National Transportation Safety Board
Aviation Accident Final Report

Location:	Plainfield, IL	**Accident Number:**	CEN16FA276
Date & Time:	07/21/2016, 1114 CDT	**Registration:**	N7409Y
Aircraft:	PIPER PA 30	**Aircraft Damage:**	Destroyed
Defining Event:	Loss of control in flight	**Injuries:**	1 Fatal
Flight Conducted Under:	Part 91: General Aviation - Personal		

Analysis

The commercial pilot departed on a cross-country flight in the multi-engine airplane and attempted to use visual flight rules flight following from air traffic control during the flight. The availability of this service is based on controller workload, and, as the flight neared an area of Class B airspace, the controller discontinued flight following services and instructed the pilot to remain clear of the Class B airspace. The airplane then climbed from its cruise altitude of 8,500 ft mean sea level (msl) to 10,300 ft msl while losing airspeed until reaching about 48 kts, well below its lowest published stall speed. The airplane subsequently entered a series of descending turns, reaching an airspeed of about 211 kts that exceeded the airplane's design maneuvering speed. The airplane experienced an in-flight breakup.

Weather radar imagery identified reflectivity values consistent with convective activity immediately adjacent to the airplane's position just before the time of the accident. It is likely that the pilot initiated the climb in order to remain clear of the developing convective activity, and it is also likely that the airplane entered instrument meteorological conditions sometime between the initiation of the climb and the loss of control. The convective conditions present at the time of the accident were conducive to the development of updrafts, downdrafts, and turbulence; however, there were no recorded pilot reports for this area and the exact conditions encountered by the accident airplane could not be determined.

Although maintenance records indicated that the airplane had undergone recent maintenance to the left wing and rivet holes in the left wing spar exhibited signs of anomalous installation, this likely did not contribute to the accident, since a performance study determined that the airplane exceeded its design maneuvering speed, which put the airplane at risk of exceeding its design load limitations and the subsequent structural failure.

Toxicology findings indicated that the pilot was using two antidepressants, one of which, trazodone, is potentially impairing. While symptoms of depression often include cognitive deficits, it is impossible to know what, if any, medication side effects or cognitive symptoms the pilot may have been experiencing at the time of the accident. Therefore, whether his depression

or its treatment contributed to the circumstances of the accident could not be determined from the available information.

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 an en route climb near convective activity, which resulted in an aerodynamic stall, an uncontrolled descent, and a subsequent in-flight breakup due to an exceedance of the airplane's design load limitations.

Findings

Aircraft	Wing structure - Failure (Cause)
	Angle of attack - Not attained/maintained (Cause)
Personnel issues	Aircraft control - Pilot (Cause)
	Predisposing condition - Pilot
	Use of medication/drugs - Pilot
Environmental issues	Thunderstorm - Ability to respond/compensate (Cause)
	Thunderstorm - Effect on operation (Cause)

Factual Information

History of Flight

Enroute-change of cruise level	Loss of control in flight (Defining event)
Uncontrolled descent	Aircraft structural failure

On July 21, 2016, about 1114 central daylight time, a Piper PA 30 airplane, N7409Y, was destroyed following an in-flight breakup near Plainfield, Illinois. The commercial pilot was fatally injured. The airplane was registered to and operated by the pilot under the provisions of Title 14 *Code of Federal Regulations* Part 91. Day visual meteorological conditions were reported near the accident site about the time of the accident and no flight plan was filed for the flight. The personal flight originated from Upper Cumberland Regional Airport (SRB), near Sparta, Tennessee, about 0845, and was destined for Eagle River Union Airport (EGV), Eagle River, Wisconsin.

According to fueling records, the airplane was fueled with 73.61 gallons of 100 low lead aviation gasoline at SRB on July 21, 2016. The airplane taxied out for departure about 0841. Shortly after takeoff, the pilot established contact with a Federal Aviation Administration (FAA) air traffic controller and requested visual flight rules flight following to EGV. Flight following service availability is based on controller workload. The flight was issued a discrete transponder code (1647) and proceeded toward the destination. At 1039, the pilot established contact with the Chicago, Illinois, Air Route Traffic Control Center. At 1104, as the airplane neared Class B airspace, the controller terminated flight following services tofor the airplane, instructed the pilot to change the transponder code to VFR (1200), and provided another frequency on which the pilot could attempt to reinstate flight following. The pilot contacted the next controller at 1105 and provided his previously-assigned discrete transponder code of 1647. The controller could not identify the airplane using that code and provided another ATC frequency to the pilot. The next controller was also unable to identify the airplane using the 1647 transponder code and instructed the pilot to remain clear of the Class B airspace.

A radar performance study indicated that, until about 1108, the airplane was travelling on a heading about 320° (true) at an altitude of 8,500 ft mean sea level (msl) and a groundspeed about 150 kts. About 1108:23, the airplane initiated a climb, during which its equivalent airspeed (groundspeed adjusted for wind conditions) began to decrease and its angle of attack increased to nearly 20° nose up. The airplane reached 10,300 ft about 1111:10. Shortly thereafter, it reached its lowest equivalent airspeed about 48 knots, then entered a series of descending turns. The final radar target was recorded about 1112:37, at an altitude of 2,200 ft and an equivalent airspeed of 211 kts.

Witnesses saw sections of the airplane descend. Sections of the airplane impacted multiple locations in the Plainfield area, one of which caught fire and ignited a nearby building. No ground injuries were reported. Witnesses reported weather in the area consistent with a rapidly-forming thunderstorm.

Pilot Information

Certificate:	Commercial; Private	**Age:**	58, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	
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 With Waivers/Limitations	**Last FAA Medical Exam:**	05/31/2016
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	04/15/2015
Flight Time:	(Estimated) 981.1 hours (Total, all aircraft)		

The 58-year-old pilot held a FAA commercial pilot certificate with airplane multiengine land and instrument airplane ratings. He held private pilot privileges in single-engine land airplanes. His most recent FAA third-class medical certificate was issued on May 31, 2016, with limitations that the pilot "must wear lenses for distant, have glasses for near vision. Must wear corrective lenses, possess glasses for near/intermediate vision." The pilot reported on the application for that medical certificate that he had accumulated 976 total hours of flight experience and 5 hours the 6 months before the exam. A review of the pilot's recovered logbook indicated that he had accumulated 981.1 total hours of flight experience and that his most recent flight review was completed on April 15, 2015.

Aircraft and Owner/Operator Information

Aircraft Make:	PIPER	**Registration:**	N7409Y
Model/Series:	PA 30	**Aircraft Category:**	Airplane
Year of Manufacture:	1964	**Amateur Built:**	No
Airworthiness Certificate:	Normal	**Serial Number:**	30-470
Landing Gear Type:	Retractable - Tricycle	**Seats:**	4
Date/Type of Last Inspection:	09/22/2015, Annual	**Certified Max Gross Wt.:**	2381 lbs
Time Since Last Inspection:		**Engines:**	2 Reciprocating
Airframe Total Time:	as of last inspection	**Engine Manufacturer:**	LYCOMING
ELT:	Installed, not activated	**Engine Model/Series:**	IO-320-B1A
Registered Owner:	On file	**Rated Power:**	160 hp
Operator:	On file	**Operating Certificate(s) Held:**	None

N7409Y was a 1964 model Piper PA 30, Twin Comanche airplane with serial number 30-470. The Twin Comanche was an all-metal, multiengine airplane that incorporated a semimonocoque fuselage and empennage design. The airplane was equipped with fully cantilevered wings, wing flaps, and retractable tricycle landing gear. The airplane was powered by two Lycoming IO-320-B1A engines, each rated at 160 horsepower. (Left engine serial number: RL-1085-55; right engine serial number L-1054-55) The IO-320-B1A engine is a four-cylinder, 320 cubic-inch displacement, fuel injected, reciprocating engine. The engines each drove a Hartzell, 2-blade, single-acting, hydraulically operated, constant speed type propeller with feathering capability.

The airplane was modified with a fuel tank mounted in both wing nacelles in accordance with supplemental type certificate (STC) SA00356WI.

The airplane was also equipped with tip tanks in accordance with STC SA727WE. The Pilot's Operating Handbook (POH) supplement in reference to the tip tanks, in part, stated:

LIMITATIONS SECTION
Same as prescribed in appropriate F.A.A. approved
Airplane Flight Manual except:
A. Auxiliary wing tip tank fuel to be used in level
flight only.
B. When using auxiliary fuel, use wing tip tank fuel
first.
C. Maximum allowable gross weight 3725 lbs. Any weight
in excess of 3600 lbs. must consist of symmetrically
loaded fuel in the tip tanks.
D. Never exceed air speed limit of 230 MPH (red line).

A review of recovered maintenance records showed that the airplane's most recent annual

inspection was completed on September 22, 2015. An airplane logbook endorsement, dated November 1, 2015, indicated that the airplane had repairs completed to include the replacement of its left side center wing leading edge skin and lower center wing skin, and replacement of its left aileron skin.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Day
Observation Facility, Elevation:	KJOT, 581 ft msl	**Distance from Accident Site:**	4 Nautical Miles
Observation Time:	1115 CDT	**Direction from Accident Site:**	151°
Lowest Cloud Condition:		**Visibility**	10 Miles
Lowest Ceiling:	Broken / 2100 ft agl	**Visibility (RVR):**	
Wind Speed/Gusts:	7 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	230°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.1 inches Hg	**Temperature/Dew Point:**	32°C / 27°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	SPARTA, TN (SRB)	**Type of Flight Plan Filed:**	None
Destination:	EAGLE RIVER, WI (EGV)	**Type of Clearance:**	None
Departure Time:	0845 CDT	**Type of Airspace:**	

According to records from Lockheed Martin Flight Service, the pilot requested a weather briefing for the flight to SRB, but did not obtain a weather briefing for the accident flight.

A National Transportation Safety Board (NTSB) Senior Meteorologist gathered weather data and produced a Weather Study in reference to this investigation. The study is appended to the docket material associated with this investigation. The study, in part, included local Aviation Routine Weather Reports (METAR) at the Joliet Regional Airport (JOT), near Joliet, Illinois.

At 0753, the Storm Prediction Center issued a Convective Outlook that identified "marginal" risk for the accident site, defined as, "isolated severe thunderstorms possible, limited in duration and/or coverage and/or intensity."

At 1115, the recorded weather at JOT included wind from 230° at 7 kts, visibility 10 statute miles, sky condition broken clouds at 2,100 ft, temperature 32° C, dew point 27° C, and an altimeter setting of 30.10 inches of mercury.

At 1135, the recorded weather at JOT included wind from 210° at 3 kts, visibility 10 statute miles, present weather thunderstorms in the vicinity, sky condition scattered clouds at 2,100 ft, broken clouds at 4,200 ft, broken clouds at 5,000 ft, temperature 31° C; dew point 27° C, and

an altimeter setting of 30.10 inches of mercury.

The meteorologist discovered that local observation stations had a lightning detection system installed. The lightning detection sensor provides cloud-to-cloud, cloud-to-ground and cloud-to-air lighting detection. Publicly disseminated METARs from the local stations were made every 20 minutes, and lightning must be detected within the previous one minute of the report in order to trigger an appropriate thunderstorm and/or lightning indication in the publicly-disseminated METAR. No special reports are issued from these observation stations, though internal reports are generated every minute, which are available via radio and phone.

Weather imagery depicted relatively clear skies at the accident location about 20 minutes before the accident time. Cumulus-type clouds were recorded to the west through north of the accident location at 1052. Subsequent imagery identified cumulus type clouds over the accident location about the accident time. Weather radar imagery identified reflectivity features consistent with convection immediately adjacent to the airplane's position immediately before the accident time.

There were no Airmen's Meteorological Information advisories active for the accident location at the accident time below 25,000 ft and there were no convective or non-convective Significant Meteorological Information advisories active for the accident location at the accident time. There were no Center Weather Advisories (CWA) or Meteorological Impact Statements issued by the Center Weather Service Unit at the Chicago Air Route Traffic Control Center that were active for the area where the accident occurred at the accident time. However, at 1140, a CWA was issued for an isolated thunderstorm with a diameter of 20 miles about 9 miles east-southeast of JOT moving from 280° at 15 knots. There were no publicly-disseminated pilot reports made within 2 hours of the accident time and 50 miles of the accident location.

The 1000 North American Mesoscale (NAM) model sounding for the accident location was retrieved from the National Oceanic and Atmospheric Administration's (NOAA) Air Resources Laboratory. The sounding indicated the most-unstable Convective Available Potential Energy (CAPE) parameter was 4,207 Joules/kilogram (from 995 hPa). The maximum vertical velocity (MVV) for this atmosphere was calculated as 92 meters/second (about 18,100 ft per minute). Additionally, the Downdraft CAPE (DCAPE) was measured at 1,194 Joules/kilogram. CAPE is a measure of the amount of energy available for convection and is directly related to the maximum potential vertical speed within an updraft; higher values indicate greater potential for severe weather. A value of 471 Joules/kilogram would be considered relatively weak. The DCAPE can be used to estimate the potential strength of rain-cooled downdrafts within thunderstorm convection, and is similar to CAPE. Larger DCAPE values are associated with stronger downdrafts. A value of 736 Joules/kilogram would be considered a moderate value.

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:	N/A	**Aircraft Fire:**	On-Ground
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Fatal	**Latitude, Longitude:**	41.555000, -88.207500 (est)

The main wreckage was located on a driveway about 328° and 2.65 nautical miles (nm) from the center of JOT on a heading about 315°. The impact angle of the fuselage with terrain was consistent with a nearly vertical descent. The fuselage, empennage, right engine, right wing, and inboard section of the left wing were discolored, deformed, charred, and melted, with sections consumed by fire. The empennage was found inverted. The right engine's propeller exhibited chordwise abrasion. The nose landing gear jackscrew position was consistent with the gear retracted position.

Sections of fiberglass and aluminum consistent with cowling material were found about 108° and 0.82 nm from the main wreckage. An outboard section of the left wing was found near an access road to a parking lot about 144° and 0.44 nm from the main wreckage site. The left fuel tank was found about 181° and 0.41 nm from the main wreckage site. The left propeller cylinder and a section of its propeller dome and cap were found about 185° and 0.36 nm from the main wreckage site. The left propeller, which had a separated section of its crankshaft attached to it, was found about 199° and 0.35 nm from the main wreckage site. The left engine was found about 204° and 0.24 nm from the main wreckage site.

Disassembly examinations of the two propellers were conducted by the propeller manufacturer's safety representative under supervision of the NTSB investigator in charge. The two right engine propeller blades exhibited chordwise abrasions on both blades; one blade had a fractured tip. A preload plate witness mark suggested a blade angle of 37° at the time of impact. Damage to the right propeller was consistent with high impact forces. The two blades from the left propeller did not exhibit chordwise or rotational witness marks; one of the blades exhibited a hole. A preload plate witness mark suggested a blade angle of 25° at the time of initial impact. Damage to the left propeller was consistent with inflight separation and high impact forces. No preimpact anomalies were detected that would have precluded operation of the propellers.

Disassembly examinations of the two engines were conducted by the engine manufacturer's safety representative under supervision of the NTSB investigator in charge. Examination of the left engine revealed that the crankcase nose was fractured across its front main bearing saddle. The front main bearing shells remained in place. The engine could not be rotated by means of a tool inserted in the vacuum pump drive pad and was further disassembled. No damage to the crankshaft was noted aft of the front main bearing journal and the crankshaft gear was secure. The front main bearing shells were distorted where the front portion of the crankshaft departed the engine. No damage was noted to the other main bearing shells. The connecting rods were free to rotate on the crankshaft rod journals. The connecting rods and their bearings, camshaft, cam followers, cylinders, piston, and piston rings did not exhibit any preimpact

anomalies. Oil was observed in the engine. No metallic debris was observed in the oil suction screen or on the oil filter media. The fuel injector servo was separated from the left engine. The servo was partially disassembled and its rubber diaphragms did not exhibit any anomalies. The servo fuel inlet screen was absent of debris. The flow divider was impact separated from the engine. The divider was partially disassembled and no debris was found internally; there was no damage to the rubber diaphragm. The fuel injector nozzles remained attached to the engine. Nozzle No. 1 was fractured. Nozzle Nos. 2 and 3 were undamaged and unobstructed. Nozzle No. 4 was bent. The left engine-driven fuel pump remained attached to the engine and was impact damaged. Disassembly of the pump revealed no anomalies. Liquid with an odor consistent with aviation gasoline was observed in the engine-driven fuel pump, the fuel injector servo, and the hose from the servo to the flow divider.

The left engine's left magneto remained partially attached to the engine and was impact damaged. The magneto could be rotated by hand and produced spark from all ignition towers. The left engine's right magneto was separated from the engine and its case was fractured. It was difficult to rotate by hand and did not produce spark.

All sparkplugs remained attached to the left engine and all their electrodes were undamaged. The No. 4 top and bottom sparkplugs exhibited reddish colored debris in their electrode wells. All other left engine sparkplugs exhibited normal combustion coloration when compared to a Champion Aviation Check-A-Plug Card.

The left engine's vacuum pump was impact damaged and separated from the engine. The composite drive coupling was in place. The carbon colored rotor and one colored carbon vane were fractured. The remaining 5 vanes were intact.

Examination of the right engine revealed that the nose portion of both crankcase halves was impact fractured and separated. Both crankcase halves displayed multiple fractures and missing portions. The accessory case and oil sump were impact fractured and separated. The Nos. 1 and 2 cylinder heads were fragmented and separated. The induction and exhaust tubing were crushed and partially separated. Continuity of the crankshaft to the rear gears was confirmed by visual inspection. Continuity of the camshaft was confirmed by visual inspection. No damage was noted other than impact damage to the piston domes. Oil was observed in the right engine. The oil sump was fragmented, and the oil suction screen was not located. The oil filter was crushed and no metallic debris was observed between the folds of the filter media. The oil cooler and oil cooler lines were impact damaged.

The right engine's fuel injector servo was separated from the engine and the servo exhibited impact damage. The regulator section was partially disassembled. The fuel and air diaphragms were intact. The throttle stem was bent. The fuel inlet screen was unobstructed. No fuel was observed.

The flow divider was separated from the engine and it exhibited impact and fire damaged. The servo diaphragm was thermally damaged and tore from the center valve when manipulated by hand. The valve was seized in the body and was not removed. No fuel was observed in the servo. The fuel injector nozzles remained with their respective cylinder heads. The No. 1 nozzle was intact and unobstructed. The Nos. 2 and 3 nozzles were bent. The No. 4 nozzle was broken

and unobstructed. The engine-driven fuel pump was separated from the engine and fragmented. Both of the right engine's magnetos were separated from the engine and were fragmented.

The electrodes of the recovered sparkplugs from the right engine exhibited worn normal condition. The No. 4 top and the Nos. 2, 3, and 4 bottom sparkplugs were impact damaged. The No. 1 bottom sparkplug was not located. The top No. 1 sparkplug had an oil-soaked appearance. The Nos. 2 and 3 top sparkplugs exhibited normal combustion coloration when compared to a Champion Aviation Check-A-Plug Card.

The right engine vacuum pump was damaged and separated from the engine. The pump was partially disassembled, and its composite drive coupling was intact. The carbon colored rotor was fragmented, and its carbon colored vanes were intact.

An instrument gyroscope housing was disassembled. The internal surface of the gyroscope housing and its rotor exhibited witness contact marks consistent with rotation of the rotor.

Communications

Recording of communications from the Chicago Terminal Radar Approach Control facility were reviewed along with their transcripts. The transcripts are appended to the docket material associated with this investigation. Communication from one sector in the facility, in part, stated:

PILOT: Private approach, twin Comanche 7409 Yankee. Would you maintain 8,500?
CONTROLLER: Whoever's calling, ident.
PILOT: Twin Comanche 7409 Yankee with you, maintaining 8,500.
CONTROLLER: Contact Chicago departure, 126.62. Maintain VFR outside the Bravo.
PILOT: 126.62?
CONTROLLER: Yes.
PILOT: Roger.

Communication from another sector in the facility, in part, stated:

PILOT: (Unintelligible) 7409 Yankee. We're just checking in at 8,500.
CONTROLLER: All right. Who, what, say your location the VFR (phonetic) craft checking in.
PILOT: I'm just outside of the class, the airspace here, by Lewiston University.
CONTROLLER: Okay. Have I already talked to you?
PILOT: Negative. They told me to call you up. I'm just passing by to the west.
CONTROLLER: Okay. Did they assign you a code?
PILOT: 1647.
CONTROLLER: Okay. Well, they haven't told me anything about you. Just maintain

(unintelligible) class Bravo. I'll get back to you.
PILOT: Roger.

That was the last recorded communication with the accident airplane.

Medical And Pathological Information

An autopsy was performed on the pilot by the Will County Coroner's Office, Crest Hill, Illinois, and toxicological samples were taken for testing. The autopsy listed the cause of death as multiple injuries. Toxicology testing performed by NMS Labs at the request of the coroner identified citalopram and its metabolite, desmethylcitalopram, in muscle tissue.

The FAA Bioaeronautical Sciences Research Laboratory, Oklahoma City, Oklahoma, performed toxicology testing on specimens of the pilot. The report, in part, indicated that the sample sustained putrefaction. However, 52 mg/dL ethanol and propanol were detected in the muscle, and no ethanol was found in the kidney citalopram and N-Desmethylcitalopram were detected in the lung; and trazodone was detected in the lung and muscle samples.

The NTSB Chief Medical Officer reviewed documents to include the pilot's FAA medical case review, autopsy report, toxicology findings, and the investigator's reports, and produced a Medical Factual Report, which is appended to the docket material associated with this investigation.

The medical report shows that Citalopram is a prescription antidepressant often marketed with the name Celexa. It carries this warning, "In studies in normal volunteers, citalopram in doses of 40 mg/day did not produce impairment of intellectual function or psychomotor performance. Because any psychoactive drug may impair judgment, thinking, or motor skills, however, patients should be cautioned about operating hazardous machinery, including automobiles, until they are reasonably certain that citalopram therapy does not affect their ability to engage in such activities."

Major depression itself is associated with significant cognitive degradation, particularly in executive functioning. Because of this, pilots with depression require specific evaluation before medical certification. The FAA's Guide for Aviation Medical Examiners states "The use of a psychotropic drug is disqualifying for aeromedical certification purposes – this includes all antidepressant drugs, including selective serotonin reuptake inhibitors (SSRIs). However, the FAA has determined that airmen requesting first, second, or third class medical certificates while being treated with one of four specific SSRIs may be considered. The Authorization decision is made on a case by case basis. The Examiner may not issue." The four potentially allowable antidepressants include citalopram.

Trazodone is another prescription antidepressant that is significantly sedating; it is often used as a sleep aid. It carries this precaution, "Antidepressants may impair the mental and/or physical ability required for the performance of potentially hazardous tasks, such as operating an automobile or machinery; the patient should be cautioned accordingly. Trazodone

hydrochloride may enhance the response to alcohol, barbiturates, and other central nervous system depressants."

The pilot had reported to the FAA a DUI conviction in 1991, but no chronic medical conditions and no use of medications.

Fire

Wreckage that came to rest away from the main wreckage did not exhibit any thermal deformation or discoloration. The area around the main wreckage exhibited damage consistent with a ground fire.

Tests And Research

Metallurgical Examination

Two pieces from the forward end of the left engine crankshaft along with the crankshaft's forward split main bearing shells were sent to the NTSB Materials Laboratory for detailed examination. An NTSB Senior Materials Engineer examined the components and produced a Materials Laboratory Factual Report, which is appended to the docket material associated with this investigation. The materials report, in part, stated that the first examined piece was the crankshaft piece from the propeller flange to a fracture through the oil tube hole in the first main bearing journal. The other piece was the crankshaft piece from the fracture to a cut through the second connecting rod journal.

The propeller flange on the crankshaft exhibited bending deformation, with one region bent forward and the opposite region, 180° around the shaft bent aft. A portion of the oil flinger flange was fractured leaving an approximate 120° region intact. The crankshaft was fractured in the circumferential direction at the oil tube hole in the first (forward) main bearing journal. The fracture surfaces had a comparatively rough appearance and were inclined about 45° to the bearing surface. The exhibited features were consistent with a bending overstress fracture. The split bearing shells were deformed; however, they exhibited no otherwise notable features.

Aircraft Performance Examination

An NTSB Air Traffic Control Specialist requested radar data from the FAA in reference to the accident flight. The radar data was provided to an NTSB Performance Specialist who produced a Performance Study, which is appended to the docket material associated with this investigation. The study, in part, stated that the radar data provided began about 1044. Until about 1108, the airplane was travelling along a path oriented at approximately 320° (true), at an altitude of 8,500 ft, and a groundspeed of about 150 kts. About 1108:23 the airplane began to gain altitude while losing speed until 1111:10 when it reached an altitude of 10,300 ft. The airplane held 10,300 ft until 1111:23 when it began to descend and gain speed. About 1111:28 the airplane reached its lowest calculated equivalent airspeed of 48 kts. The final radar point

was at 1112:37.78 when the altitude was recorded at 2,200 ft and the calculated equivalent airspeed was 211 kts.

The recorded rate of climb for the accident airplane from 8,500 ft to 10,300 ft was about 600 ft/min. The POH reported the multi-engine full throttle rates of climb, given a calculated density altitude, were between 800 ft/min at 3,600 lbs and 1,200 ft/min at 2,800 lbs. This recorded rate of climb at this altitude was within the capability of the airplane.

The calculated pitch and angle of attack for the final climb was calculated using a simplified aerodynamic model. The model showed that while the airplane gained altitude, it lost airspeed, and its angle of attack increased to nearly 20°. A high angle of attack and low airspeed can put an airplane at risk of an aerodynamic stall.

The POH reported the gear and flaps up stall speed to be between 76 mph (66 kts) at 3,600 lbs gross weight and 67 mph (58 kts) at 2,600 lbs. Radar data showed that the airplane lost altitude and began a series of turns, the first to the left, after the equivalent airspeed dropped below 60 kts. The data indicated the airplane was at 10,300 ft.

The airplane then picked up speed after it began descending and rolled left, reaching a maximum calculated equivalent airspeed of over 200 kts before the radar data ended. The flight manual reported the never exceed speed to be 230 mph (200 kts). The maneuvering speed was reported as being between 135 mph (117 kts) at 2,450 lbs gross weight and 162 mph (140 kts) at 3,600 lbs. The airplane exceeded the POH airspeed restrictions while rolling left and right during its descent.

Structures Examination

A NTSB Aircraft Structures National Resource Specialist examined the recovered wreckage and identified sections to be further examined in detail. The identified sections were subsequently examined by the structural specialist and an airplane manufacturer's engineer. The specialist produced a Structures Group Chairman's Factual Report, which is appended to the docket material associated with this investigation.

About 83 inches of the separated left outboard wing exhibited leading edge skin separations. The outboard approximate 68 inches of the left aileron remained attached to the separated section of wing with the aileron balance weight still secured to the aileron. The inboard section of the left aileron was separated from the remainder of the structure and was recovered. No evidence of fire or fire damage was noted to the separated section of wing or aileron. The left tip tank was separated from the outboard section of the wing and found breeched from impact damage to the leading edge.

The remainder of the left wing remained attached to the fuselage; fire damage was noted to the inboard area of the left wing. The left flap was found separated from its mounts at the main wreckage site and exhibited impact and fire damage along the entire span of the flap. The left engine and nacelle structure were separated from the left wing. The left aileron bell crank assembly remained attached and the bell crank fitting was recovered at the main wreckage site. The aileron control cable attach points to the bell crank were found fragmented from the bell crank assembly. Left aileron control continuity was established except where impact

separations were noted. The left aileron control cables were found twisted around themselves and the aft wing spar exhibited "saw" marks along the top edge of the spar.

The upper main spar and lower spar chord fractured and both exhibited evidence of upward and aft bending. An examination of the shear lips on the horizontal legs of the spar chord at each of the fracture locations confirmed the upward bending along with the fractured ends of the horizontal legs of the spar chords deforming in an upward direction. The left wing's spar chords also exhibited evidence of trailing edge up twisting deformation consistent with the outboard wing rotating counter clockwise about the main the spar when looking inboard. The left wing's main spar web was missing sections in the area of the aileron bell crank assembly. The rear spar was missing in the area of the rear spar aileron hinge fitting. Neither the inboard aileron nor inboard rear spar aileron hinge fitting were recovered. The bell cranks outboard support rib fractured vertically about six inches aft the main spar attachment and the inboard support was not recovered. The bell crank, the assembly, and the remaining outboard support rib were recovered at the main wreckage site. The inboard 20 inches of the aileron spar in the area of the aileron hinge fitting attachment was not recovered and the inboard twenty inches of the aileron skin panel was recovered separate from both the main wreckage and the outboard wing section. The aileron exhibited evidence of up bending. The aileron balance weight cutout exhibited evidence of impact damage. The aileron travel limit stops did not exhibit evidence of repeated contact. A section of the rear upper spar chord exhibited evidence of aileron cable contact. The upper wing skin along the rear spar had evidence of a cable tear from about the aileron hinge location extending about 2 ft inboard.

The outboard section of the wing is spliced to the inboard section of the wing. A section of the outboard horizontal leg of the upper spar in the splice area was not recovered. In this area, the spar chord is no longer an L section and only has a horizontal leg.

Fourteen rivet holes were identified for an examination to determine the quality of the rivet installation. Per manufacturing drawings, solid-shank rivets are the fasteners specified to be installed in the identified holes.

Correct installation of these rivets in the assembly is accomplished by slightly expanding the shank while being driven. During normal operation of the aircraft primer should not have been present in the rivet holes had the rivets been installed correctly, the primer, if present, would have worn off. Since primer is in these holes, it is indicative that these holes may not have had their rivets installed correctly.

The specified solid-shank rivets share the load during normal operation. During installation of these rivets and normal operation, the rotary marks created by the drill bit to produce the rivet hole should be disturbed. The identified rivet holes were stripped and etched. Rotary drill witness marks created by a drill bit rotating in the hole were observed in several holes. The rivet holes showing drill witness marks are consistent with the rivets not participating in the load sharing.

The right wing was found mostly consumed by post impact fire. The right aileron was partially consumed by fire but remained attached to its mounts. The right aileron balance weight was damaged due to impact forces and separated from the aileron. The right aileron bell crank remained attached to the wing; however, the bell crank cable attach horns were fragmented.

The aileron drive and balance cables remained attached to the fragmented bell crank horn attach points. One aileron travel limit stop was fractured and was not located within the recovered wreckage. The other travel limit stop did not exhibit evidence of repeated contact. Right aileron control continuity was established except where impact separations were noted. The right flap was found mostly consumed by fire. The right tip tank was found separated from the wing and breeched.

The rudder cables remained attached to the rudder bell crank and to the fragmented rudder pedal assembly. Rudder control continuity was established except where rudder control cables were cut for recovery purposes.

The stabilator remained attached to its mounting points on the fuselage. A section of the right stabilator aft of the main spar was separated and found approximately 30 ft north of the main wreckage. The separated section of the right stabilator exhibited skin separations at the main stabilator spar and fire damage to the outboard section. The right stabilator trim tab remained attached to the separated section of the stabilator. The outboard section of the attached right stabilator was found consumed by fire. The left side of the stabilator remained attached to its mounts on the fuselage frame and the left stabilator trim tab remained attached to the stabilator. The stabilator trim barrel exhibited impact and fire damage. The stabilator balance weight was consumed by post impact fire. However, the stabilator control cables remained attached to the stabilator balance weight tube and to the fragmented "T" bar assembly. Stabilator control continuity was established except where control cables were cut to facilitate recovery.

A load analysis plot was produced to determine if the loads achieved during the descending spiral would have exceeded the loads that the aileron was tested to during the airplane's certification. The plot demonstrated that for the accident airplane, the aileron components per type design, at a minimum, should have been structurally capable up to full deflections (down to up) between 166 to 183 knots true, and the aileron installation per type design, should have been structurally capable for full deflection (down to up) between 190 to 206 knots true.

Additional Information

The definition of design maneuvering speed is the speed below which you can move a single flight control, one time, to its full deflection, for one axis of airplane rotation only (pitch, roll or yaw), in smooth air, without risk of damage to the airplane.

Administrative Information

Investigator In Charge (IIC):	Edward F Malinowski	**Report Date:**	05/24/2018
Additional Participating Persons:	Edward. Dabrowski; Federal Aviation Administration; Des Plaines, IL J M Childers; Continental Motors; Mobile, AL Damian Galbraith; Piper; Vero Beach, FL Les Doud; Hartzell Propeller; Piqua, OH		
Publish Date:	11/30/2018		
Note:	The NTSB traveled to the scene of this accident.		
Investigation Docket:	http://dms.ntsb.gov/pubdms/search/dockList.cfm?mKey=93655		