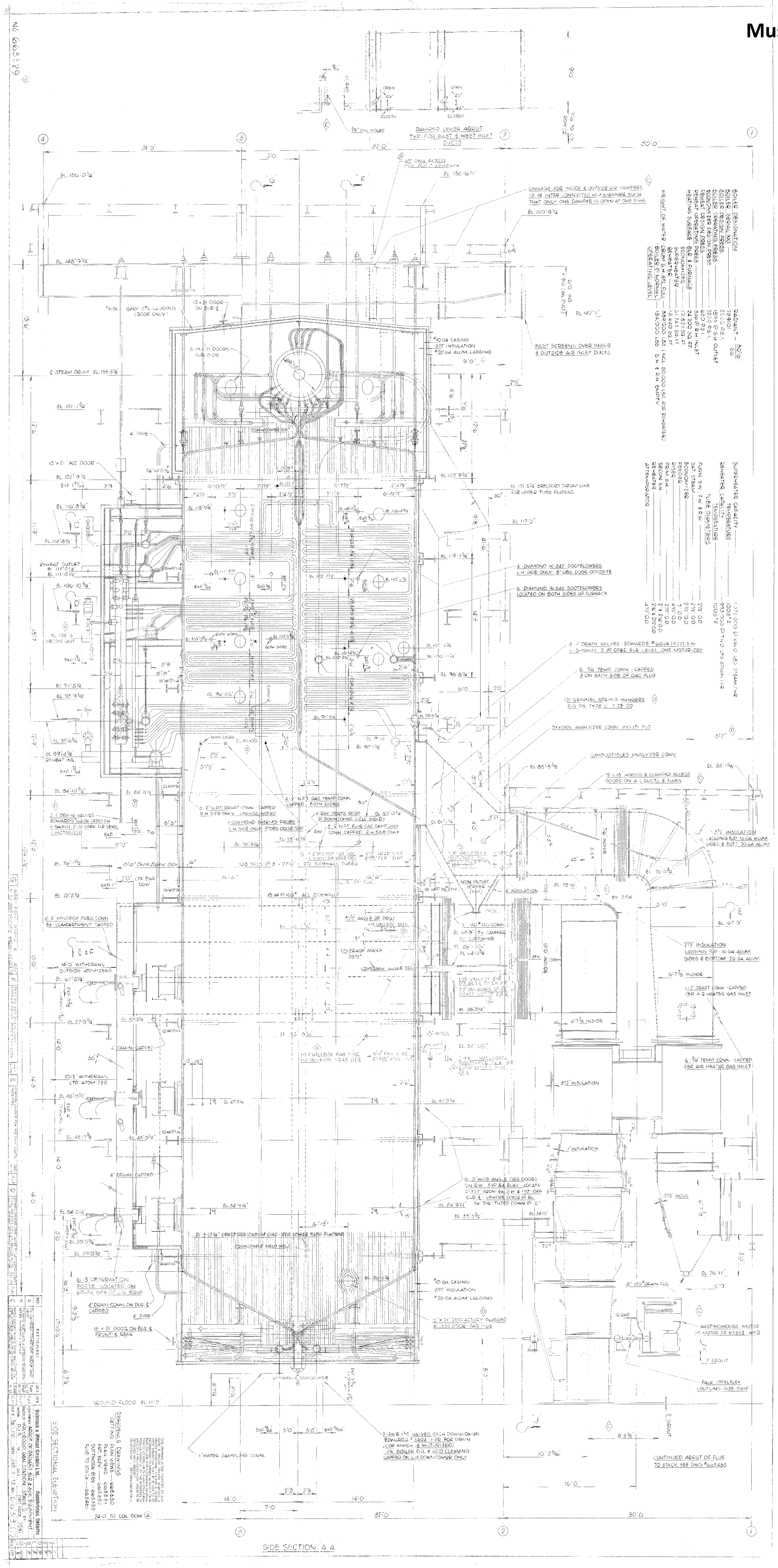
be performed in a manner consistent with generally accepted industry standards and practices. The sole remedy is that any portion of the services furnished to Purchaser which is shown not to have been so performed shall be corrected or re-performed to the standards in effect at the time of original performance at B&W expense; provided all necessary information and access requested by B&W is given to substantiate such claim, and further provided that such non-conformance is detected by Purchaser within ninety (90) days following completion of that portion of the services, and B&W is immediately notified in writing.

The foregoing shall not apply to services performed under the direct supervision of Purchaser. B&W shall not be responsible for suitability or performance of work done by others or for loss or expense arising from same, unless it is specifically ordered by B&W.

There is no warranty or representation, express or implied, with respect to the accuracy, completeness or usefulness of the information contained in any report, or that the use of any report contents may not infringe privately-owned rights. Moreover, B&W will assume no liability for any direct or indirect damages, however caused, including (without limitation) by professional negligence or fundamental breach of contract, resulting from reliance upon or application of the contents of the report by any person.

IN CONSIDERATION OF THE ABOVE EXPRESS WARRANTY EXTENDED BY B&W, ALL OTHER WARRANTIES OR CONDITIONS, EITHER EXPRESS OR IMPLIED WHETHER ARISING AT LAW, IN EQUITY, BY STATUTE, CUSTOM OF TRADE, OR OTHERWISE, INCLUDING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE EXCLUDED.

End of Report


SIDE SECTION 'A-A'
SIDE SECTIONAL ELEVATION

babcock & wilcox canada ltd.

Thermal Power Department
Field Engineering Services

Engineering Study Report

Customer:	**Stantec for Newfoundland and Labrador Hydro Holyrood Generating Station**
Subject:	Buckstay Capacity Engineering Study For CE Boiler
Ref No:	CM9021628
Page:	1 of 7
Original Date:	Sept. 10, 2008
Prepared By:	Terry Creighton, Project Engineer, Thermal Power
Reviewed By:	Gary Westerveld P. Eng. Manager Field Engineering Services

babcock & wilcox canada ltd.

Equipment Description:

Customer Name		Customer Location	
Holyrood Generating Station		**Holyrood, Newfoundland**	
Project Name / Contract #		**Report Date**	
Buckstay Capacity Engineering Study For CE Boiler		Aug. 26/08	
Equipment		**Expected Performance at MCR**	
Manufacturer:	Combustion Engineering	Capacity	175 M.W.
Superheater:		Design Pressure:	1955 psig
Economizer:		Steam Temp, °F:	1005^0 F SH
Air Heater:		Excess Air:	
Firing Equipment:		Primary Fuel:	
Control System:		Auxiliary Fuel:	
Miscellaneous:		In Service Date:	1970
Reason for Service		**Date of Service**	
B&W Service Engineer		**Customer Site Contact**	

babcock & wilcox canada ltd.

TABLE OF CONTENTS

babcock & wilcox canada ltd.

1.0 Introduction

Babcock & Wilcox Canada (B&W) was contracted by Stantec to conduct a buckstay study of the CE boilers (Unit #1 &2) at Holyrood Generating Station Holyrood, Newfoundland. The boilers were supplied and installed in the 1970's.. The boiler capacities were increased in 1988 from 160 M.W. to 175 M.W. by Alstom. Main steam flow increased from 1,050,000 lb/hr to 1,167,000 lb/hr. The buckstay system was reviewed based on a transient furnace pressure of +/- 35" W.G.

B&W utilizes proprietary mathematical spread sheets to calculate the expected stresses in the buckstay system. Various buckstay elevations were studied in order to determine whether the buckstay system can withstand a transient furnace pressure of +/- 35"W.G.

In the report B&W outlines the results of the buckstay review, and makes recommendations as to the modifications required to satisfy a transient furnace pressure of +/- 35" W.G

2.0 Buckstay Review

In order to comply with NFPA 85 the components of the buckstay system must be analyzed to determine the maximum allowable span between stiffeners (Buckstays) along the furnace wall. If the existing spacing exceeds the value established additional buckstays will have to be added. The factors which influence this spacing are as follows:

- Tube internal design pressure
- Tube material
- Tube design temperature
- Furnace internal pressures, +/- steady state, +/- transient
- Natural frequency of the wall
- Composite wall weight (i.e. existing tension on the tube due to dead load)

Once the spacing is determined the buckstay beam size is reviewed. The factors that influence the beam size are:

- Length of wall being restrained
- Furnace internal pressures, +/- steady state, +/- transient
- Seismic loads
- Natural frequency of buckstay beam

Typically, the negative transient pressures will dominate. Under these conditions the outer flange of the existing buckstay beam may exceed allowable stresses in compression. It is not strictly necessary to replace the beam in these situations as it is sufficient to improve the laterally stability of the beam. Flange stabilizers and/or overturning posts are used to accomplish this.

The tie bar or Tie channel size is reviewed. The factors that influence the tie bar size are:

- Pin spacing (wall attachment spacing)
- Stand-off spacing (tie-bar to buckstay attachment)
- Furnace internal pressures, +/- steady state, +/- transient
- Seismic loads
- Adjacent wall end reaction loads, which impose a compression or tension load on the tie bar

The wall attachment/Pin spacing is reviewed. The factors which influence the spacing are as follows:

- Negative pressure.
- Use of overturning posts vs. Flange stabilizers.
- Tube thickness, internal design pressure and temperature

The Buckstay end connections are reviewed. The factors which influence this design are:

- Buckstay length being restrained
- Adjacent buckstay being restrained
- Maximum –ve or +ve furnace pressure (transient or steady state)
- Seismic loads

2.1 Calculation Results

The CE boiler has various sizes of buckstays. The sidewalls use a W21 x 96 beam with a C8 x 11.5 tie channel, W21 x 96 beam with a 6” x ¼” tie bar, W21 x 62 beam with a 6’ x ¼” tie bar, W18 x 45 beam with a C8 x 11.5 tie channel or W24 x 68 beam with a 6” x ¼” tie bar, depending on beam elevation.

The front wall uses a W18 x 45 beam with a C8 x 11.5 tie channel, W18 x 45 beam with a C15 x 33.9 tie channel, W24 x 68 beam with a C8 x 11.5 tie channel, W18 x 64 beam with C8 x 11.5 tie channel or W8 x17, depending on beam elevation.

The rear wall uses a W18 x 45 beam with a C15 x 33.9 tie channel, W18 x 45 beam with a C8 x 11.5 tie channel, W24 x 68 beam with a C8 x 11.5 tie channel, W24 x 76 beam with a C8 x 11.5 tie channel, W18 x 64 beam with a C10 x 25 tie channel or W8 x17 beam, depending on beam

babcock & wilcox canada ltd.

elevation. Buckstay spacing varies from 5'-0" minimum to a maximum of 10'-0". See attached sketches for the buckstay arrangement.

Vertical overturning posts are used to stabilize the buckstay beam under negative furnace pressure. Typically, three overturning posts are used at each buckstay level.

Due to the limited information on the buckstay end connections and plate tie bar details, a complete analysis of the buckstay system could not be completed.

The beams and tie channels were reviewed based on a +/- 35" W.G. transient furnace pressure.

All the beams pass, except for one elevation. At elevation 64'-10", the beam size fails under stress and deflection criteria. The plate tie bar connection details to the furnace wall are unknown and could not be analyzed, thus at any location where ¼" tie bar is used, the capacity of the tie bar system is questionable. No information was made available regarding the trusses within the burner boxes which act as buckstays, and also could not be analyzed.

3.0 Recommendations

- Beams at elevation 64'-10" need to be replaced with a larger beam.
- Depending on how the plate tie bars are welded to the furnace wall, these plate tie bars may have to be replaced. A total of 8 elevations on the sidewalls would have to be changed.
- Trusses should be analyzed as to their capacity with the new desired pressure ratings.
- The actual condition of the buckstay system including beams, posts, wall connections, end connections and tubes should be inspected to ensure these are in adequate condition.

4.0 Budgetary Estimate

The budgetary estimate to replace necessary buckstay levels and remove buckstays and replace tie-bars per the calculations above is $0.75M per boiler. The detailed information on tie bars and connections to the wall was not supplied thus all tie-bars (1/4" plate type) are assumed replaced. If the tie-bars are attached to filler bars on tight spacing and in good condition then the estimate would be considerably less. This estimate includes supply and construction but does not include other items such as mobilization, scaffolding, insulation and lagging or windbox or vestibule trusses.

THE ABOVE PRICE IS AN ESTIMATED PRICE ONLY AND IS NOT GIVEN BY BABCOCK AND WILCOX AS AN OFFER, OR AS A TERM OF CONTRACT, OR AS AN UNDERSTANDING THAT THE ESTIMATED PRICE SHALL BE A FINAL PRICE. AN OFFER TO SELL IS MADE BY PROPOSAL ONLY, WHICH SHALL INCLUDE BABCOCK AND WILCOX TERMS OF SALE.

5.0 Attachments

Summary sketches S3, S4 and S5 from the calculations.

6.0 Warranty/Limitation of Liability

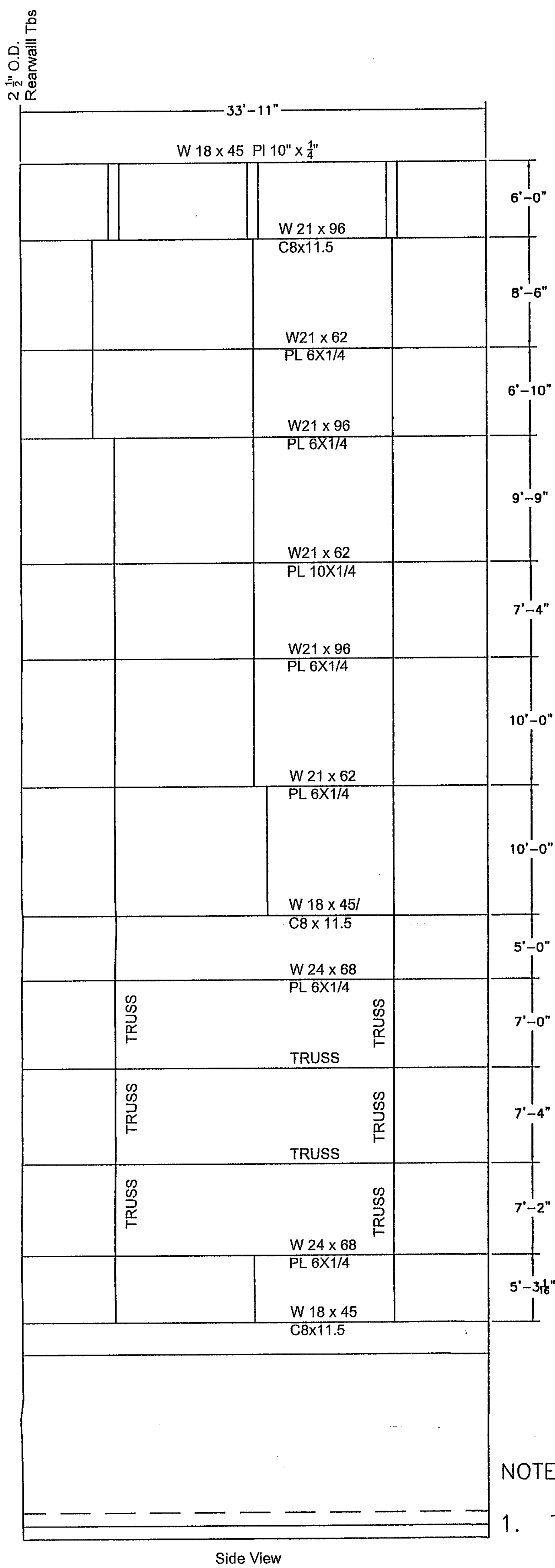
B&W warrants that advice and consultation services and engineering studies will be performed in a manner consistent with generally accepted industry standards and practices. The sole remedy is that any portion of the services furnished to Purchaser which is shown not to have been so performed shall be corrected or re-performed to the standards in effect at the time of original performance at B&W expense; provided all necessary information and access requested by B&W is given to substantiate such claim, and further provided that such non-conformance is detected by Purchaser within ninety (90) days following completion of that portion of the services, and B&W is immediately notified in writing.

The foregoing shall not apply to services performed under the direct supervision of Purchaser. B&W shall not be responsible for suitability or performance of work done by others or for loss or expense arising from same, unless it is specifically ordered by B&W.

There is no warranty or representation, express or implied, with respect to the accuracy, completeness or usefulness of the information contained in any report, or that the use of any report contents may not infringe privately-owned rights. Moreover, B&W will assume no liability for any direct or indirect damages, however caused, including (without limitation) by professional negligence or fundamental breach of contract, resulting from reliance upon or application of the contents of the report by any person.

IN CONSIDERATION OF THE ABOVE EXPRESS WARRANTY EXTENDED BY B&W, ALL OTHER WARRANTIES OR CONDITIONS, EITHER EXPRESS OR IMPLIED WHETHER ARISING AT LAW, IN EQUITY, BY STATUTE, CUSTOM OF TRADE, OR OTHERWISE, INCLUDING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE EXCLUDED.

End of Report



Side View

Elev. 123'-3" SW1 — BEAM: PASS; TIEBAR: FAIL, SEE NOTE 2

Elev. 117'-3" SW2 — BEAM: PASS; TIEBAR: PASS

Elev. 108'-9" SW3 — BEAM: PASS; TIEBAR: FAIL, SEE NOTE 2

Elev. 101'-11" SW4 — BEAM: PASS; TIEBAR: FAIL, SEE NOTE 2

Elev. 92'-2" SW5 — BEAM: PASS; TIEBAR: FAIL, SEE NOTE 2

Elev. 84'-10" SW6 — BEAM: PASS; TIEBAR: FAIL, SEE NOTE 2

Elev. 74'-10" SW7 — BEAM: PASS; TIEBAR: FAIL, SEE NOTE 2

Elev. 64'-10" SW8 — BEAM: FAIL, SRESS AND DEFLECTION; TIEBAR: PASS

Elev. 59'-10" SW9 — BEAM: PASS; TIEBAR: FAIL, SEE NOTE 2

Elev. 52'-10" SW10 — BEAM: DATA UNAVAILABLE; TIEBAR: DATA UNAVAILABLE

***VERTICAL MEMBERS: DATA UNAVAILABLE

Elev. 45'-6" SW11 — BEAM: DATA UNAVAILABLE; TIEBAR: DATA UNAVAILABLE

Elev. 38'-4" SW12 (SEE SW9) — BEAM: PASS; TIEBAR: FAIL, SEE NOTE 2

Elev. 33'-1" SW13 (SEE FW2) — BEAM: PASS; TIEBAR: PASS

NOTES:

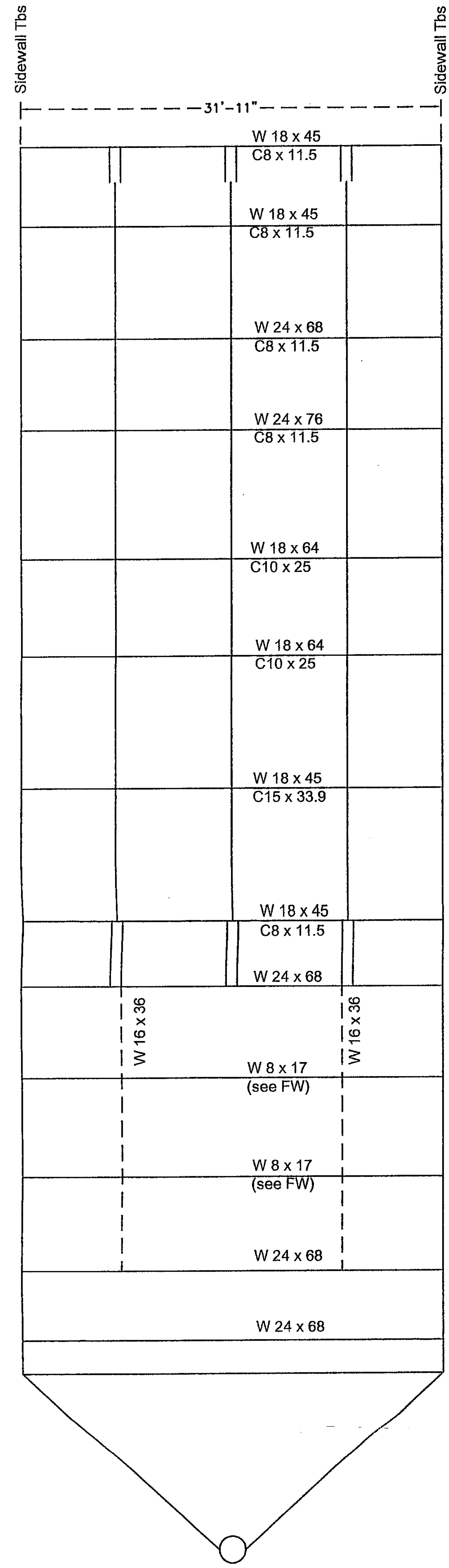
1. TIEBAR INFORMATION IS UNKNOWN. IF UPON INSPECTION THE TIEBAR IS PLATE, SEE NOTE 2.
2. TIEBAR WELD DETAILS TO WALL ARE UNKNOWN. 1/4" PLATE IS NOT A TYPICAL TIEBAR. THOROUGH INSPECTION AS TO CONDITION OF PLATE TIEBARS AND THEIR WELDS IS .RECOMMENDED

Rev.	0	A	B	C	D
Prep.	TJ				
Chk.					
App.					
Date					

Babcock & Wilcox Canada — Engineering Calculations

Customer: STANTEC - HOLYROOD GEN.STATION — Ref. CM0921628-B1

Subject: CE BOILER BUCKSTAY STUDY — Section B — Sht. No. S4



Rearwall View

Elev. 123'-3" RW1 (SEE FW1)	BEAM: PASS TIEBAR: PASS
Elev. 117'-3" RW2 (SEE FW2)	BEAM: PASS TIEBAR: PASS
Elev. 108'-9" RW3 (SEE FW3)	BEAM: PASS TIEBAR: PASS
Elev. 101'-11" RW4 (SEE FW4)	BEAM: PASS TIEBAR: PASS
Elev. 92'-2" RW5 (SEE FW5)	BEAM: PASS TIEBAR: PASS
Elev. 84'-10" RW6 (SEE FW6)	BEAM: OK TIEBAR: PASS
Elev. 74'-10" RW7 (SEE FW7)	BEAM: FAIL, STRESS AND DEFLECTION TIEBAR: PASS
Elev. 64'-10" RW8 (SEE FW8)	BEAM: PASS TIEBAR: PASS
Elev. 59'-10" RW9 (SEE FW9)	BEAM: PASS TIEBAR: SEE NOTE 1
Elev. 52'-10" RW10 (SEE FW10)	BEAM: PASS TIEBAR: SEE NOTE 1

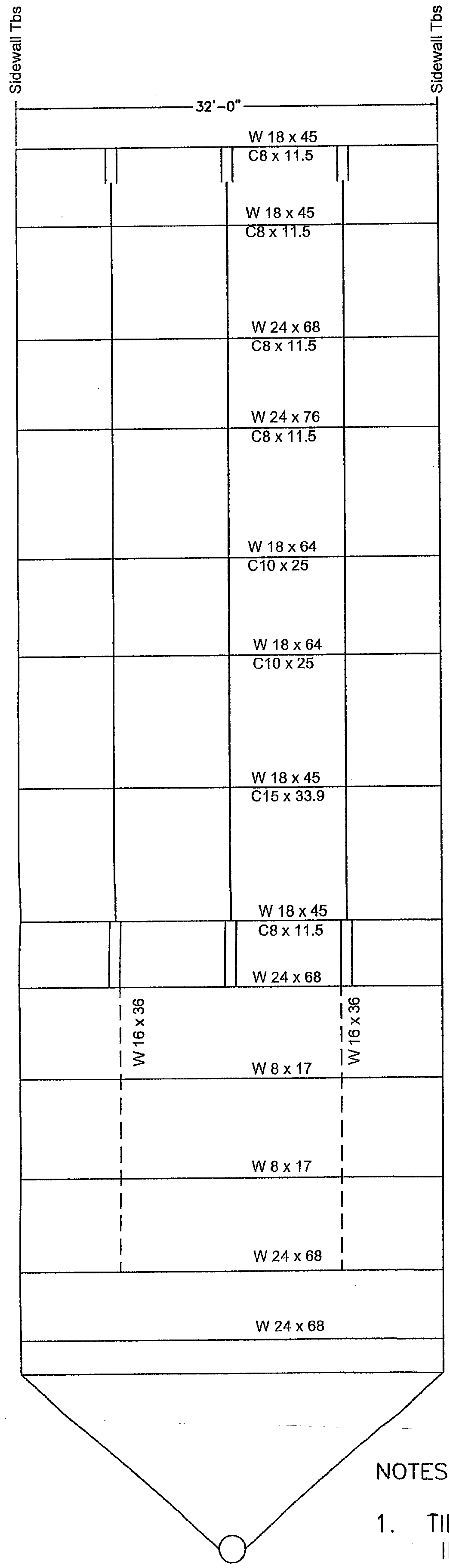
***VERTICAL MEMBERS: PASS (99% CAP.)

Elev. 45'-6" RW11 (SEE FW11)	BEAM: PASS TIEBAR: SEE NOTE 1
Elev. 38'-4" RW12 (SEE SW9)	BEAM: PASS TIEBAR: SEE NOTE 1
Elev. 33'-1" RW13 (SEE FW2)	BEAM: PASS TIEBAR: SEE NOTE 1

NOTES:

1. TIEBAR INFORMATION IS UNKNOWN. IF UPON INSPECTION THE TIEBAR IS PLATE, SEE NOTE 2.
2. TIEBAR WELD DETAILS TO WALL ARE UNKNOWN. $\frac{1}{4}$" PLATE IS NOT A TYPICAL TIEBAR. THOROUGH INSPECTION AS TO CONDITION OF PLATE TIEBARS AND THEIR WELDS IS .RECOMMENDED

Rev.	0	A	B	C	D	Babcock & Wilcox Canada	Engineering Calculations	
Prep.	[initials]							
Chk.						Customer: STANTEC - HOLYROOD GEN.STATION	Ref. CM0921628-B1	
App.								
Date						Subject: CE BOILER BUCKSTAY STUDY	Section B	Sht. No. S3



Frontwall View

EVALUATION

Elev. 123'-3" FW1	BEAM: PASS TIEBAR: PASS
Elev. 117'-3" FW2	BEAM: PASS TIEBAR: PASS
Elev. 108'-9" FW3	BEAM: PASS TIEBAR: PASS
Elev. 101'-11" FW4	BEAM: PASS TIEBAR: PASS
Elev. 92'-2" FW5	BEAM: PASS TIEBAR: PASS
Elev. 84'-10" FW6	BEAM: OK TIEBAR: PASS
Elev. 74'-10" FW7	BEAM: FAIL, STRESS AND DEFLECTION TIEBAR: PASS
Elev. 64'-10" FW8 (SEE SW8)	BEAM: PASS TIEBAR: PASS
Elev. 59'-10" FW9 (SEE SW9)	BEAM: PASS TIEBAR: SEE NOTE 1
Elev. 52'-10" FW10	BEAM: PASS TIEBAR: SEE NOTE 1
***VERTICAL MEMBERS:	PASS (99% CAP.)
Elev. 45'-6" FW11	BEAM: PASS TIEBAR: SEE NOTE 1
Elev. 38'-4" FW12 (SEE SW9)	BEAM: PASS TIEBAR: SEE NOTE 1
Elev. 33'-1" FW13 (SEE FW2)	BEAM: PASS TIEBAR: SEE NOTE 1

NOTES:

1. TIEBAR INFORMATION IS UNKNOWN. IF UPON INSPECTION THE TIEBAR IS PLATE, SEE NOTE 2.
2. TIEBAR WELD DETAILS TO WALL ARE UNKNOWN. $\frac{1}{4}$" PLATE IS NOT A TYPICAL TIEBAR. THOROUGH INSPECTION AS TO CONDITION OF PLATE TIEBARS AND THEIR WELDS IS .RECOMMENDED

Rev.	0	A	B	C	D	Babcock & Wilcox Canada	Engineering Calculations	
Prep.	[initials]							
Chk.						Customer: STANTEC - HOLYROOD GEN.STATION	Ref. CM0921628-B1	
App.								
Date						Subject: CE BOILER BUCKSTAY STUDY	Section B	Sht. No. S5

APPENDIX J.
FGD/ESP Data

babcock & wilcox power generation group
20 south van buren avenue p.o. box 351 barberton, oh 44203-0351 usa
phone 330.753.4511 fax 330.860.1886 www.babcock.com

Mr. Marc Voisine
Marc.Voisine@stantec.com
Stantec Consulting Ltd.
Mechanical Section Supervisor
845 Prospect Street
Fredericton NB E3B 2T7
(506) 452-7000 Ext. 1214

August 28, 2008

Wet Flue Gas Desulfurization and Dry Electrostatic Precipitators
Newfoundland & Labrador Hydro's Holyrood Generating Station

Dear Mr. Voisine,

The Babcock & Wilcox Power Generation Group, Inc. (B&W PGG, Inc.) is pleased to provide a budgetary estimate to engineer, procure, deliver and erect a Wet Flue Gas Desulfurization (WFGD) System and Dry Electrostatic Precipitators (ESP) to remove SO_2 and particulate from the flue gas generated by Units 1, 2 & 3 at the Holyrood Generating Station in Newfoundland. Please refer to the following proposal for a discussion on the system design basis, proposed scope, expected performance, and budgetary pricing. This proposal is being submitted in conjunction with the boiler draft study being performed by B&W Canada Ltd and in response to the Flue Gas Desulphurization and Precipitator specifications received from Stantec Consulting Ltd, reference project number 44177. Please note that a budgetary option for a Trona injection system for SO_3 removal is also included.

If you have any questions regarding this proposal or need assistance please do not hesitate to contact me using the information listed below.

Sincerely,

Jeffrey Smith
FGD Marketing Manager
330-860-1910 (office)
330-620-8104 (cell)
jmsmith01@babcock.com

babcock & wilcox power generation group
20 south van buren avenue ◗ p.o. box 351 ◗ barberton, oh 44203-0351 usa
phone 330.753.4511 ◗ fax 330.860.1886 ◗ www.babcock.com

SECTION 1 – DESIGN BASIS

The following tables summarize the flue gas conditions and limestone analysis used as the basis for the Wet Flue Gas Desulfurization (WFGD) and Dry Electrostatic Precipitator (DESP) system designs at the Holyrood Station. The WFGD System will consist of a single scrubber tower designed to remove SO_2 from the flue gas stream generated by three boilers firing No. 6 Fuel Oil (total of 500 MW). Three (3) two-chamber DESP's (one per Unit) are designed to remove particulate from the flue gas stream from each boiler prior to treatment in the common absorber tower. Tables 1 and 2 define the flue gas stream(s) that serve as the sizing basis for the WFGD and DESP at Holyrood. Table 3 defines the limestone analysis required to achieve the specified gypsum purity and used to size the reagent preparation system. The water analysis provided by Stantec is included in Attachment 1 and is suitable for use as makeup water in the WFGD system.

Table 1. Flue Gas Analysis, ESP Inlet

Species	No. 6 Fuel Oil Unit 1[1] Flow Rate (kg/s)
CO_2	38
O_2	6
N_2	140
H_2O	11
SO_2	0.49
Flyash	0.13
HCl	0.01
Total	195
Temperature	170 °C
Pressure	701 mm Hg
Flow Rate	262 m^3/s
Boiler Heat Input	4,753 MMBtu/hr
Gross MW	175
Particulate Loading	0.22 lb/MMBtu

Note 1: Identical flue gas conditions for Units 2 & 3.
Note 2: Flyash value includes Trona sorbent.

Table 2. Flue Gas Analysis, WFGD Inlet

Species	No. 6 Fuel Oil Units 1, 2 & 3 Flow Rate (kg/s)
CO_2	106
O_2	16
N_2	396
H_2O	30
SO_2	1.38
Flyash	0.02
HCl	0.02
Total	550
Temperature	170 °C[1]
Pressure	762 mm Hg
Flow Rate	680 m^3/s
Boiler Heat Input	4,753 MMBtu/hr
Gross MW	500
SO_2 Loading	2.31 lb/MMBtu

Note 1: It is assumed that the temperature to the WFGD may be higher than the temperature to the ESP due to heat of compression through the ID Fan.

Table 3. Limestone Analysis

Limestone Analysis	
$CaCO_3$	98%
Inerts/$MgCO_3$	2%
Particle Size	1" x 0" - 1/8" x 0"
Density	1,362 kg/m^3

babcock & wilcox power generation group
20 south van buren avenue · p.o. box 351 · barberton, oh 44203-0351 usa
phone 330.753.4511 · fax 330.860.1886 · www.babcock.com

SECTION 2 – SCOPE OF SUPPLY

A listing of the major equipment to be provided by B&W PGG, Inc. and included in this budgetary estimate is incorporated into the Equipment Schematic drawing located in Attachment 2. A general arrangement drawing of the ESP, absorber tower sketch, and process descriptions are also included in Attachment 2. B&W PGG, Inc. has offered an economical, highly reliable design while considering the conceptual layout as proposed by Stantec in the arrangement drawing provided as supplemental information to the equipment specifications. Final equipment sizing, location, and quantities will depend on the overall site arrangement, access, and interferences.

The following is a summary of the major scope included in the WFGD/ESP budget cost estimate:

HOLYROOD WFGD & ESP

- One (1) absorber tower including C-276 inlet nozzle (1.5 meters) and alloy 2205 outlet hood
- Absorber internals including tray, spray headers, mist eliminators and supports
- Absorber recirculation pumps and piping
- Absorber agitators
- Oxidation air blowers
- Two (2) ball mill circuits including silo, mill, product tank, pumps and classifier
- Two (2) secondary dewatering trains including drum filter, vacuum skid, etc.
- Dewatering hydroclone
- Miscellaneous pumps including limestone slurry feed, absorber bleed, reclaim water, purge, emergency hold, mist eliminator wash, and filter feed
- Instrument air compressors
- Field erected tanks including limestone slurry, reclaim water, filter feed, mist eliminator wash water, and emergency hold tank
- Slurry piping and valves
- Service water piping and valves from terminal point 7 meters from mist eliminator wash tank
- Internal supports (alloy 2205)
- Three (3) electrostatic precipitators including casing, side plates, supports and framing, nozzles and flue gas distribution
- T/R sets, rappers and associated control panels
- High voltage insulators
- Purge air fans and heaters
- Hoppers, hopper heaters
- Access, platforms, etc. for ESP
- Discharge electrodes and collector plates
- Key interlock system
- Instrumentation and controls
- Wiring and cabling on skids only (to common junction box)
- Construction of B&W PGG, Inc. supplied equipment
- B&W PGG, Inc. design engineering, project management, etc.
- Detailed arrangement and erection drawings
- Start-up and commissioning services
- Optional Trona system including silo, transport blowers, weigh bin, vibrators, conveying equipment, support structure, access, instrumentation, controls, etc.

babcock & wilcox power generation group
▸ 20 south van buren avenue ▸ p.o. box 351 ▸ barberton, oh 44203-0351 usa
▸ phone 330.753.4511 ▸ fax 330.860.1886 ▸ www.babcock.com

The following is a summary of the major scope not included in the budget cost estimate and are assumed to be provided by the Owner:

- Limestone unloading, handling and storage equipment up to Limestone Storage Silos
- Gypsum handling and storage equipment
- Fluework
- Foundations and Civil work
- Site preparation
- Buildings
- Architectural (building siding, roofing, doors, louvers, HVAC, enclosure panels, etc.)
- All electrical equipment (other than supplied equipment motors) and wiring/cabling (other than skid equipment)
- Service water piping up to 7 meters from the mist eliminator wash tank
- Service/Instrument air piping, valves, etc.
- Heat tracing
- Elevator
- CEMS
- Controls (including DCS, wiring, and cabinets)
- Waste water treatment (if required)
- Fans (ID or booster)
- Field Painting
- Stack
- Existing plant design review and/or verification
- Testing

babcock & wilcox power generation group
20 south van buren avenue • p.o. box 351 • barberton, oh 44203-0351 usa
phone 330.753.4511 • fax 330.860.1886 • www.babcock.com

SECTION 3 – SCHEDULE

A typical project schedule includes 36 – 42 months for execution of engineering, procurement, fabrication, erection and commissioning of a typical WFGD system. Further discussion on the schedule requirements would be required to produce a project specific schedule for Holyrood.

babcock & wilcox power generation group
20 south van buren avenue ▸ p.o. box 351 ▸ barberton, oh 44203-0351 usa
phone 330.753.4511 ▸ fax 330.860.1886 ▸ www.babcock.com

SECTION 4 – SYSTEM PERFORMANCE

The performance values provided in the following table are the expected values for system operation; guarantee values may differ based on final equipment design and management risk assessment. Refer to Attachment 3 for mass balance diagram and motor list specific to the Holyrood project. A Trona injection system is included as an option to the WFGD/ESP base bid. Based on B&W PGG, Inc. experience regarding scrubbing systems and the effects of SO_3 on opacity, it is recommended that a Trona system be installed to achieve the appropriate SO_3 emission levels in the stack. B&W PGG, Inc. is a licensee of AEP's Trona technology which involves injection of a dry sorbent upstream of the particulate collection device to achieve SO_3 removal.

WFGD SYSTEM PERFORMANCE	
SO_2 Removal Efficiency	97%
Limestone Consumption	8.1 metric tph (dry)
Gypsum Production	14.8 metric tph (wet)
Auxiliary Power	5,033 kW
System dP	14.6 mm Hg
Makeup Water	35.4 L/s
Purge Rate	0.88 L/s
ESP SYSTEM PERFORMANCE	
Particulate Emission	38 mg/Nm^3
Particulate Removal	95.8%
System dP	1.87 mm Hg
Opacity	20%
TRONA SYSTEM PERFORMANCE	
SO_3 Emission	16 mg/Nm^3
SO_3 Removal	86%
Trona Consumption	530 kg/hr

Note: Aux Power for WFGD includes ESP.

babcock & wilcox power generation group
20 south van buren avenue · p.o. box 351 · barberton, oh 44203-0351 usa
phone 330.753.4511 · fax 330.860.1886 · www.babcock.com

SECTION 5 – PRICING

The following is the budgetary price for engineering, procurement, and construction of a Wet Flue Gas Desulfurization system and Dry Electrostatic Precipitators at the Holyrood generating station. This portion of the proposal is not an offer to sell, and is provided for evaluation purposes. Any order resulting from this budget estimate is subject to mutually acceptable terms & conditions and schedule, as well as site information and final review by B&W PGG, Inc. management for the approval and contract acceptance.

Budget Price for WFGD/DESP (material only) ....$55,358,000 US Dollars
Budget Price for WFGDE/DESP (erection only) ....$80,800,000 CDN Dollars
Optional Budget Price for Trona System (material only) .....$5,195,000 US Dollars

Pricing is based on the following clarifications:

1. Prices are based on the design basis and scope of work generally outlined in Sections 1 and 2 of this Budgetary Proposal.
2. Pricing excludes all sales and use taxes that may be applicable for the material supply scope.
3. Pricing excludes the cost of any bonds, LOC or other project security.
4. Material prices are based on current day dollars and market price levels for steel-based materials and products, foreign currency exchange rates, and transportation costs.
5. Refer to Attachment 4, Field Installation for the basis of the field erection proposal and clarifications regarding the budgetary installation price.

babcock & wilcox power generation group
20 south van buren avenue · p.o. box 351 · barberton, oh 44203-0351 usa
phone 330.753.4511 · fax 330.860.1886 · www.babcock.com

ATTACHMENT 1

WATER ANALYSIS

GE Infrastructure
Water & Process Technologies

WATER ANALYSIS REPORT

4000018855
NEWFOUNDLAND & LABRADOR HYDRO
HOLYROOD GENERATING STATION
Holyrood, NL
CANADA A0A 2R0

Sampled: 08-MAY-2008
Reported: 21-MAY-2008
Field Rep: Maceachern, Ian
91000154

	RAW	CLEARWELL	EXTRACT #1	EXTRACT #2
	S0513154	S0513155	S0513156	S0513157
pH	6.4	6.4		
Specific Conductance, at 25°C, µmhos	44	70	< 3	< 3
Alkalinity, "P" as $CaCO_3$, ppm	0	0		
Alkalinity, "M" as $CaCO_3$, ppm	3.2	2.5		
Sulfur, Total, as SO_4, ppm	< 5	< 5	< 0.5	< 0.5
Sulfate, as SO_4, ppm			< 0.005	< 0.005
Chloride, as Cl, ppm	10.8	17.0	< 0.001	< 0.001
Hardness, Total, as $CaCO_3$, ppm	7.9	6.5	< 0.02	< 0.02
Calcium Hardness, Total, as $CaCO_3$, ppm	5.3	4.8	< 0.01	< 0.01
Magnesium Hardness, Total, as $CaCO_3$, ppm	2.6	1.7	< 0.01	< 0.01
Copper, Total, as Cu, ppm	< 0.05	< 0.05	< 0.002	< 0.002
Iron, Total, as Fe, ppm	0.17	< 0.05	< 0.002	< 0.002
Sodium, as Na, ppm	6.9	9.0	0.002	0.002
Aluminum, Total, as Al, ppm	0.2	< 0.1		
Phosphate, Total, as PO_4, ppm	< 0.4			
Phosphate, Total Inorganic, as PO_4, ppm	< 0.2			

GE Infrastructure
Water & Process Technologies

WATER ANALYSIS REPORT

4000018855
NEWFOUNDLAND & LABRADOR HYDRO
HOLYROOD GENERATING STATION
Holyrood, NL
CANADA A0A 2R0

Sampled: 08-MAY-2008
Reported: 21-MAY-2008
Field Rep: Maceachern, Ian
91000154

	RAW	CLEARWELL	EXTRACT #1	EXTRACT #2
	S0513154	S0513155	S0513156	S0513157
Phosphate, Ortho-, as PO_4, ppm	I			
Phosphate, Filtered Ortho-, as PO_4, ppm	< 0.2			
Silica, Total, as SiO_2, ppm	3.3	2.5	0.002	0.006
Carbon, Total Organic, as C, ppm	4.6	1.1		
Color, Apparent, Color Units (APHA)	30	< 1		

GE Infrastructure
Water & Process Technologies

WATER ANALYSIS REPORT

4000018855
NEWFOUNDLAND & LABRADOR HYDRO
HOLYROOD GENERATING STATION
Holyrood, NL
CANADA A0A 2R0

Sampled: 08-MAY-2008
Reported: 21-MAY-2008
Field Rep: Maceachern, Ian
91000154

	ECONOMIZ 1	ECONOMIZ 2	SAT STM 1	SAT STM 2
	S0513158	S0513159	S0513160	S0513161
Specific Conductance, at 25°C, μmhos	< 3	< 3	< 3	< 3
Sulfur, Total, as SO_4, ppm	< 0.5	< 0.5	< 0.5	< 0.5
Sulfate, as SO_4, ppm	< 0.005	< 0.005	< 0.005	< 0.005
Chloride, as Cl, ppm	< 0.001	< 0.001	0.001	< 0.001
Hardness, Total, as $CaCO_3$, ppm	< 0.02	0.05	< 0.02	< 0.02
Calcium Hardness, Total, as $CaCO_3$, ppm	< 0.01	0.04	< 0.01	< 0.01
Magnesium Hardness, Total, as $CaCO_3$, ppm	< 0.01	0.01	< 0.01	< 0.01
Copper, Total, as Cu, ppm	< 0.002	< 0.002	< 0.002	< 0.002
Iron, Total, as Fe, ppm	< 0.002	0.008	< 0.002	< 0.002
Sodium, as Na, ppm	0.002	< 0.002	0.002	< 0.002
Silica, Total, as SiO_2, ppm	0.007	0.007	0.003	0.005
Carbon, Total Organic, as C, ppm			< 1	< 1

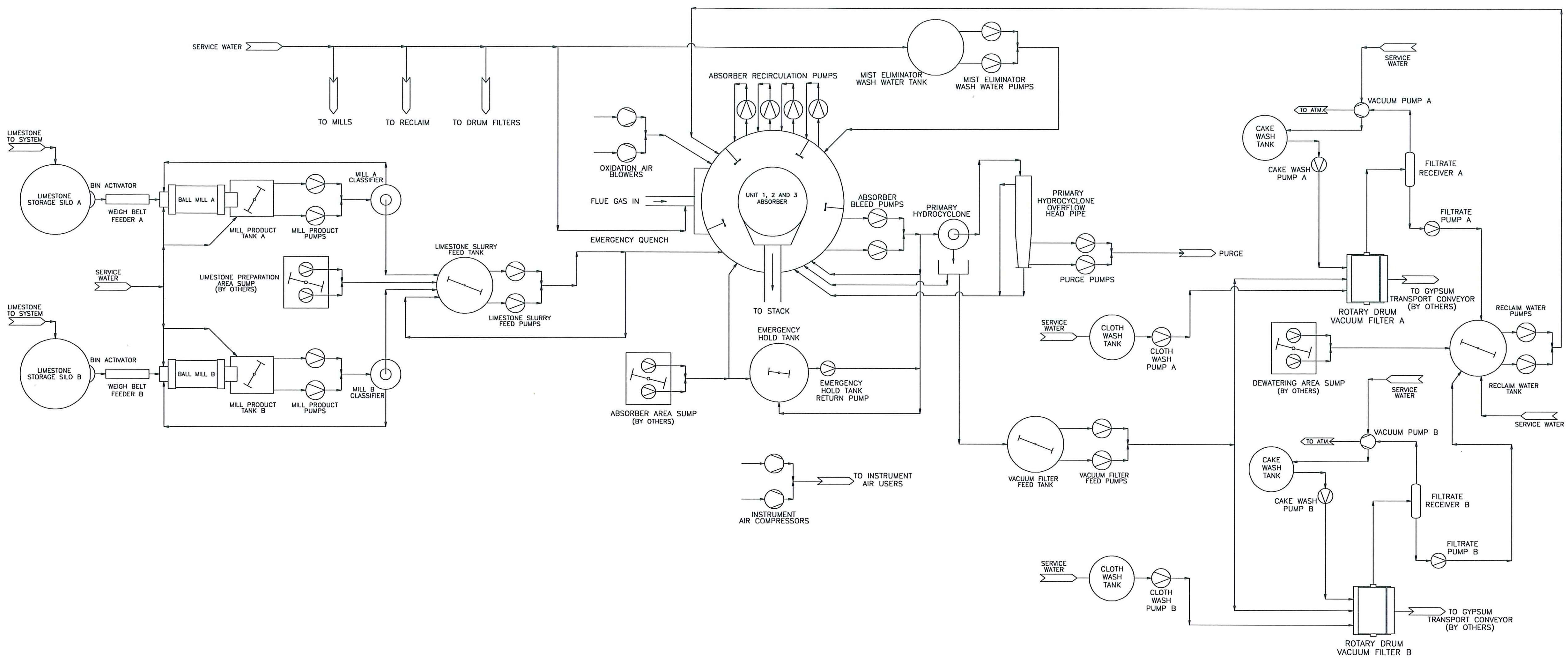
babcock & wilcox power generation group
20 south van buren avenue p.o. box 351 barberton, oh 44203-0351 usa
phone 330.753.4511 fax 330.860.1886 www.babcock.com

ATTACHMENT 2

SYSTEM DESIGN

P-009275

NEWFOUNDLAND AND LABRADOR HYDRO – HOLYROOD UNITS 1, 2 AND 3 AQCS (PRELIMINARY)



Newfoundland and Labrador Hydro - Holyrood

SILOS:	QUANTITY	DIAMETER (FT)	HEIGHT (FT)	CAPACITY, EACH	MATERIAL	NOTES
LIMESTONE STORAGE SILO	2	19.5	36	24 HRS	CARBON STEEL	

TANKS:	QUANTITY	DIAMETER (FT)	HEIGHT (FT)	CAPACITY, EACH	MATERIAL	AGITATOR HP
MILL PRODUCT TANKS	2	6 x 6 / 6 x 10	11.50	5 MIN	CSRL	5
LIMESTONE SLURRY STORAGE TANK	1	25.50	38.00	12 HR	CSRL	20
PRIMARY HYDROCLONE OVERFLOW HEAD TANK	1	2.50	8.50	0.5 MIN	FRP	NA
FILTER FEED TANK	1	18.00	26.00	4 HRS	CSRL	15
RECLAIM WATER TANK	1	37.00	53.50	8 HRS	CSFL	15
MIST ELIMINATOR WATER TANK	1	13.00	18.00	15 MIN	CSFL	NA
EMERGENCY HOLD TANK	1	37.50	54.50	1 ABS VOL	CSFL	50

SUMPS:	QUANTITY	LENGTH (FT)	WIDTH (FT)	HEIGHT (FT)	AGITATOR HP	MATERIAL
ABSORBER AREA SUMP (BY OTHERS)	1	10	10	10	5	LINED CONCRETE
REAGENT PREP AREA SUMP (BY OTHERS)	1	10	10	10	5	LINED CONCRETE
DEWATERING AREA SUMP (BY OTHERS)	1	10	10	10	5	LINED CONCRETE

OTHER:	QUANTITY	SIZE, EACH	CAPACITY	NOTES
BALL MILL LIMESTONE WEIGH BELT FEEDER	2		2 x 100%	
LiMESTONE BALL MILL	2	10.9 TPH FEED	2 x 100%	
BALL MILL CLASSIFIER	2	240 GPM FEED	2 x 100%	MINIMUM 20% INSTALLED SPARE CYCLONES
OXIDATION AIR COMPRESSOR	2	27,600 LB/HR	2 x 100%	1 OPER, 1 SPARE
INSTRUMENT AIR COMPRESSOR	2		2 x 100%	1 OPER, 1 SPARE
PRIMARY DEWATERING HYDROCYCLONE	1	320 GPM FEED	1 x 100%	MINIMUM 20% INSTALLED SPARE CYCLONES
ROTARY DRUM VACUUM FILTER	2	29,500 LB/HR DRY SOLIDS	2 x 100%	10% MOIST CAKE, 1 OPER, 1 SPARE
VACUUM FILTER VACUUM PUMP	2	250 HP	2 x 100%	1 PER FILTER

NOTE: CSRL = CARBON STEEL RUBBER LINED, CSFL = CARBON STEEL FLAKEGLASS LINED

PUMPS:	QUANTITY	FLOW, EACH (GPM)	TDH (FT)	MOTOR HP	CAPACITY	NOTES
ABSORBER RECYCLE PUMP 1	1	35,000	70	1,000	1 x 33%	
ABSORBER RECYCLE PUMP 2	1	35,000	70	1,000	1 x 33%	3 OPERATING, 1 SPARE
ABSORBER RECYCLE PUMP 3	1	35,000	75	1,000	1 x 33%	PER ABSORBER
ABSORBER RECYCLE PUMP 4	1	35,000	75	1,000	1 x 33%	
MILL PRODUCT PUMPS	4	320	170	40	4 x 100%	1 OPER, 1 SP PER TRAIN
LIMESTONE SLURRY FEED PUMPS	2	150	110	15	2 x 100%	1 OPER, 1 SPARE
ABSORBER BLEED PUMPS	2	400	115	40	2 x 100%	1 OPER, 1 SPARE
PURGE PUMPS	2	40	40	5	2 x 100%	1 OPER, 1 SPARE
MIST ELIMINATOR WASH WATER PUMPS	2	820	225	100	2 x 100%	1 OPER, 1 SPARE
VACUUM FILTER FEED PUMPS	2	125	75	10	2 x 200%	1 OPER, 1 SPARE
GYPSUM CAKE WASH PUMPS	2	20	70	5	2 x 100%	1 PER FILTER
GYPSUM CLOTH WASH PUMPS	2	20	70	5	2 x 100%	1 PER FILTER
VACUUM FILTER FILTRATE PUMPS	2	110	70	5	2 x 100%	1 PER FILTER
RECLAIM WATER PUMPS	2	520	100	40	2 x 100%	1 OPER, 1 SPARE
EMERGENCY HOLD TANK PUMP	1	850	85	75	1 x 100%	1 OPER
ABSORBER AREA SUMP PUMPS	2	500	75	30	2 x 100%	1 OPER, 1 SPARE
REAGENT PREP AREA SUMP PUMPS	2	500	75	30	3 x 100%	2 OPER, 1 SPARE
DEWATERING AREA SUMP PUMPS	2	500	75	30	4 x 100%	3 OPER, 1 SPARE

ABSORBERS: (1 x 5000 MW)

45.25 FT DIAMETER, NON-FLARED REACTION TANK, 1 FOR COMBINED UNITS 1, 2 & 3
ABSORBER INTERNAL SUPPORTS ARE A2205
2 LEVELS OF INTERSPACIAL SLURRY SPRAY HEADERS
TWO FRP SPRAY HEADERS PER LEVEL
2 LEVELS OF FRP MIST ELIMINATORS WITH 2 LEVELS OF FRP WASH HEADERS

1 TRAY, A2205 MATERIAL
4 EKATO SIDE ENTERING AGITATORS , 75 HP EA
ABSORBER EXTERNAL RECYCLE PIPING IS 42" FRP

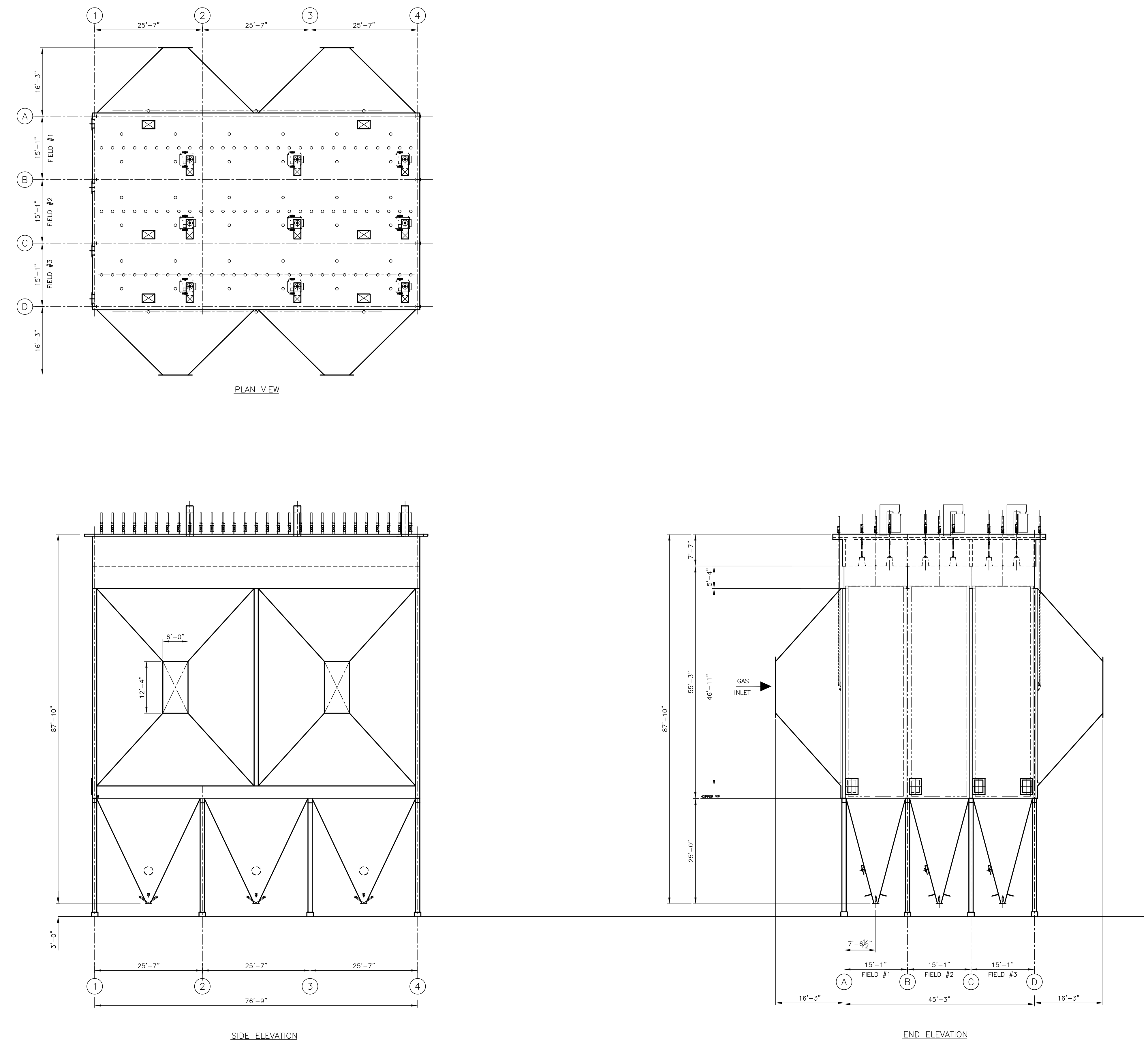
BABCOCK & WILCOX

NEWFOUNDLAND LABRADOR HYDRO
HOLLYROOD UNITS 1, 2 & 3 AQCS
PRELIMINARY

WET FLUE GAS DESULFURIZATION SYSTEM EQUIPMENT
HOLYROOD UNITS 1, 2 AND 3

BABCOCK & WILCOX
A McDermott company

DRN BY A. PERNA
DATE 07/22/08
SCALE NONE



SHT 2 DWG. NO. B0068381 REV. A

B&W PGG, INC. PROPRIETARY & CONFIDENTIAL

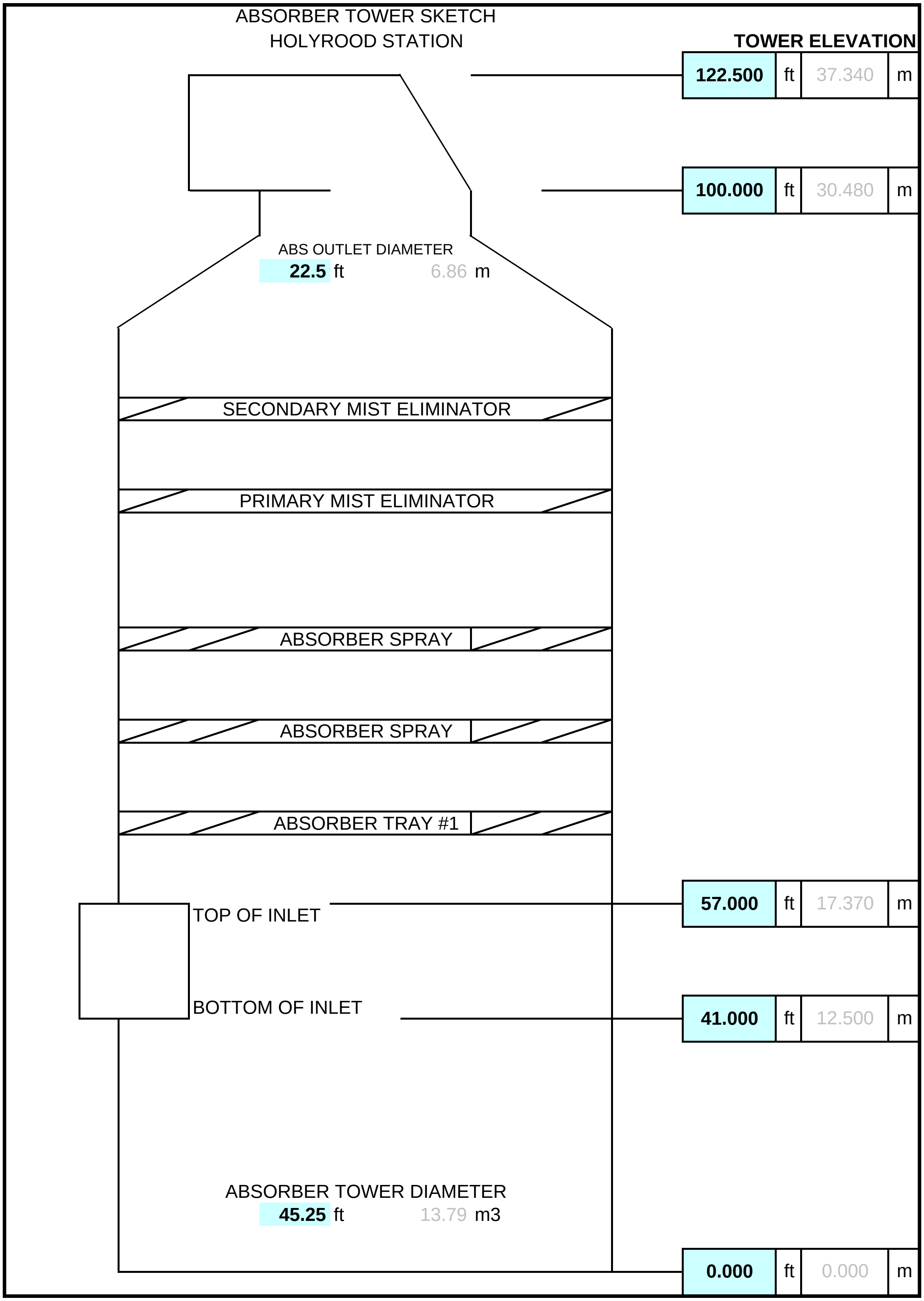
User Defined Field	XXXXXXXXXXXXXXXXXXXX
ORIG. CONTRACT NO.	XXX–XXXX–XX
– DO NOT SCALE – USE DIMENSIONS ONLY	
DWN	RAIRVING
CHK'D	X.X.XXXXXXXXXX
APPV'D	X.X.XXXXXXXXXX
DATE	08/06/08
SCALE	1/8"–1'–0"
Type	PROPOSAL
Dist.Cust.	FALSE
Dist.Erec.	FALSE
Dist.MFG.	FALSE

The Babcock & Wilcox Company
a McDermott company

STANTEC CONSULTING LTD.
NEWFOUNDLAND & LABRADOR HYDRO
GENERAL ARRANGEMENT
DRY ESP

PROJECT NO.	COA	DWG. NO.		REV.
P–000000	GB1000	B0068381	J	A

Acad (4/26/07)


ABSORBER TOWER SKETCH
HOLYROOD STATION
TOWER ELEVATION
122.500 ft 37.340 m
100.000 ft 30.480 m
ABS OUTLET DIAMETER
22.5 ft 6.86 m
SECONDARY MIST ELIMINATOR
PRIMARY MIST ELIMINATOR
ABSORBER SPRAY
ABSORBER SPRAY
ABSORBER TRAY #1
TOP OF INLET
57.000 ft 17.370 m
BOTTOM OF INLET
41.000 ft 12.500 m
ABSORBER TOWER DIAMETER
45.25 ft 13.79 m3
0.000 ft 0.000 m

WET FLUE GAS DESULFURIZATION SYSTEM GENERAL DESCRIPTION

1.1 SYSTEM SUMMARY

The following is a general description of the Wet Flue Gas Desulfurization (WFGD) system for the Holyrood Station. The limestone based, flue gas scrubbing system is designed to remove 97% of the SO_2 from the flue gas produced. The WFGD System design for this application incorporates features which have been developed over many years of commercial operation and pilot work in utility flue gas cleaning. Babcock & Wilcox Power Generation Group, Inc. has more than one hundred years of service to the power industry, with extensive experience in utility boiler air pollution control systems and is a recognized leader in flue gas desulfurization.

The proposed system will consist of three major subsystems: the wet absorber system, limestone preparation system, and the gypsum dewatering system. The major items comprising the proposed WFGD Systems are:

a. Two (2) 100% single outlet limestone storage silos with 24 hour storage capacity.

b. Two (2) 100% limestone slurry grinding trains (wet ball mills). One (1) 12 hour storage capacity limestone slurry storage tank with two (2) 100% limestone slurry storage pumps.

c. One (1) 100% absorber tower (one absorber common to Unit 1, 2 & 3 boilers) with integral reaction tank, with four (4) installed 33% absorber recycle pumps, four (4) interspatial spray headers and one (1) absorber tray. SO_2 removal occurs in the absorber.

d. Two (2) absorber bleed pumps to discharge the absorber blowdown.

e. Two (2) 100% oxidation air compressors. Oxidation of the absorber slurry will be carried out in-situ with the compressors used to supply air to the absorber reaction tank located integrally to the proposed absorber.

f. One (1) primary dewatering hydroclone cluster to meet the requirements of the WFGD absorber systems for gypsum slurry primary dewatering.

g. Two (2) 100% rotary drum vacuum filter systems, complete with associated tanks and pumps to provide gypsum product at 10% moisture. Each filter system is sized to dewater the gypsum slurry produced by the absorber.

h. Two (2) 100% rotary screw instrument air compressors complete with associated air dryer and air receiver to provide 125 psig air at -40°F dewpoint.

WET FLUE GAS DESULFURIZATION SYSTEM GENERAL DESCRIPTION

i. Two (2) 100% chloride purge pumps used to remove chlorides and fine particulate from the FGD system.

j. Motors for equipment supplied.

k. Instrumentation.

l. Process piping, valves and fittings.

WET FLUE GAS DESULFURIZATION SYSTEM GENERAL DESCRIPTION

1.2 LIMESTONE PREPARATION SYSTEM

Limestone is delivered by the Owner's conveyor to the Contractor's limestone storage silos. There are two (2) distinct limestone preparation trains per plant. Each limestone preparation train consists of one (1) limestone storage silo, one (1) limestone weigh feeder, one (1) ball mill with required accessory equipment, one (1) limestone slurry classifier, one (1) ball mill slurry tank with agitator, and two (2) ball mill slurry pumps.

Limestone exits each limestone silo and flows onto a weigh belt feeder. A controlled feed enters the wet ball mill where the limestone is reduced to 95% passing through 325 mesh by a charge of steel balls. The limestone is fed into the wet ball mill along with water via a chute leading into the mill. The limestone slurry is gravity fed from the wet ball mill to the mill product tank.

From the ball mill slurry tank, the slurry is pumped by means of two (2) x 100% ball mill slurry pumps (one (1) operating, one (1) spare) to a cyclone classifier. Fine product slurry is separated from slurry containing oversized limestone. The fine product continues to the limestone slurry storage tank while the slurry containing oversized limestone is recycled back to the wet ball mill inlet.

Limestone slurry is supplied to the absorber through the limestone feed loop via two (2) 100% limestone slurry feed pumps (one (1) operating, one (1) spare). The feed line recycles back to the limestone slurry storage tank and permits a continuous flow of slurry at various operating loads.

1.2.1 Limestone Silo

One (1) single-outlet limestone storage silo per milling train will be provided to supply limestone to each of the limestone preparation trains. Each silo will receive limestone from the limestone handling system (provided by others). Each silo is 19.5 feet in diameter by 36 feet high and is capable of storing 24 hours of the required limestone usage. Each silo is a vertical cylinder constructed of carbon steel with a vibrating bin activator type conical discharge to facilitate flow. Each silo will be provided with a dust filter fan.

1.2.2 Weigh Belt Feeders

A variable speed weigh belt feeder controls limestone flow from each limestone silo outlet to each wet ball mill by adjusting belt speed to maintain a constant set-point feed rate (typically the full load design feed rate is the default set-point). The belt feeders are horizontal belt conveyors with variable speed drives.

WET FLUE GAS DESULFURIZATION SYSTEM GENERAL DESCRIPTION

1.2.3 Ball Mills

Each ball mill is of the wet horizontal type and is provided complete with a drive system including speed reducer, air clutch, and lubrication system. Lubrication system design permits the wet ball mill to come to a complete stop, without bearing damage, in the event of failure of the lubrication system. An air clutch with receiver tank, valves, piping and manual inching station are provided.

1.2.4 Ball Mill Slurry Tanks / Pumps

One dedicated mill slurry tank per ball mill shall be provided. The ball mill feeds the mill slurry tank with ground limestone where process water is added to reduce the slurry solids content. The ball mill slurry is agitated for solids suspension. Two (2) 100% ball mill slurry pumps per mill slurry tank are provided. The ball mill slurry pumps feed the mill classifiers.

1.2.5 Mill Classifiers

Each mill classifier for the ball mills contains a battery of cyclones with a minimum of 20% spare capacity. The cyclone classifiers are arranged in a circular configuration and are fed from a cylindrical feed chamber. The feed chamber contains no internal partitions, baffles, and/or obstructions and provides a uniform and constant inlet pressure to each cyclone. Each cyclone feed connection has an individual isolating valve for on-line maintenance. A pressure indicator with diaphragm seal allows for monitoring of feed chamber pressure.

All overflow and underflow launder wetted surfaces are lined with rubber. The mill classifiers are independently supported with no interference for vertical removal. The overflow from each classier gravity feeds to the limestone slurry storage tank.

1.2.6 Limestone Slurry Storage Tank and Pumps

One (1) limestone slurry storage tank is provided to serve the absorber module. The limestone slurry storage tank has a capacity of 12 hours. A total of two (2) 100% limestone slurry feed pumps are provided to feed limestone slurry to the absorber. The slurry feed rate is continuous and maintained at a high level demand, with recycle back to the limestone slurry storage tank, in order to maintain the necessary flow velocities required to prevent plugging in the piping system.

WET FLUE GAS DESULFURIZATION SYSTEM GENERAL DESCRIPTION

1.3 WET FGD ABSORBER SYSTEM

1.3.1 Gas Path

As the hot flue gas enters the absorber horizontally, it is saturated and cooled. The gas turns upward and is evenly distributed across the absorber cross-section by the absorber tray. Experience has shown that such gas distribution devices are required to optimize SO_2 removal. In addition to providing an even gas flow for the main spray zone, the absorber tray also provide an area of intimate contact between the flue gas and limestone.

The gas leaving the absorber trays passes through three (3) operating interspatial spray headers with one (1) spare interspatial spray header separated into two (2) spray levels, which are supplied with recirculating slurry from the absorber's integral reaction tank, and continues through two (2) layers of chevron type mist eliminators for water droplet removal.

1.3.2 Absorber Tower

One (1) 45.25-foot diameter absorber tower, with an integral reaction tank will be provided. The absorber shell is constructed of alloy 2205. A complete system of internal supports and external stiffeners brace the walls and shell against pressure and other loads. The weight of the absorber and its internals are supported through the absorber structural system.

The integral reaction tank provides a minimum of 26 hours of solids residence time at full load conditions with the specified inlet SO_2 loading. The reaction tank shall be equipped with a drain line and valve to empty the reaction tank during maintenance periods.

As flue gas passes up through the absorber, it is quenched by absorber slurry falling from the sprays / trays and then passes through the perforated absorber tray. The tray, constructed of alloy 2205, is sectioned into compartments by baffles. This allows for a more even distribution of liquid on top of the trays. The tray level also serves as an excellent platform for slurry spray header / nozzle inspection and maintenance. The tray supports are constructed of alloy 2205.

After the flue gas passes through the tray, it encounters the absorber spray zone. The absorber spray headers are abrasion-lined fiberglass-reinforced plastic (FRP) and the supports are constructed of alloy 2205. The absorber slurry is sprayed from silicon carbide spray nozzles, which are bolted to the spray headers.

The absorber module is equipped with two stages of mist eliminators which remove carryover mist by inertial contact. The primary stage captures large particles and the secondary stage captures wash water droplets and finer particles. The two-stage mist eliminator is kept free of slurry deposits by using a water wash system. Service water is directed to both the upstream and downstream faces of the first stage mist eliminator by an array of spray headers and spray nozzles. The upstream face of the second stage mist eliminator is also water washed during operation by an array of spray headers and spray nozzles. The mist eliminators shall be washed sequentially by section to optimize the wash flow rate.

The mist eliminator blades shall be constructed of FRP. The mist eliminator spray headers shall be constructed of FRP and spray nozzles shall be constructed of polypropylene.

1.3.3 Absorber Agitators

The integral reaction tank shall be equipped with four (4) Ekato side-entry agitators to provide the required mixing and suspension of solids in the tank at the design conditions. The agitator design is such that operation of the absorber system will not be adversely effected if one of the agitators is out of service. All wetted components of the agitators shall be constructed of a corrosion / abrasion resistant alloy. The side-entry agitators employ the use of a flushless mechanical seal. The mechanical seal can be replaced while the absorber is on-line.

1.3.4 Absorber Recirculation Pumps and Piping

The absorber recirculation pumps are used to supply the absorber spray headers with slurry from the absorber reaction tank. Four (4) 33% recirculation pumps will be supplied. The absorber recirculation suction and discharge piping shall be 42" diameter FRP. A hydraulic actuated isolation knife gate valve shall be located on the suction piping. Paddle blind flange connections shall be located on the discharge piping for on-line pump isolation for maintenance and inspection.

1.3.5 Absorber Bleed Pumps

The absorber bleed pumps transfer gypsum slurry from the integral reaction tank to the primary dewatering hydroclone classifier. Two (2) 100% absorber bleed pumps shall be provided. The absorber bleed pumps will also have the capability to drain the absorber reaction tank during maintenance periods by pumping slurry to the emergency hold tank.

WET FLUE GAS DESULFURIZATION SYSTEM GENERAL DESCRIPTION

1.3.6 Oxidation Air System

An in-situ oxidation system will provide oxidation air to the absorber reaction tank. This oxidation system forces calcium sulfite ($CaSO_3 \cdot ½H_2O$), formed by the SO_2 removal process, to be oxidized to calcium sulfate ($CaSO_4 \cdot 2H_2O$). Two (2) 100% oxidation air compressors supply the air used for oxidizing the recirculated slurry. The air is introduced into the reaction tank via the oxidation air lances. The side entry agitators provide dispersion of the oxidation air, as well as agitating the absorber slurry.

1.3.7 Make-up Water System

The make-up water will be supplied for the types of water required in each area. The mist eliminator wash, oxidation air humidification, limestone preparation system, vacuum filter cake wash, vacuum pump seal water, reclaim tank, and flushing and area hose stations will use Service water.

The absorber reaction tank make-up will use reclaim water. Service water is added to the reclaim water tank as needed for absorber tank level and solids control.

The mist eliminators are automatically washed with 100% service water based on a programmed wash cycle to remove any deposits to assure proper performance. The mist eliminator wash water valve sequencing minimizes the demand for make-up water.

A diesel powered pump (by Owner) will supply water from the service water tank (by Owner) for use as emergency quench water. The emergency quench water piping system will contain a grid of spray nozzles inside the flue work to efficiently distribute water to quench the flue gas in the event of loss of power to the absorber recycle pumps.

1.3.8 Area Sumps

One sump will be provided in each major sub-system area: lime prep, absorber, and dewatering. Each sump is equipped with two (2) 100% sump pumps and one (1) agitator (sump concrete, linings and civil works are to be provided by others). The sumps collect all drains within their respective areas and reincorporate the water/slurry back into the process by discharging into the limestone slurry storage tank, absorber tank, and reclaim water tank.

WET FLUE GAS DESULFURIZATION SYSTEM GENERAL DESCRIPTION

1.3.9 Absorber Operating Philosophy

The absorber operates on a continuous basis. The limestone slurry feed rate to the absorber is controlled by outlet SO_2 emissions. Absorber slurry density is controlled by bleeding absorber slurry to the primary dewatering hydroclone. Absorber slurry level is controlled by adding makeup water to the absorber. Oxidation air flow is provided at the design compressor capacity.

The most important control parameter in a wet absorber system is limestone slurry feed control. Proper design of this loop provides maximum limestone utilization and the flexibility to adjust to changes in load. The limestone slurry feed flow is adjusted to control outlet SO_2 emissions. The absorber or stack CEMS is used to measure SO_2 emissions. The SO_2 emissions signal is compared to a set-point. This signal is conditioned via proportional plus integral action. The signal is then used to position the feed slurry valve, which feeds limestone slurry into the absorber reaction tank.

In order to optimize FGD system performance, absorber slurry density is continuously monitored. The density of the absorber slurry is measured in the absorber bleed pump discharge piping by a density meter. The signal is sent to the control system and compared to a density control limit set point (typically 20% suspended solids), and is used to direct gypsum slurry to the primary dewatering hydroclone as necessary to maintain the desired density.

The underflow from the primary hydroclone is directed to the vacuum filter feed tank. The overflow from the primary hydroclone is directed to primary hydroclone overflow head pipe. The majority of the primary hydroclone overflow is returned to the absorber (by gravity flow). The remainder is sent to waste water treatment in order to remove chlorides and/or fines from the FGD system.

Two instruments constantly monitor the absorber reaction tank level. The reaction tank level is controlled based on a continuous level control. The level signal is compared to the set point and is used to modulate the make-up water feed control valve.

ELECTROSTATIC PRECIPITATOR SYSTEM DESCRIPTION

2.1 Dry Electrostatic Precipitator System Description

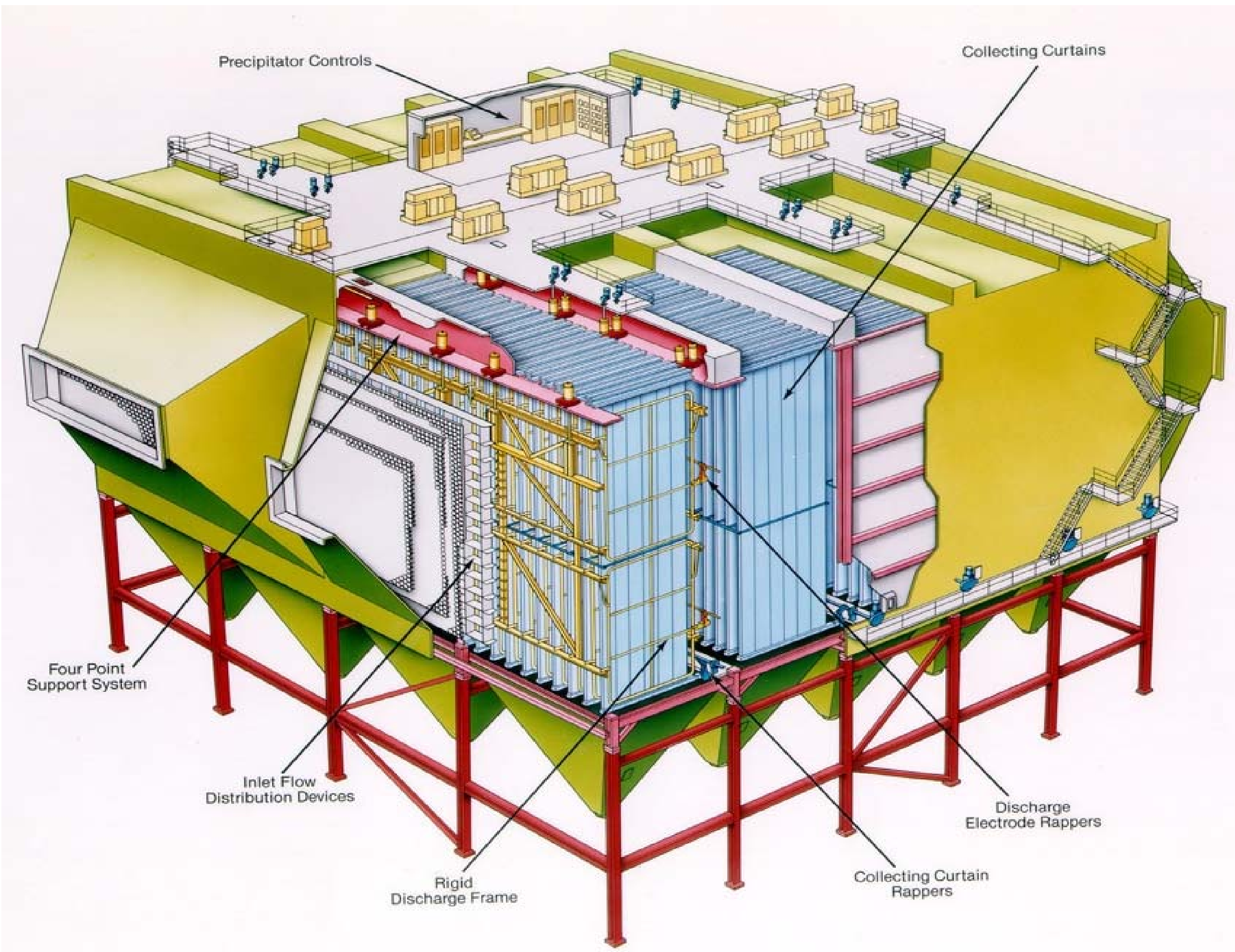
The proposed electrostatic precipitator (ESP) uses an extremely high-voltage electric current to separate dust, fume or mist from the flue gas stream. Three (3) separate ESP's will be provided, one (1) per boiler unit. These ESP's will be identical and sized to remove approximately 96% of the inlet particulate. Each precipitator is comprised of a series of parallel vertical collector plates through which the flue gas passes. Centered between the collector plates are discharge electrodes. Transformer rectifiers and voltage controllers are provided to energize the discharge electrodes, generating a corona electrical field. As the flue gas passes through the electric field, the particulates become negatively charged. These negatively charged particles are attracted to the grounded collector plates. The particles become neutralized and eventually form a dust layer on the collector plates.

Periodically, the ash layer is removed by "rapping" which consists of suddenly striking the collection plate. The agglomerated ash dislodges and drops into the ash collection hoppers which empty into the ash handling system. Rapping of the discharge electrodes is also provided to ensure cleanliness of the electrodes to maintain optimum voltage and current characteristics.

ELECTROSTATIC PRECIPITATOR SYSTEM DESCRIPTION

The unit will have several chambers with multiple gas passages in each chamber. Mechanical fields will be in the direction of flue gas flow, with each mechanical field having multiple electrical fields. The discharge electrodes are of the rigid discharge electrode (RDE) type, and will be installed in the direction of flow. Magnetic impulse, gravity impact rapper trains will be provided to rap and dislodge the collected particulate from the collection plates and discharge electrodes.

The bulk of the ash particulate is removed in the Dry ESP and collected in the hoppers. The flue gas exits the ESP cells and is transported to the absorber unit via the ID fans (by others).



ELECTROSTATIC PRECIPITATOR SYSTEM DESCRIPTION

2.2 Purge Air Systems

All support insulator compartments will be pressurized with heated air to keep the high voltage support insulators dry and clean. The precipitator will be provided with a purge air system, which consists of the required number of blowers, heaters and associated controls for operation. The proposed ESP includes a pressurized heated penthouse design, allowing easy maintenance of roof mounted equipment.

2.3 Materials of Construction

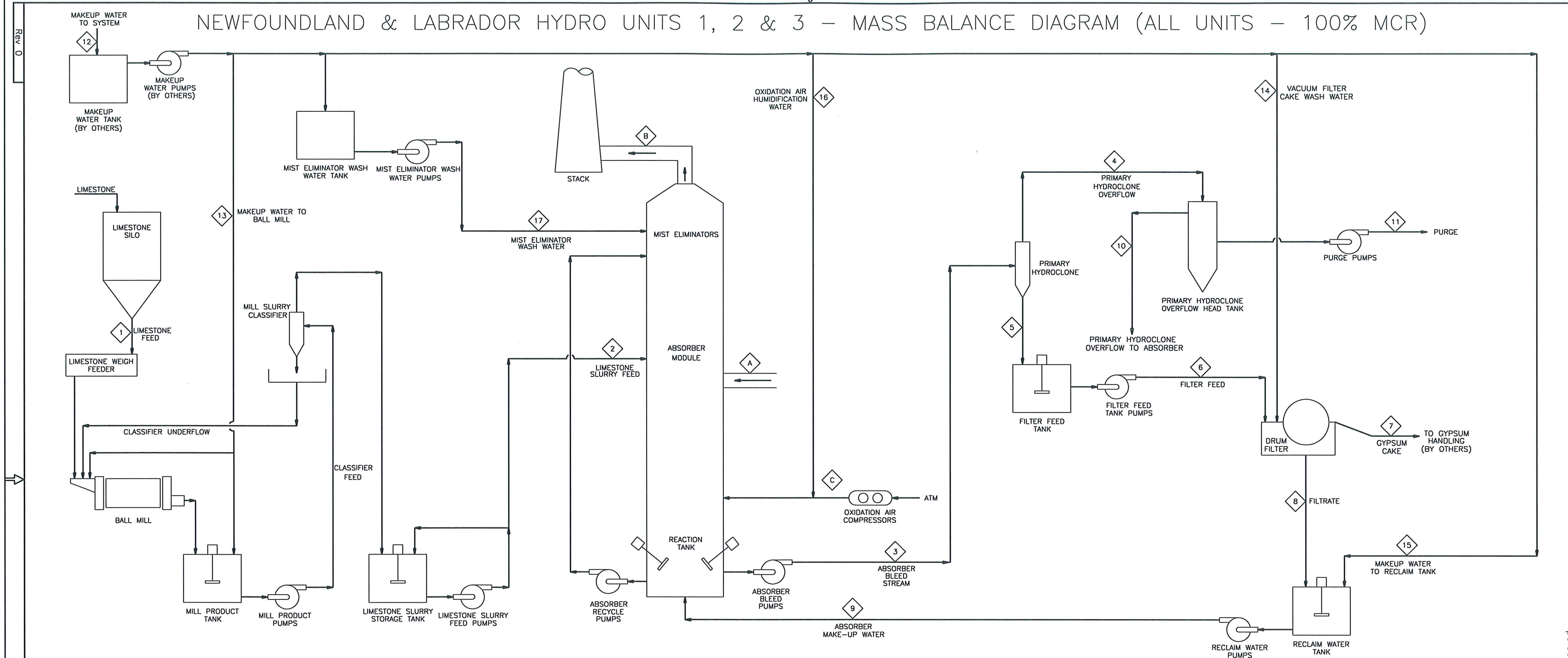
The casing shell, roof, and inlet / outlet nozzles are constructed of 6 mm thick A36 carbon steel, and are designed for -25" to +10" w.c. The one-piece collecting electrodes are constructed of solid 16 gauge A366, and are provided complete with necessary hanging and alignment hardware. The rigid discharge electrodes are fabricated from A606 killed steel. Structural supporting steel (A36) is provided for the ESP, including base plates, to allow 3'-0" clearance to grade from the hopper discharge flanges. Access steel (A36) is provided along one side of the ESP, including stairs, walkways, handrail and ladders. Each ESP is designed for an enclosed penthouse and hopper area; support steel, girts, and purlins included while insulated enclosure panels will be provided by others.

babcock & wilcox power generation group
20 south van buren avenue p.o. box 351 barberton, oh 44203-0351 usa
phone 330.753.4511 fax 330.860.1886 www.babcock.com

ATTACHMENT 3

MASS BALANCE & MOTOR LIST

NEWFOUNDLAND & LABRADOR HYDRO UNITS 1, 2 & 3 – MASS BALANCE DIAGRAM (ALL UNITS – 100% MCR)



Design Basis Summary Table	
Project	Newfoundland and Labrador - Holyrood Station
Boiler Heat Input	4,753 mmBtu/hr
	P-009275
Inlet SO2	2.31 lb/mmBtu
SO2 Removal Efficiency	97%
Limestone Analysis	Minimum 98% total CaCO3 with 2% MgCO3
Limestone Stoichiometry	1.03
Gypsum Cake Quality	Minimum Gypsum Quality Requirements
No. of Absorber Towers	One (1)
Number of AR pumps	4 Installed (3 oper/1spare). Flowrate: 35,000 GPM

Design - No. 6 Fuel Oil	
Component	% of weight
Carbon	87.69
Hydrogen	9.66
Nitrogen	0.43
Sulfur	2.10
Ash	0.08
Oxygen	0.04
Heating Value	17,983.00

Evaluation Limestone	
Avail. CaCO3	98%
MgCO3	2% (max)
Inerts	2% (max)
BWI	< 12
Size	95% passing 325 mesh

Gypsum Parameter Requirements (Dry Basis)		
Minimum Sulfate Content	96.0%	
Maximum Chloride Content	100 ppmw	
Minimum Solids Content	90.0% by weight	

PRELIMINARY INFORMATION ONLY

FLOW RATES SHOWN ARE 24 HOUR AVERAGE FLOWS

Gas Stream ID →		A	B	C
Item	Units	Absorber Inlet Flue Gas	Absorber Outlet Flue Gas	Oxidation Air
Total Flow (Wet)	ACFM	1,440,107	1,189,309	3,676
Total Flow (Wet)	SCFM	890,581	974,226	5,764
Temperature	°F	338	132	238
Total Flow (Wet)	lb/hr	4,365,101	4,622,495	27,561
CO_2	lb/hr	843,962	851,357	0
H_2O	lb/hr	236,943	473,180	354
SO_2	lb/hr	10,979	329	0
N_2	lb/hr	3,142,618	3,163,502	20,884
O_2	lb/hr	130,350	134,021	6,323
HCl	lb/hr	100	0	0
HF	lb/hr	0	0	0
H_2SO_4	lb/hr	139	97	0
Ash	lb/hr	10	7	0
SO_2	ppmdv	1,264	38	0
HCl	ppmdv	20	0	0
HF	ppmdv	0	0	0
H_2SO_4	ppmdv	10	7	0

Liquid Stream ID →		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Item	Units	Limestone Feed To FGD System	Limestone Slurry Feed To Absorber	Absorber Bleed Stream	Primary Hydroclone Overflow	Primary Hydroclone Underflow	Primary Hydroclone Underflow To Filter Feed Tanks	Vacuum Belt Filter Gypsum Cake	Vacuum Belt Filter Filtrate	Reclaim Water To Absorber	Pri. Hydroclone Overflow To Absorber	FGD System Purge Stream	Total Make-Up Water To FGD System	Fresh Water To Ball Mill	Vacuum Belt Filter Cake Wash Water	Make-Up Water To Reclaim Water Tank	Make-Up Water To Oxidation Air Humidification	Mist Eliminator Wash Water
Volumetric Flow	GPM	8.9	107	317	218	99	99	16.3	82	407	205	13	510	93	15	325	1	75
Mass Flow	lb/hr	17,888	63,884	179,705	113,005	66,700	66,700	32,683	41,358	201,560	106,394	6,611	251,240	45,997	7,341	160,202	705	36,996
Suspended Solids	%	100	28	20	5	45	45	90	1	0	5	5	0	0	0	0	0	0
Liquid	%	0	72	80	95	55	55	10	99	100	95	95	100	100	100	100	100	100
Suspended Solids	lb/hr	17,888	17,888	35,941	5,926	30,015	30,015	29,415	600	600	5,579	347	0	0	0	0	0	0
Liquid	lb/hr	0	45,997	143,764	107,079	36,685	36,685	3,268	40,758	200,960	100,814	6,264	251,240	45,997	7,341	160,202	705	36,996
$CaSO_4 \times 2H_20$	lb/hr	0	0	33,986	5,098	28,888	28,888	28,311	578	578	4,800	298	0	0	0	0	0	0
$CaSO_3 \times ½H_20$	lb/hr	0	0	136	75	61	61	60	1	1	70	4	0	0	0	0	0	0
$CaCO_3$	lb/hr	17,530	17,530	1,244	435	808	808	792	16	16	410	25	0	0	0	0	0	0
$MgSO_4$	lb/hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
$MgCO_3$	lb/hr	358	358	567	312	255	255	250	5	5	294	18	0	0	0	0	0	0
Inerts	lb/hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ash	lb/hr	0	0	8	6	2	2	2	0	0	6	0	0	0	0	0	0	0
MgF_2	lb/hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cl	ppm	0	0	15,000	15,000	15,000	15,000	100	13,421	2,722	15,000	15,000	0	0	0	0	0	0
SG Slurry		2.68	1.20	1.13	1.04	1.35	1.35	2.02	1.01	0.99	1.04	1.04	0.99	0.99	0.99	0.99	0.99	0.99

NOTE: THE ABOVE VALUES ARE CALCULATED / PREDICTED AND ARE NOT INTENDED FOR USE AS PERFORMANCE GUARANTEES.

BABCOCK & WILCOX

MASS BALANCE DIAGRAM
NEWFOUNDLAND & LABRADOR HYDRO
HOLYROOD UNITS 1, 2 & 3

MATERIAL BALANCE HOLYROOD UNITS 1, 2 AND 3
BABCOCK & WILCOX
A. PERNA
07/22/08
NONE
rev 0
HOLYROOD UNITS 1, 2 & 3

ELECTRICAL LOAD LIST

Project Name: **Newfoundland and Labrador - Holyrood Generating Station**
Project Number: **P-0009275**
Run ID: **Budgetary Electrical Load List**
Revision: **0**

R E V	Line No.	Item	Tot Qty Inst	Inst KW Each	Inst KW Total
	*	*	*	*	*
REAGENT PREPARATION SYSTEM					
0	1	LIMESTONE SILO DUST FILTER FAN	1.0	3.7	3.7
0	2	LIMESTONE SILO BIN ACTIVATOR	1.0	2.2	2.2
0	3	LIMESTONE WEIGH BELT FEEDER	2.0	3.7	7.5
0	4	BALL MILL MOTOR	2.0	335.6	671.1
0	5	HP LUBRICATION PUMP	2.0	1.5	3.0
0	6	LP LUBRICATION PUMP	2.0	1.5	3.0
0	7	JACKING PUMP	2.0	2.2	4.5
0	8	REDUCER LUBE PUMP MOTOR	2.0	1.5	3.0
0	9	BALL MILL INCHING DRIVE	2.0	7.5	14.9
0	10	MILL PRODUCT TANK AGITATOR	2.0	3.7	7.5
0	11	MILL PRODUCT PUMPS	4.0	29.8	119.3
0	12	LIMESTONE SLURRY TANK AGITATOR	1.0	14.9	14.9
0	13	LIMESTONE SLURRY FEED PUMPS	2.0	11.2	22.4
0	14	EMERGENCY HOLD TANK AGITATOR MOTOR	1.0	37.3	37.3
0	15	EMERGENCY HOLD TANK PUMPS	1.0	55.9	55.9
0	16	REAGENT PREP AREA SUMP AGITATOR	1.0	3.7	3.7
0	17	REAGENT PREP AREA SUMP PUMPS	2.0	22.4	44.7
ABSORBER SYSTEM					
0	18	ABSORBER RECIRCULATION PUMP 1	1.0	745.7	745.7
0	19	ABSORBER RECIRCULATION PUMP 2	1.0	745.7	745.7
0	20	ABSORBER RECIRCULATION PUMP 3	1.0	745.7	745.7
0	21	ABSORBER RECIRCULATION PUMP 4	1.0	745.7	745.7
0	22	ABSORBER RECIRCULATION TANK AGITATOR	4.0	55.9	223.7
0	23	OXIDATION AIR COMPRESSOR (MAIN DRIVE)	2.0	522.0	1,044.0
0	24	OXIDATION AIR COMPRESSOR LUBE OIL HEATER	2.0	7.5	14.9
0	25	OXIDATION AIR COMPRESSOR LUBE OIL PUMP	2.0	7.5	14.9
0	26	ABSORBER BLEED PUMP	2.0	29.8	59.7
0	27	PURGE PUMPS	2.0	3.7	7.5
0	28	ME WASH PUMP	2.0	74.6	149.1
0	29	ABSORBER AREA SUMP AGITATOR	1.0	3.7	3.7
0	30	ABSORBER AREA SUMP PUMPS	2.0	22.4	44.7
0	31	HYDRAULIC POWER UNIT	1.0	14.9	14.9
DEWATERING SYSTEM					
0	32	VACUUM FILTER FEED PUMPS	2.0	7.5	14.9
0	33	DRUM VACUUM FILTER DRIVE	2.0	2.2	4.5
0	34	DRUM VACUUM FILTER AGITATOR	1.0	0.7	0.7
0	35	DRUM VACUUM FILTER FILTRATE PUMP	2.0	3.7	7.5
0	36	DRUM VACUUM FILTER VACUUM PUMP	2.0	186.4	372.9
0	37	DRUM VACUUM FILTER WIRE WANDERS	2.0	0.7	1.5
0	38	DEWATERING AREA SUMP AGITATOR	1.0	3.7	3.7
0	39	DEWATERING AREA SUMP PUMPS	2.0	22.4	44.7
0	40	RECLAIM WATER PUMPS	2.0	29.8	59.7
0	41	RECLAIM WATER TANK AGITATOR	1.0	11.2	11.2
ELECTROSTATIC PRECIPITATOR					
0	42	T/R SETS	27.0	66.0	1,780.9
0	43	T/R CONTROLS	3.0	11.2	33.6
0	44	RAPPER PANELS	6.0	8.0	48.0
0	45	HOPPER HEATERS	27.0	9.6	259.2
0	46	HOPPER AREA VENT FANS	6.0	3.7	22.4
0	47	ROOF ENCLOSURE VENT FANS	6.0	3.7	22.4
0	48	PURGE AIR HEATER	6.0	40.0	240.0
0	49	PURGE AIR BLOWER	9.0	18.6	167.8
0	50	T/R HOIST	3.0	4.0	12.0
0	51	LIGHTING	6.0	8.0	48.0
TOTAL INSTALLED POWER FOR NEWFOUNDLAND & LABRADOR HOLYROOD WFGD SYSTEM					8,734.2

babcock & wilcox power generation group
20 south van buren avenue • p.o. box 351 • barberton, oh 44203-0351 usa
phone 330.753.4511 • fax 330.860.1886 • www.babcock.com

ATTACHMENT 4

FIELD INSTALLATION, BASIS OF PROPOSAL

babcock & wilcox construction co.
74 robinson avenue ▸ p.o. box 802 ▸ barberton, oh 44203-0802 usa
phone 330.753.9750 ▸ fax 330.753.9534 ▸ www.babcock.com

This section provides indicative information regarding the price to supply labor, supervision, tools and equipment necessary for field installation of the three (3) dry electrostatic precipitators and wet limestone FGD system for Holyrood Generating Station Units 1, 2, & 3.

Scope:

The field installation scope includes field erection of the material, equipment, and piping supplied by B&W. A general list of items installed is as follows:

Absorber Shell
Absorber Internal Supports
Absorber Spray Piping & Nozzles
Mist Eliminator Piping & Nozzles
Mist Eliminator Blades
Mist Eliminator Wash Pumps
Mist Eliminator Wash Tank
Area Sump Pumps
Miscellaneous Tanks, Agitators, etc.
Limestone Silo
Reagent preparation process equipment
Gypsum dewatering process equipment
ESP Casing, Internals & Rappers
ESP hopper area Support Steel
ESP Nozzles
ESP External HV including T/R Sets
Oxidation Air Compressors
Absorber Tray
Absorber Recirc Pumps
Absorber FRP Recirc Pipes
Process Valves
Process Instruments
Process Piping
Absorber Inlet Nozzle

Scope by Others:

The following list, while not all inclusive, highlights the more significant items of work NOT included
:

Foundations
Anchor Bolts
Electrical
ID fans
Chemical clean
Siding and roofing
Architectural Finishes
HVAC
Elevated Slabs
Insulation and lagging except ESP
Painting
Masonry Walls or Buildings
Heat Tracing

NDE (other than code required)
Acoustical enclosures or insulation
Supply and disposal of hydro water
Hydro static testing of absorber tower and piping systems
Testing and calibration of devices
Start-up and commissioning of equipment
Elevators
Long term storage and maintenance
Pipe Labeling
Structural Steel
Plumbing or Potable Water Systems

Construction Services, Non-Permanent Materials, Subcontracts (By B&W):

The following construction services, non-permanent materials and subcontracts are included by B&W:

Direct Craft Labor
General Craft Fore
Laborers
Operating Engineers
Mobilization
Demobilization
Home Office Support
Project Manager
Superintendents
QA Representative
Safety Representative
Site Engineer
Site Scheduler
Material Coordinator
Office Manager

Crane Mats
Grout for B&W installed equipment
Stainless Steel Tooling
Fabrication Tables
Rigging Steel
Temporary Electrical
Scaffolding
Job Supplies
Weld Rod
Tools & Equipment
Heavy Lift Cranes
Small Tools
General Liability Insurance
First Aid Facility

Indicative Price:

The preliminary estimated price for field installation of the B&W materials and equipment for one (1) Absorber System and three (3) ESP's is included in Section 5 of the proposal.

Estimated Price Basis and Clarifications:

This indicative Price is based on the following General Clarifications:

1. Current day costs are considered for all rates. Allowance for escalation to the time of performance is excluded.

2. The overall erection span from Mobilization through Demobilization is 60 to 65 weeks. Excluding start-up support time.

3. B&W has based this indicative estimate on full construction labor agreements for the applicable International trade unions. In the event a site specific Project Labor Agreement (PLA) is negotiated, the cost basis would need to be adjusted accordingly.

4. B&W's estimate is based on working a 5/10/single shift schedule.

5. B&W has not included work that would fall under the jurisdiction of electricians trades except for:

   - Mechanical installation of the precipitator internal and external high voltage system.

   - Temporary electrical labor and equipment that will be required to support our erection work. The temporary electrical work allowance is based on electrical distribution points being supplied by others in the general areas of our work. B&W's allowance includes the supply installation and maintenance of temporary electrical materials from the distribution points to our work.

6. B&W has not included an allowance for site development or maintenance of nor snow removal from parking lots, laydown areas or roads. We have assumed that this work will be completed by others.

7. No civil or architectural work is included.

8. B&W has not included costs to provide warehouse space for storage of major equipment and materials that require indoor storage.

9. Site security will be provided by others.

10. All estimates are based on working to B&W's standard Terms and Conditions.

11. Adequate lay-down area for ground fabrication and material storage will be made available on site in reasonable proximity to where the work is being executed.

12. Budgetary pricing is predicated on limited information. No drawings were utilized. All information is based on B&W's US based standards and models and factored for execution in Newfoundland at the Holyrood station site.

babcock & wilcox power generation group
20 south van buren avenue · p.o. box 351 · barberton, oh 44203-0351 usa
phone 330.753.4511 · fax 330.860.1886 · www.babcock.com

ATTACHMENT 5

B&W PGG, INC. EXPERIENCE

babcock & wilcox power generation group

Wet FGD Experience B&W

Contract	Customer	Plant and Unit	Total MW	Modules Total/ Spare	Reagent	Oxidation	Fuel	Weight % Sulfur	Inlet Gas Flow *** mg/Nm3/hr acfm	Inlet SO2 *** mg/Nm3 ppm @ 3% O2	SO2 % Removal	Startup Year	Order Date
431-0082	AEP Appalachian Power Company	John E. Amos 1	800	1 / 0	Limestone	Forced	Coal	4.5%	3,255,758 4,636,199	1867 1,867	98%	2008	
431-0082	AEP Appalachian Power Company	John E. Amos 2	800	1 / 0	Limestone	Forced	Coal	4.5%	3,255,758 4,636,199	1867 1,867	98%	2009	
431-0082	AEP Appalachian Power Company	John E. Amos 3	1300	2 / 0	Limestone	Forced	Coal	4.5%	5,201,253 7,406,584	1867 1,867	98%	2007	
APC-22	AEP Ohio Power Company	Gavin 1	1300	6 / 1	Mg-Lime	Natural	Coal	4.2%	4,900,000 6,977,600	3100 3,100	95%	1994	
APC-23	AEP Ohio Power Company	Gavin 2	1300	6 / 1	Mg-Lime	Natural	Coal	4.2%	4,900,000 6,977,600	3100 3,100	95%	1995	
431-0070	AEP Ohio Power Company	Mitchell 1	816	2 / 0	Limestone	Forced	Coal	2.92%	3,246,700 4,623,301	1877 1,877	98%	2006	
431-0071	AEP Ohio Power Company	Mitchell 2	816	2 / 0	Limestone	Forced	Coal	2.92%	3,246,700 4,623,301	1877 1,877	98%	2007	
431-0093	Allegheny Energy Supply LLC	Hatfield's Ferry 1	570	1 / 0	Limestone	Forced	Coal	4.72%	2,198,000 3,129,952	2888 2,888	98%	2009	
431-0094	Allegheny Energy Supply LLC	Hatfield's Ferry 2	570	1 / 0	Limestone	Forced	Coal	4.72%	2,198,000 3,129,952	2888 2,888	98%	2009	
431-0095	Allegheny Energy Supply LLC	Hatfield's Ferry 3	570	1 / 0	Limestone	Forced	Coal	4.72%	2,198,000 3,129,952	2888 2,888	98%	2008	
APC-5	Allegheny Energy Supply LLC	Pleasants 1	626	4 / 0	Mg-Lime	Natural	Coal	4%	2,443,000 3,478,832	3200 3,200	90%	1980	
APC-6	Allegheny Energy Supply LLC	Pleasants 2	626	4 / 0	Mg-Lime	Natural	Coal	4%	2,443,000 3,478,832	3200 3,200	90%	1980	
431-0096	Allegheny Monongahela Power Company	Fort Martin 1	552	1 / 0	Limestone	Forced	Coal	4.72%	2,016,000 2,870,784	2824 2,824	98%	2009	

babcock & wilcox power generation group

Wet FGD Experience B&W

Contract	Customer	Plant and Unit	Total MW	Modules Total/ Spare	Reagent	Oxidation	Fuel	Weight % Sulfur	Inlet Gas Flow *** mg/Nm3/hr acfm	Inlet SO2 *** mg/Nm3 ppm @ 3% O2	SO2 % Removal	Startup Year	Order Date
431-0097	Allegheny Monongahela Power Company	Fort Martin 2	555	1 / 0	Limestone	Forced	Coal	4.72%	2,065,000 2.940,560	2862 2,862	98%	2009	
APC-18	Applied Energy Services Inc.	Deepwater 1	135	2 / 1	Limestone	Forced	Petroleum Coke	8%	634,000 902,816	4869 4,869	90%	1986	
APC-15	Arizona Public Service Co.	Four Corners 4	800	5 / 1	Lime	Inhibited	Coal	1.1%	3,600,000 5,126,400	827 827	90%	1984	
APC-15	Arizona Public Service Co.	Four Corners 5	800	5 / 1	Lime	Inhibited	Coal	1.1%	3,600,000 5,126,400	827 827	90%	1984	
APC-20	Cincinnati G&E/Dayton P&L/Columbus and So. Elec.	Zimmer	1300	6 / 1	Mg-Lime	Forced	Coal	4.5%	4,900,000 6,977,600	3310 3,310	90%	1991	
APC-27	Cinergy	Gibson 4	670		Limestone	Inhibited	Coal	3.5%	2,282,000 3,249,568	2600 2,600	97%	1994	
APC-10	Cinergy / Dayton Power and Light	East Bend 2	648	3 / 1	Mg-Lime	Natural	Coal	5.1%	2,531,800 3,605,283	3918 3,918	87%	1981	
APC-12	City of Grand Haven	J.B. Sims 3	65	2 / 1	Lime	Forced	Coal	4.5%	281,000 400,144	3080 3,080	90%	1983	
APC-11	City of Lakeland	McIntosh 3	364	2 / 0	Limestone	Natural	Coal / Oil / Refuse	2.5%	1,174,200 1,672,060	2998 2,998	80%	1982	
APC-8	City of Sikeston	Sikeston 1	235	3 / 1	Limestone	Natural	Coal	2.7%	834,100 1,187,758	2421 2,421	75%	1981	
431-0098	Detroit Edison Company	Monroe 1	800	1 / 0	Limestone	Forced	Coal	1.54%	2,723,000 3,877,552	1158 1,158	97%	2012	
431-0099	Detroit Edison Company	Monroe 2	800	1 / 0	Limestone	Forced	Coal	1.5%	2,723,000 3,877,552	1158 1,158	97%	2013	
431-0088	Detroit Edison Company	Monroe 3	825	1 / 0	Limestone	Forced	Coal	1.54%	2,723,000 3,877,552	1158 1,158	98%	2009	

Contract	Customer	Plant and Unit	Total MW	Modules Total/ Spare	Reagent	Oxidation	Fuel	Weight % Sulfur	Inlet Gas Flow *** mg/Nm3/hr acfm	Inlet SO2 *** mg/Nm3 ppm @ 3% O2	SO2 % Removal	Startup Year	Order Date
431-0089	Detroit Edison Company	Monroe 4	825	1 / 0	Limestone	Forced	Coal	1.54%	2,723,000 3,866,660	1158 1,158	97%	2009	
431-1085	Detroit Edison Company (Changed to 431-0088 & 0089)	Monroe 3 & 4											
431-0065	Dongnan Power Generation Co. Ltd.	Xioashan 1-2	250	1 / 0	Limestone	Forced	Coal	1.6%	930,900 1,325,602	1317 1,317	95%	2005	
431-0078	Duke Energy Indiana	Cayuga 1	550	1 / 0	Limestone	Forced	Coal	3.56%	2,100,000 2,990,400	2729 2,729	97%	2008	
431-0079	Duke Energy Indiana	Cayuga 2	550	1 / 0	Limestone	Forced	Coal	3.56%	2,100,000 2,990,400	2729 2,729	97%	2008	
431-0075	Duke Energy Indiana	Gibson 1	670	1 / 0	Limestone	Forced	Coal	3.51%	2,697,312 3,840,972	2550 2,550	97%	2007	
431-0074	Duke Energy Indiana	Gibson 2	670	1 / 0	Limestone	Forced	Coal	3.51%	2,697,312 3,840,972	2550 2,550	97%	2007	
431-0073	Duke Energy Indiana	Gibson 3	670	1 / 0	Limestone	Forced	Coal	3.51%	2,697,312 3,840,972	2550 2,550	97%	2006	
431-0077	Duke Energy Ohio, Inc.	Miami Fort 7	552	1 / 0	Limestone	Forced	Coal	4.41%	2,266,001 3,226,785	2947 2,947	97%	2007	
431-0076	Duke Energy Ohio, Inc.	Miami Fort 8	552	1 / 0	Limestone	Forced	Coal	4.41%	2,127,000 3,028,848	2991 2,991	97%	2007	
APC-13	East Kentucky Power Cooperative, Inc. (Canceled)	J.K. Smith 1	600	4 / 1	Lime	Natural	Coal	3.5%	2,048,000 2,916,352	2600 2600	0.9	0	
APC-14	East Kentucky Power Cooperative, Inc. (Canceled)	J.K. Smith 2	600	4 / 1	Lime	Natural	Coal	3.5%	2,048,000 2,916,352	2600 2600	0.9	0	
APC-32	Illinois Power (Canceled)	Baldwin 1	560	3 / 0	Limestone	Forced	Coal	3.2%	2,508,400 3,571,962	2460 2460	0.95	0	

babcock & wilcox power generation group

Wet FGD Experience B&W

Contract	Customer	Plant and Unit	Total MW	Modules Total/ Spare	Reagent	Oxidation	Fuel	Weight % Sulfur	Inlet Gas Flow *** mg/Nm3/hr acfm	Inlet SO2 *** mg/Nm3 ppm @ 3% O2	SO2 % Removal	Startup Year	Order Date
APC-33	Illinois Power (Canceled)	Baldwin 2	560	3 / 0	Limestone	Forced	Coal	3.2%	2,508,400 3,571,962	2460 2460	0.95	0	
APC-2	Kansas City Power and Light/Kansas Gas and Electric	LaCygne 1	848	8 / 1	Limestone	Natural	Coal	5%	2,916,000 4,152,384	4910 4,910	80%	1973	
APC-28	Kentucky Utilities	Ghent 1	500	3 / 1	Limestone	Forced	Coal	3.5%	1,900,000 2,705,600	2700 2,700	95%	1994	
APC-16	Kentucky Utilities (Canceled)	Hancock 1	708	4 / 1	Limestone	Natural	Coal	30%	2,759,000 3,928,816	2320 2320	0.91	0	
GCS-6	Michigan South Central Pwr Agency	Endicott	55	1 / 0	Limestone	Forced	Coal / Oil	4.3%	253,000 360,272	3600 3,600	90%	1982	
APC-44	New Brunswick Power	Coleson Cove 1-3	1050	2 / 0	Limestone	Forced	Oil	2.9%	1,453,000 2,069,072	2311 2,311	90%	2004	
APC-29	New Brunswick Power	Dalhousie 1 & 2	315	1 / 0	Limestone	Forced	Orimuls ion	2.9%	1,849,417 2,633,570	2300 2,300	90%	1995	
APC-30	Niagara Mohawk (Canceled)	Huntley 67	210	1 / 0	Limestone	Forced	Coal	3.20%	742,000 1,056,608	2000 2000	0.94	0	
APC-31	Niagara Mohawk (Canceled)	Huntley 68	210	1 / 0	Limestone	Forced	Coal	3.2%	742,000 1,056,608	2000 2000	0.94	0	
APC-21	Pacific Power and Light	Jim Bridger 1	552	3 / 0	Soda Liquor	Natural	Coal	0.70%	2,750,,000 3,916,000	820 820	87%	1990	
APC-17	Pacific Power and Light	Jim Bridger 2	552	3 / 0	Soda Liquor	Natural	Coal	0.70%	2,750,000 3,916,000	820 820	87%	1986	
APC-19	Pacific Power and Light	Jim Bridger 3	552	3 / 0	Soda Liquor	Natural	Coal	0.70%	2,750,000 3,916,000	820 820	87%	1988	
431-0063	Progress Energy Carolinas	Asheville 1	198	1 / 0	Limestone	Forced	Coal	3.08%	715,367 1,018,682	2167 2,167	97%	2005	

Contract	Customer	Plant and Unit	Total MW	Modules Total/ Spare	Reagent	Oxidation	Fuel	Weight % Sulfur	Inlet Gas Flow *** mg/Nm3/hr acfm	Inlet SO2 *** mg/Nm3 ppm @ 3% O2	SO2 % Removal	Startup Year	Order Date
431-0064	Progress Energy Carolinas	Asheville 2	194	1 / 0	Limestone	Forced	Coal	3.08%	739,929 1,053,549	2136 2,136	97%	2006	
431-0069	Progress Energy Carolinas	Mayo 1	745	1 / 0	Limestone	Forced	Coal	3.08%	2,425,000 3,453,200	2098 2,098	97%	2009	
431-0066	Progress Energy Carolinas	Roxboro 1	385	1 / 0	Limestone	Forced	Coal	3.08%	1,211,892 1,725,734	2127 2,127	97%	2008	
431-0062	Progress Energy Carolinas	Roxboro 2	670	1 / 0	Limestone	Forced	Coal	3.08%	2,086,573 2,971,280	2150 2,150	97%	2007	
431-0067	Progress Energy Carolinas	Roxboro 3	707	1 / 0	Limestone	Forced	Coal	3.08%	2,424,548 3,452,556	2127 2,127	97%	2008	
431-0068	Progress Energy Carolinas	Roxboro 4	700	1 / 0	Limestone	Forced	Coal	3.08%	2,422,434 3,449,546	2043 2,043	97%	2007	
APC-38	Public Service Co. of New Mexico	San Juan 1	350	3 / 0	Limestone	Forced	Coal	0.90%	1,848,000 2,631,552	800 800	90%	1999	
APC-39	Public Service Co. of New Mexico	San Juan 2	350	3 / 0	Limestone	Forced	Coal	0.90%	1,848,000 2,631,552	800 800	90%	1999	
APC-40	Public Service Co. of New Mexico	San Juan 3	550	3 / 0	Limestone	Forced	Coal	0.90%	2,560,000 3,645,440	800 800	90%	1999	
APC-41	Public Service Co. of New Mexico	San Juan 4	550	3 / 0	Limestone	Forced	Coal	0.90%	2,560,000 3,645,440	800 800	90%	1999	
APC-4	San Miguel Elec. Power Coop.	San Miguel 1	410	4 / 1	Limestone	Inhibited	Coal	2.1%	1,579,000 2,248,496	4400 4,400	86%	1981	
0635-188H	Shaw, Stone & Webster for Mirant	Chalk Point	670	1 / 0	Limestone	Forced	Coal	3.01%	2,513,000 3,578,512	1554 1,554	98%	2009	
0635-188J	Shaw, Stone & Webster for Mirant	Dickerson	570	1 / 0	Limestone	Forced	Coal	3.01%	2,146,000 3,055,904	1666 1,666	98%	2009	

Contract	Customer	Plant and Unit	Total MW	Modules Total/ Spare	Reagent	Oxidation	Fuel	Weight % Sulfur	Inlet Gas Flow *** mg/Nm3/hr acfm	Inlet SO2 *** mg/Nm3 ppm @ 3% O2	SO2 % Removal	Startup Year	Order Date
0635-188K	Shaw, Stone & Webster for Mirant	Morgantown 1	624	1 / 0	Limestone	Forced	Coal	3.01%	2,102,000 2,993,248	1711 1,711	98%	2009	
0635-188L	Shaw, Stone & Webster for Mirant	Morgantown 2	624	1 / 0	Limestone	Forced	Coal	3.01%	2,102,000 2,993,248	1711 1,711	98%	2009	
APC-3	South Carolina Pub. Serv. Auth.	Winyah 2	144	1 / 0	Limestone	Natural	Coal	1.1%	407,015 579,589	1800 1,800	70%	1977	
APC-9	South Carolina Pub. Serv. Auth.	Winyah 3	288	2 / 0	Limestone	Natural	Coal	1.7%	965,900 1,375,442	1470 1,470	90%	1980	
APC-3	South Carolina Pub. Serv. Auth. - Canceled	Winyah 2	288	1 / 0	Limestone	Natural	Coal	1.1%	407,015 579,589	932 932	0.7	1977	
APC-7	Southern Illinois Power Coop.	Marion 4	184	2 / 0	Limestone	Natural	Coal	4%	691,500 984,696	3326 3,326	89%	1978	
APC-46	Sumitomo Corp. for PT Central Java Power	Tanjung Jati B-1	660	1 / 0	Limestone	Forced	Coal	1%	1,831,888 2,608,609	935 935	92%	2007	
APC-45	Sumitomo Corp. for PT Central Java Power	Tanjung Jati B-2	660	1 / 0	Limestone	Forced	Coal	1%	1,831,888 2,608,609	935 935	92%	2007	
APC-34	Taiwan Power	Taichung 5	550	1 / 0	Limestone	Forced	Coal	1.5%	1,700,000 2,420,800	1100 1,100	92%	1998	
APC-35	Taiwan Power	Taichung 6	550	1 / 0	Limestone	Forced	Coal	1.5%	1,700,000 2,420,800	1100 1,100	92%	1998	
APC-36	Taiwan Power	Taichung 7	550	1 / 0	Limestone	Forced	Coal	1.5%	1,700,000 2,420,800	1100 1,100	92%	1999	
APC-37	Taiwan Power	Taichung 8	550	1 / 0	Limestone	Forced	Coal	1.5%	1,700,000 2,420,800	1100 1,100	92%	1999	
431-0038	TEAS	Kemerkoy 1	210	1 / 0	Limestone	Forced	Turkish Lignite	2.7%	820,000 1,167,680	4600 4,600	95%	2000	

babcock & wilcox power generation group

Wet FGD Experience B&W

Contract	Customer	Plant and Unit	Total MW	Modules Total/ Spare	Reagent	Oxidation	Fuel	Weight % Sulfur	Inlet Gas Flow *** mg/Nm3/hr acfm	Inlet SO2 *** mg/Nm3 ppm @ 3% O2	SO2 % Removal	Startup Year	Order Date
431-0055	TEAS	Kemerkoy 2	210	1 / 0	Limestone	Forced	Turkish Lignite	2.7%	820,000 1,167,680	4600 4,600	95%	2000	
431-0056	TEAS	Kemerkoy 3	210	1 / 0	Limestone	Forced	Turkish Lignite	2.7%	820,000 1,167,680	4600 4,600	95%	2000	
431-0080	Unidentified Customer #1 (Canceled)	116	590	1 / 0			Coal		2,701,402 3,846,796			1	
431-0081	Unidentified Customer #1 (Canceled)	117	590	1 / 0			Coal		2,701,402 3,846,796			1	
431-0090	Unidentified Customer #2	219-222	800	1 / 0	Limestone	Forced	Coal	2.6%	2,654,959 3,780,662	1630 1630	98%	2009	
431-0092	Unidentified Customer #2	223-225	800	1 / 0	Limestone	Forced	Coal	2.6%	2,682,887 3,820,431	1702 1,702	98%	2009	
431-0091	Unidentified Customer #2	W.H. Sammis 5-7	800	1 / 0	Limestone	Forced	Coal	2.6%	2,682,887 3,820,431	1702 1,702	98%	2009	
431-0060	Zhejiang Provincial Electric Power Co.	Qianqing 2	135	1 / 0	Limestone	Forced	Coal	1.06%	450,000 640,800	1230 1,230	92%	2003	

Contract	Customer	Plant and Unit	Total MW	Modules Total/ Spare	Reagent	Oxidation	Fuel	Weight % Sulfur	Inlet Gas Flow *** mg/Nm3/hr acfm	Inlet SO2 *** mg/Nm3 ppm @ 3% O2	SO2 % Removal	Startup Year	Order Date

48,870 **Total MW**

*** Assumed flue gas temperature of 750°F and a flue gas pressure of 7.00 inwg

Since 1867, The Babcock & Wilcox Company has been a world leader in designing, manufacturing, installing, and servicing utility, industrial, marine and Independent Power Producer steam generating systems. While others may use the "Babcock" name, we are the ***original***. Insist on us by name.

Babcock & Wilcox Company Power Generation Group

For general company information:
- Within North America, call............................-800-Babcock (222-2625)
- Outside North America, call...(330) 753-4511
- Fax Worldwide .... (330) 860-1886 or (330) 860-1909

For Boiler Replacement Parts:
- Within U.S.A. 24 hours a day, call.........1-800-354-4400
- Outside U.S.A., call................................ (330) 860-1200
- Fax Worldwide....................................... (330) 860-9350

Website information, communication or e-business...www.babcock.com

No warranty or guarantee is implied by any information shown herein.

APPENDIX K.
SO3 Control Technology

The Babcock & Wilcox Company
Generating Powerful Solutions℠
a McDermott company

Trona Injection for Effective SO_3 Mitigation

Utilities are constantly facing new environmental challenges to delivering reliable and clean power to their customers. Providing solutions backed by experience and aggressive research, The Babcock & Wilcox Company (B&W) continues to develop new products to add to its wide range of emissions control equipment and systems.

Efforts to remove nitrogen oxides (NO_x) through the use of selective catalytic reduction (SCR) systems have resulted in increased sulfur trioxide (SO_3) concentrations in the flue gas. In addition, when wet flue gas desulfurization (FGD) systems are used for sulfur control, particularly with higher sulfur fuels, significant levels of sulfuric acid (H_2SO_4) mist tend to pass through the system and result in stack opacity issues.

Increased corrosion has been identified as another potential problem with increased SO_3 in the flue gas. Total plant emissions are also higher.

Successful commercial application of trona injection

B&W provides an SO_3 mitigation technology through a license with AEP ProServ, Inc., a subsidiary of American Electric Power (AEP). After conducting tests on several sorbents and sorbent systems, AEP concluded that trona (chemical name: sodium sesquicarbonate) was the best solution for their fleet of plants (see Table 1). Work progressed to develop a reliable and cost-effective trona handling, conveying and injection system at their Gavin facility.

Truck unloading and conditioning station for trona system.

The technology is successfully installed and operating. Positive results include a substantial reduction in SO_3 and enhanced performance of the existing dry electrostatic precipitators. Additionally, operation and maintenance costs are minimal. B&W is working closely with AEP to further improve system performance and reduce operating costs of the technology through joint research and development projects.

Key trona system features

System Flexibility and Optimization from Storage to Metered Delivery

- Flexible off-loading from pressure differential (PD) truck or rail car

Table 1: *Popular Sorbents – Based on Commercial Testing*

Sorbent	*Effectiveness*	*Relative Operating Costs*	*Relative Capital Costs*	*Relative Maintenance*
Trona	Excellent	Low	Low	Low
Ammonia	Good for lower SO_3 concentration	Low	Low – NH_3 already in use with SCR	Low
Magnesium Hydroxide	Good – furnace SO_3 only	High	Moderate – slurry	Moderate
Hydrated Lime	Good – limited by ESP performance	Low	Low	Moderate to low
Sodium Bisulfite*	Excellent	High	Moderate – wet injection	High
High Surface Lime	Good to excellent	Low	Low	Moderate ESP concerns

**** Based on publicly disclosed information.***

- Bulk storage in single or multiple silos based on customer requirements
- Metered delivery of sorbent
- Pneumatic conveyance up to 3000 ft. (914.4 m); greater conveyance distances can be accommodated
- Precise delivery at trona injection points
- Minimized operation and maintenance

Plant and Process Specific Design

- Flow distribution and trona injection modeled using computational fluid dynamics (CFD)
- Multiple levels of system monitoring and control redundancy
- State-of-the-art control logic

Experience and Expertise

- Licensed technology and commercially operating units
- Unmatched experience, reliability and success
- Industry leader in controlling power plant emissions

Trona injection and B&W provide measurable benefits

The trona sorbent injection system offered by B&W can cost-effectively mitigate SO_3, reducing visible stack emissions due to H_2SO_4.

The trona injection system features a relatively low injection rate and minimal operation and maintenance requirements.

In addition, B&W's total system approach and related environmental equipment experience will provide you with the greatest flexibility, accountability and certainty of outcome. Measurable benefits include:

System Specific

- Improved stack appearance (opacity)
- Reduced H_2SO_4 emissions from stack
- Unmatched equipment reliability
- Low injection rate compared to other sorbents
- Minimal plant operations personnel requirements
- Performance guarantees

Enhanced Environmental Systems Performance

- Improved dry electrostatic precipitator (ESP) performance
- Minimal system corrosion

Turnkey Solutions

- Sole source equipment supply, erection and commissioning
- Low capital cost
- Compressed project schedules

Flexible solutions in multiple applications

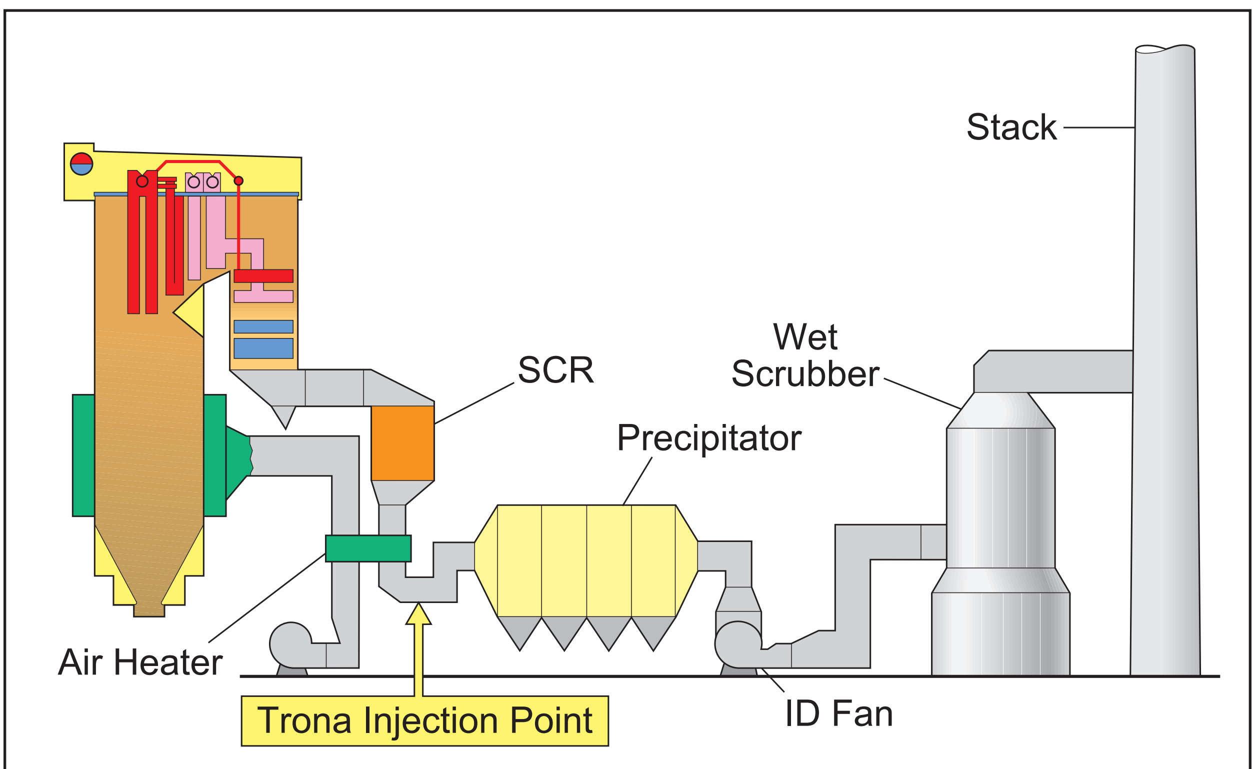
B&W can provide a cost-effective trona system in a variety of applications:

- New boiler installations
- Retrofit into plants with existing SCR systems and/or wet FGD systems
- Part of complete air quality control system (with SCR and/or wet FGD system)

B&W's environmental professionals are experts at recognizing opportunities to apply proven technology to existing equipment that provide tangible benefits. As a single-point contact, our complete package of environmental upgrade and aftermarket services includes:

- Engineering assessment
- Complete system engineering
- Engineered equipment upgrades
- Performance guarantees
- Project management
- Installation and construction services
- Startup and commissioning
- Performance testing and monitoring
- Field engineering services
- Replacement parts

For more information about the trona SO_3 mitigation system from B&W, or any of our other pollution control equipment solutions, call us at 1-800-BABCOCK (222-2625) and ask for the environmental equipment group.



Typical wet FGD configuration with dry trona injection.

The Babcock & Wilcox Company
*Generating Powerful Solutions*SM

The Babcock & Wilcox Company - we're the original. We've been generating powerful solutions in the design, construction and service of steam generating systems since 1867. So put our experience and capabilities to work for you today. Insist on us by name.

For more information, or a complete listing of our sales and service offices, call 1-800-BABCOCK (222-2625), send an e-mail to info@babcock.com, or access our Web site at www.babcock.com.

The Babcock & Wilcox Company
20 S. Van Buren Avenue
Barberton, Ohio, USA 44203
Phone: (330) 753-4511 • Fax: (330) 860-1886

Babcock & Wilcox Canada Ltd.
581 Coronation Boulevard
Cambridge, Ontario, Canada N1R 5V3
Phone: (519) 621-2130 • Fax: (519) 621-9681

PS-415 1MU7H

APPENDIX L.
Additional Vendor Data

HAMON CUSTODIS-COTTRELL CANADA, INC.

HC Ref: *P433* *19 September 2008*

Stantec Consulting Ltd. ***Fax*** *506-452-0112*
845 Prospect Street
Fredericton NB E3B 2T7

Attention: *R. Harry Olive, M.Eng., P.Eng.* *Tel.506-452-7000(1442)*
Senior Engineer, Structural

Subject: ***NLH - Holyrood Precipitator and FGD Study – Chimney Budget Cost Estimate 133544177/37***

Dear Mr. Olive,

Further to your request of 28 August 2008, we are submitting our Budget Proposal for the design and construction of a chimney for the above project. For pricing we have followed your preliminary specifications and drawings and offer the following options for your consideration:

- BASE BID: (**CONCRETE SHELL, C.S. LINER w/Borosilicate glass lining, PGB**)
  - 247'-6" of C.S. lined with 2" Borosilicate glass lining (current pricing).
  - Top 17'-6" and bottom 38'-0" of liner, rectangular breeching duct (15'-6" wide x 27'-6" high) and hopper (assuming a 45 degree cone around vertical) are solid ¼" C-276 plate based on current pricing.
  - Rectangular breeching duct is terminated at 2'-0" beyond O.D. of concrete shell, *not 45'-0" long as specified*.
  - ID. of liner is 23'-0" (with 2" block the steel liner ID. is 23'-4") resulting in gas velocity of 60fps.
  - Concrete is by others - estimated quantity = 1,900 cy
  - Basic Liquid Collection system is included (C-276 plate gutters).
  - Supply and installation of CEMS is by others.
  - Roof deck has a concrete parapet wall *not SS guardrail and chain link fence as specified.*
  - Winter concreting is excluded and assumed construction season for column will be April through October.
  - The price is based on **JUMPFORM** construction. If slipform is required, add budget price of $1,100,000.

23 West Beaver Creek Road
Unit 2/3
Richmond Hill, Ontario L4B 1K4
Canada

Telephone
905.771.0234
Fax
905.771.9730

E-mail: info.hccc@hamon.com
Web: www.hamon.com

HAMON CUSTODIS-COTTRELL CANADA, INC.

- Alternate Bid No. 1: (**CONCRETE SHELL w/FRP Liner**)
    - 328'-0" +/- FRP liner (on-site fabrication) includes top 17'-6", bottom 38'-0", rectangular breeching duct (16'-0" w. x 27'-6" h.) and hopper (assuming a 45 degree cone around vertical) all fabricated from FRP.
    - I.D. of liner is 24'-0" resulting in gas velocity of 55fps for given ACFM
    - Concrete is by others - estimated quantity = 2,500 cy.
    - Basic Liquid Collection system is included (FRP).
    - Supply and installation of CEMS is by others.
    - Roof deck has a concrete parapet wall *not SS guardrail and chain link fence as specified.*
    - Winter concreting is not included and assumed construction season for column will be April through October.
    - The price is based on **JUMPFORM** construction. If slipform is required, add budget price of $1,200,000.

Attached is HC's budget price ± 20%, for the DESIGN, AND CONSTRUCTION of the chimney. Pricing is in current CDN DOLLARS.

We remain at your service.

Yours truly,
HAMON CUSTODIS - COTTRELL CANADA INC.

L. S. Branicki
Sales Co-ord.
LSB/

YOU CAN RELY ON CUSTODIS'
~ OVER 100 YEARS ~
OF CHIMNEY EXPERIENCE

23 West Beaver Creek Road
Unit 2/3
Richmond Hill, Ontario L4B 1K4
Canada

Telephone
905.771.0234
Fax
905.771.9730

E-mail: info.hccc@hamon.com
Web: www.hamon.com

HAMON CUSTODIS-COTTRELL CANADA, INC.

23 West Beaver Creek Road
Unit 2/3
Richmond Hill, Ontario L4B 1K4
Canada

Telephone
905.771.0234
Fax
905.771.9730

E-mail: info.hccc@hamon.com
Web: www.hamon.com

Owner: Newfoundland and Labrador Hydro
Station: Holyrood G.S.
Engineer: Stantec Consulting
RFQ: Stantec 133544177/37
Hamon Custodis Budget Proposal No. OE-7570
Chimney Geometry / Budget Price / Construction Schedule
Date: September 17, 2008

Description	Base Bid	Alternate 1
Overall Chimney Height (ft)	412	412
Shell Height (ft)	397	397
Shell Top O.D. (ft)	38	39
Shell Bottom O.D. (ft)	44	57
Number of Liners	1	1
Liner Height (ft)	328	328
Liner Material	247'-6" C.S. Lined w/PGB. Top 17'-6", Bottom 38'-0", Breeching Duct, and Hopper are Solid C-276	FRP
Liner Top I.D. (ft)	23	24
Liner Bottom I.D. (ft)	23	24
Column Construction Method	JUMPFORM	JUMPFORM
Number of Platforms	3	3
Elevator (Interior/Exterior)	Interior	Interior
Number of Levels of Obstruction Lighting	2	2
Concrete Roof or Rain Hood	Concrete Roof	Concrete Roof
Budget Estimate (CDN $)	$18,250,000	$17,350,000
Construction Duration (mths.)	24	20

This proposal is based upon the attached Scope of Work and Pricing Notes

Bachmann Industries, Inc.

Stantec Consulting Ltd.

Newfoundland & Labrador Hydro Holyrood FGD Dampers

BACHMANN PROPOSAL NO.O-0523 Rev.0
Dated 12 September 2008

Table of Contents

SECTION

Section 1
Pricing
Equipment

Description	Qty	Weight Per Unit		Unit Price	Total Price
FGD Guillotine 12'x12' Gas path 144" wide by 144" high x 18" flange to flange ISO-Flex FGD Guillotine c/w closed bonnet Carbon steel external construction, All exposed surfaces of the open damper (frame inside and blade bottom) in C-276, Electric actuation.	6	10,000	kg	$210,000	$ 1,260,000
FGD Guillotine 21'x21' Gas path 252" wide by 252" high x 18" flange to flange ISO-Flex FGD Guillotine c/w closed bonnet Carbon steel external construction, All exposed surfaces of the open damper (frame inside and blade bottom) in C-276, Electric actuation.	1	20,000	kg	$396,000	$ 396,000
FGD Guillotine 12'x12' (Alternate, adder) Gas path 144" wide by 144" high x 18" flange to flange ISO-Flex FGD Guillotine c/w closed bonnet Carbon steel external construction, <u>All exposed surfaces of the open damper and one side of the closed damper (frame inside and one complete side blade) in C-276, Electric actuation.</u>	6	10,000	kg	$ 25,000	$ 150,000
FGD Guillotine 21'x21' (Alternate, adder) Gas path 252" wide by 252" high x 18" flange to flange ISO-Flex FGD Guillotine c/w closed bonnet Carbon steel external construction, <u>All exposed surfaces of the open damper and one side of the closed damper (frame inside and one complete side blade) in C-276, Electric actuation.</u>	1	20,000	kg	$ 66,000	$ 66,000
Seal Air Skid for FGD Inlet/Bypass Guillotines (12'x12') and FGD Outlet Guillotine (21'x21') Two (2 x 100%) fans (1 running and 1 standby), Intake silencer, blower isolation valves, instruments, electrical heater, heater control cabinet ducts and expansion joints.	4	2,500	kg	$70,000	$ 280,000
Total for Base FOB Shop (Eastern Canada)	**11**	**100**	**ton**		**$ 1,936,000**

Section 2
Terms, Conditions and Delivery

Pricing

Equipment prices are quoted in Canadian Dollars **exclusive of taxes**.

Validity

Prices are budgetary. However, due to the volatility of steel and alloy metal prices Bachmann Industries, Inc. reserves the right to adjust its offer due to changes in steel/alloy prices.

Schedule

The following schedule is preliminary and to be confirmed upon receipt of a purchase order or letter of intent.

Approval drawings .... 2 weeks after receipt of order

Customer Drawing Review .... 3 weeks

Equipment EXW Factory .... 24 weeks after return of approval drawings

Payment Terms

All payments to be NET 30 days. Our standard payment schedule is:

10% upon submittal of critical documents as agreed & submittal of 10% LOC covering initial and retention through guarantee period

30% upon submittal Purchase Order for Alloy materials and Drawings Certified for Construction

60% upon shipment (pro-rata should 2 or more shipments be made)

Warranty

Twenty-four (24) months from shipment or eighteen (18) months from PAC, whichever occurs first. Wear parts (found on spare parts list) and corrosion are expressly excluded from this extended warranty.

Quality Policy

Bachmann Industries, Inc., a world-class organization, is relentlessly committed to quality, customer satisfaction and leading edge equipment and services. We do this through continuous improvements, innovation, pride in workmanship, efficient equipment and services to meet or exceed a well-defined customer need. We comply to ISO-9001 and all contractual specifications. Our ISO Certificate Number is 951-00-1025.

Luis Pino
Regional Sales

Date: 12 September 2008

Section 2
Bachmann Industries, Inc.
General Terms and Conditions of Sale

The term "BII" as used herein shall refer to Bachmann Industries, Inc.

1. CONTRACT: Customer term(s) and condition(s) and specification(s) become applicable upon acceptance of the term(s) and condition(s) and specification(s) in writing by BII. Otherwise BII terms and conditions and specifications apply. BII's offer consists of specific written terms and conditions and specifications and these General Terms and Conditions of Sale. BII's specific terms and conditions of sale and specifications are set forth in it's proposal or order verification or comparable form and applicable drawings and technical documents. Drawings submitted for approval must be returned in time without changes to maintain delivery and order terms and conditions. Changes, delay of drawings or information, or new information affecting the contract may require amendment resulting in extra changes, delivery delays, or other changes in terms and conditions of the contract and will be void or affect penalties and the terms and conditions of the order. In case of conflict, the specific shall prevail. Acceptance of the offer, to the extent consistent with and confirming, without variance or enlargement, BII's specific and General Terms and Conditions of Sale, shall constitute the contract. All goods are sold and delivered only under the contract. Modifications or Amendments are void unless in writing and signed by BII's authorized employee. In the event of conflict between BII's specific and General Terms and Conditions of Sale and any other documents or instruments of either party, the provisions of BII's specific and General Terms and Conditions of Sale shall prevail. BII specifically objects to any proposed term or condition of buyer purporting to give priority in case of conflict to terms or conditions of sale proposed by buyer or purporting to eliminate from the contract any other of BII's specific General Terms or Conditions of Sale unless otherwise approved in writing by BII. In case buyer's acceptance of the contract is ineffective because conditional, buyer's receipt and use or storage for use of goods representing partial or complete delivery shall constitute buyer's acceptance of BII's specific and General Terms and Conditions of Sale and BII's specifications. BII reserves the right upon receipt of all information to accept or reject the order. Orders are accepted based on the available knowledge at the time of acceptance.

2. EXPRESS WARRANTIES: BII warrants that goods, upon shipment, will be as described, will conform to applicable written specifications, and will be free of defects in workmanship and material for a period of 12 months from the date of installation or 18 months from date of shipment, whichever occurs first. The goods will be free from any security interest, lien or encumbrances which the buyer has not assumed. Effects from corrosion, erosion, normal wear, or aging, or Force Majeure, are specifically excluded from BII's warranty.

3. BACKCHARGE: BII shall not accept backcharges for work performed by others upon, or in conjunction with, BII goods unless prior authorization is given by means of a BII purchase order. In addition, a written accounting of the authorized work performed must be approved by a service representative of BII and a copy of such accounting sent to BII. In no case may authorized backcharges exceed either the replacement part or twenty percent of the purchase price (whichever is less) of the specific goods on which backcharges are requested.

4. DISCLAIMERS: EXCEPT FOR EXPRESS WRITTEN WARRANTIES, BII MAKES NO WARRANTY, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY, OR SUITABILITY FOR PURPOSE, OR DESIGN. Any sample or literature exhibited to buyer was to illustrate the general type of goods and not an affirmation that goods will conform. No employee or representative has authority to bond BII to any other representation, affirmation or warranty.

5. EXCLUSIVE REMEDY: ALL REMEDIES OF BUYER ARISING OUT OF THIS TRANSACTION, OR WITH RESPECT TO GOODS, SHALL BE LIMITED EXCLUSIVELY, AND IN LIEU OF ANY AND ALL OTHER REMEDIES, TO THOSE CONTAINED IN THESE TERMS AND CONDITIONS, WHETHER BASED UPON BREACH OF WARRANTY, EXPRESS OR IMPLIED (INCLUDING, WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY, OR SUITABILITY FOR PURPOSE OR DESIGN) CONTRACT NEGLIGENCE, STRICT LIABILITY OR OTHER TORT. BII's liability is limited to the repair, or replacement, F.O.B. shipping point, of defective or non-conforming goods or at BII's option, to refund that portion of the purchase price applicable to the defective or non-conforming goods upon return of such goods, F.O.B. BII's plant or other place of origin of the goods as specified by BII. BII shall not be responsible under any circumstances for cost of removal or installation. If field repairs are performed under warranty on an overtime or multiple shift basis at the request of the buyer or other third parties, the cost of overtime premium pay, shift differential, raised payroll burden and overhead, and non-productive man hours associated with such overtime or multiple shift work shall be paid by the buyer. Buyer shall further provide all required access to the goods and the consents of third parties at no charge to BII.

6. LIMITATION OF LIABILITY: IN NO EVENT SHALL BII, ITS SUBCONTRACTORS OR ITS VENDORS BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL SPECIAL OR INDIRECT DAMAGES, OR LOSSES OF BUYER, ARISING OUT OF THIS TRANSACTION OR THE MISUSE OF THE GOODS OR ANY PART THEREOF, UNDER THEORY OF BREACH OF WARRANTY, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY, OR SUITABILITY FOR PURPOSE, OR DESIGN, OR CONTRACT, OR AS A RESULT OF ANY NEGLIGENCE, STRICT LIABILITY OR OTHER TORT. BII'S WARRANTY LIABILITY SHALL BE LIMITED TO THE MANUFACTURING COST OF THE BACHMANN EQUIPMENT AFFECTED BY THE WARRANTY CLAIMS. BII'S MAXIMUM LIABILITY UNDER ANY AND ALL CIRCUMSTANCES SHALL BE LIMITED TO THE MANUFACTURING COST OF THE BACHMANN EQUIPMENT AFFECTED BY THE CLAIMS.

7. CONDITIONS OF WARRANTIES: Any modification, misuse or attempted repair of the goods, made by buyer or third parties, without BII's prior written consent, voids any and all warranties with respect to such goods. Further, because of the possibility of damage to the goods from other causes, BII will have no responsibility under any warranties given except warranties of title of goods unless:
   a. The goods have been stored in accordance with BII's instructions, good industry practice and if long term storage is involved (more than (3) three months at job site), BII's service representative must approve the method of storage and determine service procedures to be followed during this period of storage.
   b. The goods are installed or erected in accordance with good industry practice and BII's installation instructions, when applicable.
   c. Goods are maintained and operated in accordance with good industry practice and in accordance with BII's Operating and Maintenance Manual, drawings, or information applicable. Plant Operating and Maintenance Records for the Equipment (In English) must be provided upon request.
   d. All spare parts for The Equipment must be purchased from Bachmann Industries, Inc. throughout the warranty period.
   e. If included as part of the contract, a BII service representative is present to perform inspection, commissioning, and functional testing of the goods after installation thereof, at least two weeks prior to start-up of commercial operation. This service is optional at current technical field service rates, but this service is recommended.
   f. Proper mating duct installation and insulation is performed.

   Bachmann Industries, Inc. recommends the use of a Field Service Technician for installation supervision. If a Bachmann Field Service Tech is not used, Bachmann reserves the right to void equipment warranties due to improper handling, installation, commissioning, adjusting, operation, or other actions or causes not by Bachmann causing a problem with equipment. The Bachmann Field Service Tech is available at a per diem plus expenses. The service of BII service representatives will be provided at rates in effect at the time of inspection. The buyer must bear the expense of correction of deficiencies noted in the goods and its installation not covered by BII's warranty. BII may in its sole discretion waive its rights to require compliance with one or more of the above stated conditions. No such waiver by BII shall be effective unless in writing, signed by an officer of BII.

8. PRICES: The prices quoted herein will remain in effect for a period of sixty (60) days from the date of this proposal. The prices quoted include only the goods listed and do not include field service, piping, field wiring, erection or spares, or other, unless otherwise stated in this proposal. Changes in scope or function may result in additional cost of manufacturing, engineering, or service time. A contract supplement will be required when such changes significantly affect the cost of delivery of the goods. Prices do not include sales, excise or use taxes, VAT, duties, levies or tariffs. Such charges shall be for the Buyer's account.

9. STORE, HANDLE, PACK, PRESERVE AS TO MAINTAIN AS-NEW CONDITION. Customer or customer's contractor must comply with this. Failure to do so will cause damage to equipment and could result in a void of warranty along with other damages.

TECHNICAL ADVISOR COST SCHEDULE

Services will be invoiced at the rates in effect at the time of usage and will include travel time between Office and Jobsite.

1. Per Eight Hour Day, Monday through Friday...$ 1,200.00 Day
2. In excess of Eight Hours, Monday through Friday ....$ 200.00 Hour
3. Per Eight Hour Day, Saturdays ....$ 1,600.00 Day
4. In excess of Eight Hours, Saturdays...$ 250.00 Hour
5. Per Eight Hour Day, Sundays and Holidays ....$ 1,800.00 Day
6. In excess of Eight Hours, Sundays and Holidays...$ 275.00 Hour
7. Travel Time to be invoiced at 75% of the above listed rates for day of travel.
8. A minimum of 4 hours will be billed once the Technical Advisor arrives on site.
9. In the event that Bachmann contracts the services of any specialized Technical Advisors, Bachmann will invoice this at direct cost + 10 % administrative charge.

STANDBY TIME

Hours during which the Technical Advisor is ready and willing to work up to the total for the forty-hour workweek, exclusive of overtime, shall be regarded as having actually been worked even though his services are not in fact utilized.

OUT OF POCKET EXPENSES

Expenses for travel, lodging, food and incidentals (tolls, parking, etc.) will be invoiced at cost plus 10%. Where company and personal cars are used, mileage will be billed at $ 0.45/mile.

GENERAL CONDITIONS

The Technical Advisor Rates and related expenses include all corporate administration charges, home office support services and communication costs.

Each Technical Advisor assigned to your facility for a period in excess of three (3) continuous weeks will be allowed a trip home once every three (3) weeks at the PURCHASER'S expense.

The PURCHASER is required to provide safe and reasonable access to the equipment with our representative to be accompanied by a qualified PURCHASER representative during internal examination of the equipment.

PRICE VALIDITY

Prices are valid through December 31, 2008 and are subject to change anytime thereafter.

Services will be invoiced at the rates in effect at the time of usage and will include travel time between Office and Jobsite.

TECHNICAL ADVISOR COST SCHEDULE – Continued

TERMS
All payments are in USD, are invoiced monthly and are payable upon submittal of invoice. All payments in arrears are subject to finance charges of 2% per month on all outstanding balances. Any non-payment is grounds for immediate demobilization of Bachmann's Technical Advisor services.

GENERAL
1. Seller's Technical Advisor does not operate the customer's equipment, nor is he authorized to supervise its installation or operation. Further, the Technical Advisor is not authorized to accept field charges or change contracts without home office approval. His responsibility on the job is to advise and consult in the operation and installation of equipment furnished by seller and to perform such repair and adjustment to seller's equipment, as seller deems necessary.

2. The purchaser shall provide all service and installation equipment and hand tools and the necessary qualifier labor required for the performance of the assignment. Special tools and equipment the Technical Advisor elects to bring to the site shall remain his property at all times.

3. The purchaser shall provide medical and first aid facilities. The purchaser for all hazardous environments shall furnish protective clothing and equipment.

4. The purchaser shall provide reasonable, secure office accommodations for the Technical Advisor complete with telephone and fax services.

SERVICE WARRANTY
Seller warrants the repair work done by its servicemen to be free from defects in his workmanship for 90 days after the work is completed. There are no other warranties, expressed or implied. If any portion of the work proves to be defective within such 90 day period and prompt notification is made in writing to seller's headquarters, seller will, at its own expense supply the necessary technical consultation to correct the defect. The forgoing shall constitute the sole remedy of the purchase and the sole liability of the company whether in warranty, contract, tort (including negligence) or otherwise.

DISCLAIMER OF DAMAGES
Seller shall not be liable for special, incidental, or consequential damages, under any circumstances, including but not limited to, damage or loss resulting from inability to use the equipment, increased operating costs, loss of production, loss of anticipated profits, or other special or incidental or consequential damages, whether similar or dissimilar, of any nature arising from any cause whatsoever.

LIMITATION OF LIABILITY
Seller's maximum liability hereunder, arising from any cause whatsoever, including but not limited to breach of contract or negligence, shall not exceed the contract price of the item which gives rise to the claim. Any above-mentioned cause of action must be commenced within one year from the date on which that action accrues.

Commercial Clarifications

1. Site services for installation and startup to be billed per the included rate sheet.
2. No field work is included in the scope contemplated by this proposal

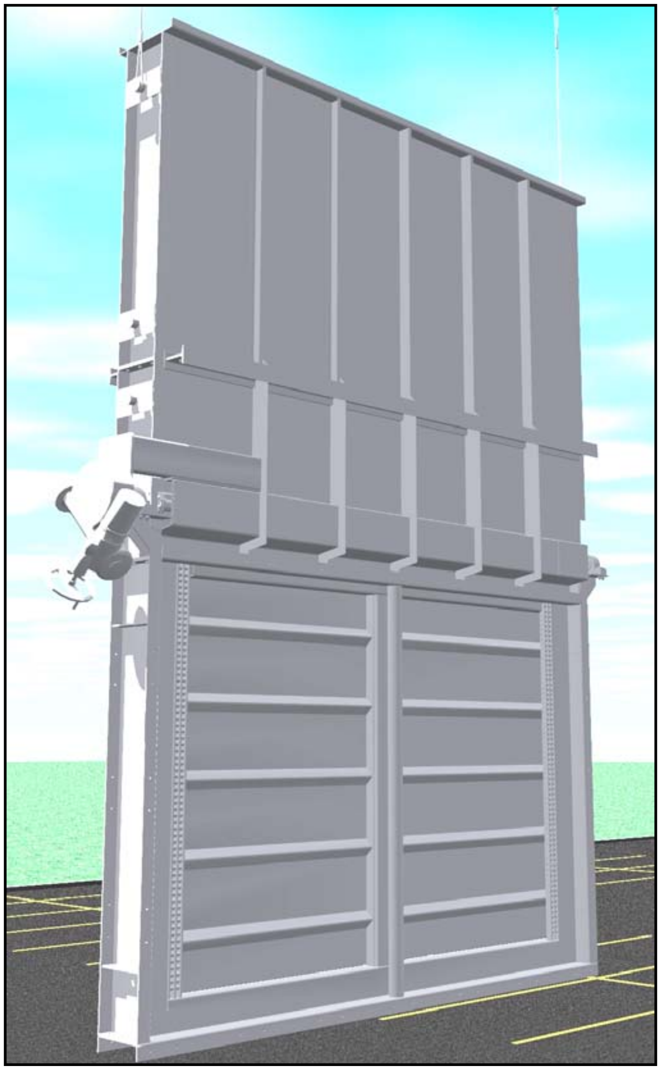
General Technical Clarifications

1. Provision for max. 300mm thick external insulation (by others) has been made. Supply, installation and design of the thermal/acoustic insulation is by others.
2. Equipment Drawings and Data sheets on separate documents.
3. Field wiring from DCS to Bachmann Industries, Inc. supplied junction boxes is supplied and installed by others (ie is not in Bachmann Industries, Inc. scope of supply).
4. Frames shall be provided to weld in the duct. No provision has been made for expansion joint set-back and bolt pattern in the damper frames.
5. A *drain and clean-out system* is NOT required for the correct operation of any of the dampers proposed by Bachmann.
6. The blade construction is a matrix design with 3/8” thick frame and ¼” skin plate. Total blade depth is 7”.
7. Counterflanges, flange hardware and alloy gap strips are not included in Bachmann’s scope of supply.
8. We have proposed C-276 material in the fabrication of the seals and some parts of our dampers. This material represents a family of materials that can be used interchangeably including; DIN 2.4819, Alloy C276, ENiCrMo-4, UNS N10276 and Hastelloy.
9. Seal air duct material, expansion joints and supports are provided by Bachmann within the distances considered in this proposal. Seal air duct installed and insulated by others.

FGD Zero-Leakage ISO-FLEX Guillotine Dampers

General

Guillotine Dampers are used for isolation purpose only. Guillotine dampers are not to be used to modulate gas flow. The guillotine dampers will provide better than 99% isolation of process gas without seal air and 100% isolation with seal air. The enclosed bonnet allows neither ingress of ambient air into the system nor leakage of process gas to the atmosphere in any blade position or operating condition.



The dampers are constructed to withstand the temperatures, pressures, and differential pressures encountered when operating under the conditions specified. The dampers are constructed as a structural member, and as such are designed in accordance with the applicable provisions of the AISC.

Materials Of Construction

Materials of construction are suitable for the temperature, pressure, and corrosive and abrasive environment of the system.

Frames

The frame will serve to hold the seals, support the drive, bonnet, and all other auxiliary equipment, and supply the structural interfacing with the supporting breeching.

The frames are self-supporting structural members that do not require any external bracing or support. The frames are rigid and capable of withstanding loads generated under operating conditions without distortion that could affect the operation or sealing characteristics of the damper.

The damper frames are fabricated of rolled structural shapes or formed plate. The damper frame thickness is calculated as per the design data given. As a minimum Guillotine dampers frames are 3/8” [10mm] thick.

The damper frame flanges are designed to transmit any required structural loads through the damper. Stresses in the frame will not exceed that which is allowed per AISC for structural members. Deflection of any frame component will not cause a decrease of sealing effectiveness of the damper.

The damper to breeching connections are designed with fit-up bolt holes and seal welded. A stitch weld around the outside perimeter helps to minimize distortion during the installation.

The blade guide tracks are attached to the inside sidewalls of the damper frame. They interlock - with the damper blade and control any side motion to within allowable limits. The guide tracks also hold the seals. The guide tracks are constructed of the same material alloy as the damper frame.

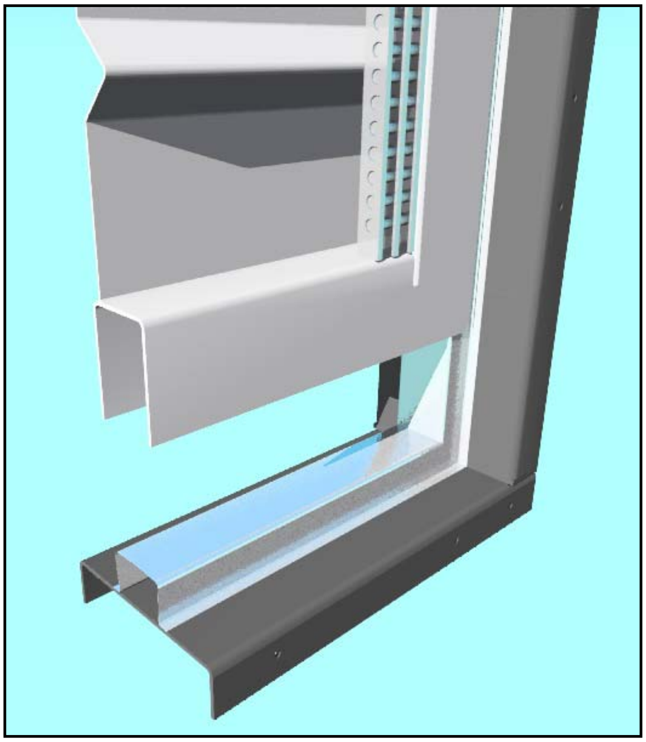
Lifting lugs are incorporated into each corner of the frame and/or as required for lifting without twisting or distorting the damper frame.

Dampers are provided with temporary shipping and erection braces as required to resist distortion due to shipping and erection forces.

Gas flow direction is clearly indicated on the frame.

Blade

The blade is constructed of a structural frame with a suitably reinforced diaphragm membrane. The blade perimeter is of a concave design, which forms a labyrinth seal in combination with the blade tracks mounted to the damper frame.



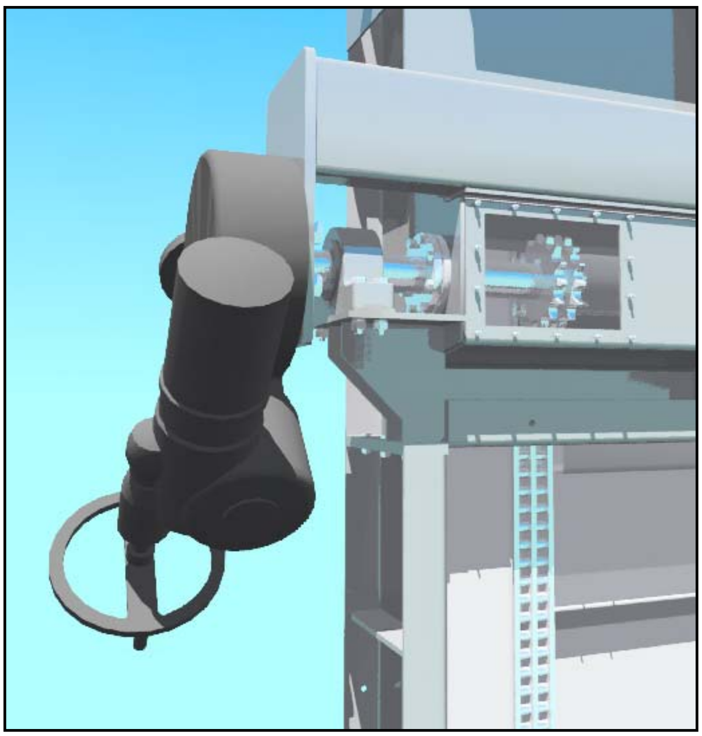
The structural frame supplies the required integrity to support the system pressure thrust as well as an interlocking arrangement for the seal system. Even without the seal elements, the blade to guide track interlock can offer less than ½% leakage. This impressive feature is due to the design concept, which allows the blade to drift just enough to come in firm contact with the guide track on the pressure side. This movement seats the two components and all but eliminates any flow path around the damper blade.

This blade design offers other benefits over the conventional solid plate blade design. Since the design uses only suitably reinforced thin membrane, it weighs only a fraction of what a comparable solid plate blade would, especially when used in higher-pressure installations. Also, since the blade is a thin membrane instead of a thick solid plate, thermal distortion due to temperature differential across the blade surfaces is minimized. This lower thermal distortion, coupled with the blade's greater flexibility, ensures improved sealing efficiencies.

Conventional designs, offered by other manufacturers, contain a concave seat in the damper body, which can fill with debris in service, causing damper binding. In the case of the "ISO-Flex" design, the concave profile is withdrawn into the damper bonnet, leaving a convex seat in the open damper, which will not fill with ashes, thus **NO cleaning system is required**.

The Bachmann matrix guillotine damper blade does not require an internal frame structure to support the blade in the closed position. Blade deflection is limited as required to ensure proper seal engagement. Frame mounted guide shoes may be used to guide the blade onto the bottom seal. Clearances are allowed for differential expansion and contraction of the damper blade.

Drive System



The drive system consists of two rigid pin racks attached to the blade, a drive pinion on each rack, supporting bearings with shaft seal assemblies, and an electric actuator with self-locking gearbox mounted on suitable brackets.

The drive is a face-drive type located at the bottom of the bonnet and easily accessible for maintenance and inspection. The close coupled rack and pinion drive system, with its rugged, self-cleaning profile offers superior performance in comparison with other systems available, such as jack screws and chain drives.

The actuator/gearbox is conservatively selected to provide a 300% minimum safety factor over the calculated torque due to blade weight, shaft seal and bearing friction, as well as pressure and seal seating forces.

The actuator is capable of a minimum of two (2) consecutive open and close cycles against the specified full differential operating pressure without damage to the actuator.

The strength of the operator mounting, based on rated operator torque, will not exceed 50% of the yield strength. The drive train is sized to withstand the greater of the stall torque developed by the actuator without exceeding 90% of the yield strength at design temperature.

Where the drive shafts penetrate through the pressure envelope, shaft seal assemblies act to seal against the leakage.

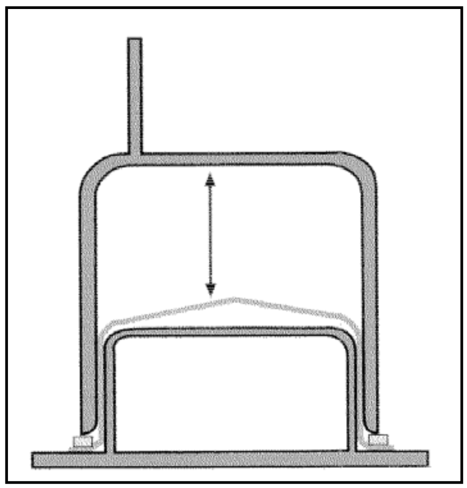
The actuator drives are mounted on supporting brackets cantilevered from the bonnet and frame. The actuator drive consists of one actuator motor complete with controlling accessories and one gearbox with direct-coupled inputs. The controlling accessories consist of torque and end of travel limit switches, and required feedback instrumentation.

The actuator is supplied with a de-clutchable manual hand-wheel override. The handwheel is sized such that the maximum force required at the rim to operate the damper at any position and at maximum operating conditions is 40 kgs. The handwheel will have a nut suitable for operation with an electric or pneumatic wrench. A fused motor, or failed motor bearing, will not prevent manual operation.

Mechanical blade lockouts for both the open and closed positions are provided to allow safe access to equipment and or interior ductwork.

Seal System

The guillotine damper seal arrangement is a metal-to-metal labyrinth seal arrangement created by the blade concave perimeter and frame mounted convex guide track. Seals are installed and maintained from inside the duct.



The seal system utilizes a flexible high alloy C-276 spring seal cap over the frame mounted guide track creating a seating perimeter on both the front and back of the guide track. The seal cap is free floating and follows the blade to ensure that both seal perimeters are maintained at all times during blade engagement.

This free floating feature allows the differential pressure to self seat the blade against the front seal face which, in turn, seats against the front face of the guide track. Any minor mismatch between the blade and guide track seating surfaces is alleviated by the flexible seal element.

The high alloy seal cap also offers the added advantage of being a corrosion resistant and flexible element, which flexes during any blade travel, thereby forming a virtually non-stick, self cleaning, guide track.

This seal design is self-cleaning and tolerant to ash accumulation. No blower cleaning system is required for the correct operation of the damper seals.

Seal Air System

To further increase the sealing efficiency of the guillotine damper to the level or 100% isolation, a seal air system is required. Seal air connections are provided on each damper.

The seal air system includes seal air fan(s), ducting, isolation valves, expansion joints, and all required instruments. A redundant blower is provided.

The seal air system shall pressurize the bonnet and cavity, which exists between the front and back seal perimeters of the blade to a pressure of **5”WC** greater than the higher pressure seen on either side of the blade.

The seal air system is sized to produce a minimum of **200%** of the maximum calculated leakage through the seals. The calculated leakage is based on the maximum anticipated differentials between the seal air cavity and each of the upstream and downstream sides of the blade.

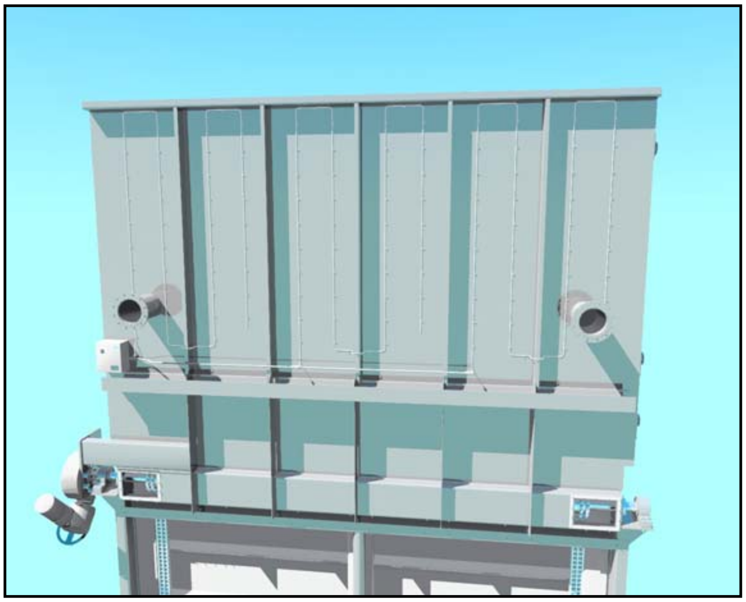
The seal air fan(s) are of the non-overloading, horizontal shaft, single inlet centrifugal type. The prime mover is an electric motor with direct drive.

The fans will meet the static pressure requirements. No credit is taken for velocity pressure recovery beyond the fan outlet. Damper losses are charged to the fan.

The fan(s) are directly coupled to the motors. Coupling guards are furnished. Bird screens and silencers, (if required) are provided for the fan inlets.

Seal air dampers are supplied to isolate the seal air system from the flue gas during periods of non-operation. The seal air dampers are motor-operated.

Bonnet



The guillotine damper will have a closed bonnet to prevent the escape of flue gas to atmosphere or the ingress of ambient air. The bonnet air-purged with a small auxiliary blower that will maintain the bonnet at a pressure above system pressure and thus avoid the ingress of flue gas inside the bonnet.

The bonnet serves as a gas tight enclosure for the blade while closed, traveling and in the open position. The bonnet is constructed of plate, suitably reinforced with a structural steel grid.

The continuous duty small auxiliary seal air blower for the bonnet offers significant savings in power consumption over an open bonnet design, which will require large amounts of purge air to prevent leakage to the atmosphere.

Testing

As a minimum, the dampers will be sufficiently assembled in the shop and ambient cycle tested to confirm operation.

Shipping Information

After shop inspection and testing and release by our Quality Assurance Manager, the equipment is match marked, disassembled, and prepared for shipment. The final drawings and manuals will include detailed instructions for field assembly of the equipment.

The equipment is delivered assembled to the greatest extent possible for reasonable shipping and handling. Components that could be damaged in transit and handling - such as actuators, auxiliary limit switches, and seal air fans (if supplied); are shipped separately. Installation of these components normally occurs after damper erection into the ductwork.

FGD INLET/BYPASS DAMPER	**Qty.**	**6**
Identification		later
Damper type		Guillotine (closed bonnet)
Nominal Dimension internal width x height	mm	3,658 x 3,658 [12’-0”x12’-0”}
Distance between flanges	mm	460 [18”]
Casing base material / thickness		Carbon steel / 3/8”
Casing cladding material / thickness		C-276 / 16Ga
Bonnet material / thickness		Carbon steel / 1/4” reinforced
Blades base material / thickness		Carbon steel / 3/8” and 1/4” (matrix construction)
Blades cladding material / thickness		C-276 / 16Ga
Seal material		C-276 or C-22
Shafts material		17-4ph SS
Bearing type		Pillow block, self-aligning, sleeve,
Seal type		Iso-Flex
Weight (including actuator)	kg	10,000
Counter flanges, nuts, bolts & gasket		Not Included
Foreseen insulation thickness (by others)	mm	150-300 (external)
Operating/Design Temperature	°C	49 to 177- / 200
Operating /Design Pressure	Pa (g)	later / ±6,500
Damper Pressure Drop when Open at Nominal Flow Conditions	Pa	Later
Sealing System Tightness	%	100 (with seal air running)
Operating/Design Required Seal Air flow	kg/h	later
Required Seal Air Pressure at Damper	Pa (g)	later
Seal Air Temperature	°C	177
Seal Air Valve		Actuator Driven c/w 2 proximity switches
Actuator type		Electric c/w local control panel, local remote selector and pushbuttons for open/closed
Function		Open/closed
Stroke Time	min	~4 minutes (not adjustable)
Emergency shut-down		DAMPER MUST STAY IN LAST POSITION on loss of electrical power
Limit switches	-	Inside the actuator and on idler shaft
Shipping, number of pieces		6 pieces plus actuator & accessories
Availability	%	99.5
Continuous operation		38 months

FGD OUTLET DAMPER	**Qty.**	**1**
Identification		later
Damper type		Guillotine (closed bonnet)
Nominal Dimension internal width x height	mm	6,400 x 6,400 [21'-0"x21'-0"}
Distance between flanges	mm	460 [18"]
Casing base material / thickness		Carbon steel / 3/8"
Casing cladding material / thickness		C-276 / 16Ga
Bonnet material / thickness		Carbon steel / 1/4" reinforced
Blades base material / thickness		Carbon steel / 3/8" and 1/4" (matrix construction)
Blades cladding material / thickness		C-276 / 16Ga
Seal material		C-276 or C-22
Shafts material		17-4ph SS
Bearing type		Pillow block, self-aligning, sleeve,
Seal type		Iso-Flex
Weight (including actuator)	kg	20,000
Counter flanges, nuts, bolts & gasket		Not Included
Foreseen insulation thickness (by others)	mm	150-300 (external)
Operating/Design Temperature	°C	49 to 177- / 200
Operating /Design Pressure	Pa (g)	later / ±6,500
Damper Pressure Drop when Open at Nominal Flow Conditions	Pa	Later
Sealing System Tightness	%	100 (with seal air running)
Operating/Design Required Seal Air flow	kg/h	later
Required Seal Air Pressure at Damper	Pa (g)	later
Seal Air Temperature	°C	177
Seal Air Valve		Actuator Driven c/w 2 proximity switches
Actuator type		Electric c/w local control panel, local remote selector and pushbuttons for open/closed
Function		Open/closed
Stroke Time	min	~4 minutes (not adjustable)
Emergency shut-down		DAMPER MUST STAY IN LAST POSITION on loss of electrical power
Limit switches	-	Inside the actuator and on idler shaft
Shipping, number of pieces		6 pieces plus actuator & accessories
Availability	%	99.5
Continuous operation		38 months

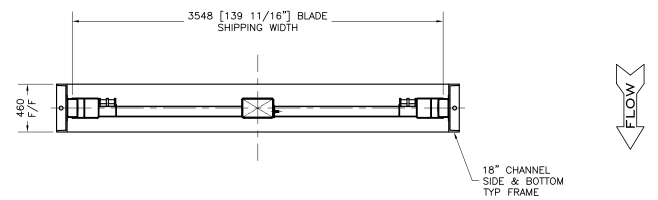
SEAL AIR SKID (INLET & BYPASS)	**Qty**	**3**
Identification		later
Number of Fans	1 + 1	Main & Stand-By
Number of Heaters	1	Electric
Backflow valves		included
Expansion joints		included
Seal air duct		Included up to a maximum 20m length
Instruments and Gauges		Differential Pressure Switch on Damper Temperature Gauge on Heater Outlet
Supply to Dampers	1	FGD Inlet or FGD Bypass
AIR IN Temperature	ºC	-20 to 35
AIR OUT Temperature	ºC	177
Operating / Installed Air Flow	Nm3/h	Later / 4925
Operating / Installed Electric Heater Power	kW	Later / 325
Nominal Pressure at Damper	Pa (g)	1250
Fan Motor Power	kW	15
Max. Noise Level at 1 meter	dBA	85
Pressure Drop Allowance for Seal Air Duct	Pa	500
Skid Footprint (W x L)	mm	2500x5000
Skid Weight	kg	2,500

SEAL AIR SKID (OUTLET)	**Qty**	**1**
Identification		later
Number of Fans	1 + 1	Main & Stand-By
Number of Heaters	1	Electric
Backflow valves		included
Expansion joints		included
Seal air duct		Included up to a maximum 10m length
Instruments and Gauges		Differential Pressure Switch on Damper Temperature Gauge on Heater Outlet
Supply to Dampers	1	FGD Outlet
AIR IN Temperature	ºC	-20 to 35
AIR OUT Temperature	ºC	177
Operating / Installed Air Flow	Nm3/h	Later / 4749
Operating / Installed Electric Heater Power	kW	Later / 311
Nominal Pressure at Damper	Pa (g)	1250
Fan Motor Power	kW	15
Max. Noise Level at 1 meter	dBA	85
Pressure Drop Allowance for Seal Air Duct	Pa	500
Skid Footprint (W x L)	mm	2500x5000
Skid Weight	kg	2,500

DESIGN DATA

DESIGN TEMPERATURE:	225°C [392°F]
OPERATING TEMPERATURE:	49 TO 177°C [120 TO 350°F]
AMBIENT TEMERATURE:	LATER
DESIGN PRESSURE STRUCTURAL:	±6500 Pa [±26"WC]
DESIGN PRESSURE:	±6500 Pa [±26"WC]
NORMAL OPERATING PRESSURE:	LATER
PRESSURE LOSS @ FULL OPEN:	<15 Pa TYP.
DESIGN FLOW:	LATER
OPERATING FLOW:	LATER
ESTIMATED WEIGHT:	10,000 KG [22,000 LBS]

ITEM	QTY	DRAWING No.	ITEM DESCRIPTION	MAT'L TYPE: TYPE	MAT'L TYPE: DESIGNATION	MATERIAL LIST DESCRIPTION
		-	FGD GUILLOTINE DAMPER	-	-	ASSEMBLY
1	1		LOWER FRAME	CS/C276		ASSEMBLY
2	1		BLADE ASSEMBLY	CS/C276		ASSEMBLY
3	1		DRIVE HOUSING	CS	-	ASSEMBLY
4	1		BONNET	CS	-	ASSEMBLY
5	1		ACTUATOR	ELECTRIC	ON-OFF	ASSEMBLY, SEE NOTE 6
6	1		LIMIT SWITCH ARRANGEMENT	-	-	ASSEMBLY, SEE NOTE 3
7	1		SEAL AIR VALVE C/W ACTUATOR	CS	-	ASSEMBLY
8	1		SEAL AIR SYSTEM	-	-	ASSEMBLY, NOT SHOWN
9	1		DIFFERENTIAL PRESSURE SWITCH	-	-	ASSEMBLY
10	1		ID TAG	SS	-	BACHMANN STANDARD



SECTION B—B

NOTES:

1) ALL DIMENSIONS ARE IN MILLIMETERS [INCHES], UNLESS NOTED.

2) QUANTITES SHOWN IN BOM FOR (1) DAMPER, TOTAL OF SIX (6) DAMPERS REQUIRED AS SHOWN.

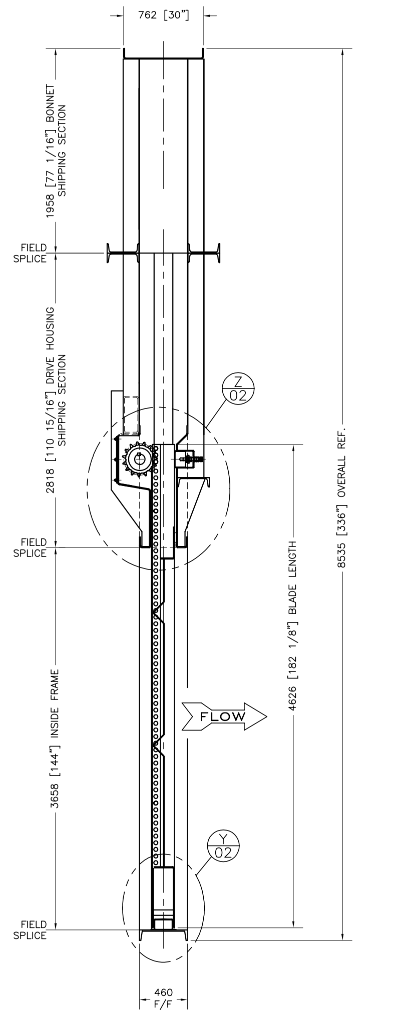
3) THREEE (3) OPEN & THREE (3) CLOSED LIMIT SWITCHES.

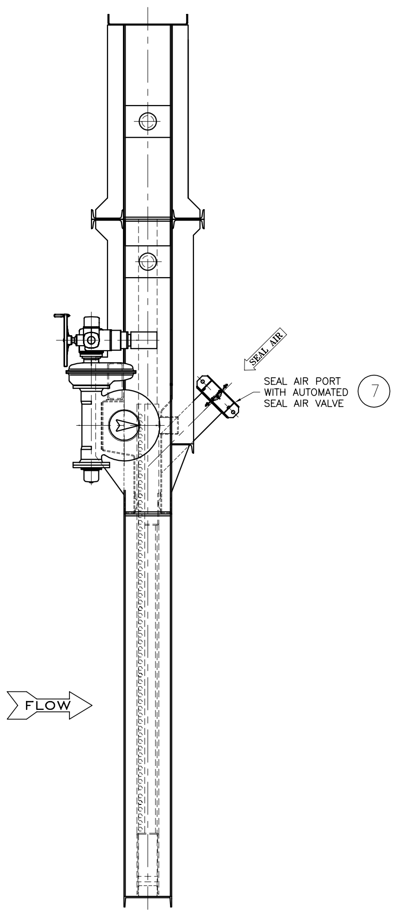
4) DAMPER FRAME SHIPPED IN 6 SECTIONS AS SHOWN. ACTUATOR ASSEMBLY AND SEAL AIR SYSTEM SHIPPED SEPARATELY.

5) EXTERNAL CARBON STEEL PARTS:
SURFACE TREATMENT SAND BLASTED SA 2½ ISO 8501
PRIMARY COAT ZINC RICH IN ETHYL SILICATE,
MINIMUM THICKNESS 75 MICRONS (DRY EXTRACT).
INTERNAL STEEL SURFACES NOT PAINTED.
ACTUATORS AND INSTRUMENTS AS PER THE MANUFACTURER'S STANDARD.

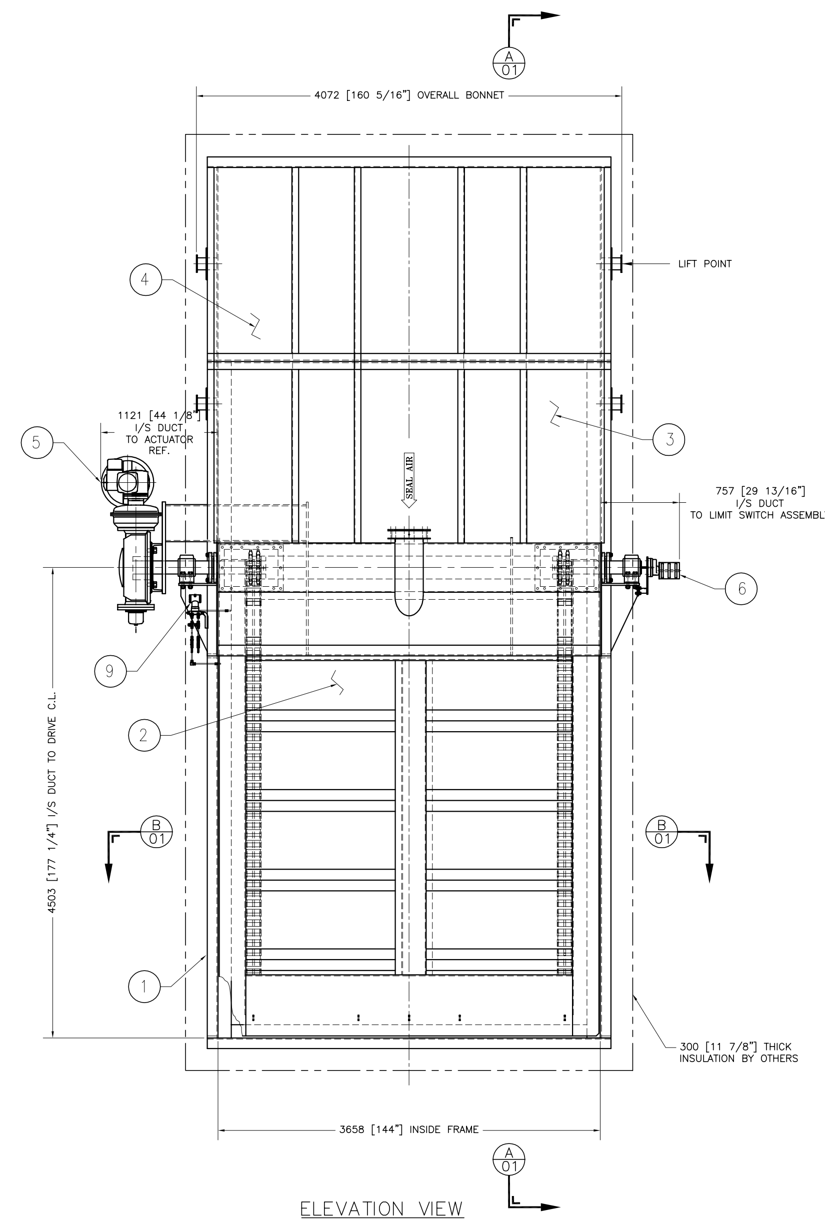
6) ACTUATOR ASSEMBLY:
ACTUATOR/GEARBOX TO BE AUMA SA25.1–45B/GSD250
AUMATIC + SEMIPACT C/W INTEGRAL CONTROLS, LOCAL/REMOTE SELECTOR, INDICATOR LIGHTS AND LOCAL PUSH BUTTONS.
EMERGENCY HANDWHEEL
MOTOR: 8KW, 575V/3PH/60HZ, 15 MIN. DUTY CYCLE
STROKE TIME: APPROX. 4 MINUTES

7) MATERIAL LIST C276 REPRESENTS A FAMILY OF MATERIALS THAT CAN BE USED INTERCHANGEABLY, INCLUDING ALLOY C276, DIN 2.4819, ENiCrMo–4, UNS N10276.

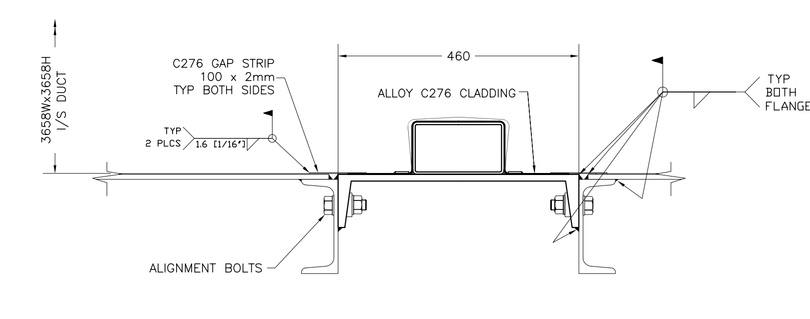




SECTION A—A



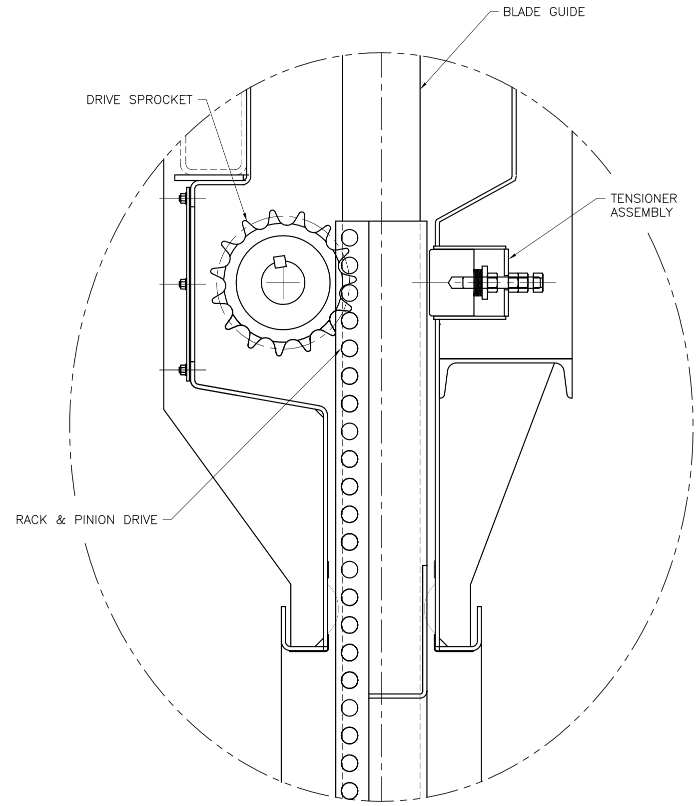
ELEVATION VIEW
FLOW OUT OF PAPER



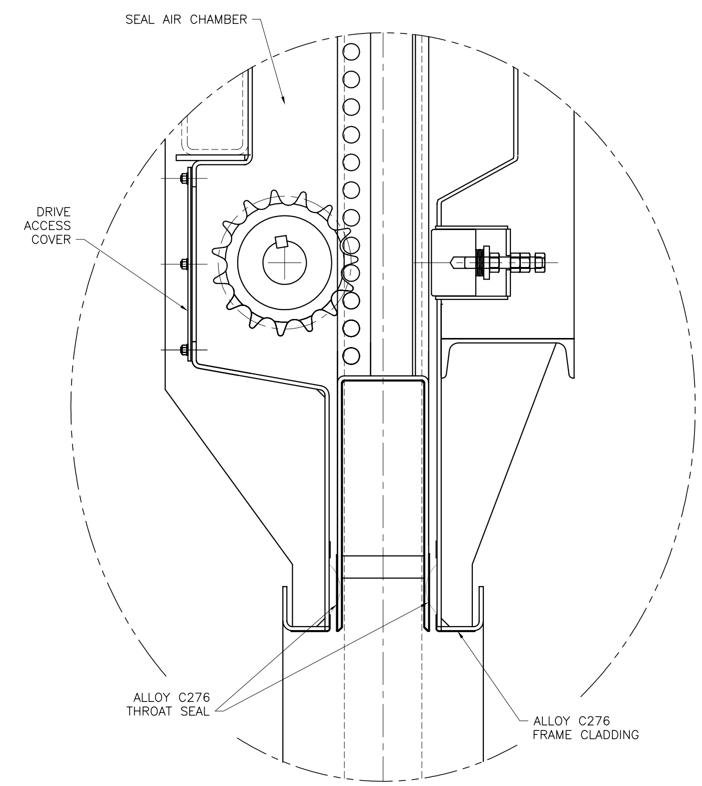
TYPICAL FRAME SECTION
SCALE 1:10

DRN	LFP — 11SEP08
SHEET	1 OF 2
MAT'L	REF. BILL OF MAT'L
FINISH	PROPOSAL DRAWING
SCALE	CAD
CUSTOMER/PROJECT	HOLYROOD FGD NLF & LABRADOR HYDRO
TITLE	FGD GUILLOTINE DAMPER 12'x12' GENERAL ARRANGEMENT
NUMBER	0-0523-01
REV	0

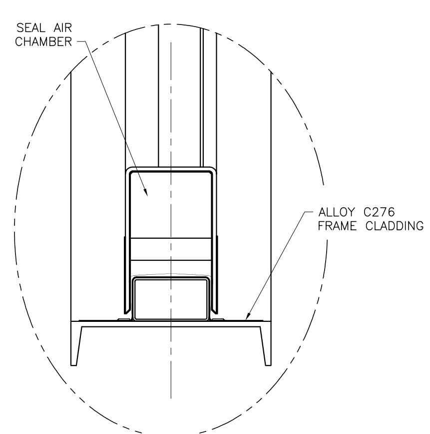
Bachmann Industries Inc.



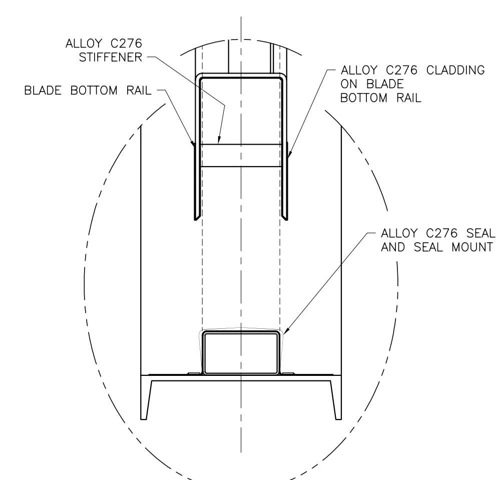
DETAIL Z
(BLADE CLOSED)
SCALE 1:6



DETAIL Z
(BLADE OPEN)
SCALE 1:6



DETAIL Y
(BLADE CLOSED)
SCALE 1:6



DETAIL Y
(BLADE PARTIALLY OPEN)
SCALE 1:6

ZONE	LTR	DESCRIPTION	BY	DATE	CHK'ED	DATE	APP'ED	DATE
REVISIONS								

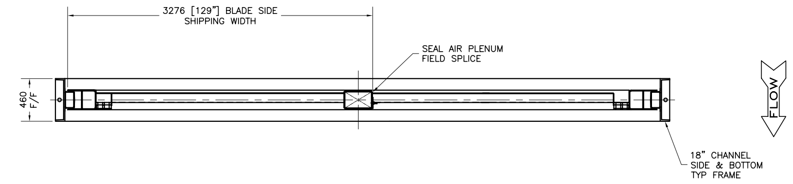
UNLESS STATED: DO NOT SCALE PRINT, DIMENSIONS APPLY TO AFTER FINISHED CONDITION, REMOVE ALL SHARP EDGES & BURRS. DIMENSION TOLERANCES ARE AS FOLLOWS: ±1/8 [3] UP THROUGH 36" [914] INCLUSIVE. ±1/4" [6] ABOVE 36" [914] THROUGH 144" [3658] INCLUSIVE. ±3/8" [10] ABOVE 144" [3658]	INITIALS	DATE	THIS DRAWING AND ALL INFORMATION IN IT'S ENTIRETY IS OWNED BY BACHMANN INDUSTRIES INCORPORATED. IT IS NOT TO BE SHARED, COPIED, DISTRIBUTED OR USED IN ANY WAY OR MANNER DETRIMENTAL TO THE INTERESTS OF BACHMANN INDUSTRIES INC.	SHEET 2 OF 2	Bachmann Industries Inc.
	DWN LFP	11SEP08		MAT'L REF. BILL OF MAT'L	TITLE FGD GUILLOTINE DAMPER 12'x12' DETAILS
	CHK		CUSTOMER/PROJECT HOLYROOD FGD NFL & LABRADOR HYDRO	FINISH PROPOSAL DRAWING	NUMBER 0-0523-01 REV 0
	APP			SCALE CAD	

FORM ID: BOR-D.DWG 21JUN02

DESIGN DATA

DESIGN TEMPERATURE:	225°C [392°F]
OPERATING TEMPERATURE:	49 TO 177°C [120 TO 350°F]
AMBIENT TEMERATURE:	LATER
DESIGN PRESSURE STRUCTURAL:	±6500 Pa [±26"WC]
DESIGN PRESSURE:	±6500 Pa [±26"WC]
NORMAL OPERATING PRESSURE:	LATER
PRESSURE LOSS @ FULL OPEN:	<15 Pa TYP.
DESIGN FLOW:	LATER
OPERATING FLOW:	LATER
ESTIMATED WEIGHT:	20,000 KG [44,000 LBS]

ITEM	QTY	DRAWING No.	ITEM DESCRIPTION	MAT'L TYPE		MATERIAL LIST DESCRIPTION
				TYPE	DESIGNATION	
		-	FGD GUILLOTINE DAMPER	-	-	ASSEMBLY
1	1		LOWER FRAME	CS/C276		ASSEMBLY
2	1		BLADE ASSEMBLY	CS/C276		ASSEMBLY
3	1		DRIVE HOUSING	CS	-	ASSEMBLY
4	1		BONNET	CS	-	ASSEMBLY
5	1		ACTUATOR	ELECTRIC	ON-OFF	ASSEMBLY, SEE NOTE 6
6	1		LIMIT SWITCH ARRANGEMENT	-	-	ASSEMBLY, SEE NOTE 3
7	1		SEAL AIR VALVE C/W ACTUATOR	CS	-	ASSEMBLY
8	1		SEAL AIR SYSTEM	-	-	ASSEMBLY, NOT SHOWN
9	1		DIFFERENTIAL PRESSURE SWITCH	-	-	ASSEMBLY
10	1		ID TAG	SS	-	BACHMANN STANDARD



SECTION B–B

NOTES:

1) ALL DIMENSIONS ARE IN MILLIMETERS [INCHES], UNLESS NOTED.

2) QUANTITES SHOWN IN BOM FOR (1) DAMPER, TOTAL OF ONE (1) DAMPER REQUIRED AS SHOWN.

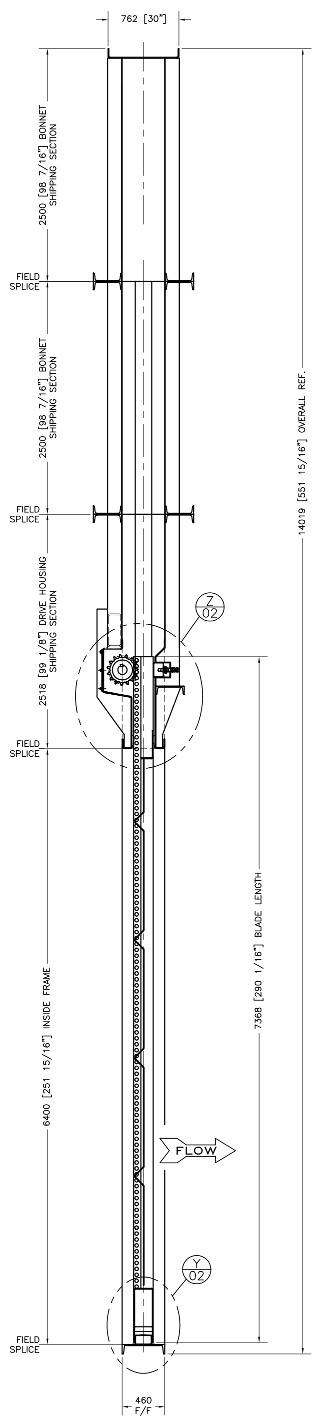
3) THREEE (3) OPEN & THREE (3) CLOSED LIMIT SWITCHES.

4) DAMPER FRAME SHIPPED IN 8 SECTIONS AS SHOWN. ACTUATOR ASSEMBLY AND SEAL AIR SYSTEM SHIPPED SEPARATELY.

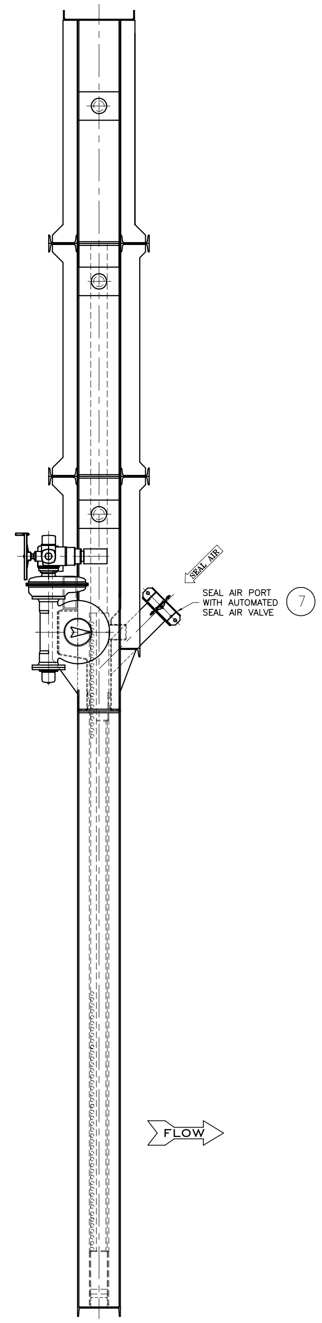
5) EXTERNAL CARBON STEEL PARTS:
SURFACE TREATMENT SAND BLASTED SA 2½ ISO 8501
PRIMARY COAT ZINC RICH IN ETHYL SILICATE,
MINIMUM THICKNESS 75 MICRONS (DRY EXTRACT).
INTERNAL STEEL SURFACES NOT PAINTED.
ACTUATORS AND INSTRUMENTS AS PER THE MANUFACTURER'S STANDARD.

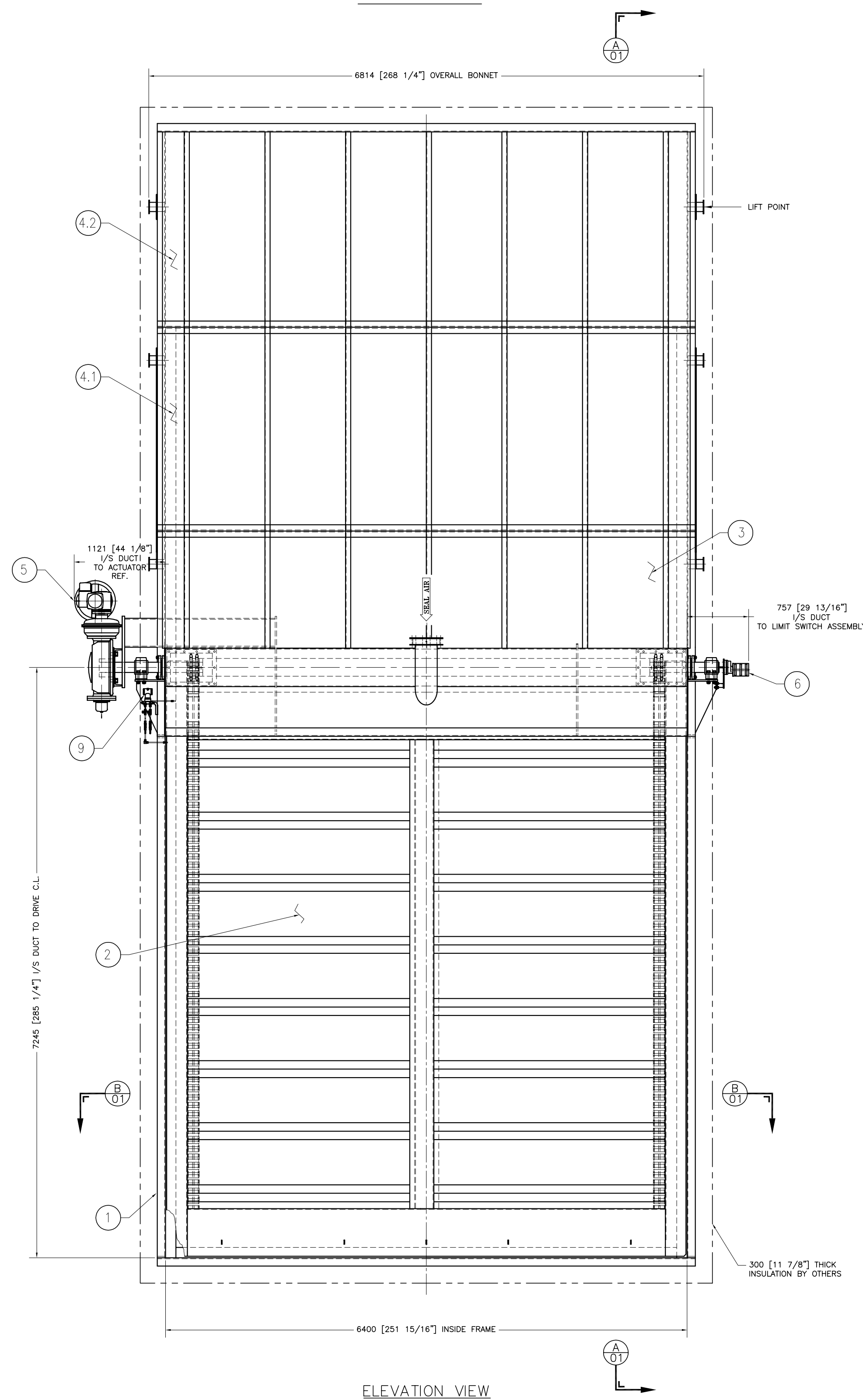
6) ACTUATOR ASSEMBLY:
ACTUATOR/GEARBOX AUMA SA30.1–90B/GSD315
AUMATIC + SEMIPACT C/W INTEGRAL CONTROLS, LOCAL/REMOTE SELECTOR, INDICATOR LIGHTS AND LOCAL PUSH BUTTONS.
EMERGENCY HANDWHEEL
MOTOR: 30KW, 575V/3PH/60HZ, 15 MIN. DUTY CYCLE
STROKE TIME: APPROX. 4 MINUTES

7) MATERIAL LIST C276 REPRESENTS A FAMILY OF MATERIALS THAT CAN BE USED INTERCHANGEABLY, INCLUDING ALLOY C276, DIN 2.4819, ENiCrMo–4, UNS N10276.

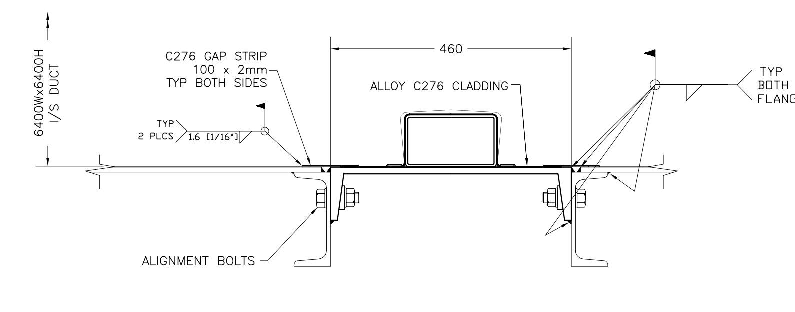


SECTION A–A



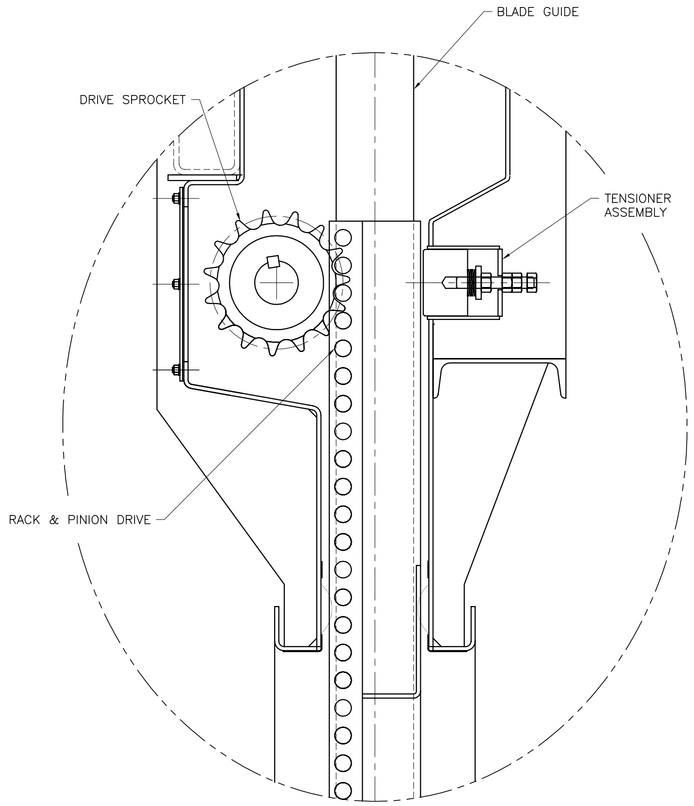


ELEVATION VIEW
FLOW OUT OF PAPER

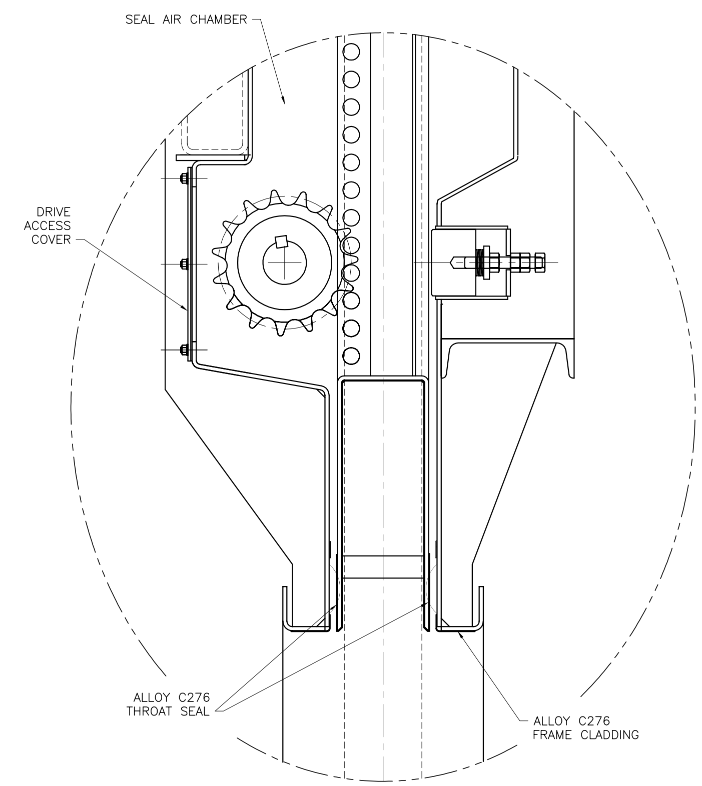


TYPICAL FRAME SECTION
SCALE 1:10

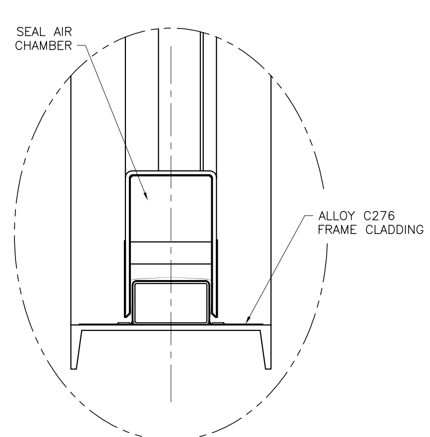
DRN	LFP 11SEP08
CUSTOMER/PROJECT	HOLYROOD FGD NLF & LABRADOR HYDRO
SHEET	1 of 2
MAT'L	REF. BILL OF MAT'L
FINISH	PROPOSAL DRAWING
SCALE	CAD
	Bachmann Industries Inc.
TITLE	FGD GUILLOTINE DAMPER 21'x21' GENERAL ARRANGEMENT
NUMBER	0–0523–02
REV	0



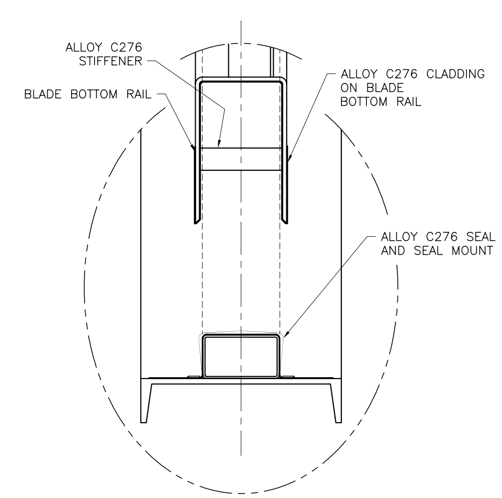
DETAIL Z
(BLADE CLOSED)
SCALE 1:6



DETAIL Z
(BLADE OPEN)
SCALE 1:6



DETAIL Y
(BLADE CLOSED)
SCALE 1:6



DETAIL Y
(BLADE PARTIALLY OPEN)
SCALE 1:6

ZONE	LTR	DESCRIPTION	BY	DATE	CHK'ED	DATE	APP'ED	DATE

REVISIONS

UNLESS STATED: DO NOT SCALE PRINT, DIMENSIONS APPLY TO AFTER FINISHED CONDITION, REMOVE ALL SHARP EDGES & BURRS. DIMENSION TOLERANCES ARE AS FOLLOWS: ±1/8 [3] UP THROUGH 36" [914] INCLUSIVE. ±1/4" [6] ABOVE 36" [914] THROUGH 144" [3658] INCLUSIVE. ±3/8" [10] ABOVE 144" [3658]

	INITIALS	DATE
DWN	LFP	11SEP08
CHK		
APP		

CUSTOMER/PROJECT: HOLYROOD FGD, NFL & LABRADOR HYDRO

SHEET 2 OF 2

MAT'L: REF. BILL OF MAT'L

FINISH: PROPOSAL DRAWING

SCALE: CAD

Bachmann Industries Inc.

TITLE: FGD GUILLOTINE DAMPER 21'x21' DETAILS

NUMBER: 0-0523-02

REV: 0

FORM ID: BOR-D.DWG 21JUN02

TLT CO-VENT

The New York Blower Company®

Sales Head Office
TLT CO-VENT Fans Inc.
684 Belmont Ave. W. Suite 302
Kitchener, ON
Canada N2M 1N6

Tel: (519) 884-7788 Ext. 201
Toll Free: (888) 244-7644
Fax: (519) 884-7588
Email: dmckinnon@tltcovent.com
Web : www.tltcovent.com

TO:	*Stantec- Unit 1,2 Holyrood*	***DATE:***	*August 01, 2008*
ATT:	*Marc Voisine*	***FROM:***	*Danny McKinnon, MBA, P.Eng. Vice President Sales & Marketing TLT CO-VENT Fans Inc.*
TEL:	*506 452-7000ext 1214*		
FAX:	*506 452-0112*		
CC:	*Claire Daoust*	*Number of pages including cover sheet*	*5 + 4 Curves & Dwg. Etc. 4 T&C*

REMARKS: ☒ *Via Email* ☐ *Via Fax*

Ref: Your: Request for Budget ID fan prices Holyrood Unit 1-3
Our: W080722C

Marc,

The following is our budget proposal for the ID fans required in your project. Please note the following important points:

Fans are c/w following features:

- DWDI (Double Width, Double Inlet) Airfoil design wheel selected at 1180 rpm.
- Dodge Sleeve bearings arranged for circulating oil lubrication
- Howard Marten Circulating oil system with dual pumps, dual filters, single air-cooled heat exchanger, local control panel and control valves and flow meter at bearings with flex hoses and drain vent (supplied loos) The piping between the lube system and the fans to be supplied and installed by others.
- Flender Rupex Resilient Coupling, model: RWS 560, 2.0 S.F. with guard suitable for variable frequency drive application
- Conical Variable Inlet Vanes (VIV) with internal moving parts protected by removable covers. The VIV has been designed with dorsal fins, overlapping vanes for low leakage and LM 800 solidlube bearings.
- CPI automation pneumatic actuator rated at 80 psig and with filter regulator, heater, positioner with feedback and fail closed/open on loss of signal or loss of air.
- Analysis includes FEA static & Dynamic analysis as well as bump test to check for rotor natural frequencies.
- 2700 hp 60/3/4160V 1200 rpm 1.0 SF WPII motor suitable for DL or VFD operation with antifriction bearings, winding and bearing RTD's and velocity pick-ups (1) per bearing.
- 2700 hp 60/3/4160v Variable Torque VFD with NEMA 1 enclosure , air-cooled design and integral transformer and switchgear.
- We have only run the data for unit1 & 2 fans. If the fans will be variable speed controlled it is possible to make all fans for units 1-3 identical with the variance in required duty accomplished by speed regulation.

Enclosures include:

- o Price Schedule

TLT CO-VENT

- Exceptions and Comments to Inquiry Documents
- Scope of Supply
- Fan Data Sheet
- Fan Performance Curve and Speed Torque Curve
- Fan Sound Data Sheet
- Outline Dimension Sketch of the Fan and Evase
- TLT CO-VENT Terms and Conditions and Service Rate sheet

Please contact either me or Claire Daoust (450) 441-3233 in our Montreal office if you require any further information at this time.

Best regards,
TLT CO-VENT Fans Inc.

Danny McKinnon, MBA, P.Eng.
Vice President Sales & Marketing

TLT CO-VENT

Pricing Data–

Fan System	ID Unit 1&2
Fan Model	A40D-9900 DWDI-1185
	$CDN per fan
Basic Fan, arr #3, centrehung with independent pedestals and soleplates	$270,607
Accessories and Options	
• Sleeve bearings, Oil-Ring, arranged for circulating oil lubrication	8,602
• Circulating oil lubrication system for sleeve bearings c/w dual pumps, dual filters, air-cooled heat exchanger and local control panel. All devices wired to Common junction box on lube skid. *Interconnecting piping between bearings and lube system provided by others.*	60,300
• Shaft seal, single carbon ring shaft seal	6,996
• Flender Rupex Resilient Coupling, model: RWS 560, 2.0 S.F. with guard, max motor bore: 8.268" with guard ***(max motor bore: 8.268")***	16,186
• G2.5 Tolerance Dynamic Balance	1,096
• Rotor thermal stress relief	2,070
• Hinged access doors with wingnuts	621
• Partial blade and full junction liners of 3/16in QT100	20,836
• Variable Inlet Vanes (VIV): for control of fan, designed with dorsal fins, overlapping vanes for low leakage and LM 800 solidlube bearings (conical design). Designed for automatic control with pneumatic actuator.	46,349
• CPI Automation Pneumatic Actuator: for control of VIV, based on 80psi air supply, modulating 4-20mA and feedback c/w (2) limit switches, linkage for automatic operation.	26,277
• 2700 hp 60/3/4160V 1200 rpm 1.0 SF WPII motor suitable for DL or VFD operation with antifriction bearings, winding and bearing RTD's and velocity pick-ups (1) per bearing and soleplates	173,135
• 2700 hp 60/3/4160v Variable Torque VFD with NEMA 1 enclosure , air-cooled design and integral transformer and switchgear	531,787
• Jacking screws and dowel pin pilot holes for alignment of bearings and motor	495
• SP6 Surface Prep, (1) Coat TLT CO-VENT standard primer and finish on all external surfaces of fan Internal surfaces SP3 prep and (1) coat primer only	8,200
• Insulation pins for customer supplied acoustic insulation/cladding	2,364
• IRD 9842v loop powered velocity pick-ups with 4-20 mA transmitter and 5m long blunt cut cable. (1) per bearing monitor by others	3,685
• Rosemount RTD 100ohm, Series 68 (4 wire) platinum spring loaded c/w aluminum connection head, T/C Smart HART transmitter (series 248), monitor by others	2,895
• Flexible connections: inlet and outlet of fan, (acoustic design) including deflectors.	26,818
• NDE, project management, FEA and Bump Test	16,923
• Packing for domestic shipment	Included
Sub-Total per unit FCA TLT CO-VENT Plant	**$1,226,242**

Terms and Conditions of Sale

- **Funds:** Prices are in Canadian dollars FCA TLT CO-VENT Plant Quebec, CAN, (Freight and Tax extra)
- **Terms:** TLT CO-VENT Fans Inc. Terms and Conditions of Sale shall apply
- **Validity:** This quotation is valid for acceptance for thirty (30) days.
- **Warranty:** 12 mo. from start-up or 18 mo. from shipment as per clause XI of TLT CO-VENT T&C
- **Payment:**
  - 10% of total contract value upon issue of outline drawings for review
  - 15% of total contract value upon completion of engineering and shop drawings
  - 35% of total contract value upon receipt of major materials at TLT CO-VENT shop
  - 40% of total contract value upon net 30 days from shipment or readiness to ship.
- **Drawings:** 6-8 weeks after order.
- **Shipment:** 38-46 weeks after approval of drawings.
- **Field Service:** is extra at the rates as specified on the enclosed rate sheet.

TLT CO-VENT

Scope of Supply

TLT CO-VENT Inc. will supply fans as specified on the enclosed Technical Data Sheet, complete with the following features and accessories:

Arrangement
- Arr. 3, Independent bearing pedestals c/w separate soleplates, Centrehung rotor

Rotor
- Type "A" Airfoil bladed wheel
- AISI1045 steel shaft
- Rotor completely assembled and balanced, statically and dynamically to ANSI S2.19 level G2.5
- Shrink fit, bolted hub to rotor connection
- Shaft seal, single carbon ring shaft seal (HRS Housing)
- Partial blade and full junction liners of 3/16in AR steel backing

Housing
- Heavy-duty casing, stiffened as required to result in low deflection, sideplate to scroll joint is stitch welded on inside and continuous welded on outside
- Hinged access doors with wingnuts
- Bolted splits for shipping and rotor removal
- Heat resistant flange gaskets at splits only bolts and gaskets to connect to system ducts by others
- Continuous welding of stiffeners to housing welds
- Jacking screws and dowel pin pilot holes for alignment of bearings and motor
- Independent bearing pedestals c/w separate soleplates, Centrehung (Arrangement 3)
- Insulation pins for customer supplied acoustic insulation/cladding

Coupling and Bearings
- Flender Rupex Resilient Coupling, model: RWS 560, 2.0 S.F. with guard, max motor bore: 8.268"
- Two (2) Dodge sleeve bearings arranged for circulating oil

Painting
- SP6 Surface Prep, (1) Coat TLT CO-VENT standard primer and finish on all external surfaces of fan Internal surfaces SP3 prep and (1) coat primer only

Accessories
- *Variable Inlet Vanes (VIV):* for control of fan, designed with dorsal fins, overlapping vanes for low leakage and LM 800 solidlube bearings (conical design). The radial bladed VIV mounts directly on the fan inlet flange is designed for automatic control of the fan with pneumatic actuator.
- *CPI Automation Pneumatic Actuator:* for control of VIV, based on 80psi air supply, modulating 4-20mA and feedback c/w (2) limit switches, linkage for automatic operation.
- *Motor:* 2700 hp 60/3/4160V 1200 rpm 1.0 SF WPII motor suitable for DL or VFD operation with antifriction bearings, winding and bearing RTD's and velocity pick-ups (1) per bearing and soleplates
- Rosemount RTD 100ohm, Series 68 (4 wire) platinum spring loaded c/w alumium connection head, T/C Smart HART transmitter (series 248), monitor by others
- IRD 9842v loop powered velocity pick-ups with 4-20 mA transmitter and 5m long blunt cut cable. (1) per bearing monitor by others
- *Flexible connections:* inlet and outlet of fan, (acoustic design) including deflectors.
- Circulating oil lubrication system for sleeve bearings c/w dual pumps, dual filters, air-cooled heat exchanger and local control panel. All devices wired to Common junction box on lube skid. *Interconnecting piping between bearings and lube system provided by others*

TLT CO-VENT

Fan Service: ID

Performance Data – *@ Sea Level with Evase of 48.18ft² supplied by others*

Fan Blade Type		**Airfoil**	
Fan Model		**A40D-9900**	
Condition	Units	Test Block	MCR
Mass Flow Rate	lb/hr	926,640	772,200
Inlet Volume Flow Rate	acfm	358,182	284,258
Inlet Temperature	°F	375	350
Inlet Density	lb/ft³	0.0431	0.0453
Inlet Static Pressure	in.wg	-34.69	-27.75
Outlet Static Pressure	in.wg	0.00	0.00
Static Pressure Rise	in.wg	34.69	27.75
Total Acc losses: VIV, InBox	in.wg	-4.286	-2.834
Fan Speed	rpm	1,185	1,185
Power Consumption by VIV	hp	2,490	1,880
Static Rise Efficiency by VIV	%	85.3%	71.1%
Approximate VIV Angle	°	90	46
Fan Speed	rpm	1,185	1,006
Power Consumption by VIV	hp	2,490	1,544
Static Rise Efficiency by VIV	%	85.3%	86.5%
Approximate VIV Angle	°	90	90

*Efficiency calculation is based on the absolute pressure rise of the fan = fan external pressure rise + fan accessory losses.

Technical Data-

Fan Model		**A40D-9900**
Blade Type		Airfoil
Width		DWDI
Arrangement		3, centrehung
Evase Area	ft²	48.18
Nominal Wheel Diameter	in	99
Mechanical Design Temp.	°F	500
Mechanical Design rpm	rpm	1,185
Tip Speed	ft/min	30,713
Rotor Weight	lb	15,996
Rotor Inertia (wk²)	lb.ft²	51,836
Blade Material/Thickness	in	A514S / 3/16 (each skin)
Blade Liner Material/Thickness	in	Partial blade and full junction liners of 3/16in AR steel backing
Shaft Material/Thickness	in	AISI1045 / 15 7/8
Critical Speed Ratio/First Critical Speed	rpm	1.58 / 1,872
Bearing Type/Diameter	in	Sleeve / 6 in.
Bearing Lubrication		Oil-Ring, Water Cooled
Housing Material/Thickness	in	A36 / Scroll = 3/8 A36 / Sideplate = 3/8
Coupling		Flender Rupex Resilient Coupling, model: RWS 560, 2.0 S.F. with guard, ***max motor bore: 8.268"***
VIV Torque Required at -4°F	lb.ft	50
Actuator for VIV		CPI Automation pneumatic actuator, sized for 80psi
Estimated Weight	lb	Fan = 47,389 Motor = 14,000
Minimum Recommended Motor Size	hp	2,700

** Data is subject to change during engineering phase at TLT CO-VENT Fans Inc.*

(Stantec) BMS Upgrade

Newfoundland & Labrador Hydro
Holyrood, Newfoundland/Labrador,
A0A 2R0 Canada

Proposal No: MPC-1008-02296
Proposal Date: 10/10/2008

Confidentiality Statement

This document contains Invensys proprietary information. Duplication and/or circulation beyond those for whom the proposal was prepared can only be done with the written permission of Invensys.

This proposal is for budgetary purposes only. Estimates are based only on information detailed in this specification and are subject to change with modifications in scope including quantities of I/O. Standard Invensys Systems, Inc. Terms and Conditions are applicable. Applicable taxes are not included in the prices shown.

Invensys Process Systems

Jeffery Smith
902 221-0484

jeffery.smith@ips.invensys.com

EXECUTIVE SUMMARY

Invensys Systems is pleased to provide this proposal package in response to your request for an automation solution. We believe the Invensys implementation of the Foxboro IA Series Automation Platform can play a key role in meeting your facility's needs for the immediate project. Equally important, Invensys would welcome the opportunity to become your automation partner and work with you to meet future demands and issues that come up as part of managing your plant.

Our sales team used the information from our discussions to develop this proposal. We appreciate your consideration and want to remind you of the solid value available with an Invensys solution. We provide engineering support from our many engineering centers located strategically throughout the world. This helps to lower risk and raise return associated with our short term and long term performance goals as follows:
1. Invensys' unparalleled success supplying customer's automation solutions
2. Experienced engineers familiar with your industry
3. Extensive global customer list of IA Series installations
4. Largest installed base of any DCS supplier which increases the trained personnel pool to draw from in the future....lowers costs!
5. Proven service/maintenance program that prevents obsolescence of the base system and promotes inclusion of newest technologies....lowers both risk and costs!

We have the industry leading support programs and people's expertise. We have a vision and track record of helping customers lower operating costs and reach new production/safety goals through automation and advanced services. The value items noted above help make you successful in terms of economic performance and increases the Return on Investment everyday. If its ROI and ROA that is important to your operation, then please seriously consider the Invensys!

Please do not hesitate to contact us if you have any questions regarding this estimate. We are excited to have the opportunity to work you. We look forward to your evaluation and continuing discussions.

IPS
INVENSYS PROCESS SYSTEMS

DESCRIPTION OF PRODUCTS AND SERVICES

Customer Information:

Qty	Description
-	**I/A Series DCS**
200	Analog Inputs - 4-20 Isolated (201)
100	Analog Outputs - 4-20 (237)
1000	Digital Inputs - Contact - Isolated (207)
500	Digital Outputs - 5 AMP Dry Contact (242)

WorkStations:

Qty	Description
-	**(Qty. 1) Engineering Station**
1	P92 Windows Engineering Station Version 8 - Windows Engineering Workstation including required cables and the following software: V8.x Windows XP Media Kit, FoxView/FoxDraw V10.x For Windows, IACC V2.0, FoxSFC Version 1.1, SysDef Software V2.x.
1	Two 20" LCDs - The workstation monitors are the primary operator interface. Speakers are included provide the I/A System Audible Alarm functions. The Flat Panel Liquid Crystal Display (LCD) Monitors provided are two 20" LCDs. Monitors include required cables.
1	S10 Software Suite License - Includes software suite license for Windows based workstations with a 1000 Analog IO point maximum, 1000 Digital IO point maximum, redundant networking, operator displays, hosting services, and IACC Configuration Tools.
-	**(Qty. 2) Operator Station**
2	P92 Windows Operator Station Version 8 - Windows Operator Workstation includes required cables and V8.x Windows XP Media Kit.
2	Two 20" LCDs - The workstation monitors are the primary operator interface. Speakers are included provide the I/A System Audible Alarm functions. The Flat Panel Liquid Crystal Display (LCD) Monitors provided are two 20" LCDs. Monitors include required cables.
2	S10 Software Suite License - Includes software suite license for Windows based workstations with a 1000 Analog IO point maximum, 1000 Digital IO point maximum, redundant networking, operator displays, hosting services, and IACC Configuration Tools.

Prepared For: Newfoundland & Labrador Hydro	Date:10/10/2008
Inquiry: (Stantec) BMS Upgrade	Page 4
Proposal No.: MPC-1008-02296	

-	**(Qty. 1) AIM*Historian SW Package**
1	AIM Historian Software 2000 Points - AIM*Historian provides enterprise-wide capability for collection, storage, and retrieval of historical process information. This licenses AIM*Historian package to collect 2000 points of data.

Controllers:

Qty	Description
5	FCP270 Redundant - FCP270 - Fault tolerant base plate mounted control processor. Control network and fieldbus network connections are 100 Mbps fiber optic. Includes required cables and fault tolerant connectors. Includes I/A Series Control software license.
5	S61 Redundant Control Small V8 - Includes I/A Series Control license supporting up to 50 AI, 50 AO, 200 DI and 100 DO.

I/O Modules:

Qty	Description
25	Hardwired Channel Isolated Analog Input - FBM201 - On a per card basis, supports up to 8 isolated input 4-20 mA signals, suitable to be mounted on a baseplate. Provides per channel loop power with per channel isolation. Includes a 1 meter cable and termination assembly per card.
13	Hardwired Analog Output - FBM237 - On a per card basis, supports up to 8 - 4-20 mA output signals, suitable to be mounted on a baseplate. Loop power is provided.
63	Hardwired Isolated Digital Input - FBM207 - On a per card basis, supports up to 16 two wire discrete digital Inputs, suitable to be mounted on a baseplate. Includes 1 meter cable and termination assembly per card.
32	Hardwired Digital Output - FBM242 - On a per card basis, supports up to 16 two wire discrete digital outputs, suitable to be mounted on a baseplate. Includes 1 meter cable and termination assembly per card.

Enclosures:

Qty	Description
5	I/O Enclosure - Consists of a sealed NEMA12 painted metal construction. Provides for a maximum of 32 module slots on up to 4 vertical baseplates with accessible front and rear doors. Vertical DIN rails for mounting baseplates, power supplies and termination assemblies.
1	Equipment Enclosure - Sealed NEMA12 enclosure with painted metal construction. Provides for mounting of switches, hubs, and other associated equipment. Front and rear accessible with utility outlet strip for 120Vac power.

Peripherals:

Qty	Description
1	Alarm Impact Printer - InFusion - Wide carriage, seven color, 24 pin impact printer for alarm logging. For use on 120 Vac systems. Has both serial and parallel interfaces. Supersedes P0913AV.

Control Network:

Qty	Description
1	Fiber-Ethernet Switch Pair - Redundant Fiber-Ethernet switch Pair with 24 Ports each, 10/100Base-Tx mounted and wired in a separate enclosure.

Base Configuration Engineering Services

Project Management

Project Management Services provides you with a single point of contact to manage all Invensys activities required to implement the project scope as defined in this document. Activities include planning, monitoring and reporting on the status of all hardware and services included in your order or contract. A monthly progress report which includes, when necessary, pertinent information on the following topics: Project schedule progress, Application engineering design activities, Manufacturing status, Invensys action items, Newfoundland & Labrador Hydro action items, and Commercial issues.

System/Configuration Engineering

Human Interface Configuration

Invensys will work with Newfoundland & Labrador Hydro to define the complete requirements for the human interface configuration work. It will include the definition and documentation of the graphic / display primitives, where possible existing Invensys primitives will be used. This activity will also define user access to the system.

The standard display suite consists of the following:

1. Overview display: consists of a general view of the controlled process and/or plant overview. It contains the more important control values, but does not allow for any control of the process.
2. Process display: consists of the graphic representation of the plant and/or the P&ID. It allows for the control of the process and also navigation through the process.
3. Trend display: consists of two half-page trends, which in return gives you 8 pens. The trend display can be configured on-line if required.
4. Group display: consists of a group of standard controller/motor/indicator or valve control overlays. Up to 15 overlays could fit in one display.
5. Overlays: consists of an interface to monitor or control the process. Overlays are based on the Invensys standards and one overlay exists for each block type.

Displays will be built from print screens, template or hand-sketches to be provided by Newfoundland & Labrador Hydro.
This proposal includes the following:

Qty	Description
20	Process Displays
10	Trend Displays
35	Overlays

Please note, for cost effectiveness, the review and approval of the graphics will be done via an on-line based collaboration tool that allows the customer to see graphics displayed directly in a browser.

Controls Configuration
This service includes configuration of the I/A series regulatory control and working with Newfoundland & Labrador Hydro the instrument index and control design input. Activities include implementation in the control configurator and design verification by open loop testing and design review. The regulatory control design includes configuration of standard I/O blocks to support indication, standard PID control, cascade control, and alarming of process measurements and control strategies defined by the existing P&ID's. The point count used for pricing of control configuration as defined in the customer information section above.

In order to develop the control database, it is assumed that Newfoundland & Labrador Hydro will provide the following Engineering Design items: P&ID's, or SAMA's and logic diagrams; I/O list in an electronic database, an MS Access or Excel format; There should be sufficient information in the database to be able to configure the control system; Control description narratives, if available; Any special calculations required for the Control System. It is assumed that all documentation supplied from site accurately reflects the current situation of the operating unit.

Device Interface Configuration
The interface to the third party devices will be done through either our serial FBM or our Ethernet based FBM. This service includes the configuration of the Invensys built module. The configuration of the third party devices is the responsibility of Newfoundland & Labrador Hydro. The gateway documentation will consist of transfer tables. No loop drawings will be provided for the points included in the customer information section above.

All Historical points
I/A Series AIM*Historian configuration service will provide access to archived data for display analysis or reports. This includes the configuration of the historian with collection groups to support the following point counts. This point count is based on all the analog values in the system. For each loop, the system will historize the measurement, the set point and the output. A joint effort will produce documents to describe all the necessary elements for the historian configuration, points to historize, naming convention, collecting period, buffer size etc.

Report Configuration
The configuration of the report is based on the standard template offered in the default system report package. These reports will be configured based on the information provided by Newfoundland & Labrador Hydro. These reports are typically shift or daily production reports. These reports do not include mass balance report or heat balance report. This proposal does not include the time to configure the logic to historize the running hours for major equipment.

Qty	Description
10	Reports

Factory Acceptance Test

I/A Series Staging and Testing Service provide you with a fully staged and tested I/A system. Staging services are beneficial for verification of system operation and can significantly reduce on site installation time. The system hardware is arranged, completely assembled, powered up, interconnected, and maintained during the testing period. The FAT location will be at an Invensys facility.

Qty	Description
3	Customer Witnessed Testing (calendar work days)

Note that the DCS will be completely tested (with signed off documentation) prior to Customer Witnessed tests. Additional testing time may be purchased, if required.

Staging

The following staging activities will be performed:

1. Your I/A system will be inventoried to ensure that all components and modules are received for staging. This service provides for assembly of all Invensys I/A hardware including loading modules in enclosures, interconnection wiring, workstations, printers, etc. Staging of non-Invensys buyout equipment is not included in this quotation.
2. Verification of power supplies and power distribution to individual modules.
3. Module diagnostic testing is performed verifying that individual hardware modules operate properly and in accordance with system specifications.
4. I/A operating system software is demonstrated to verify that it operates in accordance with system specifications.
5. System diagnostics are run, and the overall integrity of the software is verified using the I/A system management software.
6. Standard interactive tests are run to verify the operation of primary and backup system communications, system redundancies, backup features, and other standard system features provided.

After testing, the system is disassembled, repacked and shipped to your site location using Invensys standard shipping procedures.

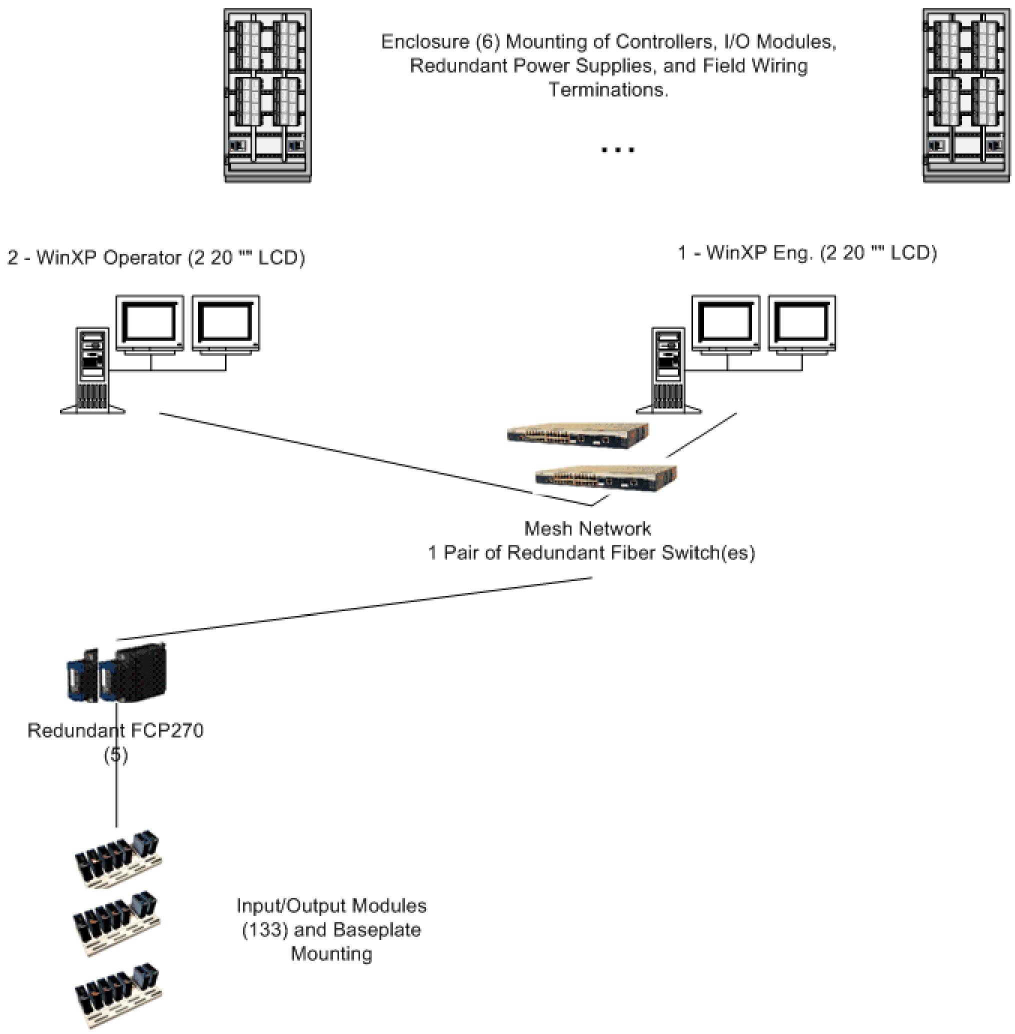
Standard Documentation

We have included standard documentation as provided by our engineering tools and a CD library for system operation, engineering, and maintenance. An initial list of all parts will be provided to and this list will be updated to reflect the final design.

Travel and Living

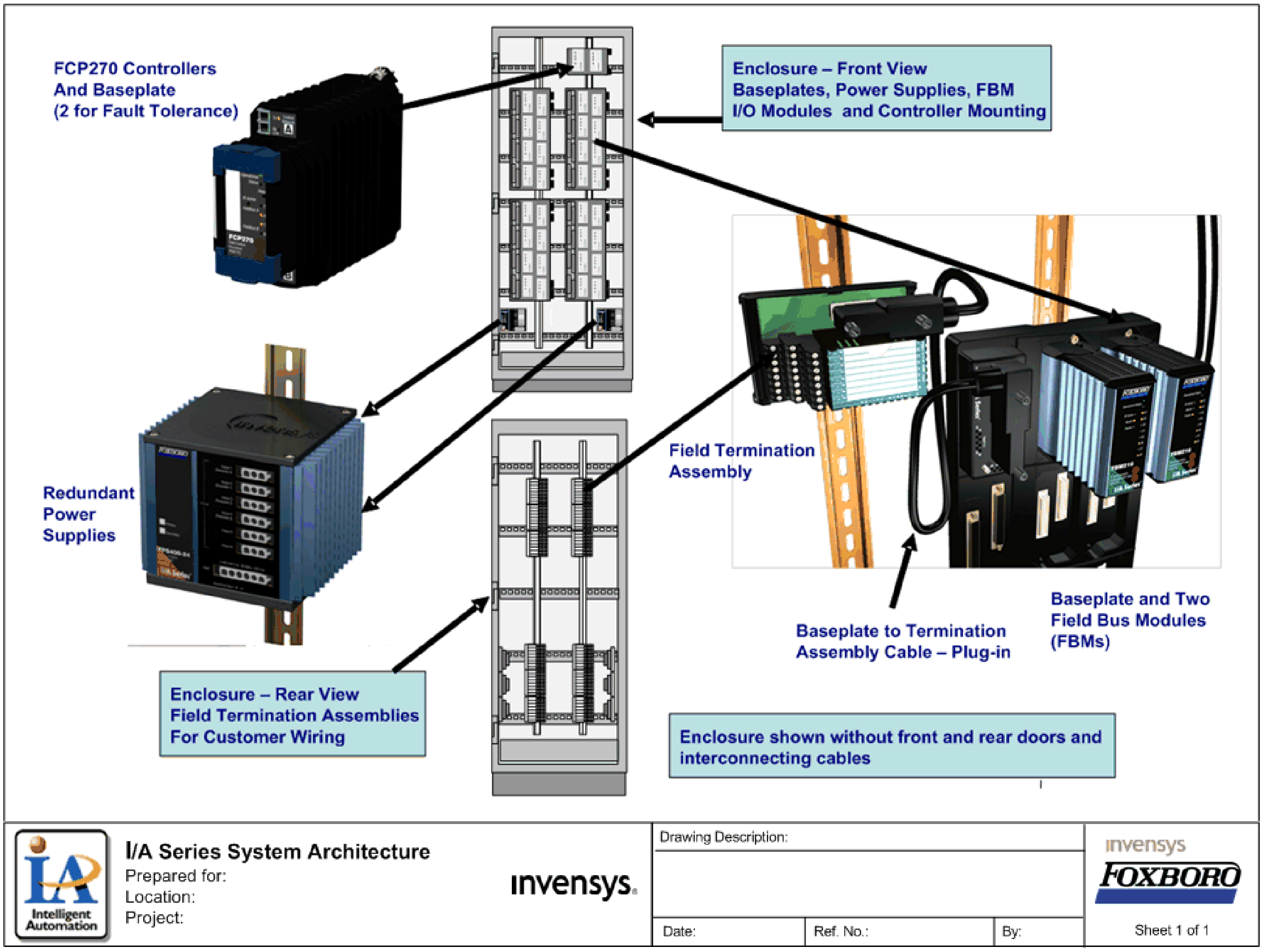
Travel and Living will be billed at cost plus 10%.

Prepared For: Newfoundland & Labrador Hydro	Date:10/10/2008
Inquiry: (Stantec) BMS Upgrade	Page 9
Proposal No.: MPC-1008-02296	



I/A System Architecture Prepared For: Newfoundland & Labrador Hydro Location: Holyrood, Newfoundland/Labrad., A0A 2R0 Canada Project: (Stantec) BMS Upgrade	Proposal Number: MPC-1008-02296 Date: 10/10/2008 By: Al Pulice

Prepared For: Newfoundland & Labrador Hydro	Date:10/10/2008
Inquiry: (Stantec) BMS Upgrade	Page 10
Proposal No.: MPC-1008-02296	



INVENSYS PROCESS SYSTEMS

COMMERCIAL SUMMARY

Total Sell Price: $513,950

Prices: This proposal is for budgetary purposes only and cannot be used for purchase. Estimates are based only on information detailed in this specification and are subject to change with modifications in scope including quantities of I/O.

Taxes: Taxes are not included.

Warranty: Standard warranty of Twelve (12) Months after Shipment is included. The system warranty may be extended for up to 36 months from date of shipment.

Services: Field services, unless otherwise indicated, are not included as part of this proposal but are available from an Invensys Local Branch Office.

Conditions of Sale: The Conditions of Sale on the following forms are an integral part of this proposal:
Form No. 2547G: **Invensys Systems Inc. – General Conditions of Sale**
Form No. 1071-C-E: **Invensys Systems Inc. – Terms and Conditions for Service**

These forms are available on request.

General Terms & Conditions of Sale of Goods and Services and License of Software

Clause 1: Definitions

1.01 "**Affiliates**" means any legal entity which has an ownership interest in or is under a common ownership interest with a Party and which is defined in attachments to this Agreement or subsequent Purchase Orders.

1.02 **"Agreement"** means these terms and conditions and applicable Purchase Orders and any appendices hereto, including without limitation, the software licenses, pricing schedules, and delivery schedules.

1.03 **"Company"** shall mean the company and any of its Affiliates which has executed a Purchase Order under this Agreement.

1.04 **"Days"** shall be calculated as calendar days unless otherwise specified under this Agreement.

1.05 **"Expenses"** shall mean all out-of-pocket expenses reasonably incurred by Seller in the provision of the Goods, Software and Services, including but not limited to, airfare, hotel, transportation, meals, supplies, data preparation, and other direct expenses incurred by Seller's personnel or subcontractors in performing Seller's obligations under a Purchase Order, as these expenses may be further detailed in a Purchase Order and the net tax costs of any non-deductible travel expenses for assignment of employees over one (1) year in locations not within a reasonable commuting radius of the employee's principal place of employment.

1.06 **"Goods"** shall mean all products, equipment, materials, spare parts, hardware, supplies, and accessories to be supplied under a Purchase Order.

1.07 **"Party and Parties"** shall mean Seller, Company, any of their affiliate(s) which has executed a Purchase Order hereunder and any third party to which the Parties may have assigned their rights under the Agreement. In its singular form, Party means any one of Seller, Company or their Affiliate having executed a Purchase Order or the third party to whom one of them has assigned its rights under the Agreement.

1.08 **"Price"** shall mean the total value of a Purchase Order after all applicable discounts have been applied. Expenses are not included in the Price unless agreed upon in the Purchase Order.

1.09 **"Purchase Order"** shall mean any purchase order, either paper or electronic, with related attachments and changes thereto, agreed upon by the Parties pursuant to this Agreement, which shall describe the specific Goods, Software or Services to be supplied by Seller to the Company and the detailed Specifications for such. Purchase Orders agreed upon from time to time between Seller and Company and/or their respective Affiliates shall constitute separate contracts that incorporate the present General Terms and Conditions by reference and shall be governed by those. Such Purchase Orders may modify or replace certain provisions of the General Terms and Conditions of this Agreement only to the extent that the Parties are required to comply with the local laws of the country in which the Purchase Order is being placed. Modifications shall be made in good faith in such a manner as to preserve the intent of this Agreement.

1.10 **"Seller"** shall mean Invensys Systems Inc. and, for purposes of the Purchase Orders, any of its Affiliate which has executed a Purchase Order under this Agreement.

1.11 **"Services"** shall mean the provision of testing, assessment, per-diem or specific time-limited engineering services, installation, start-up, configuration and any development of application programs, customization, implementation, training and any other services agreed upon between the Parties in Purchase Orders hereunder, excluding maintenance and support services which shall be rendered under a separate agreement. To the extent Services are of an advisory nature, no specific business result is assured or guaranteed.

1.12 **"Software"** shall mean computer software programs, in object code form including firmware and custom software, and instructions manuals, specifications and related documentation in written or electronic form, but excluding third party software, their related instructions manuals and documentation, for which Seller grants Company a license under a Purchase Order. The conditions of the Software license shall be set forth in the Seller's end-user license agreement applicable to the particular Software at the time of delivery or, in the absence of such end-user license agreement, the software license terms contained herein. All modifications, enhancements, developments, additions or interfaces with other computer programs made by Seller, alone or jointly with Company, in the course of the performance of a Purchase Order shall be deemed owned by Seller and included in the Seller's Software and shall be subject to all rights and limitations set forth in the Seller's standard license agreement for such Software applicable at the time of delivery or, by default in the absence of separate end-user license agreement, the terms contained herein.

1.13 **"Specifications"** shall mean the Seller standard specifications applicable to the Goods and/or Software at the time of execution of the Agreement or a Purchase Order hereunder or the specific requirements agreed upon between the Parties in Purchase Orders hereunder in relation to the Goods, Software and, with respect to Services, the agreed upon statement(s) of work containing a description of the Services to be rendered.

1.14 **"System Products"** shall mean integrated configurations of Invensys Goods and/or Software furnished by Seller.

1.15 **"Third Party Products"** shall mean products and software of a third party vendor. If Third Party Products are supplied by the Seller under the Agreement, notwithstanding anything to the contrary, such supply is made on a "pass-through" basis only and is subject to the terms and conditions of the third party vendor, including but not limited to warranties, licenses, indemnities, limitation of liability, prices and changes thereto. Third Party Products are quoted subject to price changes imposed by third party vendors between the date of Purchase Order encompassing such Third Party Products and the date of Seller's invoice related to that Third Party Product.

1.16 **"Warranty Period"** shall mean the applicable time period during which Goods, Software and Services are respectively guaranteed by Seller under the conditions set forth herein. Goods registered in the online Seller's Price Book www.Buyautomation.com as Measurement and

Instrumentation ("M&I") Products shall be guaranteed for a period of twenty-four (24) months following the date of shipment, with the exception of M&I I/A Series pressure products which are guaranteed for five (5) years following date of shipment. Goods and Software registered as Triconex Products are guaranteed for a period of twelve (12) months following installation or eighteen (18) months following the date of shipment, whichever occurs first. Goods and Software registered as Foxboro Products other than M&I Products are guaranteed for a period of twelve (12) months following the date of shipment. System Products are warranted for one (1) year from the date of shipment of the system. Spare Parts for the above are guaranteed for three (3) months, unless used for repair and replacement during the Warranty Period, in which case, the spare parts shall be guaranteed for three (3) months or until the end of the initial Warranty Period, whichever comes last. Avantis Software is guaranteed for a period of six (6) months from the date of execution of the relevant Purchase Order. Wonderware Software is guaranteed for a period of 90 days from the date of delivery. ScimSci-Esscor Software is guaranteed for the period set forth in the Purchase Order. Refinery Offsites Software is guaranteed for one (1) year from the date of the license. Services are warranted for a period of thirty (30) days following their performance. Products normally consumed in operation or which have a normal life inherently short, including but not limited to consumables such as flashtubes, lamps, batteries, storage capacitors, are guaranteed for a period of ninety (90) days from date of delivery by Seller, except for disposable PH/ORP sensors, replacement PH, ORP and reference electrodes and dissolved oxygen membranes which are guaranteed for a period of one (1) year from the date of shipment or until they are installed in the process, whichever occurs first. Third Party Products are warranted as stated in Clause 1.15.

Clause 2: Sole Agreement

2.01 This Agreement, including any Purchase Order entered into pursuant hereto, constitutes the entire agreement of the parties hereto with respect to its subject matter and supersedes all prior and contemporaneous representations, proposals, discussions, and communications, whether oral or in writing with respect to this subject matter. This Agreement may be modified only by means of a duly executed written amendment signed by the authorized representatives of both Parties. Neither the terms of any invoice or other instrument documenting a payment or transaction that is issued by Company in connection this Agreement, nor any other act, document, pre-printed form or statement, usage, custom, or course of dealing shall modify the terms of this Agreement. In the event of any conflict between the terms of this Agreement and any Purchase Order, the provisions of this Agreement shall govern unless expressly agreed upon by the Parties under the Purchase Order and modifications made by the Purchase Order to this Agreement are required to comply with local applicable laws.

2.02 It is understood that neither Party is obligated to enter into a Purchase Order under this Agreement.

Clause 3: Changes

3.01 Either Party may request changes that affect the scope, duration, delivery schedule or price of a Purchase Order, including changes in the Specifications and Goods, Software or Services to be delivered or licensed. If either Party requests any such change, the Parties shall negotiate in good faith a reasonable and equitable adjustment to the Purchase Order. Neither Party shall be bound by any change requested by the other until an amendment to the Purchase Order in the form of a Change Order has been accepted in writing by both Parties. Pricing of changes shall be based on the then current Seller's prices.

Clause 4: Price and Payment Terms

4.01 Prices for Products, Services and/or Software under this Agreement shall be in accordance with the prices set forth in Seller's e-commerce site: www.buyautomation.com at the time of the execution of the Purchase Order or Seller's proposal for services.

4.02 Seller's proposals and the Purchase Order Price exclude all sales taxes, value-added taxes, import and export duties and any other taxes, surcharges, duties or tariffs of any kind now existing or hereafter imposed upon Seller, its personnel or subcontractors or their properties in any country or territory either directly or indirectly in respect of the production, sale, supply, delivery, license export and import, or use of the Goods, Software and Services. Company shall be responsible for all such taxes, duties and charges resulting from the Agreement or a Purchase Order hereunder. Validity of Seller's proposal shall extend for thirty (30) days from the proposal date.

4.03 If Seller is required to impose, levy, collect, withhold or assess any such taxes, duties and charges on any Purchase Order under this Agreement, Seller shall invoice Company for such taxes, duties and charges unless Company furnishes Seller with an exemption certificate or other equivalent documentation demonstrating its exemption from such taxes, duties and/or charges.

4.04 If Company is required by law to make any tax withholding from amounts paid or payable to Seller under this Agreement, (i) the amount paid or payable shall be increased to the extent necessary to ensure that Seller receives a net amount equal to the amount that it would have received had no taxes been withheld; (ii) Company shall forward proof of such legally required withholding to Seller.

4.05 Company has the option as agreed by the Parties to buy and pay in U.S. Dollars, European Euros or such other currency as Company and Seller may agree. If any expenses, charges or any other amounts to be paid to Seller by Company under this Agreement were incurred by Seller in a currency other than the currency agreed in a Purchase Order, these expenses, charges or other amounts shall be invoiced in such other currency. If the Parties agree that these expenses, charges or other amounts are to be paid in the currency indicated in the Purchase Order, the amounts to be paid shall be calculated using the official spot rate on the date of payment between the currency indicated in the Purchase Order and the other currency. Where the price of quoted Goods are stated to be based in whole or in part on a conversion between two currencies, Company shall indemnify Seller against any loss incurred by Seller which results from any variation in the rates of exchange between the date of the quotation of the Goods and the date upon which payment becomes due to Seller.

4.06 Subject to Seller's approval of Company's current credit rating and unless otherwise agreed upon in the relevant Purchase Order, full payments of all invoiced Goods, Software and Services are due in the invoice currency(ies) within thirty (30) calendar days from the date of invoice.

4.07 If Company is delinquent in its payment obligations, without prejudice to any other remedies available to it by law or in equity, Seller may at its option (i) suspend all further deliveries or performance to be made under the Agreement or any further performance under any other contract with Company or Company's Affiliates, in which event Company shall not be released in any respect from its obligations to

Seller under the Agreement or the other contract; (ii) recover all costs of collection including but not limited to reasonable attorneys' fees; (iii) repossess the Goods and Software for which payment has not been made and (iv) retain any equipment supplied by Company to Seller in relation to Seller's provision of Services. Any discount from Seller's rates, if any, shall cease to apply to the delinquent invoice.

4.08 Unless otherwise expressly agreed between the Parties, payments shall be taken to discharge Company's latest debts.

4.09 Company shall reimburse Seller or, pay directly upon agreement with Seller, all reasonable Expenses.

4.10 Company shall not set off or recoup invoiced amounts or any portion thereof against sums that are due or may become due from Seller and/or its Affiliates.

Clause 5: Delivery, Title and Risk of Loss

5.01 Unless otherwise agreed upon in a Purchase Order, title to all Goods sold hereunder, except for Software whose title remains at all times with Seller, shall pass to Company upon full payment of the Purchase Order.

5.02 Upon delivery, risk of loss or damage shall pass to Company unless delivery has been delayed because of Company.

5.03 Delivery, unless otherwise agreed upon in a Purchase Order, shall be Ex-works (Incoterms 2000), Seller's facility.

5.04 If, as part of a Purchase Order, Seller is responsible for packing any Goods for shipment, Seller shall pack, mark and label such Goods in accordance with its usual packing procedures.

Clause 6: Receiving, Inspection and Acceptance

6.01 Company shall be responsible for receiving, installing, starting up and maintaining all Goods, unless otherwise agreed in a Purchase Order.

6.02 If Company fails to notify Seller of any material non-conformities with the Specifications within a reasonable period following delivery, not to exceed thirty (30) calendar days, or is using those Goods, Software or Services in a production environment or for the regular conduct of its business, the Goods, Software or Services shall be deemed accepted, without prejudice to the warranty provisions hereunder.

6.03 Company shall have the right to reject Goods, Software and Services not materially in accordance with the Specifications in the Purchase Order. Seller shall have a reasonable opportunity to correct non-conformities, replace non-conforming Goods and/or Software or correct or re-perform the Services at its option, in accordance with Clause 8. Should Seller fail to use reasonable efforts to correct non-conformities, replace the non-conforming Goods and/or Software or re-perform or correct non-conforming Services within a reasonable period of time, based on the complexity of the non-conformities, Company may terminate the Purchase Order or portion thereof. Seller's maximum liability under this Clause shall be to refund the fees and expenses paid by Company for the portion of the Goods, Software or Services that is non-conforming.

6.04 Unless other acceptance criteria are agreed upon in Purchase Orders at Company's expenses, Seller's standard testing procedures, including factory acceptance test and site acceptance test where applicable, shall apply to Goods, Software and Services provided. If Company's representative is unable to attend any of these tests having received reasonable notice thereof, Company shall be deemed to have waived its entitlement to attend such tests. To the extent that any Goods, Software or Services have been, or can be deemed approved by Company pursuant to the terms of this Agreement or the applicable Purchase Order at any stage of Seller's performance, Seller shall be entitled to rely on such approval for purposes of all subsequent stages of its performance hereunder.

Clause 7: Force Majeure

7.01 Except for Company's payment obligations, neither party shall be liable for delays caused by conditions beyond their reasonable control, ("Force Majeure"), provided notice thereof is given to the other party as soon as practicable. Force Majeure shall include, without limitation, hostilities, revolution, acts of war (whether or not declared), act of terrorism, civil commotion, strike, epidemic accident, quarantines or regional medical crisis, fire, flood, wind, earthquake or other inclement weather conditions and any impending threat of the foregoing, blockade, embargoes, shortage of materials or transportation facilities, strikes and lockouts, any other Acts of God or act of any Government or governmental agency, including laws, regulation or ordinance and proclamation affecting the parties, the Goods, Software or Services without the fault or negligence of the parties hereto.

7.02 All such Force Majeure conditions preventing performance shall entitle the Party hindered in the performance of its obligations hereunder to an extension of the date of delivery of the Goods and Software or completion of the Services by a period of time equal to the period of delay incurred as a result of the Force Majeure or to any other period as the Parties may agree in writing.

Clause 8: Warranties for Goods, Software and Services

8.01 Seller warrants to Company that the Goods, Software and Services Seller provided hereunder shall, at time of delivery, materially conform to the Specifications agreed between the Parties, including drawings or descriptions, specification sheets, drawings, notes and technical data for such Goods and Software and the description of the Services. In the absence of agreed upon Specifications for Goods and Software, Seller warrants the Goods and Software shall meet the applicable standard Specifications available from Seller for such Goods and Software at the time of the Purchase Order.

8.02 Seller further warrants that Goods, at the time of their delivery, and the media on which the licensed Software is provided will be free from defects in material and workmanship for the Warranty Period defined under Clause 8.03. If a material defect in workmanship with regard to the media carrying licensed Software occurs during the Warranty Period, Seller's sole obligation and Company's sole remedy shall be the replacement of the media and the licensed Software residing on the media.

8.03 If, any time prior to the end of the applicable Warranty Period, as defined hereunder or under the separate applicable software license agreement, the Goods, Software or Services, or any part thereof, do not conform to applicable warranties or Specifications, Company shall notify Seller within a reasonable time after its discovery and shall provide written particulars of the non-conformity and all information and assistance necessary to enable Seller to verify the nature and cause of the non-conformity and carry out its warranty obligations hereunder.

8.04 Non-conforming Goods subject to a warranty claim shall be returned to the nearest Seller's repair facility, transportation charges prepaid for the account of the Company. The costs to diagnose non-conformity on Company's site, if required, shall be for the account of the Company. Goods so returned by Company to the Seller during the Warranty Period and found upon Seller's inspection to be non-conforming and Software found non-conforming upon Seller's inspection shall be repaired, replaced or corrected, at Seller's option and shall be warranted by Seller for the remainder of the original Warranty Period or for three months, whichever is longer, free of charge and return-shipped to Company with transportation prepaid by Company. Seller shall not be responsible for any offshore transport costs.

8.05 Seller's obligation and Company's sole remedy under this Clause is, at Seller's option the repair or replacement, correction, of any non-conforming Goods, Software or part thereof.

8.06 Goods, Software and labor used, as well as any and all Expenses reasonably incurred, by Seller for the repair or replacement or correction of any Goods or Software found in whole or in part to be non-conforming for reasons listed under Section 8.07 shall be for Company's account.

8.07 The foregoing warranties do not apply to non-conformities caused by (i) Company's design or installation of the Goods and/or Software, (ii) modification or repair to the Goods and/or Software otherwise than as authorized in writing by Seller; (iii) handling, storage, use or maintenance of the Goods and/or Software in a manner or an environment inconsistent with the Specifications and/or instructions or recommendations of Seller; (iv) defect in Company's own products or software or use of the Goods and/or Software in combination with any Third Party Product not procured by Seller; (v) Company's failure to observe the payment terms under this Agreement or any other of its obligations under this Agreement; (vi) normal wear and tear; (vii) installation or wiring of the Goods and/or Software other than in accordance with Seller's instructions; (viii) transfer of the Software from the device on which it was originally installed; and/or (ix) any fault of the Company or its agents.

8.08 Seller has no obligation under this warranty unless Company maintains adequate records that accurately document operating time and maintenance performed on Goods and Software and provides those records to Seller on demand for substantiating warranty claims.

8.09 Goods subject to wear or burnout through usage such as lamps, fuses, paper media, filters, trim, packing and the like shall not be deemed not in conformity by reason of such wear or burnout.

8.10 The foregoing warranties do not apply to Third Party Products. Seller shall bear no responsibility for the performance, repair or warranty of any of Company's software or hardware product or any Third Party Products and Company shall look solely to third party vendor for all remedies and support with regard to such Third Party Products. If such Third Party Product is expressly procured by Seller to Company under a Purchase Order, that Third Party Product shall be warranted only in accordance with the warranties given to Seller in respect thereof by the relevant third party vendor and to the extent that Seller has the right to assign or transfer such warranties.

8.11 Seller warrants that Services shall be performed with reasonable skill and care and that Seller is properly licensed and qualified to perform the Services hereunder, and shall provide experienced personnel to perform Services that are materially in conformity with the Specifications of the Purchase Order. Seller's obligation and Company's sole remedy under this Warranty Period is to correct, re-perform the Services or refund the portion of the Services that cannot be corrected or re-performed, at Seller's option. All Services corrected or re-performed shall be warranted only for the unexpired portion of the original Warranty Period applicable to Services.

8.12 EXCEPT AS SET FORTH HEREIN AND IN THE WARRANTIES PROVISIONS CONTAINED IN SEPARATE SOFTWARE LICENSE(S) IF ANY, THESE WARRANTIES ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, REPRESENTATIONS, CONDITIONS, EXPRESS OR IMPLIED, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY, NON-INFRINGEMENT, INTEROPERABILITY, AND FITNESS FOR A PARTICULAR PURPOSE. SELLER DOES NOT WARRANT THAT THE OPERATION OF ANY SUCH SOFTWARE WILL BE UNINTERRUPTED AND/OR ERROR-FREE.

8.13 ALL WARRANTIES PROVIDED HEREIN ARE PERSONAL TO, AND INTENDED SOLELY FOR THE BENEFIT OF, COMPANY AND DO NOT EXTEND TO ANY THIRD PARTY, EXCEPT IN CASE OF TRANSFER OF THE SOFTWARE IN ACCORDANCE WITH CLAUSE 11.08 OR CLAUSE 18.

Clause 9: Compliance

9.01 Neither Party shall comply with any foreign boycott laws or requirements, which are in violation of any federal or state law, rule, or regulation.

9.02 Company acknowledges that each product and any related software and technology, including technical information supplied by Seller or contained in documents (collectively "Items"), is subject to export controls of the U.S. government. Software is licensed for Use in the specific location identified in the Purchase Orders and Licenses attached. Company may not export the "Items" to another country without Seller's written permission and payment of any applicable country specific surcharges. Company agrees to comply fully with all relevant export laws and regulations of the United States and foreign nations in which the "Items" will be used ("Export Laws") to ensure that neither the "Items" nor any direct product thereof are (i) exported, directly or indirectly, in violation of any Export Laws; or (ii) are intended to be used for any purposes prohibited by the Export Laws. Without limiting the foregoing, Company will not export or re-export the "Items": (i) to any country to which the United States has embargoed or restricted the export of goods or services or to any national of any such country, wherever located; (ii) to any end user who Company knows or has reason to know will utilize the "Items" in the design, development or production of nuclear, chemical or biological weapons; or (iii) to any end-user who has been prohibited from participating in U.S. export transactions by federal agency of the U.S. government.

9.03 "Software" is a "commercial item" as that term is defined under 48 CFR 2.101 (October 1995), consisting of "commercial computer software" and "commercial computer software documentation" as such terms are used in 48 CFR 12.212 (September 1995) and is provided to U.S. Government only as a commercial item. Consistent with 48 CFR 12.212 and 48 CFR 227-7202-1 through 227.7202-4 (June 1995), all U.S. Government end-users acquire the Software with only those rights set forth herein.

9.04 Either Party shall execute and deliver to the other any documents as may be required to effect or evidence compliance.

9.05 The Parties may correspond and convey documentation via the Internet unless Company expressly requests otherwise. Neither Party has control over the performance, reliability, availability or security of the Internet. Seller shall not be liable for any loss, damage, expense, harm or inconvenience resulting from the loss, delay, interception, corruption or alteration of any communication over the Internet due to any reason beyond Seller's reasonable control.

Clause 10: Laws and Dispute Resolution

10.01 This Agreement shall be governed by and construed in accordance with the laws of Delaware, USA, without regard to the conflict of laws provisions thereof. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement. The governing language for this Agreement shall be English, and no concurrent or subsequent translation of this Agreement into any language shall modify any term of this Agreement.

10.02 Any claim arising out of or relating to this Agreement, or the breach thereof, shall be settled by final and binding arbitration administered by the American Arbitration Association ("AAA") in accordance with its Commercial Arbitration Rules and its Optional Procedures for Large, Complex Commercial Disputes. The arbitration shall be heard and determined by a panel of three (3) arbitrators selected by the AAA. The arbitrators shall have exclusive authority to resolve any and all disputes relating to procedural and substantive questions of arbitrability, including but not limited to, choice of venue and choice of law issues, and the formation, interpretation, applicability, scope, and enforceability of this agreement to arbitrate. The Parties shall be entitled to conduct discovery in accordance with the Federal Rules of Civil Procedure under the supervision of the arbitrators. The arbitration proceeding shall occur in Boston, Massachusetts. Each party shall bear its own costs relating to such arbitration, the parties shall equally share the arbitrators' fees, and the arbitration and all related proceedings and discovery shall take place pursuant to a protective order entered by the arbitrators that adequately protects the confidential nature of the parties' proprietary and confidential information. In no event shall any arbitration award provide a remedy beyond those permitted under this Agreement, and any award providing a remedy beyond those permitted under this Agreement shall not be confirmed, no presumption of validity shall attach, and such award shall be vacated. No claim may be brought as a class action, combined or consolidated with any other proceeding, nor may any proceeding be pursued in a representative capacity or on behalf of a class. Neither party has the right to act as a class representative or participate as a member of a class of claimants with respect to any claim. Either party may, without waiving any remedy under this Agreement, seek from any court of competent jurisdiction any interim or provisional relief that such party deems necessary to protect its confidential information and property rights, pending the establishment of the arbitral tribunal (or pending the arbitral tribunal's determination of the merits of the claim).

10.03 Upon the request of either Party, mediation shall be conducted prior to the arbitration pursuant to the mediation rules of the AAA.

Clause 11: Intellectual Property and Software License

11.01 For purposes of this Agreement, "Intellectual Property Rights" mean any patent, trademark, service marks, copyrights, trade secrets, ideas, concepts, know-how, techniques or other proprietary right. Seller may utilize proprietary works of authorship, pre-existing or otherwise, including without limitation software, computer programs, methodologies, templates, flowcharts, architecture designs, tools, specifications, drawings, sketches, models, samples, records and documentation, as well as Intellectual Property Rights and any derivatives thereof, which have been originated, developed or purchased by Seller, a parent or affiliated company of Seller, or by third parties under contract to Seller or to a parent or affiliated company of Seller (all of the foregoing, collectively, "Seller's Information"). Seller shall retain at all times ownership of the Seller's Information.

11.02 Seller or the applicable third party owner shall retain at all times the ownership of its Software, firmware and Third Party software, regardless of the media upon which the original or copy may be recorded or fixed. Without prejudice to the license(s) expressly granted hereunder and under a Purchase Order, no right, title or interest in or to the Software, firmware, Seller's Information, any copies thereof and any Intellectual Property Rights residing in the Goods, Software or result of Services is transferred to Company. Company acknowledges that the prices for Services and Software charged by Seller under this Agreement are predicated in part on Seller's retention of ownership over such Software and any results of the Services, none of which shall be considered "work for hire."

11.03 In consideration of the receipt of full payment of the Software license fee applicable as part of the Price under a Purchase Order, and subject to Company's compliance with its obligations under this Agreement and/or the Purchase Order, Seller shall provide to Company a personal, non-transferable, non-exclusive limited license to use the Software described in the relevant Purchase Order and the Seller's Information incorporated into the Goods, Software and Services, if any, for purpose of Company's ordinary business as defined in the Purchase Order and in the particular location(s) and/or on the particular systems for which Company licensed such Software, as those locations and/or systems are identified in the Purchase Order.

11.04 Seller's Software licensed to Company may contain components that are owned by third parties. The third party owner shall retain exclusive right to its firmware and software. Use of such third party components may be subject to restrictions contained in the third party's end-user license agreement in addition to the conditions set forth herein. Seller shall make available to Company upon request the third party's end-user license agreement applicable. Copyright and other proprietary rights notices of Seller and third parties are contained in the Software and Company shall not modify, delete or obfuscate such notices.

11.05 Company may not without Seller's prior written express consent (i) copy, modify, sublicense, loan or transfer in any manner the Software licensed herein; (ii) create derivative works based on the Software licensed herein; (iii) subject the Software licensed herein to translating, decompiling, disassembling, reverse assembling, reverse engineering, emulating or performing any other operation on the Software, unless the operation is specifically authorized by law. Company shall hold the Software licensed herein in strict confidence and will not allow third parties, other than its employees with a need to use the Software and who have agreed to comply with the terms of this Software License clause, to access or use the Software without Seller's prior written consent. Company agrees to defend, indemnify and hold harmless Seller from all damages and third party claims arising from unauthorized use or transfer of the Software.

11.06 Notwithstanding the foregoing restrictions but subject to all restrictions applicable to Third Party Products as set forth in Clauses 11.02 and 11.04, Company shall be entitled to make one (1) copy of the Software for backup or archival purposes and may make a limited reasonable number of copies of the instruction manuals and documentation related to the Software for purpose of their use by Company in connection with the authorized use of the Software. All titles, trademarks and copyrights and restricted rights notices shall be reproduced in such copies.

11.07 Company shall maintain complete and accurate records documenting the location and use of the licensed Software in Company's possession. No later than thirty (30) days upon receipt of Seller's written request, Company shall provide Seller with a signed certification of compliance with the Software licensing conditions. Seller has the right to conduct an audit of Company's use of the Software. Any such audit shall be conducted during regular business hours at Company's facilities. If an audit reveals any underpayment of license fees, Company shall be invoiced for additional license fees consistent with Seller's then current price list for the Software, without any discount being applicable in that instance. Company shall then immediately pay the underpaid amount together with interest at a rate of one and one-half percent (1.5%) per month or partial month during which such amount was due and unpaid. The assessment of additional license fee is without prejudice to Seller's other remedies in the event of breach by Company of other licensing conditions.

11.08 Unless otherwise set forth in an applicable Seller's License Agreement, Company may not transfer its license to use the Software and related documentation and written materials to a third party without the Seller's prior written consent, which shall not be unreasonably withheld. In case of Seller approval of such transfer, Company shall be responsible to ensure that the recipient agrees to the terms of this Software License clause.

11.09 Unless otherwise set forth in the applicable Seller's License Agreement, Seller shall defend, indemnify and save harmless Company from and against any third party claims, suits, judgments, court costs, reasonable attorney's fees and other liabilities, demands or losses (altogether "Liabilities") to the extent such Liabilities result from an infringement due to the Services and/or Goods, Software's design or construction, of a patent or copyright owned by a third party in the country of manufacture of such Goods and/or Software or in the country of performance of the Services at the time of execution of the relevant Purchase Order under which the alleged infringement has occurred, provided that (i) Seller shall be promptly notified of the bringing of said suits; (ii) Seller shall be given the sole control of the defense and all related settlement negotiations; (iii) Company agrees to fully assist Seller in the defense of the claim and (iv) Company complies with Seller's direction to cease any use of the Goods or Software which in Seller's reasonable opinion, is likely to constitute an infringement. Seller shall not be responsible for any settlement made without its consent.

11.10 The foregoing obligations do not apply when the claim of infringement results from or is related to: (i) Goods and/or Software provided pursuant to Company's designs, drawings or specifications; (ii) Goods and/or Software stored, used or maintained otherwise than in accordance with Seller's instructions or recommendations or other than for the Company's internal business purpose; (iii) claims of infringements resulting from combining Goods or Software provided hereunder with any other item not furnished by Seller; (iv) modifications to the Goods or Software without prior written consent of Seller; (v) parts supplied or designed by Company or third parties; and (vi) Company's failure to use corrections or enhancements made available by Seller.

11.11 Seller may cease to deliver any Goods or Software or Services, which it reasonably considers could infringe third party's rights, without being in breach of this Agreement.

11.12 In case said results of Services, Software or Goods, or any part thereof, is in such suit held to constitute infringement and/or its use is enjoined, the Seller shall, at its own expense and option either: (i) procure for the Company a royalty-free license to continue using such Software, results of Services or Goods, or (ii), replace same with substantially equal but non-infringing equipment or modify it so it becomes non-infringing, provided that no such replacement or modification shall in any way amend or relieve Seller of its warranties and guarantees set forth in this Agreement. In the event Seller is unable to do either of the foregoing, the allegedly infringing item shall be returned to Seller and Seller's maximum liability shall be to refund to Company the amount paid for such item, less a reasonable depreciation for use and damage.

11.13 This Section 11 states the Parties' entire liability and sole remedy with respect to infringement or claims thereof.

Clause 12: Confidentiality

12.01 "Confidential Information" shall mean any and all information in any form that each Party provides to each other in the course of the Agreement and that either (i) has been marked as confidential; or (ii) is of such nature that a reasonable person would treat as confidential under like circumstances. Confidential Information does not include work products resulting from the Services performed hereunder and information which (i) is already known to the other Party at the time of disclosure; (iii) is independently developed without the benefit of the other's Confidential Information; (iv) is received from a third party that is not under any confidentiality obligation towards the owner of the information; or (v) has entered the public domain through no fault of the recipient.

12.02 Each Party retains ownership of its Confidential Information.

12.03 Each party agrees to (i) protect the other's Confidential Information in the same manner as it protects the confidentiality of its own proprietary and confidential materials but in no event with less than reasonable care; (ii) use the other's Confidential Information only in relation to the Purchase Order.

12.04 Upon termination of this Agreement or a relevant Purchase Order or upon written request submitted by the disclosing Party, whichever comes first, the receiving Party shall return or destroy, at the disclosing Party's choice, all of the disclosing Party's Confidential Information.

12.05 Neither Party shall, except with respect to their employees, contractors or agents with a need to know for purposes of this Agreement, disclose to any person any Confidential Information of the other Party without the other Party's prior written consent, except where Confidential Information may be disclosed by law.

12.06 Unless otherwise agreed in Purchase Orders, these confidentiality obligations shall terminate five (5) years after the expiration of the relevant Purchase Order or termination of this Agreement, whichever comes first.

Clause 13: Indemnification and Limitation of Liability

13.01 Seller shall indemnify, defend and hold Company harmless against third party claims (including without limitation, the Parties' employees) for personal injury, death or loss or damage to property caused by Seller's negligence in the performance of its obligations hereunder, provided (i) Seller is entitled to exclusively control the defense against the claim; (ii) Seller is immediately notified of such claim and (iii) Company provides reasonable assistance in the defense of the claim and does not enter into any settlement or make any concession without the Seller's prior written approval.

13.02 IN NO EVENT SHALL SELLER HAVE ANY LIABILITY UNDER THIS AGREEMENT OR ANY PURCHASE ORDER FOR ANY SPECIAL, INCIDENTAL, PUNITIVE, EXEMPLARY, INDIRECT OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO LOST PROFITS, LOSS OF PRODUCTION, LOSS OF REVENUES, INTEREST, CAPITAL, FINANCING, GOOD WILL, USE, BUSINESS REPUTATION, OPPORTUNITY OR PRODUCTIVITY, HOWSOEVER ARISING, EVEN IF COMPANY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

13.03 SELLER'S LIABILITY UNDER THIS AGREEMENT FOR ANY DIRECT DAMAGES ARISING OUT OF OR IN ANY WAY RELATED TO THIS AGREEMENT (WHETHER ARISING UNDER TORT, NEGLIGENCE, CONTRACT, WARRANTY, STRICT LIABILITY OR ANY OTHER CAUSE OR COMBINATION OF CAUSES) SHALL IN NO EVENT EXCEED THE SPECIFIC PRICE OF THE GOODS, SOFTWARE AND/OR SERVICES PROVIDED UNDER THE PURCHASE ORDER GIVING RISE TO LIABILITY. WITH RESPECT TO SITE BASED SERVICES, THE MAXIMUM AGGREGATE LIABILITY OF SELLER FOR DIRECT DAMAGES UNDER THE PURCHASE ORDER GIVING RISE TO LIABILITY SHALL NOT EXCEED THE AMOUNT EQUIVALENT TO ONE ENGINEER'S WORK DAY.

13.04 EXCEPT FOR THE TRANSFER OF SOFTWARE LICENSE IN ACCORDANCE WITH CLAUSE 11.08, THE TERMS OF THIS AGREEMENT SHALL NOT BENEFIT OR CREATE ANY RIGHT OR CAUSE OF ACTION IN OR ON BEHALF OF ANY PERSON OR ENTITY OTHER THAN COMPANY AND SELLER. ANY ACTION AGAINST THE OTHER MUST BE BROUGHT WITHIN TWELVE (12) MONTHS AFTER THE EVENTS GIVING RISE TO THE CAUSE OF ACTION EXCEPT THAT AN ACTION FOR NON-PAYMENT MAY BE BROUGHT BY A PARTY NOT LATER THAN ONE YEAR FOLLOWING THE DATE OF THE LAST PAYMENT DUE TO SUCH PARTY HEREUNDER.

13.05 TO THE EXTENT PERMITTED BY LAW, THE PROVISIONS OF THIS SECTION 13 SHALL APPLY REGARDLESS OF THE FORM OF ACTION, DAMAGE, CLAIM, LIABILITY, COST, EXPENSE, OR LOSS, WHETHER IN CONTRACT, STATUTE, TORT OR OTHERWISE.

13.06 COMPANY ACKNOWLEDGES THAT SELLER'S PRICING REFLECTS THE ALLOCATION OF RISKS, OWNERSHIP OF INTELLECTUAL PROPERTY RIGHTS AND THE LIMITATION OF LIABILITY HEREUNDER.

<u>Clause 14: Invoicing</u>

14.01 Invoices shall be sent to the address specified in the Purchase Order.

14.02 Should Company dispute any invoice, Company shall notify Seller of the nature of the dispute within thirty (30) days of the date of the invoice. Company shall have the right to withhold payment of the portion of the invoice in question until Company and Seller agree on the amount to be paid and any additional documentation or information requested by the Company has been received from the Seller. Company shall pay the undisputed portion of the disputed invoice.

14.03 SELLER shall invoice Company in accordance with the following invoicing milestones:

Hardware Only Orders less than $50,000 and less than six (6) months in duration.

20%. Upon receipt of Order
80% Upon shipment

Hardware Only Orders greater than $50,000 and greater than six (6) months in duration.

25% Upon Receipt of Order
25% Upon Release for Manufacturing
25% Upon Completion of Manufacturing
25% Upon Shipment

Staged Orders for Software and Hardware (Staged orders are system orders that require assembly and testing per project specifications at Seller integration facility.)

30% Upon receipt of Order
20% Upon design release for manufacturing
20% Upon receipt of hardware delivered to staging facility
20% Upon completion of factory acceptance test (FAT)
10% Upon Shipment

Non-Staged Orders (Non-Staged orders are system orders that do not require assembly or test at Seller's facility and may be shipped directly to Company)

30% Upon receipt of Order
40% Upon design release for manufacturing
30% Upon shipment

All Time & Material Orders

100% Labor hours billed at then current rates of the Invensys affiliate performing the services plus all Expenses incurred billed on a monthly basis with a minimum administrative fee equal to 5 % of the amount of expenses (to be determined with the relevant Invensys affiliate).

<u>Clause 15: Termination for Convenience</u>

15.01 Seller's performance of work under this Agreement or a Purchase Order may be terminated by the Company in accordance with this clause in whole or in part whenever the Company may elect, with minimum prior written notice ("Notice of Termination") of at least thirty (30) business days. Any such termination shall take place by delivery to the Seller of a Notice of Termination specifying the extent to which performance of work under the Agreement or Purchase Order is terminated, and the date upon which termination becomes effective. Upon receipt of any such notice, Seller shall, unless the notice requires otherwise:

(1) discontinue work on the date and to the extent specified in the notice; and

(2) make every reasonable effort to either obtain cancellation of all orders to subcontractors or assign those orders to Company.

15.02 Upon Notice of Termination, Company shall (i) pay all fees earned and expenses incurred in connection with the performance of this Agreement or the Purchase Order until the effective date of such termination ("Fees and Expenses") and (ii) any and all reasonable costs directly related to Company's termination pursuant to this provision, including costs associated with personnel reassignment, travel, restocking charges and other administrative requirements ("Termination Costs"). In the event of partial execution of the Agreement or when termination occurs between two invoicing milestones, a pro rated share of the fees shall be added based upon the portion of Purchase Order completed on the termination date.

15.03 Notwithstanding the foregoing, with respect to M&I Products, Company may only terminate a Purchase Order without cause before shipment.

Clause 16: Termination for Default

16.01 Either Party may terminate this Agreement or any outstanding Purchase Order for default if the other has materially breached any of its obligations under the relevant Purchase Order and has not cured the breach within thirty (30) days of receipt of a notice from the other Party.

16.02 Termination of a Purchase Order by either Party whether for default or for convenience shall not affect continuing performance by the Parties of their respective obligations under a different Purchase Order, unless otherwise agreed upon by the Parties.

Clause 17: Storage and Bailment of Company's Materials and/or Equipment

17.01 If Seller must store any of Company's materials and/or equipment under this Agreement, Seller shall charge Company a fee for storing the materials and/or equipment as set forth in the Purchase Order or in a properly executed Change Order. Seller shall:
(1) store such materials and/or equipment in a clean, dry, and secure location, unless otherwise agreed in writing by Company; and
(2) mark, notify, or otherwise indicate in a manner to make it evident to Seller's creditors, that such materials and/or equipment belong to Company.

17.02 Without prejudice to its rights under Clause 4.07, Seller will not permit any lien or encumbrance to attach to Company's Goods in the possession of Seller and will file or execute such documents of title as Company may request.

Clause 18: Assignment

18.01 This Agreement shall extend to and be binding upon the parties hereto, their successors, and assigns, provided, however, that neither Party shall assign or transfer this Agreement or any Purchase Order hereunder without the other party's express prior written consent, which shall not be unreasonably withheld. Notwithstanding the foregoing, Seller shall have the right to assign this Agreement or any Purchase Order hereunder to any of its parent, affiliates without prior written consent of Company and Company shall have the right to transfer the licensed Software in accordance with Clause 11.08.

18.02 Seller shall have the right at any time without prior consent of Company to subcontract all or part of its obligations under a Purchase Order. Such subcontract shall not relieve Seller from its obligations under this Agreement and relevant Purchase Order.

Clause 19: Non-Waiver

19.01 Failure by either Party to insist upon strict performance of any of the terms and conditions hereof or failure or delay to exercise any rights or remedies provided herein or by law or to properly notify the other in the event of breach shall not be construed as a waiver of any provision of this Agreement or Purchase Order.

19.02 No waiver by a party of a right or default under this Order shall be effective unless in writing.

Clause 20: Severability, Survivorship, Waiver, and Headings

20.01 If any provision or portion of this Agreement shall be adjudged invalid or unenforceable by a court of competent jurisdiction or by operation of any applicable law, that provision or portion of this Agreement shall be deemed omitted and the remaining provisions and portions shall remain in full force and effect.

20.02 The provisions of this Agreement that by their nature survive final acceptance under a Purchase Order, expiration, cancellation or termination of any Purchase Order or Agreement and shall remain in full force and effect after such acceptance and payment for the period specified herein, or if not specified then for the maximum time allowed by law. These provisions are: (i) Definitions, Clause 1; (ii) Price and Payment Terms, Clause 4; (iii) Indemnification and Limitation of Liability, Clause 13; (iv) Force Majeure, Clause 7; (v) Warranties, Clause 8; (vi) Confidentiality, Clause 12; (vii) Intellectual Property and Software License, Clause 11; (viii) Compliance, Clause 9; (ix) Laws and Dispute Resolution, Clause 10; (x) Severability, Survivorship, Waiver, and Headings, Clause 20.

20.03 The headings in this Agreement are for ease of reference only and shall not be used to construe or interpret the provisions of the Agreement.

Clause 21: Notice

21.01 All notices hereunder shall be deemed given if delivered in writing personally, by courier, sent via US mail, electronic transmission, telephone facsimile, telex, or telegram to Company or to Seller at the address(es) set forth in the Purchase Order(s). Electronic transmission must be acknowledged by a process requiring human action. Any notice given by US mail shall be deemed given at the time such notice is deposited with the US mail service.

Clause 22: Participants of this Agreement

22.01 In addition to its Affiliates' Purchase Order(s) against this Agreement, Company may allow third party(s) (e.g. engineering, construction, lump sum turnkey and/or maintenance contractors and others), contracted to work on behalf of Company, the right to release Purchase Order(s) against this Agreement provided the third party is not a competitor of Seller and further provided that the third party in question is either acting as agent for and on behalf of Company or that the Goods are to be purchased by the third party in its own name for use by Company or in a Company-owned facility.

22.02 All terms and conditions (including delivery obligations) of a Purchase Order released by a participant third party and any proposal submitted by Seller to a participant third party as a result of a bidding process, shall be in accordance with this Agreement. Company shall notify the participant third party of the Agreement and direct the participant third party to comply with the terms of the Agreement. A copy of any Seller's proposal to a participant third party shall be communicated to Company in accordance with Clause 21.

Clause 23: Company's Obligations and Work On Company's Site

23.01 Unless otherwise specifically agreed in the Purchase Order, Seller's personnel shall not perform Services on equipment in operation on Company's work site.

23.02 If Seller is to perform Services on Company's work site, Company shall be responsible for obtaining all applicable permits, visas or other governmental approvals required. Company shall be responsible for ensuring the safety of work conditions at its site and the safety of Seller's personnel.

23.03 Seller ensures that its employees, subcontractors and agents adhere to and comply with Company's health, safety, security and environmental ("HSSE") policies while at the work site, to the extent these policies have been made available to Seller.

23.04 The obligations of Company shall be set forth in the applicable Purchase Order. Company agrees to cooperate with Seller in the performance of the project described in the Purchase Order hereunder, including, without limitation, providing Seller with reasonable facilities, timely access to data, information and personnel of Company and a safe working environment. Company acknowledges and agrees that Seller's performance is dependent upon the timely and effective satisfaction of Company's responsibilities hereunder and timely decisions and approvals of Company where required.

23.05 Company acknowledges and agrees that Seller may, in performing its obligations pursuant to this Agreement, be dependent upon or use data, material, and other information furnished by Company without any independent investigation or verification thereof, and that Seller shall be entitled to rely upon the accuracy and completeness of such information in performing its obligations.

Clause 24: Insurance

24.01 Seller maintains insurance and shall provide upon request to Company, certificates of such insurance policies.

Clause 25: Non-Solicitation

25.01 Neither Party shall, during the term of the Agreement and for one (1) year after its termination, solicit for hire as an employee, consultant or otherwise any of the other party's personnel who have had direct involvement with the Services, without such other Party's express prior written consent.

Clause 26: Press Releases and Client List Reference

26.01 Neither Party shall issue any press release concerning Seller's work without the other consent. Notwithstanding the foregoing, Seller may identify Company as a client of Seller, use Company's name and logo and release and announcement regarding the award of this Agreement. Seller may generally describe the nature of the Services in Seller's promotional materials, presentations, case studies, qualification statements and proposals to current and prospective clients.

Clause 27: Independent Contractor

27.01 Seller is performing the Services as an independent contractor and not as an employee of Company and none of Seller's personnel shall be entitled to receive any compensation, benefits or other incidents of employment from Company. Seller shall be responsible for all taxes and other expenses arising from the employment or independent contractor relationship between Seller and its personnel and the provision of services hereunder by such personnel to Company.

27.02 At all time and notwithstanding anything to the contrary herein or in a Purchase Order, Seller retains full control over the methods, details, persons employed or otherwise used to perform the Services and any other means of performance of its obligations under a Purchase Order and vary the composition of the team assigned to the performance of the Services or make different arrangements to achieve completion of its obligations.

27.03 Nothing in this Agreement shall be deemed to constitute a partnership, joint venture, or fiduciary relationship between Company and Seller, nor shall anything in this Agreement be deemed to create an agency relationship between Company and Seller. Neither Company nor Seller shall be or become liable or bound by any representation, act or omission whatsoever of the other.