DCA22MA009

OPERATIONAL FACTORS/HUMAN PERFORMANCE

Attachment 23

Elevator Evaluation

November 2, 2022

ELEVATOR EVALUATON

Location: Everts Air Cargo Facility, Anchorage, Alaska
Date: October 17, 2022
Time: 1005 ADT

Overall Objectives:

- Document indications to crew on exterior preflight
- Document indications to crew on flight checks from cockpit
- Document movement of elevator and trim

Aircraft: MD-82/83; N963CE

Configuration:

- Hydraulics on (GPU)
- Time of testing airplane was facing west on a 243° heading
- Weather

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PANC 171953Z 33003KT 10SM BKN044 OVC090 05/04 A2947 RMK
AO2      RAE1854      SLP980      P0000      T00500044
PANC 171853Z 00000KT 10SM -RA OVC070 04/04 A2946 RMK
AO2 SLP977 P0000 T00440039
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Tools Needed:

- Force meter (e.g. fish scale)
- Tape Measure
- Scissor lift
- Walkie talkies/phones

Invited Participants:

Mike Hauf (NTSB, Investigator-in-Charge)[1]
Shawn Etcher (NTSB, Operations)
Katherine Wilson (NTSB, Human Performance)
David Gerlach (FAA AVP 100)
Sam Goodwill (Boeing)[2]
Paul Quirion (Everts Air Cargo)
Mark Rabinovitch (Everts Air Cargo)
Nathan Giles (Everts Air Cargo)

[1] Unable to attend due to previous commitment.
[2] Dan Marcotte was sent from Boeing for Sam Goodwill who had a previous engagement.

Documentation:

Excerpts from the Boeing MD-80 Flight Crew Operations Manual, Operations Bulletin 80-2-017 "ELEVATORS NOT JAMMED VERIFICATION":

WARNING: Prior to every flight, elevator surfaces must be confirmed as not jammed in the Trailing Edge Down (TED) position. If both elevators are faired with, or above the stabilizer surface, confirmation is complete.

The limitations section of both the FCOM and AFM have been revised to require this elevator preflight evaluation.

Elevator Visual Inspection

During the EXTERIOR INSPECTION PROCEDURE, if the Trailing Edges of both elevators are faired with or above the trailing edge of the stabilizer, the elevators are confirmed to be not jammed TED. If the above conditions are not met, further action is required.

Elevator TED Jam Verification

An elevator that is not faired with or above the trailing edge of the stabilizer can be verified not jammed TED by moving the control column to the full aft stop and confirming that the elevator moved in the Trailing Edge Up (TEU) direction. Movement of the column aft to a position less than full travel (approximately 95%) moves the elevator control tab to the control tab stop. Additional column movement of approximately 5%, to the control column aft stop, will cause the elevator to move towards TEU. Because this last column motion lifts the elevator, substantial physical effort is required. While the column is pulled to its aft stop, if movement of the elevator in the TEU direction is seen by an external observer, the elevator is confirmed not jammed TED. If no TEU movement is observed, inspection of the elevators per the Aircraft Maintenance Manual is required before flight.

Means of Confirmation Summary

The following are satisfactory methods for a flight crew to confirm elevators are not jammed TED. Other methods may be developed by an operator. If a flight crew cannot confirm elevators are not jammed TED, inspection of the elevators per the Aircraft Maintenance Manual is required before flight:

- *Observe whether both elevator trailing edges are faired with or above the trailing edge of the stabilizer. If one or both elevators are not faired with or above the trailing edge of the stabilizer, a flight crew may:*

  - *Contact ground personnel prior to pressurizing the hydraulic system, as procedurally required while accomplishing the BEFORE START checklist, and perform a coordinated check of elevator freedom of movement between the flight crew and ground personnel. Move either control column full forward until the ELEVATOR PWR ON light illuminates (elevators TED) and then check for any upward movement of the elevators as the control column is moved fully aft.*

OR

- *Pull a control column to the full aft stop prior to leaving the cockpit to conduct the preflight external inspection. The elevators may remain displaced and allow the pilot to confirm the elevators are aligned with, or above, the trailing edge of the stabilizer during the exterior inspection.*

OR

- *Perform an approved coordinated procedure between the captain and first officer, one pulling the column while the other observes movement of any elevator that is not faired or above the trailing edge of the stabilizer.*

Prior to start:

- Boeing provide an understanding of how the system works to all participants.

Exterior:

- Observe trailing edge down
- Observe faired position
- Photo document from ground (normal preflight location including but not limited to forward of elevator, under elevator, and looking from behind elevator towards front of airplane) of elevator
  - Adjusted elevator tab to a trailing edge down position and photo document. **Of note** all trailing edge down photographs were taken from an elevated position due to the elevator returning to a faired or trailing edge up position when manual pressure was removed due to the balance on the elevators.
- Perform "ELEVATORS NOT JAMMED VERIFICATION" preflight procedure and determine:

- if the procedure is clear and understandable.
- if the procedure allowed a pilot to clearly discern what an elevator trailing edge down position looks like.

Notes: During the test, the director of operations for Everts applied downward pressure on the elevator to simulate a TED/jammed position. The elevator, when manual downward pressure was released, was observed to return to a faired or trailing edge up position. During the testing while manually applying downward pressure on the right elevator, the left elevator moved normally when the control column was moved in the cockpit. This was observed from the ground and an elevated position. The TED position was visible from the ground and an elevated position. The line pilot provided by Everts Air Cargo also stated that the position of the elevator would be easy to detect when walking to the plane in both daylight and nighttime (with the assistance of ramp lighting and/or flashlight) conditions. The investigative team and Everts line pilot observed the procedure to be clear and understandable and allowed the pilot to clearly discern if an elevator is jammed in the trailing edge down position. The line pilot noted that although he had never observed a TED position, the faired or trailing edge up position was easy to detect for him.

Figure 1. Elevator as viewed from airstairs at the main cabin entry door located on the left (captain's) side of the airplane.

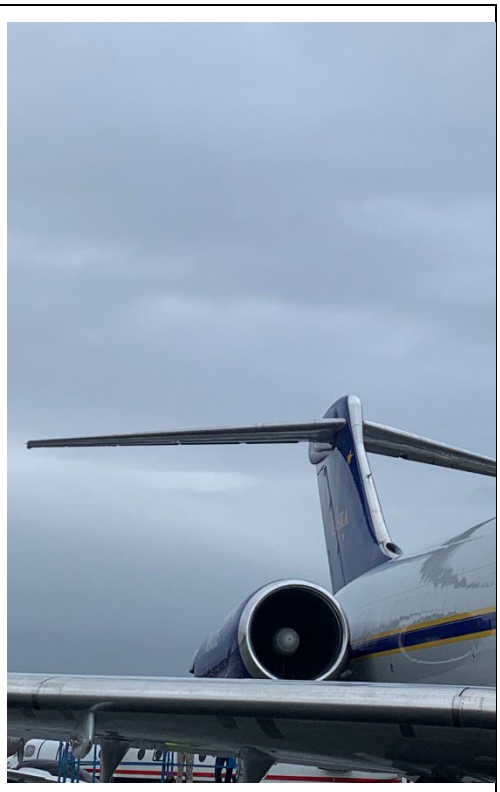

Figure 2. Elevator as viewed from the ground. As viewed in photograph left side of elevator (first officer side of aircraft) is in a faired position and the right side (captain's side) is trailing edge up.

Figure 3. Elevator as viewed from elevated position in trailing edge down.

Figure 4. Elevator as viewed from an elevated position, in trailing edge up position.

Figure 5. Elevator as viewed in trailing edge down from an elevated position aft of the aircraft looking forward, with manual downward pressure being applied during control column aft movement.

Figure 6. Elevator as viewed in faired position.

Figure 7. Elevator as viewed looking from aft of the airplane. The left side (in photo) elevator is in trailing edge up while manual pressure is being applied to the right side to remain in trailing edge down. The elevator was being moved to the aft position via the control column in the cockpit..

Figure 8. Elevator as viewed from the left side (captain side of airplane) with control column aft pressure being applied in the cockpit. In the phot manual downward pressure is being applied to the left side of the elevator to remain in trailing edge down.

Interior

- Document flight control check (elevator faired position).
    - Photo document blue overhead light activation.
    - Document force applied to obtain blue light and, if necessary, distance from first officer in full control column forward position.
        - Exterior – document movement of tab and/or elevator when column full forward and when column full aft. Additionally, if possible, document movement of tab and/or elevator prior to blue light illumination in cockpit (note photo blocks under "exterior").
    - Distance measurement will be from the footrest below the flight displays to the first officer seat side of the control column:
        - Distance to control column in full aft position was 13 3/16 inches when more pressure was required to move aft.
        - Distance from footrest to the at rest position was 8 ¾ inches.
        - Distance from footrest to full column forward position was 5 1/8

inches.

- Force meter measurement of pressure required:
  - Full aft position with manual pressure being applied at elevator: approximately 65 lbs. when resistance began.
  - Full aft position with no downward pressure being applied: approximately 75 lbs. when resistance began.
- Photo/video document elevator movement from elevated position.
- Photo/video document elevator movement from ground position and note if forward of empennage or behind empennage when photo/video taken.
- **Notes**: During the test, which was repeated multiple times, pressure required to move the column to full aft with no manual pressure being applied to the elevator was "heavy" to the feel and required two hands to achieve that position. Additionally, a similar heavy feeling occurred when manual downward pressure was applied to the elevator and the distance to achieve a similar "heavy feeling" was about 1 ¼ to 1 ½ inches less than the "normal" position. Knowing that there was pressure being applied to the elevator, there was a noticeable difference in the position of the column in relation to the pilot and force needed to move the column full aft when the elevator was simulated "jammed" versus free moving. The position of the column in relation to the pilot's body when in the full aft position was also dependent on where the pilot's seat was positioned. However, it should be noted that the line pilot provided by Everts stated that this could be a challenge for a pilot to detect due to the subtlety of the difference in column position to footrest as measured during testing, the recency with which the pilot flew the aircraft (pilots with more recency may be more likely to notice subtle differences), and if there was a tailwind or a headwind being applied to the elevator during taxi. At the time of our testing, the wind at Ted Stevens International Airport was 3 kts or less and was coming from the north and northwest which would have been from the airplane's right side.

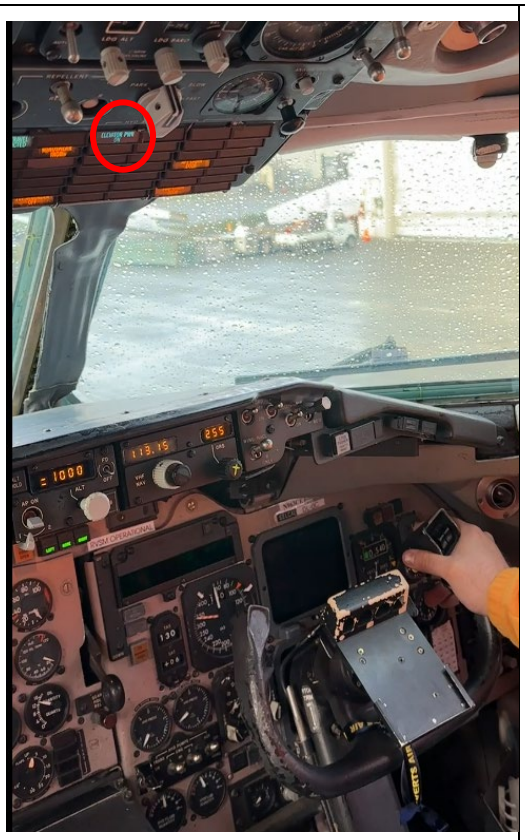

Figure 9. Elevator Power On blue overhead light (circled in red above) activation with control column in full forward position.

Figure 10. Control yoke in full aft position.

Figure 11. Left side (captain's side) elevator in trailing edge down with full forward control column.

Figure 12. Left side (captain's side of airplane) elevator with full aft control column pressure.

Figure 13. Left side (captain's side) elevator as viewed from the ground in the trailing edge up position.

Figure 14. First Officer control column at rest location. The measurement from the footrest below the flight displays to the aft side of the control column (side facing FO seat). The measurement was 8.75 inches.

Figure 15: Full aft pressure applied during a normal non-jammed elevator flight control check.

Figure 16: Full forward pressure applied during a normal non-jammed elevator flight control check.

- Document flight control check (TED elevator position)
  - **Configuration:** trailing edge down pressure held on elevator.
  - **Document:** Control column position compared to normal.
  - Photo document blue overhead light activation.
  - Document force applied to obtain blue light and distance from first officer in full control column forward position.
  - Distance from first officer's footrest to control column in "at rest" position was 9 ¼ inches.
  - Distance from first officer to control column in full aft position 11 9/16 inches.
  - Distance from the footrest to the control column in full forward position

was 5 1/8 inches.

- Full forward position was approximately 50 lbs.[3]
- Full aft position was approximately 65 lbs.

- **Notes**: During the testing the full aft position weight was an approximate as the scale was moving and to apply a similar 75 lbs. as was found in the previous section was not able to be held.

[3] Was acquired about the time of the "Elevator Power ON" blue light activation.