National Transportation Safety Board
Aviation Accident Final Report

Location:	Demopolis, Alabama	**Accident Number:**	ERA11FA391
Date & Time:	July 9, 2011, 17:40 Local	**Registration:**	N692TT
Aircraft:	Cessna 421C	**Aircraft Damage:**	Substantial
Defining Event:	Loss of control in flight	**Injuries:**	7 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The multi-engine airplane was in cruise flight at flight level 210 when the pilot declared an emergency due to a rough-running right engine and diverted to a non-towered airport about 10 miles from the airplane's position. About 4 minutes later, the pilot reported that he had shut down the right engine. The pilot orbited around the diversion airport during the descent and reported to an air traffic controller that he did not believe he would require any assistance after landing. The airplane initially approached the airport while descending through about 17,000 feet mean sea level (msl) and circled above the airport before entering a left traffic pattern approach for runway 22. About 7,000 feet msl, the airplane was about 2.5 miles northeast of the airport. The airplane descended through 2,300 feet msl when it was abeam the runway threshold on the downwind leg of the traffic pattern. According to the airplane information manual, procedures for landing with an inoperative engine call for "excessive altitude;" however, the airplane's last radar return showed the airplane at an altitude of 700 feet msl (about 600 feet above ground level) and about 3 miles from the approach end of the runway.

The airplane was configured for a single-engine landing and was likely on or turning to the final approach course when it rolled and impacted trees. The airplane came to rest in a wooded area about 0.8 miles north of the runway threshold, inverted, in a flat attitude with no longitudinal deformation. A majority of the airplane, including the cockpit, main cabin, and left wing, were consumed by a postcrash fire. Search operations located the airplane about 6 hours after its expected arrival time. Due to the severity of the postcrash fire, occupant survivability after the impact could not be determined. Examination of the airframe, the left engine, and both propellers did not reveal any preaccident mechanical malfunctions or failures that would have precluded normal operation. The investigation revealed that the right engine failed when the camshaft stopped rotating after the camshaft gear experienced a fatigue fracture on one of its gear teeth. The remaining gear teeth were fractured in overstress and/or were crushed due to interference contact with the crankshaft gear. Spalling observed on an intact gear tooth suggested abnormal loading of the camshaft gear; however, the origin of the abnormal loading could not be determined.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The pilot's failure to maintain airplane control during a single-engine approach and his failure to fly an appropriate traffic pattern for a single-engine landing. Contributing to the accident was a total loss of engine power on the right engine due to a fatigue failure of the right engine cam gear.

Findings

Aircraft	Recip eng rear section - Failure
Aircraft	Airspeed - Not attained/maintained
Personnel issues	Aircraft control - Pilot

Factual Information

HISTORY OF FLIGHT

On July 9, 2011, about 1740 central daylight time, a Cessna 421C, N629TT, operated by a private individual, was substantially damaged when it impacted terrain while on approach to the Demopolis Municipal Airport (DYA), Demopolis, Alabama. The certificated private pilot and six passengers were fatally injured. Visual meteorological conditions prevailed and an instrument flight rules flight plan was filed for the flight that departed the Creve Coeur Airport (1H0), St. Louis, Missouri, destined for the Destin-Ft. Walton Beach Airport (DTS), Destin, Florida. The personal flight was conducted under the provisions of Title 14 Code of Federal Regulations Part 91.

The airplane was based at DTS, and owned by the pilot through a limited liability company.

According to the pilot's father-in-law, the pilot, his wife, and five children, ages 10, 9, 6, 4, and 2, flew from DTS to the Pickens County Airport (JZP), Jasper, Georgia, on July 3, 2011. On July 5, 2011, they flew from JPZ to 1H0 uneventfully, to attend a family reunion, where the airplane remained parked until the accident flight. The pilot and his family departed 1H0 about 1520, on the day of the accident.

According to information obtained from the Federal Aviation Administration (FAA), the pilot was in cruise flight at flight level 210 (21,000 feet), and in contact with the Atlanta air route traffic control center when he declared an emergency due to a rough running engine, about 1725. He diverted to DYA, which was located 12 o'clock and about 10 miles from the airplane's position. The pilot was switched to Meridian Approach and he reported descending through 17,000 feet mean sea level (msl) at 1727:55, with the airplane positioned about 2.5 miles northeast of the airport. The pilot further stated that he planned to orbit over Demopolis during the descent. At 1728:59, the pilot confirmed that he was experiencing a rough running engine; however, about 10 seconds later, he reported that he had just shut down the right engine. He also stated he did not believe he would require any assistance after landing. At that time, the airplane was about 6 miles east of DYA, at an altitude of about 14,500 feet msl.

The pilot reported the airport in sight, was cleared for a visual approach and then approved for a frequency change to the local common traffic advisory frequency about 1734. At that point, the airplane was about 2.5 miles northeast of the airport, at an altitude of about 7,000 feet. There were no further communications received from the airplane. The airplane's radar track was consistent with a left traffic pattern approach to runway 22. The airplane was descending from an altitude of about 2,300 feet msl, when it was abeam the runway threshold, on the downwind leg of the traffic pattern. The last radar target was observed at 1739, at an altitude of 700 feet on the base leg of the traffic pattern, about 3 miles from the approach end of runway 22, and about .5 miles northwest of the extended centerline.

The airplane impacted trees in a wooded area, about .8 miles north of the runway 22 threshold.

PERSONNEL INFORMATION

The pilot, age 42, held a private pilot certificate, with ratings for airplane single-engine land, multiengine land, and instrument airplane. He obtained his multiengine rating during November 2006. His most recent FAA third-class medical certificate was issued on July 19, 2007.

The pilot's logbook was not recovered; however, at the time of his most recent FAA medical certificate, the pilot reported a total flight experience of 642 hours.

The pilot's flight instructor noted that about the time the pilot purchased the airplane (September 2007), the pilot had accumulated 670 hours of total flight experience which included 140 hours in multiengine airplanes. As of May 14, 2008, the pilot had accumulated 715 hours of total flight experience, which included 200 hours in multiengine airplanes. In July 2010, the flight instructor noted that the pilot had accumulated 870 total hours; however, he did not note the pilot's multiengine flight experience at that time.

The pilot's flight instructor reported that the pilot had practiced at least seven single-engine landings in the accident airplane, which included at least three single-engine landings from a VFR traffic pattern. The pilot completed Cessna 421 recurrent training on July 29, 2010, which included three practice single-engine landings at that time.

Based on the hours that the accident airplane had been operated, the pilot's total flight time at the time of the accident was estimated to be about 1,000 hours, which included about 500 total hours of multiengine flight experience.

AIRCRAFT INFORMATION

The eight-seat, low-wing, retractable-gear airplane, serial number 421C0616, was manufactured in 1978, and purchased by the pilot on September 11, 2007. It was powered by two Continental Motors, Inc., GTSIO-520-L, 375-horsepower engines, each equipped with a McCauley propeller assembly.

The airplane was for sale at the time of the accident. Copies of maintenance records were obtained from a broker, the pilot's representative, and a fixed-base-operator at DTS.

Review of the maintenance records revealed the airplane's most recent annual inspection was performed on January 19, 2011, at a total airframe time of 7,799.9 hours, and a Hobbs time of 286 hours. An annual inspection dated December 14, 2009 noted a total airframe and Hobbs time of 7,573.4, and 59.5 hours; respectively. In addition, the airplane had been operated for about 305 hours since September 2007 and the time of the most recent annual inspection.

The most recent recorded airframe logbook entry was on February 10, 2011, with no change in flight hours since the annual inspection. At that time, the left engine hydraulic filter and right main landing gear strut were replaced.

The left engine was overhauled by RAM Aircraft, Waco, Texas, on August 31, 2007, at a total time in service of 3,780.7 hours. It was installed on September 28, 2007. At the time of the

most recent annual inspection, the left engine had accumulated approximately 305 hours since overhaul.

The right engine was overhauled by Americas Aircraft Engines, Tulsa, Oklahoma, on August 24, 2004, at a total time in service of 1,595.7 hours. It was installed on September 30, 2004. At the time of the most recent annual inspection, the right engine had accumulated approximately 514.2 hours since overhaul. The most recent recorded right engine logbook entry was on February 10, 2011, and noted a reset of the engine fuel pressures.

In July 1994, vortex generators were installed on the airplane in accordance with a supplemental type certificate issued to Aeronautical Testing Service Inc., Arlington, Washington.

An oil analysis report of oil samples collected from each respective engine on January 3, 2011, stated that the samples "appeared normal."

Both propellers were overhauled on June 1, 2010. At the time of the annual inspection, they had been operated for about 172 hours.

The airplane was configured with two flight crew seats, and 5 main cabin seats, two aft facing and three forward facing. In addition, an aft lavatory seat was located next to the aft-most left passenger seat.

According to maintenance records, an Artex ME406 emergency locator transmitter was installed on May 13, 2008, with a battery replacement due October 2012. An ELT inspection and functional check was documented at the time of the most recent annual inspection.

According to a work order for a pre-purchase inspection, as of June 3, 2011, the airplane had been flown approximately 27 hours since the most recent annual inspection.

METEOROLOGICAL INFORMATION

The reported weather at Meridian Naval Air Station (NMM), Meridian, Mississippi, which was located about 35 miles west of the accident site, at an elevation 316 feet, at 1756, was: wind 270 degrees at 6 knots, visibility 10 statute miles; clear skies; temperature 34 degrees Celsius (C); dew point 22 degrees C; altimeter 29.87 inches of mercury.

AERODROME INFORMATION

The Demopolis Municipal Airport was a public-use airport, owned and operated by the City of Demopolis. It was located approximately 6 miles southwest of the town of Demopolis, Alabama, and positioned at 32 degrees, 27 minutes, 49.75 seconds north and 087 degrees, 57 minutes, 14.63 second west, at an elevation of 113 feet. It was equipped with one runway, 04-22 consisting of an asphalt surface measuring 5,002-feet-long by 100-feet-wide.

Meridian Naval Air Station (NMM) was equipped with 8,000-foot runways, a control tower, and airport rescue and firefighting (ARFF). Key Field, (MEI), Meridian, Mississippi was

located about 40 miles southwest of DYA. MEI was equipped with a 10,003-foot runway, a control tower, and ARFF.

FLIGHT RECORDERS

The airplane was not equipped; nor was it required to be equipped with a cockpit voice recorder or flight data recorder.

WRECKAGE AND IMPACT INFORMATION

The airplane came to rest inverted, in a wooded area with varied tree heights up to about 80 feet, in a flat attitude, on a course of about 100 degrees. The cockpit, the cabin up through 40-inches forward of the tail cone and the left wing was consumed by fire. A series of tree strikes were observed about 50 feet above the ground, approximately 70 feet south of the main wreckage. A navigation antenna was observed about 200 feet south-southeast of the main wreckage. The course from the antenna to the main wreckage was about 020-degrees.

All major portions of the airplane were accounted for at the accident site. There was no longitudinal deformation of the fuselage noted. The radar dome on the nose of the airplane was observed installed and retained its shape. All three landing gear actuators were observed in the extended position. Portions of the flaps that were not compromised due to fire and or impact damage were extended approximately 40 degrees. The entire right wing was separated at the root and came to rest against a tree adjacent to the main wreckage.

Aileron control cable continuity was established from the cockpit controls to the fuselage aileron bellcrank, which was melted. The cables to operate the left aileron, which was extensively fire damaged, were observed near the aft aileron bellcrank area and were continuous out to the aileron bull wheel. The aileron trim cables were continuous from the cockpit to the trim tab chain. Measurement of the aileron trim actuator jackscrew was about .8 inches beyond the full tab-up position. The right aileron control cables were observed separated consistent with overload in several locations. One of the cables remained attached to the right bull wheel; the other cable had been pulled out of the bull wheel. The right aileron remained attached to the right wing.

Elevator control cables were observed attached to the aft elevator bellcrank and continuity was established to the cockpit area. The elevators remained attached to the horizontal stabilizer. The horizontal stabilizer was separated from the aft fuselage and located near the vertical fin. The aft elevator push-pull tube remained attached to the aft elevator bellcrank. The attachment to the elevator control horns was observed separated. The elevator trim tab remained attached, and was extended beyond its up tab travel limit.

Rudder control cable continuity was established from the rudder to the rudder pedals. The top section of the rudder was observed separated from the vertical stabilizer. The lower section and rudder trim tab remained attached to the vertical stabilizer. Measurement of the rudder trim corresponded to about 3 degrees tab left (nose right setting).

The cockpit area was compromised by the post impact fire. All of the flight instruments were

heavily damaged by the post impact fire. The cabin door was found in the closed and locked position. The emergency exit was observed in the installed position.

The ELT was located in the cabin; however, it was destroyed during the postcrash fire.

The cockpit seats were compromised by the post-impact fire and were in sections. The lower sections of the cockpit seat frames were found in the cockpit area with severe fire damage. These two seat bases were fractured and the aluminum seat frames and seat backs were not found. The five passenger seat frames were found in the area of the cabin. The aft lavatory seat was completely consumed in the fire. The fabric and padding for all of the cockpit and passenger seats was consumed by fire and had no remarkable data remaining.

The two cockpit restraints were 3-point systems, and the six passenger restraints were 2-point systems. All restraints in the accident airplane had lift-latch buckles. One of the cockpit seat belts was found and observed in the latched condition, the other one was in the unlatched condition. All six of the passenger seat belts were found in the wreckage, four of which were observed in the latched condition.

The left engine and propeller assembly remained attached to the left wing and were fire damaged. The left propeller was observed a low pitch position and displayed signatures consistent with rotation at impact.

On site examination and a subsequent teardown of the left engine at Continental Motors, Inc. (CMI), Mobile, Alabama, did not reveal any preaccident mechanical malfunctions or failures that would have precluded normal operation.

The right engine and propeller assembly remained attached to the right wing. One propeller blade was separated from the hub. The remaining two right propeller blades were observed at or near the feathered position and did not display evidence of rotation. All of the cylinders and accessories remained attached to the crankcase. The top spark plugs were removed. Their electrodes were intact and exhibited normal operating signatures in accordance with the Champion aviation check-a-plug comparison chart. The fuel pump was removed. Its respective coupling was intact; however, the camshaft gear exhibited damage on its respective gear teeth when viewed through the fuel pump bay.

The right engine was disassembled at CMI under the supervision of an NTSB investigator. The disassembly revealed additional damage and several missing teeth on the cam gear, and intake and exhaust valve contact on all six piston faces. The safety wire securing a cam gear bolt was broken at the head of the bolt, and a corresponding piece of safety wire was found in the oil sump, which contained metallic debris. The No. 1 crankshaft main and connecting rod bearings exhibited damage consistent with lubrication distress. The remaining crankshaft main and connecting rod bearings were intact and did not display evidence of lubrication distress.

The crankcase halves, camshaft, camshaft gear with separated gear teeth, cluster gear, crankshaft gear, No. 1 main bearing, camshaft and crankshaft gear attachment bolts, safety wire removed from the camshaft gear attachment bolts, and contents retrieved from the oil sump were retained and forwarded to the Safety Board's Materials Laboratory, Washington,

DC, for further examination.

A subsequent teardown of both propeller assemblies at McCauley, Wichita, Kansas, did not reveal any preaccident mechanical malfunctions or failures that would have precluded normal operation.

MEDICAL AND PATHOLOGICAL INFORMATION

Autopsies were performed on the pilot and passengers by the Alabama Department of Forensic Sciences, Montgomery, Alabama. [Additional information, including the Medical and Pathological information can be found in the Survival Factors Factual Report located in the public docket.]

Toxicological testing was performed on the pilot by the FAA Bioaeronautical Science Research Laboratory, Oklahoma City, Oklahoma with no anomalies noted.

TESTS AND RESEARCH

Examination of the retained components retrieved from the right engine was performed by an NTSB materials engineer.

According to the Materials Laboratory Factual Report, the camshaft gear contained 60 teeth. Forty five of the teeth were either fractured or crushed, two teeth were damaged on the tooth flank, and 13 teeth were intact. Fracture features of the teeth with discernible fracture features were mostly uniform matte gray in the middle portion of the fracture with smeared features near the flank root surfaces. A smooth curving arrest line was observed on the fracture at the contact side of one of the teeth, with radial features emanating from the boundary. Additional examination of the fracture revealed features consistent with fatigue in steel under relatively high stress concentration. The respective adjacent gear teeth did not contain evidence of fatigue; however, another gear tooth displayed evidence consistent with surface spall.

No evidence of fretting was observed on the camshaft and cluster gear attachment bolts. Fracture features on the broken safety wire were consistent with overstress.

Examination of the crankcase revealed staining and impressions consistent with the application of silk thread around the through bolt holes on each side of the main bearing saddles at every main bearing location, and at the bolt holes at all of the camshaft main saddles.

Teledyne Continental Motors Service Information Letter SIL99-2A, dated August 27, 2002, provided information pertaining to the application of sealants, lubricants, and adhesives during maintenance, overhaul, or component repair or replacement. Page 16 of SIL99-2A contained a threading diagram for the GTSIO-520, and included a warning that stated “Apply thread and permatex only as illustrated.” Thread application locations were depicted at the edges of the crankcase and around the through-bolt holes in the saddle bosses for all the camshaft main journals; however, no thread was called for around the through-bolt holes at any of the crankshaft main bearing saddle bosses. [Additional information can be found in the

Materials Laboratory Factual Report located in the public docket.]

The crankcase from the right engine was returned to CMI for measurement of the main bearing bores with and without the application of silk thread in accordance with SIL99-2A. In both cases, the crankcase was assembled and torqued to the current CMI production procedures. Measurement of the main bearing bores with the silk thread installed ranged from zero difference to +.0006 inches, with +.0004 inches observed on the No.1 main bearing bore.

According to a CMI representative, the main bearing in that location had a .006 minimum crush on each half when installed in the crankcase and the installation of silk thread alone would not result in the damage observed during the teardown inspection or affect engine performance.

ADDITIONAL INFORMATION

Airplane Information Manual

According to the airplane information manual, the minimum flight speed at which the airplane was controllable with one engine inoperative and a 5 degree bank towards the inoperative engine, Air Minimum Control Speed (Vmca), was 80 knots.

According to the vortex generator STC holder, the installation of vortex generators reduced the Vmca to 73 knots.

The procedures for landing with an inoperative engine included an approach speed of 111 knots with excessive altitude, landing gear down within gliding distance to the field, and wing flaps down when landing was assured.

Search and Rescue

A timeline of search and rescue events was compiled using FAA air traffic control transcripts, Marengo County 911 call recordings and logs, Sumter County Sheriff's Office unit log report, Alabama Emergency Management emergency management information tracking system information, and interviews conducted with individuals central in the search and rescue mission.

The timeline showed that approximately 6.5 hours elapsed from the time of the last communication between Meridian Approach and N692TT, and about 6 hours elapsed from the time of expected arrival to DYA before the airplane was found. During this time, various local, county, state, and Federal emergency response agencies conducted search operations in an effort to locate the airplane. [Additional information, including the Search and Rescue timeline can be found in the Survival Factors Factual Report located in the public docket.]

History of Flight

Enroute-cruise	Loss of engine power (total)
Approach-VFR pattern final	Loss of control in flight (Defining event)
Uncontrolled descent	Collision with terr/obj (non-CFIT)

Pilot Information

Certificate:	Private	**Age:**	42,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:**	July 19, 2007
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	July 20, 2010
Flight Time:	(Estimated) 1000 hours (Total, all aircraft), 340 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	Cessna	**Registration:**	N692TT
Model/Series:	421C	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Normal	**Serial Number:**	421C0616
Landing Gear Type:	Retractable - Tricycle	**Seats:**	8
Date/Type of Last Inspection:	January 19, 2011 Annual	**Certified Max Gross Wt.:**	7560 lbs
Time Since Last Inspection:		**Engines:**	2 Reciprocating
Airframe Total Time:	7800 Hrs as of last inspection	**Engine Manufacturer:**	CONT MOTOR
ELT:	C91A installed	**Engine Model/Series:**	GTSIO-520-L
Registered Owner:		**Rated Power:**	375 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:		**Condition of Light:**	Day
Observation Facility, Elevation:	NMM,316 ft msl	**Distance from Accident Site:**	35 Nautical Miles
Observation Time:	17:56 Local	**Direction from Accident Site:**	280°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	6 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	270°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.87 inches Hg	**Temperature/Dew Point:**	34°C / 22°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	St. Louis, MO (1H0)	**Type of Flight Plan Filed:**	IFR
Destination:	Destin, FL (DTS)	**Type of Clearance:**	IFR
Departure Time:	15:20 Local	**Type of Airspace:**	

Airport Information

Airport:	Demopolis DYA	**Runway Surface Type:**	Asphalt
Airport Elevation:	113 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	22	**IFR Approach:**	Visual
Runway Length/Width:	5002 ft / 100 ft	**VFR Approach/Landing:**	Traffic pattern

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:	6 Fatal	**Aircraft Fire:**	On-ground
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	7 Fatal	**Latitude, Longitude:**	32.479721,-87.948059

Administrative Information

Investigator In Charge (IIC):	Schiada, Luke
Additional Participating Persons:	David W Hargett; FAA/FSDO; Vestavia Hills, AL Andrew L Hall; Cessna Aircraft Company; Wichita, KS Rodney Martinez; Continenatal Motors, Inc.; Mobile, AL Danny Ball; McCauley; Wichita, KS
Original Publish Date:	January 15, 2013
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=81055