newfoundland labrador hydro
a nalcor energy company

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September 3, 2015

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 the approval of the Hardwoods Gas Turbine Engine Refurbishment.

Please find enclosed the original and 12 copies of the above-noted Application, plus supporting affidavit, project proposal, and draft order.

The proposed project involves the refurbishment of gas turbine engine serial number 20224 at the Hardwoods Gas Turbine Plant which will restore the gas turbine at Hardwoods to full generating capability which is necessary for the supply dependable and reliable power to the Island Interconnected System.

Should you have any questions, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

Tracey Pennell

Tracey L. Pennell
Legal Counsel

TLP/bs

cc: Gerard Hayes – Newfoundland Power
Paul Coxworthy – Stewart McKelvey Stirling Scales
Sheryl Nisenbaum – Praxair Canada Inc.
Thomas Johnson – Consumer Advocate
Thomas J. O'Reilly, Q.C. – Cox & Palmer

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

AND IN THE MATTER OF an Application by Newfoundland and Labrador Hydro (Hydro) pursuant to Subsection 41(3) of the *Act*, for approval of the Hardwoods Gas Turbine Engine Refurbishment

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 is the primary generator of electricity in Newfoundland and Labrador. As part of its generating assets, Hydro owns and operates a 50 MW gas turbine plant which is located in the west end of St. John's. The Hardwoods Gas Turbine Plant (Hardwoods) was constructed in 1977 and, among other things, is used as a synchronous condenser and provides peaking support to the Island Interconnected System.

3. On March 1, 2015, a fire occurred in engine module B at Hardwoods. While the fire was extinguished quickly, damage occurred to various components within the engine module, including engine serial number 202224. As a result of that damage, gas turbine engine serial number 202224 at Hardwoods must be refurbished.

4. Hydro is recommending that gas turbine engine serial number 202224 at Hardwoods be refurbished. Details regarding Hydro's proposal to refurbish gas turbine engine serial number 202224 are contained in the attached project proposal document.

5. The availability and reliability of Hardwoods is critical to ensure voltage regulation of the Island Interconnected System. This facility is also important for the generation of peak and emergency power. The refurbishment of gas turbine engine serial number 202224 is required to return Hardwoods to its full capability.

6. The estimated cost of this project is $1,219,300 and is expected to be completed in December 2015.

7. The Applicant submits that the refurbishment of gas turbine engine serial number 202224 at Hardwoods is necessary to ensure that the electrical system can continue to provide service which is safe and adequate and just and reasonable as required by Section 37 of the *Act*. An Engineering Report supporting this supplemental capital application is attached.

8. Hydro therefore makes Application for an Order pursuant to section 41(3) of the Act approving the refurbishment of gas turbine engine serial number 202224 at Hardwoods at an estimated capital cost of $1,249,300 as set out in this Application and in the attached project description and justification document.

DATED at St. John's, in the Province of Newfoundland and Labrador, this 3rd day of September, 2015.

Tracey L. Pennell
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) 778-6671
Facsimile: (709) 737-1782

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

AND IN THE MATTER OF an Application by Newfoundland and Labrador Hydro (Hydro) pursuant to Subsection 41(3) of the *Act*, for approval of the Hardwoods Gas Turbine Engine Refurbishment

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.

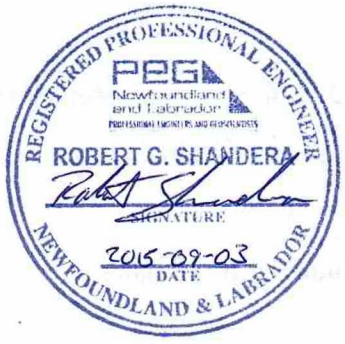
3. I have personal knowledge of the facts contained therein, except where otherwise indicated, and they are true to the best of my knowledge, information and belief.

SWORN at St. John's in the Province of Newfoundland and Labrador this 3rd day of September 2015, before me:)

Bobbi Sheppard
Commissioner for Oaths
Province of Newfoundland & Labrador
Expiry date: December 31, 2017

Robert J. Henderson

A REPORT TO
THE BOARD OF COMMISSIONERS OF PUBLIC UTILITIES

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

Hardwoods Gas Turbine Engine Refurbishment

Hardwoods Gas Turbine

August 2015

newfoundland labrador hydro
a nalcor energy company

SUMMARY

This project is to complete the refurbishment of engine serial number 202224 at Hardwoods gas turbine. The scope of work for the project includes the following:

1. Refurbishment of engine serial number 202224 which suffered internal damage as a result the failure of a pressure relief/drain line in the engine fuel supply system; and
2. Performing a root cause analysis of the failure of the engine.

This project will restore the gas turbine at Hardwoods to its full capability.

The budget estimate for this project is $1,249,300. The project is expected to be completed by December 31, 2015.

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1 INTRODUCTION

Hydro owns and operates two 50 MW gas turbine plants as part of the Island Interconnected System. Hardwoods Gas Turbine Plant (Hardwoods), is located in the west end of St. John's and Stephenville Gas Turbine Plant (Stephenville), is located in Stephenville.

Stephenville gas turbine was commissioned in 1975. Commissioning of the Hardwoods gas turbine followed a year later in 1976. The major pieces of equipment at both facilities are identical and as such, much of the equipment is interchangeable between the two plants.

The Island Interconnected System experiences constant voltage fluctuations that result from changes in the supply and demand of electricity. Since voltage fluctuations are undesirable, the system requires constant voltage correction to maintain the proper voltage levels. The system voltage is corrected using a process known as synchronous condensing. This process stabilizes the voltage of the system by acting like a shock absorber if the system experiences a voltage change. During synchronous condensing, the voltage change on the system is limited to no more than five percent below the nominal operating levels of 230, 138, or 66 kV. Synchronous condensing is the main function of the Hardwoods and Stephenville gas turbine plants. Stephenville and Hardwoods gas turbine plants are also operated in generation mode in peak and emergency periods to produce electric power for the Island Interconnected System.

The major mechanical components of each gas turbine plant include two gas generator engines, two power turbines, and an alternator (also called power generator), as well as auxiliary systems such as lube oil systems, fuel systems, electrical systems and control systems (see Figure 1). Structures such as buildings, equipment enclosures and exhaust stacks comprise the balance of components that make up the facility.

Figure 1: Hardwoods Gas Turbine Plant

No. 2 light fuel oil powers the gas generators, which produce compressed hot gases that feed into power turbines causing them to rotate. Each power turbine is connected to the alternator through a clutch. When the alternator reaches its required turning speed, it can perform as either a power generator or synchronous condenser. Each plant can produce up to 25 MW (megawatts) of electrical power when one engine is running and 50 MW with both engines running. When the alternator operates in generation mode, at least one of the gas generators has to run continuously in order for the alternator to produce power for the Island Interconnected System. However, when the alternator runs in synchronous condensing mode only one gas generator is required to start turning the alternator and get it up to the desired speed. At that point, it can operate without the gas generator, which is then declutched and shut down.

On March 1, 2015 a fire occurred in engine module B at the Hardwoods gas turbine. While the fire was extinguished quickly, damage occurred to various components within the engine module, including engine serial number (S/N) 202224.

Upon initial investigation, it appeared that the only damage to engine S/N 202224 was the visible external damage to the engine which was caused by the heat from the fire. Hydro proceeded to prepare to repair the engine and other damaged components within the module to return the unit to service. An Alba Power representative was engaged and brought to site to assist in the assessment of damage to the engine and to oversee its repair at site.

While the Alba Power representative was on site, it was decided to complete a borescope inspection of the combustion section of the engine, to determine its condition, since this inspection was scheduled for later in the year.

The borescope inspection revealed that damage had occurred to the combustion section of the engine, with combustion chambers 5, 6, and 8 showing catastrophic damage. Based on these findings, the borescope inspection was expanded to include the high pressure (HP) turbine section of the engine and the power turbine. The inspection of the HP turbine section revealed damage to the HP turbine blades as a result of materials released by the failure of the combustion chambers and also potential damage to other engine components. Inspection of the power turbine showed no visible damage, but showed that debris from the combustion chamber failures had travelled into the power turbine. Photos showing the damage to the combustion section, HP turbine section of the engine and the power turbine are provided in Appendix A.

2 PROJECT DESCRIPTION

This project is to refurbish gas turbine engine serial number 202224 at the Hardwoods Gas Turbine Plant (Hardwoods) which was damaged as a result of a fire event on March 1, 2015, which was caused by the failure of a pressure relief line in the fuel system within the engine module. The scope of work for the project was developed through internal and external visual inspection of the engine through partial disassembly and use of a borescope.

This project provides for shipping the engine to a service facility for refurbishment. At that time, the engine will be disassembled and a thorough inspection performed. Damaged components will be replaced as required. The engine will then be reassembled and tested at the repair facility to ensure its performance over its full operating range. Performance testing of the refurbished engine will be witnessed by Hydro representative(s) before it is shipped back to Hydro and returned to service.

The refurbishment of gas turbine engine S/N 202224 proposed in this Application includes the following:

- Return shipment of the engine to a repair facility for refurbishment;
- Initial disassembly and inspection of the engine to determine full refurbishment scope;
- Failure analysis;
- Refurbishment of all required components; and
- Testing of engine performance after refurbishment.

A replacement engine has been installed in place of engine S/N 202224 while it is being refurbished, making Hardwoods available at reduced capacity.

The project will be completed by a combination of internal forces and contracted labour. The installation and commissioning of the engine will take place during a planned outage.

3 JUSTIFICATION

The availability and reliability of Hardwoods gas turbine plant is critical to ensure voltage regulation of the Island Interconnected System. As well, this facility is important for the generation of peak and emergency power.

The Hardwoods gas turbine provides several critical functions on the Island Interconnected power system:

- In synchronous condenser mode, the unit provides reactive voltage support for the major load centers on the Avalon Peninsula;
- It is part of the island system reserve capacity and thus provides power under System peaking and emergency/contingency conditions;
- The unit provides power and reactive output to enable the reliable supply of power to the Avalon Peninsula which is heavily reliant on the transfer of power over transmission lines from off the Avalon Peninsula, as well as the production of power from Holyrood. This unit provides a critical backup in the event of a contingency such as the loss of a Holyrood generating unit or loss of a major transmission line into the area.
- The gas turbine is a part of the contingency plan for the reliable supply of power to the St. John's area.
- The unit is used to facilitate planned generation outages and planned Avalon Peninsula transmission outages.

3.1 Existing System

Hardwoods gas turbine consists of two identical gas turbines. Each gas turbine unit consists of one Rolls-Royce Olympus C gas turbine engine (Figure 2) and one Curtiss-Wright power turbine.

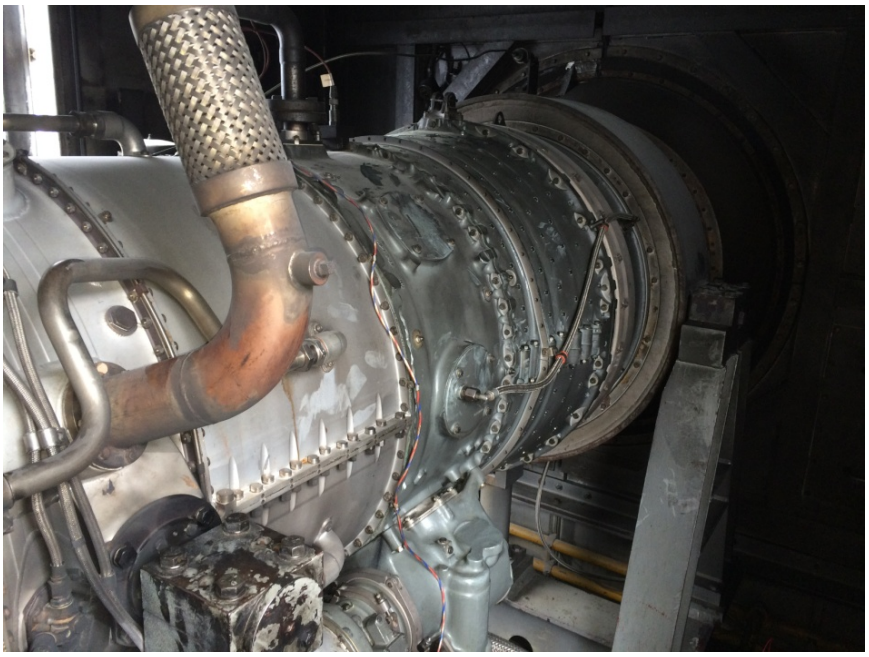


Figure 2: Gas Turbine Engine serial number 202224

One Brush alternator (power generator), is shared by the gas turbine units. Each gas turbine unit is coupled to the alternator by a clutch. Auxiliary systems, critical to the operation of the facility, include inlet air systems, fuel oil system, electrical system, and control and instrumentation systems. Buildings and structures on site include exhaust stacks, inlet air intakes, control building, fuel unloading building, fuel forwarding building, auxiliary module building, maintenance and parts storage building, high voltage switchgear building, and emergency backup diesel generator building.

The most recent major work and upgrades to the Hardwoods gas turbine are presented in Table 1.

Table 1: Major Work or Upgrades

Year	Project	Cost ($000)
2013	Alternator Replacement	7,058
2009-2013	Plant Life Extension Project	3,493

3.2 Operating Experience

The Hardwoods gas turbine has been in service for 39 years providing synchronous condensing and generation capability in supporting the Island Interconnected System. The table below provides the operating history of the Hardwoods gas turbine from 2009 to 2014.

Table 2: Hardwoods Gas Turbine Operating Hours 2009 to 2014

Year	Total Operating Hours	Peaking/Emergency Hours	Synchronous Condenser Hours	Available Hours
2014	6,121	355	5,767	6,502
2013	156	81	75	6,604
2012	3,893	103	3,790	8,259
2011	3,226	38	3,187	8,115
2010	6,093	150	5,943	7,375
2009	3,562	104	3,458	8,464

Engine serial number 202224 was last refurbished in 2011.

3.2.1 Reliability Performance

The refurbishment project is being justified based on the fact that Hardwoods is currently available at only 70% capacity as a result of the in-service failure of engine serial number S/N 202224, and not on poor reliability statistics. However, to ensure future reliability Hydro is proposing a refurbishment of the engine.

3.2.1.1 Outage Statistics

Table 3 below lists the 2009 to 2013 average Capability Factor, Utilization Forced Outage Probability (UFOP) and Failure Rate for Hardwoods gas turbine compared to all of Hydro's gas turbine units and the latest Canadian Electrical Association (CEA) average (2009 to 2013).

Table 3: Hardwoods Gas Turbine Five Year Average (2009-2013) All Causes

Unit	Capability Factor (%)[1]	UFOP (%)[2]	Failure Rate[3]
Hardwoods	82.04	23.99	146.98
All Hydro Gas Turbine Units	74.89	18.31	145.17
CEA (2009-2013)	86.67	13.07	22.39

3.2.2 Legislative or Regulatory Requirements

There are no legislative or regulatory requirements related to this project.

3.2.3 Safety Performance

This project is not expected to affect safety performance.

3.2.4 Environmental Performance

This project is not expected to affect safety performance.

3.2.5 Industry Experience

Industry experience is not relevant to this project.

3.2.6 Vendor Recommendations

There are no vendor recommendations applicable to this project.

3.2.7 Maintenance or Support Arrangements

Normal routine maintenance work is performed by Hydro personnel. However, gas turbine

[1] 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.

[2] 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.

[3] Failure Rate is defined as the rate at which the generating unit encounters a forced outage. It is calculated by dividing the number of transitions from an operating state to a forced outage by the total operating time.

service companies such as Rolls Wood Group Ltd. and Alba Power Inc., both located in the United Kingdom, have been contracted in the past to perform visual inspections, on-site specialty maintenance items, and major shop overhauls of gas turbine engines.

3.2.8 Maintenance History

The five-year maintenance cost history for Hardwoods gas turbine is shown in Table 4, below.

Table 4: Five-Year Maintenance History

Year	Preventive Maintenance ($000)	Corrective Maintenance ($000)	Total Maintenance ($000)
2014	20	925	945
2013	8	196	205
2012	15	262	277
2011	32	299	330
2010	37	191	228

3.2.9 Historical Information

The Hardwoods gas turbine plant has been in service for 39 years providing synchronous condensing and generation capability to the Island Interconnected System.

A plant life extension upgrade program was completed at Hardwoods beginning in 2010 and completed in 2013.

3.2.10 Anticipated Useful Life

A gas turbine plant has a normal anticipated service life of 35 years based on operation primarily for base load power generation. Hardwoods gas turbine has exceeded this service life primarily because it has operated primarily as a synchronous condensing facility.

3.3 Forecast Customer Growth

This project is not required to accommodate customer growth.

3.4 Development of Alternatives

Directly replacing the engine is not a viable alternative. While a temporary replacement engine is available, it is not cost effective to rent an engine for an extended period. The purchase and installation of a newer, more modern engine would require significant study and likely require the replacement of some or all of the auxiliary systems.

4 CONCLUSION

On March 1, 2015 the failure of a component of a fuel filter drain line resulted in a fire in engine module B at Hardwoods gas turbine. While the fire was quickly extinguished, upon investigation, it was determined that engine serial number 202224 had suffered internal damage.

The Hardwoods gas turbine provides several critical functions on the Island Interconnected power system. The unit provides power and reactive output to enable the reliable supply of power to the Avalon Peninsula which is heavily reliant on the transfer of power over transmission lines from off the Avalon Peninsula, as well as the production of power from Holyrood. This unit provides a critical backup in the event of a contingency such as the loss of a Holyrood generating unit or loss of a major transmission line into the area. In addition, it is a part of the contingency plan for the reliable supply of power to the St. John's area and is used to facilitate planned generation and Avalon Peninsula transmission outages.

It is important that Hydro continue to have a reliable facility for synchronous condensing and peak/emergency power generation for the Avalon Peninsula area of the Island Interconnected System.

This proposed project is to complete refurbishment of gas turbine engine serial number

202224 and is required to return the Hardwoods gas turbine to its full capability.

4.1 Budget Estimate

Hydro estimated the budget for Hardwoods utilizing budgetary information obtained from a service provider in the gas turbine refurbishment industry, in order to improve the accuracy of the budget estimate. The refurbishment cost for the engine is based on worst case, i.e., maximum expected repair cost.

The budget estimate for this project is shown in Table 5 below.

Table 5: Project Budget Estimate

Project Cost:*($ x1,000)*	**2015**	**2016**	**Beyond**	**Total**
Material Supply	15.0	0.0	0.0	15.0
Labour	147.1	0.0	0.0	147.1
Consultant	0.0	0.0	0.0	0.0
Contract Work	865.0	0.0	0.0	865.0
Other Direct Costs	13.0	0.0	0.0	13.0
Interest and Escalation	1.2	0.0	0.0	1.2
Contingency	208.0	0.0	0.0	208.0
TOTAL	**1,249.3**	**0.0**	**0.0**	**1,249.3**

4.2 Project Schedule

The anticipated schedule for this project is identified in Table 6 below.

Table 6: Project Schedule

Activity		**Start Date**	**End Date**
Planning	Job set up	September 2015	September 2015
Design	Tender preparation	September 2015	September 2015
Procurement	1. Tender and award	September 2015	September 2015
	2. Engine refurbishment	October 2015	October 2015
Construction	Engine Installation and commissioning	November 2015	November 2015
Closeout	Project Closeout	December 2015	December 2015

APPENDIX A

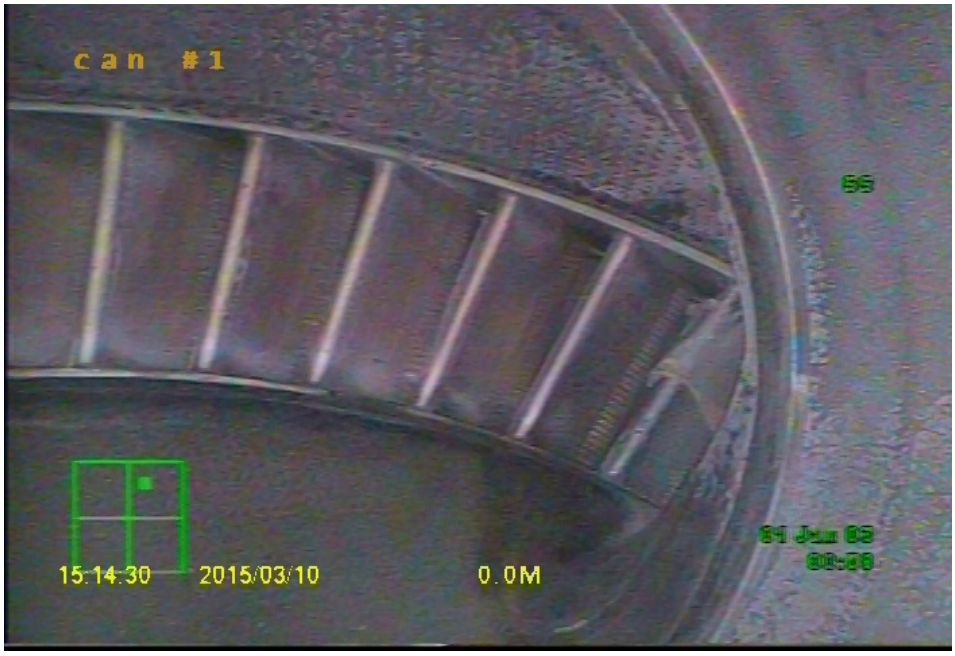
Photos

Combustion Chambers Damage

Combustion chamber #8 damage

Damage to combustion chamber #6 (large piece missing)

High Pressure Turbine



Debris visible in HP turbine as seen through combustion chamber #1

Debris visible in HP turbine as seen through combustion chamber #5

Power Turbine

Power turbine with debris visible

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

AN ORDER OF THE BOARD

NO. P.U. __ (2015)

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

AND IN THE MATTER OF an Application by Newfoundland and Labrador Hydro (Hydro) pursuant to Subsection 41(3) of the *Act*, for approval of the Hardwoods Gas Turbine Engine Refurbishment.

WHEREAS Newfoundland and Labrador Hydro ("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 *EPCA;* and

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

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

without prior approval of the Board; and

WHEREAS in Order No. P.U. 50 (2014) the Board approved Hydro's 2015 Capital Budget in the amount of $76,832,900; and

WHEREAS in Order No. P.U. 24(2015) the Board approved the supplementary 2014 capital expenditure in the amount of $1,536,300 to purchase critical spares for Hydro's Generating Stations; and

WHEREAS on August XX, 2015, Hydro applied to the Board for approval to refurbish gas turbine engine serial number 202224 located at the Hardwoods Gas Turbine Plant which was damaged as a result of a fire event at the Hardwoods Gas Turbine Plant; and

WHEREAS the Board is satisfied that the 2015 supplemental capital expenditure for the approval to refurbish gas turbine engine serial number 202224 located at the Hardwoods Gas Turbine Plant is necessary to allow Hydro to provide service and facilities which are reasonably safe and adequate and just and reasonable.

IT IS THEREFORE ORDERED THAT:

1. The proposed capital expenditure of $1,249,300 to refurbish gas turbine engine serial number 202224 located at Hardwoods Gas Turbine Plant is approved.

2. Hydro shall pay all expenses of the Board arising from this Application.

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

_____

_____

_____ _____