



ERA16FA289

Northport, Alabama

August 14, 2016

Piper PA-31 – N447SA

NTSB FUEL PUMP EXAMINATION REPORT

January 10, 2017

PARTICIPANTS IN THE EXAMINATION

**Heidi Kemner
Air Safety Investigator (IIC)
National Transportation Safety Board
Ashburn, Virginia**

**Robert Bullock
Aviation Safety Inspector
Federal Aviation Administration
Birmingham, Alabama**

**Les Doud
Air Safety Investigator
Hartzell Propeller / Hartzell Engine
Technologies
Montgomery, Alabama**

**Rick Quave
Vice President of Engineering
Hartzell Engine Technologies, LLC
Montgomery, Alabama**

HISTORY OF FLIGHT

On August 14, 2016, about 1120 central daylight time, a Piper PA-31-325, N447SA, was substantially damaged when it impacted terrain in Northport, Alabama, while diverting to Tuscaloosa Regional Airport (TCL), Tuscaloosa, Alabama. Day visual meteorological conditions prevailed and an instrument flight plan was filed for the personal flight. The private pilot and five passengers were fatally injured. The flight was conducted under the provisions of Title 14 Code of Federal Regulations Part 91. The flight departed Kissimmee Gateway Airport (ISM), Orlando, Florida, around 0855, with the intended destination of Oxford University Airport (UOX), Oxford, Mississippi.

FUEL PUMP INFORMATION

Right Engine Fuel Pump Maintenance:

Ketchel Air, Inc.

INVOICE

BILL TO
Jason Farese

INVOICE # 1334
DATE 06/26/2016
DUE DATE 07/26/2016
TERMS Net 30

DATE	ACTIVITY	QTY	RATE	AMOUNT
06/25/2016	AOG- Hourly N447SA Customer Requests Oil and filter change on #1 & #2 engines. Performed Oil and Filter changes on #1 & #2 engines as required. Serviced both engines with 1 quart of Phillips XC 20W50 Oil and installed Champion Ch 48111 C filters.	2	105.00	210.00
06/25/2016	AOG- Hourly Customer requests Oxygen service. Serviced Oxygen system as required.	0.50	105.00	52.50
06/25/2016	AOG- Hourly #2 fuel boost pump lamp illuminated. Troubleshoot #2 engine fuel boost pump, confirmed fuel flow through boost pumps, fuel flow and pressure within limits. Fuel boost pump light illuminated due to electrical fault. Unable to continue troubleshooting at this time. Previous avionic service performed before receipt of aircraft. Boost pump is OK for service at this time.	4	105.00	420.00

Picture 1. Invoice of Right Engine Fuel Pump Testing June 26, 2016

ENGINE LOG			Serial No.	License Number
Date	Time			
	Hrs			
		N447S		
		Right engine		
		Hobbs: 1433.7		
		07/19/16		
		Replaced right Engine driven Fuel Pump PN# 200F5002R SN# H-TGN020FP.		
		Replaced Right Electric Fuel Pump PN# 2B6-63 SN# 6E499. Run up operation normal.		
		No leaks noted.		
		Rushing Aviation	Kevin Rushing	
		Marks, MS 38646		
		Page Total		
		Brought Forward		
		Total to Date		

All Repair Data Must Bear the Endorsement of a Certificated Mechanic, and his Rating and Certificate Number MUST be Shown.

Picture 2. Right Engine Maintenance Log Entry – Replace Right Engine Driven Fuel Pump and Right Electric Fuel Pump

INITIAL EXAMINATION AS RECEIVED

The fuel pumps were received in a sealed box. After removal from the box, the exteriors were examined.

Right Engine Driven Fuel Pump

Part Number: 200F5002R

Serial Number: H-TGN020FP

Manufactured: 27th week of 2016

- The exterior of the fuel pump was covered in soot.
- The fuel pump drive coupling was intact; not sheared.
- The safety wire was intact and the safety cable remained secure.
- The lock nut was finger tight and the safety wire was not present.
- There was no debris noted in the inlet or outlet port.
- The drive coupling retaining clip remained in place on the rotor shaft.
- The pump rotor shaft did not rotate.



Picture 3. Views of Right Engine Driven Fuel Pump



Left Engine Driven Fuel Pump

Part Number: 200F5002

Serial Number: H-RHN008FP

Manufactured: 34th week of 2014

- The exterior of the fuel pump did not exhibit impact damage.
- The fuel pump drive coupling was intact; not sheared.
- The overboard drain hose remained attached and was removed to facilitate further examination.
- No debris was noted in the inlet or outlet port.
- All safety wires were intact and remained in place.
- The pressure adjustment lock nut safety wire was in place and the lock nut was tight. The safety wire type was not the same type used by the manufacturer.
- The fuel pump rotated both direction when rotated by hand.
- No drive coupling spline teeth damage was noted.
- The drive coupling retaining clip remained in place.
- The turbo air reference fitting remained attached to the fuel pump housing and the torque stripe remained in place.

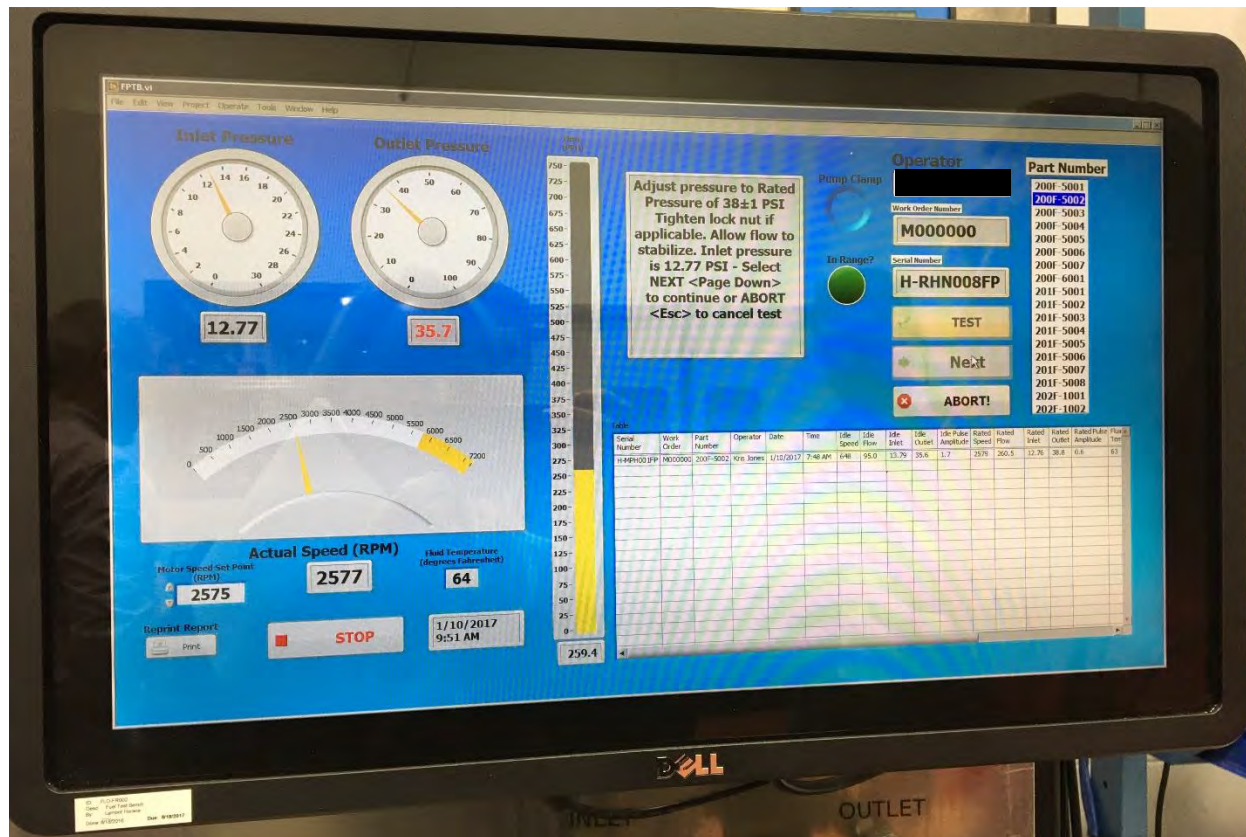


Picture 4. Views of Left Engine Driven Fuel Pump



DETAILED EXAMINATION

Left Engine Driven Fuel Pump Test



The fuel pump was mounted on a test bench in order to test the fuel flow through the pump. The pump required 9.5 oz-in (max allowed was 17 oz-in) of torque to get the pump to rotate. An internal pressure leak check demonstrated no leaks were noted.

The left engine driven fuel pump was flow tested as recovered in a cruise power setting and the pump had a low outlet pressure (35.7 psi versus 38.0 +/- 1.0 psi). A safety wire that was not the type of wire used at Hartzell Engine Technologies was cut in order to loosen the lock nut and make the adjustment to increase output pressure. When the adjustment screw was moved about a half turn, the pump passed cruise power flow requirements of the acceptance test procedure for the manufacturer. It is not uncommon for pumps to be readjusted to engine manufacturer standards once they leave Hartzell Engine Technologies.

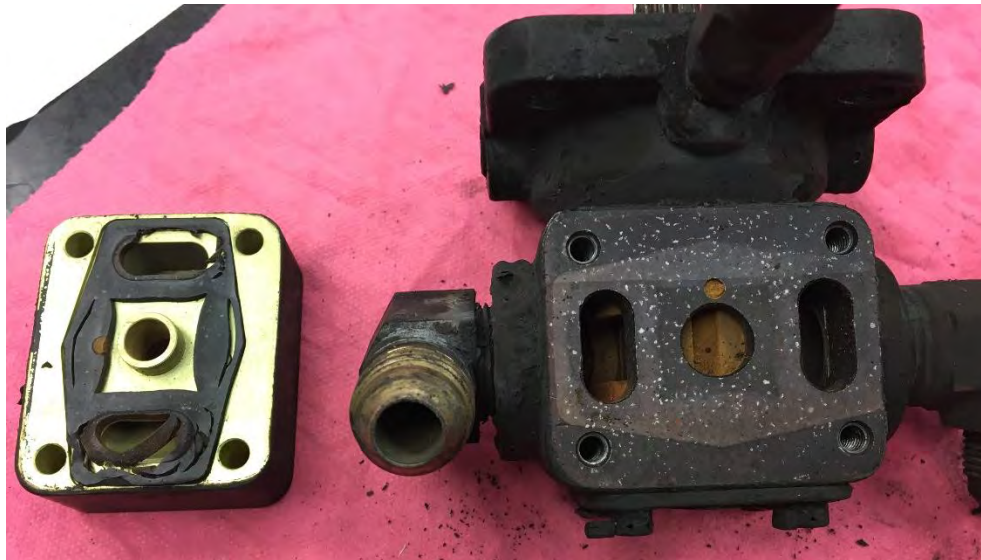
Right Engine Driven Fuel Pump Examination

The right engine driven fuel pump was disassembled for further examination of the components.

The safety wires were removed in order to facilitate further disassembly. The relief valve diaphragm remained intact, however, it exhibited heat damage (See Picture 5). It was removed for further examination. The relief valve body was removed and the relief valve gasket seal exhibited heat damage (See Picture 6). The drive coupling was removed, the drive tang did not exhibit any damage, and the drive spline teeth were all intact. The AN960L washers that were under the socket head cap screws stuck to the body cover of the pump. The rear bearing of the pump remained intact and not cracked. The rear bearing O-ring was pliable.



Picture 5. View of heat damaged relief valve diaphragm.



Picture 6. Relief Valve Body and Gasket exhibited heat damage.

The rear carbon bearing was removed and revealed that the pump liner and rotor exhibited corrosion. The rotor vanes were seized in place but remained intact (See Picture 7). The rotor and vanes were removed for further examination.



Picture 7. View of Rotor and Vanes inside the Right Engine Driven Fuel Pump

The rotor vanes sealing faces did not exhibit gouging. However, one chip was noted on the inboard section of a vane, that was 0.1805 inches in length. The rotor and vanes were removed. The rotor exhibited corrosion (See Pictures 8). An attempt to remove the vanes from the rotor was made, however, the vanes remained lodged in the rotor and were unable to be removed.



Picture 8. View of Rotor and Vanes Removed from Housing.



Picture 9. View of rotor and vanes removed from pump liner.

The fuel pump liner remained in place and exhibited corrosion (See Pictures 9). The main bearing did not exhibit any cracks or chips. The bore of the main bearing was examined and no anomalies were noted.

SUMMARY

The examination and testing of the left engine driven fuel pump revealed that the pump was able to pass a fuel flow test at cruise speed for the manufacturer. No anomalies were noted with the fuel pump that would have precluded operation prior to the accident.

The examination and disassembly of the right engine driven fuel pump found that the interior of the fuel pump exhibited corrosion. It is likely that the right fuel pump drive shaft would not rotated as a result of the corrosion binding the vanes. In addition, since a postcrash fire ensued, the local fire department doused the fire with foam or water, that in turn entered the fuel pump. Also, the pump drive coupling incorporated a shear section, that remained intact, which demonstrated that it was unlikely that the rotor seized during engine operation. No anomalies were noted with the fuel pump that would have precluded operation prior to the accident.

FUTURE ACTIVITIES

The fuel pumps will be returned to storage at Atlanta Air Salvage in Griffin, Georgia, and kept with the accident airplane in preparation for the release of the wreckage by the National Transportation Safety Board IIC.



MEMORANDUM FOR RECORD

Heidi Kemner
Air Safety Investigator
Eastern Region Aviation

Subject: ERA16FA289

An examination of the emergency and boost pumps revealed the following:

Right Emergency Fuel Pump:

- All surfaces of the pump were black and discolored as a result of the thermal exposure.
- The pump was mounted on a test bench, but would not flow.
- It was disassembled and the rotor and cavity chamber were discolored and the vanes were seized in the rotor slots.
- Corrosion was noted inside the pump.
- The armature potting epoxy was intact and no evidence of coil winding overheat condition was present.
- Continuity check of both positive and negative circuits to brushes revealed that both circuits had continuity.
- Both positive and negative terminal insulators were melted.
- Measured brush length of both brushes, 0.550". New brush length is 0.555".
- There was no evidence of electrical or mechanical malfunctions with the emergency boost pump.

Left Emergency Fuel Pump:

- Pump was received with power and ground wires.
- Checked flow control valve for freedom of movement, moved without issue.
- Check for continuity of motor between positive and negative terminals, normal motor resistance was present.
- Applied 28.0 Volts D.C. power to positive and negative terminals, pump operated immediately and began to produce flow of test fluid thru flow meter tube.

- Pump operated within all pressure, flow, and current limits.

Left Fuel Boost Pump:

- The pump was tested for case short to positive and negative wires and no case short was present.
- The fuel boost pump was installed to the test stand and the pump fully passed the required acceptance test procedure.

Right Fuel Boost Pump:

- The exterior of the pump was examined and thermal damage was noted.
- The pump's overboard seal drain port was melted, and when looking into the outlet port, the non-metal portions of the relief valve were melted.
- When the pump was moved, soot would fall out of the fluid ports.
- Further disassembly of the right fuel boost pump revealed that the wear plate spring, the aluminum housing, blades, and rotor were corroded. The field assembly magnets were fractured and thermally damaged.