

November 29, 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:

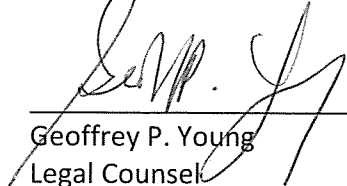
Re: An Application by Newfoundland and Labrador Hydro (Hydro) pursuant to Subsection 41(3) of the Act for approval of a capital project for the installation of diesel units at Holyrood for the purpose of blackstarting the generating units, and for the deferral of lease costs.

Enclosed please find the original and eight copies of an amended page 4 to the above noted application. The revisions to this application are necessary to correct the capital costs and annual lease costs on page 4 of the application and have been shaded for ease of reference.

Should you have any questions, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO



Geoffrey P. Young
Legal Counsel

GPY/tp

cc: Gerard Hayes – Newfoundland Power
Paul Coxworthy – Stewart McKelvey Stirling Scales

Thomas Johnson – Consumer Advocate
Thomas O'Reilly, QC – Cox & Palmer

November 22, 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:

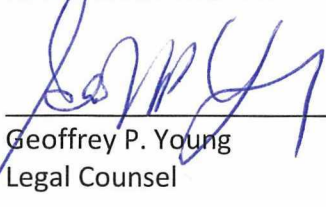
Re: An Application by Newfoundland and Labrador Hydro (Hydro) pursuant to Subsection 41(3) of the Act for approval of a capital project for the installation of diesel units at Holyrood for the purpose of blackstarting the generating units, and for the deferral of lease costs.

Enclosed for the Board's consideration is Hydro's proposal for a nominal 16 MW diesel, on-site, blackstart generator solution for the Holyrood Thermal Generating Station to be installed in 2013-2014. This proposed black start solution comprises: a deferral of \$5,724,200 in diesel unit lease expenses to be incurred over the period of from December 2013 through to the end of 2015, the recovery of which Hydro proposes to be dealt with by the Board in a further Order; and \$1,124,100 in associated capital expenses for their installation. It is anticipated that these diesel units would remain installed at Holyrood until their black start function is replaced by a 60 MW combustion turbine which Hydro intends to propose in the near future for the Holyrood site. That combustion turbine is expected to be commissioned in late 2015.

Should you have any questions, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO



Geoffrey P. Young
Legal Counsel

GPY/tp

cc: Gerard Hayes – Newfoundland Power
Paul Coxworthy – Stewart McKelvey Stirling Scales

Thomas Johnson – Consumer Advocate
Thomas O'Reilly, QC – Cox & Palmer

IN THE MATTER OF the *Electrical Power Control Act*, R.S.N.L. 1994, Chapter E-5.1 (the EPCA) and the *Public Utilities Act*, R.S.N.L. 1990, Chapter P-47 (the Act), and regulations thereunder;

AND IN THE MATTER OF an Application by Newfoundland and Labrador Hydro (Hydro) for the approval, pursuant to Subsection 41(3) of the Act of infrastructure required for the installation of diesel units at Holyrood for the purpose of blackstarting the generating units, and pursuant to Sections 49, 78 and 80 of the Act, for the deferral of lease costs relating to the diesel units required for blackstart purposes.

TO: The Board of Commissioners of Public Utilities (the Board)

THE APPLICATION OF NEWFOUNDLAND AND LABRADOR HYDRO (Hydro) STATES

THAT:

1. Hydro is a corporation continued and existing under the *Hydro Corporation Act, 2007*, is a public utility within the meaning of the Act and is subject to the provisions of the *Electrical Power Control Act, 1994*.
2. Hydro owns and operates 490 MW of thermal generation at the Holyrood Thermal Generating Station (Holyrood). A gas turbine was established at Holyrood to provide emergency standby power to the plant for blackstarting the plant in the event the grid supply was interrupted. The gas turbine was 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 enabled plant systems to be placed in a warm standby state which facilitates a faster customer load restoration when the transmission connection is established. The gas turbine was very rarely required to perform the blackstart function.

3. In 2011, an inspection of the gas turbine resulted in a stop work order being placed on the unit by the Department of Government Services, Occupational Health and Safety Inspection Branch (OHS). 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 blackstart the plant.
4. During 2011 Hydro had AMEC undertake a study on the condition of the gas turbine and the options to provide the required ongoing functionality. AMEC submitted its report to Hydro in late 2011.
5. In 2012, it was determined 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 blackstart capability.

6. In January, 2012 Hydro determined that the Hardwoods gas turbine would be used to blackstart Holyrood under the circumstance that the transmission supply to the Avalon Peninsula was interrupted. It was also decided that the options for the blackstart requirement of Holyrood would be assessed in the context of the site location decision for a new 50 MW combustion turbine required for meeting Hydro's planning criteria. 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 blackstart capability to Holyrood. This decision and recommendation will be included in Hydro's application for the new combustion turbine.
7. 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 blackstart as it cannot start the large boiler feed pump motors.
8. After considering several options, Hydro has determined that a short-term solution for the blackstart of Holyrood, which requires the installation of

infrastructure to enable eight 1.825 MW diesel generation units to be leased during the winter months of 2014 to the time of installation of the new 60 MW combustion turbine. The installation date depends upon receipt of Board approval of this project.

9. This costs of this project are shown in the project proposal report attached to this Application, and are anticipated to be:


Capital Costs \$1,263,400

Annual Lease Costs \$5,763,200

10. The Applicant submits that the proposed capital works and expenditures are necessary to ensure that this generation facility can continue to provide service which is reasonable safe and adequate and just and reasonable as required by Section 37 of the *Act*. Additionally, the Applicant submits that the lease costs are prudently incurred and are material. If those lease costs are expensed in the year they are incurred, they would cause an undue impact on Hydro's return and, therefore, they ought to be deferred until a future order of the Board concerning Hydro's recovery of such costs. Hydro intends to apply for the recovery of the lease costs though its General Rate Application process.
11. Therefore, Hydro makes Application that the Board make an Order approving, pursuant to Subsection 41(3) of the *Act*, the capital expenditure of \$1,263,400 as

set out in this Application and in the attached project description and justification document. As well, Hydro makes Application that the Board approve the deferral of the lease costs of the diesel units until future disposition by the Board.

DATED at St. John's, in the Province of Newfoundland and Labrador, this 2nd day of November, 2013.



Geoffrey P. Young
Counsel for the Applicant
Newfoundland and Labrador Hydro
500 Columbus Drive P.O. Box 12400
St. John's, Newfoundland and Labrador
A1B 4K7
Telephone: (709) 737-1277
Facsimile: (709) 737-1782

IN THE MATTER OF the *Electrical Power Control Act*, R.S.N.L. 1994, Chapter E-5.1 (the EPCA) and the *Public Utilities Act*, R.S.N.L. 1990, Chapter P-47 (the Act), and regulations thereunder;

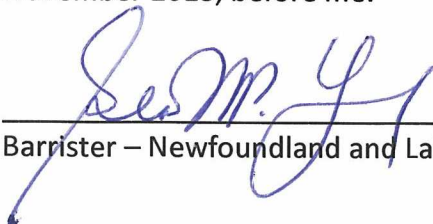
AND IN THE MATTER OF an Application by Newfoundland and Labrador Hydro (Hydro) for the approval, pursuant to Subsection 41(3) of the Act of infrastructure required for the installation of diesel units at Holyrood for the purpose of blackstarting the generating units, and pursuant to Sections 49, 78 and 80 of the Act, for the deferral of lease costs relating to the diesel units required for blackstart purposes.

AFFIDAVIT

I, Robert J. Henderson, Professional Engineer, of St. John's in the Province of Newfoundland and Labrador, make oath and say as follows:

1. I am Vice-President of Newfoundland and Labrador Hydro, the Applicant named in the attached Application.
2. I have read and understand the foregoing Application.
3. I have personal knowledge of the facts contained therein, except where otherwise indicated, and they are true to the best of my knowledge, information and belief.

SWORN at St. John's in the)
Province of Newfoundland and)
Labrador this 22nd day of)
November 2013, before me:)



Barrister – Newfoundland and Labrador



Robert J. Henderson

(DRAFT ORDER)
NEWFOUNDLAND AND LABRADOR
BOARD OF COMMISSIONERS OF PUBLIC UTILITIES

AN ORDER OF THE BOARD

NO. P.U. __ (2013)

1 **IN THE MATTER OF** the *Electrical Power*
2 *Control Act*, R.S.N.L. 1994, Chapter E-5.1 (the
3 *EPCA*) and the *Public Utilities Act*, R.S.N.L. 1990,
4 Chapter P-47 (the Act), and regulations thereunder;

5
6 **AND IN THE MATTER OF** an Application
7 by Newfoundland and Labrador Hydro (Hydro)
8 for the approval, pursuant to Subsection 41(3)
9 of the *Act* of infrastructure required for the
10 installation of diesel units at Holyrood for the
11 purpose of blackstarting the generating units, and
12 pursuant to Sections 49, 78 and 80 of the *Act*,
13 for the deferral of lease costs relating to the
14 diesel units required for blackstart purposes.

15
16
17 **WHEREAS** Newfoundland and Labrador Hydro (“Hydro”) is a corporation continued
18 and existing under the *Hydro Corporation Act, 2007*, is a public utility within the
19 meaning of the *Act*, and is subject to the provisions of the *EPCA*; and

20
21 **WHEREAS** Subsection 41(3) of the *Act* requires that a public utility not proceed with
22 the construction, purchase or lease of improvements or additions to its property where:

- 23
24 a) the cost of construction or purchase is in excess of \$50,000; or
25 b) the cost of the lease is in excess of \$5,000 in a year of the lease,

26
27 without prior approval of the Board; and

28
29 **WHEREAS** in Order Nos. P.U. 2(2013) and P.U. 4(2013) the Board approved Hydro's
30 2013 Capital Budget; and

31
32 **WHEREAS** the Board approved supplementary 2013 capital expenditures in:

- 33 (i) Order No. P.U. 1(2013) in the amount of \$284,100 for the refurbishment
34 of the stop logs at the Burnt Dam Spillway; and
35 (ii) Order No. P.U. 12(2013) in the amount of \$5,198,000 for the
36 refurbishment of the marine terminal at the Holyrood Thermal Generating
37 Station; and
38 (iii) Order No. P.U. 14(2013) in the amount of \$12,809,700 for the
39 refurbishment and repairs to Unit 1 at the Holyrood Thermal Generating
40 Station; and

- 1 (iv) Order No. P.U. 15(2013) in the amount of \$3,823,600 for 2013 and
- 2 \$15,310,400 for 2014 to install additional 230 kV transformer capacity at
- 3 the Oxen Pond Terminal Station; and
- 4 (v) Order No. P.U. 20(2013) in the amount of \$8,015,800 for the replacement
- 5 of the alternator on the Hardwoods Gas Turbine; and
- 6 (vi) Order No. P.U. 31(2013) in the amount of \$207,000 to the 2013
- 7 Allowance for Unforeseen Items; and
- 8 (vii) Order No. P.U. 33(2013) in the amount of \$388,700 for the replacement of
- 9 a breaker at Hinds Lake generating station; and

10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

WHEREAS on November 22, 2013 Hydro applied to the Board for the approval of a capital project in support of a 16 MW diesel plant blackstart generator solution for the Holyrood Thermal Generating Station in the amount of \$1,124,100; and

WHEREAS Hydro estimates it will incur \$5,724,200 of lease payment expenses to the end of 2015 and has applied for approval to defer these amounts until a future order of the Board concerning Hydro's recovery of such costs.

IT IS THEREFORE ORDERED THAT:

1. The proposed capital expenditure of \$1,124,100 in support of a 16 MW diesel plant blackstart generator solution for the Holyrood Thermal Generating Station is approved.
2. The deferral of lease expenses in the amount of \$5,724,200 for eight 1.825 MW diesel units to provide a blackstart generator solution for the Holyrood Thermal Generating Station, the recovery of which costs shall be determined by the Board in a future Order, approved.
3. Hydro shall pay all expenses of the Board arising from this Application.

DATED at St. John's, Newfoundland and Labrador, this _____ day of _____, _____.

**A REPORT TO
THE BOARD OF COMMISSIONERS OF PUBLIC UTILITIES**

	Electrical
	Mechanical
	Civil
	Protection & Control
	Transmission & Distribution
	Telecontrol
	System Planning

**Proposal to Provide Blackstart Capability to
Holyrood Thermal Generating Station**

November 2013

SUMMARY

The Holyrood Thermal Generating Station is required to have blackstart 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 Hydro has considered options to provide blackstart capability to the Holyrood plant for the 2013 – 2014 operating season and beyond.

Hydro has performed a technical analysis of the options that could provide blackstart capability to the Holyrood plant. This analysis modeled several different generator solutions. By modeling a blackstart 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 operating 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 Environment and Conservation 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 peak load period. 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 to be a 16 MW Diesel Plant leased for a period of 18 months to provide blackstart capability to the Holyrood Thermal Generating Station for the 2013 – 2015 period. Current estimates suggest that it can be installed within 11 weeks of Board of Commissioners of Public Utilities (Board) approval.

TABLE OF CONTENTS

1	Introduction	1
	Project Description - NOMINAL 16 MW Diesel Plant	1
	Technical analysis.....	1
2	Justification	2
2.1	Existing System	2
2.2	OPERATING EXPERIENCE.....	2
	Reliability Performance.....	3
	Safety Performance	4
	Industry Experience	5
	Historical Information	6
2.3	Development of Alternatives.....	6
	Planned Infrastructure for Holyrood Thermal Generating Station	7
	Existing Infrastructure at Holyrood Thermal Generating Station.....	8
	Civil Infrastructure	8
	Electrical Infrastructure	9
	Mechanical Infrastructure	10
	Basis of Financial Analysis.....	10
	Constraints and assumptions.....	10
	Technical Options considered.....	11
3	Conclusion	12
3.1	Budget Estimate	12
3.2	Project Schedule	13
	ALTERNATIVE 1 - Analysis of Refurbishment of Existing 15 MW Holyrood CT.....	2
	2013 Analysis of Gas Turbine Condition Assessment.....	3
	Analysis of 2011 Gas Turbine Condition Assessment.....	3
	Schedule differences between the 2011 analysis and 2013 analysis.....	3
	Safety Risk	4
	Cost and Schedule Risk	4
	Technical Analysis	4
	Cost	4
	ALTERNATIVE 2 - Nominal 14 MW Diesel Plant.....	5
	Technical Analysis	5
	Conclusion.....	7
	ALTERNATIVE 3 - Nominal 16MW Diesel Plant (ProPOsed SOLUTION).....	7
	Technical analysis.....	7

Schedule and Cost..... 9
Conclusion..... 10
ALTERNATIVE 4 - 15.9 MW Combustion Turbine Plant 10
 Technical analysis..... 11
 Schedule Availability 12
 Conclusion..... 12
ALTERNATIVE 5 - A 16.7 MW Combustion Turbine 12
 Technical analysis..... 13
 Schedule and Cost..... 14
 Conclusion..... 15
Alternative 6 - Single 22.5MW CT Plant..... 15
 Technical Analysis 16
 Schedule and Cost..... 17
 This generator rental will cost \$18.7M for a 16 month term..... 17
Alternative 7 - Newfoundland Power Mobile CT and Diesel Generator 18
 Conclusion..... 19

1 INTRODUCTION

The Holyrood Thermal Generating Station is required to have blackstart 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 Board of Commissioners of Public Utilities (Board) 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 blackstart plan utilizing the Hardwoods Gas Turbine and the multiple transmission paths between it and Holyrood. Hydro is proposing this capital project to immediately replace and restore blackstart capability at Holyrood.

PROJECT DESCRIPTION - NOMINAL 16 MW DIESEL PLANT

The scope of this project is to add blackstart capacity to the Holyrood Thermal Generation Plant from 2013 - 2016. This will be accomplished by installing leased generator units as follows:

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

Hydro intends to lease the diesel generators until the installation of a proposed 60 MW combustion turbine, currently scheduled for the 2015/2016 peak load period.

TECHNICAL ANALYSIS

Hydro has analyzed the generator solution to determine if it meets the technical requirements as indicated in section 2.3 below. The analysis shown in Appendix B, indicates that the system voltage does not fall below the voltage threshold requirement to ensure a successful start of the largest motor load, a boiler feed pump. Appendix B, Figure 5 indicates that this generating plant can supply the motor current, and it does not exceed the motor thermal limit shown in Appendix A.

2 JUSTIFICATION

The Holyrood Thermal generating Station requires blackstart capability in the event of a loss of grid power.

2.1 EXISTING SYSTEM

The Holyrood Gas Turbine was established in the Holyrood Generating Station to provide emergency standby power to the plant for blackstarting 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 existing gas turbine has been very rarely required to perform the blackstart function. However, it had been maintained and routinely operated to ensure availability. It was also function tested in simulated blackstart scenarios when the entire Holyrood plant had been shut down for maintenance.

2.2 OPERATING EXPERIENCE

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 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 blackstart 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.

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 blackstart 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 blackstart capability. This condition resulted in discussion within Hydro on options to provide the blackstart capability. Part of this consideration was that Hydro was preparing an estimate for a 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 blackstart 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 blackstart unit was established.

RELIABILITY PERFORMANCE

The existing gas turbine at Holyrood is not available for operation. This unit was operated as a standby unit and was inactive most of the time that it was in operation. Information regarding refusal to start or failure during operation is not available at this time. Operating experience is described in Section 3.2.5 below.

On January 11, 2013 the Holyrood plant experienced a loss of supply from the grid due to a severe winter blizzard which caused the high voltage equipment in the Holyrood switchyard to experience electrical faults and the lockout of the Holyrood switch yard equipment. This resulted in a complete shutdown of the Holyrood generating units at 06:48. Power was supplied to the Holyrood plant via its emergency diesel units. However these units provide only essential services to the plant and are not designed to start the large motors required to operate the generating units.

As a result of this situation, power could not be delivered to the Holyrood plant from the Hardwoods gas turbine to restart the generating units until the switchyard equipment could be restored. This occurred at 15:03 due to the severe weather conditions preventing switchyard maintenance personnel from accessing the switchyard. Without a local blackstart generation source the Holyrood generating units cooled down and could not be in pre-warmed state to be

ready to provide power to the grid when the switchyard was restored. This lack of being in a pre-warmed state resulted in approximately an 11 hour delay in the provision of power from the Holyrood plant which occurred at 03:54 on January 12.

In recognition of this delay in restart caused by the lack of local blackstart generation, Hydro immediately requested Newfoundland Power to station two of its mobile generators at the Holyrood site. Newfoundland Power agreed with this request and electrical infrastructure was established at the plant to connect these two mobile generators, a 6.5 MW Mobile Gas Turbine (MGT) and a 2 MW Mobile Diesel unit. These units remained at the site until late spring when Newfoundland Power required them for their annual capital and maintenance season. While at the site these mobile generators were tested and were proven to function at the site by fully loading the units while connected to the Holyrood plant. However, in repeated tests they were unable to start the large boiler feed pump motors necessary to have the units in a pre-warmed state. Therefore, while providing significant benefit to keeping much plant auxiliary equipment operating in a warm state, these units cannot provide the estimated 11 hour benefit of a blackstart unit. It is estimated that with the Newfoundland Power MGT one third of the start up time would be reduced and therefore with this unit on site the supply of power from Holyrood may have been restored approximately 4 hours earlier on January 11.

Prior to the January 2013 incident, the last time that the Holyrood generating station required blackstart capability for operational reasons was in December 1994. A major snowstorm on December 8-9 caused severe wind and ice loading related failures of multiple transmission lines, and subsequently the Holyrood generating station on December 10 at 13:35. The first Holyrood generating unit was not placed back in service until 12:44 the following day¹. The duration of this outage was exacerbated by, among other things, the inability of Hydro to successfully start and operate the Holyrood GT². After this event, Hydro performed annual tests of the Holyrood GT blackstart capability.

SAFETY PERFORMANCE

There are no known safety events associated directly with the existing Holyrood CT. In its report, AMEC examined 10 major systems in the existing CT. Of these, five were ranked “High” safety risk (Unacceptable; Corrective action required short term); four were ranked “Medium”

¹ “Power System Outage Report, Dec. 8 to Dec. 11 1994”, Newfoundland & Labrador Hydro, p. 3-4.

² *Ibid.*, p. 14

(Investigate and monitor short term, take action where beneficial); and one was ranked “Low”³ (Monitor, take action where beneficial).

As stated above, AMEC determined that there was risk of significant catastrophic failure of the gas turbine if it was operated. Such a failure could cause major safety issues, and potentially result in a fatality.

On January 11, 2013 there were small fires on unit 1 as a result of the failure of the unit’s bearing lubrication system. The diesel unit was able to be used to operate exhaust fans within the power house to remove smoke but at a slow rate. A large generating unit such as the Newfoundland Power MGT or the proposed 16 MW diesel plant would be able to operate the large unit forced draft fans which would much more quickly exhaust the smoke from the plant.

INDUSTRY EXPERIENCE

North American Electric Reliability Corporation (NERC) Emergency Preparedness and Operations Standard EOP-005-2 requires that Transmission Operators develop, maintain and test a restoration plan, including testing blackstart capability⁴.

As previously reported to the Board by Hydro,

“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.”⁵

In 2011, AMEC’s condition assessment of the Holyrood CT concluded that while a major overhaul was desirable, there is concern regarding the practicality of completing a major overhaul on certain components, due to the age of the unit⁶. As well, it concluded that the unit has suffered “considerable degradation” owing to the high atmospheric saline content at

³ Holyrood Gas Turbine Condition Assessment & Options Study, AMEC. December 19, 2011, p. 2-22.

⁴ NERC Standard EOP-005-2, “System Restoration From Blackstart Resources”, <http://www.nerc.com/files/EOP-005-2.pdf>

⁵ Correspondence from Carla L. Russell to Ms. Cheryl Blandon, Aug. 5, 2013.

⁶ Holyrood Gas Turbine Condition Assessment & Options Study, AMEC. December 19, 2011, p. 2-18.

Holyrood⁷. Specifically, the report references a study indicating that units under similar climatic conditions may have experienced the loss of useful life equivalent to 0.3 hours of running time for every hour of standby time⁸.

HISTORICAL INFORMATION

The existing CT was manufactured in 1966 and placed in service by Hydro in 1970. Up to December 2010 it had recorded approximately 4700 operating hours and approximately 2550 starts at Holyrood.

Since the unit's installation at Holyrood, major overhauls were completed in 1978, 1986, 1991 and 2007. As well, 15 overhauls of the generator component of the GT were recorded between 1978 and 2009.

2.3 DEVELOPMENT OF ALTERNATIVES

The operational requirements for the Holyrood blackstart 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.
- This ability must be maintained during any refurbishment or replacement of the existing blackstart 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.
- Blackstart capability must be capable of starting any of the three thermal units located at the plant.
- It is preferable that the blackstart solution be located at the Holyrood facility where it is less dependent on transmission infrastructure that could be exposed to severe weather conditions.

⁷ Ibid., p. 2-17.

⁸ Ibid., p. 2-5.

An analysis of the Holyrood Thermal Generating Station has determined plant specific electrical criteria that the blackstart 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 blackstart 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 blackstart is a boiler feed pump motor. There are six of these units, any one of which may need to be started during a blackstart 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.

PLANNED INFRASTRUCTURE FOR HOLYROOD THERMAL GENERATING STATION

Hydro will be requesting Board 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 blackstart capability to the station, and replace any temporary blackstart solution recommended in this analysis.

The timeline of the 60MW Combustion Turbine project suggests that a temporary blackstart generation solution would be needed until the end of the 2014 – 2015 operating 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 operating season if required. All solutions evaluated in this report can be extended to the 2015 – 2016 operating season.

EXISTING INFRASTRUCTURE AT HOLYROOD THERMAL GENERATING STATION

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

CIVIL INFRASTRUCTURE

As shown in Figure 1, there is one area which is suitable for a temporary blackstart 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. Some site work will be required to prepare the site for the proposed generators and ancillary equipment.

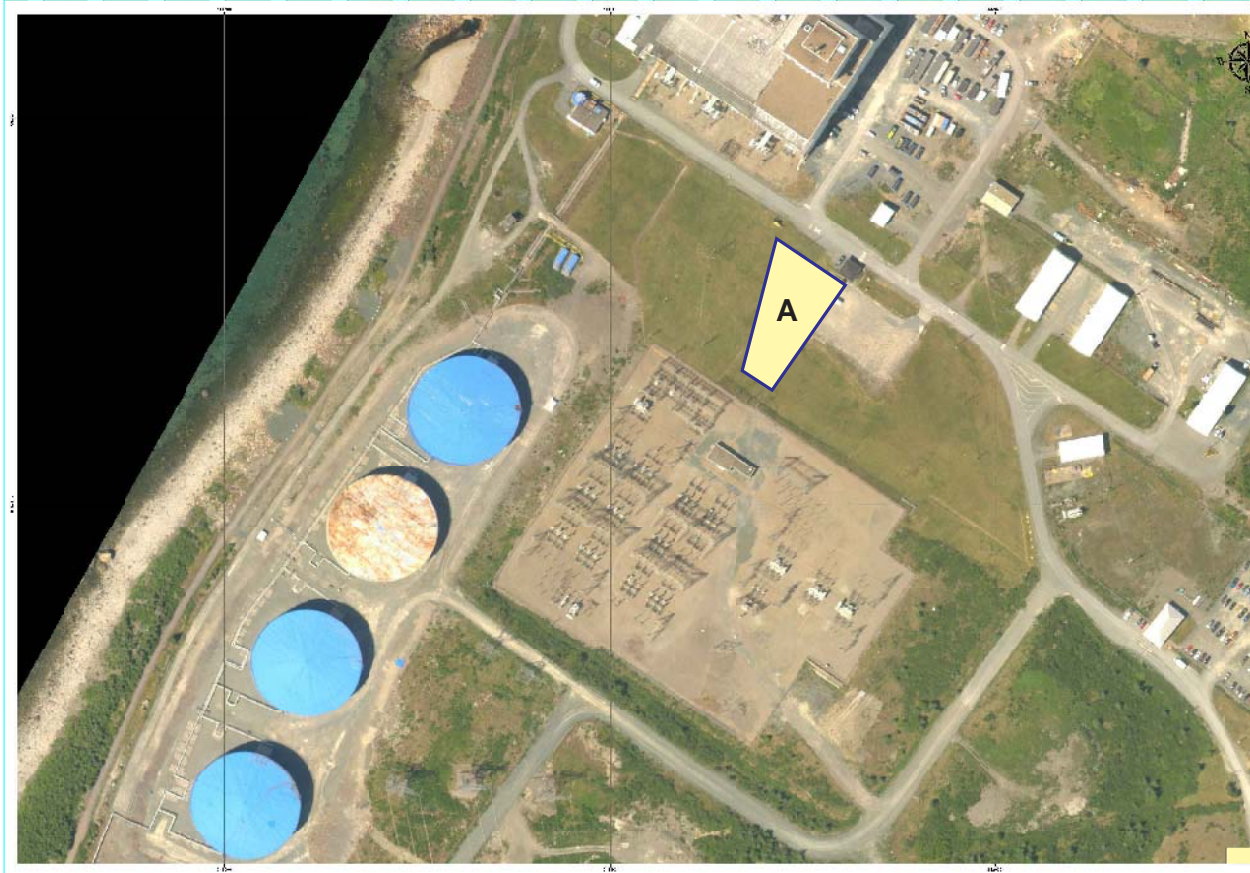


Figure 1. Location of Generator Solution

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 Gas turbine and diesel unit to potentially provide blackstart. This infrastructure serves as the bulk of the connections required to connect a mobile blackstart generating plant to Holyrood.

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

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 blackstart diesel solutions considered 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.

BASIS OF FINANCIAL ANALYSIS

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

CONSTRAINTS AND ASSUMPTIONS

This project schedule 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. Hydro intends to pursue this exemption with all dispatch.

No schedule allowance has been made for weather-related or other delays.

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

It is assumed that the acquisition of the proposed units will be exempted from public tendering in order to retain the proposed schedule.

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

With the aggressive schedule proposed to install the generating units, it will be highly unlikely that a full blackstart test can be performed until after the operating season is complete. It is

Hydro's intent to simulate as closely as possible the blackstart load conditions during commissioning of these units.

A blackstart solution is being sought to meet the current operating season to reduce exposure to a grid failure affecting a quick restoration of the Holyrood plant. A blackstart solution must remain at Holyrood until the decommissioning of the plant which is scheduled after 2020. As indicated in section 10. Hydro will be requesting Board approval for a 60MW CT to be installed at Holyrood in late 2015 or early 2016. That project would be expected to provide blackstart capability from 2016 until plant decommissioning.

TECHNICAL OPTIONS CONSIDERED

Aside from the proposed nominal 16 MW Diesel Plant consisting of eight 2MW units operating at 480V with additional transformers installed, Hydro considered several technical options to provide blackstart capability to the Holyrood thermal plant. Each is described below:

- Refurbish the existing gas turbine, and rent a generator for blackstart capability during the refurbishment.
- Lease diesel generator solutions
 - o Nominal 14MW Diesel Plant consisting of seven 1.825MW units at 480V with additional transformers installed.
- Lease a combustion turbine
 - o 15.9MW CT Plant consisting of three 5.3MW units operating at 13.8kV
 - o 16.6MW CT Plant consisting of one 5.2MW and two 5.7MW Units operating at 13.8kV
 - o Single 25MW CT Plant operating at 13.8kV
- Use the Newfoundland Power Mobile gas turbine and diesel generator.
- Maintain the status quo using Hardwoods GT as a generating source to facilitate blackstart.

These technical options are described and analyzed in more detail in Appendix B.

3 CONCLUSION

The financial analysis of the various options is tabulated below. Hydro has identified the least cost option is a 16 MW Diesel Plant leased for a period of 18 months⁹ to provide blackstart capability to the Holyrood Thermal Generating Station for 2013 – 2015 operating seasons. Current estimates suggest that it can be installed within 11 weeks of Board approval provided there are no inclement weather or other delays.

Description	Capital Cost	Lease Cost	Total Cost	Project Availability
Rental of 16MW Diesel Plant	\$1,124,100	\$5,724,200	\$6,848,300	11 weeks after PUB Approval
Refurbishment of Existing Holyrood CT	\$8,315,400	\$2,774,000	\$11,089,400	March 4, 2015
Rental of 16.7MW CT	\$1,877,800	\$10,019,600	\$11,897,400	13 weeks after Pub Approval
Rental of 22.5MW CT	\$1,999,500	\$16,683,600	\$18,683,100	18 weeks after Pub Approval

3.1 BUDGET ESTIMATE

SCHEDULE AND COST

The capital cost of renting the 16MW diesel plant is 1.2M.

Project Cost: (\$ x1,000)	<u>2014</u>	<u>2015</u>	<u>Beyond</u>	<u>Total</u>
Material Supply	0.0	0.0	0.0	0.0
Labour	439.0	0.0	0.0	439.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	530.0		0.0	
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation		0.0	0.0	100.6
Contingency	193.8		0.0	193.8
TOTAL	1,263.4	0.0	0.0	1,263.4

The lease cost of renting the 16MW Diesel Plant is 5.7M.

⁹ The 18 months assumes that the units will be returned to the lessor in June of 2015.

Project Cost: (\$ x1,000)	<u>2014</u>	<u>2015</u>	<u>Beyond</u>	<u>Total</u>
Material Supply	0.0	0.0	0.0	0.0
Labour	0.0	0.0	0.0	0.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	3,732.0	1,476.0	0.0	5,208.0
Interest and Escalation	264.0	291.2	0.0	555.2
Contingency	0.0	0.0	0.0	0.0
TOTAL	3,996.0	1,767.2	0.0	5,763.2

This solution can be installed within six weeks of signing a purchase order with the supplier. Given the timelines associated with the Hydro tendering process, the project will take an additional four to five weeks to implement, once Board approval is received.

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

3.2 PROJECT SCHEDULE

The draft project schedule is contained in Appendix C.

APPENDIX A
MOTOR TECHNICAL 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

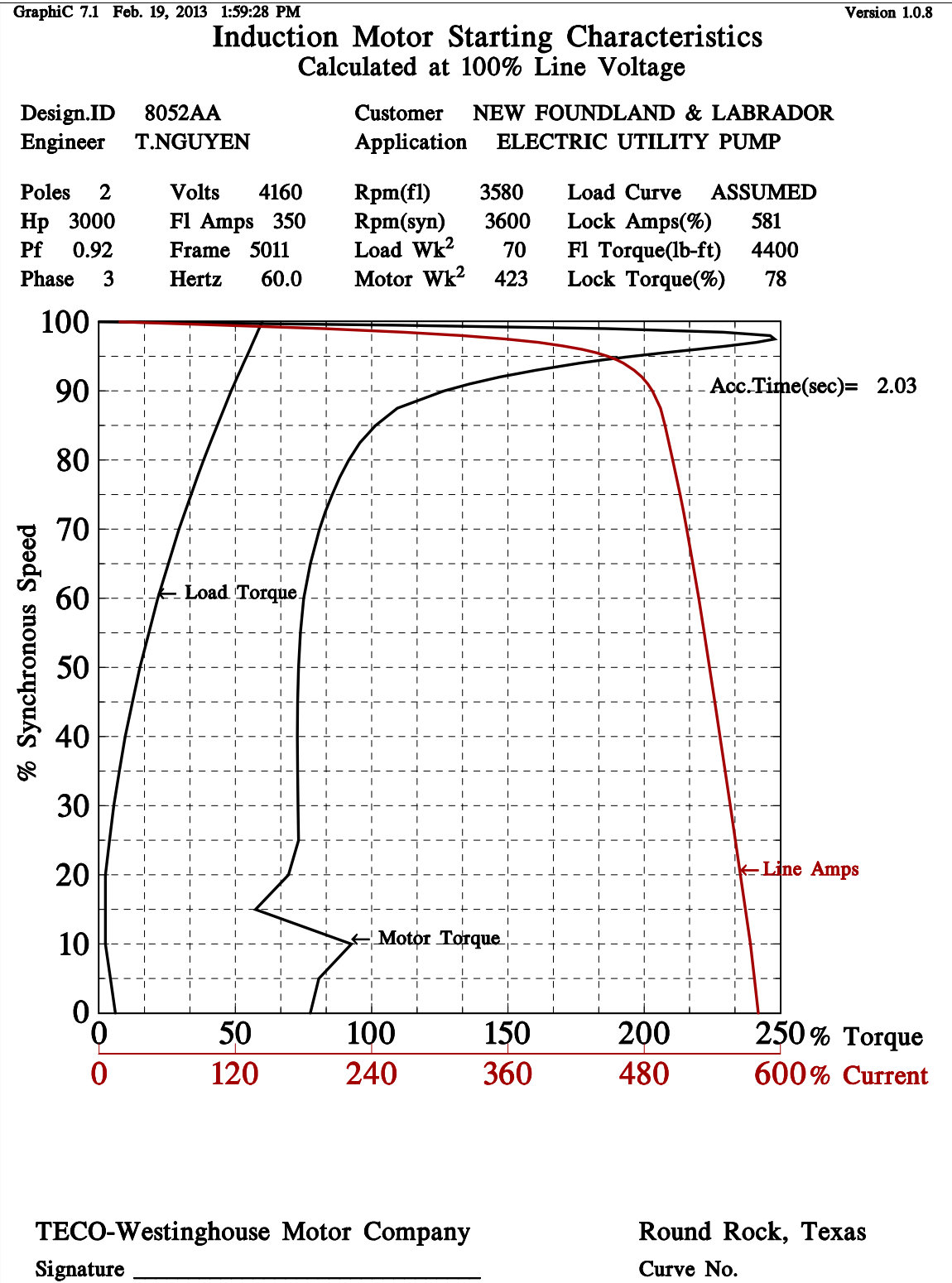
5. POWER FACTOR - NOMINAL

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 %



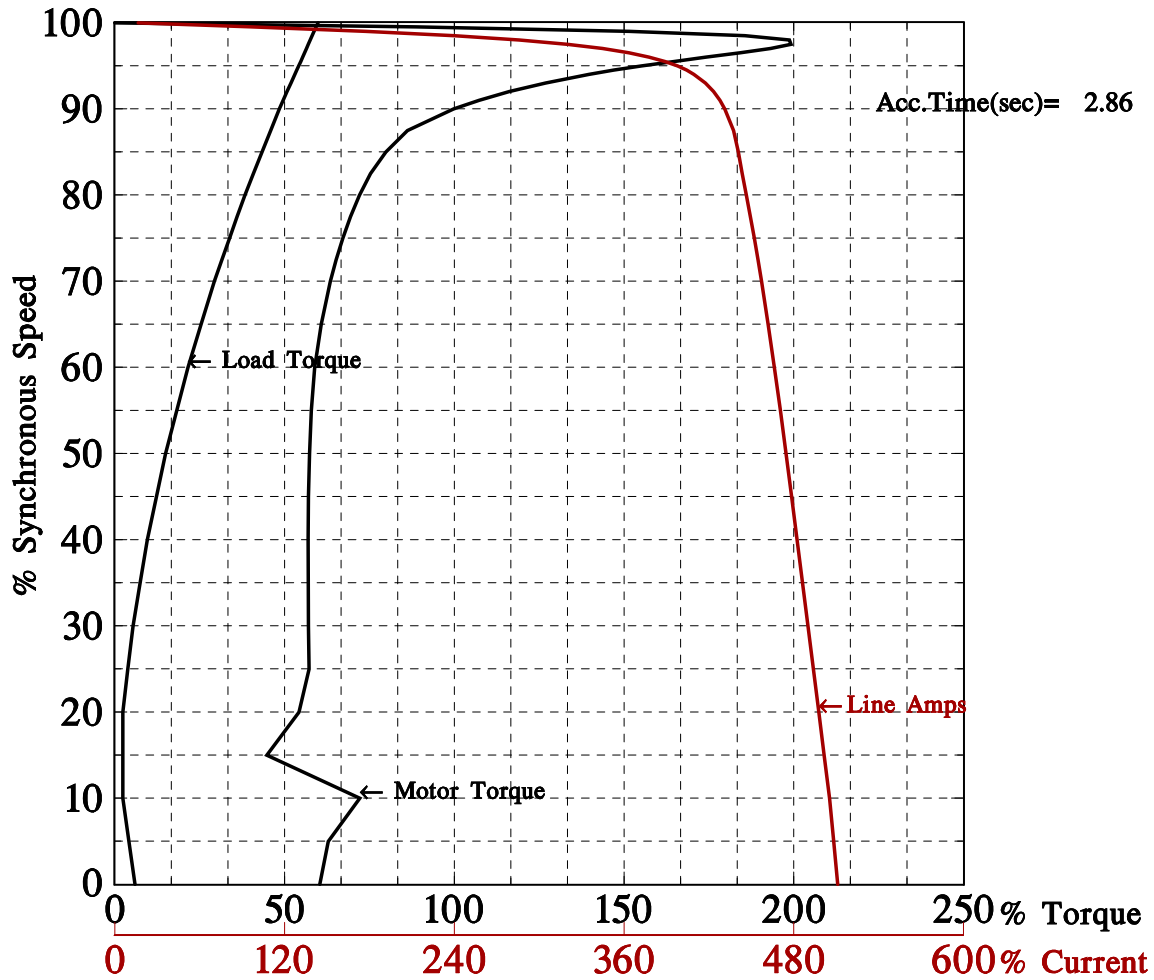
Curve 1 of 4

GraphiC 7.1 Feb. 19, 2013 1:59:28 PM

Version 1.0.8

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



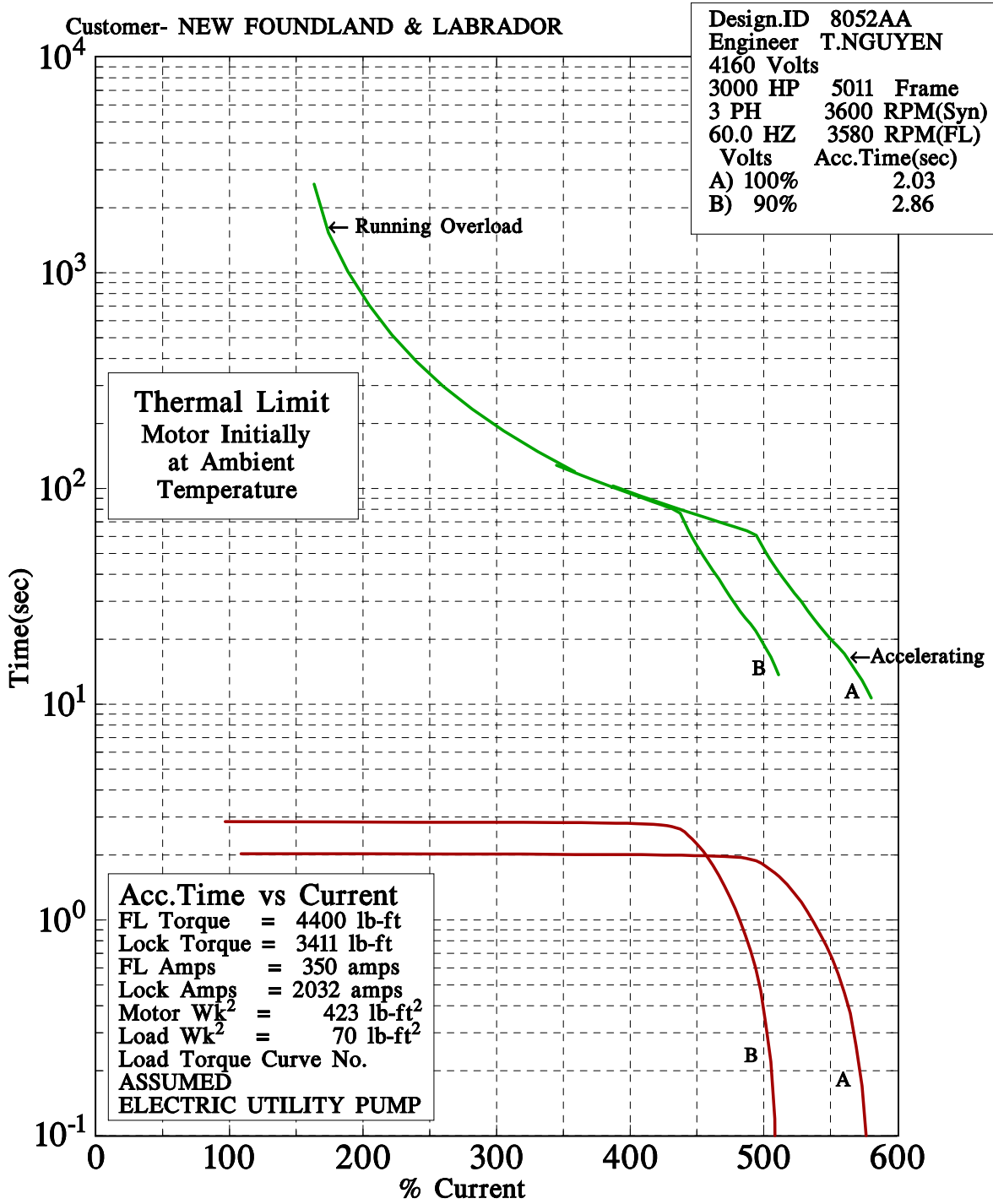
TECO-Westinghouse Motor Company
Signature _____

Round Rock, Texas
Curve No.

GraphiC 7.1 Feb. 19, 2013 1:59:28 PM

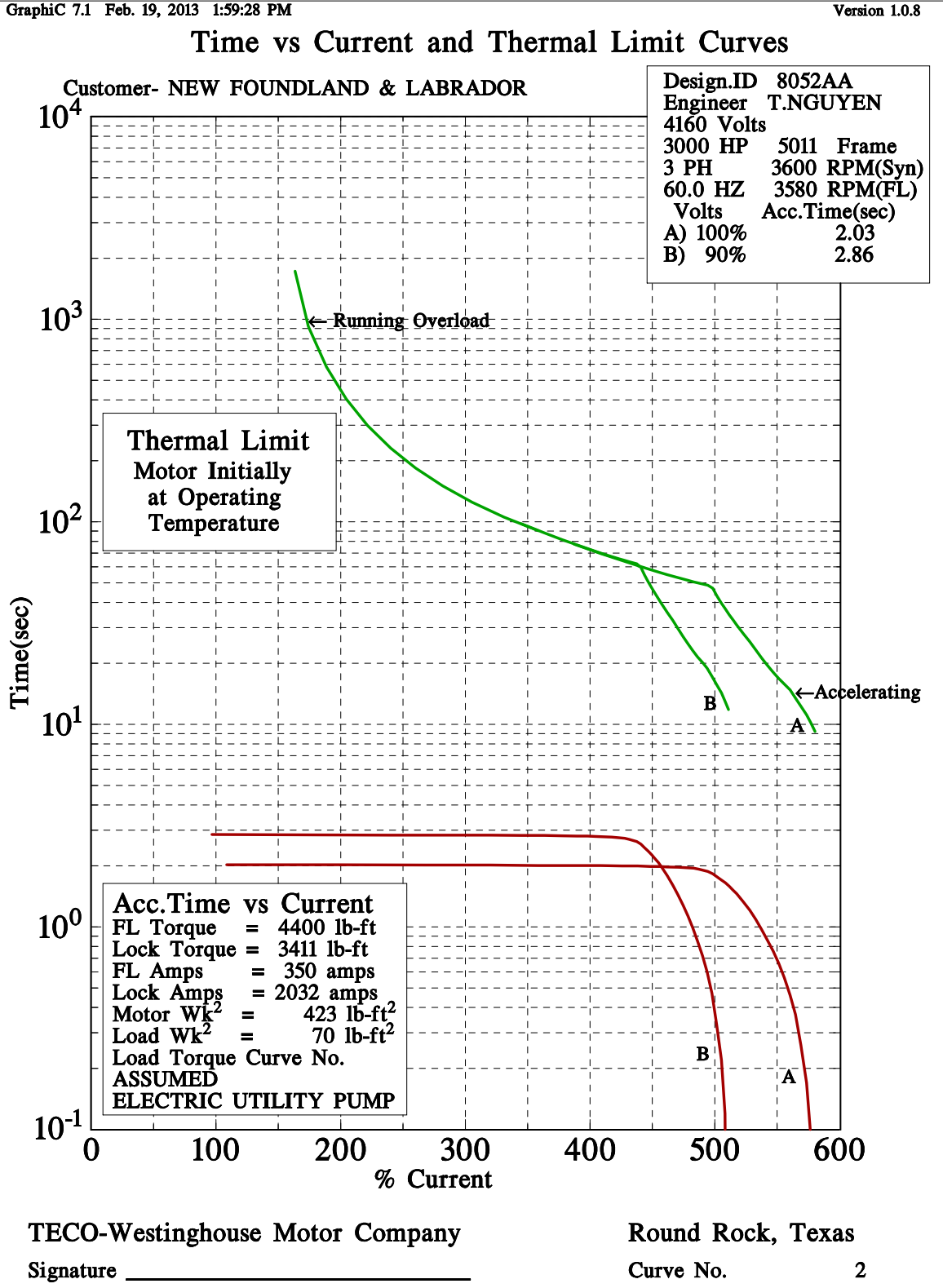
Version 1.0.8

Time vs Current and Thermal Limit Curves



TECO-Westinghouse Motor Company
Signature _____

Round Rock, Texas
Curve No. 1



APPENDIX B
EVALUATION OF ALTERNATIVES

EVALUATION OF ALTERNATIVES 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.

ALTERNATIVE 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.

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.
-

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.

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.

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.

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 obsolescence of the machine present the very real possibility of fully or over expending those contingencies.

TECHNICAL ANALYSIS

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

COST

As indicated, the expected cost to refurbish the existing Holyrood CT is \$11M. This solution has considerable technical risk owing to the advanced age and current state of the unit.

The capital cost to refurbish the existing Holyrood CT is \$8.5M

Project Cost: (\$ x1,000)	<u>2013</u>	<u>2014</u>	<u>Beyond</u>	<u>Total</u>
Material Supply	0.0	1,256.0	0.0	1,631.0
Labour	0.0	3,135.0	0.0	3,990.0
Consultant	0.0	156.0	0.0	195.0
Contract Work	0.0	530.0	0.0	530.0
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	0.0	362.4	0.0	700.2
Contingency	0.0	0.0	0.0	1,269.2
TOTAL	0.0	5,439.4	0.0	8,315.4

The lease cost to refurbish the existing Holyrood Gas Turbine is 2.8M.

Project Cost: (\$ x1,000)	<u>2013</u>	<u>2014</u>	<u>Beyond</u>	<u>Total</u>
Material Supply	0.0	1,256.0	0.0	0.0
Labour	0.0	0.0	0.0	0.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	0.0	2,308.2	0.0	2,464.8
Interest and Escalation	0.0	187.1	0.0	279.2
Contingency	0.0	0.0	0.0	0.0
TOTAL	0.0	2,495.3	0.0	2,744.0

ALTERNATIVE 2 - NOMINAL 14 MW 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.

TECHNICAL ANALYSIS

Hydro analyzed the generator solution to determine if it meets the technical requirements as indicated in Section 0. 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.

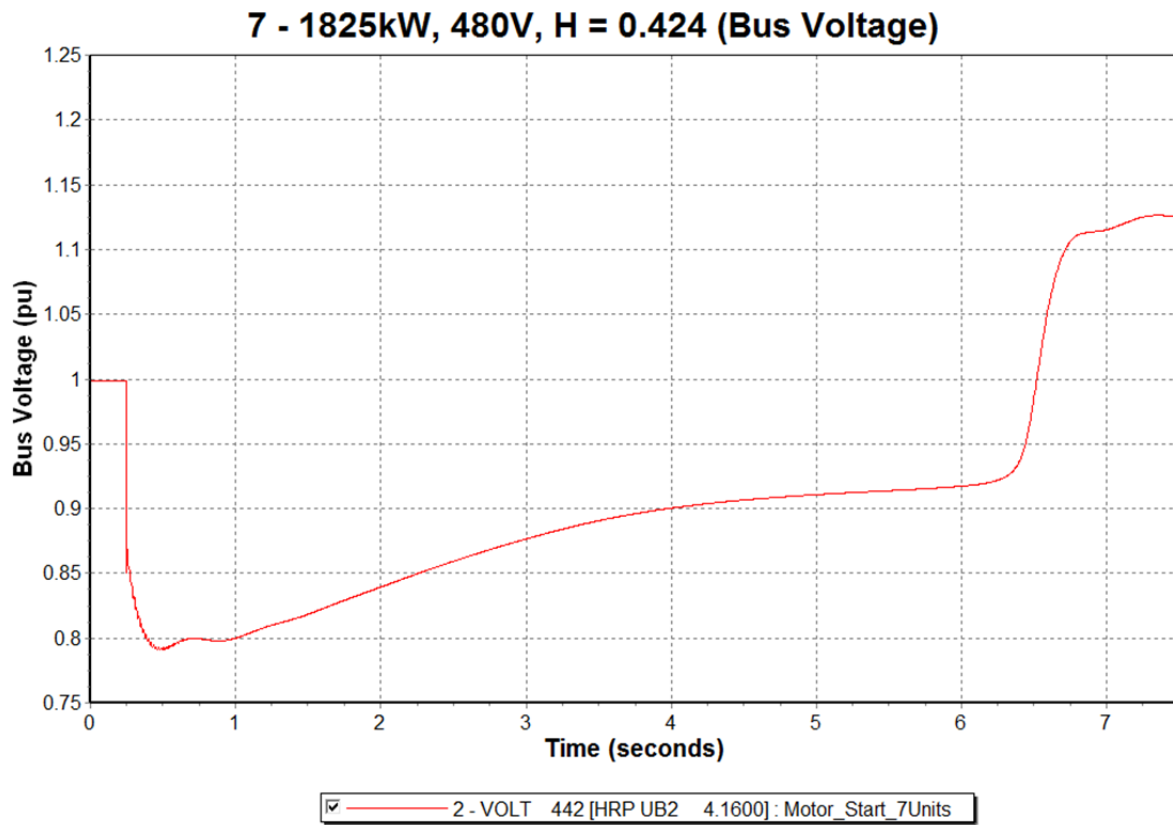


Figure 2. System Voltage Response of 7 - 1825kw Diesel Generators

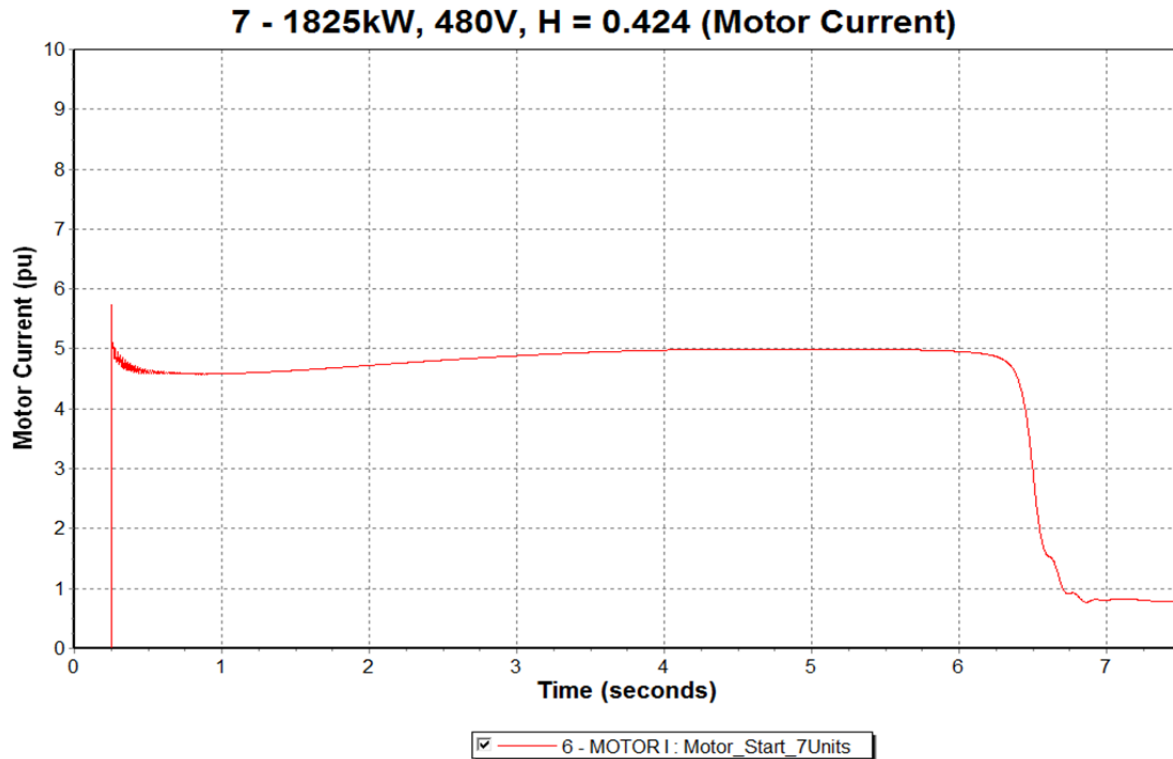


Figure 3. System Current Response on Motor Start

CONCLUSION

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

ALTERNATIVE 3 - NOMINAL 16MW DIESEL PLANT (PROPOSED SOLUTION)

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.

TECHNICAL ANALYSIS

Hydro has analyzed the generator solution to determine if it meets the technical requirements as indicated in section 0. 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.

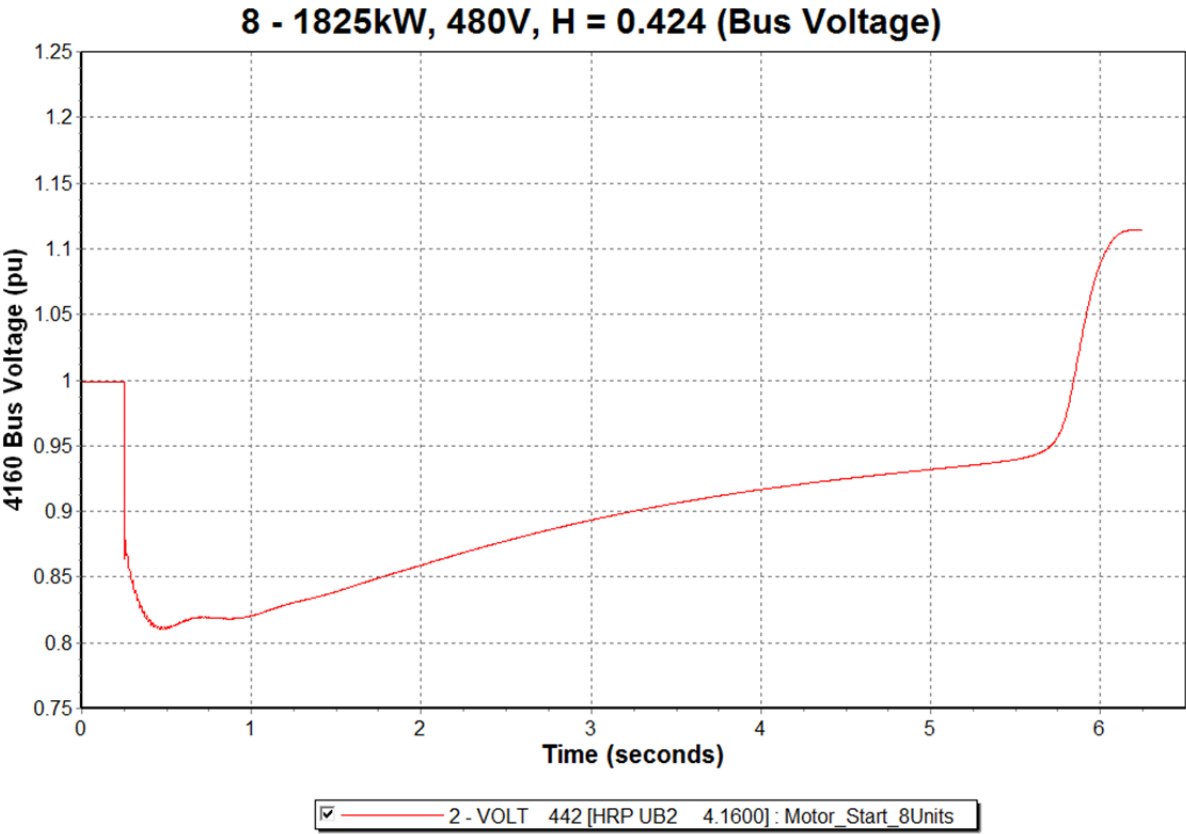


Figure 4. System Voltage Response of 8 - 1825kW Diesel Generators

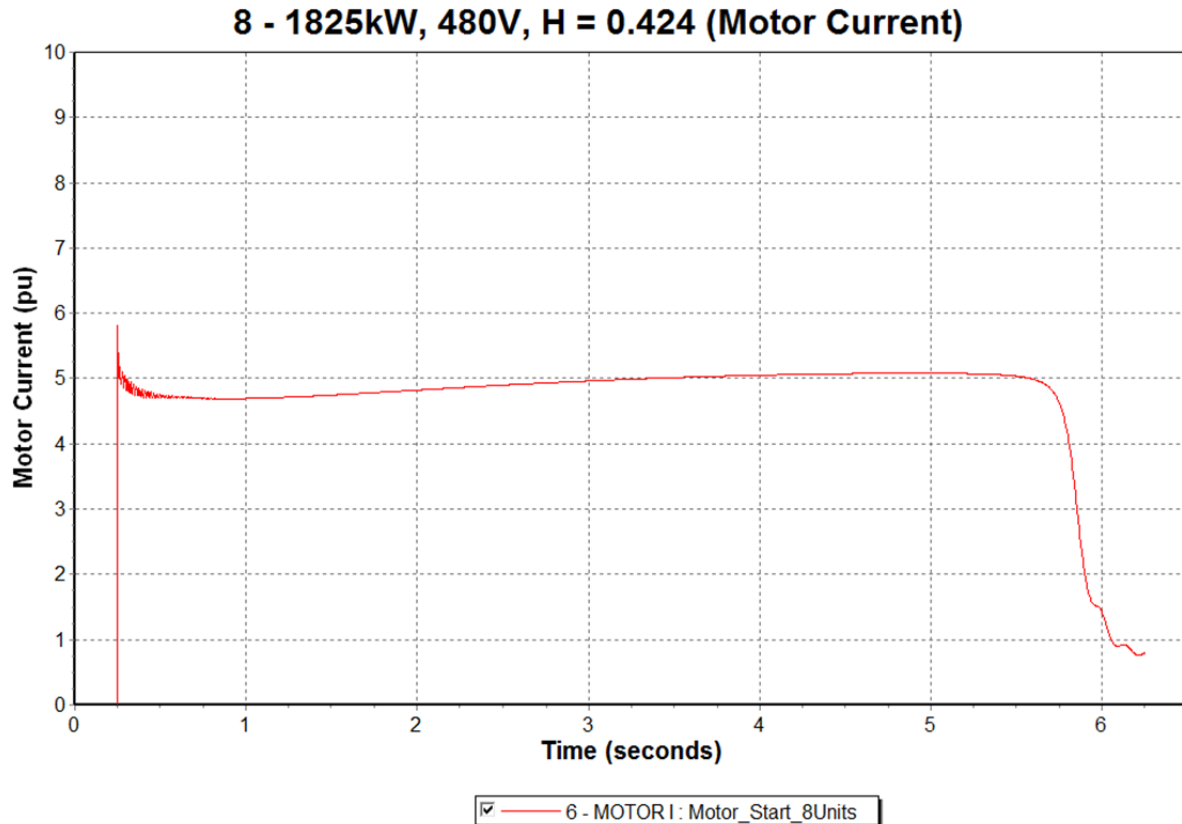


Figure 5. System Current Response of 8 - 1825kW Diesel Generators on Motor Start

SCHEDULE AND COST

The capital cost of renting the 16MW diesel plant is 1.2M.

Project Cost: (\$ x1,000)	<u>2014</u>	<u>2015</u>	<u>Beyond</u>	<u>Total</u>
Material Supply	0.0	0.0	0.0	0.0
Labour	439.0	0.0	0.0	439.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	530.0		0.0	
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation		0.0	0.0	100.6
Contingency	193.8		0.0	193.8
TOTAL	1,263.4	0.0	0.0	1,263.4

The lease cost of renting the 16MW Diesel Plant is 5.7M.

Project Cost: (\$ x1,000)	<u>2014</u>	<u>2015</u>	<u>Beyond</u>	<u>Total</u>
Material Supply	0.0	0.0	0.0	0.0
Labour	0.0	0.0	0.0	0.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	3,732.0	1,476.0	0.0	5,208.0
Interest and Escalation	264.0	291.2	0.0	555.2
Contingency	0.0	0.0	0.0	0.0
TOTAL	3,996.0	1,767.2	0.0	5,763.2

This solution can be installed within 6 weeks of signing a purchase order with the supplier. Given the timelines 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.

CONCLUSION

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

ALTERNATIVE 4 - 15.9 MW 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.

TECHNICAL ANALYSIS

Hydro has analyzed the generator solution to determine if it meets the technical requirements as indicated in section 0. 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.

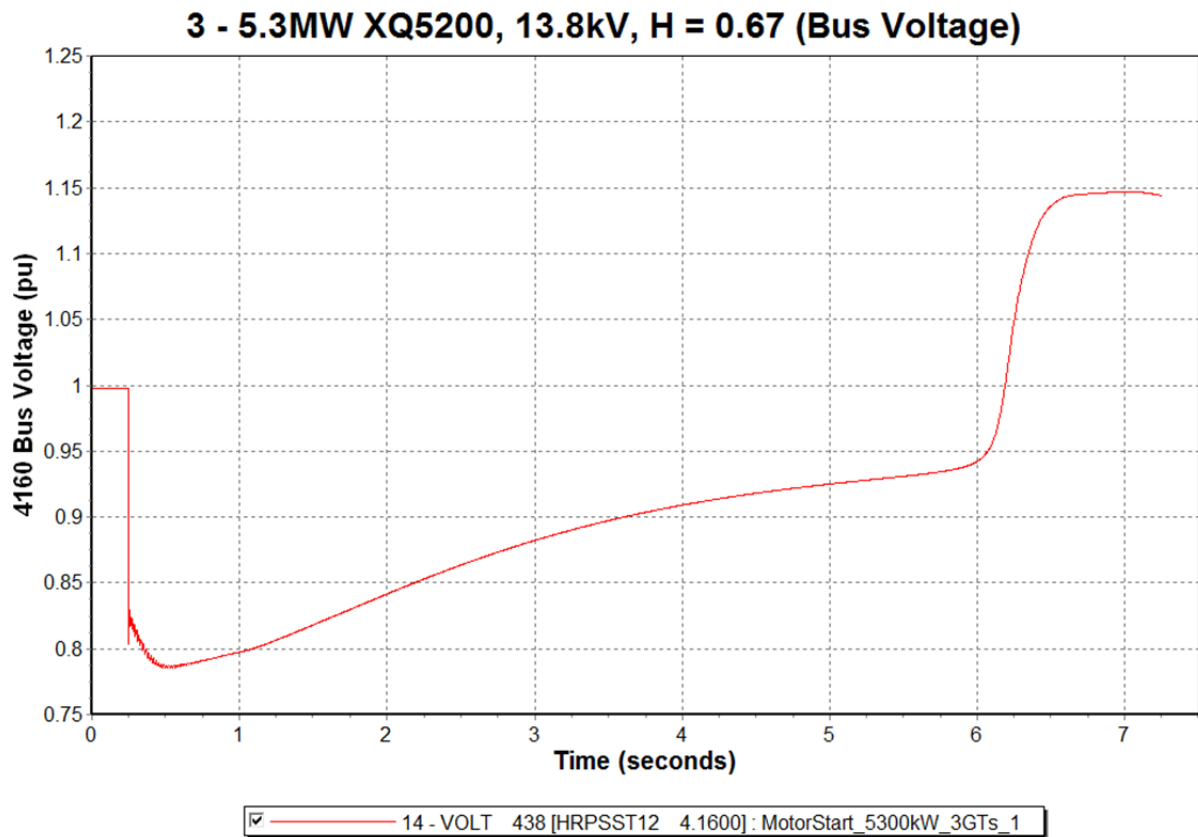


Figure 6. System Voltage Response of 3 - 5.3MW CT's during Blackstart

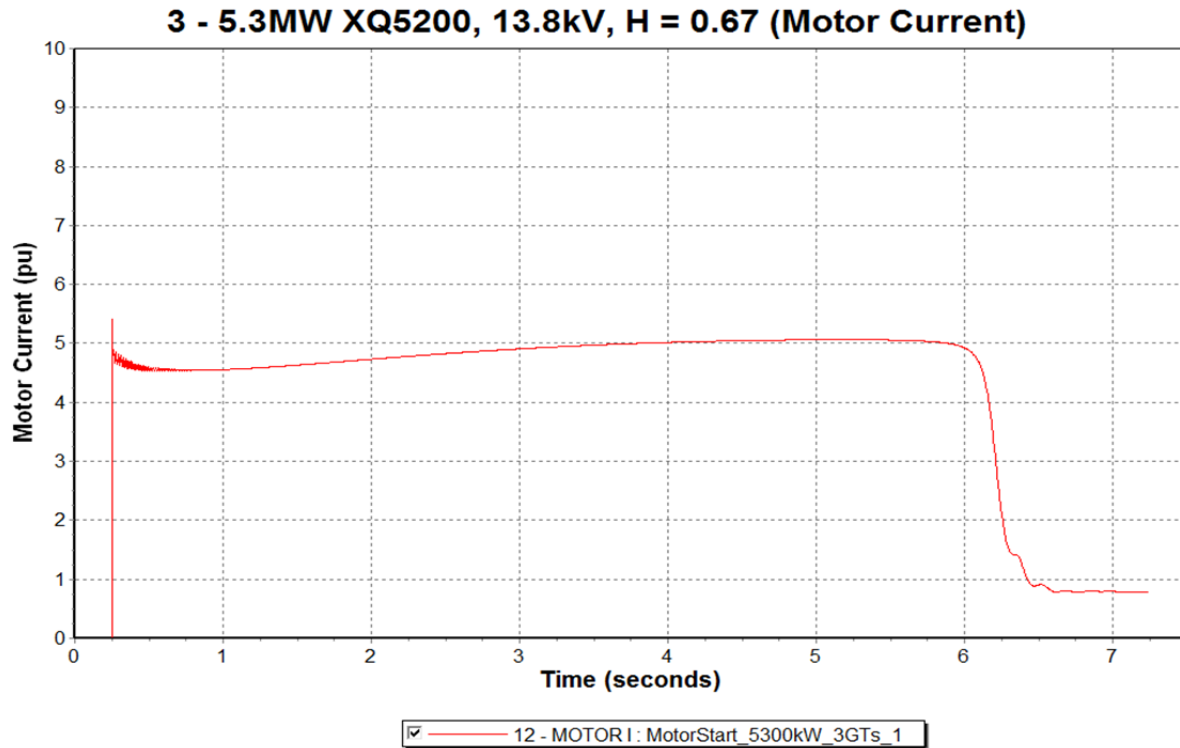


Figure 7. System Current Response during Blackstart

SCHEDULE AVAILABILITY

Currently these units are unavailable to meet the project schedule.

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.

ALTERNATIVE 5 - A 16.7 MW 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.

TECHNICAL ANALYSIS

Hydro has analyzed the generator solution to determine if it meets the technical requirements as indicated in Section 0. 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.

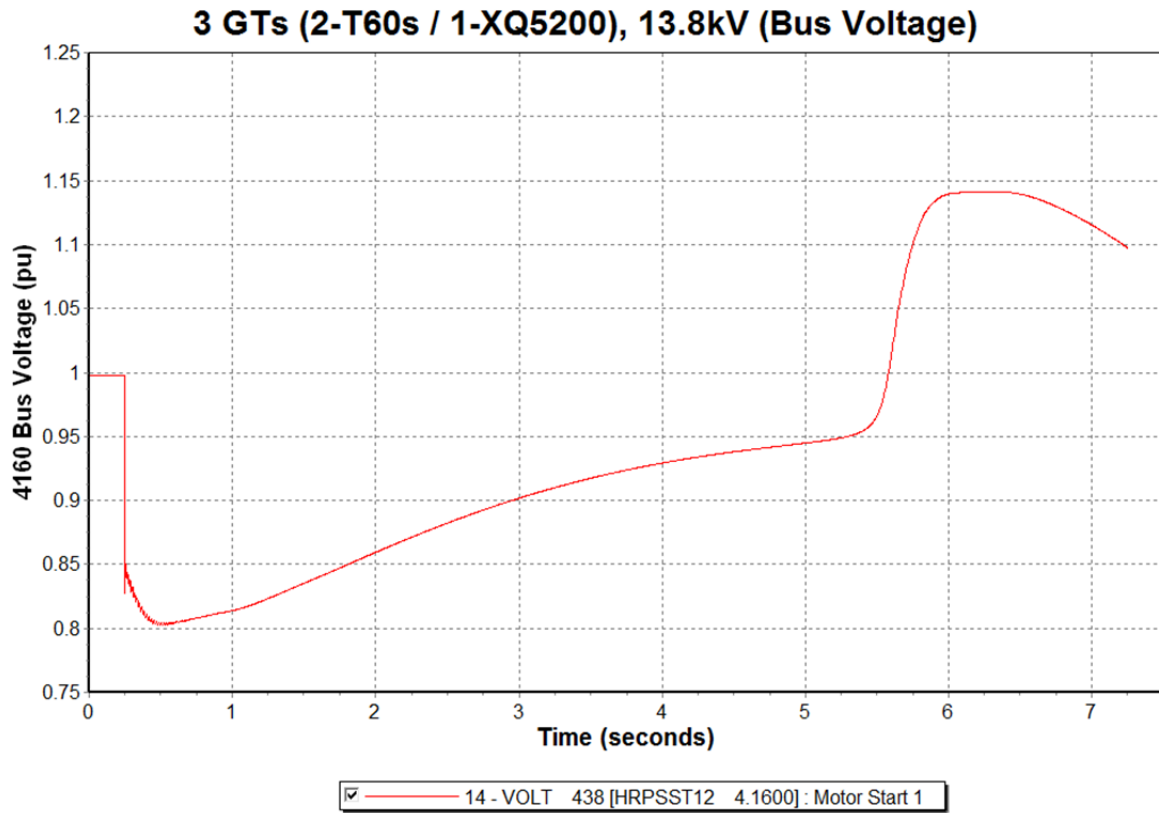


Figure 8. System Voltage Response of a 16.7MW CT plant on Blackstart

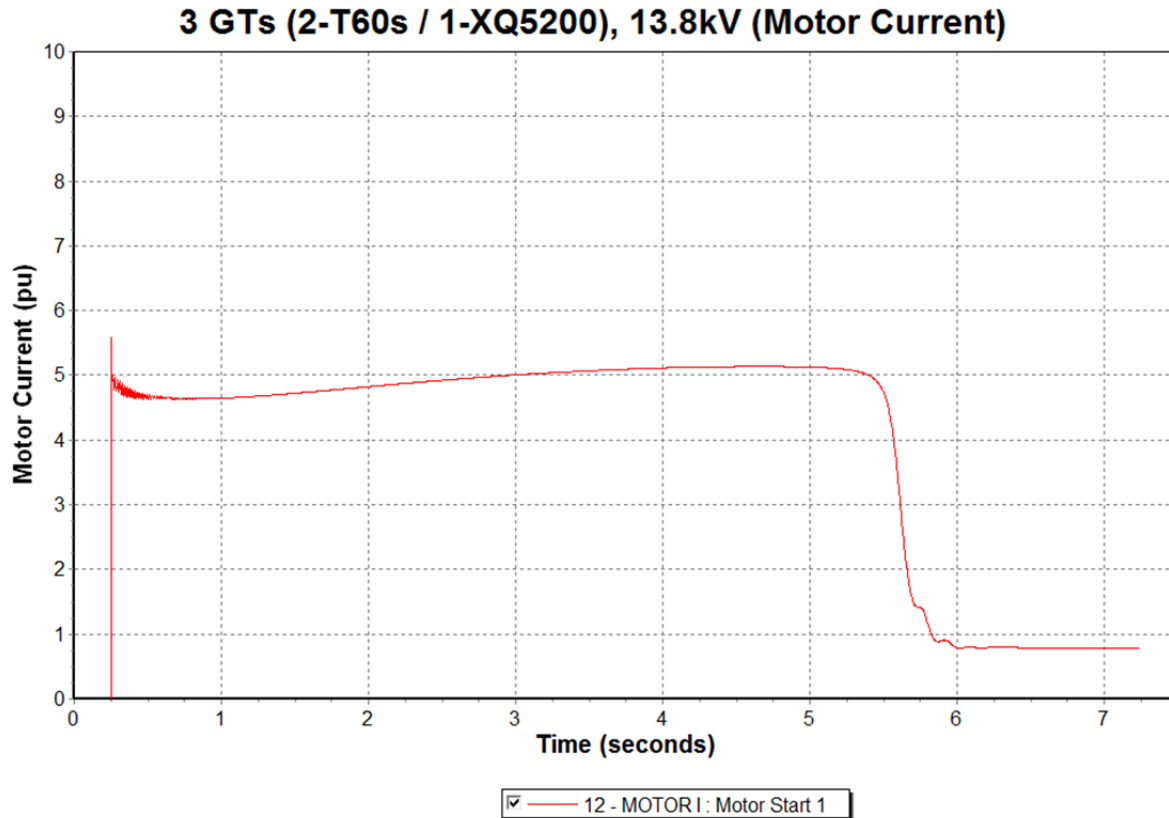


Figure 9. System Current Response of a 16.7MW CT Plant during Blackstart

SCHEDULE AND COST

This solution has a project cost of \$11.9M.

This solution has a capital cost of \$1.9M.

Project Cost: (\$ x1,000)	<u>2014</u>	<u>2015</u>	<u>Beyond</u>	<u>Total</u>
Material Supply	375.0	0.0	0.0	375.0
Labour	439.0	0.0	0.0	439.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	530.0	0.0	0.0	530.0
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	127.4	137.6	0.0	265.0
Contingency	0.0	268.8	0.0	268.8
TOTAL	1,471.4	406.4	0.0	1,877.8

This solution has a lease cost of \$10M.

Project Cost: (\$ x1,000)	<u>2014</u>	<u>2015</u>	<u>Beyond</u>	<u>Total</u>
Material Supply	0.0	0.0	0.0	0.0
Labour	0.0	0.0	0.0	0.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	5,091.0	3,744.0	0.0	8,835.0
Interest and Escalation	360.7	823.9	0.0	1,184.6
Contingency	0.0	0.0	0.0	0.0
TOTAL	5,451.7	4,567.9	0.0	10,019.6

This solution can be installed within 8 weeks of signing a purchase order with the supplier. Given the timelines 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.

CONCLUSION

This solution can meet the project requirements.

ALTERNATIVE 6 - 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.

TECHNICAL ANALYSIS

Hydro has analyzed the generator solution to determine if it meets the technical requirements as indicated in section 0. 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.

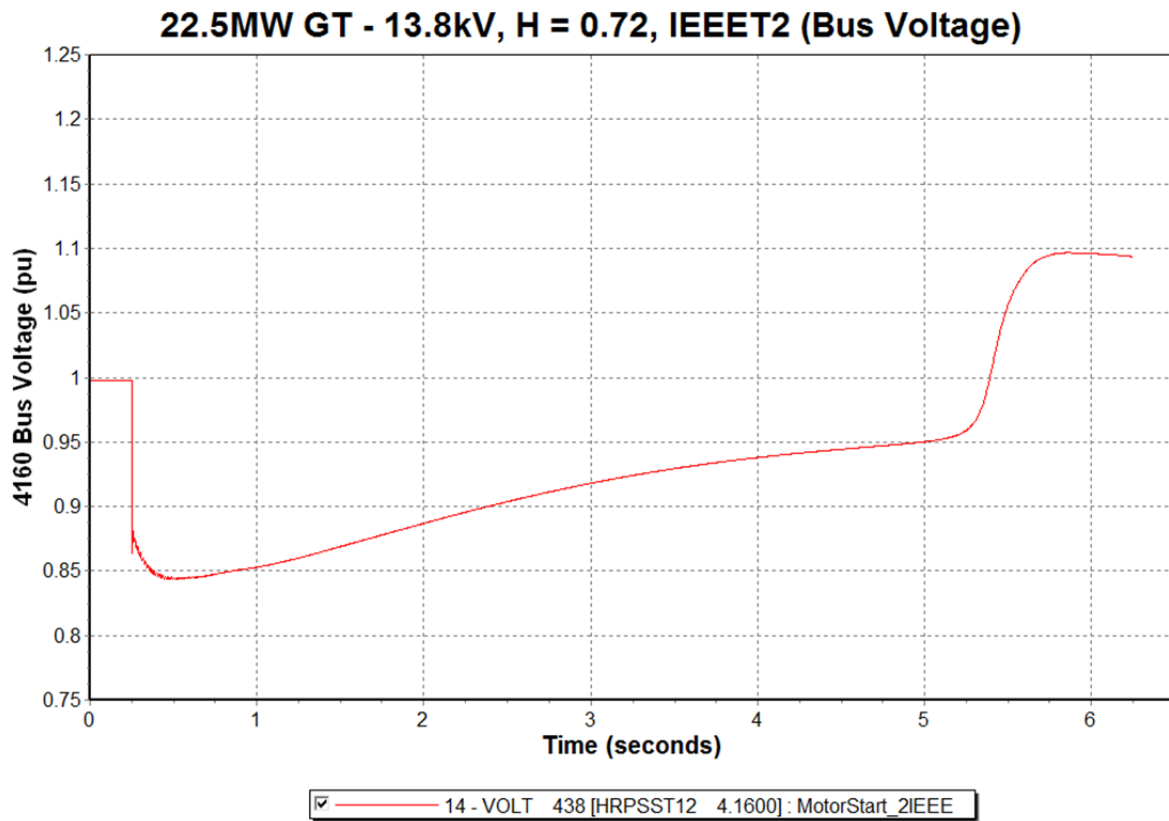


Figure 10. System Voltage Response of a 22.5MW CT during Blackstart

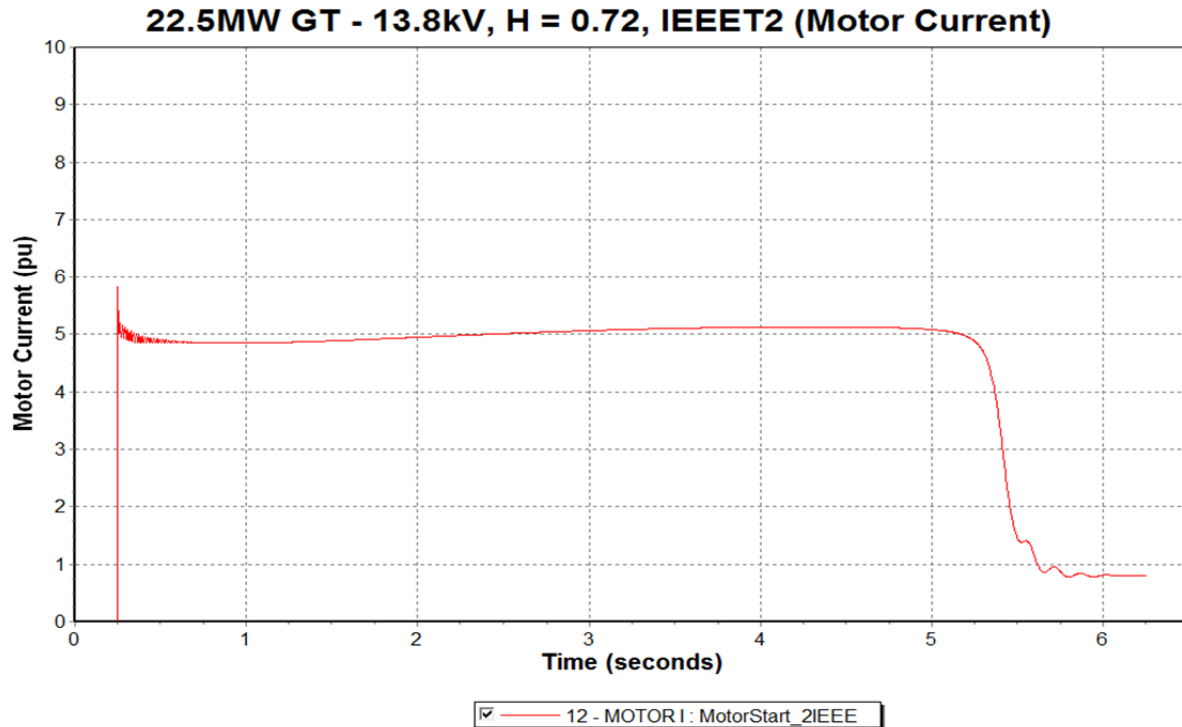


Figure 11. System Current Response of 22.5MW CT during Blackstart

SCHEDULE AND COST

This generator is available 90 days after signing a contract, assuming imminent contact signing and current equipment availability. Given the timelines 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 \$18.7M FOR A 16 MONTH TERM.

The capital cost of this solution is 2M.

Project Cost: (\$ x1,000)	<u>2014</u>	<u>2015</u>	<u>Beyond</u>	<u>Total</u>
Material Supply	0.0	0.0	0.0	0.0
Labour	509.0	0.0	0.0	509.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	930.0	0.0	0.0	930.0
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	126.3	146.4	0.0	272.7
Contingency	0.0	287.8	0.0	287.8
TOTAL	1,565.3	434.2	0.0	1,999.5

The lease cost of this solution is 16.6M.

Project Cost: (\$ x1,000)	<u>2014</u>	<u>2015</u>	<u>Beyond</u>	<u>Total</u>
Material Supply	0.0	0.0	0.0	0.0
Labour	0.0	0.0	0.0	0.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	10,944.0	3,648.0	0.0	14,592.0
Interest and Escalation	742.1	1,349.5	0.0	2,091.6
Contingency	0.0	0.0	0.0	0.0
TOTAL	11,686.1	4,997.5	0.0	16,683.6

ALTERNATIVE 7 - NEWFOUNDLAND 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 starting¹⁰.
- 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.

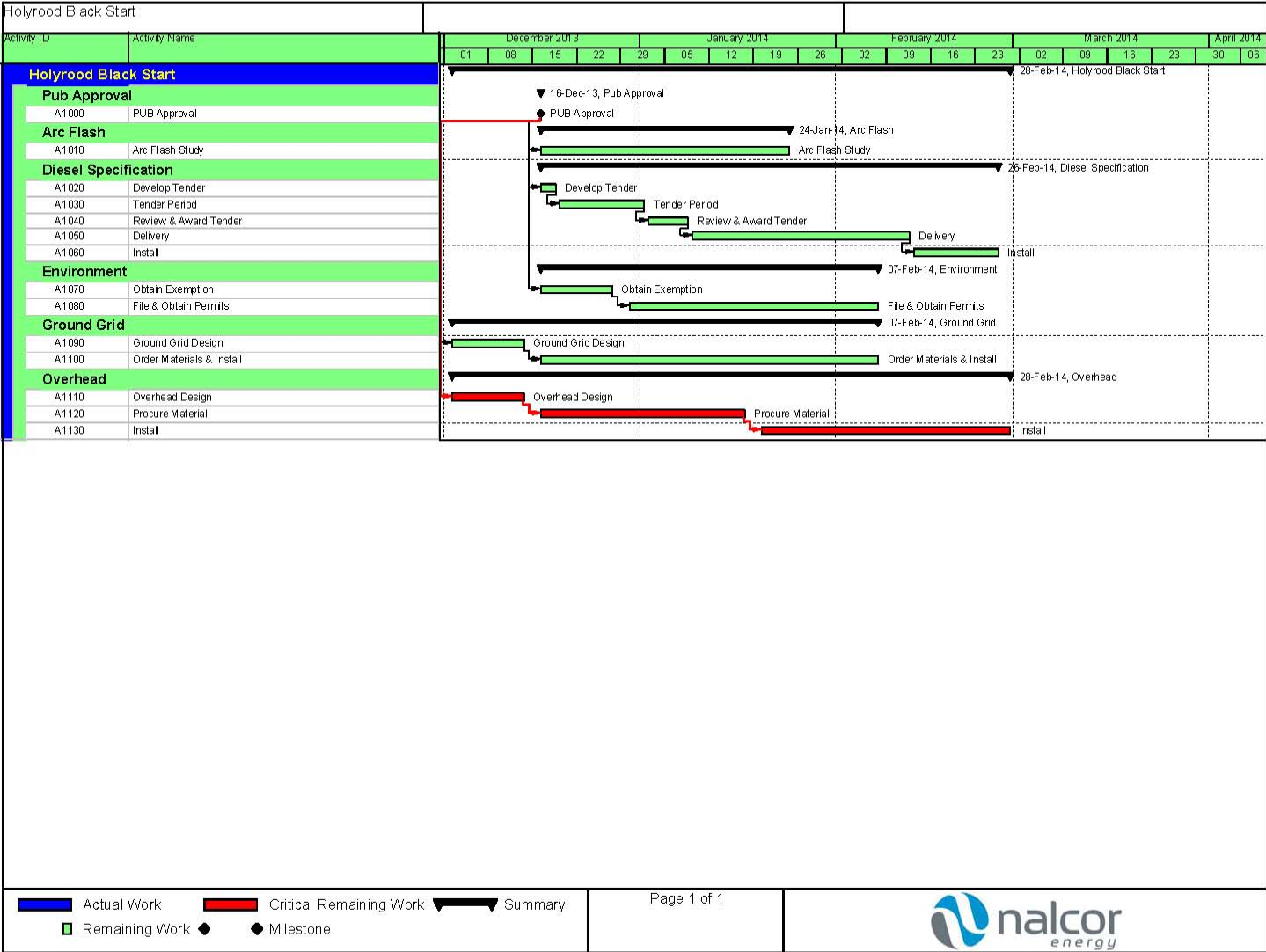
In the spring of 2013, Hydro installed both the NP Mobile Gas Turbine and the NP Mobile Diesel Generator at the Holyrood plant. A black start was attempted several times. During each attempt, the NP Mobile Gas Turbine tripped off-line and could not start the large boiler feed pump motors.

CONCLUSION

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

¹⁰ Analysis of Holyrood Unit 2 Boiler Feed Pump

APPENDIX C
DRAFT PROJECT SCHEDULE



█ Actual Work
 █ Critical Remaining Work
 ▼ Summary
 Remaining Work
 ◆ Milestone

