Aviation Investigation Final Report

Location:	Chugiak, Alaska	**Accident Number:**	ANC17LA028
Date & Time:	June 5, 2017, 18:00 Local	**Registration:**	N35700
Aircraft:	Cessna 172	**Aircraft Damage:**	Substantial
Defining Event:	Fuel related	**Injuries:**	2 Minor
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot reported that, about 1 hour after takeoff on the personal flight, the engine started "sputtering" and then lost all power. The pilot was unable to restart the engine and maneuvered the airplane for landing at a nearby airport. The airplane subsequently touched down in an open field, impacted a fence, and came to rest inverted in the grass, resulting in substantial damage.

During recovery of the airplane, about 1 gallon of fuel was drained from the left wing and about 7.5 gallons of fuel were drained from the right wing. Examination revealed no preimpact mechanical malfunctions or failures with the airframe or engine. The engine was satisfactorily test run several times during the examination. The fuel injector servo successfully passed a flow check and showed no preimpact mechanical malfunctions or failures. Various fuel samples from the airplane were tested and no water was detected.

The pilot initially reported that the fuel selector valve was positioned at the left tank position when the engine started experiencing issues, but later reported that he was using the right tank position during the engine issues. Given the airplane's fuel state following the accident and the lack of anomalies found during postaccident examination, it is likely that the loss of engine power was the result of fuel starvation when the pilot exhausted the fuel supply of the left wing tank.

Probable Cause and Findings

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

The pilot's improper in-flight fuel management, which resulted in a total loss of engine power due to fuel starvation.

Findings

Aircraft	Fuel - Fluid management
Aircraft	Fuel - Incorrect use/operation
Personnel issues	Use of equip/system - Pilot
Personnel issues	Monitoring equip/instruments - Pilot

Factual Information

History of Flight

Enroute-cruise	Fuel related (Defining event)
Enroute-cruise	Fuel starvation
Enroute-cruise	Attempted remediation/recovery
Landing	Off-field or emergency landing
Landing	Collision during takeoff/land

On June 6, 2017, about 1800 Alaska daylight time, a Cessna 172I (Skyhawk) airplane, N35700, sustained substantial damage following a loss of engine power and a subsequent impact with terrain at the Birchwood Airport (BCV), Chugiak, Alaska. The private pilot and sole passenger sustained minor injuries. The airplane was registered to and operated by the pilot under the provisions of Title 14 *Code of Federal Regulations* Part 91 as a visual flight rules personal flight when the accident occurred. Day visual meteorological conditions prevailed, and no flight plan had been filed. The flight departed from the Sixmile Lake Airport (AA06), Anchorage, Alaska at about 1700.

The pilot reported the route of the flight went to the Knik Glacier area and was to terminate back at AA06. The purpose of the flight was for sightseeing with a friend. Enroute back to AA06 while flying about one half mile southwest of BCV at 1,200 ft above mean sea level and 100 kts, the engine started "sputtering" and then quit. The pilot reported he adjusted the airspeed to about 65 kts and attempted to restart the engine. In a written statement dated June 11, 2017, he reported he "went through a quick flow" of checking the master switch, the key position, all of the electrical circuit breakers, the throttle, the mixture, the propeller control, and the fuel selector valve. He switched the fuel selector valve from the right position to the left position, turned on the boost pump, and tried to restart the airplane with no success. He then switched the fuel selector valve to the both position and tried another start with no success.

The pilot attempted to conduct a forced landing at the nearest airport and maneuvered the airplane for a landing to runway 02L at BCV. Subsequently, the airplane touched down short of the runway in a flat open field about 20 ft south of the airport. During the landing roll, the airplane impacted the airport perimeter chain-link fence, the nose wheel separated, the propeller impacted terrain, and the airplane came to rest inverted in the grass, about 150 ft to the southeast of the threshold of runway 02L as shown below in figure 1. The airplane sustained substantial damage to both wings, the fuselage, and the empennage. The two occupants egressed from the inverted airplane without further incident.

Figure 1 – View of the inverted airplane at BCV (courtesy of the NTSB).

In a conversation on June 8, 2017 with the NTSB investigator-in-charge (IIC), the pilot reported that the fuel selector valve was in the "left position" when the engine started to cause problems. He initially reported that he was "using the left" fuel tank prior to the accident. He later reported that he was "using the right" fuel tank prior to the accident. He added, he switched the fuel selector valve to "both" after being in the left and right positions. After the airplane impacted terrain and came to rest, he reported that he set the fuel selector valve to the off position.

In the safety recommendation section of the NTSB Accident/Incident Reporting Form 6120.1, the pilot recommended further experience for himself with the inflight restarting procedures for the airplane.

Pilot Information

Certificate:	Private	**Age:**	35,Male
Airplane Rating(s):	Single-engine land; Single-engine sea	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Lap only
Instrument Rating(s):	None	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	January 22, 2016
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	September 4, 2016
Flight Time:	(Estimated) 180.8 hours (Total, all aircraft), 165.3 hours (Total, this make and model), 88 hours (Pilot In Command, all aircraft), 15 hours (Last 90 days, all aircraft), 5.6 hours (Last 30 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Cessna	**Registration:**	N35700
Model/Series:	172 I	**Aircraft Category:**	Airplane
Year of Manufacture:	1968	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	17256916
Landing Gear Type:	Tricycle	**Seats:**	4
Date/Type of Last Inspection:	February 11, 2017 Annual	**Certified Max Gross Wt.:**	2299 lbs
Time Since Last Inspection:	18 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	3874.7 Hrs at time of accident	**Engine Manufacturer:**	Lycoming Engines
ELT:	C91 installed, not activated	**Engine Model/Series:**	IO-360-A1B6
Registered Owner:		**Rated Power:**	200 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

A review of the airplane maintenance records revealed that the originally installed engine, a 150-horsepower Lycoming Engines O-320-E2D, was removed and the accident engine, a 200-horsepower Lycoming Engines IO-360-A1B6 (serial number L-19632-51A), was installed in May 1995. The engine retrofit was completed under Supplemental Type Certificate (STC) SA807CE.

In May 1995, an 18-gallon O&N Aircraft Modifications, Inc., auxiliary fuel tank (kit number 172100, serial number 182) was installed in the aft baggage compartment under STC SA615NE.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	PABV,96 ft msl	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	01:56 Local	**Direction from Accident Site:**	40°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	3 knots /	**Turbulence Type Forecast/Actual:**	None / None
Wind Direction:	230°	**Turbulence Severity Forecast/Actual:**	N/A / N/A
Altimeter Setting:	29.72 inches Hg	**Temperature/Dew Point:**	17°C / 7°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	ANCHORAGE, AK (AA06)	**Type of Flight Plan Filed:**	None
Destination:	ANCHORAGE, AK (AA06)	**Type of Clearance:**	None
Departure Time:		**Type of Airspace:**	Class G

Airport Information

Airport:	BIRCHWOOD BCV	**Runway Surface Type:**	Asphalt
Airport Elevation:	83 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	02L	**IFR Approach:**	None
Runway Length/Width:	4010 ft / 100 ft	**VFR Approach/Landing:**	Forced landing

Wreckage and Impact Information

Crew Injuries:	1 Minor	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Minor	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 Minor	**Latitude, Longitude:**	61.411109,-149.515548(est)

The NTSB IIC and a Federal Aviation Administration (FAA) aviation safety inspector (ASI) traveled to BCV shortly after the accident occurred on June 6, 2017. The NTSB IIC and the FAA ASI documented the accident site. Both wing fuel tanks remained intact from the accident sequence and no signs of a fuel leak were observed. Both wing fuel tank caps were observed to be correctly installed and secured. The wreckage was recovered and transported to a secure location in Wasilla, Alaska for a future examination

of the airframe and engine. During the recovery process, about 1 gallon of fuel was retrieved from the left wing and about 7.5 gallons of fuel were retrieved from the right wing. On August 15, 2017, a wreckage examination and layout were conducted under the direction of the NTSB IIC. Two FAA ASIs along with air safety investigators from the NTSB and Textron Aviation were present.

Airframe control continuity was established. Airframe to engine control continuity was also established.

The fuel selector valve, as shown below in figure 2, was examined and manipulated freely to all four positions (left tank, right tank, both tanks, and off) with no issues noted. Heavy usage marks were observed on the valve, which was intact and connected to the system via a split pin. The placard on the fuel selector valve stated, "Switch to single tank operation immediately upon reaching cruse altitude above 5,000 feet."


AFT FUEL TRANSFER SYSTEM CAPACITY 16.0 GAL.
1. OPERATE ON MAIN TANKS UNTIL RIGHT FUEL GAUGE READS 2/3 FULL
TRANSFER WHILE OPERATING ON RIGHT MAIN TANK IN STRAIGHT AND
EVEL FLIGHT ONLY.
3. TRANSFER IN PROGR
HT ILLUMIN
ALL FLIGHT BOTH ATTITUDES
GAL
BOTH TANKS ON
FOR TAKEOFF AND LANDING
FUEL SELECTOR
RIGHT
3 gal.
LEVEL
FLIGHT
ONLY
LEFT
2 gal.
LEVEL
LIGHT
ONLY
SWITCH
OPERATION
CRUISE ALTITUDE
TANKS
UPON REACHING
5000 FEET

Figure 2 – Fuel selector valve (courtesy of the NTSB).

The fuel strainer screen was observed to be clean and free from debris. The fuel strainer bowl was observed to have light corrosion and free from debris.

Upon examination of the auxiliary tank, residual fuel was observed, but it was located below the fuel pickup port in the auxiliary tank. Fuel samples from the left wing tank, the right wing tank, the auxiliary tank, and the gascolator were tested using water-finding paste. No presence of water was detected in all the fuel samples. All the fuel samples had similar appearance and smell to 100 low lead fuel.

The engine was functionally tested on the airframe as shown below in figure 3. A fuel can, containing about 2 gallons of fuel that had been recovered from the wing tanks, was plumbed directly to the boost pump. The engine was started normally and operated at idle for about 5 minutes. The throttle was advanced to 1,700 RPM and a magneto check was performed; both magnetos dropped about 100 RPM. The throttle was advanced to a higher power momentarily and then power was reduced to further stabilize the airframe. The engine was shut down by pulling the mixture lever to cutoff.

Figure 3 – View of the engine operating (courtesy of the NTSB).

The airframe was secured, and a second engine run was attempted. The second attempt to start the engine was unsuccessful. The fuel line from the fuel servo to the flow divider was disconnected and the

boost pump was operated to verify fuel system continuity. Fuel was observed exiting from the disconnected servo fuel line. The line was reconnected. The fuel injector lines were disconnected, and the boost pump was operated again to verify fuel system continuity through the manifold valve. Fuel was observed exiting from all four injector lines. The magneto P-leads were disconnected, and the engine was restarted. The engine started roughly and exemplified a rich mixture. After about 15-20 seconds the engine cleared and stabilized at an idle speed. The engine was operated at idle for several minutes and then at full power momentarily. The engine was then shutdown and the magneto P-leads were reconnected. The engine was started again and operated normally when the mixture lever was pulled out about 2 inches to lean the engine. Refer to the engine test video in the public docket.

The fuel injector servo (Bendix, model RSA-5AD1, serial number 69450) was removed from the engine after the test runs for further examination and testing.

The examination revealed no preimpact mechanical malfunctions or failures with the airframe and engine. An examination of the airplane's maintenance records revealed no evidence of uncorrected mechanical discrepancies with the airframe, engine, and propeller.

Additional Information

Cessna 172I Fuel System

The Cessna 172I Owner's Manual discusses the fuel system and starts in part:

Fuel is supplied to the engine from two tanks, one in each wing.

Fuel from each wing tank flows by gravity to a selector valve.

Fuel Management

The Cessna Pilot Safety and Warning Supplements (D5139-13) discusses the importance of fuel management and states in part:

Poor fuel management is often the cause of aircraft accidents.

Pilots should be thoroughly familiar with the airplane fuel system and tank switching procedures.

Fuel Selector Valves

The FAA Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25B) discusses how a fuel selector valve works and states:

The fuel selector valve allows selection of fuel from various tanks. A common type of selector valve contains four positions: LEFT, RIGHT, BOTH, and OFF. Selecting the LEFT or RIGHT position allows fuel to feed only from the respective tank, while selecting the BOTH position feeds fuel from both tanks. The LEFT or RIGHT position may be used to balance the amount of fuel remaining in each wing tank.

Fuel placards show any limitations on fuel tank usage, such as "level flight only" and/or "both" for landings and takeoffs.

Regardless of the type of fuel selector in use, fuel consumption should be monitored closely to ensure that a tank does not run completely out of fuel. Running a fuel tank dry does not only cause the engine to stop but running for prolonged periods on one tank causes an unbalanced fuel load between tanks. Running a tank completely dry may allow air to enter the fuel system and cause vapor lock, which makes it difficult to restart the engine. On fuel-injected engines, the fuel becomes so hot it vaporizes in the fuel line, not allowing fuel to reach the cylinders.

Fuel Injection Systems

The FAA Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25B) discusses the basic components of a fuel injection system works and states in part:

A fuel injection system usually incorporates six basic components: an engine-driven fuel pump, a fuel-air control unit, a fuel manifold (fuel distributor), discharge nozzles, an auxiliary fuel pump, and fuel pressure/flow indicators.

This document also discusses the disadvantages of using fuel injection and states in part:

Difficulty in starting a hot engine.

Problems associated with restarting an engine that quits because of fuel starvation.

Flight recorders

The airplane did not carry, nor was required to carry, a crashworthy flight data recorder.

Tests and Research

Fuel Injector Servo

On November 28, 2017, an examination and flow check of the fuel injector servo were conducted under the direction of the NTSB IIC at Precision Airmotive in Arlington, Washington. The examination revealed no preimpact mechanical malfunctions or failures with the fuel injector servo. The fuel servo successfully passed the flow check.

Global Positioning System

An undamaged Garmin Aera 660 hand-held global positioning system (GPS) was recovered from the airplane and downloaded by the NTSB. The flight track data showed the airplane descended in a left turn toward BCV before it impacted terrain just short of runway 02L. Refer to the NTSB GPS Factual Report in the public docket for additional information.

Administrative Information

Investigator In Charge (IIC):	Hodges, Michael		
Additional Participating Persons:	William Lowen; FAA Anchorage FSDO; Anchorage , AK Peter Basile; Textron Aviation; Wichita, KS Peter Nielson; Precision Airmotive; Arlington, WA		
Original Publish Date:	December 3, 2020	**Investigation Class:**	2
Note:	The NTSB did not travel to the scene of this accident.		
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=95319		

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.