



Aviation Investigation Final Report

Location:	Show Low, Arizona	Accident Number:	WPR13LA043
Date & Time:	November 16, 2012, 07:26 Local	Registration:	N800RW
Aircraft:	Cirrus SR22	Aircraft Damage:	Substantial
Defining Event:	Powerplant sys/comp malf/fail	Injuries:	1 Minor
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

While the airplane was in a cruise climb from 12,000 to 14,000 ft mean sea level, the pilot/owner of the airplane heard a loud "pop," and, about 4 minutes later, he observed an oil pressure annunciation on the primary flight display. Within 1 minute, the pilot saw that the engine had completely lost oil pressure, so he shut down the engine and advised an air traffic controller of the situation. He then asked for and received vectors to the nearest airport, but, during the descent, he recognized that the airplane would be unable to reach the airport. Shortly thereafter, he advised the controller that he would deploy the airplane's ballistic parachute when the airplane was over suitable terrain. After the pilot deployed the parachute, the airplane impacted a field and came to rest upright.

Postaccident examination of the airplane revealed that a nipple in the flexible oil line used to provide engine oil to an aftermarket engine supercharger had failed due to fatigue, which resulted in a complete loss of engine oil. The fatigue crack had multiple initiation sites that were not the result of any manufacturing or material defects. Evidence indicates that a washer was present on the nipple threads between the nipple and the oil nozzle at one time. The washer initially prevented proper thread engagement and sealing of the joint between the nipple and the nozzle. To seal the joint, the nipple was then overtorqued, which resulted in the fatigue crack initiation. Engine vibration caused the flexible oil line to impose cyclic loads on the nipple, which, over time, failed due to fatigue.

Although the supercharger installation was approved under a Federal Aviation Administration supplemental type certificate (STC), the installation was not in accordance with the STC installation and maintenance instructions or standard maintenance practices. Although review of the supercharger STC installation and maintenance instructions revealed that they did not contain detailed information for installing the oil nozzle or nipple, the lack of this information did not appear to directly contribute to the improper installation of the supercharger on the accident airplane. It could not be determined when or by whom the improper installation was accomplished.

Probable Cause and Findings

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

The fatigue failure of an improperly installed nipple in the oil system of a supplemental type certificate-installed supercharger, which resulted in a complete loss of engine oil during cruise climb.

Findings

Personnel issues	Incorrect action selection - Maintenance personnel
Aircraft	Recip eng supercharger - Incorrect service/maintenance
Aircraft	(general) - Incorrect service/maintenance
Aircraft	Hoses and tubes - Incorrect service/maintenance
Aircraft	Recip eng oil sys - Failure
Aircraft	(general) - Related maintenance info
Aircraft	Oil - Fluid level

Factual Information

History of Flight

Prior to flight	Aircraft maintenance event
Enroute-change of cruise level	Powerplant sys/comp malf/fail (Defining event)
Enroute-change of cruise level	Engine shutdown
Enroute-change of cruise level	Loss of engine power (total)
Enroute-change of cruise level	Off-field or emergency landing

HISTORY OF FLIGHT

On November 16, 2012, about 0726 mountain standard time, a Cirrus Aircraft SR22, N800RW, was substantially damaged when the airplane descended to the ground under parachute near Show Low, Arizona, after the engine experienced a complete loss of oil pressure during cruise flight. The pilot/owner received minor injuries. The personal flight was conducted under the provisions of Title 14 Code of Federal Regulations Part 91. Visual meteorological conditions prevailed, and the flight was operating on a Federal Aviation Administration (FAA) instrument flight rules (IFR) flight plan.

According to the pilot, he departed Animas Airpark (00C), Durango, Colorado, about 0600, with an intended destination of Nogales International Airport (OLS), Nogales, Arizona. About 2 hours after takeoff, while in cruise flight at 12,000 feet above mean sea level, air traffic control (ATC) cleared the flight to 14,000 feet for terrain clearance purposes. Just before the airplane reached the new assigned altitude, the pilot heard a loud "pop." About 4 minutes later, he received an oil pressure annunciation on the primary flight display. At that time, the indicated oil pressure was about 47 pounds per square inch (psi), which was at the bottom of the normal range. Within 1 minute the pilot saw the oil pressure had decreased to 0 psi, so he shut down the engine, and advised ATC. He asked for vectors to the nearest airport, was advised that Show Low Regional Airport (SOW), Show Low, was the closest, and then turned towards SOW. During the descent, about the same time that ATC advised him that radar contact had been lost, the pilot recognized that he would be unable to reach SOW. He then advised ATC that he would deploy the ballistic parachute when he was over terrain that appeared suitable for a parachute landing. The pilot estimated that he deployed the parachute between 1,000 and 2,000 feet above ground level. The airplane impacted in a field while it was swinging towards the left under the parachute, bounced at least one time, and came to rest upright. The pilot shut down the airplane and exited. He contacted assistance via his satellite telephone. The pilot and airplane were located about 2 hours after the landing, aided by his re-inflation of the parachute and use of his personal mobile (not satellite) telephone.

PERSONNEL INFORMATION

The pilot held a private pilot certificate with airplane single- and multi-engine, and instrument airplane ratings. He had approximately 1,661 total hours of flight experience, including approximately 1,140 hours in the accident airplane make and model. His most recent flight review was completed in December 2011, and his most recent FAA third-class medical certificate was issued in January 2011.

AIRCRAFT INFORMATION

FAA records indicated that the airplane was manufactured in 2005, and was purchased new by the pilot. The airplane was equipped with the standard Cirrus Airframe Parachute System (CAPS) and a Continental Motors IO-550 series engine. In February 2009 a Forced Aeromotive Technologies (FAT) supercharger was installed in accordance with supplemental type certificate (STC) SA10925SC.

The most recent annual inspection was completed in July 2012, and the airplane had accumulated about 60 hours in service since that inspection. At the time of the accident, the airplane and engine each had a total time (TT) in service of about 1,150 hours.

METEOROLOGICAL INFORMATION

The 0735 automated weather observation at SOW, located about 8 miles north of the landing site, included calm winds, visibility 10 miles, clear skies, temperature 1 degree C, dew point -5 degrees C, and an altimeter setting of 30.25 inches of mercury.

WRECKAGE AND IMPACT INFORMATION

The landing site was in remote territory. According to the pilot, after he exited the airplane, he photo-documented the scene. The right main landing gear was fracture-separated from the airplane, and the nose and left main landing gear remained attached but were displaced up and right. Propeller damage was minor, consistent with it not rotating during the impact sequence. The airplane was otherwise intact, except for the normal disruptions caused by the parachute deployment. Shortly after the pilot documented the scene, the wind inflated the parachute, and dragged the airplane about 100 feet across the terrain. The pilot left the scene to obtain assistance, and on his return with first responders, discovered that the airplane had then been dragged further by the parachute, and had been inverted, before the parachute deflated and ceased dragging the airplane. The responding law enforcement agency personnel cut the parachute bridle straps to prevent further movement of the airplane. FAA personnel responded to the scene, but NTSB personnel did not.

The responding FAA inspectors reported that the exterior surfaces of the left side and aft lower fuselage exhibited significant oil streaking. While the airplane was still inverted, the inspectors decowled the engine, and observed a significant amount of engine oil had been deposited inside the cowling and engine compartment. They observed that the oil line that supplied engine oil to the supercharger bearing for lubrication had fracture-separated from the supercharger at the nipple fitting. FAA personnel removed several avionics units for possible data download by the NTSB recorders laboratory. The airplane was recovered and transported to a secure location for detailed examination. The downloaded data corroborated the information provided by the pilot.

ADDITIONAL INFORMATION

Supercharger Design and Installation Information

The supercharger was mounted to the aft section of the engine, and was driven via a belt by a pulley mounted to an engine accessory drive. The supercharger bearings were lubricated by pressurized engine oil, which was sprayed into the supercharger via a nozzle. The nozzle connected to the engine oil system via a series of fittings and a flexible hose. The nozzle was provided as part of the STC, and threaded directly into the supercharger body. A standard AN816-6-2D aluminum nipple fitting installed into the nozzle, and an MS27226 fitting with a B-nut was used to attach the flexible oil line to the nipple.

According to the STC holder, in order to attain a leak-proof joint from the oil line to the supercharger without damaging the supercharger, nozzle, or AN816 nipple, two wrenches had to be used concurrently to properly attach and secure the oil line to the supercharger. This requirement was explicitly specified in the supercharger installation instructions. However, those instructions did not specify the installation torque values for any of those components.

The STC instructions for continued airworthiness (ICA) required that the oil nozzle be removed and cleaned in conjunction with every annual inspection. However, the ICA did not contain any information regarding the need to use two wrenches, and did not specify the installation torque values for the nozzle, AN816 nipple, or oil line B-nut fitting.

Review of the STC installation and ICA documentation that was current at the time of the accident revealed that neither document set contained any guidance regarding the use of sealant for the nozzle, nipple, or oil line B-nut.

Supercharger Maintenance Information

The supercharger was installed when the airplane had a TT of 674 hours. According to the maintenance records, a new supercharger "drive seal" was installed, and the oil nozzle was "cleaned, resealed, and torqued" by Arapahoe Aero on 7/11/12. That activity was accomplished in conjunction with the airplane's most recent annual inspection. At that time, the airplane had a TT of about 1,090 hours.

The most recent recorded maintenance regarding or affecting the supercharger was conducted by an aircraft mechanic on 10/03/2012. That mechanic was not associated with Arapahoe Aero. The maintenance records entry cited the removal and reinstallation of the "Forced Airmotive compressor after factory repair." At that time, the airplane had a TT of about 1,125 hours, which was about 451 hours since the initial installation of the supercharger.

According to the mechanic who conducted that activity, he had removed and reinstalled FAT superchargers four or five times previously. He had worked with FAT maintenance personnel several times on the accident airplane, and had received guidance from FAT for performing supercharger removal & installation. The mechanic was aware of the need to use two wrenches while tightening the oil line (a flexible hose) fitting to the nozzle.

The mechanic also stated that he had not been involved in annual inspections of the accident airplane subsequent to the supercharger installation, and had not ever performed the repetitive nozzle cleaning required during an annual inspection. Regarding his actions to remove the supercharger, the mechanic stated that he removed the oil line B-nut from the AN816 nipple that was installed in the oil nozzle. He reported that the nipple fitting and oil nozzle stayed in the compressor when it was sent to FAT for repair, and that the repaired supercharger was provided to him with the oil nozzle already installed in the supercharger. He stated that when he reinstalled the oil line B-nut onto the nipple, he used a wrench to

hold the oil nozzle in place, and another to secure and torque the joint. The mechanic also stated that he did not apply any sealant or RTV(room temperature vulcanization) silicone to the oil nozzle or the nipple.

The AN816-6-2D nipple that connected the flexible oil line to the supercharger nozzle was aluminum, and consisted of two male ends with different, incompatible thread types. The end that threaded into the oil nozzle was a tapered pipe thread, while the end that threaded into the oil line was non-tapered. Examination revealed that the nipple had fractured on the section that threaded into the nozzle, and that a fractured section of the nipple remained threaded into the nozzle.

The NTSB Materials Laboratory determined the fracture to be fatigue "that developed at multiple initiation sites at a thread root valley. No material or mechanical defects were identified at the crack initiation sites that may have led to premature failure. The fatigue crack progressed through approximately 95% of the fitting cross section before the remaining material separated by ductile overstress. The large area of the fracture surface exhibiting fine fatigue striations suggests low applied stress on the fitting during crack propagation."

Computer tomography (CT) X-ray scans of the oil nozzle with the fracture-separated end of the AN816 nipple still installed were conducted in order to determine the nipple thread engagement quality and depth, as well as detect any possible material or installation anomalies. The CT scans revealed that the nipple end was variously engaged between 3 and 4 threads into the oil nozzle fitting, that the fracture initiation points were generally in the nipple thread valleys (as also observed by the NTSB Materials laboratory examination), and that the nipple fracture face varied between 0.3mm (0.012 inches) 'above' to about 0.6 mm (0.024 inches) 'below' the manufactured face of the oil nozzle. No anomalies were observed with the thread engagement of the nipple into the nozzle, and no material anomalies were observed.

Remnants of thread sealant or thread-locking material were observed at the interface of the fractured AN816 nipple segment that remained in the oil nozzle, and the oil nozzle. The material was hard, brittle, light yellow in color, and its exposed surface was very rough. When queried about the material, the FAT representative stated that the material was "probably Loctite 567 which we use for thread sealant. When assembled a nice uniform bead is left between the male and female fitting. That bead hardens over time and if disturbed would not have a smooth appearance like the RTV on the other side. Something appears to have destroyed that bead."

Substantial remnants of red RTV silicone material were observed on the nozzle side of the segment of the fractured AN816 nipple that remained attached to the oil line. The material was distributed on the threads towards the nipple 'body' (wrench flat area), and terminated on its other end in a pattern that was consistent with it being mated up with, or applied to, a very flat and smooth surface, such as a washer. The absence of any RTV on the threaded portion beyond the 'flat/smooth' RTV terminus was also consistent with the presence of a washer on the AN816 threads at the time the RTV was applied. The distance from the AN816 fracture face to the flat portion of the RTV was greater than the distance from the fracture face of the nipple that remained in the nozzle to the nozzle face, which again was consistent with the presence of a washer at the time the RTV was applied. The flat/smooth RTV face was inconsistent with the very rough texture of the yellow sealant noted in the previous section, which again was consistent with the presence of an undetermined component (such as a washer) between the two.

As an additional avenue of investigation, three washers of the sequential manufactured internal diameters (ID) were attempted to be fitted onto the tapered threaded section of an exemplar AN816 nipple. The ID of an AN960-516 washer was too small to allow the washer to pass over the nipple threads. An AN960-616 washer was able to be positioned about 4 nipple threads 'up' (beyond the nipple end) with very light finger pressure. An AN960-617 washer was able to be positioned completely 'up' the threads, with significant freeplay remaining between the nipple threads and the washer ID.

No such washer was located in the wreckage, but its presence was not deduced, and no attempts to locate it were made, until after the wreckage had been examined at the recovery facility in Phoenix, Arizona. Between the loss of oil pressure in flight and the deduction of the presence of the washer, the airplane had flown several miles, descended under parachute, was dragged and inverted by the parachute after ground impact, was de-cowled in the field, was righted, partly disassembled, loaded onto and transported to Phoenix by truck, offloaded at the recovery facility, and then re-positioned for examination. Each of those events provided an opportunity for an undetected loss of the washer or any other very small unsecured items.

Neither the STC installation instructions nor the ICA called for any washer or other hardware to be installed over the AN816 threads. Neither the STC installation instructions, nor the ICA, specified the application of RTV or other sealant external to the joint subsequent to assembly, and no FAA or any other guidance recommends such a practice.

Pilot Information

Certificate:	Private	Age:	61
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:	No
Instructor Rating(s):	None	Toxicology Performed:	No
Medical Certification:	Class 3 With waivers/limitations	Last FAA Medical Exam:	January 5, 2011
Occupational Pilot:	No	Last Flight Review or Equivalent:	
Flight Time:	1661 hours (Total, all aircraft), 1140 hours (Total, this make and model), 38 hours (Last 90 days, all aircraft), 26 hours (Last 30 days, all aircraft), 0 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Cirrus	Registration:	N800RW
Model/Series:	SR22	Aircraft Category:	Airplane
Year of Manufacture:	2005	Amateur Built:	
Airworthiness Certificate:	Normal	Serial Number:	1266
Landing Gear Type:	Tricycle	Seats:	4
Date/Type of Last Inspection:	July 11, 2012 Annual	Certified Max Gross Wt.:	3400 lbs
Time Since Last Inspection:	60 Hrs	Engines:	1 Reciprocating
Airframe Total Time:	1150 Hrs at time of accident	Engine Manufacturer:	Continental Motors
ELT:	C126 installed, activated, did not aid in locating accident	Engine Model/Series:	IO-550
Registered Owner:	On file	Rated Power:	310 Horsepower
Operator:	On file	Operating Certificate(s) Held:	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	Condition of Light:	Day
Observation Facility, Elevation:	SOW,6350 ft msl	Distance from Accident Site:	8 Nautical Miles
Observation Time:	07:35 Local	Direction from Accident Site:	360°
Lowest Cloud Condition:	Clear	Visibility	10 miles
Lowest Ceiling:	None	Visibility (RVR):	
Wind Speed/Gusts:	/	Turbulence Type Forecast/Actual:	/
Wind Direction:		Turbulence Severity Forecast/Actual:	/
Altimeter Setting:	30.25 inches Hg	Temperature/Dew Point:	1°C / -5°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Durango, CO (00C)	Type of Flight Plan Filed:	IFR
Destination:	Nogales, AZ (OSL)	Type of Clearance:	IFR
Departure Time:	06:00 Local	Type of Airspace:	

Wreckage and Impact Information

Crew Injuries:	1 Minor	Aircraft Damage:	Substantial
Passenger Injuries:		Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	1 Minor	Latitude, Longitude:	34.218887,-109.873886(est)

Administrative Information

Investigator In Charge (IIC):	Huhn, Michael
Additional Participating Persons:	Daren DuFriend; FAA FSDO; Scottsdale, AZ Nicole Charnon; Continental Motors; Mobile, AL Brad Miller; Cirrus Aircraft; Duluth, MN Greg Ellsworth; BRS Aerospace; St. Paul, MN
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Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.nts.gov/Docket?ProjectID=85611

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