



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Western Pacific Region

FUEL SYSTEM COMPONENTS

WPR19LA128

Accident Date: May 1, 2019
Exam Date: February 20, 2020

This document contains 13 embedded images

A. ACCIDENT

Location: Sedona, Arizona
Date: May 1, 2019
Aircraft: Beech S35, N6864Q, Serial # D-7479
NTSB IIC: Michael Huhn

B. EXAMINATION PARTICIPANTS:

Michael Huhn
Air Safety Investigator
NTSB
Western Pacific Region

Henry Soderlund
Chief Air Safety Investigator
Textron Aviation Inc
Wichita, KS

Kurt Gibson
Air Safety Investigator
Continental Aerospace Technologies (CAT)
Mobile, AL

Philip Grice
Analytical Division
CAT

C. PREVIOUS EXAMINATION ACTIVITY

The airframe and engine were examined at the recovery facility on 10/23/19. The relevant details are described in a separate document. The engine was run but fuel was observed to be leaking from the throttle and metering assembly (T/MA). The T/MA, engine-driven fuel pump (EDP), and fuel distribution manifold were removed and shipped to CAT Mobile AL. The removal and packaging was accomplished by NTSB personnel.

D. COMPONENTS & EXAMINATIONS

1.0 Throttle and Metering Assembly

- PN 631515A8, SN A04JA280R
- No evidence of impact or any other damage or deficiencies
- Safety wire/lead seal from original manufacture was present/undisturbed
- A Continental records check indicated the following
 - Engine manufactured 2004
 - Component delivered on engine
- Therefore unit not overhauled since manufacture in 2004 (14 years prior to accident)
- Manufacturer's recommended overhaul interval every 12 calendar years or 1,700 hours in service, whichever comes first

- Date of engine installation in airplane was not able to be determined (insufficient documentation)
- All linkages were properly installed and safetied
- The body bore was clean and undamaged

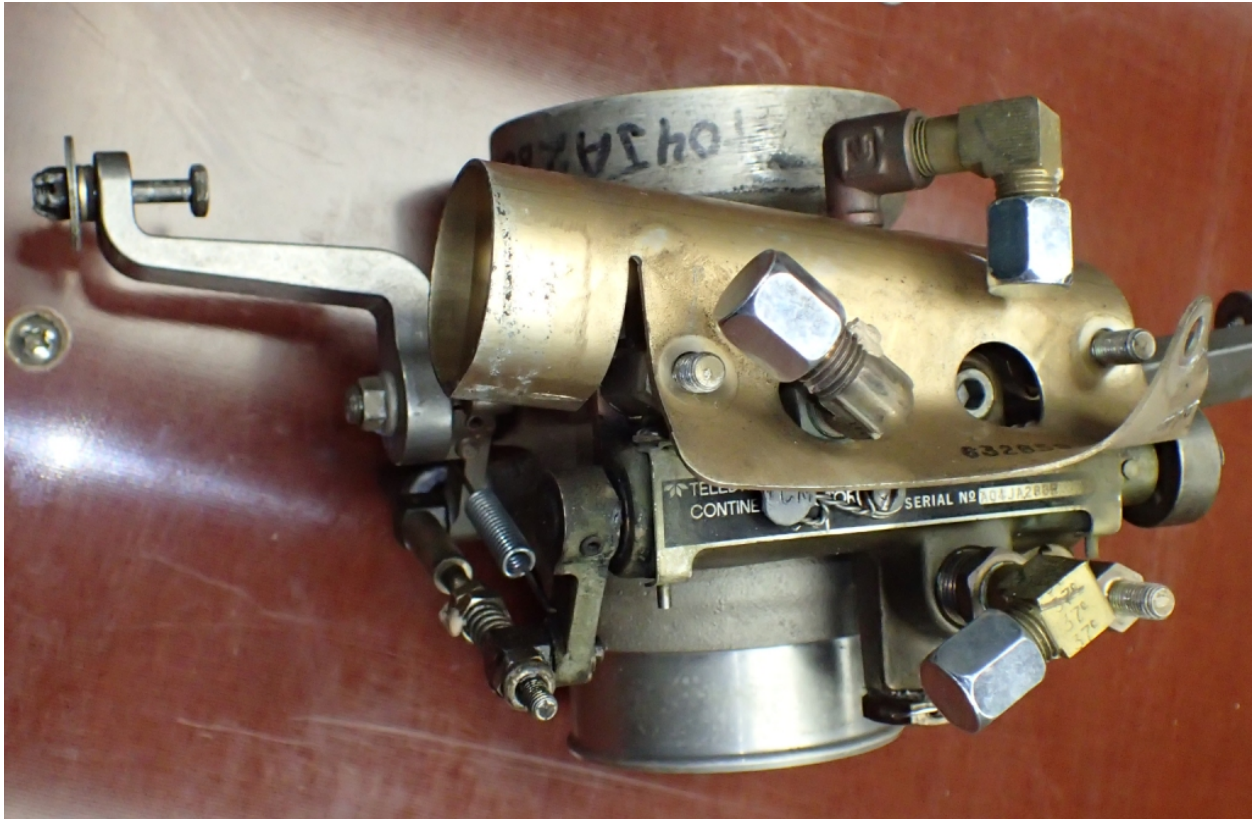


Figure 1 - Throttle and Metering Assembly

2.0 Engine Driven Fuel Pump

- PN 646212-24A1, SN B04JA328R
- No evidence of impact, or any other damage or deficiencies
- Drive shear shaft installed & intact
- Adjustment bolt retained intact torque/motion stripe



Figure 2 - Engine-Driven Fuel Pump



Figure 3 - EDP Adjustment Bolt (undisturbed)



Figure 4 - EDP Drive Shaft

3.0 Fuel Distribution Manifold Valve, Lines, and Injectors

- Manifold Valve PN 631427-2A21, SN A04JA280R
- GAMI-brand Injectors GA173 (qty 2, cyls 1 & 2), GM156 (qty 2, cyls 3 & 4), GA147 (qty 2, cyls 5 & 6)
- Manifold valve, lines, and injectors removed from engine as a unit
- No evidence of impact, or any other damage or deficiencies

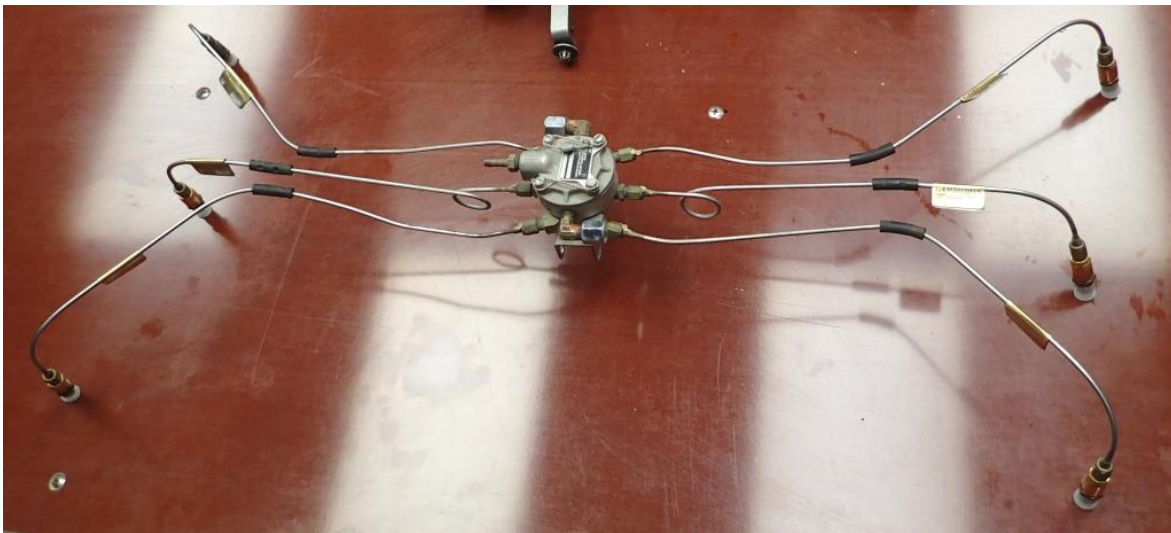


Figure 5 - Distribution Manifold and Lines

E. TEST EQUIPMENT

- The test equipment and procedures were designed and calibrated for CAT's production tests of new-manufacture components
 - These are sometimes referred to as "acceptance test procedures" (ATP)
 - ATPs are intended to ensure both the component's functionality and its ability to be successfully incorporated/installed onto an engine/airframe
 - Certain components meeting ATP criteria will require additional adjustment once installed on an engine/airframe
 - Conversely, components that have been installed on aircraft and adjusted for the installed condition, and then removed for ATP testing, may not always successfully meet the ATP test criteria without re-adjustment
- For safety purposes, the test equipment used an unspecified liquid as a fuel substitute. This liquid will be referred to as 'fuel' in this report

TEST RESULTS

1.0 Throttle and Metering Assembly (T/MA)

- The test used a fixed target input fuel pressure, and then measured fuel output pressure
- The full test consisted of a sweep through a series of 7 throttle plate angles (2°, 8°, 16°, 21°, 28°, 36°, 73°), each with its own target input pressure
- The output pressures were converted to flow rates (as lbs/hr or pph) and compared to the target ranges as the pass/fail criteria
- When installed on the test equipment and supplied with fuel, the T/MA displayed leakage rate and source(s) similar to those observed during the on-airframe engine tests during the examination at the recovery facility.
- All test points were completed, but the T/MA did not pass the ATP
 - The first 4 flow rates were outside their respective acceptable ranges
 - The last 3 flow rates were within their respective acceptable ranges
- The test equipment can provide the necessary fuel pressure and flow rates to ensure that the test is conducted at the specified fuel pressure
 - This differs from the output of an engine-driven pump, which can only provide fixed (and limited) pressures and flows



Figure 6 - T/MA Test Results

2.0 Engine Driven Fuel Pump (EDP)

- The ATP consisted of 4 test points
 - o The EDP was run at 4 reference rpm values (600, 2600, 1600, 600 repeat), and output flow and pressure values were compared to target value ranges
- The EDP output values met the test criteria at all test points

----- Continental Motors, Inc. -----

Airframe Name	: 632845-8	Model Number	:	
Part Number	: 646212-24A1	Test Document	:	632845
Accy Name	: 632845 -8			
Test Type	: calibration-8_CCW			
Serial Number	: B04JA328R	Operator	:	fferguson
Test Station ID	: R678	Work Order	:	na
Run Date/Time	: 2/20/2020 2:32:00 PM	Report Type	:	Final

Paragraph Number : 1
Paragraph Name : ----

Test Point	supply temp F	pump speed Min	pump speed RPM	pump speed Max	pump flow Min	pump flow PPH	pump flow Max	discharged pressure Min	discharged pressure PSIG	discharge pressure Max
3	69.6	594.0	599.8	606.0	6.500	6.620	7.000	10.50	9.67-	11.50
4	70.4	2574.0	2600.1	2626.0	149.000	149.130	151.000	32.70	31.91-	33.30
5	69.7	1584.0	1600.0	1616.0	37.000	37.100	38.000	18.50	17.01-	21.50
6	69.4	594.0	600.6	606.0	6.500	6.900	7.000	10.50	9.32-	11.50

Figure 7 - EDP Test Results

3.0 Fuel Distribution Manifold Valve Assembly

- The test assembly/procedure provided fuel at 1 set test reference pressure, and then 3 set test pressures, and then measured flow at those 3 test pressures
- All 3 test points fell within the prescribed flow rate range boundaries

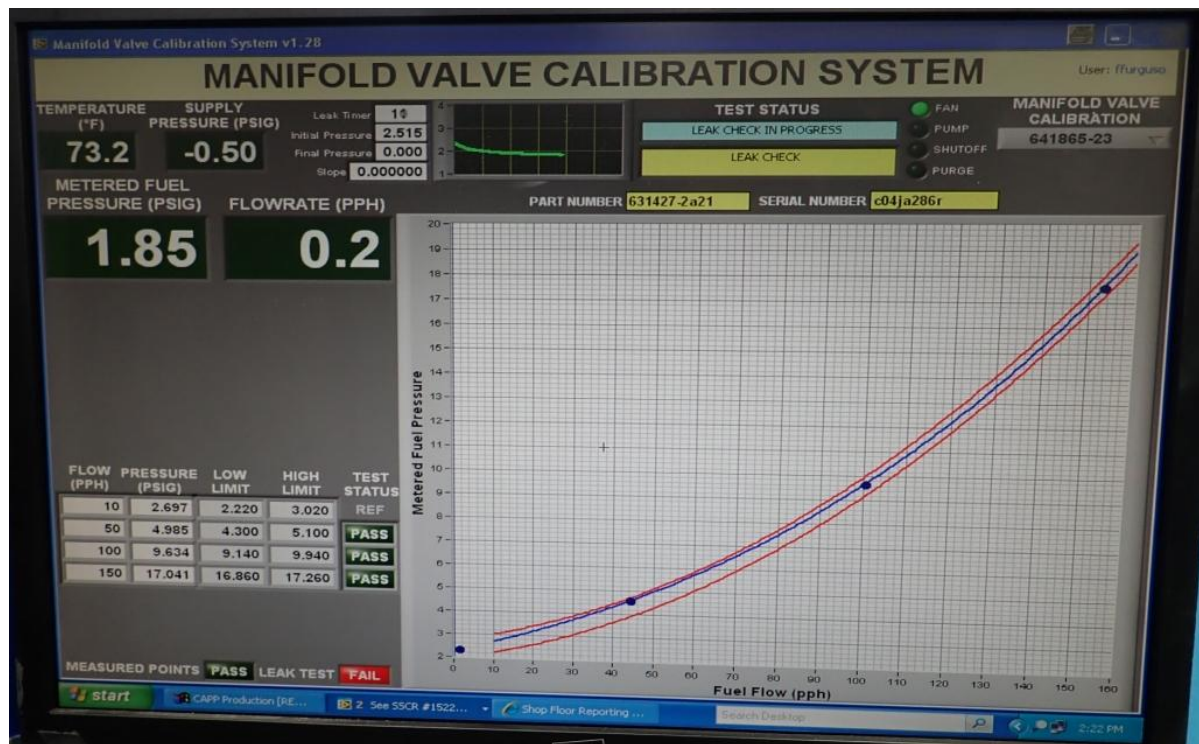


Figure 8 - Manifold/Injector Test Results

F. POST TEST EXAMINATIONS

- Metering assembly on the T/MA was identified as the source of the fuel leak(s).
- The metering unit was detached from the throttle body and tested for leak locations using compressed air and soapy water.
- Leaks were observed at both ends (throttle and mixture) of the metering unit
- The metering unit was disassembled and its O-rings examined
 - o The O-rings lacked normal flexibility and were non-resilient

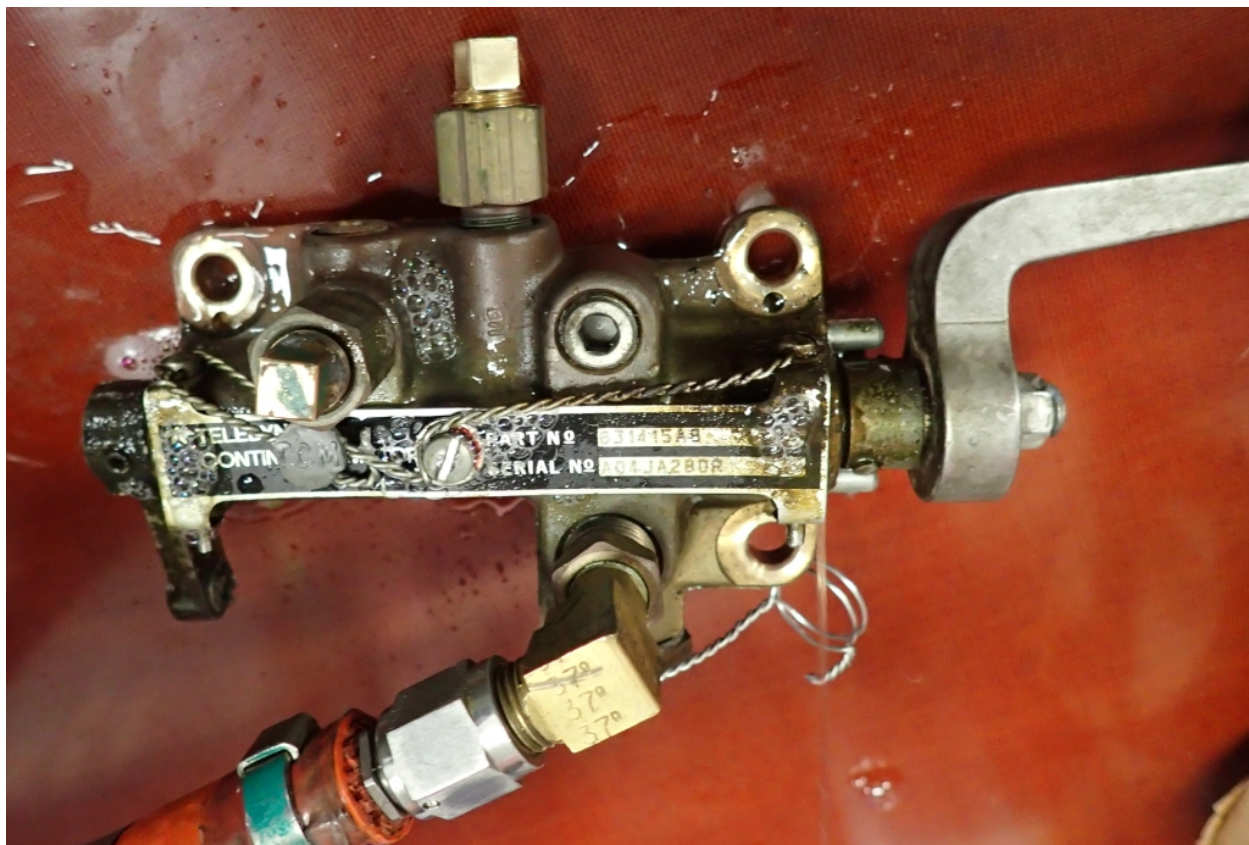


Figure 9 - Leaking Metering Unit



Figure 10 - Disassembled Metering Unit



Figure 11 - Throttle Metering Cam and O-Ring



Figure 12 - Throttle Cam O-Ring

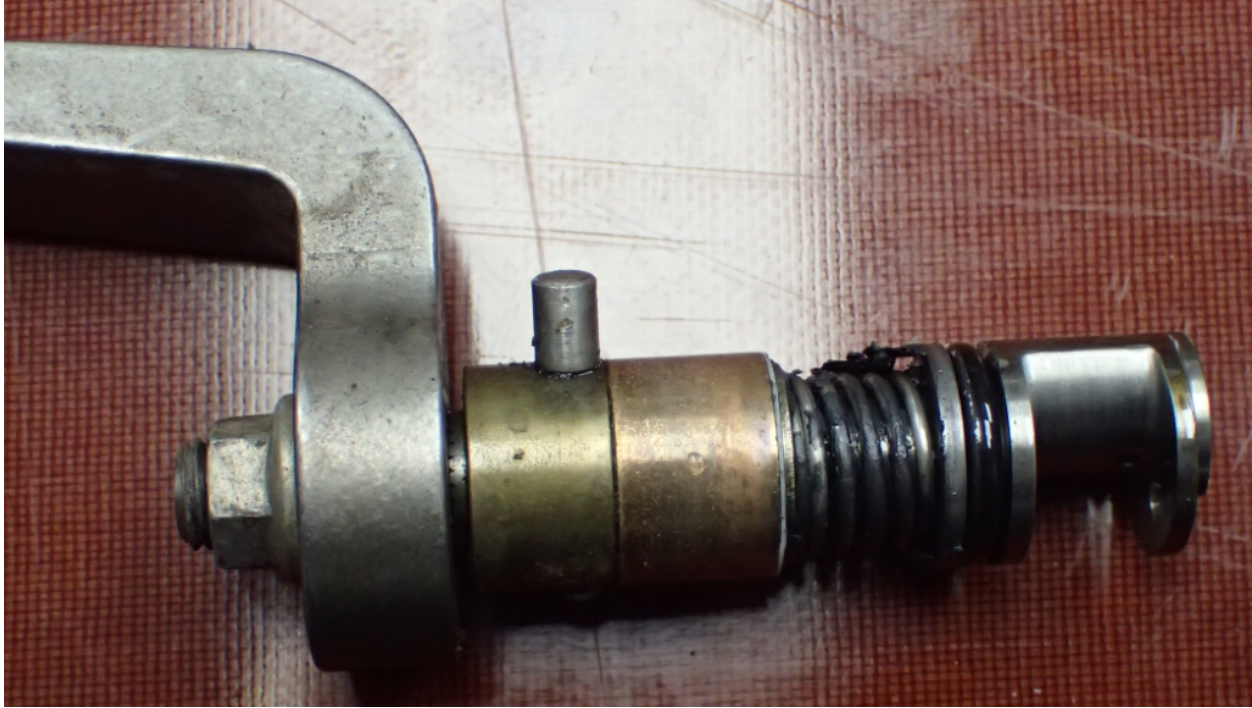


Figure 13 - Mixture Metering Cam

G. TEST RESULT IMPLICATIONS & CONCLUSIONS

1.0 General

- As discussed above, the failure of a previously-installed component to meet ATP criteria cannot be used as the sole determinant as to whether the component is serviceable or airworthy.
- As noted, at least two of the components usually require adjustment once installed on the aircraft
 - Most of the adjustment is on the fuel pump
 - The idle mixture is the adjustment made on the T/MA
- A CAT representative stated that most of the units that are tested per the ATP subsequent to on-aircraft service do not meet the ATP test criteria
 - However, if the test values are close to the ATP limits, the components can usually be adjusted to meet the ATP criteria

2.0 T/MA Leak

- Due to the fixed/limited output of an EDP, any leak in the system downstream of the EDP would result in the potential of not providing the necessary fuel pressure or flow to the metering unit
 - This could result in adverse effects on engine operation, primarily in the form of a too-lean mixture

- The only way to safely test how the observed leaks would affect engine operation is by testing the fuel system as a whole, but CAT does not have such capability
- During the engine runs at the recovery facility and the follow-up individual fuel system component examinations and tests, the metering assembly fuel leaks were the only anomalies detected that could have resulted in a loss of engine power