

Accident / Incident Report

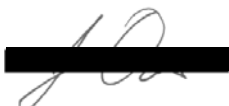
P&WC 8114 (11-98)

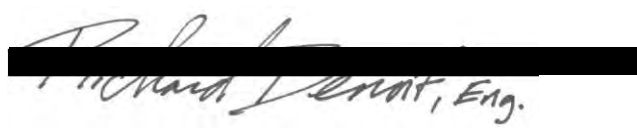
**Pratt & Whitney Canada**

A United Technologies Company

Report No.: 15-012

**Brinks Inc.
Beech 1900C, Aircraft Reg. No. YV1674
Miami, Florida, USA
February 11, 2015
PT6A-65B
L/H S/N 32138
R/H S/N G/G 32040 P/S 32065**

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I ANALYSIS

1.0 ACCIDENT SYNOPSIS

On 11 February 2015, a Beech 1900C, Aircraft Reg. YV1674, operated by Brinks Inc., crashed on take-off from Kendall-Tamiami Executive Airport (KTMB). The aircraft was destroyed during a collision with the terrain. A post flight fire consumed most of the cockpit, cabin and portions of both wings. Both of the pilots and two passengers were fatally injured.

2.0 SUMMARY OF FINDINGS

The left hand engine displayed some compressional damage to the gas generator case and the exhaust duct. Circumferential rubbing was evident on the compressor turbine, 1st stage power turbine vane and 1st stage power turbine. The dirt and debris ingested in the engine gas path is consistent with debris being ingested at impact. The propeller reversing lever was most likely pushed against the guide pin with enough force to bend the guide pin upward until the lever passed over the top of the pin during the sectioning of the propeller shaft.

The right hand engine displayed torsional bending of the exhaust duct. Circumferential rubbing was evident on the compressor turbine, 1st stage power turbine vane and 1st stage power turbine. The dirt and debris ingested in the engine gas path is consistent with debris being ingested at impact.

3.0 CONCLUSIONS

The left hand engine displayed contact signatures to its internal components that are consistent with an engine that was producing some power at the time of impact.

The right hand engine displayed contact signatures to its internal components and torsional signatures characteristic of an engine developing significant power at the time of impact.

The engines displayed no indications of any pre-impact anomalies or distress that would have precluded normal engine operation prior to impact.



II FACTUAL INFORMATION

1.0 INVESTIGATION PARTICIPANTS

An external examination of the left hand powerplant and the right hand powerplant investigation were performed on February 14, 2015 at the Florida Air Recovery, Fort Pierce, Florida, USA. The following individuals participated in the investigation as representatives of their respective organisations:

Robert Gretz	National Transportation Safety Board Senior Air Safety Investigator
Paul Yoos	Textron Aviation Senior Air Safety Investigator
Ricardo Asensio	Textron Aviation Air Safety Investigator
Jeff Davis	Pratt & Whitney Canada Investigator

The left hand powerplant investigation was performed on March 24, 2015 at the Pratt & Whitney Canada (P&WC) Service Investigation Facilities at Bridgeport, West Virginia, USA. The following individuals participated in the investigation as representatives of their respective organisations:

Robert Hunsberger	National Transportation Safety Board (NTSB) Air Safety Investigator
Nathan Rohrbaugh	Federal Aviation Administration (FAA) Flight Data Analyst
Paul Yoos	Textron Aviation Senior Air Safety Investigator
Jeff Davis	Pratt & Whitney Canada Investigator



2.0 LEFT HAND ENGINE HISTORY

PT6A-65B Engine S/N 32138

Power Section S/N 32138

Hours Since New: 35561.44

Hours Since New: 34764.38

Cycles Since New: 47914

Cycles Since New: 46571

Hours Since Overhaul: 2330.56

Hours Since Overhaul: 2330.56

Cycles Since Overhaul: 2905

Cycles Since Overhaul: 2905

3.0 LEFT HAND 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 propeller shaft had been sectioned at the accident site to remove the propeller for examination (Ref. Photo No. 1). The propeller reversing lever was found above its respective guide pin that keeps the carbon block in the beta ring (Ref. Photos 1 to 3). There was a wear mark noted on the guide pin (Ref. Photo No. 2, red arrow). The four aircraft mounts were attached to their respective mount pads on the gas generator case but the rubber grommets were deteriorated from exposure to the post flight fire. The left hand exhaust stack was bent and the right hand exhaust stack and exhaust port flange were missing. The engine exhibited staining and some burnt regions from exposure to the post flight fire (Ref. Photos No. 4 to 7). The engine data plate showed the serial number was PC-E 32138 (Ref. Photo No. 8). The power section data plate showed the serial number was 32138 (Ref. Photo No. 9). Photo No. 10 shows an overview of the removed propeller.



Photo No. 1, The carbon block is missing (white arrow). The propeller reversing lever is above its respective guide pin (blue oval). Sectioned end of the propeller shaft (yellow arrow).



Photo No. 2

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Photo No. 3



Photo No. 4, Right hand side of the engine



Photo No. 5, Left hand side of the engine



Photo No. 6, Rear of the engine

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Photo No. 7, Front of the engine



Photo No. 8



Photo No. 9



Photo No. 10

3.1.1 External Cases

Reduction Gearbox: The gearbox housing was discoloured from exposure to the post flight fire and the scavenge oil tube boss was missing (Ref. Photo No. 11, red arrow). Several of the gearbox to the exhaust duct mating flange bolts were missing (Ref. Photo No. 12, red oval).

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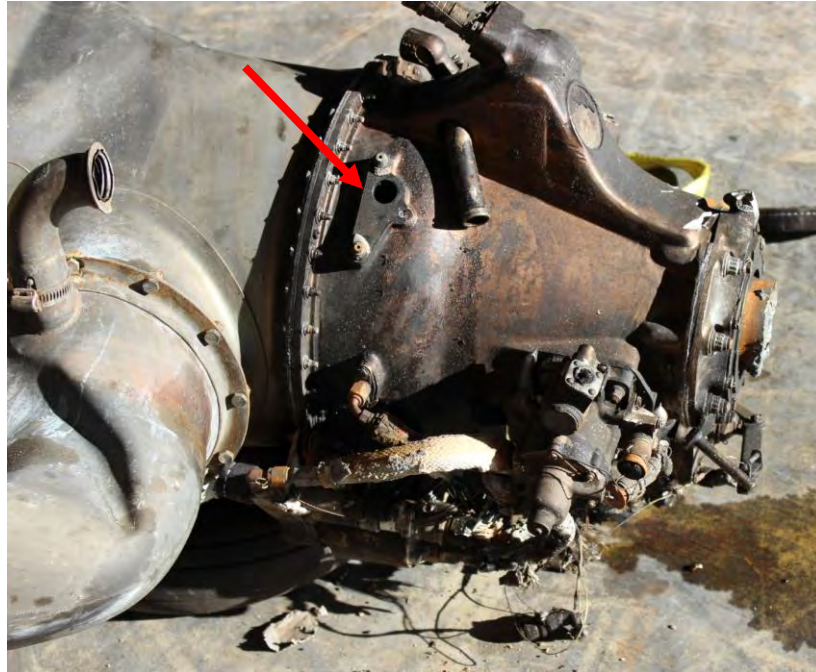


Photo No. 11

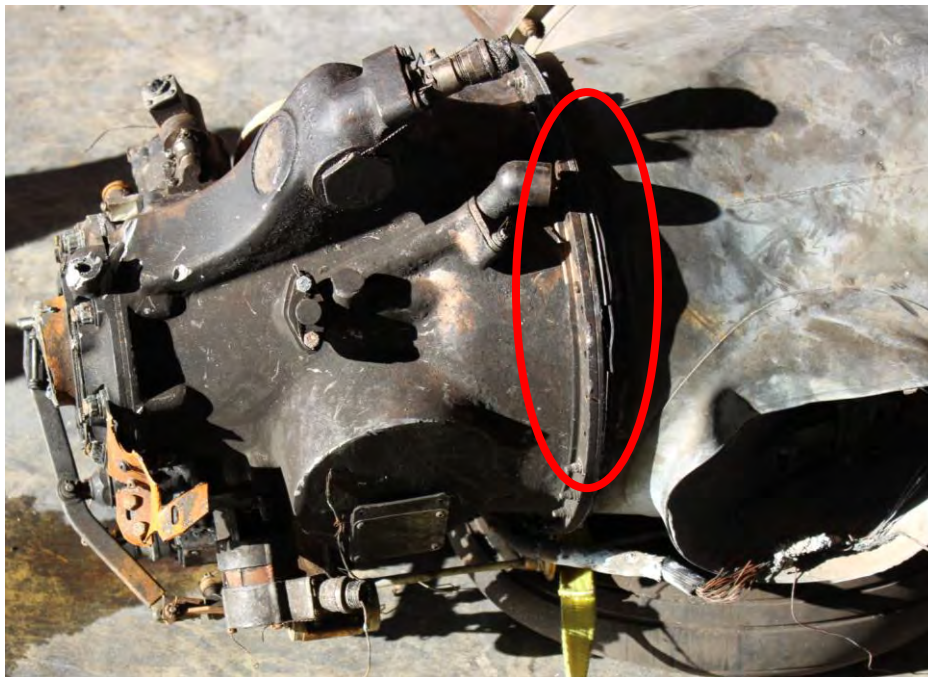


Photo No. 12



Exhaust Duct: The duct was bent and buckled mainly adjacent to the right exhaust port (Ref. Photo No. 13). The left exhaust stack was bent and buckled and the flange for the right hand exhaust stack was missing (Ref. Photos No. 14 & 15). Several of the exhaust duct to the gas generator mating flange bolts were missing (Ref. Photo No. 15, red oval).



Photo No. 13



Photo No. 14



Photo No. 15



Gas Generator Case: The case exhibited compressional bending and external heat distress from exposure to the post flight fire (Ref. Photos No. 16 & 17).



Photo No. 16



Photo No. 17



Accessory Gearbox: The exterior of the gearbox was blackened (Ref. Photos No. 18 & 19) and the inlet case exhibited some localized burning from exposure to the post flight fire (Ref. Photo No. 20).



Photo No. 18



Photo No. 19

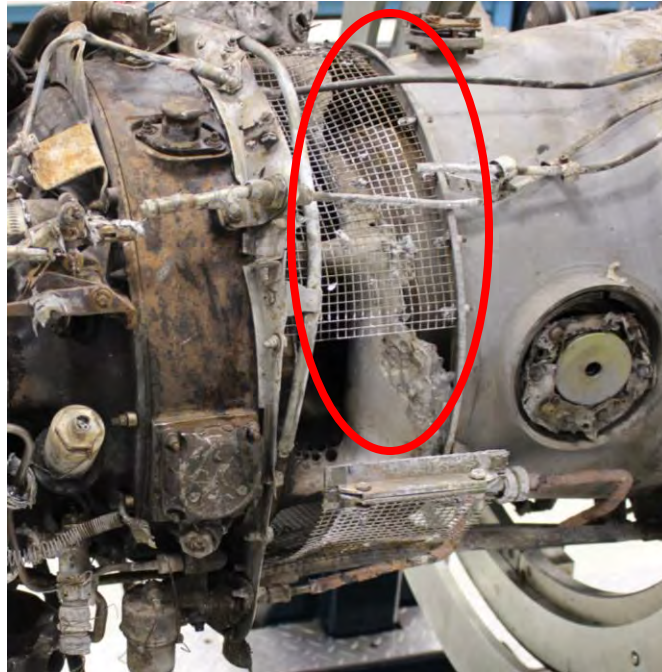


Photo No. 20

- 3.1.2 **Power Control and Reversing Linkage:** The propeller speed control actuating arm was missing from the propeller governor (Ref. Photo No. 21, red arrow). The front linkage was complete and secure (Ref. Photo No. 21). The propeller reversing lever was above the guide pin (Ref. Photo No. 21, red oval). The correct orientation for the guide pin and reversing lever is shown in Figure 1. The lever sustained some cutting damage during the sectioning of the propeller shaft. The guide pin and reversing lever were forwarded to P&WC Accessories Investigation and Material Laboratory for additional analysis.

Photo No. 22 shows an overview of the propeller reversing lever and guide pin. The guide pin exhibited a shiny contact wear area indicating the propeller reversing lever had recently been properly seated against the underside of the pin (Ref. Photo No. 23, green rectangle). The width of the worn area corresponds to the width of the lever. An intermittent wear mark extending from the normal contact area to the forward tip of the pin indicating that the lever slid forcefully in a non-continuous manner from the underside of the pin across to its top side (Ref. Photo No. 23, red arrows). Scanning Electron Microscope (SEM)-Energy Dispersive X-Ray Spectrometry (EDS) analysis of debris recovered from the red dash outlined region in Photo No. 23 were Cadmium which suggest the debris originated from the Cadmium plated lever. A magnified view of the top side of the pin shows a continuous wear mark suggesting a continuous sliding movement (Ref. Photo No. 24, red arrows).



A magnified view of the top end of the propeller reversing lever shows evidence of contact damage on the aft edge of the lever (Ref. Photo No. 25). The shiny appearance of the damage indicates that the damage is recent and is consistent with the lever being forcefully moved from the underside of the pin across to its top side, most likely during the propeller removal process. In the normal position, this side of the lever is in contact with the underside of the guide pin. The groove depicted by the green rectangle, that exhibits a shiny appearance, indicates that it was seated correctly (Ref. Photo No. 25). A magnified view of the underside of the lever end shows slight contact damage along the edge (Ref. Photo No. 26, red rectangle). This portion of the lever was contacting the guide pin after the propeller was removed. The shiny appearance of the damage indicates that the damage is recent and was most likely created during the removal of the propeller. SEM/EDS analysis confirmed the presence of the Cadmium plated on the lever.

The wire rope casing was bent at several locations. The sleeve nut that connects to the clevis was fractured, adjacent to the CAM box (Ref. Photo No. 27, red arrow). The CAM box was fractured (Ref. Photo No. 27, green oval) and the connecting rod between the fuel control and the CAM box was bent (Ref. Photo No. 27, blue arrow). The aircraft cable to the fuel condition lever was connected but was pulled from its mounting bracket (Ref. Photo No. 27, yellow arrows). The CAM box input lever and airframe power lever cable were missing.

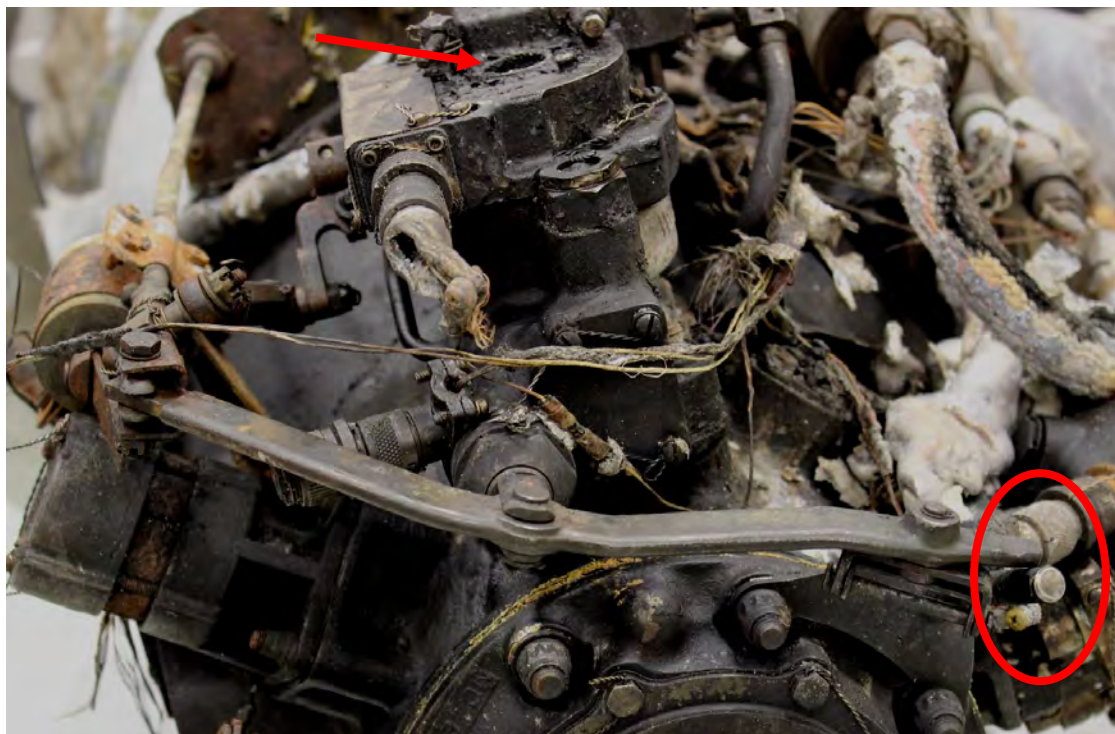


Photo No. 21

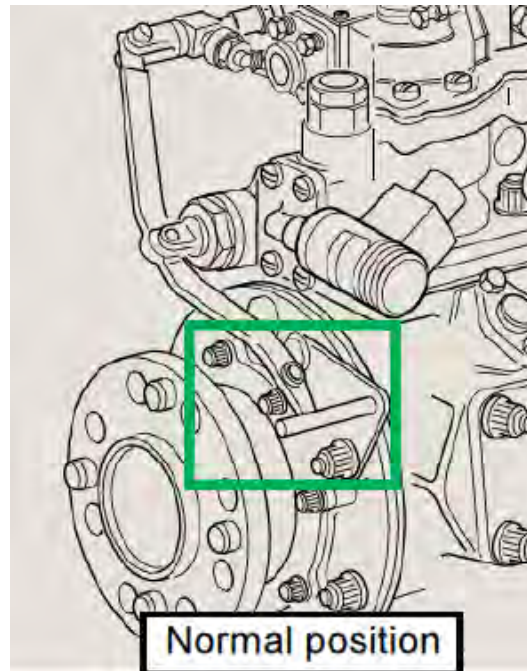


Figure 1



Photo No. 22

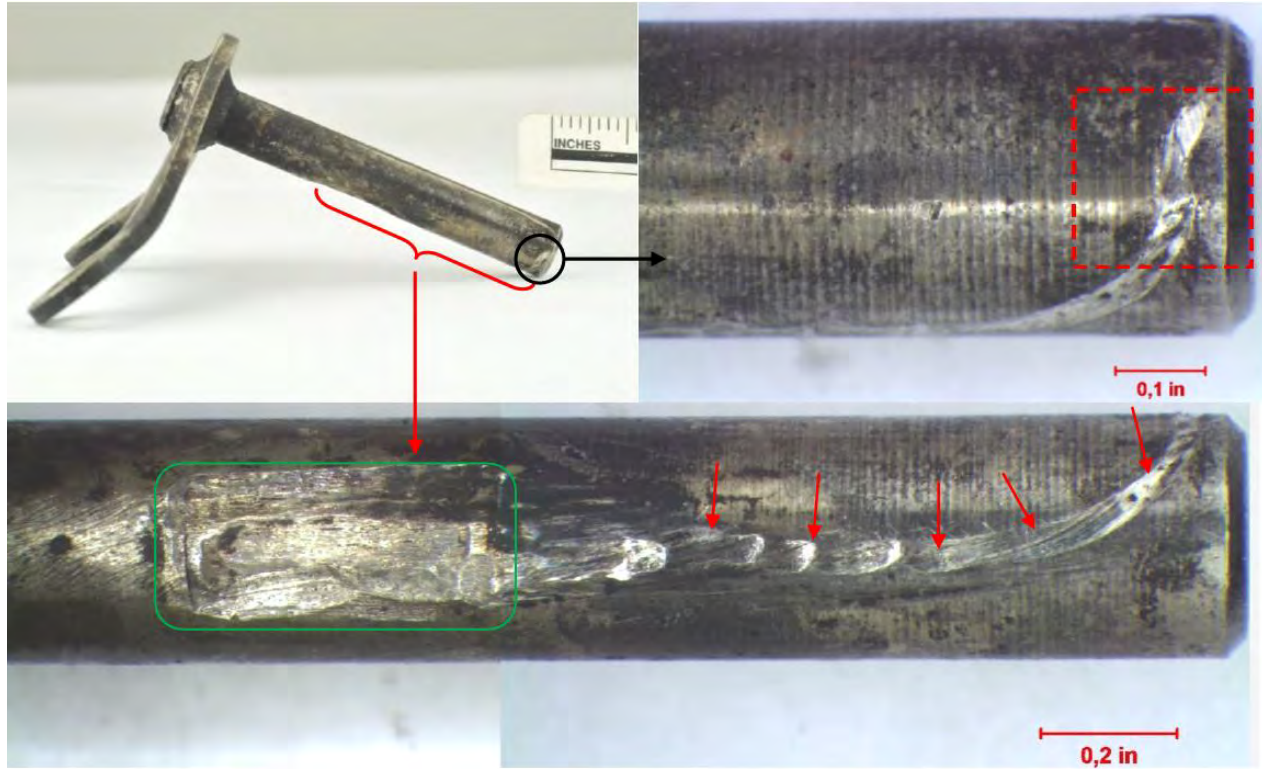


Photo No. 23

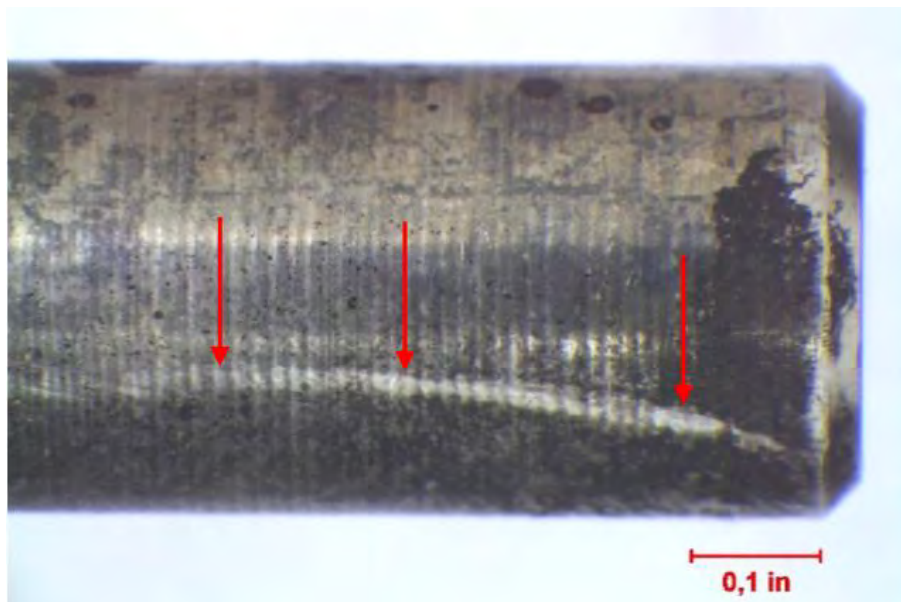


Photo No. 24

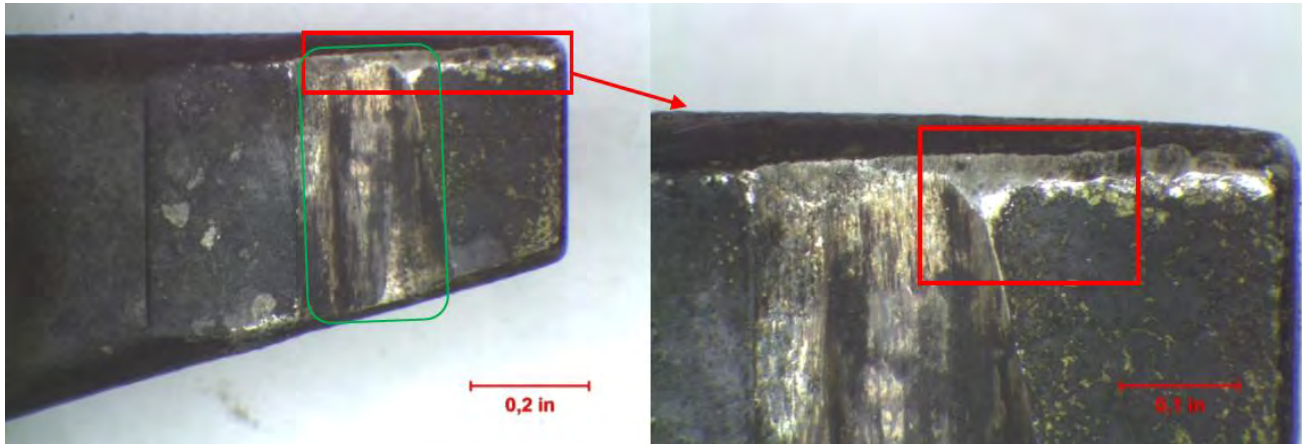


Photo No. 25

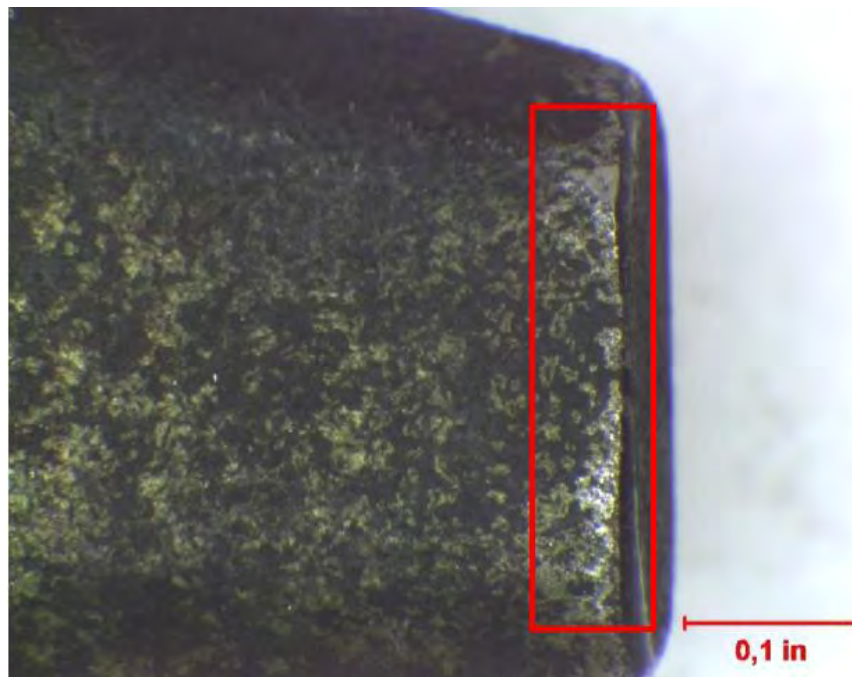


Photo No. 26

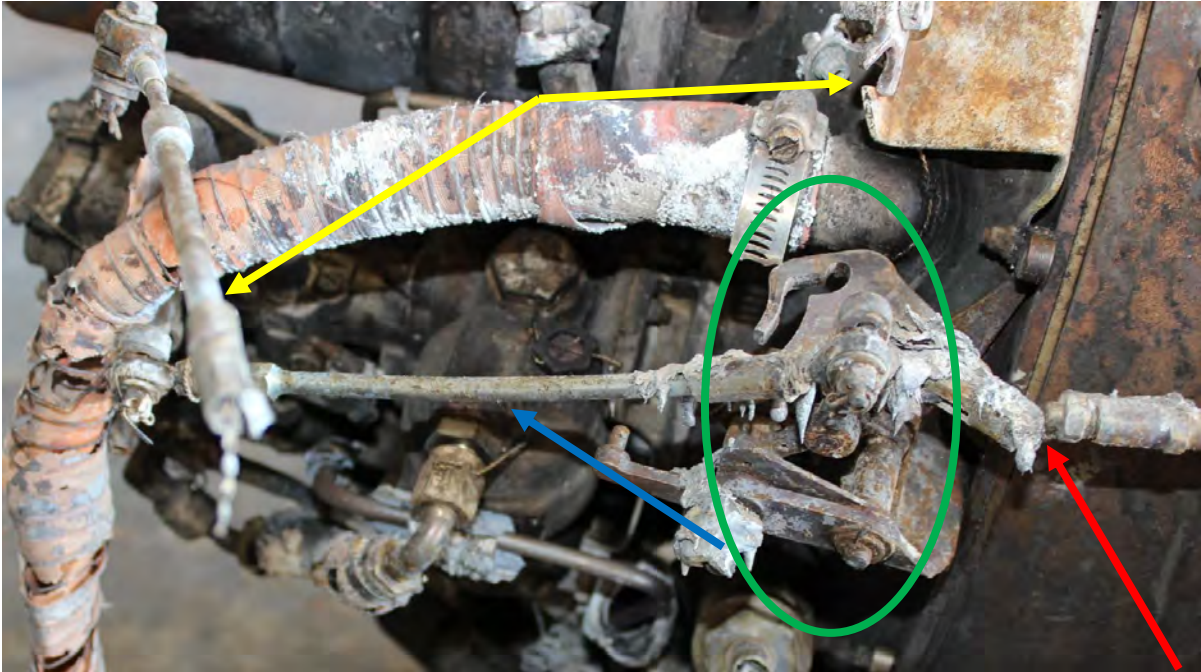


Photo No. 27

3.1.3 Pneumatic Lines

Compressor Discharge Air (P3): The tubes and filter housing were in place and secure. The thermal insulation was deteriorated from heat exposure from the post flight fire (Ref. Photo No. 28, red arrow). The P-3 air filter was discoloured, most likely due to heat exposure from the post flight fire (Ref. Photo No. 29).

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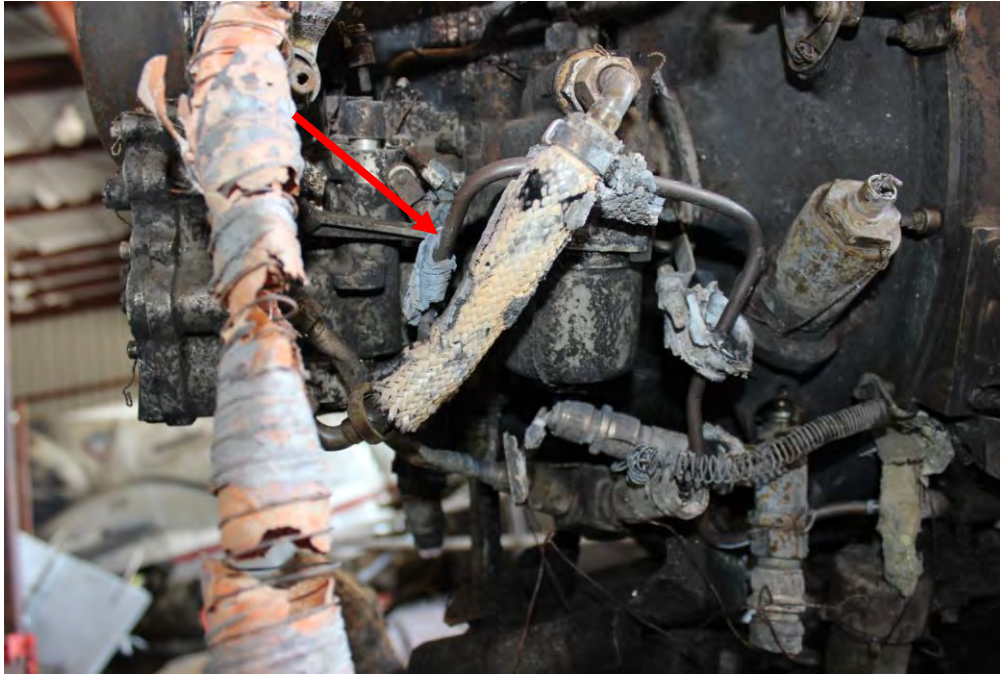


Photo No. 28

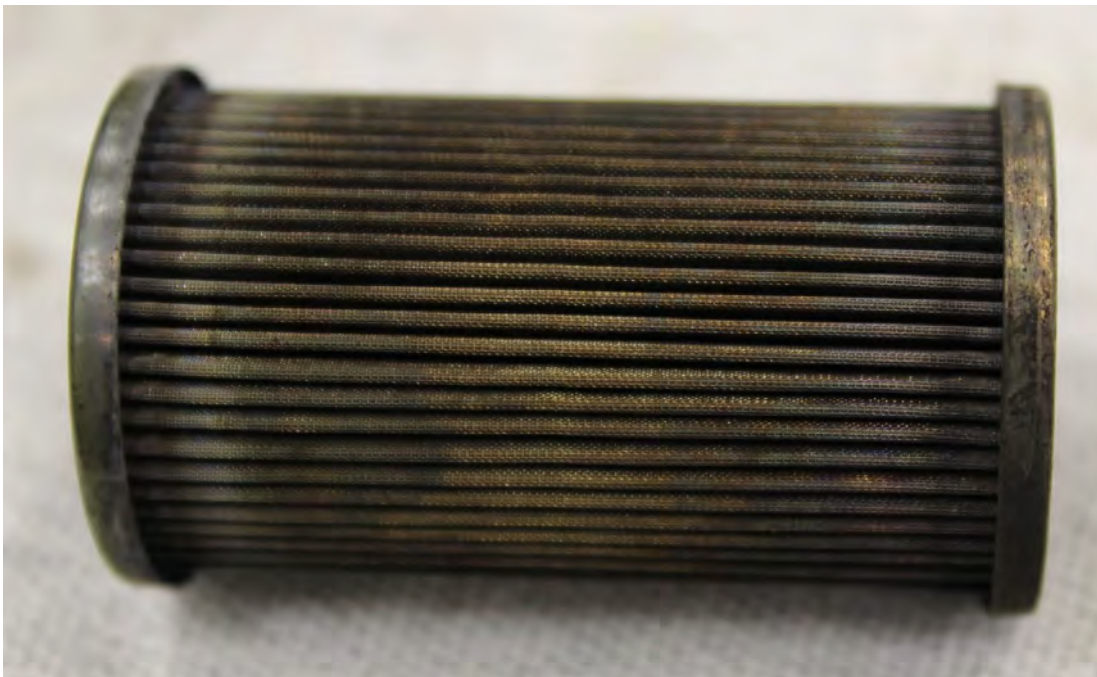


Photo No. 29



Power Turbine Control (Py): The line was in place and secure. The line was bent adjacent to the accessory gearbox and the inlet case (Ref. Photo No. 30, red arrow).

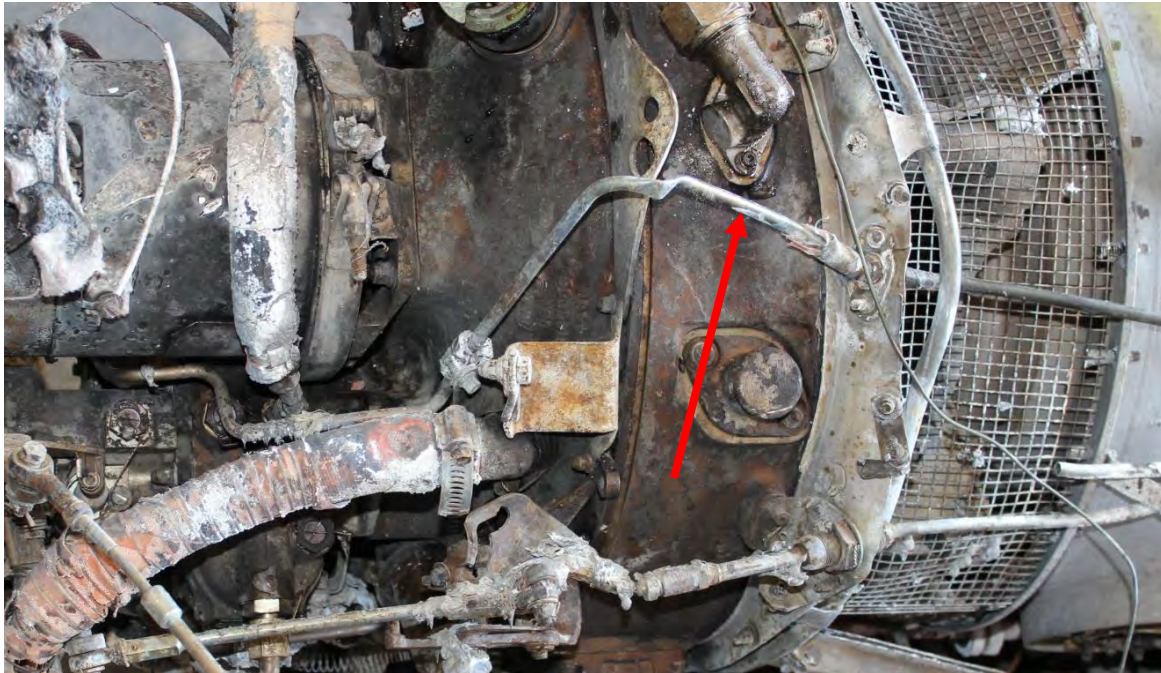


Photo No. 30

3.1.4 Chip Detectors and Filters

Reduction Gearbox Chip Detector: The detector was in place and secure. The potting material around the magnetic poles was swelled from heat exposure from the post flight fire (Ref. Photo No. 31, red arrow).



Photo No. 31

Oil Filter: The filter was clean but emitted an acrid smell (Ref. Photo No. 32).



Photo No. 32

Fuel Filter: The filter was burned, blackened, and deteriorating due to heat exposure from the post flight fire (Ref. Photo No. 33, red arrow).



Photo No. 33

3.2 Disassembly Observations

3.2.1 Compressor Section

Compressor 1st, 2nd, 3rd, and 4th Stage Discs and Blades: The compressor was not capable of rotation. The compressor was removed from the gas generator case and placed on the disassembly fixture (Ref. Photo No. 34). The compressor stators were manipulated by hand and the stators rotated freely on the stationary rotor components. The 1st stage was coated with soot and debris (Ref. Photo No. 35 to 38). The blades had rubbed with the 1st stage shroud. Portions of the 2nd stage blade were viewed through the 1st stage stator airfoils and were coated with soot. The 2nd, 3rd, and 4th stage discs and blades were not accessed for the purposes of this investigation.



Photo No. 34



Photo No. 35



Photo No. 36



Photo No. 37



Photo No. 38

Compressor 1st, 2nd, 3rd, and 4th Stage Stators and Shrouds: The 1st stage shroud and stator exhibited soot and debris build-up (Ref. Photos No. 39 & 40). Static imprint marks from the 1st stage blades were evident in the shrouds protective coating (Ref. Photo No. 40, red arrow). The imprint marks may be attributed to thermal expansion of the stator/rotor during the post flight fire or may have occurred during recovery of the engine. The 2nd, 3rd, and 4th stage shrouds and stators were not accessed for the purposes of this investigation.

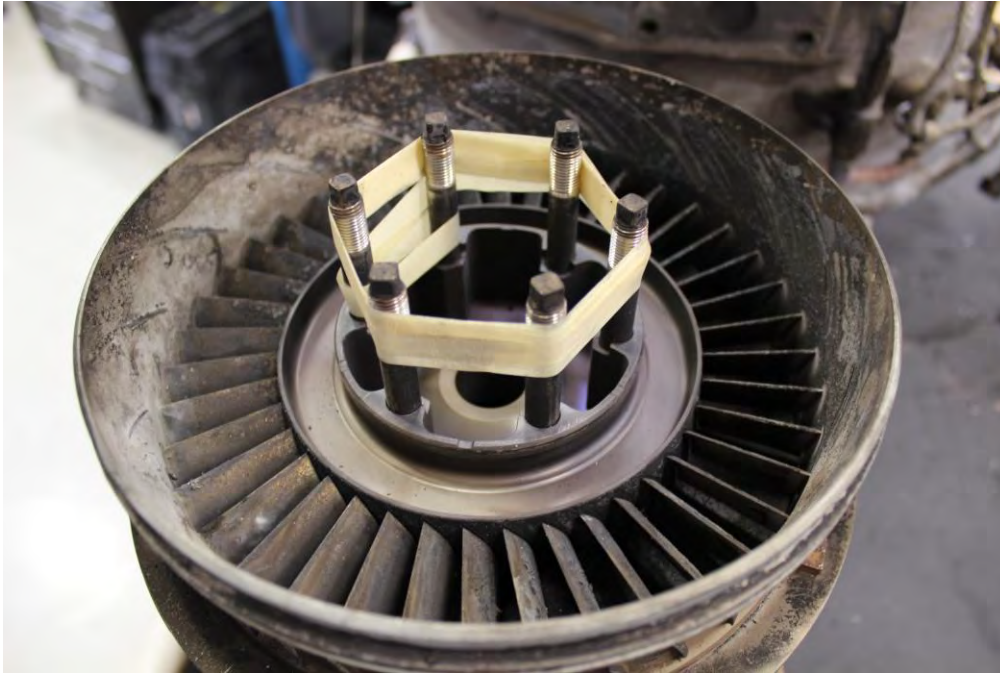


Photo No. 39



Photo No. 40



Compressor 1st, 2nd, 3rd, and 4th Stage Spacers: The gas path surface of the 1st stage spacer was coated with soot and debris (Ref. Photo No. 41, red arrow). The spacers were not removed for the purposes of this investigation.

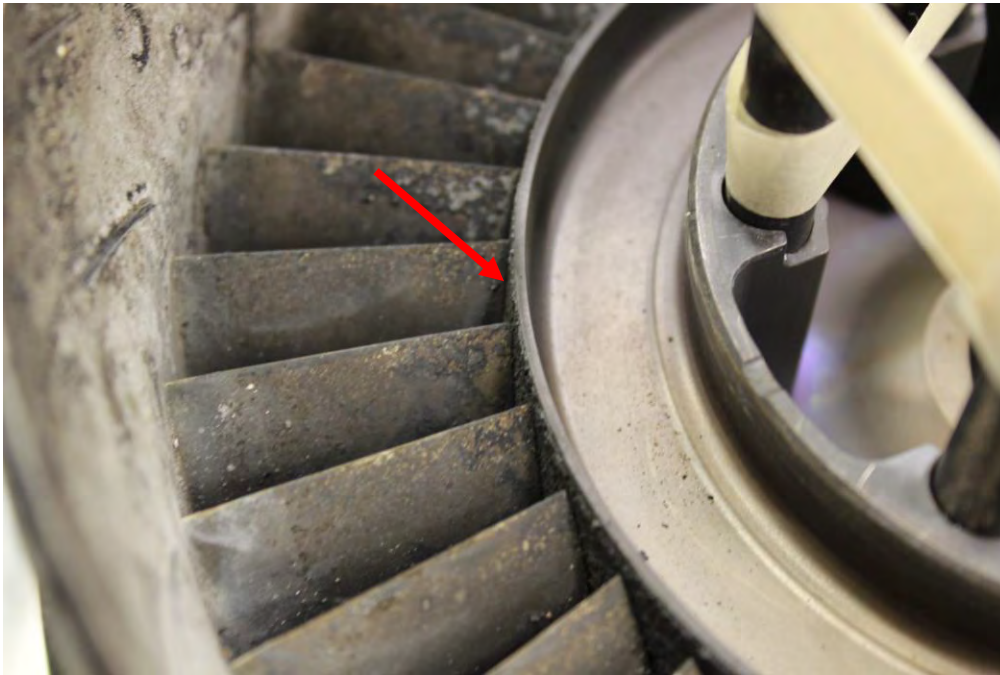


Photo No. 41

Centrifugal Impeller: Light debris was noted on the upstream side of the impeller (Ref. Photo No. 42). No distress was noted on the visible portions of the impeller. The impeller was not removed for the purposes of this investigation.



Photo No. 42

Centrifugal Impeller Shroud: The shroud was not accessed for the purposes of this investigation.

Front Stub Shaft: The stubshaft was in place and secure.

No. 1 Bearing and Airseals: The No. 1 bearing was oil wetted and rotated freely (Ref. Photo No. 43). The airseals did not exhibit any distress (Ref. Photo No. 44).



Photo No. 43



Photo No. 44



No. 2 Bearing and Airseals: The bearing was oil wetted and rotated freely. The airseals exhibited light rotation scoring (Ref. Photo No. 45, red arrow).



Photo No. 45

3.2.2 Combustion Section

Combustion Chamber Liner: The liners exhibited some operational staining but did not exhibit any anomalies (Ref. Photo No. 46, inner liner & 47, outer liner). The outer liner was not removed for the purposes of this investigation.



Photo No. 46

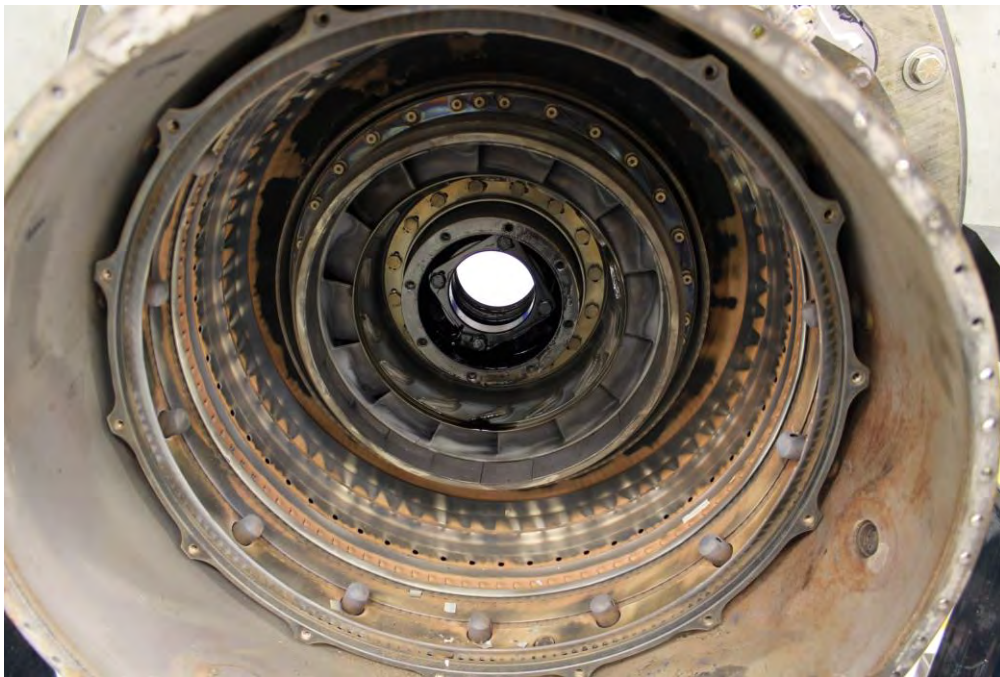


Photo No. 47



Small Exit Duct: The visible portion of the duct was unremarkable. The duct was not removed for the purposes of this investigation.

3.2.3 Turbine Section

Compressor Turbine Guide Vane Ring: The visible portion of the vane did not exhibit any distress but some staining was evident on the airfoils (Ref. Photos No. 48 & 49). The staining was most likely residue from incomplete fuel combustion.

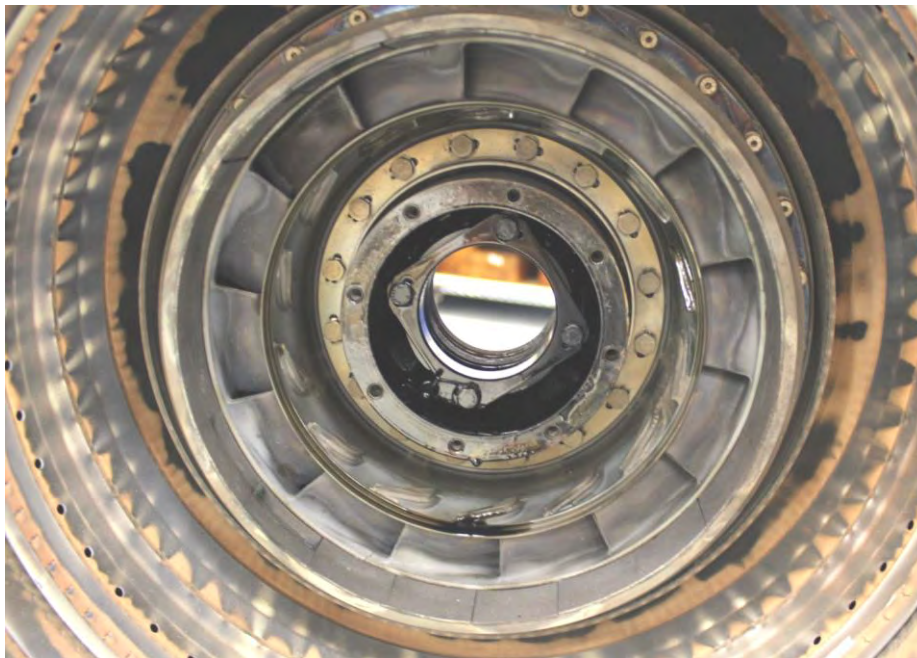


Photo No. 48, downstream side



Photo No. 49, downstream side

Compressor Turbine Shroud: The shroud was exhibited rubs from the 10 to 11 and from the 3 to 6 o'clock positions (Ref. Photos No. 50 & 51).



Photo No. 50



Photo No. 51

Compressor Turbine: The upstream side of the disc exhibited a stained region from a post impact oil leak from the turbine air seals (Ref. Photo No. 52 & 53). Some staining was evident on the upstream side of the blades (Ref. Photo No. 54). Several of the rivet flares and blade root firtrrees exhibited rub marks on the downstream side from contact the 1st stage power turbine vane and baffle (Ref. Photo's No. 55 to 57, red ovals). Staining was also evident on the downstream side of the blades (Ref. Photo No. 58). The blade tips were rubbed from contact with the compressor turbine shroud (Ref. Photo No. 59).



Photo No. 52, upstream side



Photo No. 53, upstream side



Photo No. 54, upstream side



Photo No. 55, downstream side

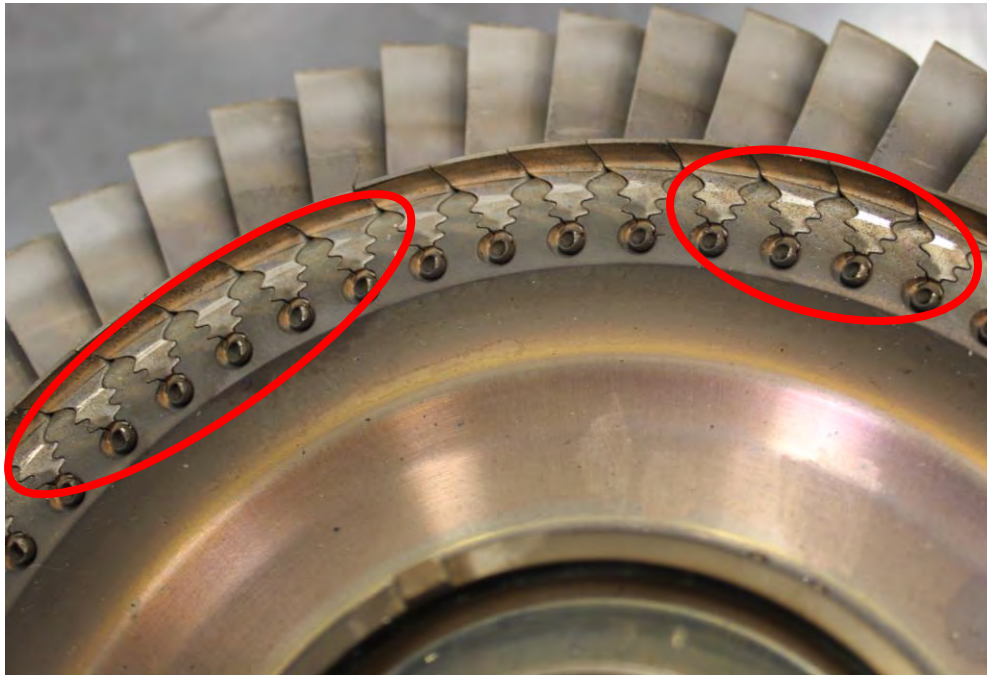


Photo No. 56, downstream side

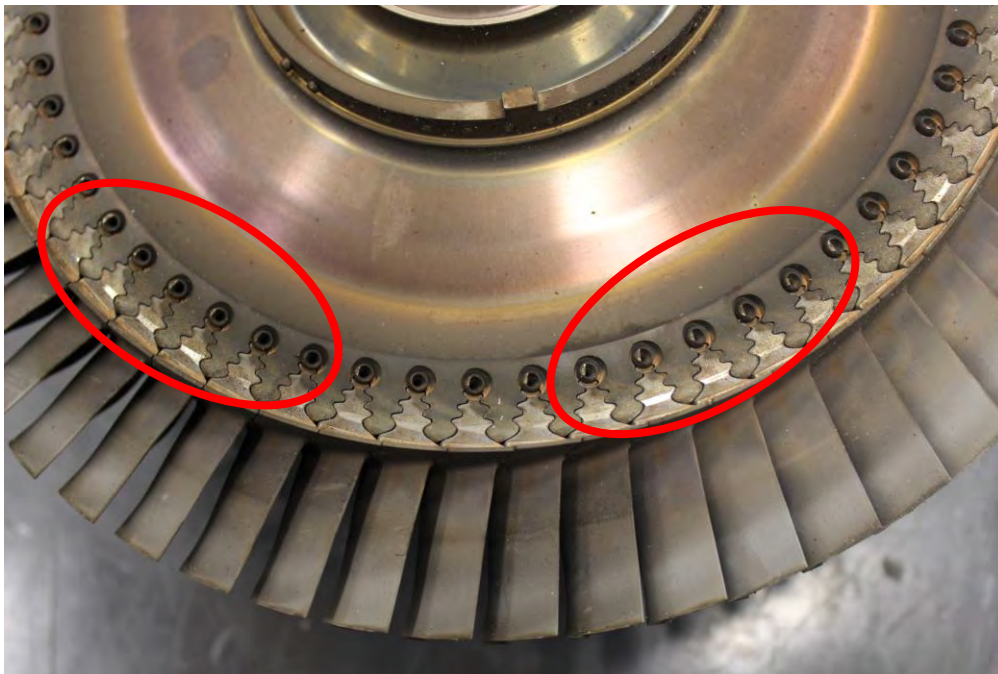


Photo No. 57, downstream side



Photo No. 58, downstream side



Photo No. 59



ITT Probes, Busbar, and Harness: All of the probes were in place and secure (Ref. Photo No. 60). One probe exhibited a burned region, most likely from operation (Ref. Photos No. 61, red arrow). The harness and busbar were in place and secure.



Photo No. 60

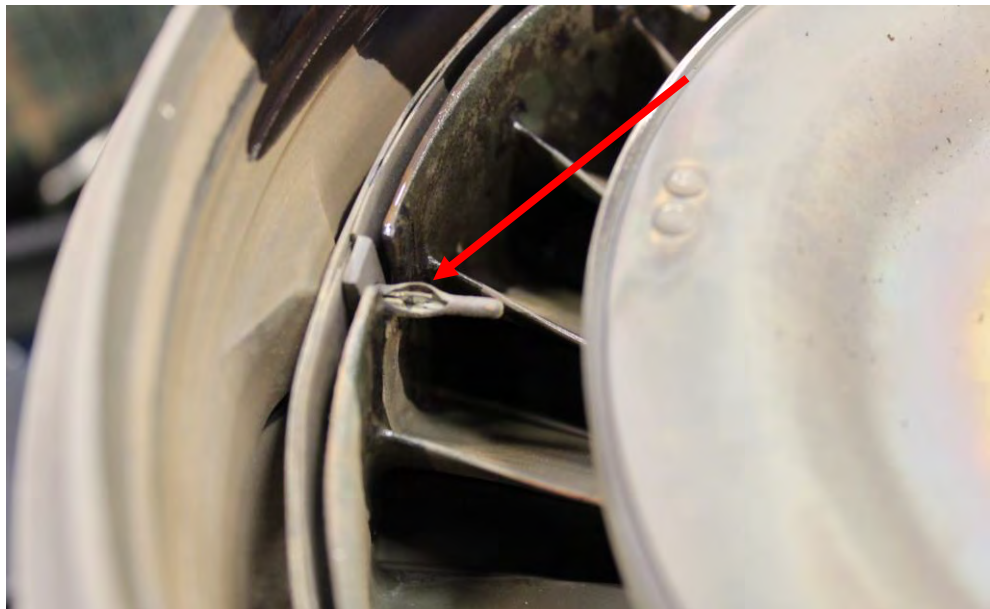


Photo No. 61



Power Turbine Housing: The housing was displaced rearward from its mating flange with the exhaust duct (Ref. Photos No. 62 & 63, red arrow).



Photo No. 62

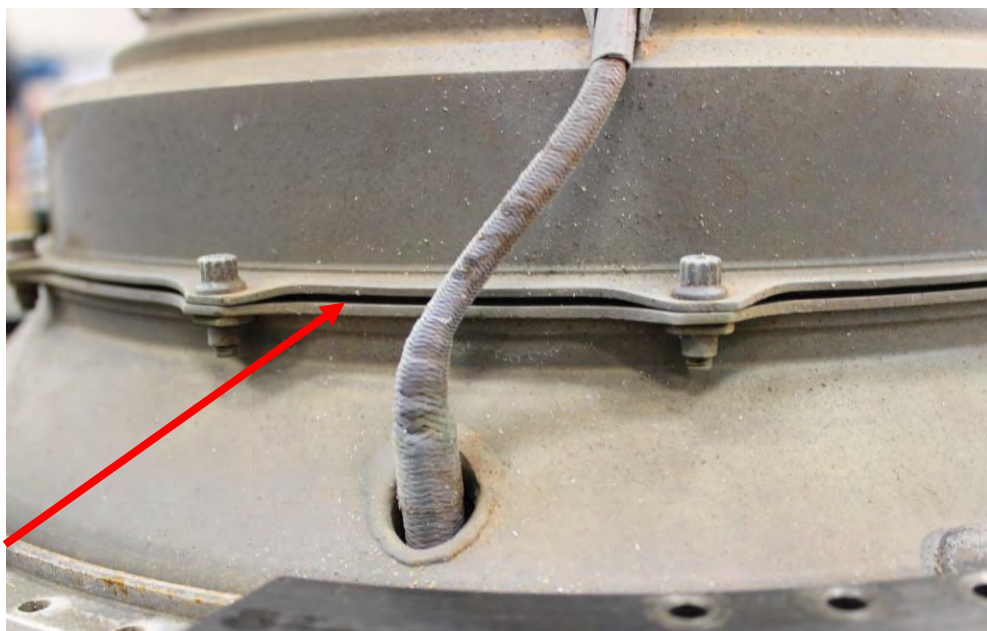


Photo No. 63



1st Stage Power Turbine Guide Vane Ring and Interstage Baffle: The centre of the baffle on the upstream side exhibited a rub from contact with the bolt bore of the compressor turbine disc (Ref. Photos No. 64 & 65, red arrow). The inner rim of the vane and the retention rivets for the baffle were rubbed from contact with the compressor turbine blades and retention rivets (Ref. Photos No. 65 & 66, blue arrows). The outer rim exhibited a crack extending from one of the thermocouple slots to the face (Ref. Photo No. 67). The airfoils were covered with soot, soil, and oil coated (Ref. Photo No. 68).



Photo No. 64, upstream side

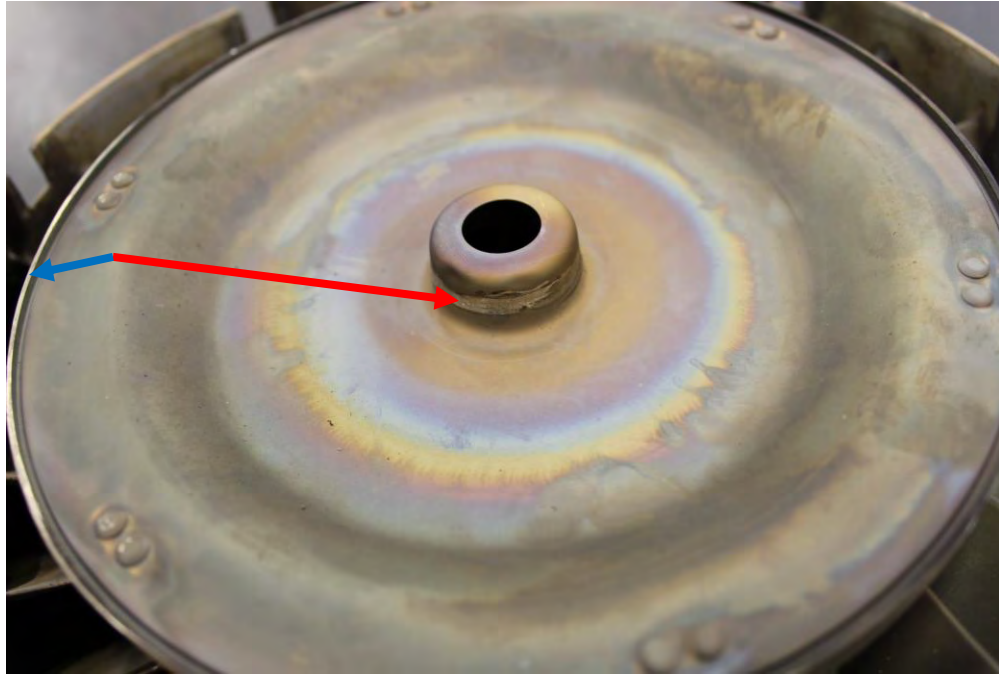


Photo No. 65, upstream side

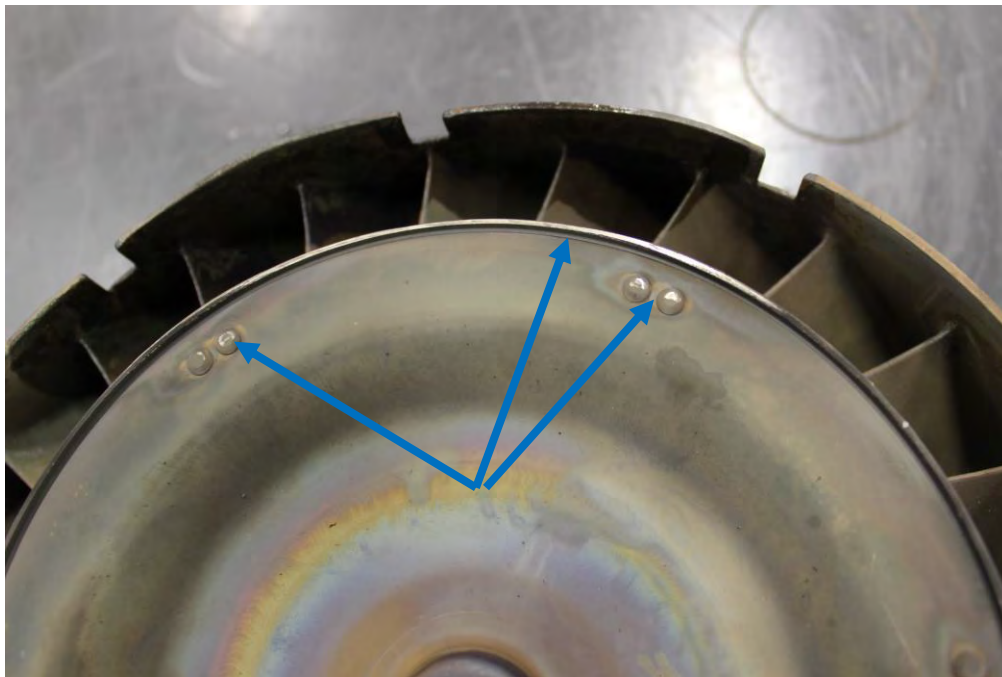


Photo No. 66, upstream side



Photo No. 67



Photo No. 68, downstream side



1st Stage Power Turbine Shroud: The 1st stage shroud exhibited rubs from contact with 1st stage power turbine blades (Ref. Photo No. 69, red arrows).



Photo No. 69

1st Stage Power Turbine: The turbine was oil wetted in two regions, covered with soot and debris (Ref. Photos No. 70 & 72). A light rub was noted on upstream side of a few of the blade roots (Ref. Photo No. 71, red arrow). The blade tips exhibited rubs from contact with their respective shroud (Ref. Photo No. 73).



Photo No. 70, upstream side

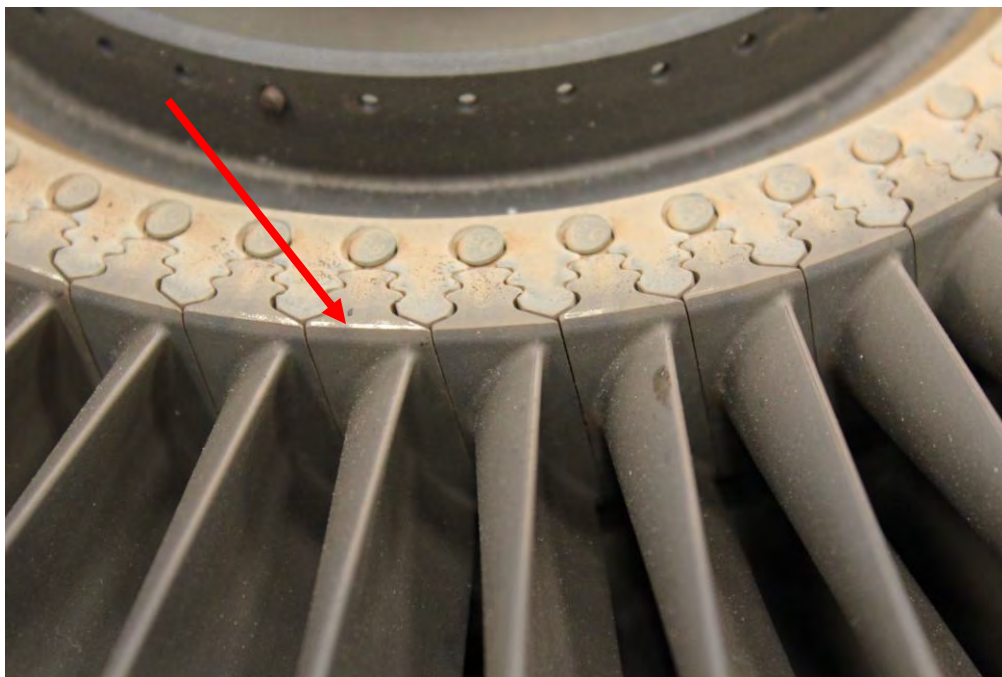


Photo No. 71, upstream side



Photo No. 72, downstream side

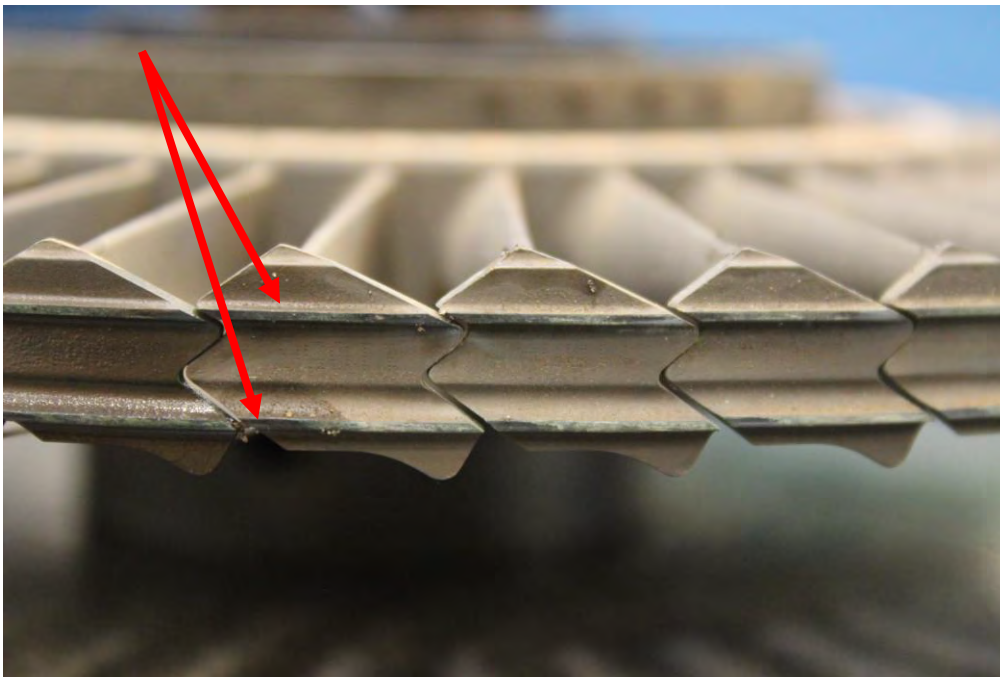


Photo No. 73



2nd Stage Power Turbine Guide Vane Ring: The vane was partially oil wetted and covered with soot and debris (Ref. Photos No. 74 & 75).



Photo No. 74, upstream side



Photo No. 75, downstream side



2nd Stage Power Turbine Shroud: The shroud exhibited rubs from contact with the 2nd stage turbine blade tips (Ref. Photo No. 76, red arrows).



Photo No. 76

2nd Stage Power Turbine: The vane was partially oil wetted and covered with soot and debris (Ref. Photos No. 77 & 78). The blade tips had rubbed against their respective shroud (Ref. Photo No. 79, red arrows).



Photo No. 77, upstream side



Photo No. 78, downstream side

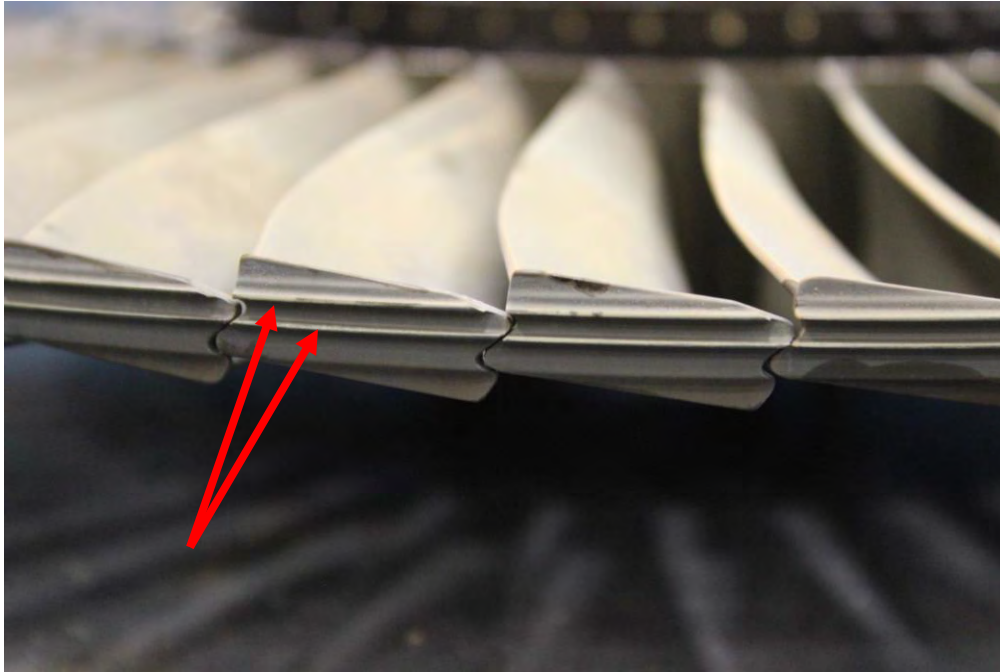


Photo No. 79

Power Turbine Shaft and Shaft Housing: The shaft and housing were not disassembled for the purposes of this investigation. The shaft, 1st stage carrier, No. 3, No. 4, and No. 5 bearings were rotated by hand and they rotated freely.

3.2.4 Reduction Gearbox

Rear Housing: The housing was coated with soot from exposure to the post flight fire (Ref. Photo No. 80). The rear reduction gearbox was not disassembled for the purposes of this investigation. The No. 6, No. 7, propeller shaft, and 2nd stage carrier were not capable of rotation in the gearbox housing. The visible section of the interior of the housing that was above the residual oil level was stained (Ref. Photo No. 82).



Photo No. 80

1st Stage Sun gear: The gear was not accessed for the purposes of this investigation.

1st Stage Planet Gear Carrier: The visible portions of the carrier were in good condition (Ref. Photo No. 81, red arrow). Some staining was evident on the region of the carrier that was above the residual oil level in the gearbox. The staining is a residue from the heated residual oil during the post flight fire.

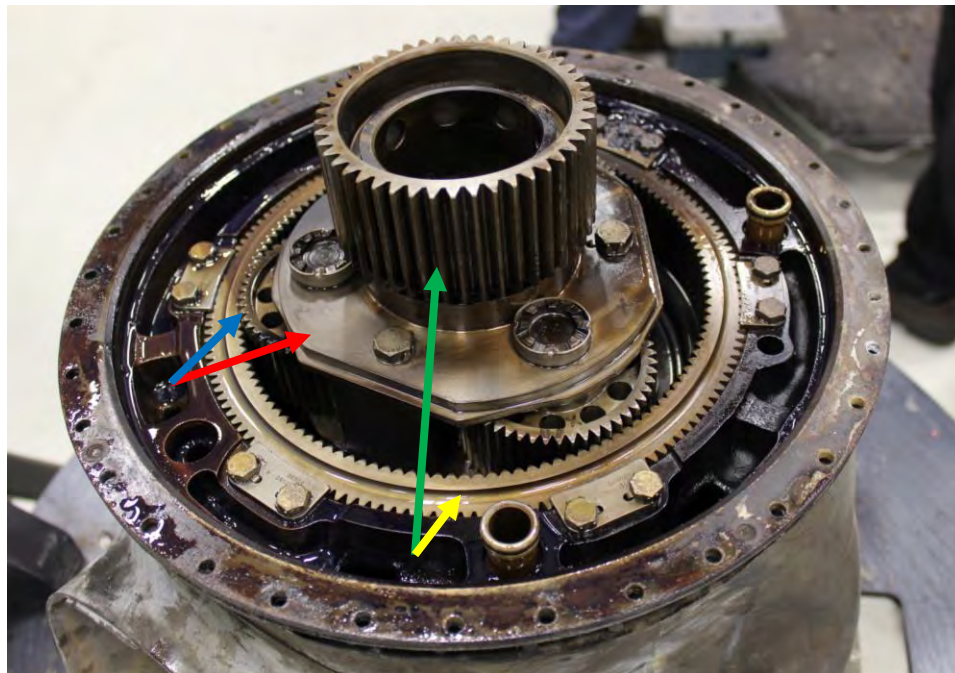


Photo No. 81

1st Stage Planet Gears: The visible portions of the gears were in good condition (Ref. Photo No. 81, blue arrow). The gears were capable of manual rotation with the ring gear.

1st Stage Ring Gear: The visible portion of the gear was in good condition (Ref. Photo No. 81, yellow arrow). Some staining was evident on the region of the gear that was above the residual oil level in the gearbox. The staining is a residue from the heated residual oil during the post flight fire.

Torque Meter: The gear was not accessed for the purposes of this investigation.

2nd Stage Sun Gear and Flex Coupling: The gear and coupling were in place and secure (Ref. Photo No. 81, green arrow).

2nd Stage Planet Gear Carrier: The visible portion of the carrier was in good condition. Staining was evident on one gear that was above the residual oil level in the gearbox (Ref. Photo No. 82, red arrow). The staining is a residue from the heated residual oil during the post flight fire.

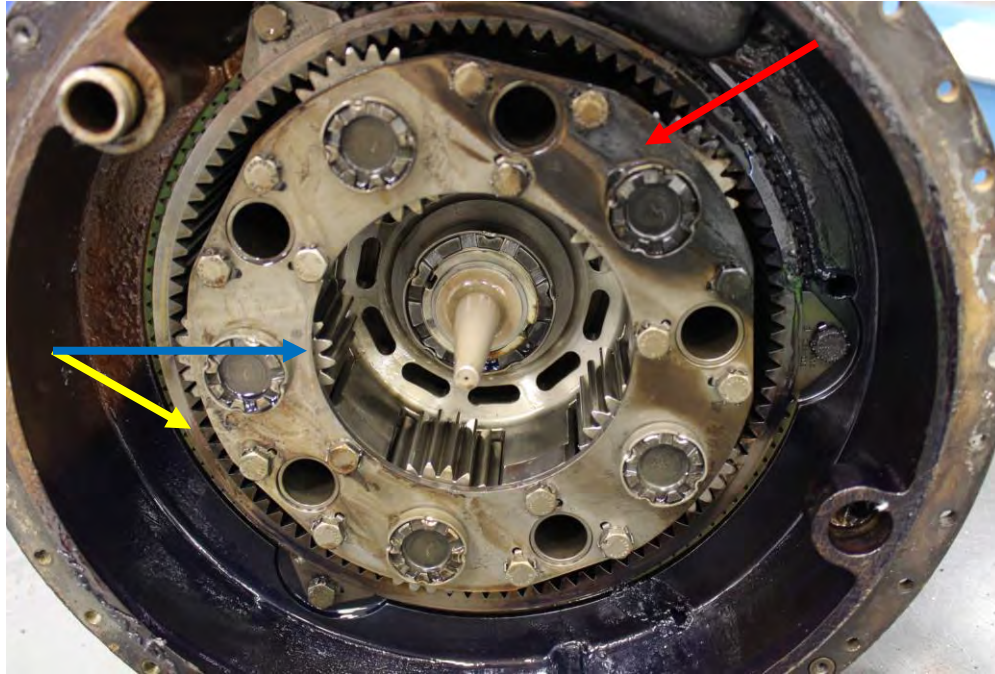


Photo No. 82

2nd Stage Planet Gears: The visible portions of the gears were in good condition (Ref. Photo No. 82, blue arrow). Staining was evident on the gears that were above the residual oil level in the gearbox. The staining is a residue from the heated residual oil during the post flight fire.

2nd Stage Ring Gear: The gear was not removed for the purposes of this investigation. The portion of the gear that was above the residual oil level in the gearbox exhibited staining (Ref. Photo No. 82, yellow arrow). The staining is a residue from the heated residual oil during the post flight fire.

No. 5 Bearing: The bearing was not accessed for the purposes of this investigation. The bearing was capable of rotation within the rear reduction gearbox.

Propeller Shaft: The shaft was sectioned to remove the propeller. The shaft was not capable of rotation in the front reduction gearbox. The shaft was not accessed for the purposes of this investigation.

No. 6 and 7 Bearings: The bearings were not accessed for the purposes of this investigation. The bearings would not rotate within the front reduction gearbox.



Forward Housing: The housing was not disassembled for the purposes of this investigation. The visible portions of the housing exhibited staining above the residual oil level in the housing. The staining is a residue from the heated residual oil during the post flight fire.

3.2.5 **Accessory Gearbox:** The gearbox was not disassembled for the purposes of this investigation. The gearbox manually rotated and rotated freely. The external scavenge oil pumps were missing from their mounting pad on the gearbox (Ref. Photo No. 83, red arrow). Portions of the accessory gearbox diaphragm and the inlet case exhibited staining above the residual oil level in the tank (Ref. Photo No. 84). The staining is a residue from the heated residual oil during the post flight fire.

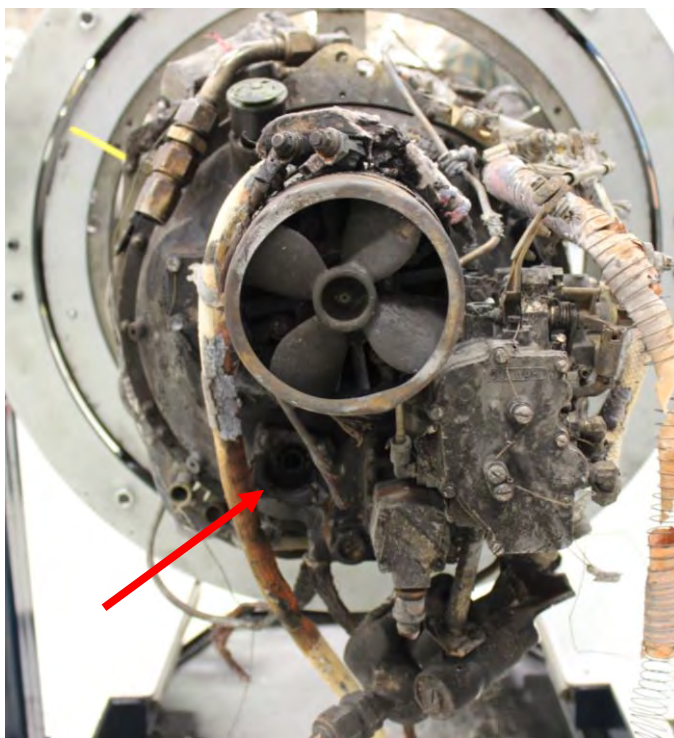


Photo No. 83



Photo No. 84

3.3 Controls and Accessories Evaluation

3.3.1 Ignition System

Exciter Box: The post flight fire had burnt the exterior of the box housing exposing the internal components (Ref. Photo No. 85).



Photo No. 85



Ignition Leads: One of the leads was fractured at the connection to the ignition plug (Ref. Photo No. 86, red arrow). The leads were in place and attached to the ignition box and the other plug.

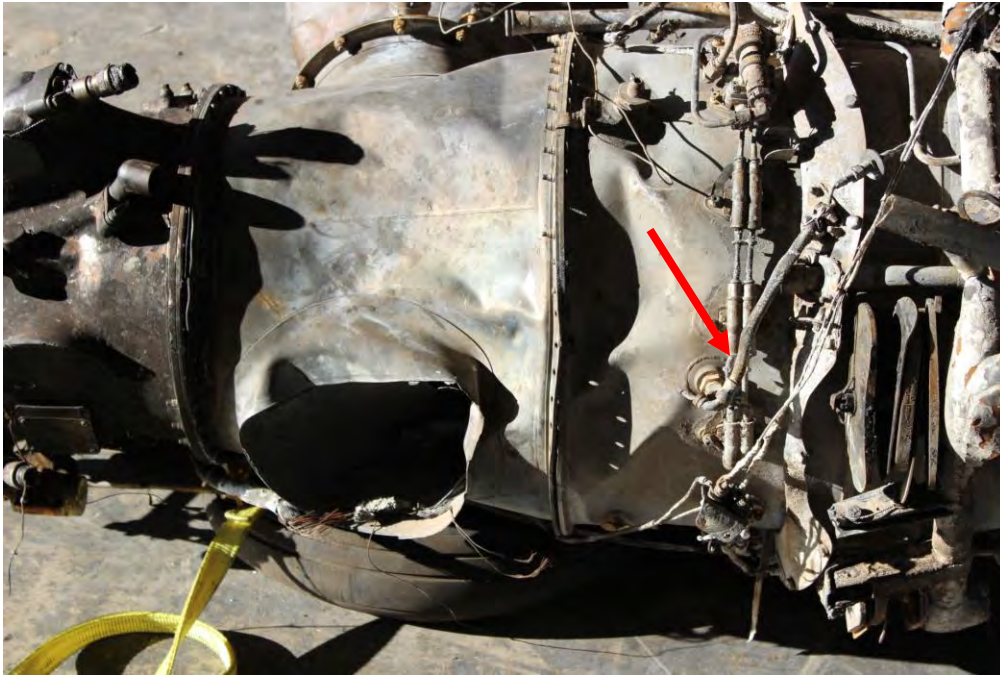


Photo No. 86

Ignition Plugs: The plugs were in place and secure.

3.3.2 Fuel System

Fuel Heater: The heater mounting bracket to the accessory gear box was fractured (Ref. Photo No. 87, red arrow). The exterior of the heater was coated with soot.



Photo No. 87

Fuel Pump: The pump was in place and secure (Ref. Photo No. 88, red arrow). The exterior of the pump was soot covered and exhibited some thermal damage from the post flight fire. The pump was forwarded to P&WC's Accessories Investigation for additional analysis. Due to the damage to the pump a functional test could not be performed. The outlet filter bowl required cutting to access the filter element. The filter was burned, blackened, and deteriorated due to heat exposure (Ref. Photo No. 89). The pump was disassembled. There was no evidence of cavitation of the gear pockets, on the gears or on the bearings. The packings and external fittings were heat-damaged. There were no defects or damage evident that would have prevented normal pump operation prior to the event.

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Photo No. 88



Photo No. 89



Fuel Control Unit: The unit was in place and secure. The exterior of the unit was blackened with some heat distortion noted from the post flight fire (Ref. photo No. 88, blue arrow). A section of the airframe cable was attached to the fuel condition lever. The unit was forwarded to P&WC's Accessories Investigation for additional analysis. The power and condition levers could not be moved by hand. A functional test of the control was attempted, however it could not be performed due to fuel leaks. The unit was disassembled. The condition of many of the components showed damage due to heat exposure in the post flight fire. There were no defects or damage evident that would have prevented normal unit operation prior to the event.

Flow Divider: The divider was in place and secure (Ref. Photo No. 90, red arrow). The exterior was discoloured with some melting evident from exposure to the post flight fire.

Fuel Nozzles: The nozzles were in place and secure (Ref. Photo No. 90, blue arrow). The nozzle exteriors were discoloured from exposure to the post flight fire. Several of the fuel nozzle transfer tubes were melted (Ref. Photo No. 90, yellow arrow).

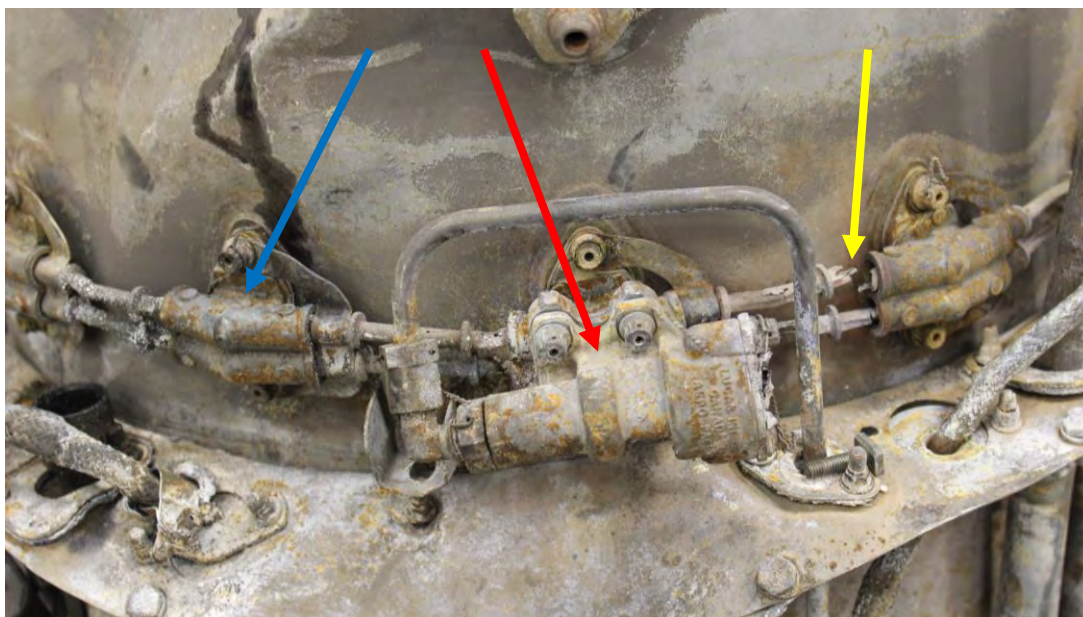


Photo No. 90

3.3.3 Air System:

Compressor Bleed Valve: The majority of the bleed valve housing was melted and burnt (Ref. Photo No. 91, red arrow).



Photo No. 91

3.3.4 Oil System:

Propeller Governor: The governor was in place and secure. The propeller speed control lever was missing (Ref. Photo No. 92, red arrow). The exterior of the governor was discoloured from exposure to the post flight fire. The beta valve clevis sustained some cutting damage during the sectioning of the propeller shaft. The governor was forwarded to P&WC's Accessories Investigation for additional analysis. Due to the damage to the governor a functional test could not be performed. The governor was disassembled. The reset lever and the beta valve were stuck. The internal components of the governor section were covered with burnt oil. The pump gears and housing appeared normal. There were no defects or damage evident that would have prevented normal operation of the governor prior to the event.



Photo No. 92

Overspeed Governor: The governor was in place and secure (Ref. Photo No. 93). The electrical connections were discoloured and melted from exposure to the post flight fire.



Photo No. 93



4.0 RIGHT HAND ENGINE HISTORY

PT6A-65B Engine S/N 32040

Power Section S/N 32065

Hours Since New: 39581.22

Hours Since New: 33254.42

Cycles Since New: 64526

Cycles Since New: 53479

Hours Since Overhaul: 3474.02

Hours Since Overhaul: 3474.02

Cycles Since Overhaul: 4640

Cycles Since Overhaul: 4640

5.0 RIGHT HAND 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.

- 5.1 **External Condition:** The propeller shaft had been sectioned at the accident site to remove the propeller for examination (Ref. Photo No. 94). The four aircraft mounts were attached to their respective mount pads on the gas generator case. Both of the exhaust stacks were bent and buckled. The right hand exhaust port was filled with dirt. The engine exhibited staining and some burnt regions from exposure to the post flight fire (Ref. Photos No. 95 to 97). The engine data plate showed the serial number was PC-E 32040 (Ref. Photo No. 98). The power section data plate showed the serial number was 32065 (Ref. Photo No. 99). Photos No. 100 and 101 show an overview of the removed propeller with chain link fencing from the accident site adhered to the mating flange of the propeller shaft.



Photo No. 94, View of the front of the engine



Photo No. 95, View of the right hand side of the engine

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Photo No. 96 View of the left hand side of the engine



Photo No. 97, View of the rear of the engine



Photo No. 98, View of the engine data plate



Photo No. 99, View of the power section data plate

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Photo No. 100



Photo No. 101



5.1.1 External Cases

Reduction Gearbox: The exterior of the front reduction gearbox housing was discoloured from exposure to the post flight fire. (Ref. Photo No. 102). The scavenge and the pressure oil tube adapters were missing.



Photo No. 102

Exhaust Duct: The duct exhibited torsional bending, with a large portion of the exterior surface discoloured from exposure to the post flight fire (Ref. Photo No. 103).



Photo No. 103

Gas Generator Case: The case was visually unremarkable except some discoloration from exposure to the post flight fire (Ref. Photo No. 104).



Photo No. 104



Accessory Gearbox: The paint on the gearbox was burnt off and the housing exhibited a burnt through area adjacent to a spur gear from exposure to the post flight fire (Ref. Photos No. 105 & 106).



Photo No. 105



Photo No. 106



5.1.2 Power Control and Reversing Linkage: The propeller reversing lever guide pin was in place and bent (Ref. Photo No. 107, red arrow). The pin sustained some damage during the sectioning of the propeller shaft. The propeller reversing lever was bent but was in place and secure (Ref. Photo No. 107, blue arrow). The lever sustained some cutting damage during the sectioning of the propeller shaft. The propeller speed control lever was missing from the governor (Ref. Photo No. 108, blue arrow). The reset interconnect rod was in place and secure but was uncoupled at the slip joint (Ref. Photo No. 108, red arrows). The linkage was complete and secure from the propeller reversing lever connection to the CAM box connection. The CAM box was in place and all of the engine connections were in place and secure (Ref. Photo No. 109). The CAM box input lever and airframe power lever cable were missing. The interconnect rod between the CAM box and the fuel control unit (FCU) was in place and secure (Ref. Photo No. 109). The arm and connection hardware to the FCU was bent. The aircraft cable to the fuel condition lever was in place and connected (Ref. Photo No. 110, red arrow). The cable was severed adjacent to its respective mount connected to the accessory gearbox flange.



Photo No. 107

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Photo No. 108



Photo No. 109



Photo No. 110

5.1.3 Pneumatic Lines

Compressor Discharge Air (P3): The tube from the gas generator case to the filter housing was in place and secure. The tube from the filter housing to the FCU was in place and secure. The tubes exhibited a loss of their external insulation from exposure to the post flight fire. The P-3 filter was removed. The filter exhibited some discoloration and staining from exposure to the post flight fire (Photo No. 111).



Photo No. 111



Power Turbine Control (Py): The tube from the propeller governor to the centre fire seal was in place and secure. The tube from the centre fire seal to the FCU was in place and secure. The hex nut for the FCU elbow was loose.

5.1.4 Chip Detectors and Filters

Reduction Gearbox Chip Detector: The chip detector was in place and secure. The detector was removed. Some carbon debris was noted on the magnetic poles. The rubber insulation around the poles was thermally expanded due to heat exposure from the post flight fire (Ref. Photo No. 112).



Photo No. 112

Oil Filter: The filter element exhibited no apparent contamination (Ref. Photo No. 113). The ends of the filter were loose due to heat exposure from the post flight fire affecting the adhesion compound. Partially solidified oil was adhered to the oil filter housing cover (Ref. Photo No. 114).

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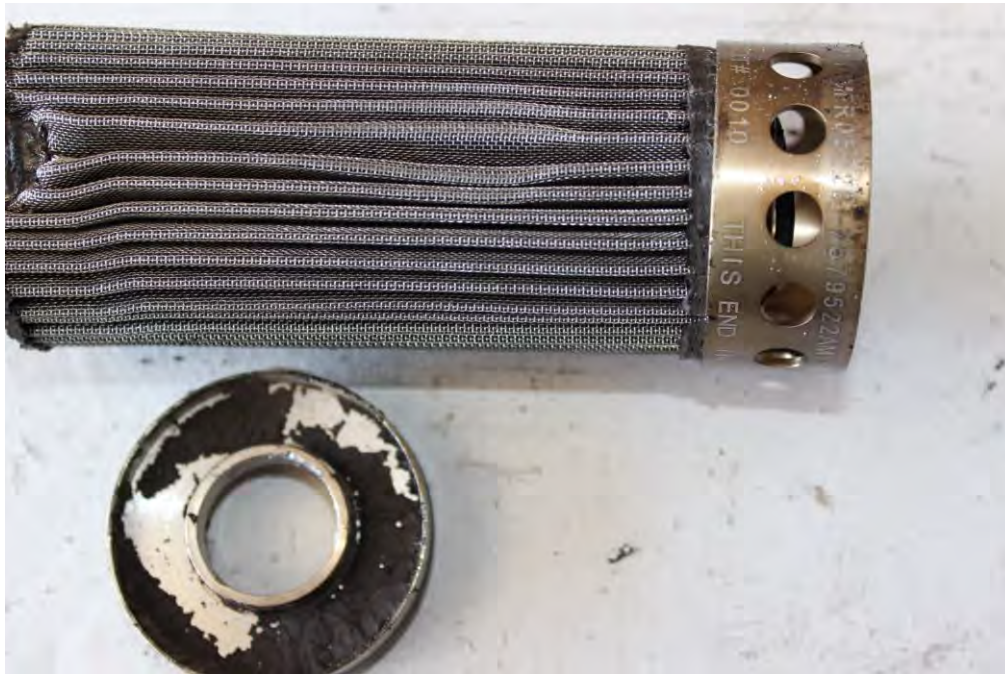


Photo No. 113



Photo No. 114

Fuel Filter: The fuel filter was not accessed for the purposes of this investigation. The filter housing threads were seized due to thermal distress from exposure to the post flight fire.



5.2 Disassembly Observations

5.2.1 Compressor Section

Compressor 1st, 2nd, 3rd, and 4th Stage Discs and Blades: The compressor was not accessed or disassembled for the purposes of this investigation. Mechanical continuity was evident from rotating the compressor turbine disk through the compressor and the accessory gearbox.

Compressor 1st, 2nd, 3rd, and 4th Stage Stators and Shrouds: The stators and shrouds were not accessed for the purposes of this investigation.

Compressor 1st, 2nd, 3rd, and 4th Stage Spacers: The spacers were not accessed for the purposes of this investigation.

Centrifugal Impeller: The impeller was not accessed for the purposes of this investigation.

Centrifugal Impeller Shroud: The shroud was not accessed for the purposes of this investigation.

Front Stub Shaft: The shaft was not accessed for the purposes of this investigation.

No. 1 Bearing and Airseals: The bearing and airseals were not accessed for the purposes of this investigation.

No. 2 Bearing and Airseals: The bearing and airseals were not accessed for the purposes of this investigation.

5.2.2 Combustion Section

Combustion Chamber Liner: The visible section of the liner was unremarkable.

Small Exit Duct: The duct was not accessed for the purposes of this investigation.

5.2.3 Turbine Section

Compressor Turbine Guide Vane Ring: The downstream side of the vane airfoils were in good condition (Ref. Photo No. 115). The outer wall of the vane was cracked adjacent to the trailing edge of most of the airfoils (Ref. Photo No. 116, red arrows).



Photo No. 115

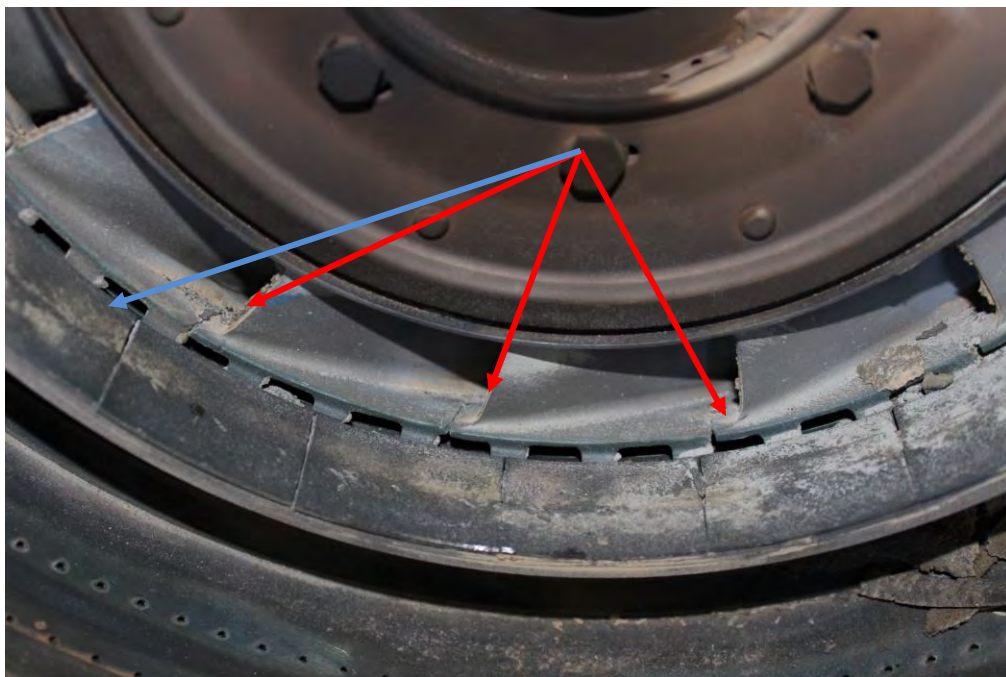


Photo No. 116



Compressor Turbine Shroud: The shroud was in good condition (Ref. Photo No. 116, blue arrow). Some debris that appeared to be partially melted sand had built up on the shroud (Ref. Photo No. 116).

Compressor Turbine: The downstream side of the disc lip adjacent to the retention bolt bore exhibited rubbing marks from contact with the 1st stage power turbine vane baffle (Ref. Photo No. 117 & 118, red arrow). The blade root region on the downstream face of the disc and blades displayed a rub from contact with the 1st stage power turbine vane (Ref. Photo No. 119 & 120). The upstream side of the disc was unremarkable (Ref. Photo No. 121). A build-up of sand and dirt was adhered to pressure side of the blades (Ref. Photo No. 122).



Photo No. 117, downstream side



Photo No. 118, downstream side



Photo No. 119, downstream side



Photo No. 120, downstream side



Photo No. 121, upstream side



Photo No. 122, upstream side

ITT Probes, Busbar, and Harness: The probes, the busbar, and the harness were unremarkable.

Power Turbine Housing: The housing was bent at the exhaust duct mating flange, a gap was evident adjacent to all of the housing retention bolts (Ref. Photos No. 123 & 124).



Photo No. 123



Photo No. 124



1st Stage Power Turbine Guide Vane Ring and Interstage Baffle: The upstream side of the vane exhibited a rub on the inner wall and on the baffle from rubbing with the compressor turbine disc and blades (Ref. Photos No. 125 to 127, red arrows). The downstream side of the vane and baffle exhibited rubs from contact with the 1st stage power turbine disc and blades (Ref. Photos No. 128 & 129, red arrows).



Photo No. 125, upstream side

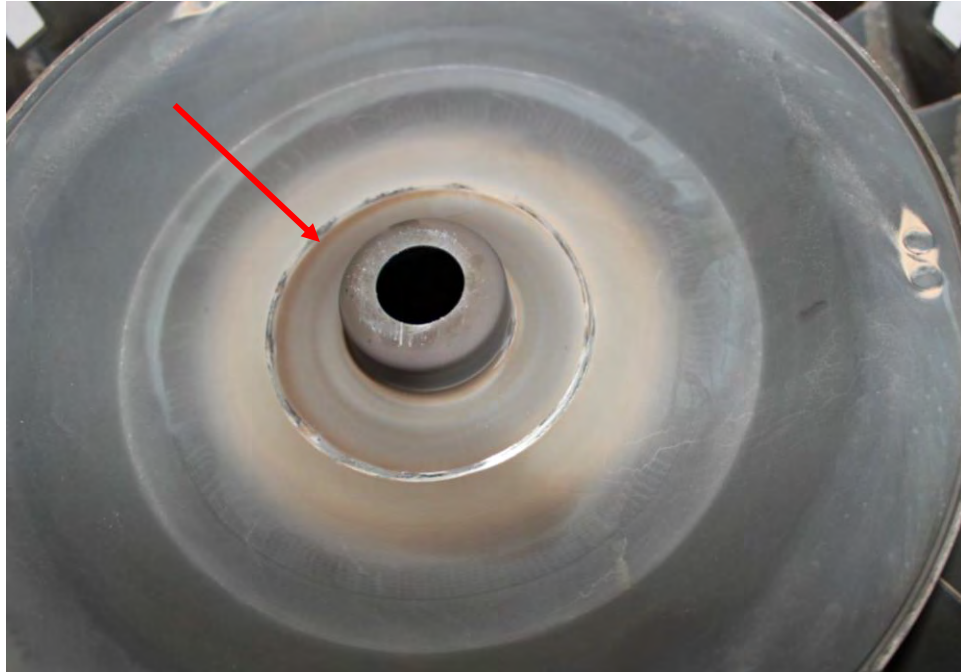


Photo No. 126, upstream side



Photo No. 127, upstream side



Photo No. 128, downstream side

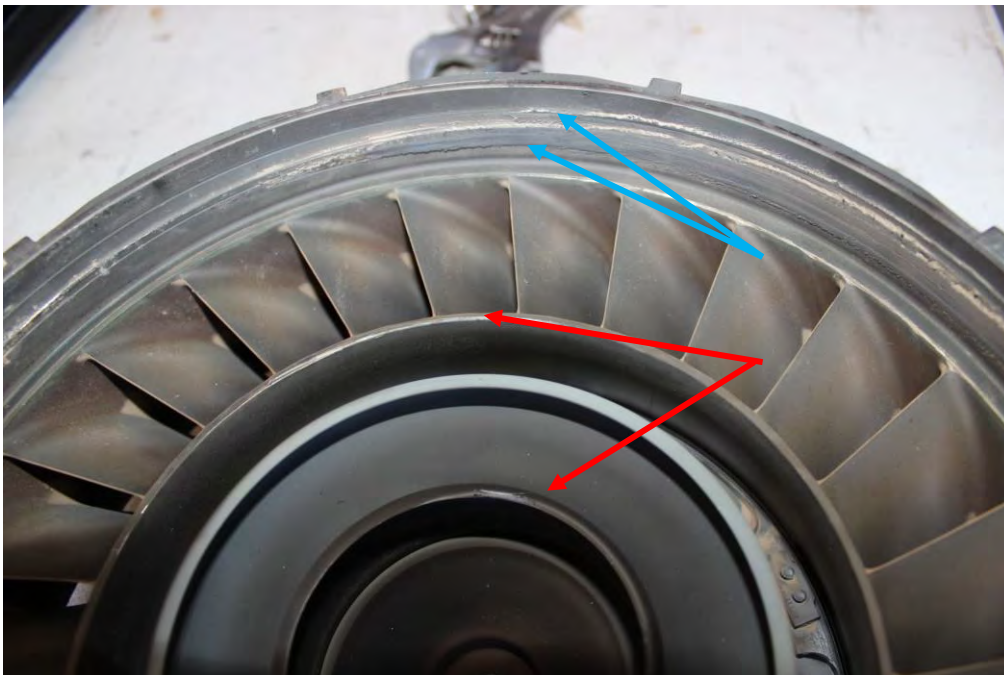


Photo No. 129, downstream side



1st Stage Power Turbine Shroud: Both lands of the shroud exhibited rubs and material build up from contact with the 1st stage power turbine blades tips (Ref. Photo No. 129, blue arrows).

1st Stage Power Turbine: The turbine blades exhibited a tip rub on both lands from contact with the 1st stage power turbine shroud (Ref. Photos No. 130 & 131, red arrows). The upstream side of the disc had rubbed with the 1st stage power turbine vane baffle (Ref. Photo No. 132, red arrow). The upstream side of the disc face and blade roots had rubbed with the inner wall of the 1st stage power turbine vane (Ref. Photo No. 133, red arrow).



Photo No. 130



Photo No. 131

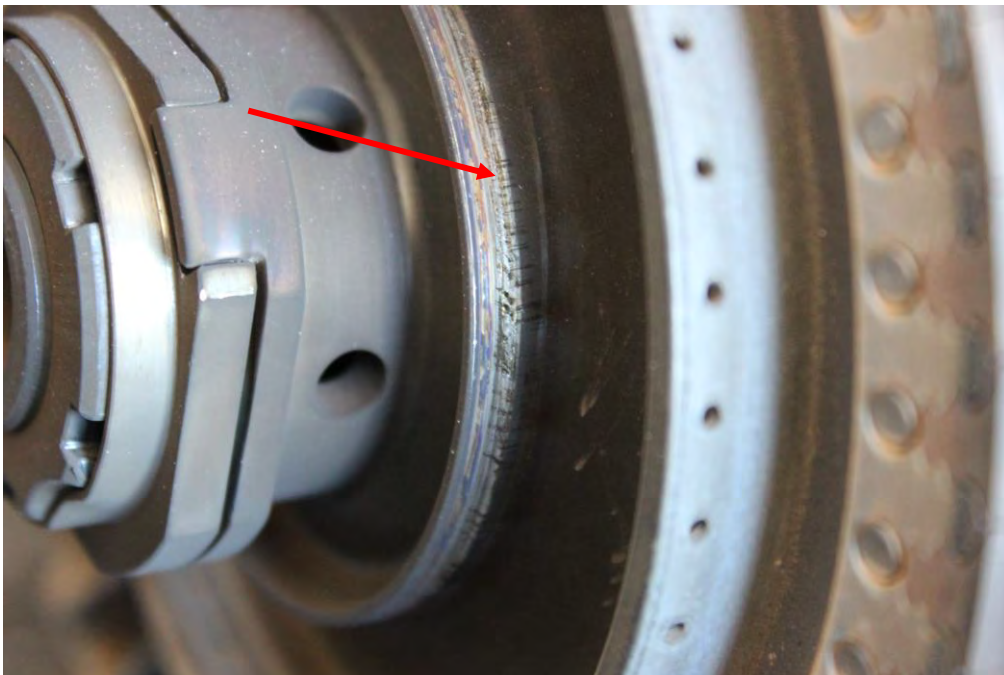


Photo No. 132



Photo No. 133

2nd Stage Power Turbine Guide Vane Ring: The vane ring was not accessed for the purposes of this investigation.

2nd Stage Power Turbine Shroud: The shroud was not accessed for the purposes of this investigation.

2nd Stage Power Turbine: The turbine was not accessed for the purposes of this investigation.

Power Turbine Shaft and Shaft Housing: The vane ring was not accessed for the purposes of this investigation.

5.2.4 Reduction Gearbox

Rear Housing: The housing was not accessed for the purposes of this investigation.

1st Stage Sun gear: The gear was not accessed for the purposes of this investigation.

1st Stage Planet Gear Carrier: The carrier was not accessed for the purposes of this investigation.

1st Stage Planet Gears: The gears were not accessed for the purposes of this investigation.



1st Stage Ring Gear: The gear was not accessed for the purposes of this investigation.

Torque Meter: The meter was not accessed for the purposes of this investigation.

2nd Stage Sun Gear and Flex Coupling: The gear and coupling were not accessed for the purposes of this investigation.

2nd Stage Planet Gear Carrier: The carrier was not accessed for the purposes of this investigation.

2nd Stage Planet Gears: The gears were not accessed for the purposes of this investigation.

2nd Stage Ring Gear: The gear was not accessed for the purposes of this investigation.

No. 5 Bearing: The bearing was not accessed for the purposes of this investigation.

Propeller Shaft: The shaft was section for removal of the propeller. The shaft was not accessed for the purposes of this investigation.

No. 6 and 7 Bearings: The bearings were not accessed for the purposes of this investigation.

Forward Housing: The housing was not accessed for the purposes of this investigation.

5.2.5 **Accessory Gearbox:** The gearbox was not accessed for the purposes of this investigation.

5.3 **Controls and Accessories Evaluation**

5.3.1 **Ignition System**

Exciter Box: The box was missing.

Ignition Leads: The leads were damaged at the connection with the exciter box but were in place and secure.

Ignition Plugs: The plugs were in place and secure.

5.3.2 **Fuel System**

Fuel Heater: The heater was in place and secure. The housing exhibited heat distress from exposure to the post flight fire (Ref. Photo No. 134).



Photo No. 134

Fuel Pump: The pump was in place and secure. Some discoloration was evident from exposure to the post flight fire (Ref. Photo No. 135, red arrow).

Fuel Control Unit: The unit was in place and secure. The rear cover exhibited heat distress from exposure to the post flight fire (Ref. Photo No. 135, blue arrow).

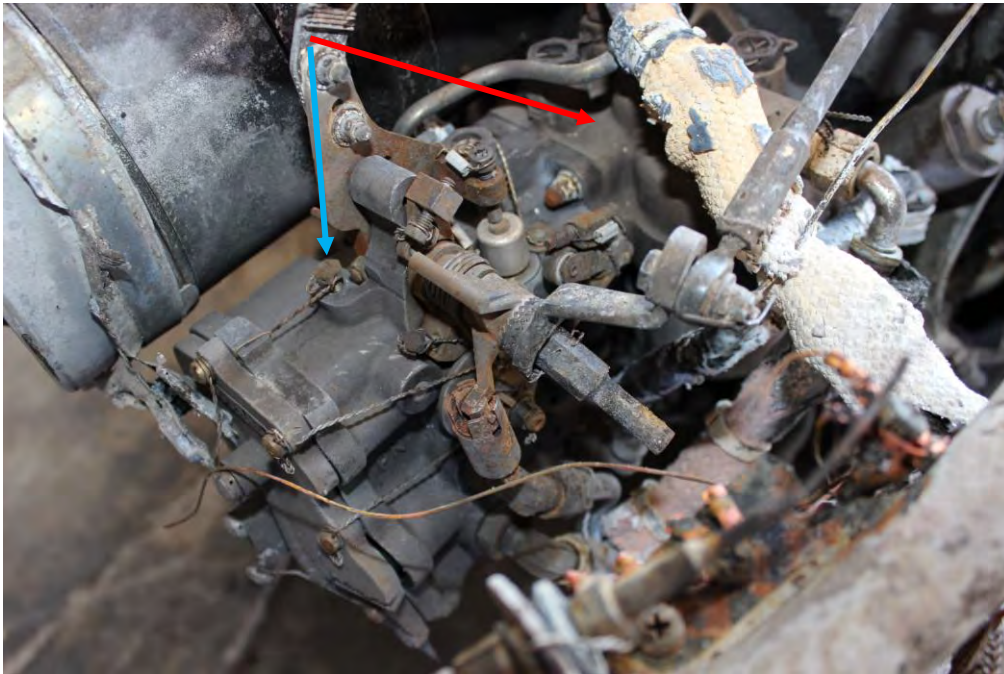


Photo No. 135

Flow Divider: The divider was in place and secure. The divider was burned and discoloured from exposure to the post flight fire (Ref. Photo No. 136, red arrow).

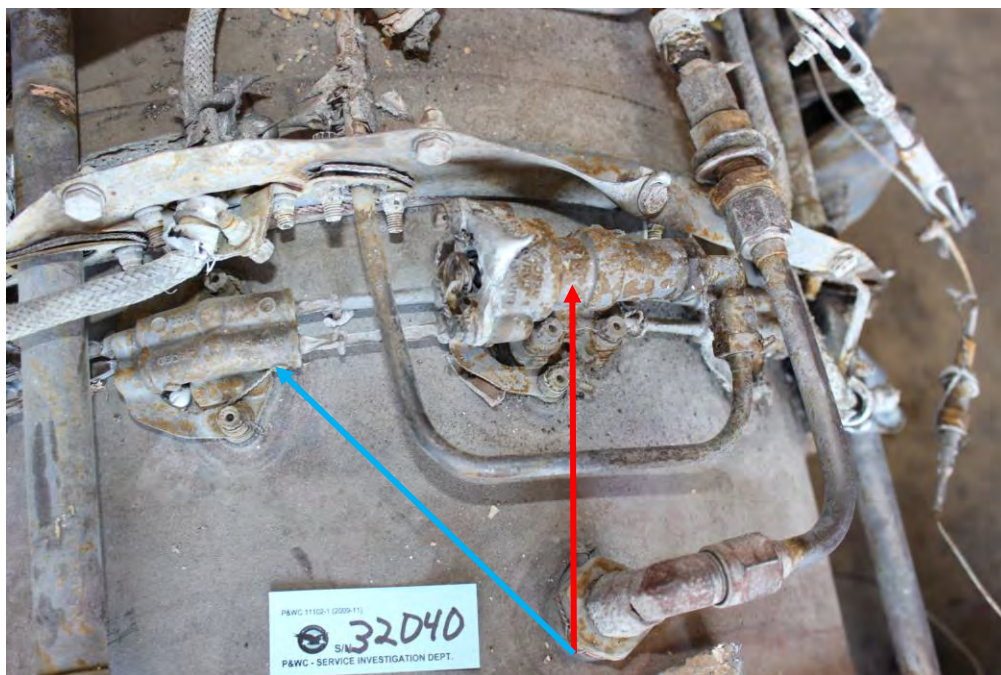


Photo No. 136



Fuel Nozzles: The nozzles were in place and secure. The nozzles were discoloured and several of the fuel transfer tubes were melted from exposure to the post flight fire (Ref. Photo No. 136, blue arrow).

5.3.3 Air System:

Compressor Bleed Valve: The valve was in place and secure. The valve was discoloured from exposure to the post flight fire (Ref. Photo No. 137).



Photo No. 137

5.3.4 Oil System:

Propeller Governor: The governor was in place and secure. The governor was discoloured from exposure to the post flight fire. The propeller speed control lever was missing from the governor (Ref. Photo No. 138, red arrow).

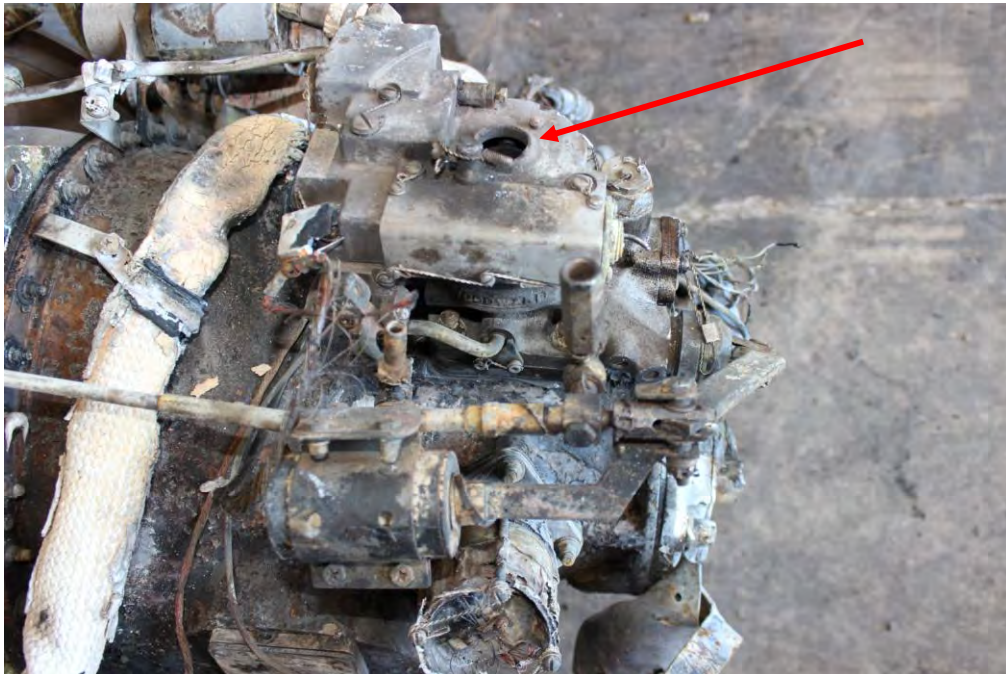


Photo No. 138

Overspeed Governor: The governor was in place and secure. The electrical connection was fractured. The governor was discoloured from exposure to the post flight fire (Ref. Photo No. 139).



Photo No. 139