



# Aviation Investigation Final Report

<b>Location:</b>	Valkaria, Florida	<b>Accident Number:</b>	ERA19LA032
<b>Date &amp; Time:</b>	October 27, 2018, 13:15 Local	<b>Registration:</b>	N154DF
<b>Aircraft:</b>	Titan T51	<b>Aircraft Damage:</b>	Substantial
<b>Defining Event:</b>	Loss of engine power (partial)	<b>Injuries:</b>	1 Serious
<b>Flight Conducted Under:</b>	Part 91: General aviation - Personal		

## Analysis

The pilot stated that, shortly after takeoff on a local test flight of the experimental, amateur-built airplane, the engine surged, with a corresponding fuel pressure fluctuation. Because the engine was developing partial power, he elected to return to the airport for landing, but while on the base leg of the airport traffic pattern, the engine lost total power. The airplane subsequently impacted a small retention pond and came to rest partially submerged in water. Postaccident examination of the engine revealed damage to the Nos. 2 and 5 cast aluminum pistons consistent with detonation. The fuel pumps and engine control unit were operationally tested with no discrepancies reported. Inspection of the cooling system components revealed no evidence of pre-impact failure or malfunction, and no evidence of warpage of the cylinder heads was observed.

The owner reported continuing engine overheating problems that occurred at sustained “moderate” power settings, which he was unable to correct despite extensive troubleshooting efforts including re-routing of the coolant reservoir. Although he believed he was operating the engine with a rich fuel-to-air ratio, when compared to an identical airplane that was operating successfully, the accident engine was being operated in a lean fuel-to-air ratio at all power settings (500 to 5,000 in 250 rpm increments). This finding was consistent with the pilot’s report of overheating at sustained moderate power settings.

## Probable Cause and Findings

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

The partial, then total, loss of engine power due to detonation and associated damage to several pistons as a result of an overly lean fuel-to-air ratio.

## Findings

<b>Aircraft</b>	Recip engine power section - Damaged/degraded
<b>Aircraft</b>	Fuel control electronic - Incorrect service/maintenance
<b>Personnel issues</b>	Modification/alteration - Owner/builder

# Factual Information

## History of Flight

Initial climb	Loss of engine power (partial) (Defining event)
Maneuvering	Loss of engine power (total)
Landing-flare/touchdown	Dragged wing/rotor/float/other

On October 27, 2018, about 1315 eastern daylight time, an experimental, amateur-built Titan T-51 airplane, N154DF, was substantially damaged when it was involved in an accident near Valkaria, Florida. The commercial pilot sustained serious injuries. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

The airplane was equipped with a Simple Digital System (SDS) EM-5 engine control unit (ECU), an electronic ignition system that also regulated fuel delivery. Before the ground engine runs, the owner consulted for programming values of the ECU with a representative of the airplane designer, and a designated airworthiness representative (DAR) who owned a similar airplane. He added that the provided ECU programming values for both were close, but not exact, so he contacted the manufacturer of the ECU and obtained their values, which he adopted and adjusted for the use of automotive gasoline. He also indicated that, since setting up the system, he experienced a continuing engine overheating issue, which resulted in extensive inspection of the cooling system and relocation of the coolant reservoir, the latter of which worked satisfactorily to prevent overheating during ground run testing. The pilot reported the overheating issue first appeared at “moderate” power levels. The purpose of the accident flight was to verify that the engine operating temperatures and pressures were good. The pilot reported that he also planned to monitor the high-pressure fuel pump due to its recent replacement because of fuel pressure fluctuation during the previous flight.

The airplane was fueled with ethanol free 90- or 100-octane racing fuel, and no contamination was noted. The pilot stated that the preflight inspection also included a check of the flight controls and engine fluid levels. After the engine was started, he taxied to runway 28 and performed a "high power" engine run-up, noting that the temperatures and pressures were normal.

The pilot departed from runway 28 with the airplane's flaps retracted, 15 gallons of fuel, the fuel shutoff valve on, and one high pressure and the low-pressure fuel pumps on. Between about 300 ft and 500 ft, after retracting the landing gear, he noted the engine surge, and saw the fuel pressure fluctuating. The engine was developing partial power, and the pilot initiated a right turn to land on runway 14. When the turn was nearly completed while on a close right base leg for runway 14, the engine lost total power. About that time, he noticed a "puff" of white smoke from the engine's right exhaust stack. While in a slight right wing low, nose-up attitude, the airplane impacted a small retention pond and came to rest on the bank, partially submerged in the water. The pilot exited the airplane and was transported to a local hospital for treatment.

Examination of the engine following recovery was performed by the airplane owner/builder with Federal Aviation Administration (FAA) oversight. The engine was equipped with pistons that were marked with "RGL AO" and, according to the builder, were made of cast aluminum. All six pistons except the No. 1 showed signatures of overheating. The Nos. 2 and 5 pistons exhibited damage at the outer edge of the piston crown and on the sides; both pistons exhibited coarse scoring of the piston skirt. The damage to the No. 5 piston was greater than that of the No. 2 piston and extended past the ring lands. Impact damage was noted to the fuel delivery system. The fuel lines that were intact were examined and contained fuel; the fuel pumps were operationally tested, though no attempt was made to verify there were operating at the correct pressure or volume. The valve clearances were checked on all cylinders and all were within limits, except for the No. 1 cylinder. The ECU was sent to the manufacturer's facility in Canada, where no anomalies were found during examination. The owner reported there was no warpage of the cylinder heads, and no discrepancies with the cooling system components were reported.

A review of high-quality photographs of the damaged pistons by NTSB Materials Laboratory personnel revealed that the damage was consistent with detonation.

The owner of a similar airplane with the same engine reported having four separate piston damage events, one of which was during the airplane's first flight. In all four cases, the ECU programming values were based on data provided by the airplane designer. He contacted the manufacturer of the ECU and eventually they identified a fuel schedule that did not result in engine damage, and that owner subsequently accumulated about 200 trouble-free hours of engine operation.

According to the data provided by the manufacturer of the ECU, the fuel values at all rpm points (500 to 5,000 in 250 rpm increments) for the accident airplane were less than the fuel values for the same type airplane with the same engine flying successfully. At 1,000, 2,000, 3,000, 4,000, and 5,000 rpm (full rated rpm), the fuel values for the accident airplane were about 24%, 21%, 20%, 11%, and about 6% less (leaner), respectively, than those of the similar airplane that was operating successfully.

## Pilot Information

<b>Certificate:</b>	Commercial; Flight instructor	<b>Age:</b>	66, Male
<b>Airplane Rating(s):</b>	Single-engine land; Single-engine sea; Multi-engine land	<b>Seat Occupied:</b>	Front
<b>Other Aircraft Rating(s):</b>	None	<b>Restraint Used:</b>	4-point
<b>Instrument Rating(s):</b>	Airplane	<b>Second Pilot Present:</b>	No
<b>Instructor Rating(s):</b>	Airplane multi-engine; Airplane single-engine; Instrument airplane	<b>Toxicology Performed:</b>	No
<b>Medical Certification:</b>	Class 3 Without waivers/limitations	<b>Last FAA Medical Exam:</b>	June 17, 2017
<b>Occupational Pilot:</b>	No	<b>Last Flight Review or Equivalent:</b>	June 21, 2017
<b>Flight Time:</b>	9988 hours (Total, all aircraft), 4 hours (Total, this make and model), 9851 hours (Pilot In Command, all aircraft), 20 hours (Last 90 days, all aircraft), 7 hours (Last 30 days, all aircraft)		

## Aircraft and Owner/Operator Information

<b>Aircraft Make:</b>	Titan	<b>Registration:</b>	N154DF
<b>Model/Series:</b>	T51 NO SERIES	<b>Aircraft Category:</b>	Airplane
<b>Year of Manufacture:</b>	2015	<b>Amateur Built:</b>	Yes
<b>Airworthiness Certificate:</b>	Experimental (Special)	<b>Serial Number:</b>	M10SV6S0HK0154
<b>Landing Gear Type:</b>	Retractable - Tailwheel	<b>Seats:</b>	1
<b>Date/Type of Last Inspection:</b>	April 14, 2018 Condition	<b>Certified Max Gross Wt.:</b>	1462 lbs
<b>Time Since Last Inspection:</b>		<b>Engines:</b>	1 Reciprocating
<b>Airframe Total Time:</b>	10 Hrs at time of accident	<b>Engine Manufacturer:</b>	Honda
<b>ELT:</b>	C126 installed, not activated	<b>Engine Model/Series:</b>	J35 A6
<b>Registered Owner:</b>		<b>Rated Power:</b>	241 Horsepower
<b>Operator:</b>	On file	<b>Operating Certificate(s) Held:</b>	None

## Meteorological Information and Flight Plan

<b>Conditions at Accident Site:</b>	Visual (VMC)	<b>Condition of Light:</b>	Day
<b>Observation Facility, Elevation:</b>	MLB,33 ft msl	<b>Distance from Accident Site:</b>	9 Nautical Miles
<b>Observation Time:</b>	12:53 Local	<b>Direction from Accident Site:</b>	332°
<b>Lowest Cloud Condition:</b>		<b>Visibility</b>	10 miles
<b>Lowest Ceiling:</b>	Broken / 3600 ft AGL	<b>Visibility (RVR):</b>	
<b>Wind Speed/Gusts:</b>	11 knots /	<b>Turbulence Type Forecast/Actual:</b>	None / None
<b>Wind Direction:</b>	280°	<b>Turbulence Severity Forecast/Actual:</b>	N/A / N/A
<b>Altimeter Setting:</b>	29.9 inches Hg	<b>Temperature/Dew Point:</b>	27°C / 16°C
<b>Precipitation and Obscuration:</b>	No Obscuration; No Precipitation		
<b>Departure Point:</b>	Valkaria, FL (X59 )	<b>Type of Flight Plan Filed:</b>	None
<b>Destination:</b>	Valkaria, FL (X59 )	<b>Type of Clearance:</b>	None
<b>Departure Time:</b>	13:43 Local	<b>Type of Airspace:</b>	

## Airport Information

<b>Airport:</b>	Valkaria Airport X59	<b>Runway Surface Type:</b>	Asphalt
<b>Airport Elevation:</b>	26 ft msl	<b>Runway Surface Condition:</b>	Unknown
<b>Runway Used:</b>	28	<b>IFR Approach:</b>	None
<b>Runway Length/Width:</b>	4000 ft / 75 ft	<b>VFR Approach/Landing:</b>	Forced landing

## Wreckage and Impact Information

<b>Crew Injuries:</b>	1 Serious	<b>Aircraft Damage:</b>	Substantial
<b>Passenger Injuries:</b>		<b>Aircraft Fire:</b>	None
<b>Ground Injuries:</b>	N/A	<b>Aircraft Explosion:</b>	None
<b>Total Injuries:</b>	1 Serious	<b>Latitude, Longitude:</b>	27.962499,-80.564445(est)

## Administrative Information

<b>Investigator In Charge (IIC):</b>	Monville, Timothy		
<b>Additional Participating Persons:</b>	Cheryl King; FAA/FSDO; Orlando, FL		
<b>Original Publish Date:</b>	February 9, 2022	<b>Investigation Class:</b>	3
<b>Note:</b>	The NTSB did not travel to the scene of this accident.		
<b>Investigation Docket:</b>	<a href="https://data.nts.gov/Docket?ProjectID=98567">https://data.nts.gov/Docket?ProjectID=98567</a>		

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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](#).