

Accident / Incident Report

P&WC 8114 (11-98)

**Pratt & Whitney Canada**

A United Technologies Company

Report No.: 17-183

[REDACTED]
Beech C90, N500KR
Rockford, Illinois
December 4th 2017
PT6A-21
Left-hand S/N 24390
Right-hand S/N 24387

[REDACTED]
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I ANALYSIS

1.0 ACCIDENT SYNOPSIS

On December 4th 2017, a Beech C90, N500KR impacted the terrain near the Chicago/Rockford International Airport. The pilot and one passenger sustained serious injuries and two passengers sustained minor injuries. The airplane fuselage was damaged during impact.

2.0 SUMMARY OF FINDINGS

The left and right hand engines both sustained compressional damage to their exhaust ducts and the gas generator cases were bent during impact.

The left hand engine's fuel pump displayed cavitation pits on the front and rear plain bearings, the discoloration on the bearings, polishing of the housing and the scoring on the shafts indicates that the pump was operated without an adequate supply of fuel.

The right hand engine's fuel pump displayed cavitation pits on the front plain bearing, several pits on one of the rear bearings, polishing of the pump housing, and the scoring on the shafts indicates that the pump was operated without an adequate supply of fuel.

3.0 CONCLUSIONS

The fuel pumps from both engines exhibited evidence of cavitation from a lack of lubrication on the plain bearings. This damage is consistent with the pumps operating without an adequate fuel supply.

There was no evidence of pre-impact mechanical anomalies on either engine which would have prevented normal operation.



II FACTUAL INFORMATION

1.0 INVESTIGATION PARTICIPANTS

The powerplant investigation was performed on January 31st 2018, at the Emory Air Facilities in Rockford, Illinois. The following individuals participated in the investigation as representatives of their respective organisations:

Edward Malinowski	National Transportation Safety Board Senior Air Safety Investigator
Jeff Davis	Pratt & Whitney Canada Investigator

2.0 LEFT HAND ENGINE HISTORY

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.

PT6A-21 S/N 24390

Hours Since New: 9602.6

Cycles Since New: 9104

Hours Since Overhaul: 2472.4

Cycles Since Overhaul: 2429

The times and cycle information was obtained from an Aircraft Due List Report, from Air Care Inc., Aviation Services, dated 6/9/2015.

3.0 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 blades displayed varying degrees of bending and the aircraft cowling was bent and distorted at numerous locations (Ref. Photos No. 1 & 2). The engine was attached to the aircraft mounts (Ref. Photo No. 3). The engine data plate shows the engine serial number is PC-E 24390 (Ref. Photo No. 4).

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Photo No. 1



Photo No. 2

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Photo No. 3

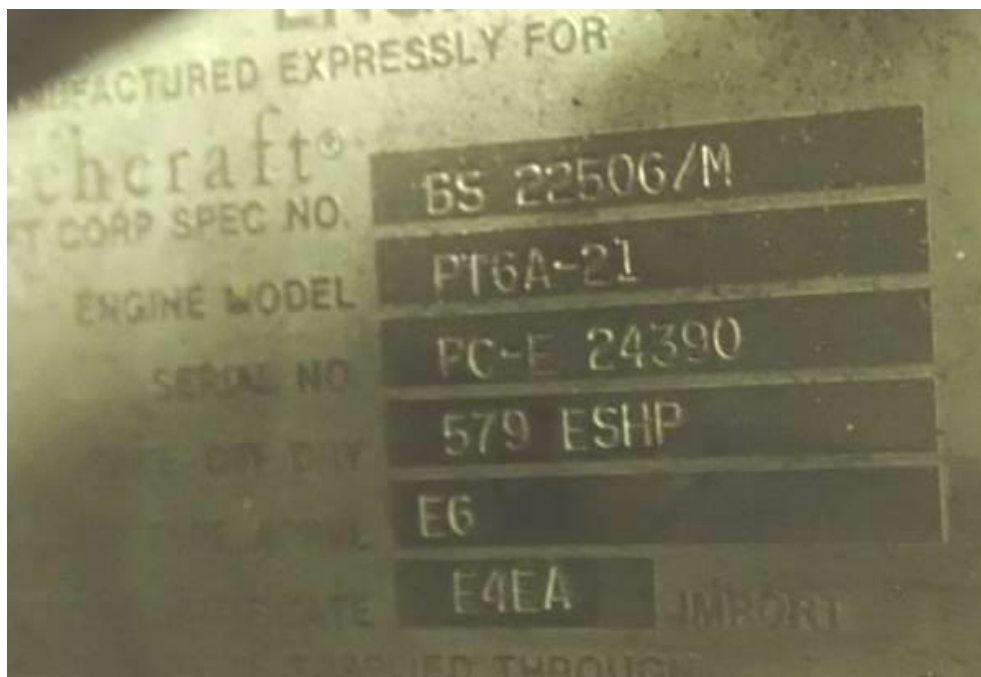


Photo No. 4



3.1.1 External Cases

Reduction Gearbox: The gearbox was in place and no visible external damage was evident (Ref. Photo No. 5, red arrow).

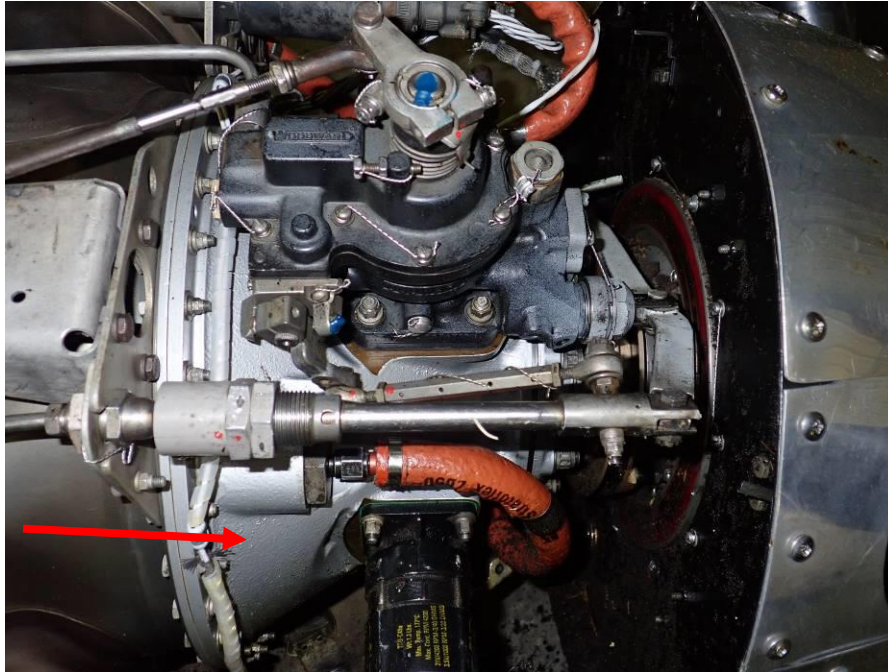


Photo No. 5

Exhaust Duct: The right hand side of the duct was compressed (Ref. Photo No. 6, red arrow).

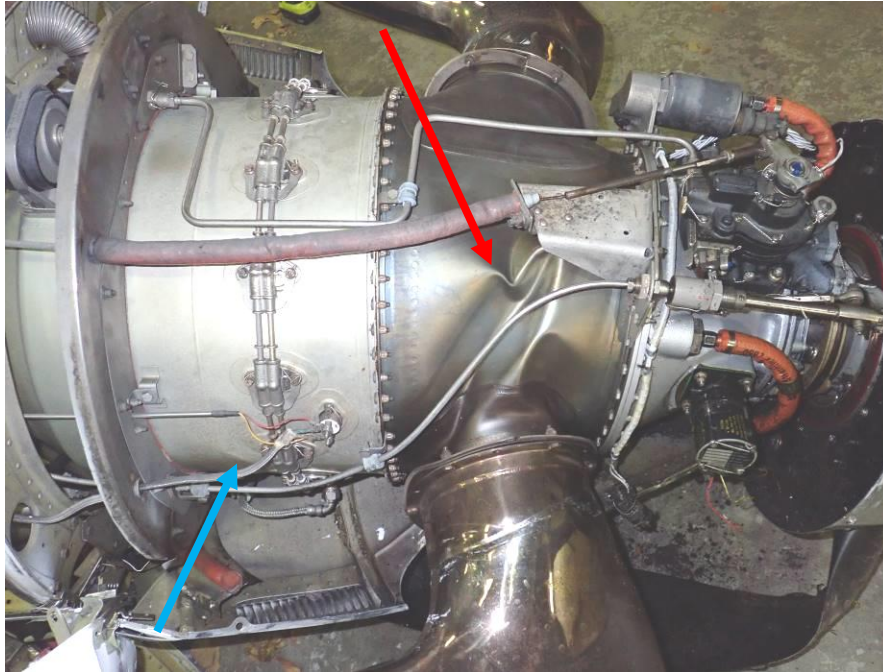


Photo No. 6

Gas Generator Case: The case was bent adjacent to the right hand igniter plug (Ref. Photo No. 6, blue arrow). The visible portion of the rear section of the case was unremarkable (Ref. Photo No. 7, blue arrow).

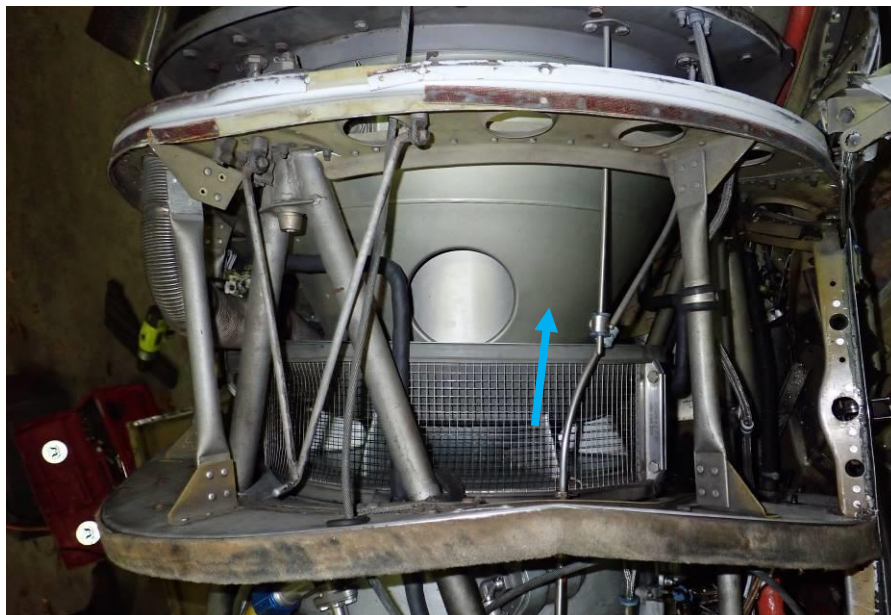


Photo No. 7



Accessory Gearbox: The gearbox and inlet case were in place and no visible external damage was evident (Ref. Photo No. 8).

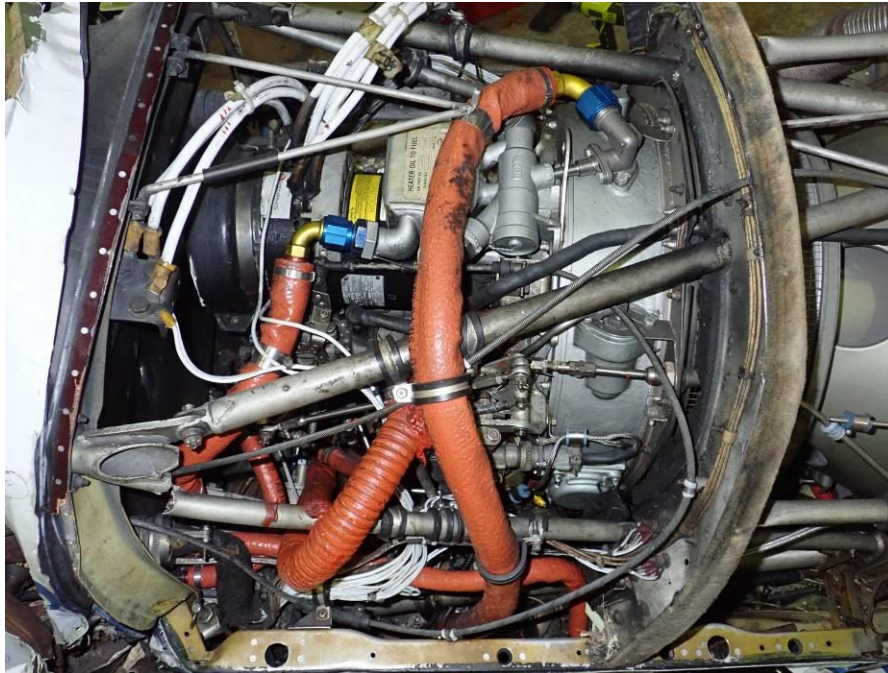


Photo No. 8

3.1.2 Power Control and Reversing Linkage: The propeller reversing lever and guide pin were bent (Ref. Photo No. 9, red arrows). The front linkage was in place (Ref. Photo No. 10, red arrow). The rear linkage was in place (Ref. Photo No. 11, red arrows). The end of the fuel control connection rod was bent (Ref. Photo No. 12, red arrow).

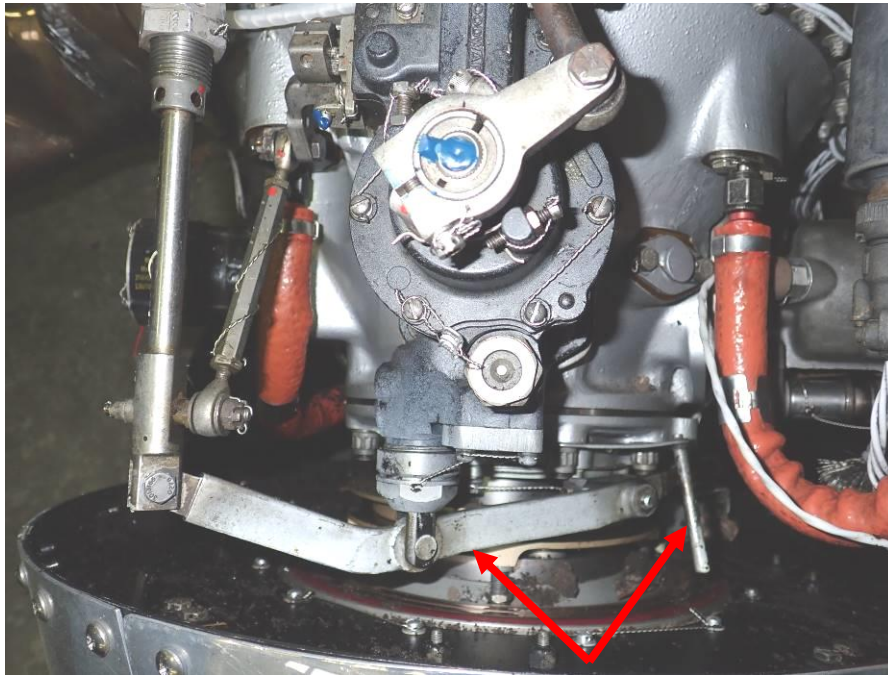


Photo No. 9

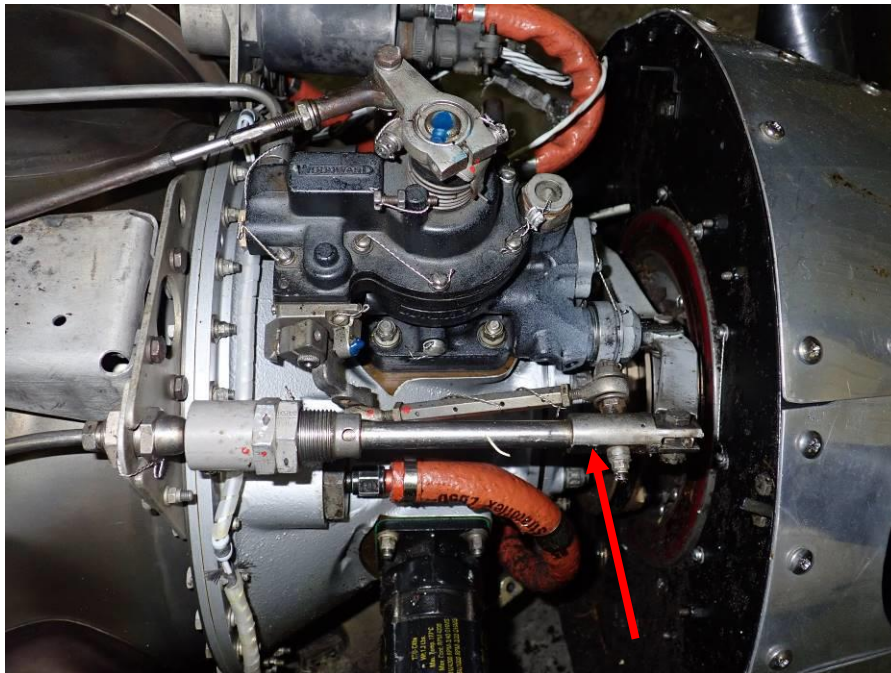


Photo No. 10

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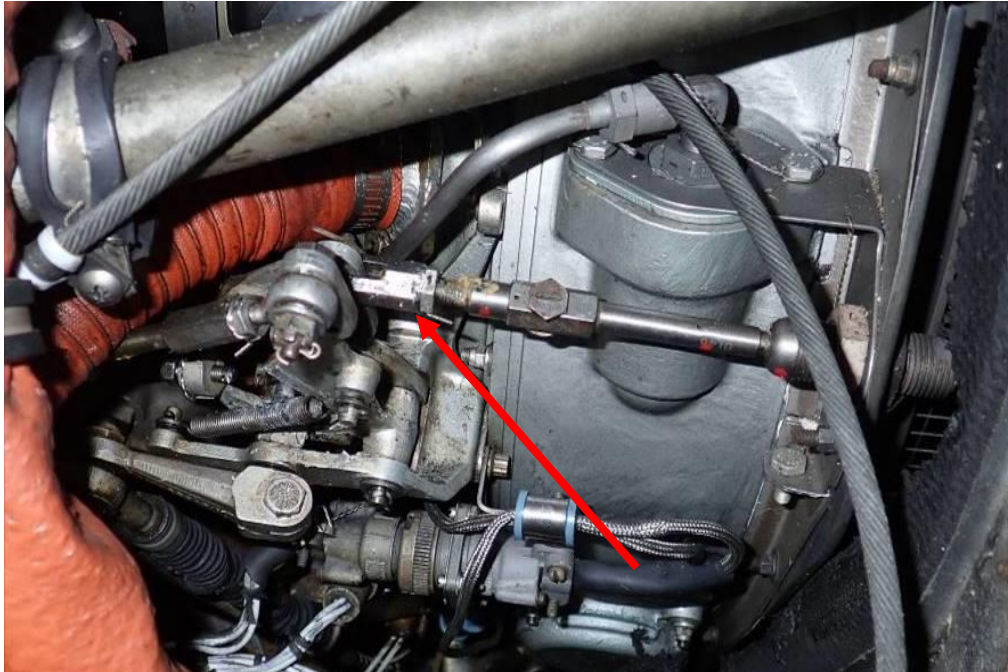


Photo No. 11

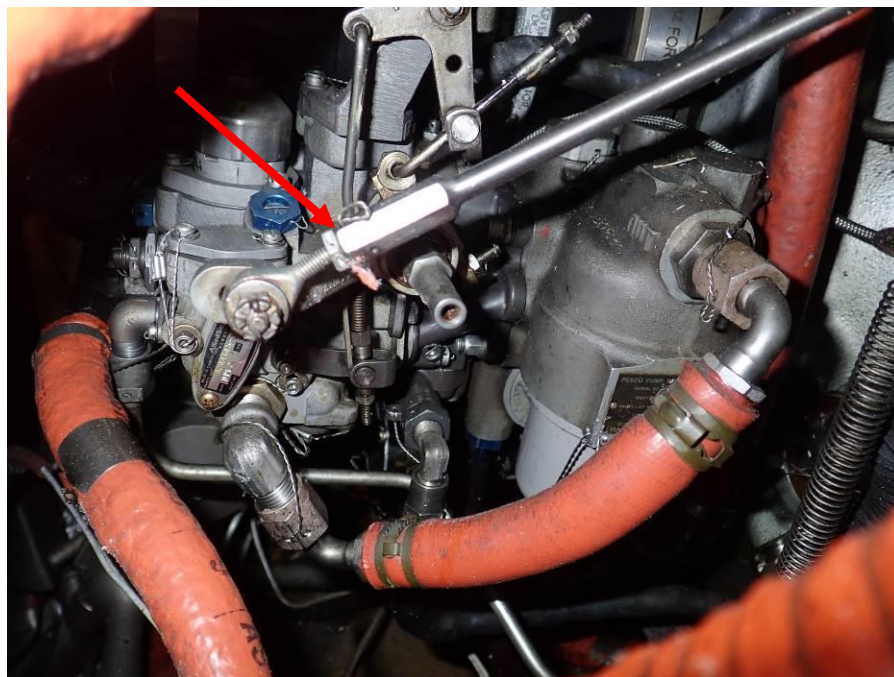


Photo No. 12



3.1.3 Pneumatic Lines

Compressor Discharge Air (P3): The line was in place and the fitting connections were secure (Ref. Photo No. 13, red arrow).

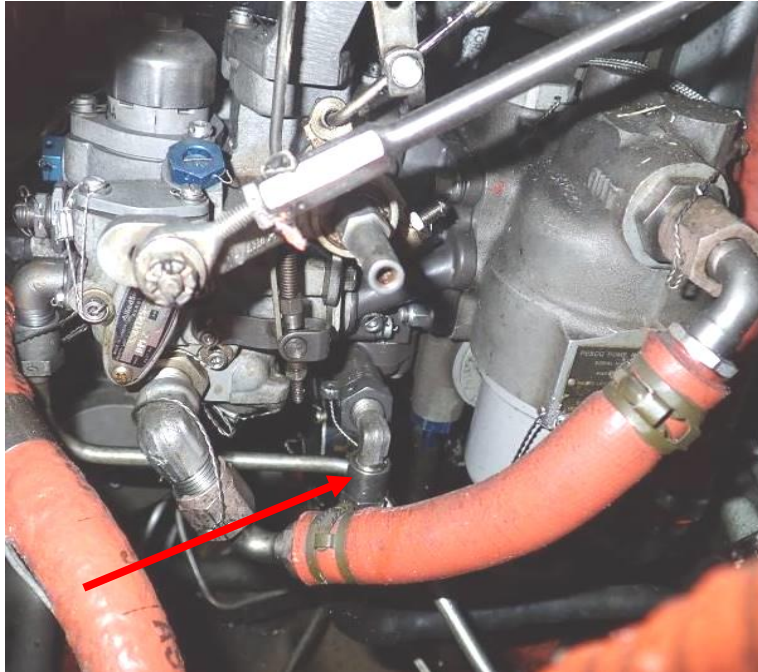


Photo No. 13

Power Turbine Control (Py): The line was in place and the fitting connections were secure (Ref. Photos No. 14 & 15, red arrows).

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Photo No. 14

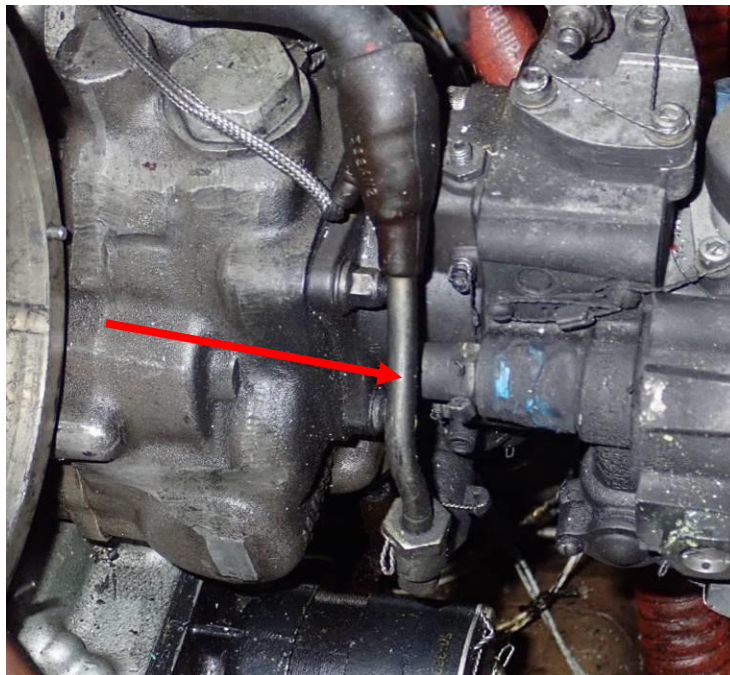


Photo No. 15



3.1.4 Chip Detectors and Filters

Reduction Gearbox Chip Detector: The chip detector was removed and a lock washer fell out of the gearbox port (Ref. Photo No. 16, red arrow). Some magnetic debris was adhered to the magnetic poles (Ref. Photo No. 17).

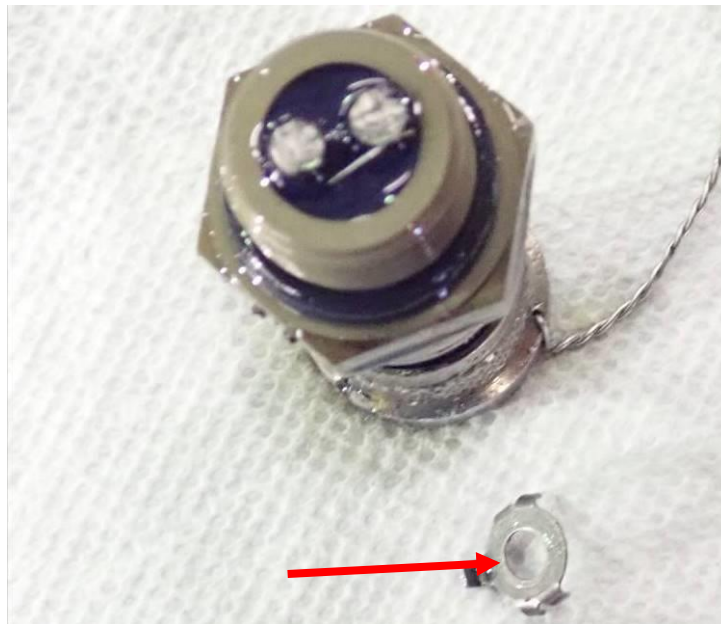


Photo No. 16



Photo No. 17



Oil Filter: No visible debris was evident in the oil filter (Ref. Photo No. 18).



Photo No. 18

Fuel Filter: The filter was discoloured, most likely from sediment in the fuel (Ref. Photo No. 19). The residual fuel in the filter bowl was clean but the interior of the bowl was stained (Ref. Photo No. 20).



Photo No. 19



Photo No. 20

3.2 Disassembly Observations

3.2.1 **Compressor Section:** The inlet screen was removed to view the 1st stage compressor blades. The visible portions of the 1st stage compressor blades were unremarkable. The compressor was manually rotated by the 1st stage blades and mechanical continuity was established with the accessory gearbox.

3.2.2 **Combustion Section:** The engine was not disassembled to access the combustion section for the purpose of this investigation.

3.2.3 **Turbine Section:** The engine was not disassembled to access the turbine section for the purpose of this investigation. Manual rotation of the power section was not attempted as the propeller blades were bent and touching the floor.

Power Turbine: The left hand exhaust stack was removed and the power turbine was viewed through the exhaust port. Several of the turbine blades were partially fractured (Ref. Photo No. 21, red arrow).



Photo No. 21

3.2.4 **Reduction Gearbox:** The gearbox section was not disassembled for the purpose of this investigation.

3.2.5 **Accessory Gearbox:** The gearbox section was not disassembled for the purpose of this investigation.

3.3 Controls and Accessories Evaluation

3.3.1 Ignition System

Exciter Box: The box was attached to its respective mount on the aircraft. The exterior of the box exhibited impact damage (Ref. Photo No. 22).



Photo No. 22

Ignition Leads: The leads were in place and did not display any visible distress (Ref. Photo No. 23, blue arrow).

Ignition Plugs: The plugs were in place and secure (Ref. Photo No. 23, red arrow).

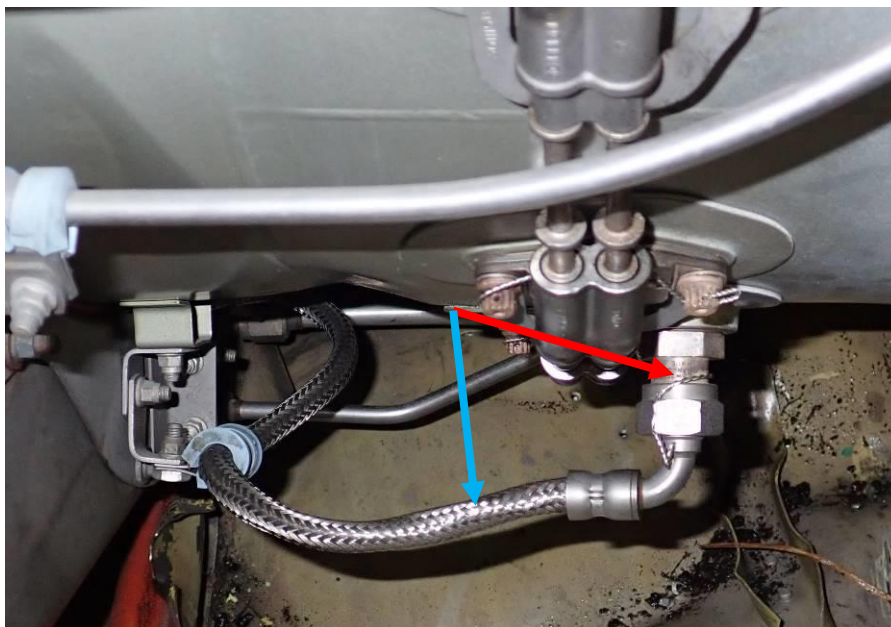


Photo No. 23



3.3.2 Fuel System

Fuel Heater: The heater was in place on the accessory gearbox (Ref. Photo No. 24, red arrow).



Photo No. 24

Fuel Pump: The pump was in place on its respective accessory gearbox mounting pad. The pump was removed (Ref. Photo No. 25, red arrow) from the gearbox and it was separated from the fuel control. The pump was capable of manual rotation. The inlet filter was removed, no contamination was noted, but the strainer portion was stained (Ref. Photo No. 26). The pump was disassembled (Ref. Photo No. 27).

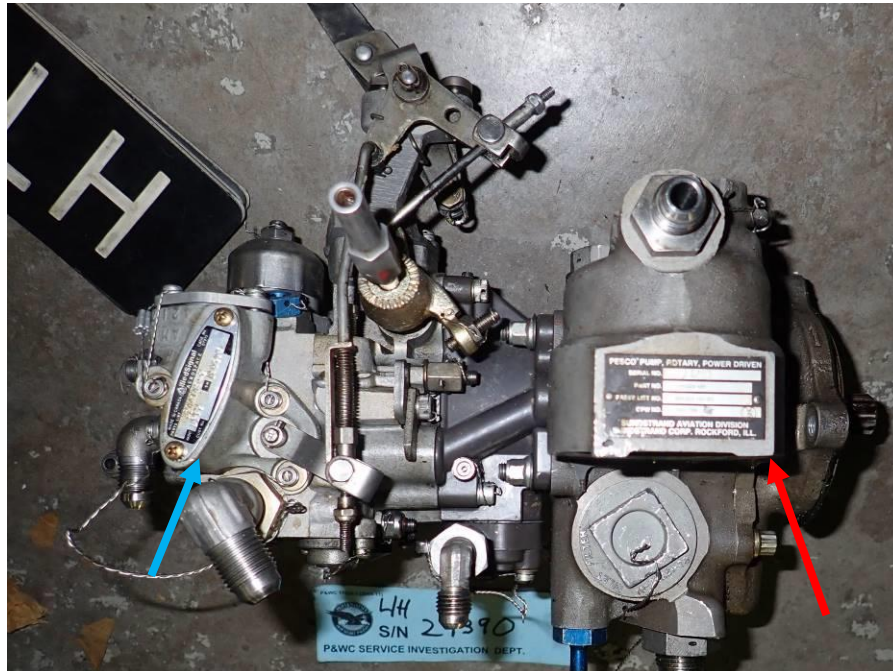


Photo No. 25



Photo No. 26



Photo No. 27

The fuel pump housing exhibited some polished regions from contact with the gears (Ref. Photo No. 28, red arrow). The teeth on both gears exhibited frosted regions on their contact surfaces (Ref. Photos No. 29 & 30). Light scoring was evident on the shaft bearing land surfaces of the gears (Ref. Photo No. 29).

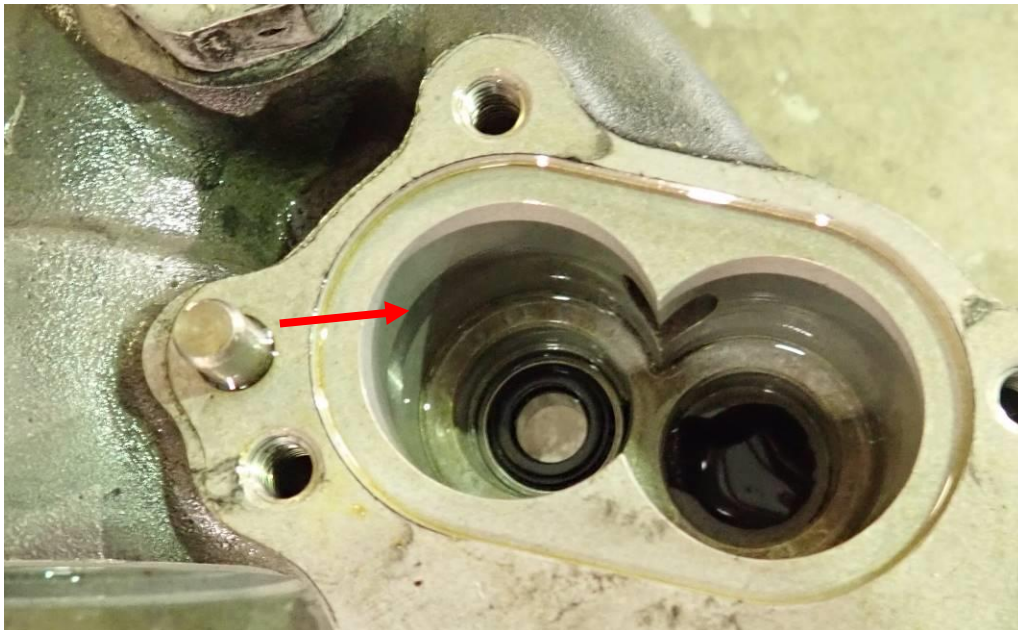


Photo No. 28



Photo No. 29



Photo No. 30



The front bearings exhibited multiple cavitation pits on their front face, which does not have contact with the gears (Ref. Photo No. 31). The bearings exhibited multiple cavitation pits on the gear contact faces and in the plain bearing bores (Ref. Photos No. 32 & 33). Some localized discoloration was observed adjacent to some of the pits. The pump surfaces are lubricated by the fuel passing through the pump. The bearing cavitation pits indicates that pump was operated without an adequate fuel supply.



Photo No. 31, Front bearings



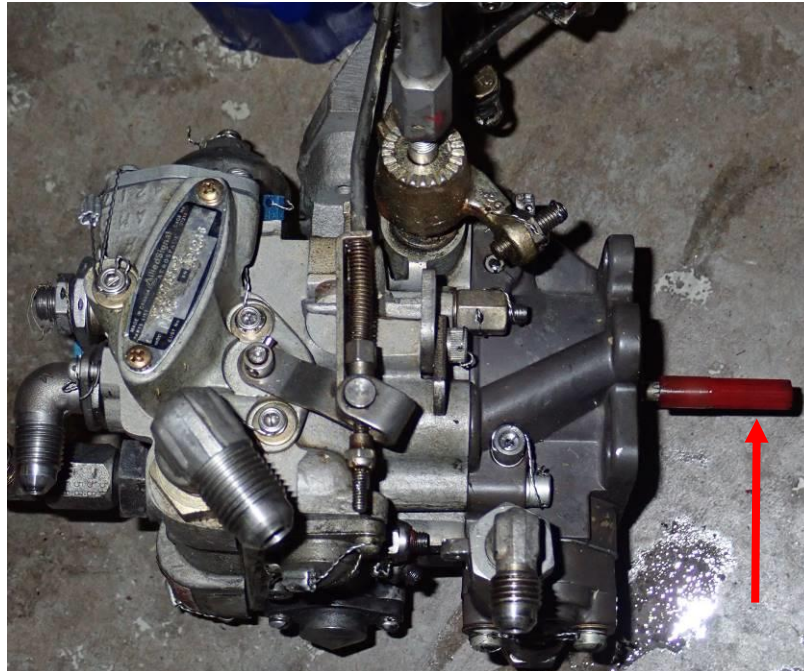
Photo No. 32, Front bearings



Photo No. 33, Rear bearings



Fuel Control Unit: The control was secured to the mounting pad on the fuel pump (Ref. Photo No. 25, blue arrow). The control was removed from the pump (Ref. Photo No. 34). The fuel control to fuel pump coupling was found unremarkable (Ref. Photo No. 34, red arrow). The control rotated freely with manual input on the drive shaft.



Ref. Photo No. 34

Flow Divider: The divider was in place and was visually unremarkable.

Fuel Nozzles: The nozzles were in place and were visually unremarkable (Ref. Photo No. 35).

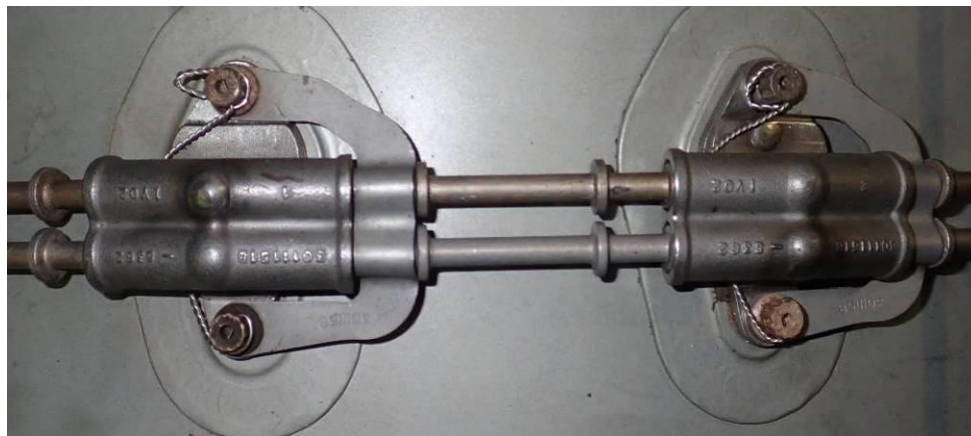


Photo No. 35



3.3.3 Air System:

Compressor Bleed Valve: The valve was not accessed for the purposes of this investigation.

3.3.4 Oil System:

Propeller Governor: The governor was in place and was visually unremarkable (Ref. Photo No. 36).

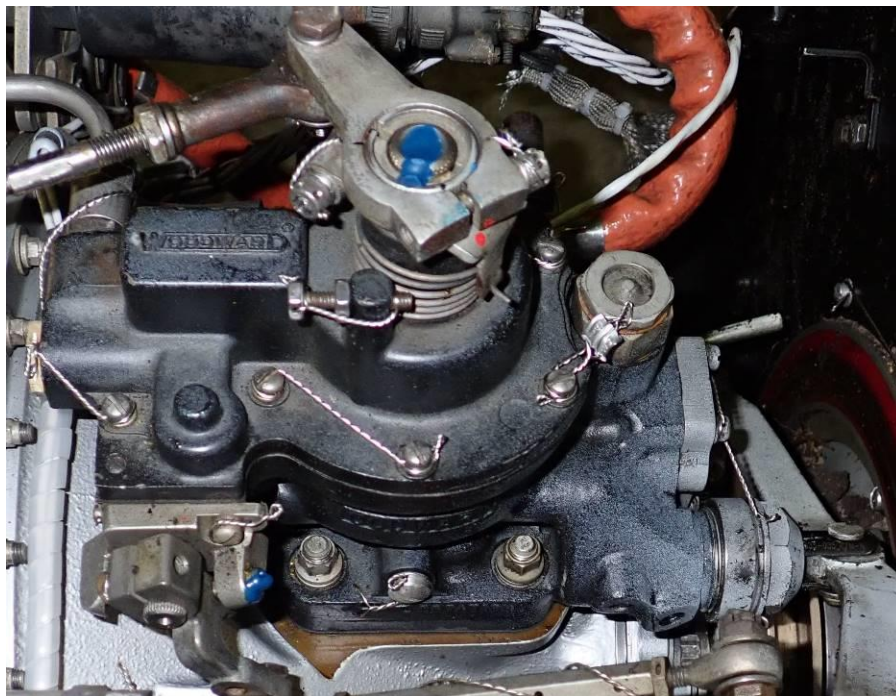


Photo No. 36



Overspeed Governor: The governor was in place and was visually unremarkable (Ref. Photo No. 37).



Photo No. 37

4.0 **RIGHT HAND ENGINE HISTORY**

PT6A-21 S/N 24387

Hours Since New: 9575.7

Cycles Since New: 9523

Hours Since Overhaul: 2545.9

Cycles Since Overhaul: 2503

The times and cycle information was obtained from an Aircraft Due List Report, from Air Care Inc., Aviation Services, dated 6/9/2015.



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 blades displayed varying degrees of bending and the aircraft cowling was bent and distorted at numerous locations (Ref. Photos No. 38 & 39). The engine was attached to the aircraft mounts (Ref. Photo No. 40). The engine data plate shows the engine serial number is PC-E 24387 (Ref. Photo No. 41).



Photo No. 38

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Photo No. 39

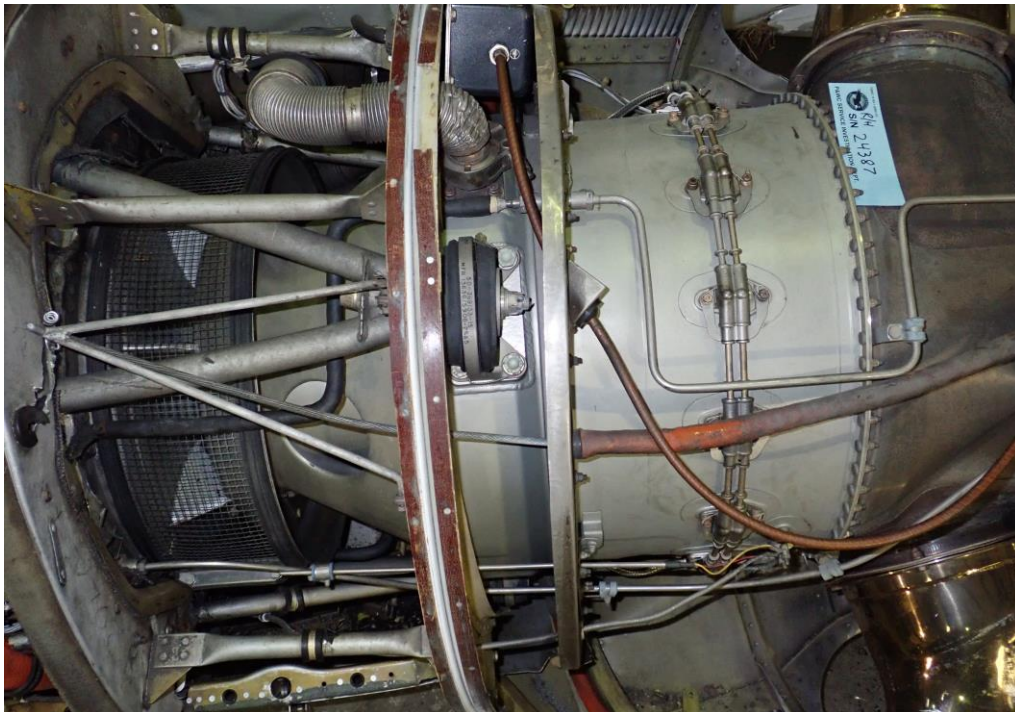


Photo No. 40

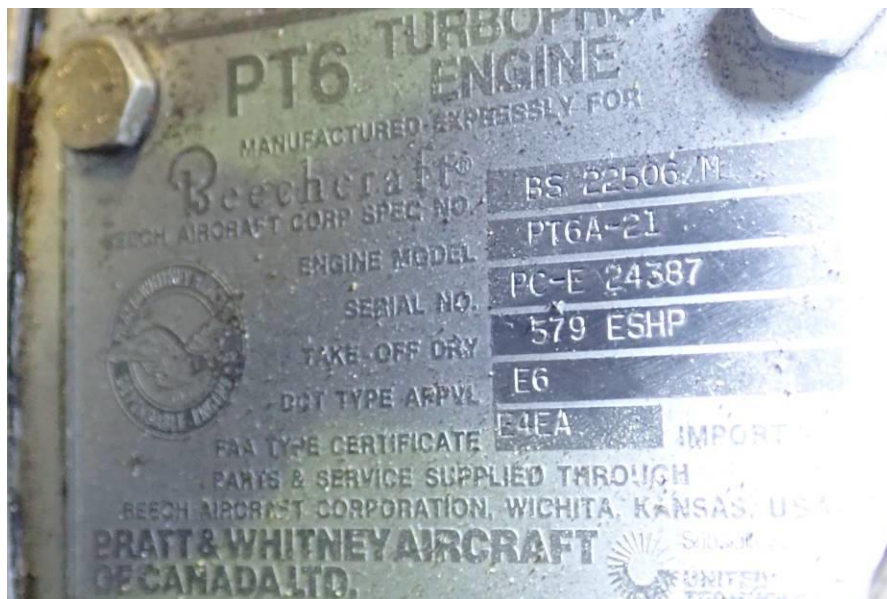


Photo No. 41

5.1.1 External Cases

Reduction Gearbox: The gearbox was in place and no visible external damage was evident (Ref. Photo No. 42, red arrow).

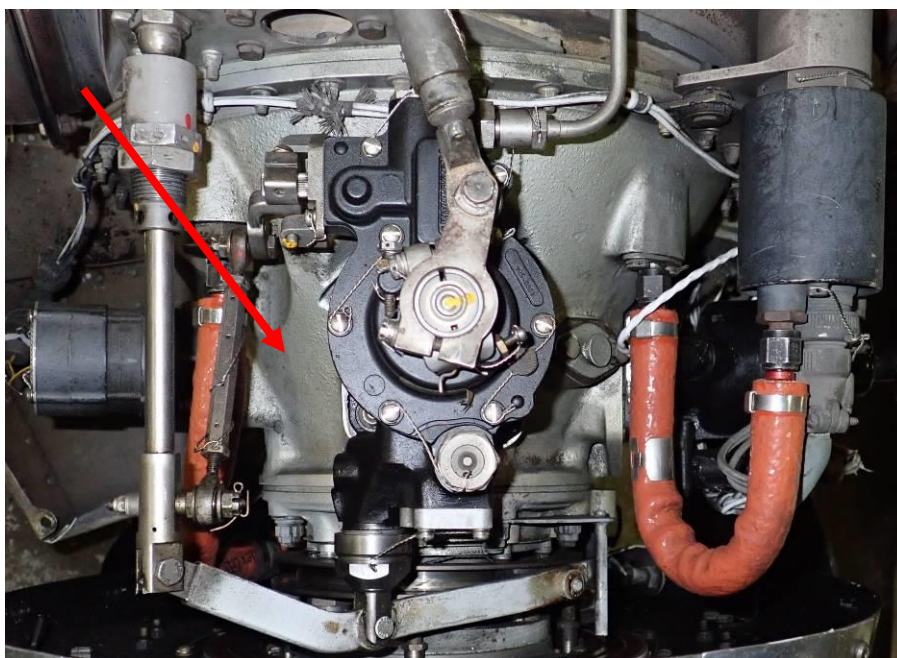


Photo No. 42



Exhaust Duct: The duct was compressed on the right hand side (Ref. Photo No. 43, red arrow).

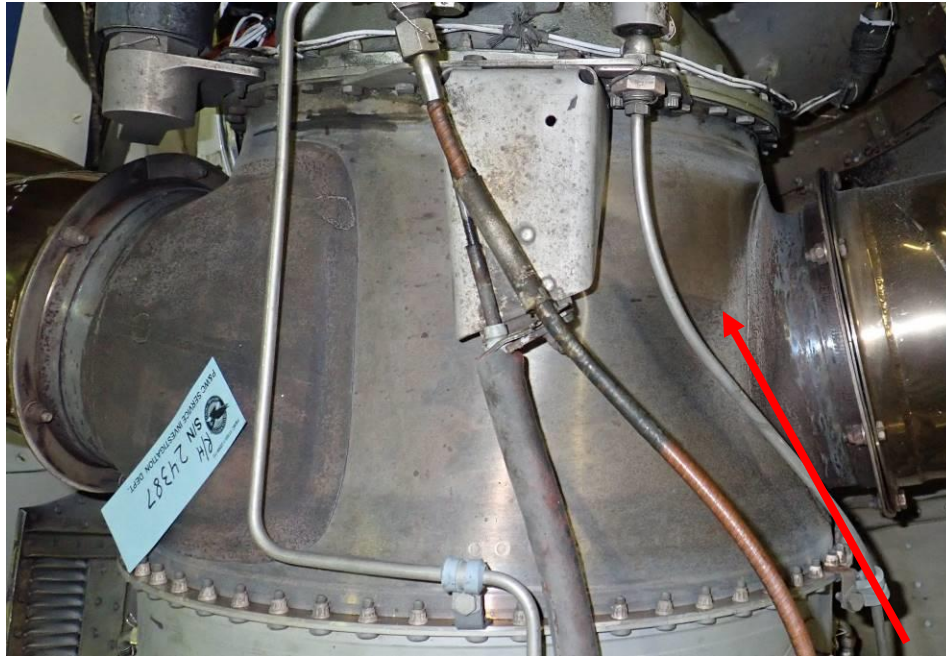


Photo No. 43

Gas Generator Case: The upper section of the front of the case and the visible portion of the rear section of the case were unremarkable (Ref. Photo No. 44, blue arrows). The bottom section of the case was bent adjacent to the center fire seal (Ref. Photo No. 45, blue arrow).

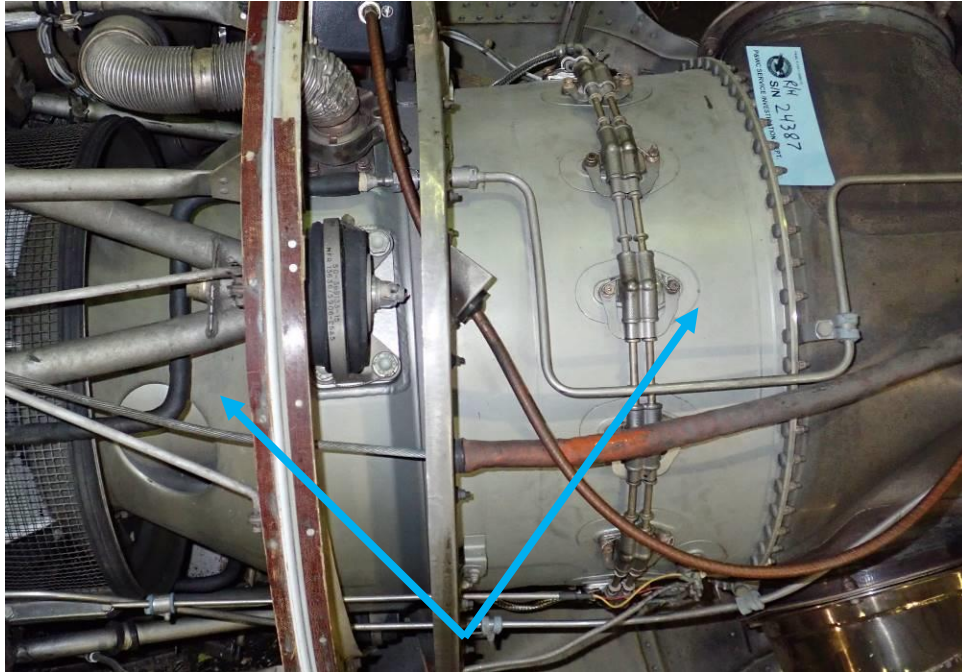


Photo No. 44

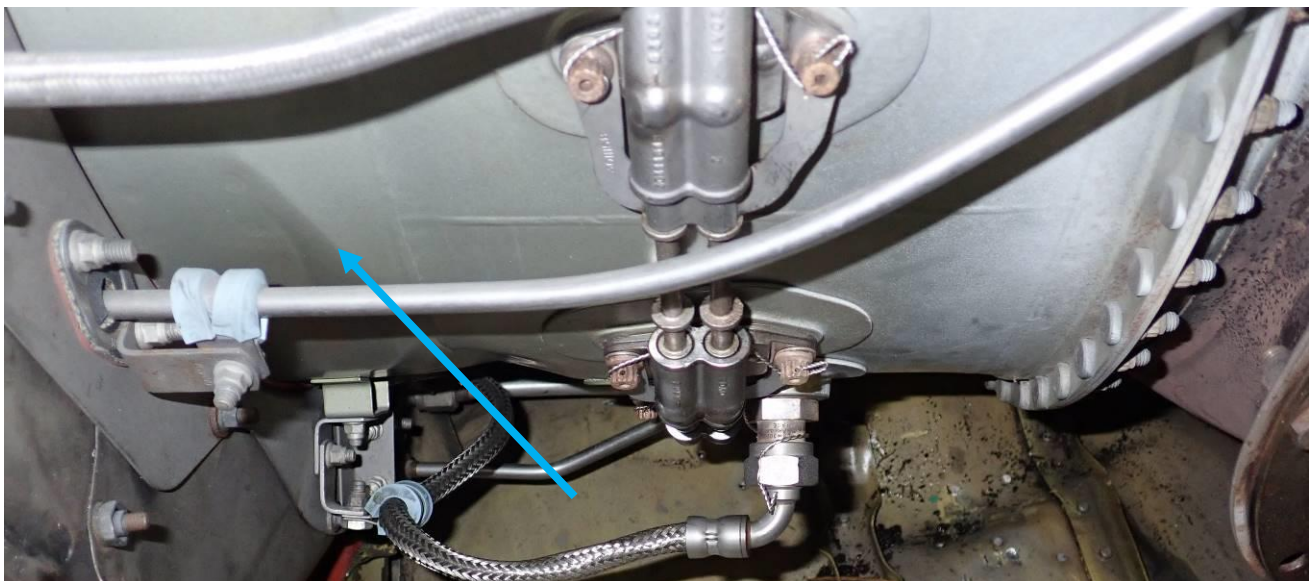


Photo No. 45



Accessory Gearbox: The gearbox and inlet case were in place and no visible external damage was evident (Ref. Photo No. 46).

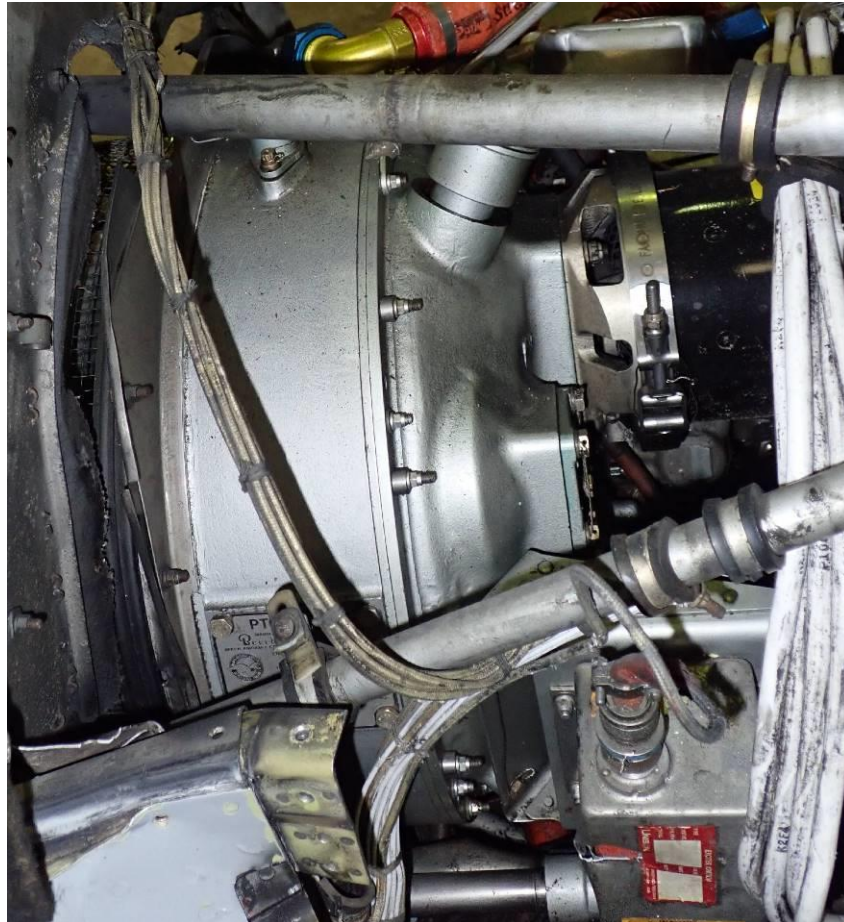


Photo No. 46

5.1.2 Power Control and Reversing Linkage: The propeller reversing lever was in place (Ref. Photo No. 47, red arrow). The front linkage was in place (Ref. Photo No. 47, blue arrow). The rear linkage was in place (Ref. Photo No. 48, red arrow). The end of the fuel control connection rod was bent (Ref. Photo No. 49, yellow arrow).

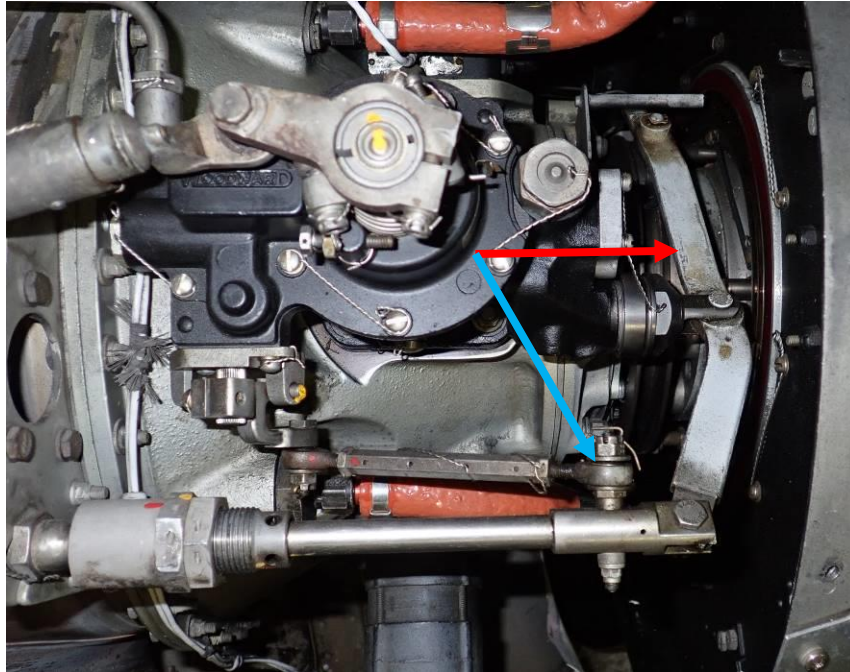


Photo No. 47

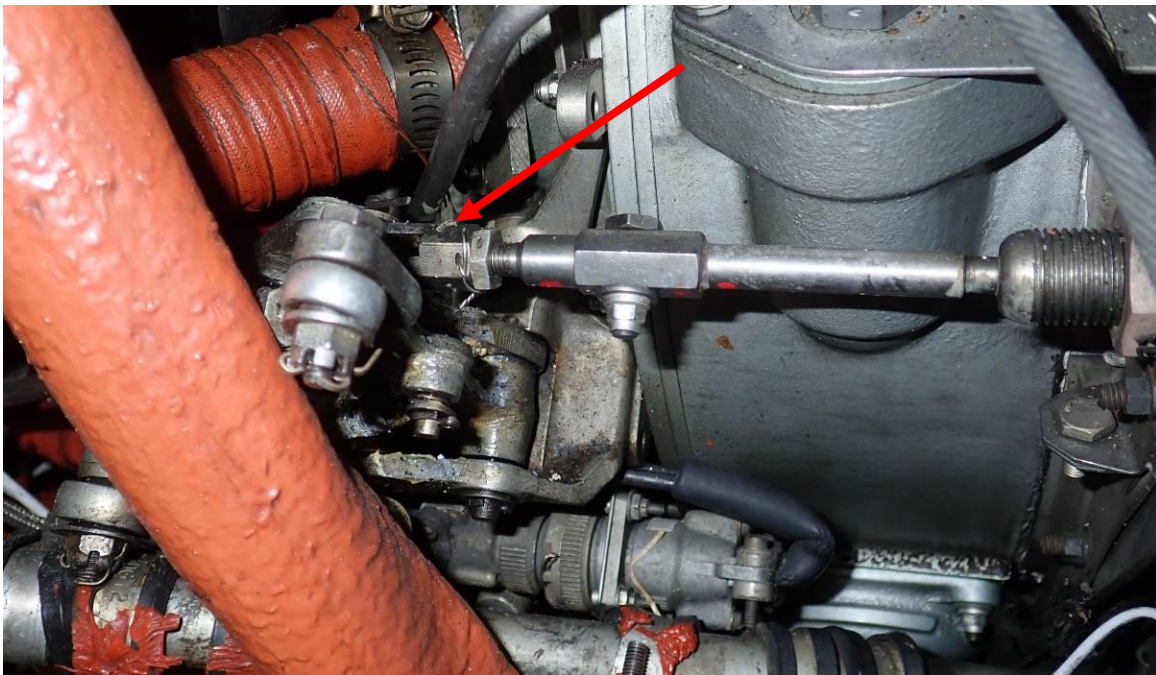


Photo No. 48

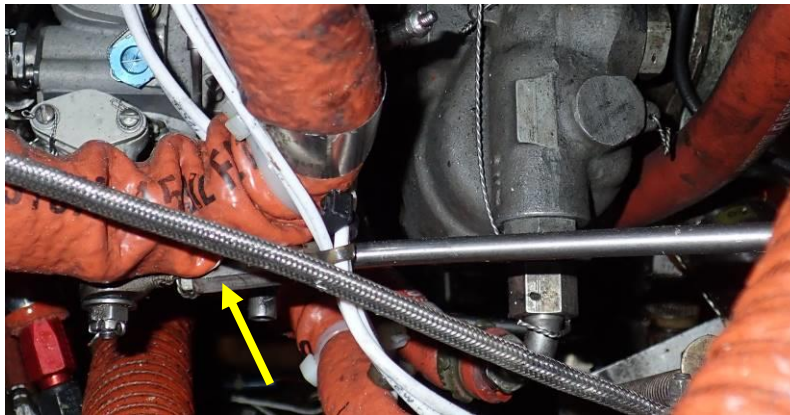


Photo No. 49

5.1.3 Pneumatic Lines

Compressor Discharge Air (P3): The line was in place and the fitting connections were secure.

Power Turbine Control (Py): The line was in place and the fitting connections were secure (Ref. Photo No. 50, red arrow). The line was bent adjacent to the rear fire seal (Ref. Photo No. 51, red arrow).

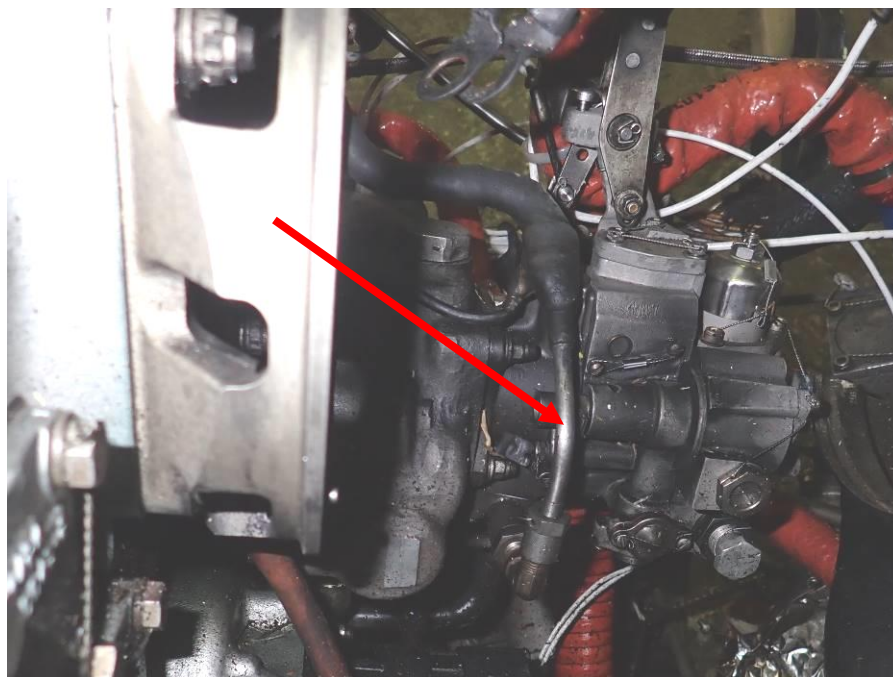


Photo No. 50



Photo No. 51

5.1.4 Chip Detectors and Filters

Reduction Gearbox Chip Detector: The chip detector poles were clean (Ref. Photo No. 52).



Photo No. 52



Oil Filter: No visible debris was evident in the oil filter (Ref. Photo No. 53).



Photo No. 53

Fuel Filter: The filter was discoloured, most likely from sediment in the fuel (Ref. Photo No. 54). The residual fuel in the filter bowl was clean but the interior of the bowl was stained (Ref. Photo No. 55).

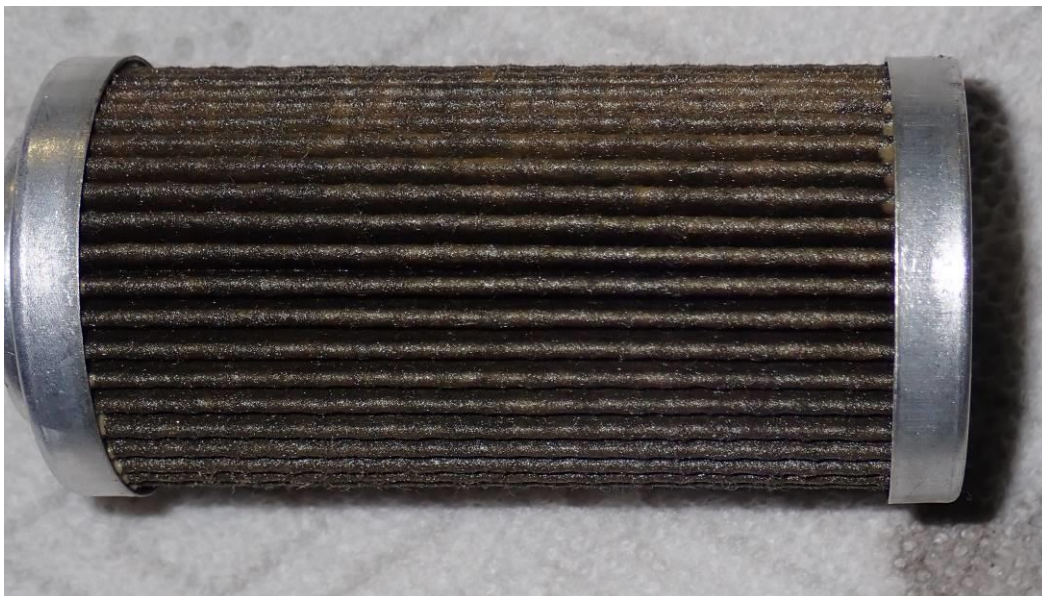


Photo No. 54



Photo No. 55

5.2 Disassembly Observations

- 5.2.1 **Compressor Section:** The inlet screen was removed to view the 1st stage compressor blades. The visible portions of the 1st stage compressor blades were unremarkable. The compressor was manually rotated by the 1st stage blades and mechanical continuity was established with the accessory gearbox.
- 5.2.2 **Combustion Section:** The engine was not disassembled to access the combustion section for the purpose of this investigation.
- 5.2.3 **Turbine Section:** The engine was not disassembled to access the turbine section for the purpose of this investigation. Manual rotation of the power section was not attempted as the propeller blades were bent and touching the floor.

Power Turbine: The left hand exhaust stack was removed and the power turbine was viewed through the exhaust port. The turbine blades were in place (Ref. Photo No. 56).

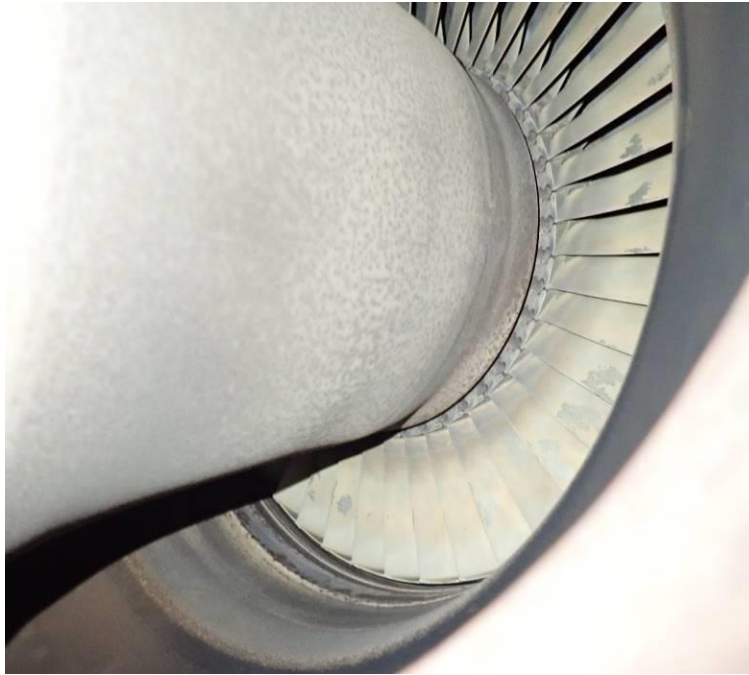


Photo No. 56

5.2.4 **Reduction Gearbox:** The gearbox section was not disassembled for the purpose of this investigation.

5.2.5 **Accessory Gearbox:** The gearbox section was not disassembled for the purpose of this investigation.

5.3 **Controls and Accessories Evaluation**

5.3.1 **Ignition System**

Exciter Box: The box was attached to its respective mount on the aircraft. The exterior of the box breached from impact damage (Ref. Photo No. 57).

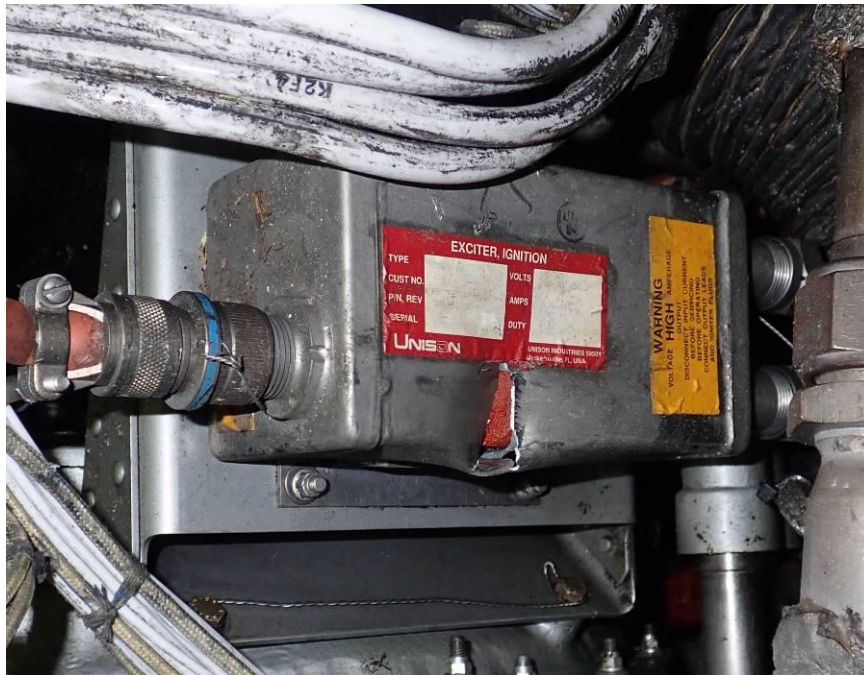


Photo No. 57

Ignition Leads: The leads were in place and secured (Ref. Photo No. 58, red arrow).



Photo No. 58

Ignition Plugs: The leads were in place and secured (Ref. Photo No. 58, blue arrow).

5.3.2 Fuel System

Fuel Heater: The heater was in place and one mount was fractured (Ref. Photo No. 59, blue arrow).

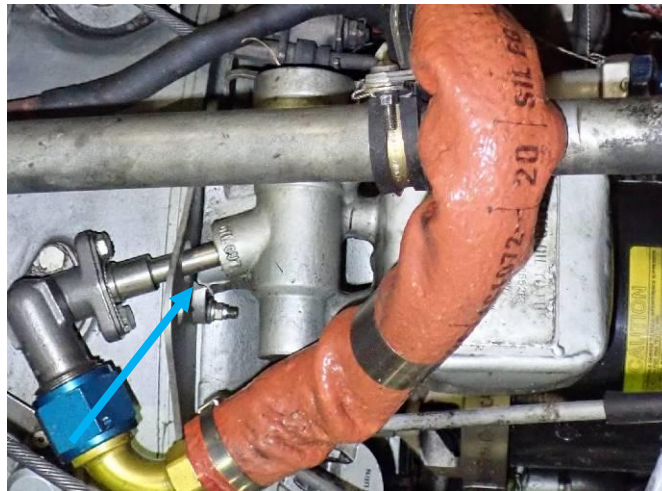


Photo No. 59

Fuel Pump: The pump was in place on its respective accessory gearbox mounting pad. The pump was removed (Ref. Photo No. 60, red arrow) from the gearbox and it was separated from the fuel control. The pump was capable of manual rotation. The inlet filter was removed, no contamination was noted, but the strainer portion was stained (Ref. Photo No. 61). The pump was disassembled (Ref. Photo No. 62).

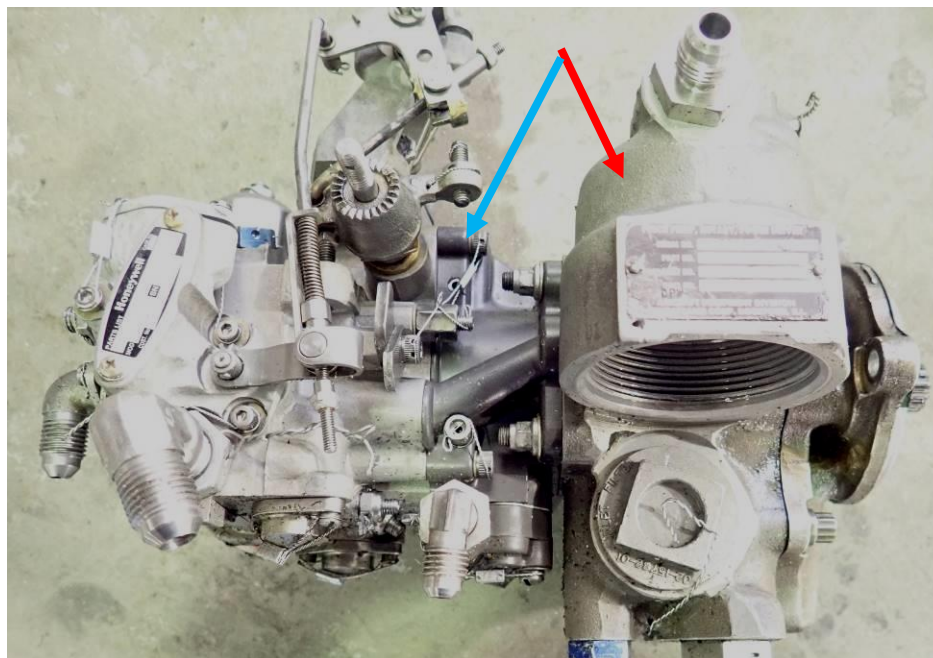


Photo No. 60



Photo No. 61



Photo No. 62

The fuel pump housing exhibited some polished regions from contact with the gears (Ref. Photo No. 63, red arrows). The teeth on both gears exhibited frosted regions on their contact surfaces (Ref. Photos No. 64 & 66). Light scoring was evident on the shaft bearing land surfaces of the gears (Ref. Photos No. 64 & 65).



Photo No. 63



Photo No. 64

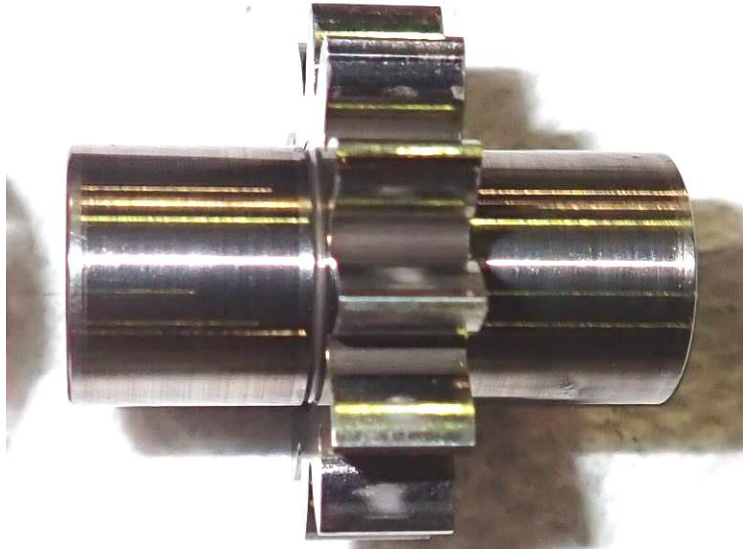


Photo No. 65

The front bearings exhibited multiple cavitation pits on the gear contact faces and in the bearing bores (Ref. Photo No. 66). The rear bearing exhibited some pits on the gear contact face (Ref. Photo No. 67). The pump surfaces are lubricated by the fuel passing through the pump. The bearing cavitation pits indicates that pump was operated without an adequate fuel supply.



Photo No. 66, Front bearings



Photo No. 67, Rear bearings

Fuel Control Unit: The control was secured to the mounting pad on the fuel pump (Ref. Photo No. 60, blue arrow). The control was removed from the pump (Ref. Photo No. 68). The fuel control to fuel pump coupling was found unremarkable (Ref. Photo No. 68, red arrow). The control rotated freely with manual input on the drive shaft.

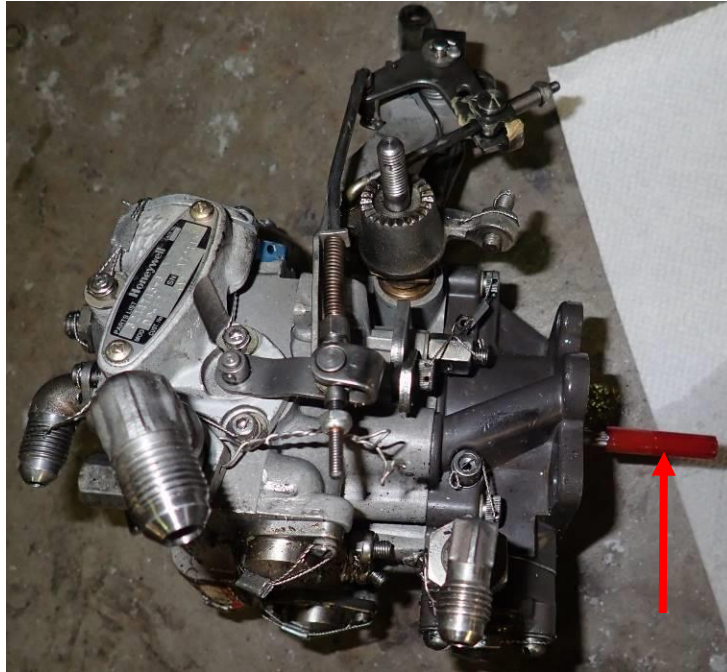


Photo No. 68

Flow Divider: The divider was in place and was visually unremarkable.

Fuel Nozzles: The nozzles were in place and were visually unremarkable (Ref. Photo No. 69).

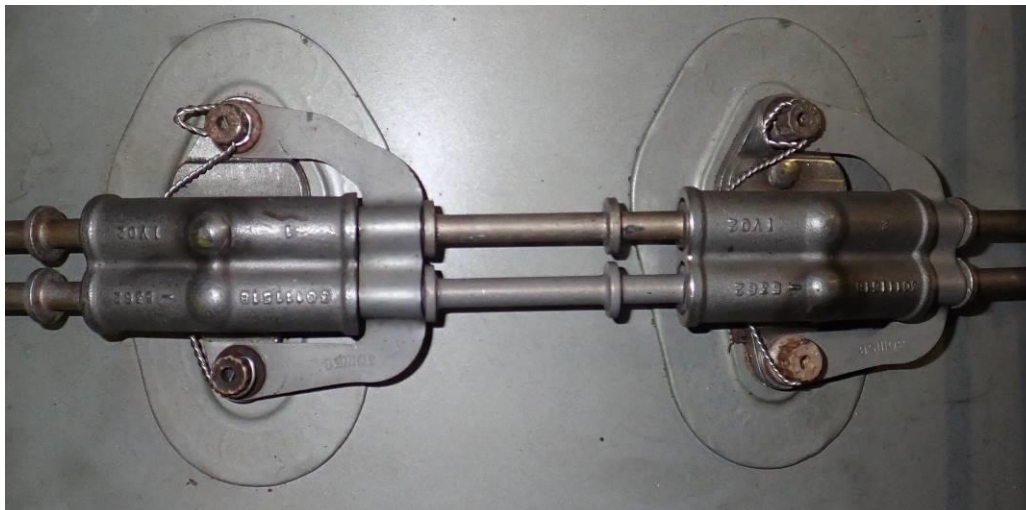


Photo No. 69



5.3.3 Air System:

Compressor Bleed Valve: The valve was not accessed for the purposes of this investigation.

5.3.4 Oil System:

Propeller Governor: The governor was in place and was visually unremarkable (Ref. Photo No. 70).

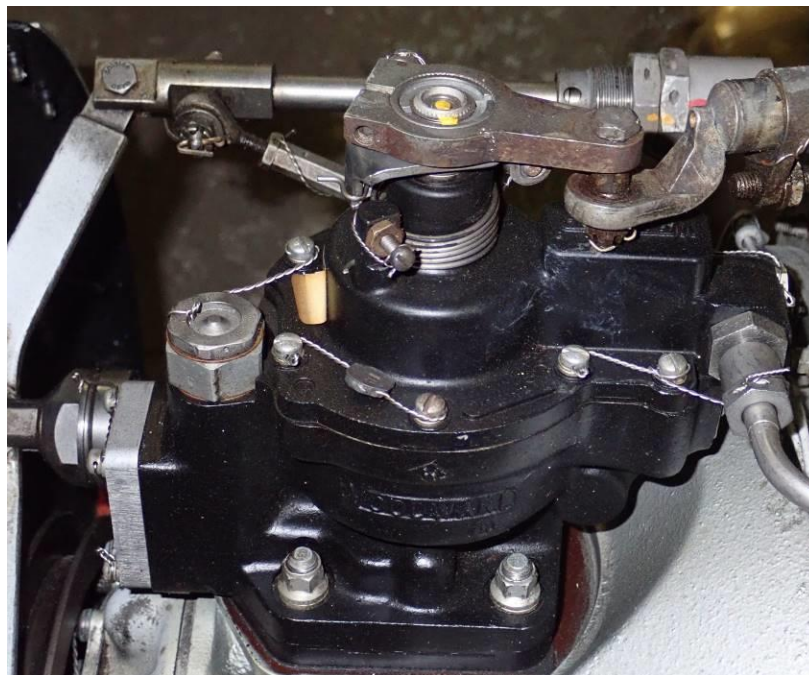


Photo No. 70



Overspeed Governor: The governor was in place and was visually unremarkable (Ref. Photo No. 71).

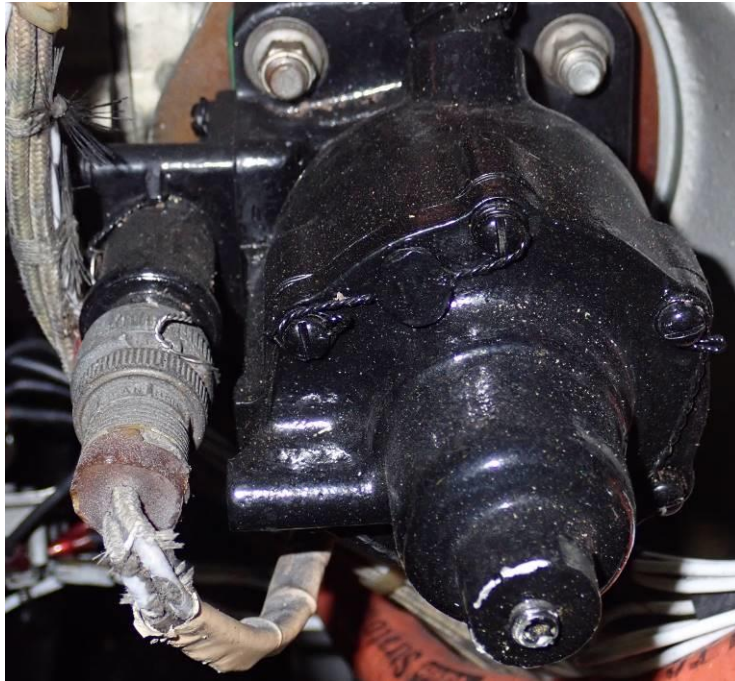


Photo No. 71