Aviation Investigation Final Report

Location:	West Columbia, South Carolina	**Accident Number:**	ERA15FA221
Date & Time:	May 23, 2015, 09:21 Local	**Registration:**	N42BR
Aircraft:	BR LEGEND LLC TURBINE LEGEND	**Aircraft Damage:**	Destroyed
Defining Event:	Fuel starvation	**Injuries:**	1 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The commercial pilot departed on a cross-country flight in the experimental, amateur-built, turboprop airplane. About 3 minutes after takeoff, the pilot initiated a return to the departure airport. About 6.8 nautical miles (nm) from the runway, at an altitude of about 6,500 ft mean sea level, the pilot declared an emergency, stating that he had "lost" the engine. Shortly thereafter, he informed air traffic control that the airplane had experienced a loss of fuel pressure. Witnesses saw the airplane collide with a tree and subsequently impact a pond about 1.2 nm from the runway. They reported no engine sound.

Examination of the airplane revealed no evidence of preimpact failures or malfunctions of the flight controls that would have precluded normal operation. The landing gear and flaps were found retracted. There was no evidence of preimpact failure or malfunction of the engine core. The engine-driven fuel pump showed signs of internal cavitation, while the auxiliary fuel pump, which provided fuel under pressure to the engine-driven fuel pump, flowed nearly 48% less than specified by the manufacturer, and had an inconsistent/intermittent laboring sound during testing. Disassembly revealed an improperly-installed fitting, which resulted in the decreased fuel flow rate, a loss of fuel pressure, and a subsequent engine flame-out. Inspection also revealed that a component of the fuel pump had been replaced after manufacture, but there was no record of this maintenance in the airplane's logbooks.

While it was not known if the pilot attempted to perform an air restart of the engine, a worn ignitor box and ignitor plug may have precluded a successful restart of the engine.

Although the pilot descended the airplane at its published best glide airspeed in his attempt to return to the airport, because the airplane was not equipped with an electrically-operated feathering pump, the propeller blade angle remained where it was set when the engine flame-out occurred, which was likely flat pitch. The flat pitch of the propeller blades significantly decreased the airplane's engine-out glide ratio. Had the pilot promptly feathered the propeller blades to reduce drag following engine flame-out, or had the airplane been equipped with a feathering pump, it is likely the airplane would have been able to reach the intended runway and land uneventfully.

Although an enlarged heart was noted during the autopsy and toxicological testing detected quinine, given that the pilot was actively controlling the airplane just before the accident, there is no evidence that a medical condition or use of quinine contributed to the pilot's inability to fly the airplane.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: An engine flame-out due to fuel starvation as the result of an improperly-installed auxiliary fuel pump fitting, and the pilot's failure to promptly feather the propeller following the engine-flame out, which resulted in decreased glide capability and impact with terrain. Contributing to the accident was the pilot's operation of the airplane with no emergency electric propeller feathering system.

Findings

Aircraft	Fuel pumps - Incorrect service/maintenance
Aircraft	Fuel - Not specified
Personnel issues	Delayed action - Pilot
Aircraft	Propeller feather/reversing - Not used/operated
Aircraft	Propeller feather/reversing - Not installed/available

Factual Information

History of Flight

Initial climb	Fuel related
Initial climb	Fuel starvation (Defining event)
Emergency descent	Off-field or emergency landing
Maneuvering-low-alt flying	Collision with terr/obj (non-CFIT)

On May 23, 2015, about 0921 eastern daylight time, an experimental, amateur-built Turbine Legend, N42BR, collided with trees and a pond about 1.2 nautical miles (nm) west of Columbia Metropolitan Airport (CAE), West Columbia, South Carolina. The airplane was destroyed and the commercial pilot was fatally injured. The airplane was registered to BR Legend, LLC and privately operated. Visual meteorological conditions prevailed at the time, and a visual flight rules (VFR) flight plan was filed for the 14 *Code of Federal Regulations* Part 91 personal flight, which originated about 7 minutes earlier from CAE, and was destined for Asheville Regional Airport (AVL), Asheville, North Carolina.

Air traffic control (ATC) radar and voice communication information indicated that the pilot was cleared to taxi to runway 11 and was provided a VFR clearance. He subsequently contacted the local controller and advised he was ready to depart. At 0913:27, the controller cleared the flight for takeoff and instructed the pilot to turn left heading 050°, which he acknowledged. Shortly after takeoff, ATC communications were transferred to departure control.

The flight was radar-identified at 0914:56, and the pilot was instructed to turn left on course toward the destination airport. The pilot acknowledged the transmission and proceeded in a north-northwesterly direction until 0917:26, at which time the airplane turned left from its on-course heading and continued to climb. At 0917:56, the pilot declared a mayday, advising the controller that he, "…lost ah my engine." About this time, the airplane was 6.8 nm from the approach end of runway 11 and about 6,500 ft mean sea level (msl). Immediately after the mayday call, the controller asked what aircraft was declaring an emergency, to which pilot replied with the partial call sign and that he was, "trying to make it back to the field." Following the mayday transmission, the pilot turned to a southerly heading.

The controller advised the pilot to enter the left base leg of the airport traffic pattern for runway 11, provided the altimeter setting, and indicated the wind was calm. Coordination between the Radar North controller and the local controller occurred, and at 0918:41, the Radar North controller advised the pilot that CAE was at his 10-to-9 o'clock position and 6 miles, and asked him if the airport was in sight, but the pilot did not reply. About 10 seconds later, the Radar North controller inquired, "and uh 42BR Columbia" to which the pilot replied, "Roger I have it in sight I think I can make it." The controller then instructed the pilot to make a straight-in approach to runway 11, and about 0919:02, the pilot advised the controller that he "…lost my fuel pressure."

The pilot was cleared to land twice; however, he did not reply to either clearance, nor did he establish contact with the local controller. At 0921:06, the Radar North controller asked the local controller if she

could see the airplane, to which the local controller responded that the airplane was on short final and she was giving the green light-gun signal to land.

Witnesses reported seeing the airplane impact trees and then a pond; they did not hear any sound from the engine. Three witnesses saw the airplane bank left, and one of those said the airplane pitched up just before it struck the tree. None of the witnesses saw any smoke or fire trailing the airplane.

Pilot Information

Certificate:	Commercial	**Age:**	85,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Front
Other Aircraft Rating(s):	None	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	February 5, 2015
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:	(Estimated) 10000 hours (Total, all aircraft), 430 hours (Total, this make and model)		

The pilot, age 85, held a Federal Aviation Administration (FAA) commercial pilot certificate with ratings for airplane single and multi-engine land, and instrument airplane. He was issued a second-class medical certificate on February 5, 2015, with a limitation requiring the use of corrective lenses. On the application for his last medical certificate, the pilot reported 10,000 hours total flight experience. Based on maintenance records, it was estimated that the pilot had accumulated about 430 hours in the accident airplane.

Family members reported that the pilot was in excellent health and did not take any medication.

Aircraft and Owner/Operator Information

Aircraft Make:	BR LEGEND LLC	**Registration:**	N42BR
Model/Series:	TURBINE LEGEND	**Aircraft Category:**	Airplane
Year of Manufacture:	2003	**Amateur Built:**	Yes
Airworthiness Certificate:	Experimental (Special)	**Serial Number:**	127
Landing Gear Type:	Retractable - Tricycle	**Seats:**	2
Date/Type of Last Inspection:	November 29, 2014 Condition	**Certified Max Gross Wt.:**	3300 lbs
Time Since Last Inspection:		**Engines:**	1 Turbo prop
Airframe Total Time:	428.2 Hrs as of last inspection	**Engine Manufacturer:**	WALTER
ELT:	Installed	**Engine Model/Series:**	M601D
Registered Owner:	On file	**Rated Power:**	770 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

The airplane was manufactured in 2003. The special airworthiness certificate was issued by an FAA Designated Airworthiness Representative (DAR), who also assisted the pilot with building a portion of the airplane. It was powered by a Walters M601D turbine engine that was equipped with a three-bladed Avia V508E-AG/99B/A constant speed, variable pitch, manual feathering, dual-acting, hydraulically-controlled propeller. Propeller blade angle was controlled from the cockpit by a lever that connected via cable to a dual-acting propeller governor, although the feathering circuit at the propeller governor was blanked off with a plate and not available. The airplane was not equipped with an electrically-actuated feathering pump. Although propeller counterweights helped to increase pitch of the propeller blades in the event of oil system failure, they were ineffective in feathering the blades when the propeller was spinning at low rpm due to insufficient centrifugal force generated.

According to the engine maintenance records, the last condition inspection in accordance with the FAA-Approved Turbine Legend Maintenance and Inspection Program was completed on November 29, 2014 at an airplane total time of 428.2 hours. Further review of the maintenance records revealed no entry related to removal of a feathering pump or installation of a plate on the feathering pump circuit at the propeller governor.

The airplane's fuel system consisted of one integral fuel tank spanning the entire length of the wing, with a fuel filler cap at each wingtip; the standard tank configuration held about 100 gallons. Fuel was gravity-fed from each wing into a sump located on the bottom surface of the wing on the airplane centerline. Attached to the outlet fitting of the sump tank was a manually-activated shutoff valve, which connected via aluminum tubing and a flexible hose to an electrically-controlled auxiliary fuel pump. The outlet of the auxiliary fuel pump connected via a flexible hose to a canister fitted with a pleated paper element and a "T" fitting for reading fuel pressure, then via a flexible hose from the filter to the engine-driven fuel pump.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	CAE,236 ft msl	**Distance from Accident Site:**	2 Nautical Miles
Observation Time:	08:56 Local	**Direction from Accident Site:**	101°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	3 knots /	**Turbulence Type Forecast/Actual:**	/ None
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/ N/A
Altimeter Setting:	30.38 inches Hg	**Temperature/Dew Point:**	19°C / 12°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	West Columbia, SC (CAE)	**Type of Flight Plan Filed:**	VFR
Destination:	Asheville, NC (AVL)	**Type of Clearance:**	VFR
Departure Time:	09:14 Local	**Type of Airspace:**	

The 0856 surface observation at CAE indicated wind variable at 3 knots, 10 statute miles visibility, and clear skies. The temperature and dew point were 19 and 12° C, respectively, and the altimeter setting was 30.39 inches of mercury.

Airport Information

Airport:	Columbia Metropolitan Airport CAE	**Runway Surface Type:**	
Airport Elevation:	236 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 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Fatal	**Latitude, Longitude:**	33.947498,-81.162223

The airplane crashed in a pond located adjacent to houses in a residential area. The wreckage was recovered and transferred to a hangar located at Lexington County Airport at Pelion (6J0), Pelion, South Carolina.

According to first responders and FAA personnel, the empennage was partially submerged in the water and was in an inverted position, with the airplane's nose on a magnetic heading of 032°. The wreckage location was about 1.24 nm and 279° from the approach end of runway 11 and about 600 ft south of the runway's final approach path.

Further examination of the accident site area revealed no damage to unmarked powerlines located adjacent to the pond. A strong smell of jet fuel and fuel sheen were noted on the west end of the pond. Damage to the top of a pine tree was noted about 70 ft above ground level; the top of the tree was observed in the water adjacent to the tree. Pieces of curved acrylic material were at the base of the tree, and pieces of composite material were in the water at the west end of the pond. There was no evidence of any tree limbs cut by the propeller blades.

Examination of the wreckage following recovery accounted for all primary and secondary flight controls. The one-piece wing was separated from the impact-damaged fuselage. The vertical and horizontal stabilizers remained attached, and the primary and secondary flight control surfaces remained attached to their respective attach points. With the rudder placed in the neutral position, the rudder trim tab was trailing edge left (tail left); with the elevator in the neutral position, the trim tab was positioned trailing edge up (tail up). Damage to the right horizontal stabilizer was noted on the outboard portion. The engine remained attached to the airframe by the engine mount and the propeller was separated from the engine. There was no evidence of fire.

Examination of the wing revealed extensive impact damage, including fracture of the forward and aft spars of the left wing about 5 ft outboard of the landing gear attachment, and fracture of the aft spar of the right wing. Impact damage was also noted to the left and right ailerons and flaps. The right main landing gear was retracted, and the left main landing gear was extended, although the FAA inspector reported it was retracted when the airplane was recovered. The center section of the wing revealed the flap actuator remained attached to the aft side of the main spar and to the flap torque tube. Continuity was confirmed from the flap torque tube to the control surface for the left flap, but the right flap push/pull rod exhibited bending overload at the rod end. The flaps appeared retracted. The fuel vents of both integral wing tanks were clear of obstructions.

Examination of the flight controls for pitch and yaw revealed both tandem seat controls remained connected and continuity was confirmed from each respective control surface to the cockpit controls. Examination of the aileron flight controls revealed rod ends remained connected for the left and right aileron attachments at the control stick, but both rod ends exhibited bending overload. The left aileron push/pull tube exhibited bending overload outboard of the landing gear location and about 12 inches inboard of the bellcrank near the control surface, but was continuous from the bellcrank to the control surface. The right aileron push/pull tube was continuous from the fracture near the control stick to the aileron control surface.

Examination of the cockpit revealed the lap belt and shoulder harness of the front seat restraint remained latched, but the left side of the lap belt webbing was cut. The fuel shutoff valve was full in, and

continuity was confirmed from the cockpit control to the valve. The auxiliary fuel pump switch was in the on position, and the auxiliary fuel boost pump circuit breaker was not tripped. Examination of the throttle quadrant revealed the engine control lever was in the aft position, the propeller control was in the aft position, and the fuel control lever was in the run position. The landing gear selector was in the up position.

Examination of the fuselage fuel system revealed the sump tank was ruptured, and the fuel supply line from the sump tank was separated at the tank attach point. The manually-actuated shutoff valve was fully open at impact based on an impact mark from hardware attached to the lever and adjacent flat of a b-nut. The Facet-type fuel pump at the sump tank was dry, and the sump tank fuel cap was in place. The auxiliary fuel pump and a Facet-type pump associated with the sump fuel tank were connected electrically to a portable, 24-volt power source and both were operational. The auxiliary fuel pump with attached hoses and fittings, part number 2003-B, serial number 103252 was retained for operational testing at the manufacturer's facility.

Examination of the engine revealed the propeller was separated from the propeller shaft. The right side of the firewall was damaged and pushed aft above the right lower engine mount. The fuel supply line from the auxiliary fuel pump to the fuel filter was tight at both ends. The fuel supply line from the filter outlet to the engine-driven fuel pump was tight at the filter and connected at the fuel pump; the B-nut at the fuel pump was safety wired. Approximately 1 ounce of straw-colored fuel consistent with jet fuel was drained from the fuel filter, while a drop of straw-colored fuel was noted in the threads of the inlet of the engine-driven fuel pump. A small amount of metal shavings were noted at the inlet of the engine-driven fuel pump, while a small amount of metal shavings, sludge, and a portion of a plastic tie wrap tip were noted at the inlet area of the fuel filter housing. The engine and ignition exciters were removed for further examination.

Examination of the engine was performed at a facility in the US, while the fuel control unit, engine-driven fuel pump, and propeller governor were examined at the manufacturer's facility in the Czech Republic. There were no pre-existing mechanical anomalies issues found during the engine examination which would have prevented normal operation. Examination of the engine-driven fuel pump revealed evidence of internal cavitation. In addition, one of the two ignitor boxes displayed evidence of internal coil movement, consistent with too long a duty cycle, and the supporting insulation material on one of the ignitor plugs had disintegrated.

Examination of the propeller revealed all bolts that secured the propeller to the propeller shaft were damaged consistent with pull-out. All three blades remained secured inside the propeller hub, and exhibited large radius aft bending about 30°, beginning midspan. Two of the three blades appeared to be in the low-pitch range position with the counterweights trapped by the spinner in the corresponding positions. The third blade was less than the low-pitch position, and the blade tip was torn. The trapping of the propeller spinner and the counterweights was consistent with the blades being in an un-feathered position. Examination of the propeller revealed no anomalies that may have prevented normal operation.

Flight recorders

The airplane was equipped with digital instruments that recorded engine parameters, including compressor speed (N1), propeller speed (N2), Torque, inter-turbine temperature (ITT), Oil Pressure/Temperature, and Fuel Level. The instruments were retained and submitted to the NTSB's Vehicle Recorder Division located in Washington, D.C.

The instruments contained data from the last power cycle, and parameters were shown in relation to elapsed time since the application of power to the instrument. Three recorded values were noted for oil pressure and oil temperature at 236 seconds, 472 seconds, and 708 seconds. The oil pressure values were 17 pounds per square inch (psi), 34 psi, and 31 psi; the oil temperature values were 15° C, 49° C, and 57° C, respectively. Torque values at 218 seconds, 436 seconds, and 654 seconds were 14%, 78%, and 17%, respectively. Three values for ITT were recorded at 217 seconds, 434 seconds, and 651 seconds: 485° C, 620° C, and 410° C, respectively. There was only one recorded value for N1(58.4%) and N2 (1950 rpm), which was logged at 163 seconds.

The pilot's first contact with ground control before taxi occurred at 0909:37, and the airplane was last visually spotted by ATC personnel at 0921:07, resulting in an elapsed time of 690 seconds. However, no correlation to real time could be made, because the time between engine start and the pilot's first contact with ground control could not be determined.

According to the engine manufacturer representative, comparing the recorded data with established limits of the engine revealed that all recorded readings for oil pressure and the last two readings for oil temperature were within specified limits. The last two recorded ITT and torque readings were consistent with an engine at flight idle.

Medical and Pathological Information

A postmortem examination of the pilot was performed by the Newberry Pathology Associates, P.A. The cause of death was listed as multiple blunt force injuries. The autopsy report further indicated that the heart weighed 560 grams.

Forensic toxicology was performed on specimens of the pilot by the FAA Bioaeronautical Sciences Research Laboratory, Oklahoma City, Oklahoma. The toxicology report indicated the results were negative for carbon monoxide and volatiles, and unquantified amounts of Quinine were detected in the submitted urine and iliac blood specimens.

Tests and Research

Examination and operational testing of the auxiliary fuel pump were performed at the manufacturer's facility. According to the report from the manufacturer, examination of the pump revealed that one of the two motor brush caps was red in color, indicating installation of parts by someone other than the manufacturer or factory repair station. For operational testing, the inlet and outlet hoses and their

respective fittings remained attached. With a 28-volt electrical supply, the fuel boost pump outlet fuel flow was 55 gallons per hour (gph), which is below the factory requirement of 105 gph. Further examination revealed that the pump outlet adapter fitting was installed deeper than that allowed by the AND10064 specification for this interface, which impeded the maximum open position of the internal no-return poppet valve, thereby restricting the outlet fuel flow. After the incorrectly-installed adapter fitting was removed, the pump performance was 109 gph, an acceptable factory test pressure. During subsequent vacuum testing, the motor had an inconsistent/intermittent laboring sound.

Review of the airplane maintenance records revealed no record of removal, replacement, or repair of the auxiliary fuel pump.

Examination of the annunciator panel was performed by the NTSB Materials Laboratory. The results indicated all bulb filaments were intact, and none exhibited evidence of stretching.

Review of the Pilot Information Handbook revealed an emergency checklist titled, "Engine Flame-out In Flight." The first step specified to move the propeller control lever (PCL) to the feather position. The checklist stated to maintain a minimum airspeed of 130 knots indicated if at a low altitude.

According to FAA Order 8130.2H, Airworthiness Certification of Products and Articles, aircraft inspection guidelines for issuance of a special airworthiness certificate specify, in part, that the flight control system should operate properly and the engine(s), propeller(s), and associated instruments operate in accordance with the manufacturer's instructions. There was no mention for a Designated Airworthiness Representative to determine compatibility of airframe, engine, and propeller systems related to emergency systems.

A review of FAA Advisory Circulars (AC) AC 20-27G titled, "Certification and Operation of Amateur-Built Aircraft" issued September 30, 2009, and AC 90-89B titled, "Amateur-Built Aircraft and Ultralight Flight Testing Handbook" issued April 27, 2015, revealed no guidance for experimental aircraft builders regarding turbine engine installation considerations.

Additional Information

Performance Study

An NTSB Performance Study indicated that the pilot maintained the airplane's best glide speed of 130 knots following the emergency declaration and during the attempted return to the runway. The airplane's angle of attack (AOA) was between 1 and 2° before the pilot reported the loss of fuel pressure and between 5 and 10° after. Based on the radar data, the accident airplane's glide ratio was estimated to be 7.5. The glide ratio with a feathered propeller would have been 12.0, resulting in a power-off glide distance of about 12.8 nm from an initial altitude of 6,500 ft.

Administrative Information

Investigator In Charge (IIC):	Monville, Timothy
Additional Participating Persons:	Billy M Marlowe; FAA/FSDO; West Columbia, SC David Gridley; GE Aviation; Lynn, MA Sandor Janosy; FAA/MIDO; North Olmsted, OH Lubomir Strihavka; Air Accidents Investigation Institute Zuzana Sekeresova; GE Aviation Stanislav Suchy; Air Accidents Investigation Institute
Original Publish Date:	June 7, 2017
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=91224

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