Aviation Investigation Final Report

Location:	Fallbrook, California	**Accident Number:**	WPR22FA265
Date & Time:	July 23, 2022, 13:31 Local	**Registration:**	N787AS
Aircraft:	North American T-28B	**Aircraft Damage:**	Substantial
Defining Event:	Fuel starvation	**Injuries:**	1 Fatal, 1 Minor
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot flew the airplane earlier in the day and made a stop at the accident airport. He performed a pre-flight inspection and positioned himself in the front seat, with the pilot-rated passenger in the rear seat. After takeoff, with the airplane about 200 feet above ground level (agl), the engine sustained a loss of power. The airplane collided with a plant nursery.

The fuel system was designed where fuel flowed by gravity from all internal cells into the sump tank where an electric fuel boost pump was located. The airplane was also equipped with an engine-driven fuel pump. When the pilot turned the fuel “ON”, the electric fuel pump would simultaneously be turned on. An electric fuel-boost-pump test switch was in the cockpit and, as part of the start-up checklist, the switch had to be activated to momentarily interrupt power to the electric pump, allowing the pilot to confirm that the engine-driven fuel pump pressure is adequate (and that the electric fuel pump is operational). There was a 20-amp circuit breaker in series with the switch and the pump. If the electric pump fails below 10,000 feet pressure altitude, fuel drawn by the engine-driven pump is designed to bypass through the electric pump and sustain approximately normal fuel flow to the carburetor (with a slight drop in fuel pressure indication that may be noted).

Disassembly of the electric fuel pump revealed that metal shavings were lodged in the armature creating a short in the system. The blades on the impeller showed wear consistent with instability of the shaft during rotation. The upper commutator was cracked and showed wear on the upper portion. The pump-end bearing was worn on the outside with the labyrinth seal, washer, and shims deformed. The bearing cage was determined to be the metal pieces shorting out the armature.

Continuity was established from the electric pump test switch in the cockpit to the electric pump and to the circuit breaker. Attempts to trip the breaker were unsuccessful and further

testing of the unit revealed it was functional. It could not be determined why the breaker did not trip when the electric pump shorted, but if the pilot had used the test switch, he likely would have been able to see the pump had failed.

A flow test of the carburetor revealed that numerous parameters were out of limits. At low power settings, the carburetor ran rich (more fuel flow than required for normal operation), and at high power settings the carburetor ran lean (less fuel flow than required for normal operation). Disassembly revealed that the enrichment valve's diaphragm was stiff/rigid, consistent with it not being submerged in fuel for long durations. The carburetor manufacturer recommended that it should be overhauled at least every ten years and be pressurized regularly (if in a hot and dry climate, it should be done monthly). The internal diaphragms become brittle and can fail if they are not wetted with fuel regularly. The carburetor was overhauled over 12 years before the accident, equating to about 400 hours of flight time; during that time the pilot stated he had not completed any maintenance on it.

At takeoff power, the carburetor was not able to provide enough fuel to the engine because the enrichment diaphragm was brittle from inactivity. Additionally, because the electric fuel pump was inoperative, the fuel flow pressure was diminished providing less fuel to the carburetor.

Probable Cause and Findings

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

A loss of power due to an unmaintained carburetor diaphragm and inoperative electric fuel pump that resulted in fuel starvation to the engine.

Findings

Aircraft	Fuel control/carburetor - Not serviced/maintained
Aircraft	Fuel control/carburetor - Damaged/degraded
Aircraft	Fuel pump - Failure

Factual Information

History of Flight

Takeoff	Fuel starvation (Defining event)

On July 23, 2022, at 1331 Pacific daylight time, a North American T-28B, N787AS, was substantially damaged when it was involved in an accident near Fallbrook, California. The pilot was seriously injured and the pilot-rated passenger was fatally injured. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

A law enforcement officer interviewed the pilot immediately after the accident. The pilot stated that he and the passenger have been good friends for over 50 years, and both have extensive aviation experience. Earlier in the day, he and the passenger both departed from Chino, California, in separate airplanes. The pilot was flying the T-28 and the passenger was flying the pilot's Cessna 150 with the purpose of dropping it off in Fallbrook. The plan was for them to both leave Fallbrook in the T-28, stop for lunch in Temecula, California, and then return to Chino.

The airplanes departed from Chino and the T-28 landed in Fallbrook about four minutes ahead of the Cessna. After dropping off the Cessna, the pilot performed a pre-flight inspection. The pilot then positioned himself in the front seat and the passenger was in the rear seat. The pilot stated that after takeoff, with the airplane about 200 feet above ground level (agl), the engine sustained a total loss of power. He checked the mixture, power, and fuel, and lowered the nose in an effort to avoid a stall. The airplane collided with a plant nursery. The pilot estimated that about 30 seconds had elapsed from the engine failure to the time of impact. After impact, several people helped him exit the airplane by prying the canopy open. The pilot stated that he forgot to open the canopy before impact.

The pilot additionally stated that he is a mechanic and performs the maintenance on the airplane. He recalled the last time he performed any maintenance on the airplane was about six months before the accident.

Investigators reviewed video recordings, audio recordings, and flight track data covering the area of the accident during the time surrounding the accident using automatic dependent surveillance-broadcast (ADS-B) data. A review of the data revealed that the T-28 landed in Fallbrook about 1255. At 1326:01 the airplane taxied to runway 18 and began the takeoff roll at 1331:20. The airplane began the departure roll and was midfield about 12 seconds later at a ground speed of 88 kts. At 1331:44, the airplane was about 300 ft south of the runway identifier markings and the airspeed was 97 knots. The last position recorded was at 1331:49

and located about 160 ft north of the first identified impact point; the airspeed at that point was 94 knots and the airplane was on a heading of about 180° (see Figure 1 below).

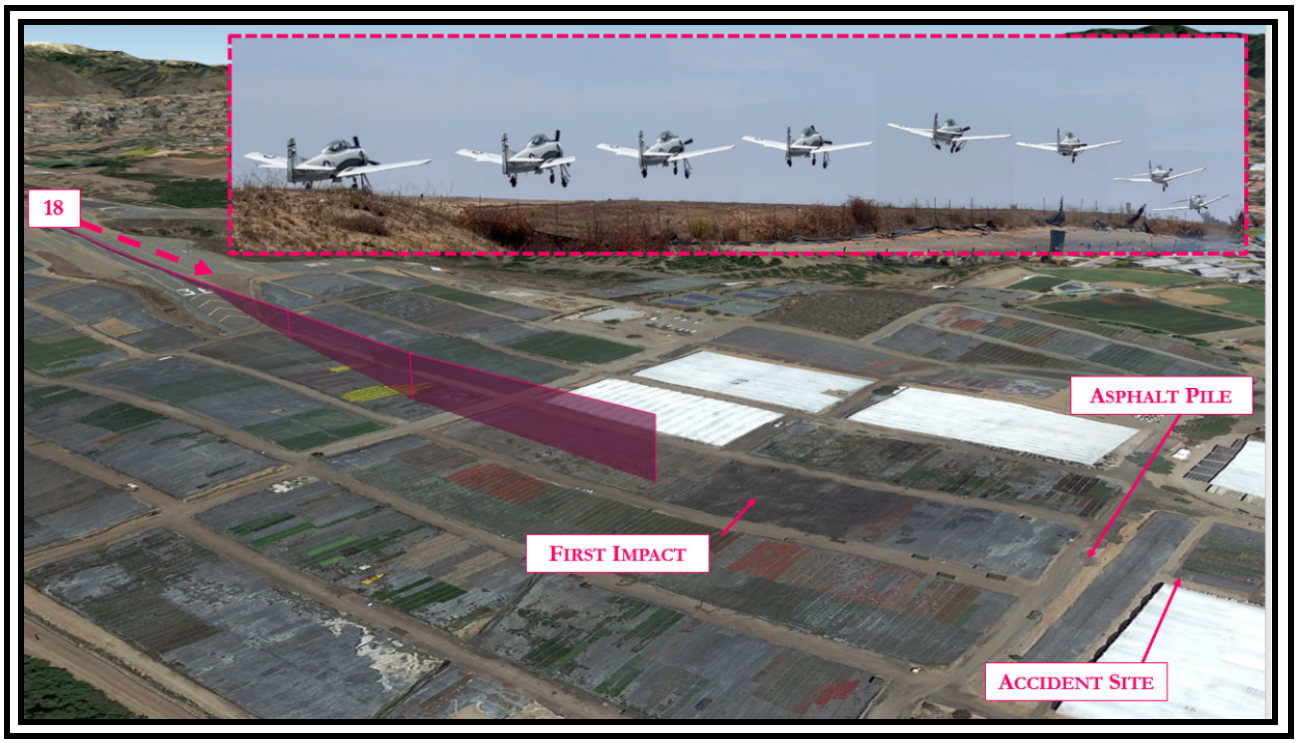

Figure 1: ADS-B Plot with Inset of Video Images of the Takeoff

A sound spectrum analysis from a witness's recorded cell phone video revealed the engine was idling smoothly about 1,530 rpm. Thereafter, it was running rough for about 10 seconds as it increased its speed to about 2,420 rpm and the airplane was moving along the runway. The engine was then running smoothly for the next 12 seconds as it passed by the camera. The engine then suddenly decreased in rpm, similar to when it was at idle, and the airplane impacted several seconds later.

Pilot Information

Certificate:	Airline transport	**Age:**	78,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Front
Other Aircraft Rating(s):	None	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Instrument airplane	**Toxicology Performed:**	
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	April 8, 2022
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:	(Estimated) 27700 hours (Total, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	North American	**Registration:**	N787AS
Model/Series:	T-28B	**Aircraft Category:**	Airplane
Year of Manufacture:	1953	**Amateur Built:**	
Airworthiness Certificate:	Experimental (Special)	**Serial Number:**	137787
Landing Gear Type:	Retractable - Tricycle	**Seats:**	2
Date/Type of Last Inspection:	Continuous airworthiness	**Certified Max Gross Wt.:**	
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:		**Engine Manufacturer:**	WRIGHT
ELT:	Installed, not activated	**Engine Model/Series:**	R-1820-86B
Registered Owner:	MACH ONE AIR CHARTERS INC	**Rated Power:**	1475 Horsepower
Operator:	MACH ONE AIR CHARTERS INC	**Operating Certificate(s) Held:**	None

The T-28B trainer was a two-place, single-engine, low-wing monoplane. The airplane was powered by a nine-cylinder R-1820-86 Wright engine developing 1,425 horsepower and driving a Hamilton Standard three-blade constant-speed propeller. Dual flight controls were installed in the tandem cockpit, and a speed brake was installed on the bottom fuselage aft of the main landing gear wheel wells. The tricycle landing gear was fully retractable.

The pilot owned the airplane for over 10 years. During that time, he never had any work done on the carburetor and never had issues with it. He estimated that at the time of the accident, the engine had just under 400 hours since major overhaul.

A review of the maintenance records revealed that they were incomplete, and it is unknown the full extent of maintenance the airplane and engine had undergone. The last conditional inspection was recorded as occurring on September 5, 2021, at an airframe total time of 14,772.3 hours and a Hobbs time of 362.3 hours. The rebuilt electric fuel pump was purchased in September 2015. The carburetor was last overhauled in February 2010, over 12 years before the accident. The engine-driven fuel pump was last overhauled in February 2010 and the paperwork indicated the reason for removal as “engine failure,” and normal wear was noted. There was no other indication of an engine failure. The last engine overhaul was recorded as being completed in April 2010.

Fuel System

The fuel system consisted of four bladder-type fuel cells, an aluminum alloy sump tank containing an electric boost pump, a fuel shutoff valve, a fuel strainer, an engine-driven fuel pump, check valves, and necessary fuel feed and vent lines. The system was controlled by the fuel shutoff valve handle in either cockpit.

The system is designed where fuel flows by gravity from all internal cells into the sump tank (located in the inboard right wing). A fuel shutoff control handle, located on the left console of each cockpit, has two positions: “ON” and “OFF”. Each position operates the fuel shutoff valve and the electric boost pump simultaneously. An electric fuel-boost-pump test switch was located on the electrical switch panel in the bottom forward right cockpit. The test switch was wired in series with the electric fuel pump switch on the fuel shutoff control handle. When held in the “TEST” position, the system was designed for power to the electric pump to be interrupted, allowing the pilot to confirm that the engine-driven fuel pump pressure is adequate.

The electric pump forced fuel under a pressure of 19 to 24 psi through the shutoff valve, strainer, and engine-driven fuel pump. When the engine started, the engine-driven fuel pump maintained the fuel to the carburetor at an operating pressure of 23 to 25 psi.

If the electric pump fails below 10,000 feet pressure altitude, fuel drawn by the engine-driven pump is designed to bypass through the electric pump and sustain approximately normal fuel flow to the carburetor (with a slight drop in fuel pressure indication that may be noted). If the engine-driven fuel pump failed, fuel was forced by the electric pump to the carburetor to maintain normal engine operation.

The airplane’s take-off checklist stated that at 1,800 rpm “Place FUEL BOOST PUMP switch to TEST, check fuel pressure 21 to 25 psi.”

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KNFG,70 ft msl	**Distance from Accident Site:**	6 Nautical Miles
Observation Time:	13:52 Local	**Direction from Accident Site:**	237°
Lowest Cloud Condition:	Few / 20000 ft AGL	**Visibility**	10 miles
Lowest Ceiling:		**Visibility (RVR):**	
Wind Speed/Gusts:	8 knots /	**Turbulence Type Forecast/Actual:**	None / None
Wind Direction:	230°	**Turbulence Severity Forecast/Actual:**	N/A / N/A
Altimeter Setting:	29.86 inches Hg	**Temperature/Dew Point:**	25°C / 17°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Fallbrook, CA	**Type of Flight Plan Filed:**	None
Destination:	Temecula, CA (F70)	**Type of Clearance:**	None
Departure Time:		**Type of Airspace:**	

Airport Information

Airport:	FALLBROOK COMMUNITY AIRPARK L18	**Runway Surface Type:**	Asphalt
Airport Elevation:	708 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	18	**IFR Approach:**	None
Runway Length/Width:	2160 ft / 60 ft	**VFR Approach/Landing:**	Forced landing

Wreckage and Impact Information

Crew Injuries:	1 Minor	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Fatal	**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	1 Fatal, 1 Minor	**Latitude, Longitude:**	33.348248,-117.25172(est)

The accident site was located in a nursery about 1,815 feet from the departure end of runway 36. The debris field was located on upsloping terrain with numerous plants in plastic crates and an asphalt pile toward the end. The main wreckage, consisting of the engine and almost all the fuselage, came to rest upright and the right-wing had impacted a greenhouse structure.

The wreckage was found distributed over a 415 ft distance on a median magnetic bearing of about 175° (see Figure 2 below).

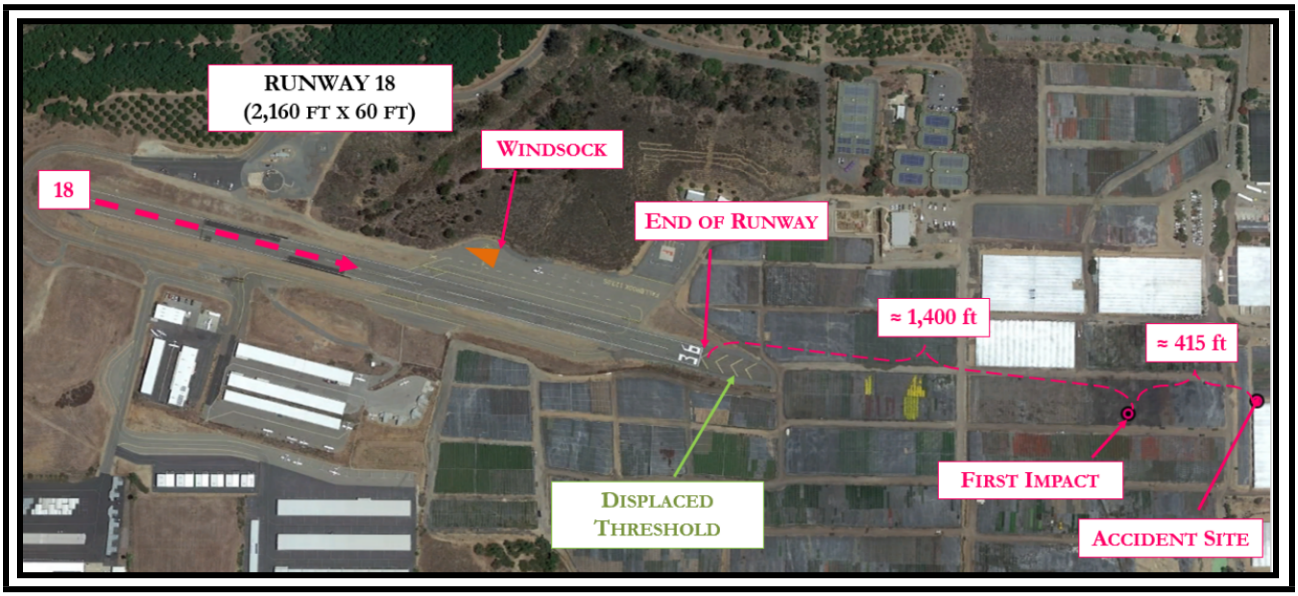

Figure 2: Map of Accident Site

An on-scene examination revealed no external evidence of catastrophic failure. The forward spark plugs were removed; no mechanical damage was noted and the electrodes and posts exhibited a light ash gray coloration, consistent with normal operation (the No. 6 plug was oil-soaked). Upon rotation of the propeller, “thumb" compression was observed in proper order on all nine cylinders. The complete valvetrain was observed to operate in proper order and appeared to be free of any pre-mishap mechanical malfunction. Normal lift action was observed at each rocker assembly. Both magnetos were found securely clamped at their respective mounting pad and the timing was found within the manufacturer specifications. Both oil screens were removed and found free of debris. The carburetor sustained impact damage and continuity of the mixture and throttle could not be established.

There were over 50 gallons of fuel found in each inboard wing tank. The fuel selector was in the on position. There was a fluid consistent in odor and appearance with fuel found in the carburetor’s fuel strainer reservoir; the screen was clean of debris and no water was detected.

The header tank contained trace amounts of fuel and the electronic fuel boost pump was intact. Investigators' efforts to obtain continuity of the electronic fuel pump revealed that there was a short with the electronic connector box on the pump. The box contained a copper jumper between two posts (presumably high and low setting). Disassembly of the electronic fuel pump revealed that metal shavings were lodged in the armature creating a short in the system. The blades on the impeller showed wear consistent with instability of the shaft during rotation. The upper commutator was cracked and showed wear on the upper portion. The brushes appeared normal.

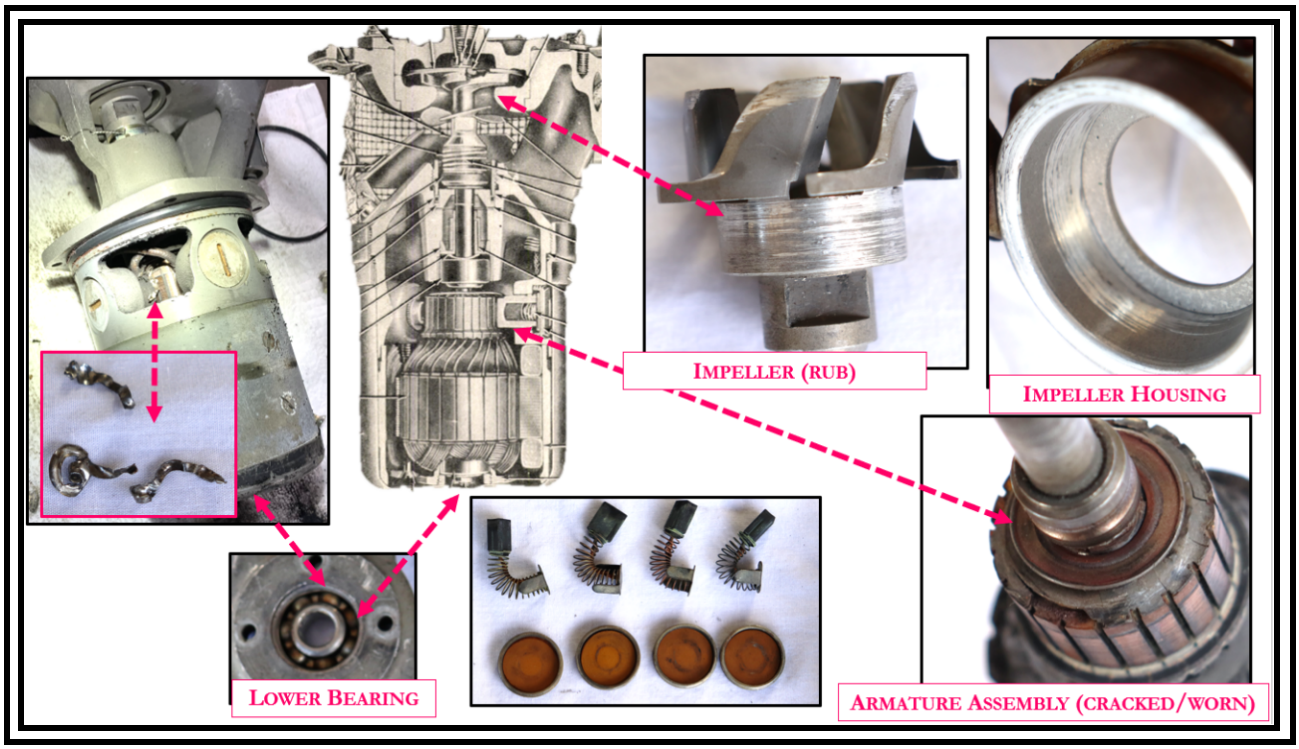

Figure 3: Inside Components of Electric Fuel Pump

Further disassembly revealed that the pump-end bearing was worn on the outside with the labyrinth seal, washer, and shims deformed. The bearing cage was absent. Further examination of the metal pieces in the armature revealed that they were shaped with rounded lips consistent with being pieces of the bearing cage.

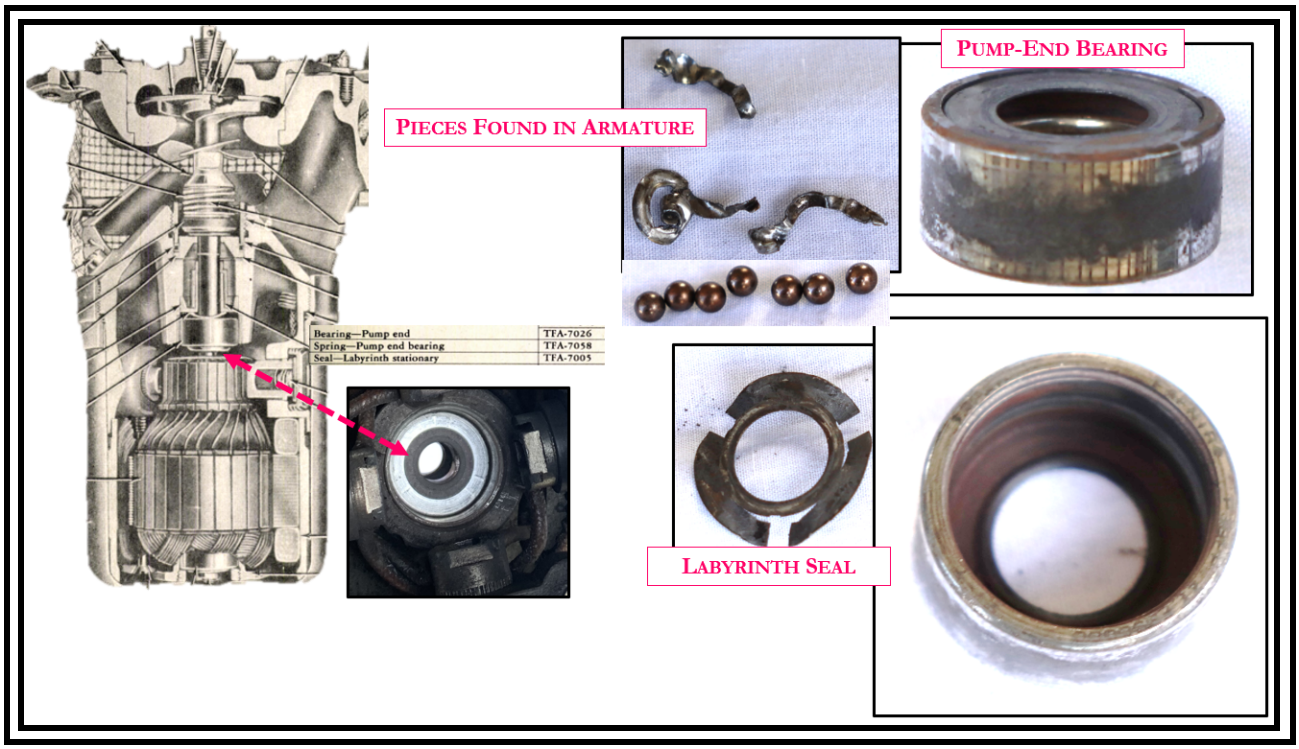

Figure 4: Pump-End Bearing and Fragments Inside the Pump

Continuity was established from the boost pump test switch in the cockpit to the pump. Using a multi-meter, investigators confirmed wire continuity from the boost pump to the 20-amp circuit breaker. The breaker could be moved in and out. Attempts to trip the breaker were unsuccessful. The circuit breaker was taken for testing and found to operate as expected and it could not be determined why the breaker was unable to trip when installed.

Carburetor Examination

The carburetor, a Stromberg PD-12-K18 (s/n 792490), was an injection carburetor that was a double-barrel, downdraft unit equipped with a fuel head enrichment valve, a constant head idle spring, an automatic mixture control unit, a mechanically operated accelerator pump, and an electric primer valve. The mixture control had settings for "IDLE CUTOFF," "NORMAL," and "RICH," offering control over performance.

The power enrichment valve in the fuel control unit is operated by a diaphragm exposed to un-metered fuel pressure on one side and metered fuel pressure on the other. When the pressure differential applied across the enrichment valve diaphragm creates a force greater than the enrichment valve spring force, the valve opens. The opening point of the valve can be adjusted to a predetermined point by increasing or decreasing the tension on the enrichment valve spring.

The carburetor remained attached to the engine and had sustained impact damage; continuity of the mixture and throttle could not be established. At the accident site, fuel was found in the carburetor. Later, corrosion was found in the screen housing and on the spring.

A flow test of the carburetor revealed that numerous parameters were out of limits. At low power settings the carburetor ran rich (more fuel flow than required for normal operation) and at high power settings the carburetor ran lean (less fuel flow than required for normal operation). This would be consistent with the engine running lean (not providing enough fuel) at takeoff power. Disassembly revealed that the enrichment valve's diaphragm was stiff/rigid, consistent with it not being submerged in fuel for long durations. The carburetor manufacturer recommended that it should be overhauled at least every ten years and be pressurized regularly (if in a hot and dry climate, it should be done monthly). The internal diaphragms become brittle and can fail if not wetted with fuel regularly.

Tests and Research

Recorders

Data obtained from the Advanced AF-5500 revealed that the device began recording at 1331:26. Airspeed was increasing, and the heading of the airplane was recorded consistent with that of the accident event. Manifold pressure and fuel flow were increasing. At 1331:31, manifold pressure and fuel flow appeared to stabilize, and the airplane's heading was continually recorded consistent with the accident runway. In the next few seconds, the pitch began to increase, as well as vertical speed. At1331:39, manifold pressure and fuel flow began decreasing, followed shortly thereafter by vertical speed. Airspeed plateaued and began a slight decreasing trend. As the data reached the end of the recording, the pitch decreased but was only below 0 degrees for one sample. The recording ended at 13:31:46.

Administrative Information

Investigator In Charge (IIC):	Keliher, Zoe
Additional Participating Persons:	James Treiber; Federal Aviation Administration; San Diego, CA
Original Publish Date:	February 28, 2024
Last Revision Date:	
Investigation Class:	Class 3
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=105555

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