

Doe Mountain Aviation Services
611 Airport Road Mountain City, Tenn. 37683

To: National Transportation Safety Board

Date: April 18th, 2022

RE: Investigation of the crash of N6688S for the NTSB by Michael Darocha; A&P/IA, with the assistance of Airman Dave Garris and Airman Steve Elks at Doe Mountain Aviation Services at The Johnson County Airport in Mountain City Tennessee.

Airport

Johnson County Airport is a single paved airstrip that is 4,498 feet long with a directional heading of 6 and 24.

Aircraft

Aircraft in question is an Experimental Aircraft marketed by Arion Aircraft LLC. Model is the Lightning LS1 powered by a six cylinder Jabaroo engine with a fixed pitch wooden prop. Aircraft was built by Lee Berrier and Rayvon Young. Fuselage and wings are predominately fiberglass construction. Engine Ignition is composed of two [REDACTED] Magnetos. Carburetor is fed by a mechanical pump located on the right rear of the engine case, behind #5 exhaust pipe, with an inline automotive type solenoid plunger fuel pump as an electric boost pump upstream of the mechanical pump. Fuel comes from the tanks via a nylon reinforced flexible automotive type fuel hose, through a see through plastic automotive filter located in the cockpit area, and then goes out to the engine side of the firewall where the gascolator and boost pump are located.

Aircraft rollout and takeoff

Aircraft started takeoff roll from the end of runway 24. Aircraft took flight before midfield. At the taxiway/midpoint of the runway security camera footage shows the engine rpm drop off and subsequent drop in the altitude of the aircraft. After approximately 2 seconds the rpm comes back up and aircraft continues on climb out. As the aircraft approaches the end of runway 6 the engine loses rpm and dies. Aircraft starts to descend and pilot pulls up the nose in an attempt to clear the fence. Aircraft clears the fence and comes down in the road skidding off the far embankment into the creek where aircraft comes to a complete stop. A local resident was traveling down the road at the time and watched the plane come down right in front of him. The occupants exited the truck and rendered assistance. Upon reaching the aircraft, Airman Steve Elks noted the fuel tanks in the on position and the boost pump was off.

The black box

Aircraft is equipped with a Dynon touch screen avionics display with the rocker switch panel for aircraft electrical components located at the top center of the dash. The Dynon system records flight parameters and engine performance and is updating info 16 times a second which provides a very precise record of the aircraft operation. Reviewing the past complete successful flights of the aircraft

and the short flight that resulted in a crash [REDACTED] The higher the engine rpm, the lower the fuel pressure. Fuel pressure reached zero/0 psi at the top of the rpm range (2,650-2,700) on the last few flights at altitude and came up when the rpm was reduced for cruise. Recorded indication was 0 to .9 psi during operation. Note: Jabaroo considers 3 psi nominal. CHT's and EGT's were in range. No ignition failure or malfunction was recorded. The flight parameters were matched to the recorded video footage of the flight and the recorded fuel pressure and rpm tracks with flight pattern. The computer shows a drop in rpm and fuel pressure at mid field where the aircraft altitude starts to drop. It then records the fuel pressure increase, however slight and the rpm come back up with the aircraft continuing the flight. The computer shows the fuel pressure and rpm drop again but this time the engine stops running and the aircraft starts its decent where it ends up off the airport property and in the adjacent creek across Crackers Neck Road at the end of runway 6.

Post-crash mechanical analysis

Aircraft had just returned previously from Georgia where it had an annual conditional inspection and miscellaneous repairs performed. The computer shows the fuel pressure dropping to zero at altitude on that flight at high rpm.

Fuel lines

Fuel lines were checked for condition and obstruction. All lines showed clear with no problem with ample fuel coming through the lines when a vacuum was pulled on them at the end of the line where the fuel line attaches to the carburetor.

Boost pump

The boost pump was checked for proper operation and was run to remove five gallons of fuel from the wing tank. It was noticed that the wire was disconnected from the pump switch post crash. We surmise that the wire was short and pulled away from the switch when the fuselage broke apart. Wire was reattached for testing. Spade connector was looser than normal on the switch spade and had to be wiggled at one time during testing to make the pump come on. Whether this was relevant during the crash is unknown. Pump pressure was measured by mechanical gauge and was confirmed to be 4 PSI and would push fuel through the mechanical pump and to the carburetor with no problem. Dynon recording of the flight seem to indicate the boost pump was not on during takeoff.

Mechanical pump

[REDACTED] The pump was removed and taken apart. Problems were found. The rubber poppet valve plastic disc assembly was found to be in good condition and functioning properly. The debris screen was clean. Inlet and outlet lines were clear. The diaphragm return spring on the engine side of the diaphragm was corroded and the shop end of the spring, where it sat against the steel plate on the diaphragm was rusted completely away leaving an abrupt sharp point. Plate was also rusty. Diaphragms were intact but the diaphragm on the fuel side was stiffer than normal, probably from age. Return spring on the actuating lever side was intact and functioning normally. Actuating pushrod was in good shape. Measuring 2.868" and weighing in at 1.005 oz. Pump pushrod travel was approximately .150". Pushrod was barely touching the actuator arm with the pump installed with the plastic spacer when the arm was in its fully retracted position on the cam. Pushrod provides the motion necessary for the pump to induce suction force on the fuel lines,

not pressure. Pressure is completely relied upon by the return spring which in this case had one end rusted away. Spring force was tested and was found to be an average of 71 oz. or 4.4 pounds. Effective diaphragm area exerting pressure on fuel coulomb is 2.54" resulting in an effective average fuel pressure of 1.74 PSI with an effective volume of .762 sq. inches. It should be noted that the pump has no built in pressure regulating bypass valve. When the pump cavity fills up it is hydraulic locked in its most upward position with fuel flow out of the pump being regulated by the needle and seat assembly whose position is regulated by the float in the carburetor. Pushrod return force exerted by the return spring in combination with the diaphragm spring is an average of 12 pounds. When the diaphragm spring is taken out of the equation, like when the diaphragm is at the top of its suction stroke and floating there, the amount of force available to maintain pushrod contact with the spring drops to an average of 2.61 pounds. This is insufficient to keep the solid steel pushrod in contact with the cam at the top of the RPM range where the pushrod is being actuated 22.5 times a second for a total estimated travel length of 6.75" per second back and forth if the pushrod maintains contact with the cam. We have come to the conclusion that the pump was floating at higher rpm and the pump pushrod had lost contact with the cam and was not actuating the lever arm properly. The cam lobe was coming around and smacking the pushrod at the top of the acceleration ramp shooting it into the lever arm, which was enough to float the diaphragm and eliminate any force the diaphragm was exerting on the fuel coulomb, which explains why the fuel pressure was dropping to zero at higher rpm. The engine was sucking the carburetor bowl dry which caused the fuel mixture to lean out to a non-combustion sustaining level and the engine quit running from fuel starvation. When the rpm dropped mid field, the fuel pump pushrod had time to come in contact with the cam and the diaphragm had just enough time to replenish the fuel in the carburetor to bring the fuel/air mixture back to an optimum ratio. The bottom line is that the diaphragm spring had lost length and effective spring pressure from rusting away rendering the pump ineffective at supplying fuel in the higher rpm range.

Carburetor

The carburetor was disassembled [REDACTED] It had been run at some time in its past with auto gas. The inside surface of the carb had medium corrosion with tell tale signs of gelled previous varnish from rotten auto gas. There was some small particle debris and one of the two floats was broken and hanging toward the center of the carb. Its function however seemed unaffected. A sizable piece of debris contamination was found above the idle circuit jet upon removal. Its size was large enough to impede fuel flow through the idle, secondary or tertiary idle circuit orifices. The main jet was clear and so was the emulsifier tube. The economizer circuit was in the full rich position and was functioning normally. The economizer jet was clear and free of obstruction. The Constant velocity slide was functioning properly and was oriented properly in the carburetor body.

Exhaust

Exhaust was unobstructed and functioning properly.

Dynon Flight Display

The fuel pressure data display had been deleted from the screen and was not available to the pilot so the pilot had no idea what his fuel pressure was or if there was any fuel pressure. The fuel pressure transducer type was not programmed into the Dynon system correctly and was not indicating

the correct fuel pressure. When the correct data was entered into the system by Dave Garris the Dynon indicated fuel pressure properly. The Dynon system was otherwise functioning properly.

