newfoundland labrador hydro
a nalcor energy company

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May 19, 2016

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 Gas Generator Engine Refurbishments at the Hardwoods Gas Turbine Plant and the Stephenville Gas Turbine Plant

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 generator engine, End A engine, serial number 202205, at the Hardwoods Gas Turbine Plant and gas generator engine, End A engine, serial number 202204, at the Stephenville Gas Turbine Plant which is necessary for the supply of safe and adequate 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 Gas Generator Engine Refurbishments at the Hardwoods Gas Turbine Plant and the Stephenville Gas Turbine Plant

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 two 50 MW gas turbine plants. The Hardwoods Gas Turbine Plant (Hardwoods) was constructed in 1976 and is located in the west end of the city of St. John's. The Stephenville Gas Turbine Plant was commissioned in 1975 and is located in the town of Stephenville. Both plants operate in either generation mode to provide peak and emergency power or as synchronous condensers to provide voltage support to the Island Interconnected System.

3. On February 8, 2016, gas generator engine, End A engine, serial number 202205, at Hardwoods failed resulting in internal damage to the housing and turbine sections of the engine. On March 26, 2016 gas generator engine, End A engine, serial number 202204, at Stephenville failed causing internal damage. Both failed engines have been removed from service and cannot be operated. As a result of the aforementioned damage, End A

engine, serial number 202205, at Hardwoods and End A engine, serial number 202204, at Stephenville, must be refurbished.

4. Hydro is recommending that End A engine, serial number 202205 at Hardwoods and End A engine, serial number 202204 at Stephenville be refurbished. Details regarding Hydro's proposal to refurbish these gas generator engines are contained in the attached project proposal document.

5. The availability and reliability of Hardwoods and Stephenville is critical to ensure voltage regulation of the Island Interconnected System. These facilities are also important for the generation of peak and emergency power and for planned generation or transmission outages. The refurbishment of these gas generator engines are required to return Hardwoods and Stephenville to their full capability.

6. The estimated cost of this project is $3,047,100 and is expected to be completed in November 2016.

7. The Applicant submits that the proposed refurbishment of the gas generator engines at Hardwoods and Stephenville is necessary to ensure that the Hydro 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 generator, End A engine, serial number 202205, at Hardwoods and gas generator, End A engine, serial number 202204, at Stephenville at an estimated capital cost of $3,047,100 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 19 day of May, 2016.

Tracey L. Pennell
Counsel for the Applicant
Newfoundland and Labrador Hydro
500 Columbus Drive P.O. Box 12400
St. John's, NL 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 Gas Generator Engine Refurbishments at the Hardwoods Gas Turbine Plant and the Stephenville Gas Turbine Plant.

AFFIDAVIT

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

1. I am the General Manager of Thermal Production 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 19 day of May 2016, before me:)

Tracy Pennell
Barrister – Newfoundland and Labrador

Scott Crosbie

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

AN ORDER OF THE BOARD

NO. P.U. __ (2016)

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 Gas Generator Engine Refurbishments at the Hardwoods Gas Turbine Plant and the Stephenville Gas Turbine Plant.
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WHEREAS the Applicant 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; and

WHEREAS Section 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. 33(2015) the Board approved Hydro's 2016 Capital Budget in the amount of $183,082,800; and

WHEREAS on February 8, 2016, gas generator engine, End A engine, serial number 202205, at the Hardwoods Gas Turbine Plant failed resulting in internal damage to the housing and turbine sections of the engine. On March 26, 2016 gas generator engine, End A engine, serial number 202204, at the Stephenville Gas Turbine Plant also failed causing internal damage; and

WHEREAS the Hardwoods Gas Turbine Plant and the Stephenville Gas Turbine Plant are required to provide voltage regulation on the Island Interconnected System, to provide generation of peak and emergency power, and for planned generation or transmission outages; and

WHEREAS on May 18, 2016 Hydro applied to the Board for approval to refurbish the two damaged gas generator engines in order to return the Hardwoods Gas Turbine Plant and the Stephenville Gas Turbine Plant to their full capability; and

WHEREAS the capital cost of the project is anticipated to be $3,047,100; and

WHEREAS the Board is satisfied that the refurbishment of gas generator engine, End A engine, serial number 202205, at the Hardwoods Gas Turbine Plant and gas generator engine, End A engine, serial number 202204, at the Stephenville Gas Turbine Plant, is necessary and reasonable 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 to refurbish gas generator engine, End A engine, serial number 202205, at the Hardwoods Gas Turbine Plant and gas generator engine, End A engine, serial number 202204, at the Stephenville Gas Turbine Plant of $3,047,100 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 , 2016.

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A REPORT TO
THE BOARD OF COMMISSIONERS OF PUBLIC UTILITIES

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

Gas Generator Engine Refurbishments

Hardwoods and Stephenville

May 2016

newfoundland labrador hydro
a nalcor energy company

SUMMARY

On February 8, 2016, a gas generator engine failed at the Hardwoods Gas Turbine Plant (Hardwoods). On March 26, 2016, another gas generator failed at the Stephenville Gas Turbine Plant (Stephenville). Both failed engines have been removed from service and cannot be operated. As an interim measure, a leased spare engine (19 MW) was installed at Hardwoods on February 14, 2016 to restore a portion of its capability for the winter of 2016. The Stephenville engine has not been replaced.

The availability and reliability of the Hardwoods and Stephenville plants is critical to ensure voltage regulation of the Island Interconnected System (IIS). In addition, both facilities are important for the generation of peak and emergency power, particularly during the winter. If these engines are not replaced, the power generation capacity of each plant is reduced by 50% (without the leased engine). The capacity of the synchronous condensing start-up system is also reduced by 50%. To restore operational reliability of the gas turbine plants for the IIS, both engines need to be sent to a specialty repair facility for refurbishment.

The Hardwoods engine experienced a failure resulting in damage to the outer casing and turbine sections of the engine. A public tender will be issued and awarded for refurbishment of that engine.

The Stephenville engine experienced a suspected bearing failure in the low pressure compressor section of the engine and failed before its warranty period. The engine has to be returned to the service shop that last refurbished the engine for disassembly and inspection to determine cause of failure. Hydro will be engaging a third party consultant to provide Owner's oversight during this process.

It is anticipated that both engines will be refurbished and returned to service by November 2016 for winter readiness, with the first available engine installed in Hardwoods.

An analysis of each engine failure will be completed as part of the proposed project. It is anticipated that this will be completed by August 2016.

The budget estimate for this project is $3,047,100 and includes all refurbishment costs for both engines. Pending the results of the investigation to determine the cause of the Stephenville failure, some costs associated with the engine may be recovered under warranty.

TABLE OF CONTENTS

1 INTRODUCTION

Newfoundland and Labrador Hydro (Hydro) owns and operates three gas turbine plants as part of the Island Interconnected System (IIS). The Stephenville Gas Turbine Plant (Stephenville) was commissioned in 1975 and is located in the town of Stephenville. The Hardwoods Gas Turbine Plant (Hardwoods) is located in the west end of St. John's and was commissioned in 1976. The Holyrood Gas Turbine Plant (Holyrood) is located at the Holyrood Thermal Generating Station and was commissioned in 2015.

The Hardwoods and Stephenville plants operate in either generation mode to meet peak and emergency power requirements or synchronous condenser mode to provide voltage support to the IIS. The IIS experiences constant voltage fluctuations that result from changes in the supply and demand of electricity, requiring voltage correction to maintain proper levels. System voltage is managed, in part, by using synchronous condensing equipment. It stabilizes voltage by acting as a shock absorber in the event that the system experiences a voltage change as a result. During synchronous condensing, the voltage change is limited to no more than five percent below nominal operating levels of 230, 138, or 66 kV. Synchronous condensing is an important function of the Hardwoods and Stephenville gas turbine plants. All three of Hydro's gas turbine plants provided significant generation to the IIS in 2016 to support reliable customer service.

The Hardwoods and Stephenville plants each include major mechanical components that consist of two gas generator engines (A and B), two power turbines (A and B), an alternator (see Figures 1 and 2), and auxiliaries such as lube oil, fuel, electrical and control systems. Structures such as buildings, equipment enclosures and exhaust stacks comprise the balance of plant.

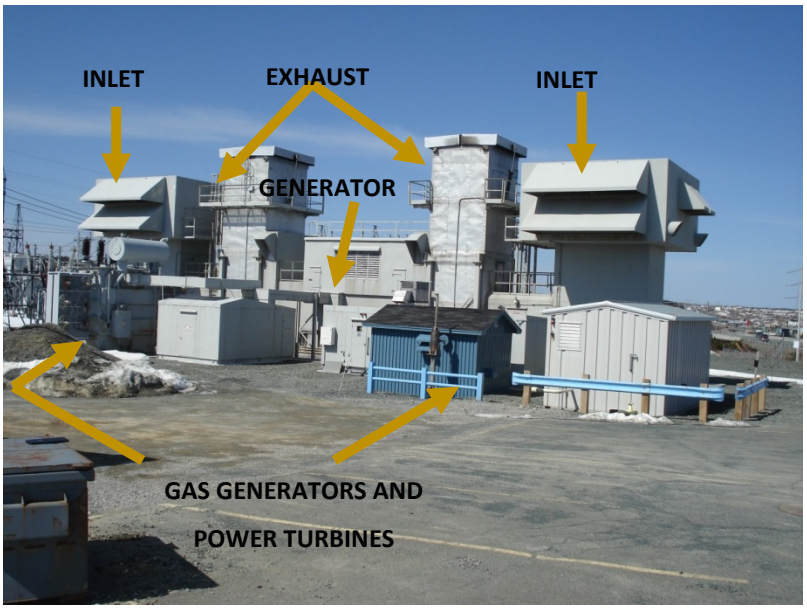

Figure 1: Hardwoods Gas Turbine Plant

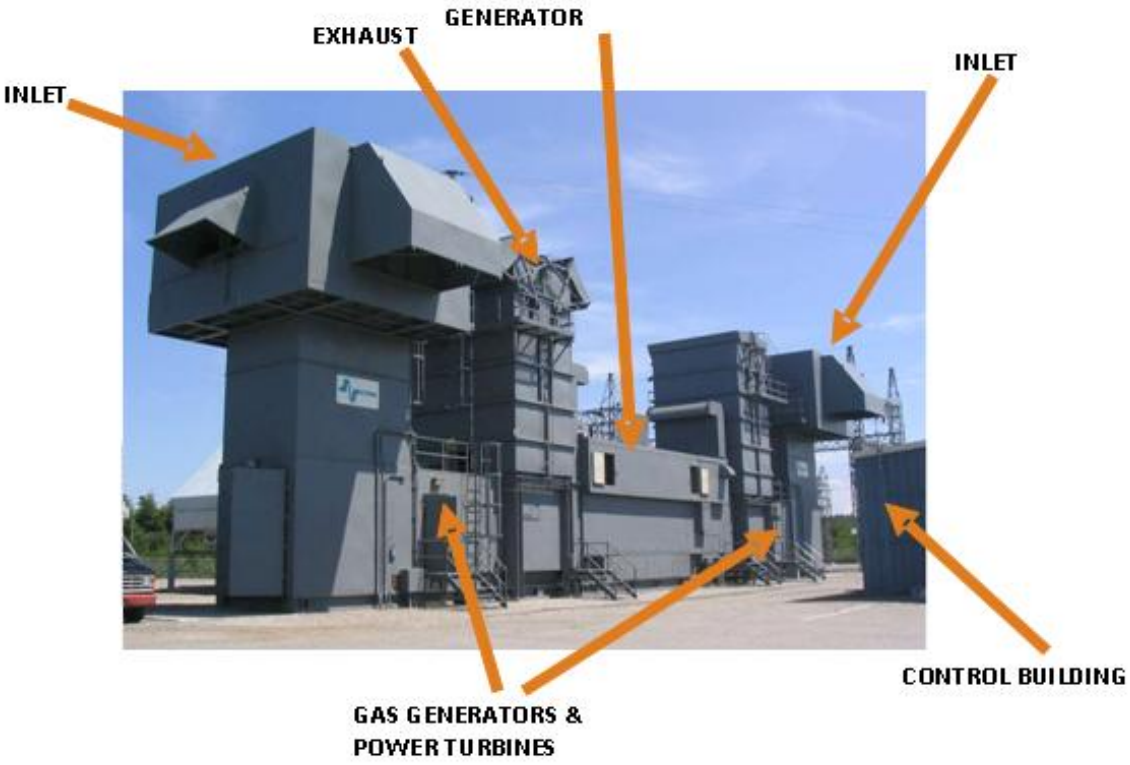

Figure 2: Stephenville Gas Turbine Plant

No. 2 fuel oil powers the gas generator engines, which produces 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 an electricity generator or synchronous condenser. When the alternator operates in generation mode, at least one of the gas generator engines has to operate continuously in order for the alternator to produce power. If two engines are operating, load must be balanced across each. Therefore, if two engines are operating, the total maximum plant output can only be twice that of the smallest unit. When the alternator operates in synchronous condensing mode, only one gas generator is required for a short period of time to start the alternator rotation and get it up to the proper speed. At that point it can operate without the gas generator, which is then shut down.

On February 8, 2016, Hardwoods End A engine, serial number 202205, failed. The preliminary investigation indicated that a combustion can failed causing internal damage to the housing and turbine sections of the engine. The engine was removed from the plant and replaced, on an interim basis, with a leased spare unit provided by Alba Power Ltd. The leased unit is of smaller generation capacity (19MW vs 25MW) than the one being replaced, but fit the installation berth and was readily available for the quickest in-service date during the winter period. The cost of the leased unit is $4,000 per week plus $42 for each hour of operation.

On March 26, 2016, Stephenville End A engine, serial number 202204, also failed. Preliminary investigation suggests that a bearing in the low pressure section of the engine failed and caused other internal damage. Further details will be available after engine removal and analysis are completed. The Stephenville engine is not operational and has not been replaced.

2 PROJECT DESCRIPTION

The scope of this project is to refurbish two failed gas generator engines, one from each of

the Hardwoods and Stephenville plants which suffered damage in February and March 2016, respectively.

The scope of work for this project includes the following:

1. Remove and transport Hardwoods End A engine, serial number 202205, to a service facility for disassembly, inspection and refurbishment. The service facility will be determined by public tender;
2. Remove and transport Stephenville End A engine, serial number 202204, to the Alba Power Ltd. service facility for disassembly, warranty investigation and refurbishment;
3. Performance test the two refurbished engines at the respective service facilities;
4. Return transport, installation and commissioning of the two engines; and
5. Independent third party technical oversight of the Stephenville engine at the Alba Power Ltd. service facility on behalf of Hydro to determine cause of failure.

In addition, an analysis of each engine failure will be completed. It is anticipated that the findings of this analysis will be available by August 2016.

This project will be completed by a combination of internal and contracted labour. Installation and commissioning will take place during a planned outage. It is anticipated that both engines will be refurbished and installed by November 2016 for winter readiness, with the first available engine installed in Hardwoods.

3 JUSTIFICATION

The availability and reliability of the Hardwoods and Stephenville plants is critical to ensure voltage regulation of the IIS. In addition, both facilities are important for the generation of peak and emergency power.

More specifically, Hardwoods and Stephenville provide several critical functions on the IIS:

- In synchronous condenser mode, both plants provide reactive voltage support for the major load centers on the island of Newfoundland;
- Both plants are a part of the island system reserve capacity and thus provide power under system peaking and emergency/contingency conditions;
- Hardwoods 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 the Holyrood Thermal Generating Station. 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;
- Both plants are a part of the contingency plan for the reliable supply of power to the island of Newfoundland; and
- Both plants are also used to facilitate planned generation outages. In addition, Hardwoods is used to facilitate planned transmission outages on the Avalon Peninsula.

To start the plants for synchronous condensing duty, one engine is required to operate for a short period of time. Having two operational engines available provides redundancy for the start-up system. Having one engine out of service eliminates this redundancy and thereby reduces system reliability.

Each gas turbine plant can produce up to 25 MW with one engine operating and 50 MW with both operating. With one engine out of service, generation capacity at each plant is reduced to 25 MW. The out of service engine at Hardwoods was replaced in February 2016 with a leased engine (19 MW). At present the other engine (25 MW) has to be operated at the same output as the leased engine (max 19 MW) to balance the two engines. This provides maximum plant generation capacity at Hardwoods of 38 MW.

3.1 Existing System

The Hardwoods and Stephenville gas turbine plants have two identical drive ends. Each end can generate power up to 25 MW. To differentiate one drive end from the other, the naming convention of End A and End B is used. Each drive end consists of one Rolls-Royce Olympus C gas generator engine (Figure 3) and one Curtiss-Wright power turbine. The gas generator engines are identical and interchangeable between Hardwoods and Stephenville.

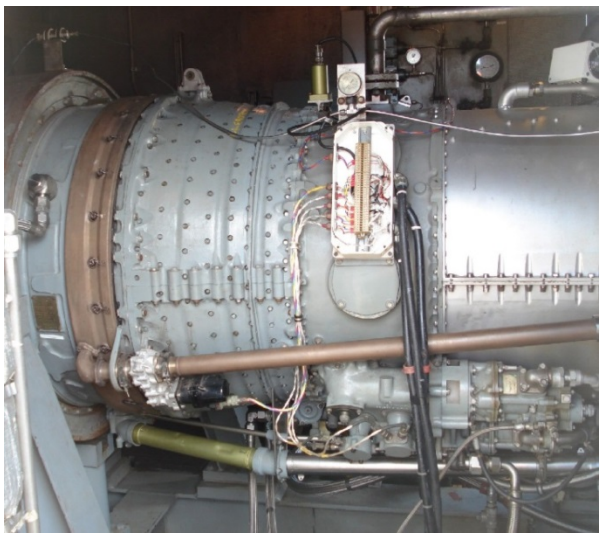

Figure 3: Gas Turbine Engine

At each plant, one Brush generator is shared between the two drive ends. Each drive end is coupled to the alternator by a clutch. Auxiliary systems, critical to the operation of each gas turbine plant, 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**.**

Recent major work and upgrades to the Hardwoods and Stephenville gas turbines are provided in Tables 1 and 2.

Table 1: Major Work or Upgrades – Hardwoods

Year	Item	Cost ($000)
2015	**Engine 202224 Overhaul**	**1,252**
2013	**Alternator Replacement Project**	**7,058**
2009-2013	**Plant Life Extension Program**	**3,493**

Table 2: Major Work or Upgrades - Stephenville

Year	Item	Cost ($000)
2014-2016B	**Plant Life Extension Program**	**8,175**
2012-2013	**Alternator Rewind**	**4,135**
2010-2011	**Replacement of Alternator Glycol Cooler**	**861**

3.2 Operating Experience

The Hardwoods and Stephenville plants have been in service for approximately 40 years. Stephenville End A engine, serial no. 202204, was overhauled in 2014 due to age. Hardwoods End A engine, serial no. 202205, was overhauled in 2010 as a result of turbine blade damage.

Tables 3 and 4 provide the generation hours and synchronous condensing hours for Hardwoods and Stephenville from 2011 up to and including April 2016.

Table 3: Hardwoods Gas Turbine Operating Hours 2011 to 2015

Year	Total Operating Hours	Peaking/Emergency Hours	Synchronous Condenser Hours	Available Hours
2016[1]	2,750	624	2,126	2,893
2015	6,036	410	5,626	7,081
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

Table 4: Stephenville Gas Turbine Operating Hours 2011 to 2015

Year	Total Operating Hours	Peaking/Emergency Hours	Synchronous Condenser Hours	Available Hours
2016[2]	2,048	227	1,821	2,900
2015	4,984	236	4,748	5,875
2014	6,853	381	6,472	7,043
2013	4,235	66	4,169	4,500
2012	0	0	0	0
2011	8,109	13	8,096	8,438

The following is the timeline of events for each engine from the time of the incident to the date of application to the Board of Public Utilities (Board).

Engine 202205, Hardwoods:

Failure:	February 8, 2016
Initial investigation by Hydro:	February 8/9, 2016
Alba Power engagement:	February 8, 2016
Alba Power representative on site:	February 11, 2016
Installation of replacement engine:	February 14, 2016

[1] From January 1 to April 30
[2] From January 1 to April 30

Alba Power representative inspection completed: February 18, 2016

Submission to Board: May, 2016

Engine 202204 Stephenville:

Failure: March 26, 2016

Initial investigation by Hydro: March 26/27, 2016

Alba Power engagement: March 27, 2016

Alba Power representative on site: March 30, 2016

Alba Power representative inspection completed: March 30, 2016

Submission to Board May, 2016

3.2.1 Reliability Performance

Table 5 provides the five year (2011-2015) average Capability Factor, Utilization Forced Outage Probability (UFOP) and Failure Rate for Hardwoods and Stephenville compared to all of Hydro's gas turbine plants and the latest Canadian Electrical Association (CEA) average (2010 to 2014).

Table 5: Hardwoods and Stephenville Five Year Average (2011-2015) All Causes

Unit	Capability Factor (%)[3]	UFOP (%)[4]	Failure Rate[5]
Hardwoods	75.88	24.82	133.05
Stephenville	42.39	40.10	151.13
All Hydro Gas Turbine Units	70.30	24.83	107.51
CEA (2010-2014)	84.16	9.52	66.60

[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.

[4] 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.

[5] 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. It can be greatly influenced by operating time of standby units such as gas turbines.

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 environmental 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. However, gas turbine service companies such as Rolls Wood Group Ltd. and Alba Power Ltd., 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 generator engines. Most recent engine refurbishments were publicly tendered and awarded to Alba Power Ltd.

3.2.8 Maintenance History

Borescope inspections for Hardwoods and Stephenville gas generator engines were completed every two years until 2014. Considering the age and anticipated increased operation of the engines, annual borescope inspections were planned thereafter. The most recent internal inspection was performed on Hardwoods in December 2015 and on Stephenville in November 2015 (see Appendix B). In each case no problematic conditions were observed.

Both engines have received a major refurbishment in the past under approved planned capital plant life extension programs. The Hardwoods engine was last overhauled in 2010. The Stephenville engine was last overhauled in 2014. Hydro expected to operate each of these engines for at least ten years following each refurbishment before another would be required.

The five-year operating maintenance history for the gas turbine plants at Hardwoods and Stephenville is provided in Tables 6 and 7.

Table 6: Five-Year Maintenance History - Hardwoods

Year	Preventive Maintenance ($000)	Corrective Maintenance ($000)	Total Maintenance ($000)
2015	45	543	588
2014	65	657	722
2013	13	65	78
2012	22	116	138
2011	43	104	147

Table 7: Five-Year Maintenance History - Stephenville

Year	Preventive Maintenance ($000)	Corrective Maintenance ($000)	Total Maintenance ($000)
2015	30	274	304
2014	21	562	583
2013	39	191	230
2012	12	105	117
2011	26	89	115

3.2.9 Historical Information

Hardwoods has been in service for 40 years providing synchronous condensing and generation capability to the IIS. Stephenville has been in service for 41 years providing similar functions.

Plant life extension upgrade programs began at Hardwoods in 2009 and at Stephenville in 2014.

3.2.10 Anticipated Useful Life

A typical gas turbine plant has an average useful life of 35 years based on primary operation for base load power generation. The Hardwoods and Stephenville plants have exceeded this service life because they have operated primarily as synchronous condensers. The result has been relatively few operating hours on each plant while running in base load power generation. Hydro has confirmed with specialized vendors that they will continue to service the engines for the foreseeable future. A conservative estimate is that each engine will have at least 10 years of service life remaining after engine refurbishment.

3.3 Forecast Customer Growth

This project is not required to accommodate customer growth.

3.4 Development of Alternatives

A number of alternatives were considered before one was selected for this proposal. The following provides commentary on those alternatives with particular consideration to cost, reliability and the greatest potential to achieve in-service status by November 2016 to meet winter availability requirements.

<u>Alternative No. 1 – Refurbish the existing engines:</u>

This alternative includes removing the failed engines and sending them to a specialty service facility for disassembly, inspection, refurbishment, and performance testing. They would then be returned to the generation plants, installed and commissioned. This alternative has a budget of $3.05 million and both engines would be returned to service by the November 2016 target date for winter readiness. This is the preferred option.

Alternative No. 2 – Replace the engines with leased engines:

This alternative would replace the failed engines with leased engines of the same capacity. Hydro has been unable to identify new or used engines on the market with the same capacity that are readily available for installation. It is anticipated that other used engines could be located but would need to be refurbished prior to installation. Hydro submits that the reliability of these leased, refurbished engines, would be equal to Hydro's own refurbished engines. However, there could be unexpected fitting problems installing the engines in the existing berths. Such problems would increase the risk of not meeting the November 2016 in-service date for winter readiness. It is estimated that the annual lease cost would be $300,000 plus an estimated $40,000 annually for hourly operating charges for Hardwoods and $15,000 annually for hourly operating charges for Stephenville. Transportation and installation costs would be in additional to the lease amounts. It is estimated that the leasing costs alone for this alternative would equal the total capital cost of Alternative 1 in less than two and a half years with the lease costs continuing thereafter.

Alternative No. 3 – Replace the engines with new engines:

There are no newly manufactured engines available on the market that can be readily installed in the existing engine berths. Modifications to the existing berths would be required along with auxiliary support systems. This would also be a prototype design with no history of reliable service. A high level project budget estimate is in excess of $10 million and the project cannot be completed by November 2016.

With consideration to the alternatives discussed above, Alternative No. 1 is proposed as the least cost viable option.

4 CONCLUSION

In February 2016, Hardwoods End A engine, serial number 202205 failed. In March 2016, Stephenville End A engine, serial number 202204 also failed. Both engines have been removed from service and are no longer operational. The availability and reliability of the

Hardwoods and Stephenville plants is critical to ensure voltage regulation of the IIS, generation of peak power, emergency power and planned generation or transmission outages. Without refurbishing these engines, power generation capacity of each plant and reliability of the synchronous condensing start-up system are reduced. As such, both engines are required to provide reliability to the IIS.

This project proposes to refurbish the two failed gas generator engines in order to restore the generation capacity and reliability of the gas turbine plants and provide continued reliability support to the IIS.

Budget Estimate

Hydro consulted the successful bidder on previous tenders, Alba Power Ltd., to determine a reasonable budget estimate. As per Table 8, the project budget to refurbish and reinstall both engines is estimated at $3,047,100, including a contingency for unanticipated items.

Table 8: Project Budget Estimate

Project Cost: *($ x1,000)*	**2016**	**2017**	**Beyond**	**Total**
Material Supply	1.0	0.0	0.0	1.0
Labour	160.6	0.0	0.0	160.6
Consultant	200.0	0.0	0.0	200.0
Contract Work	2,120.0	0.0	0.0	2,120.0
Other Direct Costs	46.7	0.0	0.0	46.7
Interest and Escalation	13.1	0.0	0.0	13.1
Contingency	505.7	0.0	0.0	505.7
TOTAL	**3,047.1**	**0.0**	**0.0**	**3,047.1**

The budget for this project provides for the full cost of completing two engine overhauls. It is estimated that 55% of the total project cost is associated with the Stephenville work and 45% with the Hardwoods work. It should be noted that the Stephenville engine failed within the warranty period from a previous refurbishment in 2014. A copy of the warranty is

provided in Appendix A. This project will also investigate the cause of the recent failure to determine if there is any cost recovery under warranty.

A review of Hydro's insurance policy determined that these engine refurbishment costs are not recoverable, as the deducible for property damage is $10M.

Project Schedule

The anticipated project schedule is provided in Table 9.

Table 9: Project Schedule

Activity		Start Date	End Date
	Stephenville Engine 202204		
Planning	Transport engine to Alba for disassembly and warranty inspection.	May 2016	June 2016
	RFP for third party warranty inspection.	May 2016	May 2016
Procurement	Disassembly and warranty evaluation.	June 2016	July 2016
	Refurbish and bench test.	July 2016	Sept 2016
	Transport to HWD and install.	Sept 2016	Oct 2016
Commissioning	Commission and in-service.	Oct 2016	Oct 2016
	Hardwoods Engine 202205		
Planning	Prepare tender for engine refurbishment and public tender.	May 2016	May 2016
Procurement	Tender evaluation and award.	Jun 2016	Jun 2016
	Transport to repair facility, refurbish and bench test.	July 2016	Oct 2016
	Transport to SVL and install.	Oct 2016	Nov 2016
Commissioning	Commission and in-service.	Nov 2016	Nov 2016
Project Closeout	Prepare post implementation review report and closeout documents.	Dec 2016	Dec 2016

The schedule is aggressive and provides for refurbished engines to be in service by the end of November 2016 for winter readiness. To facilitate that schedule, Hydro will be undertaking planning actions in May and early June while regulatory review takes place.

It is anticipated that the Stephenville engine will be refurbished and ready for installation earlier then the Hardwoods engine. Restoration of the Hardwoods plant is first priority, for that reason, Hydro plans on installing the first available engine at that plant.

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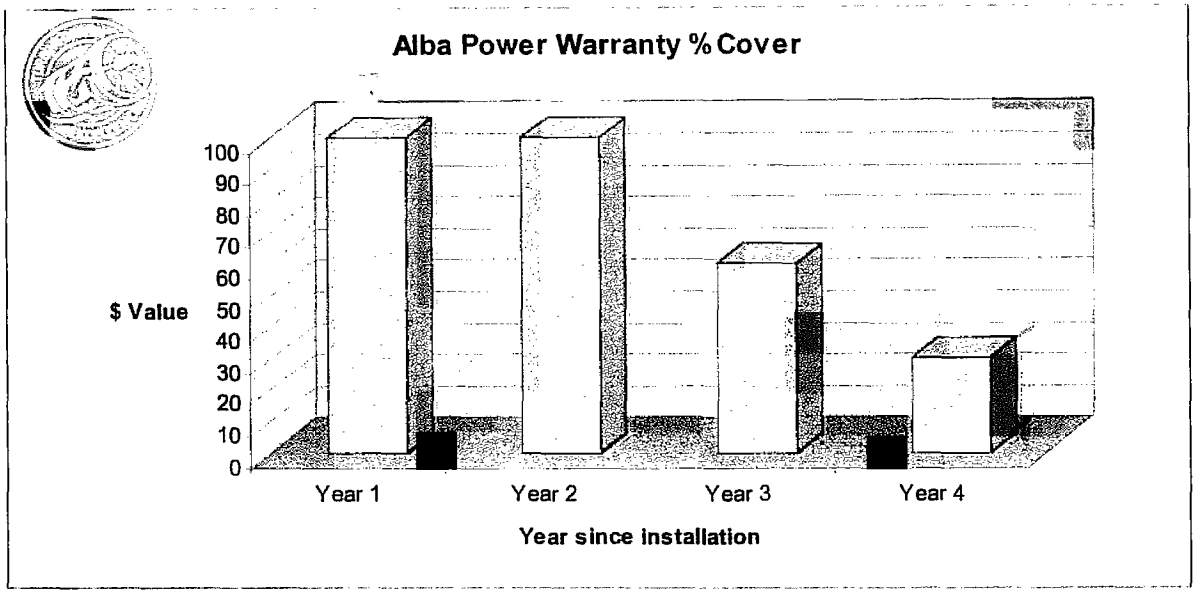
Extended Warranty

Alba Power has pleasure in offering coverage for 4 years as below, all included within fixed price proposal.



Benefits of extended warranty

- Piece of mind throughout operation
- Access to Alba Power Lease units if required
- Manpower pool access for remedial works if required
- Spare parts exchange access

Normal client responsibilities for maintenance and operation apply throughout

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Hot End Borescope Inspection Report For Gas Turbine 202205

newfoundland labrador hydro
a nalcor energy company

Customer: Newfoundland Hydro Hardwoods

Date: 3rd December 2015

Project Number: Alba 4927

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1 Introduction

Mr Colin Smith was mobilised to Hardwoods, St Johns, Newfoundland Hydro power station to carry out the hot end borescope inspection and health check survey on the Olympus Gas Turbine serial number 202205.

2 Purpose

The purpose of the borescope and hot end inspection is to determine the internal and external condition of Olympus gas turbine 202205. A general inspection was carried out on the Olympus gas turbine and air intake plenum.

The following report outlines the associated inspections and actions carried out during the time on site.

3 Onsite Personnel

Colin Smith (Alba Power)

4 Daily Report

4.1 Tuesday 1st December.

Travel from Stephenville to St Johns Newfoundland, could not get the outage to carry out borescope inspection.

4.2 Wednesday 2nd December.

Due to power outage at Holyrood site Hardwoods site could not allow outage to perform borescope inspection.

4.3 Thursday 3rd December.

Arrived on site. Tail board talk carried out. Gas Turbine 202205 was isolated and Fuel Nozzles 2,4,6 and 8 removed, and a borescopic inspection of the rear stages of the HP compressor , snouts, combustion chambers, HP NGVs and LP NGVs was carried out. G lab vent duct was removed and borescope inspection carried out inside turbine support housing number 7 bearing housing assembly and HP shaft seal.

5 Borescope Report

LP Compressor

Stage 1 to 5 Rotor blades and stator vanes are deemed in a serviceable condition.

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Intermediate Casing

A limited inspection of the inner starter and oil pump drives indicated they were in a serviceable condition with no visual defects or damage noted on this unit.

HP Compressor

The 1st stage HP rotor blades are in good condition with no visual defects or damage noted; they are in a serviceable condition.

The 7th stage HP rotor blades and stator vanes are in good condition with no visual defects or damage noted and the coatings look to be in a good condition and they are considered to be in a serviceable condition.

Combustion Chambers and snouts

The snouts exhibit typical carbon deposits around the burner entry location, there is also evidence of a build-up of carbon inside the combustion chambers, there was no visual signs of any cracks within the combustion chambers of this unit.

The No6 combustion chamber interconnector has a small crack but is within limits.

Fuel nozzles

The fuel nozzles exhibit typical carbon deposit on the heads, no other defects or damage was noted.

HP& LP Nozzle Guide Vanes

The HP nozzle guide vanes and LP nozzle guide vanes were noted as having no visual damage; however they did show some signs of coating loss and carbon built up. All are considered to be in a serviceable condition.

HP Turbine Blades

The HP turbine blades were noted as having no visual damage or defects but showed some signs of coating loss. All are considered to be in a serviceable condition.

Magnetic Chip Detectors

All found to be clear and free from any debris.

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6 Olympus Gas Turbine 202205 Images

<table>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>Pipe Connection</td><td>Slight oil leak at number 7bearing housing</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>Rear of HP Compressor</td><td>HP NGV’s</td></tr>
</table>

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Carbon build up on Fuel Nozzle

Entry Snout

Carbon deposits

Crack at No6 Interconnector

LP Compressor early stages

HP compressor

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	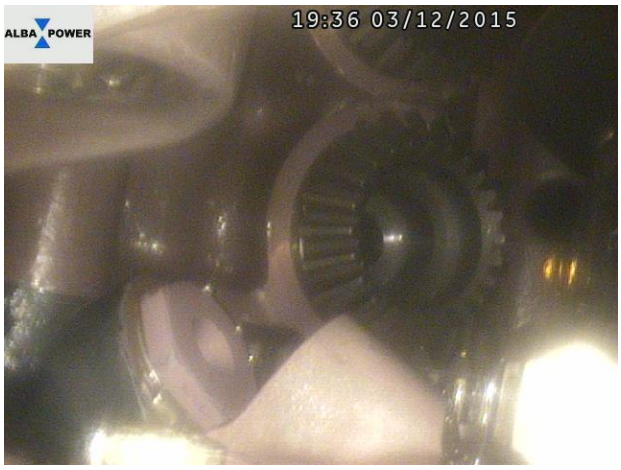
Drive gears Intermediate Case	Fuel pump drive gears

7 Summary

The Olympus 202205 gas turbine was found to be in a serviceable condition.

8 Recommendations

The Gas Turbine should be regularly serviced to maintain a good level of engine performance.

On site personnel:	Colin Smith	Date:	1st December 3rd December
Report compiled by:	Colin Smith	Date:	7th December 2015
Reviewed by:	Bruce Proctor	Date:	8th December 2015

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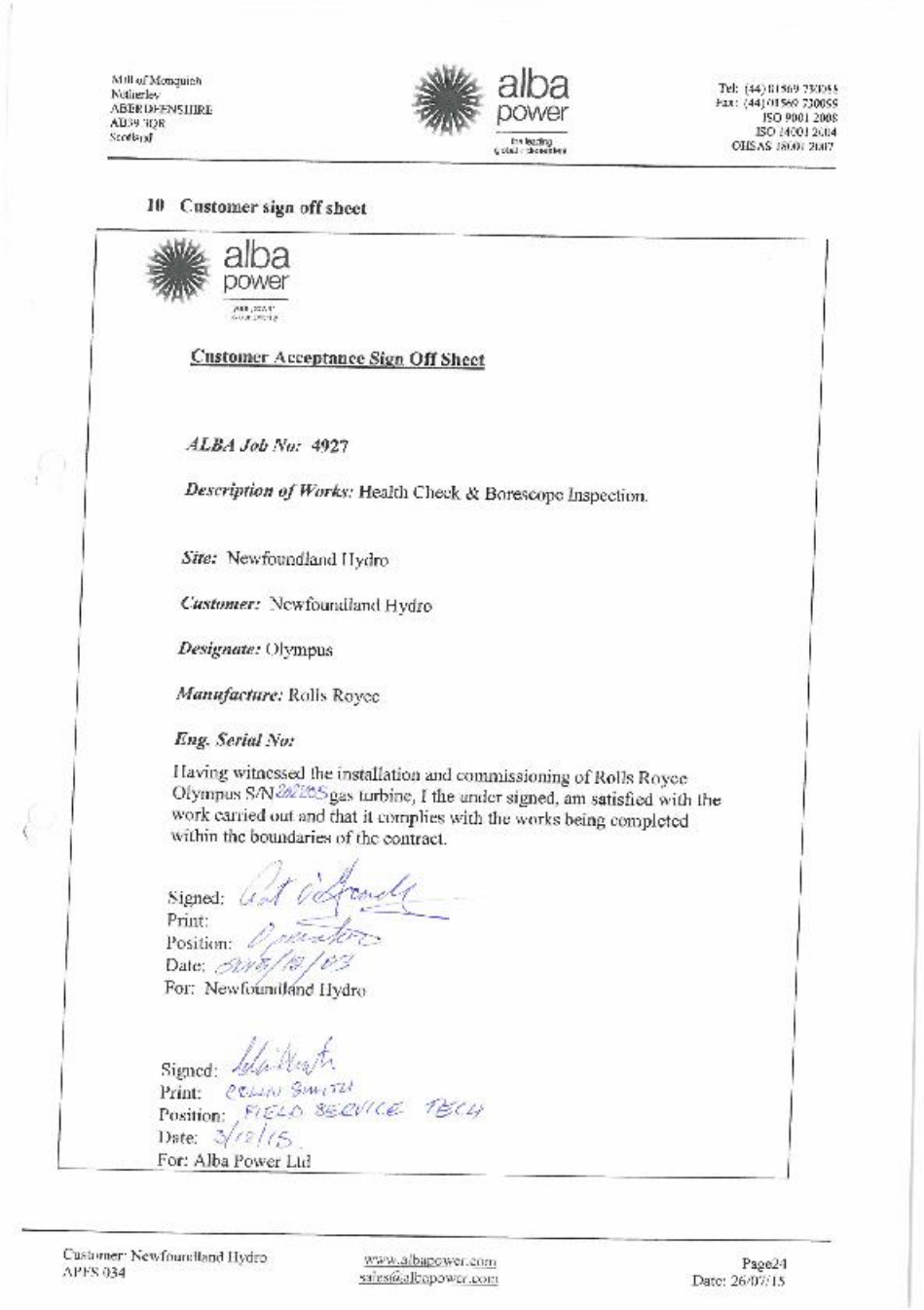
9 Customer Acceptance



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10 Customer sign off sheet

Customer Acceptance Sign Off Sheet

ALBA Job No: 4927

Description of Works: Health Check & Borescope Inspection.

Site: Newfoundland Hydro

Customer: Newfoundland Hydro

Designate: Olympus

Manufacture: Rolls Royce

Eng. Serial No:

Having witnessed the installation and commissioning of Rolls Royce Olympus S/N [illegible] gas turbine, I the under signed, am satisfied with the work carried out and that it complies with the works being completed within the boundaries of the contract.

Signed:
Print:
Position: Operators
Date: 23/10/15
For: Newfoundland Hydro

Signed:
Print: COLIN SMITH
Position: FIELD SERVICE TECH
Date: 23/10/15
For: Alba Power Ltd

Customer: Newfoundland Hydro
APFS 034

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Date: 26/07/15

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Hot End Borescope Inspection Report For Gas Turbine 202204

newfoundland labrador hydro
a nalcor energy company

Customer: Newfoundland Hydro Stephenville

Date: 30th November 2015

Project Number: Alba 4927

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1 Introduction

Mr Colin Smith was mobilised to Stephenville Newfoundland Hydro power station to carry out the hot end borescope inspection and health check survey on the Olympus Gas Turbine serial number 202204.

2 Purpose

The purpose of the borescope and hot end inspection is to determine the internal and external condition of Olympus gas turbine 202204. A general inspection was carried out on the Olympus gas turbine and air intake plenum.

The following report outlines the associated inspections and actions carried out during the time on site.

3 Onsite Personnel

Colin Smith (Alba Power)

4 Daily Report

4.1 Sunday 29th November.

Travelled to Stephenville Newfoundland

4.2 Monday 30th November.

An induction for safety regulations of site was conducted between 08.30am – 09.30am.

Tail board talk was carried out by Ray Rowe (Newfoundland Hydro Operator) . Set A 202204 was isolated and fuel nozzles, 2, 4, 6 and 8 were removed and a borescopic inspection of the rear stages of the HP compressor, snouts, combustion chambers, HP NGVs and LP NGVs was carried out.

5 Borescope Report

LP Compressor

Stage 1 to 5 Rotor blades were found to be in a serviceable condition.

HP Compressor

Stages 1 to 7 HP rotor blades are in good condition with no visual defects or damage noted; they are in a serviceable condition.

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Combustion Chambers and snouts

The snouts exhibit typical carbon deposits around the burner entry location, there is also evidence of a build-up of carbon inside the combustion chambers, there was no visual signs of any cracks within the combustion chambers of this unit.

Fuel nozzles

The fuel nozzles exhibit typical carbon deposits with no other defects or damage noted.
.

HP& LP Nozzle Guide Vanes

The HP nozzle guide vanes and LP nozzle guide vanes were noted as having no visual damage; however they did show some signs of coating loss and carbon built up. All are considered to be in a serviceable condition.

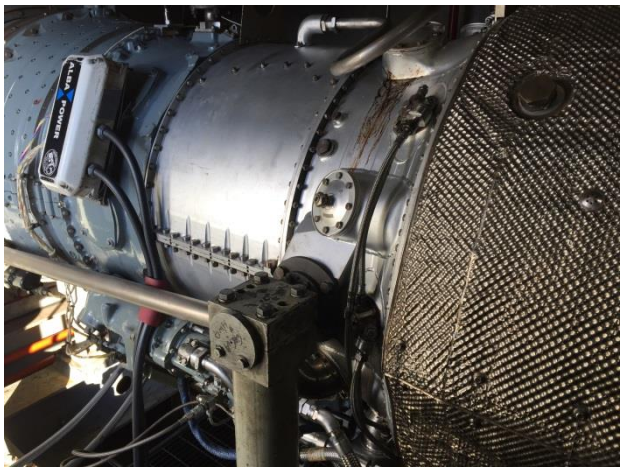
HP Turbine Blades

The HP turbine blades were noted as having no visual damage or defects and are considered to be in a serviceable condition.

Magnetic Chip Detectors

No debris was found on any of the chip detectors.

6 Olympus Gas Turbine 202204 Images

	
Olympus 202204	Olympus 202204 exterior condition port side

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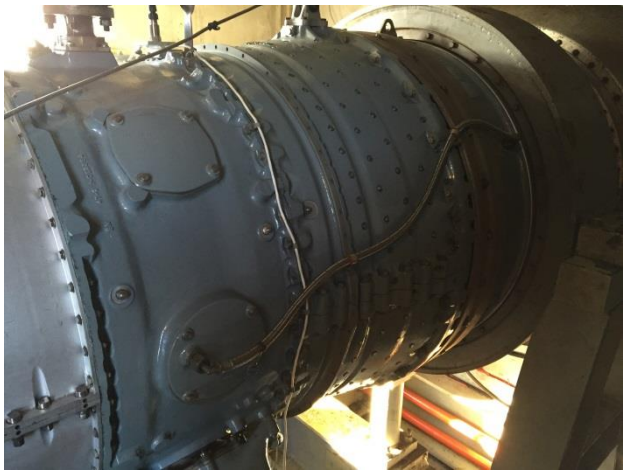	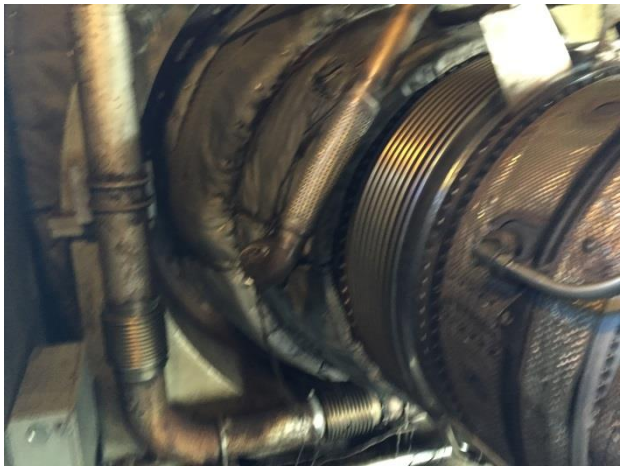
Olympus 202204 exterior condition starboard	Olympus 202204 exterior condition
	
Rear stages of HP compressor	Carbon build up on base of combustion can
	
HP NGVs and turbine blades	Carbon build up on combustion chamber

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Combustion chamber exterior	HP NGV,s
	
Combustion chamber side wall	LP compressor rear
	
Condition of snouts	Turbine entry duct

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7 Summary

The Olympus Gas Turbine 202204 was found to be in a serviceable condition.

8 Recommendations

The Gas Turbine should be regularly serviced to maintain a good level of engine performance.

On site personnel:	Colin Smith	Date:	29th Nov –30th Nov 2015
Report compiled by:	Colin Smith	Date:	7th December 2015
Reviewed by:	Bruce Proctor	Date:	8th December 2015

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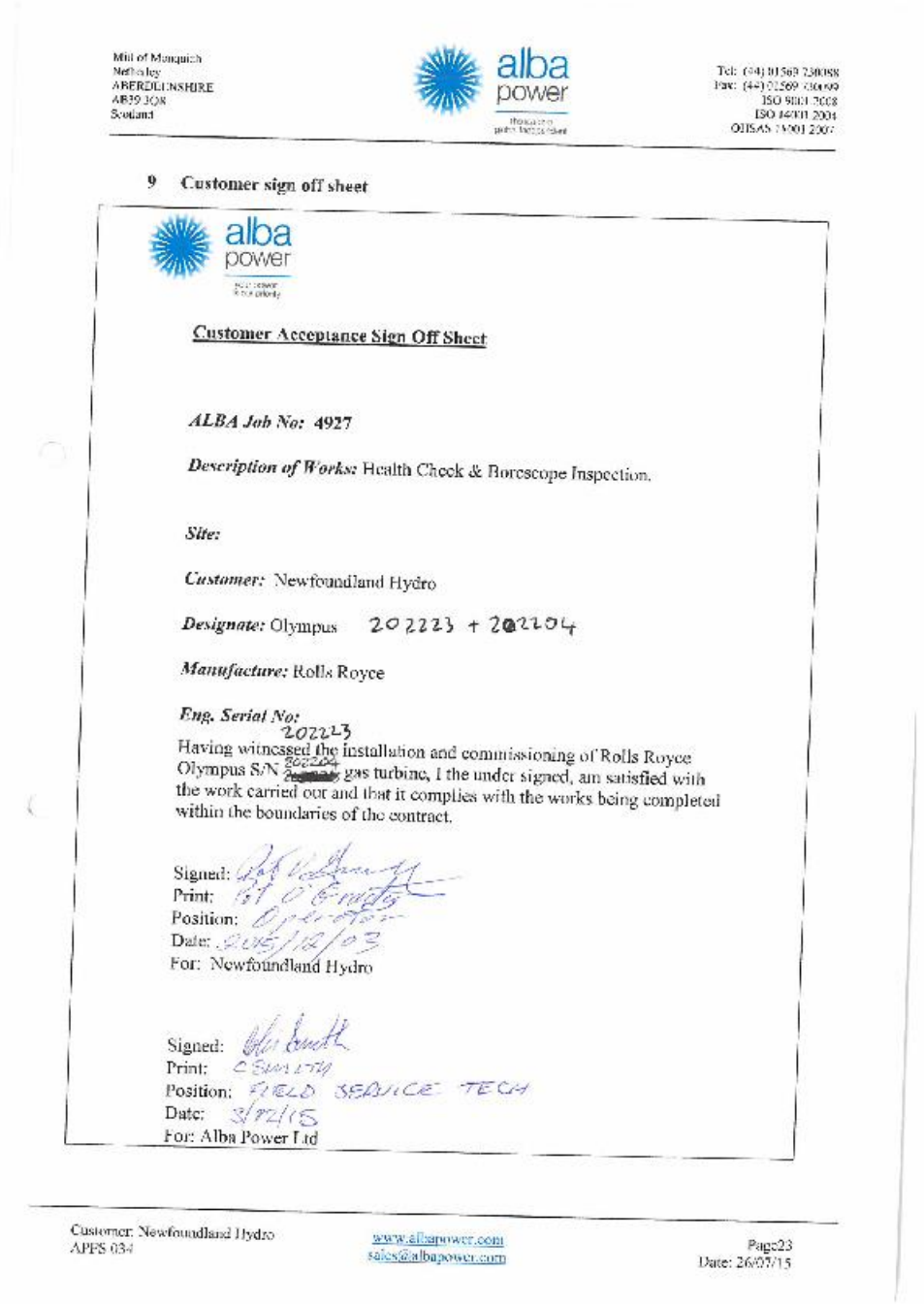

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9 Customer sign off sheet

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Customer Acceptance Sign Off Sheet

ALBA Job No: **4927**

Description of Works: Health Check & Borescope Inspection.

Site:

Customer: Newfoundland Hydro

Designate: Olympus 202223 + 202204

Manufacture: Rolls Royce

Eng. Serial No:
202223
Having witnessed the installation and commissioning of Rolls Royce Olympus S/N 202204 [redacted] gas turbine, I the under signed, am satisfied with the work carried out and that it complies with the works being completed within the boundaries of the contract.

Signed:
Print:
Position:
Date: 26/11/15
For: Newfoundland Hydro

Signed:
Print: C Smith
Position: FIELD SERVICE TECH
Date: 3/12/15
For: Alba Power Ltd

Customer: Newfoundland Hydro
APPS 034

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Date: 26/07/15