Aviation Investigation Final Report

Location:	Pittsburg, California	**Accident Number:**	WPR17FA013
Date & Time:	October 25, 2016, 12:20 Local	**Registration:**	N364RM
Aircraft:	Beech A36	**Aircraft Damage:**	Destroyed
Defining Event:	Unknown or undetermined	**Injuries:**	2 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The private pilot and the pilot-rated passenger were making a local personal flight in the airplane in visual flight rules conditions so that the passenger could assist the pilot in becoming familiar with avionics components that had recently been installed. The new avionics components were upgrades of the previously-installed combination communication, ground-based navigation, and GPS navigation units. No flight testing of the airplane was conducted after the installation of the new avionics, nor was any required. The airplane was only flown once in the period between the avionics installation and the accident flight. That flight was conducted by the pilot who was the passenger on the accident flight and was uneventful.

According to acquaintances, both pilots were experienced in the accident airplane make and model. The pilots planned to fly to a practice area east of the airport, but the details of their plans were not known. Following a normal takeoff, the airplane began a turn to the east at an altitude of about 500 ft and climbed at a normal speed and rate for about 3 1/2 minutes. The airplane reached a maximum radar-indicated altitude of about 3,400 ft, where it leveled off for about 8 seconds. It then entered a descending left turn, and the descent rate and airspeed increased continuously. Analysis indicated that the average descent rate was about 5,000 ft per minute (fpm), and the maximum rate was about 10,000 fpm. During the descent, the speed increased from about 120 kts to nearly 250 kts, which was significantly above the airplane's never-exceed speed of 203 kts. During the descent, the pitch attitude decreased from about 5° airplane nose up to nearly 30° airplane nose down, and the total heading change was about 70°. The high descent rate, airspeed, and nose-down pitch attitude were consistent with an uncontrolled descent. About 30 seconds after the descent began, the airplane struck high-tension powerlines and then impacted terrain.

The airplane was highly fragmented by impact with the line, ground impact, and a post-impact fire altered or consumed much of the remaining structure and other evidence. All flight control surfaces were accounted for; however, flight control continuity could not be confirmed due to the extent of the damage.

No evidence of an in-flight fire or a bird strike was observed in the wreckage. Further, the two occupants were both capable of flying the airplane, any incapacitation would have had to affect both. Although ethanol was detected in the passenger's tissues, the levels varied widely, consistent with post-mortem ethanol formation; therefore, the ethanol did not contribute to the accident. Thus, it is unlikely that a flight control malfunction or failure or pilot incapacitation contributed to this accident.

It is possible the recent avionics installation may have resulted in physical control interference or mechanical failure; while no direct evidence of this was found, the condition of the wreckage precluded elimination of that possibility. Also, although there were no reports of any previous problem with the airplane's electronic flight control system, it is possible that an uncommanded or inadvertent control input via the autopilot or electric trim may have occurred and led to the loss of control. No direct evidence of an electronic flight control system malfunction was found; however, the condition of the wreckage precluded elimination of the possibility.

Probable Cause and Findings

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

A loss of airplane control for reasons that could not be determined due to the extensive impact and fire damage to the airplane.

Findings

Not determined	(general) - Unknown/Not determined
Personnel issues	Aircraft control - Pilot

Factual Information

History of Flight

Enroute-descent	Unknown or undetermined (Defining event)
Uncontrolled descent	Collision with terr/obj (non-CFIT)
Post-impact	Fire/smoke (post-impact)

HISTORY OF FLIGHT

On October 25, 2016, about 1220 Pacific daylight time, a Textron Aviation (formerly Beechcraft) A36 Bonanza, N364RM, was destroyed when it impacted powerlines and terrain during a steep descent near Pittsburg, California. The private pilot and pilot rated passenger received fatal injuries. The airplane was registered to Accretion LLC and operated by the pilot under the provisions of Title 14 *Code of Federal Regulations* Part 91. Visual meteorological conditions prevailed, and no flight plan was filed for the local personal flight that departed from Buchanan Field Airport (CCR), Concord, California, about 1215.

According to persons familiar with one or both occupants, the airplane had recently undergone the installation of a new avionics' suite, and the accident flight was the second flight since the avionics upgrade. The purpose of the flight was for the passenger to assist the pilot in becoming familiar with the new avionics. They were reportedly planning to fly to a known practice area east of CCR. Coroner's forensic evidence indicated that the pilot was in the left seat for the flight, and that the passenger was in the right seat.

CCR fuel records indicated that the airplane was fueled with 37.0 gallons of 100LL aviation gasoline on the day of the accident flight. Review of Federal Aviation Administration (FAA) air traffic control (ATC) audio communications and ground tracking radar information indicated that the airplane departed from CCR runway 19R, made a left turnout shortly thereafter, and that there were no further communications from the airplane. The airplane continued to climb in a relatively straight track to the east, until about 4 ½ minutes after the start of the takeoff. The airplane reached its maximum altitude of about 3,600 ft, and then commenced a left turn and a steep descent. The airplane struck high tension powerlines and then the sloped face of a ravine.

The accident site was in rolling open hills about 8 miles east of CCR. There were no eyewitnesses to the accident, and it was initially reported as a grass fire. Responding personnel determined that it was an airplane accident, but by that time the fire had been burning for a while. The wreckage was highly fragmented, and the post impact fire consumed much of the airplane. The wreckage was examined on scene, and then recovered and subjected to additional examination.

PERSONNEL INFORMATION

Efforts to locate the pilot logbooks for both persons on board were unsuccessful. According to persons who knew the pilots, both were well-experienced, and familiar with the accident airplane make and model.

Pilot

FAA records indicated that the pilot held a private pilot certificate with airplane single-engine land and instrument airplane ratings. His most recent FAA third-class medical certificate was issued in May 2015. According to information provided by the pilot on his most recent FAA medical application, he had about 1,775 total hours of flight experience.

Passenger

FAA records indicated that the passenger held airline transport pilot and flight instructor certificates, with airplane single- and multi-engine land, and instrument airplane ratings.
His most recent FAA first-class medical certificate was issued in March 2016. According to information provided by the passenger on his most recent FAA medical application, he had about 7,035 total hours of flight experience.

AIRCRAFT INFORMATION

FAA information indicated that the airplane was manufactured in 1995, as manufacturer's serial number E-2957. The pilot's company had owned the airplane for about 10 years. The airplane was equipped with a Continental Motors IO-520 series piston engine that was field converted to a TIO-550 series engine via Supplemental Type Certificate (STC) SE02881AT. The engine was also modified with the installation of a Tornado Alley brand turbonormalizer system via STC SA5223NM. Those modifications, as well as the installation of Osborne-brand wingtip fuel tanks, were accomplished in September 2007.

Maintenance records were recovered at the accident site. According to the recovered maintenance records, the most recent annual inspection was completed in May 2016, at which time the airplane had accumulated about 2,626 total hours in service. The engine maintenance records indicated that, at the time of the annual inspection, the engine had accumulated about 2,382 total hours in service, and about 681 hours since major overhaul.

The most recent avionics upgrade had been accomplished at Westover Field / Amador County Airport (JAQ) Jackson, California. According to the owner of the avionics shop that accomplished the installation, the airplane arrived the week of October 11, 2016, and the maintenance was completed on October 19, 2016. Ground tests were satisfactory, and no flight testing was required or conducted.

On October 20, 2016, at the request of the airplane owner, the accident passenger took possession of the airplane and flew it solo from JAQ back to its base at CCR, a distance of about 64 miles. The pilot who flew the accident passenger to JAQ to retrieve the accident airplane reported that the accident passenger encountered an anomaly during his preflight inspection, and although he considered leaving the airplane at JAQ, he decided to fly it to CCR. That flight was the first flight of the airplane after the avionics installation, and the accident flight was the second post-installation flight. The accident passenger did not specify the nature of the anomaly to the drop-off pilot. The avionics installer reported that the accident passenger advised him that the new avionics equipment operated satisfactorily, except for a complaint about sidetone volume.

The details of the avionics installation activity are documented under ADDITIONAL INFORMATION.

METEOROLOGICAL INFORMATION

The CCR automated terminal information service (ATIS) that was current at the time of the airplane's taxi-out included wind from 170° at 9 knots. When the airplane was in the runup area, the ground controller advised the pilots that the winds were from 170° at 14 knots, with gusts to 27 knots.

The 1220 CCR automated weather observation included wind from 180° at 12 knots, visibility 10 miles, scattered clouds at 4,200 ft, overcast layer at 11,000 ft, temperature 68° C, dew point 52° C, and an altimeter setting of 30.07 inches of mercury.

COMMUNICATIONS

The communications between the airplane and the CCR ATCT ground and local control positions were recorded and provided to the investigation. The communications from the airplane were accomplished by both the pilot and the passenger. There were no communications regarding any significant problems.

The first communication from the airplane was from the pilot to the ground controller about 1204:40, for taxi instructions. The full length of the departure runway (19R) was not available, but the communications indicated that the available length was acceptable to the pilot for the departure. Based on the radio communications, an engine runup was conducted prior to the takeoff. The airplane switched to the local controller (LC) about 1212:20, and the pilot advised that he was ready for takeoff on runway 19R and requested a left crosswind departure from the airport traffic area. The airplane was cleared for takeoff about 1212:34, but then that takeoff clearance was cancelled when the pilot requested a "minute" for an unspecified reason.

The passenger then asked for a "radio check," and the LC responded with "loud and clear." About 1213:50, the pilot again announced he was ready for takeoff, and the airplane was cleared for takeoff about 3 seconds later. About 6 seconds after that, the pilot acknowledged the takeoff clearance; that was the last recorded communication from or to the airplane. Except for the left crosswind turnout request, there were no communications regarding the intended route of flight or destination.

WRECKAGE AND IMPACT INFORMATION

Powerlines

Two of the individual lines on the powerline were damaged, consistent with the airplane striking the line just before it impacted the ground. The powerlines were oriented roughly perpendicular to the flight path, and consisted of 6 separate lines, arrayed as 3 vertically-stacked lines on either side of the support tower. According to a PG&E representative, the tower was 170 ft high, the highest lines were at a height of 165 ft (at the tower), and the vertical separation between lines was about 16 ft. Investigators estimated the horizontal separation of the lines to be about 40 ft.

Although no powerlines were severed by the airplane, two were damaged. The first powerline along the flight track exhibited three discontinuous/separate damage sites, over a span of about 25 ft. The second powerline exhibited three discontinuous/separate damage sites, over a span of about 12 ft. The lines were composed of 7 steel support strands, wrapped with 54 aluminum conductor strands. The powerline manufacturer's "rated strength" of the lines was cited to range from 26,000 to 32,300 lbs.

Line damage and airplane debris was consistent with the airplane striking the lines about 130 ft from the tower; line catenary sag was estimated to be about 5 ft at the strike location. The airplane struck the middle line of the first array along the flight track, and the lower line of the second array. Point calculations based on the damage locations, but which did not account for airplane dimensions or attitude, indicated a flight path angle of about 21º below horizontal. A second, similar array of 6 more powerlines was situated just beyond, and parallel to, the struck set. None of those powerlines were damaged.

Debris Field

The struck powerlines were located about 300 ft prior to (short of) the ground impact point. About 50 fracture-separated fragments of the airplane were scattered below the powerlines, and in the field between the powerlines and the ground impact site. A segment of a wing tip tank rib remained wrapped around one of the powerlines. The debris field fragments were primarily from the empennage or right wing, with some later fragments from the left wing. None of those fragments contained any evidence of smoke or thermal distress. The fragments were catalogued in a database, recovered, and re-assembled in a two-dimensional layout at the recovery facility.

The plane of the vertical stabilizer and rudder cut/tear line was approximately parallel to the plane defined by the lateral and longitudinal axes of the airplane, consistent with the airplane being approximately wings level (either upright or inverted) at the time of the powerline strike.

The plane(s) of the wing, horizontal stabilizer and elevator fragment cut/tear lines were irregular and inconsistent with one another, with no clear pattern observed. The outboard left-wing damage appeared consistent with it becoming separated during the powerline strikes, but the section was found in the main wreckage area.

Main Wreckage

Ground scar and wreckage distribution were consistent with the airplane striking the ground in a relatively steep trajectory, approximately perpendicular to the ravine face. The main wreckage was very tightly contained, approximately within the area of a circle about the diameter of the wing span. The overall main wreckage distribution was generally consistent with the airplane striking the ravine face approximately upright, and then coming to rest inverted, consistent with a nose-over during impact.

The left aileron remained attached to the left wing, but the right aileron was fracture-separated from the right wing, consistent with powerline impact. The aileron trim actuator extension was consistent with a trim setting of about 4° left aileron trailing edge down (TED). The rudder and left and right elevators were fracture-separated from their respective stabilizers and were almost all found in the debris field between the powerlines and the impact site. No measurements of the left or right elevator trim actuators were possible due to impact and/or thermal damage. The airplane was not equipped with cockpit-controlled rudder trim. Both flaps remained partially attached to their respective wings. All evidence was consistent with a flap extension of 0° (flaps up/retracted).

On-site and post-recovery examinations of the airplane indicated that all primary flight control surfaces were present at the time of the powerline strike and/or ground impact. Due to severe impact disruption, and damage and/or consumption by fire, only a coarse approximation of flight control continuity was able to be accomplished. No pre-impact anomalies were observed.

The nose and main landing gear actuator configurations were consistent with the landing gear being retracted at the time of impact. Although some components or fragments of components were able to be identified, impact and thermal damage precluded the determination of the integrity, functionality, or settings of any portions of the fuel system.

Portions of flight, navigation, and engine instruments, electrical switches, circuit breakers, and avionics devices, were observed in the wreckage, but due to damage, no information regarding the integrity, functionality, operational status, or indications/settings of any of those systems or subsystems was able to be determined.

The engine had separated from the airframe, and was located at the bottom of the ravine, about 15 ft downslope of its impact location. The engine sustained significant impact damage, and thermal damage consistent with the post impact fire. Most accessories were fracture-separated from the engine. No evidence of any pre-impact engine or engine component failures was observed. No direct information regarding the engine functionality or operational status was able to be determined.

All three propeller blades were recovered at the main wreckage site. Two blades were fracture-separated from the propeller hub, which was fractured into numerous pieces. All three blades displayed relatively minimal shape deformation, and all three were missing about ¾" to 1-1/2" from their tips. No evidence of any pre-impact failure of the propeller or its system components and controls was observed.

No evidence consistent with in-flight fire, in-flight structural failure, catastrophic engine failure, or a bird strike was observed. Refer to the NTSB public docket for detailed accident site and wreckage examination information.

MEDICAL AND PATHOLOGICAL INFORMATION

Pilot

The 67-year-old pilot reported the following to the FAA that he had hypertension and high cholesterol treated with valsartan and atorvastatin respectively. These medications are not considered impairing.

The Coroner's Division of the Office of the Sheriff, Contra Costa County, California, performed an autopsy of the pilot. The autopsy cited the cause of death as multiple blunt force injuries. The autopsy was inconclusive for significant natural disease due to the level of trauma.

NMS Labs performed toxicological testing at the request of the coroner and identified 57 ng/g of pseudoephedrine in liver. The FAA's Bioaeronautical Sciences Research Laboratory, Oklahoma City, Oklahoma, performed toxicological tests and detected atorvastatin and valsartan in liver tissue. Bupropion and a metabolite were detected in liver and muscle tissue.

Pseudoephedrine is a sympathomimetic often used to treat nasal congestion. It is not generally considered impairing. Bupropion is a prescription antidepressant that is also indicated for use as an aid to smoking cessation. It carries a boxed warning about the risk of significant neurocognitive effects and the potential for suicidality. There is also a dose dependent risk of seizure with the drug.

Passenger

The 58-year-old passenger reported no significant conditions or medications to the FAA.

The Coroner's Division of the Office of the Sheriff - Contra Costa County, California performed an autopsy of the passenger. The autopsy cited the cause of death as multiple blunt force injuries. The autopsy was inconclusive for significant natural disease due to the level of trauma.

NMS Labs performed toxicology testing at the request of the coroner and identified 0.074 gm% of ethanol in liver tissue. The FAA's Bioaeronautical Sciences Research Laboratory, Oklahoma City, Oklahoma, performed toxicology tests and identified 0.010 gm% of ethanol in muscle, but no ethanol in liver.

When ethanol is ingested, it is rapidly distributed throughout the body. Ethanol may also be produced in the body after death (post-mortem) by microbial activity. In such post-mortem cases, the amount of ethanol identified in different tissues may vary widely.

ADDITIONAL INFORMATION

Radar Tracking Information

FAA ground-based tracking radar captured a portion of the taxi-out to the runway, and the majority of the flight. The new avionics installation included ADS-B (automatic dependent surveillance-broadcast) capability, whereby the airplane broadcast its GPS-determined position to FAA radar antennae at a sample rate of approximately once per second.

The first radar return, when the airplane was on the CCR ramp, was recorded at 1207:36. The airplane stopped for the engine runup about 1209, in the runup area east southeast of the threshold of runway 19R. The takeoff roll began about 1214:40.

The airplane tracked south in a shallow climb to about 500 ft before beginning a turn to the east about 0.8 miles beyond the runway end. The airplane then tracked approximately east, climbing at a rate of about 830 ft per minute (fpm) until about 1219:01, when it leveled off at about 3,000 ft for about 5 seconds. The airplane then resumed its climb at the same approximate rate of 830 fpm until about 1219:28, when the altitude remained about 3,400 ft for about 8 seconds. About the same time that the climb stopped, the ground track began a continuous left turn to the northeast, and the track changed from about 098° to about 030°.

The airplane then entered a descent that lasted about 30 seconds. The descent rate appeared to be continuously increasing, with an average rate of about 5,000 fpm, and a maximum rate of about 10,000 fpm.

The last ADS-B return had a time tag of 1220:05. The last ADS-B return had an indicated altitude of 1,175 ft and was situated about 700 ft southwest of (prior to) the powerline strike location.

The radar track data information was used as the input for an aerodynamic modeling program, in order to derive some basic performance and aerodynamic parameters. The results were consistent with the normal airplane performance values until the descent that resulted in ground impact. During the descent, the airspeed increased from about 120 kts to nearly 250 kts. Pitch attitude decreased from about 5° airplane nose up to nearly 30° airplane nose down, and normal load factor decreased from 1g to about 0.4g. During the descent, the airplane remained in a left-wing-down bank, with average values between about 10° and 20°.

Airspeeds and Flight Control Forces

Aerodynamic loads and flight control forces increase with increasing speed, and those speeds and loads are key elements in the design of any aircraft. Certification criteria require the determination of certain critical operating speeds for each airplane model. Many of those speeds are required to be denoted on the pilot's airspeed indication display. Some of these speeds relevant to this accident include:

Maneuvering Speed (Va) - This is defined as the maximum speed where full, abrupt control deflections can be used without overstressing the airframe. This is sometimes referred to as the "rough air" or "turbulent air" speed that is to be used when significant turbulence is encountered in flight. Operations at this speed minimize stress on the airplane structure. Va will decrease with decreasing airplane weight. The Va speed range is not typically annotated on the airspeed indicator.

Maximum Structural Cruising speed (Vno) - This is the speed that is not to be exceeded except in smooth air. Vno is denoted by the upper limit of the green arc on the airspeed indicator.

Never-Exceed Speed (Vne) – This is the maximum permitted flight speed of the airplane. Operation above this speed is prohibited, since it may result in damage or structural failure. Vne is denoted by a red line on the airspeed indicator.

These calibrated speeds for the accident airplane were
Va - 139 kts (at maximum gross weight)
Vno - 165 kts
Vne - 203 kts

The A36 is an aerodynamically clean (low drag) general aviation airplane and will gain speed quickly when the nose is lowered below a level pitch attitude. The retracted landing gear and flaps of the accident airplane resulted in near the lowest-drag configuration, which would increase the airplane's acceleration in a dive. The airplane began its descent about 1219:30. Review of the speeds calculated from the radar data indicated that the airplane passed through Va, Vno, and Vne about 1219:30, 1219:42, and 1220:00 respectively. At those respective times the airplane indicated altitudes were about 3,400 ft, 3,250 ft, and 1,900 ft. For reference purposes, under the airplane's descent path, the approximate underlying terrain elevations ranged irregularly between about 800 and 1,200 ft.

As airspeed increases, the increasing air loads increase the forces required to deflect the flight control surfaces. An airplane in a high speed, rapid-rate descent (sometimes referred to as a dive) will typically require significant nose up elevator force to recover to level flight. Control yoke recovery forces required of the pilot can be significantly reduced or increased as a function of the pitch trim setting. Timely dive recovery is necessary to avoid airplane overspeed or ground impact. Improper recovery can result in aerodynamic stall, or structural damage or failure.

Flight Control System Information

The airplane was equipped with two elevator panels (one per horizontal stabilizer) that were connected to a common bellcrank, and an elevator trim tab on each elevator. The elevators were operated through conventional cable/pulley/bellcrank systems. Elevator trim was controlled by a handwheel located on the left side of the pedestal. The trim handwheel drum-cable system drove a jackscrew actuator for each trim tab. An elevator tab position indicator dial was located to the right of the elevator trim handwheel. The electric elevator trim was operated by a control switch on the outboard (left) horn of the left control wheel.

The manufacturer's specified elevator travel range was 25° trailing edge up (TEU) to 20° TED. The specified left elevator trim tab travel range was 8° TEU to 27° TED, and the specified right elevator trim tab travel range was 10° TEU to 25° TED. Tolerances for all panel travel deflections were +/- 1°.

According to a Honeywell representative, the pilot-commanded electric pitch trim rate is about 1°/second, and the autopilot-commanded pitch trim rate is approximately half that rate.

Avionics Installation

The new avionics suite consisted of Garmin GTN 650, GTN 750, GTX 345R, and two GA35 WAAS antennae. Both the GTN 650 and GTN 750 units were combination communication, ground-based (VOR etc) navigation, and GPS navigation devices, with touchscreen displays and controls, and ADS-B capability. The GTX 345R was a remote transponder, and the two antennae were for the GTN units.

The new avionics were newer-model versions of the avionics that were previously installed in the airplane. Those previous avionics included Garmin GNS 430W and GNS 530W communication/navigation/GPS units, and King KT-70 transponder.

According to the owner of the avionics shop that conducted the installation of the new avionics, the actual installation was accomplished by a technician, and then another technician accomplished "the inspection of the avionics installation work under panel, etc., software programming, aircraft avionics operations checks with engine run up and return to service paperwork."

The avionics shop owner also stated that the replacement of the GNS 430W and 530W units with the GTN 650 and 750 devices required the replacement of the radio rack trays, one connector pin change, plus the addition of some wiring for the "ADS-B unit." He reported that almost all work was conducted from the pilot/copilot-facing side of the instrument panel, as opposed to accessing items from the underside of the instrument panel. The only underside work was verification that the circuit breaker on the subpanel was properly wired and connected. The new remote transponder was installed on the aft electronics shelf behind the cabin.

The shop owner stated that no flight controls were loosened or disconnected for the work. The post-installation checkout included ground-based function checks (including autopilot) with a signal generator, and physical verification of full control movement, including checks for binding or interference. The shop owner noted that behind the instrument panel, each control yoke travel area is protected by a factory-original "8-inch shelf" which is intended to prevent any components, wires, etc from intruding into the area required for unobstructed flight control movement. Final, ground-only checks included function tests with the engine running, and electrical power on all equipment.

The accident passenger was the pilot who retrieved the airplane to the owner's home airport after the avionics installation. The investigation was unable to determine what modes or testing, if any, that pilot conducted with the new avionics, and/or their interface with the autopilot, on that return flight.

Flight Control Interference Information

No evidence of any mechanical interference of the cockpit flight controls was observed in the wreckage, but such evidence could have been obscured or destroyed by the impact and/or fire damage. The potential for cockpit flight control travel restrictions due to improper avionics installations and/or wire bundle routing and security was discussed in guidance issued previously by both the FAA and the airplane manufacturer. Synopses of the relevant guidance are presented below.

Paragraph 11-125 ('Movable Controls Wiring Precautions') of FAA Advisory Circular (AC) 43.13-1B ('Acceptable Methods, Techniques, and Practices, Aircraft Inspection and Repair') states: "Clamping of wires routed near movable flight controls must be attached with steel hardware and must be spaced so that failure of a single attachment point can not result in interference with controls. The minimum separation between wiring and movable controls must be at least 1/2 inch when the bundle is displaced by light hand pressure in the direction of the controls."

In February 1992, which predated the accident airplane manufacture date by about 3 years, Beechcraft issued Service Communique No. 90. It contained a section entitled "Flight Control Interference - Bonanzas and Barons with Dual Control Column Installations," and applied to "1984 and later aircraft." The communique explained that elevator control column travel could be limited by the use of incorrectly-sized (too long) screws or bolts for avionics installations.

In August 1998, the airplane manufacturer issued Safety Communique No. 149, which was followed by Safety Communique No. 149, Rev. 1 in November 1998. These service documents pertain to multiple models, including the accident airplane model. The documents specified inspection and correction procedures for interference or inadequate clearance between the flight control mechanism and any components located forward of the instrument panel. The information was further codified in the airplane manufacturer's Mandatory Service Bulletin (SB 27-3232) that was issued in March 1999.

Soon thereafter, the FAA issued Airworthiness Directive 99-09-15, effective May 18, 1999 which mandated the accomplishment of SB 27-3232. The AD was the result of an incident where the "electrical/avionics wires made contact with and restricted the control system of the affected airplanes." The actions specified by the AD were intended to prevent any components or wiring from interfering with the flight control mechanism caused by inadequate clearance, which could result in reduced or loss of aileron and/or elevator control, with possible consequent loss of the airplane. The corrective action required "securing all components so that they are clear of the flight control mechanism."

For the Beech A36 model, the effectivity of the SB and AD began with airplane serial number E-3058 and did not include any A36 models with preceding (lower) serial numbers. Thus, on the basis of serial number, the accident airplane was not affected by the SB or AD. The specific reason(s) for the SB and AD effectivity cutoff points were not provided by the manufacturer. Typically, SB and AD effectivity ranges are a function of the specific design of, and equipment on, the affected aircraft.

Bendix/King Flight Control System

The condition of the wreckage precluded positive determination of the electronic flight control system components and configuration; the following descriptions are based upon aircraft maintenance records, avionics manufacturer's guidance, and pre-accident photographs of the airplane.

The airplane was equipped with a Bendix/King KFC 150 flight control system (FCS), more commonly referred to as an autopilot. The FCS incorporated a two-axis (pitch and roll) autopilot and a flight director system. Components of the FCS included a KI 256 Flight Command Indicator, KC 192 Autopilot Computer/Controller/Annunciator, KS 177 Pitch Servo, KS 179 (Pitch) Trim Servo, and KS 178 Roll Servo.

According to the FAA Form 337 that documented the avionics upgrade, the GTN 750 interfaced with the automatic FCS, but the GTN 650 did not.

Altitude preselect, vertical speed hold, and yaw damper functions were optional mode installations for the KFC150 FCS and required equipment in addition to the standard equipment. There was no evidence to indicate that the airplane was configured with any of these optional components.

The pitch servo drove the elevator via a bridle cable which attached directly to the elevator control cables. The pitch trim servo drove the elevator trim tabs via a bridle cable which attached directly to the elevator tab control cables. The roll servo drove the ailerons via a bridle cable which attached directly to the aileron control system to provide roll and heading control.

According to the Bendix/King Pilot's Guide:
The flight director system is a computer which calculates the appropriate pitch and roll attitudes required to intercept and maintain headings, courses, approach paths, pitch attitudes and altitudes. Once computed, the commands are displayed to the pilot on the single-cue steering command which is part of the KI 256 Flight Command Indicator (FCI). The pilot can then manually fly the commands shown on the KI 256, or engage the autopilot portion of the system and have it fly the commands.

System capabilities included manual and automatic electric pitch trim, altitude hold, vertical trim, multiple nav capture and track modes, and control wheel steering (CWS). Pilot interface with the FCS was via both the panel-mounted KC 192 and several switches on the left horn of the pilot's control yoke. Self-test, mode select/engage, and vertical trim were controlled via the KC 192. Autopilot disconnect/trim interrupt, CWS, and dual rocker pitch trim switches were on the left yoke horn.

The automatic trim allows the KFC 150 system to trim off elevator control surface pressures while the autopilot is controlling the elevator through the pitch servo. If the autopilot is not engaged, the pilot can use the yoke-mounted electric trim switch to trim off elevator control forces. The vertical trim switch may be used to adjust altitude up or down at a maximum rate of 500 fpm without disengaging altitude hold. When the vertical trim switch is released, the flight director V-bar will begin to command pitch changes to maintain the new altitude

With the autopilot engaged, control wheel steering (CWS) allows the pilot to maneuver the aircraft without disengaging the autopilot. Depressing the CWS button on the yoke releases the autopilot servos and allows the pilot to assume manual control while autopilot control functions are placed in a synchronization state. Release of the CWS button allows the autopilot to resume control of the aircraft and fly it to the lateral command in use prior to engaging CWS. The vertical command used by the autopilot will be the one existing when CWS is released.

Section X ("SAFETY INFORMATION") of the POH contained the following information regarding the autopilot (all emphases original):
Do not try to manually override the autopilot during flight.

IN CASE OF EMERGENCY, YOU CAN OVERPOWER THE AUTOPILOT TO CORRECT THE ATITUDE, BUT THE AUTOPILOT AND ELECTRIC TRIM MUST THEN IMMEDIATELY BE DISENGAGED.

It is often difficult to distinguish an autopilot malfunction from an electric trim system malfunction. The safest course is to deactivate both. Do not re-engage either system until after you have safely landed.

The Bendix/King Pilot's Guide contained the following text regarding autopilot usage and cautions (all emphases original):

NOTE: The autopilot cannot be engaged until the flight director is engaged.
The autopilot is engaged by depressing the 'AP ENG' button on the KC 192.

CAUTION: Prior to autopilot engagement, the pilot should make sure the V-bar commands are satisfied. This will prevent any rapid changes in the aircraft's attitude when the autopilot is engaged.

Once engaged, the autopilot will attempt to satisfy the V-bar commands generated by the selected flight director modes.

The autopilot provides two-axis (pitch and roll) stabilization and automatic elevator trim as well as automatic response to all selected flight director commands.

WARNING: WHENEVER THE AUTOPILOT IS DISENGAGED, THE AP LEGEND ON THE ANNUNCIATOR PANEL WILL FLASH AND AN AURAL TONE WILL SOUND TO ALERT THE PILOT.

CAUTION: Overpowering the Autopilot in the pitch axis in flight for periods of three seconds or more will result in the autotrim system operating in the direction to oppose the pilot and will, therefore, cause an increase in the pitch overpower forces, and if Autopilot is disengaged, will result in a pitch transient control force. Operation of the autopilot on the ground may cause the autotrim to run because of backforce generated by elevator downsprings or pilot induced forces.

With regard to the pitch axis, the POH caution to ensure that the "V-bar commands are satisfied" prior to autopilot engagement means that the preselected altitude and the airplane pitch attitude should be in relative harmony prior to engaging the autopilot. In other words, if the airplane is in a climb, the preselected altitude should be above the airplane's current altitude, with the reverse case for a descent. Engaging the autopilot while the airplane is in a climb, but the preselected altitude is below the airplane's current altitude would result in a rapid change in pitch attitude. The investigation did not obtain any data regarding the time, pitch attitude changes, or the resulting trajectory for the airplane to transition from a climb to a descent if the autopilot was engaged in a climb with a preselected altitude below the airplane's current altitude.

Review of pitch control force data provided by the airplane manufacturer indicated that elevator trim tab motion at the autopilot rate, which is approximately half the pilot-controlled trim rate, could result in significant control forces after 15 to 20 seconds. Approximated modeling of the accident flight conditions indicated that, after 15 seconds of AND trim motion, a pull (ANU) force of about 75 lbs would be required to restore the elevator to the neutral position. This force would increase to about 125 lbs after 20 seconds of AND trim motion.

Per FAA aircraft certification regulations, autopilot systems must be able to be "quickly and positively disengaged by the pilots to prevent it from interfering with their control of the airplane; or be sufficiently overpowered by one pilot to let him control the airplane." In the accident airplane, in addition to that manual override capability, there were several other means to disengage the autopilot. Pressing the CWS (control wheel steering) switch on the right horn of pilot's yoke disengages the autopilot pitch and roll servo clutches while the switch is pressed, enabling temporary disengagement of the autopilot, which re-engages when the CWS switch is released.

More permanent disengagement of the autopilot, which requires discrete actions by the pilot to then re-engage it, can be accomplished by several means, including:
- Manual override of the autopilot via control wheel inputs
- Pilot actuation of the control trim(s)
- Pressing the autopilot interrupt/disconnect switch
- Switching the autopilot master switch to OFF
- Pulling (deactivating) the autopilot circuit breaker

Deactivation of the electric pitch trim system is accomplished by pulling the appropriate system circuit breaker.

In addition to the manual disconnect options, the autopilot will automatically disconnect under the following conditions:
- Electrical power failure
- Internal FCS failure
- Loss of "compass valid" internal condition (only with KCS55A compass system, while a heading mode is active)
- Roll rate > 14°/sec (unless CWS switch held depressed)
- Pitch rate > 5°/sec (unless CWS switch held depressed)

Pilot Information

Certificate:	Private	**Age:**	67,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Unknown
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 3 With waivers/limitations	**Last FAA Medical Exam:**	May 26, 2015
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:	(Estimated) 1775 hours (Total, all aircraft)		

Flight instructor Information

Certificate:	Airline transport; Flight instructor	**Age:**	58,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	Unknown
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Instrument airplane	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	March 17, 2016
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	(Estimated) 7703 hours (Total, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Beech	**Registration:**	N364RM
Model/Series:	A36 UNDESIGNAT	**Aircraft Category:**	Airplane
Year of Manufacture:	1995	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	E-2957
Landing Gear Type:	Retractable - Tricycle	**Seats:**	6
Date/Type of Last Inspection:	May 15, 2016 Annual	**Certified Max Gross Wt.:**	3651 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	2626 Hrs as of last inspection	**Engine Manufacturer:**	Continental
ELT:	Installed, not activated	**Engine Model/Series:**	TIO-550
Registered Owner:	On file	**Rated Power:**	
Operator:	On file	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KCCR,60 ft msl	**Distance from Accident Site:**	8 Nautical Miles
Observation Time:	18:53 Local	**Direction from Accident Site:**	280°
Lowest Cloud Condition:		**Visibility**	10 miles
Lowest Ceiling:	Overcast / 4200 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	6 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	180°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.05 inches Hg	**Temperature/Dew Point:**	21°C / 11°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Concord, CA (CCR)	**Type of Flight Plan Filed:**	None
Destination:	Concord, CA (CCR)	**Type of Clearance:**	None
Departure Time:	12:15 Local	**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	2 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:		**Aircraft Fire:**	On-ground
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 Fatal	**Latitude, Longitude:**	37.968887,-121.889442(est)

Administrative Information

Investigator In Charge (IIC):	Huhn, Michael
Additional Participating Persons:	David Jenson; Federal Aviation Administration; Oakland, CA Ernie Hall; Textron Aviation ; Wichita, KS Chris Lang; Continental Motors, Inc.; Mobile, AL Bill Gill; Honeywell Avionics; Olathe, KS
Original Publish Date:	February 26, 2019
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=94283