



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

October 15, 2021

Powerplants Group Chairman's Factual Report
NTSB No.: CEN20LA159

A. ACCIDENT

Location: Mesquite, Texas

Date: April 23, 2020

Time: 1600 Central Daylight Time

Aircraft: Boutique Air, Pilatus PC-12, N477SS

B. POWERPLANTS GROUP

Group Chairman: Robert Hunsberger
National Transportation Safety Board
Washington D.C.

Member: Jerry Morgan
Federal Aviation Administration
Charleston, West Virginia

Member: Les Doud
Hartzell Propeller
Piqua, Ohio

Technical Advisor (Canada): Jeff Davis
Pratt and Whitney Canada
Bridgeport, West Virginia

C. SUMMARY

On April 23, 2020, about 1600 central daylight time (CDT), a Pilatus PC-12 airplane, N477SS, was substantially damaged when it was involved in an accident near Mesquite, Texas. The pilot received serious injuries. The airplane was operated as a Title 14 *Code of Federal Regulations* 91 cross-country flight.

Preliminary reports indicate the pilot reported to air traffic control that he was losing engine power. The pilot then said he was going to divert to Rockwall (airport) and accepted vectors to the airport. The pilot then reported the loss of engine power had stabilized, so he wanted to return to DFW (Dallas-Fort Worth International airport). A few moments later the pilot reported that he was losing engine power and he needed to go back to Rockwall. The controller reported that the Mesquite airport (HQZ) was at the pilot's 11 o'clock position and about 3 miles and gave a heading.

The pilot reported that he was going to perform a 360° turn to set-up for a left base for the Mesquite Airport. The airplane impacted terrain in a muddy field, short of the airport. The airplane's wings separated in the accident and a post-crash fire developed near the wings.

Investigation party members from Pratt & Whitney Canada, Hartzell Propeller, the Federal Aviation Administration, and the NTSB met at the Pratt & Whitney Canada, Bridgeport, West Virginia facility to examine the engine and propeller from May 4-5, 2021.

D. DETAILS OF THE INVESTIGATION

1.0 Engine and Propeller Information

1.1 Engine Description

The Pratt & Whitney Canada (PWC) PT6A-67B engine is a dual spool turboprop engine featuring a four-stage axial plus one-stage centrifugal stage compressor, a single annular combustion chamber, a single-stage compressor turbine (CT), and a two-stage free power turbine (PT) (**Figure 1**). The engine has a hydromechanical fuel control. According to the FAA Type Certificate Data Sheet, E26NE, Revision 20, September 8, 2021, the engine has a sea level takeoff shaft power rating of 1,200 horsepower¹.

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

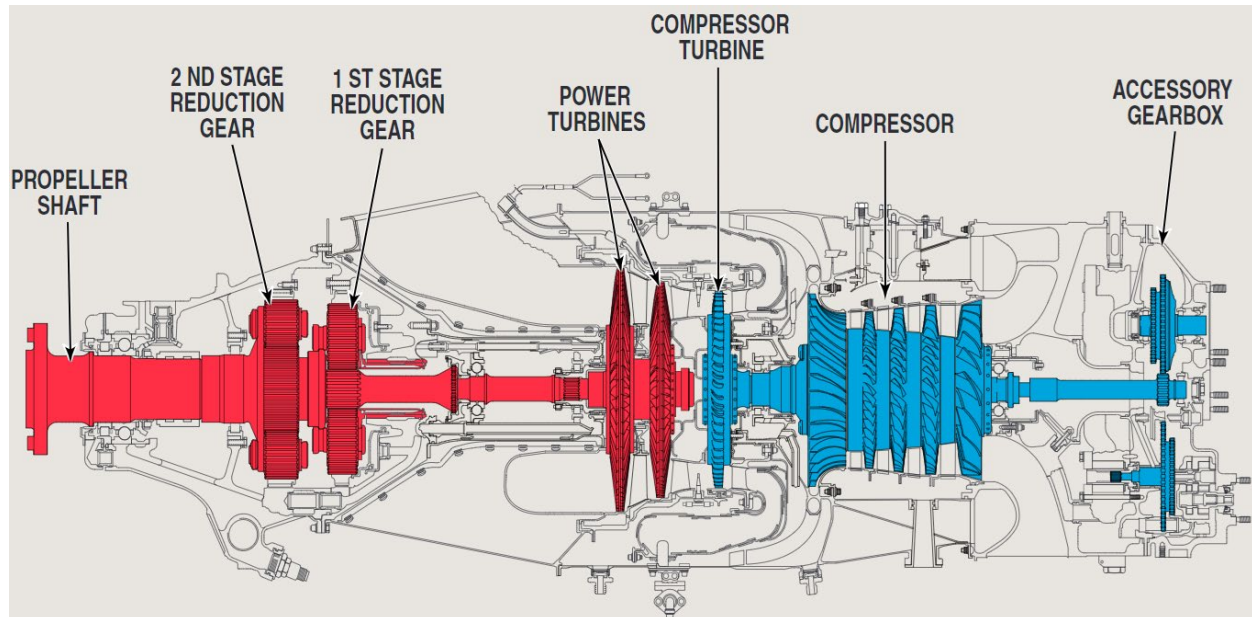


Figure 1- PWC PT6A-60 Series Turboprop Engine Cross Section

1.2 Propeller Description

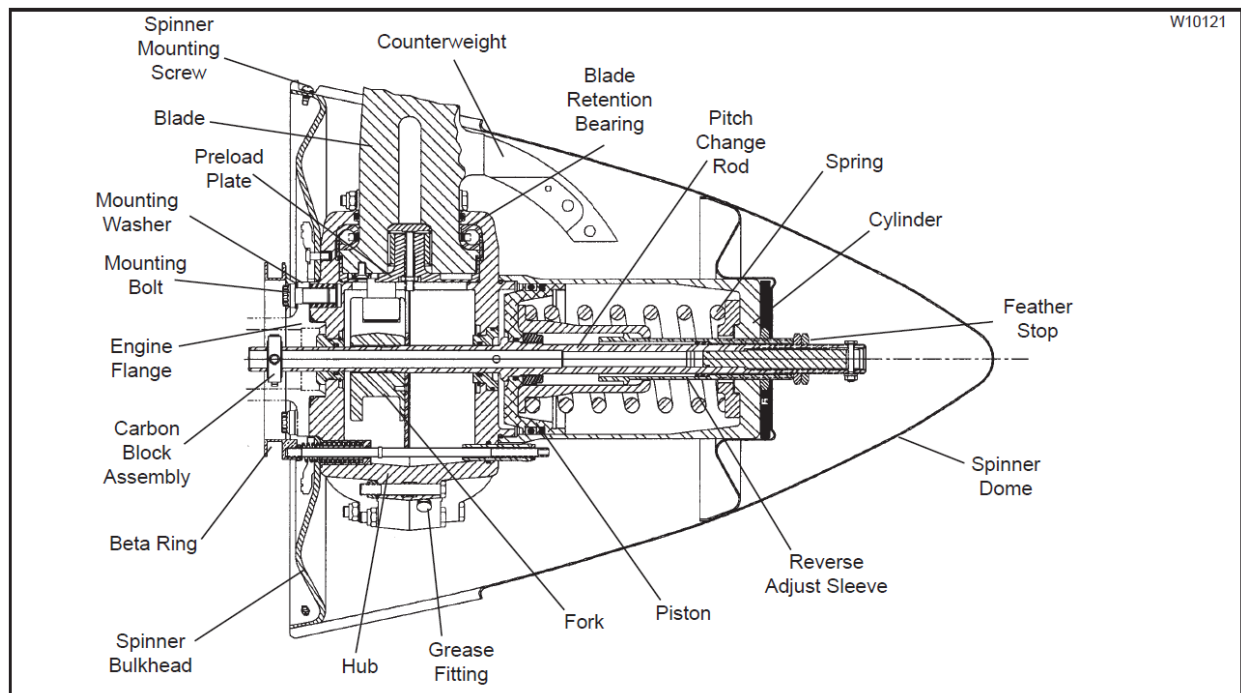
The Hartzell Propeller, Model HC-E4A-3D/E10477SK installed on the accident airplane is a 105-inch diameter, 4-blade, single-acting, hydraulically operated constant speed model with feathering and reverse pitch capability (**Figure 2**). Oil pressure from the propeller governor is used to move the blades to the low pitch (blade angle) direction. A force from a feathering spring and counterweight moments from the blade counterweights are used to move the

¹ Engine rating is based on static sea level condition 29.92 in Hg pressure, compressor intake screen installed, no external accessory loads, and no air bleed.

blades to the high pitch/feather direction in the absence of governor oil pressure. The propeller incorporates a Beta mechanism that actuates when blade angles are lower than the flight idle position. The propeller utilizes an aluminum hub with aluminum blades. Rotation is clockwise ALF.

Installation Data: (Blade angles referenced at the 42-inch station)

Reverse:	-17.5 ± 0.5 degrees
Flight Idle:	19.0 ± 0.2 degrees
Feather:	79.6 ± 0.5 degrees



2.0 Engine and Propeller History

According to maintenance records, the accident engine serial number (ESN) PCE-PR0699, was installed on February 5, 2020. At the time of installation, the engine had a total of 5,835.7 hours time since new (TSN) and the propeller, serial number KX190 had 2,920 hours TSN.

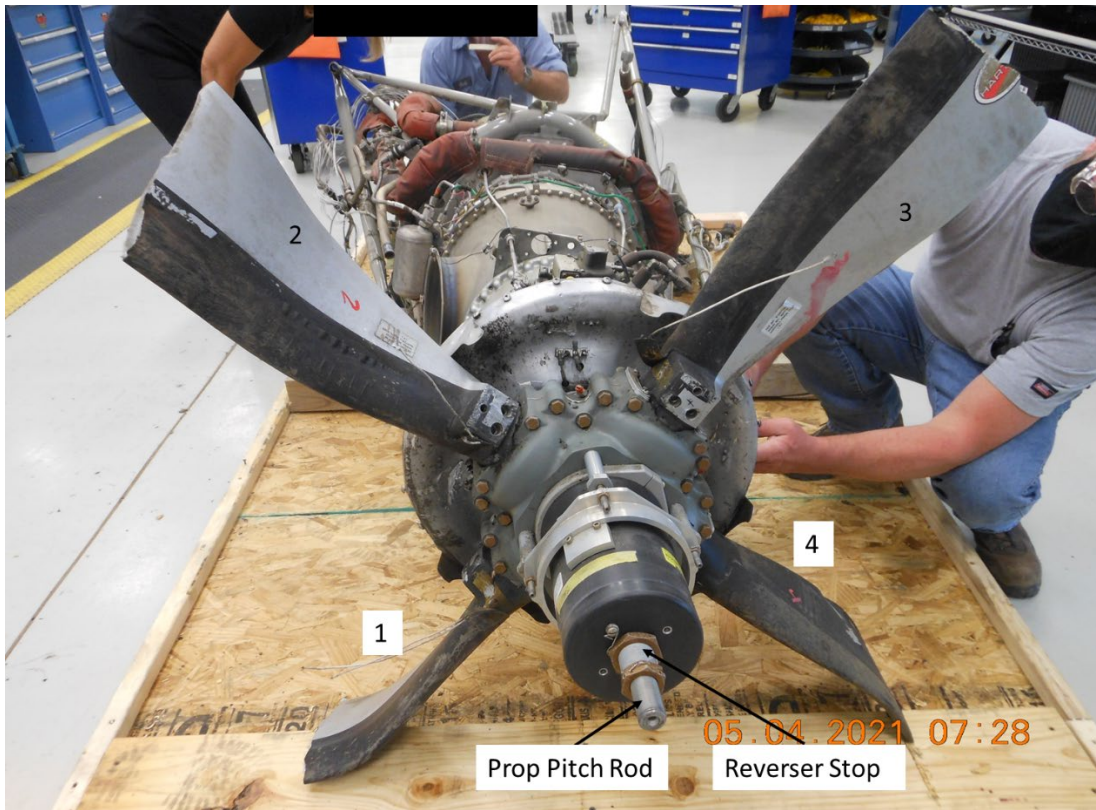
According to the airframe logbook, on April 23, 2020, the operator, Boutique Air DFW Maintenance performed non-routine maintenance to replace the carbon block and correct engine push-pull propeller reversing control binding issues. The logbook entry is shown below in **Photo 1**. According to the Pratt & Whitney Canada PT6-67B and Pilatus PC-12 maintenance procedures called out in the logbook entry, maintenance technicians would have been required to disconnect the reversing cable/beta arm linkage and verify proper rigging after the cable was reinstalled. The accident flight was the first flight following maintenance.

04. DCS - FOUND BETA CARBON BLOCK WORN - REMOVED WORN CARBON BLOCK (P/N: A-3074 S/N: N/A TSN: 914.2 CSN: 851) AND INSTALLED NEW CARBON BLOCK (P/N: A-3074 S/N: N/A TSN: 0 CSN: 0). NO DEFECTS NOTED AT THIS TIME. IAW PILATUS PC-12 AMM DMC 12-A-61-10-01-00A-920A-A
05. DCS - PCL takes extreme effort to move past the gate and into reverse - INSPECTED CONTROL CABLES FROM PILOTS CONTROL QUADRANT TO ENGINE AND ENGINE CONTROLS TO PROP GOVERNOR , FOUND SEVERE BINDING ON ENGINE PUSH-PULL PROPELLER REVERSING CONTROL ASSEMBLY, PERFORMED STATIC RIGGING OF PCL, NO DEFECTS FOUND ON STATIC RIG. BINDING REMAINS, IAW PILATUS PC-12 AMM DMC 12-A-76-10-00-00A-903A-A WORK PERFORMED BY SAMUEL HOLDAR A&P 4212219 REMOVED ENGINE PUSH-PULL PROPELLER REVERSING CONTROL ASSEMBLY FROM ENGINE, CLEANED CABLE AND ASSEMBLY, RE-INSTALLED ORIGINAL ENGINE PUSH-PULL PROPELLER REVERSING CONTROL ASSEMBLY, NO DEFECTS NOTED AT THIS TIME, IAW PILATUS PC-12 AMM DMC 12-A-76-10-00-00A-903A-A AND PRATT AND WHITNEY EMM PT6A-67B/-67P 76-10-00 WORK PERFORMED BY SAMUEL HOLDAR A&P 4212219 SET RIGGING ADJUSTMENT ON ENGINE PUSH-PULL PROPELLER REVERSING CONTROL ASSEMBLY, NO DEFECTS NOTED AT THIS TIME, IAW PILATUS PC-12 AMM DMC 12-A-76-10-00-00A-903A-A AND PRATT AND WHITNEY EMM PT6A-67B/-67P EMM 76-10-00 , WORK PERFORMED BY SAMUEL REYES A&P 4007498. ACCOMPLISHED POWERPLANT TEST 17- REVERSE POWER - ADJUSTMENT/TEST. OPS CHECK GOOD AND NO DEFECTS NOTED AT THIS TIME, IAW PILATUS PC - 12 AMM DMC 12-A-71-00-00-00A-903S-A. - Notes: **PARTS ON ORDER** #DFW-024405

3.0 Propeller Serial Number KX190 Examination

The propeller and engine were shipped as an assembly in a large particle board crate to the Pratt & Whitney Canada, Bridgeport, West Virginia facility. The crate was secured in the PWC PT6 shop when the investigation team arrived (**Photo 2**). All four propeller blade tips were separated during the impact sequence and were not included in the shipping container. The propeller blades were numbered with a paint marker in the counterclockwise direction (ALF) (**Photos 3 and 4**). Blade radius measurements were taken off the hub flat (**Table 1**). The spinner dome was separated during impact, and small remnants of the dome and the attaching screws remained fastened to the spinner bulkhead flange. The pitch change rod was in the full aft position, on the mechanical feather stop. The counterweights were missing from propeller blades 1, 2, and 3 and the blade pitch could be rotated by hand. There were shiny impact marks on the spinner bulkhead coincident with the position of the missing counterweights (**Photo 5**). The shanks on blades 1, 2, and 3 had impact witness marks from contact with the hub blade aperture and/or static balance weights in a location consistent with the blades being in the feather position at impact.





Propeller Blade	Radius at Fracture (inches)
1	18.25
2	18.5
3	19.25
4	19.0

Table 1- Propeller Blade Radius Measurements



Photo 5- Spinner Bulkhead Impact Damage

The twelve propeller mount bolts were torqued, and safety wired. Following propeller removal, the aft pitch rod bushing was loose, deformed, and missing material. The distance between the top of the beta ring and the hub mount flange measured approximately 2.4 inches² using a metal ruler (**Photo 6**). Propeller blades 2 and 3 had tip bending opposite the direction of rotation while propeller blades 1 and 4 exhibited S-shaped bending (**Photo 7**). Shop air was ported into the pitch change rod and the hydraulic unit, and blade 4 actuated normally³. There was no oil leakage visible during hydraulic actuation. The fracture surface on all four blades was rough and granular (**Photo 8**).

² According to the Hartzell Propeller maintenance manual, the beta ring should be rigged to 2.37 inches $\pm 0.005/-0.020$.

³ As noted earlier in the report, blades 1, 2, and 3 could be rotated by hand consistent with a broken pitch change knob bracket. The pitch change knob bracket maintains blade pitch and when broken would have also prevented normal blade actuation during the air pressure check.

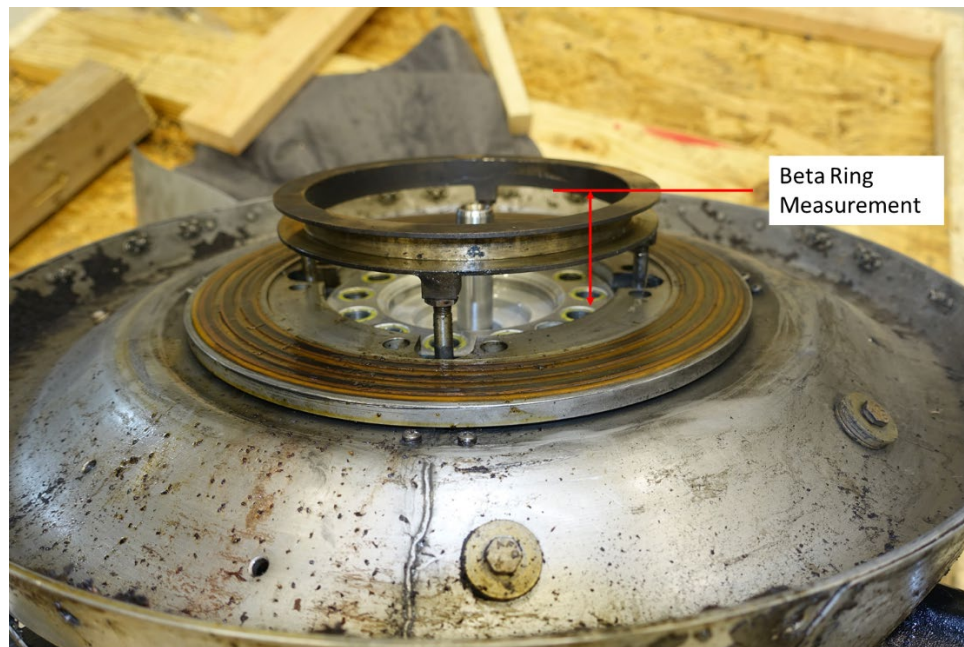


Photo 6- Beta Ring Measurement



Photo 7- Blade Deformation



Photo 8- Propeller Blade Fracture Surfaces

4.0 Engine Serial Number PCE-PR0699 Examination

The engine was intact and did not exhibit indications of undercowl fire or uncontainment (**Photos 9, 10, and 11**). The engine was shipped with multiple airframe components installed including: the plenum, sections of the mount structure, starter, air conditioning (A/C) compressor, and multiple ducts and wiring harnesses. Prior to airframe component removal, the reversing cable-to-beta valve rigging was checked in accordance with the Pilatus aircraft maintenance manual (AMM) procedure 12-A-76-10-00-00A-903A-A, Section 3.4- Adjustment of the Beta Control Cable and Pratt and Whitney engine maintenance manual (EMM) Section 76-10-00, Prop Reverse Linkage- Maintenance Procedures. The beta valve plunger was extended beyond the face of the propeller governor (**Photo 12**)⁴. A wire could be inserted through both the forward and aft clevis inspection holes that act as check points for proper thread engagement (**Photos 13 and 14**). The forward clevis adjustment nut was rotated full aft. The wire rope, swaging ball end⁵ on the forward end of the reversing cable was not properly secured between the clevis rod end and the push-pull control terminal and was free to rotate within the linkage assembly (**Photo 16**). The reversing cable was removed and was measured for indications of stretch. According to the PWC drawing, the cable has a maximum tolerance of 55.5425-inches. An informal measurement of the cable determined the cable was at approximately the maximum allowable length.

⁴ The Pilatus AMM includes a step in both the test and rigging procedures to “make sure the beta valve aligns with the face of the propeller governor.”

⁵ The wire rope, swaging ball end is commonly referred to as the “football.”

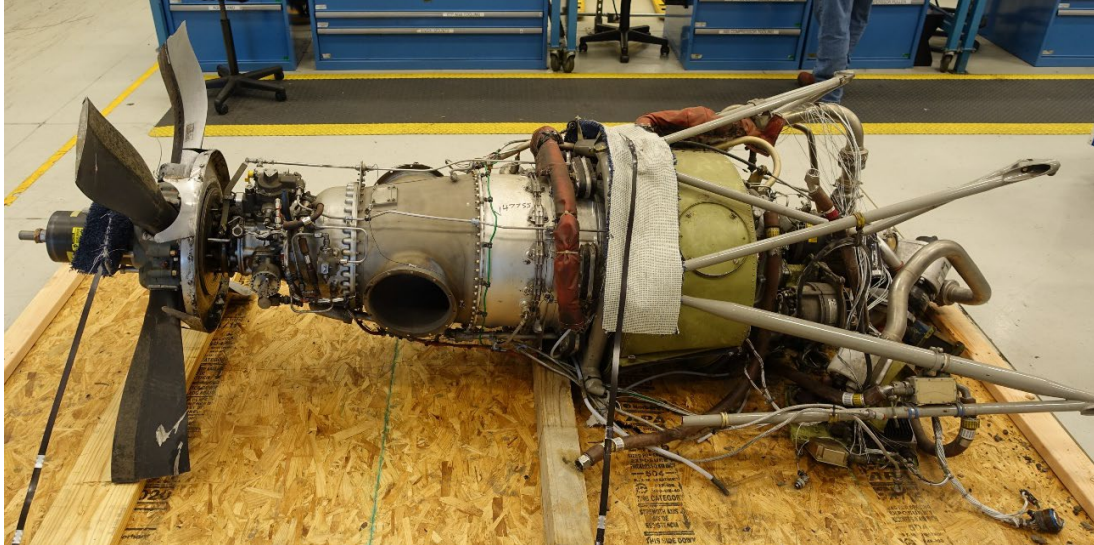


Photo 9- Left Side of Engine, as Received

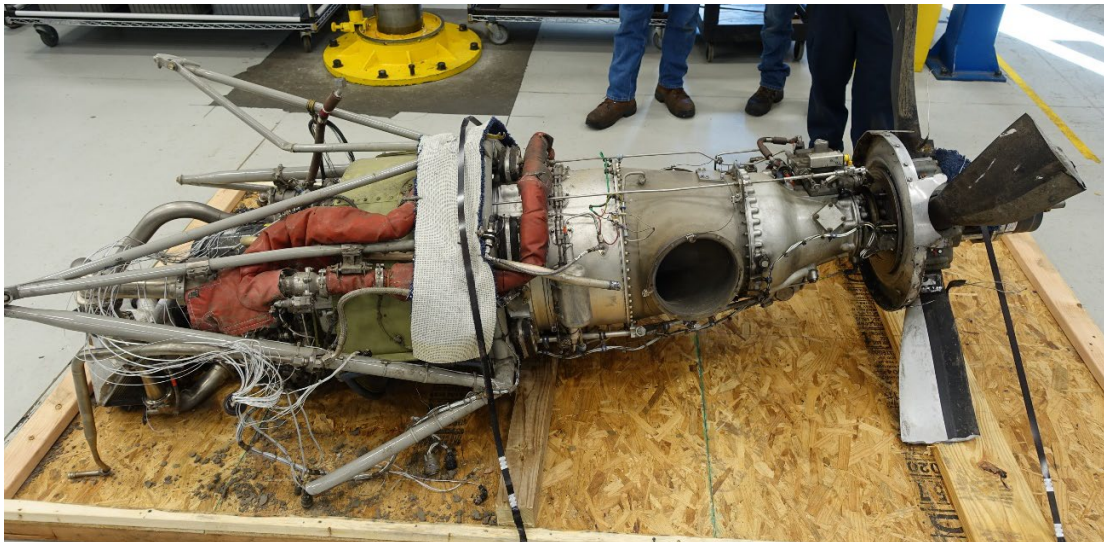


Photo 10-Right Side of Engine, as Received



Photo 11- Engine Data Plate

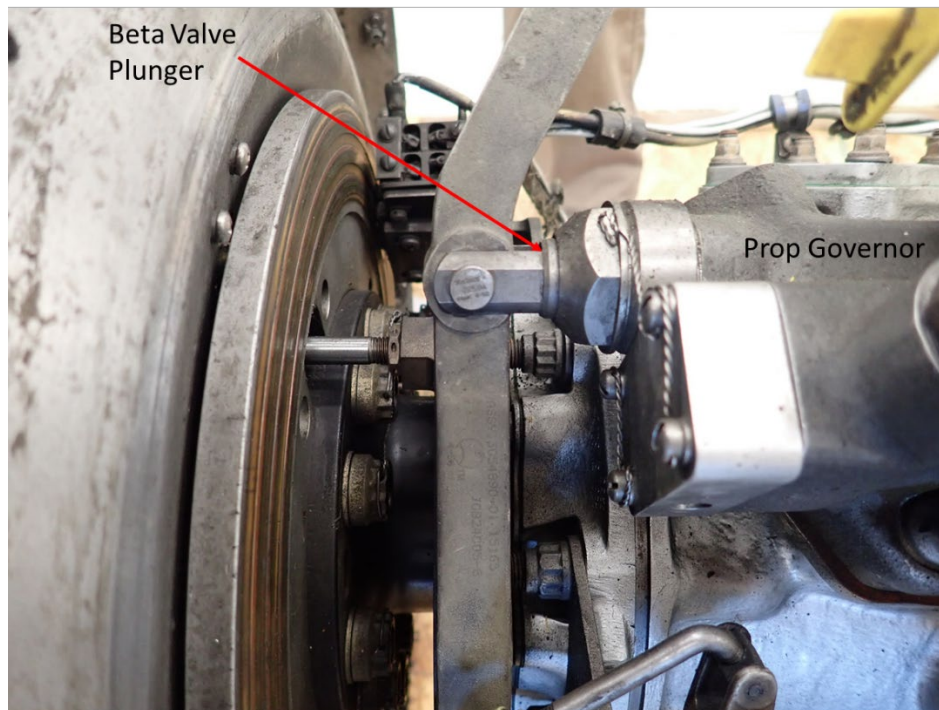


Photo 12- Beta Valve Position

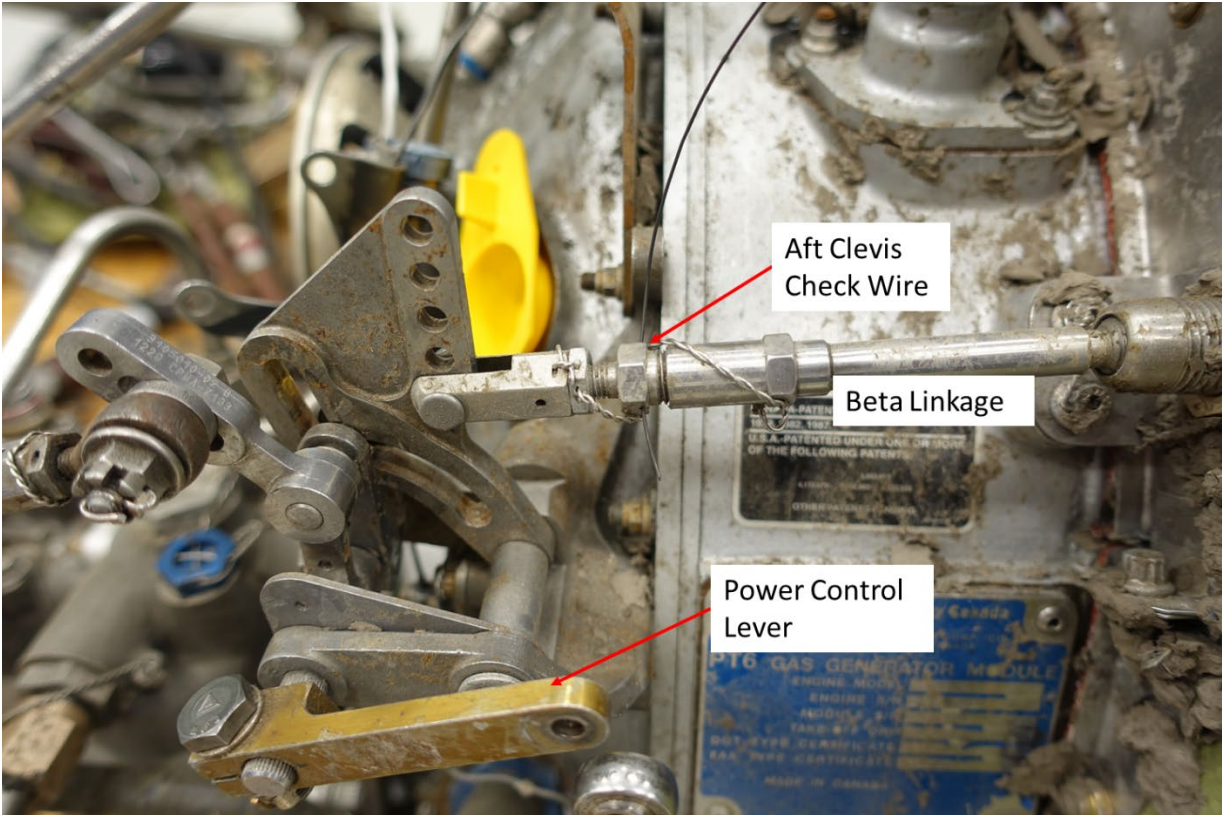


Photo 13- Aft Beta Linkage Clevis

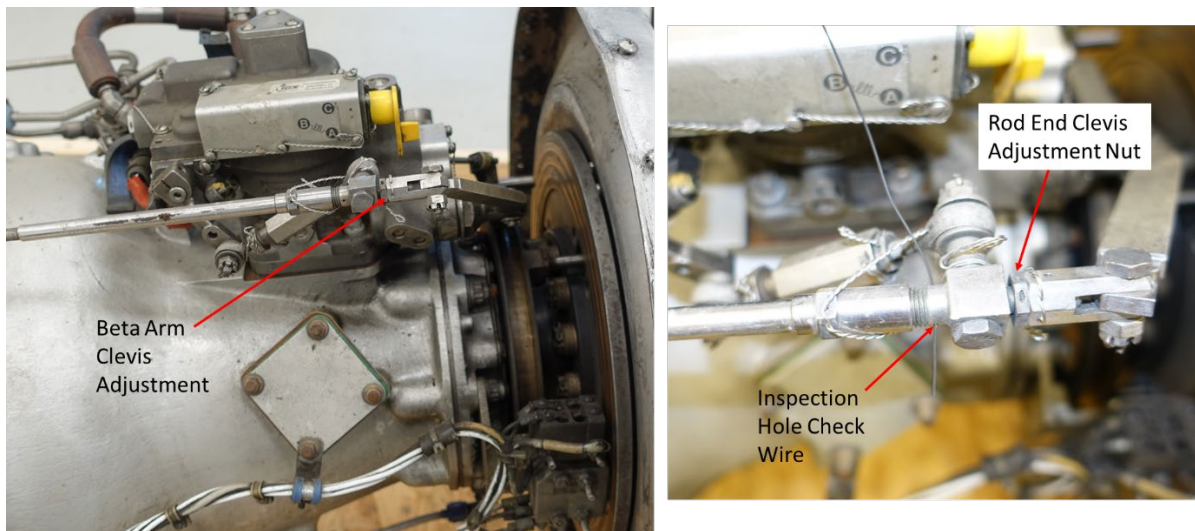


Photo 14- Forward Beta Linkage Clevis

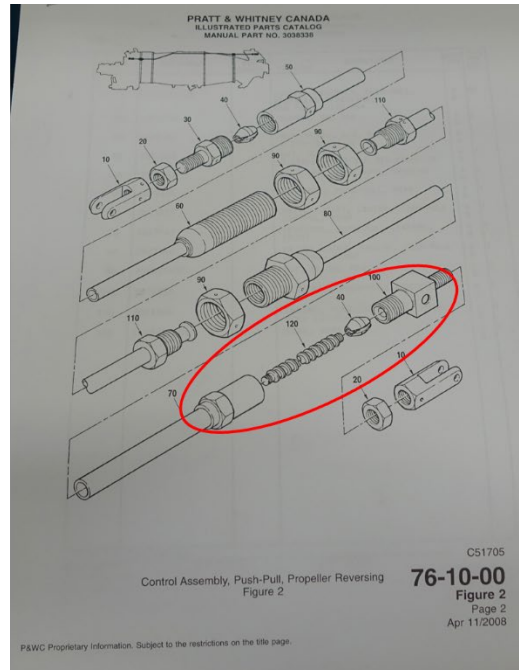
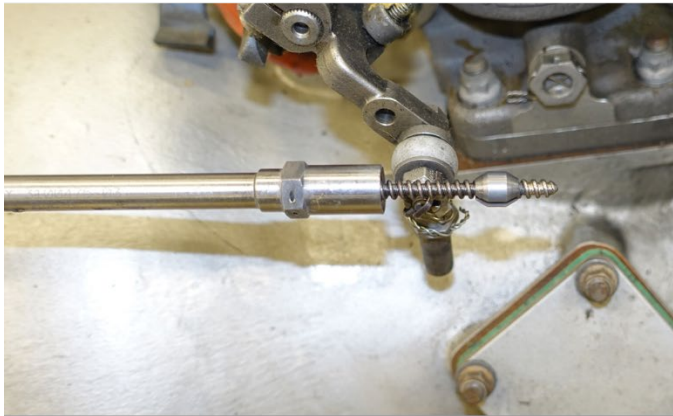


Photo 15- Wire Rope, Swaging Ball End, Forward Beta Linkage Clevis

The airframe components were removed, and the engine external surfaces were visually examined (**Photo 16 and 17**). Mud/earthen debris was adhered to the engine inlet screen 360 degrees around the engine. The No. 2 bearing scavenge line and a fuel supply line located at the 6 o'clock position exhibited bending deformation (**Photo 18**). The Ng and Nf spools⁶ both spun smoothly with no indication of internal rub. The magnetic chip detector (MCD) was removed from the reduction gearbox (RGB) and there was no debris accumulation. One of the two MCD prongs was damaged during removal (**Photo 19**). The fuel, oil, and P3⁷ filters were in good condition and free of debris.

⁶ The Ng spool consists of the compressor and compressor turbine stages. The Nf spool consists of the two-stage independent power turbine.

⁷ P3 is compressor discharge pressure

Inlet Screen Debris



Photo 16- Left Side of Engine



Photo 17- Right Side of Engine



Photo 18- Engine Line Deformation, 6 o'clock Position



Photo 19- Magnetic Chip Detector (*Damaged During Removal)

4.1 Compressor

Impact damage/tearing was observed on the leading edge of one 1st stage compressor blade and minor leading edge damage was present on four blades (**Photo 20**)⁸. A

⁸ The compressor blade damage precluded safely running the engine on the test cell.

borescope was used to inspect the centrifugal impeller and a small amount dirt/debris accumulation was visible, but the impeller vanes were all in good condition and unremarkable.



Photo 20- 1st Stage Compressor Blade Damage

4.2 Compressor Turbine/Combustor/Power Turbine

The PT module was separated from the engine. The trailing edge of all CT blades were in good condition. The combustion liner was intact and there was no evidence of burn through and fuel nozzle streaking (**Photo 22**). The leading edge of the 1st stage PT blades and trailing edge of the 2nd stage PT blades visible through the exhaust were unremarkable (**Photo 23**). The team decided not to further disassemble the engine modules due to a lack of evidence of internal damage.



Photo 21- Compressor Turbine and Combustion Liner



Photo 22- Trailing Edge, 2nd Stage Power Turbine Blades

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