Aviation Investigation Final Report

Location:	Wickenburg, Arizona	**Accident Number:**	WPR16FA176
Date & Time:	September 9, 2016, 07:00 Local	**Registration:**	N126P
Aircraft:	Cessna 310N	**Aircraft Damage:**	Substantial
Defining Event:	Fuel starvation	**Injuries:**	4 Serious
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The airline transport pilot and three passengers were departing in the multi-engine airplane when, during the early phase of takeoff, most likely shortly after rotation, the right engine experienced a total loss of power. The power loss occurred during a critical phase of flight, at a time when the airplane was close to or just below the manufacturer's recommended "safe single-engine speed." The hilly terrain surrounding the airport, particularly in the takeoff direction, left the pilot with few options for a safe climb out. Further hindering the takeoff was the airplane's anemic single-engine climb performance due to the high density altitude conditions and the airplane's weight. As a result, shortly after the loss of power, the airplane rolled right, consistent with it flying slower than its minimum controllable single-engine airspeed, collided with the ground, and sustained substantial damage.

The pilot and passengers all sustained serious injuries and could not remember the circumstances of the accident.

Examination of the right engine revealed that a clear, gelatinous substance had blocked the inlet port of the fuel flow transducer, leading to fuel starvation. The substance was determined to be silicone, most likely room-temperature-vulcanization silicone sealant. There were no indications that this material had been used anywhere within the fuel system, nor were there any signs of recent maintenance that could have resulted in the introduction of this contaminant. To get to the fuel flow transducer, the silicone would have had to pass through multiple fine mesh filters, which was unlikely based on the material's size when dry. However, silicone becomes semi-soluble once in contact with aviation gasoline, and it is possible that it was extruded through the filters in this state, and eventually coalesced in the flow divider inlet port. Smaller fragments of the silicone were found in the fuel manifold valve, beyond the flow divider, and a fuel injector valve port was partially occluded, possibly with the same material.

The specific source of contamination could not be determined. The pilot last purchased fuel for the airplane about one month before the accident. Later on the day of purchase, the fuel system was shut down by the airport management due to metering inaccuracies; however, the problems were all electrical

in nature, and did not require the repair or replacement of any components that would have come into contact with fuel.

Probable Cause and Findings

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

Total loss of power to the right engine during takeoff due to a fuel contaminant, which blocked the fuel flow transducer and resulted in fuel starvation to the engine.

Findings

Aircraft	Fuel - Fluid condition
Aircraft	Fuel flow indicating - Damaged/degraded
Aircraft	Engine out capability - Attain/maintain not possible

Factual Information

History of Flight

Prior to flight	Fuel contamination
Takeoff	Fuel starvation (Defining event)
Uncontrolled descent	Collision with terr/obj (non-CFIT)

On September 9, 2016, about 0700 mountain standard time, a Cessna 310N, N126P, struck a refuse transfer trailer shortly after takeoff from Wickenburg Municipal Airport, Wickenburg, Arizona. The airline transport pilot and three passengers were seriously injured, and the airplane sustained substantial damage. The twin-engine airplane was registered to and operated by the pilot under the provisions of 14 *Code of Federal Regulations* Part 91. The personal flight departed Wickenburg with a planned destination of Payson, Arizona. Visual meteorological conditions prevailed, and no flight plan had been filed.

Witnesses reported observing the airplane takeoff from runway 23, and veer to the right of centerline shortly after rotation. Having reached an altitude of about 75 ft above ground level, the airplane did not climb, and crossed over the runway verge and towards an adjacent industrial park. A witness stated that a few seconds later, the airplane rolled almost 90^{o} to the right, and the right wing struck the refuse trailer. The right wing separated from the airframe, and the main fuselage came to rest about 75 ft downrange. The airplane came to rest within the confines of the City Sanitation Department, about 2,200 ft beyond the runway departure threshold, and about 30^{o} right of its centerline.

The pilot and passengers sustained multiple serious injuries, and were initially treated and stabilized at the accident site by first response personnel. Due to the nature of their injuries, they were unable to recall the circumstances of the accident.

Pilot Information

Certificate:	Airline transport	**Age:**	63,Male
Airplane Rating(s):	Single-engine land; Multi-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):	Airplane single-engine	**Toxicology Performed:**	Yes
Medical Certification:	Class 3 With waivers/limitations	**Last FAA Medical Exam:**	October 17, 2014
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	March 1, 2014
Flight Time:	(Estimated) 18000 hours (Total, all aircraft), 1000 hours (Total, this make and model)		

The pilot held an airline transport pilot certificate with ratings for airplane multiengine land. He also held an instructor rating for airplane single-engine land, along with type ratings for the B-727, B-757, B-767, DC3, and N-265. He held an airframe and powerplant mechanic certificate with inspection authorization.

The pilot's last flight review took place in March 2014, he also reported practicing single-engine procedures in the accident airplane during July 2016.

Aircraft and Owner/Operator Information

Aircraft Make:	Cessna	**Registration:**	N126P
Model/Series:	310N	**Aircraft Category:**	Airplane
Year of Manufacture:	1968	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	310N-0127
Landing Gear Type:	Retractable - Tricycle	**Seats:**	6
Date/Type of Last Inspection:	July 6, 2016 Annual	**Certified Max Gross Wt.:**	5200 lbs
Time Since Last Inspection:	16 Hrs	**Engines:**	2 Reciprocating
Airframe Total Time:	3487.7 Hrs as of last inspection	**Engine Manufacturer:**	Continental Motors
ELT:	C91 installed, activated, did not aid in locating accident	**Engine Model/Series:**	IO-470-VO9B
Registered Owner:		**Rated Power:**	260 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

The airplane was manufactured in 1968, and had been owned and maintained by the pilot since 1985. It was equipped with two six-cylinder, fuel injected, Continental Motors IO-470 series engines. The right engine had been overhauled and installed in 1986, and had accrued 690.9 flight hours at the last annual inspection on July 6, 2016. The left engine was overhauled and installed in a Cessna 310N airplane in 1978, and removed and installed on the accident airplane in 1988. It had accrued 1,268.7 flight hours at the last annual inspection.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KLUF,1085 ft msl	**Distance from Accident Site:**	33 Nautical Miles
Observation Time:	13:58 Local	**Direction from Accident Site:**	138°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	5 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	320°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.93 inches Hg	**Temperature/Dew Point:**	25°C / 16°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Wickenburg, AZ (E25)	**Type of Flight Plan Filed:**	None
Destination:	PAYSON, AZ (PAN)	**Type of Clearance:**	None
Departure Time:	07:00 Local	**Type of Airspace:**	Class E

Area winds were out of the northwest at 5 knots, with an altimeter setting at 29. 93 inches of mercury, and a temperature and dewpoint of 25° C and 16° C respectively. The corresponding density altitude for field elevation was about 4,200 ft.

Airport Information

Airport:	WICKENBURG MUNI E25	**Runway Surface Type:**	Asphalt
Airport Elevation:	2378 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	23	**IFR Approach:**	None
Runway Length/Width:	6101 ft / 75 ft	**VFR Approach/Landing:**	None

Wickenburg Airport is at an elevation of 2,378 ft, and is composed of a single 6,101-ft-long asphalt runway, designated 5/23. Runway 23 is on a 1.2% uphill gradient. Terrain 1.5 miles beyond the departure end of runway 23 rises to a peak about 300 ft above runway elevation. Highway 60, which is offset about 30° right of the runway centerline, follows the foothills of the rising terrain, about 200 ft below the peak.

The only fueling facility at the airport was a self-serve pump, managed by the City of Wickenburg. During the period July 16 through 30, the pilot serviced the airplane twice at Wickenburg, and then three times at different airports in Kansas and Wisconsin. The last fuel purchased for the accident aircraft before the accident was from the Wickenburg pump on July 30, 2016. He then flew to Payson, Arizona a few days later.

The airport operations manager provided the certificate of analysis for the fuel delivered to the tank farm during that period, and the sample met the tested specifications for ASTM 5191 (vapor pressure), ASTM

D86 (distillation), and IP 559 (density). Additionally, daily fuel system facility checks for the month of July and August, did not reveal any anomalies, and no pilots reported issues with fuel.

According to the operations manager, the fuel system experienced a failure on July 12, 2016, attributed to a lightning strike, and as a result, the system's computer motherboard was replaced. Metering problems persisted, and on July 30, the same day that the accident pilot purchased fuel, the system was shut down for a week because the delivery meter did not read correctly. The meter's pulse transmitter was replaced; however, anomalies persisted, and in early December, the entire fuel island was shut down for redesign. The operations manager stated that the problems were all electrical in nature, and did not require repair or replacement of any components that would have come into contact with fuel.

Wreckage and Impact Information

Crew Injuries:	1 Serious	**Aircraft Damage:**	Substantial
Passenger Injuries:	3 Serious	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	4 Serious	**Latitude, Longitude:**	33.965831,-112.813056

Medical and Pathological Information

Toxicological tests on specimens recovered from the pilot after he was admitted to the hospital were performed by the FAA Bioaeronautical Sciences Research Laboratory. Analysis revealed negative findings for ethanol and all screened drug substances except Etomidate, which is an anesthetic agent often used in emergency treatment.

Tests and Research

Examination of the engine control quadrant at the accident site revealed that both mixture controls were in the full rich position, the propeller controls were 1-inch short of full forward, and the throttle controls had bent to the right and over the quadrant about midrange. Both the flap actuator and landing gear assemblies were in positions consistent with retraction.

Left Engine

The left engine had partially separated from the firewall during the impact sequence, sustaining damage to the throttle body and rocker covers, and exposing the valve springs and rocker assemblies for all

cylinders except number 4. The propeller blades and hub assembly remained attached to the crankshaft. Both blades exhibited a 15^{o} bend about 12 inches from the hub, along with multiple nicks and chordwise scratches to their leading edges.

The fuel lines along with both the engine and propeller controls were intact, and the spark plug electrodes exhibited normal service life wear signatures, and dark grey coloration. The magneto-to-engine timing was correct, and "thumb" compression was confirmed at all cylinders, along with drive train continuity to all valves and accessories. The fuel lines from the metering unit through to the fuel flow transducer and the fuel manifold valve were free of obstruction, and the internal impellor of the transducer could be heard spinning when low-pressure air was applied to the inlet.

Disassembly of the fuel manifold valve, engine driven fuel pump, and throttle body metering unit revealed no mechanical anomalies, and residual fuel was observed within the cavity of the manifold valve. The fuel inlet screen was found clear and free from obstructions. During disassembly of the metering unit, debris was observed on the spring side of the mixture control cam. The debris appeared to be a combination of dried grease and ferrous material.

Right Engine

The right engine sustained similar impact damage, with the propeller hub assembly remaining attached to the crankshaft. Both blades had detached from the hub, and both were straight, with neither exhibiting any damage signatures associated with rotation such as leading edge nicks or chordwise scratches. Both blades displayed blue streak marks, similar in color to the paint on the refuse trailer which was struck during impact.

The engine exhibited comparable magneto-to-engine timing, cylinder compression, and spark plug characteristics as the left engine. Disassembly of the fuel manifold valve, engine driven fuel pump, and throttle body metering unit revealed no mechanical anomalies. However, about 1/8 of one side of the surface of the throttle body inlet screen was covered in lint material, and the fuel injector nozzle for cylinder 3 was partially occluded and coated with a solid glaze. No fuel was observed within the cavity of the manifold valve or the fuel line between the fuel flow transducer and the fuel manifold valve.

Disassembly of the fuel lines revealed that a clear gelatinous substance had completely blocked the fuel flow transducer inlet port (metering orifice) (Photo 1). The material was removed, and had a slimy wet texture. After one hour of exposure to air, the material had hardened and took on a texture similar to room-temperature-vulcanization (RTV) silicone. Six fragments were recovered, which, after drying for 24 hours, ranged in size from 1 to 3 mm. Further examination of the fuel manifold valve revealed a similar fragment of the material within the manifold cavity on the pre-filtered side of its screen.

Photo 1 - Fuel Flow Transducer Inlet Port

Fuel System

The airplane was equipped with a 20-gallon auxiliary fuel tank in each wing, and a 50-gallon main tank at each wingtip. The auxiliary tanks fed the system through gravity, and an electrically driven submerged fuel pump was housed in each tip tank for use during priming and starting, and for backup operation to the engine-driven fuel pump.

Each wing housed a combination fuel selector valve/strainer, which was controlled by a selector lever in the cabin via a set of cables. The mesh size of the strainer was 104 microns. The fuel flowed from the strainer to the engine driven fuel pump, and onward to the inlet port of the fuel metering unit, which was protected by a 210-micron mesh filter. Downstream of the metering unit, the fuel passed through the fuel flow transducer, and into the fuel manifold valve, which contained a 210-micron mesh filter.

Maintenance records revealed that a Shadin 910502 fuel flow indicating system was installed in 1982, in accordance with supplemental type certificate SA573GL and SE552GL. The fuel flow transducer installed at the time of the accident was a FloScan 201 series (p/n 680501), which according to the

engine logbook, had been installed in 1995 as a replacement for the original unit.

The transducer inlet and outlet ports used 1/4-inch NPT threads, and the inlet metering orifice was about 0.115 inches (2.92mm) in diameter.

Both outboard tip tanks had been breached, exposing their inner surfaces. No debris was observed within the tanks. The auxiliary tanks were intact, and no debris was observed when examined through the respective fuel filler necks.

The airframe and engine fuel lines, filter plugs, fittings, and gaskets were examined to determine if RTV sealant material had been used as a sealing medium. No traces of such material were observed. Additionally, the fuel lines within the engine compartment were stiff, almost brittle, and exhibited significant chaffing damage. The owner stated that he had never used RTV silicon to seal any components within the fuel system.

Data provided by Continental Engines indicated that the fuel pressure from the engine driven fuel pump to the metering unit was between 28.8 and 31.0 psi when the engine was operating at 2,625 RPM, and 6.5 to 7.5 psi at 600 RPM. The metered fuel pressure at 2,625 RPM varies between 17.8 and 18.8 psi.

Material Examination

The rubber-like material was sent to the NTSB Materials Laboratory Division for analysis using a Fourier Transform Infrared spectrometer. The results revealed spectral peaks, which when evaluated, were a strong match to polydimethylsiloxane, also known as silicone.

A survey of manufacturer's data sheets for silicon rubber compounds revealed multiple warnings regarding its soluble properties and limitations when exposed to gasoline. The data advised that silicon can swell from 75% to 260% when exposed to gasoline, with the manufacturer of a popular RTV silicon brand specifically stating:

"Do not use for gasketing carburetors or fuel control devices where it will be in constant contact with hydrocarbon fuels. Material will develop excessive swell and loss of mechanical properties."

The Floscan 200 Series Application Notes, current at the time of the accident stated the following:

"SAFETY WARNING: Never use RTV or similar sealants when installing Floscan senders or any fuel system components. Sealants can get into the fuel system and cause fuel starvation."

Performance

The pilot reported the airplanes takeoff weight was 4,900 pounds.

The airplane owner's manual stated that for a normal takeoff, the pilot should raise the nose at 90 MPH, break ground at 105 MPH, and allow the airplane to accelerate to the best "twin-engine" rate-of-climb speed of 124 MPH. It further stated that the most critical time for an engine-out condition was during the two to three second period late in takeoff, while the airplane was accelerating to a safe engine-out speed.

Furthermore, during an engine-out scenario on takeoff, at a field elevation of 5,000 ft, 4,527 ft is the total distance required to accelerate to 105 MPH, recognize and respond to an engine out-event, and stop the airplane.

The manual's "Single Engine Takeoff Distance" chart provided the means to calculate the total distance required to clear a 50 ft obstacle, assuming an engine failure occurred at takeoff speed, and that the propeller was feathered, and the landing gear and flaps were retracted. Under the reported temperature, with a 4-knot headwind, and a gross weight of 4,800 pounds, the distance required would have been about 4,100 ft. Extrapolation of the graph for a gross weight of 4,900 pounds (reported takeoff weight), indicated a distance of about 6,200 ft. At airplane weights between 4,900 and 5,200 pounds (max gross weight), the distance fell beyond the 7,000 ft scale of the graph.

The manual stated that under single-engine operation at maximum gross weight, the rate of climb at sea level and standard temperature was 330 ft per minute, with a service ceiling of 6,850 ft. The minimum single-engine control speed was 87 MPH, and the best single-engine angle of climb and rate of climb speeds were 105 and 113 MPH respectively. The manual stated that although the airplane is controllable at the minimum single-engine control speed, "the performance is so far below optimum that continued flight near the ground is improbable. A more suitable recommended safe single-engine speed is 105 MPH, since at this speed, altitude can be maintained more easily while the landing gear is being retracted and the propeller is being feathered."

The propellers for both engines rotate in the same direction, with the left engine considered the, "critical engine" during engine-out conditions.

Administrative Information

Investigator In Charge (IIC):	Simpson, Eliott
Additional Participating Persons:	Steve Meisner; Federal Aviation Administration FSDO; Scottsdale, AZ Nicole Charnon; Continental Motors; Mobile, AL Henry Soderlund; Cessna; Wichita , KS
Original Publish Date:	January 25, 2018
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=93979

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