



National Transportation Safety Board Aviation Accident Final Report

Location:	Englewood, CO	Accident Number:	DEN02FA034
Date & Time:	03/24/2002, 1631 MST	Registration:	N341DM
Aircraft:	Cessna 340	Aircraft Damage:	Destroyed
Defining Event:		Injuries:	4 Fatal
Flight Conducted Under:	Part 91: General Aviation - Personal		

Analysis

The pilot was flying a three leg IFR cross-country, and was on an ILS approach in IMC weather conditions for his final stop. Radar data indicated that the pilot had crossed the final approach fix inbound and was approximately 3 nm from the runway threshold when he transmitted that he had "lost an engine." Radar data indicates that the airplane turned left approximately 180 degrees, and radar contact was lost. A witness said "the airplane appeared to gain a slight amount of altitude before banking sharply to the left and nose diving into the ground just over the crest of the hill." Postimpact fuel consumption calculations suggest that there should have been 50 to 60 gallons of fuel onboard at the time of the accident. Displaced rubber O-ring seals on two Rulon seals in the left fuel valve and hydraulic pressure/deflection tests performed on an exemplar fuel valve suggest that the fuel selector valve was in the auxiliary position at the time of impact. The airplane's Owner's Manual states: "The fuel selector valve handles should be turned to LEFT MAIN for the left engine and RIGHT MAIN for the right engine, during takeoff, landing, and all emergency operations." No preimpact engine or airframe anomalies, which might have affected the airplane's performance, were identified.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: the pilot not following procedures/directives (flying a landing approach with the left fuel selector in the auxiliary position). Contributing factors were the loss of the left engine power due to fuel starvation, the pilot's failure to maintain aircraft control, and the subsequent inadvertent stall into terrain.

Findings

Occurrence #1: LOSS OF ENGINE POWER(TOTAL) - NONMECHANICAL
Phase of Operation: APPROACH - FAF/OUTER MARKER TO THRESHOLD (IFR)

Findings

1. (C) PROCEDURES/DIRECTIVES - NOT FOLLOWED - PILOT IN COMMAND
 2. (F) FLUID,FUEL - STARVATION
 3. (F) 1 ENGINE
-

Occurrence #2: LOSS OF CONTROL - IN FLIGHT
Phase of Operation: APPROACH - FAF/OUTER MARKER TO THRESHOLD (IFR)

Findings

4. (F) AIRCRAFT CONTROL - NOT OBTAINED/MAINTAINED - PILOT IN COMMAND
 5. (F) STALL/SPIN - INADVERTENT - PILOT IN COMMAND
-

Occurrence #3: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: DESCENT - UNCONTROLLED

Findings

6. TERRAIN CONDITION - MOUNTAINOUS/HILLY

Factual Information

HISTORY OF FLIGHT

On March 24, 2002, at 1631 mountain standard time, a Cessna 340, N341DM, was destroyed when it collided with terrain while on final approach to Centennial Airport, Englewood, Colorado. The airline transport pilot and his three passengers were fatally injured. The airplane was being operated by Lear 171 Inc., of Billings, Montana, under Title 14 CFR Part 91. Instrument meteorological conditions prevailed for the cross-country flight that originated from Gunnison, Colorado, at approximately 1545. The pilot was flying under an instrument flight rules (IFR) flight plan.

The pilot called Denver Flight Service Station at 0818 to file a three-leg IFR flight plan from Denver, Colorado, to Aspen, Colorado, to Gunnison, Colorado, and return to Denver. The refueler at Centennial Airport said that he topped off the main (wing-tip) tanks with 62 gallons (approximately 31 gallons per side) at 1232. This would have given the pilot 100 gallons usable fuel total. The refueler said at 1250, the pilot requested that an additional 20 gallons of fuel be put in each auxiliary tank. The owner of the airplane said that the auxiliary fuel tanks, which had a 31.5 gallon capacity, were not used for every flight. He further stated that they normally left 2 to 5 gallons [an unknown amount] of "slosh" fuel in them to keep the rubber fuel bladders in good shape. The pilot departed Centennial Airport with approximately 140 gallons of fuel.

The pilot flew to Aspen (96 nautical miles (nm)) and picked up his three passengers. He then departed for Gunnison (42 nm) where the passengers owned a ranch. They were on the ground less than an hour, when they departed for Centennial Airport at approximately 1545. The pilot had requested an altitude of 17,000 feet, and estimated that he would fly the 118 nm (direct) in 42 minutes. Denver Terminal Radar Approach Control (TRACON) radar data indicates that the airplane began its descent from 17,000 feet at 1616. At 1621:03, the pilot was told by the TRACON controller, to expect light to moderate icing at 8,000 feet. The airplane leveled off at 8,300 feet for approximately 30 seconds before it crossed Casse (Centennial Airport's Initial Approach Fix), and then began its final descent to runway 35R on the Instrument Landing System (ILS).

At 1628:56, approximately 2.5 nm before Casse, the airplane was cleared to land on runway 35R. At approximately 1630:52, the radar data indicates that the airplane began to turn left (westbound) at 7,200 feet. At 1631:24, the pilot transmitted that "41DM [N341DM] lost an engine," and at 1631:30, he exclaimed "oh sh__"! Radar data indicates that the airplane completed a 180 degree turn (approximately 6 degrees per second), then radar contact was lost.

One witness said the airplane was flying "about 150 to 200 feet from the ground," and when it "attempted to clear the approaching hill, it tipped 90 degrees to the left (right wing straight up)." Another witness said the airplane was flying "very low," and "it appeared to gain a slight amount of altitude before banking sharply to the left and nose diving into the ground just over the crest of the hill. He exited the highway, ran to the crash site, but observed no movement from the aircraft.

PERSONNEL INFORMATION

According to the pilot's personal flight log book, he started flying in September 1966. He received his airline transport pilots certificate on March 12, 1989. His flight logbook indicates that, at the time of the accident, he had a total of 3,563 hours of flight experience, of which 2,580 hours was in multiengine aircraft. He had approximately 560 hours in make and model. He had flown an estimated 239 hours during the 12 months before the accident. His last Federal Aviation Administration (FAA) medical, a class two, was taken on August 31, 2000. His last flight review was successfully completed on September 21, 2001. On December 14 through 16, 2000, he attended Flight Safety's training program for the Cessna 340, and on September 17 through 21, 2001, he attended their program on the Cessna 441.

The pilot flew the airplane (N341DM) on three occasions during January 2002; the last flight was on January 24, 2002. He also flew a Cessna 441 (N88727) on five occasions during January 2002, and the last flight in that airplane was on January 29, 2002. During most of February he was on vacation in South America, and did not fly again until March 3, 2002. That flight was with another pilot (in a Cessna 421, N421HW), and the accident pilot did not log the flight in his flight log book. During this flight, the other pilot reported that the accident pilot flew two to three instrument approaches. The pilot did fly the accident airplane on March 19, 2002, and that was his last flight before the accident.

AIRCRAFT INFORMATION

The airplane was a twin engine, propeller-driven, retractable landing gear, five seat airplane which was manufactured by Cessna Aircraft Company in 1974. It was powered by two Continental TSIO-520-NB, six cylinder, reciprocating, horizontally opposed, direct drive, air cooled, fuel injected, turbo-charged engines, which had a maximum takeoff rating of 310 horsepower at sea level. The airplanes records indicated that the last annual inspection was completed on July 12, 2001. The airplane's Hobbs meter indicates that at the time of the accident, the airframe had approximately 3,977 hours of flight time (127.6 hours since the annual on July 12, 2001). The engine maintenance records indicate that the left engine had 1,091 hours since rebuild and the right engine had 1,185 hours since rebuild (Continental's recommended TBO is 1,600 hours).

The airplane had been modified with a RAM II conversion (STC-SA2346SW) in 1981, and an Aeronautical Testing Service (now owned by Boundary Layer Research) Vortex Generator Kit (STC-SA5198NM) in January of 1996. These modifications increased the maximum gross weight from 5,990 pounds to 6,305 pounds, increased the maximum horsepower from 285 to 310, and reduced the Vmc from 84 knots to 73 knots. The airplane was equipped with two 50 gallon (usable) main wing tip tanks and two 31.5 gallon (usable) auxiliary tanks. The airplane's Owner's Manual states that the main tanks must be selected for the first 90 minutes of flight before auxiliary tanks should be selected. When auxiliary tanks are selected, the surplus fuel is returned to the main tanks. The owner of the airplane estimated that this could be as high as 17 to 18 gallons of fuel in a 50 minute period.

The airplane's Owner's Manual also states: "The fuel selector valve handles should be turned to LEFT MAIN for the left engine and RIGHT MAIN for the right engine, during takeoff, landing and all emergency operations."

The airplane was equipped with the following anti-icing and deicing equipment: pneumatic boots for the leading edges of the wings and empennage, electrically heated front pilot windows, electrically heated propellers, electrically heated pitot static system, and electrically

heated stall vain.

METEOROLOGICAL INFORMATION

At 1641, the weather at Centennial Airport (elevation 5,883 feet) 360 degrees 3.5 nm from the accident site, was as follows: wind 050 degrees at 10 knots; visibility 5 statute miles; broken clouds at 900 feet and overcast clouds at 1,500 feet; temperature 25 degrees Fahrenheit, dew point 21 degrees Fahrenheit; altimeter setting 29.86 inches. A King Air pilot, who flew the ILS approximately 10 to 15 minutes after the accident aircraft, said that she experienced solid instrument meteorological conditions (IMC) from 11,000 feet down to 6,500 feet. She said that she had all available electrical anti-icing devices turned on; including engine inlet heat, window heat, propeller heat, and pitot heat. She said that she experienced occasional light to moderate icing conditions during her ILS approach, and she inflated her pneumatic boots on the wing leading edges and empennage two to three times. She said that once she was under the clouds, visibility was 3 to 4 miles with light mist and light snow.

A pilot flying approximately 20 minutes behind the accident airplane said that his airplane accumulated some light ice at 9,000 feet. A pilot flying behind him, approximately 30 minutes after the accident, said he picked up rime ice on his trip from Gunnison to Centennial, but it dissipated itself. He said that during his approach to Centennial Airport, he intermittently accumulated light to moderate ice all the way down. A pilot flying a Starship, immediately before the accident airplane, reported that during his ILS approach, his automatic deicing system did not deploy [.16 inches of ice accretion on a sensor located on the airplane's nose is required for icing boot deployment]. The accident pilot never mentioned any ice accumulation on his airplane in any of his transmissions.

AERODROME INFORMATION

Centennial Airport (elevation 5,883 feet), Englewood, Colorado, is a tower controlled field that has three runways, but only one precision instrument approach. The ILS (111.3 MHz) to runway 35R has an initial approach altitude of 8,000 feet msl (2,817 feet agl), to the outer marker (Casse). The final approach course is 347 degrees, the decision height is 6,083 feet msl, and the touchdown zone's elevation is 5,883 feet msl. The distance from Casse to the approach end of runway 35R is 6.3 nm.

WRECKAGE AND IMPACT INFORMATION

The airplane was found (N39 degrees, 29.63'; W104 degrees, 52.10'; elevation 6,312 feet) near a rolling grassy field with 4 to 10 feet high scrub brush to the north and east. The first aircraft debris was found approximately 8 to 10 feet down the side of a 35 foot deep ravine (sloping down to the north). The debris extended on a 182 degree orientation for approximately 140 feet; the main wreckage was between 60 and 80 feet from initial impact. There was no postimpact fire, but the first witnesses to the scene reported smelling "massive fuel fumes."

The initial impact crater contained the aft section of the left main tip tank (to the right of debris track centerline). The left propeller was imbedded in the side of the ravine approximately 15 feet east of the aft left main tip tank debris. The left engine was located above the ravine next to the right propeller; cleanly cut branches (3.5 inches in diameter) which were separated at 30 to 45 degrees were found near the right propeller. The right main tip tank was found further to the left of the debris track and approximately 15 feet further down track. The airplane manufacturer's representative said "the debris pattern suggests that the airplane impacted the terrain inverted with the left wing approximately 40 degrees below the horizon and nose down

about 65 degrees."

The main wreckage was laying right side up and was pointed back towards the point of initial impact. The empennage was broken to the left (west) about 45 degrees, at a point just aft of the pressure capsule. The nose section of the airframe was crushed back flat, and the flat nose section was angled aft approximately 20 degrees and to the left approximately 40 degrees. Most of the left wing was separated from the fuselage. The right wing was damaged, but remained attached to the airframe and was in one piece. The right engine had separated from its mounts, rotated back, and was lying on top of the right wing inverted. It remained attached to the firewall by hoses and cables.

All of the airplane's major components were accounted for at the accident site. The flight control surfaces were all identified. Impact damage precluded control cable continuity to the ailerons; rudder and elevator cable continuity was confirmed from the front empennage area aft. Documentation of cockpit controls, avionics, and instrumentation was minimal due to impact damage. The left engine tachometer was found at 1,600 rpm, and the right engine tachometer was found at 2,800 rpm. The landing gear was found extended, and the flaps were set at approximately 10 degrees.

The left engine had been forced back into its firewall, and had completely separated from the airframe. The firewall and a section of the mounting frame remained attached to the engine. The propeller flange was broken from the crankshaft, and remained bolted to the propeller hub. The front of the case, below the crankshaft was broken, exposing the gearing. After the crankcase was loosened, the crankshaft was rotated confirming internal continuity. The crankshaft could not be rotated fast enough to obtain "thumb compression." All the pistons were visually inspected through the top spark plug holes. The spark plugs showed normal wear, and their electrodes were clean and gray in color.

The right engine had been forced back into its firewall, and remained attached to the airframe by only a "few cables and hoses." The right engine case was not compromised. The crankshaft was rotated, confirming internal continuity, by turning the alternator gear. The crankshaft could not be rotated fast enough to obtain "thumb compression," but all pistons were visually inspected through their respective spark plug holes. The spark plugs showed normal wear, and their electrodes were clean and gray in color.

Both propellers' three blades were still in their hubs, but bent aft. The left propeller had one blade bent about 45 degrees at mid-span, and there was no blade twisting or chordwise damage. The right propeller had one blade bent nearly 90 degrees along the whole blade span. These three blades exhibited chordwise scratching and leading edge damage. One of these blades was "S" type twisted. The propeller manufacturer's representative said that both propellers were "clearly rotating and not feathered at the time of impact." He further stated that the blades of the right propeller assembly indicated there was greater power on it, than on the left propeller assembly.

No preimpact engine or airframe anomalies, which might have affected the airplane's performance, were identified.

MEDICAL AND PATHOLOGICAL INFORMATION

An autopsy was performed on the pilot by an independent forensic pathologist at the Douglas County Coroner's Office, Castle Rock, Colorado, on March 26, 2002.

The FAA's Civil Aeromedical Institute (CAMI) in Oklahoma City, Oklahoma performed toxicology tests on the pilot. According to CAMI's report (#200200076001), the pilot's blood was tested for carbon monoxide, cyanide, and drugs with negative results. His vitreous was tested for volatiles (ethanol) with negative results.

TESTS AND RESEARCH

The airplane's left fuel select handle was found on the right main position, and the left fuel valve was found in the off position. The right fuel selector handle was found beyond the left main, and the right fuel valve was near the right main tank position (but not in its detent). The fuel selectors and the fuel valves are actuated/connected by a 9.6 foot long cable. Actuation of the fuel valve from "off," mechanically pushes the cable to select one of the fuel tanks. The detent, which lets the pilot know that the selected valve location has been properly positioned, is located in the valve, not the selector. Any tensional force applied to this cable, such as during an accident sequence, will pull fuel valves to their off position and the fuel selectors to their cross feed (other wing main tip tank) position.

Postaccident examination of the left fuel valve found black O-ring material jammed between the rotating fuel tank selection plate and two of the Rulon cylindrical seals. Disassembly of the valve revealed that the O-ring seals on the #1 (main tank port), and #2 (cross feed--right main) Rulon cylindrical seals were fragmented and separated their seal grooves. The #3 (auxiliary tank) Rulon cylindrical seal, and its O-ring, appeared to be intact. The right fuel valve was also disassembled, and a piece of black O-ring material was found protruding from the outside diameter of the port plate at #3 (cross feed--left tank) port. Further disassembly revealed that the #3 O-ring seal was found in its groove, but it was cut and migrating out of the Rulon seal groove.

Maintenance records documented that the right fuel valve was installed on January 11, 1980, and the left fuel valve was installed on February 12, 1980. The Cessna service manual indicated that fuel valves should be inspected after their first 100 hours of use, and every 200 hours or every year (whichever comes first) thereafter. There is no life limit on fuel valves; they are a "Change on condition" change out item. All the O-rings in question were analyzed using Joel JSM-5800 scanning electron microscope equipped with an Oxford Link ISIS energy-dispersive spectrometer (EDS) and Nicolet Nexus 670 fourier transform infrared-spectroscopy (FT-IR) in order to verify the O-rings material. Tests concluded that all the O-ring material met their specification requirements.

The airplane manufacturer's representative, in the presence of an FAA inspector, performed a series of hydraulic pressure/deflection tests on an exemplar fuel valve (identical to the left accident fuel valve). The fuel valve was placed in the auxiliary position, and the main fuel line and the cross feed fuel line were hydraulically pressurized. The tests indicated that 190 psi (pounds per square inch) of fluid pressure would be sufficient force to move the respective Rulon seals to an area where their O-rings would start to lose circumferential support and subsequent release of fluid pressure. Accident impact calculations suggest that sufficient force could have been generated during this event. He further stated that the damage observed on the main fuel port Rulon seal O-ring and the cross feed fuel port Rulon seal O-ring indicates that these ports were closed at the time of impact, and therefore the fuel selector valve was positioned to either the auxiliary fuel tank position or the off position.

The airplane manufacturer's representative made a fuel consumption calculation for the three

leg flight, and determined that approximately 50 to 60 gallons of fuel should have been onboard at the time of the accident.

Witnesses said the airplane was started by ground power units (GPUs) at each of its starting locations; Centennial Airport, Aspen Airport, and Gunnison Airport. The airplane had been flown (by another pilot) to Aspen, Colorado, on March 22, 2002, and was parked on the ramp until Sunday morning, March 24, 2002. It was determined that a cabin light had been left on for that time period, and the airplane's battery was either very weak or dead. When the airplane arrived at Centennial Airport on Sunday morning, the battery was charged for over an hour. The accident pilot talked with the airplane's owner, and they decided that using GPUs would facilitate the batteries full recovery.

Approximately 2 pints of fuel were recovered from the right side auxiliary fuel tank. The sample was tested by Dixie Services, Inc., Galena Park, Texas. The fuel sample was determined to have the proper chemical composition for 100LL aviation gasoline, and no additives were detected.

It was noted by the owner of the airplane that Flight Safety International did not include, in their training curriculum, engine failure on approach.

ADDITIONAL DATA

The airplane, including all components and logbooks, was released to the owner's insurance representative on November 4, 2002.

Pilot Information

Certificate:	Airline Transport; Commercial	Age:	63, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	Seat Occupied:	Left
Other Aircraft Rating(s):	None	Restraint Used:	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	Second Pilot Present:	No
Instructor Rating(s):	None	Toxicology Performed:	Yes
Medical Certification:	Class 2 Valid Medical--w/ waivers/lim.	Last FAA Medical Exam:	08/31/2000
Occupational Pilot:		Last Flight Review or Equivalent:	09/15/2001
Flight Time:	3563 hours (Total, all aircraft), 560 hours (Total, this make and model), 3 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Cessna	Registration:	N341DM
Model/Series:	340	Aircraft Category:	Airplane
Year of Manufacture:		Amateur Built:	No
Airworthiness Certificate:	Normal	Serial Number:	340-0347
Landing Gear Type:	Retractable - Tricycle	Seats:	5
Date/Type of Last Inspection:	07/12/2001, Annual	Certified Max Gross Wt.:	6305 lbs
Time Since Last Inspection:	128 Hours	Engines:	2 Reciprocating
Airframe Total Time:	3977 Hours at time of accident	Engine Manufacturer:	Continental
ELT:	Installed, not activated	Engine Model/Series:	TSIO-520-NB
Registered Owner:	Lear 171 Inc.	Rated Power:	310 hp
Operator:	Lear 171 Inc.	Operating Certificate(s) Held:	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Instrument Conditions	Condition of Light:	Day
Observation Facility, Elevation:	APA, 5883 ft msl	Distance from Accident Site:	4 Nautical Miles
Observation Time:	1641 MST	Direction from Accident Site:	360°
Lowest Cloud Condition:	Thin Broken / 900 ft agl	Visibility	5 Miles
Lowest Ceiling:	Overcast / 1500 ft agl	Visibility (RVR):	
Wind Speed/Gusts:	10 knots /	Turbulence Type Forecast/Actual:	/
Wind Direction:	50°	Turbulence Severity Forecast/Actual:	/
Altimeter Setting:	29.86 inches Hg	Temperature/Dew Point:	-2 °C / -4 °C
Precipitation and Obscuration:			
Departure Point:	Gunnison, CO (GUC)	Type of Flight Plan Filed:	IFR
Destination:	Englewood, CO (APA)	Type of Clearance:	IFR
Departure Time:	1540 MST	Type of Airspace:	Class C

Wreckage and Impact Information

Crew Injuries:	1 Fatal	Aircraft Damage:	Destroyed
Passenger Injuries:	3 Fatal	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	4 Fatal	Latitude, Longitude:	39.493611, -104.867778

Administrative Information

Investigator In Charge (IIC):	James F Struhsaker	Report Date:	05/30/2003
Additional Participating Persons:	Mike Zadar; Denver, CO Scott Boyle; Teledyne Continental Motors; Mobile, AL Joe Hutterer; Cessna Aircraft Company; Wichita, KS		
Publish Date:			
Investigation Docket:	NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov , or at 800-877-6799. Dockets released after this date are available at http://dms.nts.gov/pubdms/ .		

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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](#).