



NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

December 20, 2021

POWERPLANT GROUP CHAIRMAN'S FACTUAL REPORT

NTSB No: CEN20LA402

A. ACCIDENT

Location: Hilltop Lakes, Texas

Date: September 20, 2020

Time: 1050 central daylight time (CDT)

Aircraft: Piper PA-46-310P, N236KM

B. POWERPLANT GROUP

Group Leader:	Robert Hunsberger National Transportation Safety Board Washington, D.C.
Member:	Jonathon Hirsch Piper Aircraft Vero Beach, Florida
Technical Advisor (Canada):	Jeff Davis Pratt & Whitney Canada Bridgeport, West Virginia

C. SUMMARY

On September 20, 2020, about 1050 central daylight time (CDT), a Piper PA-46-310P, N236KM, was substantially damaged when it was involved in an accident near Hilltop Lakes, Texas. The commercial pilot and 3 passengers sustained fatal injuries. The airplane was operated as a Title 14 Code of Federal Regulations (CFR) Part 91 personal flight. While in cruise flight at 19,000 ft mean sea level (MSL), the pilot declared an emergency to air traffic control (ATC) and stated that the airplane had lost engine power and that he needed to divert. The pilot elected to divert to Hilltop Lakes Airport (0TE4), which was about 5 miles south of his position. Archived Federal Aviation Administration (FAA) automatic dependent surveillance-broadcast (ADS-B) data revealed that when the airplane was about 5 miles west of 0TE4, a descent was initiated from 19,000 ft and the airplane proceeded directly to, and circled around, the airport

while descending. ADS-B data was lost about 3 miles northeast of the airport, as the airplane descended below the floor of the ADS-B reception capability. Commercially available flight track data, which aggregates and georeferences FAA data sources, continued to receive aircraft data as the airplane turned to a final approach segment. The last data point showed the airplane about 1 mile north of the approach end of runway 15 at 0TE4 at an altitude of 1,250 ft, 169 knots ground speed and on a ground track of 145°. Witnesses located about ¼ mile south of the end of runway 15 reported seeing what they described as the airplane taking off, before noticing the propeller was not turning. They stated they saw the airplane in a left bank just prior to the nose dropping and the airplane impacting the ground in a near vertical attitude. The airplane came to rest along a road about 200 ft south of the airport property. The airplane impacted the terrain in a nose low, near vertical attitude and sustained substantial damage to fuselage and both wings. The airplane was equipped with a Pratt & Whitney Canada (PWC) PT6A-34 turboprop engine that had been installed in accordance with Supplemental Type Certificate ST00541SE.

The PWC PT6-34 turboprop engine was examined at the PWC- Bridgeport, West Virginia facility with party members from PWC, Piper Aircraft, and the NTSB between March 10-11, 2021.

D. DETAILS OF THE INVESTIGATION

1.0 Engine Information

1.1 Engine Description

The PWC PT6A-34 is a reverse flow turboprop engine featuring a three-stage axial compressor, a single-stage centrifugal compressor, an annular combustion chamber, a single-stage compressor turbine (CT), a single-stage independent power turbine (PT), and a hydromechanical fuel control unit (FCU). According to the FAA type certificate data sheet E4EA, Revision 28, July 17, 2020, the engine has a takeoff dry power rating of 750 shaft horsepower¹.

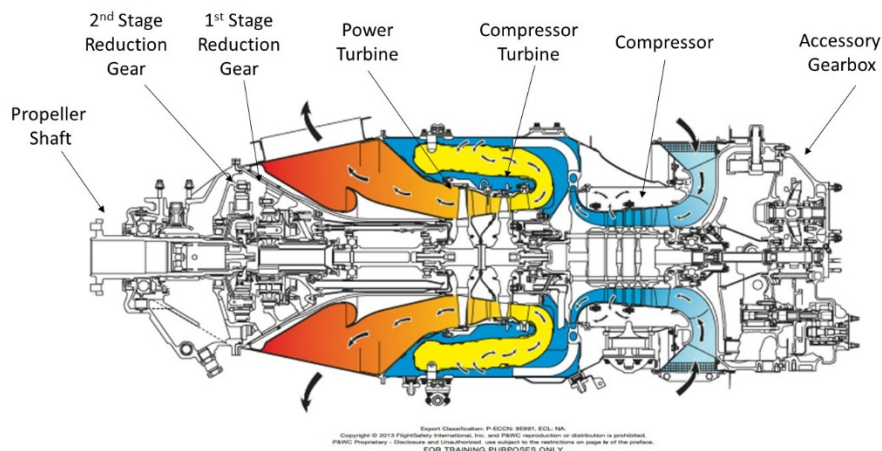


Figure 1- Pratt & Whitney Canada PT6-30 Series Engine

¹ The engine ratings are based on static sea level condition 29.92 in of mercury (Hg) pressure, compressor intake screen installed, no external accessory loads and no air bleed.

All directional references to front and rear, right and left, top and bottom, and clockwise and counterclockwise are made aft looking forward (ALF).

1.2 Engine History

There was limited engine operating history recovered for engine serial number (ESN) PCE-RB0095. According to aircraft maintenance logbook and engine trend monitor data, the engine had accumulated 3,353.0 hours time since new at the time of the accident. A hot section inspection was completed on October 17, 2019, at which time the engine had accumulated 2,114 cycles since new. The last engine related maintenance performed was an engine sump drain and debris check on June 26, 2020. The logbook entry pages are shown below in **Figures 2 and 3²**.

wo: WO_204		Engine - page 1 of 2	
 First Line Aero, LLC - 458 CR 1618 - Rusk, TX 75785 - 903-316-8331			
N236KM hobbs: 5680.0	TTSN: 3478.0		October 17, 2019
1. Complied with a hot section inspection IAW PT6A-34 MM. Sent out fuel nozzles for 400 Hour flow check and cleaning, reinstalled. (1) 3041153-GF - Hot Section Inspection Kit, Installed (1) FNS-34 - Fuel Nozzle Set. 2. Removed thermocouple buss bar due to short. Installed new thermocouple buss bar. Installed (1) 3027629 - Buss Bar Thermocouple. 3. Replace T5 harness from buss bar. Installed (1) 3117924-01 - Thermocouple Harness, S/N: NR161146. 4. Replaced large exit with exchange overhauled unit. Installed (1) 3109263-02 - Exit Duct, S/N: UIA0005RLX 5. Installed repaired CT vane and small exit duct assembly. See 8130 for repair details. 6. Replaced 2 T5 thermocouples that were near failure during inspection. Installed (2) 3022983 - Thermocouple, T5, Installed (2) 3010671 - Thermocouple washer. 7. Sent CT disk out for inspection. Re-installed same SN as originally installed. Installed (1) 3013411 - CT Disk assembly. 8. Set idle Ng and Np speeds as required.			

Figure 2- Aircraft Maintenance Logbook Entry, October 17, 2019

wo: WO_355		Airframe - page 1 of 1	
 First Line Aero, LLC - 458 CR 1618 - Rusk, TX 75785 - 903-316-8331			
N236KM hobbs: 336.8	PIPER, PA-46-310P, S/N: 46-8508014 TTSN: 5840.8		June 26, 2020
1. Drained sumps and checked for debris. 2. Removed and installed new vacuum pump. Installed (1) 441CC-7 - Overhauled Pump. 3. Replaced Alternator/AC belts, tension and safety bolt. Installed (2) 560.07.707 - AC/ALT belts.			
Ops and leak checked, no defects noted. With respect to the work performed, this aircraft is approved for return to service.			

Figure 3- Aircraft Maintenance Logbook Entry, June 26, 2020

² Hobbs and total time since new hour readings were erroneously recorded multiple time throughout the logbook.

2.0 ENGINE SERIAL NUMBER PCE-RB0095 TEARDOWN EXAMINATION

The engine was secured in a shipping container when the team arrived at PWC- Bridgeport (**Photo 1**). Due to the condition of the engine, the teardown was completed on an outdoor concrete pad (**Photos 2, 3, and 4**). The center firewall was deformed around the engine and multiple airframe components including: the starter, alternator, air conditioning compressor, wiring, and parts of the mount structure remained attached to the engine. A cutting wheel and saw were used to remove some of the airframe components so the external engine condition could be documented (**Photo 5**).



Photo 1- Engine Shipping Container, as Received at PWC-Bridgeport, WV



Photo 2- Left Side of Engine, as Received



Photo 3- Right Side of Engine, as Received



Photo 4- Engine Data Plate



Photo 5- Left Side of the Engine After Airframe Parts Removal

There were no indications of uncontained engine failure or fire damage. The engine cases exhibited severe impact damage and buckling. The reduction gearbox (RGB) was bent upwards and to the left relative to the engine centerline, consistent with a nose down impact. The top section of the turboprop governor housing was fractured but remained attached to the prop control linkage. The Py³ line was complete from the turboprop governor to the FCU. The Py line fittings at the turboprop governor, on both sides of the center firewall, and the FCU were secure but could be backed off without a wrench (finger tight torque) (**Photo 6**). The P3⁴ line to FCU fitting was also finger tight. The reversing linkage was deformed but was complete except for the cam box which was fragmented. The FCU was partially separated from the fuel pump and remained tethered to the engine by the control lines. The chip detector plug was removed from the reduction gearbox (RGB) and the oil filter was removed from the inlet case and there was no debris accumulation observed (**Photo 7**). The fuel filter was removed from the fuel pump and appeared discolored but there were no obstructions and the fuel smelled normal (**Photo 8**). There was fuel remaining in the filter bowl and a small amount of shiny particulate was visible in the fuel when viewed under light.

³ The Py line is a pneumatic pressure air line between the Nf (turboprop governor) and the FCU used for overspeed control. In the event of an overspeed, the turboprop governor can bleed Py pressure. The reduction in Py line pressure moves the FCU metering valve in the closed direction and reduces fuel flow.

⁴ P3 pressure is axial compressor discharge pressure.



Photo 6- Turboprop Governor and Py Line Fittings



Photo 7- (L) Chip Detector, (R) Oil Filter



Photo 8- Fuel Filter

2.1 Power Turbine

The PT rotor disk blades and nozzle vanes were fractured. The PT shaft was deformed/bent (**Photo 9**). All fracture surfaces that were visually examined appeared rough and dimpled consistent with overload failure.



Photo 9- Power Turbine Rotor and Nozzle Impact Damage

2.2 Compressor Turbine

The CT rotor disk blades and nozzle vanes were all present and complete (**Photo 10**). The CT vane shroud had static CT rotor blade tip impact marks from the 2 to 12 o'clock positions (**Photo 11**). The forward face of the CT blade platform also had static witness marks from contact with CT vane ring (**Photo 12**).

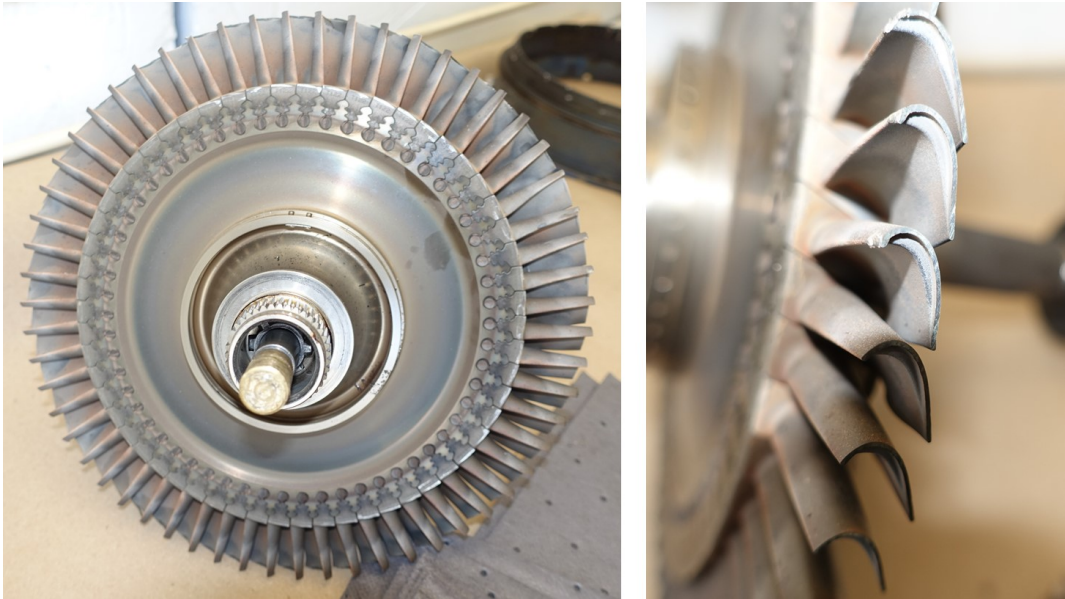


Photo 10- (L) CT Rotor Disk, (R) Blade Leading Edge Close up

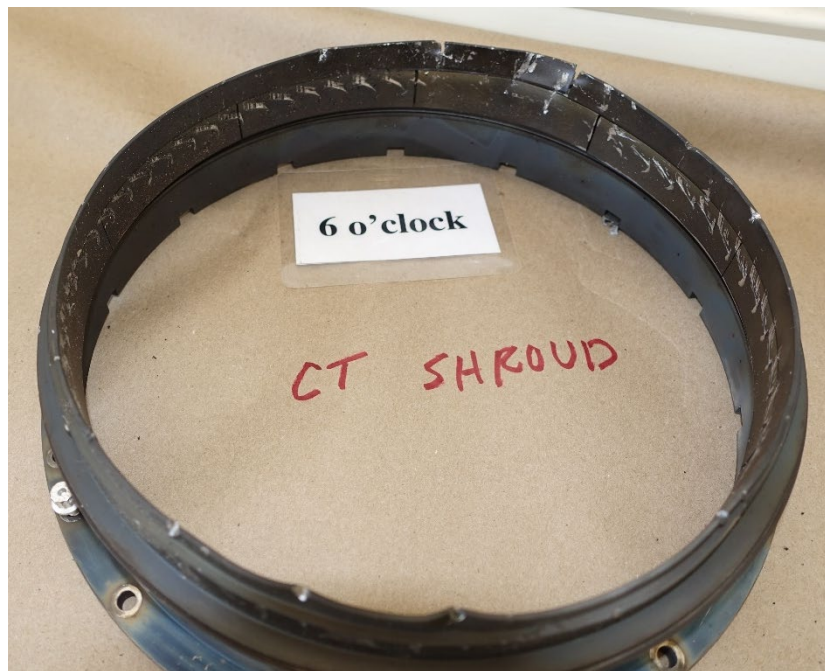


Photo 11- Compressor Turbine Shroud Impact Witness Marks

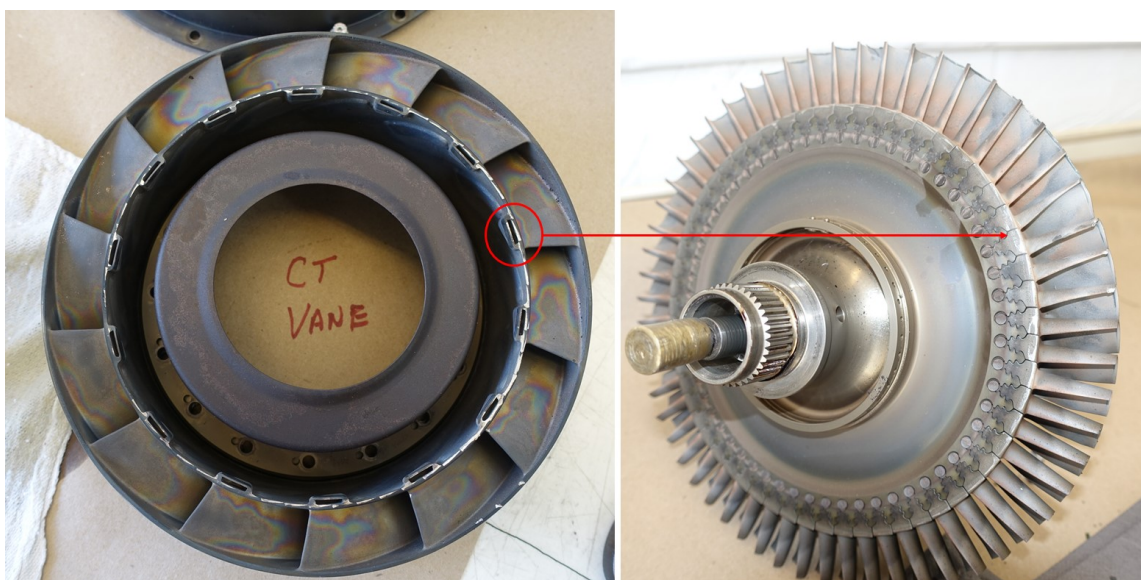


Photo 12- (L) Compressor Turbine Vane Ring, (R) Compressor Turbine Rotor Witness Marks

2.3 Combustor

The combustion liner was deformed but there was no evidence of thermal damage, uneven wear, or fuel nozzle streaking. Two fuel nozzles were removed, and no coking was visible (**Photo 13**). The igniter plugs were removed and functionally checked on a bench with a slave exciter box and both igniters sparked normally.



Photo 13- Fuel Nozzle

2.4 Compressor

All three stages of axial compressor rotor blades and stator vanes were intact and in good condition. The 1st stage rotor had an oily residue and debris on the forward face of the blades (**Photo 14**). The stator case lands did not exhibit circumferential rub damage or witness marks. The centrifugal impeller was in good condition (**Photo 15**). The No. 1 and No. 2 bearings were oil wetted, and the ball/roller elements spun smoothly.

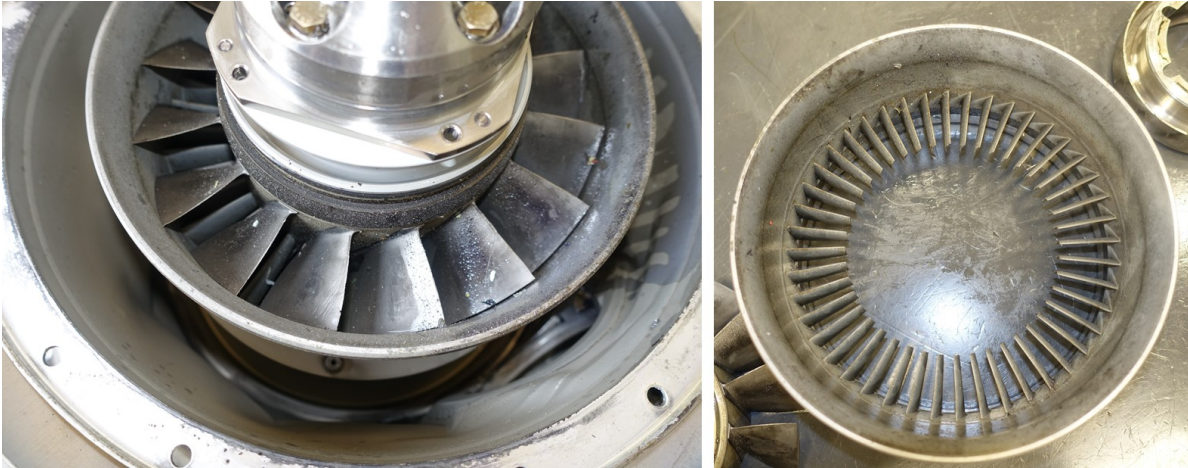


Photo 14- (L) Compressor 1st Stage Rotor Blades, (R) Compressor 1st Stage Stator Vanes and Case



Photo 15- Centrifugal Compressor Impeller

2.5 Reduction Gearbox

The RGB sun, planet, and ring gears were all present, and unremarkable (**Photo 16**). After removal, the front RGB was rotated by hand and all gearing rotated smoothly. The rear RGB could not be rotated due to impact deformation.

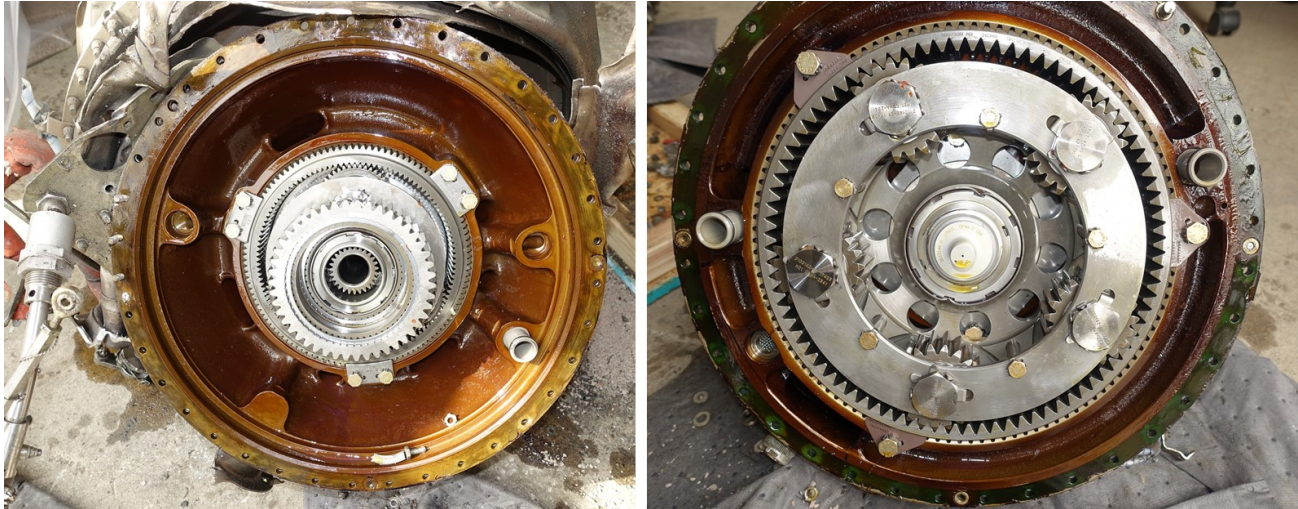


Photo 16- Reduction Gearbox

2.6 Accessory Gearbox and Accessory Components

The accessory gearbox coupling shaft was intact and after removal was manually rotated with concurrent rotation of all AGB pad splines. The pressure pump oil screen was clean and there was residual oil remaining the AGB cavity (**Photo 17**).

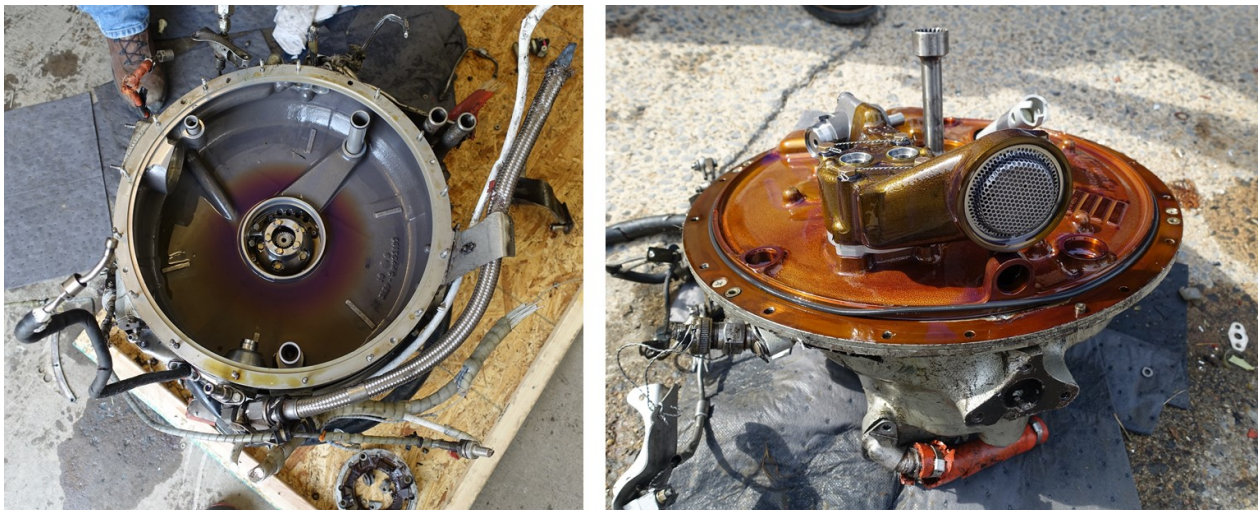


Photo 17- Accessory Gearbox

The fuel pump drive spline was intact and could be rotated by hand (**Photo 18**).



Photo 18- Fuel Pump Spline

3.0 ACCESSORY COMPONENT TESTING

The FCU, fuel pump, flow divider valve (FDV), and turboprop governor were shipped to PWC in Montreal, Quebec, Canada for examination and testing in the presence of a Transportation Safety Board of Canada (TSB) representative. The overspeed governor was shipped to Woodward in Loves Park, Illinois for examination and testing under oversight of the NTSB. The complete PWC accessories report is available in the investigation docket as “Powerplants- Attachment 1- PWC Accessories Accident Report.”

3.1 Fuel Control Unit

The FCU and fuel pump were shipped as an assembly. The FCU, part number (P/N) 3122696-03, serial number (S/N) C25444, was separated from the fuel pump for visual examination (**Photo 19**). The FCU drive-body was fractured, and the input drive shaft rotation was restricted due to interference between the governor flyweights and the governor lever. The condition lever linkage was deformed. The throttle lever shaft was bent, and movement of the lever was restricted. Due to impact damage, the FCU could not be bench tested so it was disassembled and there were no internal obstructions or anomalies noted that would have affected FCU operation (**Photo 20**).

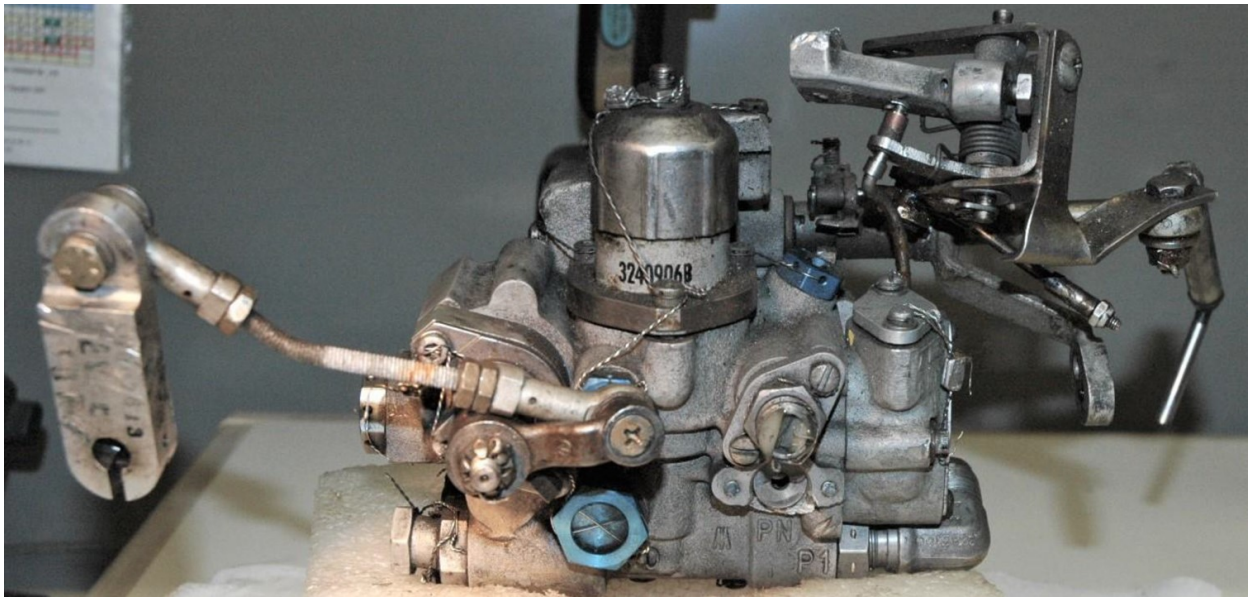


Photo 19- Fuel Control Unit, as Received at PWC (Photo Courtesy of PWC)



Photo 20- Fuel Control Unit Disassembled (Photo Courtesy of PWC)

3.2 Fuel Pump

The fuel pump, P/N 3034794, S/N 1403, input driveshaft rotated smoothly after the pump was separated from the FCU. There was no significant debris present in the pump inlet screen. The fuel pump was bench tested in accordance with Eaton component maintenance manual (CMM) 73-10-10 Revision 4 and met test procedure requirements.

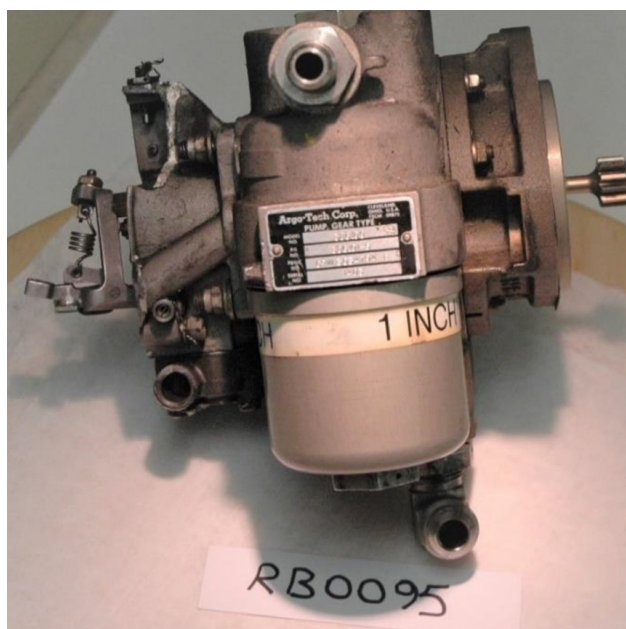


Photo 21- Fuel Pump, as Received at PWC (Photo Courtesy of PWC)

3.3 Flow Divider Valve

The FDV, P/N 3019906, S/N 20368, body appeared slightly distorted. The fuel manifold adapter face did not exhibit scratches/deformation and bore o-rings were present and in good condition. The FDV was tested in accordance with Triumph overhaul manual 73-10-01 Revision 7. The test procedure could not be completed because the dump valve opened before the secondary transfer valve. The FDV was disassembled, and the primary valve was unable to slide freely in the FDV housing due to deformation (**Photo 22**). There were no preimpact related anomalies noted that would have affected engine operation.

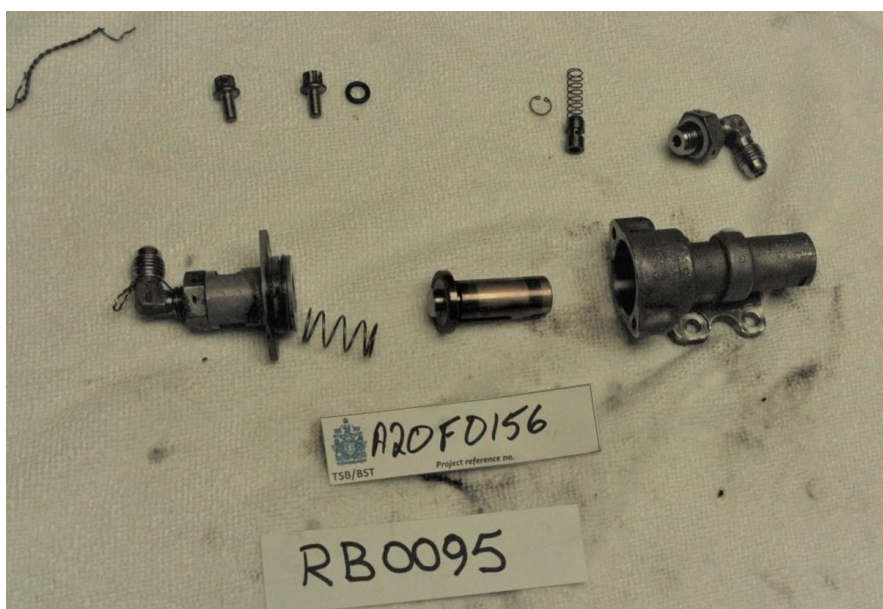


Photo 22- Flow Divider Valve Disassembled (Photo Courtesy of PWC)

3.4 Turboprop Governor

The turboprop governor⁵, P/N 3035926, S/N 12350694AE, exhibited significant impact damage (**Photo 23**). The turboprop governor cover and pilot-valve were missing material. The input driveshaft rotation was restricted. The reset arm and speed setting levers moved freely and returned to position under influence of the spring. The turboprop governor could not be bench tested due to the impact damage, so it was disassembled, and no internal anomalies were noted during disassembly that would have affected turboprop governor operation (**Photo 24**).

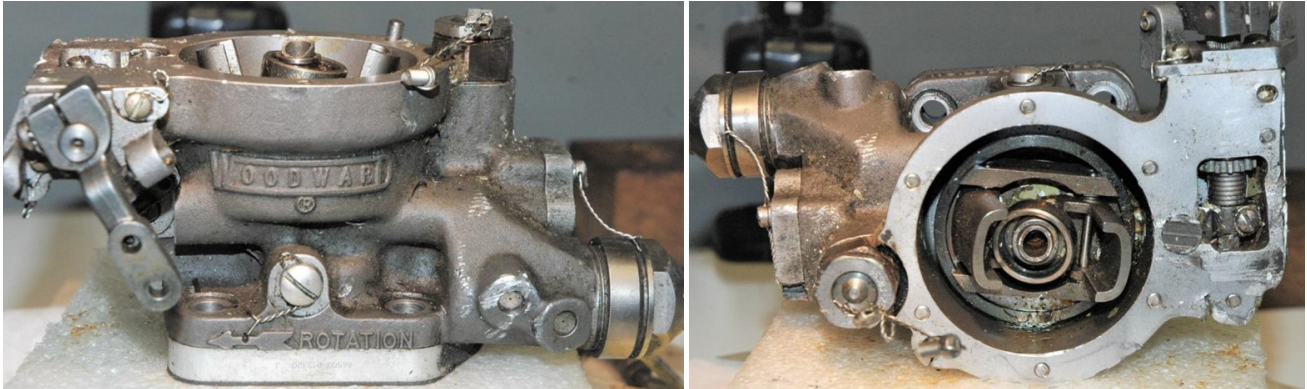


Photo 23- Turboprop Governor, as Received at PWC (Photos Courtesy of PWC)

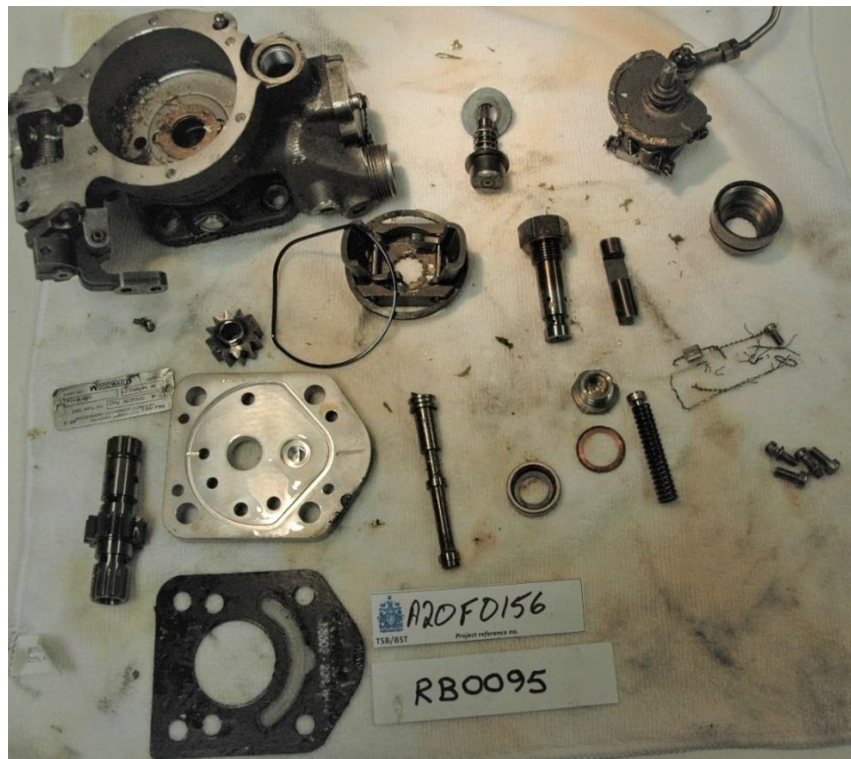


Photo 24- Propeller Governor Disassembled (Photo Courtesy of PWC)

⁵ PWC also refers to the turboprop governor as the constant-speed unit (CSU).

3.5 Overspeed Governor

The overspeed governor, P/N 210632, S/N 1440813, was tested at Woodward in accordance with test specification procedure (TSP)-847 Revision AC (**Photo 25**). All test points met test specification except “maximum speed” and “internal leakage.” According to Woodward, the maximum speed measurement was within the range of what would be expected after operator field adjustment. During bench testing, there was some external leakage observed that was consistent with impact damage and did not affect governor operation.



Photo 25- Overspeed Governor, as Received at Woodward

4.0 ENGINE TREND MONITOR

The accident airplane was equipped with a Shadin Avionics engine trend monitor (ETM), P/N 943200-11, S/N 0200. The ETM was recovered from the wreckage and shipped to the NTSB Recorders Laboratory in Washington, DC for evaluation and download. A total of 116 files recorded between May 19-September 20, 2020, were successfully downloaded from a microSD card. Three of the files were recorded on the date of the accident flight. Additional details about the ETM are available in the Recorders Group Chairman’s Factual Report in the investigation docket.

Shadin Avionics was added as an investigation party member to provide background on the system programming and help evaluate the ETM files. The unit was programmed to record select engine events including start, engine operating limit exceedances, and power checks. The engine operating limits were provided to Shadin by the PT6 engine replacement supplemental type certificate (STC) holder, Rocket Engineering. According to Shadin, the following engine parameters trigger the ETM to log engine status⁶:

⁶ Ng is the speed of the compressor and compressor turbine. ITT is inter-turbine temperature (T5) recorded by thermocouples between the compressor turbine and the first stage power turbine vane ring.

Ng for engine start abort report print < 10%
 ITT for engine start abort report print < 230 °C
 Ng for stop test and reset for start count >15%
 Ng for engine off report or going from idle to off < 48%
 Ng begin run > 70%
 ITT for start beginning > 250 °C
 Ng for start cycle counts > 40%
 Ng for engine start report and bounds for ITT start exceedance case > 51%

The power assurance check sample interval was configurable by the operator to record between once per flight to as frequently as every two minutes. The following criteria had to be met simultaneously for a power assurance check to be recorded:

Pressure Altitude change < 200 feet for 2 minutes
 IAS change < 20 knots for 2 minutes
 Torque change < 50 foot-pounds for 2 minutes

The logged events from the accident flight are summarized in **Table 1**.

TIME (CDT)	EVENT DESCRIPTION	COMMENTS
09:36:44	LOGON	Logon message is consistent with power being cycled on. Pressure Altitude at airport: 970 ft.
09:52:51	LOGON	
09:54:21	UNSUCCESSFUL ENGINE START ATTEMPT #1	Start Max ITT: 732°C, Ng light-off speed: 20.3%, Start Time- 13 seconds. Start cycle was logged but there was no run time before engine off was recorded.
09:57:02	UNSUCCESSFUL ENGINE START ATTEMPT #2	ETM recorded Low Bus Voltage: 327.68V. According to Shadin, 327.68V is recorded when the expected sequence of engine parameters is not met.
10:01:03	UNSUCCESSFUL ENGINE START ATTEMPT #3	Low Bus Voltage: 327.68V
10:02:20	ENGINE START ATTEMPT #4	Low Bus Voltage: 327.68V. There was no associated “engine off log” timestamp after start attempt #4 consistent with a successful engine start where the expected sequence of engine parameters was not met. The ETM did not record engine start parameters.
10:03:11	ENGINE TORQUE EXCEEDANCE	Level 1 Torque Exceedance- 1460 ft-lb for a duration of 1 second.
10:03:20	TAKEOFF	

10:05:36	ENGINE TORQUE EXCEEDANCE	Level 1 Torque Exceedance- 1424 ft-lb for a duration of 4 seconds.
10:24:11	ENGINE POWER CHECK	Pressure Altitude: 19090 ft, Indicated Airspeed- 171 kts., Np- 2141RPM, Torque- 880 ft-lb., Fuel Flow- 36.1 GPH, ITT- 704°C, Ng- 94.2%
10:38:16	ENGINE POWER CHECK	Pressure Altitude: 19100 ft, Indicated Airspeed- 171 kts., Np- 2155 RPM, Torque- 866 ft-lb., Fuel Flow- 35.5 GPH, ITT- 701°C, Ng- 94.2%
10:41:48	ENGINE OFF LOG	Engine off is logged when Ng drops below 48%.
10:51:40	LOGON	Logon message is consistent with power being cycled on. There was not a subsequent engine start attempt. Pressure Altitude- 3,540 ft.

Table 1- Engine Trend Monitor Events Recorded During Accident Flight

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