Service Investigation

Accident / Incident Report

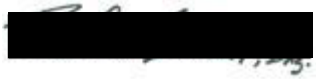
P&WC 8114 (11-98)

Pratt & Whitney Canada
A United Technologies Company

Report No.:16-157

Aero Smart Solutions Inc.
Lancair Evolution & Registration No. N38DM
Allen County, Kansas
October 1st 2016
PT6A-42
S/N 93158

Written By: **Jeff Davis**
Service Investigation Department



Approved By: **Richard Benoit, Eng.**
Manager, Service Investigation Department

Date of Issue: May 11, 2017

Distribution : Courtney Liedler (NTSB), Raymond Pelletier, Ron Ortuso, Peter Boyd, Yvan Nadeau, Craig Huisson, Chadi Tannous, Toufik Djeridane, File 16-157

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I ANALYSIS

1.0 ACCIDENT SYNOPSIS

The aircraft experienced a total loss of engine power during cruise flight. The pilot made a forced landing onto a roadway near Iola, Kansas. The aircraft sustained substantial damage to both wings and the tail section during landing. The pilot was not injured. The passenger suffered minor injuries.

2.0 SUMMARY OF FINDINGS

Light rotational scoring on the 1st stage compressor shroud and compressor turbine shroud indicates the compressor was rotating during the landing. The rotational scoring on the downstream side of the 1st stage power turbine baffle and vane, the 1st stage turbine shroud and the 2nd stage power turbine shroud indicates rotation during the landing/impact.

The analysis of the fluid recovered from the fuel pump showed water contamination and the discoloured/separation of fluids from all of the fuel wetted components indicates the fuel system was contaminated, most likely with water.

3.0 CONCLUSIONS

The rotational scoring on the compressor rotor components and the power turbines indicates the engine was most likely rotating from wind milling at the time of forced landing/impact.

The engine was not capable of combusting the water contaminated fuel which lead to a complete loss of engine power as reported by the pilot.

II FACTUAL INFORMATION

1.0 INVESTIGATION PARTICIPANTS

The powerplant investigation was performed on November 29th and 30th 2016, at the Saint Peters Recovery & Storage Facilities at Wright City, Missouri. The following individuals participated in the investigation as representatives of their respective organisations:

Courtney Liedler	National Transportation Safety Board (NTSB) Air Safety Investigator
Jeff Davis	Pratt & Whitney Canada (P&WC) Investigator

2.0 ENGINE HISTORY

PT6A-42 S/N 93158

Hours Since New: 13260.9 (per the engine log book entry on 04/08/2015)

Cycles Since New: 10818 (per the engine log book entry on 04/08/2015)

Hours Since Overhaul: 302.8 (per the engine log book entry on 04/08/2015)

Cycles Since Overhaul: 291(per the engine log book entry on 04/08/2015)

Hobbs 59.71(per the engine log book entry on 04/08/2015)

Hobbs 317.0 (per the last engine log book entry on May 24, 2016)

3. ENGINE EXAMINATION

3.1 **External Condition:** The engine was attached to the mounting support frame but it was separated from the aircraft due to the impact with unknown objects during the forced landing (Ref. Photos No. 1 & 2). The inlet case and accessory gearbox were only connected to the engine with some external tubes. The inlet case studs on the flange that mates with the gas generator case were all fractured (Ref. Photos No. 3 to 5). The engine data plate showed the engine model was a PT6A-42 and the serial number was PC-E 93158 (Ref. Photo No. 6).

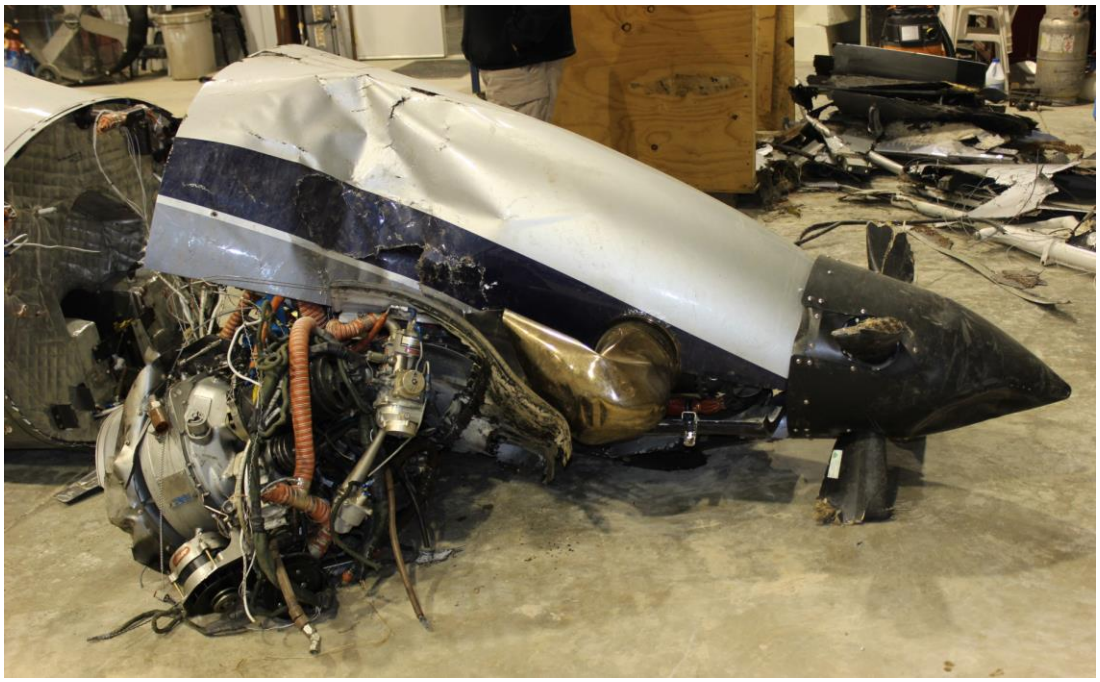
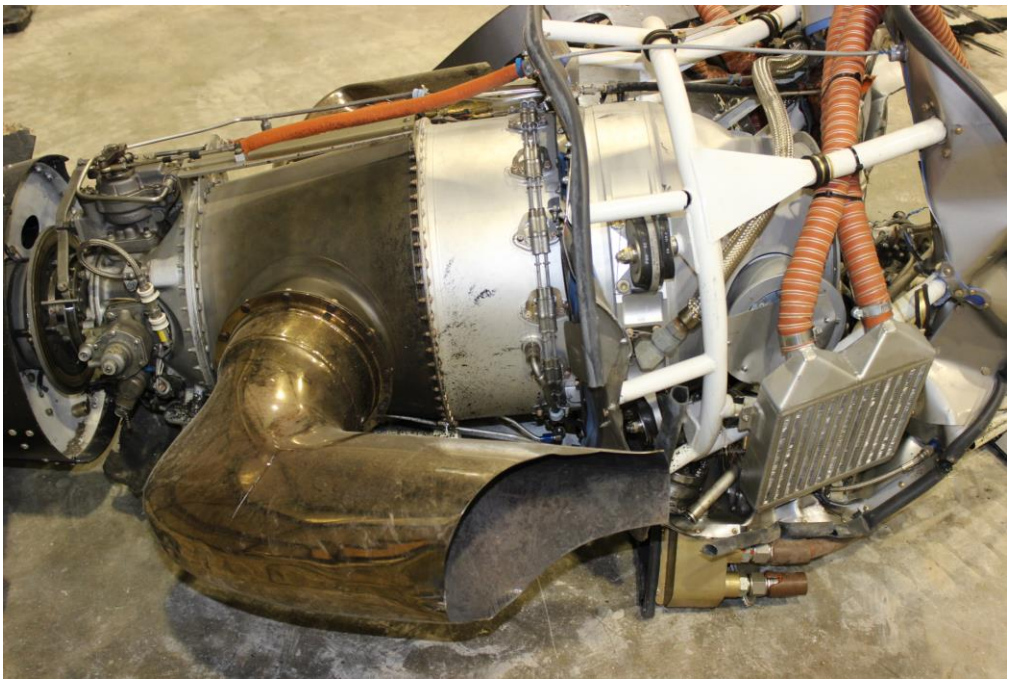


Photo No. 1



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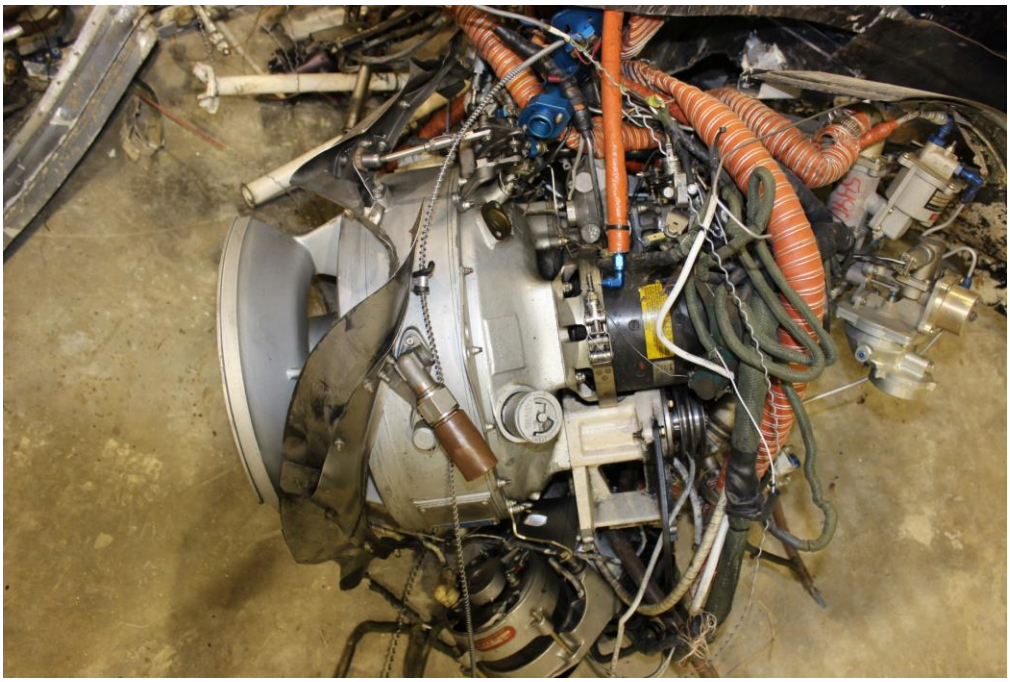
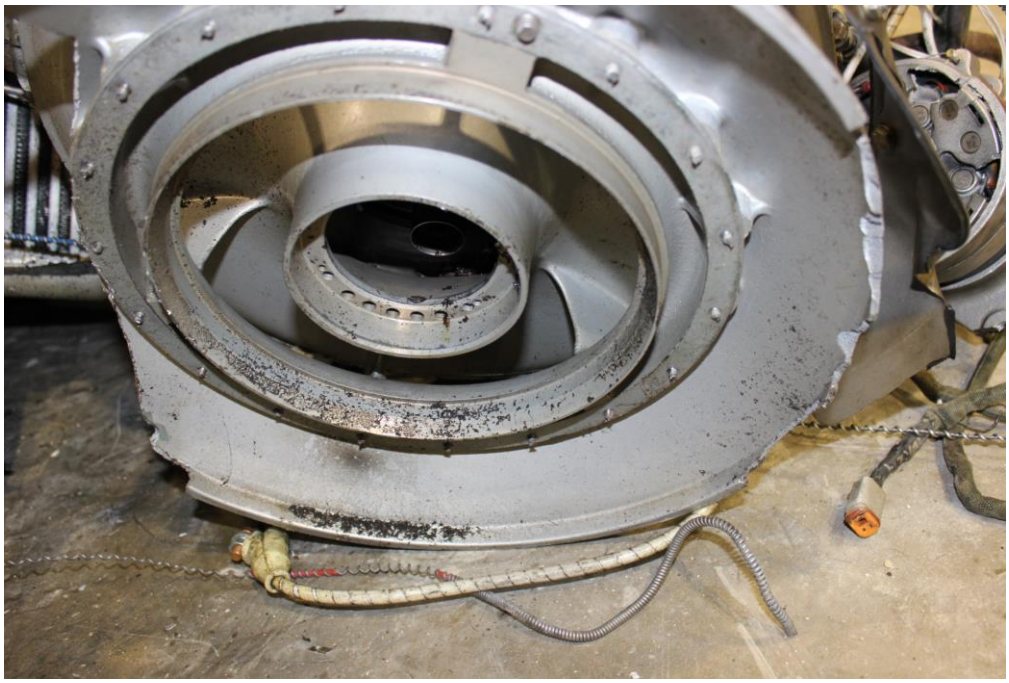


Photo No. 3



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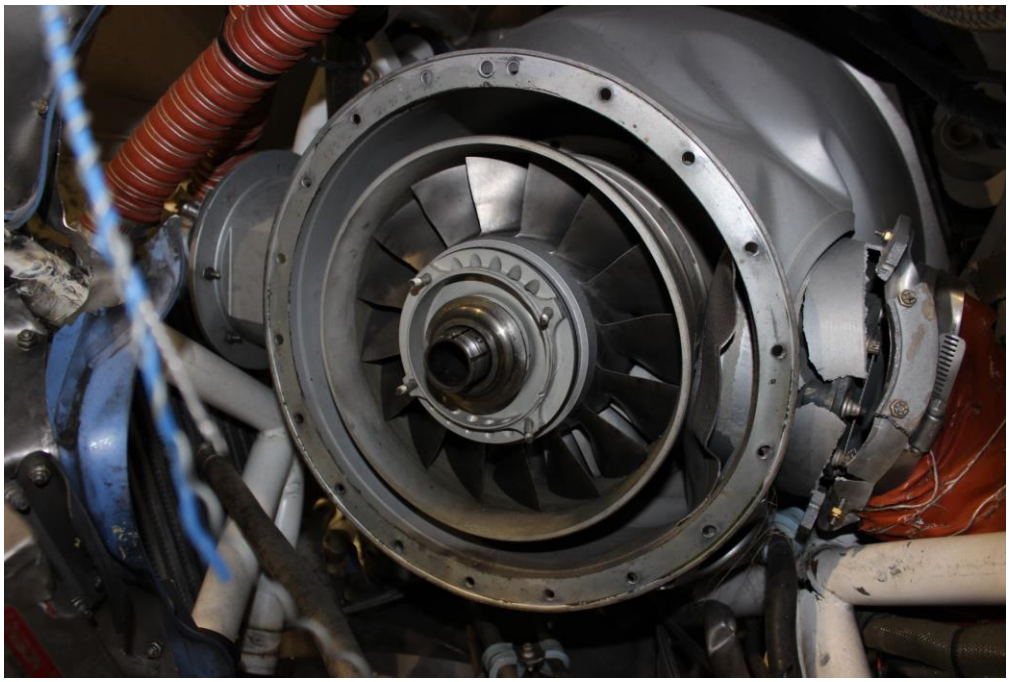


Photo No. 5

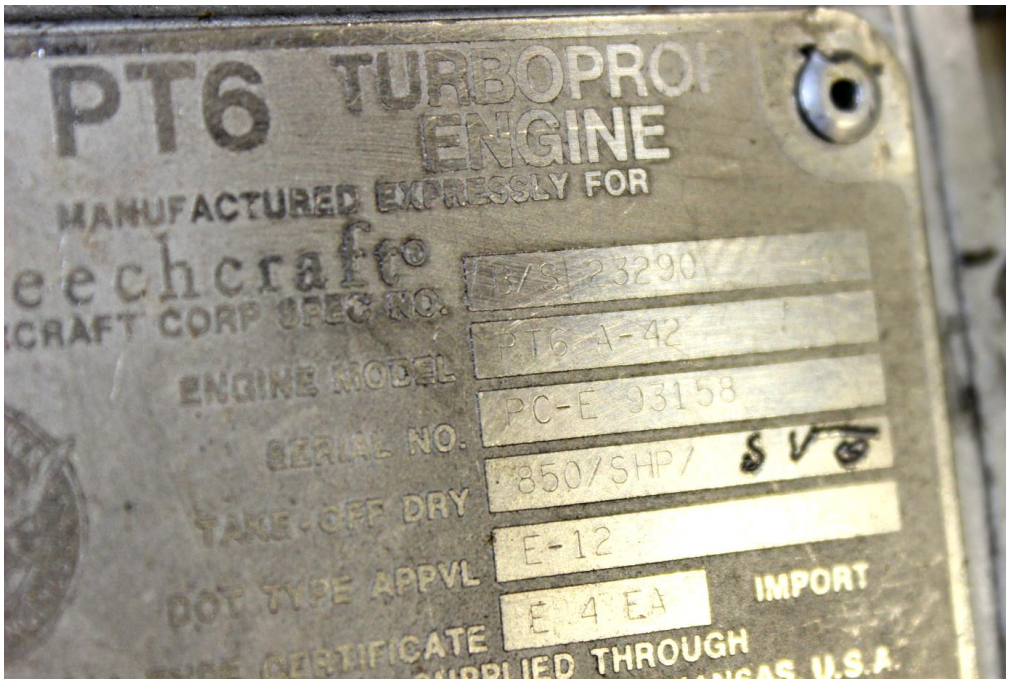


Photo No. 6

3.1.1 External Cases

Reduction Gearbox: No visible external distress was noted on the gearbox (Ref. Photo No. 7).

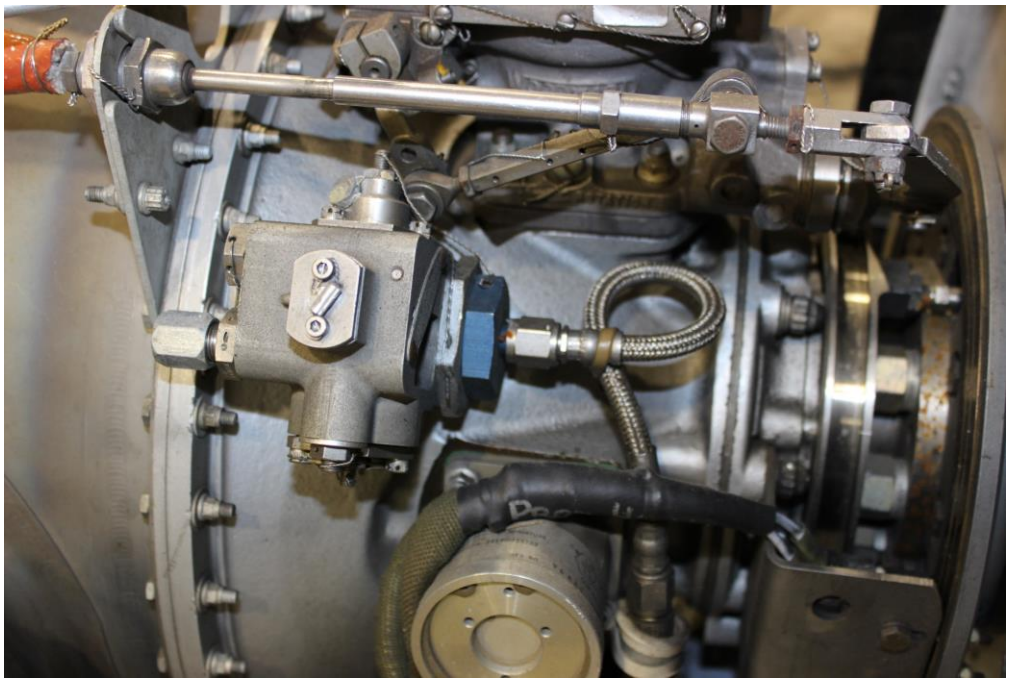


Photo No. 7

Exhaust Duct: Some dark stains were evident on the left hand side of the duct adjacent to the gas generator mating flange (Ref. Photo No. 8). The right hand exhaust stack was bent.

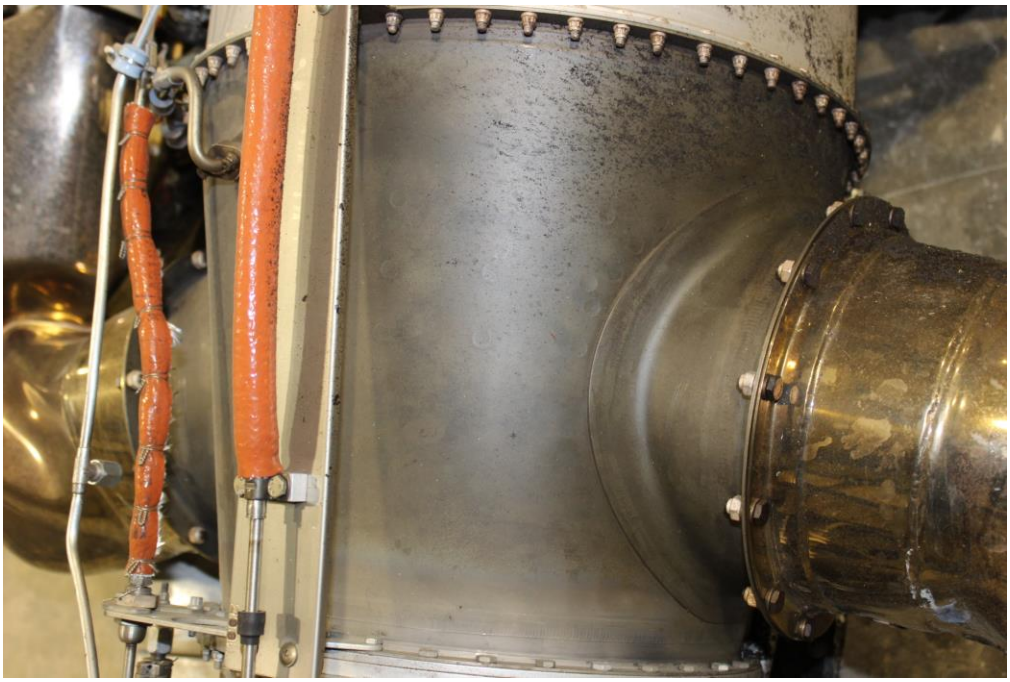


Photo No. 8

Gas Generator Case: The case was compressed, bent, and torn from the impact with unknown objects during the forced landing. (Ref. Photos No. 9 to 11).

Photo No. 9

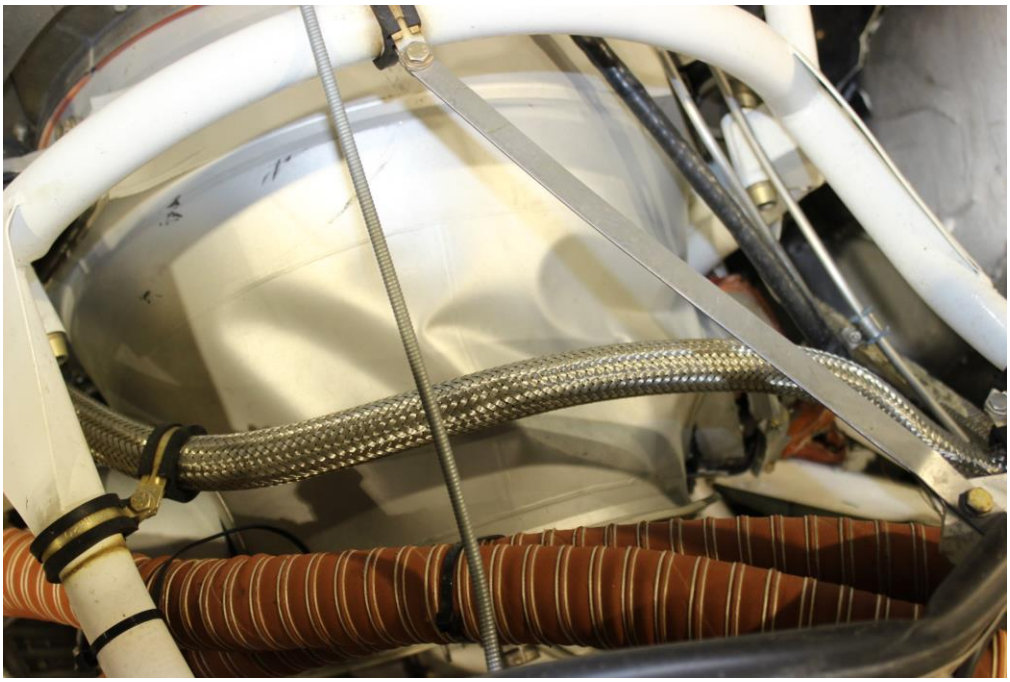


Photo No. 10

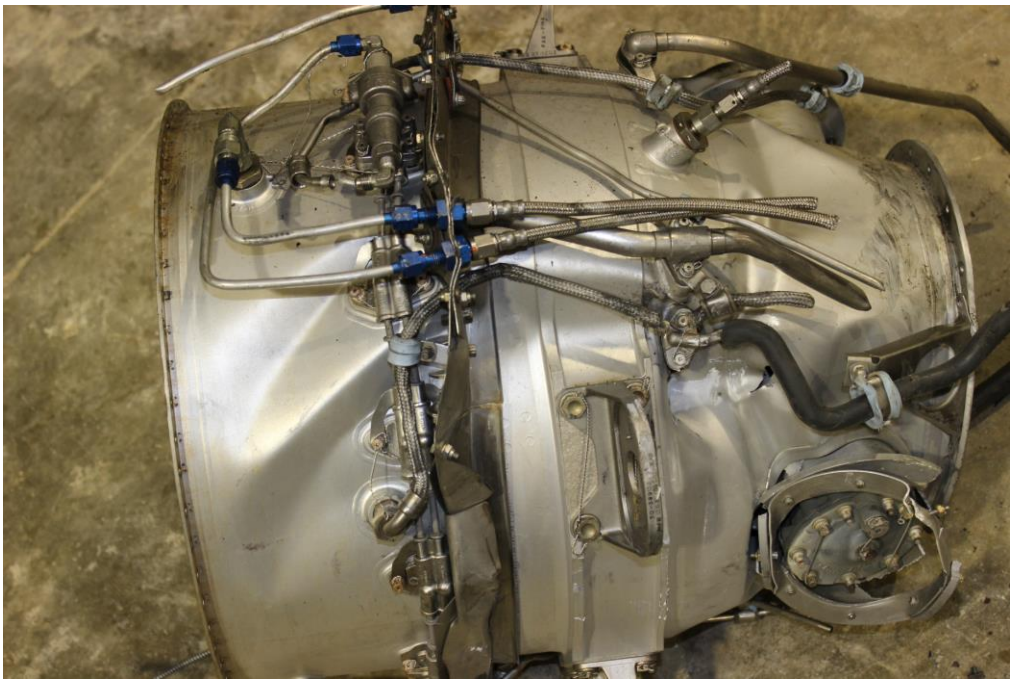


Photo No. 11

Accessory Gearbox: Two of the studs on the external scavenge oil pump mounting pad were fractured due to the pumps separating from the gearbox (Ref. Photos No. 12 & 13).

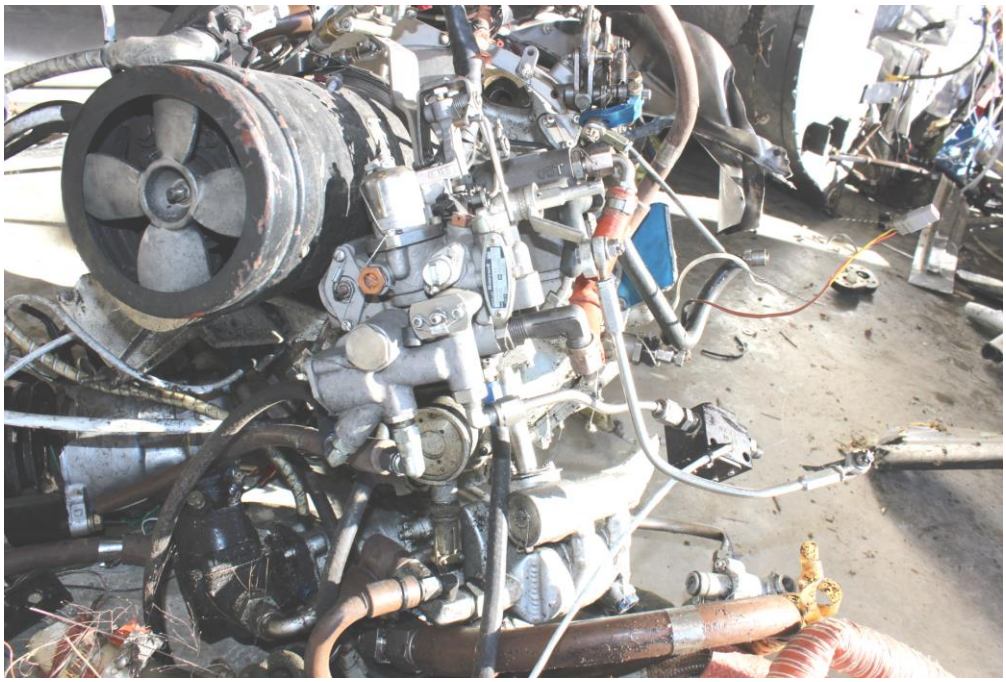


Photo No. 12

Photo No. 13

3.1.2 **Power Control and Reversing Linkage:** The front linkage was in place and secure (Ref. Photos No. 14 & 15, blue arrows). The wire rope and casing were fractured adjacent to the rear fire seal. The CAM box was in place but the actuating control lever was fractured at the fuel control unit rod connection (Ref. Photos No. 16, blue arrow & 17, red oval). The fuel control rod was bent (Ref. Photo No. 17, blue arrow).

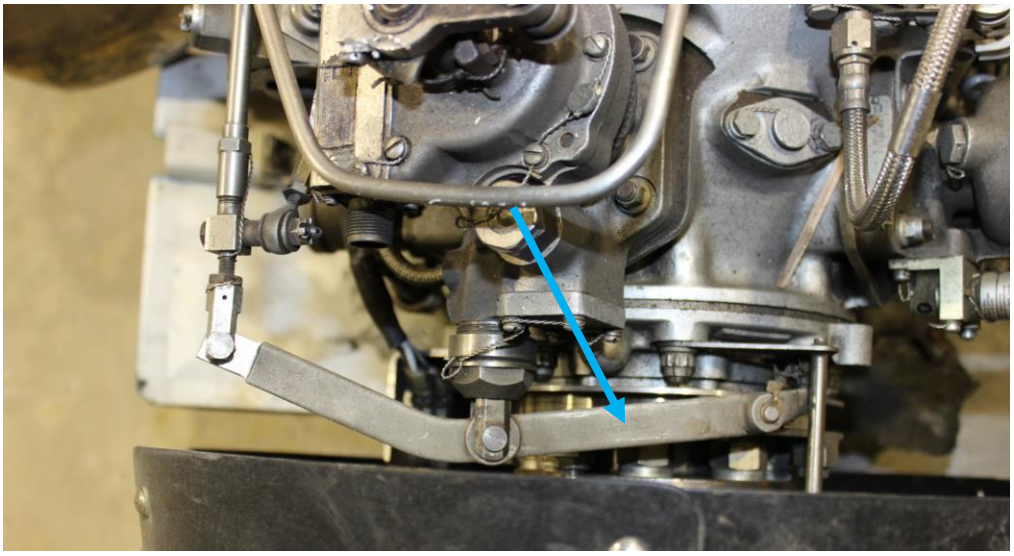
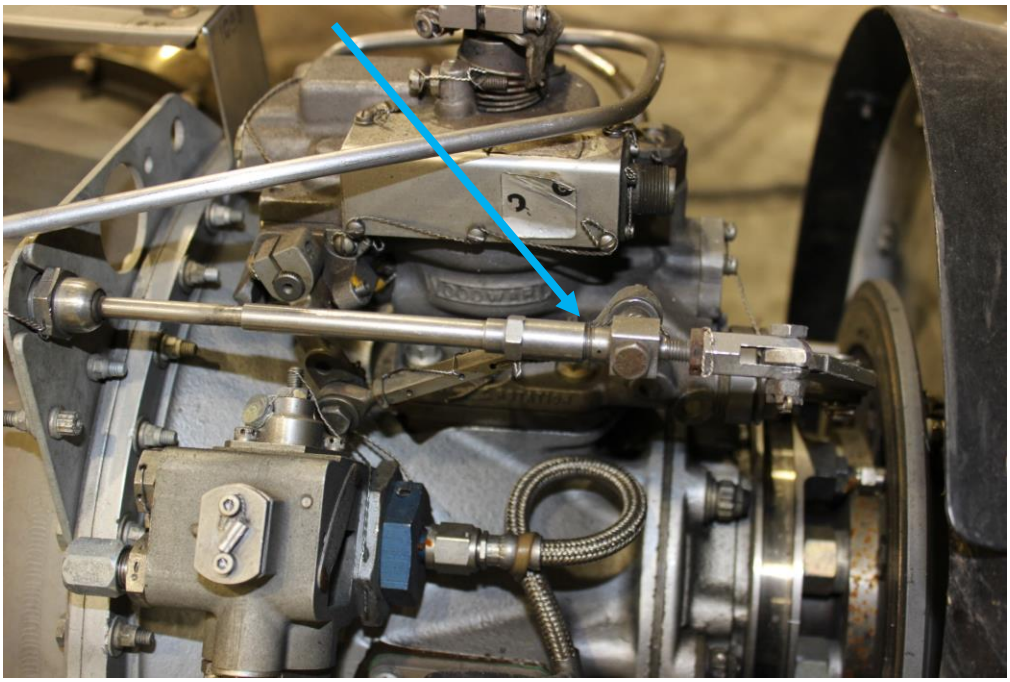


Photo No. 14



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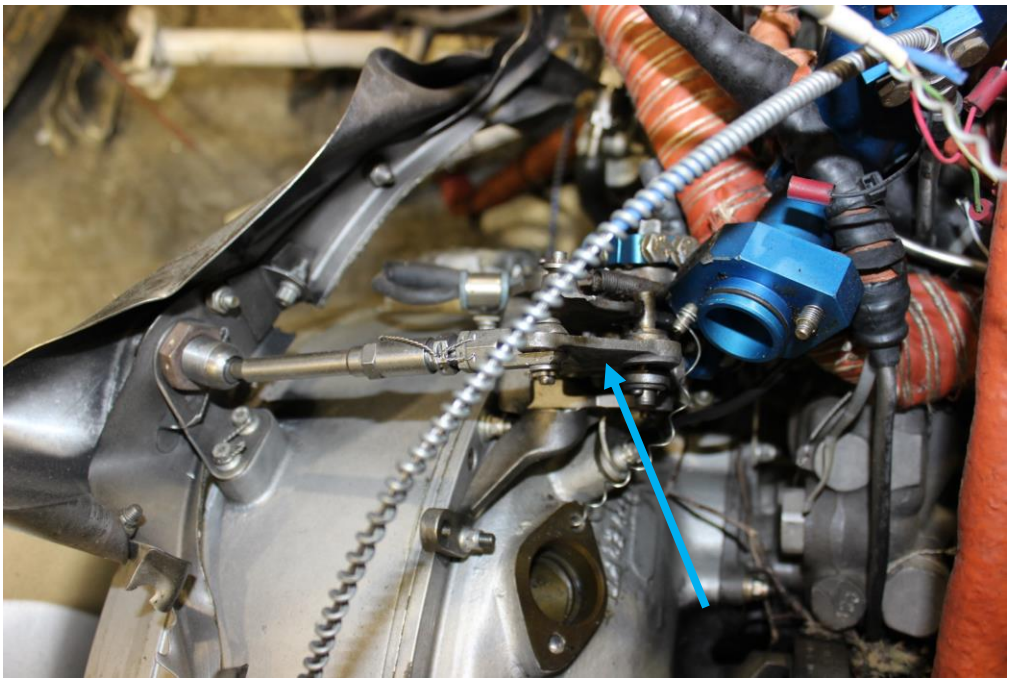

Photo No. 16

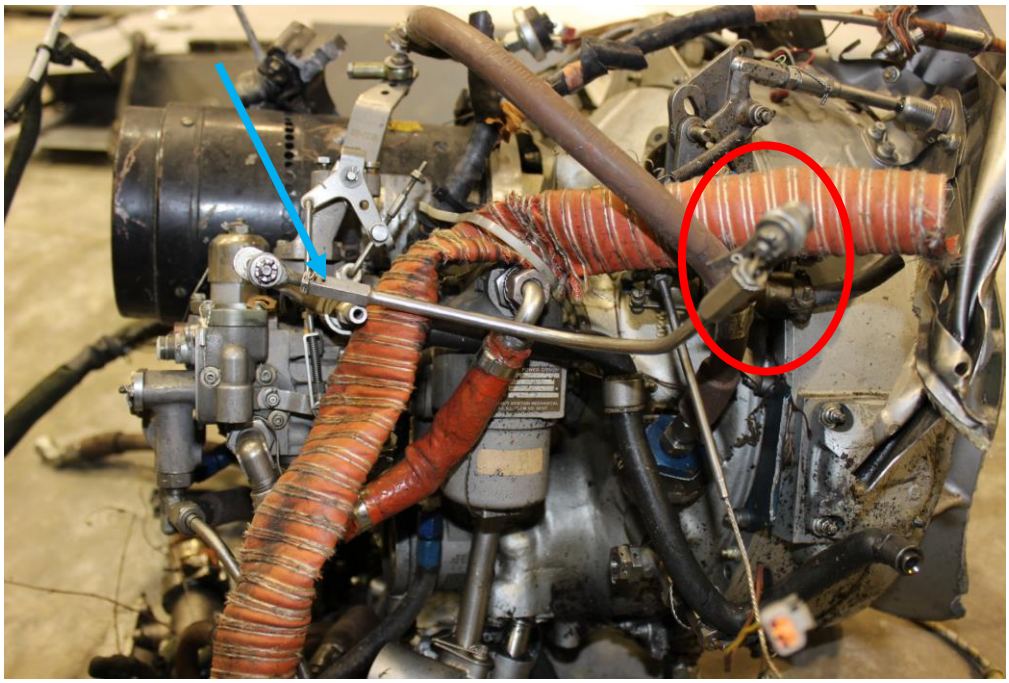

Photo No. 17

3.1.3 **Pneumatic Tubes**

Compressor Discharge Air (P3): The tube was in place and secure except it was separated from the connection adjacent to the filter housing (Ref. Photo No. 20, green arrow). The filter was clean (Ref. Photo No. 18).

Photo No. 18

Power Turbine Control (Py): The front of the tube was in place and secured (Ref. Photo No. 19, yellow arrow). The tube was distorted from the centre fire seal to the fuel control and the fuel control boss for the tube was fractured (Ref. Photos No. 20 & 21, yellow ovals).

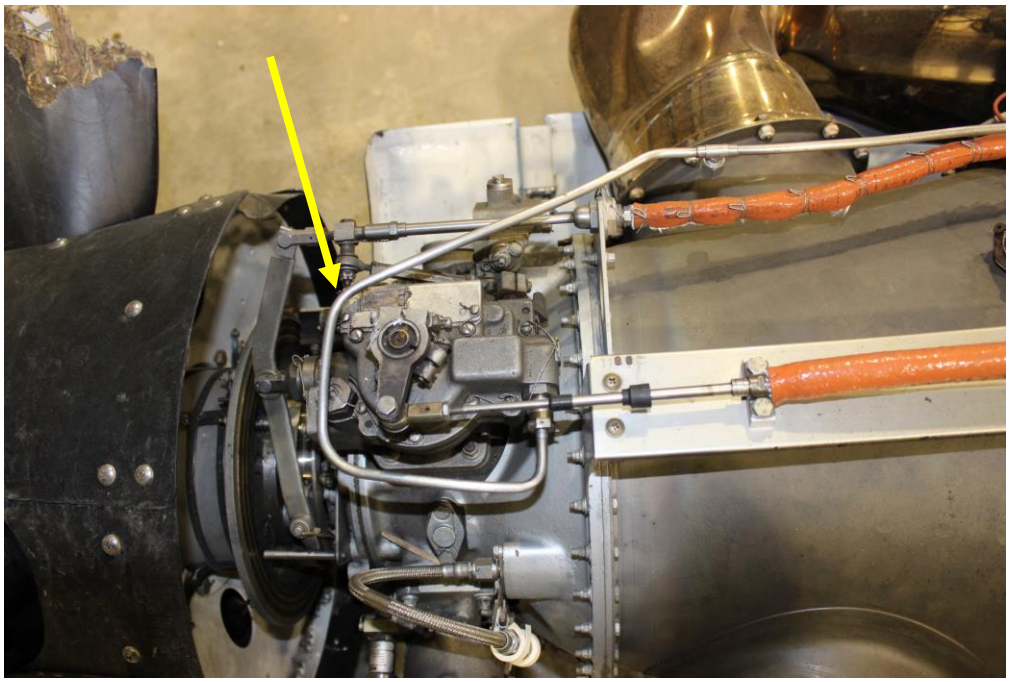

Photo No. 19

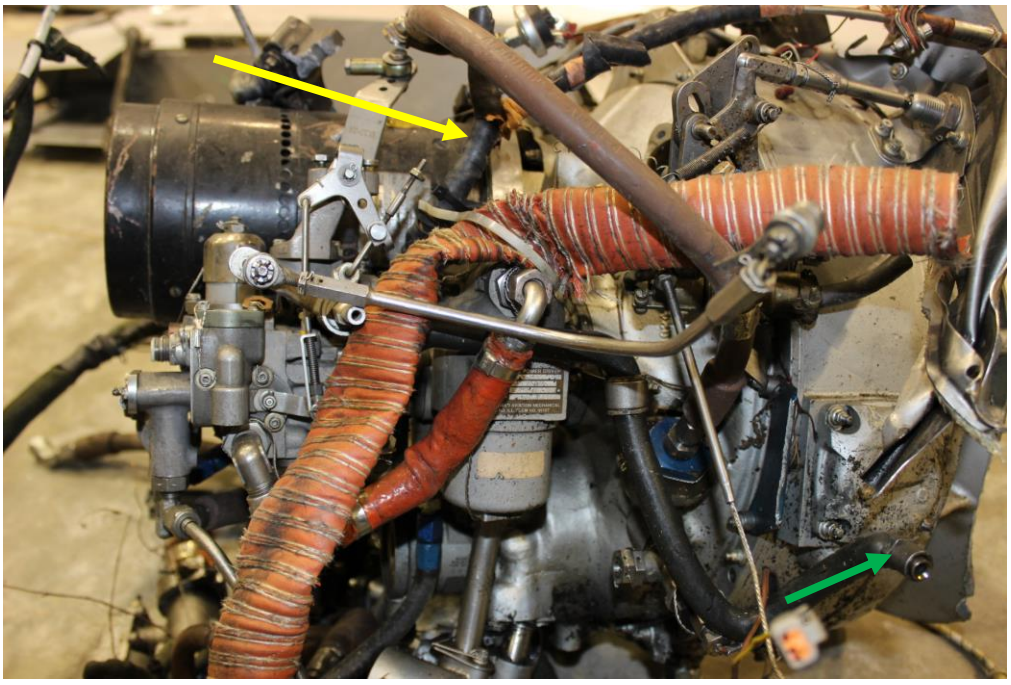

Photo No. 20

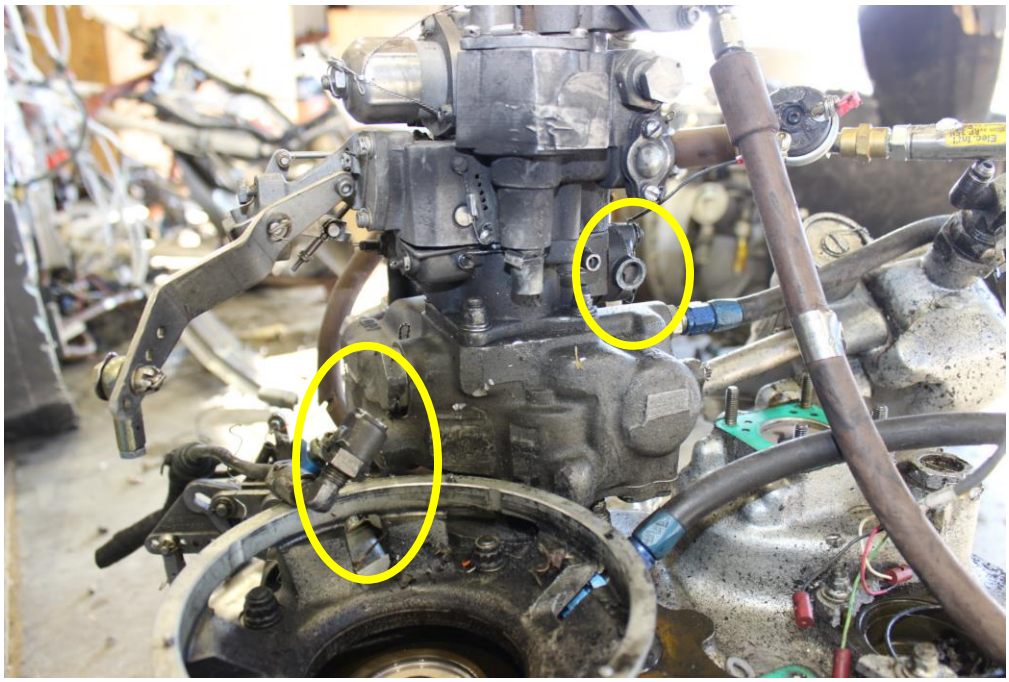

Photo No. 21

3.1.4 Chip Detectors and Filters

Reduction Gearbox Chip Detector: Some minor metal flakes and particulate were adhered to the magnetic poles (Ref. Photo No. 22).

Photo No. 22

Oil Filter: No visible contamination was evident in the oil filter (Ref. Photo No. 23).

Photo No. 23

Fuel Filter: Outlet filter was discoloured and sediment was evident on the surface of the filter (Ref. Photo No. 24). The residual liquid in the outlet filter cover bowl was contaminated with sediment and there was a visible separation of the liquids, indicating it was most likely contaminated with water (Ref. Photo No. 25). The liquid was retained by the NTSB for analysis. The inlet filter exhibited a sediment build up on the surface (Ref. Photo No. 26). The residual liquid in the inlet filter cavity of the pump was contaminated with sediment and there was a visible separation of the liquids, indicating it was most likely contaminated with water (Ref. Photo No. 27). The liquid and filter were retained by the NTSB for analysis.

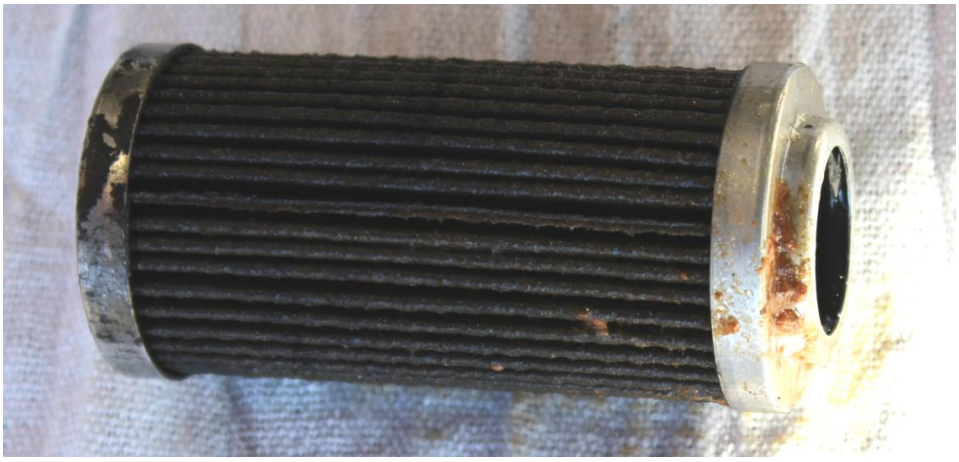

Photo No. 24

Photo No. 25

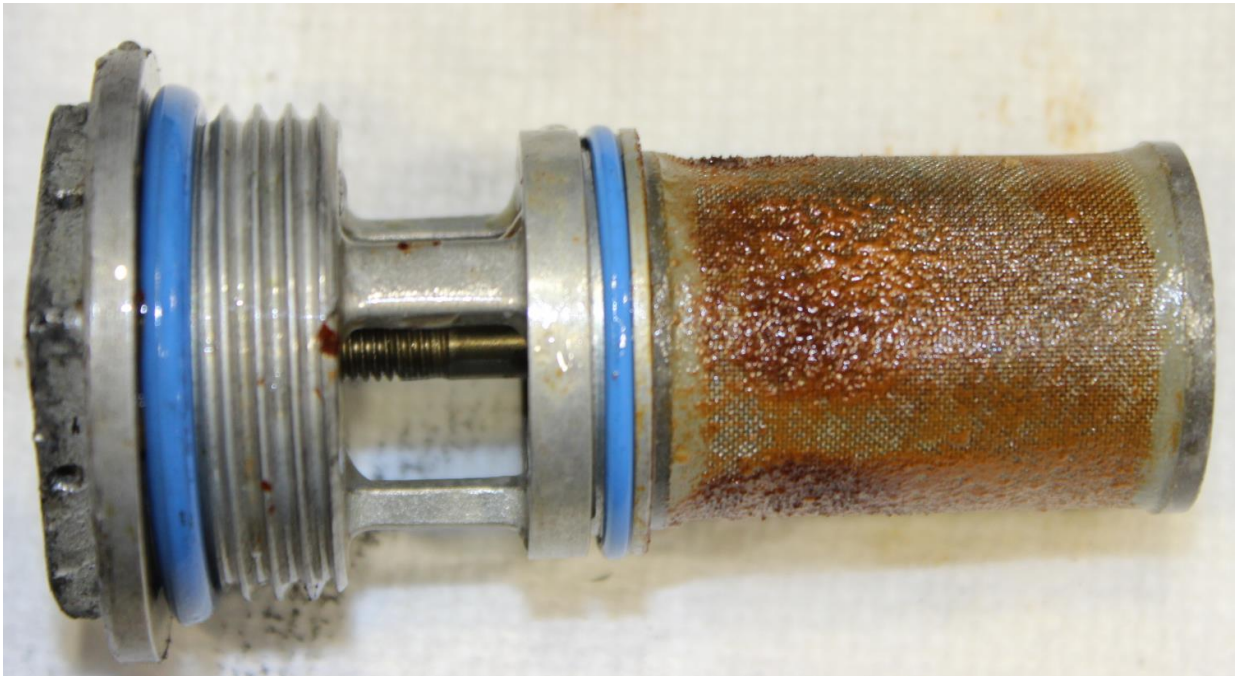

Photo No. 26

Photo No. 27

3.2 Disassembly Observations

3.2.1 **Compressor Section:** The compressor rear hub coupling, No. 1 bearing grooved inner race, bearing cage, ball elements, and the No. 1 bearing retention nut were not recovered. Both ends of the spring pin that retains the compressor rear hub coupling into the 1st stage compressor rotor were in place (Ref. Photo No. 28, red arrow). The No. 1 bearing retention nut threads were damaged (Ref. Photo No. 28, blue arrow).

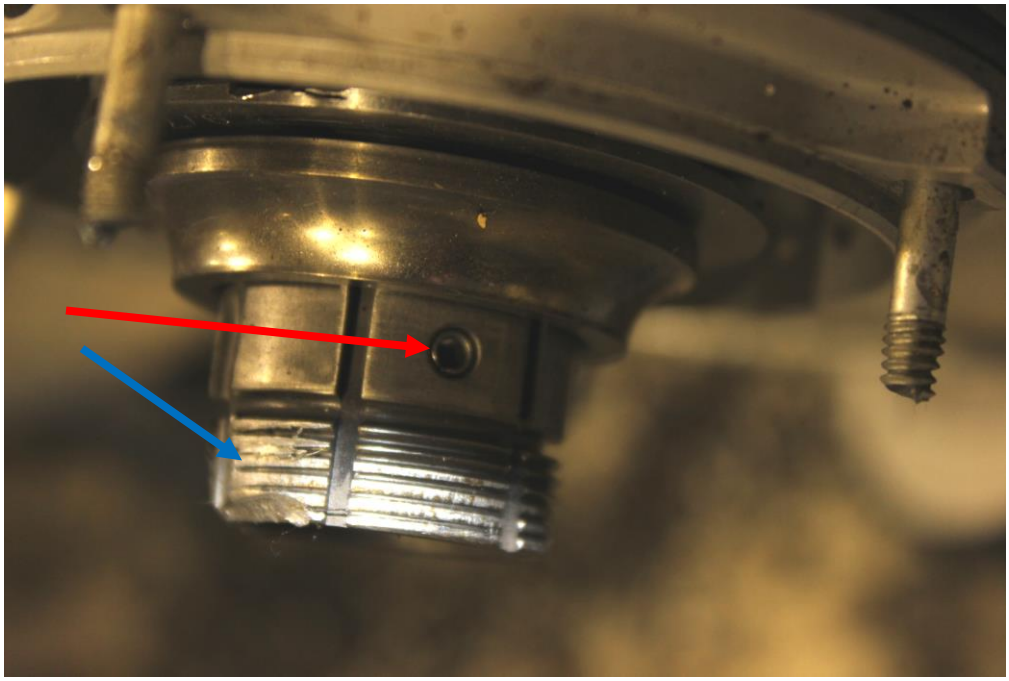

Photo No. 28

Compressor 1st, 2nd, and 3rd Stage Discs and Blades: One 1st stage blade exhibited a bent tip and one additional blade exhibited light impact damage (Ref. Photos No. 29 & 30). The compressor was not removed or disassembled to access the 2nd and 3rd stage blades for the purpose of this investigation.

Photo No. 29

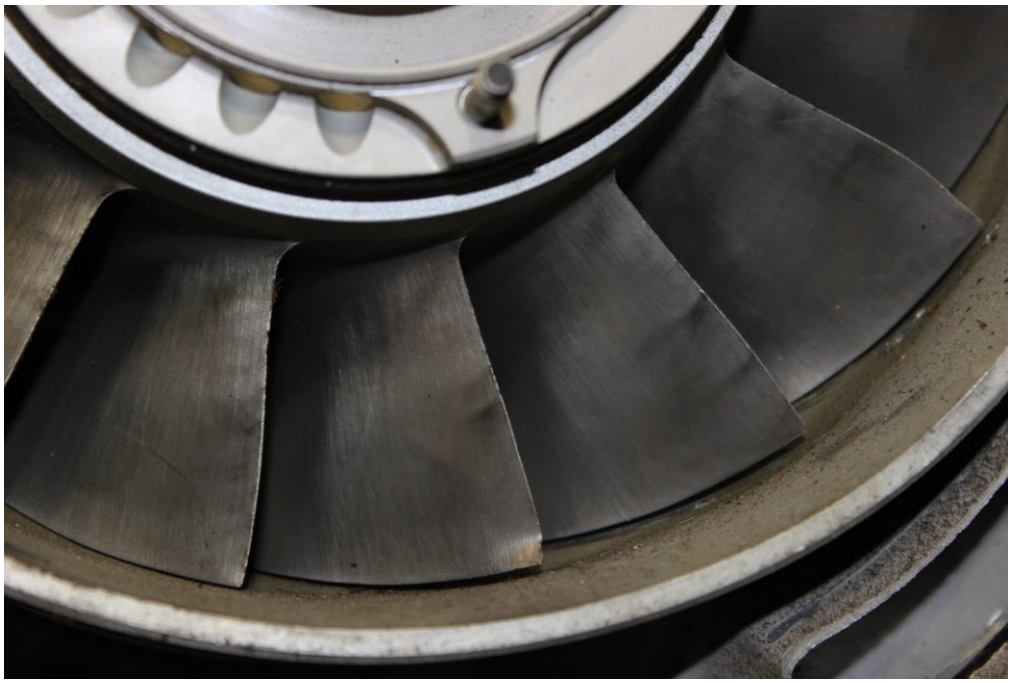

Photo No. 30

Compressor 1st, 2nd, and 3rd Stage Stators and Shrouds: The 1st stage shroud exhibited a light rub. The 1st stage stator exhibited a bent region where the right hand bleed valve and gas generator case were bent inward (Ref. Photo No. 31, red arrow). The 2nd and 3rd stage stators and shrouds were not accessed for the purpose of this investigation.

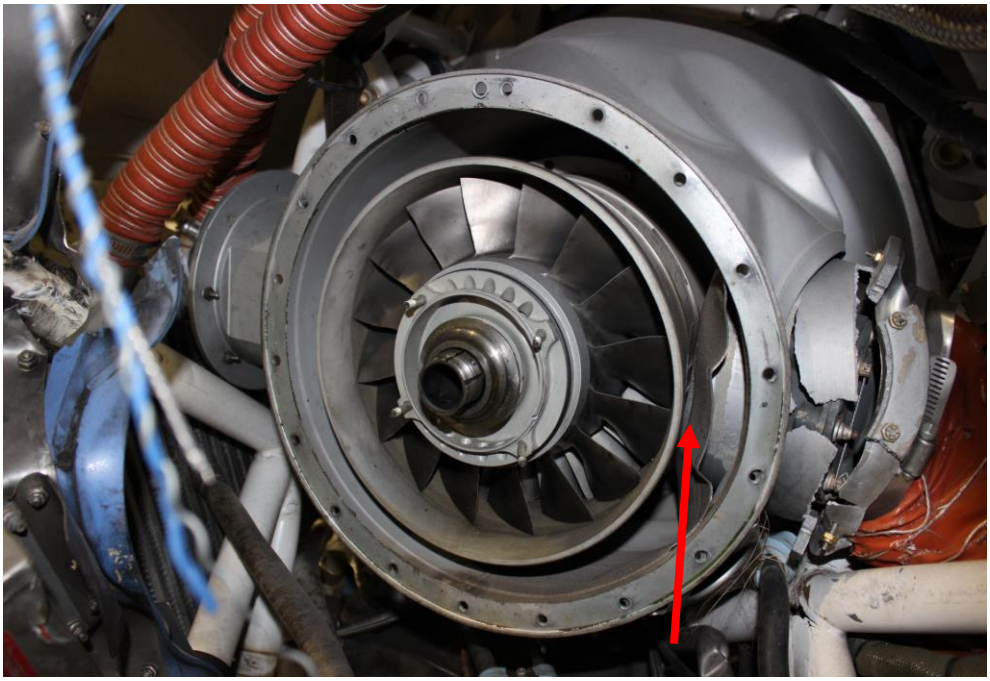

Photo No. 31

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

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

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

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

No. 1 Bearing and Airseals: The No. 1 bearing grooved inner race, cage and ball elements were not recovered. The No. 1 bearing housing was separated from the engine due to impact during the forced landing and it was distorted/bent (Ref. Photo No. 32). The outer race was in place in the bearing housing. The plain inner race and the air seals were in place but were not removed for the purpose of this investigation (Ref. Photo No. 33, red arrows).

Photo No. 32

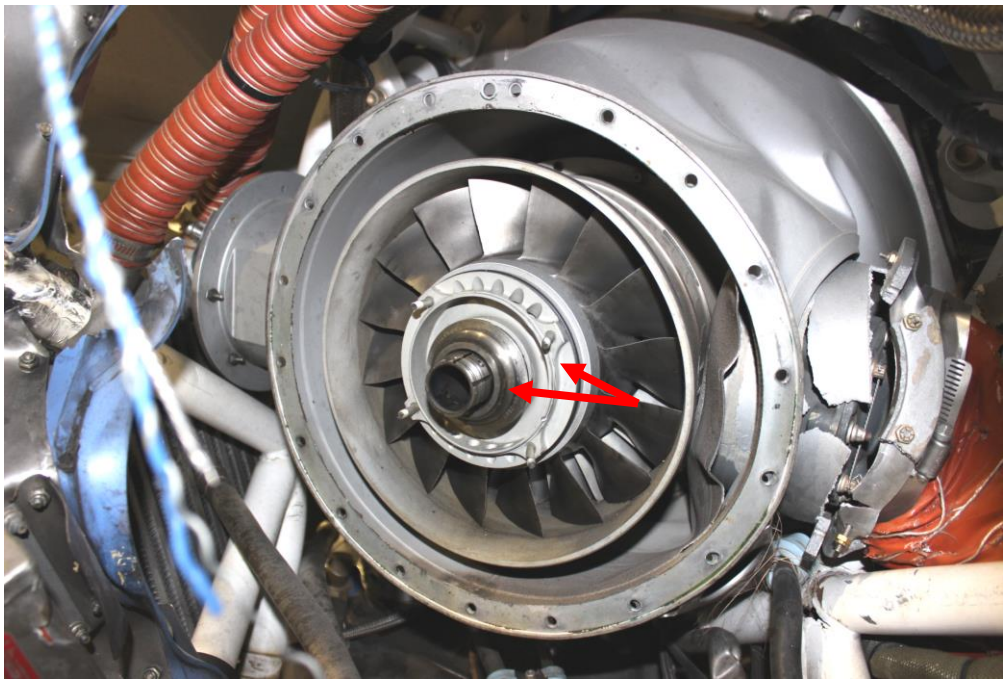

Photo No. 33

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

3.2.2 Combustion Section

Combustion Chamber Liner: The visible portion of the liner exhibited operational discoloration (Ref. Photo No. 34). The liner was not removed for the purpose of this investigation.

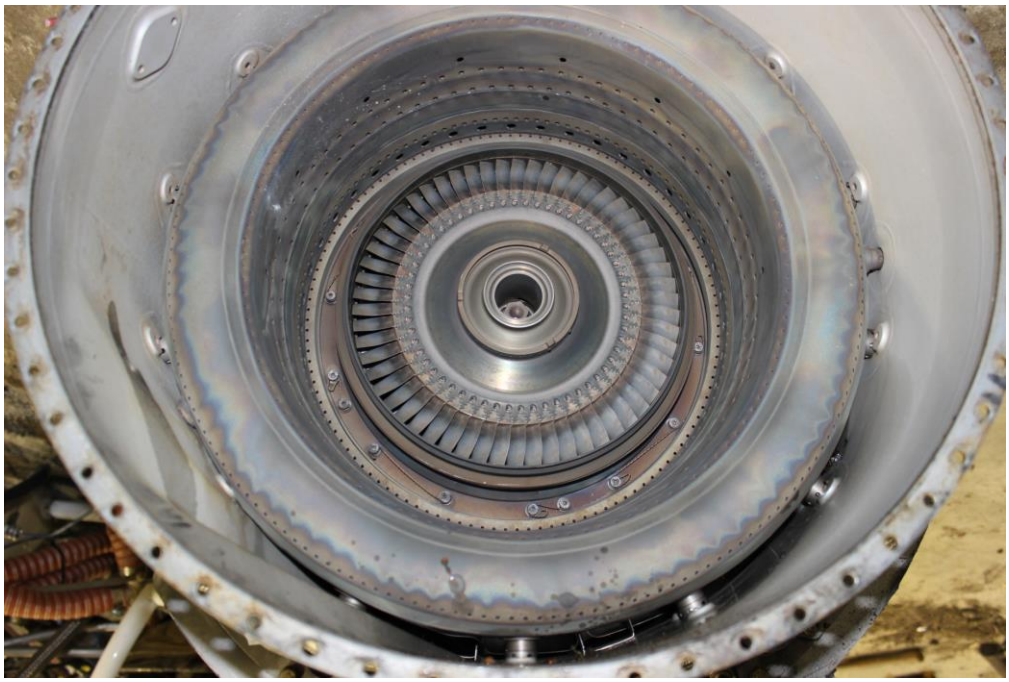

Photo No. 34

Large Exit Duct: The duct was not accessed for the purpose of this investigation.

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

3.2.3 Turbine Section

Compressor Turbine Guide Vane Ring: The visible section of the vane was unremarkable except for some operational stains (Ref. Photo No. 35). The vane was not removed.

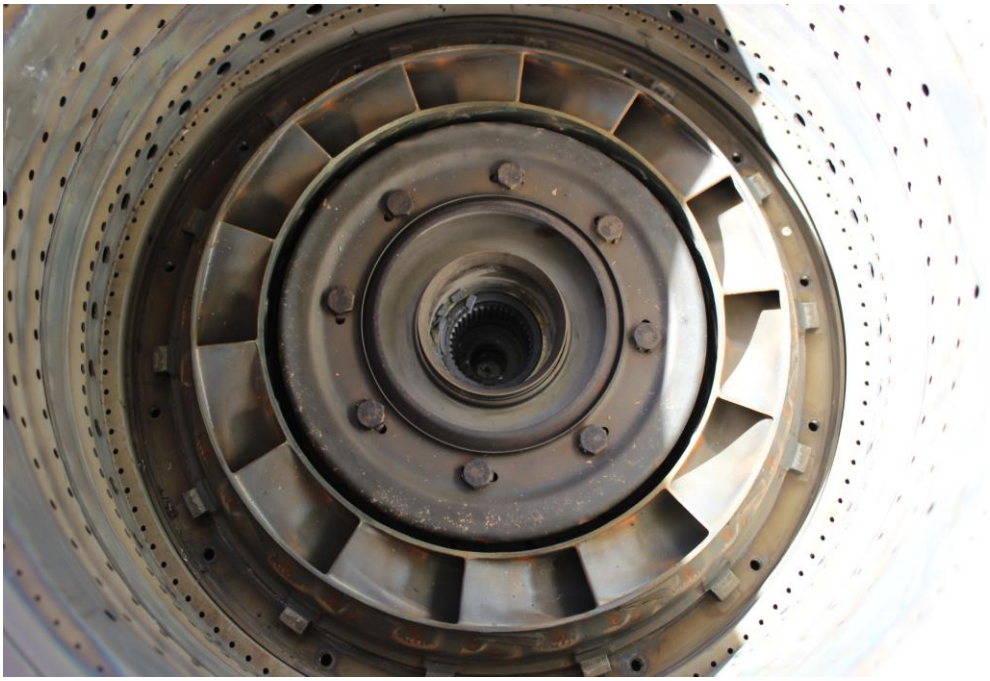

Photo No. 35

Compressor Turbine Shroud: The shroud exhibited some circumferential rubs from contact with the compressor turbine blades (Ref. Photo No. 36, red oval).

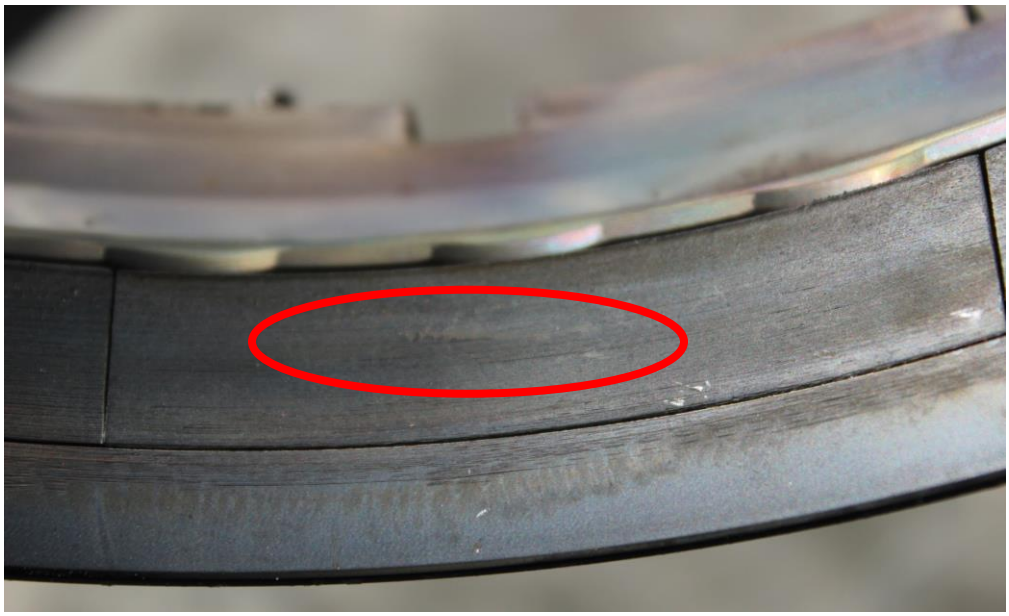

Photo No. 36

Compressor Turbine: The upstream side of the turbine and blades exhibited operational stains (Ref. Photos No. 37 & 38). The area adjacent to the retention bolt bore on the downstream side was polished from contact with the 1st stage power turbine baffle (Ref. Photos No. 39 & 40, red arrow). One of the tooling lugs was polished and several blade platforms exhibit mechanical damage (Ref. Photos No. 40, blue arrow & No. 41, blue arrow). The polished lip, polished lug and the blade platform damage were most likely from the compression of the gas generator case and rotor displacement from the loss of inlet case/No. 1 bearing support.

Photo No. 37, view of the upstream side

Photo No. 38, view of the upstream side

Photo No. 39, view of the downstream side

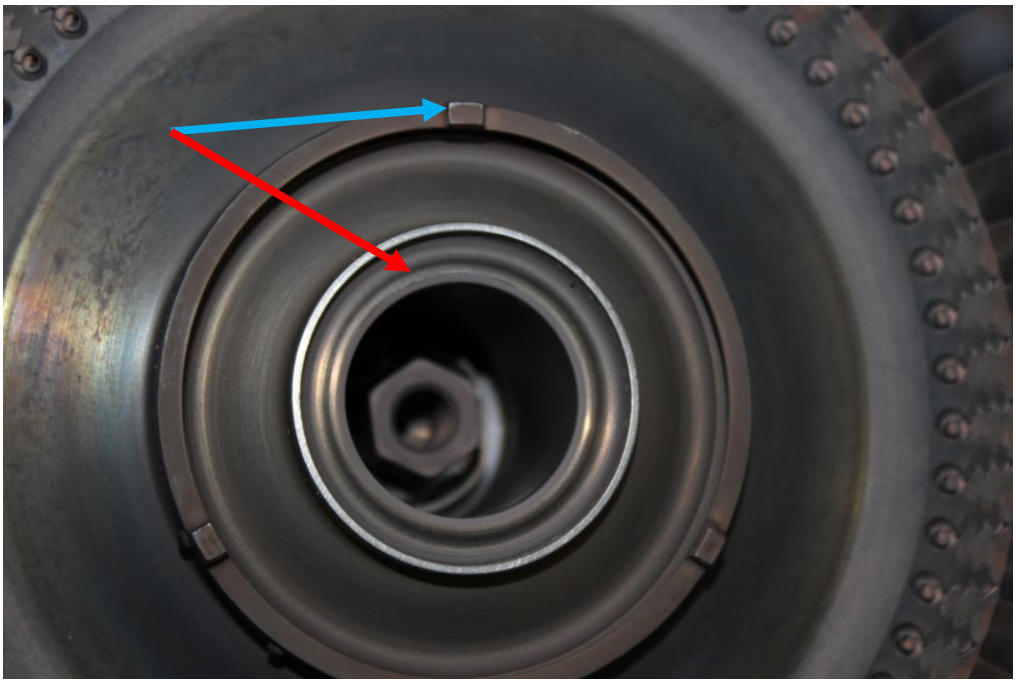

Photo No. 40, view of the downstream side

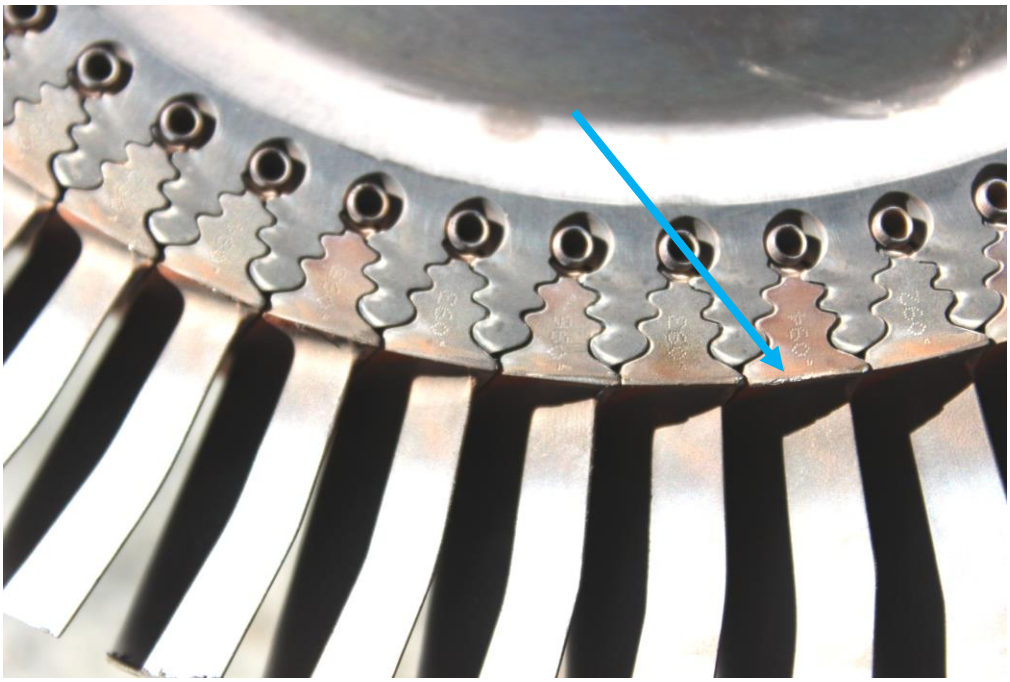

Photo No. 41, view of the downstream side

ITT Probes, Busbar, and Harness: The probes, busbar, and harness were visually unremarkable (Ref. Photo No. 42).

Photo No. 42

Power Turbine Housing: No visible distress was noted on the housing (Ref. Photo No. 43).

Photo No. 43

1st Stage Power Turbine Guide Vane Ring and Interstage Baffle: The compressor turbine had contacted the upstream side of the baffle, the centre area was polished, a section of the baffle lip was bent, an imprint from a tooling lug, and displaced material on the inner rim of the vane (Ref. Photo No. 44 & 45, red arrows). The downstream side exhibited circumferential rub on the centre from contact with the turbine retention nut and the lip of the baffle from contact with the 1st stage disc (Ref. Photos No. 46 & 47, red arrows). The inner rim of the vane exhibited an operational crack.

Photo No. 44, view of the upstream side

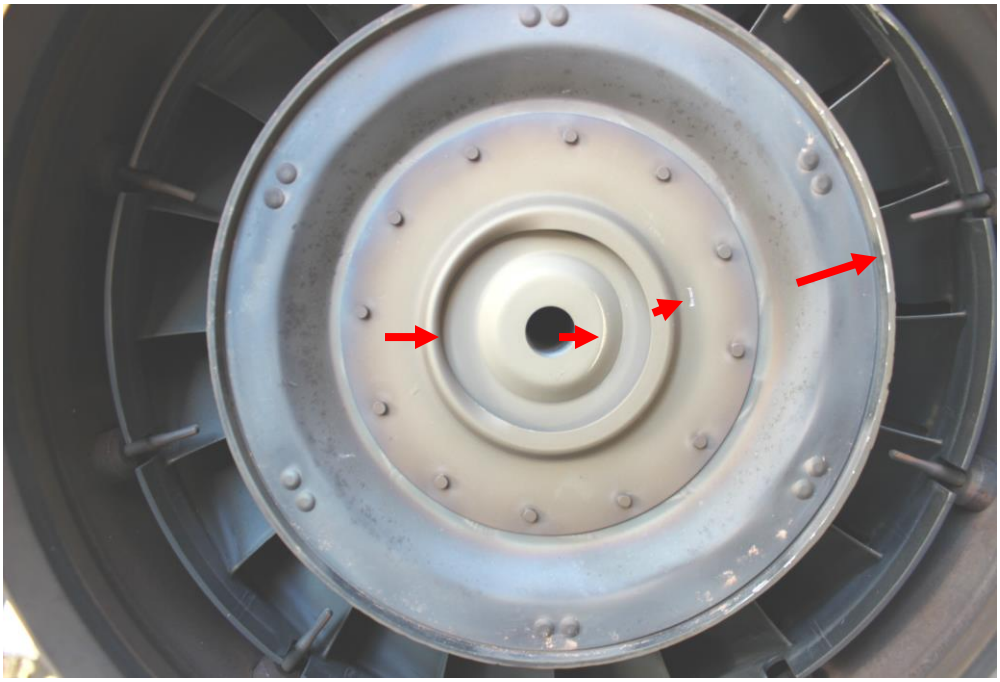

Photo No. 45, view of the upstream side

Photo No. 46, view of the downstream side

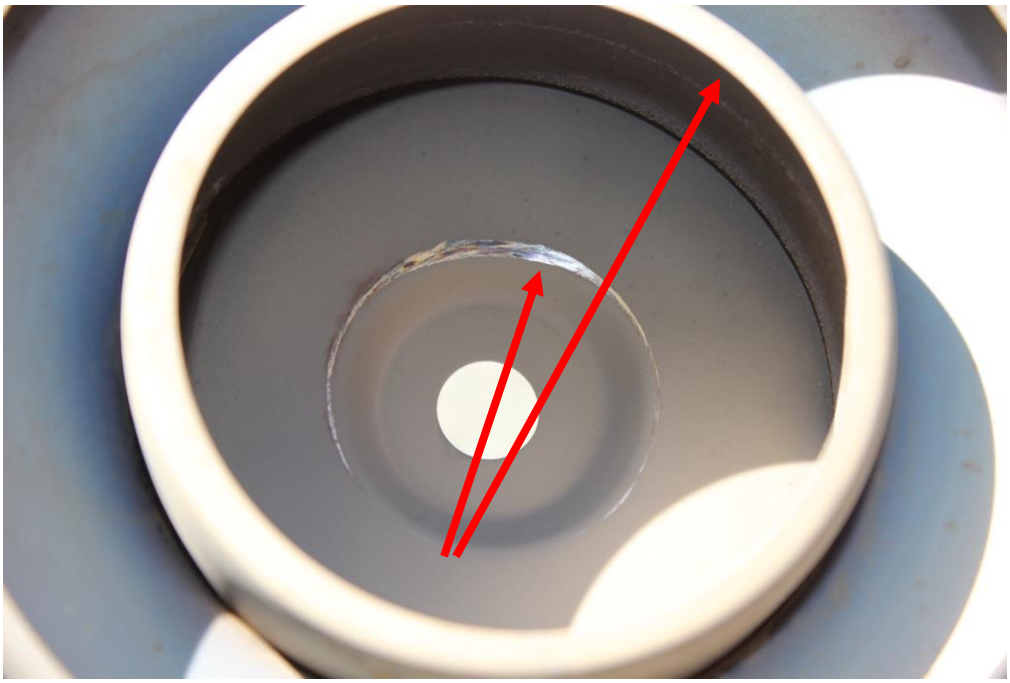

Photo No. 47, view of the downstream side

1st Stage Power Turbine Shroud: The shroud exhibited a rub from both knife edges of the 1st stage power turbine blade tips (Ref. Photo No. 48, red arrows). The surface of the shroud also exhibited some blisters and missing material on the shroud restoration coating that was applied during a previous shop visit (Ref. Photo No. 49).

Photo No. 48

Photo No. 49

1st Stage Power Turbine: The turbine retention nut exhibited circumferential rubs from contact with the downstream side of the 1st stage baffle (Ref. Photos No. 50 & 51, red arrow). The disc exhibited a circumferential rub from contact with the lip of the baffle (Ref. Photo No. 52, red arrow). The tips of the blades had rubbed against their respective shroud (Ref. Photo No. 53, red arrows). The 1st & 2nd stage power turbines were not separated for the purpose of this investigation.

Photo No. 50, view of the upstream side

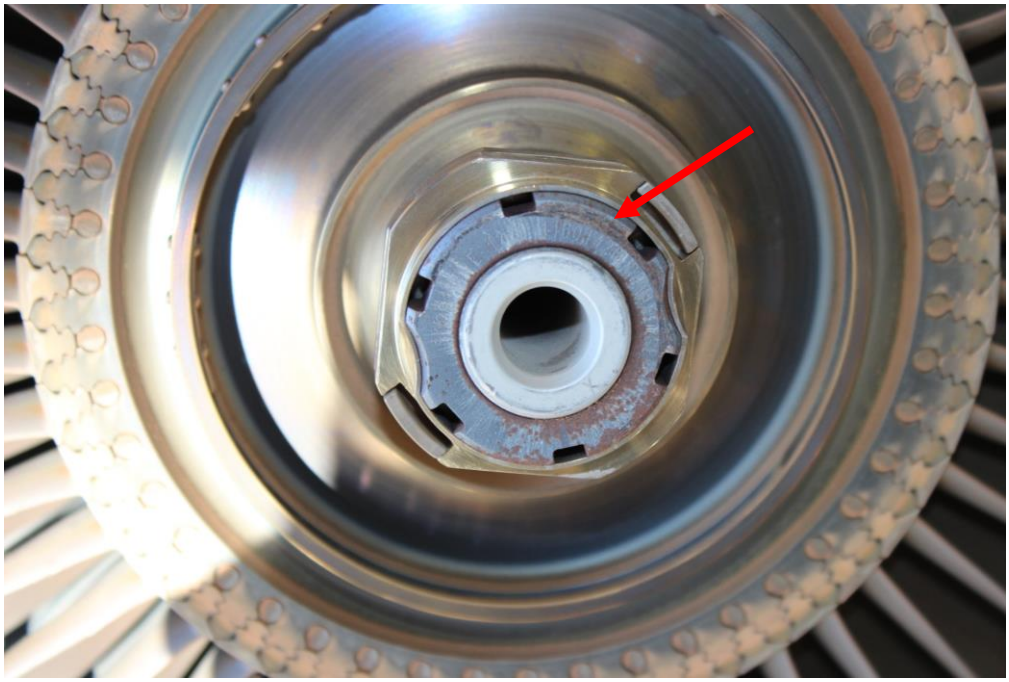

Photo No. 51, view of the upstream side

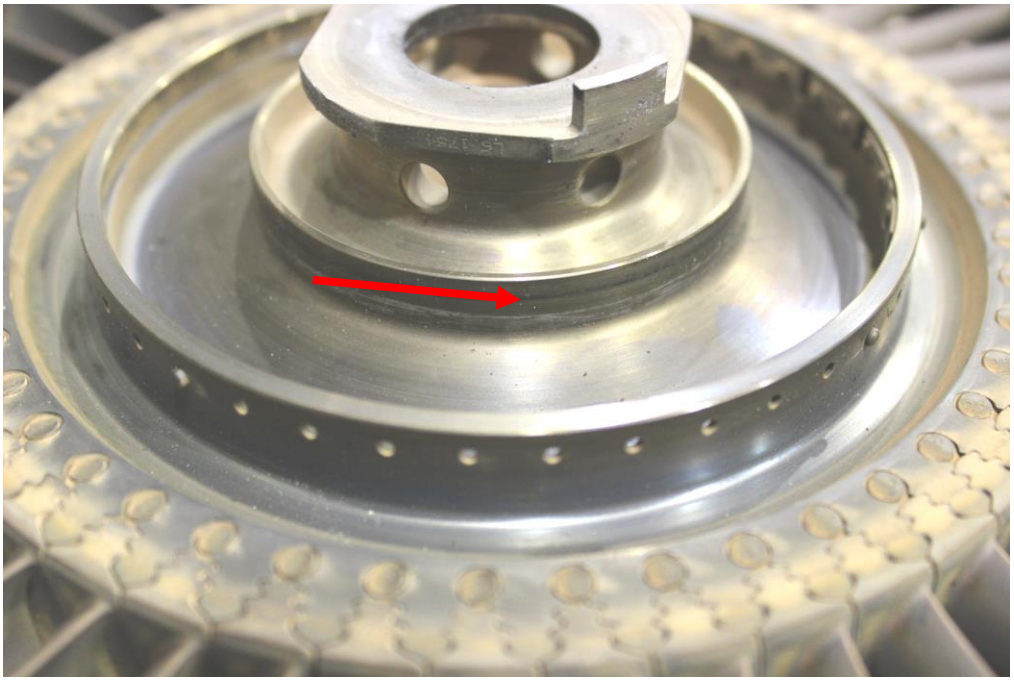

Photo No. 52, view of the upstream side

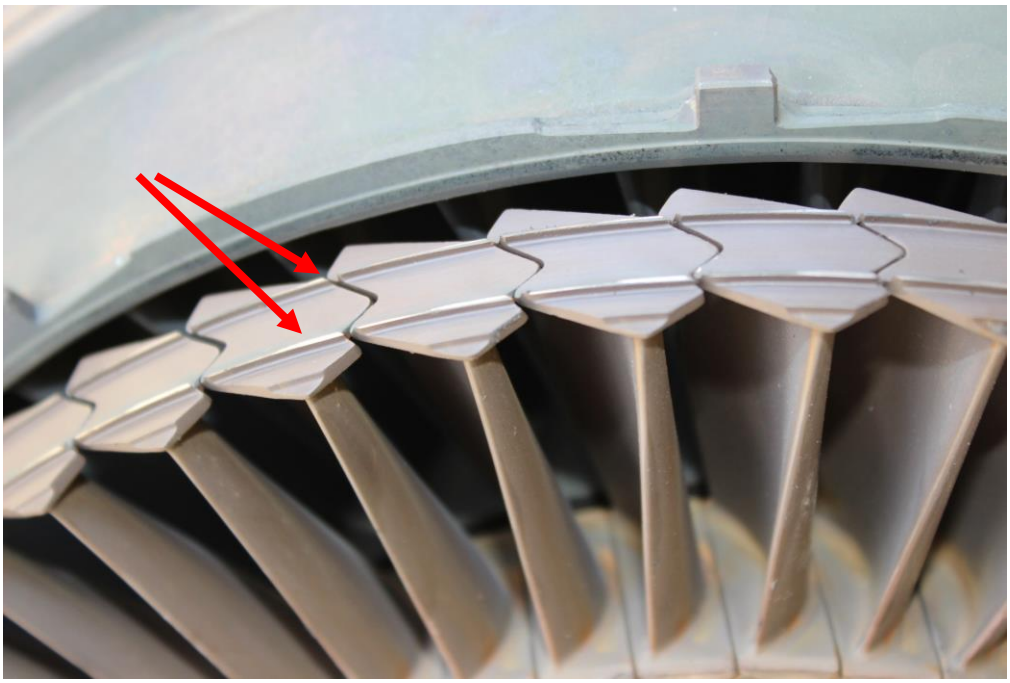

Photo No. 53

2nd Stage Power Turbine Guide Vane Ring and Interstage Baffle: The vane and the baffle were not accessed for the purpose of this investigation.

2nd Stage Power Turbine Shroud: The shroud exhibited localized rubs from contact with the 2nd stage power turbine blade tips (Ref. Photo No. 54, red arrow).

Photo No. 54

2nd Stage Power Turbine: The downstream side of the disc was unremarkable (Ref. Photo No. 55). The blade tips had rubbed with their respective shroud (Ref. Photo 56, red arrow).

Photo No. 55, view of the downstream side

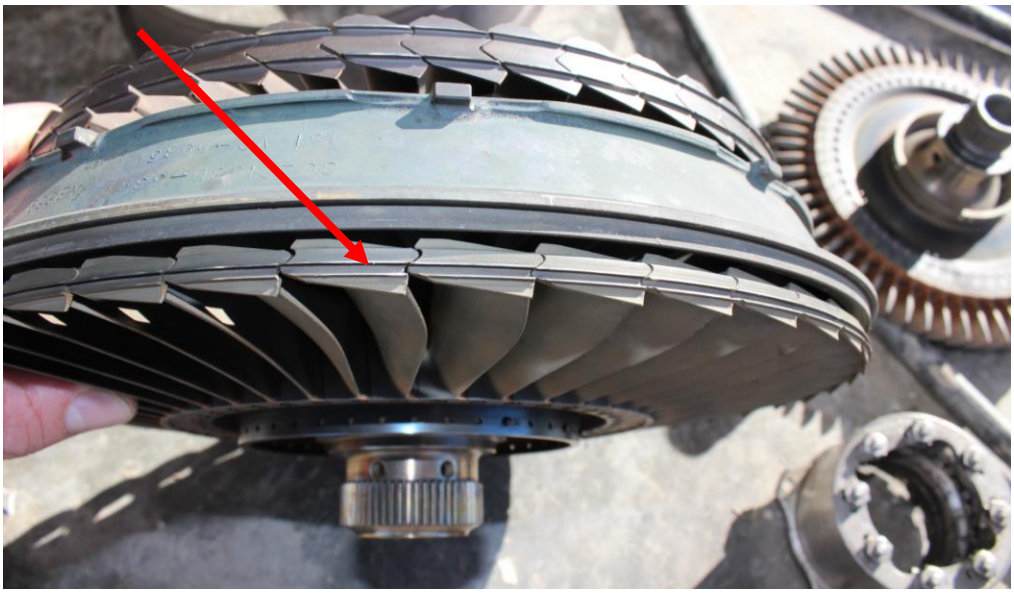

Photo No. 56

Power Turbine Shaft and Shaft Housing: A section of the shaft was visible after the power turbines were removed and was found unremarkable (Ref. Photo No. 57). The housing and the shaft were not accessed for the purpose of this investigation.

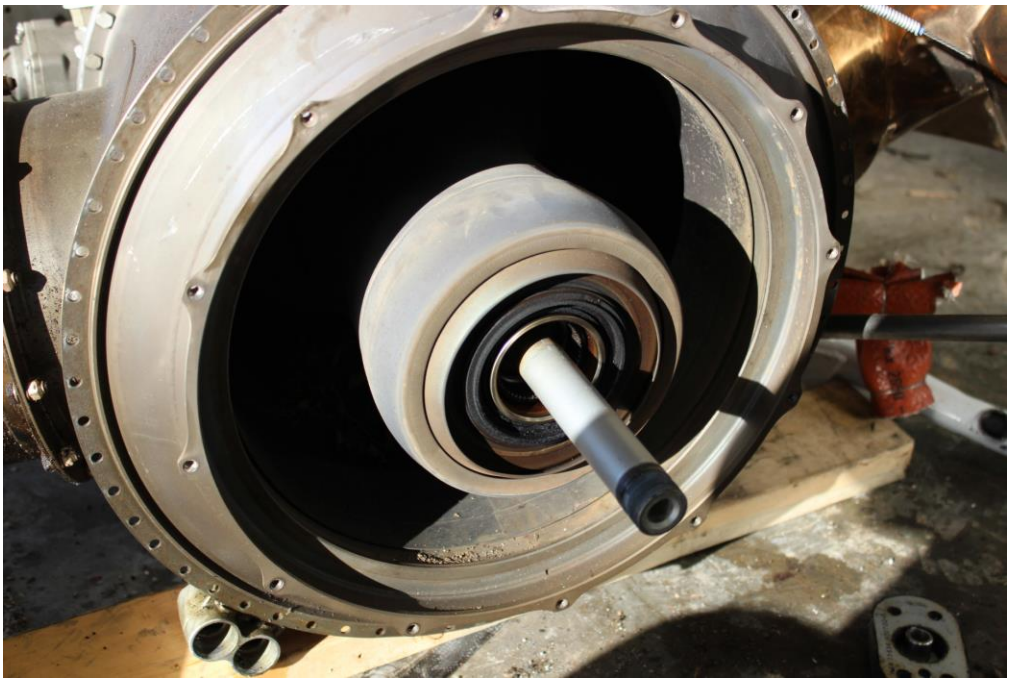

Photo No. 57

3.2.4 **Reduction Gearbox:** The propeller was rotated and the power section components rotated freely and mechanical continuity with the power turbines was evident.

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

1st Stage Sungear: The gear was not accessed for the purpose of this investigation.

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

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

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

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

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

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

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

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

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

Propeller Shaft: The visible section of the shaft was connected to the propeller and was found unremarkable. The shaft was not accessed for the purpose of this investigation.

Nos. 6 and 7 Bearings: The bearings were not accessed for the purpose of this investigation.

Forward Housing: The housing was not disassembled for the purpose of this investigation.

3.2.5 **Accessory Gearbox:** The external accessories were removed and the gearbox gear train was capable of rotation but an audible noise was evident (Ref. Photos No. 58 & 59).

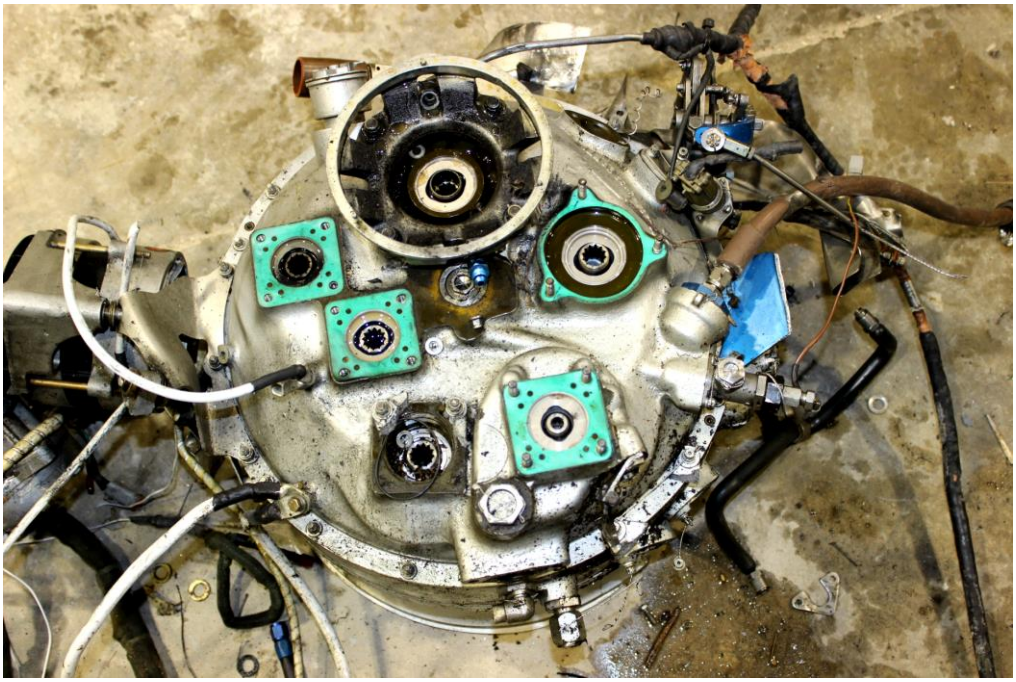

Photo No. 58

Photo No. 59

3.3 Controls and Accessories Evaluation

3.3.1 Ignition System

Exciter Box: The housing was breached at two locations and both ignition lead connectors were pulled from the box (Ref. Photo No. 60).

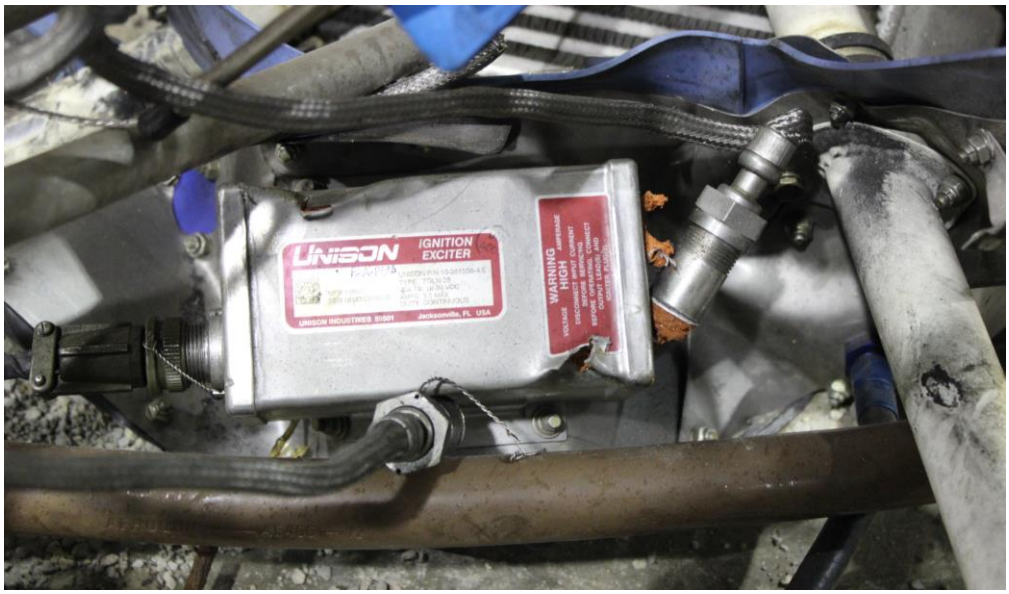

Photo No. 60

Ignition Leads: The leads were in place and secure (Ref. Photo No. 61).

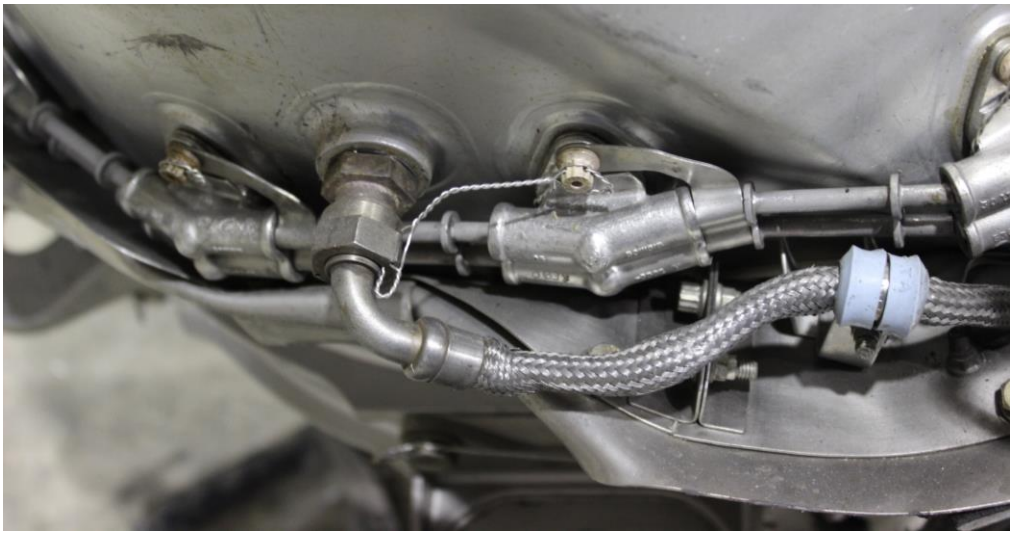

Photo No. 61

Ignition Plugs: Erosion was evident to the tips of both plugs (Ref. Photo No. 62). The ends were scored during the removal process from contact with the liner (Ref. Photo No. 62, red arrows).

Photo No. 62

3.3.2 Fuel System

Fuel Heater: The heater mounting bracket was fractured (Ref. Photo No. 63).

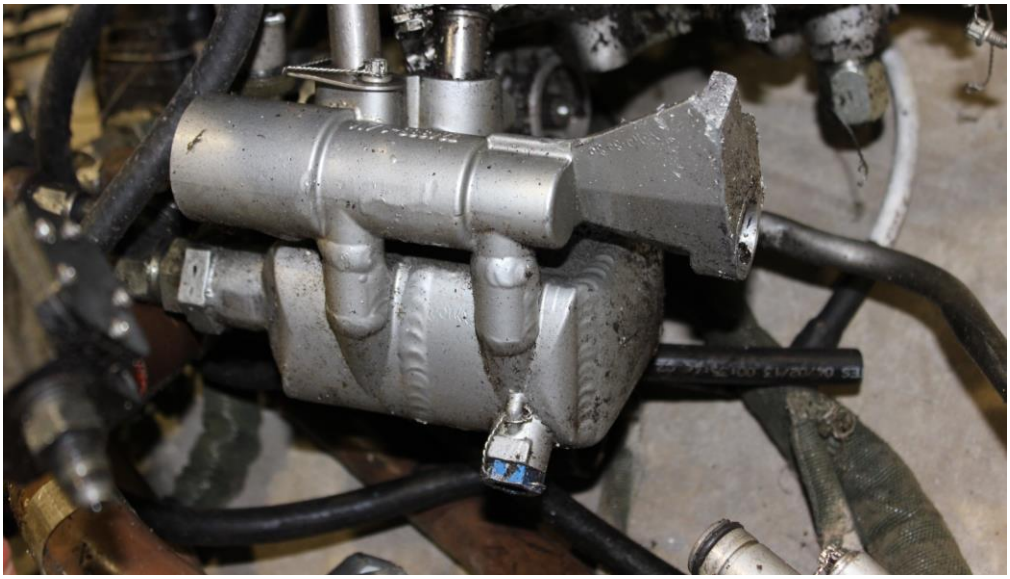

Photo No. 63

Fuel Pump: The pump was in place and secure (Ref. Photo No. 64, blue arrow). The inlet filter and the outlet filter bowl were reinstalled and the pump was forwarded to P&WC's Accessories Investigation for additional testing and analysis (Ref. Photo No. 65).

A visual examination found a dark residue was present in the outlet filter bowl and some residual brown liquid was still in the inlet filter cavity. The liquid was collected for testing. The Chemical analysis of the liquid recovered from the inlet filter cavity identified the presence of water with traces of sulphur, sodium, calcium, and potassium in the presence of oxygen and carbon. Iron oxide was also detected.

The pump was flushed, a clean inlet and outlet filter were installed. The pump was submitted for testing per the manufactures overhaul manual and the test was satisfactory. The pump was disassembled for examination. Corrosion was present on the steel components including the gears (Ref. Photo No. 66). Rust deposits were apparent on the bearings. There was no visible cavitation in the gear pockets, bearings or on the gear teeth (Ref. Photos No. 67 & 68). The corrosion deposit on the gears was not smeared, suggesting that it had formed while the pump was not turning.

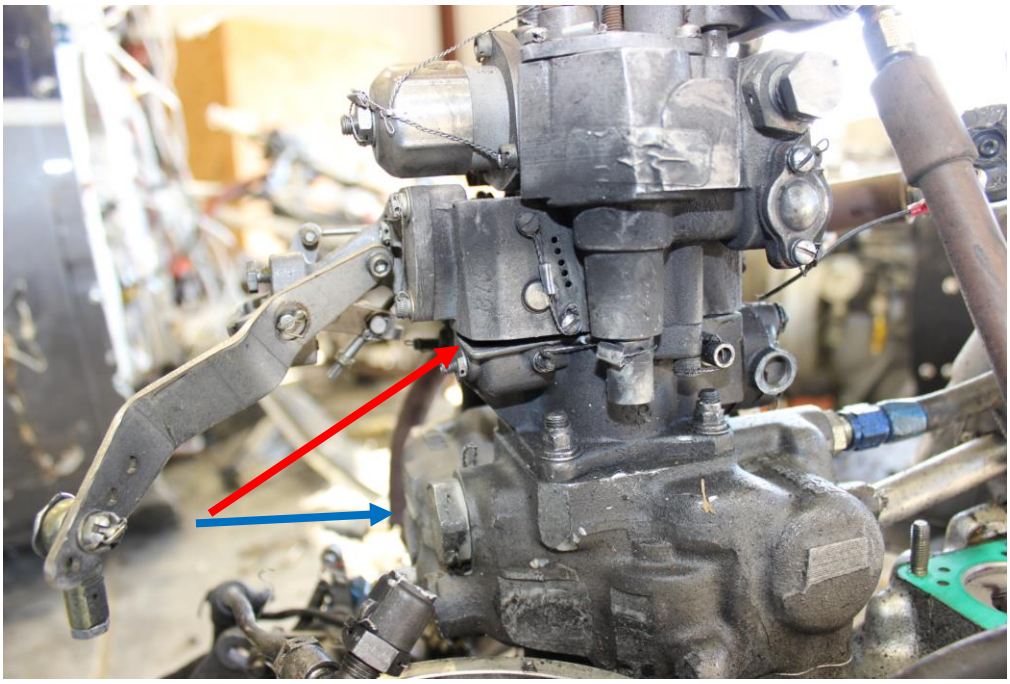

Photo No. 64

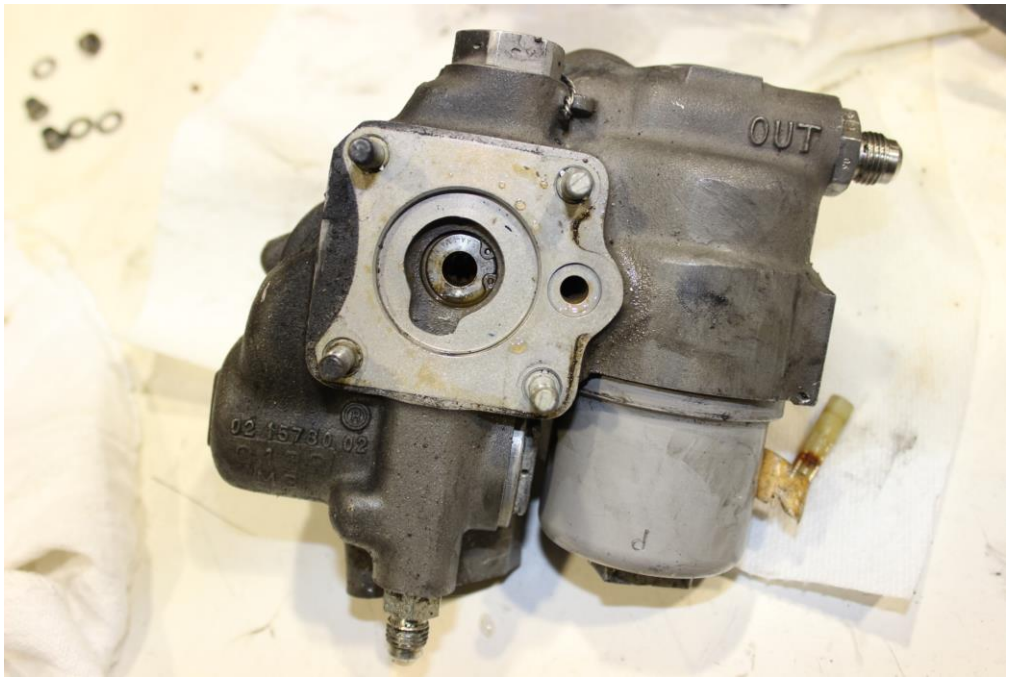

Photo No. 65

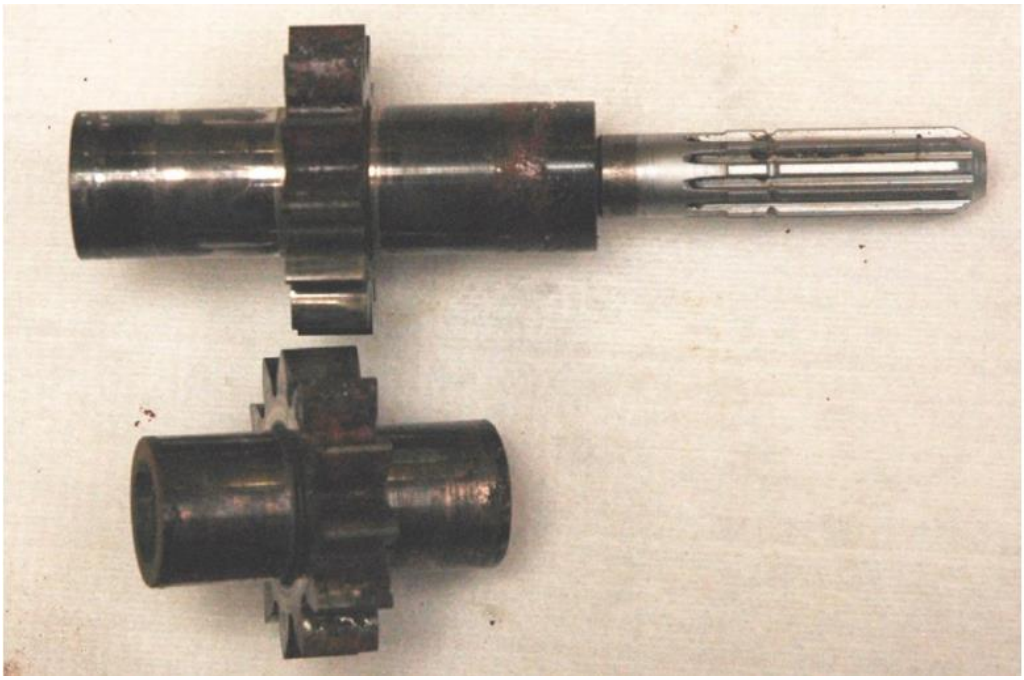

Photo No. 66

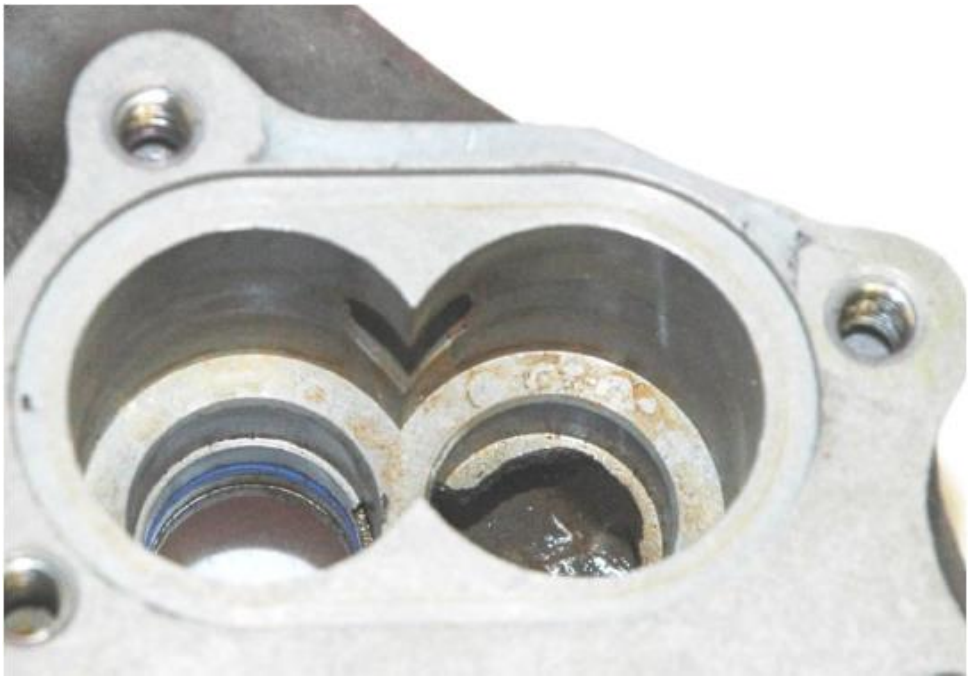

Photo No. 67

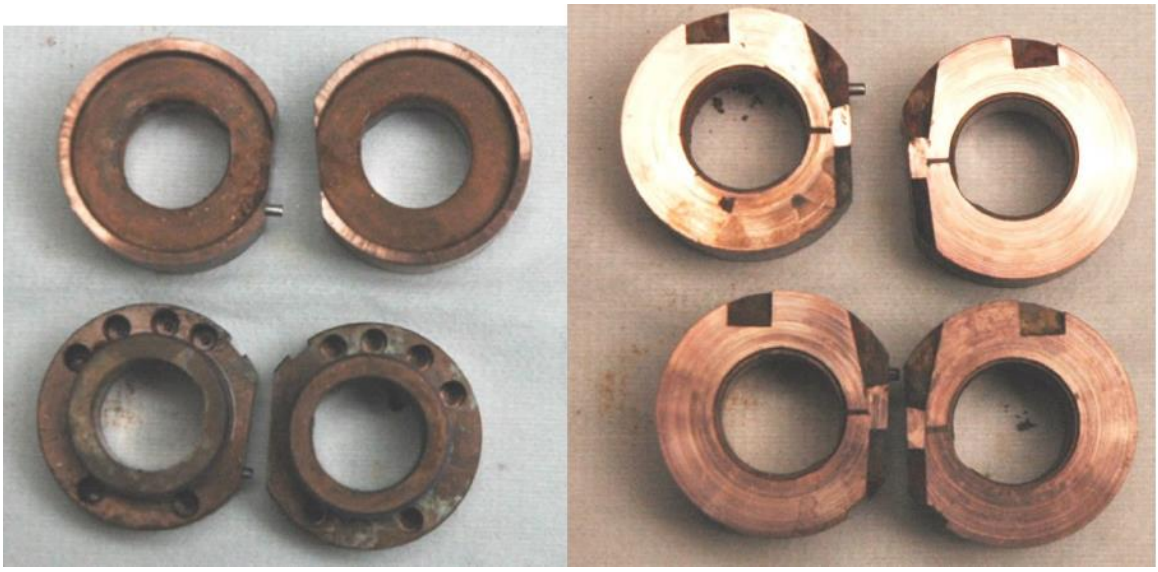

Photo No. 68

Fuel Control Unit: The fuel control unit (FCU) was in place and secure (Ref. Photo No. 64, red arrow). One of the FCU housings was fractured and partially separated from the adjacent housing (Ref. Photos No. 69 & 70, red arrows). Some of the residual fluid that remained on the FCU housing flange after it was separated from the fuel pump appeared to be water (Ref. Photo No. 71, red oval). The FCU was forwarded to P&WC's Accessories Investigation for additional testing and analysis. The fuel pump to FCU coupling surface exhibited a rust coloured stain (Ref. Photo No. 72).

The FCU driveshaft rotation was restricted and the drive-housing was damaged. The drive-body was removed and another drive-body was installed for testing purposes (Ref. Photo No. 73). The FCU was tested per the manufactures overhaul manual. The results were consistent with field adjustments and impact damage, this would not have impeded the function of the control.

The FCU was disassembled. Contamination was present in the spill-valve sleeve and cavity (Ref. Photo No. 74).

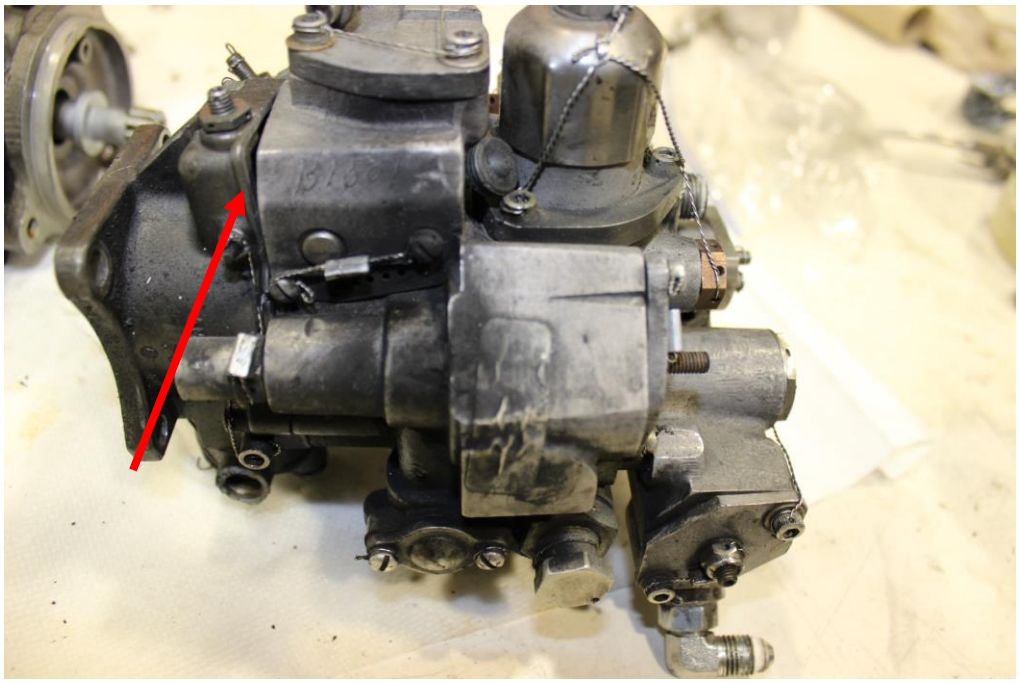

Photo No. 69

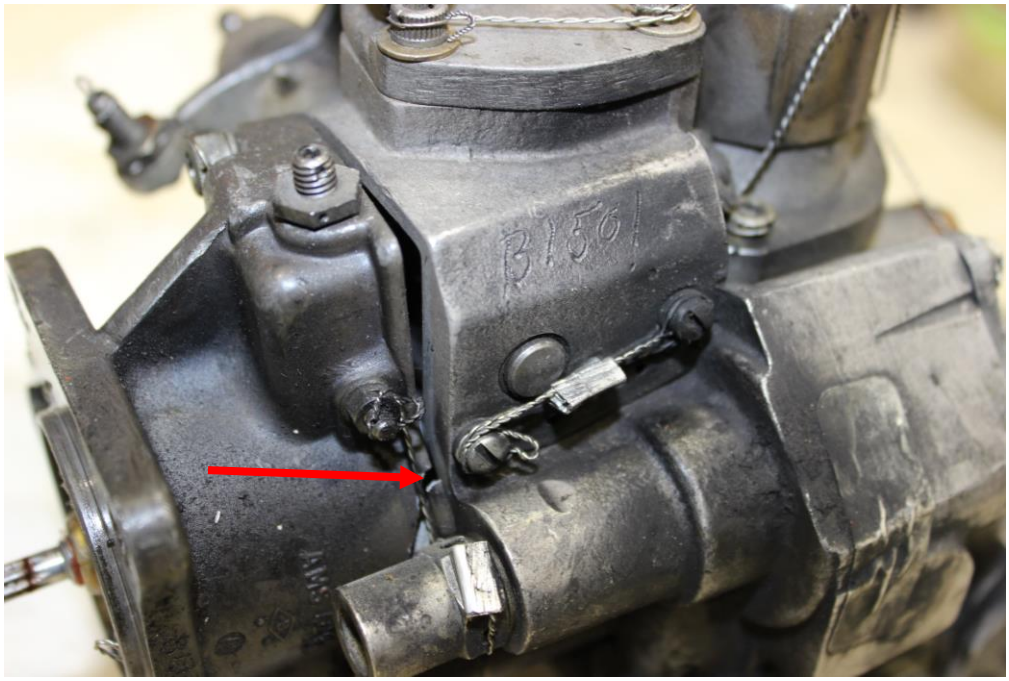

Photo No. 70

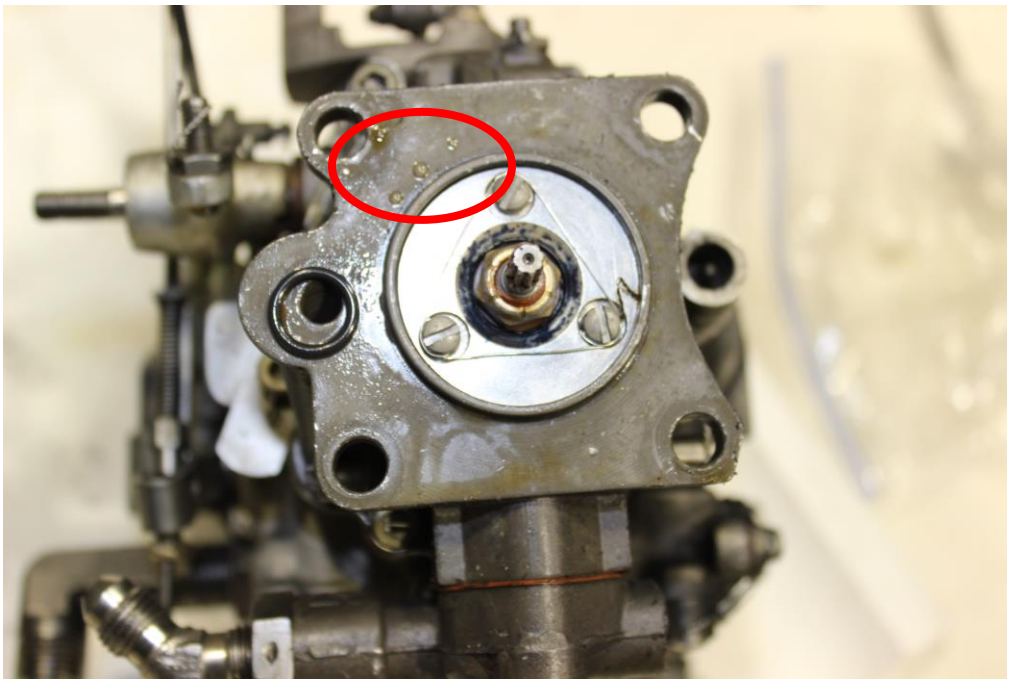

Photo No. 71

Photo No. 72

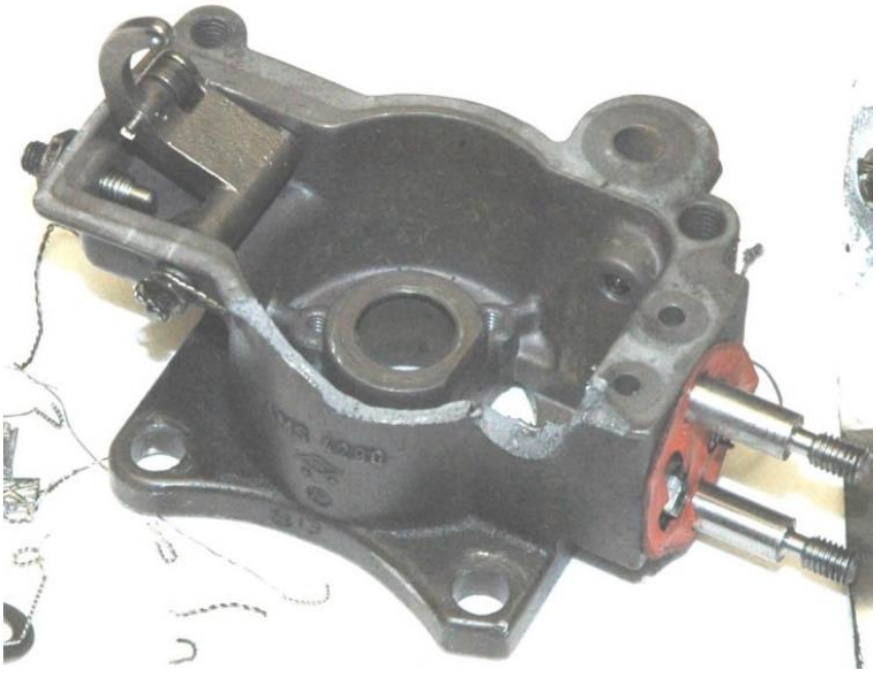

Photo No. 73

Photo No. 74

Flow Divider: The divider was in place and secure (Ref. Photo No. 75). The fuel supply tube from the FCU was removed and some fluid was captured. The fluid was retained by the NTSB for analysis.

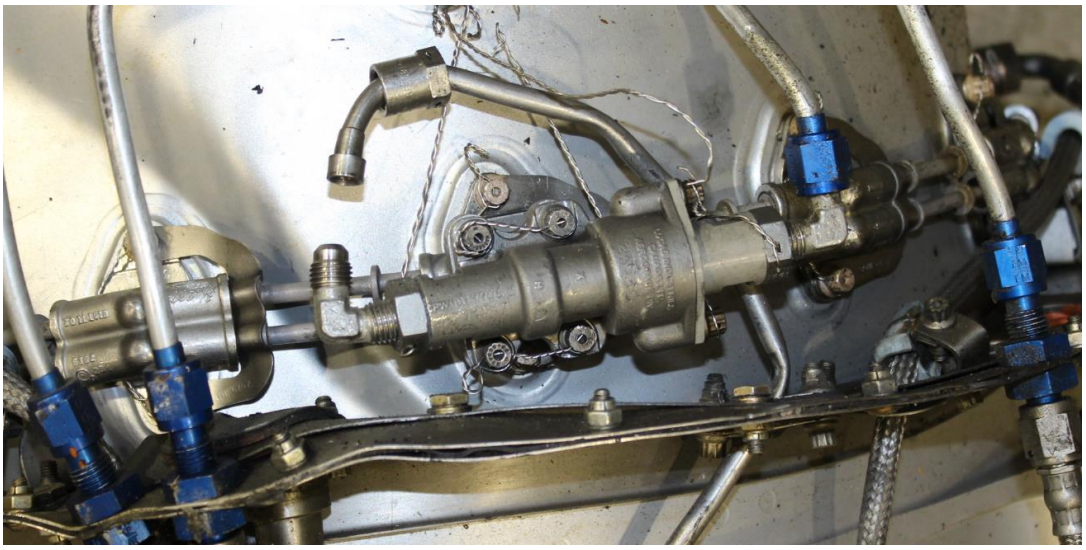

Photo No. 75

Fuel Nozzles: The nozzles were in place and secure (Ref. Photo No. 76). Three nozzles were removed. The nozzle tips were visually inspected and were found unremarkable except for some minor staining (Ref. Photo No. 77).

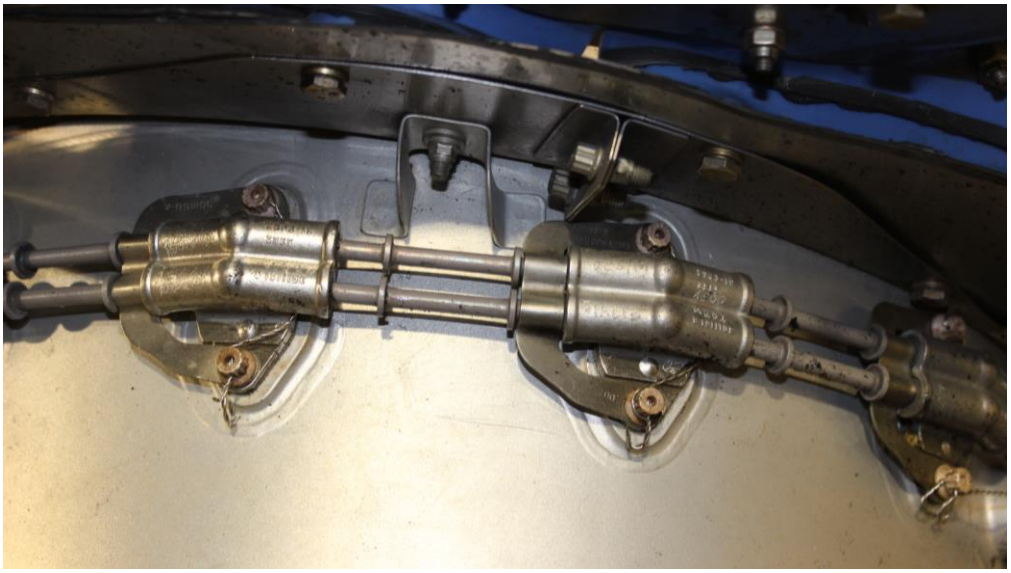

Photo No. 76

Photo No. 77

3.3.3 **Air System:**

Compressor Bleed Valves: Both valves were in place and secure (Ref. Photos No. 78 & 79). The right hand valve housing was fractured at several locations (Ref. Photo No. 78, red arrow).

Photo No. 78, view of the right hand valve

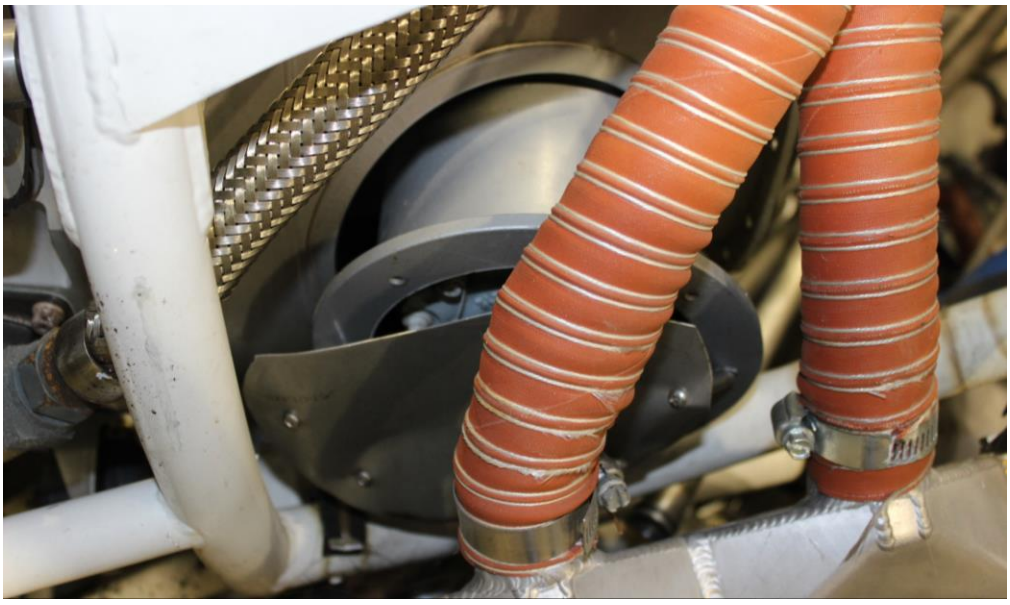

Photo No. 79, view of the left hand valve

3.3.4 **Oil System:**

Propeller Governor: The governor was in place and secure (Ref. Photo No. 80).

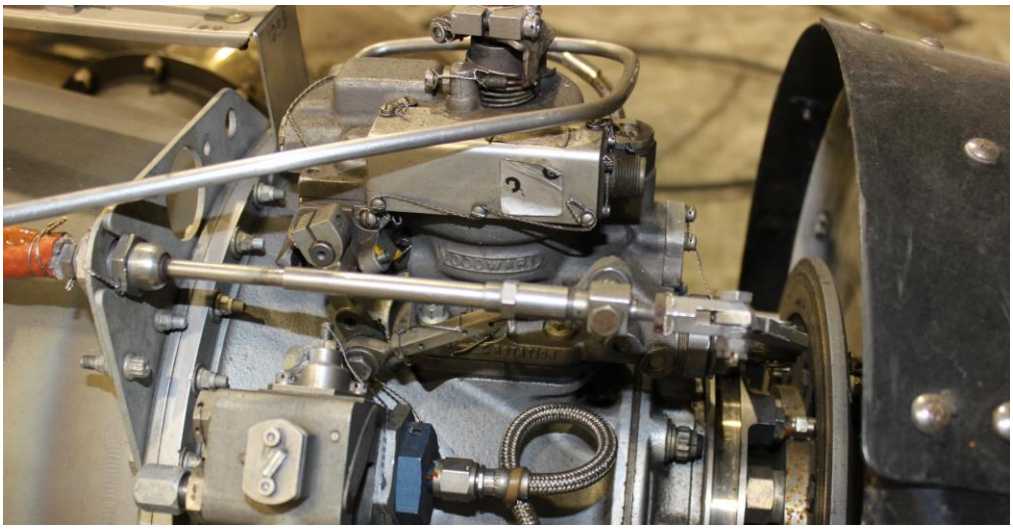

Photo No. 80

Overspeed Governor: The governor was in place and secure (Ref. Photo No. 81).

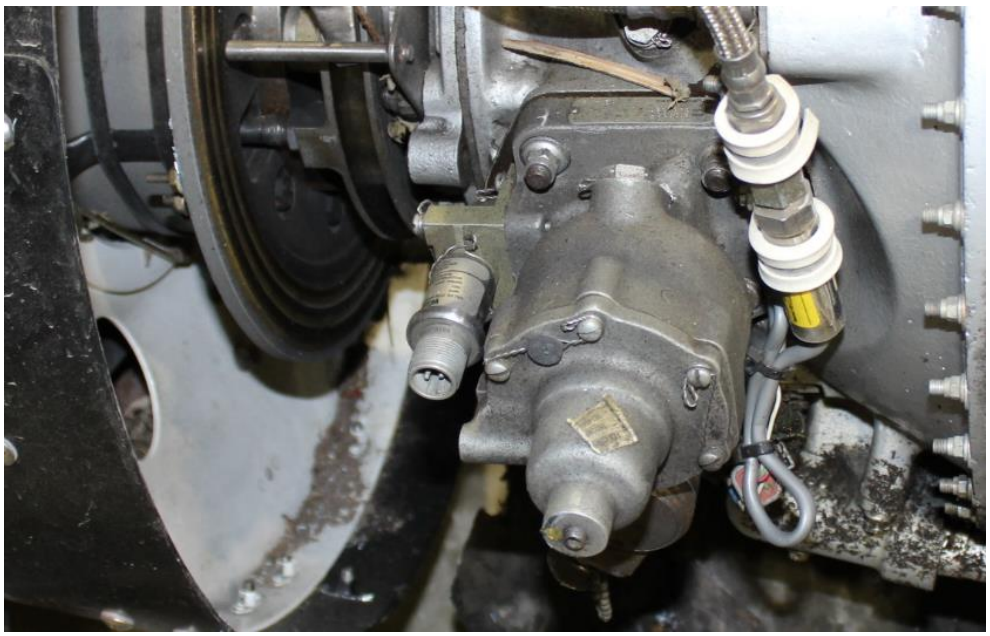

Photo No. 81