



National Transportation Safety Board

Washington, DC 20594

Safety Recommendation Report

Stratus Oil Filter Adapter Assembly Oil Leaks

The National Transportation Safety Board (NTSB) is providing the following information to urge the Federal Aviation Administration (FAA) to take action on this safety recommendation. It is derived from both preliminary findings of ongoing investigations and our review of investigations and reports of airplane accidents in which the airplane was equipped with an oil filter adapter assembly installed under a supplemental type certificate (STC). In each of these accidents, oil leaked from the assembly, resulting in oil starvation to the engine and a subsequent total loss of engine power. Although the cause of the leaks cannot be definitively determined, our investigations suggest that it could be attributed to the installation or maintenance of the oil filter adapter assembly. The NTSB is issuing one safety recommendation to the FAA.

Background

On May 1, 2019, a Cessna 182 airplane experienced a total loss of engine power; during the emergency landing, the airplane collided with a power line near Mill Creek, California.¹ One passenger was fatally injured, and the pilot and other passenger were seriously injured. Investigators noted an oil sheen on the belly of the fuselage and lower surface of the horizontal stabilizer and elevator control surfaces. A postaccident examination of the airplane revealed that a fiber gasket between the airplane's engine oil pump assembly and the F&M Enterprises Inc. (F&M) oil filter adapter was torn and had a crescent mark, and oil had leaked from the broken gasket seal; the oil leak led to the loss of engine power. About a month later, on June 10, 2019, a Cessna 210D airplane experienced a total loss of engine power and collided with terrain near Ramona, California.² Investigators noted an oil sheen on the belly of the fuselage, and a postaccident examination found that the fiber gasket between the engine oil pump assembly and the F&M oil filter adapter had a crescent mark and was torn and oil had leaked from that area, similar to the earlier accident.

Oil Filter Adapter Design, Manufacture, and Function

F&M originally designed and manufactured the oil filter adapter, and the FAA issued the original STC for the oil filter adapter to F&M in 1996.³ According to the FAA, an STC is "a type certificate (TC) issued when an applicant has received FAA approval to modify an aeronautical product from its original design. The STC, which incorporates by reference the related TC,

¹ More information about this accident, NTSB case number WPR19FA126, is available from the NTSB's [Aviation Accident Database web page](#). See appendix 1 for more information about the accidents referenced in this report.

² More information about this accident, NTSB case number WPR19LA166, is available from the NTSB's [Aviation Accident Database web page](#).

³ The FAA reissued the STC in 1997, 1998, and 2015.

approves not only the modification but also how that modification affects the original design.”⁴ Stratus Tool Technologies (Stratus), the current STC holder and manufacturer, bought the STC from F&M in 2015 and last amended the STC in 2017. In addition, F&M held a parts manufacturer approval (PMA) for the oil filter adapter; a PMA is an approval granted by the FAA to a manufacturer to make replacement parts for aircraft, even though the PMA holder may not have been the original manufacturer of an aircraft.

The adapters can be used on various models of airframes and engines (see table below); however, the exact number of adapters sold by F&M and Stratus is unknown.

Table. Models of aircraft and engines that are compatible with Stratus oil filter adapters.

Oil Filter Adapter Models (STC Numbers)	CO-300 (SE8409SW)	C6LC-L (SE09356SC)	C6LC-S (SE09356SC)	C6SC (SE8409SW)	C6LC-11/15 (SE10348SC)
Aircraft	Beechcraft Bonanza Beechcraft Debonair Cessna 170, 172 Globe Swift Maule	Beechcraft Bonanza Beechcraft Debonair Cessna 205, 206, 207, 210, 310 Grumman Wideon Meyers Navion Twin Commander	Beechcraft Bonanza Beach Baron (Model 55) Beechcraft Debonair Cessna 180, 182, 185, 188	Cessna 172 Hawk XP, 175, 336, 337 Maule Mooney M20-K Piper Seneca II Piper Turbo Arrow III & IV	Cessna L-19 Bird Dog
Continental Motors, Inc. Engine Models	C-125 Series C-145 Series O-300 Series	O-470 Series (Sand Cast Crankcase Only) IO-470 Series IO-520 Series IO-550 Series TSIO-520 Series	O-470 Series (Sand Cast Crankcase Only) IO-470 Series IO-520 Series IO-550 Series TSIO-520 Series	GO-300 Series IO-360 Series TSIO-360 Series	O-470-11 O-470-15

The engine oil filter adapter installed on each of these accident airplanes enabled the Continental Motors, Inc., engine to use a conventional spin-on oil filter rather than the manufacturer’s brass oil screen. The oil filter adapter was attached to the engine using the oil screen bore. Two gaskets were used in the oil filter adapter assembly kit: a fiber gasket located between the oil pump bore and the oil filter adapter and a copper crush gasket located between the oil filter adapter and the bolt used to secure the adapter housing to the oil pump bore (see figure 1). The fiber gasket’s purpose was to create a seal between the oil pump and oil filter adapter, and the copper gasket’s purpose was to create a seal at the top of the oil filter adapter housing.

⁴ https://www.faa.gov/aircraft/air_cert/design_approvals/stc/. Accessed August 26, 2020.

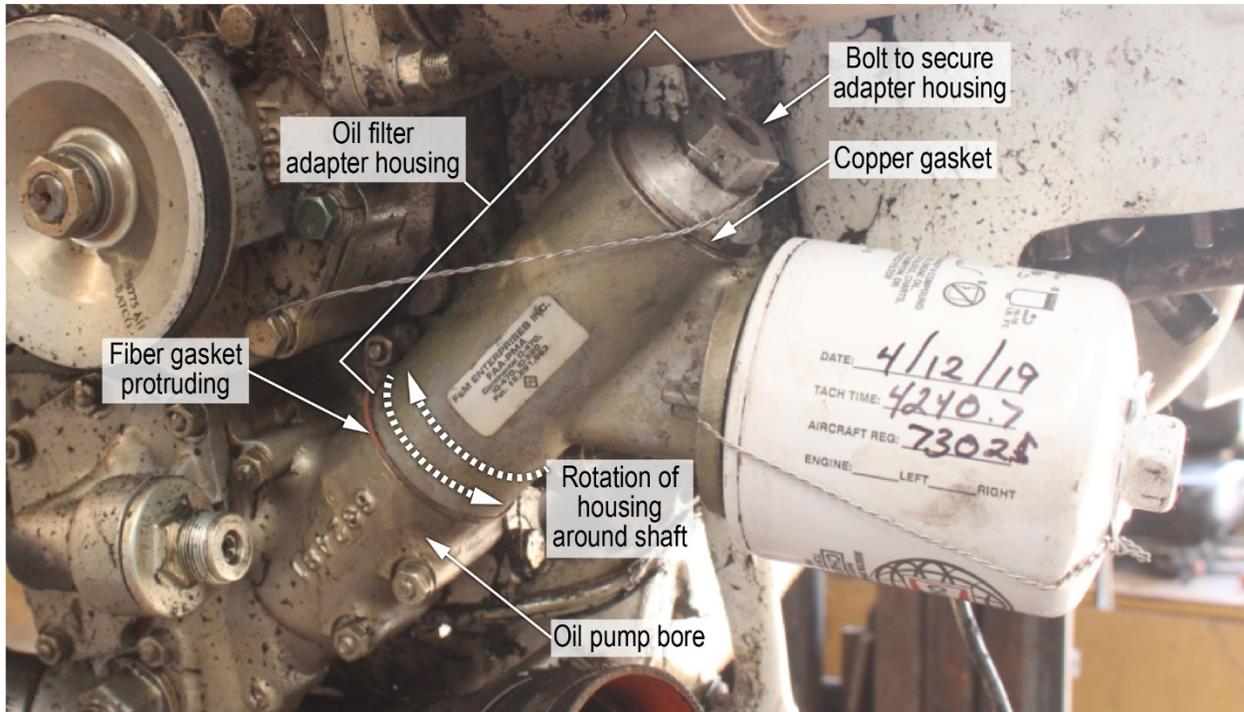


Figure 1. Mill Creek accident oil filter adapter attached to the engine.

Gaskets rely on both friction and even compressive force (also called seating stress) to create a seal between mating surfaces. One of the signatures of uneven gasket compression is uneven impression marks around the gasket; if the gasket is not positioned flat during installation (for example, the housing is torqued while the gasket is canted), uneven compression could occur or the gasket material could be torn.

The oil filter adapter gasket installation instructions and instructions for continued airworthiness (ICA) have changed since its first iteration in 2007. The F&M installation instructions issued in 2007 included directions to retorque the oil filter adapter to 65 pound-foot (lbf-ft) after 10 hours of flight; in 2017, Stratus modified the time period of those instructions to retorque after 8 to 12 hours. In May 2011, F&M modified the installation instructions to specify that the oil filter adapter must be installed using new gaskets. In October 2013, F&M added a new section on gaskets to its ICA that directed the installation of new gaskets anytime the oil filter adapter is removed and re-installed, and the replacement of gaskets at 300 hours or 3 years whichever occurs first. More recent installation instructions have removed that requirement and instead specify, “There are no mandatory replacement times for any components.” In addition, the original oil filter adapter kits included two copper crush gaskets but later versions included one copper crush gasket and one fiber gasket; it is unknown when fiber gaskets were first included in the installation kits.

Other Accidents and Service Bulletin

Postaccident examinations of the oil filter adapters on the Ramona and Mill Creek accident airplanes revealed a crescent indentation in the fiber gasket material. Further, investigators found that the housing for both accident airplanes’ oil filter adapter rotated freely around the shaft and the fiber gasket protruded from the interface between the oil pump bore and adapter. Postaccident

examinations of the accident adapters from the Ramona and Mill Creek accidents revealed that the torque was 9 lbf-ft and less than 20 lbf-ft, respectively. However, investigators were not able to determine the root cause of these irregularities.

A review of NTSB accidents and incidents showed that the two oil filter adapter leaks and gasket ruptures cited above were not isolated events.⁵ Figure 2 shows the torn fiber gaskets and crescent marks from the two accidents described above and from a June 25, 2010, accident that occurred following an oil leak, a total loss of engine power, and a forced landing near Babylon, New York.⁶ In addition, at least 10 other accidents or incidents occurred in which the airplane was equipped with an F&M or Stratus oil filter adapter and had a loss of engine power following an oil leak; 5 of those included evidence of torn fiber gaskets and crescent marks and 4 of those had loose adapters. Some of the issues identified in those accidents and incidents included misalignment of the gasket and adapter, use of a copper gasket instead of a fiber gasket, undertorqued oil filter adapters, missed or undocumented adapter retorques, and gaskets that had not been recently replaced.

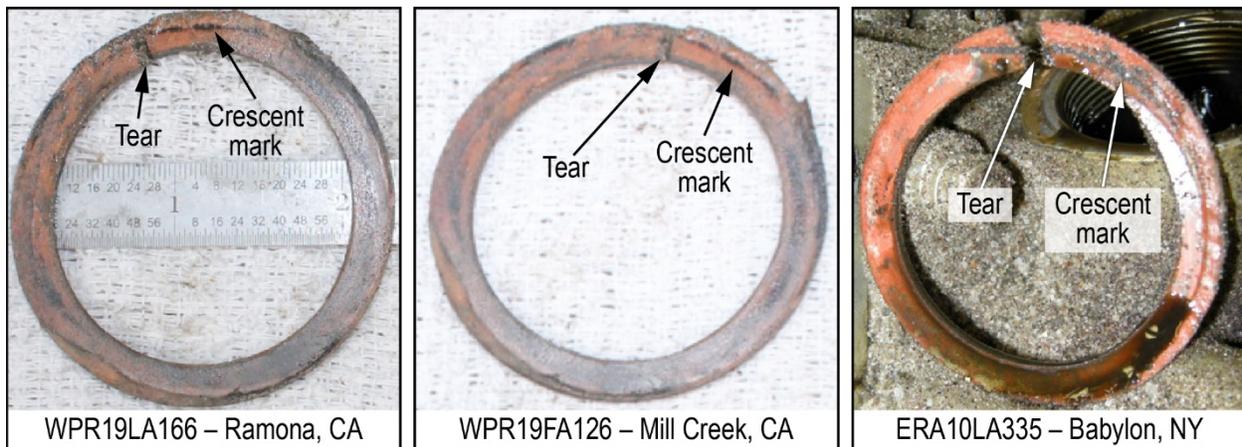


Figure 2. Torn gaskets with crescent marks from three different accidents.

In response to the findings of the ongoing investigations and other reports of oil leaks, on October 25, 2019, Stratus issued a mandatory service bulletin (SB), SB-001, to the owners of affected aircraft. Stratus' SB instructs mechanics to inspect the adapter for leaks, gasket damage or protrusion, and movement of the assembly; reinstall the oil filter adapter, if necessary; tighten the cylinder torque to 65 lbf-ft; and install safety wire. The SB instructs owners to inspect oil adapters before the next flight, every time the oil is changed, each 100-hour or annual inspection, and whenever the adapter is removed and installed. The SB also instructs mechanics to make an index mark on the adapter housing and the oil pump bore and calls for a wooden block to be placed behind the adapter to ensure that the adapter housing does not rotate while increasing the torque. The FAA has not issued an airworthiness directive (AD) mandating compliance with Stratus SB-001.

⁵ See appendix 1 for more information about the accidents referenced in this report, including the type of gaskets used on the accident airplanes, damage to the gasket, and whether the gasket was overdue to be replaced.

⁶ More information about this accident, NTSB case number ERA10LA335, is available from the NTSB's [Aviation Accident Database web page](#).

Analysis

Stratus' mandatory SB provides timely instructions on inspecting then retorquing or reinstalling its oil filter adapters; these actions could prevent oil loss and a subsequent engine failure resulting from misaligned gaskets, rotated housing, or improper torque. However, an SB is not mandatory for Part 91 operators. In June 2019, the FAA told the NTSB that they were working on a Safety Alert for Operators (SAFO) regarding the installation of oil filter adapter assemblies. However, as of November 2020, the FAA has not issued such a SAFO and has not otherwise alerted operators and mechanics of the issues associated with leaking Stratus oil filter adapter assemblies.

Although a SAFO that directs operators to inspect, correctly install, and maintain oil filter adapters would provide this important information to operators of airplanes with these oil filter adapters, compliance with a SAFO is not required. The NTSB therefore determines that because owners who operate airplanes under Part 91 are not required to comply with an SB or SAFO, Stratus' SB-001 and the FAA's proposed SAFO may be insufficient to address all affected airplanes, which could result in a gasket rupture, oil starvation, and a subsequent engine failure.

Accidents involving these oil filter adapter assemblies have occurred with different gasket materials, existing and recently replaced gaskets, and undertorqued or loose assemblies. There are currently no mandatory replacement times for any of their components and the exact number of adapters sold is unknown. ADs are issued to correct an unsafe condition. While an engine failure itself may not cause an accident, it can lead to circumstances in which an accident occurs if the pilot is unable to reach a safe emergency landing area; accidents stemming from a Stratus or F&M oil filter adapter have led to three fatalities. Therefore, the NTSB recommends that the FAA issue an AD to address the unsafe conditions of F&M or Stratus oil filter adapters that have led to oil starvation and loss of engine power by requiring owners of airplanes equipped with the adapters to repetitively inspect and, if necessary, reinstall the adapters in compliance with Stratus' SB-001.

Recommendation(s)

To the Federal Aviation Administration

Issue an Airworthiness Directive to address the unsafe conditions of F&M Enterprises Inc. or Stratus Tool Technologies (Stratus) oil filter adapters that have led to oil starvation and loss of engine power by requiring owners of airplanes equipped with the adapters to repetitively inspect and, if necessary, reinstall the adapters in compliance with Stratus' service bulletin SB-001. (A-20-39)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

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Report Date: November 30, 2020

Appendix

NTSB Accidents Involving a Stratus Tool Technologies Oil Filter Adapter (2004 to 2019)¹

Accident	Date	Relevant Accident Details	Fatalities and Serious Injuries
Wiscasset, Maine (NYC04LA210).	9/12/2004	-	None
Show Low, Arizona (WPR09LA422).	8/27/2009	Mechanic could not produce evidence that adapter was retorqued after 10 hours as required.	None
Babylon, New York (ERA10LA335)	6/25/2010	Copper crush gasket not crushed; torn fiber gasket with crescent mark.	None
Stotts City, Missouri (CEN13FA044).	11/4/2012	Not safety wired; adapter was loose; two copper gaskets used.	Two fatalities
La Grange, Texas (CEN13LA056).	11/9/2012	Fiber gasket misaligned. Adapter was improperly installed; torn fiber gasket with crescent mark.	None
Monroe, Georgia (ERA14LA436).	9/13/2014	No record of installation; 2 copper gaskets used. Adapter was loose.	Two serious injuries
Atlantic Ocean (ERA16LA158).	4/15/2016	-	None
Westerly, Rhode Island (ERA16LA217).	6/18/2016	Adapter was loose; torn fiber gasket with crescent mark.	None
Opelika, Alabama (ERA19LA017).	10/16/2018	Adapter was loose.	One serious injury
Mill Creek, California (WPR19FA126).	5/1/2019	Adapter was loose; torn fiber gasket with crescent mark.	One fatality Two serious injuries
Ramona, California (WPR19LA166).	6/10/2019	Adapter was loose; torn fiber gasket with crescent mark.	None

Aviation Safety Reporting System Incidents Involving a Stratus Tool Technologies Oil Filter Adapter (2019)²

Incident Number	Date	Relevant Accident Details
1665186	7/2019	-
1678358	8/2019	Torn fiber gasket.

¹ More information about the accidents in this table is available from the NTSB's [Aviation Accident Database webpage](#).

² More information about the incidents in this table is available from the [Aviation Safety Reporting System online database](#).