Aviation Investigation Final Report

Location:	Atlanta, Georgia	**Incident Number:**	DCA20IA014
Date & Time:	November 6, 2019, 21:15 Local	**Registration:**	N117HQ
Aircraft:	Embraer ERJ170	**Aircraft Damage:**	None
Defining Event:	Loss of control in flight	**Injuries:**	9 None
Flight Conducted Under:	Part 121: Air carrier - Scheduled		

Analysis

The incident flight occurred during the third flight leg of the day. During the first flight leg, the engine indicating and crew alerting system (EICAS) provided the "PITCH TRIM SW 1 [switch 1] FAIL" advisory message. After an uneventful landing, maintenance personnel met the airplane to address the issue. The maintenance personnel reported that they partially removed the switch before deciding to defer the maintenance per the minimum equipment list. The maintenance personnel then reinstalled the switch but did not perform a functional test because the switch was a deferred maintenance item. They also placed a placard to indicate it was inoperative; thus, the captain's trim switch, although not deactivated, was not supposed to be used during the subsequent flight legs.

After takeoff on the incident flight, the captain instructed the first officer to declare an emergency because of runaway pitch trim. The captain stated that he conducted the single memory item on the pitch trim runaway emergency checklist in Republic Airways' quick reference handbook. The memory item required him to push and hold the autopilot/trim disconnect button on his yoke to stop the runaway condition. The captain then instructed the first officer to push and hold the autopilot/trim disconnect button on the first officer's yoke. The flight crewmembers reported that they did not notice any change in the runaway condition and continued to have difficulty controlling the airplane's pitch. The captain stated that the flight crew banked the airplane to maintain control.

The captain and the first officer stated that they needed to use both hands at the same time to counter the airplane's nose-up pitch motion. As a result, neither was able to physically reference the quick reference handbook procedures to troubleshoot the problem.

The captain selected the cutout button for the pitch trim system on his yoke to interrupt the nose-up trim condition and instructed the first officer to use the trim switch on the first officer's yoke to pitch the airplane down to a normal attitude.

The first officer, now in control of the pitch trim using his pitch trim switch, was able to trim and regain control of the airplane. About three minutes later the captain took back control of the airplane. For about 2.5 minutes afterwards the FDR recorded multiple pitch trim up commands from the captain's pitch trim switch, and the airplane again went into a mis-trimmed condition.

The first officer took back control of the airplane and remained in control until the end of the flight. During this time the FDR showed no pitch trim commands originating from the captain's trim switch although there were multiple up and down pitch trim commands originating from the first officer's trim switch. The airplane was controllable and in a trimmed condition and able to return to the departure airport and land uneventfully.

Postincident examination of the captain's pitch trim control switch identified imprint marks on the back of the switch, indicating that, at some point, the switch was installed in an inverted position. The most likely opportunity for this to occur would have been during maintenance after the first flight leg when the pitch trim switch was partially removed then reinstalled since the decision was made to defer maintenance. Since maintenance was deferred, the switch was not functionally tested.

If a functional test had been completed, maintenance personnel would likely have identified the reversed switch position. On April 13, 2020, Embraer and the FAA revised their master minimum equipment lists to remove the yoke pitch trim switches from the list of deferrable items, effectively requiring pitch trim switches to be functionally tested and operational before flight.

Embraer issued Service Bulletins (SBs) 170-27-0051, 190-27-0039, and 190LIN-27-0019 in February 2015 after reports about inverted pitch trim switches. The SBs recommended the installation of a support in the control yoke within the next 7,500 flight hours or 36 months after the SB's issuance (whichever occurred first). However, the SB 170-27-0051 had not been accomplished on the incident airplane. If the SB had been accomplished, the recommended support in the control yoke would have prevented the faulty installation.

In January 2020, the National Transportation Safety Board issued Safety Recommendations A-20-5 and -9 to the National Civil Aviation Agency of Brazil (ANAC) and the Federal Aviation Administration (FAA), respectively, to mandate incorporation of the SB. On May 26, 2020, ANAC published Brazilian Airworthiness Directive 2020-05-0051, which mandated compliance with the SB; as a result, Safety Recommendation A-20-5 was classified "Closed—Acceptable Action" on September 2, 2020. Regarding Safety Recommendation A-20-9 (classified "Closed—Acceptable Action" on October 21, 2022), the FAA stated that it issued Airworthiness Directive 2020-25-08, which became effective on January 21, 2021, and mandated operator compliance with the ANAC's airworthiness directive requirements.

The installation of the pitch trim switch in reverse and the captain's use of the deferred trim switch resulted in the pitch excursion; when the captain attempted to trim the airplane nose down, the airplane responded with nose-up inputs. Thus, to effectively control the reversed pitch trim system, the captain would have had to recognize that his trim-down inputs were causing trim-up commands. However, the captain would not have been aware that the switch had been reinstalled incorrectly and was commanding trim opposite of his inputs.

The captain was aware that the pitch trim switch was not to be used because it had been deferred per the minimum equipment list. However, highly practiced behavior, such as making inputs to keep an airplane in trim, can result in typical motor actions being made automatically despite higher-level knowledge indicating that such action might not be appropriate. During the captain's interview he stated that it was second nature to use the trim switch on the yoke.

Systems with deferred maintenance are typically deactivated to prevent any errant command input from a faulty control. However, there was no requirement, nor was there a published procedure, to disconnect or disarm a faulty pitch trim switch.

Placards for inoperative equipment are typically collocated with the related control to remind pilots that the equipment should not be used. However, the pitch trim switch position on the yoke did not allow space for a placard on or near the switch.

The captain's use of an inoperative and a placarded flight control was inappropriate and caused the airplane to pitch up when the captain was trying to trim down, resulting in flight crew difficulties in controlling the pitch of the airplane. In addition, the captain thought that the airplane had a runaway trim condition, but, once he transferred control of the airplane to the first officer, the mistrim condition stopped, and the crew was able to regain control of the airplane. Thus, the captain's trim inputs (and not a runaway trim) caused the pitch trim anomaly. In addition, FDR data show that the captain's pitch trim only inputted nose up trim and there were no nose down trim commands.

Maintenance records showed a history of "PITCH TRIM SW 1 FAIL" EICAS messages on the airplane between August 4, 2019, and the incident date, resulting in five replacements of the captain's pitch trim control switch and two replacements of the horizontal stabilizer actuator control electronics. Also, during the first flight leg on the day of the incident, the FDR recorded multiple "TRIM FAIL" occurrences related to the captain's pitch trim control switch. The "TRIM FAIL" occurrences and the "PITCH TRIM SW 1 FAIL" EICAS messages were caused by a short to ground of a single circuit to the captain's pitch trim switch. The short was created by contact with the incorrectly tucked pigtail from the safety wire retaining the forward mechanical stop bolt for the captain's control column.

Although both wires enabling the captain's pitch trim switch trim-up command were damaged and chafed and were capable of allowing continuity to the untucked safety wire pigtail (which would result in a short to ground condition), it is unlikely that the pigtail would have made continuity to both wires at the same time. Both wires would need to short to ground simultaneously to allow the stabilizer trim to activate. If both wires shorted to ground, the

horizontal stabilizer control surface movement would automatically stop after three seconds, and if the condition persisted the aural alert “TRIM” would annunciate. This alert was not reported by the crew.

Finally, the maintenance history for the captain’s pitch trim switch had many reports of a “Pitch Trim Switch 1 Fail” EICAS message, but no reports of a trim runaway. FDR showed that the captain's pitch trim switch only provided trim up commands when there was force being applied to the captain's control column, suggest that the captain was in control of the airplane during those times.

Probable Cause and Findings

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

The captain’s use of his pitch trim switch, which had been placarded inoperative but not deactivated, resulting in the airplane pitching up when the captain was trying to trim down. The trim commands were reversed due to maintenance personnel’s incorrect installation of the pitch trim switch. Contributing to the incident was the operator’s delay in incorporating SB 170-27-0051 which would have prevented the switch from being installed inverted.

Findings

Personnel issues	Incorrect action selection - Pilot
Aircraft	Stabilizer control system - Incorrect service/maintenance
Personnel issues	Delayed action - Maintenance personnel

Factual Information

History of Flight

Initial climb	Flight control sys malf/fail
Initial climb	Loss of control in flight (Defining event)

On November 6, 2019, about 2115 eastern standard time, Republic Airways flight 4439, an Embraer EMB-175LR, N117HQ, experienced a pitch trim anomaly shortly after takeoff from Hartsfield-Jackson Atlanta International Airport (ATL), Atlanta, Georgia. The flight crew declared an emergency and returned to ATL. The nine passengers and crewmembers aboard the airplane were not injured, and the airplane was not damaged. The airplane was operating under the provisions of Title 14 *Code of Federal Regulations* Part 121 as regularly scheduled passenger flight destined for LaGuardia Airport (LGA), New York, New York.

The flight crew reported for duty on the day of the incident about 1400 at Detroit Metropolitan Wayne County Airport (DTW), Detroit, Michigan. The incident occurred during the third flight leg of the day. The captain flew the first leg, from DTW to LGA. According to the captain, while en route, the engine indicating and crew alerting system (EICAS) annunciated the "PITCH TRIM SW 1 [switch 1] FAIL" message. The captain stated that he and the first officer referred to the company's quick reference handbook and saw that the EICAS message was advisory. As a result, they noted the message in the airplane's logbook and planned to have the discrepancy addressed after the airplane landed at LGA.

According to the flight crewmembers, maintenance personnel at LGA initially advised that they would change the pitch trim switch on the captain's yoke to resolve the EICAS message and that it would take about 20 minutes to obtain the part. The maintenance personnel reported that they partially removed the switch before deciding to defer the maintenance per the minimum equipment list. The maintenance personnel then reinstalled the partially removed switch but did not perform a functional test because the switch was a deferred maintenance item. The maintenance personnel placarded the switch inoperative and advised the captain to use the backup trim switch instead of the faulty trim switch on his yoke.

The first officer flew the second leg of the day, from LGA to ATL, which he described as "just a normal leg." The first officer stated that no further maintenance was performed after arriving at ATL.

The captain was the pilot flying for the third (incident) leg of the day, from ATL to LGA. Air traffic control (ATC) communications showed that the airplane was cleared for takeoff at 2105:05. The flight crew stated the taxi and takeoff were normal. The first officer stated that, during takeoff, the airplane's climb rate was "moving pretty rapidly" and reached about 4,000 ft per minute,

which he described as normal given that the airplane was “very light” with only six passengers aboard.

The captain reported that he was unable to engage the autopilot when the airplane reached an altitude of about 2,200 ft mean sea level. The captain stated that he “knew that something was wrong,” so the captain instructed the first officer to declare an emergency. ATC communications showed that, at 2106:53, the emergency was declared to the controller. The controller confirmed that the airplane needed to return to the airport and provided instructions to the flight crew to enter the downwind leg for runway 10.

The captain thought that a pitch trim runaway was occurring, so he conducted the single memory item on Republic Airways’ runaway trim emergency checklist, which was to push and hold the autopilot/trim disconnect button on his yoke. The captain also stated that he kept pushing the button and that he was unable to pick up the quick reference card from his lap to continue to troubleshoot the issue because he had to keep both of his hands on the yoke to control the airplane.

The first officer stated that the captain was struggling to control the airplane. The captain asked the first officer to push and hold the autopilot/trim disconnect button located on the first officer’s yoke. The flight crewmembers reported that they did not notice any changes in the airplane’s pitch condition and were having difficulty holding the airplane’s nose down. According to the captain, both he and the first officer had to push forward on their control columns to keep the airplane from pitching up.

According to the flight data recorder (FDR), the horizontal stabilizer was initially positioned about 4° nose up. The stabilizer began moving about 2105:50 and reached a maximum nose-up position of 13° at 2107:45. Between 2105:50 and 2107:50, the FDR recorded multiple trim-up commands from the captain’s switch (and only one trim-down command from the first officer switch). The airplane experienced several pitch oscillations, reaching a maximum pitch-up attitude of about 27° at 2108:08. About 7 second later, the flight crew told the controller that the airplane was “in a stalling situation.” About 1 minute later, the flight crew reported that “we can’t pitch down,” and FDR data showed that the flight crew banked the airplane to maintain control.

The captain pressed the button to cut out pitch trim system 1 because that was the system associated with the EICAS message. FDR data showed that all recorded pitch trim commands from both the captain’s and the first officer’s pitch trim control switches corresponded to the stabilizer movement until 2110:36, at which time the stabilizer parameter suddenly went to 0°, which was consistent with trim cutout switch actuation. According to Embraer, if only one cutout switch is pressed, the system is still capable of moving the horizontal stabilizer, but if both cutout switches are pressed, the system stops moving the horizontal stabilizer. The first officer stated that the airspeed dropped to 138 knots before they regained control of the airplane.

Between 2110:40 and 2113:30, the FDR recorded multiple trim-down commands from only the first officer’s switch (except for one instance of backup switch usage at 2111:00). Between

2114:30 and 2116:40, the FDR recorded multiple trim-up commands from only the captain's switch. Afterward, the captain transferred control of the airplane to the first officer. (The captain wanted to talk with ATC and continue to troubleshoot.) The first officer stated that, with pitch trim system 1 cut out, he was able to trim the airplane nose down and regain airspeed. Between 2116:40 and the 2118:10, the FDR recorded multiple trim-down commands from only the first officer's switch; between 2118:10 and the end of the flight, the FDR recorded multiple trim-up and -down commands from only the first officer's switch.

At 2119:58, the controller instructed the flight crew to join the localizer for runway 10. At 2121:16, the controller cleared the airplane to land on runway 10. The crew acknowledged those instructions. The airplane landed uneventfully about 2125. A cockpit voice recorder summery transcript was prepared to document the communications between maintenance personnel after the incident airplane arrived at the gate. The incident flight had been recorded over.

Pilot Information

Certificate:	Airline transport	**Age:**	32,Male
Airplane Rating(s):	Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	
Medical Certification:	Class 1	**Last FAA Medical Exam:**	
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	May 25, 2019
Flight Time:	4500 hours (Total, all aircraft), 3135 hours (Total, this make and model)		

Co-pilot Information

Certificate:	Airline transport; Commercial	**Age:**	30,Male
Airplane Rating(s):	Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):		**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane single-engine	**Toxicology Performed:**	
Medical Certification:	Class 1	**Last FAA Medical Exam:**	
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	November 1, 2018
Flight Time:	677 hours (Total, all aircraft), 677 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	Embraer	**Registration:**	N117HQ
Model/Series:	ERJ170 200LR	**Aircraft Category:**	Airplane
Year of Manufacture:	2007	**Amateur Built:**	
Airworthiness Certificate:	Transport	**Serial Number:**	17000184
Landing Gear Type:	Retractable - Tricycle	**Seats:**	
Date/Type of Last Inspection:		**Certified Max Gross Wt.:**	
Time Since Last Inspection:		**Engines:**	
Airframe Total Time:		**Engine Manufacturer:**	
ELT:		**Engine Model/Series:**	
Registered Owner:	REPUBLIC AIRWAYS INC	**Rated Power:**	
Operator:	Republic Airline Inc	**Operating Certificate(s) Held:**	Flag carrier (121)

Pitch Trim System

The horizontal stabilizer control surface provides the airplane with stability and control during pitch trim adjustments. The control surface is moved by the horizontal stabilizer trim actuator, which is driven by two electric motors.

A manual pitch trim control switch is located on each control yoke, and a backup manual pitch trim control switch is located on the center pedestal. All three switches are dual-split switches that are spring loaded to neutral. Two stabilizer cutout switches are located on the center pedestal. If both cutout switches are pressed, the stabilizer actuator would be locked in place. If one cutout switch is pressed, the pitch trim system, including all three manual pitch trim switches, would continue to work normally.

An autopilot/trim quick disconnect switch button is located on each control yoke. Pressing and holding either quick disconnect switch, while both cutout switches are in the normal (not pressed) position, prevents any active manual or autotrim command. Pressing either switch also disengages the autopilot. Releasing the pressed quick disconnect button allows trim commands. If only one cutout switch is pressed, the associated quick disconnect switch would not function.

Pitch Trim Runaway Procedures

Republic Airways' quick reference handbook had one memory item for a pitch trim runaway: the autopilot/trim disconnect button was required to be pressed in and held. The Embraer 170/175 *Airplane Operations Manual* required two memory items; the autopilot/trim disconnect button

had to be pressed in and held, and both cutout buttons had to be pushed in. Figure 1 compares the two documents and shows other steps to address a pitch trim runaway.

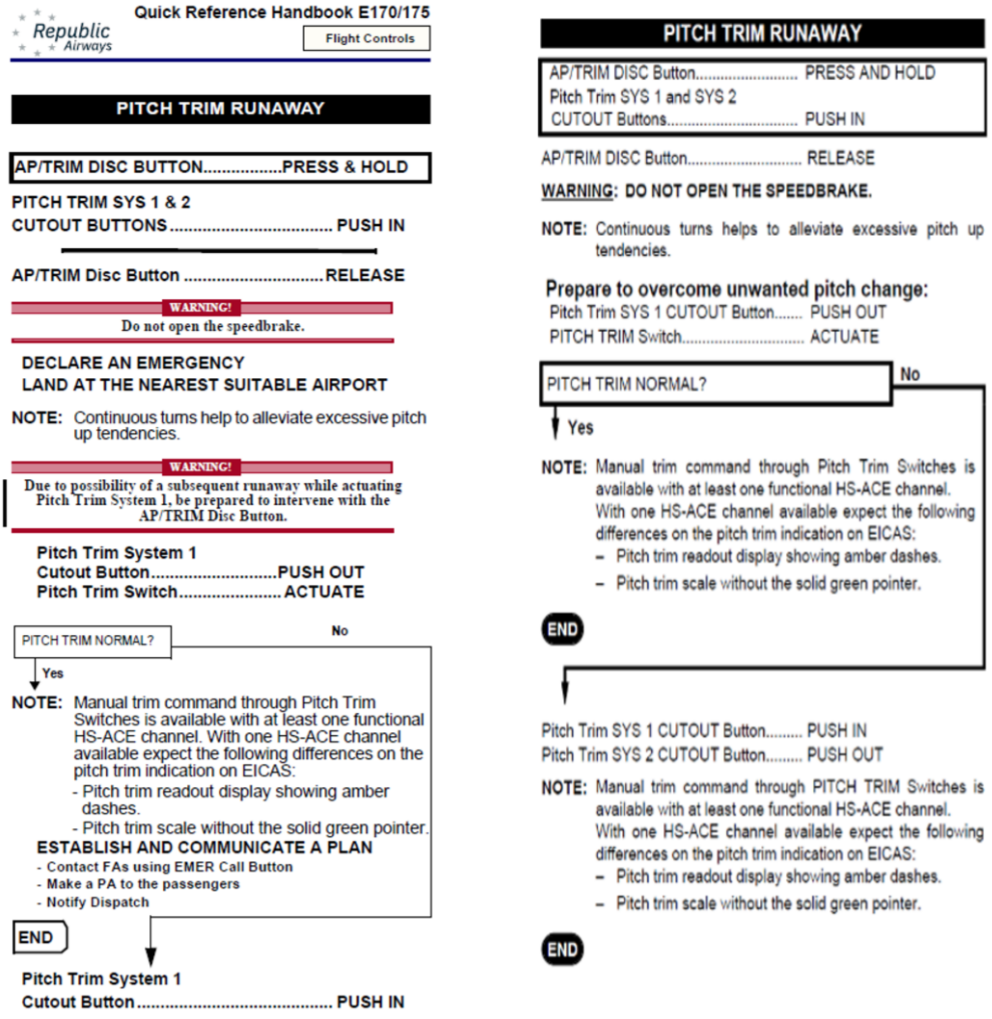

Figure 1. Company and manufacturer pitch trim runaway procedures (Source: Republic Airways and Embraer).

Maintenance Records

The airplane's flight logs from August 7 to November 5, 2019, were reviewed for items related to the pitch trim system. The table below shows the items that were noted.

Table. Pitch trim system discrepancies before the incident.

Date	Discrepancy	Corrective action
8/7/2019	Pitch trim switch 1 fail	Performed related *Fault Isolation Manual* (FIM) task. Message cleared; operational check good.

8/19/2019	Pitch trim switch 1 fail EICAS message with aural trim	Performed related FIM task. Removed and replaced captain's side pitch trim switch.
8/24/2019	Pitch trim switch 1 fail	Performed related FIM task and aircraft maintenance manual (AMM) procedure. Operational checks okay.
9/3/2019	EICAS message en route while on autopilot pitch trim switch-1 fail. Captain trim switch verified inoperative.	Performed related FIM task. Message cleared; operational checks good.
9/8/2019	Pitch trim switch 1 fail	Deferred captain's pitch trim switch in accordance with the minimum equipment list. Removed and replaced captain's pitch trim switch; operational checks good.
9/8/2019	Backup pitch trim switch has no "TRIM" aural callout at the 3-second cutout	Reset trim system cutouts. Trim aural warning operational checks okay.
9/25/2019	Pitch trim switch 1 fail EICAS message	Performed related AMM procedure and operational check of pitch trim controls. Operational check good; no defects noted.
9/27/2019	Aileron cable fairlead broken off at frame 22	Replaced fairlead.
10/12/2019	Pitch trim switch 1 fail	Deferred per MEL 27-43-02-01.
10/13/2019	When rolling right to full deflection, ailerons felt like they were binding	Performed aileron operational check; no defects noted. Found aileron autopilot servo cable frayed. Replaced autopilot servo bracket and frayed cable. Operational checks good.
10/15/2019	Pitch trim switch 1 fail	Removed and replaced pilot pitch control yoke switch. No fix. Removed and replaced horizontal stabilizer actuator control electronics. Operational checks good.
10/23/2019	Pitch trim 1 switch fail message	Deferred pitch trim 1 switch. 10/25/2019: Removed and replaced yoke trim switch. Operational checks good.
11/2/2019	Pitch trim switch 1 fail; captain's switch on yoke inoperative	Replaced captain's yoke trim switch Operational checks good.
11/3/2019	Pitch trim switch 1 fail EICAS message	Replaced horizontal stabilizer actuator control electronics. Operational checks good.

From May 1 to November 5, 2019, Republic Airways provided 15 mechanical interruption summary reports to the Federal Aviation Administration (FAA) for the incident airplane, which included several of the trim switch items.

Pitch Trim Anomaly During Incident Flight

As previously stated, maintenance personnel at LGA deferred changing the pitch trim switch on the captain's yoke, per the minimum equipment list, and placarded the faulty switch as inoperative. Note: There was no requirement to disconnect or disarm a faulty pitch trim switch.

Maintenance records showed that, after the incident, the maintainer found fault code 27430200HS2. The definition for this fault code is "HSACE2 (X CHANNEL PWR)/WRG FAULT" and means there is a loss of power to channel 1 of the HS-ACE. It will be logged when channel 2 detects that channel 1 has been cut out, which is consistent with the activation of the channel 1 pitch trim cutout switch during the event flight as reported by the flight crew.

A senior maintenance manager from Republic arrived on 11/7/2019 to secure the airplane and remove the FDR/CVR. Republic reported that no additional work was done to the aircraft until two additional Republic Airways mechanics arrived from their Headquarters on November 8.

The maintenance crew stated that they confirmed the correct operation of all three switches per the AMM Part II 1963, Rev 80, Task 27-40-00-710-801-A (Horizontal Stabilizer System – Operational Check). They stated that the technician performing the procedure was very familiar with the horizontal stabilizer trim system, indication, and associated direction of movement. In addition, a technician was placed near the horizontal stabilizer, one at the pitch trim controls, and one in between, and verbal communication was used to verify that the stabilizer moved in the correct direction when operated. The maintenance crew stated that they did not observe any anomalies with the operation of the pitch trim system.

The captains yoke pitch trim control inputs to horizontal stabilizer actuator control electronics (HS-ACE) were removed and an operational check of horizontal stabilizer system to confirm that the captain's yoke pitch trim was deactivated and the first officer's and backup switch was still active was accomplished. The switch was not disturbed at the control column during this procedure. The aircraft was ferried to Indianapolis for further maintenance.

The ferry flight occurred on 11/9/2021 with no anomalies noted. Once in Indianapolis, the Republic Airways maintenance crew performed wire inspections and identified damaged wiring at the base of the captain's control column.

In response to this incident, on April 13, 2020, Embraer and the FAA revised their master minimum equipment lists to remove the yoke pitch trim switches from the list of deferrable items.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Night
Observation Facility, Elevation:	KATL	**Distance from Accident Site:**	
Observation Time:	20:52 Local	**Direction from Accident Site:**	
Lowest Cloud Condition:		**Visibility**	10 miles
Lowest Ceiling:	2500 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	5 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	100°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:		**Temperature/Dew Point:**	
Precipitation and Obscuration:			
Departure Point:	Atlanta, GA (ATL)	**Type of Flight Plan Filed:**	IFR
Destination:	New York, NY (LGA)	**Type of Clearance:**	None
Departure Time:		**Type of Airspace:**	

Airport Information

Airport:	Hartsfield - Jackson Atlanta I ATL	**Runway Surface Type:**	
Airport Elevation:	1026 ft msl	**Runway Surface Condition:**	
Runway Used:		**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	

Wreckage and Impact Information

Crew Injuries:	3 None	**Aircraft Damage:**	None
Passenger Injuries:	6 None	**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	9 None	**Latitude, Longitude:**	33.750164,-84.390525(est)

Postincident examination of the area near the captain's control column revealed wires with chafed insulation. These wires connected the horizontal stabilizer actuator control electronics to the captain's pitch trim switch and autopilot/trim disconnect button. The wires contacted an incorrectly tucked pigtail on the safety wire retaining the captain's control column forward mechanical stop bolt, as shown in in figure 2.

Figure 2. Bolt with pigtail contacting wires (Source: Republic Airways).

Subsequent laboratory testing revealed that the insulation for three wires (the captain's quick disconnect switch, the captain's nose-up trim switch A, and the captain's nose-up trim switch B) was damaged but that continuity to the internal wire strands could be achieved. Specifically, the quick disconnect switch wire insulation was damaged completely around the wire strands, and multiple exposed wire strands were severed. The nose-up trim switch A wire insulation was chafed, and a small section of exposed conducting wire showed signs of mechanical scraping. The nose-up trim switch B wire insulation was chafed and damaged, and the conducting wire strands were not visible. Continuity was achieved by using both a cotton swab soaked in soapy

water placed on the damage area as well as a sample piece of cut safety wire pressed lightly on the damaged area. No evidence of arcing was observed.

Examination of the pitch trim control switch revealed an imprint mark in the silicone area on the back of the switch, as shown in figure 3. According to Embraer, this mark was caused by contact against a spring and was consistent with the switch being installed inverted at some point.

Figure 3. Captain-side pitch trim control switch after removal from the incident airplane (Source: Republic Airways).

Note: The red circles show the location of the imprint marks on the back of the control switch.

Flight recorders

During the flight from DTW to LGA, the FDR recorded multiple occurrences of the "TRIM FAIL" condition for the captain's pitch trim control switch. According to Embraer, the FDR records the TRIM FAIL discrete for a disabled pitch trim control switch whenever there is a pitch trim input from any operational source (that is, another pitch trim control switch or autopilot trim input). As a result, the TRIM FAIL discrete indicates that a pitch trim control switch was in a failed state when the horizontal stabilizer actuator control electronics received a pitch trim command from an operational source.

Additional Information

Embraer released Service Bulletin (SB) 170-27- 0051 on February 27, 2015, to alert operators of the possibility that the pitch trim switch could be installed inverted. The SB recommended the installation of a support in the control yoke to prevent the incorrect installation of the switch. The SB compliance time was 7,500 hours or 36 months, whichever occurred first. This SB had not been performed on the airplane before the incident.

As a result of this incident investigation, the NTSB made the following recommendations to the National Civil Aviation Agency of Brazil and the FAA on January 16, 2020:

To the National Civil Aviation Agency of Brazil:

> Require Embraer to develop instructions for operators of Embraer EMB-170/175/190/195/Lineage 1000 series airplanes to inspect the wiring in the captain's and first officer's control columns for damage, replace where needed, and ensure proper clearance from adjacent components, including the forward mechanical stop bolt and its safety wire. (A-20-1, classified "Closed—Acceptable Action" on September 2, 2020)
>
> Once Embraer develops inspection instructions for the wiring in the captain's and first officer's control columns as requested in Safety Recommendation A-20-1, require operators of Embraer EMB-170/175/190/195/Lineage 1000 series airplanes to inspect that wiring for damage, in compliance with Embraer's instructions, replace where needed, and ensure proper clearance from adjacent components, including the forward mechanical stop bolt and its safety wire. (A-20-2, classified "Open—Acceptable Response" on September 2, 2020)

Once inspections are completed as outlined in the instructions developed in response to Safety Recommendation A-20-1, require Embraer to review the inspection results and revise design and maintenance documentation for Embraer EMB-170/175/190/195/Lineage 1000 series airplanes as necessary to prevent any hazards identified during the inspections. (A-20-3, classified "Open—Acceptable Response" on September 2, 2020)

Once Embraer revises design and maintenance documentation for Embraer EMB-170/175/190/195/Lineage 1000 series airplanes as requested in Safety Recommendation A-20-3, require operators of theseairplanes to incorporate these changes. (A-20-4, classified "Open—Acceptable Response" on September 2, 2020)

Mandate the incorporation of Embraer Service Bulletins (SB) 170-27-0051, 190-27-0039, and 190LIN-27-0019 on all applicable airplanes, as specified in the SBs. (A-20-5, classified "Closed—Acceptable Action" on September 2, 2020)

In coordination with the Federal Aviation Administration, Embraer, and US operators, determine if changes to the Embraer EMB-170/175/190/195/Lineage 1000 series airplane Pitch Trim Runaway checklists are required to adequately address all potential trim system failures, and make such changes as necessary. (A-20-6, classified "Open—Acceptable Response" on September 2, 2020)

To the FAA:

Once Embraer develops inspection instructions for the wiring on the captain's and first officer's control columns as requested in Safety Recommendation A-20-1, require operators of Embraer EMB-170/175/190/195/Lineage 1000 series airplanes to inspect that wiring for damage, in compliance with Embraer's instructions, replace where needed, and ensure proper clearance from adjacent components, including the forward mechanical stop bolt and its safety wire. (A-20-7, classified "Closed—Unacceptable Action" on October 21, 2022)

Once Embraer revises design and maintenance documentation for Embraer EMB-170/175/190/195/Lineage 1000 series airplanes as requested in Safety Recommendation A-20-3, require operators of these airplanes to incorporate these changes. (A-20-8, classified "Closed—Acceptable Alternate Action" on October 21, 2022)

Mandate the incorporation of Embraer Service Bulletins (SB) 170-27-0051, 190-27-0039, and 190LIN-27-0019 on all applicable airplanes, as specified in the SBs. (A-20-9, classified "Closed—Acceptable Action" on October 21, 2022)

In coordination with the National Civil Aviation Agency of Brazil, Embraer, and US operators, determine if changes to the Embraer EMB-170/175/190/195/ Lineage 1000 series airplane Pitch Trim Runaway checklists are required to adequately address all potential trim system failures, and make such changes as necessary. (A-20-10, classified "Closed—Acceptable Action" on October 21, 2022)

For more information about these recommendations, see *Reported Flight Control System Difficulty on Embraer EMB-175* (NTSB/ASR-20-01).

Administrative Information

Investigator In Charge (IIC):	Ward, Effie Lorenda
Additional Participating Persons:	Lee Hayes; Republic party coordinator Patrick Lusch; FAA party coordinator Paulo M Ribeiro; Embraer/North America Alexandre Thiago; CENIPA Accredited Representative
Original Publish Date:	December 1, 2022
Last Revision Date:	July 8, 2024
Investigation Class:	Class 3
Note:	The NTSB did not travel to the scene of this incident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=100540