

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

December 20, 2021

Attachment 1 – Pratt & Whitney Canada Accessories Accident Report

POWERPLANTS

CEN21LA004

ACCESSORIES ACCIDENT REPORT

Date issued: 13 October 2021

Customer: Maria Squared Aviation LLC
Engine Model: PT6A-42A, **Serial No.:** RM0091
Time Since New (TSN): Unknown
Cycles Since New (CSN): Unknown
SI RFA No.: 20SIE00263, **P&WC File No.:** 20-144

This report is to support the engine review regarding an accident that occurred on 02 October 2020.

1.0 Event:

Shortly after takeoff, the pilot reported a loss of engine power and force-landed in a cornfield. The airplane sustained substantial damage from the impact and post-impact fire.

2.0 Summary of findings:

Investigation of the accessories comprised inspection and testing of the fuel pump, fuel control unit (FCU), flow divider valve (FDV), propeller governor (CSU), and fuel oil heat exchanger (FOHE). An external leak was present during initial testing of the fuel pump. This was believed to have been a consequence of the crash and was rectified by replacement of the fuel inlet nipple. Testing of the FCU revealed observations that were suggestive of typical field adjustment however, the governor spring tests (test point 4) suggested that the governor spring tension was weak, or wear was present at the spring attachments. This observation did not prevent obtaining maximum fuel flow (test point 2.05), had no significant detrimental effect on any other test points and is not a field adjustment. This test point is representative of the FCU governing the fuel flow to govern gas-generator speed such as during acceleration to prevent over-shooting. Testing of the fuel pump, FDV, FOHE and CSU were unremarkable.

3.0 Conclusion:

There were no defects or damage evident that would have prevented normal operation prior to the event. Testing of the FCU revealed generally minor observations however, the governor spring test points suggested that the governor spring tension was weak, or wear was present at the spring attachments. It did not prevent obtaining maximum fuel flow, had no significant detrimental effect on any other test points and is not a field adjustment.

This supplement was issued to replace the proprietary notice on page 1 with the statement for the National Transportation Safety Board docket, correct the Fuel Oil Heat Exchanger part number and serial number in the table "List of Accessories" on page 2, revise the distribution list on page 13.

EXPORT CONTROL CLASSIFICATION	LOCATION	U.S. REGULATION			
		EAR		ITAR	
	U.S.	P-ECCN	9E991	P-USML	NSR
	OUTSIDE U.S.	ECCN	9E991	USML	NSR
	CANADA	LOCAL REGULATION			
		EIPA (ECL)		DPA (CG)	
		NSR		NSR	

This document has been cleared for posting on the National Transportation Safety Board docket

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4.0 Investigation:

Conducted at: Pratt & Whitney Canada

Initiated on: 08 June 2021

In attendance:

Name	Representing
Thomas Armstrong	Transportation Safety Board of Canada
Dave Barnard	P&WC
Marc Hamilton	Transportation Safety Board of Canada

List of Accessories:

Accessory	P&WC P/N	Manufacturer	Supplier P/N	S/N	Times/cycles
Fuel pump	3033808	Eaton	399701-5	5606	Unknown
Fuel control unit (FCU)	3052899-02	Honeywell	4138010-2	C77121	Unknown
Flow divider valve (FDV)	3019906	Triumph	25536-4	20599	Unknown
Propeller governor	3074158-01	Woodward	8210-007-01	1516406	Unknown
Fuel oil heat exchanger (FOHE)	3124177-01	Meggitt	10994A	WA6250	Unknown

Accessory: Fuel pump

Note: This unit was on the engine at original engine delivery.

Investigation Results:

The fuel pump (figure 1) was received packed with a fuel sample bottle. There was no evidence of water in the fuel sample. A solenoid valve was attached to the fuel pump motive-flow port. The exterior of the fuel pump was lightly soiled. The driveshaft turned with normal resistance. There was no evidence of bearing grease dilution at the fuel control unit mounting flange. There was a temperature sticker on the outlet filter bowl. Lockwire was missing from the fuel pump outlet filter-bowl, but the bowl could not be removed by hand. Lockwire was present at all other locations.

Prior to testing the fuel pump, the outlet filter and inlet screen were removed for inspection (figure 2). No significant debris was present in the outlet filter, outlet filter bowl, inlet-screen, or inlet screen cavity. With the fuel pump installed on the test stand a leak was observed at the fuel outlet nipple. The nipple was replaced with a slave and the fuel pump was tested in accordance with Eaton overhaul manual 73-10-12 rev. 2. The test was satisfactory.

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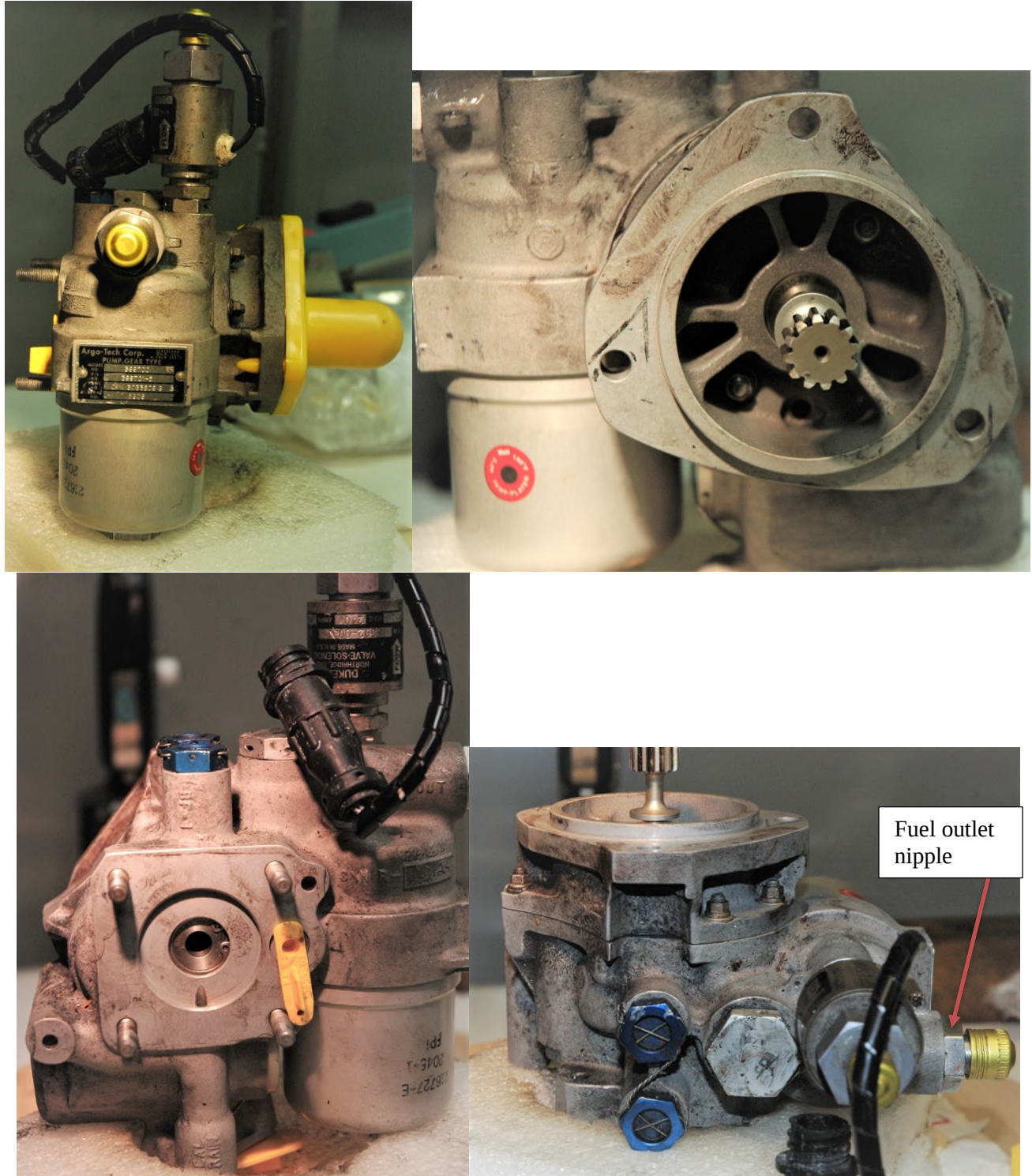


Figure 1
Fuel pump as received

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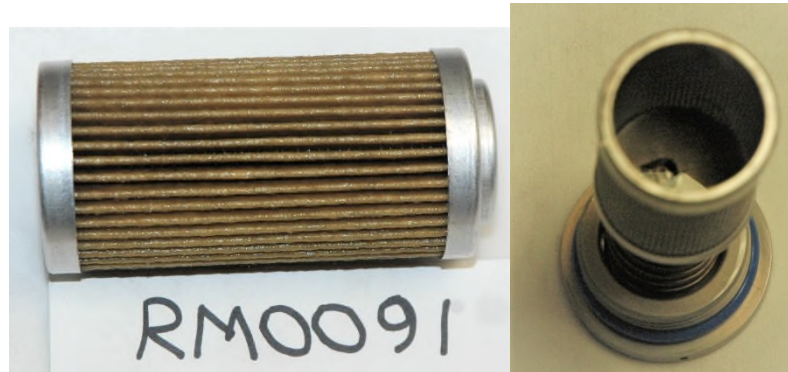


Figure 2

Fuel pump outlet filter (left) and inlet screen (right) prior to testing

Accessory: Fuel control unit (FCU)

Note: This unit was on the engine at original engine delivery.

Investigation Results:

The exterior of the fuel control unit (FCU) was lightly soiled (figure 3). The plastic drive-coupling (figure 4) was attached to the mounting pad by a tie-wrap. The driveshaft turned freely. The throttle lever/cut-off lever linkage moved freely over the full range. The part-power trim stop was in the stowed (flight) position. The index mark of the Sg dome was in-line with the datum line on the bypass valve collar. The manual override lever moved freely over the full range. Lockwire was present at all locations. There were no identification marks on the lockwire seals.

Prior to testing the FCU the P3 air inlet fitting, Py air outlet fitting, and air adapter were removed for inspection. The P3 inlet fitting was intact with no obstruction present in the Px restrictor. There was galvanic corrosion present on the Py outlet fitting and in the corresponding threads of the air adapter (figure 5). There was no obstruction present in the Pa bleed, Py bleed or Py restrictor. With the FCU installed on the test stand air was applied to the pneumatic system and a leak-test solution was applied to the air system fittings and flanges. Acceptable slow bubbling was observed at the drive-body/flow body flange and the air adapter flange. No other air leaks were observed. The FCU was operated at fixed speed, fixed P3 air pressure and fixed throttle lever position for 5 minutes while monitoring the fuel outlet flow for a decrease, as could be anticipated if the acceleration bellows was leaking, or an increase, as could be anticipated if the governing bellows was leaking. No significant change in fuel outlet flow was observed during the monitoring period. The FCU was tested in accordance with Honeywell CMM 73-20-35 Rev. 1. The following observations were recorded:

Test point 2.02 Metering valve orifice and bypass valve differential pressure setting: with the drive-speed at 2900RPM, the throttle lever at 29degrees nominal, the outlet pressure at 75psig and P3 air at 40psia the fuel outlet flow was 2pph below the test point minimum limit.

Test point 2.03 Metering valve orifice and bypass valve differential pressure setting: with the drive-speed at 6200RPM, the throttle lever at maximum, the metering valve pressure at 760psig and P3 air at 90psia the fuel outlet flow was 5pph above the test point maximum limit.

Test point 2.04 Metering valve orifice and bypass valve differential pressure setting: with the drive-speed at 6200RPM, the throttle lever at maximum, the metering valve pressure at 950psig and P3 air at 120psia the fuel outlet flow was 1pph above the test point maximum limit.

Test point 2.05 Metering valve orifice and bypass valve differential pressure setting: with the drive-speed at 6200RPM, the throttle lever at maximum, the metering valve pressure at 950psig and P3 air at 135psia the fuel outlet flow was 3pph above the test point maximum limit.

Test point 4.01 Governor Spring Setting: with the drive-speed at 6487RPM, the throttle lever at 93.5degrees, the metering valve pressure at 650psig and P3 air at 95psia the fuel outlet flow was 92pph below the test point minimum limit.

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Test point 4.01A Governor Spring Setting: with the drive-speed at 6487RPM, the throttle lever at 93.5degrees, the metering valve pressure at 650psig and P3 air at 95psia the fuel outlet flow was 85pph below the test point minimum limit.

Test point 4.03 Governor Spring Setting: with the drive-speed at 6575RPM, the throttle lever at 93.5degrees, the metering valve pressure at 370psig and P3 air at 95psia the fuel outlet flow was 13pph below the test point minimum limit.

Test point 5.01 Idle speed stop setting and throttle pick-up angle: with the drive-speed at 3560RPM, the throttle lever at 29degrees nominal, the fuel outlet pressure at 107psig and P3 air at 34psia the fuel outlet flow was 3pph above the test point maximum limit.

Test point 5.02 Idle speed stop setting and throttle pick-up angle: with the drive-speed at 3560RPM, the throttle lever at which fuel flow was observed to increase by 4pph was 1 degree above the test point maximum limit. Adjustment of the idle stop screw after the test sequence was completed restored this test point to within factory limits confirming that this was due of typical rigging adjustment.

Test point 7.01 Maximum idle reset (high-idle): with the drive-speed at 4380RPM, the throttle lever at 45degrees, the fuel outlet pressure at 240psig and P3 air at 70psia the fuel outlet flow was 127pph below the test point minimum limit. This was equivalent to the idle speed minimum limit. Adjustment of the idle reset stop screw after the test sequence was completed restored this test point to within factory limits confirming that this was due of typical rigging adjustment.

Test point 9.02 Cut-off modulation and cut-off leakage: with the drive-speed at 5000RPM cut-off occurred at a throttle lever angle that was 3 degrees below the test point minimum limit.

The FCU was partially disassembled (figure 6). The throttle lever shaft was straight. The bypass valve diaphragm was marked 4Q10 indicating that it was manufactured in the 4th quarter of 2010 and was not within the 6-year life limit recommended by Honeywell at the time of the event (figure 7). The rubber of the diaphragm was pliable, blistering was present on the underside of the diaphragm and there was no evidence of leaks. There was no debris or broken wires in the fuel inlet screen. There were no burrs or obstructions in the bypass valve sleeve. There was no obstruction in the metering valve and the metering valve fell freely in the sleeve. The torque-tube was tested and confirmed to have no leaks. The ratio levers were straight, and the bronze insert was present in the metering valve ratio lever. The length of the acceleration bellows was within 0.007in of the length marked on the end plate confirming that the acceleration bellows was not leaking. The governing bellows was tested and confirmed to have no leaks. There was no marking on the back of the identification plate.

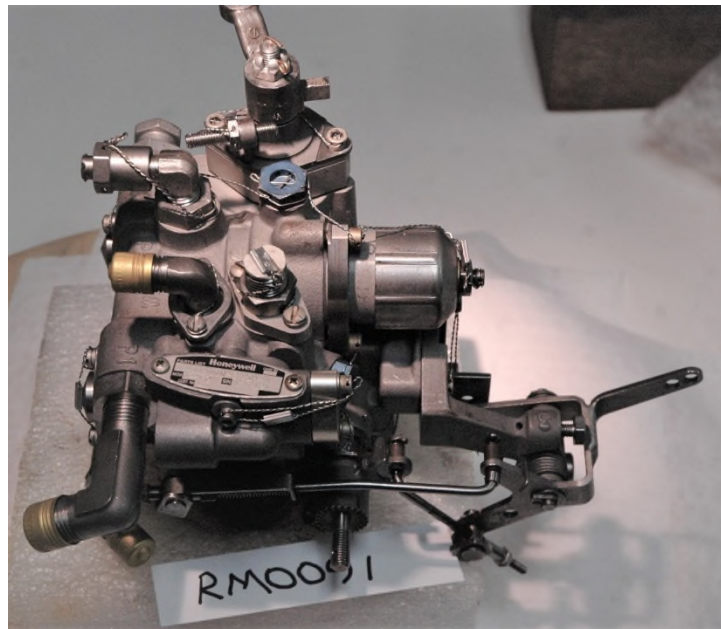


Figure 3

P&WC 10760(2012-12)

This document is subject to the restriction contained in the first page.
The export control classification with respect to this document is contained on the first page

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Fuel control unit (FCU) as received



Figure 4
FCU plastic drive-coupling

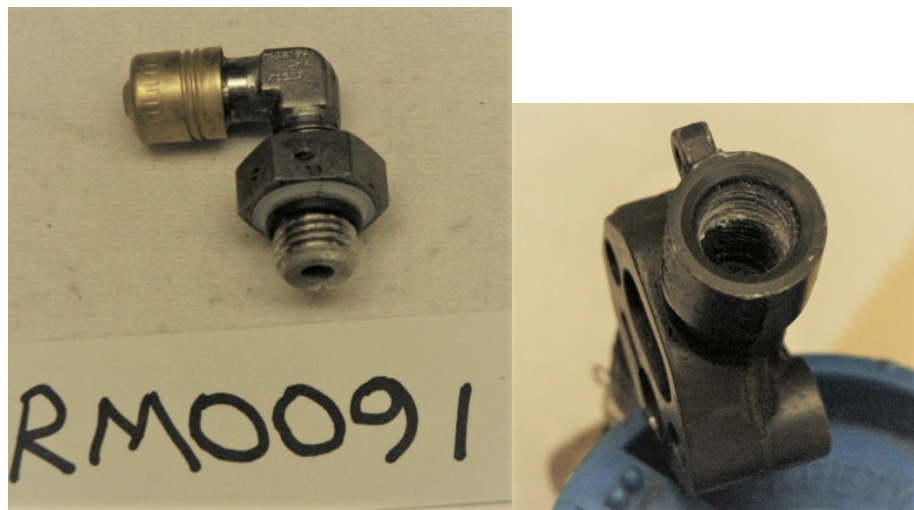


Figure 5
FCU Py outlet elbow and P3 air adapter galvanic corrosion residue

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Figure 6
FCU partially disassembled

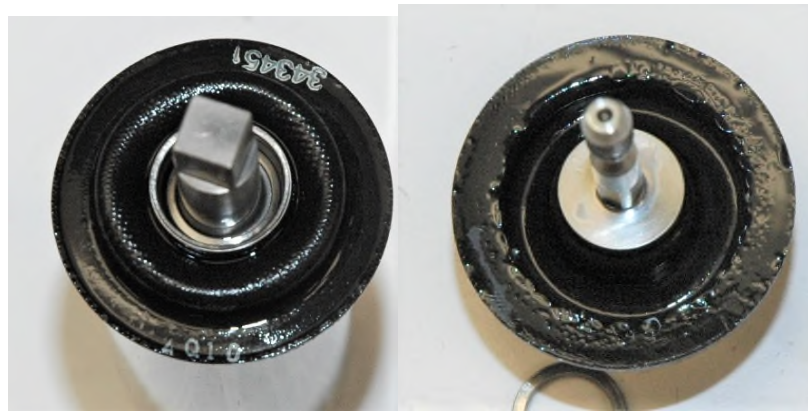


Figure 7
FCU bypass valve diaphragm

Accessory: Flow divider valve (FDV)

Note: This unit was on the engine at original engine delivery.

Investigation Results:

The exterior of the flow divider valve (FDV) was generally clean (figure 8). There were no significant scratches on the fuel manifold inlet adapter mating face. There were no leak-paths visible in the packing grooves and no packings in the grooves. Lockwire was present at all locations.

The FDV was tested in accordance with Triumph overhaul manual 73-10-01 Rev. 7. The test was satisfactory. During set up for testing it was observed that the primary transfer valve retaining clip was not in the clip groove (figure 9). This had no detrimental effect on the function of the FDV during testing.

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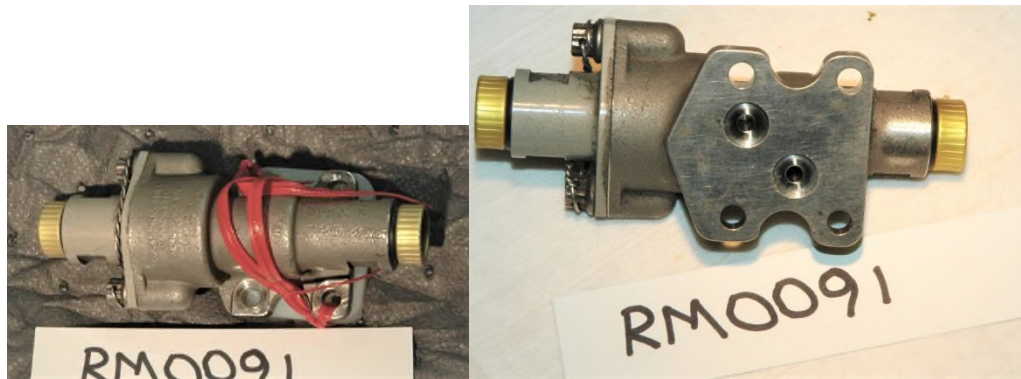


Figure 8

Flow divider valve (FDV) as received



Figure 9

FDV primary transfer valve retaining clip (arrowed)

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Accessory: Propeller governor (CSU)

Note: This unit was on the engine at original engine delivery.

Investigation Results:

The exterior of the propeller governor (CSU) was generally clean (figure 10). The speed setting lever moved freely over the full range and returned under the influence of its spring. There was un-broken yellow anti-tamper paint on the pilot-valve/speed setting lever. The reset arm moved freely over the full range and returned under the influence of its spring. There was un-broken yellow anti-tamper paint in the reset arm stop screw. There was un-broken yellow anti-tamper paint on the minimum governor adjustment. The driveshaft turned freely and there was no debris in the mounting pad gasket screen. There was an International Governor service-label on the cover. The data plate was marked 01/2015 indicating that the CSU had been serviced in January 2015. Lockwire was present at all locations. The lockwire seal was marked IGS (International Governor).

Prior to shipping the CSU to Woodward, the plug was removed from the Py bleed port to check the port for contamination (figure 11). No contamination was observed. The CSU was forwarded to Woodward (the manufacturer) for investigation in the presence of a representative from the National Transportation Safety Board (NTSB). Their investigation conclusion was as follows:

The unit was received and an as received visual inspection was conducted. During the inspection it was noted that the lockwire, seals, and torque sealant were foreign indicating the originals had been removed after leaving the Woodward facility. Additionally, there were no significant signs of damage to the unit that would have prevented running an As Received Test. After the visual assessment, the unit was sent for an as received test. During testing the unit was started up slowly to check for any audible signs of internal damage to the unit. There were no anomalies during start-up, so the unit proceeded through the test as received. The unit's "Max Speed" and "Control Arm Location" test points were slightly out of limits high. The shift in the test data and non-Woodward lockwire suggest that these settings were adjusted in the field. Although, there were some test points slightly out of limits there were no significant anomalies that appeared to contribute to the reported event. Due to these findings, it was determined between the NTSB representative and Woodward engineering that a disassembly of the unit was not necessary. In summary, the unit had evidence of being adjusted in the field. However, even with those adjustments all indications from testing suggest that the unit was functioning properly.

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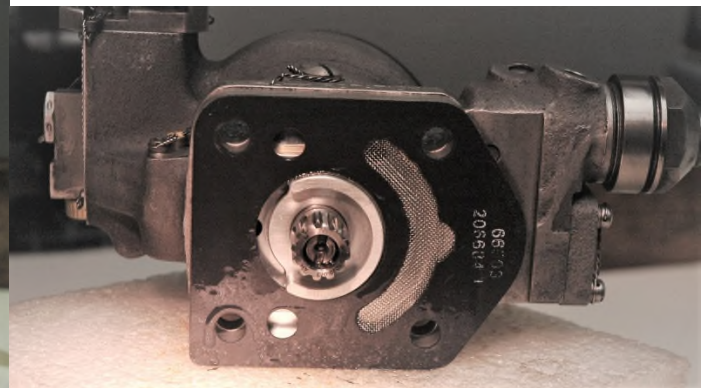
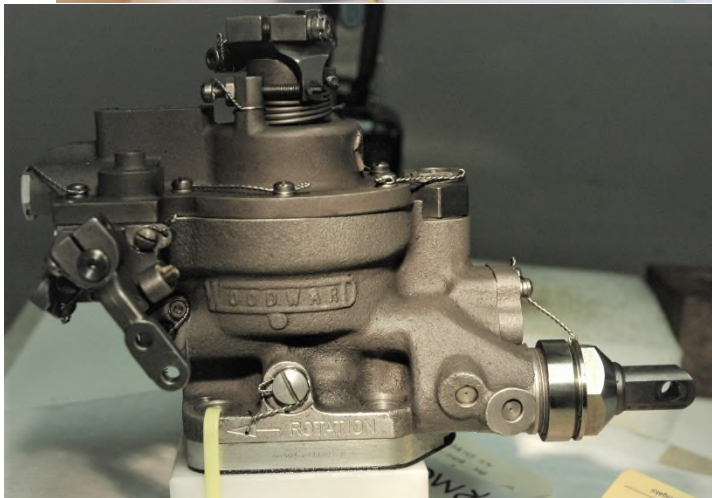
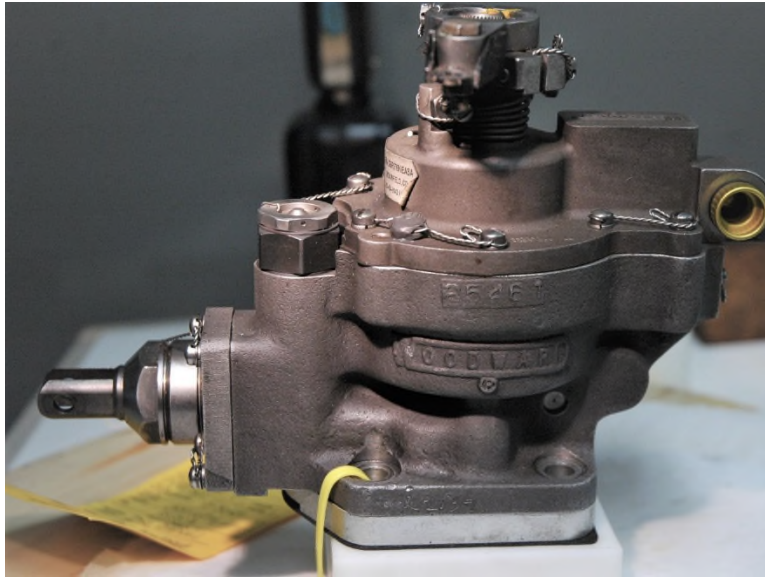


Figure 10
Propeller governor (CSU) as received

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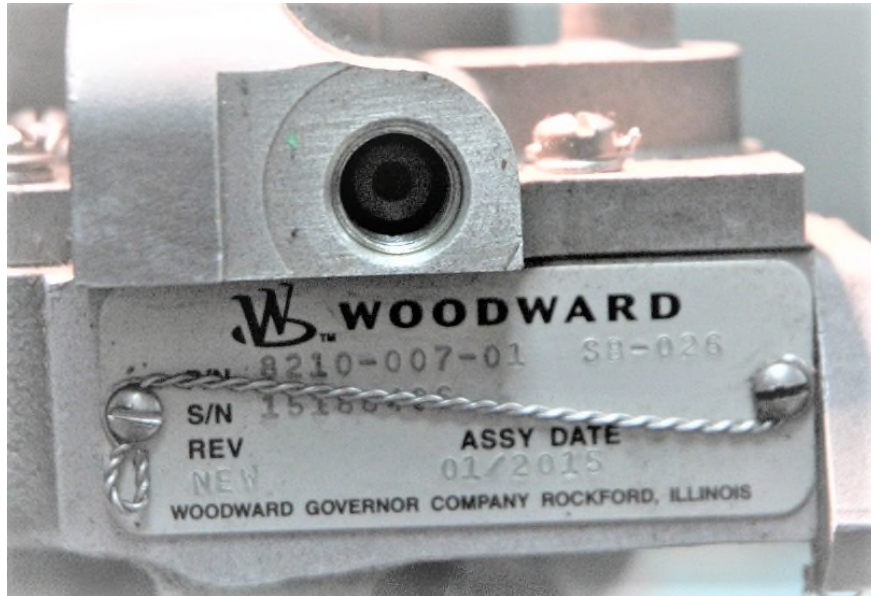


Figure 11
CSU Py port

Accessory: Fuel oil heat exchanger (FOHE)

Note: This unit was on the engine at original engine delivery.

Investigation Results:

The exterior of the fuel oil heat exchanger was lightly soiled (figure 12). There was a Kansas Aviation service label on the top of the tank. Lockwire was present at the thermal element cap and the flushing plug. A low-pressure air source was attached to the FOHE fuel inlet port, the fuel outlet port was sealed, and the unit was pressurized while submerged in a water-bath to check for leakage across the fuel and oil matrices. No leakage was observed. The thermal element was removed (figure 13) and tested in accordance with Meggitt CMM 73-10-20. The thermal element was confirmed to be functioning.

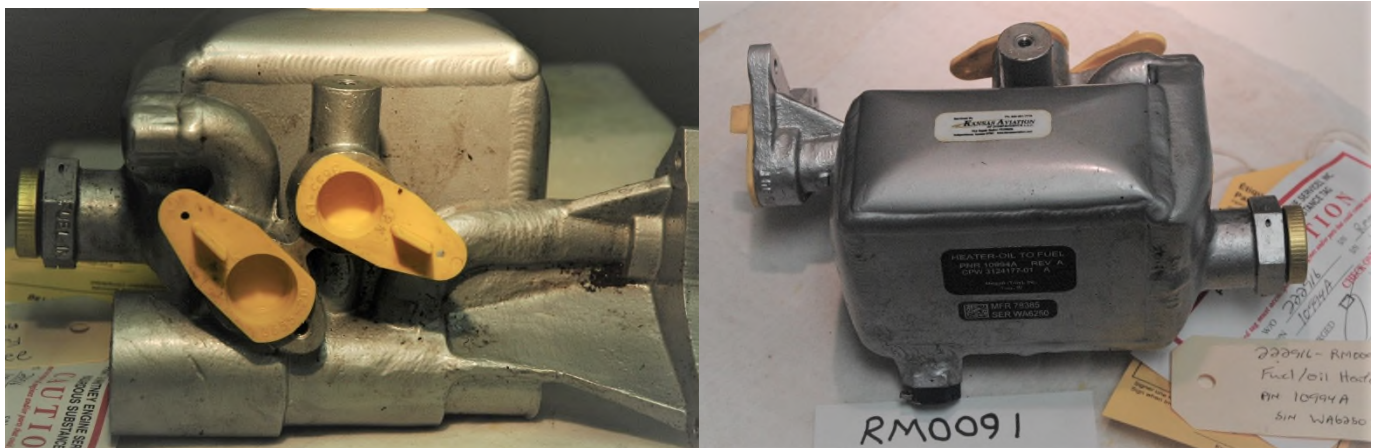


Figure 12
Fuel oil heat exchanger (FOHE) as received

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Actuating rod retracted (above) and extended (below)



Figure 13
FOHE thermal element

5.0 Attachments: Woodward report 1172282.

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6.0 Closing Statement

The data contained in this report, collected at the time of the review may be altered or corrected on the basis of further information.



Dave Barnard
Senior Air Safety Investigator
Engine Controls & Nacelles Technical Services
Mail Stop: 05AQ1



For the supplement
Jean-Marc Limoges
Air Safety Investigator
Engine Controls & Nacelles Technical Services
Mail Stop: 05AQ1


T. DJERIDANE

Toufik Djeridane
Manager, Service Investigation
Mail Stop 05AQ1

Distribution:

Karel Currey
File No. 20-144

CUSTOMER PRATT & WHITNEY OF CANADA			INVESTIGATION NO 1172282
CUSTOMER ORDER 201403	WOODWARD SALES ORDER 3752948		WOODWARD WORK ORDER F074494
CUSTOMER REJECTION DOCUMENT (CAR,QN RFA DMR,ETC.) N/A	WARRANTY DISPOSITION N/A		PRODUCT STATUS 1 RCVD
PROGRAM/ENGINE TYPE P&WC PT6 CSU		ITEM RECEIVED 8210-007-01	ENGINE MFR. MODEL RECEIVED 3074158-01
PROGRAM CODE 83053 CSU	SERIAL NUMBER 1516406	ITEM SHIPPED 8210-007-01	ENGINE MFR. MODEL SHIPPED 3074158-01
PARENT ITEM NUMBER 8210-007-01	PARENT ITEM SERIAL NUMBER 1516406	FIRST SHIPPED N/A	LAST SHIPPED N/A
CUSTOMER SERIAL NUMBER N/A	APPLICATION N/A	VESSEL TYPE & VESSEL NUMBER N/A N/A	SITE & LOCATION GRID ID N/A N/A
TIME/CYCLES SINCE NEW, OVERHAUL, OR REPAIR TSN - TSO - TSR - CSN - CSO - CSR -			
DATE REPORT OPENED 23-AUG-2021	DATE PART REMOVED N/A	DATE RECEIVED N/A	

TEAM MEMBERS (D1)

Product Engineer: NATHAN BOGDONAS
Customer QA Engineer: Daniel Hintz
Tech Advisor/Reviewer: David S. Kuchinski

Customer Account Manager: Nicholas Schaid
Customer Service Rep: SHANNON L. COTE
Product Integrity Coordinator: James D. Rosplack

REASON FOR INVESTIGATION (D2)

Reported Issue: ** INVESTIGATE PER NTSB INSTRUCTION ** RFA #21ECN00058 REMOVAL REASON: CRASH INVESTIGATION TO BE CONDUCTED IN THE PRESENCE OF A REPRESENTATIVE FROM THE TRANSPORTATION SAFETY BOARD OR DELEGATE. PERFORM A TEST AS RECEIVED IN ACCORDANCE WITH APPLICABLE CMM. SHOULD THE TAR REVEAL ANY SIGNIFICANT PROBLEM, THEN PROCEED WITH DISASSEMBLY AND INSPECTION OF THE INTERNAL COMPONENTS. AT COMPLETION OF THE INVESTIGATION, PROVIDE A DETAILED REPORT TO DAVE BARNARD P&WC ACCESSORY INVESTIGATOR (DAVID.BARNARD@PWC.CA). COMPONENTS ARE TO BE RETURNED TO P&WC.

CONTAINMENT/IMMEDIATE ACTIONS (D3)
INVESTIGATION SUMMARY (D4)

Confirmation Text: DID NOT CONFIRM REASON FOR INVESTIGATION/RETURN
Discrepant Item Number: NA
Discrepancy: No Discrepancy Found
Finding: No Findings
Conclusion:

The unit was received and an as received visual inspection was conducted. During the inspection it was noted that the lockwire, seals, and torque sealant were foreign indicating the originals had been removed after leaving the Woodward facility. Additionally, there were no significant signs of damage to the unit that would have prevented running an As Received Test.

After the visual assessment, the unit was sent for an as received test. During testing the unit was started up slowly to check for any audible signs of internal damage to the unit. There were no anomalies during startup, so the unit proceeded through the test as received. The unit's "Max Speed" and "Control Arm Location" test points were slightly out of limits high. The shift in the test data and non-Woodward lockwire suggest that these settings were adjusted in the field. Although, there were some test points slightly out of limits there were no significant anomalies that appeared to contribute to the reported event. Due to these findings, it was determined between the NTSB representative and Woodward engineering that a disassembly of the unit was not necessary.

In summary, the unit had evidence of being adjusted in the field. However, even with those adjustments all indications from testing suggest that the unit was functioning properly.

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ROOT CAUSE (D4)

Origin of Cause: FIELD / END CUSTOMER (OWNER)
General Cause: No Problem Found
Cause: No Problem Found or Identified
Cause Notes:

CORRECTIVE ACTION PLAN (D5)

General Corrective Action: No Action without Additional Customer Input
Specific Corrective Action: No Direct Action, Continue to Monitor
Corrective Action:

CORRECTIVE ACTION IMPLEMENTATION (D6)

Corrective Action Status: NO ACTION