NEWFOUNDLAND AND LABRADOR

BOARD OF COMMISSIONERS OF PUBLIC UTILITIES

120 Torbay Road, P.O. Box 21040, St. John's, Newfoundland and Labrador, Canada, A1A 5B2

2013-11-25

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Dear Sirs:

Re: Newfoundland and Labrador Hydro – Application for approval of a capital project for the installation of diesel units at Holyrood for the purposes of blackstarting the generating units, and for the deferral of lease costs.

The above application was received and copied to you on November 22, 2013. Attached is a copy of the documentation relating to this file on record with the Board. The Board considers this application time-sensitive and has shortened the timeframe for the filing of comments to 3:00 pm Thursday November 28, 2013.

If you have any questions, please do not hesitate to contact the Board's Legal Counsel, Ms. Jacqui Glynn, by email jgylnn@pub.nl.ca or by telephone, 709-726-6781.

Yours truly,

Cheryl Blundon
Board Secretary

/cpj
Encls.

ecc. **Newfoundland and Labrador Hydro**
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February 17, 2011

Board of Commissioners of Public Utilities
Prince Charles Building
120 Torbay Road, P.O. Box 21040
St. John's, NL
A1A 5B2

ATTENTION: Ms. Cheryl Blundon
Director of Corporate Services & Board Secretary

Dear Ms. Blundon:

Re: Holyrood Gas Turbine Generating Unit - Blackstart

Over the past few months, we have been communicating with Board staff as to Stop Work Orders that had been issued by the Occupational Health and Safety Division of the Department of Government Services concerning the gas turbine at the Holyrood Thermal Generating Station. This gas turbine unit provides Hydro with "blackstart" capability for that generating station. I can now confirm that we have been informed that these Stop Work Orders have now been closed so the gas turbine unit is again available for Hydro's use for blackstart purposes.

Should you have any questions or comments, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

Geoffrey P. Young
Senior Legal Counsel

GPY/jc

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March 4, 2013

Board of Commissioners of Public Utilities
Prince Charles Building
120 Torbay Road, P.O. Box 21040
St. John's, NL
A1A 5B2

ATTENTION: Ms. Cheryl Blundon
Director of Corporate Services & Board Secretary

Dear Ms. Blundon:

Re: System Wide Power Outage January 11 and 12, 2013

This is further to correspondence from the Board on the above-noted matter dated February 12 and 14, 2013 in which the Board posed a number of follow-up questions arising from the meeting held at the Board's offices on January 29, 2013. The answer to the questions posed are provided below in question and answer format.

February 12, 2013

Q1. Confirm that the Holyrood gas turbine is in fact not available for service, and provide the date at which the decision was made to take this unit out of service.

A1. The Holyrood gas turbine has not been available for service since January 18, 2012. No decision has been made to permanently remove the gas turbine and it is possible that, with some remedial work being performed, it can be brought back to a full operating state. Hydro is presently evaluating the cost effectiveness of doing that remedial work in the context of Hydro's stated intention of constructing a new combustion turbine, possibly sited at Holyrood (this option was referred to in Hydro's *Generation Planning Issues Report 2012*, filed in response to PUB-NLH-1 in Hydro 2013 Capital Budget proceeding).

Q2. Provide an update concerning the present condition of this unit and what actions have been taken since February 17, 2011 to reinstate or replace this unit.

A2. At present, the unit is not in operating condition and no work has been carried out to bring it into operation. Hydro is presently working with Newfoundland Power (NP) to install their 6 MW mobile gas turbine and 2.5 MW mobile diesel unit at the Holyrood site to provide equivalent capabilities. These mobile units are part of the Island's shared generation resources and will be available for these purposes while connected to the grid at Holyrood.

Q3. Confirm that the NP gas turbine and a diesel generator are being relocated to the Holyrood plant.

A3. Yes, this work is in progress.

Q4. Provide an update as to when these units will be available including when the blackstart capability of this arrangement will be confirmed.

A4. The work on the installation of the mobile generating units is in progress and is expected to be completed shortly. Hydro will confirm installation and availability with the Board.

Blackstart capability is being approached from a combination of resources. The combined capacity of the NP mobile generation (8.5 MW) to be deployed at Holyrood is close in capacity to the 10 MW Holyrood gas turbine. In addition, Hydro has devised and successfully tested, through operator simulator models, an operating instruction to provide blackstart power from its Hardwoods gas turbine with power routed through Hydro's 230 kV TL-242 transmission line. In addition to this power routing, an alternative routing of power to Holyrood from Hardwoods has been planned along NP's 69 kV sub-transmission system between the two stations that runs through Conception Bay South.

February 14, 2013

Q1. The Board wishes to know what contingency plans have been implemented by Hydro to ensure timely access the station in the event of another significant snow storm and possible power outage.

A1. Hydro has reviewed its operational response from the January 11 storm and has made some adjustments in the manner in which staff are placed on-call to respond.

On January 11, crews were delayed in arriving to site until around noon due to unsafe road and severe weather conditions impeding travel. There were issues at the time securing appropriate snow clearing from both provincial government operations and private contractors in a timely manner due to safety considerations. Assigned non-supervisory crew members were equipped with vehicles at their private residence on the evening prior to the storm; however, they were still unable to safely traverse roadways.

A challenge to devising an emergency transportation plan is that the location of storm related trouble is unpredictable—such a problem can arise anywhere on Hydro's systems (generation, transmission, terminal station, distribution or communication). This means that the type of personnel and equipment required to address the problem and the location where those resources will need to be deployed are not possible to plan and predict with confidence. Therefore, the emergency transportation has to be sufficiently general and flexible to be responsive to any emergency that might arise.

Notwithstanding those challenges, to enable the greatest flexibility Hydro has determined that at times of future impending storms, front line supervisors will be designated to be on-call and will be equipped with the most suitable of the available vehicles to travel in snow storm conditions. The intention is that, in a storm related event, with consideration for safe transit, they will be able to pick up the required personnel and bring them to the location of the trouble so that remedial action can be taken in as timely a manner as possible.

Q2. Please provide an update on the status of Hydro's post event analysis including the Emergency Response and Life Safety Review discussed at the meeting with Board staff on January 29, 2013.

A2. The Emergency Response and Life Safety Review is in progress but is not yet complete.

Should you require additional information, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

Geoffrey P. Young
Senior Legal Counsel

GPY/jc

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August 5, 2013

Board of Commissioners of Public Utilities
Prince Charles Building
120 Torbay Road, P.O. Box 21040
St. John's, NL
A1A 5B2

ATTENTION: Ms. Cheryl Blundon
Director of Corporate Services & Board Secretary

Dear Ms. Blundon:

Re: Holyrood Blackstart Capability

Further to your letter of July 23, 2013 regarding the above noted matter, the following are Hydro's responses to the Board's questions:

Q1. Please confirm that Newfoundland Power Inc.'s mobile units are now in place at Holyrood and are capable of providing reliable blackstart capability.

A1. Newfoundland Power's mobile gas turbine and diesel units were in place at Holyrood during the winter season but have since been removed as they are not required during the summer months and Newfoundland Power needed them for their own purposes. Testing of the mobile units determined that they are not of sufficient capability to start a boiler feed pump and therefore cannot provide blackstart capability. There are, however, several advantages to having the mobile units installed to provide 4160 v power such as:

a. Life Safety:
- forced draft fans can be ran to evacuate smoke from furnaces / powerhouse in the unlikely circumstance of a smoke producing event.

b. Faster restoration of unit generation (4-6 hours faster) upon re-establishing station service to the powerhouse:
- ability to restart air compressors;
- cooling water pumps can be ran to maintain equipment temperatures; and
- extraction pumps can be ran to manage water chemistry and exhaust hood temperature.

c. Increased generation on the east coast of the province.

d. Holyrood now has infrastructure installed that will allow for easier connection of future mobile generation to the powerhouse at the correct voltage level.

Q2. What other means of blackstart are available for Holyrood? List all the alternatives and the benefits and issues associated with each.

A2. Hydro has considered several alternatives to provide the blackstart capability for the Holyrood Generating Station including:

- Installation of a new gas turbine at Holyrood;
- Refurbishment of the existing Holyrood gas turbine;
- Leasing of a gas turbine for Holyrood blackstart; and
- Utilizing the Hardwoods gas turbine for blackstart of Holyrood.

Hydro has identified the need for a new 60 MW (nominal) gas turbine in the year 2015 to meet the generation planning criteria with respect to loss of load hours (LOLH). The installation of this new gas turbine at the Holyrood site would not only satisfy the generation planning criteria, but also provide the blackstart capability for the Holyrood Generating Station. By comparison, refurbishment of the existing Holyrood gas turbine in the interim is viewed as an unnecessary capital expenditure, given that a new gas turbine is required in 2015. In the intervening period, between 2013 and completion of the new gas turbine in 2015, it is prudent for Hydro to provide blackstart capability for Holyrood given the significance of this generation on the system. Therefore, Hydro proposes to utilize the Hardwoods gas turbine and associated 230 kV transmission connections between Hardwoods and Holyrood in the 2013 – 2015 timeframe. This existing blackstart capability within the Island Interconnected Transmission System negates the need to lease mobile gas turbine for the two-year period.

It is Hydro's intent to provide the Board with a capital budget application for the purchase and installation of this 60 MW (nominal) combustion turbine at the Holyrood site.

Q3. In the event of an outage, how will station service be provided to Holyrood? List all alternatives and the benefits and issues associated with each.

A3. In the event of a unit outage there are 4160 v tie breakers within the powerhouse which can be closed to distribute power from one station service board to another in order to provide power to the necessary equipment. In the event of a complete plant outage, with all three units down, the station service is supplied by two redundant transformers and lines from the ring bus configured terminal station. Only one of these lines from the terminal station is required to provide full station service power to the powerhouse. If the terminal station has an outage then blackstart station service power must be provided by an external generator as was the case on January 11, 2013. As stated earlier, the Newfoundland Power mobile units would offer some benefit in terms of restoration time improvement, but testing has established that the units could not blackstart a unit at the plant.

Q4. In relation to the possible use of the Hardwoods Gas Turbine for blackstart at Holyrood please respond to the following information requests:

a. Please provide the age and the reliability history of the Hardwoods unit.
b. Please explain the planned system configuration to provide Holyrood blackstart from the Hardwoods unit.
c. Please provide details of the past usage, or considered usage, of the Hardwoods unit for blackstart at Holyrood, including the success of such efforts or the reasons for the failure of any efforts.
d. Please provide an explanation of industry practice, setting out sources, in relation to offsite blackstart capability and station service for a generating station like Holyrood.
e. Please provide a comparison of the estimated time for blackstart at Holyrood using the Hardwoods unit, taking into account the necessary configuration and switching operations, to that of a blackstart from an onsite unit, clearly explaining the reasons for any differences. Please explain the issues and implications associated with the timeframes for each, addressing the issue of station service.
f. Please provide an explanation in relation to any issues or problems that may delay or otherwise negatively impact Holyrood blackstart from the Hardwoods unit. Please include in the response any possible problems on the system with generation, transmission or distribution, i.e. downed lines, that might negatively impact Holyrood blackstart from the Hardwoods unit.

A4. a. The Hardwoods gas turbine is 36 years old. It has been in service since 1977.

Certain major components have been replaced or refurbished in recent years. These include:

- End A Clutch Inspection (2010);
- End B Clutch Inspection (2011);
- Alternator Bearing Replacement (2010);
- Engine 2022-24 Overhaul (2011);
- Engine 2022-23 Overhaul (2012); and
- End B Speed Governor / Fuel Valve Assembly Replacement (2011).

The reliability statistics are shown below.

Five Year Average 2008-2012

Unit	All Causes		
	Capability Factor (%)	UFOP (%)	Failure Rate
Hardwoods	85.53	26.39	116.37
All Hydro Gas Turbine Units	76.88	22.64	137.89
CEA (2002-2012)	86.19	11.84	22.3

Capability Factor is defined as unit available time. It is the ratio of the unit's available time to the total number of unit hours.

DAFOR is defined as Derated Adjusted Forced Outage Rate. It is the ratio of equivalent forced outage time to equivalent forced outage time plus the total equivalent operating time. It is not reported for gas turbines due to the very low operating time.

UFOP is defined as the Utilization Forced Outage Probability. It is the probability that a generation unit will not be available when required. It is used to measure performance of standby units with low operating time such as gas turbines.

Failure Rate is defined as the rate at which the generating unit encouters a forced outage. It is calculated by dividing the number of transitions from an Operating state to a forced outage by the total operting time. It can be greatly influenced by operating time of standby units such as gas turbines.

b. The planned system configuration to provide Holyrood blackstart from the Hardwoods unit is to provide a direct path from the Hardwoods terminal station to the Holyrood terminal station via the 230 kV transmission line, TL242.

In order to achieve this configuration, Hydro would perform the following:

- Isolate from the power system the Hardwoods and Holyrood terminal stations by opening the particular breakers in each terminal station; and
- Isolate Newfoundland Power's distribution at Hardwoods terminal station by requesting Newfoundland Power to open particular breakers in that terminal station.

Hydro would then begin switching operations to energize the system path to supply the Holyrood Generating Station. This would be achieved by:

- Start the Hardwoods gas turbine;
- Energize the 66 kV Bus at Hardwoods;
- Energize one of Hardwoods 230 kV/66 kV transformers (T3);

- Energize the 230 kV transmission line (TL242) to the Holyrood Terminal Station;
- Energize 230 kV/66 kV transformer (T10) at Holyrood Terminal Station; and
- Supply station service by energizing station service transformer (SST-34) at the Holyrood Generating Station.

c. The Hardwoods gas turbine has not been used nor tested for a blackstart of the Holyrood Generating Station.

In the past, the Hardwoods gas turbine was thought of as an option for blackstart at Holyrood. However, with the availability of the Holyrood gas turbine, it was not required. With the GT at Holyrood not available, the option of Hardwoods blackstart was more closely considered. Hydro has conducted successful simulations to this effect using power system models and the Operator Training Simulator. Based on the simulations, an operating procedure was developed.

d. Hydro has not completed in-depth research into industry practice in relation blackstart/station service for specific plant types such as Holyrood. Hydro, while not a member of any regional reliability organization, provides the following information to the Board.

The North American Electric Reliability Corporation (NERC) defines Blackstart Resource as:

A generating unit(s) and its associated set of equipment which has the ability to be started without support from the System or is designed to remain energized without connection to the remainder of the System, with the ability to energize a bus, meeting the Transmission Operator's restoration plan needs for real and reactive power capability, frequency and voltage control, and that has been included in the Transmission Operator's restoration plan.

NERC Emergency Preparedness and Operations (EOP) standard EOP-005-2 covers system restoration from blackstart resources. In essence the standard requires that each Transmission Operator have a restoration plan. The plan must include the capabilities of the blackstart resources.

The Northeastern Power Coordinating Council, Inc. (NPCC) defines Blackstart Capability as:

The ability of a generating unit or station to go from a shutdown condition to an operating condition and start delivering power without assistance from the electric system.

NPCC Directory 8 "System Restoration" provides the basic criteria for entities to plan for and perform power system restoration following a major, or total, blackout. Section 5.1 of the directory provides the restoration plan requirements for NPCC members. Included in these requirements is the need to identify a basic minimum power system (i.e. one or more generators, lines and substations operating in the form of an island) which can be used to initiate the restoration process.

Upon review of the noted NERC and NPCC standards with respect to blackstart of Holyrood, there is nothing at this point that would prevent use of the Hardwoods gas turbine (which can be started independent of the system) to energize the 66 and 230 kV buses at Hardwoods, the 230 kV transmission line TL242 to Holyrood and then the 230/66 kV and 66/4.16 kV transformation at Holyrood to blackstart the Holyrood plant.

e. Please see below.

Call in Hardwoods Gas Turbine Operator (If operator is not onsite, i.e. outside regular working hours)	1 hour
Open Holyrood and Hardwoods breakers (Including Newfoundland Power's breakers at Hardwoods)	10 minutes
Start Hardwoods Gas Turbine and warm up	15 minutes
Energise Hardwoods Terminal Station and make voltage adjustments	5 minutes
Energise TL242 from Hardwoods to Holyrood and make voltage adjustments	5 minutes
Energise Holyrood Terminal Station and make voltage adjustments	5 minutes
Energise Holyrood Station Service	5 minutes
Approximate Total Time (With operator onsite)	45 minutes
Approximate Total Time (Without operator onsite)	1 hour 45 minutes

<u>Blackstart with onsite unit:</u>

600v emergency diesels start and provide Power to the two essential services motor control Centers	5 minutes
Energise station service for the onsite gas turbine	5 minutes
Start the onsite gas turbine and warm up	15 minutes
Energise the plant 4160 station service	5 minutes
Approximate Total Time	30 minutes

As can be seen from the above timelines, the Hardwoods option is more time-consuming. Any misoperation of equipment associated with the delivery of blackstart capability from Hardwoods could expand the required time. As well, having onsite blackstart capability removes the requirement for voltage adjustment across the transmission line from Hardwoods to Holyrood.

f. Issues or problems that may delay or otherwise negatively impact Holyrood blackstart from the Hardwoods unit are:

- TL242 Unavailable: If TL242 was unavailable for use (i.e. a fault on the line, a downed conductor, severe weather, etc.), the approach would be to use TL236 to the Oxen Pond terminal station, then TL218 to the Holyrood terminal station. Given this is a longer transmission route, an additional 20 km, voltage levels will need to be monitored closely and adjusted as required.
- TL242 and TL236 or TL218 Unavailable: If TL242 and TL236 or TL218 were unavailable for use the approach would be to use Newfoundland Power's 69 kV transmission system from the Hardwoods terminal station to the Holyrood terminal station. This approach utilizes transmission lines 79L or 49L (Hardwoods), 51L (Chamberlains), 52L (Kelligrews), and 38L (Seal Cove). Given this is a 69k V transmission route and utilizes both Hydro and Newfoundland Power's equipment, strong communication and coordination would be required.
- Hardwoods Gas Turbine Unavailable: If the Hardwoods gas turbine was unavailable, then a blackstart of Holyrood would not be possible. The Hardwoods GT could be unavailable due to planned maintenance or forced outage on the GT or its associated breaker or transformer.
- Hardwoods Gas Turbine Fails to Start: If the Hardwoods GT fails to start or subsequently trips upon synchronization, then a blackstart of Holyrood would not be possible. Hydro personnel would be dispatched to investigate and correct the problem.
- Terminal Station / Transmission Line Lockouts: If a terminal station (i.e. Hardwoods, Holyrood) was to have a bus lockout or breaker lockout that affects the transmission path, then either the lockouts would have to be cleared (which requires onsite intervention), or another transmission path would be attempted.
- Power System Instability: The largest load at the Holyrood plant, that affects system stability, is the boiler feed pump/motor. When this pump is started, due to inrush currents and load pickup, it can create voltage suppression and frequency instability.

Q5. Please provide a cost benefit analysis that compares the procurement of an onsite gas turbine for blackstart at Holyrood, which may then be used for other purposes when and if it is no longer necessary at Holyrood, with any other options that may be available for the supply of blackstart capability at Holyrood.

A5. Later this year, Hydro is planning on submitting a capital budget proposal to the Board to construct a nominal 60 MW gas turbine onsite at Holyrood. One of the justifications for this gas turbine is to provide blackstart capability for Holyrood.

The capital budget submission will include the cost benefit analysis indicating why this is the most cost-effective option to providing all the benefits associated with this proposal, including blackstart capability.

If you have any questions or comments, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

Carla L. Russell, CA
Manager, Rates and Regulation

CLR/jc

NEWFOUNDLAND AND LABRADOR
BOARD OF COMMISSIONERS OF PUBLIC UTILITIES
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2013-10-17

Mr. Geoffrey Young
Newfoundland and Labrador Hydro
P. O. Box 12400
Hydro Place, Columbus Drive
St. John's, NL A1B 4K7

Dear Mr. Young:

Re: Holyrood Black Start Capability

This is a follow-up regarding Hydro's proposed plan in relation to black start capability at Holyrood. The Board has concerns about this plan and Hydro's handling of the matter to date. This letter sets out the Board's concerns and the steps that Hydro should take to address these concerns.

In its 2011 Capital Budget application Hydro proposed a project to overhaul the Holyrood gas turbine which was used for Holyrood black start, stating:

> *"The Holyrood gas turbine plant is critical to the successful operation of the Island Interconnected System. Its main function is to supply power to Holyrood during a black start. A black start of Holyrood is required when the plant is unable to attain power from the Island Interconnected grid due to an emergency outage caused by other generation sources. If the gas turbine failed to supply power to Holyrood during a black start, Holyrood would not be able to start until power was restored to the grid by alternate generation sources. This would cause an unnecessary delay in restoring full power to the grid. For this reason, the gas turbine plant needs to be reliable".* (Newfoundland and Labrador Hydro 2011 Capital Budget Application, Volume I, page B-16; see *Overhaul Gas Turbine, Holyrood Thermal Generating Station, April 2010,* pages 10 and 12)

During the 2011 Capital Budget application process Hydro advised that the Occupational Health and Safety Department of the provincial Government had issued a directive preventing the Holyrood gas turbine from being operated as a result of health and safety concerns associated with exhaust and gas leaks and oil leaks in the power turbine and main gearbox. Hydro advised that, as a result of this directive, it was deferring the project to overhaul the Holyrood gas turbine and explained that:

> *"The gas turbine is essential to black start the Holyrood plant. Without this gas turbine the Holyrood plant would not be able to be started when there is a loss of transmission connection to the plant from of the Avalon Peninsula. A source with a capability of approximately 10 MW is necessary to start a Holyrood generating unit. Given the uncertain of the repair time it is prudent to secure another source of black start capability prior to the 2010/2011 winter. Otherwise, while the unit is out of service for repairs and assessment, the supply to the Avalon Peninsula area will be vulnerable to long outages cause by extended transmission outages. While such events are rare, the requirement for black starting occurred in the past as result of severe ice storms, the last one being in December, 1994."*
>
> *"For the immediate future, until the problems associated with the gas turbine plant are resolved, Hydro will need to put in place an alternate source of power supply for the Holyrood Thermal Generating Station to replace the capability of the gas turbine plant. To fulfil this need Hydro intends to submit a new capital budget proposal in the coming weeks to lease a mobile gas turbine plant."*

On February 17, 2011 Hydro confirmed with the Board that the directive had been rescinded and that the gas turbine at Holyrood was available for black start purposes.

On January 11, 2013 there was a system wide outage event on the Island Interconnected system. On January 29, 2013, during a meeting with Hydro personnel in relation to this outage, Board staff learned that the Holyrood gas turbine was not available for black start. On March 4, 2013, in response to information requests from the Board, Hydro confirmed that that the Holyrood gas turbine had not been available for service since January 18, 2012. Hydro advised that it was working with Newfoundland Power to install its 6 MW mobile gas turbine and 2.5 MW mobile diesel unit and that it would report to the Board once the system was installed and operational. Hydro also reported that as an alternative it had devised and modelled an operating instruction to provide black start power from its Hardwoods gas turbine with power routed through Hydro's 230 kV TL-242 transmission line or alternatively along Newfoundland Power's 69kV sub-transmission system between the two stations that run through Conception Bay South.

On August 5, 2013, in reply to further inquiries from the Board, Hydro advised that the Newfoundland Power mobile units had been removed as it was determined that they could not provide black start capability for Holyrood. Hydro advised that it intends to submit a capital budget application for the installation of a 60MW gas turbine at the Holyrood site which would provide black start capability for the Holyrood Thermal Generating Station in 2015. Hydro explained that it views the refurbishment of the existing Holyrood gas turbine as an unnecessary capital expenditure given that a new gas turbine is required in 2015, stating:

> *"In the intervening period, between 2013 and completion of the new gas turbine in 2015, it is prudent for Hydro to provide black start capability for Holyrood given the significance of this generation on the system. Therefore, Hydro proposes to utilize the Hardwoods gas turbine and associated 230 kV transmission connection between Hardwoods and Holyrood in the 2013-2015 timeframe. This existing black start capability within the Island Interconnected Transmission System negates the need to lease mobile gas turbine for the two-year period."*

Hydro provided the planned system configuration for Holyrood black start using the Hardwoods gas turbine. While Hydro confirmed that the Hardwoods gas turbine had not been used or tested for a black start of the Holyrood Thermal Generating Station it explained that

simulations using the power system models and the Operator Training Simulator were successfully conducted. Hydro explained that black start with an onsite unit would be about 30 minutes but using Hardwoods would require approximately 45 minutes if there is an operator on site and, if not, 1 hour and 45 minutes. Hydro also noted several issues which may delay or otherwise impact Holyrood black start from Hardwoods, including the unavailability of certain transmission lines and terminal stations as well as power system instability. Hydro confirmed that Holyrood now has infrastructure installed that would allow for easier connection of mobile generation to the powerhouse at the correct voltage level. In relation to station service Hydro advised that, in the event of a complete plant outage with failure of the terminal station like the circumstances of the system wide outage on January 11, 2013, black start station service power must be provided by an external generator.

The Board has reviewed the information provided by Hydro with respect to the ongoing issues associated with black start at Holyrood. The Board accepts Hydro's evidence that the Holyrood gas turbine plant was critical to the operation of the Island Interconnected system. Hydro advised that the 60MW generating unit that it plans to install at Holyrood in 2015 to meet generation planning criteria will also provide black start capability. In the interim, Hydro advised that modelling suggests that Holyrood black start capability can be provided from the Hardwoods gas turbine. However, Hydro also explained that this approach has not been used in the past and further that there may be issues with Holyrood black start using the Hardwoods gas turbine if certain transmission lines and terminal stations are not available or if there is power system instability.

While the Board accepts that Hardwoods could provide black start capability, the Board has concerns in relation to the reliability of this approach given the uncertainties and issues cited by Hydro. The Board believes that the potential delays caused by black start using Hardwoods could possibly be critical to system operation, especially as it relates to station service. As set out in Hydro's correspondence dated August 5, 2013, the timely restoration of station service is critical to life safety and system operations as it allows the operation of forced draft fans to evacuate smoke, the restart of air compressors, operation of cooling water pumps to maintain equipment temperatures, and operation of extraction pumps to manage water chemistry and exhaust hood temperature.

Hydro is required to provide services that are reasonably safe and adequate and just and reasonable. Hydro provided evidence that the Holyrood gas turbine is critical and that the proposed plan for Holyrood black start has not been used before and may not work at a time when it is most needed such as during the January 2013 event. The Board is not persuaded based on the information provided that Hydro's proposed plan for Holyrood black start meets the required standard.

The Board will therefore require Hydro to take immediate action to ensure all possible options have been considered to provide reliable Holyrood black start capability. The Board notes that Hydro failed to answer the Board's July 23, 2013 request to provide a cost benefit analysis as to alternatives in relation to Holyrood black start, including the procurement of an onsite gas turbine for black start at Holyrood. Hydro should make the necessary inquiries on an urgent basis and report back to the Board immediately as to the available alternatives. To be clear Hydro is required to inquire, investigate, analyze and report within 30 days as to whether an appropriately sized gas turbine is available to be purchased or leased and installed for Holyrood black start. Hydro should also advise as to the timeframes and costs associated with refurbishing the existing Holyrood gas turbine. The Board realizes that this is very short

timeframe but this is necessary to address its concerns in relation to the Holyrood black start, especially given we are now approaching the winter peak season.

The Board would also like to express its concern with Hydro's failure to communicate in a timely manner in relation to this issue. Hydro did not advise the Board that Holyrood did not have black start capability as of January 18, 2012 and also failed to advise the Board when it became apparent that Newfoundland Power's mobile units could not provide black start capability. This is especially concerning given that the issues associated with Holyrood black start had been raised in the fall of 2010 as part of Hydro's 2011 Capital Budget. Therefore the Board requires Hydro to undertake a review to determine what caused the failure in communication and then report to the Board as to the steps that have been taken to ensure better regulatory reporting in the future.

If you have any questions, please do not hesitate to contact the Board's Legal Counsel, Ms. Jacqui Glynn, via jgylnn@pub.nl.ca or (709) 726-6781.

Yours truly,

C Blundon

Cheryl Blundon
Board Secretary

/cpj

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November 1, 2013

Ms. Cheryl Blundon, Director
Corporate Services and Board Secretary
Newfoundland and Labrador
Board of Commissioners of Public Utilities
120 Torbay Road
P. O. Box 12040
St. John's, NL A1A 5B2

Dear Ms. Blundon:

Re: Holyrood Black Start Capability

I am writing in response to your letter of October 17, 2013, in which you request Newfoundland and Labrador Hydro (Hydro) to provide an update with respect to the status of the steps Hydro is taking to address concerns regarding black start capability at Holyrood.

In response to this request, Hydro has initiated the following actions:

We have begun an investigation of the viable options with respect to providing on-site black start capability at the Holyrood Thermal Generating Station (HTGS). The following four options are being explored:

i. Purchase or lease a mobile gas turbine;
ii. Purchase or lease a mobile diesel plant;
iii. Purchase or lease a mobile diesel to be installed with Newfoundland Power's mobile generation; and
iv. Refurbishment of the existing gas turbines.

This activity requires technical analysis to determine the starting power required to start a boiler feed pump at the plant. The boiler feed pump is the single largest load that has to be started in a black start scenario. With this information in hand, Hydro will provide to the Board by November 18 the availability of an appropriately sized gas turbine for installation at Holyrood, as well as a review of the benefits and costs of the other options.

We are also concerned about the breakdown in communication on the status of the Holyrood Gas Turbine and appreciate the Board's concern in this regard as well. We will be investigating how this occurred and we will advise the Board how we intend to improve regulatory reporting in the future for these circumstances. If you require additional information or have any questions, or would like to meet on the matter once we have completed the report, please contact Geoff Young, who will make arrangements.

Sincerely,

R. J. Henderson
Vice-President
Newfoundland & Labrador Hydro

RH:bt

.cc Mr. Geoff Young, Senior Legal Counsel
Ms. Carla Russell, Manager, Rates and Regulation
Ms. Jill Chisamore, Regulatory Coordinator

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November 18, 2013

Ms. Cheryl Blundon, Director
Corporate Services and Board Secretary
Newfoundland and Labrador
Board of Commissioners of Public Utilities
120 Torbay Road
P. O. Box 12040
St. John's, NL A1A 5B2

Dear Ms. Blundon:

Re: Holyrood Black Start Capability

This is in response to your letter from the Board of October 17, 2013 requesting Hydro address two issues regarding black start at the Holyrood Thermal Generating Station (HTGS).

The first request regarding options to provide full black start capability was as follows:

The Board will therefore require Hydro to take immediate action to ensure all possible options have been considered to provide reliable Holyrood black start capability. The Board notes that Hydro failed to answer the Board's July 23, 2013 request to provide a cost benefit analysis as to alternatives in relation to Holyrood black start, including the procurement of an onsite gas turbine for black start at Holyrood. Hydro should make the necessary inquiries on an urgent basis and report back to the Board immediately as to the available alternatives. To be clear Hydro is required to inquire, investigate, analyze and report within 30 days as to whether an appropriately sized gas turbine is available to be purchased or leased and installed for Holyrood black start. Hydro should also advise as to the timeframes and costs associated with refurbishing the existing Holyrood gas turbine.

The second request was regarding communications with the Board as follows:

The Board requires Hydro to undertake a review to determine what caused the failure in communication and then report to the Board as to the steps that have been taken to ensure better regulatory reporting in the future.

Hydro addresses each of these requests below.

1.0 Black Start Alternatives

In response to this request please see the attached report summarizing the availability and the options for providing on site black start capability at the HTGS.

1.1 Availability of a Gas Turbine Option

The report identifies two feasible gas turbine options. The least cost gas turbine option is a three unit 16.7 MW solution. It is estimated to cost $12.8 Million with a scheduled completion of approximately 12 to 13 weeks upon project approval. The other solution is a single unit 22.5 MW plant at a cost estimate of $22.4 Million with a 17 to 18 week schedule upon project approval.

1.2 Least Cost Near Term Black Start Option

The report identified a nominal 16 MW mobile diesel plant as being the least cost technical solution to provide full black start capability in the near term:

> The 16MW mobile diesel plant would be leased for a period of 18 months to provide black start capability to the Holyrood Thermal Plant for the 2013 – 2015 period. Current estimates suggest that it can be installed within 11 weeks of Board and internal Hydro approval.

This solution has a capital cost of $8.2 M.

Project Cost: *($ x1,000)*	**2014**	**2015**	**Beyond**	**Total**
Material Supply	175.0	0.0	0.0	175.0
Labour	381.0	228.0	0.0	609.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	625.0	0.0	0.0	625.0
Other Direct Costs	3,330.0	1,344.0	0.0	4,674.0
Interest and Escalation	330.1	646.0	0.0	
Contingency	0.0	1,216.6	0.0	1,216.6
TOTAL	**4,841.1**	**3,434.6**	**0.0**	**8,275.7**

1.3 Timeframe and Cost of Refurbishing the Existing Gas Turbine

The existing Holyrood CT cannot be refurbished prior to the upcoming winter period. However, it can be ready for the 2014/2015 period. It would require a temporary generation option for this upcoming winter period. This increases the cost of this option. The following is the capital cost estimate:

Project Cost: *($ x1,000)*		**2014**	**Beyond**	**Total**
Material Supply	0.0	1,256.0	0.0	1,631.0
Labour	0.0	2,696.0	0.0	3,551.0
Consultant	0.0	156.0	0.0	195.0
Contract Work	0.0	225.0	0.0	225.0
Other Direct Costs	0.0	2,160.0	0.0	2,160.0
Interest and Escalation	0.0	461.7	0.0	669.8
Contingency	0.0	0.0	0.0	1,071.2
TOTAL	**0.0**	**6,954.7**	**0.0**	**9,503.0**

1.4 Use of the Newfoundland Power Mobile Generation

As mentioned in the letter from the Board, during the winter of 2013 following the January 11 disturbance, Hydro made arrangements with Newfoundland Power to move their mobile gas turbine and a mobile diesel unit to Holyrood. Hydro established an electrical infrastructure in the station to connect mobile generation to the plant. It was hoped that the Newfoundland Power mobile generation would provide black start functionality. However, as noted in the attached report, the units were unable to start a boiler feed pump motor. The units did, however, provide the security of alternative generation that can provide significant benefit to the plant in a situation where supply from the grid is unavailable. In particular all station auxiliary loads other than the boiler feed pump motor can be started. This provides the benefit of keeping equipment warm and operating to enable a quicker plant restart once the supply from other remote generation is available. They were also available for grid support in the event of a generation contingency.

The Newfoundland Power mobile units were removed from Holyrood in late May as Newfoundland Power required them to perform their annual maintenance program. Hydro had intended to request Newfoundland Power to relocate this mobile generation to Holyrood for each winter season until the new 60 MW CT is placed in service. This

had not been mentioned to Newfoundland Power until a recent meeting between the companies. Newfoundland Power asked for a formal Hydro request and also expressed a concern that the units be able to be quickly disconnected for deployment in an emergency. Hydro has since formally requested Newfoundland Power to relocate the Mobile Gas Turbine (MGT) to Holyrood and committed to work with Newfoundland Power to put procedures in place to allow for quick removal to address sustained localized transmission reliability issues. Hydro requested only the MGT as it is sufficient to meet all required station requirements during a grid supply interruption. Hydro indicated to Newfoundland Power in its request, that it was assessing options for full black start capability and therefore the relocation need be only temporary.

2.0 Communications Failure and Steps for Better Regulatory Reporting

The review and the proposed steps to be taken with respect to the communications breakdown are provided below.

2.1 Regulatory Reporting of the Holyrood Gas Turbine Station

Hydro regularly reports to the Board through a number of mechanisms established by the Board for its oversight of Hydro. All of these mechanisms are reasonably adhered to with respect to content and timing. Most of this reporting is of a routine nature such as quarterly reporting, annual reporting and specific reporting related to applications presented to the Board. Reporting of a non-routine nature is made with respect to incidents related to power system equipment affecting reliability or safety.

The reporting of plant conditions and capability has been generally addressed in the context of capital budget applications to the Board for equipment upgrades, refurbishments or replacements. There has been no mechanism established which clearly identifies the requirements to report to the Board of changes in equipment status or capability. It was in this context that Hydro did not report the change in status of the Holyrood Gas Turbine in January 2012.

2.2 Background of Status of the Holyrood Gas Turbine

The Holyrood Gas Turbine was established in the Holyrood Generating Station to provide emergency standby power to the plant for black starting the plant in the event the grid supply was interrupted. The gas turbine is intended to enable the starting of all systems within the plant to enable a large steam generating unit at the plant to be

placed on line to restore service to customers through available transmission lines connecting the plant to load centres. If the transmission lines are unavailable, the gas turbine enables plant systems to be placed in a warm stand-by state which facilitates a faster customer load restoration when the transmission connection is established.

The gas turbine has been very rarely required to perform the black start function. However, it has been maintained and routinely operated to ensure availability. It has also been function tested in simulated black start scenarios when the entire Holyrood plant has been shut down for maintenance.

Due to the age of the gas turbine, Hydro undertook and proposed to the Board as part of the 2011 capital program, a major overhaul work project on the gas turbine to be completed in 2011. Subsequent to proposing this work, an inspection of the unit resulted in a stop work order being placed on the unit by the Department of Government Services, Occupational Health and Safety Inspection Branch (OHS). This resulted in Hydro withdrawing the overhaul proposal and assessing other options. These options included acquiring a replacement facility.

As a result of the withdrawal of the overhaul proposal in the capital program, Hydro informed the Board of this condition and that it was working on solutions. At the time, the Board expressed its concern with the lack of black start capability. In order to expeditiously resolve the situation, Hydro addressed the problem by determining new generation options and also addressing the OHS stop work order concerns. The least cost option was to address the OHS concerns while assessing longer term solutions for the plant. As a result, in February, 2011, the stop work order was removed and the gas turbine was made available with restricted use. The restriction imposed was primarily that it be used only in emergency conditions to black start the plant. This situation was communicated to the Board at that time.

2.3 Actions resulting in unavailability of the Holyrood Gas Turbine

During 2011, Hydro engaged AMEC Consulting to do a condition assessment of the gas turbine plant to assist Hydro in determining the long-term solution for black start of the Holyrood plant. This report was received by Hydro on December 19, 2011; a subsequent meeting with AMEC was held on January 17, 2012, to discuss and better understand the details in the report. This report revealed that there was risk of significant catastrophic failure of the gas turbine if it was operated and AMEC recommended discontinuing for any purpose. As a result, Hydro decided the unit would

no longer be available for black start capability. This condition resulted in discussion within Hydro on options to provide the black start capability. Part of this consideration was that Hydro was preparing an estimate for the new gas turbine to be installed in 2015 on the Avalon Peninsula. The site for this had not been determined at this time but one option was the Holyrood site. A decision was made by Hydro in January 2012 that the Hardwoods gas turbine would be used to black start Holyrood under the circumstance that the transmission supply to the Avalon Peninsula was interrupted. This was Hydro's established plan for the unavailability of the gas turbine. This was considered a short term measure until a new black start unit was established. It was also decided that the options for the black start requirement of Holyrood would be assessed in the context of the site location decision for the new 50 MW combustion turbine. The decisions and considerations that occurred in January 2012 were not communicated to the Board as there were no pending applications before the Board.

There was no intention for Hydro not to communicate the decision to discontinue black start operation using the Holyrood gas turbine and the short-term measure of using Hardwoods. It was more related to the fact that normal reporting of these circumstances is communicated in the context of capital project submissions. It was Hydro's intention to report this circumstance as part of an application to the Board for the proposed replacement black start facility.

During 2012, Hydro assessed the option for location of the new 50 MW combustion turbine and concluded that the least cost option was to locate the combustion turbine in Holyrood. This decision involved a number of factors, one of which was the unit would be able to provide black start capability to Holyrood. This decision and recommendation will be included in Hydro's application for the new combustion turbine to be filed later in 2013.

2.4 Future Reporting Recommendation

As a result of the concerns raised by the Board in their letter of October 2013, Hydro proposes that in future, Hydro will report within forty-eight (48) hours, as part of its incident reporting system, any changes to plant generating capacity as a result of condition assessments or equipment failure that will require capital investment or an extended time to correct.

Included in these reports will be the corrective measures being undertaken by Hydro to mitigate the capacity deficiency to minimize the impact on the reliable supply to customers during the period the long-term solution is put in place.

3.0 Summary

In summary, Hydro shares the Board's concern for the safe and reliable supply of electricity to consumers. The contingency plan Hydro implemented using the Hardwoods gas turbine proved to be inadequate in the circumstances experienced on January 11, 2013. In response to that, Hydro took steps to move the Newfoundland Power mobile generation to Holyrood. Hydro established a safe and reliable connection in Holyrood to connect this mobile generation. This solution has proven to be unable to provide full black start as it cannot start the large boiler feed pump motors. However, it does provide some substantial station service benefits that will provide both safety and reliability benefits. The recommended long term black start option is use of the new 60 MW CT at Holyrood. In the interim there are leasing options to establish full black start capability during the upcoming winter with the least cost estimated to cost $8.2 Million.

Hydro recognizes that communications with regard to black start at Holyrood and the loss in capability have not met the Board's expectations. Hydro is committed to improving communications with the Board and has proposed a solution to deal with the specific issue of significant changes in system equipment capability. However, Hydro would also welcome an opportunity to meet with Board staff to discuss other areas of concern to ensure a full understanding of the Board's expectations with regard to communications on Hydro's activities and that these are met.

Sincerely,

R. J. Henderson
Vice-President
Newfoundland and Labrador Hydro

RH:bt

.cc Mr. Geoff Young, Senior Legal Counsel
Ms. Jill Chisamore, Regulatory Coordinator

Analysis of Options to Provide Black Start Capability to Holyrood Thermal Generating Station

Nov 18, 2013

Executive Summary

The Holyrood Thermal Generating Station is required to have black start capability in the event of a loss of grid power. In light of the unavailability of the existing Holyrood Gas Turbine and concerns with the use of the Hardwoods Gas Turbine as a reliable short term alternative, the Public Utilities Board (PUB) has recently asked that Hydro consider options to provide black start capability to the Holyrood plant for the 2013 – 2014 heating season and beyond.

Hydro has performed a technical analysis of the options that could provide black start capability to the Holyrood plant. This analysis modeled several different generator solutions interconnected to the Holyrood plant. By modeling a black start event, Hydro was able to predict the ability of a particular generation solution to start the thermal plant and in particular the large boiler feed pump motors.

Additionally, Hydro has worked with generator suppliers to source units that could be delivered to the Holyrood plant on very short notice, in order to meet the needs of the 2013-2014 heating season. There are several technically viable options, however it is worth noting that recent infrastructure devastation in the Philippines has greatly increased the demand for mobile generation units. This may change the availability of the generators modeled in this study.

This project will require an exemption from the Department of Environmental Affairs so as to meet the project schedule. The current legislation process would effectively cause this solution to miss much, if not all, of the 2013 – 2014 heating season. While approval of an exemption is outside of the control of Hydro, Hydro is cautiously optimistic that such an exemption can be received.

Hydro has identified the least cost option is a 16MW Diesel Plant leased for a period of 18 months to provide black start capability to the Holyrood Thermal Generating Station for 2013 – 2015 heating seasons. Current estimates suggest that it can be installed within 11 weeks of PUB and internal Hydro approval.

Contents

1 Introduction

The Holyrood Thermal Generating Station is required to have black start capability in the event of a loss of grid power. This capability had been provided by a 15MW Combustion Turbine (CT) located at the Holyrood facility. However, because of its age and technical issues with the unit, Hydro undertook a study in 2011 to determine if the existing CT should be refurbished, or replaced with another generation solution. That study recommended that the existing unit be replaced with a new combustion turbine. Hydro has been advancing that option through the preparation of a capital project application to the Public Utilities Board (PUB) for the approval of a 60 MW CT in Holyrood for in-service in late 2015. In the interim due to the condition of the existing Holyrood CT and significant safety risks with its operation, Hydro decided to disable its use and put in place an interim black start plan utilizing the Hardwoods Gas Turbine and the multiple transmission paths between it and Holyrood.

The PUB has recently asked that Hydro reconsider options to provide black start capability to the Holyrood plant due to reliability risks associated with Hydro's interim black start solution using the Hardwoods Gas Turbine. Part of that analysis must include the option of refurbishing the existing Combustion Turbine.

This report will review the results of the 2011 Condition Assessment of the Holyrood Gas Turbine, and carry them forward to 2013. It will also consider several alternatives involving leasing or purchasing generators.

2 Operational Requirements

The operational requirements for the Holyrood black start unit are listed below:

- Hydro is required to maintain an operational ability to restart the Holyrood thermal generating unit in the case of a loss of grid power. This ability must be available throughout the year when Holyrood is operating. This is most significantly in the fall through spring period (the "heating season").
- This ability must be maintained during any refurbishment or replacement of the existing black start system. This particular criterion impacts any refurbishment of the existing Holyrood Gas Turbine, as that project must bear the cost of providing standby generation during the refurbishment period.
- Black start capability must be capable of starting any of the three thermal units located at the plant.
- The black start solution is desired to be located at the Holyrood facility where it is less dependent on transmission infrastructure that could be exposed to severe weather conditions.

3 Basis of Technical Analysis

An analysis of the Holyrood Thermal Generating Station has determined plant specific electrical criteria that the black start system must meet or surpass. These criteria are related to the specific start-up and trip characteristics of motors and other systems found in the plant, as well as previously established system planning criteria for the electrical system.

In general, a black start generator must supply motor starting currents to the largest motor in the system, while maintaining other electrical parameters within normal system specifications. As a result, the most critical aspect of any proposed generator solution is its short circuit current rating, rather than the overall power rating of the unit. Furthermore, the available short circuit current from a generator will be reduced or diminished by any transformers which may be required to change or transform its output voltage to the rated voltage of the motor. As such, Hydro has developed models which consider both the generator and any transformers required for interconnection to the thermal plant.

The station service voltage must be maintained during motor start, as a severe voltage drop may cause other thermal plant equipment to cease operation during a critical motor starting event. The voltage must not drop below 81 percent during a motor start. However, given the fact that there is expected to be some discrepancy between the model predictions and the real world observations, any solution which only marginally meets this requirement must be studied in greater detail before final acceptance of the solution.

The largest motor to be started during black start is a boiler feed pump motor. There are six of these units, any one of which may need to be started during a black start event. Appendix A contains technical details for the largest boiler feed pump motor to be started.

The analysis in this study was completed using the Siemens Power Technologies Int. software package PSS®E version 32.0. It must be noted that there is expected to be some discrepancy between the predicted electrical behaviour and the real world system behaviour.

3.1 Planned Infrastructure for Holyrood Thermal Generating Station

Hydro will be requesting PUB approval for a 60MW Combustion Turbine to be installed in late 2015 at the Holyrood Thermal Generating Station. If approved, that gas turbine could provide black start capability to the station, and replace any temporary black start solution recommended in this analysis.

The timeline of the 60MW Combustion Turbine project suggests that a temporary black start generation solution would be needed until the end of the 2014 – 2015 heating season. However, because of potential risks in the 60MW project schedule, it is prudent to recommend a solution which would be available during the 2015 – 2016 heating season if required. All solutions evaluated in this report can be extended to the 2015 – 2016 heating season.

3.2 Existing Infrastructure at Holyrood Thermal Generating Station

The plant contains existing infrastructure which impacts this project and is detailed below.

3.2.1 Civil Infrastructure

As shown in Figure 1, there is one area which is suitable for a temporary black start generator solution. It consists of flat land across from the thermal plant. This area will be adjacent to the proposed 60MW combustion turbine for Holyrood, hence it is prudent to situate this project so as to allow for the construction of a 60MW plant at that location. In order to maximize the space available, and allow for future projects, this location will require some civil work.

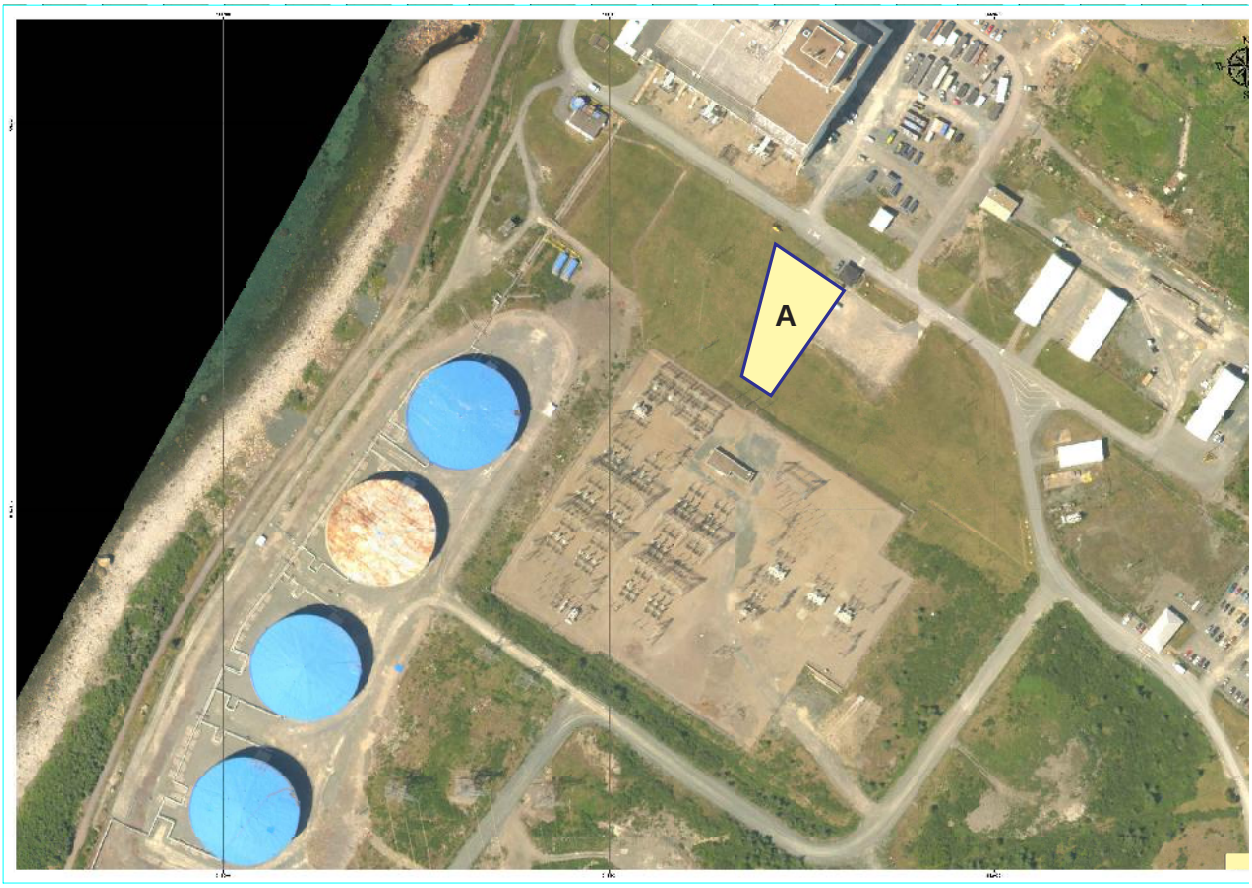

Figure 1. Location of Generator Solution

3.3 Electrical Infrastructure

There is existing electrical infrastructure installed at Holyrood which can be used for this project. Some of the infrastructure is currently connected to the existing combustion turbine, and would ease any connection from a new combustion turbine to the plant. Other infrastructure has recently been installed to connect Newfoundland Power's Mobile Combustion turbine and diesel unit to potentially provide black start. This infrastructure serves as the bulk of the connections required to connect a mobile black start generating plant to Holyrood.

Hydro has estimated the cost and schedule impacts of connecting generation units to this existing infrastructure.

3.4 Mechanical Infrastructure

The Holyrood facility includes fuel tanks and piping currently used to supply the existing gas turbine as well as other generators in the Holyrood facility. This infrastructure could be modified to supply fuel to a proposed gas turbine. Because black start diesel solutions typically include onboard fuel tanks, the existing tank infrastructure would not be needed if a diesel generator is installed at the facility.

The cost of piping has been included in the estimates.

4 Basis of Financial Analysis

Each solution will be evaluated based on the capital cost for equipment or rental cost for the equipment.

5 Constraints

This project assumes that the project can be exempted from the typical environmental approval process required under current legislation for a diesel plant of this size. Under that assumption, it is expected that an exemption could be obtained, and relevant permits received within 60 days. This is an aggressive assumption.

It is assumed that Hydro staff will maintain and operate the generator solution, with technical assistance from the manufacturer as required.

Currently, Hydro has been asked to provide a black start solution for late Dec 2013. A black start solution must remain at Holyrood until the decommissioning of the plant which is scheduled after 2020. As indicated in section 3.1. Hydro will be requesting PUB approval for a 60MW CT to be installed at Holyrood in late 2015 or early 2016. That project would be expected to provide black start capability from 2016 until plant decommissioning.

6 Technical Options considered

Hydro has considered several technical options to provide black start capability to the Holyrood thermal plant. Each is described below:

- Refurbish Existing GT, and rent a generator for black start capability during the refurbishment.
- Lease a diesel generator solutions
    - Nominal 14MW Diesel Plant consisting of seven 1.825MW units at 480V with additional transformers installed.
    - Nominal 16MW Diesel Plant consisting of eight 2MW units operating at 480V with additional transformers installed.
- Lease a Combustion Turbine Solution
    - 15.9MW CT Plant consisting of three 5.3MW units operating at 13.8kV
    - 16.6MW CT Plant consisting of one 5.2MW and two 5.7MW Units operating at 13.8kV
    - Single 25MW CT Plant operating at 13.8kV
- Use the Newfoundland Power Mobile CT and diesel generator.

Another potential option would be to install Variable Frequency Drives (VFD) on the large boiler feed pump motors which could reduce the cost of black start generation. However it will require significantly more engineering to determine its feasibility. For the 2013 / 2014 heating period, Hydro would still be required to install diesel or CT generators to provide black start. During that time, Hydro could study the feasibility of installing VFD’s on the large boiler feed pump motors.

If feasible, these units would reduce the cost of renting generators required for future heating seasons. A more detailed technical study of this option would have to be completed in order to estimate cost and schedule implications.

6.1 Analysis of Refurbishment of Existing 15 MW Holyrood CT

The Holyrood Thermal Generating station is required to have black start capability to start the plant in the event of a loss of grid power. This capability has been provided with a 15MW gas turbine (GT) located at the Holyrood facility. However, because of the age and condition of the unit, Hydro undertook a study in 2011 to determine if the existing GT should be refurbished, or replaced with another generation solution. The study recommended that the existing unit be replaced. Currently the existing combustion turbine has been left in a cold standby state with all combustible fluids removed.

Hydro has reviewed the results of the Condition Assessment of the Holyrood Gas Turbine, and carried them forward to 2013.

6.1.1 2013 Analysis of Gas Turbine Condition Assessment

In reconsidering the cost and schedule required to refurbish the existing gas turbine located at Holyrood, Hydro has considered the following sources of information:

- The 2011 “Gas Turbine Condition Assessment and Replacement Options Study”
- Schedule differences between the 2011 analysis and 2013 analysis.
- Updated costs to provide full black start capability to the plant during the refurbishment of the existing Gas Turbine.

6.1.2 Analysis of 2011 Gas Turbine Condition Assessment

This study estimated the cost to refurbish the existing gas turbine so that it could remain in service until 2020. Because a full teardown of the equipment was not authorized prior to estimating the needed repairs, the report invited suppliers to consider both the observed system failures as well as suspected repairs that would typically be required on a unit built in 1966. As a result, in 2011 suppliers estimated an appropriate scope of work which is expected to be valid today despite any further degradation of the unit during the past two years. Nevertheless, should this alternative be selected, Hydro will undertake a 4 month review of the CT to determine if further deterioration of the unit has occurred. Assuming a Jan 1, 2014 start date, the project will be complete March 4, 2015, or 428 days after project start.

6.1.3 Schedule differences between the 2011 analysis and 2013 analysis

In order to reduce cost, the 2011 analysis relied upon a novel method of supplying Black Start capability during the refurbishment of the Gas Turbine. Hydro proposed leasing replacement units for several of the generator subsystems that required lengthy repairs. Other original gas turbine systems could be repaired relatively quickly (4 months) and reassembled with the leased units. The resulting system could then operate and temporarily provide black start capability, at a marginal rental cost of approximately $173,000. Note however that there are significant technical and equipment supply challenges associated with this approach.

While this option would meet the schedule demands for the 2014 – 2015 heating season, it does not meet the schedule demands for the 2013 – 2014 season. As such, Hydro must consider a more expensive option of leasing a complete generation unit that could provide power during the 2013 – 2014 operating season. Providing a generation solution to provide black start capabilities to the plant during the 2013 – 2014 heating season will cost $1.7M.

Hence, as a result of the schedule impact, the capital cost to refurbish the Gas Turbine has increased from approximately $4.8M (2011 dollars) to $8.7M today.

6.1.4 Safety Risk

Because of the age and condition of the generator as outlined in the 2011 study, there is a risk that a significant catastrophic mechanical failure could put personnel in the vicinity of the unit at risk of severe injury. As a result, Hydro decided after receiving the final 2011 study to not operate the unit without refurbishment.

6.1.5 Cost and Schedule Risk

These repairs will be carried out on a machine manufactured in 1966, with the understanding that many replacement parts are obsolete and must be re-engineered or obtained from OEM suppliers. It is therefore prudent to assume that technical issues may require rework or re-engineering during the commissioning process. While the class 5 cost and schedule estimates incorporate appropriate contingencies, it is worthwhile noting that the age and obsolesce of the machine present the very real possibility of fully or over expending those contingencies.

6.1.6 Technical Analysis

Assuming that the equipment can be fully refurbished to a reliable state, it could provide black start capability to the plant.

6.1.7 Cost

As indicated, the expected cost to refurbish the existing Holyrood CT is $9.5M. This solution has considerable technical risk owing to the advanced age and current state of the unit.

Project Cost: *($ x1,000)*		**2014**	**Beyond**	**Total**
Material Supply	0.0	1,256.0	0.0	1,631.0
Labour	0.0	2,696.0	0.0	3,551.0
Consultant	0.0	156.0	0.0	195.0
Contract Work	0.0	225.0	0.0	225.0
Other Direct Costs	0.0	2,160.0	0.0	2,160.0
Interest and Escalation	0.0	461.7	0.0	669.8
Contingency	0.0	0.0	0.0	1,071.2
TOTAL	**0.0**	**6,954.7**	**0.0**	**9,503.0**

6.2 Nominal 14MW Diesel Plant

This project involves the following equipment:

- Installation of seven 1.825MW mobile diesel generators with a 480V operational voltage.
- Installation of transformers to convert the 480V diesel generator output to 4160V.

6.2.1 Technical Analysis

Hydro analyzed the generator solution to determine if it meets the technical requirements as indicated in Section 3. The analysis shown in Figure 2 indicates that the system voltage will fall below the 0.81pu (81% of nominal) voltage threshold requirement. Figure 3 indicates that the generator can supply the motor current, and it does not exceed the motor thermal limit shown in Appendix A.

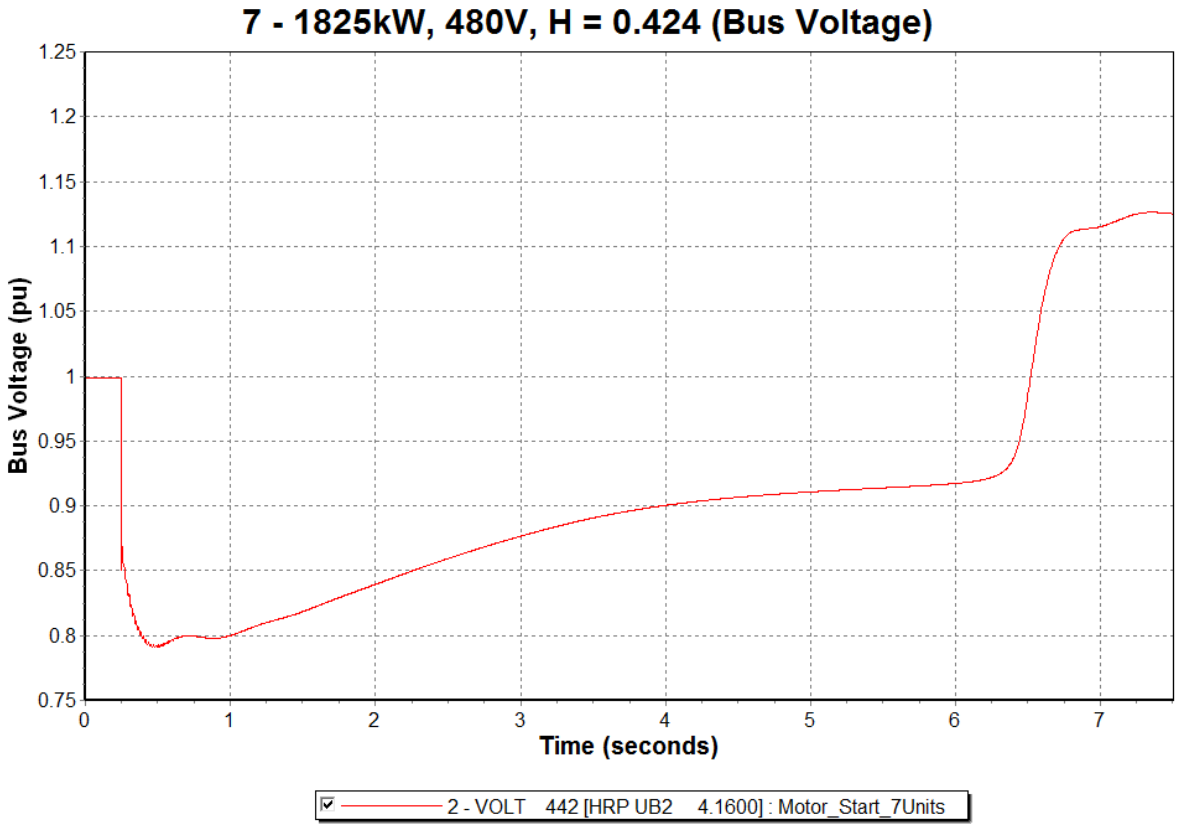

Figure 2. System Voltage Response of 7 - 1825kw Diesel Generators

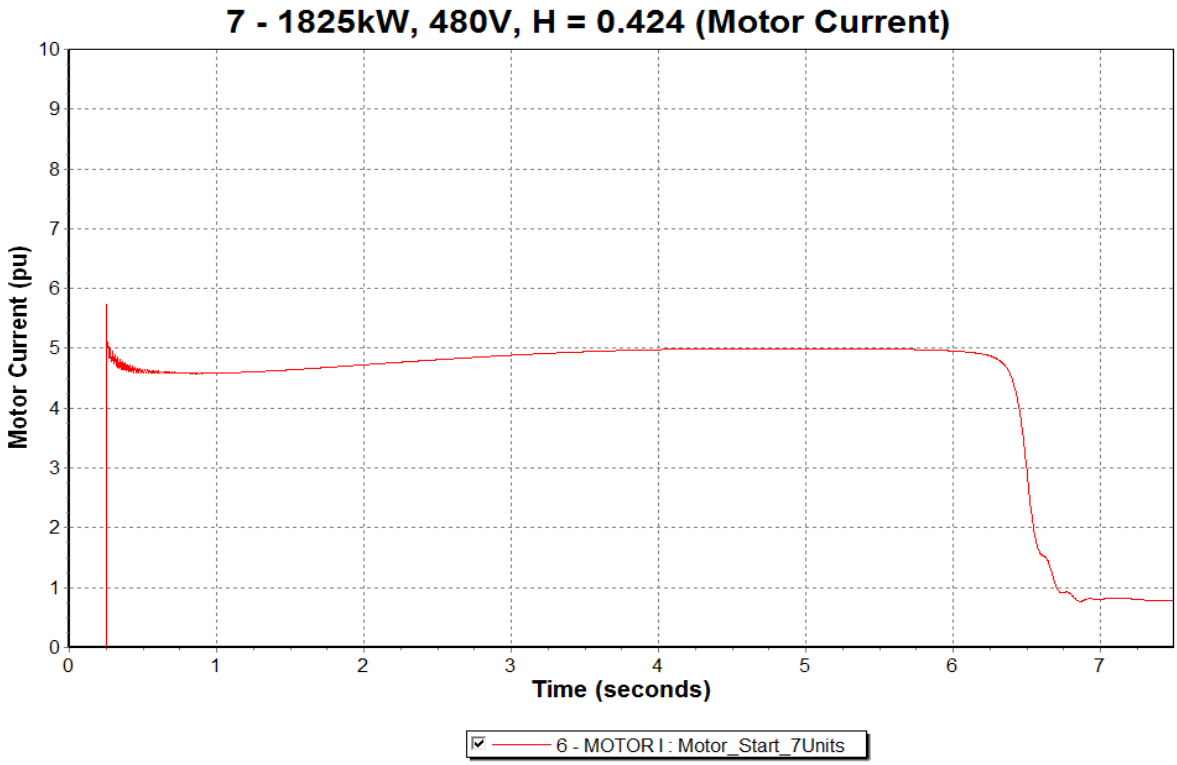

Figure 3. System Current Response on Motor Start

6.2.2 Conclusion

This option does not meet the technical requirements for black start and is rejected on that basis.

6.3 Nominal 16MW Diesel Plant

This project involves the following equipment:

- Installation of eight 1.825MW mobile diesel generators with a 480V operational voltage.
- Installation of transformers to convert the 480V diesel generator output to 4160V.

6.3.1 Technical analysis

Hydro has analyzed the generator solution to determine if it meets the technical requirements as indicated in section 3. The analysis shown in Figure 4 indicates that the system voltage does not fall below the 0.81pu voltage threshold requirement. Figure 5 indicates that the generator can supply the motor current, and it does not exceed the motor thermal limit shown in Appendix A.

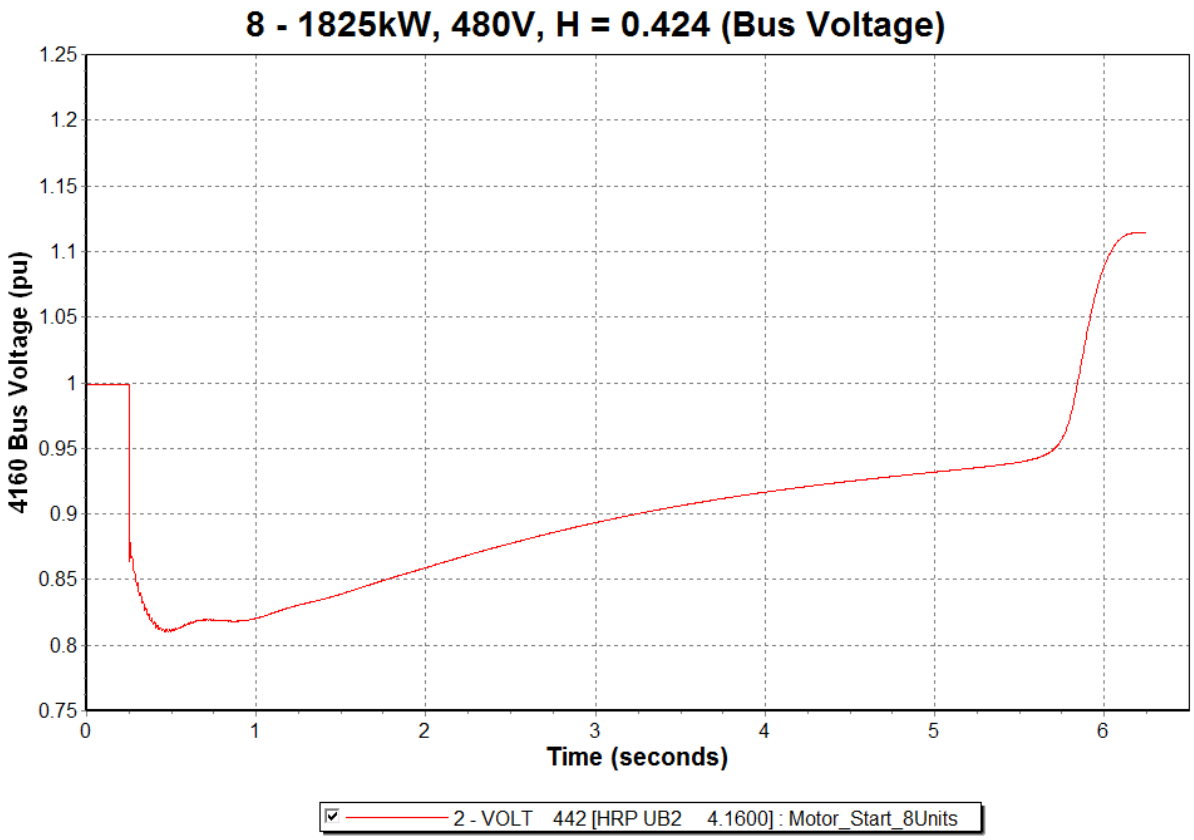

Figure 4. System Voltage Response of 8 - 1825kW Diesel Generators

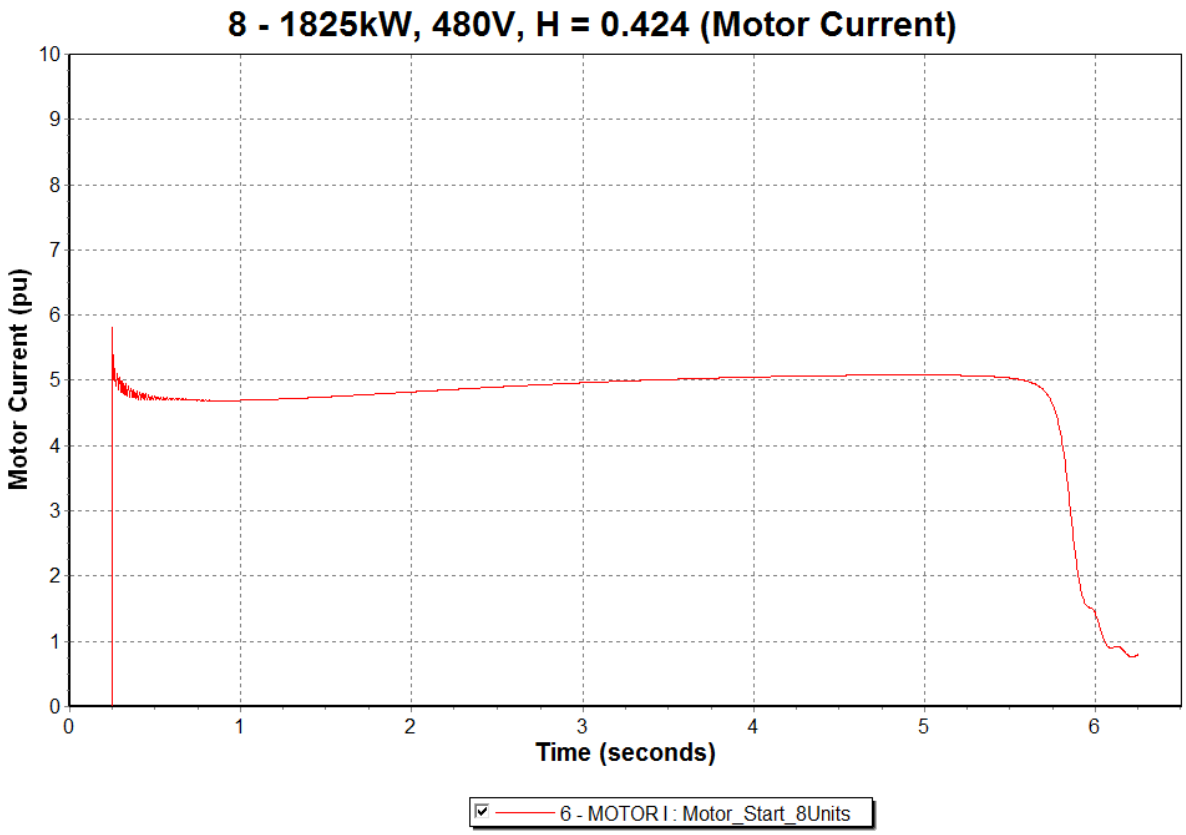

Figure 5. System Current Response on Motor Start

6.3.2 Schedule and Cost

This rental solution has a capital cost of $8.2M.

Project Cost: *($ x1,000)*	2014	2015	Beyond	Total
Material Supply	175.0	0.0	0.0	175.0
Labour	381.0	228.0	0.0	609.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	625.0	0.0	0.0	625.0
Other Direct Costs	3,330.0	1,344.0	0.0	4,674.0
Interest and Escalation	330.1	646.0	0.0	
Contingency	0.0	1,216.6	0.0	1,216.6
TOTAL	**4,841.1**	**3,434.6**	**0.0**	**8,275.7**

This solution can be installed within 6 weeks of signing a purchase order with the supplier. Given the delays associated with the Hydro tendering process, the project will take an additional 4 -5 weeks to implement, once PUB approval is received and Hydro agrees to expedite a solution.

Note: Given the recent events in the Philippines, there is a worldwide demand for generation units to be shipped that country. This may affect the availability of this solution, and is outside the control of Hydro.

6.3.3 Conclusion

This option is a technically feasible solution for black start capability, with a favorable schedule.

6.4 15.9MW Combustion Turbine Plant

This project involves the following equipment:

- Installation of three 5.3MW combustion turbine generators with a 13.8kV operating voltage.
- Connection of the combustion turbine output to the existing 13.8kV – 4.160kV transformer (T9) located at the Holyrood facility.

6.4.1 Technical analysis

Hydro has analyzed the generator solution to determine if it meets the technical requirements as indicated in section 3. The analysis shown in Figure 6 indicates that the system voltage does fall below the 0.81pu voltage threshold requirement. Figure 7 indicates that the generator can supply the motor current, and it does not exceed the thermal limit shown in Appendix A.

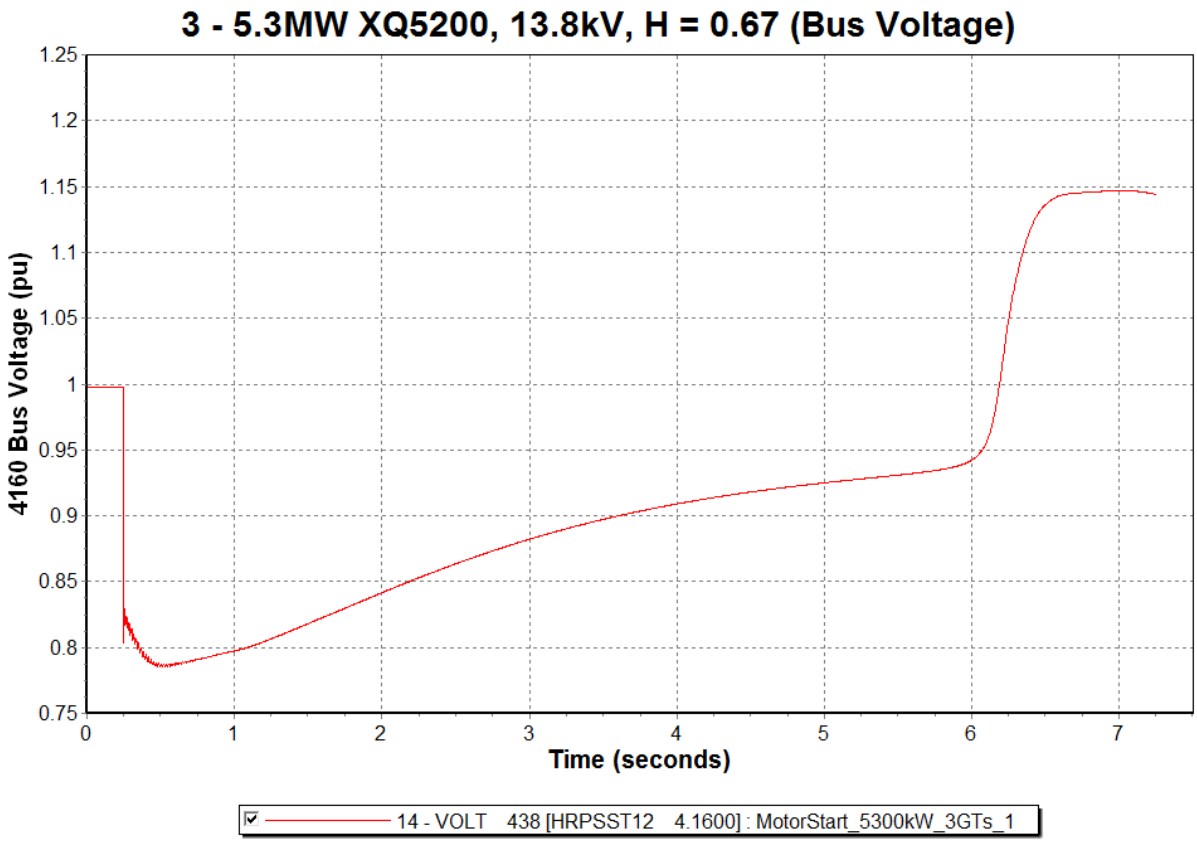

Figure 6. System Voltage Response of 3 - 5.3MW CT's during Blackstart

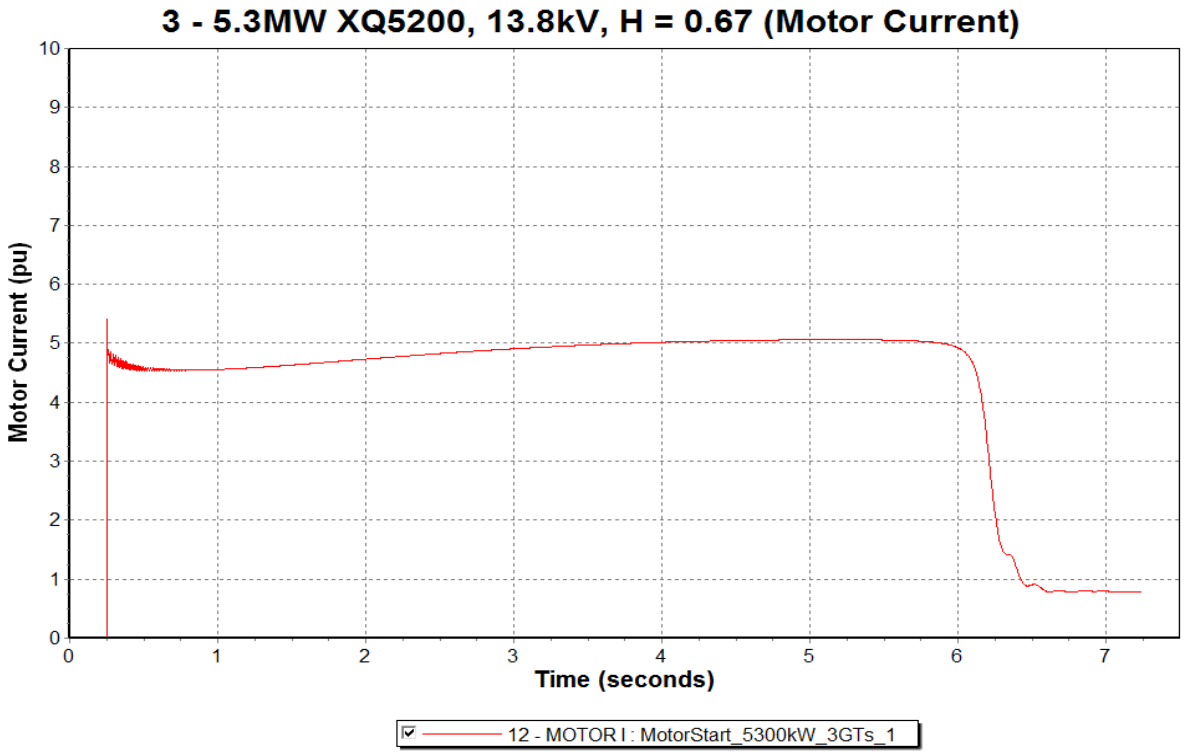

Figure 7. System Current Response during Blackstart

6.4.2 Schedule Availability

Currently these units are unavailable to meet the project schedule.

6.4.3 Conclusion

This option does not meet the system voltage requirements during motor startup. Additionally these units are not available on the market to meet the project schedule. As a result this option is rejected on that basis.

6.5 A 16.7MW Combustion Turbine

This project involves the following equipment:

- Installation of one 5.3MW mobile combustion turbine generator with a 13.8kV operating voltage.
- Installation of two 5.7MW mobile combustion turbine generators with a 13.8kV operating voltage.
- Connection of the combustion turbine output to the existing 13.8kV – 4.160kV transformer (T9) located at the Holyrood facility.

6.5.1 Technical analysis

Hydro has analyzed the generator solution to determine if it meets the technical requirements as indicated in Section 3. The analysis shown in Figure 8 indicates that the system voltage does not fall below the 0.81pu voltage threshold requirement. However, because the system voltage comes quite close to the threshold, verification of the Hydro model would be required from the manufacturer during the tendering process.

Figure 9 indicates that the generator can supply the motor current, and it does not exceed the motor thermal limit shown in Appendix A.

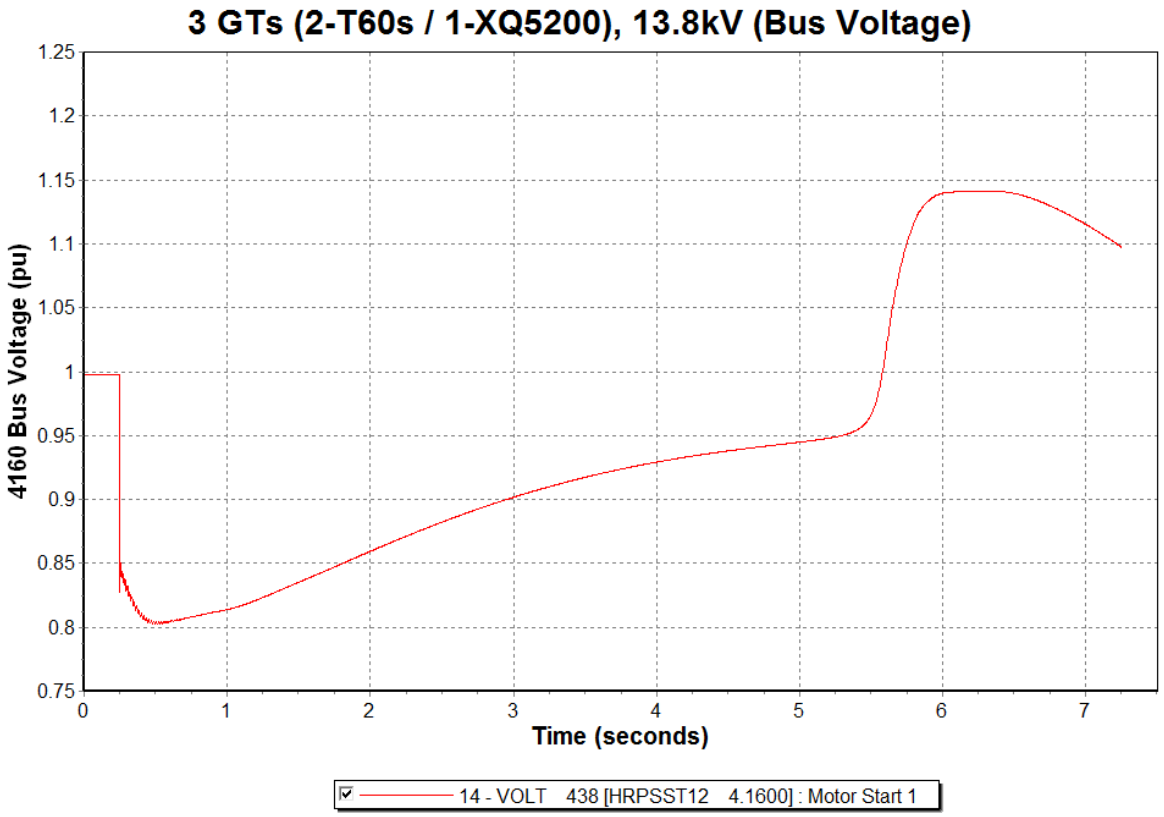

Figure 8. System Voltage Response of a 16.7MW CT plant on Blackstart

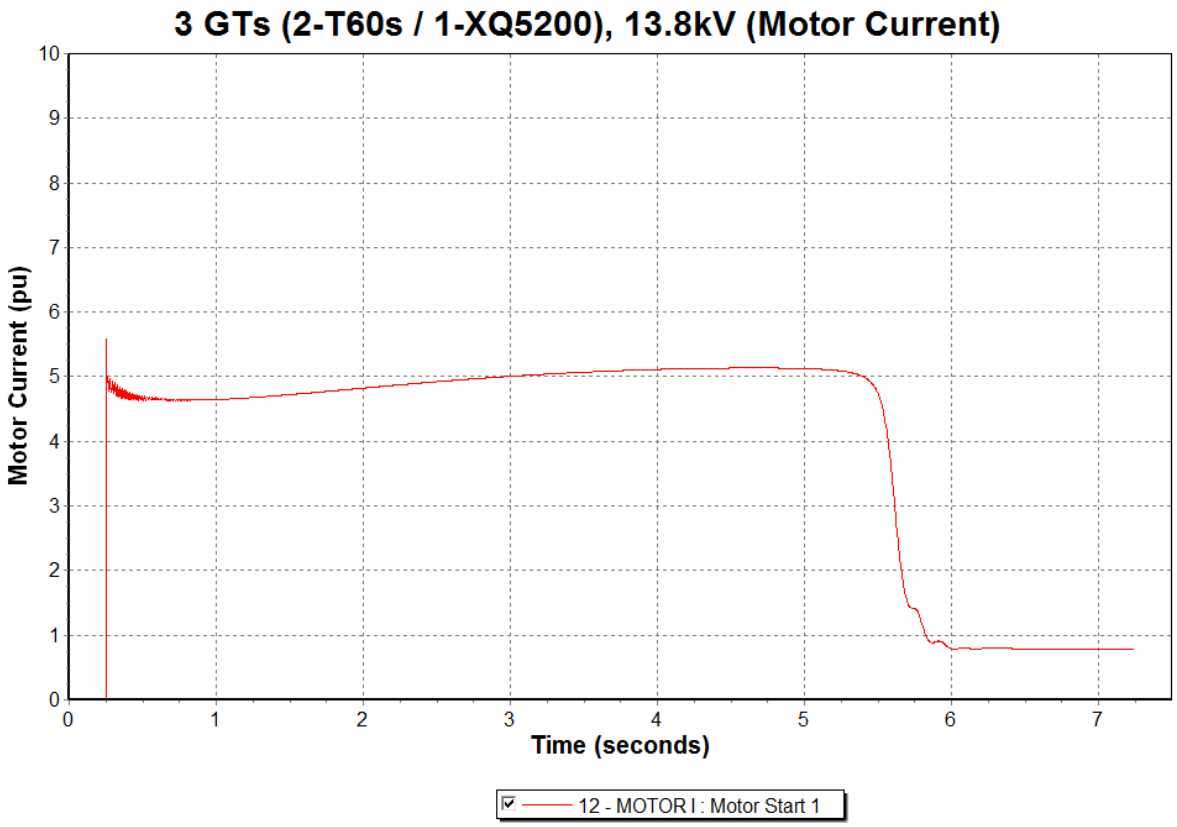

Figure 9. System Current Response of a 16.7MW CT Plant during Blackstart

6.5.2 Schedule and Cost

This solution has a project cost of $12.8M.

Project Cost: *($ x1,000)*	**2014**	**2015**	**Beyond**	**Total**
Material Supply	375.0	0.0	0.0	375.0
Labour	120.0	0.0	0.0	120.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	500.0	0.0	0.0	500.0
Other Direct Costs	5,091.0	3,744.0	0.0	8,835.0
Interest and Escalation	444.4	1,015.4	0.0	1,459.8
Contingency	0.0	1,474.5	0.0	1,474.5
TOTAL	**6,530.4**	**6,233.9**	**0.0**	**12,764.3**

This solution can be installed within 8 weeks of signing a purchase order with the supplier. Given the delays associated with the Hydro tendering process, the project will take an additional 4 -5 weeks to implement.

Note: Given the recent events in the Philippines, there is a worldwide demand for generation units to be shipped that country. This may affect the availability of this solution and is outside the control of Hydro.

6.5.3 Conclusion

This solution can meet the project requirements.

7 Single 22.5MW CT Plant

This project involves the following equipment:

- Installation of one 22.5MW combustion turbine generator with a 13.8kV operational voltage.
- Connection of the combustion turbine output to the existing 13.8kV – 4.160kV transformer (T9) located at the Holyrood facility.

7.1 Technical Analysis

Hydro has analyzed the generator solution to determine if it meets the technical requirements as indicated in section 3. The analysis shown in Figure 10 indicates that the system voltage does not fall below the 0.81pu voltage threshold requirement. Figure 11 indicates that the generator can supply the motor current, and it does not exceed the thermal limit shown in Appendix A.

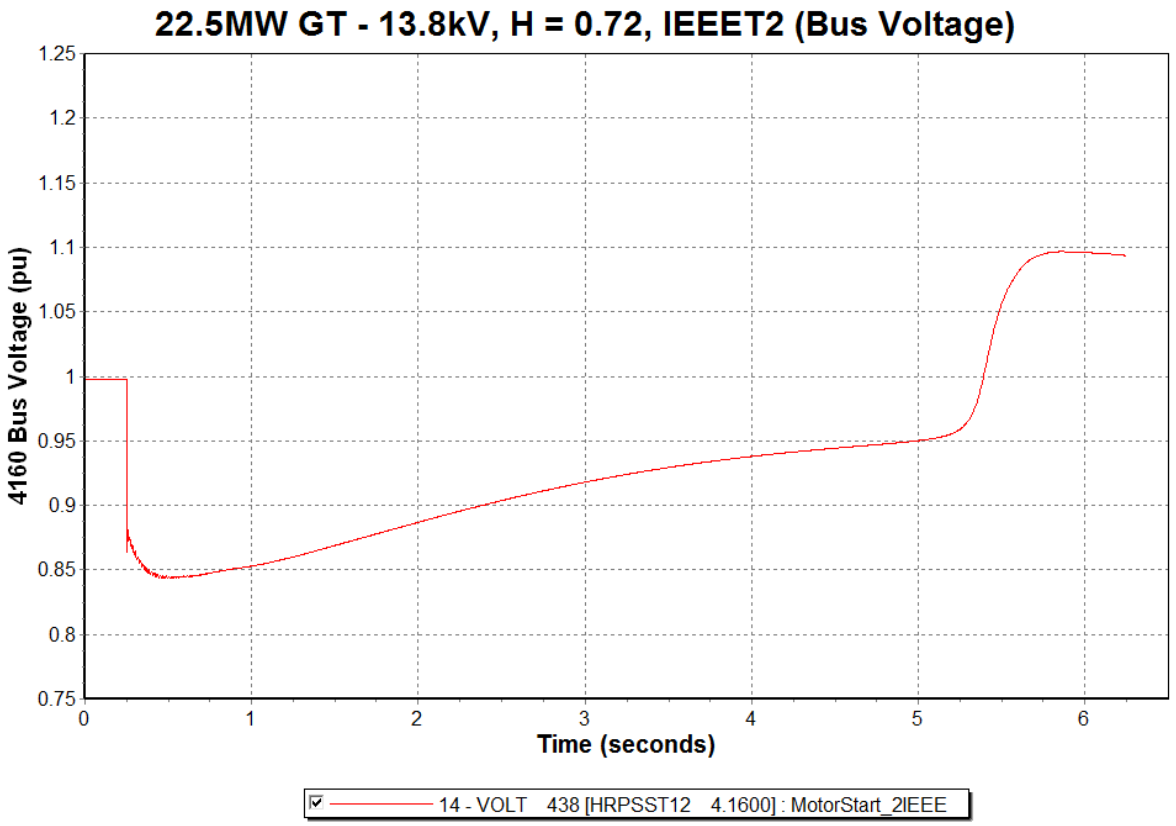

Figure 10. System Voltage Response of a 22.5MW CT during Blackstart

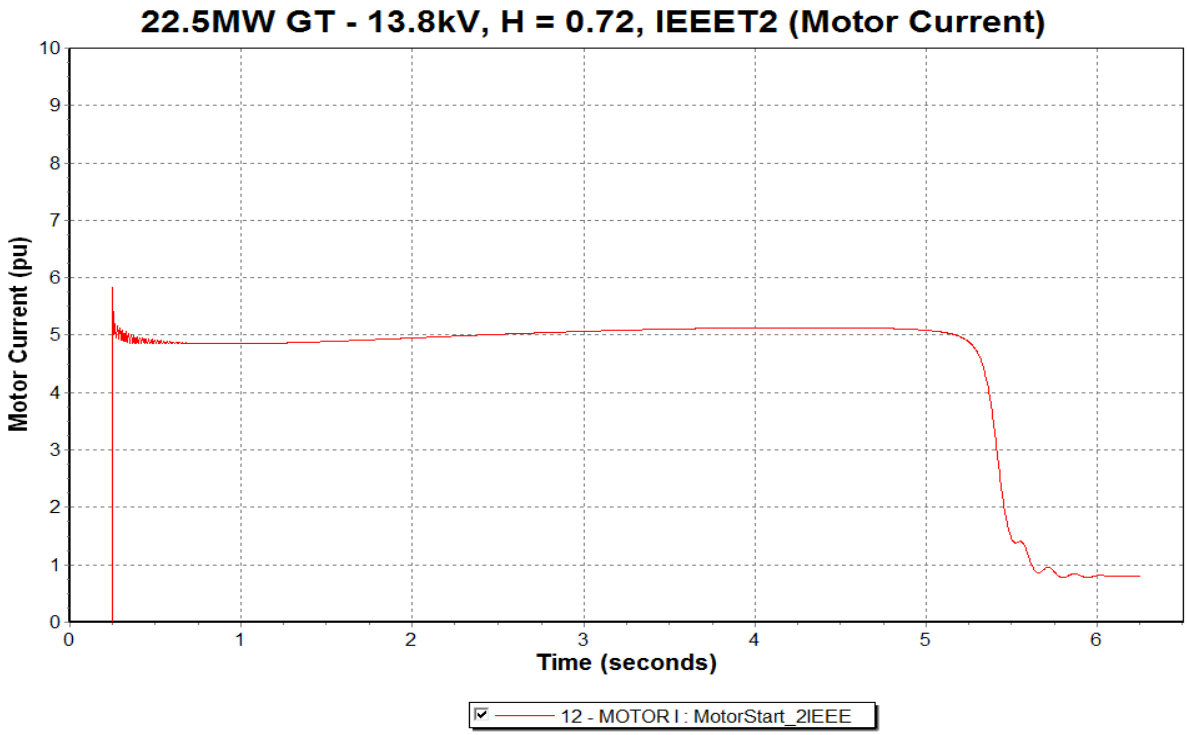

Figure 11. System Current Response of 22.5MW CT during Blackstart

7.2 Schedule and Cost

This generator is available 90 days after signing a contract, assuming imminent contact signing and current equipment availability. Given the delays associated with the Hydro tendering process, the project will take an additional 4 -5 weeks to implement.

Note: Given the recent events in the Philippines, there is a worldwide demand for generation units to be shipped that country. This may affect the availability of this solution and is outside the control of Hydro.

Although this solution could meet part of the 2013 – 2014 heating season, it would not provide black start for the full heating season.

This generator rental will cost $22M for a 16 month term.

Project Cost: *($ x1,000)*	**2014**	**2015**	**Beyond**	**Total**
Material Supply	175.0	0.0	0.0	175.0
Labour	120.0	0.0	0.0	120.0
Consultant	816.0	272.0	0.0	1,088.0
Contract Work	500.0	0.0	0.0	500.0
Other Direct Costs	10,944.0	3,648.0	0.0	14,592.0
Interest and Escalation	862.3	1,753.2	0.0	2,615.5
Contingency	0.0	3,295.0	0.0	3,295.0
TOTAL	**13,417.3**	**8,968.2**	**0.0**	**22,385.5**

7.3 NF Power Mobile CT and Diesel Generator

In March 2013, Hydro prepared a report "Analysis of Holyrood Unit 2 Boiler Feed Pump East Start-up using Newfoundland Power's Gas Turbine/Mobile Diesel". This report modeled the ability of the two Newfoundland Power generators to provide black start capability to the Holyrood Thermal Plant. The report concluded that while the units could theoretically start the plant, there was a significant voltage drop on the 4160V bus, as well as increased motor starting time. The areas of concern were:

- Under voltage relay settings on the 4610V or 600V system within the plant that could cause equipment tripping as a result of the depressed voltages during motor starting[1].
- The NP Mobile Gas Turbine / excitation system may not have the capability to supply up to 150% of nameplate rating for several seconds without tripping off-line.

In the spring of 2013, Hydro installed both the NP Mobile Gas Turbine and the NP Mobile Diesel Generator at the Holyrood plant. A black start was attempted several times. During each attempt, the NP Mobile Gas Turbine tripped off-line and could not start the large boiler feed pump motors.

[1] Analysis of Holyrood Unit 2 Boiler Feed Pump

7.3.1 Conclusion

This option does not meet the technical requirements to provide full black start capability to the Holyrood thermal plant.

8 Financial Analysis

The financial analysis of the various options is tabulated below. It clearly indicates that the rental of a 16MW Diesel plant is the least cost solution for Holyrood black start capability.

Description	Cost	Project Availability
Rental of 16MW Diesel Plant	$8,275,000	11 weeks after PUB Approval
Refurbishment of Existing Holyrood CT	$9,503,000	March 4, 2015, with interim diesel rental available 11 weeks after PUB Approval
Rental of 16.7MW CT	$12,495,000	13 weeks after PUB Approval
Rental of 22.5MW CT	$22,385,500	18 weeks after PUB Approval

9 Recommendation

Hydro has identified the least cost option is a 16MW Diesel Plant leased for a period of 18 months to provide black start capability to the Holyrood Thermal Generating Station for 2013 – 2015 heating seasons. Current estimates suggest that it can be installed within 11 weeks of PUB and internal Hydro approval.

10 Appendix A: Motor Data

TECO-WESTINGHOUSE MOTOR COMPANY
ROUND ROCK, TEXAS U.S.A.

CUSTOMER NEWFOUNDLAND & LABRADOR HYDR DATE - FEB 19, 2013
CUSTOMER ORDER NO. 1022269
APPLICATION ELECTRIC UTILITY PUMP
S.O. 8052AA

DATA FOR WORLD SERIES, HORIZONTAL, BRACKET TYPE INDUCTION MOTOR

1. RATING

HP	3000	HERTZ	60.0	INSUL CLASS	F
RPM FL	3580	SERVICE FACTOR	1.15	KVA CODE	E
VOLTS	4160	RISE C (1.00 SF)	80	DUTY	CONTINUOUS
AMPS FL	350	METHOD	RES	NUMBER OF POLES	2
PHASES	3	AMBIENT C	40		

2. MECHANICAL

FRAME	5011	BRG TYPE	SLEEVE	END PLAY INCH	0.50
ENCL TYPE	WP2	LUBE TYPE	FLOOD	MOTOR WK2	423
		ROTATION(FROM NDE)	CCW	LOAD WK2	70

3. STARTING PERFORMANCE - NOMINAL, VALUES WITH (*) ARE GUARANTEED

		100% VOLTS	90% VOLTS
AMPS (LR)		2032	1789
AMPS (LR)	%	581	511
POWER FACTOR	%	15.2	14.8
START TORQUE	%	78	60
ACCELERATION SEC		2.0	2.9
SAFE LOCK SEC	FROM HOT	9.2	11.8
SAFE LOCK SEC	FROM COLD	10.7	13.7

PULLOUT TORQUE AT 100% VOLTS = 248 %

4. EFFICIENCY - NOMINAL

LOAD	%	115	100	75	50
EFFICIENCY	%	96.67	96.86	97.03	96.82

5. POWER FACTOR - NOMINAL

LOAD	%	115	100	75	50
POWER FACTOR	%	91.2	91.6	91.3	88.6

6. POWER FACTOR CORRECTION

MAX KVAR = 327 MAX FL P.F. = 95.8 %

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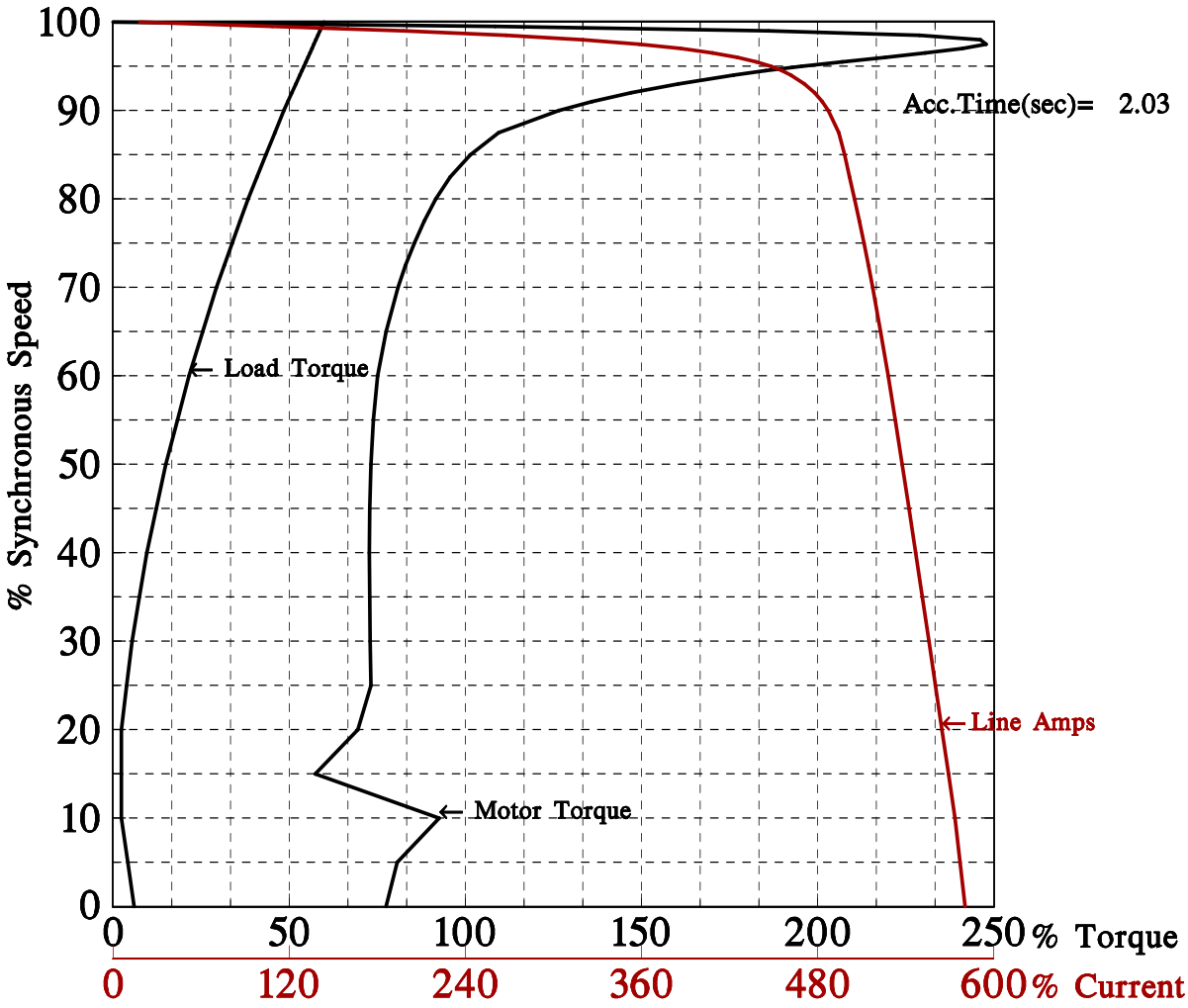
Induction Motor Starting Characteristics
Calculated at 100% Line Voltage

Design.ID 8052AA		Customer	NEW FOUNDLAND & LABRADOR
Engineer T.NGUYEN		Application	ELECTRIC UTILITY PUMP
Poles 2	Volts 4160	Rpm(fl) 3580	Load Curve ASSUMED
Hp 3000	Fl Amps 350	Rpm(syn) 3600	Lock Amps(%) 581
Pf 0.92	Frame 5011	Load Wk^2 70	Fl Torque(lb-ft) 4400
Phase 3	Hertz 60.0	Motor Wk^2 423	Lock Torque(%) 78



TECO-Westinghouse Motor Company Round Rock, Texas

Signature _____ Curve No.

Curve 1 of 4

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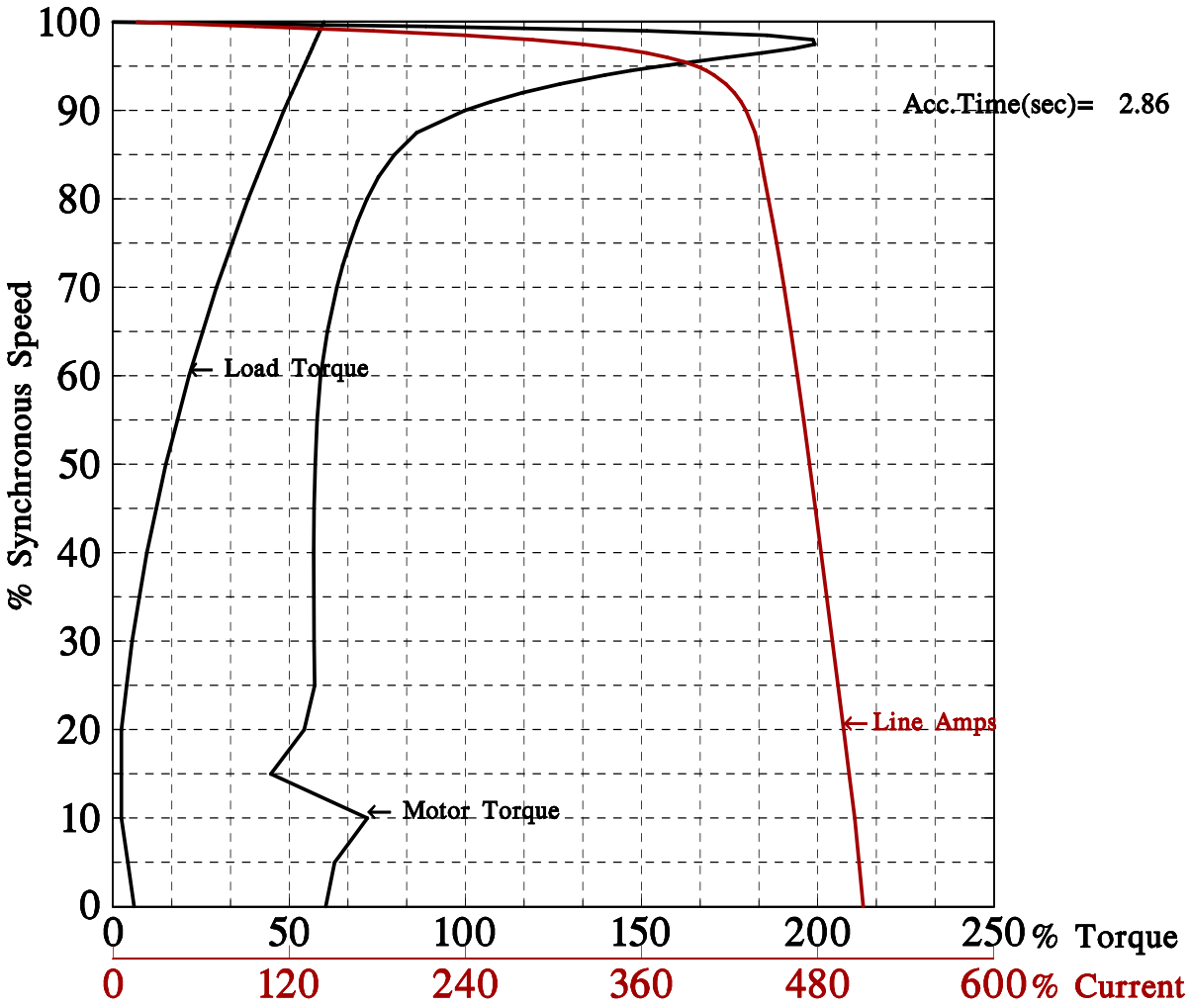
Induction Motor Starting Characteristics
Calculated at 90% Line Voltage

Design.ID 8052AA		Customer	NEW FOUNDLAND & LABRADOR
Engineer T.NGUYEN		Application	ELECTRIC UTILITY PUMP
Poles 2	Volts 4160	Rpm(fl) 3580	Load Curve ASSUMED
Hp 3000	Fl Amps 350	Rpm(syn) 3600	Lock Amps(%) 511
Pf 0.92	Frame 5011	Load Wk^2 70	Fl Torque(lb-ft) 4400
Phase 3	Hertz 60.0	Motor Wk^2 423	Lock Torque(%) 60



TECO-Westinghouse Motor Company Round Rock, Texas

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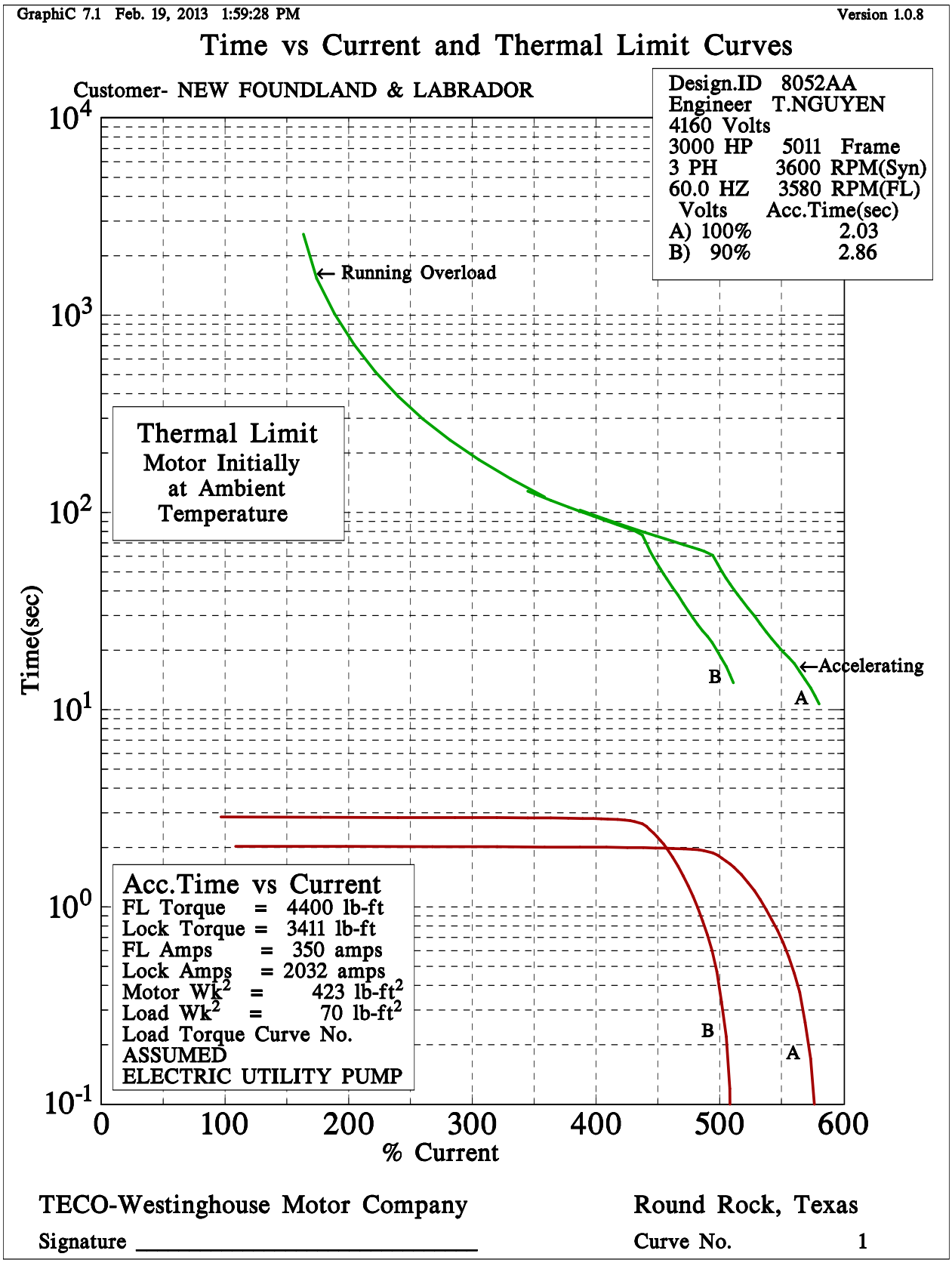
Curve 2 of 4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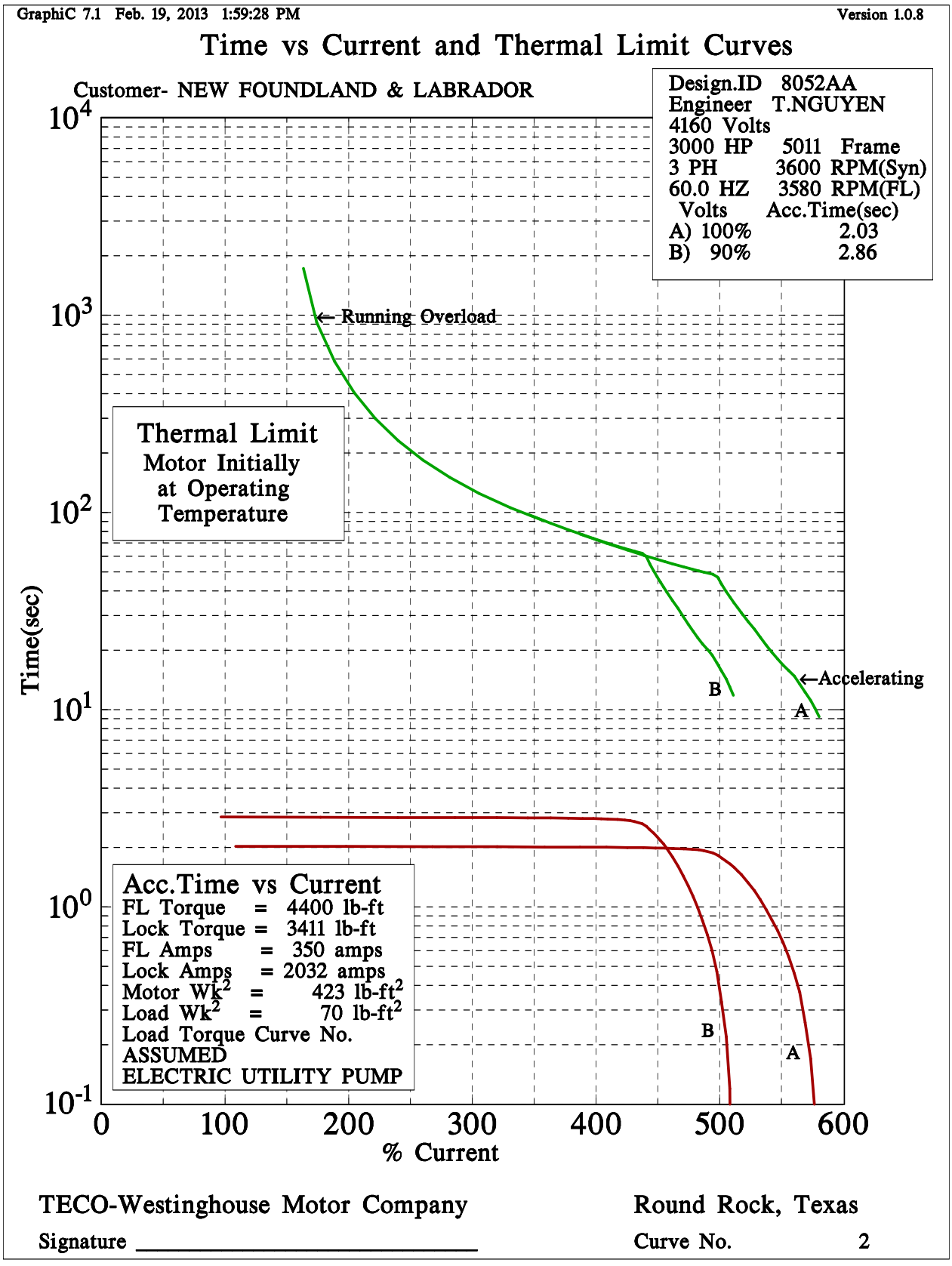
Version 1.0.8
Time vs Current and Thermal Limit Curves
Customer- NEW FOUNDLAND & LABRADOR
Design.ID 8052AA
Engineer T.NGUYEN
4160 Volts
3000 HP 5011 Frame
3 PH 3600 RPM(Syn)
60.0 HZ 3580 RPM(FL)
Volts Acc.Time(sec)
A) 100% 2.03
B) 90% 2.86
← Running Overload
Thermal Limit
Motor Initially
at Ambient
Temperature
←Accelerating
B
A
Acc.Time vs Current
FL Torque = 4400 lb-ft
Lock Torque = 3411 lb-ft
FL Amps = 350 amps
Lock Amps = 2032 amps
Motor Wk² = 423 lb-ft²
Load Wk² = 70 lb-ft²
Load Torque Curve No.
ASSUMED
ELECTRIC UTILITY PUMP
B
A
Time(sec)
10⁴
10³
10²
10¹
10⁰
10⁻¹
0
100
200
300
400
500
600
% Current
TECO-Westinghouse Motor Company
Round Rock, Texas
Signature _____
Curve No. 1

Curve 3 of 4


GraphiC 7.1 Feb. 19, 2013 1:59:28 PM
Version 1.0.8
Time vs Current and Thermal Limit Curves
Customer- NEW FOUNDLAND & LABRADOR
Design.ID 8052AA
Engineer T.NGUYEN
4160 Volts
3000 HP 5011 Frame
3 PH 3600 RPM(Syn)
60.0 HZ 3580 RPM(FL)
Volts Acc.Time(sec)
A) 100% 2.03
B) 90% 2.86
← Running Overload
Thermal Limit
Motor Initially
at Operating
Temperature
←Accelerating
B
A
Acc.Time vs Current
FL Torque = 4400 lb-ft
Lock Torque = 3411 lb-ft
FL Amps = 350 amps
Lock Amps = 2032 amps
Motor Wk² = 423 lb-ft²
Load Wk² = 70 lb-ft²
Load Torque Curve No.
ASSUMED
ELECTRIC UTILITY PUMP
B
A
Time(sec)
10⁴
10³
10²
10¹
10⁰
10⁻¹
0
100
200
300
400
500
600
% Current
TECO-Westinghouse Motor Company
Round Rock, Texas
Signature _____
Curve No. 2

Curve 4 of 4