National Transportation Safety Board
Aviation Accident Factual Report

Location:	Northport, AL	**Accident Number:**	ERA16FA289
Date & Time:	08/14/2016, 1115 CDT	**Registration:**	N447SA
Aircraft:	PIPER PA 31	**Aircraft Damage:**	Substantial
Defining Event:	Fuel starvation	**Injuries:**	6 Fatal
Flight Conducted Under:	Part 91: General Aviation - Personal		

On August 14, 2016, about 1115 central daylight time, a Piper PA-31-325, N447SA, was substantially damaged when it impacted terrain near Northport, Alabama, while diverting to Tuscaloosa Regional Airport (TCL), Tuscaloosa, Alabama. The private pilot and five passengers were fatally injured. The airplane was owned by Oxford University Aircraft Charters, LLC and operated by the pilot under the provisions of Title 14 *Code of Federal Regulations* Part 91. Day visual meteorological conditions prevailed and an instrument flight rules flight plan was filed for the personal flight, which departed Kissimmee Gateway Airport (ISM), Orlando, Florida, about 0855 with an intended destination of Oxford University Airport (UOX), Oxford, Mississippi.

According to the fixed-based operator that serviced the airplane before departure, the pilot and passengers arrived at ISM on August 10. Fuel receipts indicated that the airplane's fuel tanks were "topped off" with 134 gallons of fuel before departure on the day of the accident. In the filed flight plan, the pilot reported that the airplane had about 5 hours 10 minutes of fuel on board.

According to air traffic control data, at 0915 the airplane leveled off in cruise flight at 12,000 ft mean sea level. At 1059, the pilot reported a failure of the right engine fuel pump and requested a diversion to the nearest airport. The controller then provided radar vectors toward runway 30 at TCL. When the airplane was about 13 miles from TCL, the pilot reported that the airplane "lost both fuel pumps" and that there was "no power." The airplane continued to descend on an extended final approach to runway 30 until it impacted trees about 1,650 ft short of the approach end of the runway.

Pilot Information

Certificate:	Private	**Age:**	41, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Lap Only
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 3 With Waivers/Limitations	**Last FAA Medical Exam:**	08/01/2014
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	05/14/2014
Flight Time:	749.7 hours (Total, all aircraft), 48.7 hours (Total, this make and model), 25.1 hours (Last 90 days, all aircraft), 7 hours (Last 30 days, all aircraft)		

According to Federal Aviation Administration (FAA) records, the pilot held a private pilot certificate with ratings for airplane single- and multi-engine land and instrument airplane. His most recent FAA third-class medical certificate was issued in August 2014. According to a flight log found in the airplane, the pilot had accumulated 48.7 hours of flight experience in the accident airplane since March 2016.

The pilot's logbook noted that he received a total of 2.9 hours of dual flight instruction during two flights on March 17, 2016. The flight instructor who flew with the pilot on March 17 and accompanied him on several other flights stated that he did not provide the pilot with any multi-engine training and he believed that the pilot had not received any training in the accident airplane. The pilot "took the airplane pilot operating handbook home and read it." In addition, the flight instructor did not practice any single-engine operations or emergency procedures with the pilot in the accident airplane. He stated that they couldn't practice those procedures with "people in the airplane and we always flew" with passengers. When asked about the pilot's checklist usage, he stated that the pilot would use the checklists and "go through the cockpit like [he] should."

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	PIPER	**Registration:**	N447SA
Model/Series:	PA 31 325	**Aircraft Category:**	Airplane
Year of Manufacture:	1984	**Amateur Built:**	No
Airworthiness Certificate:	Normal	**Serial Number:**	318312016
Landing Gear Type:	Retractable - Tricycle	**Seats:**	6
Date/Type of Last Inspection:	11/13/2015, Annual	**Certified Max Gross Wt.:**	6499 lbs
Time Since Last Inspection:	187 Hours	**Engines:**	2 Reciprocating
Airframe Total Time:	3447.8 Hours at time of accident	**Engine Manufacturer:**	LYCOMING
ELT:	C126 installed, activated, did not aid in locating accident	**Engine Model/Series:**	TIO-540-J2B
Registered Owner:	Oxford University Aircraft Charters LCC	**Rated Power:**	350 hp
Operator:	On file	**Operating Certificate(s) Held:**	None

According to FAA records, the airplane was manufactured in 1984, and purchased by the pilot through a limited-liability company on March 14, 2016.. It was equipped with two Lycoming TIO-540-series, 350-horsepower engines, each of which drove a 4-bladed Hartzell controllable pitch propeller. The most recent annual inspection was performed on November 13, 2015; at that time, the airplane had accumulated 3,260.8 total hours in service.

According to a flight log squawk list, the right engine fuel boost pump light illuminated several times in the month before the accident. The right engine fuel pump was reported as intermittent, the right fuel pressure gauge was oscillating, and the "[right engine] doesn't want to run [without] boost pump." According to receipts located at the accident site, the fuel boost pump annunciator light illuminated and the pump was tested on June 25, 2016. The fuel pressure and flow were found to be within operating limitations at that time. According to maintenance records, the right engine-driven fuel pump and right engine boost pump were replaced on July 19, 2016, at a Hobbs meter time of 1433.7 hours, about 17 hours before the accident.

According to the flight instructor who flew the accident airplane with the pilot, neither he nor the pilot experienced any right engine fuel pump issues after the engine-driven fuel pump and emergency boost pump were replaced in July. The flight instructor spoke with the pilot after the flight to ISM on August 10, and the pilot stated that, "everything was fine, but the screen on the EDM was going out."

The flight log squawk list also included an entry made by the pilot on August 10, 2016 that the right engine cylinder No. 1 was "hot on climb." The log also contained an entry dated the day of the accident that the right engine cylinder No. 1 was "hot on climb" and "ran rich of peak = 31", 2200, 23 gal/side, and EDM [engine data monitor] screen flicker."

According to the Pilot Operating Handbook (POH), the fuel system of the airplane consisted of fuel cells, engine driven fuel pumps, fuel boost pumps, emergency fuel pumps, fuel injectors, control valves, fuel filters, fuel pressure and flow gauges, fuel drains, fuel tanks vents, and a fuel selector panel. Fuel was stored in four fuel tanks, two in each wing. The outboard fuel tanks have a capacity of 40 gallons each, and the inboard fuel tanks have a capacity of 56 gallons each, for a total fuel capacity of 192 gallons, 183.4 gallons of which is usable.

The right and left wing fuel systems were independent of each other and were connected only when the crossfeed system was activated. Under normal operation, fuel was routed from the fuel cells, through the selector valve and fuel filter to the fuel boost pump. Fuel from the boost pump travels through the emergency fuel pump, the fire wall shutoff valve and the engine driven fuel pump to the fuel injector and then into the cylinders.

Emergency fuel pumps are installed to provide fuel pressure in the event an engine-driven pump fails. The emergency fuel pumps are also used under normal conditions for takeoff, landing, and when necessary, priming the engines for start. Left and right emergency fuel pump switches are located on the overhead panel to the right of the fuel gauges in the cockpit.

The fuel boost pumps are operated continuously and are provided to maintain fuel under pressure to the other fuel pumps, improving the altitude performance of the fuel system. Each fuel boost pump was controlled by a separate circuit breaker located in the circuit breaker control panel. The fuel boost pumps were activated when the master switch was turned on and continue to operate until the master switch was turned off or the fuel boost pump circuit breakers were pulled (off). Red fuel boost pump warning lights, mounted in the annunciator panel, provided a visual indication of an inoperative fuel boost pump.

The fuel management controls were located in the fuel system control panel mounted between the front seats on the forward edge of the wing spar carry-through cover. Located on the fuel control panel are the fuel tank selectors, fire wall fuel shutoffs and the crossfeed controls.

Two electric fuel quantity gauges were mounted in the overhead switch panel. The right fuel quantity gauge indicated that quantity of the fuel in the selected right fuel system tank (right inboard or right outboard), and the left fuel quantity gauge indicated the quantity of the fuel in the selected left fuel tank (inboard or outboard).

Section 4, "Normal Procedures" in the POH recommended that when the airplane is loaded to a rearward center of gravity, fuel from the outboard tanks be used first during cruise flight. In addition, the flight instructor who flew with the pilot stated that they would check the fuel selectors and verify that they were on the inboard fuel tanks before takeoff; once the airplane was in cruise flight, they would switch to the outboard fuel tanks. Once the outboard fuel tanks were "drained," they would switch the fuel selectors back to the inboard fuel tanks. He stated that there was enough fuel for about 2 hours of flight time in the outboard fuel tanks.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Day
Observation Facility, Elevation:	TCL, 186 ft msl	**Observation Time:**	1121 CDT
Distance from Accident Site:	1 Nautical Miles	**Direction from Accident Site:**	232°
Lowest Cloud Condition:	Scattered / 2600 ft agl	**Temperature/Dew Point:**	30°C / 25°C
Lowest Ceiling:	Broken / 3600 ft agl	**Visibility**	10 Miles
Wind Speed/Gusts, Direction:	10 knots/ 14 knots, 170°	**Visibility (RVR):**	
Altimeter Setting:	30.09 inches Hg	**Visibility (RVV):**	
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	ORLANDO, FL (ISM)	**Type of Flight Plan Filed:**	IFR
Destination:	OXFORD, MS (UOX)	**Type of Clearance:**	IFR
Departure Time:	0855 CDT	**Type of Airspace:**	

The 1121 recorded weather observation at TCL included wind from 170° at 10 knots gusting to 14 knots, visibility 10 miles, scattered clouds at 2,600 ft above ground level, broken clouds at 3,600 ft above ground level, temperature 30°C, dew point 25°C, and an altimeter setting of 30.09 inches of mercury.

Airport Information

Airport:	TUSCALOOSA RGNL (TCL)	**Runway Surface Type:**	Asphalt
Airport Elevation:	169 ft	**Runway Surface Condition:**	Dry
Runway Used:	30	**IFR Approach:**	None
Runway Length/Width:	4001 ft / 100 ft	**VFR Approach/Landing:**	Forced Landing; Straight-in

TCL was located 3 miles northwest of Tuscaloosa, Alabama, at an elevation of 169.9 ft. It had two runways: 4/22 and 12/30. Runway 4/22 was 6,499 ft long by 150 ft wide, and runway 12/30 was 4,001 ft long by 100 ft wide. At the time of the accident, the airport had an operating control tower between the hours of 0500-2200.

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:	5 Fatal	**Aircraft Fire:**	On-Ground
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	6 Fatal	**Latitude, Longitude:**	33.222778, -87.599722

The airplane impacted trees and the ground, and came to rest in an upright position on a magnetic heading of 011°. The debris path was oriented on a 300° magnetic heading and was about 250 ft long. All major components of the airplane were accounted for at the scene. A postimpact fire ensued, and first responders doused the wreckage with water to extinguish the fire.

The forward fuselage was separated forward of the aft bulkhead and was heavily damaged by impact and postimpact fire. Control continuity was confirmed from all flight control surfaces to the cockpit through multiple overload failures. Examination of the cockpit and cabin areas revealed that both control yokes were attached to their respective columns at the time of impact and that the throttle, mixture, and propeller levers were intact in the throttle quadrant and in the full forward position. The left and right engine fuel selector levers were found in the outboard tank positions. The left and right fuel shut off valves were found in the ON position (not shut off) and the crossfeed selector was found in the OFF position. All fuel control positions were confirmed at the fuel valves. The right engine alternate air source was found in the ON position. The left engine alternate air source was found in the OFF position. The flap lever was in the retracted position. The Hobbs meter was located in the vicinity of the cockpit and indicated 1450.4 hours. The circuit breaker panel was thermally damaged; all of the breakers remained in place except the flap control and compass circuit breakers, which were open.

The right wing was fragmented and partially separated and all sections were located along the debris path. Several sections were consumed by postimpact fire. The right wing fuel caps remained intact and seated in place. Both the outboard and inboard fuel tanks were breached. The fuel filter bowl was removed and had an odor similar to 100LL aviation fuel; a small amount of fluid was noted on the fuel screens. The right main landing gear remained attached in the retracted position. The aileron trim was measured and corresponded to the neutral position.

The right engine remained attached to all engine mounts but was separated from the nacelle. All major components remained attached to the engine. The turbocharger was removed and examined, and the vanes rotated without resistance. There was no rotational scoring on the housing unit. The right propeller remained attached to the engine in the unfeathered position and was rotated by hand. Two propeller blades were bent aft and the other two remained straight. Crankshaft continuity was confirmed from the propeller to the accessory section of the engine. Thumb compression and suction were observed on cylinder Nos. 1, 2, 4, and 6. The No. 5 cylinder was impact damaged. The No. 3 cylinder was removed from the engine and no anomalies were noted with the cylinder, piston, or piston rings.

The left wing was fragmented and partially separated, and all sections were located along the debris path. Several sections were consumed by postimpact fire. The left main landing gear was in the retracted position. Both outboard and inboard fuel tanks were breached; the inboard tank contained an unmeasured amount of fuel.

The left engine was separated from the nacelle and remained attached to the engine mounts. The turbocharger was removed; the turbocharger vanes rotated without resistance. There was no rotational scoring on the housing unit. The left propeller remained attached to the engine in the unfeathered position and was rotated by hand. Two propeller blades were bent aft and the other two remained straight. Crankshaft continuity was confirmed from the propeller to the accessory section of the engine. Thumb compression and suction were observed on all cylinders when the propeller was rotated.

The empennage remained attached to the fuselage. The left and right elevators and horizontal stabilizers were impact damaged, partially separated, and located along the debris path. The vertical stabilizer was partially separated from the empennage and the leading edge exhibited impact damage. The rudder remained attached to the vertical stabilizer; however, the top 12-inch section of the rudder and balance weight were separated and located along the debris path. The rudder trim was measured and corresponded to about 50 percent nose-left trim. The elevator trim was measured and corresponded to the neutral position.

Medical And Pathological Information

The Alabama Department of Forensic Sciences Medical Examiner's Office, Montgomery, Alabama performed the autopsy on the pilot. The autopsy report indicated that the pilot died as a result of multiple blunt force injuries.

The FAA's Bioaeronautical Sciences Research Laboratory, Oklahoma City, Oklahoma, performed toxicological testing of the pilot. Fluid and tissue specimens from the pilot tested negative for carbon monoxide, ethanol, and other drugs.

Tests And Research

Engine-Driven Fuel Pump Examinations

The right engine-driven fuel pump was examined at the manufacturer facility. The drive coupling was intact but would not rotate; therefore, it was disassembled for further examination. The relief valve diaphragm was thermally damaged but remained intact. The drive coupling was removed; the drive tang did not exhibit any damage and the teeth were intact. The rear bearing of the pump remained intact and was not cracked. The rear bearing O-

ring was pliable. The rear carbon bearing was removed and revealed that the pump liner and rotor exhibited corrosion. The main bearing did not exhibit any cracks or chips. There were no anomalies noted with the right engine-driven fuel pump.

The left engine-driven fuel pump examination revealed that the fuel pump drive coupling was intact, and the fuel pump rotated in both directions by hand. The fuel pump was mounted to a test stand and in a cruise power setting, it had a low outlet pressure. When the lock nut was loosened a half turn to adjust the pressure, the engine driven fuel pump passed the cruise power flow test requirements.

Emergency Fuel Pump Examinations

The right engine emergency fuel pump was examined at the manufacturer facility and revealed all surfaces of the pump were black and thermally discolored. The pump was disassembled, and the flow control was in the partial bypass position and unable to move as a result of corrosion. The rotor and cavity chamber were discolored, and the vanes were seized in the rotor slots. There was no evidence of a coil winding overheat condition present in the electric fuel pump. There were no anomalies noted with the right engine electric fuel pump aside from the postimpact fire damage.

The left engine emergency fuel pump examination revealed that the flow control/relief valve was in the partial bypass position in the flow housing. The flow control valve moved without anomaly. The electric fuel pump was mounted to a test bench and operated within all pressure, flow, and current limits. The pump was disassembled, and no anomalies were noted that would have precluded normal operation.

Fuel Boost Pump Examinations

The right fuel boost pump was examined at the manufacturer facility. The pump exhibited thermal damage to the exterior. When looking into the outlet port, the non-metal portions of the relief/bypass valve assembly were melted away. When the pump was handled, soot fell 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.

The left fuel boost pump examination revealed that the cable-actuated ball valve was in the open position. The pump was installed onto a test stand and operated with manufacturer test requirements for operating pressure, fuel flow volume, and electrical consumption in amperes.

Engine Data Monitor – JPI

An engine data monitor was recovered from the cockpit and forwarded to the NTSB Vehicle Recorders Laboratory, Washington, DC, for data download. Review of the downloaded data revealed that the accident flight was recorded in its entirety from 0851 to 1120. According to the data, the right engine exhibited an erratic fuel flow beginning around 1105. The recorded fuel flow continued to be erratic and increased to around 110 gallons per hour until the fuel flow decreased at the end of the recording. The right engine turbine inlet temperature, exhaust gas temperature, and cylinder head temperatures all began decreasing within a few minutes

after the right engine fuel flow became erratic. The left engine fuel flow became erratic around 1113. The recorded fuel flow continued to be erratic and then increased to over 90 gallons per hour until it decreased at the end of the recording. In addition, the left engine turbine inlet temperature, exhaust gas temperatures, and cylinder head temperatures began to decrease within a minute of the left fuel flow becoming erratic.

Additional Information

Normal Procedures Checklist

According to the cruise checklist found in the POH, the following items should be completed.

Fuel Selectors – OUTBOARD OR INBOARD
Power – Set
Cowl Flaps – As required
Mixture – Leaned

Emergency Procedures Checklist – Engine Failure During Flight

According to the checklist found in the POH, the following items should be completed.

Inop eng – identify
Operative eng – adjust as required
Airspeed – attain and maintain at least 97 KIAS

Before securing inop. Engine:
Fuel flow – Check (if deficient – emergency fuel pump ON)
Fuel quantity – check
Fuel selector (inop. Engine) – Switch to other tank containing fuel
Oil pressure and temp – check
Magneto switches – check
Air Start - attempt

Fuel Performance Calculations

Using the fuel consumption rate of 23 gallons per hour per engine noted in the pilot's flight log entry for the accident flight, the fuel endurance for the outboard fuel tanks was about 1 hour, 45 minutes.

Administrative Information

Investigator In Charge (IIC):	Heidi Kemner
Additional Participating Persons:	Robert Bullock; FAA/FSDO; Birmingham, AL Mike McClure; Piper Aircraft; Vero Beach, FL Jud Rupert; Lycoming Engines; Williamsport, PA Les Doud; Hartzell Propeller; Piqua, OH
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	http://dms.ntsb.gov/pubdms/search/dockList.cfm?mKey=93824