Aviation Investigation Final Report

Location:	St. Jacob, Illinois	**Accident Number:**	CEN22FA298
Date & Time:	July 2, 2022, 11:35 Local	**Registration:**	N5235P
Aircraft:	Piper PA-24-250	**Aircraft Damage:**	Destroyed
Defining Event:	Fuel exhaustion	**Injuries:**	1 Fatal, 1 Serious
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The airplane was topped off with fuel on the day of the accident. The airplane was flown to an intermediate airport then back to the original departure airport. After returning to the departure airport, the pilot and a pilot-rated passenger took off to practice full-stop takeoffs and landings. They performed five uneventful takeoffs and landings; during the last takeoff climb, the airplane sustained a loss of engine power. Witnesses reported that the airplane's right wing dropped and the airplane rotated clockwise, as viewed from above, before it impacted the ground.

Postaccident examination of the airplane revealed no useable fuel in the wing's fuel bladder tanks. Both fuel bladders were collapsed and the attachment hardware for the bladder was not properly attached to the wing. Examination of the fuel system revealed that the fuel sending units had bends on their float arms inconsistent with their design and did not meet airplane maintenance manual specifications for resistance values. Additionally, the fuel selector valve did not contain detents for the position of each fuel tank selection. Examination of the engine, engine accessories, and airframe revealed no other mechanical anomalies that would have precluded normal engine operation.

The last maintenance entries that were provided, including the annual inspection, were not part of the airframe and engine logbook(s), and did not show date of maintenance, time-in-service, and signature. Investigators were unable to determine who performed the most recent maintenance of the airplane.

The collapsed fuel bladder would have reduced the fuel capacity when the airplane was last serviced with fuel. The fuel sending units likely provided incorrect fuel tank indications on the fuel gauges in the cabin. The pilot likely would have performed fuel calculations based upon

the designed fuel tank capacity. Both the diminished fuel bladder capacity due to the collapsed bladders and the improper fuel level indications likely led to the loss of engine power due to fuel exhaustion.

The pilot had cardiomegaly with left ventricular wall thickening and moderate atherosclerosis in two coronary arteries. He also had asthma and the bronchodilator albuterol was detected in his blood in urine. While these medical conditions can result in a sudden impairing or incapacitating event, there was no evidence that this occurred. The pilot had opportunity to discontinue the flight if he felt ill, he was actively flying the airplane, and there was a pilot-rated passenger aboard who could assist. Thus, the pilot's medical conditions were not a factor in this accident.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

The inadequate maintenance of the airplane fuel system that resulted in fuel exhaustion and a loss of engine power.

Findings

Aircraft	Fuel - Fluid level
Aircraft	Fuel storage - Not specified
Personnel issues	Aircraft/maintenance logs - Maintenance personnel

Factual Information

History of Flight

Prior to flight	Aircraft maintenance event
Prior to flight	Sys/Comp malf/fail (non-power)
Initial climb	Fuel exhaustion (Defining event)
Initial climb	Loss of control in flight
Uncontrolled descent	Collision with terr/obj (non-CFIT)

On July 2, 2022, at 1135 central daylight time, a Piper PA-24-250, N5235P, was involved in an accident near St. Jacob, Illinois. The airplane was destroyed. The pilot rated passenger received serious injuries and the pilot was fatally injured. The airplane was operated under Title 14 *Code of Federal Regulations* (CFR) Part 91 as a personal flight.

The private pilot/airplane owner and his son departed in the accident airplane from St Louis Metro-East Airport/Shafer Field (IL48), St Jacob, Illinois, to pick up the airline-transport-pilot-rated passenger at Eagle Creek Airpark (EYE), Indianapolis, Indiana. The pilot was to familiarize the pilot-rated passenger with the airplane so that he could later provide flight instruction to the pilot's son.

Before departure from IL48, the airplane was "topped off" with fuel by the pilot's son, and no fuel was obtained at EYE. Before departure from EYE, an "abrupt" airplane preflight was performed and the airplane fuel system was not sumped, and the fuel level within the fuel tanks was not [visually] checked. Upon return to IL48, the pilot's son stated that he exited the airplane and at that time the right fuel tank gauge indicated just under a ¼ tank, and the left fuel tank gauge indicated just under ½ tank; he estimated there was about 12 gallons of fuel remaining.

The pilot's son stated that after he exited the airplane, his father and the pilot-rated passenger switched seats so that the pilot-rated passenger was in the left seat and the his father was in the right seat. They then performed five normal takeoffs and full-stop landings. He heard the engine sputter on the last takeoff, the landing gear retracted, and the airplane began to climb. The airplane then rolled to the right, nosed down, and impacted the terrain.

The pilot-rated passenger stated that they were "just above the treetops" when the engine lost power during climbout from the sixth takeoff. He noted that the pilot took control of the airplane and began "actions that you would undertake following engine power loss." Although he recalls the pilot turning the airplane to the right "pretty aggressively," he did not recall any

indications of a stall, such as a stall warning horn, before the airplane quickly descended in a nose-low attitude into the ground.

A witness stated that he saw the airplane make several full-stop takeoff and landings before the accident takeoff, during which the "engine started to sputter right after it lost power, in and out couple of times." The airplane's right wing then dropped down, and the airplane started to rotate clockwise as viewed from above. He saw the airplane descend behind a hill with a soybean field, at which time he lost sight of the airplane.

Pilot Information

Certificate:	Private	**Age:**	54,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	Lap only
Instrument Rating(s):	None	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	January 19, 2022
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:	(Estimated) 1310 hours (Total, all aircraft)		

Pilot-rated passenger Information

Certificate:	Airline transport; Commercial; Flight instructor	**Age:**	39,Male
Airplane Rating(s):	Single-engine land; Single-engine sea; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Glider	**Restraint Used:**	Lap only
Instrument Rating(s):		**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Glider; Instrument airplane	**Toxicology Performed:**	
Medical Certification:	Class 1 Without waivers/limitations	**Last FAA Medical Exam:**	May 27, 2022
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	(Estimated) 10000 hours (Total, all aircraft)		

The pilot/owner held a mechanic's certificate with airframe and powerplant ratings in addition to his pilot certificate and ratings. The pilot's logbook showed entries for the completion of flight reviews in 2017, 2019, and an undated entry for the completion of a flight review.

A National Transportation Safety Board Pilot/Operator Aircraft Accident/Incident form was not received from the airline-transport-pilot-rated passenger.

Aircraft and Owner/Operator Information

Aircraft Make:	Piper	**Registration:**	N5235P
Model/Series:	PA-24-250	**Aircraft Category:**	Airplane
Year of Manufacture:	1958	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	24-265
Landing Gear Type:	Retractable - Tricycle	**Seats:**	4
Date/Type of Last Inspection:		**Certified Max Gross Wt.:**	2800 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:		**Engine Manufacturer:**	LYCOMING
ELT:	C126 installed	**Engine Model/Series:**	O-540 SERIES
Registered Owner:	On file	**Rated Power:**	250 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

The Piper Comanche PA-24-250 Owner's Manual, Design Features, 1. Specifications, stated that the cruising range with 60 gallon fuel tanks, at sea level, and 75% power is 4.3 hours.

Aircraft logbooks provided by the pilot's son included a separate page that was not part of the "Aircraft Log". The separate page did not cite the aircraft's registration number and had only three printed entries that were not consistent in completion and format as those entries in the "Aircraft Log" and "Engine Log." These entries did not meet requirements cited in 14 CFR Part 43.11, "Content, form, and disposition of records for inspections conducted under parts 91 and 125 and 135.411(a)(1) and 135.419 of this chapter."

The first entry on the separate page stated that an annual inspection was completed and it was signed by an airframe and powerplant mechanic with inspection authorization. The first entry had a date entry of April 12, 2022, and had blank entries for aircraft total time and tachometer time.

The second entry on the separate page was for a 100-hour inspection of the engine with the pilot's printed name and airframe and powerplant certification number; there was no signature. The second entry's aircraft total time, tachometer, time since major overhaul, and date were blank.

The third entry on the separate page was for an oil change with the pilot's printed name and airframe and powerplant certification number; there was no signature. The third entry's aircraft total time, tachometer, time since major overhaul, and date were blank.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	BLV,459 ft msl	**Distance from Accident Site:**	12 Nautical Miles
Observation Time:	11:32 Local	**Direction from Accident Site:**	180°
Lowest Cloud Condition:		**Visibility**	5 miles
Lowest Ceiling:	Broken / 1700 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	/	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.05 inches Hg	**Temperature/Dew Point:**	24°C / 22°C
Precipitation and Obscuration:	Moderate - Thunderstorm - Rain		
Departure Point:	St. Jacob, IL	**Type of Flight Plan Filed:**	None
Destination:	St. Jacob, IL	**Type of Clearance:**	None
Departure Time:		**Type of Airspace:**	Class G

Airport Information

Airport:	ST LOUIS METRO-EAST/SHAFER FLD IL48	**Runway Surface Type:**	Asphalt
Airport Elevation:	477 ft msl	**Runway Surface Condition:**	
Runway Used:	13	**IFR Approach:**	None
Runway Length/Width:	2662 ft / 50 ft	**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	1 Fatal, 1 Serious	**Aircraft Damage:**	Destroyed
Passenger Injuries:	N/A	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Fatal, 1 Serious	**Latitude, Longitude:**	38.728889,-89.803056(est)

The airplane impacted terrain and came to rest in an upright attitude in a field southeast of the departure end runway 13. The airplane wings, fuselage, and empennage exhibited vertical crush/deformation and low-speed impact features. The airplane was destroyed by impact forces.

Postaccident examination of the airplane's fuel system revealed that both wing fuel lines were attached and secured to their respective fuel tanks and to the fuel selector assembly. The fuel lines were unbroken and did not exhibit fuel leakage. There was no usable fuel in either the left- or right-wing fuel tanks.

Air was heard flowing from the wing's respective fuel filler ports and into their respective fuel tanks when air was blown into the left- and right-wing fuel tank underwing vent tubes.

Fuel system diagrams show that the airplane's main fuel tank lines connect to the fuel selector assembly, which provide left, right, and off positions. Fuel cannot flow from a fuel tank when the selector is selected to the opposite tank. The fuel selector handle was found positioned to the right fuel tank. The fuel selector handle was rotated by hand and no detents were felt.

The fuel selector handle was positioned to the right and then the left fuel tank, and air was blown into the fuel selector output line. The resultant airflow could be heard from each wing's respective filler port. Air could not be blown through the fuel selector when the fuel selector handle was in the off position.

The fuel flow transducer, which was part of the cockpit fuel flow indicator, was tested and met the manufacturer's test specifications.

Removal of left- and right-wing fuel tank fuel senders revealed that the metal float arm of the left fuel tank sender had an acute angular bend near its midpoint and near its float. The right fuel tank sender float arm had an approximate 45^{o} angular bend near its midpoint. The shapes of both fuel sender arms were not in accordance with the airplane manufacturer's design specifications.

Both sender float arms were able to free fall without binding in both directions of travel and their respective floats did not display weighting from fluid within the floats.

Resistance measurements of both senders at the bottom stop, mid-travel, and top stop, showed values of:

Left fuel tank: bottom stop - 3 ohms, mid-travel – mid-travel - fluctuated 13-35 ohms, top stop - 32 ohms

Right fuel tank: bottom stop 3 ohms, mid-travel - 20 ohms, top stop - 35 ohms

The Piper Comanche Service Manual for PA-24-250 (May 1, 2010), Section 8-10, Fuel Quantity Indicating System, specifies the fuel sender resistance when the fuel sender arm was at the

bottom stop as: 0.0 to 0.5 ohms. There is no mid-travel resistance specification in the service manual. The fuel sender resistance when the sender arm is at the top stop is specified as 29.6 to 31.3 ohms. The manual states that if incorrect resistance or fluctuation is found, the sender should be replaced.

Examination of the wing tank fuel tank bladders revealed that the left-and right-wing tank fuel bladders were collapsed and those areas of collapse were equipped with bayonet attachment clips.

The left-wing fuel tank bladder was collapsed at the inboard and forward middle sections from the wing filler port. Three inboard and one forward middle bladder mounting clips were not connected to the top of wing. The left-wing tank fuel bladder was part number (P/N): 524, serial number (S/N) CR544, which replaced original equipment manufacturer (OEM) P/N 454-324, manufactured 6/1998.

The right-wing fuel tank fuel bladder was collapsed at the inboard section of the wing filler port. Three inboard bladder mounting clips were not connected to the top of wing. The right-wing fuel tank bladder was P/N: 525, S/N: CR564, which replaced OEM P/N: 454-325, manufactured: 11/1999.

The electric-driven fuel pump was drained of about 1 ounce of liquid, consistent in smell and color with 100 low lead (100LL) fuel, through the inlet and outlet lines. A 12V source of DC power was then applied to the pump, and the pump motor was heard operating. The captured liquid that was drained was tested with water sensing paste and there was no change in paste color that would have indicated the presence of water. The fuel pump screens did not contain debris.

The engine-driven fuel pump was disassembled and the diaphragm was intact and pliable. There was residual liquid consistent in smell with 100LL and was less than the pump's internal capacity within the assembly that spilled out during disassembly.

The carburetor sustained impact damage and, upon removing the carburetor bowl, there were about 2 ounces of liquid consistent in smell and color with that of engine oil and 100LL fuel.

Examination of the engine and engine accessories revealed no mechanical anomalies that would have precluded normal engine operation. Examination of the airframe revealed no other mechanical anomalies, aside from those noted within the fuel system, that that would have precluded normal airplane operation.

Medical and Pathological Information

The 60-year-old male pilot held a second class medical certificate with the limitation that he must wear corrective lenses and possess glasses for near/intermediate vision. At his most recent Federal Aviation Administration (FAA) medical certification examination on January 19, 2022, he reported taking no medications. He had a history of hay fever and asthma. According to the autopsy report, the cause of death of the private pilot was craniocerebral, thoracic, and abdominal blunt trauma, and the manner of death was accident. The private pilot was found to have an enlarged heart (600 grams) with a left ventricular wall of 1.6 centimeters and 50% atherosclerosis in his left anterior descending and right coronary arteries. Toxicology testing detected the generally non-impairing asthma medication albuterol in the private pilot's cavity blood and urine.

The 39-year-old male pilot-rated passenger held a first class medical certificate without limitation. At the time of his most recent FAA medical certification examination on May 27, 2022, he reported no medical concerns, and no significant conditions were identified on physical examination. No specimens were obtained from the pilot-rated passenger for toxicology testing.

Administrative Information

Investigator In Charge (IIC):	Gallo, Mitchell
Additional Participating Persons:	Robert Prenger; Federal Aviation Administration, St Louis FSDO; St. Ann, MO Mark Platt; Lycoming Engines; Williamsport, PA Jonathon Hirsch; Piper Aircraft; Vero Beach, FL
Original Publish Date:	January 31, 2024
Last Revision Date:	
Investigation Class:	Class 3
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=105410