



# Aviation Investigation Final Report

<b>Location:</b>	Cleveland, Tennessee	<b>Accident Number:</b>	ERA18LA199
<b>Date &amp; Time:</b>	July 26, 2018, 16:48 Local	<b>Registration:</b>	N1311S
<b>Aircraft:</b>	Cessna 182	<b>Aircraft Damage:</b>	None
<b>Defining Event:</b>	AC/prop/rotor contact w person	<b>Injuries:</b>	1 Fatal
<b>Flight Conducted Under:</b>	Part 91: General aviation - Personal		

## Analysis

After completing a personal flight with his wife, the private pilot secured the engine by placing the mixture control in the idle cut-off position. Based on physical evidence observed after the accident, he likely moved the ignition switch toward the off position and removed the key. The pilot's wife indicated that, after they performed local errands and returned to the airport, the pilot was performing his preflight inspection of the airplane with the ignition key in his pocket. Although airport security video did not capture the accident sequence and the pilot's wife, who was by the airplane's right cabin door, did not see her husband move the propeller, she heard the propeller move and the engine starting or trying to start. The pilot likely slightly moved the propeller and the engine briefly started; the propeller then rotated and fatally injured the pilot. The engine did not sustain operation, and the propeller ceased rotating.

Postaccident examination of the 42-year-old ignition switch revealed that it appeared to be in the off position when observed visually from the pilot's seat, but its actual selected position was more toward the right magneto position. The switch and key were determined to be slightly misaligned with the instrument panel placard markings. On- and off-airframe operational testing of the ignition switch in the as-found position revealed the right magneto was hot, or not grounded. In addition, examination of the cut surfaces of the key notches revealed relatively smooth and reflective surface features consistent with a worn surface on the flank of the notch adjacent to the key retention ridge and on the tip end of the shank opposite the notched side. Examination of the key cylinder revealed an area with a smooth and reflective surface consistent with wear on the lower side of the key slot. The location and shape of the worn area was consistent with wear contact with the tip of the key as it was inserted and removed. The key could be removed from the switch in any of the five positions due to the wear of the switch's internal components, contrary to its intended function that would retain the key in any position except the off position. Although the switch manufacturer tested all new switches to ensure this functionality when new, that test is not specified to be performed at any time as part of any inspection or checklist by the switch manufacturer, airframe manufacturer, or Title 14 *Code of Federal Regulations* Part 43 Appendix D.

Although the mechanic who performed the last annual inspection reported the key-to-switch integrity was satisfactory with no discrepancies, the worn condition of the ignition switch likely existed at the time of the annual inspection, which was about 31 flight hours before the accident flight (excluding the pilot's previous flight the day of the accident). Additionally, during the annual inspection when the mechanic installed the ignition switch after repairs, he failed to properly align the switch positions with the marks on the instrument panel placard.

## Probable Cause and Findings

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

The undetected wear of the ignition switch and key, which allowed removal of the key from an intermediate position and subsequently led to an unintended engine start-up. Contributing to the undetected wear of the 42-year-old ignition switch was the lack of guidance by the switch manufacturer and airframe manufacturer for procedures to detect lack of integrity between the ignition key and switch.

### Findings

<b>Aircraft</b>	Switching - Fatigue/wear/corrosion
<b>Organizational issues</b>	Availability of policy/proc - Manufacturer
<b>Organizational issues</b>	Availability of policy/proc - Equipment supplier

## Factual Information

### History of Flight

<b>Standing</b>	Preflight or dispatch event
<b>Standing-engine(s) start-up</b>	AC/prop/rotor contact w person (Defining event)

#### HISTORY OF FLIGHT

On July 26, 2018, about 1648 eastern daylight time, the private pilot of a Cessna 182P, N1311S, was fatally injured when he was struck by the propeller during a preflight inspection of the airplane at the Cleveland Regional Jetport (RZR), Cleveland, Tennessee. The airplane, which was not damaged, was owned by NCFL Ltd., and privately operated under the provisions of Title 14 *Code of Federal Regulations* (CFR) Part 91. Visual meteorological conditions prevailed for the intended personal flight to Blairsville Airport (DZJ), Blairsville, Georgia.

The pilot's wife reported that they had flown to RZR earlier that day, and her husband performed a normal shutdown of the engine utilizing the mixture control. They performed errands then returned to the airport. While outside the airplane behind the passenger door facing her seat, her husband was performing a preflight inspection of the airplane with the airplane's ignition key in his pocket. She heard the "propeller move" which she described as unusual and heard the engine like it was starting or trying to start. She looked up and noticed her husband fall to the ground. She went to him and thought the propeller stopped at that time, then went inside the fixed-base-operator to summon help.

According to FAA and airport personnel, airport security video did not capture the sequence of events.

#### AIRCRAFT INFORMATION

##### *Airplane History*

The four-place, high-wing airplane, serial number 18264876, was manufactured in 1976. It was powered by a 230-hp Continental O-470-S engine equipped with two independent engine-driven magnetos electrically controlled by an on-condition, key actuated, five position rotary ignition switch mounted on the lower left portion of the pilot's instrument panel.

The pilot purchased the airplane in April 2007, and it remained in his operational control the entire time. According to the pilot's wife, since then, there was no previous instance in which the ignition key could be removed from the switch in an intermediate position, or any position other than the off position. She also indicated that since owning the airplane, there was no previous issue of the key coming out, falling out, or being loose.

Cessna Service Bulletin SEB91-5 Revision 1, dated June 14, 1991, applicable to the accident make and model airplane by serial number and also by the installed ignition switch, specified an inspection and

lubrication of the ignition switch; however, there was no requirement to determine if the key could be removed from any position other than off.

Review of the airplane service manual that describes inspection procedures at 50 Hours, 100 Hours, 200 Hours, and special inspection items, and review of 14 CFR Part 43 Appendix D which documents the scope and detail of items to be inspected in the annual or 100-hour inspections revealed no specific mention to check if the key could be removed from any position other than off.

A review of the Pilot's Operating Handbook that documents the preflight inspection items revealed a requirement to verify the ignition switch being in the off position before beginning the outside inspection. The inspection of the propeller specifies to check for nicks, security and oil leaks.

Airworthiness Directive (AD) 93-05-06, applicable to ACS Products Company and Gerdes Products Company ignition switches and the accident make and model airplane by serial number, specified an internal inspection for corrosion, lubrication of the ignition switch, and to determine if a diode or other surge suppresser was installed on the starter solenoid. The AD was required to be completed within 100 hours after the effective date of the AD (April 29, 1993), or at the next annual inspection, whichever occurred first. The AD did not specify a test to determine key to switch integrity, or to determine if the key could be removed from any position other than off. The maintenance records reflect that the AD was originally signed off as being completed on July 27, 1993, at airframe total time of 2,880.7 hours. The next compliance with the AD as part of an annual inspection was on January 10, 2018, at airframe total time 4,895 hours. Based on pilot records excluding the flight earlier that day, the airplane had been operated about 31 hours since the inspection was performed. There was no entry in the airframe maintenance records dating to manufacture indicating replacement of the ignition switch or key.

The mechanic who performed the annual inspection and complied with AD 93-05-06 indicated that he also installed new internal ignition switch contacts and terminal board supplied in kit A3650-2. He also reportedly checked the ignition key to switch integrity in all switch positions other than off reporting no discrepancies. Additionally, as part of his procedures, while the engine was running, he slightly pulled aft on the key to see if it could be removed from any position and also in between positions. The key did not come out in any position other than off.

#### *Postaccident Airplane and Ignition Switch Examination*

Examination of the cockpit by representatives of the FAA revealed that the mixture control was in the idle-cutoff position, the throttle was full out, the battery and alternator rocker switches were each in the off position. From the pilot's perspective, the ignition switch appeared to be in the off position; however, on closer inspection the ignition switch was more toward the right magneto position. The ignition switch was photographed and then after installation of the ignition key, the switch was able to be turned counterclockwise to the OFF position. The inspector also noted that the ignition key was easily removable from the ignition switch in the right and left positions. Subsequent testing of the ignition system was performed by a mechanic with FAA oversight. The ignition switch was marked where found (between the off and right positions), and in that position, the right magneto was hot, or not grounded, and the key could be fully removed from the ignition switch that was tightly secured to the instrument panel. When in the off position, the switch did not align with the instrument panel placard marking. The airplane's ignition switch and key were then removed and sent to the FAA for operational testing at the manufacturer's facility with FAA oversight.

Examination of the Gerdes Products Company ignition switch (Model No. A-510, Cessna part number (P/N) C292501-0105) and key were performed at ACS Products Company. The switch was manufactured in April 1976, and there was no record of it being returned to either Gerdes or ACS since being manufactured as neither company repairs switches after delivery. The switch testing was performed using the current procedure for a A-510-2 Ignition Switch (With start), which required verification in part that the key could not be removed in any position other than off. The examination revealed that the key was removable in every position (left, right, both, start, and off). In the as-found position which was marked, testing verified the key could be removed and the right magneto was not grounded. The key tumbler was removed but company personnel reportedly were unable to determine why the key could be removed from the left, right, both, and start positions. With NTSB permission, a black rubber coating was removed from the end of the key that would be held by hand during rotation of the key. The key was marked with "Y11", "USA" and a single line parallel to the long axis. It also could not be determined if the key was the original supplied with the switch as there were no markings to indicate it was an original key (manufacturer logo and key number). The manufacturer representative indicated that the drawing specifies the key to be brass, but does not specify what type of brass. The key P/N is specified to be L1054B from ILCO (Kaba Ilco Corporation). The switch was reassembled and it and the key were sent to the NTSB Materials Laboratory.

According to the NTSB Materials Laboratory factual report, examination of the cut surfaces of the key notches revealed relatively smooth and reflective surface features consistent with a worn surface on the flank of the notch adjacent to the key retention ridge. A smooth and reflective surface consistent with wear was also observed on the tip end of the shank opposite the notched side. Examination of the key cylinder revealed a quadrilateral-shaped area with a smooth and reflective surface consistent with wear on the lower side of the key slot. The location and shape of the worn area was consistent with wear contact with the tip of the key as it was inserted and removed. Although not part of the report, the key material was determined to be brass alloy c377.

## MEDICAL AND PATHOLOGICAL

An autopsy examination was not requested by NTSB or FAA, nor was an autopsy or external examination performed by the medical examiner's office. Forensic toxicology was performed on specimens of the pilot by the FAA Bioaeronautical Sciences Research Laboratory, Oklahoma City, Oklahoma. The toxicology report stated no ethanol or tested drugs were detected. Testing for cyanide was not performed and the specimens were insufficient for carbon monoxide analysis.

## TESTS AND RESEARCH

### *Previous NTSB Investigations*

A review of the NTSB's database for previous accidents and incidents in which a loss of ignition switch-to-key integrity led to unintended engine startup revealed three previous investigations. In all three, the key was not in the ignition switch which was believed to be in the off position, but the engine started which resulted in injury or uncommanded movement of the airplane. The three cases were NTSB Case Nos. NYC82FNA13, CHI87DER02, and BFO90DIG02.

### *FAA Service Difficult Reports (SDR's)*

A search of FAA SDR's database from 1993 to October 2018 revealed four reports which cited that the ignition key could be removed from the ignition switch in various positions.

### Pilot Information

<b>Certificate:</b>	Private	<b>Age:</b>	70,Male
<b>Airplane Rating(s):</b>	Single-engine land	<b>Seat Occupied:</b>	None
<b>Other Aircraft Rating(s):</b>	None	<b>Restraint Used:</b>	None
<b>Instrument Rating(s):</b>	None	<b>Second Pilot Present:</b>	No
<b>Instructor Rating(s):</b>	None	<b>Toxicology Performed:</b>	Yes
<b>Medical Certification:</b>	BasicMed With waivers/limitations	<b>Last FAA Medical Exam:</b>	June 12, 2017
<b>Occupational Pilot:</b>	No	<b>Last Flight Review or Equivalent:</b>	July 10, 2017
<b>Flight Time:</b>	1500 hours (Total, all aircraft), 811 hours (Total, this make and model), 1453 hours (Pilot In Command, all aircraft), 15 hours (Last 90 days, all aircraft), 12 hours (Last 30 days, all aircraft), 2 hours (Last 24 hours, all aircraft)		

### Aircraft and Owner/Operator Information

<b>Aircraft Make:</b>	Cessna	<b>Registration:</b>	N1311S
<b>Model/Series:</b>	182 P	<b>Aircraft Category:</b>	Airplane
<b>Year of Manufacture:</b>	1976	<b>Amateur Built:</b>	
<b>Airworthiness Certificate:</b>	Normal	<b>Serial Number:</b>	18264876
<b>Landing Gear Type:</b>	Tricycle	<b>Seats:</b>	4
<b>Date/Type of Last Inspection:</b>	January 10, 2018 Annual	<b>Certified Max Gross Wt.:</b>	2950 lbs
<b>Time Since Last Inspection:</b>	31 Hrs	<b>Engines:</b>	1 Reciprocating
<b>Airframe Total Time:</b>	4895 Hrs	<b>Engine Manufacturer:</b>	Continental
<b>ELT:</b>		<b>Engine Model/Series:</b>	O-470-S
<b>Registered Owner:</b>		<b>Rated Power:</b>	230 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>	KRZR, 860 ft msl	<b>Distance from Accident Site:</b>	
<b>Observation Time:</b>	16:55 Local	<b>Direction from Accident Site:</b>	
<b>Lowest Cloud Condition:</b>	Few / 6000 ft AGL	<b>Visibility</b>	10 miles
<b>Lowest Ceiling:</b>	None	<b>Visibility (RVR):</b>	
<b>Wind Speed/Gusts:</b>	/	<b>Turbulence Type Forecast/Actual:</b>	Unknown / Unknown
<b>Wind Direction:</b>		<b>Turbulence Severity Forecast/Actual:</b>	N/A / N/A
<b>Altimeter Setting:</b>	29.97 inches Hg	<b>Temperature/Dew Point:</b>	31°C / 16°C
<b>Precipitation and Obscuration:</b>	No Obscuration; No Precipitation		
<b>Departure Point:</b>	Cleveland, TN (RZR )	<b>Type of Flight Plan Filed:</b>	Unknown
<b>Destination:</b>	Blairsville, GA (DZJ )	<b>Type of Clearance:</b>	None
<b>Departure Time:</b>	16:48 Local	<b>Type of Airspace:</b>	

## Airport Information

<b>Airport:</b>	Cleveland Regional Jetport RZR	<b>Runway Surface Type:</b>	
<b>Airport Elevation:</b>	860 ft msl	<b>Runway Surface Condition:</b>	
<b>Runway Used:</b>		<b>IFR Approach:</b>	None
<b>Runway Length/Width:</b>		<b>VFR Approach/Landing:</b>	None

## Wreckage and Impact Information

<b>Crew Injuries:</b>	1 Fatal	<b>Aircraft Damage:</b>	None
<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 Fatal	<b>Latitude, Longitude:</b>	35.211944, -84.798057(est)

## Administrative Information

<b>Investigator In Charge (IIC):</b>	Monville, Timothy
<b>Additional Participating Persons:</b>	William J Hess; FAA/FSDO; Nashville, TN Raymond Almgren; FAA MIDO; Phoenix, AZ Jeff Janusz; FAA ACO; Wichita, KS
<b>Original Publish Date:</b>	November 6, 2019
<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=97895">https://data.nts.gov/Docket?ProjectID=97895</a>

The National Transportation Safety Board (NTSB), established in 1967, is an independent federal agency mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The NTSB makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

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](#).