Aviation Investigation Final Report

Location:	Mill Creek, California	**Accident Number:**	WPR19FA126
Date & Time:	May 1, 2019, 11:00 Local	**Registration:**	N7302S
Aircraft:	Cessna 182	**Aircraft Damage:**	Substantial
Defining Event:	Loss of engine power (total)	**Injuries:**	1 Fatal, 2 Serious
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot and two passengers departed on a sightseeing flight over mountainous terrain. About 30 minutes into the flight, the engine lost partial power and smoke began to enter the cockpit. The pilot turned the airplane toward a grassy meadow for a forced landing. While approaching the field, the pilot suddenly saw power lines immediately ahead and attempted to maneuver the airplane below them. The airplane contacted the wires and came to rest inverted.

Postaccident examination revealed several holes in the engine crankcase. The oil filter adapter was found loose and the fiber gasket was protruding beyond the castings. Removal of the oil filter adapter revealed that the fiber gasket was split. The failure of the gasket allowed oil to exit the engine, resulting in oil starvation and the subsequent catastrophic failure.

During postaccident testing, the gasket failure seen in the accident adapter could not be replicated, and the reason for the failure could not be determined. The testing did reveal that the adapters were difficult to install properly, and on some occasions, when the proper torque was achieved, the adapter housing could still be rotated about the hub when hand pressure was applied. In response to the accident and testing, the supplemental type certificate (STC) holder issued a service bulletin (SB) that stated that the adapter should be inspected for oil leakage and gasket damage. The SB also provided detailed instructions to eliminate and identify rotation of the housing during and after installation.

The purpose of the oil filter adapter was to enable use of a conventional spin-on oil filter. The adapter was installed on the engine about 2 years before the accident; the engine had accrued about 340 hours since that time. There were no documents regarding the installation of the oil filter adapter, and it is unknown how it was installed or if new gaskets were used at the time of installation. Maintenance records indicated that the oil filter was changed 7 times between the engine installation and the accident. The last maintenance performed on the airplane was an annual inspection completed 5 days and about 9.4 flight hours before the accident. During this maintenance, the oil filter and the vacuum pump

accessory driveshaft seal were replaced. It is possible that the vacuum pump seal was replaced because the mechanics thought it was leaking due to the presence of oil in the engine compartment. This may have been the first indication that the oil filter adapter was beginning to leak.

Probable Cause and Findings

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

A total loss of engine power due to oil starvation as a result of the failure of a gasket on the oil filter adapter and the pilot's inability to clear power lines during the emergency landing.

Findings

Aircraft	Recip eng oil sys - Failure
Environmental issues	Wire - Contributed to outcome
Personnel issues	Monitoring environment - Pilot
Aircraft	Oil - Incorrect service/maintenance

Factual Information

History of Flight

Enroute	Loss of engine power (total) (Defining event)
Emergency descent	Off-field or emergency landing

On May 01, 2019, about 1100 Pacific daylight time, a Cessna T182P airplane, N7302S, was substantially damaged when it was involved in an accident near Mill Creek, California. The pilot and one passenger sustained serious injuries and one passenger was fatally injured. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

The pilot stated that the purpose of the flight was to fly around Mount Lassen, California. After takeoff, he climbed the airplane to between 11,000 and 11,500 ft mean sea level (msl). The airplane approached the west side of the mountain and the pilot began a right turn with the intention of circling the mountain. As the airplane transitioned to the east side of Mount Lassen, he heard a muffled "boom" from the engine compartment, which was immediately followed by a visible puff of white vapor and a partial loss of engine power. Thereafter, black smoke, consistent with the smell of burnt oil, began to enter the cockpit. The pilot trimmed the airplane for its best glide airspeed and the airplane began to descend at an estimated 1,000 ft per minute. While looking for a suitable place to make an off-airport landing, the pilot briefly attempted to troubleshoot the engine problem and noted that when he retarded the throttle control, there was a slight reduction in power, which indicated to him that at least one piston continued to operate. He then advanced the throttle fully forward to arrest the descent as much as possible.

After rejecting his first selected field, the pilot turned the airplane toward a grassy meadow that was beyond trees. He planned to flare the airplane immediately after clearing the 4-ft fence that stretched northwest-southeast across the field. After the airplane passed over the treetops, he extended the flaps and continued toward the fence. The pilot suddenly saw powerlines immediately ahead and attempted to maneuver the airplane underneath them. The airplane contacted the wires and spun from the impact, coming to rest inverted (see Figure 1).

Figure 1. Accident Site

The rear-seated passenger's cellphone contained photographs and a video of the flight. A 24-second video, beginning at 1032:43, captured part of the cockpit. Images revealed that the engine oil pressure gauge was indicating near 0 psi and the tachometer read 4,249.7 hours, which was 24 minutes before the accident.

PILOT INFORMATION

The pilot also held a mechanic certificate with airframe and powerplant ratings.

AIRPLANE INFORMATION

The logbook entries and an interview with maintenance personnel revealed that, during the last maintenance, the airplane's owner changed the oil and another maintenance facility replaced the vacuum pump accessory driveshaft seal.

According to the engine manufacturer, the engine pumps about 16 quarts of oil per minute at the maximum oil pressure of 60 psi (the sump capacity is 12 quarts).

Oil Filter Adapter Design

The engine was equipped with an F&M Enterprises Inc engine oil filter adapter, model No. C6LC-S installed under FAA Supplemental Type Certificate (STC) No. SE09356SC. According to the current STC holder, Stratus Tool Technologies (owned by Aero Accessories Inc.), Stratus purchased the STC from F&M Enterprises Inc about 5 years before the accident.

The purpose of the adapter was to enable the engine to use a conventional, spin-on oil filter. As manufactured, the oil pump was equipped with a brass oil screen mounted to the casing; the filter adapter used the oil screen bore to attach to the engine. The adapter included a tee casting (housing) and a hub (shaft), which was threaded into the oil screen hole on the engine's oil pump casting. The tee casting had a sleeve with a through-bore and a mounting base that accepted a spin-on oil filter. When installed, the shaft was journaled into the bore of the sleeve and screwed into the oil screen hole, which had two oil passage openings. A crown (1-inch bolt head) at the outboard end of the shaft secured the tee casting against the oil pump casing; a gasket was placed between the crown and the outboard surface of the sleeve's bore. Another gasket was placed between the oil pump casting and the inboard surface of the sleeve's bore. Oil inlet and oil outlet passages are provided through the hub and the tee casting to circulate oil from the oil screen hole into the spin-on filter, and back into the oil screen hole from the spin-on filter (see Figure 2).

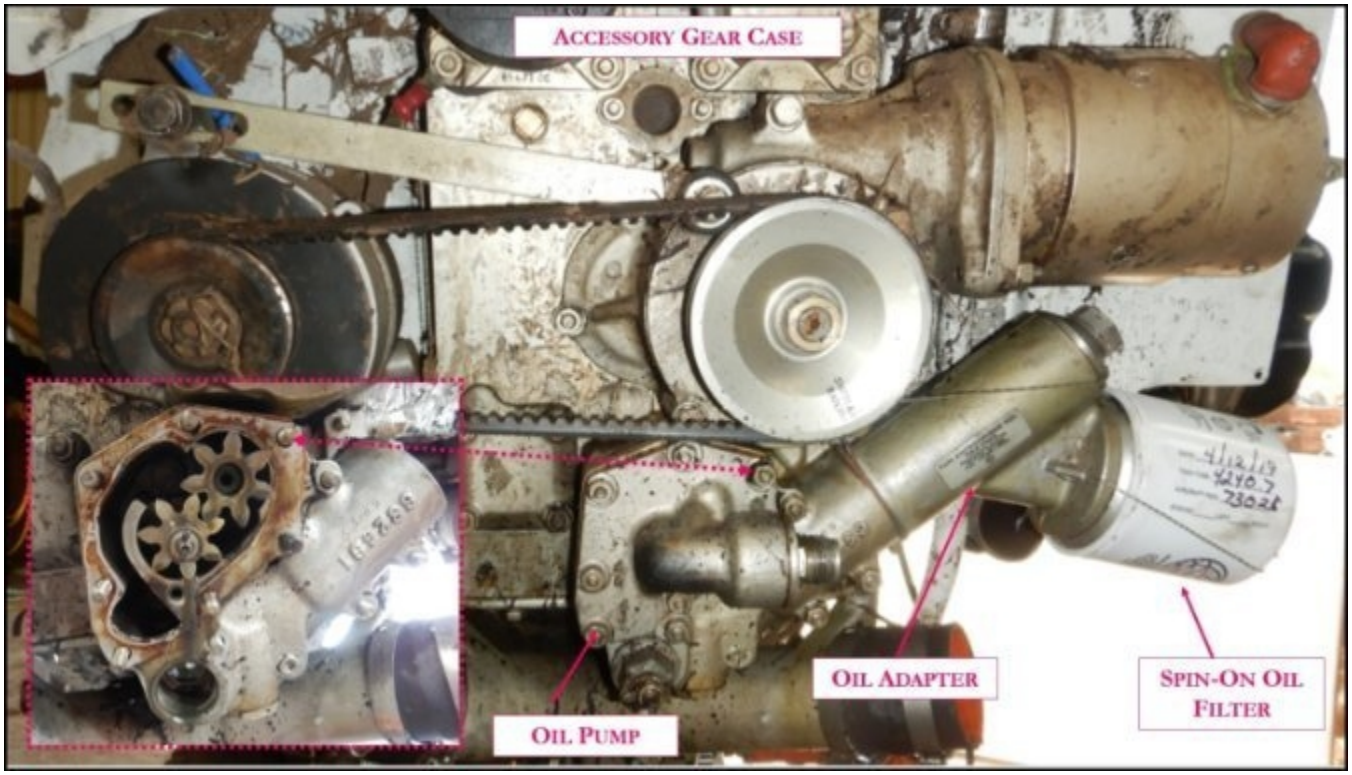

Figure 2. Accessory Gear Case Showing Location of Oil Filter Adapter

Oil Filter Adapter Gaskets

The adapter was originally designed to use two AN900-200 copper crush gaskets (one between the crown and the outboard surface of the sleeve's bore and the other between the oil pump casting and the inboard surface of the sleeve's bore). At an unknown time and for an unknown reason, F&M Enterprises changed the gasket on the inboard surface of the sleeve's bore to a fiber gasket. The fiber gasket, part number FM07, was manufactured from 3750 Leak-Guard material produced by Garlock and originally cut by GPI using an FAA-certified die (the last order placed by F&M Enterprises was in July 2013). Stratus Tool Technologies stated that, since they purchased the STC, they ordered the gaskets from Corley Gasket Company, which has not had any FAA oversight.

Oil Filter Adapter on Accident Airplane

The airplane owner stated that he installed the oil filter adapter upon receipt of the engine in February 2017 after removing the adapter from the airplane's previous engine and installing it on the newly-overhauled engine in the airplane. The owner stated that he could not recall the procedures that he used to install the adapter on the accident engine, but he thought he would have looked at the manufacturer's instructions.

The maintenance records indicated that after engine installation, the engine's oil filter was changed seven times, all of which were performed by the owner

Oil Filter Adapter Examination

Following the accident, testing was performed to try to induce failure of an exemplar fiber gasket in a manner similar to the accident adapter. When the adapter hub was not torqued to the required 65 ft/lbs, the housing could be moved about the shaft with minimum force and oil was observed leaking from the area where the adapter housing meets the engine case while the engine was running.

During installation of the oil filter adapters, investigators had difficulty keeping the housing from rotating while torqueing the hub. On some of the installations, when the adapter was torqued to 65 ft/lbs, the housing could still be rotated about the hub when hand pressure was applied. When the adapter was properly torqued and the adapter housing was rotated by force, the rotation would result in a crescent impression in the gasket's outer material, similar to the accident gasket. Less force was required to leave the crescent impression if there was oil on the fiber gasket. However, despite creating various imperfections on both new and used gaskets and using a variety of installation methods and torque values, investigators were unable to duplicate the fiber gasket blowout that was seen in the accident oil filter adapter.

STC Holders' Installation Instructions

The complete certification package for the STC could not be found by the FAA Aircraft Certification Office (ACO) responsible for its oversight. According to records provided by Status Tool Technologies, at the time the accident engine was installed in February 2017, the Instructions for Continued Airworthiness (ICAW) for the oil filter adapter assembly had last been published in October 2013. The ICAW stated, in part, "New gaskets are to be installed anytime the oil filter adapter assy is removed and re-installed," and to "Replace gaskets at 300 hours or 3 yrs whichever occurs first." It further stated to "Refer to F&M Installation Instructions for gasket P/Ns." At the time of the accident, the fiber gasket had accumulated 41.9 hours beyond the 300-hour replacement recommendation.

In April 2017, a revised oil filter adapter installation manual was released and contained a note stating, "The oil filter adapter transfer cylinder must be re-tightened to 65 foot pounds of torque between 8 and 12 hours of operation after installation or any time the adapter is removed and reinstalled." Another note stated that the mechanic must include the following statement in the Form 337 (in pertinent part): "If the oil filter adapter is loosened, or removed from the engine for any reason, it must be re-installed using new gaskets, tightened in accordance with these installation instructions and properly safety-wired."

Also in April 2017, Stratus Tool Technologies issued a ICAW which gave instructions that at each oil change and each 100-hour or annual inspection, the mechanic should "inspect the oil filter adapter for oil

seepage," and "if oil seepage is detected, replace the fiber and copper gaskets on the transfer cylinder with new gaskets." It stated that the "use of a torque wrench is mandatory when installing or reinstalling the filter adapter," and to "safety-wire the transfer cylinder to an appropriate safety-wire location on the engine accessory case." Following that maintenance, the mechanic should "run the engine and check for oil leaks." An additional instruction stated that a mechanic should "Check and verify that the body does not move (rotate around the transfer cylinder) when 10 to 20 pounds of force is applied to the body in a manner that would tend to rotate it around the transfer cylinder," and "if the body rotates around the transfer cylinder, remove the safety-wire and tighten the adapter." The instructions further stated to "always install new fiber and copper (where used) gaskets each time the filter adapter is removed and reinstalled on the engine."

WRECKAGE AND IMPACT INFORMATION

The accident site was located in a marshy field about 37.5 nautical miles from the departure airport. The wreckage was found distributed 565-ft distance along a magnetic bearing of about 230°. Power lines, which comprised two parallel wires about 20 ft tall, stretched across the field oriented east west.

The first identified pieces of debris were pieces of the fairing from the left-wing strut located about 40 and 70 ft from the power lines. The towers supporting the lines were about 375 ft apart (see Figure 3). The first identified points of ground contact were two nearly parallel indentations in the vegetation and dirt spaced about 6 ft apart on the far northeastern end of the debris field. There were deep craters after the indentations and disrupted grass that continued southwest toward the main wreckage. The craters corresponded in size and orientation to that of the vertical stabilizer and rudder, consistent with the airplane impacting terrain inverted.

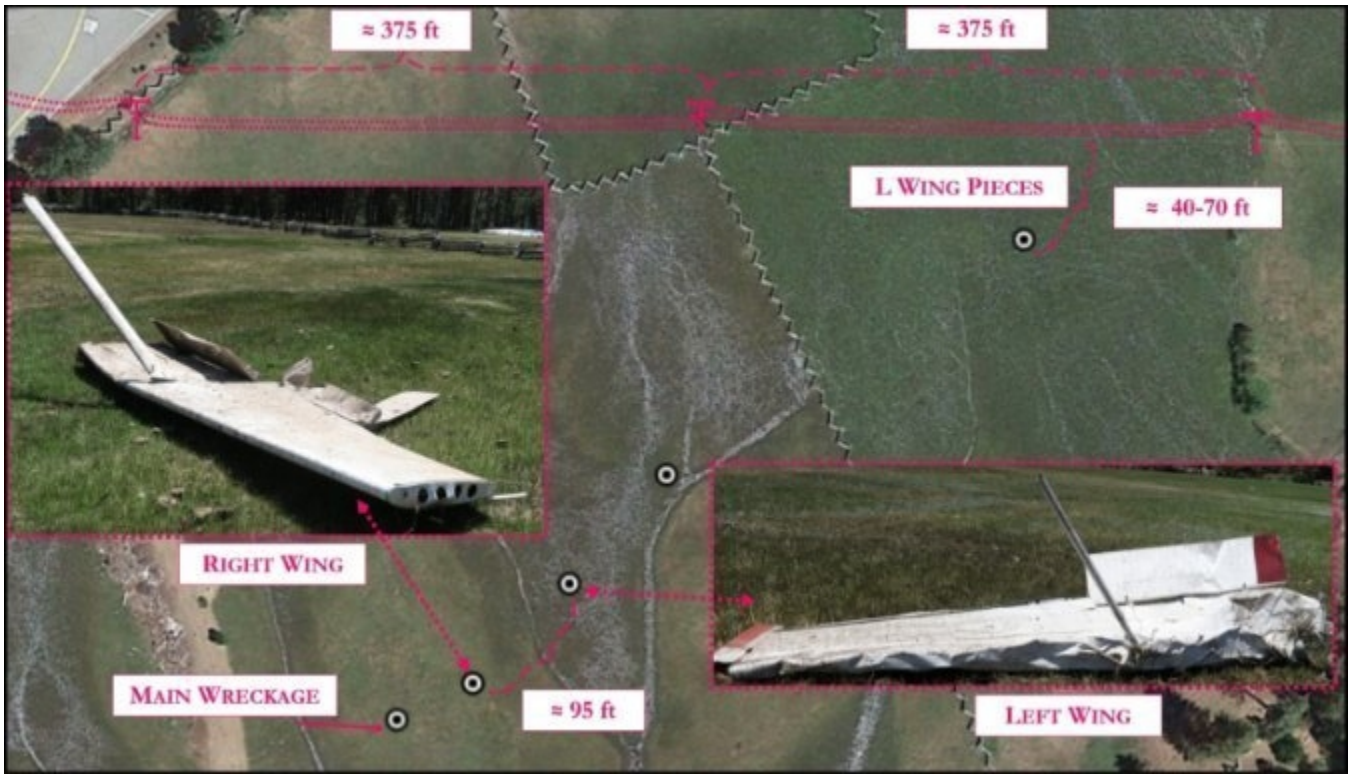

Figure 3. Accident Location Showing Debris Field

The fuselage came to rest inverted. A 2.5-ft portion of the left-wing strut remained attached to the fuselage. The cabin doors had been removed by first responders. There was an oil sheen on the entire belly of the fuselage, the lower surface of the horizontal stabilizer, and the elevator control surfaces. The lower left cowling contained a rub mark consistent with contact with a wire.

The left-wing aileron and flap remained attached at their respective attachment points. The leading edge exhibited crush damage along its entire length, with the inboard section crushed significantly farther aft. The upper 5 ft of wing strut remained attached to the wing. The leading edge of the wing strut exhibited numerous rub marks and small holes consistent with electrical arcing. The area where the separation of the strut occurred contained a small metal wire in the fracture surface that was consistent with having been sliced. The crush damage to the inboard portion of the wing had damaged the bladder of the fuel tank. The right-wing flap remained attached at its hinges. The aileron had folded on itself and only remained attached to the inboard attach points. The right-wing bladder tank contained a liquid consistent in odor and appearance with 100 low-lead aviation fuel. A measurement of the flap actuator extension was consistent with the flaps extended about 20° at the time of impact.

An external visual examination of the engine revealed oil staining on the firewall. There was a hole in the bottom of the crankcase adjacent to the No. 3 cylinder, and the corresponding push rods were loose. There was also a hole in the upper crankcase near the No. 4 cylinder. The internal engine components were examined using a lighted borescope through the hole in the crankcase. The oil sump contained a small amount of visible oil and numerous pieces of metal debris, including pieces of pistons and connecting rods.

The upper spark plugs were light gray in color, with the No. 3 plug face slightly darker gray. According to the Champion Aviation Check-A-Plug AV-27 Chart, the observed spark plug features corresponded to normal engine operation. Borescope examination of the cylinders revealed no foreign object damage, no evidence of detonation, and no indication of excessive oil consumption. The No. 4 cylinder could not be internally examined due to the position of its piston. The carburetor was disassembled, revealing intact plastic floats and liquid resembling 100 low-lead aviation fuel in the bowl. The oil filter adapter was found loose at the accident site and the area adjacent to the filter's adapter was wet with oil.

Additional examination revealed that the oil filter adapter was loose, and the adapter housing could be rotated about the shaft (see Figure 4). The safety wire was removed and the breakaway torque of the adapter, which was required to be 65 foot-pounds (ft/lbs), was less than 20 ft/lbs and the housing could be rotated by hand with minimal effort.

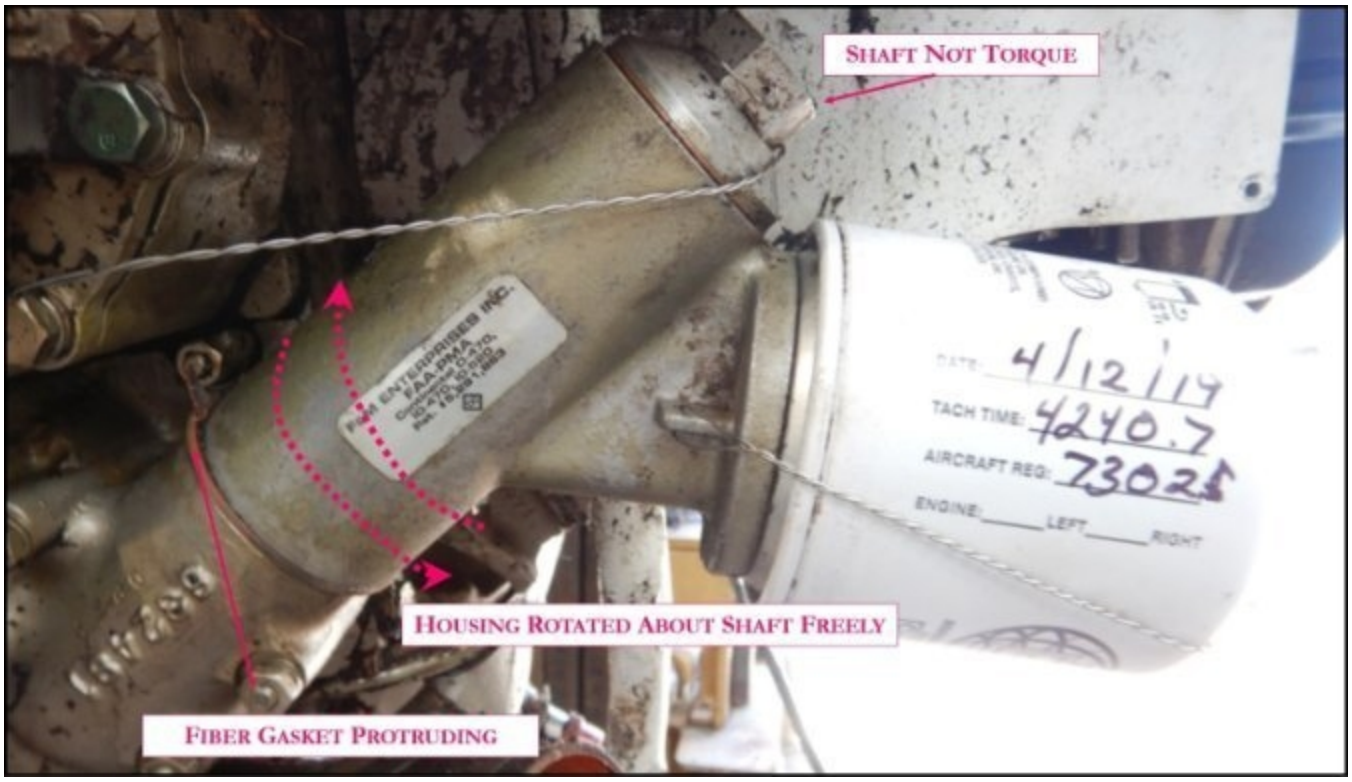

Figure 4. Oil Filter Housing Movement

The fiber gasket, located between the oil pump casting and the adapter housing, was protruding with the outside edge extending beyond the castings (see Figure 5). Additionally, a tear could be seen in the gasket where the adapter housing abutted the engine case. Removal of the adapter revealed that the fiber gasket was completely split. The copper crush gasket was intact.

Figure 5. Fiber Gasket

ADDITIONAL INFORMATION

In response to this accident and related testing, Stratus Tool Technologies issued a Service Bulletin (SB), SB-001, dated October 25, 2019, that stated that the oil filter adapter should be inspected for oil leakage and gasket damage. If no discrepancies were found, the SB provided detailed instructions of how to install the adapter properly (eliminating rotation of the housing by use of a wood block) and how to mark the adapter to provide a visual indication of rotation after it is installed.

A review of the National Transportation Safety Board accident/incident database revealed at least six previous accidents involving an oil starvation event involving an F&M Enterprises Inc./Stratus Tool Technologies oil filter adapter due to either the failure of the gasket and/or having improper gaskets.

According to an Atlanta ACO representative, using the FAA's Monitor Safety/Analyze Data (MSAD) process, the ACO performed a risk assessment following the Small Airplane Risk Analysis (SARA) guidelines and found that the issue did not warrant mandatory regulatory action. The ACO did initiate an activity with the FAA FSDO to issue a Safety Alert for Operators (SAFO) to address the issue, advising operators and maintainers of the potential unsafe condition associated with the oil adapters. At the time of this report, the SAFO has not been published.

Pilot Information

Certificate:	Commercial; Flight instructor	**Age:**	69,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	3-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine	**Toxicology Performed:**	No
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	March 16, 2017
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:	(Estimated) 2500 hours (Total, all aircraft), 75 hours (Total, this make and model), 1850 hours (Pilot In Command, all aircraft), 20 hours (Last 90 days, all aircraft), 5 hours (Last 30 days, all aircraft), 1 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Cessna	**Registration:**	N7302S
Model/Series:	182 P	**Aircraft Category:**	Airplane
Year of Manufacture:	1976	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	18265095
Landing Gear Type:	Tricycle	**Seats:**	4
Date/Type of Last Inspection:	April 26, 2019 Annual	**Certified Max Gross Wt.:**	2348 lbs
Time Since Last Inspection:	9 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	4240.7 Hrs as of last inspection	**Engine Manufacturer:**	Continental
ELT:	C91 installed, activated, did not aid in locating accident	**Engine Model/Series:**	O-470-S (1)
Registered Owner:		**Rated Power:**	230 Horsepower
Operator:		**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KRDD,497 ft msl	**Distance from Accident Site:**	37 Nautical Miles
Observation Time:	10:53 Local	**Direction from Accident Site:**	285°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	6 knots /	**Turbulence Type Forecast/Actual:**	None / None
Wind Direction:		**Turbulence Severity Forecast/Actual:**	N/A / N/A
Altimeter Setting:	29.39 inches Hg	**Temperature/Dew Point:**	25°C / -3°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Chico, CA (CIC)	**Type of Flight Plan Filed:**	None
Destination:	Chico, CA (CIC)	**Type of Clearance:**	None
Departure Time:	10:10 Local	**Type of Airspace:**	

Wreckage and Impact Information

Crew Injuries:	1 Serious	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Fatal, 1 Serious	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Fatal, 2 Serious	**Latitude, Longitude:**	40.36,-121.510559

Administrative Information

Investigator In Charge (IIC):	Keliher, Zoe		
Additional Participating Persons:	Stanley Phillips; Federal Aviation Administration; Sacramento, CA Henry Soderlund; Textron Aviation (Cessna); Witchita, KS Michael Council; Continental Aerospace Technologies; Mobile, AL		
Original Publish Date:	December 3, 2020	**Investigation Class:**	3
Note:	The NTSB traveled to the scene of this accident.		
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=99352		

The National Transportation Safety Board (NTSB), established in 1967, is an independent federal agency mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The NTSB makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

The Independent Safety Board Act, as codified at 49 U.S.C. Section 1154(b), precludes the admission into evidence or use of any part of an NTSB report related to an incident or accident in a civil action for damages resulting from a matter mentioned in the report. A factual report that may be admissible under 49 U.S.C. § 1154(b) is available here.