Aviation Investigation Final Report

Location:	San Marcos, California	**Accident Number:**	WPR22LA259
Date & Time:	July 16, 2022, 18:17 Local	**Registration:**	N718TB
Aircraft:	Socata TB21	**Aircraft Damage:**	Substantial
Defining Event:	Sys/Comp malf/fail (non-power)	**Injuries:**	2 Minor, 2 None
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

According to the pilot, he had just picked up the airplane after an annual inspection. He conducted a pattern-only flight before departing for a cross-country flight to reposition the airplane. About 30 minutes after takeoff, there was a total loss of engine power and the pilot performed a forced landing on a road. The airplane struck a vehicle during landing, which separated the left wing from the fuselage.

Postaccident examination of the engine revealed the mechanical fuel pump shaft had sheared. Further disassembly revealed rotational scoring, heat discoloration, and foreign (aluminum) debris on the pump's rotor shaft and bearing bore. The scoring and heat discoloration were determined to have occurred due to friction occurring between the rotor shaft and bearing bore. Mechanical damage to the affected components did not allow for the determination of pre-event component measurements, including the rotor shaft or the bearing dimensions.

The mechanical fuel pump was a recently rebuilt unit and was installed on the engine during the annual inspection that was completed five days before the accident. The overhaul procedures for the fuel pump specify the bearing to be honed and the rotor to be lubricated during reassembly. Honing to incorrect dimensions or improper lubrication would likely result in increased friction between the two components. Debris between the rotor and bearing could also increase friction. The rubber seal installed at the driven end of the rotor exhibited softening and deformation consistent with thermal distress, which could have allowed debris to enter the fuel pump after the pump began to overheat. Additionally, debris could have been introduced during the rebuild process or during the installation process through the fuel line ports and fittings, but due to the friction damage the source of the debris could not be identified. The fuel pump shaft sheared due to the friction between the rotor shaft and bearing bore; however, damage prevented determination of the source of the friction.

Probable Cause and Findings

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

The failure of the mechanical fuel pump due to internal friction for reasons that could not be determined based on available evidence, which resulted in a total loss of engine power.

Findings

Personnel issues	Repair - Other
Aircraft	Fuel pumps - Failure
Aircraft	(general) - Failure
Aircraft	Altitude - Attain/maintain not possible
Environmental issues	(general) - Ability to respond/compensate
Environmental issues	Ground vehicle - Ability to respond/compensate

Factual Information

History of Flight

Enroute-cruise	Sys/Comp malf/fail (non-power) (Defining event)
Enroute-cruise	Fuel starvation
Landing	Collision during takeoff/land

On July 16, 2022, at 1817 Pacific daylight time, a Socata TB-21, N718TB, was substantially damaged when it was involved in an accident near San Marcos, California. The pilot and passenger were not injured. Two people on the ground received minor injuries. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

According to the pilot, he had picked up the airplane following an annual inspection and refueled the airplane to about 56 gallons of fuel onboard. He then conducted a pattern-only flight limited to one approach and landing due to operational constraints imposed by the local tower. The pilot landed, shutdown, and picked up a passenger for a cross-country flight to Fullerton Municipal Airport (FUL), Fullerton, California, to reposition the airplane. The flight departed and about 30 minutes after takeoff, while cruising at 6,500 ft mean sea level (msl) above a heavy marine layer, the engine lost power. The pilot attempted to navigate towards the edge of the marine layer and divert to a nearby airport but could not reach the runway and was forced to land on a road. The airplane struck a vehicle on the road, which separated the left wing from the fuselage. Two occupants of the vehicle received minor injuries.

The wreckage was recovered to a secure location and an engine run was attempted. The engine would not start and run unless the electric fuel pump was turned on. The mechanical fuel pump was removed from the engine. During removal, it was noted that the pump's drive shaft had sheared. The fuel pump was disassembled; rotational scoring, heat discoloration, and debris were noted on the rotor shaft and bearing bore.

The fuel pump components and debris were sent to the National Transportation Safety Board (NTSB) Materials Laboratory for further examination. The scoring and heat discoloration were determined to have occurred due to friction occurring between the rotor shaft and bearing bore, which resulted in the fuel pump drive coupling driveshaft shearing by torsional overstress. Mechanical damage to the affected components did not allow for the determination of pre-event component dimensions.

The pump components and debris were examined by a scanning electron microscope (SEM) equipped with an energy-dispersive X-ray spectrometer (EDS). EDS scans of rotor material determined the primary element was iron with small alloy additions of chromium, aluminum, and silicon. An EDS spectrum taken from the remaining journal surface showed similar

composition. By contrast, the spectrum from the scored (spalled) region exhibited primarily aluminum and silicon elements with some sulfur and iron.

The foreign debris on the carbon bearing examined by EDS exhibited primarily iron peaks (as well as carbon and sulfur). The middle contrast region was similar but with an increase in the relative peak heights of aluminum and silicon.

Several of the ports on the pump exhibited metal shavings or burrs. Two of the three plugged ports on the mounting flange contained one or more metal shavings. A shaving/burr was observed on one of the fuel flow ports, and shavings were observed at the threaded port on the relief valve housing cover plate. A thread was removed from one of the plugged mounting flange ports and an EDS spectrum of the shaving indicated it consisted primarily of aluminum and silicon, with a trace of zinc from the zinc-plated port plug. A reference EDS spectrum of the pump housing consisted primarily of aluminum and silicon. The surfaces of the pump housing were examined for any signs of notable mechanical damage, but none were found. The rubber seal installed at the driven end of the rotor exhibited softening and deformation, consistent with thermal distress.

The mechanical fuel pump had been overhauled May 19, 2022, and was installed on the engine during the annual inspection dated July 11, 2022. The overhaul procedures provide instructions for the removal and replacement of the liner and bearings in the fuel pump housing. After the old liner and bearing are removed, the pump housing is cleaned and prepared for installation of the new liner and bearing. The pump housing is then heated to a prescribed temperature and the bearing and liner are pressed into the pump housing. A powered flexible hone is then used to machine the inside diameter of the bearing to final size. A seal is then installed into the pump housing before the rotor is installed. The rotor installation instructions call for a light coat of petroleum jelly to be applied to the bearing journal of the rotor before installing the rotor, sealing it, and retaining it inthe pump housing. The tongue on the drive coupling and groove/slot on the rotor are coated with grease before installing the drive coupling retaining ring.

Pilot Information

Certificate:	Private	**Age:**	28,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	None	**Second Pilot Present:**	
Instructor Rating(s):	None	**Toxicology Performed:**	
Medical Certification:	Class 3 Without waivers/limitations	**Last FAA Medical Exam:**	September 18, 2020
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:	158 hours (Total, all aircraft), 16 hours (Total, this make and model), 63 hours (Pilot In Command, all aircraft), 1.2 hours (Last 90 days, all aircraft), 1.2 hours (Last 30 days, all aircraft), 1.2 hours (Last 24 hours, all aircraft)		

Passenger Information

Certificate:		**Age:**	
Airplane Rating(s):		**Seat Occupied:**	Right
Other Aircraft Rating(s):		**Restraint Used:**	
Instrument Rating(s):		**Second Pilot Present:**	
Instructor Rating(s):		**Toxicology Performed:**	
Medical Certification:		**Last FAA Medical Exam:**	
Occupational Pilot:		**Last Flight Review or Equivalent:**	
Flight Time:			

Aircraft and Owner/Operator Information

Aircraft Make:	Socata	**Registration:**	N718TB
Model/Series:	TB21	**Aircraft Category:**	Airplane
Year of Manufacture:	2002	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	2128
Landing Gear Type:	Retractable - Tricycle	**Seats:**	4
Date/Type of Last Inspection:	July 11, 2022 Annual	**Certified Max Gross Wt.:**	
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	634.87 Hrs as of last inspection	**Engine Manufacturer:**	LYCOMING
ELT:		**Engine Model/Series:**	TI0-540 SER
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:	5:53	**Distance from Accident Site:**	
Observation Time:		**Direction from Accident Site:**	
Lowest Cloud Condition:	Few	**Visibility**	10 miles
Lowest Ceiling:	Broken / 800 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	5 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	200°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.88 inches Hg	**Temperature/Dew Point:**	20°C / 17.2°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	San Diego, CA (MYF)	**Type of Flight Plan Filed:**	None
Destination:	Fullerton, CA (FUL)	**Type of Clearance:**	Special VFR
Departure Time:	17:58 Local	**Type of Airspace:**	Class E

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 None	**Aircraft Fire:**	None
Ground Injuries:	2 Minor	**Aircraft Explosion:**	None
Total Injuries:	2 Minor, 2 None	**Latitude, Longitude:**	33.109852,-117.22536(est)

Administrative Information

Investigator In Charge (IIC):	Baker, Daniel
Additional Participating Persons:	Roger Messick; FAA; San Diego, CA Les Doud; Hartzell Propellers
Original Publish Date:	April 25, 2024
Last Revision Date:	
Investigation Class:	Class 3
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=105509