

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



ERA23LA272

POWERPLANTS

Specialist's Factual Report

August 16, 2024

A. INCIDENT

Location: Wellington, FLZ, USA
Date: June 20, 2023
Time: 3:20pm MST (Mountain Standard Time)
Aircraft: Air Tractor AT802, registration number N3069S
NTSB IIC: Lynn Spencer

B. ENGINE EXAMINATION GROUP

Powerplant Specialist	Thomas Driscoll National Transportation Safety Board Washington, D.C., USA
Participant	Jim Rosplock Woodward Inc. Loves Park, Illinois

C. DETAILS OF THE INVESTIGATION

The fuel control unit (FCU) (Woodward Serial Number 14587842), previously examined by Pratt & Whitney Canada (P&WC), was shipped from P&WC to the Woodward Inc. facility in Loves Park Illinois for further examination. The examination took place April 23, 2024, with persons from the NTSB and Woodward Inc. present.

1.1 Visual Inspection

The shipping container was opened, the FCU and individual parts (FCU drive shaft, FCU inlet strainer and the FCU tachometer valve strainer) were found sealed within plastic bags. The FCU was removed from the plastic bag and the serial number verified on the data plate (Photo 1).



Photo 1. Sealed FCU and Components

Initial visual as received inspection (Attachment 1) of the FCU was performed, the manual override screw was found wired in the closed position and no other anomalies were observed (Photo 2). The manual override screw being wired closed will not allow the pilot to manually control the fuel flow metering valve to allow engine power modulation in the event that P3 or PY air pressure is lost. The FCU drive shaft, previously found to be worn during the P&WC exam, was taken to Woodward's metallurgy laboratory for scanning electron microscope (SEM) analysis.

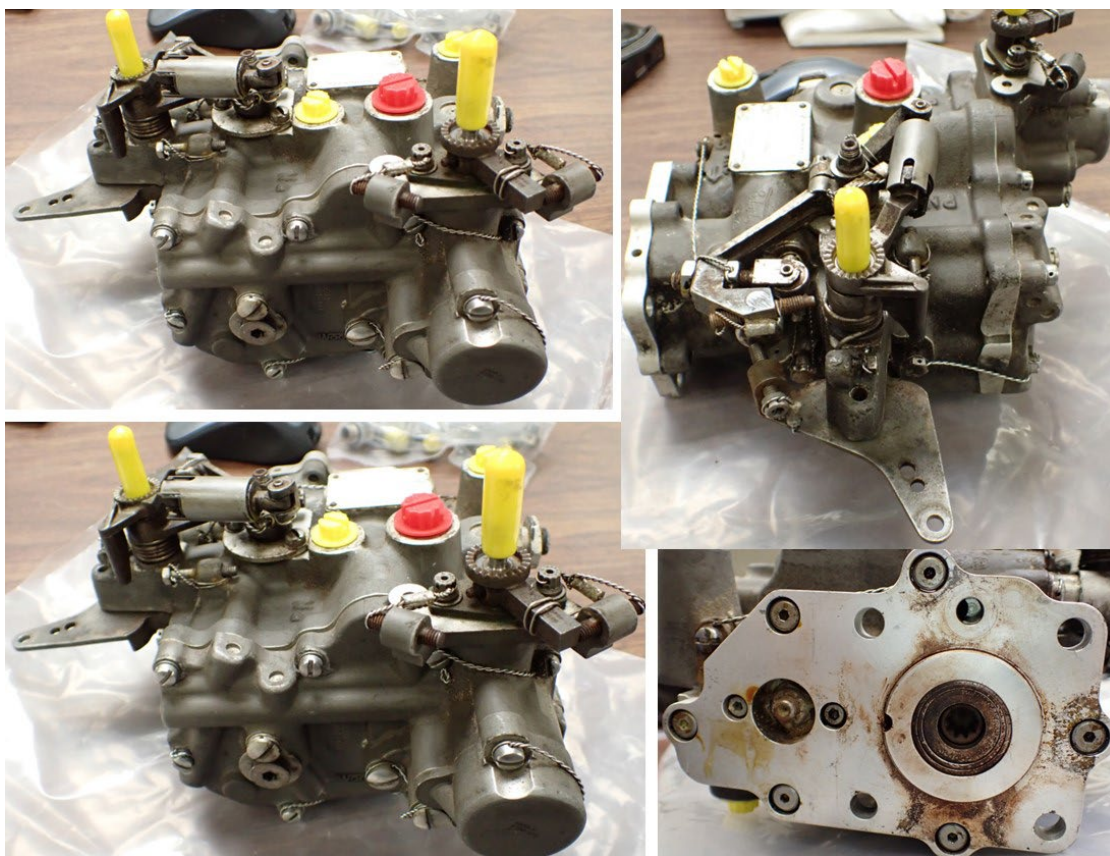


Photo 2. As Received FCU

The shipping caps were removed from the FCU, a sliver of metal debris was removed from the base plate, next to the drive adapter, and placed in a plastic bag. Additional debris was found on the P3 port and on the P3 port shipping cap, the debris was removed and placed in a plastic bag. All lockwire was removed to facilitate further disassembly/examination.

1.2 Bench Testing

In order to facilitate bench testing of the FCU, the installation of a Woodward provided FCU drive shaft and FCU inlet strainer was required. The original FCU tachometer valve strainer was removed during the P&WC exam and sealed in a plastic bag, but the tachometer valve strainer was found installed. With the required hardware installed onto the FCU, the FCU was placed onto the test bench to assess FCU performance at maximum forward power lever position with zero speed input (Photo 3).

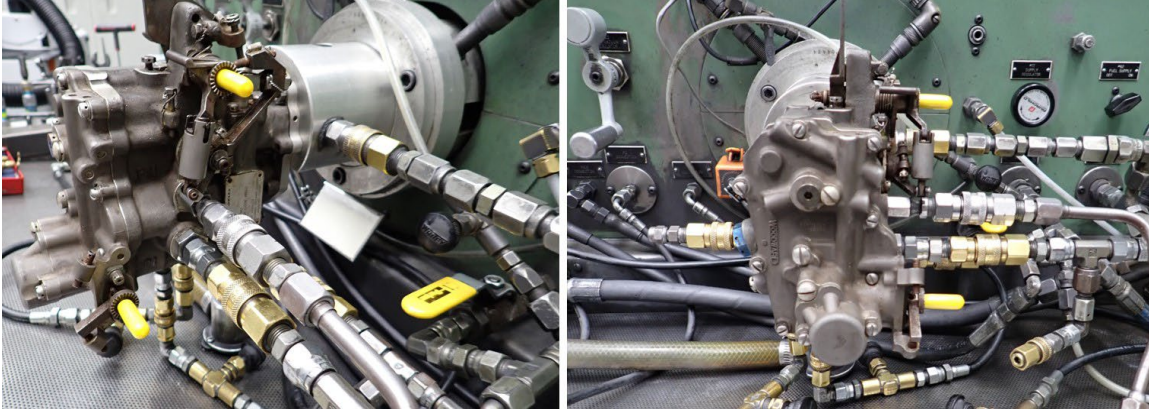


Photo 3. FCU on the Test Bench

The maximum forward power lever speed setting is a normal customer adjustment and was slightly higher than the acceptance test procedure (ATP) setting. The Woodward test stand had a separate fuel pump that was not coupled to the FCU drive such that inlet flow to the FCU can be controlled independent of the drive speed input to the FCU. The inlet flow was set at the maximum power lever condition and the drive speed was reduced to zero. The fuel flow initially increased to the maximum flow value as speed was reduced as expected based on the acceleration schedule. The final flow with zero speed was 416 pounds per hour (pph) with P3 set at 140 pounds per square inch differential (psid) per the maximum forward power lever test point. An indicator was installed on the speed setting cam of the tachometer assembly and the minimum speed stop was measured to be at 1460 revolutions per minute (rpm). See Attachment 2 for the bench test summary.

1.3 FCU Disassembly

The FCU housing base cover was separated to facilitate further examination, the blue o-ring seal was found intact and undamaged, the bellows appeared undamaged and otherwise unremarkable (Photo 4). The ballhead bearings, spun with hand pressure, and had smooth and continuous rotation.

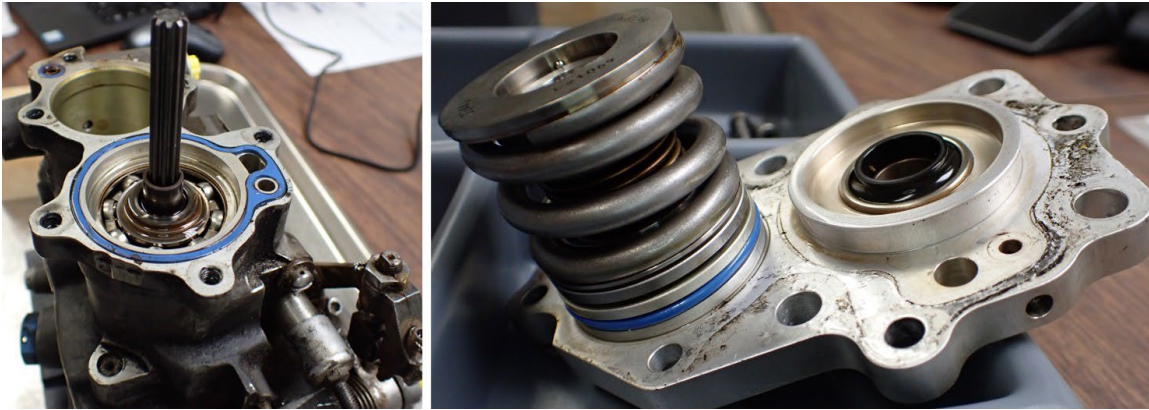


Photo 4. FCU with Top Cover Removed

The FCU housing top cover was separated to facilitate further examination (Photo 5). The overboard drain port was found to be dirty and have debris within the port, which Woodward personnel reported as unusual. A dent or puncture next to fuel valve was found on the fuel valve plate.

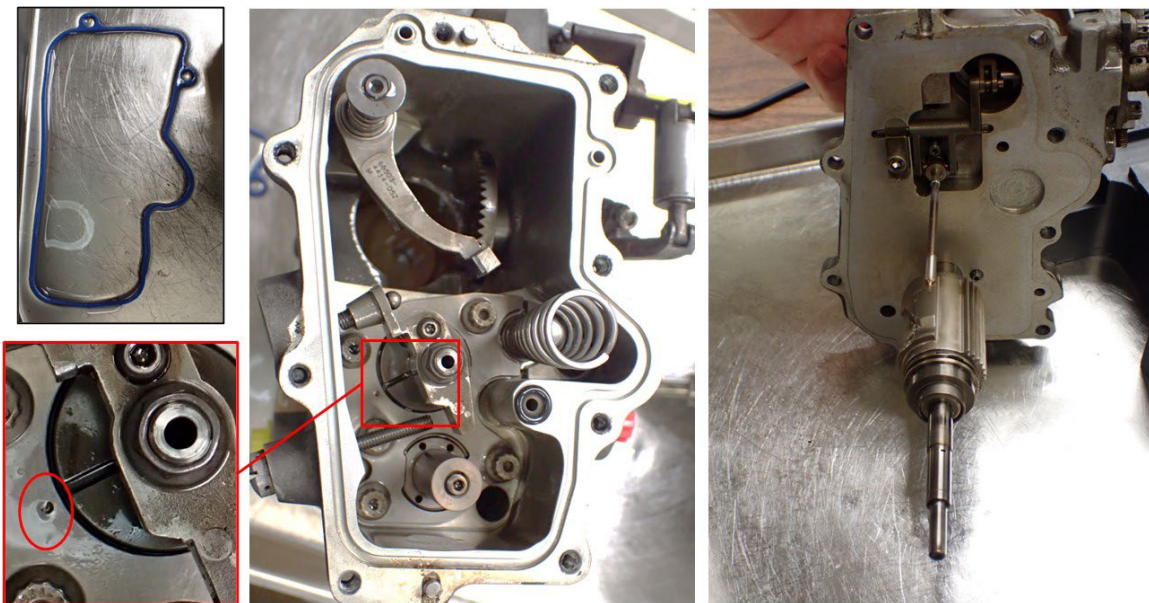


Photo 5. FCU with Bottom Cover Removed, Punctured Valve Plate

The three-dimensional (3D) cam and shaft assembly was removed from the FCU housing cover, and a nonmetallic substance was observed on the cam shaft (Photo 6). The 3D cam was separated from the cam shaft, the cam shaft Teflon seal was found partially extruded from its typical position. Teflon seal shedding/wear is a typical condition of used hardware according to Woodward personnel.

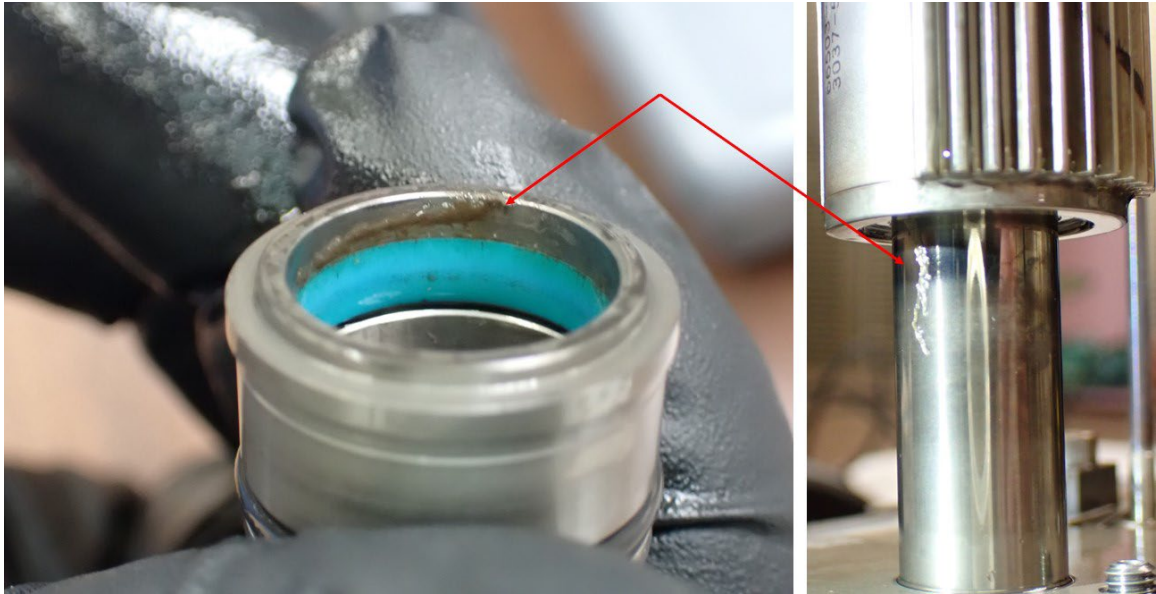


Photo 6. Nonmetallic Substance on the Cam Shaft

The 3D cam was found to be undamaged and otherwise unremarkable (Photo 7), a small dent or area of wear was found on the cam shaft (Photo 8).



Photo 7. 3D Cam

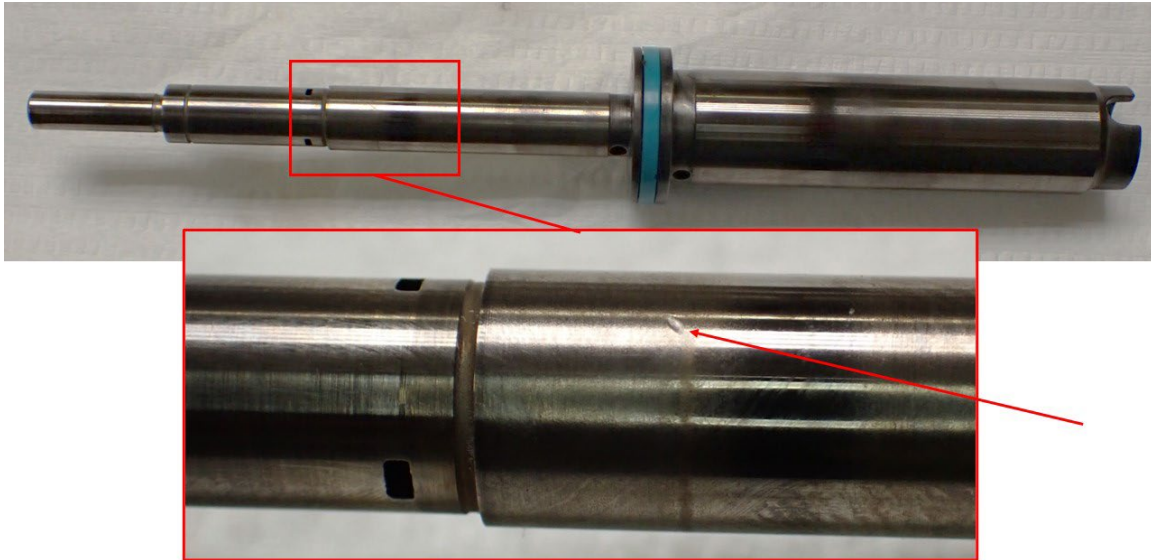


Photo 8. Cam Shaft

The fuel valve appeared undamaged and otherwise unremarkable. The fuel valve assembly, the piston and the sleeve, were correctly marked with matching serial numbers. The pressurizing valve appeared undamaged and otherwise unremarkable. The bypass valve appeared undamaged with some polishing and otherwise unremarkable. All the o-ring seals appeared intact and undamaged (Photo 9).



Photo 9. Fuel Valve(L), Pressurizing Valve (C), Bypass Valve (R)

1.4 Metallurgy of the FCU Drive Shaft/Spline

Metallurgical analysis of the FCU drive shaft was performed by Woodward Inc. personnel. The base material of the FCU drive shaft was inspected using an energy-dispersive spectroscopy (EDS) and the chemistry was found to be consistent with 410 stainless steel (SST). The only observable material components on the exposed surface were iron, chrome, and silicon. Chrome was measured at 15%, slightly higher than the 11.5-13.5% per the 410SST specification, but this is within the reasonable error margin for the SEM according to Woodward personnel.

Superficial microhardness of the drive shaft was measured using 5 Vickers indentations at 500-gram load. The hardness was recorded at 277 on the Vickers scale (HV) (equivalent to 29 on the rockwell hardness on the C-scale (HRC)), within Woodward Engineering tolerance of 18-32 HRC for 410 SST, indicating that case hardening was present on the undamaged surface of the part. The nitride case hardening depth of the draft shaft splines was measured in three locations with measurement values between 0.00115 inches and 0.00144 inches which is within the Woodward Inc. procedure tolerance range of 0.0005 inches to 0.0020 inches. EDS of the shaft end showed evidence of the wear direction being the clockwise radial direction (relative to the customer interface end of the component) and there was no imbedded foreign material found on the wear surface.

ATTACHMENTS

1. Woodward's Visual As Received Inspection
2. Woodward's Bench Test Summary

Thomas Driscoll
Aerospace Engineer - Powerplant
National Transportation Safety Board