



# Aviation Investigation Final Report

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<b>Location:</b>	Cave-In-Rock, Illinois	<b>Accident Number:</b>	CEN16LA335
<b>Date &amp; Time:</b>	August 25, 2016, 10:05 Local	<b>Registration:</b>	N891LL
<b>Aircraft:</b>	Cessna U206G	<b>Aircraft Damage:</b>	Substantial
<b>Defining Event:</b>	Loss of engine power (total)	<b>Injuries:</b>	1 Serious, 1 Minor
<b>Flight Conducted Under:</b>	Public aircraft		

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## Analysis

The airline transport pilot and camera operator were conducting an aerial mapping flight. While level at 3,500 ft above ground level, the turbo propeller-equipped airplane experienced a total loss of engine power. The pilot attempted to restart the engine three times without success. During the subsequent forced landing, the airplane struck a berm, which damaged both wings.

Examination of the engine revealed that fuel would not flow to the fuel nozzle until air pressure was bled upstream of the check valve assembly, located between the engine fuel control and the fuel nozzle. After the air pressure was bled and the fuel pump purged, normal fuel flow resumed, indicating that air had entered the fuel system. Because of the check valve assembly design, an in-flight engine restart was not possible after air entered the fuel line, and there was no procedure to clear air from the fuel line while in flight. Examination of the engine and fuel system could not establish a reason for air entering the fuel line.

## Probable Cause and Findings

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

A total loss of engine power due to air entering the fuel system for reasons that could not be determined based on available information. Contributing to the accident was the pilot's inability to restart the engine due to the check valve assembly design.

## Findings

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**Aircraft** (general) - Malfunction

**Aircraft** (general) - Design

## Factual Information

### History of Flight

<b>Enroute</b>	Loss of engine power (total) (Defining event)
<b>Landing</b>	Hard landing

On August 25, 2016, about 1005 central daylight time, a Cessna U206G airplane, N891LL, was substantially damaged during a forced landing near Cave-In-Rock, Illinois. The pilot received minor injuries and the camera operator received serious injuries. The airplane was registered to and operated by the State of Illinois under the provisions of 14 *Code of Federal Regulations* Part 91 as a public use flight. Day visual meteorological conditions prevailed for the local flight, which departed without a flight plan from Abraham Lincoln Capital Airport (SPI), Springfield, Illinois at 0845.

Prior to departure for the aerial mapping flight, the pilot stated the fuel tanks were dipped to confirm a desired fuel load of 550 lbs (89 gallons). During the first 45 minutes of the flight, the fuel selector was in the "both" tanks position. After noticing a fuel imbalance, the pilot moved the fuel selector to the "right" tank position, where it remained for about the next 30 minutes.

While wings level at 3,500 ft above ground level (agl), the pilot and photographer noticed an abrupt loss of engine power. The pilot switched the fuel selector back to the "both" tanks position and was unsuccessful in restarting the engine three times. During the restart attempts and engine out descent, the pilot elected not to feather the propeller due to his concern of the time required to unfeather the propeller. Step No. 2 of the 'Engine Restart During Flight' checklist in the airplane's Pilot Operating Handbook directs the propeller control be placed to feather. With the propeller not feathered, the pilot stated the airplane descended at a high vertical speed.

The pilot executed a forced landing, during which the airplane impacted a grassy area at a high descent rate. Both wings and the engine firewall were damaged when the airplane hit a berm. Prior to egressing the airplane, the pilot turned the battery switch off and moved the fuel selector to the "off" position.

Examination at the accident site revealed the airplane was resting left wing low, with fuel leaking out of the left-wing tank vent. During recovery operations, 20 gallons of fuel were drained from the right wing and 5 gallons from the left wing. After removal from the accident site, the airplane was placed in the operator's hangar, where the investigative team performed a records review and examined the airframe and engine systems.

In 1988, a Soloy Turbine PAC engine was installed in accordance with supplemental type certificate (STC) SA2353NM. This powerplant conversion included an Allison 250-C20S free turboshaft engine and a Soloy reduction gearbox.

Examination of the engine revealed no evidence of engine fire, uncontained failure or malfunction. Minor impact damage was present on the outer combustion chamber, but the engine was otherwise

undamaged. Both oil and fuel filters were equipped with bypass indicators. Neither filter indicated bypass.

The N2 rotor rotated smoothly by manually turning the power output shaft. Rotational continuity from the power turbine to the propeller was confirmed and the power turbine was not damaged. The N1 rotor rotated normally after energizing the starter-generator. The N1 spun up normally. Borescope inspection of turbine blades revealed no evidence of thermal erosion, foreign object damage or abnormal combustion.

The fuel supply line was disconnected from the fuel spray nozzle, revealing a few drops of fuel in the line. The starter-generator was engaged to check for fuel flow to the fuel spray nozzle; no fuel flowed. The fuel line to the fuel-flow transducer was disconnected and the starter-generator was engaged, with no fuel flow.

The fuel line to the check valve assembly was disconnected and the starter-generator was engaged. After a brief purge of air, fuel flowed freely from the fuel supply line. The disconnected fuel lines were reconnected, the fuel spray nozzle was connected to the fuel supply line, and the starter-generator was engaged again. After air was purged from the fuel pump, fuel flowed freely to the fuel nozzle, which produced a normal spray pattern.

The purpose of the check valve assembly is to prevent a buildup of raw fuel in the combustion case if the burner drain valve remains in the open position when the engine is not operating, which could result in a hot start. The check valve also prevents fuel nozzle drip at shutdown, reducing the risk of a fire. Based on the design, an engine restart is not possible when air from the fuel system has reached the check valve, and there is no procedure to clear the air while in-flight.

A vacuum test was performed on the engine fuel system. The fuel line at the fuel selector switch was capped off, and 8 pounds per square in vacuum (PSIV) was applied to the drain port of the engine-mounted fuel pump. The system held the vacuum for two minutes.

The wing fuel vent systems were examined by applying compressed air through each wing fuel vent line, with no blockages observed. Both wing fuel vent valves operated normally, with no restrictions. Both wing float switches were electrically tested, with no anomalies. The respective wing fuel low level lights illuminated when each wing fuel float valve reached about 2 inches from the bottom of the respective fuel tank. A vacuum test was performed from the engine pump filter bowl to the fuel valve, with no defects noted.

Compressed air was applied to test for air leaks in the wing fuel feed tubes/lines, from the wing to each fuel reservoir. No anomalies were noted. The fuel selector valve was removed from the airplane and the bottom plate was removed to expose the plate with the ports. The valve was selected to each position (OFF, LEFT, RIGHT, BOTH), with no anomalies noted.

After completion of the examination, the engine was shipped to the Rolls-Royce engine testing facility, where an engine functional test run was conducted. The engine started normally. Since a propeller was not available to prevent an overspeed, the engine was only accelerated past ground idle enough to demonstrate normal acceleration capability. The fuel pump was disassembled and there was no evidence of cavitation or other malfunction.

The Shadin Fuel Flow Indicator was removed from the airplane and shipped to the National Transportation Safety Board Vehicle Recorder Division. The unit displayed engine fuel flow, fuel used, and fuel remaining. The unit did not interface with airplane's fuel quantity indicating system and required the crew to enter the initial fuel onboard. All calculations and data provided by the unit were based on fuel flow. Between power cycles, the indicator retained the last fuel used and fuel remaining. After power up, the unit indicated fuel remaining was 325 lbs. and fuel used was 225 lbs.

## Pilot Information

<b>Certificate:</b>	Airline transport	<b>Age:</b>	69, Male
<b>Airplane Rating(s):</b>	Single-engine land; Multi-engine land	<b>Seat Occupied:</b>	Left
<b>Other Aircraft Rating(s):</b>	Helicopter	<b>Restraint Used:</b>	3-point
<b>Instrument Rating(s):</b>	Airplane	<b>Second Pilot Present:</b>	No
<b>Instructor Rating(s):</b>	Airplane multi-engine; Airplane single-engine	<b>Toxicology Performed:</b>	No
<b>Medical Certification:</b>	Class 2 Without waivers/limitations	<b>Last FAA Medical Exam:</b>	February 10, 2016
<b>Occupational Pilot:</b>	Yes	<b>Last Flight Review or Equivalent:</b>	October 9, 2015
<b>Flight Time:</b>	8357 hours (Total, all aircraft), 268 hours (Total, this make and model), 7135 hours (Pilot In Command, all aircraft), 43 hours (Last 90 days, all aircraft), 25 hours (Last 30 days, all aircraft), 2 hours (Last 24 hours, all aircraft)		

## Passenger Information

<b>Certificate:</b>		<b>Age:</b>	
<b>Airplane Rating(s):</b>		<b>Seat Occupied:</b>	Right
<b>Other Aircraft Rating(s):</b>		<b>Restraint Used:</b>	3-point
<b>Instrument Rating(s):</b>		<b>Second Pilot Present:</b>	No
<b>Instructor Rating(s):</b>		<b>Toxicology Performed:</b>	No
<b>Medical Certification:</b>		<b>Last FAA Medical Exam:</b>	
<b>Occupational Pilot:</b>	No	<b>Last Flight Review or Equivalent:</b>	
<b>Flight Time:</b>			

## Aircraft and Owner/Operator Information

<b>Aircraft Make:</b>	Cessna	<b>Registration:</b>	N891LL
<b>Model/Series:</b>	U206G	<b>Aircraft Category:</b>	Airplane
<b>Year of Manufacture:</b>	1986	<b>Amateur Built:</b>	
<b>Airworthiness Certificate:</b>	Experimental (Special)	<b>Serial Number:</b>	U206-06937
<b>Landing Gear Type:</b>	Tricycle	<b>Seats:</b>	2
<b>Date/Type of Last Inspection:</b>	February 4, 2016 Annual	<b>Certified Max Gross Wt.:</b>	3600 lbs
<b>Time Since Last Inspection:</b>		<b>Engines:</b>	1 Turbo prop
<b>Airframe Total Time:</b>	6170 Hrs at time of accident	<b>Engine Manufacturer:</b>	Allison
<b>ELT:</b>	C126 installed, activated, aided in locating accident	<b>Engine Model/Series:</b>	250C20S
<b>Registered Owner:</b>	STATE OF ILLINOIS	<b>Rated Power:</b>	420 Horsepower
<b>Operator:</b>	STATE OF ILLINOIS	<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>	KHSB,396 ft msl	<b>Distance from Accident Site:</b>	26 Nautical Miles
<b>Observation Time:</b>	10:15 Local	<b>Direction from Accident Site:</b>	322°
<b>Lowest Cloud Condition:</b>	Clear	<b>Visibility</b>	10 miles
<b>Lowest Ceiling:</b>	None	<b>Visibility (RVR):</b>	
<b>Wind Speed/Gusts:</b>	6 knots /	<b>Turbulence Type Forecast/Actual:</b>	/ None
<b>Wind Direction:</b>	240°	<b>Turbulence Severity Forecast/Actual:</b>	/
<b>Altimeter Setting:</b>	30.1 inches Hg	<b>Temperature/Dew Point:</b>	29°C / 25°C
<b>Precipitation and Obscuration:</b>	No Obscuration; No Precipitation		
<b>Departure Point:</b>	SPRINGFIELD, IL (SPI )	<b>Type of Flight Plan Filed:</b>	None
<b>Destination:</b>	SPRINGFIELD, IL (SPI )	<b>Type of Clearance:</b>	None
<b>Departure Time:</b>	08:45 Local	<b>Type of Airspace:</b>	Class G

## Wreckage and Impact Information

<b>Crew Injuries:</b>	1 Serious, 1 Minor	<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, 1 Minor	<b>Latitude, Longitude:</b>	37.4775,-88.214447

## Administrative Information

<b>Investigator In Charge (IIC):</b>	Folkerts, Michael
<b>Additional Participating Persons:</b>	Marshel Humphries; Flight Standards District Office; Springfield, IL Timothy Grigsby; Illinois Department of Transportation; Springfield, IL John Miller; Soloy Aviation Solutions; Olympia, WA Ernest Hall; Textron Aviation; Wichita, KS
<b>Original Publish Date:</b>	September 11, 2018
<b>Last Revision Date:</b>	
<b>Investigation Class:</b>	<a href="#">Class</a>
<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=93896">https://data.nts.gov/Docket?ProjectID=93896</a>

The National Transportation Safety Board (NTSB) is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in other modes of transportation—railroad, transit, highway, marine, pipeline, and commercial space. We determine the probable causes of the accidents and events we investigate, and issue safety recommendations aimed at preventing future occurrences. In addition, we conduct transportation safety research studies and offer information and other assistance to family members and survivors for each accident or event we investigate. We also serve as the appellate authority for enforcement actions involving aviation and mariner certificates issued by the Federal Aviation Administration (FAA) and US Coast Guard, and we adjudicate appeals of civil penalty actions taken by the FAA.

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, “accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties ... and are not conducted for the purpose of determining the rights or liabilities of any person” (Title 49 *Code of Federal Regulations* section 831.4). Assignment of fault or legal liability is not relevant to the NTSB’s statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code* section 1154(b)). A factual report that may be admissible under 49 *United States Code* section 1154(b) is available [here](#).