



AVIATION



HIGHWAY



MARINE



RAILROAD



PIPELINE

Aviation Investigation Final Report

Location:	McCormick, South Carolina	Accident Number:	ERA19LA074
Date & Time:	December 19, 2018, 14:20 Local	Registration:	N346MA
Aircraft:	Diamond DA20	Aircraft Damage:	Substantial
Defining Event:	Fuel related	Injuries:	2 Minor
Flight Conducted Under:	Part 91: General aviation - Flight test		

Analysis

After the accident airplane experienced a partial loss of engine power the previous day, the accident pilot/mechanic was dispatched to perform maintenance on the airplane. The previous pilot reported that after landing, the engine would not run with the electric fuel pump turned off. The engine would run slightly better if the primer was on.

The accident pilot/mechanic replaced the throttle and metering unit, the engine-driven fuel pump, and the manifold valve with overhauled units. He set the metered and unmetered fuel pressures to within specifications and the engine ran satisfactorily. A preflight inspection revealed no anomalies, and the pilot departed. After takeoff, the pilot initially remained in the traffic pattern until he was satisfied that the engine was performing normally. He then began to climb and proceeded toward his destination when the engine lost partial power and would not respond to throttle inputs. The pilot performed a forced landing to a nearby clearing, during which the airplane impacted trees, resulting in substantial damage to the fuselage and left wing.

A test run of the engine at the manufacturer's facility found that it ran very rough and would not idle. Similar to the conditions reported by the previous pilot, the engine would remain running only when the test stand fuel boost pressure was increased beyond the normal values.

Examination of the throttle and metering unit revealed debris lodged in the metering plug orifice, obstructing about 90% of the opening. When the debris was removed, the engine ran normally and within manufacturer specifications. Examination of the debris found that it was similar in composition to a sample of torque putty, commonly used to mark threaded fittings after assembly; however, there was no indication that torque putty was used on any of the as-installed fuel system components or on the components that were removed before the accident. Similar debris was found in the previously installed manifold valve (the one removed prior to the accident flight) downstream of the internal filter screen.

The origin of the debris or when it may have been introduced into the fuel system could not be determined. The debris was too large to pass through the fuel pump inlet screen or the airframe filter bowl, making it unlikely to have been introduced during fueling.

Given that debris was found in two different components, one installed on the day of the accident and the other removed before the flight (and found downstream of filters), it was likely introduced during one or more maintenance events. However, it could not be determined if it occurred during the maintenance performed on the day of the accident, a previous maintenance event, or both.

Probable Cause and Findings

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

A partial loss of engine power due to debris obstructing the metering plug orifice in the throttle and metering unit.

Findings

Aircraft	Fuel controlling system - Not specified
Aircraft	(general) - Incorrect service/maintenance
Personnel issues	(general) - Maintenance personnel

Factual Information

History of Flight

Enroute	Fuel related (Defining event)
Approach-VFR pattern final	Off-field or emergency landing
Approach-VFR pattern final	Collision with terr/obj (non-CFIT)

On December 19, 2018, about 1420 eastern standard time, a Diamond DA20, N346MA, was substantially damaged when it was involved in an accident in McCormick, South Carolina. The pilot and passenger sustained minor injuries. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 post-maintenance test flight.

On the day before the accident, another pilot performed a precautionary landing in the airplane at McCormick County Airport (S19), McCormick, South Carolina, due to a partial loss of engine power. That pilot reported that after landing, the engine would not run when the electric fuel pump was turned off. The engine would run “slightly better” if the primer was running (the primer switch, normally used when starting the engine, operates the electric fuel pump on HIGH).

The accident pilot, who also held a mechanic certificate, was dispatched to S19 to diagnose and repair the airplane on the day of the accident. After checking the oil quantity, he started and ran the engine, which was “not running smoothly.” He connected test equipment to the fuel-injected engine and determined that the unmetered fuel pressure was above the manufacturer-specified limits at 1,000 rpm, and the metered fuel pressure was below the specified limits at full power. He then replaced the throttle and metering unit (also referred to as the “fuel servo” or “fuel control unit”), the engine-driven fuel pump, and the fuel manifold valve (also referred to as a “flow divider” or “distribution manifold”). After replacing the fuel manifold valve, he was able to adjust both the metered and unmetered fuel pressures to within the specified limits. The engine ran satisfactorily at idle, during a normal run-up, and at full power. He asked a coworker to check his work, which was found satisfactory with no fuel leaks observed.

Before takeoff, the pilot performed a preflight inspection and sumped each fuel drain three times to ensure there was no debris or contamination and found none. He checked the fuel quantity and noted that the single tank was about 3/4 full. He started the engine and performed a normal run-up before taxiing for departure from runway 36.

The pilot initially remained in the traffic pattern until he was satisfied that the engine was performing normally. He then began a climb and proceeded toward Newnan Coweta County Airport (CCO), Atlanta, Georgia. At an altitude between 3,000 and 3,500 feet, the engine lost partial power. The engine speed reduced from about 2,500 rpm to 1,000 rpm and would not respond to throttle input. The pilot ensured that the mixture was in the rich position, the fuel boost pump was on, and attempted to adjust the throttle, but was unsuccessful in restoring power. He turned the airplane back toward S19 and

prepared for an emergency landing, but realized that he would be unable to reach the runway and attempted to land in a clearing about 1 mile southwest of the airport, during which the airplane impacted trees.

Examination of the wreckage by a Federal Aviation Administration inspector revealed that the left wing was completely separated from the fuselage at the root and a large section of roof and canopy was fragmented.

The engine was examined at the manufacturer's facility under oversight of the NTSB. The engine was installed on a test stand and found to run very rough and would not idle. The engine remained running only when the test stand fuel boost pressure was increased beyond the normal values. The throttle and metering unit was removed from the engine and tested on a production test bench, where the fuel flow parameter was below the acceptable range at all throttle positions. The throttle and metering unit was disassembled and a piece of green glassy solid debris about 1/16" square was found in the metering plug orifice, obstructing about 90% of the orifice area. The debris was too large to pass through the fuel pump inlet screen or the airframe fuel filter bowl (gascolator). The debris was removed, the throttle and metering unit was reassembled and reinstalled on the engine. All subsequent engine test runs appeared normal.

An examination of the fuel manifold valve that was removed from the airplane prior to the accident flight revealed several pieces of debris on the downstream side of the manifold's filter screen. The debris appeared to be identical in color to the debris found in the throttle and metering unit. The particles were smaller, but too large to have passed through the manifold screen.

The debris found in the throttle and metering unit was sent to the NTSB materials lab for further examination. A Fourier transform infrared spectrometer examination revealed that the composition of the debris was similar to (but not an exact match) an exemplar sample of "torque putty." Torque putty is a liquid/paste substance that can be used to mark threaded fittings or fasteners after they have been assembled and properly torqued. When used, a line of putty is typically applied across both sides of a fitting, which dries after application. During subsequent visual inspections of the fitting, any cracks in the putty or displacement of its line is an indicator that the fitting may have loosened. During disassembly of a fitting marked with torque putty, the putty is typically cleaned/removed from the components. At the time of the engine examination, none of the fuel system fittings were found marked with torque putty.

AIRCRAFT INFORMATION

A review of the airplane maintenance records over the 13 months (about 1,300 flight hours) preceding the accident revealed that the only other fuel system related entries occurred in August 2018 (see table).

Table - Fuel System Maintenance Events

Date	Maintenance entry	# flight hours prior to accident flight
8/17/18	Set fuel flow injection pressure	549
8/29/18	Removed/Replaced inoperative	426

	(electrical/boost) fuel pump, Set fuel flow injection pressure	
8/30/18	Set fuel flow injection pressure	422

Fuel System

Fuel flows from a single fuel tank, through one of two outlet finger screens, to a filter bowl and then the electrical fuel pump. It then passes through a shutoff valve before entering the engine driven fuel pump, which is fitted with an inlet finger screen. Fuel then flows to the throttle and metering unit (labeled “Fuel Control Unit” in the figure below) before entering the manifold valve (labeled “Distribution Manifold”) which is fitted with an internal filter screen. Four lines deliver fuel from the manifold valve to the four engine cylinders through the fuel injector nozzles.

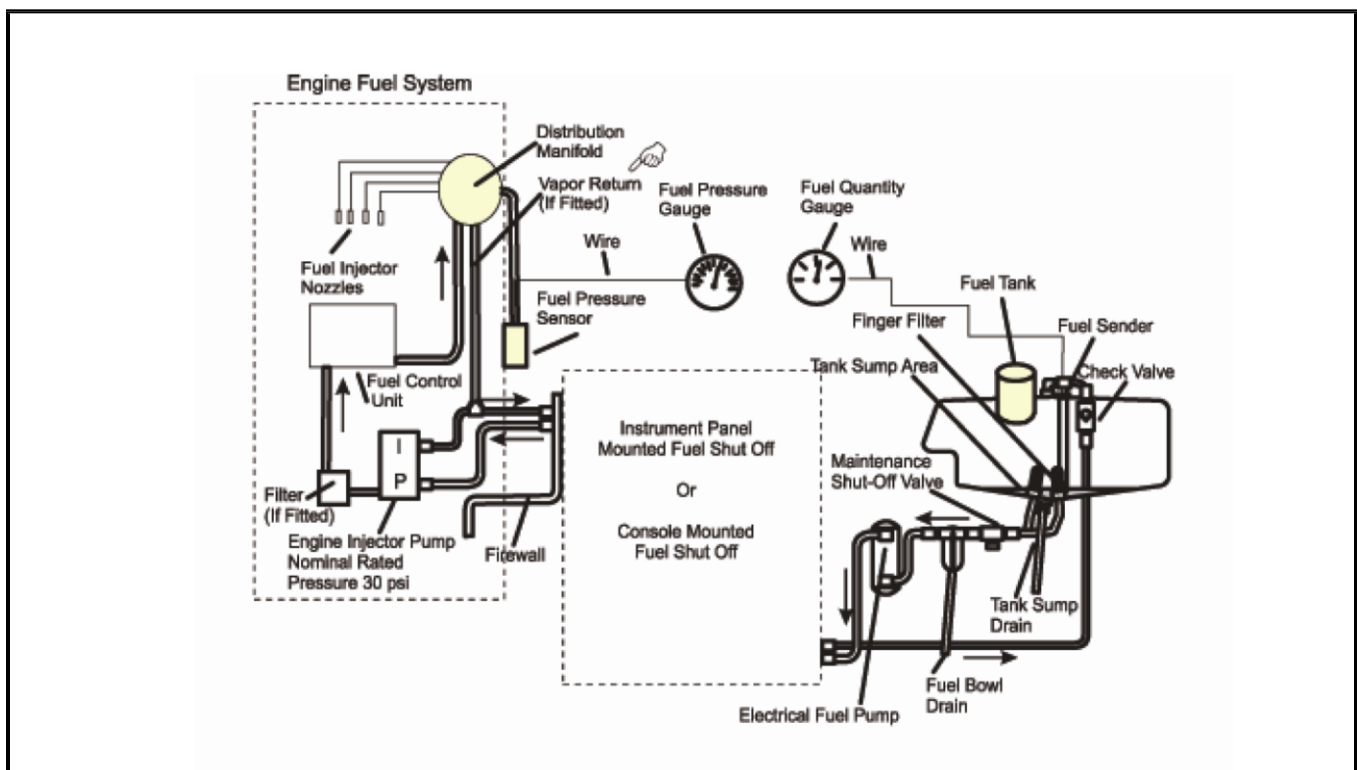


Figure. – Fuel system diagram with annotations

Pilot Information

Certificate:	Private	Age:	29,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	Seat Occupied:	Left
Other Aircraft Rating(s):	None	Restraint Used:	5-point
Instrument Rating(s):	None	Second Pilot Present:	No
Instructor Rating(s):	None	Toxicology Performed:	No
Medical Certification:	Class 2 With waivers/limitations	Last FAA Medical Exam:	October 9, 2017
Occupational Pilot:	No	Last Flight Review or Equivalent:	November 19, 2018
Flight Time:	212.6 hours (Total, all aircraft), 44.5 hours (Total, this make and model), 78.5 hours (Pilot In Command, all aircraft), 13.8 hours (Last 90 days, all aircraft), 2.2 hours (Last 30 days, all aircraft), 0 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Diamond	Registration:	N346MA
Model/Series:	DA20 C1	Aircraft Category:	Airplane
Year of Manufacture:	2004	Amateur Built:	
Airworthiness Certificate:	Utility	Serial Number:	C0304
Landing Gear Type:	Tricycle	Seats:	2
Date/Type of Last Inspection:	December 3, 2018 100 hour	Certified Max Gross Wt.:	1770 lbs
Time Since Last Inspection:	75 Hrs	Engines:	1 Reciprocating
Airframe Total Time:	10663 Hrs as of last inspection	Engine Manufacturer:	Continental
ELT:	Installed, activated, did not aid in locating accident	Engine Model/Series:	IO-240-B
Registered Owner:		Rated Power:	125 Horsepower
Operator:		Operating Certificate(s) Held:	Pilot school (141)

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	Condition of Light:	Day
Observation Facility, Elevation:	GRD,631 ft msl	Distance from Accident Site:	23 Nautical Miles
Observation Time:	13:56 Local	Direction from Accident Site:	15°
Lowest Cloud Condition:	Few / 3400 ft AGL	Visibility	10 miles
Lowest Ceiling:	None	Visibility (RVR):	
Wind Speed/Gusts:	/	Turbulence Type Forecast/Actual:	/
Wind Direction:		Turbulence Severity Forecast/Actual:	/
Altimeter Setting:	30.06 inches Hg	Temperature/Dew Point:	13°C / 3°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	McCormick, SC (S19)	Type of Flight Plan Filed:	None
Destination:	Atlanta, GA (CCO)	Type of Clearance:	None
Departure Time:	14:00 Local	Type of Airspace:	Class G

Airport Information

Airport:	MC CORMICK COUNTY S19	Runway Surface Type:	
Airport Elevation:	459 ft msl	Runway Surface Condition:	
Runway Used:		IFR Approach:	None
Runway Length/Width:		VFR Approach/Landing:	Forced landing

Wreckage and Impact Information

Crew Injuries:	1 Minor	Aircraft Damage:	Substantial
Passenger Injuries:	1 Minor	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	2 Minor	Latitude, Longitude:	33.885555,-82.277496(est)

Administrative Information

Investigator In Charge (IIC):	Brazy, Douglass		
Additional Participating Persons:	James W Cook; FAA/FSDO ; West Columbia , SC Kurt Gibson; Continental Aerospace Technologies; Mobile, AL John D Hudson; Falcon Aviation Maintenance; Newnan, GA		
Original Publish Date:	February 9, 2022	Investigation Class:	3
Note:	The NTSB did not travel to the scene of this accident.		
Investigation Docket:	https://data.nts.gov/Docket?ProjectID=98800		

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](#).