National Transportation Safety Board

Washington, DC 20594

Safety Recommendation Report

Reported Flight Control System Difficulty on Embraer EMB-175

Accident Number:	DCA20IA014
Operator:	Republic Airways
Aircraft:	Embraer-175
Location:	Hartsfield-Jackson Atlanta International Airport, Atlanta, GA
Date:	November 6, 2019

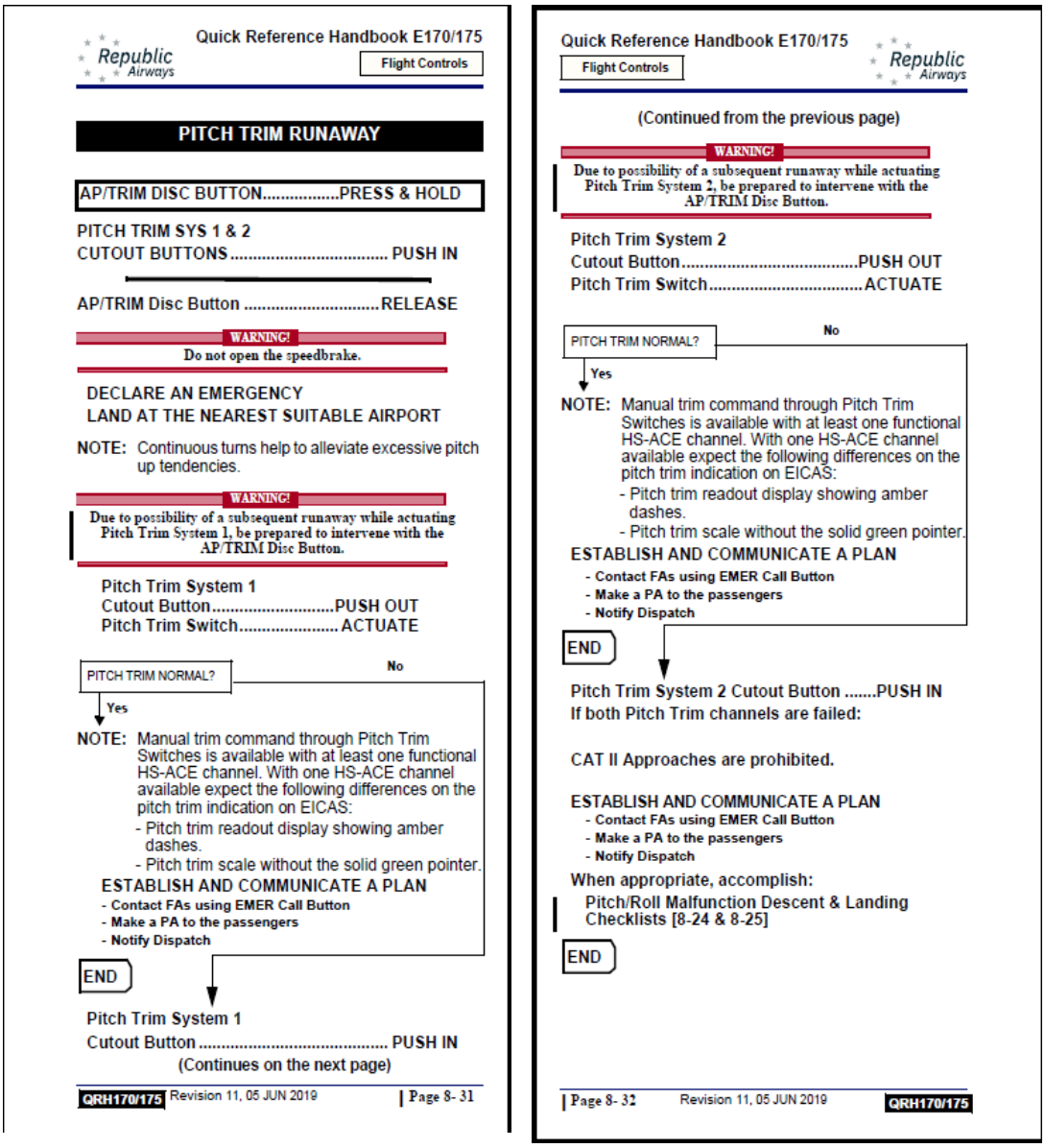
The National Transportation Safety Board (NTSB) is providing the following information to urge the National Civil Aviation Agency of Brazil (ANAC) and the Federal Aviation Administration (FAA) to take action on the safety recommendations in this report. They are derived from preliminary findings of an ongoing investigation of an incident in which the flight crew of a Republic Airways Embraer EMB-175 reported a flight control difficulty involving pitch in the airplane nose-up direction shortly after takeoff from Hartsfield-Jackson Atlanta International Airport (ATL), Atlanta, Georgia. While the cause of the difficulties reported by this flight crew has not yet been determined, these recommendations are intended to address safety issues that we have identified during the initial stage of the investigation. As a result of preliminary findings in this investigation, the NTSB is issuing six safety recommendations to ANAC and four recommendations to the FAA.

Background and Analysis

On November 6, 2019, the flight crew of Republic Airways flight 4439, an Embraer EMB-175, declared an emergency shortly after takeoff from ATL with six passengers on board, reporting a pitch trim-related flight control issue and difficulty controlling the airplane. The captain (who was in the left seat and the pilot flying) later reported recognizing the flight control issue after a failed attempt to engage the autopilot about 2,200 ft mean sea level. The captain stated that he conducted the single memory item on Republic's Pitch Trim Runaway checklist to push and hold the autopilot/trim disconnect button on his side (figure 1 shows Republic's quick reference handbook [QRH] checklist for a pitch trim runaway).[1] The captain then asked the first officer to push and hold the right-side autopilot/trim disconnect button. The flight crewmembers reported

[1] The stabilizer trim system consists of trim switches located on the captain's and first officer's yokes. A trim panel is located on the pedestal and has two spring-loaded manual trim switches for backup trim operation (the pitch backup trim switch) and two guarded buttons, the PITCH TRIM SYS 1 and PITCH TRIM SYS 2 cutouts, that disable the horizontal stabilizer actuator control electronics for channels 1 and 2, respectively. The PITCH TRIM SYS 1 button (on the captain's side) had been added to the minimum equipment list as a deferred maintenance item before the flight preceding the incident flight.

that they did not notice any change in the pitch condition and continued to have difficulty holding the nose down.[2]



Quick Reference Handbook E170/175

Republic Airways

Flight Controls

PITCH TRIM RUNAWAY

AP/TRIM DISC BUTTON.....PRESS & HOLD

PITCH TRIM SYS 1 & 2
CUTOUT BUTTONS..... PUSH IN

AP/TRIM Disc Button .....RELEASE

WARNING!
Do not open the speedbrake.

DECLARE AN EMERGENCY
LAND AT THE NEAREST SUITABLE AIRPORT

NOTE: Continuous turns help to alleviate excessive pitch up tendencies.

WARNING!
Due to possibility of a subsequent runaway while actuating Pitch Trim System 1, be prepared to intervene with the AP/TRIM Disc Button.

Pitch Trim System 1
Cutout Button.....PUSH OUT
Pitch Trim Switch..... ACTUATE

PITCH TRIM NORMAL?

No

Yes

NOTE: Manual trim command through Pitch Trim Switches is available with at least one functional HS-ACE channel. With one HS-ACE channel available expect the following differences on the pitch trim indication on EICAS:
- Pitch trim readout display showing amber dashes.
- Pitch trim scale without the solid green pointer.

ESTABLISH AND COMMUNICATE A PLAN
- Contact FAs using EMER Call Button
- Make a PA to the passengers
- Notify Dispatch

END

Pitch Trim System 1
Cutout Button ..... PUSH IN

(Continues on the next page)

Quick Reference Handbook E170/175

Republic Airways

Flight Controls

(Continued from the previous page)

WARNING!
Due to possibility of a subsequent runaway while actuating Pitch Trim System 2, be prepared to intervene with the AP/TRIM Disc Button.

Pitch Trim System 2
Cutout Button.....PUSH OUT
Pitch Trim Switch.....ACTUATE

PITCH TRIM NORMAL?

No

Yes

NOTE: Manual trim command through Pitch Trim Switches is available with at least one functional HS-ACE channel. With one HS-ACE channel available expect the following differences on the pitch trim indication on EICAS:
- Pitch trim readout display showing amber dashes.
- Pitch trim scale without the solid green pointer.

ESTABLISH AND COMMUNICATE A PLAN
- Contact FAs using EMER Call Button
- Make a PA to the passengers
- Notify Dispatch

END

Pitch Trim System 2 Cutout Button .....PUSH IN
If both Pitch Trim channels are failed:

CAT II Approaches are prohibited.

ESTABLISH AND COMMUNICATE A PLAN
- Contact FAs using EMER Call Button
- Make a PA to the passengers
- Notify Dispatch

When appropriate, accomplish:
Pitch/Roll Malfunction Descent & Landing Checklists [8-24 & 8-25]

END

Figure 1. Republic Airways Pitch Trim Runaway Checklist.

Note: The memory item is outlined in a black box.

The captain and first officer later reported that they both needed to use both hands to counter the airplane's nose-up pitch motion and that doing so involved such effort that neither felt that they could reach for the QRH to troubleshoot the problem. Ultimately, the flight crew was

[2] Flight data recorder data showed that the stabilizer did not move when the autopilot/trim disconnect button was pushed, as designed.

able to trim the airplane with the first officer's trim switch, return to ATL, and land the airplane safely about 15 minutes after declaring the emergency.

Review of data from the incident flight revealed that the airplane was in a mistrim condition for a portion of the flight. While this incident is still under investigation, three areas of concern have been identified: wire chafing, application of Embraer service bulletins (SB) related to the pitch trim switch, and potential limitations in checklist memory item(s) to help Embraer pilots address unintended operation of the pitch trim system.

Wire Chafing

Postincident examination of the airplane (in the area where the captain's control column runs through the flight deck floor) revealed chafed insulation around the wires connecting the horizontal stabilizer actuator control electronics to the captain's pitch trim switch and autopilot/trim disconnect button. The chafing damage was caused by contact with the incorrectly untucked pigtail of the forward mechanical stop bolt safety wire (see figure 2).[3] The maintenance procedures in the EMB-175 airplane maintenance manual (AMM) for adjusting the mechanical stop bolt do not currently draw any specific attention to this critical area.

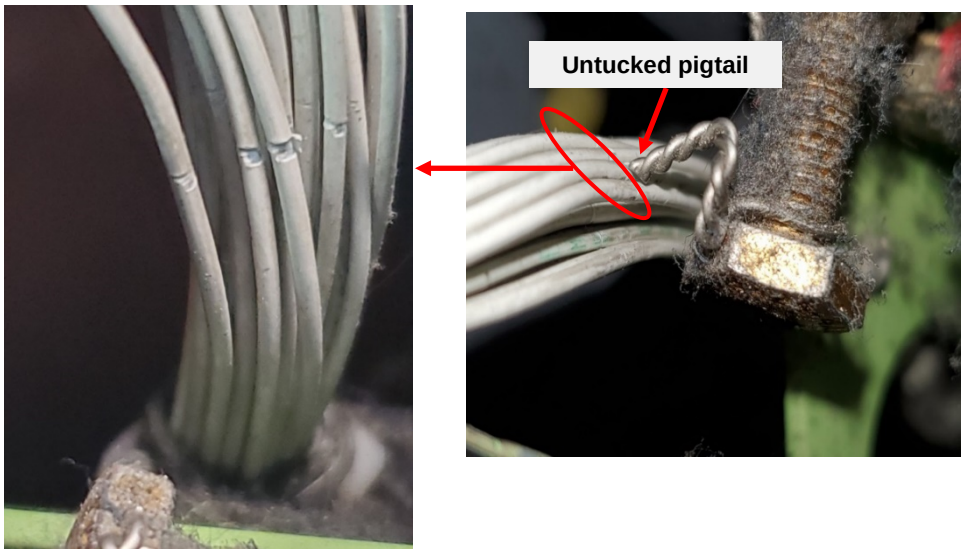


Figure 2. Photographs showing damaged wire (red circle in right photo and enlarged view on the left) of the forward mechanical stop bolt safety wire on incident EMB-175.

Postincident inspections of some EMB-170/175 airplanes have found additional airplanes with damaged wiring in the same area adjacent to the forward mechanical stop bolt. After chafed wires were found on the incident airplane, Republic voluntarily inspected the rest of its fleet and found nine airplanes with chafed wiring. Other operators have also voluntarily inspected their airplanes; thus far, one additional airplane has been found with damaged wiring. The NTSB concludes that damaged wiring could be present on other Embraer EMB-170/175 airplanes—as well as EMB-190/195/Lineage 1000 series airplanes, which have a similar control column

[3] The safety wire is required hardware that retains the control column mechanical stop bolt.

design—which could lead to electrical shorting and adversely affect systems mounted on the control column and yoke.[4]

Therefore, the NTSB recommends that ANAC 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. The NTSB also recommends that, 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, ANAC and the FAA 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.

Further, the NTSB recommends that, once inspections are completed as outlined in the instructions developed in response to Safety Recommendation A-20-1, ANAC 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. The NTSB also recommends that, 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, ANAC and the FAA require operators of these airplanes to incorporate these changes.

Pitch Trim Switch Service Bulletins

In addition to finding chafed wires on the incident airplane, when the captain's pitch trim switch was removed from the yoke postincident, witness marks were observed indicating that, at some point before the incident flight, the switch had been installed in an inverted position. The NTSB's investigation is ongoing but in 2015, in response to reports about inverted installations of pitch trim switches on Embraer airplanes in which flight crews also reported similar flight control system difficulties, Embraer issued Service Bulletins (SB) 170-27-0051, 190-27-0039, and 190LIN-27-0019.[5] These SBs recommended that owners and operators install a support in the control yoke to prevent the incorrect installation of the pitch trim switch and that the modification be accomplished within the next 7,500 flight hours or 36 months (whichever occurred first) after the SBs' issuance. Neither the FAA nor ANAC required incorporation of the SBs to prevent inverted installations of pitch trim switches on Embraer airplanes.[6]

[4] There are currently 667 US-registered Embraer EMB-170/175/190/Lineage 1000 series airplanes in service. There are no EMB-190 E2 or 195 airplanes registered in the United States. The recommendations to the FAA only include the US-registered airplanes.

[5] SBs 170-27-0051 and 190-27-0039, applicable to specified serial numbers of EMB-170/175 and EMB-190/195 airplanes, respectively, were originally issued on February 27, 2015; they were both reissued with revisions, the most recent dated September 14, 2017. SB 190LIN-27-0019, applicable to specified serial numbers of Lineage 1000 series airplanes, was originally issued on March 12, 2015; it was reissued twice with revisions, the most recent dated June 7, 2018.

[6] ANAC issued a special airworthiness bulletin in May 2015 to owners and operators of the affected airplane models advising them of the SBs.

SB 170-27-0051 had not been incorporated on the incident airplane at the time of the event.[7] Although it is currently unknown if an inverted pitch trim installation was a factor in this incident, the NTSB is concerned that an inverted switch installation resulting in pitch trim operation opposite to that expected by a flight crew could lead to confusion, delaying appropriate recognition and response to increased control forces. We also note that Republic had not incorporated SB 170-27-0051 more than 4 years after its issuance; as a result, we are concerned that without a requirement to incorporate these SBs, other operators also may not have taken the recommended action and pitch trim switches could be installed incorrectly.[8] The NTSB concludes that the incorporation of Embraer SBs 170-27-0051, 190-27-0039, and 190LIN-27-0019 would prevent the incorrect installation of pitch trim switches, which could result in pitch control difficulties at low altitude leading to loss of control in flight. Thus, the NTSB recommends that ANAC and the FAA mandate the incorporation of Embraer SBs 170-27-0051, 190-27-0039, and 190LIN-27-0019 on all applicable airplanes, as specified in the SBs.

Pilot Response to Pitch Trim-Related Flight Control Issue

In this incident, the flight control issue manifested in a phase of flight in which its adverse effects of excessive nose-up trim were masked by expected airplane orientation during climb. Although quick recognition and proper response by the flight crew are critical for a positive outcome, the nature of the issue resulted in little warning before control forces became almost unmanageable, as reported by the captain, and were perceived as a runaway by the flight crew. The captain further reported performing the single memory item on Republic's Pitch Trim Runaway checklist (press and hold the autopilot/trim disconnect button) but reported they were unable to quickly grab the QRH due to the difficulty in controlling the airplane.

The NTSB is concerned that, in the event of high control forces resulting from a pitch trim malfunction, flight control failure, or other system anomaly that occurs in a similar phase of flight, other pilots of EMB-170/175/190/195/Lineage 1000 series airplanes may experience difficulty in quickly responding to the problem. In addition, the NTSB notes that Embraer's Pitch Trim Runaway checklist contained a memory item to select both the PITCH TRIM SYS 1 and PITCH TRIM SYS 2 cutout buttons; Republic's checklist did not contain this memory item. During this incident, without access to the checklist or the QRH, the crew only selected the PITCH TRIM SYS 1 cutout button.

Because of the high control forces necessary to maintain control of the airplane, the flight crew in this incident had to rely on the memory item and their understanding of the pitch trim system to resolve the issue by using the first officer's trim switch. Although this memory item was intended to stop a pitch runaway condition, it did not provide information for crews to re-trim the airplane. Thus, it is critical that the memory items are robust enough to protect against incomplete system knowledge and physical limitations preventing access to the QRH so that pilots can quickly trim to regain control of the airplane.

[7] The serial number of the incident airplane (170-0184) is within a range identified in SB 170-27-0051.

[8] Based on the NTSB's preliminary findings from this incident, Embraer issued an Embraer Release of Field Report to its customers recommending that SBs 170-27-0051 and 190-27-0039 be accomplished.

Further, in light of the potential for multiple system failures or reverse installation of a trim switch to result in high control force conditions like that encountered in this incident, operators must work with Embraer to closely evaluate their checklists and ensure that memory items comprehensively address unintended pitch trim system activation—regardless of underlying cause—enabling pilots to control the airplane and appropriately respond. The NTSB notes that, as a result of this incident and until further information is known, the FAA principal operations inspector for Republic requested that its airplane flight manual and QRH replicate Embraer's concerning memory items for "pitch trim runaway."

The NTSB concludes that when an unintended pitch trim operation is masked, the crew's application of the memory item(s) on the EMB-175 Pitch Trim Runaway checklist may not comprehensively address the circumstances of the trim system operation in a timely manner; limitations in the checklist memory item(s) may delay pilots in properly responding to and regaining control of Embraer EMB-170/175/190/195/Lineage 1000 series airplanes. Therefore, the NTSB recommends that ANAC, in coordination with the FAA, 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. Further, the NTSB recommends that the FAA, in coordination with ANAC, 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.

Recommendations

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)

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)

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)

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-20-4)

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)

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)

To the Federal Aviation Administration

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)

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)

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)

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)

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Report Date: January 16, 2020