NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

June 20, 2016

AIRWORTHINESS

Group Chairman's Factual Report

ANC15MA041

Attachment 3 – Pratt & Whitney Canada Engine Report No. 15-064 (48 pages)

Service Investigation

Accident / Incident Summary Report

P&WC 8114 (11-98)

Pratt & Whitney Canada
A United Technologies Company

Report No.: 15-064

Promech Air Inc.
de Havilland DHC-3 Reg. N270PA
Ketchikan, Alaska
25 June 2015
PT6A-135A Engine
S/N 35056

Written By:

Thomas A. Berthe
Investigator
Service Investigation Department

Approved By:

Richard Benoit
Manager
Service Investigation Department

Date of Issue: **10 June 2016**

Distribution: **Clinton Crookshanks (NTSB), File 15-064**

This document is subject to the following Export Control Classification	**Canadian ECL #**	No License Required
	ECCN or USML (ITAR) #	9E991
	P-ECCN or P-USML (Non US Origin)	

Table of Contents

Service Investigation

Accident / Incident Summary Report

P&WC 8114 (11-98)

Pratt & Whitney Canada
A United Technologies Company

Report No.: 15-064

I ANALYSIS

1.0 ACCIDENT SYNOPSIS

On 25 June 2015, a float equipped de Havilland DHC-3 Reg. N 270PA, operated by Promech Air Inc. as a visual flight rules commercial sightseeing flight, departed Rudyerd Bay, Alaska with the intended destination of Ketchikan, Alaska, under marginal visual meteorological conditions. The aircraft impacted mountainous tree-covered terrain about 24 miles northeast of Ketchikan. The pilot and the eight passengers were fatally injured. The aircraft was destroyed.

2.0 SUMMARY OF FINDINGS

The engine displayed moderate impact damage including impact fracture of the propeller shaft and downward deformation of the exhaust duct.

Strong circumferential contact signatures were displayed by the compressor assembly, compressor turbine guide vane ring, compressor turbine shroud, compressor turbine, power turbine guide vane ring, power turbine shroud, and power turbine due to their making contact under impact loads and external housing deformation. The propeller shaft, reduction gear box 2nd stage sun gear coupling, and power turbine blades were impact fractured, and displayed strong collateral circumferential contact signatures.

Functional testing of the high pressure fuel pump, fuel control unit, compressor bleed valve, fuel heater, and fuel nozzles, and disassembly inspection of the fuel control unit, flow divider valve, and propeller governor showed no conditions that would have precluded normal operation prior to impact.

None of the engine components displayed any indications of any pre-impact anomalies or distress.

3.0 CONCLUSIONS

The engine displayed contact signatures to its internal components characteristic of the engine developing power in a high power range at the time of impact.

There were no indications of any pre-impact mechanical anomalies or dysfunction to any of the engine components observed that would have precluded normal engine operation.

II FACTUAL INFORMATION

1. INVESTIGATION PARTICIPANTS

The power plant investigation was performed on 17-18 November 2015 at the Pratt& Whitney Canada Service Investigation facilities at St. Hubert, Quebec. The following individuals participated in the investigation as representatives of their respective organisations:

Brice Banning	Air Safety Investigator National Transportation Safety Board
Clinton R. Crookshanks	Aerospace Engineer National Transportation Safety Board
Shaun Williams	Air Safety Investigator National Transportation Safety Board
Patrick A. Hempen	Air Safety Investigator Federal Aviation Administration
David Barnard	Engine Controls & Nacelles Technical Services Pratt & Whitney Canada
Thomas Berthe	Service Investigation Pratt & Whitney Canada

2. ENGINE HISTORY

PT6A-135A S/N 35056

Hours Since New: 14,470

Cycles Since New: 35,969

Hours Since Overhaul: 10,300

The above hours and cycles are as of the last recorded maintenance for the engine, a Promech Air AAIP inspection completed on 11 May 2015. The AAIP inspection suffix (“A”, “B”, or “C”) performed was not recorded. A hot section inspection was completed by the operator in February 2011 at 12,543 total hours. The last recorded major repair for the engine was the installation of a repaired power section S/N 92466 at 11,038 total hours, completed in April 2008. Logbook information prior to this date was not available. Logbook information was reviewed in PDF format

as provided by the National Transportation Safety Board. The physical engine logbooks were not received with the engine.

3. ENGINE EXAMINATION

All positional references are in relation to view from aft looking forward. Upstream and downstream references are in relation to gas path flow from the compressor inlet to exhaust.

3.1 External Condition

The engine was received in a normal shipping container with all airframe related components removed. The engine displayed moderate impact damage and no fire damage. The gas generator and power section rotors were seized. The engine was placed in a disassembly stand for inspection.

3.1.1 External Cases

Reduction Gearbox: The propeller shaft was impact fractured immediately aft of the propeller mounting flange. The housing was impact fractured around the lower circumference. The Np tachometer generator and the propeller over speed governor housings were impact fractured. The propeller governor was in place and intact.

Exhaust Duct: The duct was deformed approximately 30 degrees downward in relation to the engine centreline. Power turbine blade debris was recovered from the duct interior.

Gas Generator Case: The housing was intact. The fuel manifold was in place and intact.

Accessory Gearbox: The housing was intact. The accessory gearbox mounted controls and accessories were in place with impact damage.

Please refer to photos No. 1 through 6.

Photo No. 1
Engine left hand forward view.

Photo No. 2
Engine right hand forward view.

Photo No. 3
Engine left hand aft view.

Photo No. 4
Engine right hand aft view.

Photo No. 5
Reduction gearbox and exhaust duct, right hand top view.

Photo No. 6
Aft gas generator case and accessory gearbox, lower right hand view.

3.1.2 Power Control and Reversing Linkage

The forward linkage was removed. The controls cam box was impact fractured. The fuel control unit input lever was impact fractured. Please refer to photos No. 1 and 3 through 5.

3.1.3 Pneumatic Lines

Compressor Discharge Air (P3): The line was intact and continuous from the gas generator case fitting to the fuel control unit fitting. All connections were intact. A P3 filter system was not installed. Please refer to photo No. 6.

Power Turbine Control (Py): The line was intact and continuous from the fuel control unit fitting to the propeller governor fitting. All connections were intact. Please refer to photos No. 1 through 3.

3.1.4 Chip Detectors and Filters

Reduction Gearbox Chip Detector: The chip detector mounting boss was impact fractured from the reduction gearbox. The chip detector was not recovered.

Oil Filter: Clean. Please refer to photo No. 7.

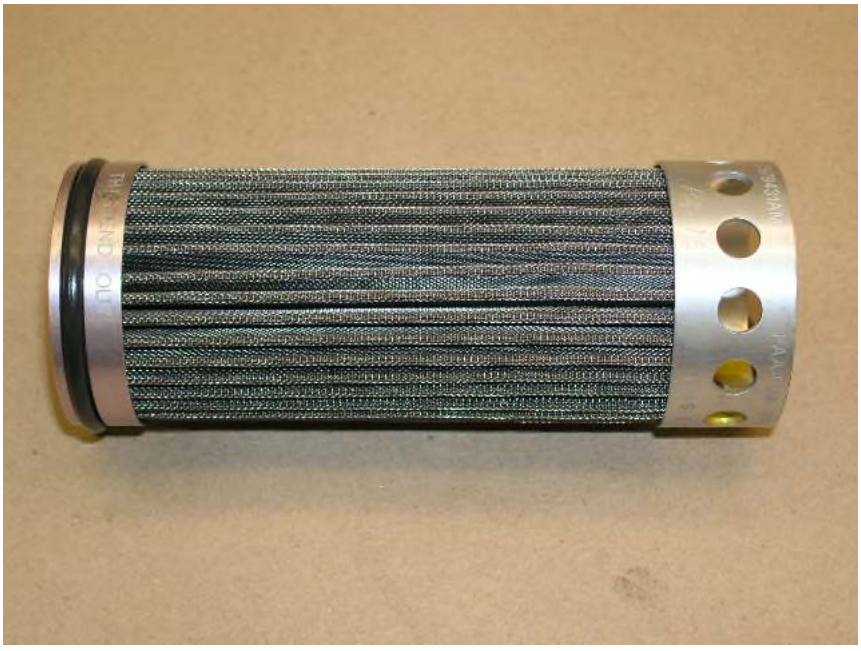

Photo No. 7
Oil filter.

Fuel Filter: The inlet screen and outlet filter were clean. Please refer to photos No. 8 and 9.

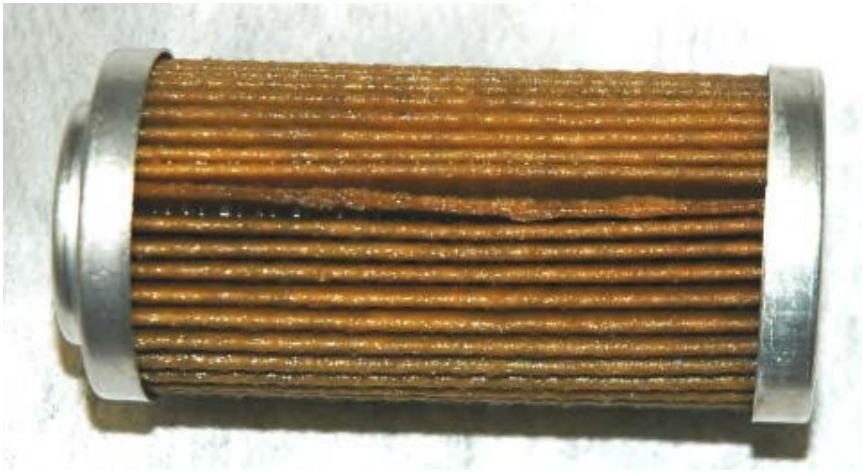

Photo No. 8
Fuel filter.

Photo No. 9
Fuel pump inlet screen.

3.2 Disassembly Observations

3.2.1 Compressor Section

Loose soil was ingested through the compressor to the centrifugal impeller. Please refer to photos No. 10, 11, and 16.

Compressor 1st, 2nd, and 3rd Stage Discs and Blades: The blade airfoils were intact. The tips displayed light circumferential rubbing due to contact with their adjacent shrouds. Please refer to photos No. 10 through 12.

Photo No. 10
Compressor 1st stage and No. 1 bearing housing, in-situ.

Photo No. 11
Compressor 1st stage blades and shroud, in-situ, detail.

Photo No. 12
Compressor 1st, 2nd, and 3rd stage blades and discs.

Compressor 1st, 2nd, and 3rd Stage Stators and Shrouds: The stator airfoils were intact, with light circumferential rubbing to the tips due to contact with their adjacent spacers. The shrouds displayed light circumferential rubbing due to the contact with their adjacent blades. Please refer to photos No. 11 and 13.

Photo No. 13
Compressor 1st, 2nd, and 3rd stage stators and shrouds.

Compressor 1st, 2nd, and 3rd Stage Spacers: The spacers displayed circumferential rubbing due to contact with their adjacent stator vane tips. The 1st stage spacer displayed axial cracks at the compressor through bolt locations. There were no indications of operational distress. Please refer to Photos No. 14 and 15.

Photo No. 14
Compressor 1st, 2nd and 3rd stage spacers.

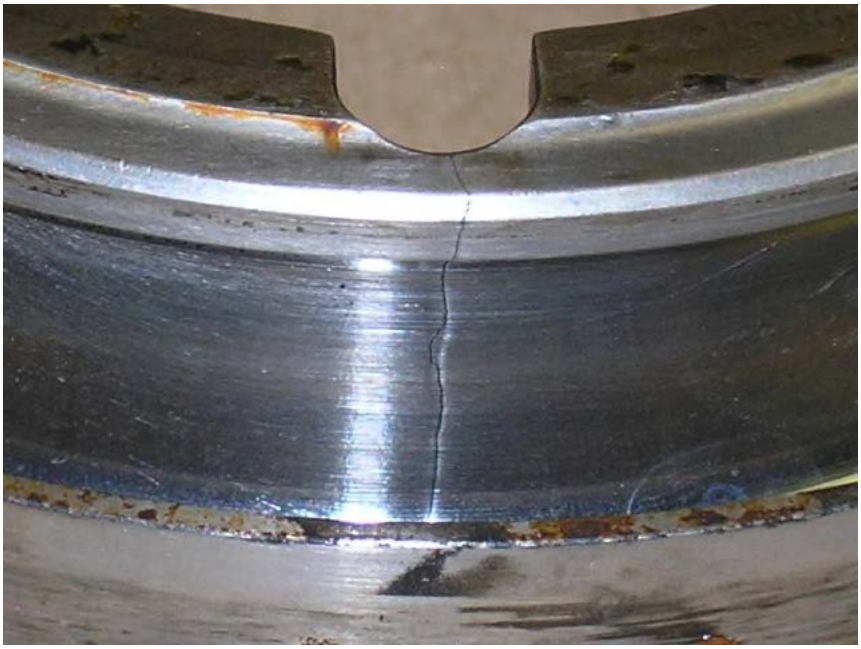

Photo No. 15
1st stage spacer, detail.

Centrifugal Impeller and Shroud: Loose ingested soil was observed distributed through the impeller prior to disassembly. The impeller vanes and shroud displayed severe circumferential contact rubbing, with heavy frictional heat discoloration and material smearing. Please refer to photos No. 16 through 19.

Photo No. 16
Centrifugal impeller and shroud outlet, detail.

Photo No. 17
Centrifugal impeller and shroud.

Photo No. 18
Centrifugal impeller, detail.

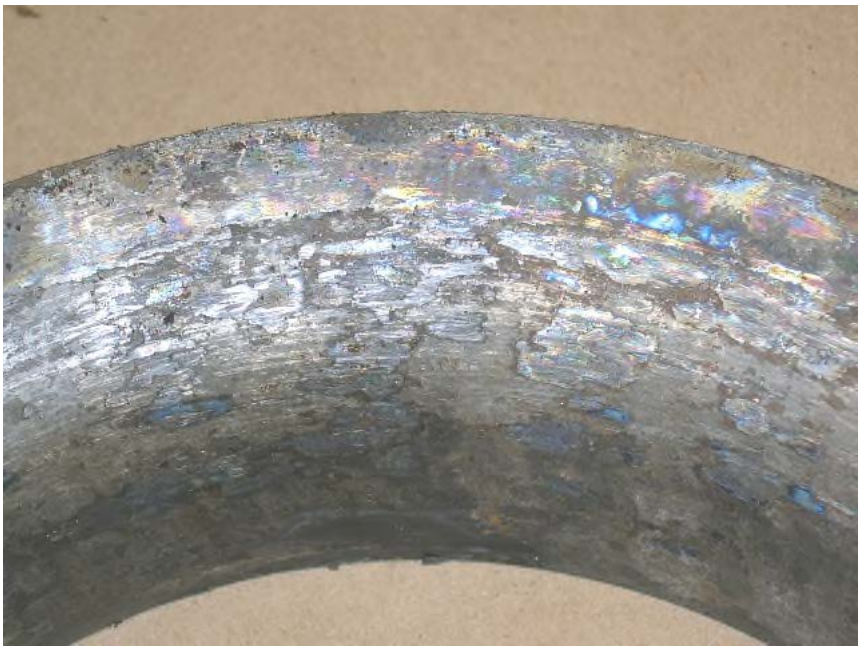

Photo No. 19
Centrifugal impeller shroud.

No. 1 Bearing and Air seals: The bearing displayed no indications of distress. Please refer to photo No. 20.

No. 2 Bearing and Air seals: The bearing displayed no indications of distress. The air seal rotors displayed circumferential rubbing and scoring due to contact with the stator knife edges. Please refer to photo No. 21.

Photo No. 20
No. 1 bearing.

Photo No. 21
No. 2 bearing and air seal rotors, in-situ.

3.2.2 Combustion Section

Combustion Chamber Liner: Displayed no operational distress. Please refer to photos No. 24 and 38.

Large Exit Duct: Displayed no operational distress. The flame pattern indications were normal. Please refer to photos No. 22 and 23.

Small Exit Duct: Displayed minor heat erosion, with no operational distress. Please refer to photo No. 25.

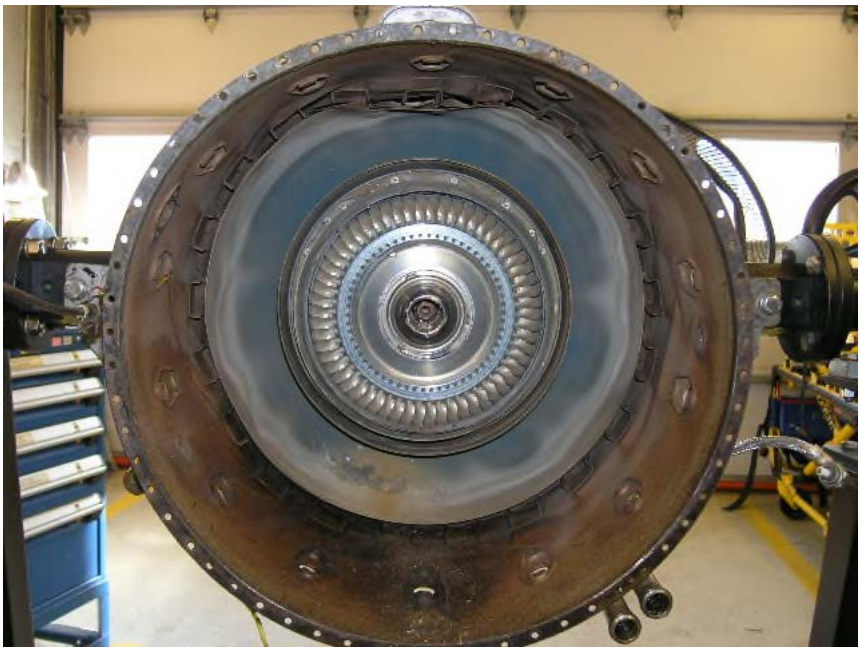

Photo No. 22
Gas generator case interior, large exit duct and compressor turbine, in-situ.

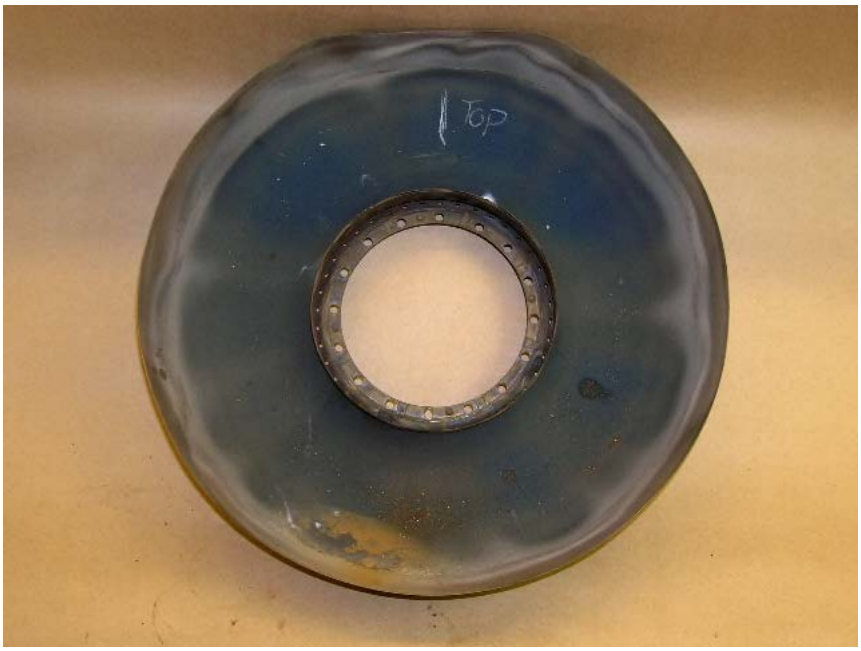

Photo No. 23
Large exit duct.

Photo No. 24
Combustion chamber liner.

3.2.3 **Turbine Section**

Compressor Turbine Guide Vane Ring: The vane airfoils displayed no operational distress. The inner drum downstream side displayed circumferential machining, with frictional heat discoloration, due to contact with the compressor turbine. Please refer to photos No. 25 through 27.

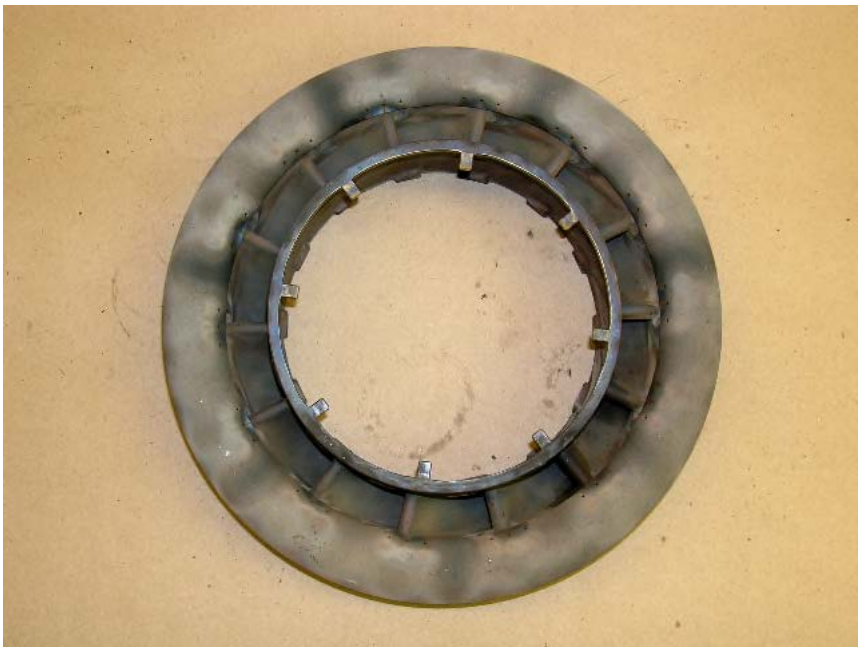

Photo No. 25
Small exit duct and compressor turbine guide vane ring, upstream side.

Photo No. 26
Compressor turbine guide vane downstream side.

Photo No. 27
Compressor turbine guide vane ring downstream side, detail.

Compressor Turbine Shroud: Displayed heavy circumferential rubbing, with frictional heat discoloration and material smearing, due to contact with the compressor turbine blades. Please refer to photos No. 28 and 29.

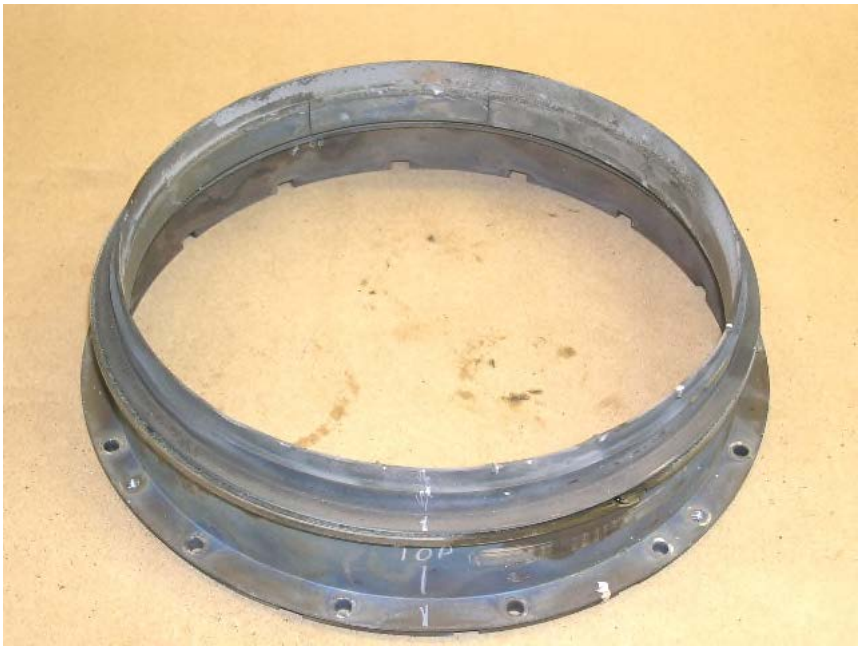

Photo No. 28
Compressor turbine shroud.

Photo No. 29
Compressor turbine shroud lower circumference, detail.

Compressor Turbine: The blade airfoils displayed no indications of operational distress. The blade tips displayed heavy circumferential rubbing, with frictional heat discoloration and material smearing, due to contact with the adjacent shroud. The upstream side disc outer rim and blade platforms displayed circumferential machining, with frictional heat discoloration, due to contact with the compressor turbine guide vane ring. The blade airfoil trailing edges displayed circumferential machining and deformation, and the disc downstream side displayed severe circumferential rubbing, with heavy frictional heat discoloration and material smearing, due to contact with the power turbine guide vane ring and interstage baffle. The downstream side disc hub displayed heavy circumferential machining due to contact with the power turbine disc, though the interstage baffle. Please refer to photos No. 30 through 37.

Photo No. 30
Compressor turbine downstream side and shroud, in-situ.

Photo No. 31
Compressor turbine downstream side and shroud, in-situ, detail.

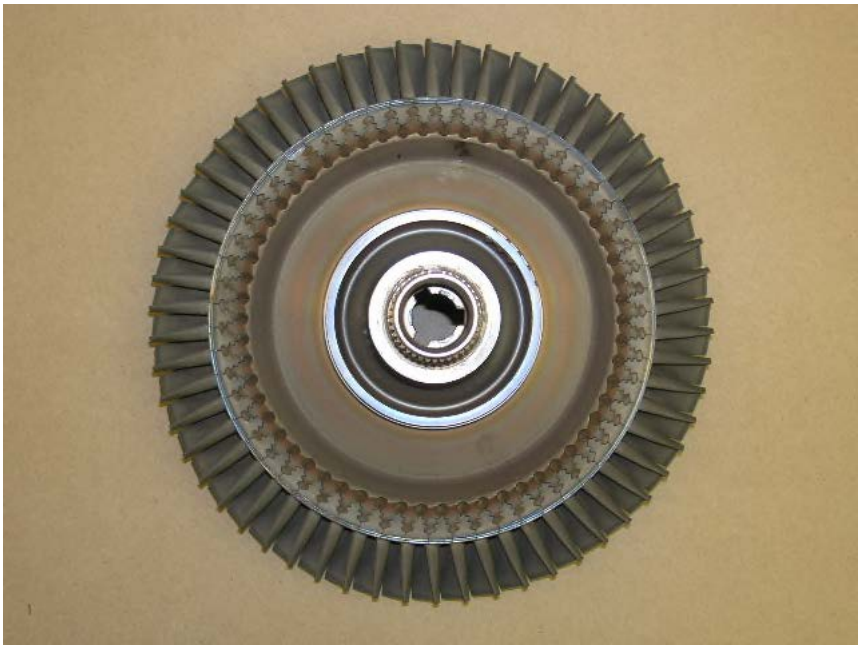

Photo No. 32
Compressor turbine, upstream side.

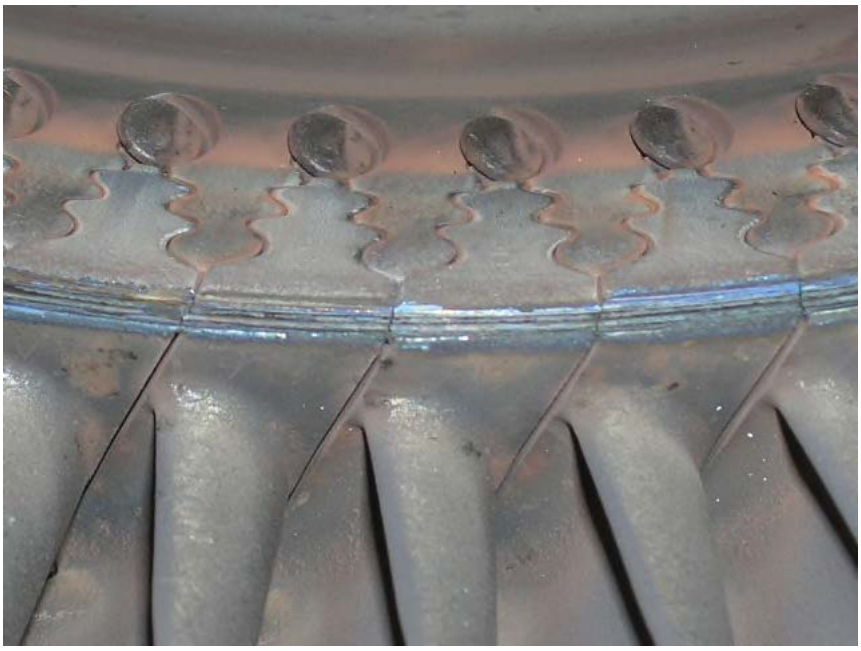

Photo No. 33
Compressor turbine upstream side, detail.

Photo No. 34
Compressor turbine blade tips, detail.

Photo No. 35
Compressor turbine, downstream side.

Photo No. 36
Compressor turbine downstream side, detail.

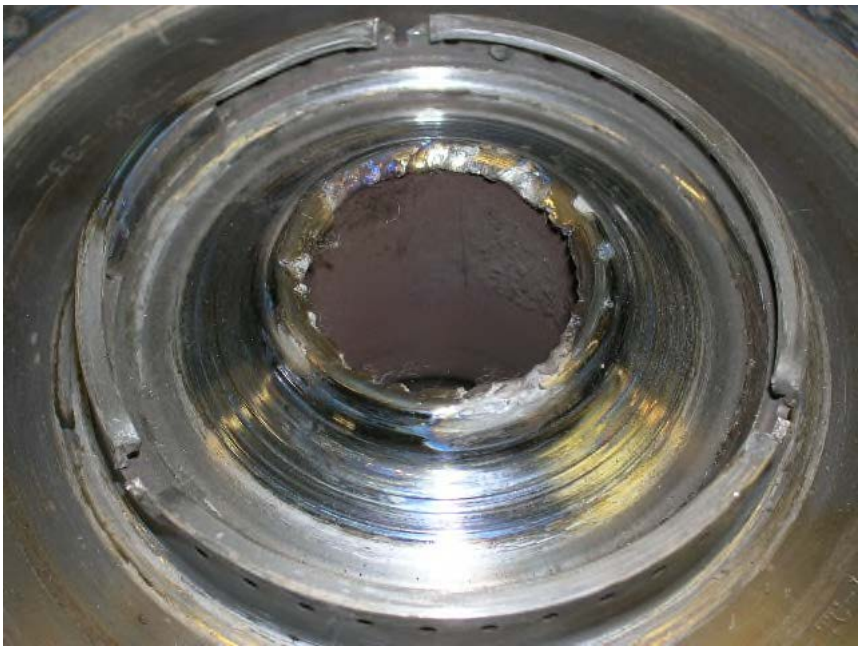

Photo No. 37
Compressor turbine downstream side hub, detail.

ITT Probes, Busbar, and Harness: The probes displayed impact deformation due to contact with the power turbine guide vane ring. The probes displayed no burning or other indications of operational distress. Please refer to photos No. 38 through 41.

Power Turbine Housing: Displayed impact deformation around the upper circumference due to deformation of the exhaust duct and power turbine shaft. Please refer to photos No. 38 and 39.

Power Turbine Guide Vane Ring and Interstage Baffle: The vane ring and airfoils were impact fractured around the right hand circumference and the interstage baffle was displaced due to contact with the power turbine. The upstream side inner drum and baffle face displayed severe circumferential rubbing and machining, with heavy frictional heat discoloration, due to contact with the compressor turbine. The downstream side vane ring, airfoils, and baffle face displayed heavy circumferential rubbing and machining, with heavy frictional heat discoloration due to contact with the power turbine. The baffle was machined completely through the material in localised areas. Please refer to photos No. 38 through 47

Photo No. 38
Power turbine housing, power turbine guide vane ring, and combustion chamber, in-situ.

Photo No. 39
Power turbine housing right hand side.

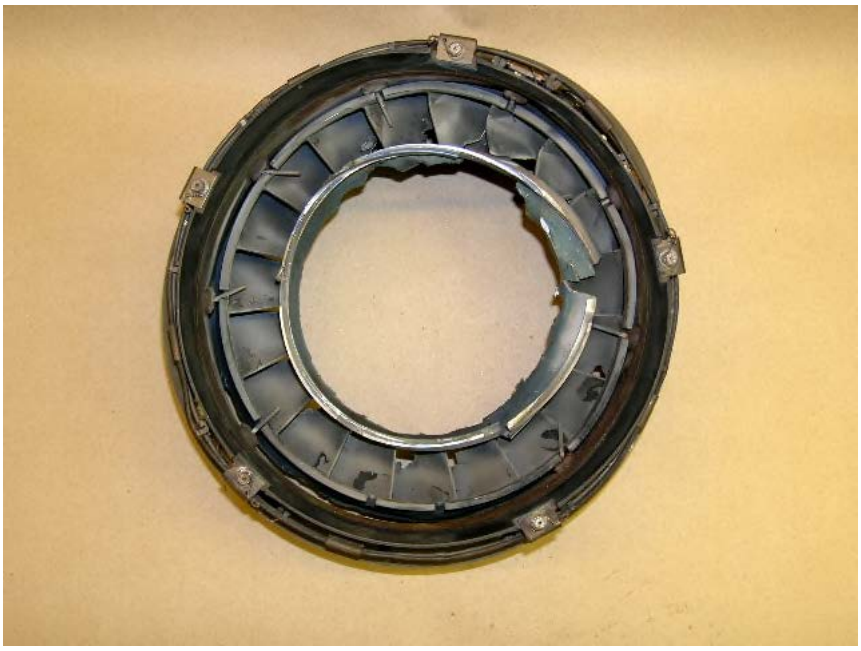

Photo No. 40
Power turbine housing and power turbine guide vane ring, upstream side.

Photo No. 41
Power turbine guide vane ring upstream side, detail.

Photo No. 42
Power turbine housing and power turbine guide vane ring, downstream side.

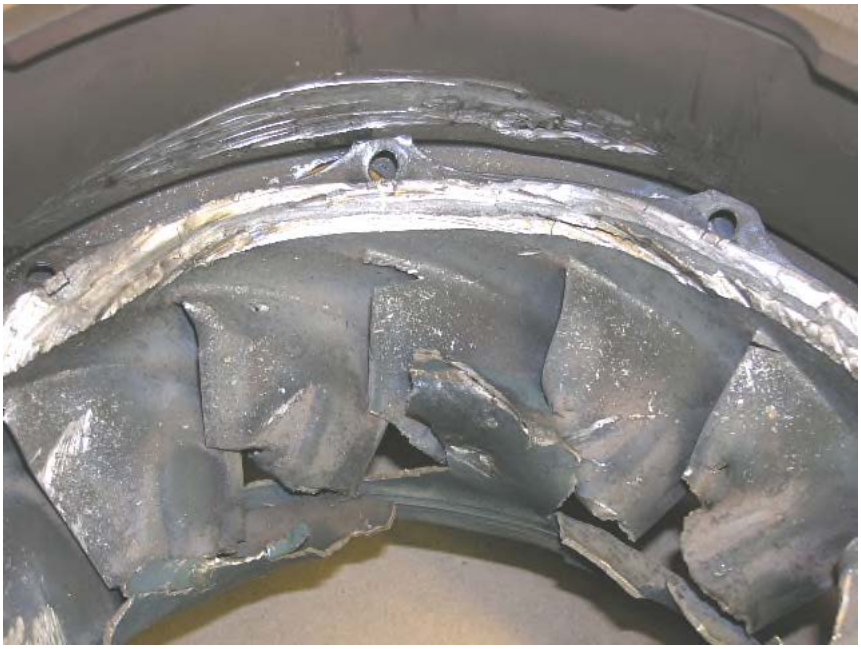

Photo No. 43
Power turbine housing and power turbine guide vane ring downstream side, detail.
Centred at the approximate 1:00 position.

Photo No. 44
Interstage baffle, upstream side.

Photo No. 45
Interstage baffle, upstream side. Centred at the approximate 1:00 position.

Photo No. 46
Interstage baffle, downstream side.

Photo No. 47
Interstage baffle downstream side, detail.
Centred at the approximate 1:00 position.

Power Turbine Shroud: Displayed heavy circumferential rubbing and machining, with frictional heat discoloration and material smearing, due to contact with the power turbine disc. Please refer to photos No. 48 and 49.

Photo No. 48
Power turbine shroud lower circumference, detail.

Power Turbine: The power turbine was displaced sharply to the approximate 1:00 position due to deformation of the exhaust duct and power turbine housing. The blades airfoils were impact fractured and displaced forward in their serrated fixings due to contact with the shroud, housing, and power turbine guide vane ring. Under unaided visual and macroscopic inspection the airfoil fracture surfaces displayed coarse granular features with no indications of fatigue or other progressive fracture mechanism. The disc face and blade platforms displayed heavy circumferential rubbing, machining, and deformation due to contact with the power turbine guide vane ring and compressor turbine disc. Please refer to photos No. 49 through 53.

Photo No. 49
Power turbine downstream side, in-situ.

Photo No. 50
Power turbine downstream side, in-situ.

Photo No. 51
Power turbine downstream side, in-situ, detail.

Photo No. 52
Power turbine blade roots, detail

Photo No. 53
Power turbine downstream side hub, detail.

Power Turbine Shaft and Shaft Housing: Severe impact deformation precluded disassembly. One displaced No. 3 bearing roller was located in the reduction gearbox oil sump.

3.2.4 **Reduction Gearbox**

The propeller shaft was impact fractured immediately aft of the propeller mounting flange. Unaided visual and macroscopic inspection of the fracture surfaces showed coarse granular features with collateral circumferential rubbing. The fracture surfaces displayed no indications of fatigue or other progressive fracture mechanism. The 1st stage planet gear carrier spline coupling to the 2nd stage sun gear was impact fractured at the carrier web. Unaided visual and macroscopic inspection of the fracture surfaces showed coarse granular features with collateral circumferential rubbing. The fracture surfaces displayed no indications of fatigue or other progressive fracture mechanism. The 1st and 2nd stage carrier webs displayed circumferential rubbing, with frictional heat discoloration, due to their making axial contact. The reduction gearbox 1st and 2nd stage gearing displayed no indications of operational distress. Please refer to photos No. 54 through 62.

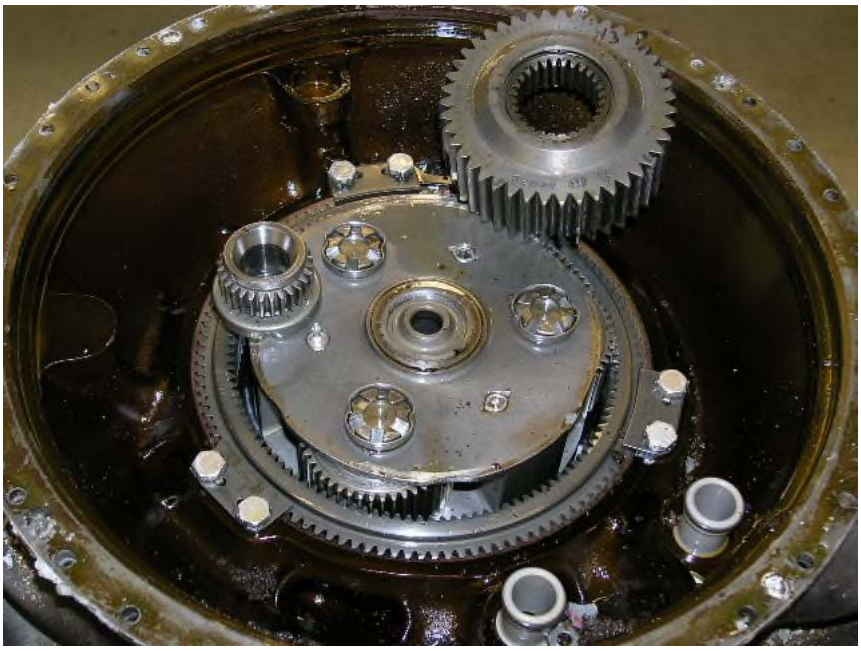

Photo No. 54
1st stage reduction gearing and 2nd stage planet gear assembly, in-situ.

Photo No. 55
1st stage planet gear carrier hub, detail.

Photo No. 56
1st stage planet gear carrier hub, detail.

Photo No. 57
1st stage planet gear carrier hub 2nd stage sun gear input spline, detail.

Photo No. 58
1st stage planet gear carrier, detail.

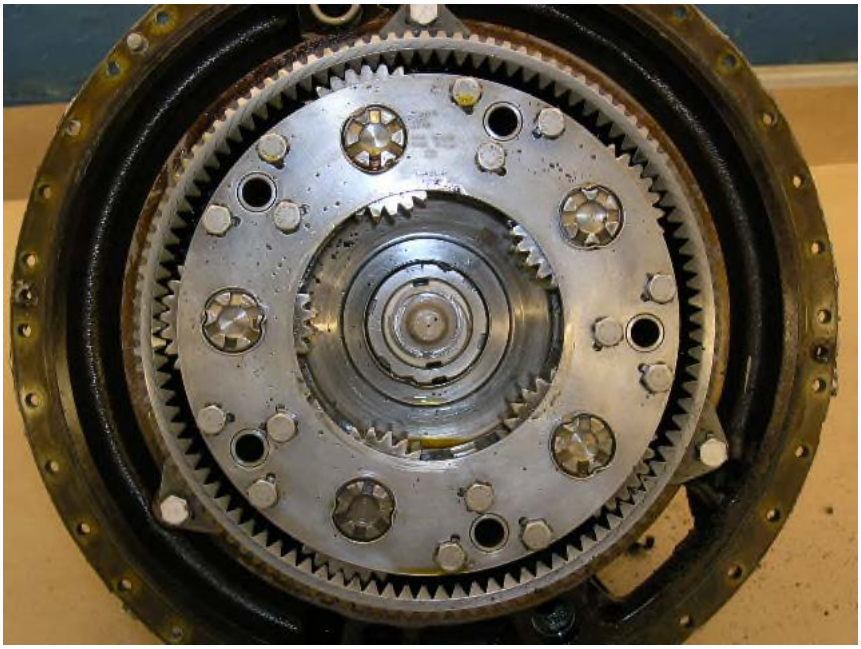

Photo No. 59
2nd stage reduction gearing, in-situ.

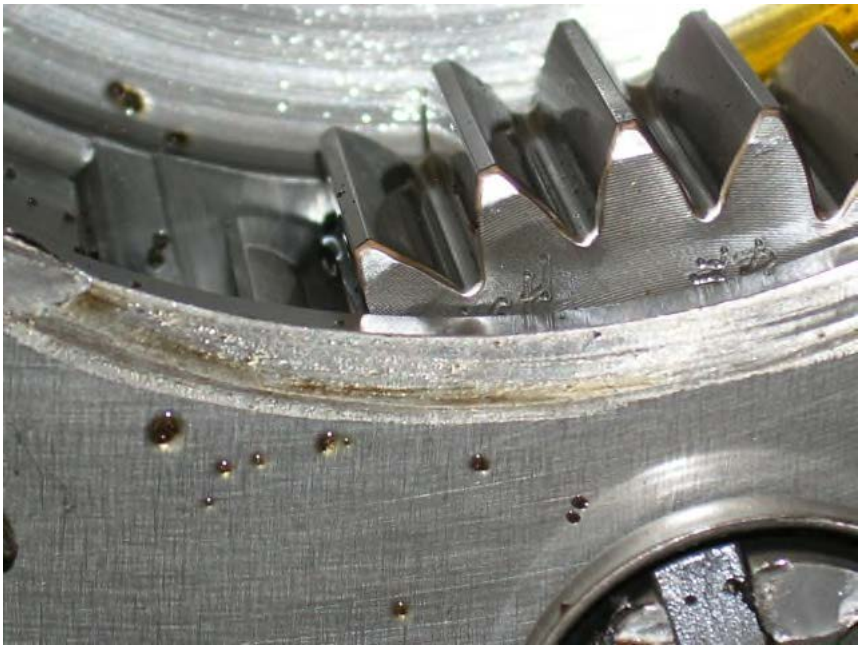

Photo No. 60
2nd stage planet gear carrier, detail.

Photo No. 61
Propeller shaft hub.

Photo No. 62
Propeller mounting flange, detail.

Photo No. 63
Propeller shaft detail.

3.2.5 Accessory Gearbox

The accessory gearbox was not disassembled.

3.3 Controls and Accessories Evaluation

3.3.1 Ignition System

The ignition exciter box was not received. The ignition plugs and harness displayed no visual indications of distress.

3.3.2 Fuel System

Fuel Heater: The unit displayed impact damage including impact fracture of the mounting foot and the fuel inlet fitting. Functional testing of the thermal element showed limited travel toward the full cold position due to impact damage. Please refer to photos No. 64 and 65.

Photo No. 64
Oil to fuel heater.

Photo No. 65
Fuel heater thermal element.

Fuel Pump: Impact damage included partial fracture of the mounting pad. Functional testing was satisfactory with minor deviations not affecting normal operation. Please refer to photos No. 66 and 67.

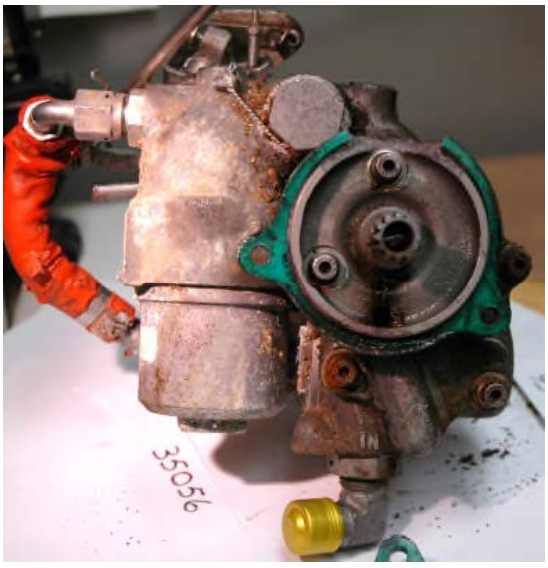

Photo No. 66
High pressure fuel pump.

Fuel Control Unit: Impact damage included deformation of the input lever to the maximum flow position and deformation of the condition lever assembly. Functional testing was limited to operation at the fixed input lever position and showed no conditions limiting full power operation. Disassembly and inspection revealed no pre-impact conditions that would preclude normal operation. Please refer to photos No. 67 and 68.

Photo No. 67
Fuel control unit and high pressure fuel pump.

Photo No. 68
Fuel control unit, as disassembled.

Flow Divider: Functional testing and disassembly inspection were satisfactory. Please refer to photo No. 69.

Photo No. 69
Flow divider, as disassembled.

Fuel Nozzles: Functional testing of the fuel nozzles showed streaking of the nozzle flows in excess of the return to service specifications. The condition of the large exit and compressor turbine guide vane did not reflect any streaking or other flow anomaly of the fuel nozzles in operation prior to impact. Please refer to photos No. 70, and 23, and 25.

Photo No. 70
Fuel nozzle assemblies.

3.3.3 **Air System:**

Compressor Bleed Valve: Functional testing was satisfactory. Please refer to photo No. 71.

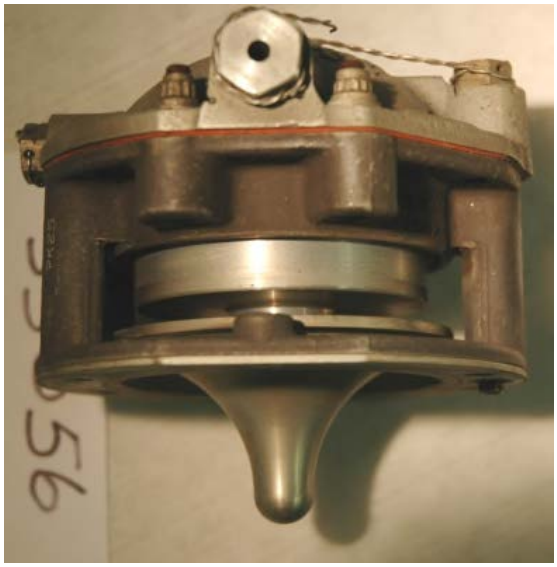

Photo No. 71
Compressor bleed valve.

3.3.4 **Oil System:**

Propeller Governor: Impact damage included limitation of travel of the speed setting lever and the reset arm. The input shaft could not be rotated by hand. This impact damage precluded functional testing. Disassembly and inspection showed no conditions affecting normal operation prior to impact. Please refer to photos Nos. 72 and 73.

Photo No. 72
Propeller governor.

Photo No. 73
Propeller governor, as disassembled.