Aviation Investigation Final Report

Location:	Calhoun, Kentucky	**Accident Number:**	ERA12FA262
Date & Time:	April 1, 2012, 16:00 Local	**Registration:**	N9448Q
Aircraft:	Beech 58	**Aircraft Damage:**	Substantial
Defining Event:	Loss of control in flight	**Injuries:**	1 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot was departing his home airport to fly to another airport to refuel the airplane. Witnesses reported that the airplane lifted off from the 1,800-foot-long grass runway; however, none of the witnesses observed the airplane crash shortly after takeoff. The airplane rolled left and impacted the ground inverted in a wooded area near the departure end of the runway; there was no postcrash fire.

Examination of the flight controls revealed no evidence of preimpact failure or malfunction. Damage to one of the right engine propeller blades was consistent with engine power at impact, whereas the left engine propeller blades showed no evidence of power at impact. Thus it is likely that the left engine experienced a total loss of power just after takeoff, which the pilot was unable to control. Both engines were removed, transported to the manufacturer's facility, and test run with no mechanical discrepancies noted.

Rust-colored water was detected in various fuel system components from both engines. Further, the strainer drain lines and outer tank drains in both engines' fuel systems were partially blocked by rust-colored debris. Postaccident examination revealed evidence of long-term water contamination of both engines' fuel systems due to leakage past the fuel caps, which are normally replaced on an "on-condition" basis during maintenance. The engine failure was likely due to the water contamination in the fuel system, which was not detected by the pilot during the preflight inspection.

Further, the leaking fuel caps most likely existed, but went undetected, when the airplane's most recent annual inspection was performed about 4 months earlier. A review of airplane maintenance records revealed that the only entry related to the fuel filler caps since the airplane was manufactured in 1972 was dated July 2010, at which time the left fuel filler cap was replaced and an outer o-ring of the incorrect dimension was installed. In April 2011, as a result of a 2008 investigation of a Canadian registered Beech 58 airplane that had water enter the fuel tank due to deteriorated fuel filler cap o-rings, the manufacturer revised the maintenance manual of Beech 55 and 58-series airplanes to require fuel cap overhaul. Maintenance manual guidance in effect when the accident airplane's most recent annual inspection was performed excluded the accident airplane (by serial number) from this overhaul. Since this accident, the manufacturer has revised its Beech 55 and 58 maintenance manuals to include the fuel cap overhaul requirement for all potentially affected airplanes, including the accident airplane.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:
The failure of the pilot to maintain airplane control after experiencing a loss of power from the left engine due to water contamination of the fuel system. Contributing to the accident was the pilot's inadequate preflight inspection of the airplane and maintenance personnel's inadequate annual inspection, because both failed to detect the long-term water contamination of the fuel system and the deteriorated outer o-rings on both fuel caps. Also contributing to the water contamination of the fuel system was the inaccurate information and instructions in the airplane maintenance manual pertaining to overhaul requirements of the fuel filler caps.

Findings

Personnel issues	Preflight inspection - Pilot
Aircraft	Scheduled maint checks - Inadequate inspection
Aircraft	(general) - Related maintenance info
Aircraft	Directional control - Not attained/maintained
Aircraft	(general) - Related maintenance info

Factual Information

History of Flight

Takeoff	Fuel contamination
Initial climb	Loss of control in flight (Defining event)
Uncontrolled descent	Collision with terr/obj (non-CFIT)

HISTORY OF FLIGHT

On April 1, 2012, about 1600 central daylight time, a Beech 58, N9448Q, registered to and operated by a private individual, crashed shortly after takeoff from Woosley Field Airport (96KY), Calhoun, Kentucky. Visual meteorological conditions prevailed at the time and no flight plan was filed for the 14 Code of Federal Regulations (CFR) Part 91 personal flight from 96KY to Madisonville Municipal Airport (2I0), Madisonville, Kentucky. The airplane sustained substantial damage and the private pilot, the sole occupant was fatally injured. The flight was originating at the time of the occurrence.

The purpose of the flight was for the pilot to fly to 2I0 for fuel.

Two witnesses reported to the Federal Aviation Administration (FAA) inspector-in-charge (IIC) that they observed the airplane takeoff and noted the airplane became airborne before being abeam a building on the north side of the runway. One witness also reported that after becoming airborne and before reaching tree height, the wings rocked then returned to wings level. The witness reported the airplane turned left and flew over trees on the south side of the runway. The witnesses who were familiar with the pilot reported he “always” flew past the departure end of the runway then turned to fly over the neighborhood, and they considered it strange for him to turn before reaching the end of the runway.

Another witness reported observing the accident airplane being taxied to the approach end of runway 27, followed by staying there for a longer than normal period of time. While there, the witness heard run-up of the engines followed by seeing the airplane being positioned into alignment for takeoff. The witness further stated the airplane was on the takeoff roll and appeared to get airborne faster than normal. The witness estimated that the airplane became airborne abeam the pilot’s house, then she lost sight of the airplane but heard what she thought was the sound of an impact. She went inside her house and listened to her local scanner and heard nothing about the crash. Because she did not see any smoke, and not believing the airplane had crashed, she did not immediately report the crash. About 2246 that evening, she called the McClean County 911 Center, and reported observing the airplane takeoff.

Later that same day, because the pilot did not return as expected, a search was initiated. The wreckage was located about 2330.

PERSONNEL INFORMATION

The pilot, age 46, held a commercial pilot certificate with ratings airplane single land and instrument airplane. He also held a private pilot certificate with airplane multi-engine land rating which was limited to visual flight rules only. He was issued a third class medical certificate with no limitations or restrictions on April 30, 2010.

Review of the pilot’s third logbook that begins with an entry dated May 29, 2010, and ends with an entry dated December 10, 2011, revealed the carry forward time on the first page was recorded to be approximately 1,609 hours. Between those dates, he logged a total of approximately 138 hours, of which, approximately 117 hours were in multi-engine airplanes. Of the 117 hours in multi-engine airplanes, approximately 2 hours were logged in the accident airplane on the date of his airplane purchase (December 10, 2011). The approximately 2 hours of flight were from Middlesboro-Bell County Airport (1A6), Middlesboro, Kentucky, to the Madisonville Municipal Airport (2I0), Madisonville, Kentucky. The airplane hour meter reflected that the airplane had been operated approximately 5 hours since the pilot’s purchase on December 10, 2011.

A certified flight instructor reported that during the flight on December 10, 2011, the accident pilot had performed all of the maneuvers required for a flight review, so he endorsed the pilot logbook.

The pilot’s wife reported that her husband did not have any significant health issues. Review of his medical file from FAA located in Oklahoma City, Oklahoma, revealed he had not previously reported any heart issues.

AIRCRAFT INFORMATION

The airplane was manufactured in 1972 by Beech Aircraft Corporation as model 58, and was designated serial number TH-204. It was powered by two 285 horsepower Continental Motors, Inc., IO-520-C engines and equipped with Hartzell constant speed propellers.

The airplane was equipped with 172 gallon total capacity bladder type fuel tanks of which 166 gallons are usable. Each wing contained three interconnected fuel cells for a total capacity of 86 gallons per wing. The fuel cells consist of an inboard leading edge baffled cell, an outboard leading edge cell in which the fuel filler cap is installed, and a box section cell. Each wing fuel system has 3 drains consisting of one in the inboard aft section of the inboard leading edge baffled cell, the fuel strainer drain, and a drain in the aft inboard section of the box section cell.

The fuel system is an off/on/crossfeed selectable arrangement controlled from the cockpit via cable to a valve located in each respective wheel well. With the fuel selector in the on position, each engine receives its fuel supply from the inboard baffled cell, to the selector valve, strainer, airframe electric boost pump, then to the engine-driven fuel pump on the accessory section of the engine.

Review of the maintenance records that begin with the standard airworthiness certificate issuance entry in the 1st airframe logbook dated February 23, 1972, to the last entry in the 4th airframe logbook dated December 9, 2011, revealed only 1 entry specifically referencing replacement or repair of the fuel filler caps. The entry, dated July 2, 2010, indicates the left fuel cap was replaced with a serviceable unit and a new packing part number (P/N) MS29513-338 was installed; the hour meter reading at that time was recorded to be approximately 778. There was no entry in the maintenance records indicating the right fuel cap was repaired, replaced, or overhauled since the airplane was manufactured.

The airplane was last inspected in accordance with an annual inspection on December 9, 2011, which was 1 day before the pilot purchased the airplane. The airplane total time at the time of the annual inspection was recorded to be approximately 5,542 hours, and the hour meter reading was 784.

The mechanic who performed the last annual inspection of the airplane reported he used 14 CFR Part 43 Appendix D and the Beech 100-Hour or Annual Long Form Inspection Guide as references; however, he did not keep the copy of the Beech 100-Hour or Annual Long Form Inspection Guide which he marked on during the inspection signifying compliance with each inspection item. The mechanic further stated that discrepancies noted during the inspection were annotated on the invoice he provided to the airplane owner and subsequently to NTSB. A statement from the mechanic is an attachment to the public docket for this case.

The hour meter reading at the time of the accident was approximately 789.

METEOROLOGICAL INFORMATION

A surface observation weather report taken at Owensboro-Daviess County Airport (OWB), Owensboro, Kentucky, on the day of the accident at 1556 hours local, or approximately 4 minutes before the accident indicates the wind was from 230 degrees at 11 knots with gusts to 16 knots, the visibility was 10 miles, and scattered clouds existed at 8,500 feet. The temperature and dew point were 31 and 17 degrees Celsius, respectively, and the altimeter setting was 29.68 inches of Mercury. The accident site was located about 205 degrees and 13 nautical miles from OWB.

AIRPORT INFORMATION

The Woosley Field Airport (96KY) is a private airstrip owned by the pilot and is equipped with a single grass runway oriented 09/27, which is listed as being 1,800 feet in length and 100 feet wide. The airport elevation was reported to be an estimated 465 feet. A steep drop-off in terrain elevation from the runway elevation was noted beyond the departure end of runway 27.

Trees border the south side of the runway beginning at 37 degrees 33.146 North latitude and 087 degrees 16.360 minutes West longitude. Inspection of the trees revealed no evidence of tree contact.

Inspection of the airstrip and hangar on April 3, 2012, revealed no airplane parts on the runway and no evidence of fuel storage. Further inspection of the airstrip revealed tie down stakes associated an outside parking space; the pilot's stepson reported his stepfather would park the airplane outside if intended to be flown soon.

WRECKAGE AND IMPACT

The airplane impacted in a wooded area and came to rest inverted with the empennage elevated; the airplane was resting on a magnetic heading of approximately 250 degrees. The accident site was located at 37 degrees 33 minutes 03.9 seconds North latitude and 087 degrees 16 minutes 37.2 seconds West longitude, or approximately 1000 feet and 225 degrees from the departure end of runway 27.

Examination of the airplane revealed all components necessary to sustain flight remained attached or were in close proximity to the main wreckage. There was no in-flight or postcrash fire noted. Flight control cable continuity was confirmed for roll, pitch, and yaw; the elevator and rudder flight control cables were cut to facilitate recovery of the airplane. All primary and secondary flight control surfaces remained attached at their respective attach points. Both engines remained attached and the right propeller remained attached to the engine while the left propeller was separated from the engine but found in the area of the left engine. The landing gear was extended and the flaps were symmetrically extended approximately 15 degrees (approach setting). Both engines were removed and retained for further examination.

Examination of the fuel system of left wing revealed a section of the outer fuel cell with attached fuel cap was separated; no fuel was detected in the remaining cells of the wing. An aluminum fuel line from the auxiliary fuel pump to the fuel strainer was partially fractured; no fuel stains were noted in the area. Additionally, the spar web in that area was fractured. The fuel sump/strainer was not safety wired. Following removal of the fuel sump/strainer bowl, rust colored water was noted and the interior surface of the strainer bowl was heavy corroded. The strainer filter was also corroded. Disassembly of the fuel strainer drain line revealed it was nearly completely blocked internally by rust debris. Examination of the drain of the inboard baffled fuel cell revealed no obstructions, while inspection of the box section cell sump drain revealed the drain holes were plugged by unknown debris. The fuel selector was in the on position and there were no obstructions from the inboard cell to the engine. No obstructions were noted to the fuel vent system. The fuel cap and adapter were retained for further examination. Further examination of the left wing revealed the aileron trim measured 1.75 inches extended, which equates to approximately 6 units tab trailing edge down (up and down limits are 12.5 units).

Examination of the right wing revealed fuel leakage was noted from the installed right wing fuel cap during recovery of the airplane. Approximately 11 gallons of blue colored fuel consistent with 100 low lead were drained from the right wing fuel tank. No fuel was noted at the fuel sump/strainer. Rust colored water was noted coming from the fuel sump/strainer during removal of the strainer bowl. Following removal of the fuel sump/strainer bowl, rust colored water was noted and the interior surface of the strainer bowl was heavy corroded. The strainer filter was also corroded. The fuel strainer drain line was nearly completely blocked internally by white powdery substance (consistent from corrosion) at the 90-degree fitting. A sample of liquid from the auxiliary fuel pump to the strainer then to the firewall contained fuel admixed with water. Examination of the drain of the inboard baffled fuel cell revealed no obstructions, while inspection of the impact damaged drain of the box section cell sump also revealed no obstructions. The fuel selector was in the on position and there were no obstructions from the inboard cell to the engine. No obstructions were noted to the fuel vent system. The fuel cap and adapter were retained for further examination.

Examination of the cockpit revealed the elevator trim indicator indicated 6 units airplane nose up, the aileron trim indicated neutral, and the rudder trim indicated 6 units airplane nose left. The left and right fuel selectors were in the on position, and both fuel boost pump switches were in the high position. Inspection of the single control throw-over control yoke revealed it was positioned to the left seat and found consistent with right roll input. The cockpit floor was crushed and clockwise displacement of the co-pilot's rudder torque tube was noted. Examination of the rudder flight control system revealed the rudder interconnect rod was connected to the pilot's rudder bellcrank; however, the rod was fractured near the attach point of the co-pilot's rudder bellcrank. Further, the interconnect rod exhibited chafing associated with contact by a lighting hole of a structural member adjacent to the pilot's rudder bellcrank.

Examination of the empennage revealed the left elevator trim actuator near the control surface revealed an extension between 1 1/8 to 1 3/16 inches, which corresponds to 7 to 8 degrees tab trailing edge down (limits are 10 units up and 25 units down). The right elevator trim actuator near the control surface measured 1.0 inch extension which corresponds to 2 to 3 degrees tab trailing edge down. Inspection of the rudder trim actuator near the control surface revealed an extension of 3 ¾ inches, which corresponds to 5 degrees trailing edge tab right (limits are 25 left and right).

The fuel system components of both engines were examined to determine whether fuel or contaminants were noted. Testing of samples of fluid recovered from the fuel system components and lines in both engine compartments was performed with a new tube of "SAR-GEL", which is an alcohol and water indicating paste. By design, a change to red indicates the presence of water and/or alcohol. Water/alcohol was detected in the samples taken at the left engine-driven fuel pump, left engine fuel strainer sump filter, and left engine-driven fuel pump drain line, while water/alcohol was detected in samples taken at the right engine fuel pressure line, right engine fuel metering unit, right engine fuel strainer sump filter, and right engine fuel boost pump to firewall. No water/alcohol was detected in a sample of blue colored fuel consistent with 100 low lead fuel drained from the right fuel tank. The water and fuel samples drained from the airplane's fuel system were not further analyzed.

Both engines were removed from the airframe, and sent to the engine manufacturer's facility for proposed engine runs. Impact damaged components of the left engine consisting of the starter adapter, starter, induction elbows, and engine mounts were removed and replaced. Also, the oil pump housing which was cracked was temporary repaired for the engine run. The crankshaft flange was fractured and missing a section consisting of approximately 1 ½ propeller mounting holes; circumferential cracks were noted on the exterior surface of the crankshaft aft of the crankshaft flange. Safety concerns pertaining to the cracked crankshaft precluded a full operational test of the engine, which was operated a total of approximately 9 minutes. The engine was placed in the test cell with a test club propeller installed, started, and allowed to warm up. Magneto testing was performed at 2,100 rpm, each magneto drop was approximately 40 rpm, and full throttle rpm was recorded to be approximately 2,550 (specification is 2,700 rpm). Throttle chop and throttle burst checks were performed twice, no discrepancies were noted. During the engine run, there was no oil pressure at the oil transfer collar; this was later attributed to impact damage to the nose section of the engine. Removal of the alternator to inspect the collar revealed no visible discrepancies. Post engine run, a differential compression check of each cylinder was performed at 80 psi; all cylinders were 69 psi or greater.

Impact damaged components of the right engine consisting of the oil sump, inlet and outlet fittings of the mechanical fuel pump, inlet fitting of the metering unit, induction elbows, engine mounts, and exhaust risers for cylinder Nos. 1, 3, and 5 were removed and replaced. The top and bottom ignition leads for the No. 5 cylinder which were impact damaged were repaired. Additionally, a crack related to impact damage in the induction "Y" was temporarily repaired. A circumferential crack in the crankshaft aft of the crankshaft flange was weld repaired in an effort to run the engine. Safety concerns pertaining to the cracked crankshaft precluded a full operational test of the engine, which was operated twice. The engine was placed in the test cell with a test club propeller, started, and allowed to warm up, but shut down after 4 minutes due to a fuel leak. The engine was started a second time and operated a total of 11 minutes. During the second engine run magneto testing was performed at 2,100 rpm, each magneto drop was approximately 60 rpm, and full throttle rpm was recorded to be approximately 2,572 (specification is 2,700 rpm). Throttle chop and throttle burst checks were performed twice, no discrepancies were noted. During the engine run, there was no oil pressure at the oil transfer collar; this was later attributed to impact damage to the nose section of the engine. Post engine run, a differential compression check of each cylinder was performed at 80 psi; all cylinders were 70 psi or greater.

MEDICAL AND PATHOLOGICAL

A postmortem examination of the pilot was not performed. Specimens for toxicological testing were not taken prior to embalming which began about 30 minutes after the body was received at the funeral home.

While no x-rays were performed, the coroner stated that based on his experience, the right radius and ulna were fractured. He also said that 3 bones in the cervical vertebrae were fractured. Bruising was noted on the abdomen and right side of the abdomen. The coroner estimated that the pilot weighed 260 pounds. The skull was fractured about the left eye, and the left index finger was broken. He also had a possible broken right ankle. After embalming, vitreous fluid, blood, and urine specimens were obtained at the request of the FAA/NTSB for toxicological testing.

Forensic toxicology was performed on specimens of the pilot by the FAA Bioaeronautical Sciences Research Laboratory, Oklahoma City, Oklahoma. The toxicology report stated testing for carbon monoxide, cyanide, and drug screen was not performed. The results were negative in vitreous for ethanol, while 2 mg/dL Isopropanol and 36 mg/dL Methanol were detected in vitreous. The blood and urine specimens were not in sufficient amounts for analysis.

TESTS AND RESEARCH

A review of the Beechcraft Baron B55/E55/58 and G58 Illustrated Parts Catalog (IPC), P/N 58-590000-19, Section 28-10-00, Fuel Cap and Adapter, revealed two fuel cap assemblies are useable on the accident airplane. The applicable P/N's are 96-380035-1, and 96-380035-3. The IPC further indicates that Beech fuel cap assembly P/N 96-380035-1 correlates to Shaw Aero Devices fuel cap assembly P/N 431-40, while Beech fuel cap assembly P/N 96-380035-3 correlates to Gabb Special Products, Inc., fuel cap assembly P/N 37810-1. The Beech IPC for Beech fuel cap assembly P/N 96-380035-1 specifies the outer and inner packing or o-ring's are P/N's MS29513-338 and MS29513-10 or spares replacement P/N MS29513-010, respectively. The IPC for Beech fuel cap assembly P/N 96-380035-3 specifies the outer and inner packing or o-ring's are P/N's MS37617-339 and MS9021-110, or spares P/N AS3578-110, respectively. Outer packing or o-ring P/N 37617-339 is equivalent to packing or o-ring P/N MS29513-339.

Parker Hannifin (formerly Shaw Aero Devices, Inc.) purchased the Gabb Special Products, Inc., product line in 1975, and the last fuel cap of P/N 37810-1 was manufactured by Parker Hannifin in 1979.

Examination and operational testing of the fuel caps was performed at Parker Hannifin's facility located in Naples, Florida. The left and right fuel caps installed on the airplane at the time of the accident were identified by raised markings on their cap bodies as Gabb Special Products, Inc., P/N 37810-1. The fuel caps were not serialized; therefore, the date of manufacture could not be determined. Operational testing of the fuel caps was performed by placing them as received into a manufactured adapter, and then placing water in the center of the fuel cap followed by pressurizing the adapter from below. Leakage from the cap outer perimeter or shaft lock is evidenced by bubbles. The acceptance test procedures (ATP) for the fuel cap specifies to examine the product, and pressure testing at 0.8 and 25.0 psig.

Examination of the left fuel cap and adapter revealed impact damage was noted to the radius adapter flange. Extensive embedded corrosion was noted on the sealing surface of the adapter. The handle (P/N 37656), did not remain flush with the base when pushed closed; the upper surface of the handle protruded slightly above the base and would not remain completely closed. Slight contact mark was noted on the base adjacent to the adapter flange bend. Damage to the adapter precluded testing of the cap and adapter as an assembly. The fuel cap as received was placed in a test fixture which was attached to a calibrated air supply. Water was poured onto the center of the fuel cap and the fixture was pressurized to 0.01 psig; leakage was noted. The fuel cap was pressurized to 0.02 to 0.03 psig; bubbles of air were noted from the lock P/N 38038 and also at the outer seal. At 0.09 psig, leakage from the lock P/N 38028 and the entire perimeter of the fuel cap/test adapter was noted. The fuel cap/test fixture could not be pressurized greater than 5.0 psig because of excessive leakage noted from the lock and perimeter of the cap/test fixture. Air pressure was removed from the fixture and with the cap installed onto the test fixture, 100mL of water were poured onto the center of the fuel cap. The water drained into the test fixture in a total of 1 minute 36 seconds. As viewed while installed, the outer o-ring was hard and had embedded corrosion on the outer surface which contacts the adapter. The outer o-ring was removed from the base and was still pliable on the inner surface. No surface cracks were noted on the outer surface of the o-ring when it was deformed by hand. Inspection of the surface area of the outer o-ring of the base revealed it appeared to be in satisfactory condition, but was dirty (normal). An exemplar o-ring of the same P/N that was installed per the maintenance records on July 2, 2010, P/N MS29513-338 (incorrect for this fuel cap), was installed onto the base and the fuel cap was returned to the test fixture. The cap and test fixture were pressurized to 0.18 psig. Leakage was noted from the center of the lock and 3 areas of the cap perimeter. A new outer o-ring P/N MS29513-339 (correct for this fuel cap) was installed onto the base and the fuel cap was returned to the test fixture. The cap and test fixture were pressurized to 0.08 psig. Leakage was only noted from the center of the lock. At 5.0 psig, no leakage was noted around the cap perimeter; however, heavy leakage was noted around the center of the lock.

Further examination of the left fuel cap revealed initial attempts to remove the handle by normal disassembly methods were unsuccessful. The handle was submerged in penetrating fluid for greater than 1 hour in an attempt to remove it, but was unsuccessful. Because the handle pin P/N 38061 could not be removed and to facilitate complete disassembly of the fuel cap, the handle was cut in half from the finger recess towards the center of the lock shaft. Following cutting, a calibrated torque wrench was positioned on both halves of the cut handle to document the lifting force required to open the handle. Repeated testing revealed no detectable measurable force was required to open the handle beyond the unlock position. It should be noted that the ATP for this fuel cap does not specify this type of test. Complete disassembly of the fuel cap was then performed. The handle was worn on the radius portion that contacts the surface of the bearing plate (which resulted in the handle not remaining fully closed despite being fully pushed down and released). Examination of the inner o-ring revealed more visible cracks on the bottom surface, and the o-ring was flat on the bottom, sides, and inside diameter surfaces. The inner o-ring was hard and not pliable. The base, retainer, spring, and bearing plate were unremarkable. The fuel cap was reassembled using the existing base, retainer, spring, bearing plate, handle from the right fuel cap, and new outer and inner o-rings. The fuel cap was placed in the test fixture and pressurized to 25.0 psig. Only slight leakage was noted from the outer perimeter. Because an exemplar handle was not available, with new inner and outer or-rings installed, the left fuel cap would not pass testing to 25.0 psig due to the worn radius of the right handle. An adequate seal was obtained by pushing down on the handle (roughly simulating a handle that is seated properly). Inspection of the outer o-ring revealed the outer surface had a rough texture. The outer o-ring was measured with a ring gauge, and the ID was confirmed to be a "-338" P/N, which corresponds to the entry in the airframe maintenance records.

Examination of the right fuel cap and adapter revealed extensive embedded corrosion on the sealing surface of the adapter. The handle P/N 37656 did not remain flush with the base when pushed closed; the upper surface of the handle protruded slightly above the base and would not remain completely closed. Paint build-up was noted on the shaft of the lock. The outer o-ring exhibited a rough texture with embedded corrosion on the outer surface of the o-ring. The fuel cap as received was placed in a test fixture which was attached to a calibrated air supply. Water was poured onto the center of the fuel cap and the fixture was pressurized to 0.09 psig. Leakage was noted at the lock shaft and 1 area of the outer perimeter. At 2.35 psig, heavy leakage was noted at the lock shaft and some at the perimeter, while at 5.54 psig, heavy leakage was noted at the lock shaft and some at the perimeter which precluded testing at a higher value. The outer o-ring sealing surface area of the base appeared OK. The base did not exhibit evidence of a contact mark. The outer o-ring was removed from the base and was still pliable on the inner surface, but heavy surface corrosion was noted on the adapter sealing surface area of the o-ring. No surface cracks were noted on the outer surface of the o-ring when it was deformed by hand. An exemplar o-ring P/N MS29513-338 was installed onto the base of the fuel cap in an effort to determine the affect of an incorrect sized outer o-ring installed. The fuel cap was returned to the test fixture. The cap and test fixture were pressurized to 0.03 psig; leakage was noted from the perimeter. The pressure was increased and at approximately 0.07 psig, leakage began at the shaft of the lock. At approximately 0.09 psig, leakage was noted at the shaft of the lock and perimeter, while at approximately 0.10 psig, leakage was noted at the perimeter. The exemplar outer o-ring P/N MS29513-338 was removed, and o-ring P/N MS29513-339 (correct for this fuel cap) was installed. The fuel cap was returned to the test fixture. The cap and test fixture were pressurized to 0.03 psi; leakage was noted from the perimeter. At 0.07 psig, leakage was noted from the shaft of the lock. At 0.91 psig, heavy leakage was noted at the shaft of the lock, while at 1.77 psig, heavy leakage was noted at the shaft of the lock and some at the outer perimeter. At 6.2 psig, heavy leakage was noted at the shaft of the lock and some at the outer perimeter. Further testing at a higher pressure was not feasible due to the leakage from the shaft of the lock. The fuel cap was completely disassembled and the inner o-ring was noted to be flat on the top, bottom, and inside diameter.

Further examination of the right fuel cap revealed the outside diameter of the inner o-ring was somewhat curved. Cracks were noted on the bottom side of the o-ring, which was hard but somewhat pliable. The radius of the handle was worn. The base, retainer, spring, and bearing plate were unremarkable. The fuel cap was reassembled using the existing base, retainer, spring, bearing plate, handle, and new outer and inner o-rings. The fuel cap was placed in the test fixture and pressurized to 25.37 psig. No leakage was noted at the shaft of the lock or outer perimeter. With new inner and outer o-rings installed, a calibrated torque wrench was positioned on the handle to document the lifting force required to open the handle. Repeated testing revealed no detectable measurable force was required to open the handle beyond the unlock position. It should be noted that the ATP for this fuel cap does not specify this type of test.

Dimensionally, o-ring P/N's MS29513-338 and 37617-339/MS29513-339 have the same thickness; however, the inside diameter for P/N MS29513-338 is 3.124 to 3.076 inches, while the inside diameter for P/N 37617-339/MS29513-339 is 3.310 to 3.240 inches.

The Transportation Safety Board of Canada (TSB of Canada) tested the fuel caps from a Canadian registered Beech 58 airplane, registration C-GLAC, that was ditched in a river in British Columbia on September 17, 2008, following loss of power from the right engine shortly after takeoff. The TSB of Canada file number for the event was A08W0197, which according to the IIC, is not a public report. Following recovery of the airplane, a sample of water taken from the engine-driven fuel pump cavity was compared with the river water and the properties were different. The TSB of Canada requested testing of the fuel caps Parker Hannifin (formerly Shaw Aero Devices, Inc.) which revealed that at 0.5 psi applied to the test fixture, both fuel caps leaked past the axle and handle assembly. Both fuel caps were disassembled after testing which revealed missing parts, o-rings on both axles were cracked and broken, and both axle shafts had corrosion suggesting long term exposure to moisture. In September 2009, Transport Canada published Service Difficulty Advisory AV-2009-05, which outlined the discrepancies of flush mounted fuel caps from the September 2008 event, and the importance of proper maintenance of the fuel cap assemblies.

In December 2009, the FAA published Aviation Maintenance Alert No. 377, referencing Transport Canada's Service Difficult Advisory AV-2009-05.

As the TSB of Canada investigation was ongoing, personnel from HBC along with personnel from Parker Hannifin, the current manufacturer of the Shaw Aero Devices flush mounted fuel caps, reviewed the then current HBC Maintenance Manual (MM) procedures for the Model 35, 36, 55 and 58 series airplanes and the King Air Model 90, 100, 200, and 300 series airplanes in regards to the flush mounted fuel filler caps. These MMs were revised to include a note stating the following: "Inspect the fuel filler cap outer o-ring for flexibility, splits, cracks, or distortion. If the o-ring is damaged in any way, replace or overhaul the fuel filler cap." This was to provide the user with a defined condition to allow the flush cap to be effectively evaluated for condition. After the revision was incorporated in the Baron 55 and 58 MM, specifically to section 28-10-00, HBC realized that because of the note's placement it may not be obvious to the user that this requirement was applicable to all Baron 55 and 58 airplanes. The applicable MM paragraphs for the other airplanes referred to read correctly. The Baron 55 and 58 MM, section 28-10-00, was corrected to read as intended in the July 2012 MM change; the note was applicable to all serial number airplanes.

Inspection of the fuel filler cap is also specified in the Baron 55, 56TC and 58 100-Hour or

Annual Long Form Inspection Guide. Section D of the guide titled Wings and Carry-Through Structure, item 7, which calls to inspect the fuel filler cap and fuel filler adapters, and references the Maintenance Manual Chapter 28-10-00, 201.

A review of the maintenance manual revealed the fuel caps used for the accident airplane are considered an on-condition item, and there is no procedure(s) described in the MM that a mechanic can perform/use to determine whether there is leakage past the fuel cap's inner or outer packings or o-rings.

According to documents from 2 different airports, and information from the pilot's wife, the accident airplane was fueled at 1A6 after the pilot took possession of it. The Middlesboro Bell County Aiport (1A6) Board Attorney reported that there were 2 fuel sales on the date the pilot took possession of the accident airplane (December 10, 2011). One sale was associated with his previous airplane, and the second sale was attributed to the accident airplane; both were associated with 100 low lead (100LL). The Board Attorney reported that the self- service fuel pump used to fuel both airplanes has a standard filtration system that is "sumped' regularly. Additionally, water absorbing filters were installed. The last servicing of the fuel tank before the fuel sale of December 10, 2011, was made on November 25, 2011. Between December 10, 2011, and March 31, 2012, a total of approximately 127 fuel sales were made; there were no reported issues related to the quality of fuel. On February 13, 2012, a total of 50.0 gallons 100LL fuel were purchased by the pilot at the Madisonville Municipal Airport, Madisonville, KY. The Madisonville Municipal Airport manager reported the water absorbing fuel filters are installed, and the last fuel load received prior to the fueling on February 13, 2012, was on October 12, 2011. The manager also reported that there have been no fuel issues prior to or since receipt of the fuel load. The pilot's wife reported that her husband put the fuel from that sale into a portable container and transported that container to an airstrip located in Sacramento, KY.

Weight and balance calculations were performed using the latest empty weight of the airplane listed in the maintenance records (3,609.5 pounds), empty weight moment (291,322.74), and the weight of the pilot per medical records from his last medical visit of March 13, 2012 (276.6 pounds), positioned at midpoint of the allowable seat positions (arm 78.5). Because the actual fuel load on board could not be determined, a fuel load of 13 gallons in each wing stipulated by the POH/AFM for minimum required for takeoff was used for calculation purposes. The calculations indicate the weight and center of gravity at the moment of engine start was 3,970.1 pounds and 80.47 inches aft of datum, respectively. The center of gravity range about that weight is 74.01 to 86.01 inches aft of datum. Assuming all other variables remain the same, any increase in fuel load causes an increase in gross weight.

Calculations to determine takeoff roll distance and accelerate stop distance were performed using weather data listed in the Meteorological Information section of this report, and the estimated airplane weight at the moment of engine start. The takeoff distance chart in the POH/AFM stipulates that takeoff power is applied, the flaps are retracted, the landing gear is retracted at positive climb, the runway is paved, level, and dry, and lift off speed is 86 knots.

Based on the estimated weight of (3,970 pounds), pressure altitude of 705 feet, temperature 31 degrees Celsius, and headwind component of 9 knots, the takeoff roll distance from a paved, level dry runway would have been 1,200 feet. The accelerate stop distance chart in the POH/AFM stipulates that takeoff power is applied, the flaps are retracted, the cowl flaps are open, the runway is paved, level, and dry, and the decision speed for all weights is 86 knots. Based on the estimated weight of (3,970 pounds), pressure altitude of 705 feet, temperature 31 degrees Celsius, and headwind component of 9 knots, the accelerate stop distance from a paved, level, dry runway would have been 3,100 feet. Neither chart have notes indicating how to adjust the distances for a grass runway or flap extension.

The airplane Pilot's Operating Handbook and FAA Approved Airplane Flight Manual (POH/AFM) indicates that during a preflight inspection, the fuel sumps in the left and right wheel wells, and also the fuel drains in each wing are to be drained. Section VIII of the POH/AFM indicates that to open on a daily basis the snap-type fuel drains to purge any water from the system.

Pilot Information

Certificate:	Commercial; Private	**Age:**	46,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 3 Without waivers/limitations	**Last FAA Medical Exam:**	April 30, 2010
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	December 10, 2011
Flight Time:	1747 hours (Total, all aircraft), 2 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	Beech	**Registration:**	N9448Q
Model/Series:	58	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	TH-204
Landing Gear Type:	Retractable - Tricycle	**Seats:**	6
Date/Type of Last Inspection:	December 9, 2011 Annual	**Certified Max Gross Wt.:**	5500 lbs
Time Since Last Inspection:	5 Hrs	**Engines:**	2 Reciprocating
Airframe Total Time:	5542 Hrs as of last inspection	**Engine Manufacturer:**	CONT MOTOR
ELT:	C91 installed, not activated	**Engine Model/Series:**	IO-520-C
Registered Owner:	Daniel J. Woosley	**Rated Power:**	285 Horsepower
Operator:	Daniel J. Woosley	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	OWB,407 ft msl	**Distance from Accident Site:**	13 Nautical Miles
Observation Time:	15:56 Local	**Direction from Accident Site:**	25°
Lowest Cloud Condition:	Scattered / 8500 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	11 knots / 16 knots	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	230°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.68 inches Hg	**Temperature/Dew Point:**	31°C / 17°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Calhoun, KY (96KY)	**Type of Flight Plan Filed:**	None
Destination:	Madisonville, KY (2I0)	**Type of Clearance:**	None
Departure Time:	16:00 Local	**Type of Airspace:**	

Airport Information

Airport:	Woosley Field Airport 96KY	**Runway Surface Type:**	Grass/turf
Airport Elevation:	465 ft msl	**Runway Surface Condition:**	Unknown
Runway Used:	27	**IFR Approach:**	None
Runway Length/Width:	1800 ft / 100 ft	**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Fatal	**Latitude, Longitude:**	37.550834,-87.276947

Administrative Information

Investigator In Charge (IIC):	Monville, Timothy
Additional Participating Persons:	Matthew J Galica; FAA/FSDO; Louisville, KY Paul Yoos; Hawker Beechcraft Corporation; Wichita, KS Chris Lang; Continental Motors, Inc.; Mobile, AL
Original Publish Date:	August 13, 2013
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=83261