Q. Please provide Alba Power's report(s) to Hydro concerning its work in relation to the engine.

A. Please see CA-NLH-006 Attachment 1.

GTB
Olympus serial number: 202224
Fire Investigation
And
Inspection

Customer: Newfoundland Hydro

Date: 23rd March 2015

Project Number: Alba 4636

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Quality Certification
ISO 9001:2008
ISO 14001:2004
OHSAS 18001:2007
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1 Introduction

Mr. Symon Hanna arrived at the Newfoundland Hydro Hardwoods site to inspect and repair GTB following the recent fire.

Symon attended a safety tailboard meeting with Newfoundland Hydro site personnel before starting work each day.

Date of works: Friday 6th March – Saturday 21st March 2015.

Alba Power on site personnel: Mr. Symon Hanna.

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2 Saturday 7th March 2015

Symon remained on standby as site personnel were finishing shift early due to starting an early shift for operational requirements.

3 Sunday 8th March 2015

All on engine pipe work was inspected to identify which pipes were damaged in the fire. All pilot and main fuel pipes were removed from the distributor and burners. The number 8 oil feed and return pipes were removed along with the number 4 and 7 oil return pipes. All drain lines were removed going to the drain block under the combustion casing. The on engine fuel filter to LP fuel pump pipe was removed as there was evidence of blistering from the heat of the fire.

The on engine fuel filter was removed and drained along with the fuel cooled oil cooler assembly and distributor.

It was identified that a replacement combustion casing drain pipe and the on engine fuel filter to LP fuel pump pipe will need to be ordered.

3.1 Digital Images

Damaged Oil Cooler	Damaged Distributor	Damaged Fuel Lines	Damaged Oil Pressure and Main Drain Line
			
Damaged Number 4 and 7 Oil Return Lines	Damaged Fuel Filter To LP Fuel Pump Pipe	Damaged Combustion Casing Drain Line	Damaged Oil Cooler Drain Line
			

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4 Monday 9th March 2015

All 8 burners were removed and all Dowty seals were removed before the burners were cleaned in an ultrasonic bath.

All engine casings were cleaned using a degreasing cleaner. The oil pumps, fuel pumps, starter motor and gearbox were all cleaned.

5 Tuesday 10th March 2015

The spare pipes arrived on site along with the spare oil cooler and distributor. The crate was unpacked and all oil lines were inspected for debris. All fittings and fixings were inspected and cleaned.

A borescope inspection was carried out on the combustion section. It was found that number's 5, 6 and 8 combustion cans were severely damaged. It was recommended that the top combustion casing be removed to inspect the extent of the combustion section damage.

5.1 Digital Images

Large Piece Of Combustion Can Missing	Several Large Pieces Of Combustion Can Against HP Turbine Stator Blades	Large Piece Of Combustion Can Formed Around HP Turbine Stator Blade	Large Piece Of Combustion Can Wedged Between HP Turbine Stator Blades
			

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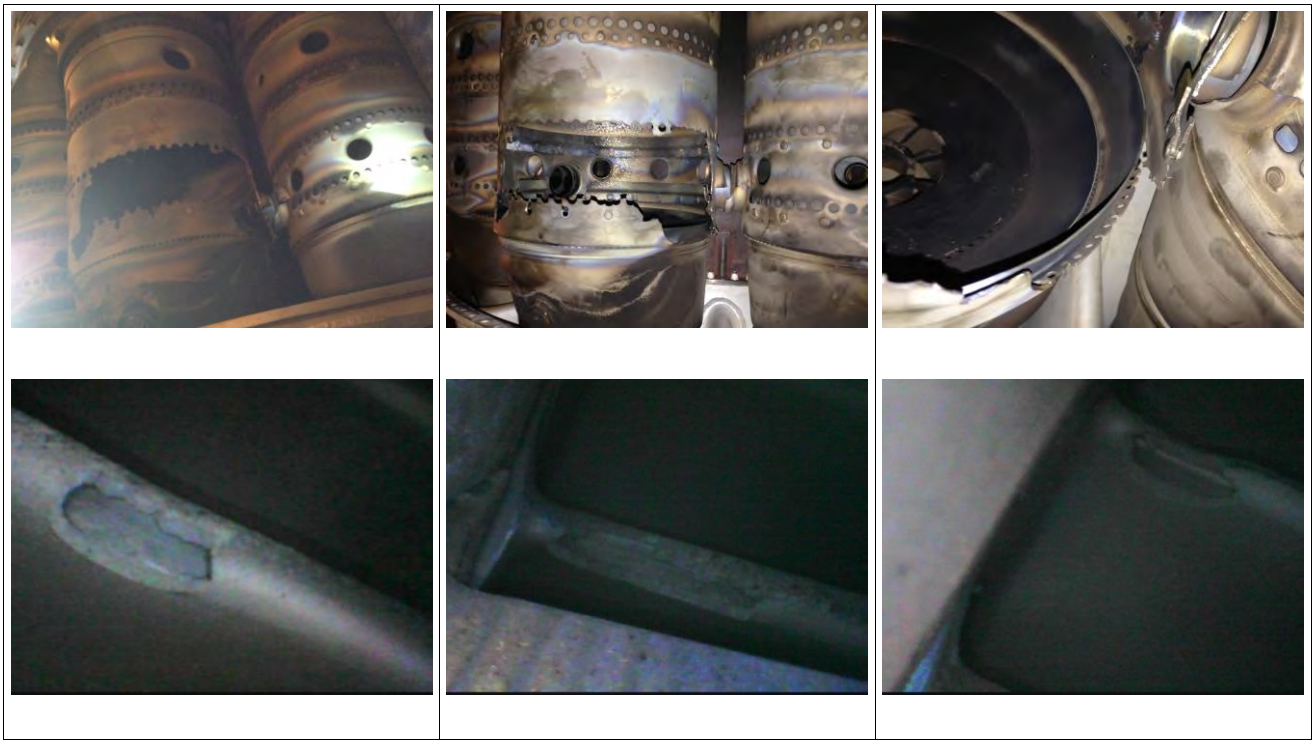
6 Wednesday 11th March 2015

All cooling air and oil pipes were removed from around the combustion section of the turbine. The heat shields were removed and stored outside the enclosure. The vent pipe and PT cooling air pipes were removed and stored outside the enclosure. All bolts were removed from the top half combustion casing. All split line bolts were removed. The combustion casing dowels were removed. The top half combustion casing was jacked up and removed.

It was confirmed that combustion can number 8 had been blown outwards and pieces were lodged in the HP turbine section. An inspection of the HP turbine blades confirmed that there was sufficient damage to make the turbine unfit for a site repair.

Pictures below show HP Turbine rotor blade damage and combustion can damage. The combustion cans were damaged from the inside and blown outwards.

6.1 Digital Images



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7 Thursday 12th March 2015

All remaining oil lines, fuel lines and breather lines were disconnected and stored appropriately.

The Power Turbine bellows were disconnected from the turbine exhaust section and all plates were removed. This was to allow access to inspect the power turbine.

8 Friday 13th March 2015

Due to the engine being unfit for a site repair it was decided that the original fire damaged ancillaries be re-fitted and the spare ancillaries supplied by Alba Power Ltd to remain at site. The original fuel cooled oil cooler, distributor and fuel filter were fitted. The Number 4, 7 and 8 oil return pipes were marked fire damaged and fitted to stop any ingress of debris into the scavenge oil pump.

The top combustion case was fitted and secured in place using all fitted split line bolts, several rear face bolts and several front face bolts.

9 Saturday 14th March 2015

The combustion section heat resistant blankets, number 8 bearing oil pipes and sealing air pipes were fitted that surround the combustion casing.

All 8 burners were fitted and all remaining open ports on the engine were blanked off to stop any ingress of debris.

10 Sunday 15th March 2015

All fixings for the internal doors were removed and doors opened to gain access to the air intake section. The inlet flare was removed and stored within the air intake section. The centre section of the top fixing beam was removed to enable fitting of the main crane beam.

All tooling and equipment was tidied and removed from enclosure.

11 Monday 16th March 2015

All combustion casing fixings were sorted out, bagged and labelled. All removed fittings were bagged and labelled.

The engine was checked over and any remaining open ports were blanked off to stop the ingress of debris.

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12 Tuesday 17th March 2015

On completion of a borescopic inspection of the Power Turbine, it was confirmed that the debris from the damaged combustion cans was small enough not to have caused visible damage when it reached the Power Turbine blades.

All fire damaged pipe work had any salvageable P-clips removed and the pipes were disposed of.

13 Wednesday 18th March 2015

Arrived on site and packed up equipment for returning to the UK'

14 Summary

The damage from the fire on site was assessed and all parts were identified that would need to be replaced. Many of the damaged pipes were removed and disposed of.

On inspection of the combustion section of the GTB Olympus it was confirmed that combustion cans 5, 6 and 8 had broken up sending large pieces through the Turbine section. This meant the engine was unfit for an onsite repair as there was significant damage to the HP Turbine rotor blades caused by pieces of combustion cans passing through.

The cause of the combustion can failure was a drop in fuel pressure when the fitting on the top of the off engine fuel filter broke. This sudden drop in fuel pressure caused a flame out condition that was not picked up by the DCS control system. As the engine speed started to drop the DCS control system compensated by opening up the fuel valve to increase the speed. When the fuel pressure returned to the system the engine re-lit with the fuel valve fully open causing an explosion inside the combustion section.

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15 Customer acceptance

Customer Acceptance Sign Off Sheet

ALBA Job No: **CO 4636**

Description of Works: Fire Investigation

Site: Hardwoods

Manufacture : Rolls Royce

Type: Olympus

I the under signed, am satisfied with the works carried out and that it complies with the works being completed within the boundaries of the contract.

Signed:
Print: Reg Day
Position: E/M Supervisor
Date: March 18/2015
For: Newfoundland Hydro

Signed:
Print: Symon Hanna
Position: Lead Field Service Engineer
Date: 18-3-2015
For: Alba Power Ltd

On site personnel:	Symon Hanna	Date:	6th - 21st March 2015
Report compiled by:	Symon Hanna	Date:	23rd March 2015
Reviewed by:	Paul Hayworth	Date:	26th March 2015