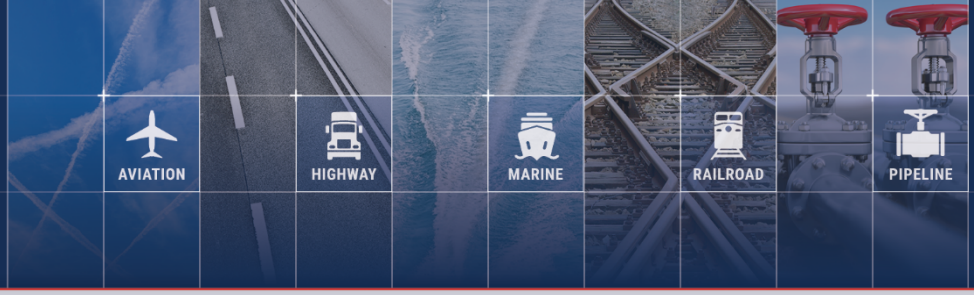


# Aviation Investigation Factual Report

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| **Location:** | Orlando, Florida | **Accident Number:** | ERA16FA043 |
| **Date & Time:** | November 20, 2015, 11:27 Local | **Registration:** | N7FG |
| **Aircraft:** | Beech A36TC | **Aircraft Damage:** | Destroyed |
| **Defining Event:** | Miscellaneous/other | **Injuries:** | 2 Fatal |
| **Flight Conducted Under:** | Part 91: General aviation - Personal | | |

On November 20, 2015, about 1127 eastern standard time, a Beech A36TC, N7FG, descended into Clear Lake, Orlando, Florida. The private pilot and the passenger were fatally injured, and the airplane was destroyed. The airplane was registered to Kavak Aviation, LLC, and was being operated by the pilot as a 14 Code of Federal Regulations (CFR) Part 91 personal flight. Visual meteorological conditions prevailed at the time, and a visual flight rules (VFR) flight plan was filed. The flight originated from Orlando Executive Airport (ORL), Orlando, Florida, about 1115, and was destined for Gainesville Municipal Airport (GLE), Gainesville, Texas.

According to a chronological summary of flight communications, audio recordings, and transcriptions of communications, prepared by the Federal Aviation Administration (FAA), while in contact with ground control, the pilot was advised to remain outside of Class B airspace, provided departure instructions, and cleared to taxi to runway 7. The flight was then cleared for takeoff, and the pilot was instructed to turn left on course.

Radar data indicated that, between 1116:39 and 1118:43, the airplane proceeded in an east-northeasterly direction, turned to a northwesterly direction, and climbed from 200 ft to 1,800 ft mean sea level (msl). About 1118:47, while the airplane was flying in a northwesterly direction about 1,900 ft msl, the local controller advised the pilot, "november seven foxtrot golf remain outside Bravo airspace at or below one thousand five hundred and contact Orlando departure one one niner point four," and the pilot immediately replied, "alright one one niner point four what was the altitude restriction." The controller replied, "at or below one thousand five hundred," and, at 1118:59, the pilot replied, "at or below one thousand five hundred I'm already at two thousand" followed by a pause and then, "I'm descending for seven foxtrot golf (unintelligible)."

At 1119:09, when the airplane was about 2,100 ft msl, an Orlando Approach Control controller advised the local controller that the airplane needed to descend immediately, and the local controller replied, "yeah I'm starting him down."

While the airplane was flying in a northwesterly direction at 1,900 ft msl, the pilot established contact with Orlando Approach Control, and, at 1119:54, he advised the controller, "…seven foxtrot golf with you at uh one thousand eight hundred descending." The controller instructed the pilot to "ident," provided the Orlando altimeter setting, and asked him his request. The pilot replied by correctly reading back the altimeter setting and advised that he was requesting flight following. The controller asked the pilot for his destination, and the pilot said that it was GLE and asked to start his climb as there was an opening in the clouds. Between 1120:05, and 1120:30, the airplane climbed from 1,700 to 2,200 ft msl. The controller asked several times about the pilot's destination, and, at 1120:37, when the airplane was about 2,200 ft msl, the controller advised the pilot, "seven foxtrot golf okay, you have not been given a clearance through the Bravo why are you climbing;" the pilot did not reply. The controller then instructed the pilot to turn left to a heading of 270°, and the pilot did not reply. At 1120:51, the controller advised the pilot, "seven foxtrot golf I need you to listen cause you're in my Bravo without a clearance turn left heading 270." Between 1120:40 and 1120:53, the airplane descended from 2,200 ft msl to 1,700 ft msl.

At 1120:59, while the airplane was flying in a northwesterly direction at 1,700 ft msl, the pilot advised the controller that he was turning left to a heading of 270° and that "for some reason" he could not get the airplane's autopilot to disengage. The controller immediately replied, "thank you."

The controller provided the pilot with a transponder code, which the pilot read back, and the pilot then said, "listen I think we need to put this thing on the ground I don't know what's going on." The controller asked if the pilot wanted to return to ORL, and the pilot replied, "affirmative can you help me get there." The controller instructed the pilot to maintain VFR at 1,600 ft msl, to fly a heading of 210°, and to expect vectors to runway 7.

At 1121:53, when the airplane was about 1,800 ft msl, the pilot advised the controller, "ok listen um I have to use full force does anybody have any ideas what I can do to shut off this autopilot." The pilot then asked the controller for the assigned heading, which the controller provided, and, about 20 seconds after the pilot's request for assistance, the pilot of another airplane said, "pull your circuit breaker." At 1122:55, when the airplane was about 2,200 ft msl, the controller asked the pilot if he was able to descend, and the pilot replied, "…I'm trying I'm pushing as hard as I can on the yoke." The controller instructed the pilot to fly a heading of 180° when able, and the pilot replied, "descending to one eight I'm sorry going to one eight."

At 1123:34, the pilot of the other airplane advised the controller to have the pilot pull the circuit breaker. The accident pilot said that, "uh we pulled the circuit breaker but it just keeps uh porpoising up and down and it's taking full forward to go down and full back to go up to com compensate." The pilot of the other airplane advised the pilot to "power off the airplane" for 30 seconds, and the controller instructed the pilot to make a right turn to stay away from airplanes departing from Orlando International Airport. At 1124:34, when the airplane was about 1,800 ft msl, the pilot stated, "we're powered way down." The pilot of the other airplane advised the pilot not to reduce engine power but to turn off the airplane's master switch, which would remove electrical power and disconnect the autopilot. The accident pilot asked the other pilot if he was referring to the key (ignition) switch, and the other pilot replied, "no don't turn the key to the off position just turn your master switch your electrical master switch off." The accident pilot asked if the other pilot was referring to the avionics master switch and said that he was "relatively new" to the airplane. The pilot of the other airplane clarified that the pilot was to turn off the battery and alternator switches.
Between 1124:34 and 1126:15 (the time of the last secondary radar return), the airplane descended from 1,800 to 1,100 ft msl and leveled off momentarily every 100 ft between 1,500 and 1,100 ft msl. At 1126:18, the controller advised the pilot that he was cleared to land on runway 7 at ORL. Primary radar returns (with no altitude reported) continued in a south-southeasterly direction from the location where the secondary radar returns ended, and, at 1126:58, the pilot said, "Orlando I'm (unintelligible)." The last primary radar return at 1127:02 was located about 0.1 nautical mile and 319° from the accident site location.

At 1127:11, the ORL local controller advised the approach controller, "ah he just rolled over straight down he's in the ground." Another air traffic controller said, "he rolled it over," and the local controller replied, "uh yeah it looked like he started a right turn to rejoin the final which turned into kind of a wing over uh it was nose down and uh he he went straight down and I lost sight of him…."

Several witnesses noticed the airplane immediately before it impacted Clear Lake. The witnesses saw the airplane in a "hard" right bank, which was followed by the airplane entering a vertical descent and impacting the lake. The witnesses did not see smoke trailing behind the airplane or parts separating during the descent.

Before first responders arrived, bystanders rushed to the area and recovered the occupants from the submerged wreckage.

## Pilot Information

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| **Certificate:** | Private | **Age:** | 61,Male |
| **Airplane Rating(s):** | Single-engine land; Multi-engine land | **Seat Occupied:** | Left |
| **Other Aircraft Rating(s):** | None | **Restraint Used:** | 3-point |
| **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:** | July 3, 2015 |
| **Occupational Pilot:** | No | **Last Flight Review or Equivalent:** | July 16, 2015 |
| **Flight Time:** | 1541.4 hours (Total, all aircraft), 36.9 hours (Total, this make and model), 1312 hours (Pilot In Command, all aircraft), 36.9 hours (Last 90 days, all aircraft), 12.5 hours (Last 30 days, all aircraft) | | |

The pilot, age 61, held a private pilot certificate with ratings for airplane single-engine land, airplane multi-engine land, and instrument airplane. He held a third-class medical certificate, issued July 3, 2015, with a limitation to wear corrective lenses.

A review of the pilot's second logbook, which contained entries dated between November 3, 1995, and October 30, 2015, revealed that he logged a total time of about 1,541 hours of which 1,374 hours were in single-engine airplanes. No logged flights were noted between July 16, 2006, and March 9, 2012. The pilot logged three flights in 2013; the last one was on November 17, 2013. The pilot's next logged flight was on July 16, 2015, which was a sign-off for a flight review in accordance with 14 CFR Part 61.56.

Since purchasing the airplane on September 9, 2015, the pilot had logged about 37 hours in the airplane of which 12.5 hours were in the last 30 days. The remarks section of an entry in his pilot logbook for a flight 19 days after the airplane's purchase stated, "GPS + Autopilot Practice," and the logged duration was 4.2 hours.

## Aircraft and Owner/Operator Information

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| **Aircraft Make:** | Beech | **Registration:** | N7FG |
| **Model/Series:** | A36TC | **Aircraft Category:** | Airplane |
| **Year of Manufacture:** | 1981 | **Amateur Built:** | |
| **Airworthiness Certificate:** | Utility | **Serial Number:** | EA-250 |
| **Landing Gear Type:** | Retractable - Tricycle | **Seats:** | 6 |
| **Date/Type of Last Inspection:** | June 1, 2015 Annual | **Certified Max Gross Wt.:** | 3650 lbs |
| **Time Since Last Inspection:** | 69 Hrs | **Engines:** | 1 Reciprocating |
| **Airframe Total Time:** | 5240.3 Hrs as of last inspection | **Engine Manufacturer:** | Continental |
| **ELT:** | C91 installed | **Engine Model/Series:** | TSIO-520-UB |
| **Registered Owner:** | On file | **Rated Power:** | 300 Horsepower |
| **Operator:** | On file | **Operating Certificate(s) Held:** | None |

The airplane was certificated in accordance with Civil Air Regulations 3 and was manufactured by Beech in 1981. It was powered by a 300-horsepower Continental TSIO-520-UB engine and equipped with a Hartzell PHC-C3YF-1RF constant speed propeller.

A two-axis KFC 200 autopilot system was installed at manufacture in accordance with Supplemental Type Certificate SA1496CE. Components of the system consisted of a KA 285 mode annunciator, KI 256 flight command indicator, KC 290 mode controller, KC 295 flight computer, KS 270 pitch servo and mount, KS 272 trim servo and mount, and KS 271 roll servo and mount. The bridle cable of the KS 270 pitch servo attached to the primary elevator flight control cable by a clamp at each end of the bridle cable. A manual electric autopilot trim switch assembly installed on the pilot's left control yoke grip controlled the KS 272 trim servo, which was connected to the elevator trim actuator by a control cable. Actuation of trim using the switch required movement of both switch rockers in the same direction. An autopilot disconnect/trim interrupt switch was also installed on the pilot's left grip, and a control wheel steering (CWS) switch was installed on the pilot's right grip.
Depressing the CWS switch with the autopilot engaged released the autopilot servos allowing manual manipulation of the flight controls without the need to disengage and re-engage the autopilot or reselect any modes of operation. When the pitch servo, which was mechanically connected to the elevator primary control cables, sensed control forces that continued for longer than 3 seconds with the autopilot engaged, the autopilot computer activated the trim servo to trim away the control force on the pitch servo. The autotrim was specified to go from stop to stop in 94 seconds, and the manual electric trim was specified to go from stop to stop in 42 seconds. There was no audible annunciation when the autotrim was in motion; however, autotrim in motion could be detected by observing movement of the manual elevator pitch trim wheel, which was located in the lower portion of the pilot's side instrument panel. The KA 285 mode annunciator had a "Trim Warning" light bulb that illuminated when an autotrim failure occurred or when the trim circuit breaker was pulled. The light was designed to flash at least 4 times when the test switch on the KC 290 mode controller was depressed.

Review of the airplane's maintenance records revealed an entry dated May 15, 2003, that indicated a new autopilot trim switch assembly (part number 200-02276-0000) was installed and operationally checked satisfactory at an airplane total time of about 4,390 hours. There were no other entries in the maintenance records related to the autopilot trim switch assembly.

The airplane's last annual inspection was signed off as being completed on June 1, 2015, at an airplane total time of about 5,240 hours.

The previous owner of the airplane reported that, in over 4 years of owning the airplane and operating it for about 400 hours, he did not have any issues with the autopilot.

The airplane total time when the pilot purchased it in September 2015 was about 5,268 hours, and, since that time, there was no documented repair performed to any component of the autopilot system or the pitch trim system. The airplane total time at the time of the accident was about 5,310 hours.

According to a logbook entry dated November 13, 2015, two defective static wicks were replaced, loose headphone jacks at the pilot and co-pilot positions were tightened, and troubleshooting of the primary turbine inlet temperature gauge occurred. There was no other documented maintenance performed before the accident flight.

According to the pilot who ferried the airplane to the pilot when the pilot purchased the airplane, during the course of several flights totaling between 6 and 7 hours, when using the electric pitch trim, he noticed a lag of about 2 seconds from activation until seeing the trim wheel move. Because of the lag time and his personal preference, the ferry pilot used the manual pitch trim wheel and did not use the electric pitch trim further. The ferry pilot also reported that, with respect to the autopilot, the only issue he noted was that, when he disconnected the autopilot, the airplane had a tendency to have some nose-down trim, which was easily corrected by about 1/2 turn of the manual pitch trim wheel in the airplane nose-up direction. The autopilot disconnect/trim interrupt switch on the left grip of the pilot's control yoke did disconnect the autopilot. The ferry pilot indicated there were no further issues with the airplane's pitch trim or autopilot.

## Meteorological Information and Flight Plan

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| **Conditions at Accident Site:** | Visual (VMC) | **Condition of Light:** | Day |
| **Observation Facility, Elevation:** | ORL,113 ft msl | **Distance from Accident Site:** | 4 Nautical Miles |
| **Observation Time:** | 11:53 Local | **Direction from Accident Site:** | 70° |
| **Lowest Cloud Condition:** | Scattered / 2300 ft AGL | **Visibility** | 10 miles |
| **Lowest Ceiling:** | None | **Visibility (RVR):** | |
| **Wind Speed/Gusts:** | 8 knots / None | **Turbulence Type Forecast/Actual:** | / Unknown |
| **Wind Direction:** | 20° | **Turbulence Severity Forecast/Actual:** | / Unknown |
| **Altimeter Setting:** | 30.04 inches Hg | **Temperature/Dew Point:** | 27°C / 21°C |
| **Precipitation and Obscuration:** | No Obscuration; No Precipitation | | |
| **Departure Point:** | Orlando, FL (ORL ) | **Type of Flight Plan Filed:** | VFR |
| **Destination:** | Gainesville, TX (GLE ) | **Type of Clearance:** | None |
| **Departure Time:** | 11:15 Local | **Type of Airspace:** | |

At 1153, a surface weather observation taken at ORL, which was located about 3.7 nautical miles east-northeast from the accident site, reported wind 020° at 8 knots, scattered clouds at 2,300 ft, temperature and dew point were 27°C and 21°C, respectively, and altimeter setting 30.04 inches of mercury.

## Airport Information

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| **Airport:** | Orlando Executive KORL | **Runway Surface Type:** | |
| **Airport Elevation:** | 113 ft msl | **Runway Surface Condition:** | |
| **Runway Used:** | | **IFR Approach:** | None |
| **Runway Length/Width:** | | **VFR Approach/Landing:** | None |

## Wreckage and Impact Information

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| **Crew Injuries:** | 1 Fatal | **Aircraft Damage:** | Destroyed |
| **Passenger Injuries:** | 1 Fatal | **Aircraft Fire:** | None |
| **Ground Injuries:** | N/A | **Aircraft Explosion:** | None |
| **Total Injuries:** | 2 Fatal | **Latitude, Longitude:** | 28.52,-81.404441 |

The accident site was located about 3.7 nautical miles west-southwest from the approach end of runway 7 at ORL. The wreckage was raised from the bottom of Clear Lake and towed to a nearby boat ramp, then lifted while being pulled onto land. To facilitate transportation, the fuselage was cut at fuselage station 147, located near the middle of the utility doors.

Examination of the cockpit revealed that an aftermarket mount for a tablet computer was attached to the center portion of the pilot's control yoke. Neither grip of the pilot's control yoke was fractured, and the left grip of the co-pilot's control yoke was fractured. The interconnect aileron chain was around the sprockets of the pilot's control yoke, but the chain was separated. The top portion of the autopilot disconnect/trim interrupt switch located on the left grip of the pilot's yoke was missing and not recovered. The dual rocker switches of the autopilot trim switch assembly were not aligned; the left screw was broken; and the right screw was engaged and tight. The go-around switch, which is also located on the left grip of the pilot's yoke, was missing and not recovered. Normal operation of the CWS switch installed on the right grip of the pilot's yoke was noted when actuated by hand, and electrical continuity was noted from the switch to the appropriate pin of the autopilot computer and from the other wire to a ground terminal connection. Testing of the autopilot disconnect/trim interrupt switch revealed continuity between terminals 3 and 4, which is consistent with the switch being engaged to disconnect the autopilot; no continuity was noted between terminals 1 and 2 (normal relaxed state).

Further examination of the cockpit revealed that the KC 290 mode controller was impact damaged. The flight level trim switch was in the up position, and the plastic on/off switch was deformed. The pre-impact switch positions of the mode controller could not be determined. The KA 285 mode annunciator was not crushed. The connector remained secured by the screws and was fully seated, but the backshell was cracked. Examination of the autopilot disconnect relay revealed no evidence of visible damage. Continuity was noted between pins 4 and 12 of the relay (normal) and from terminal 14 to a ring terminal connection with multiple wires; the ring terminal was impact separated from its airframe attach point. The mode controller, mode annunciator, and autopilot disconnect relay were retained for further examination.

Examination of the wiring from the autopilot disconnect/trim interrupt switch to the autopilot disconnect and trim interrupt relay installed on the upper aft side of the firewall (identified as KPN 032-0029-01) revealed continuity from terminal 13 of the relay to terminal 4 of the autopilot disconnect/trim interrupt switch (normal). The wires at the pilot's control yoke were cut to facilitate removal of the autopilot disconnect/trim interrupt switch and the autopilot trim switch assembly, which were retained for further examination.

Examination of the avionics bus bar revealed that the top portions of the autopilot and trim circuit breakers were damaged. Both circuit breakers were removed from the panel, and the housings of both were missing and not recovered. Both power side screws remained tightly secured to the bus bar.

Examination of the left and right wings revealed that both remained attached by the forward and aft spars, and both exhibited impact damage. Both main landing gears were in the wheel wells, and both flap actuators were extended 2.0 inches, which equates to flaps retracted. The stall warning vane remained electrically connected but was separated from the wing.

Examination of the empennage revealed that the left and right elevator trim tab actuators were

symmetrically extended 1 7/8 inches, which equates to the full airplane nose-up stop.

All structure and primary and secondary flight controls remained attached or were recovered with the exception of the outboard portion of the right elevator. Impact damage was noted to the inboard portion of the right elevator and horizontal stabilizer. Examination of the aileron servo revealed that the bridle cable remained secured to the balance cable, and the middle ball was in the slot of the capstan, which rotated freely. The connector was fully seated to the airframe harness, and each swaged ball was at the end of each clamp.

Examination of the autopilot components, which were located in the aft fuselage, revealed that both electrical connections and the static line of the autopilot computer remained secured. The pitch servo and the airframe electrical connection were not fully mated. Further examination of the airframe wiring harness revealed that it was pulled free of the airframe security plastic clamp. One of the locks for the airframe side of the harness remained secured to the female side of the electrical connection, but the opposite side lock was separated. Further examination of the electrical connection revealed that a plastic tie-wrap remained secured around the body of the locks to prevent separation of the connection. The trim servo electrical connection was fully seated and locked on both sides. A plastic tie wrap remained in place around the body of the locks to prevent separation of the connection.

Further examination of the autopilot pitch servo revealed that the capstan rotated freely, the middle ball was in the slot, and the cable was around the capstan. Both clamps remained connected to each primary control cable, and the swaged ball was located against the end of both clamps (normal). Examination of the trim servo revealed that the capstan was free to rotate, and the cable was routed properly. The trim servo, identified as KS 272, and the pitch servo, identified as KS 270, were retained for testing at the manufacturer's facility.

Examination of the flight controls confirmed control cable continuity for roll, pitch, and yaw to each respective control surface to the cockpit, except where cables were cut for recovery. The pitch trim cables were exercised after recording of the elevator trim actuator positions, and both actuators moved symmetrically. Examination of the upper and lower elevator pitch trim stops revealed normal appearance; there was no evidence of impact to either stop.

Examination of the engine revealed crankshaft, camshaft, and valve train continuity. No evidence of preimpact failure or malfunction of the engine or engine components was noted.

Examination of the propeller revealed all three blades remained secured in the hub, and one blade rotated freely; all blades exhibited varying degrees of aft bending.

## Medical and Pathological Information

The District Nine Medical Examiner's Office performed postmortem examinations of the pilot and passenger. The cause of death for both was blunt force trauma.

Forensic toxicology of specimens of the pilot were performed by the FAA Bioaeronautical Sciences

Research Laboratory, Oklahoma City, Oklahoma, and Wuesthoff Reference Laboratory, Melbourne, Florida. Forensic toxicology of specimens of the passenger was performed by Wuesthoff and Orlando Health Clinical Laboratories.

The pilot's FAA toxicology report indicated that the results were negative for carbon monoxide and volatiles. An unquantified amount of diphenhydramine, which is a sedating antihistamine available in a wide variety of over the counter products used to treat cold symptoms, allergic reactions, and as a sleep aid, was detected in urine but not detected in cavity blood. The pilot's Wuesthoff toxicology report indicated that the results were negative for volatiles, and the blood immunoassay screen detected 4.9% carboxyhemoglobin in the heart blood.

The passenger's Wuesthoff toxicology report indicated that the results were negative for volatiles. The blood immunoassay screen was negative for all tested drugs except benzodiazepines; a note on the report suggested the need for further testing; and 5.3% carboxyhemoglobin was detected in the left chest blood. Unquantified amounts of caffeine, sertraline, trazodone, and trazodone metabolite were detected in the blood drug screen. Although specimens of the passenger were submitted to the FAA, testing was not performed.

## Tests and Research

Recorders

The airplane was equipped with a JPI EDM 700 engine monitor. Also located in the wreckage were a DeLorme inReach GPS, and a digital camera with installed SD card. However, none of the submitted components retained data associated with the accident flight.

Autopilot System Components

The autopilot disconnect relay, pitch and pitch trim servos with mounts, autopilot disconnect/trim interrupt switch, the autopilot trim switch assembly, and the autopilot computer circuit boards (which were properly seated and undamaged) were dried before operational testing. After drying, the autopilot disconnect/trim interrupt switch, autopilot disconnect relay, and the autopilot trim switch assembly were examined, and no preimpact anomalies were found that would have precluded normal operation.
The autopilot computer failed several tests during initial testing. However, several months later, the computer passed all tests with the exception of a pitch-related test, the "Pitch High Pass" test, and tests related to the "Approach" lateral mode. According to Honeywell, the computer's failure to pass the Pitch High Pass test would have resulted in a minor altitude offset in the "Altitude Hold" pitch mode but would not have adversely affected proper autopilot function. The Approach lateral failure was attributed to a faulty operational amplifier. The faulty operational amplifier was replaced; the unit was subjected to full acceptance testing, and it passed all lateral mode tests and continued to fail the Pitch High Pass test.. According to Honeywell, the faulty operational amplifier would have rendered the Approach lateral mode inoperative, and the "Nav" and "HDG" lateral modes would have remained operational. No determination could be made as to when the operational amplifier failed.

To facilitate operational testing of the pitch servo, the impact damaged tach motor bracket was realigned to engage the gear with the motor gear, and the unit operated normally. The pitch servo clutch testing showed that the first test in the clockwise direction was 4 inch-pounds greater than specification, and subsequent tests in both directions were within limits.
Examination of the pitch trim servo revealed impact damage and a red/brown colored wire that had separated from the standoff associated with the manual electric trim circuit. The separated wire was temporarily connected to the proper attach point, and the unit was subjected to final acceptance testing. The unit passed all tests with the exception of the regulator current foldback test, which it was later determined should not have been performed on this unit because the servo did not have the foldback circuit installed. Performing the current foldback test damaged the manual trim circuit components, and a final test of the manual trim motor at maximum torque was not possible because of the inoperative status of the manual trim circuit. The slip clutch was removed from the mount, and it tested within limits in both directions.

The autopilot computer, pitch servo, and pitch trim servo were then tested on an engineering harness with exemplar autopilot system components installed. The autopilot computer (with the faulty operational amplifier replaced) passed the preflight test and all functional tests. The pitch servo clutch engaged and disengaged normally. With the servo engaged and clockwise or counterclockwise force applied, the trim servo responded in the appropriate direction after the appropriate delay. The trim servo clutch engaged and disengaged normally. The trim servo functioned satisfactorily when commanded for autotrim.

The autopilot annunciator panel was submitted to the NTSB Materials Laboratory for examination. The panel was x-rayed to determine the status of the bulb filaments for each annunciator light, and only the "Trim Warning" light bulb filament exhibited filament stretching.

Airplane Certification

Civil Air Regulations 3.667, which pertained to autopilot systems, specified that the autopilot be designed so that it could be quickly and positively disengaged by the pilot to prevent it from interfering with the control of the airplane and so that it could be overpowered by the pilot to enable him/her to control the airplane. The regulation also stated that any malfunction, assuming corrective action was initiated within a reasonable period of time, should not produce hazardous loads on the airplane or create hazardous deviations in the flight path. Civil Air Regulations 3.337-2, which pertained to electrical trim tab systems, specified that, when a malfunction occurred during normal flight conditions, it should be possible for the pilot to control the airplane readily and easily for a prolonged period of time without requiring undue effort or concentration. The regulation also stated that the system should be designed to allow the pilot to perform all the maneuvers and operations necessary in effecting a safe landing.

According to certification flight testing documents provided by the autopilot manufacturer, testing in pitch (airplane nose-up direction) was performed to determine control forces as part of the autotrim or manual trim with either a 1.0 or 3.0 second delay. The testing was performed during climb, cruise/maneuvering, descent, and simulated approach at corresponding speeds. With respect to testing during climb configuration while flying at 100 knots with a 1.0 second recognition delay for either the autotrim or manual trim in the up direction, the control force was 5 pounds for autotrim, and there was no change in the control force for manual trim. Testing at 205 knots while in a descent with a 3.0 second

delay in manual trim nose-up direction resulted in a control force of 38 pounds.

According to the airframe manufacturer, the control force necessary to return the control column or elevator to a neutral position at full airplane nose-up elevator trim tab deflection at 120 knots calibrated airspeed was about 311 pounds.

Autopilot Flight Manual Supplement

The airplane's flight manual supplement for the autopilot indicated that, in the event of an electric pitch trim malfunction (either manual, electric, or autotrim), the specified steps in the emergency procedure included:

(a) AP DISC/TRIM INTERRUP Switch – Press and hold down until recovery can be made.
(b) Avionics MASTER – OFF
(c) Airplane – manually retrim
(d) Pitch Trim circuit breaker – Pull

The supplement also stated, "when the autopilot is engaged, manual application of a force to the pitch axis of the control wheel for a period of 3 seconds or more will result in the autotrim system operating in the direction to create a force opposite the pilot. The opposing mistrim force will continue to increase as long as the pilot applies a force to the control wheel and will ultimately overpower the autopilot. If the autopilot is disengaged under these conditions, the pilot may be required to exert control forces in excess of 50 pounds to maintain the desired airplane attitude. The pilot will have to maintain this control force while he manually retrims the airplane."

Weight and Balance

Weight calculations were performed based on the airplane's last weight and balance from 2012 (2,342.50 pounds), the full usable fuel load (624 pounds), and the weight of the pilot, passenger, and wet recovered baggage (465 pounds) minus the fuel burn for engine start, taxi, and run-up (16 pounds). Thus, the weight at takeoff was below the airplane's maximum gross weight of 3,650 pounds.

Performance Study

According to the NTSB Performance Study, which used radar data from Orlando, winds aloft data, and the estimated weight of the airplane, the airplane's speed varied between 100 and 150 knots while climbing and descending. Between 1124:20 and 1126:11, the airplane lost 44 knots of airspeed and 900 ft of altitude. After 1126:15, primary radar returns (did not contain altitude information. For the last 47 seconds of primary radar returns, the airplane's groundspeed continued to decrease. Based on the bank angle (8° left wing low) required to complete the turn between the last primary return and the wreckage location, the calculated groundspeed was about 68 knots. The stall speed for the airplane's weight and configuration (flaps retracted and 8° bank) was about 66 knots.

Accidents Involving Beech 36 Series airplanes

A review of 657 accidents, incidents, and occurrences investigated by the NTSB involving Beech 36

series airplanes from 1982 to 2016 (excluding this accident) found 2 accidents in which the autopilot or pitch trim was listed as a cause, factor, or finding. In both cases, ATL84FA184 and ATL89FA196, the elevator trim was in the full nose-down position. In ATL84FA184, the pilot reported that the autopilot was stuck and that it was taking all his strength to hold the airplane's nose up. The airplane pitched down during cruise flight and impact the ground. The NTSB determined that the probable cause of this accident included the pilot's failure to re-trim the airplane. Contributing factors included physical strength overload. In ATL89FA196, the pilot reported that he was unable to disengage the autopilot and was fighting hard to maintain control. The pilot was being vectored to an airport when the airplane was lost from radar and impacted the ground. The NTSB determined that the probable cause of the accident was the pilot's failure to maintain control of the airplane while maneuvering for a landing. Contributing factors were the pilot's failure to follow the emergency procedures for an autopilot malfunction and pilot fatigue. Review of the supporting documents contained in the public dockets for both investigations revealed that the reason for the as-found trim setting was not determined.

The NTSB public docket for the ATL89FA196 investigation contained correspondence from the FAA responding to a congressional inquiry regarding the King KFC 200 autopilot system. The correspondence from the FAA indicated that there were two recent reports of uncommanded trim runaway, and the investigation by the autopilot manufacturer attributed the problems to two diodes (identified as CR438 and CR439) installed on the KC 295 adapter board of the autopilot computer. A service bulletin was developed in 1987 by the manufacturer that suggested removal of the diodes. The adapter board installed in the autopilot computer in the airplane involved in the accident that is the subject of this report did not contain diodes CR438 and CR439.

The correspondence in the ATL89FA196 docket further indicated that, during certification flight testing of the KFC 200 autopilot system, unknown to the test pilot, a nose-down trim runaway was induced while flying at normal operating speed. After recognition, the test pilot waited 3 seconds before initiating corrective action. During the recovery, the test pilot used the manual trim wheel and autopilot disconnect/trim interrupt switch; the airplane did not exceed velocity never exceed speed; and there were no excessive structural loads. The FAA's response to the congressional inquiry noted an apparent lack of pilot understanding of autopilot system operation.

Service Difficulty Reports

A review of the FAA Service Difficulty Report (SDR) data pertaining to the KFC 200 autopilot system for all aircraft revealed no reports of uncommanded pitch trim in the 19 records submitted between 1995 and March 2017.

## Administrative Information

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| **Investigator In Charge (IIC):** | Monville, Timothy |
| **Additional Participating Persons:** | Alexander Honig; FAA/FSDO; Orlando, FL<br>Brian J Weber; Textron Aviation; Wichita, KS<br>Bill Gill; Honeywell; Olathe, KS<br>Mike Council; Continental Motors, Inc.; Mobile, AL |
| **Report Date:** | June 21, 2017 |
| **Last Revision Date:** | |
| **Investigation Class:** | Class |
| **Note:** | The NTSB traveled to the scene of this accident. |
| **Investigation Docket:** | https://data.ntsb.gov/Docket?ProjectID=92347 |