National Transportation Safety Board
Aviation Accident Factual Report

Location:	Bloomington, IL	**Accident Number:**	CEN15FA190
Date & Time:	04/07/2015, 0006 CDT	**Registration:**	N789UP
Aircraft:	CESSNA 414A	**Aircraft Damage:**	Substantial
Defining Event:	Loss of control in flight	**Injuries:**	7 Fatal
Flight Conducted Under:	Part 91: General Aviation - Personal		

The is an INTERIM FACTUAL SUMMARY of this accident investigation. A final report that includes all pertinent facts, conditions, and circumstances of the accident will be issued upon completion, along with the Safety Board's analysis and probable cause of the accident.

On April 7, 2015, about 0006 central daylight time (all referenced times will reflect central daylight time), a Cessna model 414A twin-engine airplane, N789UP, was substantially damaged when it collided with terrain following a loss of control during an instrument approach to Central Illinois Regional Airport (BMI), Bloomington, Illinois. The airline transport pilot and six passengers were fatally injured. The airplane was owned by and registered to Make It Happen Aviation, LLC, and was operated by the pilot under the provisions of 14 Code of Federal Regulations Part 91 while on an instrument flight rules (IFR) flight plan. Night instrument meteorological conditions prevailed for the cross-country flight that departed Indianapolis International Airport (IND), Indianapolis, Indiana, at 2307 central daylight time.

According to Federal Aviation Administration (FAA) Air Traffic Control (ATC) data, after departure the flight proceeded direct to BMI and climbed to a final cruise altitude of 8,000 feet mean sea level (msl). At 2344:38 (hhmm:ss), about 42 nautical miles (nm) south-southeast of BMI, the flight entered a cruise descent to 4,000 feet msl. At 2352:06, the pilot established contact with Peoria Terminal Radar Approach Control, reported being level at 4,000 feet mean sea level (msl), and requested the Instrument Landing System (ILS) Runway 20 instrument approach to BMI. According to radar data, the flight was located about 21 nm south-southeast of BMI and was established on a direct course to BMI at 4,000 feet msl. The controller told the pilot to expect radar vectors for the ILS Runway 20 approach. At 2354:18, the controller told the pilot to make a right turn to a 330 degree heading. The pilot acknowledged the heading change. At 2359:16, the controller cleared the flight to descend to maintain 2,500 feet msl. At 2359:20, the pilot acknowledged the descent clearance.

At 0000:01, the controller told the pilot to turn left to a 290 heading and the pilot acknowledged the heading change. At 0000:39, the controller told the pilot that the flight was 5 nm from EGROW intersection, cleared the flight for the ILS Runway 20 instrument approach, issued a heading change to 230 degrees to intercept the final approach course, and

told the pilot to maintain 2,500 feet until established on the inbound course. The pilot correctly read-back the instrument approach clearance, the heading to intercept the localizer, and the altitude restriction.

At 0001:26, the flight crossed through the final approach course while on the assigned 230 degree heading before turning to a southerly heading. The plotted radar data showed the flight made course corrections on both sides of the localizer centerline as it proceeded inbound toward EGROW. At 0001:47, the controller told the pilot to cancel his IFR flight plan on the approach control radio frequency, that radar services were terminated, and authorized a change to the airport's common traffic advisory frequency (CTAF). According to radar data, the flight was 3.4 nm outside of EGROW, established inbound on the localizer, at 2,400 feet msl. At 0002:00, the pilot transmitted over the unmonitored airport CTAF, "twin Cessna seven eight nine uniform pop is coming up on EGROW, ILS Runway 20, full stop." No additional transmissions from the pilot were recorded on the airport CTAF or by Peoria Approach Control.

At 0003:12, the flight crossed the locator outer marker (EGROW) at 2,100 feet msl and continued to descend while right of the localizer centerline. At 0003:46, the airplane descended below available radar coverage at 1,500 feet msl. The flight was about 3.5 nm from the end of the runway when it descended below radar coverage. Subsequently, at 0004:34, radar coverage was reestablished with the flight about 1.7 nm north of the runway threshold at 1,400 feet msl. The plotted radar data showed that, between 0004:34 and 0005:08, the flight climbed from 1,400 feet msl to 2,000 feet msl while maintaining a southerly course. At 0005:08, the flight began a descending left turn to an easterly course. The airplane continued to descend on the easterly course until reaching 1,500 feet msl at 0005:27. The airplane then began a climb while maintaining an easterly course. At 0005:42, the airplane had flown 0.75 nm east of the localizer centerline and had climbed to 2,000 feet msl. At 0005:47, the flight descended below available radar coverage at 1,800 feet msl. Subsequently, at 0006:11, radar coverage was reestablished at 1,600 feet msl about 0.7 nm southeast of the previous radar return. The next two radar returns, recorded at 0006:16 and 0006:20, were at 1,900 feet msl and were consistent with the airplane on an easterly course. The final radar return was recorded at 0006:25 at 1,600 feet msl about 2 nm east-northeast of the runway 20 threshold, and was approximately coincident with the accident site location.

There were numerous individuals who reported being awoken shortly after midnight by the sound of a low-flying airplane over their respective residences. Additionally, several of these witnesses observed dense fog and/or rain after the airplane had overflew their position.

Pilot Information

Certificate:	Airline Transport	**Age:**	51, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Lap Only
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane Multi-engine; Airplane Single-engine; Instrument Airplane	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 With Waivers/Limitations	**Last Medical Exam:**	02/02/2015
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	03/11/2015
Flight Time:	(Estimated) 12100 hours (Total, all aircraft), 1150 hours (Total, this make and model)		

According to Federal Aviation Administration (FAA) records, the 51-year-old pilot held an airline transport pilot certificate with single engine land, multiengine land, and instrument airplane ratings. The single engine land rating was limited to commercial privileges. The pilot was type-rated for the Cessna Citation, Learjet 35, Rockwell Sabreliner, Dassault Falcon 10, and Embraer Phenom business jets. He also held a flight instructor certificate with single engine, multiengine, and instrument airplane ratings. The pilot's last aviation medical examination was on February 2, 2015, when he was issued a second-class medical certificate with a limitation for corrective lenses. On the application for his current medical certificate, the pilot reported having accumulated 12,000 hours of total flight experience, of which 500 hours were flown within the previous 6 months. A search of FAA records showed no previous accidents, incidents, or enforcement proceedings.

A current pilot logbook was not located during the investigation; the pilot's most recent logbook entry was dated February 15, 2005. A portfolio was found in the airplane wreckage that contained numerous pilot training certificates, fleet management documents, and airplane insurance applications. According to an insurance application that was submitted for the operation of the accident airplane, dated May 12, 2014, the pilot reported having a total flight experience of 12,100 hours, 9,850 hours in multiengine airplanes, 8,575 hours in turbine-powered airplanes, and 1,150 hours in Cessna 414A airplanes. The portfolio also contained documentation for simulator-based proficiency training in the Cessna 414A that was completed on August 14, 2013, at Recurrent Training Center, Inc., located in Savoy, Illinois. According to available information, the pilot's last flight review and instrument proficiency check was completed on March 11, 2015, in conjunction with simulator-based recurrent training for a Dassault Falcon 10 business jet at FlightSafety International, located in Dallas, Texas.

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	CESSNA	**Registration:**	N789UP
Model/Series:	414A	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Normal	**Serial Number:**	414A0495
Landing Gear Type:	Retractable - Tricycle	**Seats:**	7
Date/Type of Last Inspection:	10/01/2014, Annual	**Certified Max Gross Wt.:**	7087 lbs
Time Since Last Inspection:	43 Hours	**Engines:**	2 Reciprocating
Airframe Total Time:	8390.2 Hours	**Engine Manufacturer:**	Continental Motors
ELT:	C91 installed, activated, aided in locating accident	**Engine Model/Series:**	TSIO-520-NB
Registered Owner:	Make It Happen Aviation, LLC	**Rated Power:**	325 hp
Operator:	Make It Happen Aviation, LLC	**Air Carrier Operating Certificate:**	None

The accident airplane was a 1980 Cessna model 414A (Chancellor), serial number 414A0495. Two turbo-charged Continental model TSIO-520-NB reciprocating engines provided thrust through constant-speed, full-feathering, three blade, Hartzell model PHC-C3YF-2UF/FC7663DB-2Q propellers. The low-wing airplane was of conventional aluminum construction, equipped with a retractable tricycle landing gear, and a pressurized cabin that was configured to seat seven individuals. The airplane was equipped for night operations in instrument meteorological conditions. The airplane had been modified by supplemental type certificates (STC) to include winglets, vortex generators, and wing spoilers. Additionally, the maximum continuous horsepower of each engine had been increased to 325-horsepower after a STC modification. The airplane had a total fuel capacity of 213.4 gallons (206 gallons usable) distributed between two wing fuel tanks. A review of prior flights, fueling records, and fuel consumption calculations established that the airplane departed on the accident flight with about 133.4 gallons of usable fuel.

According to the current weight-and-balance record, dated November 27, 2013, the airplane had an empty weight of 5,226.6 lbs and a useful load of 1,860.4 lbs. The empty weight center-of-gravity (CG) was 156.52 inches aft of the datum. At maximum takeoff weight, 7,087 lbs, the forward and aft CG limits were 152.2 inches and 159.04 inches, respectively. At maximum landing weight, 6,750 lbs, the forward and aft CG limits were 151.2 inches and 160.04 inches, respectively.

The airplane was originally issued an export certificate of airworthiness on May 22, 1980. The airplane was issued a Canadian registration number, C-GFJT, and was based in Canada until September 1986 when it was imported back into the United States of America and issued a standard airworthiness certificate and a new registration number (N144PC) on October 1, 1986. On April 12, 1993, the registration number was changed to N789UP.

According to an airplane utilization log found in the wreckage, the airplane's hour meter indicated 2,109.7 hours before the previous flight leg (BMI to IND). The airplane's hour meter

was not located during the accident investigation; however, postaccident calculations indicated that the airplane had accumulated about 1.9 hours during the final two flights (BMI to IND and IND to BMI).

According to available maintenance documentation, the airframe had accumulated a total service time of 8,390.2 hours since new. The last annual inspection of the airplane was completed on October 1, 2014, at 8,346.9 total airframe hours. The airplane had accumulated 43.3 hours since the annual inspection. The static system, altimeter system, automatic pressure altitude reporting system, and transponder were last tested on December 2, 2013. A postaccident review of the maintenance records found no history of unresolved airworthiness issues.

The left engine, serial number 503140, had accumulated a total service time of 4,881.5 hours since new and 556.7 hours since being overhauled on March 20, 2008. The left propeller, serial number EB1994, had accumulated a total service time of 6,936.4 hours since new and 165.3 hours since being overhauled on November 23, 2010.

The right engine, serial number 519303, had accumulated a total service time of 5,591 hours since new and 1,699.9 hours since being overhauled on June 13, 2000. The right propeller, serial number EB1993, had accumulated a total service time of 6,936.4 hours since new and 691.3 hours since being overhauled on February 10, 2006.

Meteorological Information and Flight Plan

Observation Facility, Elevation:	BMI, 871 ft msl	**Observation Time:**	0005 CDT
Distance from Accident Site:	2 Nautical Miles	**Condition of Light:**	Night/Dark
Direction from Accident Site:	250°	**Conditions at Accident Site:**	Instrument Conditions
Lowest Cloud Condition:		**Temperature/Dew Point:**	13°C / 13°C
Lowest Ceiling:	Overcast / 200 ft agl	**Visibility**	0.5 Miles
Wind Speed/Gusts, Direction:	6 knots, 60°	**Visibility (RVR):**	4000 ft
Altimeter Setting:	29.98 inches Hg	**Visibility (RVV):**	
Precipitation and Obscuration:	Light - Rain; Moderate - Fog		
Departure Point:	Indianapolis, IN (IND)	**Type of Flight Plan Filed:**	IFR
Destination:	Bloomington, IL (BMI)	**Type of Clearance:**	IFR
Departure Time:	2307 CDT	**Type of Airspace:**	Class E

A National Weather Service (NWS) Surface Analysis Chart, issued at 0100 central daylight time (CDT) depicted a stationary front extending across central Iowa, northern Illinois and Indiana, and immediately north of Bloomington, Illinois. A second stationary front was depicted extending over Kansas, into Missouri, and turning southeastward into Tennessee and Alabama. The station models on the chart indicated northeasterly winds at 10 to 15 knots north of the stationary front located across Illinois, and from the east-southeast at 5 knots or less south of the frontal boundary. The station models also depicted an extensive area of overcast clouds over the region, and with most stations along and south of the front reporting light continuous

rain, drizzle, and/or mist. The station model for Bloomington indicated wind from the east-southeast at about 5 knots, surface visibility restricted in mist, overcast cloud cover, temperature and dew point at 13 degrees Celsius, and a sea level pressure of 29.98 inches of mercury. The station models surrounding Bloomington indicated similar conditions with overcast clouds, light continuous rain and/or mist.

A review of weather radar data recorded at 0004 CDT revealed no significant radar echoes greater than 15 dBZ over the greater Bloomington-Normal area. The observed radar echoes were consistent with light rain. The observed radar echoes along the recorded flight track were consistent with the accident airplane operating in instrument meteorological conditions (IMC) during the approach and at the time of the accident.

At 2156 CDT, about an hour before the accident flight departed, the BMI automated surface observing system (ASOS) reported: wind 150 degrees at 4 knots, an overcast ceiling at 1,200 feet above ground level (agl), 10 mile surface visibility, temperature 14 degrees Celsius, dew point 12 degrees Celsius, and an altimeter setting of 29.98 inches of mercury.

At 2303 CDT, about four minutes before the accident flight departed, the BMI ASOS reported: wind 140 degrees at 6 knots, scattered clouds at 100 feet agl and an overcast ceiling at 800 feet agl, 2 mile surface visibility with light rain and mist, temperature 13 degrees Celsius, dew point 13 degrees Celsius, and an altimeter setting of 29.99 inches of mercury.

At 0005 CDT, about a minute before the accident, the BMI ASOS reported: wind 060 degrees at 6 knots, an overcast ceiling at 200 feet above ground level (agl), 1/2 mile surface visibility with light rain and fog, the runway visibility range (RVR) for runway 29 was variable 4,000-6,000 feet, temperature 13 degrees Celsius, dew point 13 degrees Celsius, and an altimeter setting of 29.98 inches of mercury.

The terminal aerodrome forecast (TAF) issued at 1826 CDT for BMI expected marginal visual flight rules (MVFR) conditions to prevail during the forecast period with a surface visibility greater than 6 miles, an overcast ceiling at 2,500 feet agl, and with rain showers in the vicinity after 0100 CDT. The terminal forecast was amended at 2048 CDT, lowering the overcast ceiling to 1,200 feet agl. At 0038 CDT, an updated terminal forecast indicated that low instrument meteorological (LIFR) conditions were expected, including an overcast ceiling at 200 feet agl, and a 1/2 mile surface visibility with light drizzle and fog.

According to available information, the pilot utilized a commercial weather vendor (FlightPlan.com) to obtain his preflight weather briefing. The vendor logged weather briefings at 1614, 1957, 2117, and 2228 CDT. The briefings included weather reports, forecast, and notice to airmen for the departure, destination, alternate, and selected nearby airports and pilot reports. The final weather briefing, obtained at 2228 CDT, included the TAF for Bloomington that had been issued at 2048 CDT, which forecasted MVFR conditions. The 2228 CDT briefing also provided weather conditions for nearby airports that were reporting LIFR conditions with overcast ceilings ranging between 200 and 300 feet agl. The 2228 CDT briefing did not include the Area Forecast or any in-flight weather advisories. The pilot filed an IFR flight plan from IND to BMI and designated Lambert-St Louis International Airport (STL) as his alternate airport.

Airport Information

Airport:	Central Illinois Regional (BMI)	**Runway Surface Type:**	Concrete
Airport Elevation:	871 ft	**Runway Surface Condition:**	Wet
Runway Used:	20	**IFR Approach:**	ILS
Runway Length/Width:	8000 ft / 150 ft	**VFR Approach/Landing:**	None

Central Illinois Regional Airport (BMI), a public airport located about 3 miles east of Bloomington, Illinois, was owned and operated by the Bloomington-Normal Airport Authority. The airport field elevation was 871 feet msl. The airport had two runways: runway 2/20 (8,000 feet by 150 feet, concrete) and runway 11/29 (6,525 feet by 150 feet, asphalt/concrete). Although airport was equipped with an air traffic control tower, the control tower was closed at the time of the accident.

Runway 20 incorporated a dual-mode Approach Lighting System II (ALSF-2) and Simplified Short Approach Lighting System with Runway Alignment Indicator Lights (SSALR). The SSALR system was active when the control tower was closed. The runway was also equipped with runway touchdown zone and centerline lighting, and high intensity runway edge lighting.

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		

The accident site was located in an open harvested corn field, about 2.2 miles east-northeast of the runway 20 threshold and about 1.75 miles east of the localizer centerline. The GPS altitude of the accident site was 854 feet. The main wreckage consisted of the entire airplane, which was orientated on a 074-degree magnetic heading. The wreckage was in an upright position and there was no appreciable wreckage debris path. All observed airframe structural separations were consistent with impact-related damage. The forward fuselage and cockpit were crushed upward and displaced aft. Flight control cable continuity was traced from the cockpit to the individual flight control surfaces. All observed flight control cable separations were consistent with overstress or were cut to facilitate recovery of the wreckage. There was no evidence of fire damage inside the cockpit, main cabin, aft fuselage, or empennage. Both wings remained attached to the fuselage and exhibited postimpact fire damage of their respective engine nacelle/locker. Both ailerons were found partially separated from their respective hinge attachments. The aileron trim actuator extension measured 11/16 inch, which corresponded to the trailing-edge of the aileron trim tab being deflected up about 15-degrees. The aileron trim indicator was damaged during impact. The right wing leading edge outboard of the engine nacelle was crushed upward and displaced aft. The right wing deice boot and winglet were damaged by the postimpact fire. The left wing aft structural attachment exhibited features consistent with an overstress separation. The left winglet had separated and was found laying

adjacent to the wing. The left wing leading edge outboard of the engine nacelle was crushed upward and displaced aft. The tail section was found separated immediately aft of the aft pressure bulkhead and remained attached through control cables. Both elevators remained attached to their respective horizontal stabilizer. The elevator trim actuator extension measured 1-11/16 inch, which corresponded to the trailing-edge of the elevator trim tab being deflected up about 5-degrees. The elevator trim indicator was damaged during impact. The rudder remained attached to the vertical stabilizer. The rudder trim actuator extension measured 2-1/4 inch, which was consistent with a neutral rudder trim position. The rudder trim indicator was damaged during impact. The nose and main landing gear were found fully retracted and the cockpit selector handle was found in the GEAR UP position. A measurement of the wing flap control chain corresponded with a fully-retracted flap position. The flap selector handle and indicator were damaged during impact. An operational test of the wing spoiler actuators did not reveal any anomalies. The cockpit instrument panel sustained considerable damage during impact. The throttle quadrant was buckled and displaced to the right. Both throttles levers were found in the idle position and bent to the right. Both propeller levers were found full forward and bent to the right. Both mixture levers were found in an intermediate position and bent to the right. The cockpit altimeters had a Kollsman window setting between 29.98 and 29.99 inches of mercury. The stall warning horn and landing gear warning horn were extracted from the cockpit and both horns produced an aural tone when electrical power was applied. Switch continuity for the wing-mounted lift sensor was confirmed. Both engine-mounted vacuum pumps exhibited impact and thermal damage. Disassembly of both vacuum pumps did not reveal any anomalies attributable to a preimpact malfunction.

Both integral wing fuel tanks were breached at their respective wingtips. Fuel was observed to drain from the left wing during wreckage recovery. Both fuel tank caps were found in the secured position. The airplane was equipped with cable-operated fuel selector valves, one for each engine, that were installed inboard of each engine nacelle. Both fuel selector valves were found in the OFF position; however, a reliable determination of the preimpact position was not possible due to impact-related damage to the selector handles. The structure supporting the selector handles, located between the cockpit seats, had been displaced forward into a vertical position during impact. Both auxiliary fuel pumps exhibited thermal damage from the postimpact fire that precluded further testing.

Both engines remained partially attached to their respective nacelles and exhibited impact and postimpact fire damage. The observed thermal damage was concentrated between the airframe firewalls and the rear accessory section of each engine. Both propellers had separated from their respective engine and were found in front of each engine, buried at a depth of about 18 inches. Both propellers retained their respective propeller flange and a fractured portion of their respective engine crankshaft. Both crankshafts displayed a bend in one direction with circumferential cracks observed on the tension side of the bend, a 45-degree sheer lip fracture on the tension side, and an irregular/jagged fracture on the compression side. Mechanical continuity from the engine components to their respective cockpit controls could not be determined due to impact and fire damage. Internal engine and valve train continuity was confirmed when each engine was rotated through the accessory section. Compression and suction were noted on all cylinders in conjunction with crankshaft rotation. Teardown examinations of both engines and their respective turbochargers did not reveal any anomalies

attributable to a preimpact malfunction. Additional documentation for each engine and turbocharger examination is included with the docket materials associated with the investigation.

Each propeller had one blade that was bent aft, one blade that appeared straight, and one blade that exhibited forward bending near the tip. Both propellers had their spinner domes formed around the propeller hub and counterweights. The spinner domes also exhibited a spiral/twisting deformation pattern. The observed blade and spinner dome damage was consistent with both propellers rotating at impact. Neither propeller was found in a feathered position. Both propellers were found on their respective start locks. According to the propeller manufacturer, for the propellers to be found on the start locks, the propeller blade angle at impact was either at or below the start lock angle when engine speed decreased below 700-900 RPM, or the blade forces during impact had moved the blade angle into a start lock position after engine speed decreased below 700-900 RPM. A teardown examination of each propeller did not reveal any anomalies that would have precluded normal operation. Additional documentation for each propeller examination is included with the docket materials associated with the investigation.

Aids To Navigation

The published inbound course for ILS runway 20 approach was 198 degrees magnetic, the crossing altitude for the final approach fix (EGROW) was 2,459 feet msl, and the distance between EGROW and the runway threshold was 4.8 nautical miles. The touchdown zone elevation was 871 feet msl. The published decision altitude was 1,071 feet msl (200 feet agl) and required 1,800 feet runway visibility range (RVR). The published missed approach procedure was to climb on runway heading to 1,500 feet msl, then make a right turn to a 270 degree magnetic heading and climb to 3,000 feet msl, then join the 214 degree radial from the Pontiac VOR and hold at MCLEN intersection.

In the event of a loss of vertical guidance from the glideslope during an approach, or if a pilot was cleared for the non-precision localizer approach, the missed approach point (MAP) was located 4.8 nm from the final approach fix (EGROW) while established on the localizer. The non-precision localizer approach minimum descent altitude (MDA) was 1,260 feet msl (389 feet agl) and required 2,400 feet RVR. The MDA for a circling approach was 1,340 feet msl (468 feet agl) and required 1 mile surface visibility.

According to air traffic control documentation, at the time of the accident, all components of the ILS were functional, with no recorded errors, and the localizer was radiating a front-course to runway 20. Additionally, a postaccident flight check further confirmed that there were no anomalies with the instrument approach.

Flight Recorders

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

Medical And Pathological Information

On April 7, 2015, the McLean County Coroner Office, located in Bloomington, Illinois, performed an autopsy on the pilot. The cause of death was attributed to multiple blunt-force injuries sustained during the accident. The autopsy also identified an enlarged heart with wall thickening and dilation of the chambers, 60-75 percent stenosis of the proximal left anterior descending artery, extensive interstitial myocardial fibrosis within the left ventricle, and severe atherosclerosis of the basal septum nodal artery. The FAA's Civil Aerospace Medical Institute located in Oklahoma City, Oklahoma, performed toxicology tests on samples obtained during the autopsy. The testing identified 0.010 gm/dl of ethanol in cavity blood; however, no ethanol was detected in liver or brain samples. Ethanol can be produced by microbial activity after death. Additional toxicology testing did not identify any drugs and medications in cavity blood.

The pilot's wife reported that the pilot had not experienced any major life events or stressors in the days or weeks preceding the accident. She stated that the pilot would typically sleep about 8 hours each night and that he never mentioned having any sleep-related issues. Additionally, she could not recall him being fatigued in the days preceding the accident. She reported that he had no serious health related issues and that he regularly exercised by running. She indicated that the pilot had recently seen a chiropractor for back pain and that he would take Aleve for pain management.

An acquaintance of the pilot reported that he and the pilot had a lengthy conversation during the hours before the accident flight as they waited for their respective passengers to return to the fixed based operator. According to the acquaintance, the pilot appeared very relaxed throughout their conversation and did not appear to be fatigued or ill.

Tests And Research

Glideslope Validity

A laboratory examination of the Garmin GNS 530W NAV/COM/GPS receiver, serial number 78410737, established that the active communication (COM) frequency was set to the BMI control tower frequency (124.6 MHz), which also served as the airport's common traffic advisory frequency (CTAF) when the control tower was closed. The standby COM frequency was set to Peoria Approach Control (128.725 MHz). The active navigation (NAV) frequency was for the BMI ILS Runway 20 instrument approach (111.9 MHz). The standby NAV frequency was set to the BMI VOR/DME frequency (108.2 MHz). The course deviation indicator (CDI) mode was selected to VOR/Localizer (VLOC). The Garmin GNS 530W did not record any historical flight parameter or navigational data.

A laboratory examination of the Garmin GNS 430W NAV/COM/GPS receiver, serial number 97103703, established that the active COM frequency was set to the BMI control tower

frequency (124.6 MHz). The standby COM frequency was set to the BMI automatic terminal information service (ATIS) frequency (135.35 MHz). The active NAV frequency was for the BMI ILS Runway 20 approach (111.9 MHz). The standby NAV frequency was set to the BMI VOR/DME frequency (108.2 MHz). The CDI mode was selected to VLOC. The Garmin GNS 430W did not record any historical flight parameter or navigational data.

The airplane was equipped with a Sandel Avionics SN3500 electronic horizontal situation indicator (EHSI), serial number 1058. The device performed the basic functions of a traditional horizontal situation indicator (HSI) and radio magnetic indicator (RMI). Additionally, depending on installation, the device can provide RMI navigation to GPS waypoints, weather information, and traffic information. The device was configured to receive navigational data from the Garmin 530W and Garmin 430W as NAV Channel 1 and 2, respectively. The device recorded the incoming navigation data once per second to a 24-megabyte circular buffer. The intended purpose of the recorded data was for diagnostic purposes by the manufacturer. The device was sent to the manufacturer to be downloaded and decoded. The recovered dataset included, but was not limited to, the following historic flight parameters: latitude, longitude, ground speed, magnetic heading, ground track, VOR/ILS mode status, localizer and glideslope validity, and localizer and glideslope deviation. The device did not record an altitude data parameter.

A review of the data recorded by the Sandel Avionics SN3500 during the previous flight leg (BMI to IND) established that despite being in ILS mode during the approach phase and having achieved a valid localizer state on both NAV channels, the device did not achieve a valid glideslope state until about 0.6 nm from the approach end of runway 23L at IND. A postaccident review of available weather documentation established that the airplane had landed at IND in day visual meteorological conditions, which consisted of a 10 sm surface visibility and an overcast cloud ceiling at 2,400 feet agl (about 3,200 feet msl).

A review of the recovered data for the accident flight revealed that the Sandel Avionics SN3500 was in the ILS mode during the instrument approach phase and that it had achieved a valid localizer state on both NAV channels; however, the device never achieved a valid glideslope state on either NAV channel during the accident flight.

With the assistance of the manufacturer, the recorded data for the accident flight was replayed back through the Sandel Avionics SN3500 to document the navigational information that was displayed by the device. The replay confirmed that the glideslope did not achieve a valid state on either NAV channel during the accident flight. The device displayed a large "X" through the glideslope scale and did not display a glideslope deviation pointer. According to the Sandel Avionics SN3500 pilot's guide, an "X" through the glideslope scale and the absence of a glideslope pointer indicated a lack of a valid glideslope. According to the manufacturer, the glideslope deviation and validity state are independently determined by the NAV/COM/GPS devices (Garmin 530W and Garmin 430W) before being transmitted, along with other navigational data, to the SN3500 device as NAV Channel 1 and NAV Channel 2 data via a standard avionics data transfer protocol (ARINC 429).

According to the FAA Instrument Flying Handbook, a glideslope signal consists of two intersecting radio signals that are modulated at 90 Hz and 150 Hz. According to Garmin, the

operating conditions that would result in an invalid glideslope state include any of the following conditions:

(a) In the absence of a glideslope radio frequency signal.
(b) In the absence of 150 Hz modulation.
(c) In the absence of 90 Hz modulation.
(d) In the absence of both 90 Hz and 150 Hz modulation.
(e) When the level of a standard deviation test signal, as generated during ground maintenance/testing, produces 50-percent or less of standard deflection of the deviation indicator.

A follow-up examination of the airplane wreckage located the glideslope antenna on a small portion of radome structure. The radome had fragmented during the impact sequence. One of the solid wire antennas had separated from the antenna body and was not located during the investigation. The other solid wire antenna remained attached to the antenna body and exhibited minor damage. As found, the glideslope antenna was not connected to the coaxial cable that provided signal to the glideslope signal diplexer. Additionally, the coaxial cable was found crimped around a fuselage bulkhead stiffener. The observed crimp was consistent with damage sustained during the accident. The glideslope signal diplexer remained attached to the fuselage bulkhead and its single coaxial input connector and two coaxial output connectors were found intact and properly secured. The remaining coaxial cable paths were continuous to the cockpit where the Garmin 530W and Garmin 430W had been previously removed during the investigation.

The glideslope antenna design incorporated a quarter-turn twist-lock BNC-type connector with the female portion of the connector installed on the glideslope antenna body. The male portion of the connector was attached to the coaxial cable that connected to the glideslope signal diplexer. A laboratory examination of the female portion of the connector revealed that it was intact with some minor deformation and light debris found on the interior and exterior surfaces. The locking pins of the female connector were intact and no corrosion was observed. The male portion of the connector was intact and undamaged except for one of the six shielding/ground fingers. The damaged finger was folded and bent into the connector. The central conductor pin was undamaged and no corrosion was apparent. Although initially found disconnected from the glideslope antenna, the coaxial cable could be reconnected and twist locked with minimal difficulty.

The electrical properties of the glideslope signal diplexer were subsequently evaluated at an avionics repair station. No repairs were made to the crimped portion of the coaxial cable that normally connected the glideslope antenna to the glideslope signal diplexer. A glideslope source signal of 92 decibels (dbm) was transmitted by the test bench through the coaxial cable that was connected to the diplexer. The signal level was measured after it passed through the diplexer at the two output connectors. During the bench test, the diplexer split the original source signal into two signal paths which measured 89.8 dbm and 88.8 dbm for glideslope 1 and 2, respectively. According to the bench technician, the observed differences between the source and output signals was normal and would not have affected glideslope signal transmission to the Garmin 530W and Garmin 430W that were located downstream of the diplexer. The operational bench test revealed no anomalies with the glideslope signal diplexer

and, although damaged during impact, the coaxial cable remained capable of transmitting a strong glideslope signal to the diplexer.

Weight and Balance

The airplane weight and balance for the accident flight and the preceding flight (BMI to IND) were calculated using the reported weights and seat position for the pilot and the six passengers, maintenance records that established the airplane basic empty weight and moment, fueling receipts/invoices, and recent flight tracking data.

The average fuel consumption rate was estimated to be 47.36 gallons per hour based on the accumulated flight time between known fuel tank top-offs. Based on this estimated fuel consumption rate and fuel receipts/invoices, the accident airplane departed BMI for IND with about 114.5 gallons of usable fuel. After landing at IND, the airplane was fueled with 60 gallons of fuel, and subsequently departed on the accident flight with 133.4 gallons of usable fuel.

Postaccident weight and balance calculations estimated that the preceding flight (BMI to IND) departed 160 lbs over the maximum takeoff weight (7,087 lbs) and aft of the permitted weight and balance envelope. The same calculations estimated that airplane landed 287 lbs over the maximum landing weight (6,750 lbs) and remained aft of the permitted weight and balance envelope.

The weight and balance calculations estimated that the accident flight departed 271 lbs over the maximum takeoff weight and about 4.37 inches aft of the permitted weight and balance envelope. The calculations estimated that at the time of the accident the airplane was 366 lbs over the maximum landing weight and about 3.71 inches aft of the permitted weight and balance envelope.

Additional Information

During an ILS approach, the localizer provides lateral guidance for the final approach course and the glideslope provides vertical guidance as the aircraft descends towards the runway. For a precision approach, such as an ILS approach, the missed approach point (MAP) is where the aircraft reaches the decision altitude while on the glideslope. If a pilot observes an invalid glideslope indication, such as an "X" displayed through the glideslope scale of an electronic horizontal situation indicator (EHSI) or a warning flag on an analog course deviation indicator (CDI), they may continue the instrument approach using the lateral guidance of the localizer; however, without the vertical guidance of a glideslope, a higher minimum descent altitude (MDA) is stipulated for the non-precision localizer instrument approach. Further, the location of the MAP for a non-precision approach will be a DME distance from a navigational aid, or a fixed distance (from the final approach fix to the MAP) with an associated elapsed time that is based on the groundspeed of the aircraft, or a specific intersection/waypoint.

According to the FAA Aircraft Weight and Balance Handbook, if the center of gravity (CG) is maintained within the allowable limits for its weight, an airplane has adequate longitudinal stability and control. However, if the loaded airplane results in a CG that is aft of the allowable

limits, the airplane can become unstable and difficult to recover from an aerodynamic stall. Additionally, if the unstable airplane should enter an aerodynamic spin, the spin could become flat making recovery difficult or impossible.

Administrative Information

Investigator In Charge (IIC):	Andrew T Fox
Additional Participating Persons:	Stanley Swank; Federal Aviation Administration - Springfield FSDO; Springfield, IL Ernest Hall; Textron Aviation; Wichita, KS Christopher Lang; Continental Motors; Mobile, AL Les A Doud; Hartzell Propeller; Piqua, OH Rick Roper; RAM Aircraft; Waco, TX Tom Carr; Garmin; Olathe, KS Ken Kochi; Sandel Avionics; Vista, CA Jeff Shapiro; Spoilers, Inc.; Gig Harbor, WA
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	http://dms.ntsb.gov/pubdms/search/dockList.cfm?mKey=90991