Aviation Investigation Final Report

Location:	Franklin, Virginia	**Accident Number:**	ERA17LA067
Date & Time:	December 10, 2016, 12:19 Local	**Registration:**	N59JL
Aircraft:	MATHIAS LINDA B LIGHTNING	**Aircraft Damage:**	Substantial
Defining Event:	Loss of engine power (partial)	**Injuries:**	1 Serious, 1 Minor
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The commercial pilot was conducting a local personal flight with a pilot-rated passenger in the experimental, amateur-built airplane. During the initial climb, when the airplane was at 100 ft above ground level (agl), the pilot felt a vibration that soon stopped. She continued the takeoff and noted that all exhaust gas temperature (EGT) readings were higher than normal, with the No. 2 cylinder EGT over the maximum red line limit; the engine then lost partial power. She kept full throttle applied, informed her passenger of the discrepancy, and remained in the traffic pattern to return to the airport. While flying about 200 ft agl and turning onto the base leg of the airport traffic pattern, she reduced the throttle to slow the airplane from 80 to 75 mph; at that moment, the left wing dropped immediately, which she later indicated was consistent with an aerodynamic stall although she did not feel any airframe buffet. The airplane impacted and remained suspended in trees a few feet off the ground.

Postaccident examination of the engine revealed damage to the No. 2 cylinder piston consistent with pre-ignition. This damage was likely the source of the partial loss of engine power. While the pilot was using an oil additive, the investigation could not determine whether the additive contributed to pre-ignition.

The airplane was not equipped with stall warning protection. Although the pilot/builder had accrued about 290 flight hours in the accident airplane and should have been familiar with its aerodynamic stall characteristics, stall warning protection could have alerted the pilot to an impending stall so that she could take action to avoid the stall.

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 pre-ignition damage to the No. 2 cylinder piston and the pilot's exceedance of the airplane's critical angle of attack while maneuvering in the airport traffic pattern, which resulted in an aerodynamic stall.

Findings

Aircraft	Recip eng cyl section - Malfunction
Personnel issues	Aircraft control - Pilot
Aircraft	Airspeed - Not attained/maintained
Aircraft	Angle of attack - Not attained/maintained
Environmental issues	Tree(s) - Contributed to outcome

Factual Information

History of Flight

Initial climb	Loss of engine power (partial) (Defining event)
Approach-VFR pattern base	Aerodynamic stall/spin
Uncontrolled descent	Collision with terr/obj (non-CFIT)

On December 10, 2016, about 1219 eastern standard time, an experimental amateur-built Lightning, N59JL, was substantially damaged when it impacted terrain while maneuvering in the traffic pattern at Franklin Municipal-John Beverly Rose Airport, Franklin, Virginia. The commercial pilot sustained minor injuries and the pilot-rated passenger sustained a serious injury. The airplane was privately owned and operated by the pilot as a Title 14 *Code of Federal Regulations* (CFR) Part 91 personal flight. Visual meteorological conditions prevailed at the time and no flight plan was filed for the local flight which originated about 2 minutes earlier.

The pilot stated that both fuel tanks were filled with 100 low lead (100LL) fuel, then she performed a preflight inspection with no discrepancies reported. After starting the engine she taxied to runway 27, and performed an engine run-up also with no discrepancies reported. During the initial climb when the airplane was at 100 ft above ground level (agl), she felt a vibration which soon stopped. She continued the takeoff and noted that all exhaust gas temperature (EGT) readings were higher than normal, the No. 2 cylinder EGT was over the maximum red line limit, and the airplane had experienced a partial loss of engine power. She kept full throttle applied, informed her passenger of the discrepancy, and turned crosswind. On the downwind legs of the airport traffic pattern, where while maintaining 80 mph, she made a radio call announcing her intention to return. The flight continued in the traffic pattern turning onto the base leg of the airport traffic pattern, and while flying about 200 ft agl, she reduced the throttle to slow the airplane from 80 to 75 mph in preparation to turn onto the final approach leg of the airport traffic pattern. At that moment, the left wing dropped immediately, which she later agreed was consistent with an aerodynamic stall though she did not feel any airframe buffet. The airplane impacted trees while in the left-wing low attitude, and remained suspended in the trees, "…a few feet [off] the ground…." Both occupants exited the airplane and walked to a nearby highway where first responders spotted them, then both were transported to a hospital for treatment of their injuries.

Pilot Information

Certificate:	Airline transport; Commercial; Flight instructor	**Age:**	75,Female
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Glider	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Glider; Instrument airplane	**Toxicology Performed:**	No
Medical Certification:	Class 3 Without waivers/limitations	**Last FAA Medical Exam:**	December 18, 2015
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	July 28, 2015
Flight Time:	4951 hours (Total, all aircraft), 290 hours (Total, this make and model), 4703 hours (Pilot In Command, all aircraft), 3 hours (Last 90 days, all aircraft)		

Pilot-rated passenger Information

Certificate:	Commercial; Flight instructor	**Age:**	69,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Glider	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane single-engine; Glider; Instrument airplane	**Toxicology Performed:**	No
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	July 13, 2009
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:	1800 hours (Total, all aircraft)		

The pilot, age 75, held an airline transport pilot certificate with airplane multi-engine land rating, a commercial pilot certificate with ratings for airplane single engine land and glider. She also held a flight instructor certificate with ratings for airplane single and multi-engine, glider, and instrument airplane, a ground instructor certificate, and a repairman experimental aircraft builder certificate. She was a designated pilot examiner . She held a third-class medical certificate with no limitations issued December 18, 2015. She reported 4,951 hours total flight time, of which 290 hours were in the accident airplane.

The passenger, age 69, held a commercial pilot certificate with ratings for airplane single and multi-engine land, instrument airplane and glider. He also held a flight instructor certificate with ratings for airplane single engine and glider, a remote pilot certificate, and a ground instructor certificate. He held a second-class medical certificate with a limitation to wear corrective lenses issued July 13, 2009. On the application for his last medical certificate he listed a total flight time of 1,800 hours.

Aircraft and Owner/Operator Information

Aircraft Make:	MATHIAS LINDA B	**Registration:**	N59JL
Model/Series:	LIGHTNING NO SERIES	**Aircraft Category:**	Airplane
Year of Manufacture:	2007	**Amateur Built:**	Yes
Airworthiness Certificate:	Experimental (Special)	**Serial Number:**	20
Landing Gear Type:	Tricycle	**Seats:**	2
Date/Type of Last Inspection:	September 9, 2016 Condition	**Certified Max Gross Wt.:**	1425 lbs
Time Since Last Inspection:	2 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	293 Hrs at time of accident	**Engine Manufacturer:**	JABIRU
ELT:	C91 installed, activated, did not aid in locating accident	**Engine Model/Series:**	3300
Registered Owner:	On file	**Rated Power:**	120 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

The accident airplane was built at the Lightning factory using "Builder Assist mode" in 2007, and was equipped with a 120 horsepower, Jabiru 3300 engine, which was new when installed. It was also equipped with Genesys Aerosystems IDU-450 primary and multi-function displays (PFD and MFD), and a Grand Rapids Technology (GRT) 6000 engine information system (EIS). It was not equipped with stall warning annunciation, or angle of attack indicator. The pilot/builder reported that it had always been operated using only 100LL fuel and aviation oil. She also reported that in the beginning she did not add any oil additives, but later, "…I started using a product called CamGuard designed to protect the camshaft…." She indicated that she used the "Instruction and Maintenance Manual for Jabiru 3300 Aircraft Engine, JEM3304-3" when performing maintenance on the engine, and section 3.4 of that manual titled "Lubricant" contained no warning or note against using oil additives.

The airplane's most recent condition inspection in accordance with the scope and detail of Title 14 CFR Part 43 Appendix D was completed on September 9, 2016, at airplane total time 291.5 hours. A review of the engine logbook revealed only 1 entry indicating that an oil additive was installed; the entry was dated July 31, 2015. An entry dated August 31, 2016, specified that the results of a differential compression test using 80 psi as a base revealed the No. 2 cylinder was reading 66 psi. The airplane had been operated about 2 hours since the inspection.

According to the builder, the maximum specified cylinder head temperature (CHT) and EGT readings were 392°F and 1450°F, respectively.

The PFD and MFD were read-out by the National Transportation Safety Board's Vehicle Recorder Division and according to the report, a total of about 14 minutes of data was recorded that day at 1 second intervals, of which the last 2 minutes 15 seconds was from the accident flight. A review of the downloaded data revealed that during takeoff the EGT reading for the No. 2 cylinder increased to a

maximum of 1,468°F and remained at that value for another 2 seconds, then began to decrease to the last reported value of 631°F. The EGT readings from the remaining cylinders were normal from takeoff until about 47 seconds after the highest reading for No. 2 cylinder, then they also began to decrease. There were no exceedances of CHT for any cylinder.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	FKN,40 ft msl	**Distance from Accident Site:**	
Observation Time:	12:15 Local	**Direction from Accident Site:**	
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	/	**Turbulence Type Forecast/Actual:**	None / None
Wind Direction:		**Turbulence Severity Forecast/Actual:**	N/A / N/A
Altimeter Setting:	30.51 inches Hg	**Temperature/Dew Point:**	3°C / -9°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Franklin, VA (FKN)	**Type of Flight Plan Filed:**	None
Destination:	Franklin, VA (FKN)	**Type of Clearance:**	None
Departure Time:	12:17 Local	**Type of Airspace:**	

Airport Information

Airport:	Franklin Municipal-John Beverl FKN	**Runway Surface Type:**	Asphalt
Airport Elevation:	40 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	27	**IFR Approach:**	None
Runway Length/Width:	4976 ft / 100 ft	**VFR Approach/Landing:**	Forced landing;Traffic pattern

Wreckage and Impact Information

Crew Injuries:	1 Minor	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Serious	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Serious, 1 Minor	**Latitude, Longitude:**	36.646389,-76.918052(est)

Examination of the Jabiru 3300 engine was performed following recovery of the airplane by several

Federal Aviation Administration (FAA) inspectors. Erosion of the piston of the No. 2 cylinder (left forward) was noted. The spark plugs were inspected and the only reported discrepancy was that the No. 2 cylinder spark plugs were slightly oil fouled. Examination of the No. 2 cylinder induction and exhaust systems revealed no evidence of leakage. The No. 2 cylinder barrel and head, No. 2 piston, piston pin, and connecting rod were retained for examination by the NTSB Materials Laboratory.

According to the NTSB Materials Laboratory factual report, the interior portion of the cylinder head near the intake and exhaust valves contained deposits that were consistent with lead oxides and lead bromide, which form after combustion of tetraethyl lead and 1,2 dibromoethane (anti-knocking and lead scavenging additives in aviation fuel). The cylinder barrel exhibited scars that were consistent with sliding wear from the piston crown and skirt, and the sides of the piston exhibited material loss from wear and material spalling. The piston crown exhibited a rough surface with erosion of the surfaces facing the cylinder head and barrel, with deposits similar to those found on the cylinder head. The report stated that the observed damage was consistent with that caused by pre-ignition.

Tests and Research

Fueling

According to the facility that supplied fuel, 5 aircraft were fueled from the same source before the accident airplane, and 2 aircraft were fueled from the same source after the accident airplane. There were no fuel reported issues. Postaccident, the specific gravity tested the same as the value when the fuel was delivered.

Preignition

According to Advisory Circular FAA-H-8083-25B, titled Pilot's Handbook of Aeronautical Knowledge, preignition can occur when the fuel-air mixture ignites prior to the engine's normal ignition event and is usually caused by a residual hot spot in the combustion chamber. Preignition causes the engine to lose power and produces high operating temperature and may also cause severe engine damage because the expanding gases exert excessive pressure on the piston while still on its compression stroke.

Jabiru Manuals and Documents, Oil Additive

According to the quality manager of the engine manufacturer, current manuals are available on their website. The Instruction and Maintenance Manual for Jabiru 3300 Aircraft Engine, JEM3304-3 which was utilized by the pilot to perform engine maintenance, dated January 2007, was periodically updated to the final version JEM3304-9, dated April 2011. It was not published since then and was replaced by JEM0002-1, titled Maintenance Manual for Jabiru 2200 Aircraft Engine, Jabiru 3300 Aircraft Engine dated July 2012, and updated through JEM0002-7 dated June 2016, currently published on their website.

The quality manager also indicated that warnings about the non-use of oil additives and/or oil stabilizers are located in several documents including a tag attached to every engine they distribute, in section 1.5.5 of the installation manual, in the warranty exclusions section of the maintenance manual, and also in

section 2.14 of the engine overhaul manual.

Section 3.5 titled "Lubricant" and section 6.1 titled "Lubrication System" of a newer version of the Instruction and Maintenance Manual did not contain a warning regarding the use of oil additives or oil stabilizers. The engine maintenance manual (JEM0002-7) which, "…has been prepared as a guide to correctly operate, maintain, and service Jabiru 2200 & 3300 engines" was further reviewed and section 3.8 titled "Lubricant" or section 9.5 titled "Oil & Filter Change" did not contain a warning or caution against the use of oil additives or oil stabilizers.

The engine manufacturer had no information as to what impact the oil additive used would have had on the engine.

Administrative Information

Investigator In Charge (IIC):	Monville, Timothy
Additional Participating Persons:	Ken Bain; FAA/FSDO; Richmond, VA Stephen M Harness; FAA/FSDO; Richmond, VA
Original Publish Date:	November 6, 2019
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=94486