National Transportation Safety Board
Aviation Accident Final Report

Location:	Nantucket, Massachusetts	**Accident Number:**	ERA17LA329
Date & Time:	September 13, 2017, 07:23 Local	**Registration:**	N836GW
Aircraft:	Cessna 402	**Aircraft Damage:**	Substantial
Defining Event:	Flight control sys malf/fail	**Injuries:**	1 Minor
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The commercial pilot stated that, shortly after taking off for a cross-country, personal flight and while accelerating, he noticed high airplane nose-down control forces and that the airplane became increasingly difficult to control. He used manual trim to attempt to trim out the control forces and verified that the autopilot was not engaged; however, the nose-down tendency continued, and the pilot had trouble maintaining altitude. During the subsequent emergency landing, the airframe sustained substantial damage.

Postaccident examination of the airplane revealed that the elevator trim push rod assembly was separated from the elevator trim tab actuator, and the end of the elevator trim push rod assembly was found wedged against the elevator's main spar. The elevator trim indicator in the cockpit was found in the nose-up stop position; however, the elevator trim tab was deflected 24° trailing edge up/airplane nose down (the maximum airplane nose-down setting is 6°). A drilled bolt was recovered from inside the right elevator; however, the associated washer, castellated nut, and cotter pin were not found. Examination of the bolt revealed that the threads were damaged and that the bolt hole on one of the clevis yoke halves exhibited deformation, consistent with the bolt separating. About 2 weeks before the accident, the pilot flew the airplane to a maintenance facility for an annual inspection. At that time, Airworthiness Directive (AD) 2016-07-24, which required installation of new hardware at both ends of the pushrod for the elevator trim tab, was overdue. While the airplane was in for the annual inspection, AD 2016-07-24 was superseded by AD 2016-17-08, which also required the installation of new hardware. The ADs were issued to prevent jamming of the elevator trim tab in a position outside the normal limits of travel due to the loss of the attachment hardware connecting the elevator trim tab actuator to the elevator trim tab push-pull rod, which could result in loss of airplane control.

While in for the annual inspection, the airplane was stripped and painted, which would have required removal of the right elevator. Although the repair station personnel indicated that they did not disconnect the elevator trim pushrod from the elevator trim tab actuator when they painted the airplane, photographs taken of the airplane while it was undergoing inspection and painting revealed that the pushrod likely had been disconnected. The repair station owner reported that he reinstalled the right elevator and the elevator trim pushrod after the airplane was painted; however, he did not replace the hardware at either end of the pushrod as required by the ADs. Subsequently, the airplane was approved for return to service. After the annual inspection, no work, repairs, or adjustments were made to the elevator trim system. The airplane had accrued about 58 hours since the annual inspection at the time of the accident. Although reusing the self-locking nut might have resulted in it coming off by itself, the cotter pin should have prevented this from happening. Therefore, although the castellated self-locking nut, washer, and cotter pin normally used to secure the elevator trim pushrod at the elevator trim tab actuator were not found, given the evidence it is likely that the hardware, which was not the required hardware, was not properly secured at installation, which allowed it to separate in flight. It is also likely that the pushrod assembly then moved aft and jammed in a position well past the maximum nose-down trim setting, which rendered controlled flight impossible.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The separation of the pushrod from the elevator trim tab actuator, which rendered controlled flight impossible. Contributing to the separation of the pushrod was the failure of maintenance personnel to properly secure it to the elevator trim tab actuator.

Findings

Aircraft	Elevator tab control system - Failure
Aircraft	Pitch control - Attain/maintain not possible
Personnel issues	Replacement - Maintenance personnel

Factual Information

History of Flight

Takeoff	Flight control sys malf/fail (Defining event)
Takeoff	Attempted remediation/recovery
Landing	Off-field or emergency landing
Landing	Collision with terr/obj (non-CFIT)

On September 13, 2017, about 0723 eastern daylight time, a Cessna 402B, N836GW, was substantially damaged during a rejected takeoff at the Nantucket Memorial Airport (ACK), Nantucket, Massachusetts. The commercial pilot/airplane owner sustained minor injuries. The airplane was being operated under the provisions of Title 14 *Code of Federal Regulations* Part 91 as a personal flight. Visual meteorological conditions prevailed at the time and no flight plan was filed for the flight that was originating at the time of the accident. The flight was destined for Barnstable Municipal Airport-Boardman/Polando Field Airport, Hyannis, Massachusetts.

The pilot stated that he had completed his routine "takeoff flow" confirmed by the airplane before takeoff checklist, and was then cleared to take off from runway 24. The airplane accelerated to between 90 and 95 knots, and he began to rotate. The airplane achieved a positive rate of climb and he retracted the landing gear; however, after becoming airborne he was "fighting the controls to keep the aircraft from a nose down configuration." He used manual trim and verified the autopilot was not engaged; however, the nose-down tendency continued and "controlling the airplane was increasingly difficult along with maintaining altitude." At that time he rejected the takeoff and executed an emergency landing on the remaining portion of the runway.

Pilot Information

Certificate:	Commercial; Private	**Age:**	56,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:**	No
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	August 12, 2017
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	July 15, 2017
Flight Time:	1500 hours (Total, all aircraft), 1100 hours (Total, this make and model)		

The pilot, age 56, held a commercial pilot certificate with airplane multi-engine land and instrument airplane ratings issued December 5, 2005, and a private pilot certificate with airplane single engine land rating issued January 12, 2003. He held a first-class medical certificate with a limitation to possess glasses for near and intermediate vision issued August

12. 2017. He reported 1,500 hours total flight time, of which 1,100 were in the accident make and model airplane. His last flight review was conducted in the accident airplane on July 15, 2017.

Aircraft and Owner/Operator Information

Aircraft Make:	Cessna	**Registration:**	N836GW
Model/Series:	402 B	**Aircraft Category:**	Airplane
Year of Manufacture:	1977	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	402B1242
Landing Gear Type:	Retractable - Tricycle	**Seats:**	7
Date/Type of Last Inspection:	February 6, 2017 Annual	**Certified Max Gross Wt.:**	6300 lbs
Time Since Last Inspection:	58 Hrs	**Engines:**	2 Reciprocating
Airframe Total Time:	4928.3 Hrs as of last inspection	**Engine Manufacturer:**	Teledyne Continental
ELT:	Installed	**Engine Model/Series:**	TSIO-520-E
Registered Owner:		**Rated Power:**	300 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

The seven-place, low-wing airplane, was manufactured in 1977. It was powered by two 300-horsepower Continental TSIO-520-E engines and equipped with constant-speed, manual feathering three-blade McCauley propellers.

The elevator trim control system was operated by a control wheel mounted on the left side of the pedestal in the cockpit. The control wheel was attached to a sprocket which operated a chain and cables. The chain and cables were routed to pulleys, forward and down through the pedestal under the floor and aft to the tailcone of the airplane. In the tailcone, the cables were routed aft to pulleys just forward of the horizontal stabilizer rear spar, then up and through the right horizontal stabilizer to a chain which operated the trim actuator. A push rod connected the trim tab actuator to the elevator trim tab which was mounted to the right elevator by a continuous hinge. The published maximum elevator trim tab trailing edge up deflection with the elevator in the neutral position was 5° +1°, -0°.

Airworthiness Directive (AD) 2016-07-24, with an effective date of April 26, 2016, specified replacement within 90 days of the effective date of attaching hardware of the elevator trim pushrod at the elevator trim tab actuator and trim tab ends. A review of the maintenance records revealed that between March 3, 2016, and February 6, 2017, there was no entry indicating compliance with the AD. The airplane owner/pilot later reported that he was not aware of the AD when it came out, but he felt confident that the maintenance facility would comply with it during the annual inspection.

On August 31, 2016, the owner flew the airplane to a repair station in New Bedford, MA, for an annual

inspection.

As part of the repair station incoming process, the chief inspector performed an AD search of the airplane using Avantext. At that time, AD 2016-07-24, was on the recurring list of the AD service provider; however, the chief inspector did not include this in the handwritten notes of recurring AD's that were applicable to the airplane. Subsequently, AD 2016-17-08, with an effective date of September 12, 2016, which replaced AD 2016-07-24, also required replacement of the hardware but revised the repetitive inspection intervals and allowed for a longer bolt for the attachment of the elevator trim tab actuator rod end to the push-pull tube connection and/or for the elevator trim tab horn end to the push-pull tune connection. The AD's were issued to prevent jamming of the elevator trim tab in a position outside the normal limits of travel due to the loss of the attachment hardware connecting the elevator trim tab actuator to the elevator trim tab push-pull rod, which could result in loss of control.

During the annual inspection, the airplane was stripped and painted. As part of that process, and also because the right elevator control tube assembly end fitting part was cracked, an employee of the repair station removed the right elevator requiring separation of the elevator trim push rod from the trim tab end only. Repair station personnel reported that the elevator trim push rod remained connected at the elevator trim tab actuator and was safety wired to prevent movement of the elevator trim tab actuator.

In conflict with the report that the push rod remained connected at the elevator trim tab actuator, subsequent pictures of the airplane taken by the airplane owner while in the hangar in December 2016, depicted the right elevator removed and the push rod disconnected from the elevator trim tab actuator. The repair station owner reported he installed the right elevator after painting. When he did so, the elevator trim push rod assembly was already attached at the actuator, and the appropriate securing hardware was in-place at the actuator; however, the hardware at the actuator and trim tab ends were not replaced as specified by AD 2016-17-08, because the repair station owner interpreted it to only require an inspection of the hardware and not replacement of the attachment hardware.

The airplane was flown on January 28, 2017, and approved for return to service on February 6, 2017. According to the airplane owner, no work, repairs, or adjustments were made to the elevator primary or secondary flight control system between the annual sign-off date and the accident date. The airplane had accrued 58 hours since the inspection at the time of the accident.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	ACK,47 ft msl	**Distance from Accident Site:**	
Observation Time:	06:53 Local	**Direction from Accident Site:**	
Lowest Cloud Condition:	Clear	**Visibility**	6 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	5 knots /	**Turbulence Type Forecast/Actual:**	None / None
Wind Direction:	280°	**Turbulence Severity Forecast/Actual:**	N/A / N/A
Altimeter Setting:	29.89 inches Hg	**Temperature/Dew Point:**	17°C / 17°C
Precipitation and Obscuration:	Moderate - None - Mist		
Departure Point:	Nantucket, MA (ACK)	**Type of Flight Plan Filed:**	None
Destination:	Hyannis, MA (HYA)	**Type of Clearance:**	None
Departure Time:	07:23 Local	**Type of Airspace:**	

At 0653, a surface weather observation taken at ACK reported wind 280° at 5 knots, 6 miles visibility with moderate mist, clear skies, temperature 17°C, dew point 17°C, and altimeter setting 29.90 inches of mercury.

Airport Information

Airport:	Nantucket Memorial ACK	**Runway Surface Type:**	Asphalt
Airport Elevation:	47 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	24	**IFR Approach:**	None
Runway Length/Width:	6303 ft / 150 ft	**VFR Approach/Landing:**	Forced landing

ACK was a public use airport equipped with multiple runways. Runway 06/24 was a grooved asphalt runway 6,303 ft long and 150 ft wide.

Multiple airport security videos depicted various segments of the flight including the taxi to takeoff, takeoff roll, while airborne over the runway, the descent, impact onto the runway, and finally coming to rest. The video segmented that depicted flight while over the runway and the airplane just before impact revealed all three landing gear were extended. Debris was noted becoming airborne after impact with the runway.

Wreckage and Impact Information

Crew Injuries:	1 Minor	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Minor	**Latitude, Longitude:**	41.250831,-70.067497(est)

Examination of the accident site by the Federal Aviation Administration (FAA) inspector revealed the airplane impacted on the runway about 36 feet left of the runway centerline and 1,773 feet before the departure end of the runway. The airplane came to rest upright on the runway about 1,400 feet from the initial runway impact.

Postaccident examination of the airplane by a FAA inspector revealed the left and right main landing gear upper trunnion assemblies were fractured, separating the left and right main landing gear wheel assemblies from the aircraft and exposing the barrel assemblies. The nose landing gear wheel was deformed and the fork and tube assembly were fractured, separating the nose landing gear wheel assembly on impact.

Further examination of the airplane revealed that with the elevator in a neutral position (per the airplane Type Certificate Data Sheet), the elevator trim tab was extended approximately 24° tab trailing edge up (airplane nose-down), and the elevator trim indicator in the cockpit was at the nose-up stop position. Further examination of the airplane revealed the elevator trim push rod assembly was separated from the actuator, but remained connected at the elevator trim tab. The end of the push rod assembly that was separated from the trim tab actuator was wedged against the forward spar of the elevator. A drilled bolt was recovered from inside the right elevator; however, the associated washer, castellated nut, and cotter pin were not located. The elevator trim tab actuator, elevator trim push rod assembly, and recovered drilled bolt were retained for further examination by the NTSB Materials Laboratory.

According to the NTSB Materials Laboratory report, deformation (characterized by a rounding of the bolt hole edge and raised burr) was noted of the bolt hole on one of the clevis yoke halves, as well as an impression from rubbing between the clevis yoke and the actuator end bearing. The cross drilled bolt had remnants of paint on the head and did not appear to have been a replacement. The threads on the end of the bolt had a flattened and polished appearance. Debris was noted inside the cross drilled hole.

Additional Information

Similar Accident Investigations Conducted by NTSB

On May 25, 1988, in West Columbia, South Carolina, a Cessna 402B, N8493A, was involved in a fatal accident after the pilot radioed shortly after takeoff that he was having a problem with the elevator that required "full back pressure" to keep the nose up (NTSB accident number ATL88FA186). While attempting to return to land, the airplane pitched 70-80° nose down and descended into terrain. A

postaccident examination revealed that the bolt securing the elevator trim tab push rod to the actuator was missing. The rod had become wedged inside the elevator, which led to an "extreme tab up" (airplane nose down) condition. The investigation noted that the airplane underwent an annual inspection 2 days and 5 flight hours prior to the accident; there was no reported maintenance done to the elevator trim tab system.

On July 28, 1995, in Wenatchee, Washington, a Cessna 402B, N51816, experienced a "greater than normal" nose-down trim and impacted terrain during an attempted emergency landing, resulting in substantial damage (NTSB accident number SEA95LA159). The operator reported that the elevator trim actuator rod failed during takeoff. A postaccident examination by FAA investigators found the elevator trim pushrod separated from the elevator trim tab actuator, and the pushrod was jammed behind the elevator spar, forcing the elevator trim tab "into its extreme nose-down trim position." The investigation also noted that the right elevator had been replaced 13 days and 24.9 flight hours prior to the accident.

On April 26, 2001, in Del Rio, Texas, a Cessna 402B, N80Q, was involved in a fatal accident after the pilot reported that he would circle the airport a few times "because he was having trouble with his autopilot" (NTSB accident number FTW01FA104). A witness observed the airplane turn onto final and stated that the airplane "suddenly stalled and slammed into the ground from about two hundred feet." During the investigation, the elevator trim tab was found to be in the 28° tab-up position (airplane nose-down), or about 23° past the maximum tab-up travel limit (when connected) of 5°. The clevis end of the trim tab pushrod was separated from the actuator, and the pushrod was wedged against the forward spar of the elevator's internal structure; the attach hardware was not located. The clevis end of the pushrod and the actuator were not damaged, and no impact damage was apparent on the trim tab. The investigation noted that the right elevator had been replaced 4 days and 10 flight hours prior to the accident.

On November 7, 2001, in Winston Salem, North Carolina, a Cessna M310Q, N7648Q, was involved in a fatal accident after the pilot radioed that he was experiencing oscillations in the airplane's controls (NTSB accident number ATL02FA010). He then radioed that the problem was under control, but shortly after he radioed that he was experiencing a lot of down pressure on the yoke. The airplane crashed shortly after that transmission. The forward end of the pushrod had separated from the elevator trim tab actuator. The dry, oxidized condition of the pushrod's forward end was consistent with the attaching bolt likely being missing for some time before the crash, the rub marks on the opening in the forward elevator spar corresponded to rub marks found on the underside of the pushrod, and the geometry of the disconnected pushrod allowed it to pass behind the forward spar of the right elevator. The observed damage was consistent with the elevator trim tab being in the full trailing edge up (airplane nose-down) position. The investigation noted that all flight control surfaces including the elevator were removed for painting 7 months 6 days and 35 hours prior to the accident.

On September 25, 2015, in Wichita, Kansas, a Cessna T310Q, N301JA, was involved in a fatal accident after witnesses observed the airplane pitch nose down "greater than 45 degrees" and "50 to 70 degrees" during takeoff initial climb (NTSB accident number CEN15FA425). The elevator trim pushrod was found detached from the trim tab actuator, and the attach hardware was not located. The elevator trim actuator which remained attached to its attachment point on the horizontal stabilizer was extended about 5/8 inch, which corresponded to a position outside its normal limits. Scrape marks on the aft side of the elevator spar below the guide hole for the trim tab pushrod were consistent with the pushrod's forward

(disconnected) end hitting against the spar's aft side after the pushrod separated from the actuator and became trapped behind the elevator spar. The investigation did not indicate any recent work to the elevator primary or secondary flight control system.

FAA Review of Previous Pushrod Separation Accidents and Extreme Trim Tab Position

Based on their review of the previous fatal accidents, and of the NTSB and FAA Service Difficulty Report (SDR) databases involving separation of the pushrod from the elevator trim tab actuator, the FAA Aircraft Certification Office (FAA-ACO) located in Wichita, Kansas, began dialog with Textron Aviation (Textron). The focus was to have Textron design a way to prevent jamming of the elevator trim tab beyond the normal range in the event of separation of the push rod from the elevator trim tab actuator on aircraft that utilize the same secondary pitch trim design.

Airplane Certification

The airplane was certificated under Part 3 of *Civil Air Regulations* (CAR) dated May 15, 1956, as amended by 3-1 through 3-5 and 3-8.

A review of CAR 3 pertaining to design and construction of the trimming controls revealed there was no explicit requirement to prevent jamming of the elevator trim tab travel beyond the normal range in the event of single point failure or malfunction.

Airplane Work Done by Other than Repair Station Personnel

The stripping and painting of the airplane was performed by personnel hired by the owner. The work was performed after normal hours and the personnel were unaccompanied by personnel of the maintenance facility. The individuals involved in the painting informed NTSB they did not remove any part of the airplane for the stripping or painting process. The repair station subsequently changed their procedures after the accident to only allow non repair station personnel access to the hangar with direct supervision.

Tests and Research

Postaccident review of the AD's list printout provided by the airplane owner revealed the corrective action for AD 2016-17-08 dated February 6, 2017, specified that the hardware was replaced; however, the corrective action for the same AD provided to the FAA during the postaccident investigation visit to the repair station on January 19, 2018, revealed it indicated "Inspected hardware per AD instructions."

A review of the documents provided by the repair station revealed no documentation of replacement hardware at the elevator trim tab actuator and elevator trim tab.

Administrative Information

Investigator In Charge (IIC):	Monville, Timothy
Additional Participating Persons:	Aulio A Giron; FAA/FSDO; Burlington, MA
Original Publish Date:	April 20, 2020
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=96038