



Memorandum For Record

Timothy W. Monville
Sr. Air Safety Investigator
Eastern Region

Date: March 13, 2023
NTSB Accident Number: ERA21LA201

Following examination of the engine, the throttle body and metering valve, manifold valve, fuel injector nozzles and lines, and engine-driven fuel pump with drive coupling were shipped to Continental Aerospace Technologies (CAT) via UPS 2nd Day Air 1ZA3978T0294341006 on August 17, 2021, and were received on August 19, 2021, where they remained in bonded storage pending examination with NTSB oversight.

On March 30, 2022, a FACETIME call was made with Phillip Grice of CAT at 0902 EDT. The box was presented unopened (Figure 1).

Examination of the engine-driven fuel pump (Figure 2), P/N FT-B8.5/632818-2-11, S/N 104 revealed the main inlet and the vapor return fittings were fractured, and the drive coupling was intact. The fractured fittings were removed and replaced for operational testing. The pump exterior had evidence of soot.

The engine-driven fuel pump was operationally tested as is with no adjustment and the results are included in Attachment 1¹. During start up fluid flowed from the vapor ejector (normal). Slight leakage was noted from the seal drain. During testing four of the five test points were out of limits. During testing at 2,700 rpm with the aneroid pressure set to about 33 inches of Mercury (inHg) and the fuel flow set to between 198 and 202 PPH, and the supply pressure set to 15.48 psi, the pump discharge pressure was 2.05 psi less than the minimum specified, and the fuel flow was 1.265 PPH greater than the upper limit. During the same testing but with the exception that the aneroid pressure set to about 30 inHg, the pump discharge pressure was 6.35 psi greater than the maximum specified while the fuel flow was within limits. The pump was considered operational though no adjustments were made.

¹ Because of the GAMI injectors and Turbonormalizing, the fuel pump is adjusted. The CAT representative indicated that they don't make that pump.

Examination of the Throttle Body and Metering Valve (Figure 3), P/N FT-B8.5/1-442, S/N A01EA285 revealed the mixture return fitting which was impact fractured was replaced with a 90° fitting for bench testing. The unit was heat damaged consistent with the postcrash fire. The nut securing the throttle lever to the shaft of the metering unit was threaded on 1.5 threads. The throttle lever was bent near the attach point at the metering valve from the normal 90° towards 45°. Movement of the throttle lever did not result in movement of the throttle shaft. Brass material transfer from the throttle lever was noted on the shaft. The throttle shaft also appeared bent. The fuel inlet screen was clean.

During bench testing of the throttle body and metering valve to a -2 cam, slight leakage was noted at the throttle shaft on the throttle side of the metering unit. The unit flowed high at all test points as noted below and in (Figure 4).

- 2° - Flowed 13.69 PPH (Specification 6.6 to 6.9 PPH)- Too High
- 8° - Flowed 52.87 PPH (Specification 30.6 to 36.7 PPH) - Too High
- 16° - Flowed 123.35 PPH (Specification 57.3 to 68.8 PPH) - Too High
- 21° - Flowed 149.3 PPH (Specification 72.8 to 80.1 PPH) - Too High
- 28° - Flowed 174.76 PPH (Specification 94.0 to 103.4 PPH) - Too High
- 36° - Flowed 176.44 PPH (Specification 106.2 to 116.8 PPH) - Too High
- 73°² - Flowed 161.44 PPH³ (Specification 130.0 to 136.5 PPH) - Too High

Subsequent testing of the throttle body and metering valve to a -11 cam was performed. The following results were noted at the various throttle shaft/plate angles (Figure 5):

- 2° - Flowed 12.68 PPH (Within Specification)
- 11° - Flowed 23.25 PPH (Specification 35.4 to 42.5 PPH) - Too low
- 18° - Flowed 49.73 PPH (Specification 61.0 to 73.2 PPH) - Too low
- 23° - Flowed 59.69 PPH (Specification 80.0 to 88.0 PPH) - Too low
- 33° - Flowed 88.84 PPH (Specification 108.0 to 118.8 PPH) - Too low
- 48° - Flowed 112.91 PPH (Specification 129.1 to 139.2 PPH) - Too low
- 74°⁴ - Flowed 169.04 PPH⁵ (Specification 192.5 to 202.1 PPH) - Too low

An exemplar throttle lever was obtained and compared with the accident throttle lever. The accident throttle lever was bent near both ends (Figure 6).

Examination of the fuel injector nozzles revealed the following:

No. 1 nozzle - Appeared to have some foreign debris inside⁶. A small diameter stainless steel safety wire was pushed through, and the material was captured. It was placed under a microscope and appeared to be the diameter of a hair (Figure 7).

² This is wide open.

³ Based on the test fluid value of 5.87 pounds per gallon, this resulted in a flow rate of 28.79 gallons-per-hour.

⁴ This is wide open.

⁵ Based on the test fluid value of 5.87 pounds per gallon, this resulted in a flow rate of 28.79 gallons-per-hour.

⁶ According to the Field Notes, organic material was noted inside the nozzle, but borescope inspection of the No. 1

No. 3 nozzle - Appeared to be bent.

No. 5 nozzle was also bent at the top and broken out of the cylinder. It also had oil blown from the vent.

No. 2 nozzle - Was oil covered and a little oil came out of the vent.

No. 4 nozzle was clear and the threads felt gritty (like sand).

No. 6 nozzle – Was oil covered.

For operational testing the fuel injector nozzles were placed on their respective lines which were adjusted for operational testing to allow the flow from the nozzle to be directed down.

The manifold valves with attached lines and nozzles were tested to production limits (Figure 8). The flow from all nozzles appeared equal. The No. 1 nozzle was flowed separately, and the pressure was low; the machine automatically sets the pressure. The fuel injector line for the No. 3 cylinder was slightly kinked at the nozzle connection.

The machine operator manually adjusted the test points and the manifold valve spool did not open at 4.1 psi as specified, rather, it opened at 4.2 psi⁷.

The following results were recorded⁸:

9.8 pounds-per-hour (PPH)⁹ – 4.22 psi (Specification is 3.3 to 4.1 psi)

50.2 PPH¹⁰ – 5.38 psi (Specification is 5.14 to 5.94 psi)

100 PPH – 7.45 psi (Specification is 9.5 to 9.9 psi)

150 PPH – 10.15 psi (Specification is 15.89 to 16.69 psi)

All nozzles passed the spray pattern test with no issues noted.

On or about January 4th or 5th, 2023, when cleaning up the secure area where the accident parts were stored, without NTSB knowledge, consent or permission, CAT personnel inadvertently discarded components of the engine-driven fuel pump, flow divider or manifold valve, all fuel injector lines, and all fuel injector nozzles. The remaining components were returned as instructed by the insurance adjuster.

cylinder revealed no damage to the cylinder or piston.

⁷ This is the setting with the specified 3 psi spring. According to the STC holder, they do not modify it.

⁸ Because GAMI injectors were installed the results failed. This is due to how the engine is set with GAMI installed. The STC holder reported that they use larger fuel injectors which drops pressure.

⁹ The testing was to be performed at 10.0 PPH.

¹⁰ The testing was to be performed at 50.0 PPH.



Figure 1: Digital Photograph from CAT. View of the Top of the Unopened Box at the Start of the Facetime Virtual Examination.

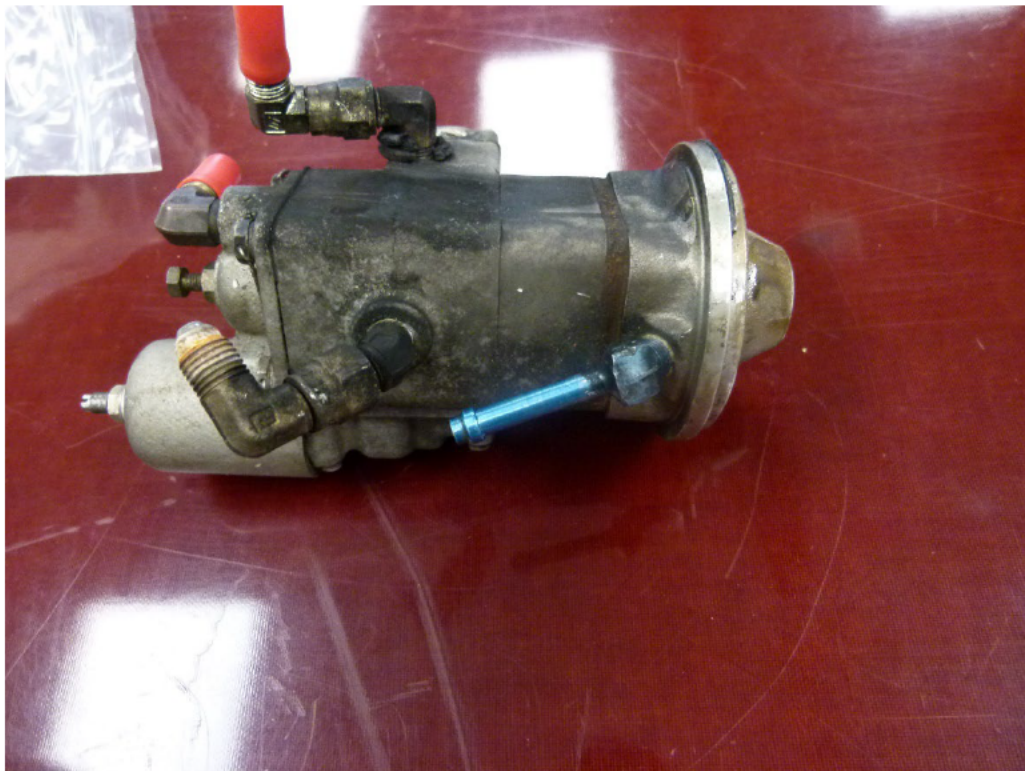


Figure 2: Digital Photograph from CAT. View of the Engine-Driven Fuel Pump As Received.



Figure 3: Digital Photograph from CAT. View of the Throttle Body and Metering Valve.

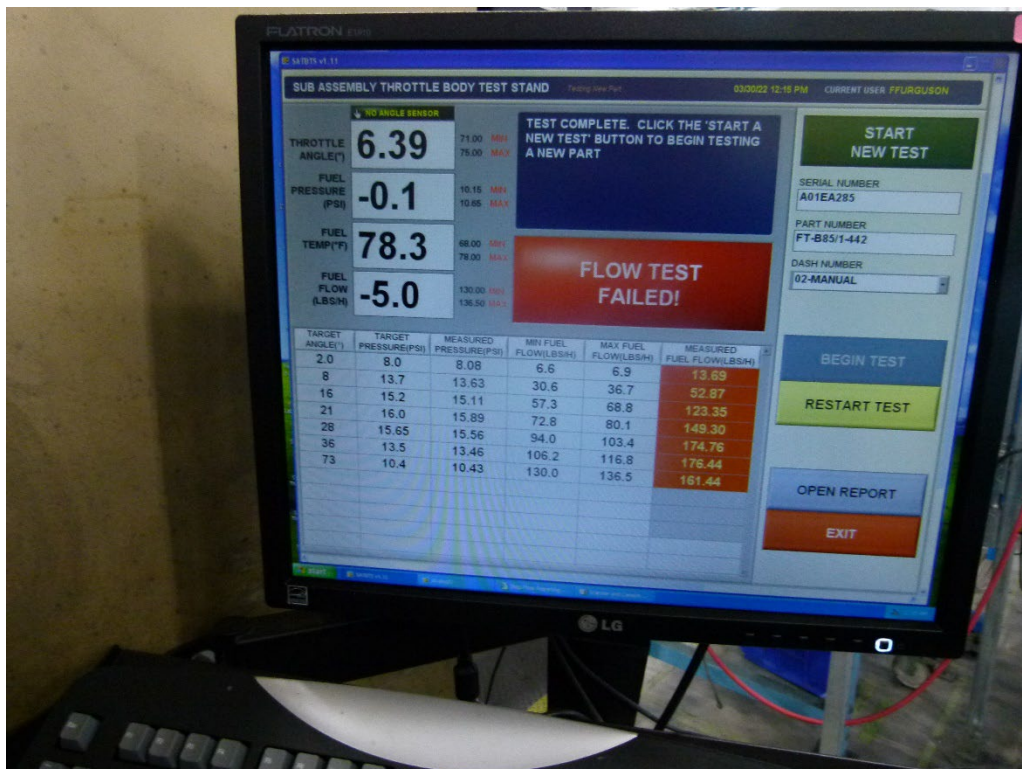


Figure 4: Digital Photograph from CAT. View of the Test Results of the Throttle Body And Metering Valve.



Figure 5: Digital Photograph from CAT. View of the Throttle Body and Metering Valve Subsequent Test Result to a -11 Cam.



Figure 6: Digital Photograph from CAT. View of the Accident Throttle Control Lever on Top and Exemplar Lever on the Bottom. Note the Impact Damage to The Accident Lever Near Both Ends.



Figure 7: Microscope Image From CAT. View of the Debris removed from the No. 1 Fuel Injector Nozzle. The horizontal component holding the object is a piece of safety wire no more than 0.032 inch in diameter.



Figure 8: Digital Photograph from CAT. View of the Testing of the Manifold Valve Injector Lines and Injector Nozzles.

ATTACHMENT 1

----- Continental Aerospace Technologies -----

Final Report
OF
calibration-17_CCW_MIXTURE TEST RESULTS
FOR

Accy Name : 632845 -17

Part Number : 649368-60A3

Serial Number : 104

LOGGED BETWEEN : 3/30/2022 12:53:11 PM

AND : 3/30/2022 12:59:44 PM

BY

Operator : etaylor

Work Order Number : 632818-2-11

Report Generated On : 3/31/2022 2:12:29 PM

----- Continental Aerospace Technologies -----

Airframe Name	: 632845-17	Model Number	:	
Part Number	: 649368-60A3	Test Document	:	632845
Accy Name	: 632845 -17			
Test Type	: calibration-17_CCW_MIXTURE			
Serial Number	: 104	Operator	:	etaylor
Test Station ID:	R678	Work Order	:	632818-2-11
Run Date/Time	: 3/30/2022 12:53:11 PM	Report Type	:	Final

Paragraph Number : 1

Paragraph Name : ----

Test Point	supply temp F	pump speed RPM	fuel flow Min	fuel flow PPH	fuel flow Max	supply press PSIA	discharge pressure Min	discharge pressure PSIG	discharge pressure Max	aneroid press Min	aneroid press "HgA	aneroid press Max
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ATTACHMENT 1 - CONTINUED

3	69.0	598.9	6.500	6.760	7.000	15.46	6.50	9.88+	7.00	-	29.868	-
4	69.8	2700.7	198.000	203.265+	202.000	15.48	32.18	30.13-	32.82	35.900	33.391-	36.100
5	69.7	2700.0	188.000	196.244	202.000	15.50	15.50	28.35+	22.00	-	29.889	-
6	68.5	600.0	6.500	6.630	7.000	15.48	6.50	8.11+	7.00	-	29.889	-
7	68.5	600.0	0.000	1.220	2.000	15.54	-	8.41	-	-	29.889	-

----- Continental Aerospace Technologies -----

Airframe Name	: 632845-17	Model Number	:
Part Number	: 649368-60A3	Test Document	: 632845
Accy Name	: 632845 -17		
Test Type	: calibration-17_CCW_MIXTURE		
Serial Number	: 104	Operator	: etaylor
Test Station ID	: R678	Work Order	: 632818-2-11
Run Date/Time	: 3/30/2022 12:53:11 PM	Report Type	: Final

----- Data Variance Report -----

Paragraph Number : 1

Paragraph Name : ----

Data for Test Point "3" out of limits

Data for Test Point "4" out of limits

Data for Test Point "5" out of limits

Data for Test Point "6" out of limits