Ethiopian MAX Crash Simulator Scenario Stuns Pilots

Aviation Daily

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Fri, 2019-05-10 12:08

WASHINGTON—A simulator session flown by a U.S.-based Boeing 737 MAX crew that mimicked a key portion of the Ethiopian Airlines Flight 302 (ET302) accident sequence suggests that the Ethiopian crew faced a near-impossible task of getting their 737 MAX 8 back under control, and underscores the importance of pilots understanding severe runaway trim recovery procedures.

Details of the session, shared with Aviation Week, were flown voluntarily as part of routine, recurrent training. Its purpose: practice recovering from a scenario in which the aircraft was out of trim and wanting to descend while flying at a high rate of speed. This is what the ET302 crew faced when it toggled cutout switches to de-power the MAX's automatic stabilizer trim motor, disabling the maneuvering characteristics augmentation system (MCAS) that was erroneously trimming the horizontal stabilizer nose-down.

In such a scenario, once the trim motor is de-powered, the pilots must use the hand-operated manual trim wheels to adjust the stabilizers. But they also must to keep the aircraft from descending by pulling back on the control columns to deflect the elevator portions of the stabilizer upward. Aerodynamic forces from the nose-up elevator deflection make the entire stabilizer more difficult to move, and higher airspeed exacerbates the issue.

The U.S. crew tested this by setting up a 737-Next Generationsimulator at 10,000 ft., 250 kt. and 2 deg. nose up stabilizer trim. This is slightly higher altitude but otherwise similar to what the ET302 crew faced as it de-powered the trim motors 3 min. into the 6 min. flight, and about 1 min. after the first uncommanded MCAS input.Leading up to the scenario, the Ethiopian crew used column-mounted manual electric trim to counter some of the MCAS inputs, but did not get the aircraft back to level trim, as the 737 manual instructs beforede-powering the stabilizer trim motor. The crew also did not reduce their unusuallyhigh speed.

What the U.S. crew found was eye-opening. Keeping the aircraft level required significant aft-column pressure by the captain, and aerodynamic forces prevented the first officer from moving the trim wheel a full turn. They resorted to a little-known procedure to regain control.

The crew repeatedly executed a three-step process known as the roller coaster. First, let the aircraft's nose drop, removing elevator nose-down force. Second, crank the trim wheel, inputting nose-up stabilizer, as the aircraft descends. Third, pull back on the yokes to raise the nose and slow the descent. The excessive descent rates during the first two steps meant the crew got as low as 2,000 ft. during the recovery.

The Ethiopian Ministry of Transport preliminary report on the Mar. 10 ET302 accident suggests the crew attempted to use manual trim after de-powering the stabilizer motors, but determined it "was not working," the report said. A constant trust setting at 94% N1 meant ET302's airspeed increased to the 737 MAX's maximum (Vmo), 340 kt., soon after the stabilizer trim motors were cut off, and did not drop below that level for the remainder of the flight. The pilots, struggling to keep the aircraft from descending, also maintained steady to strong aft control-column inputs from the time MCAS first fired through the end of the flight.

The U.S. crew's session and a video posted recently by YouTube's Mentour Pilot that shows a similar scenario inside a simulator suggest that the resulting forces on ET302's stabilizer would have made it nearly impossible to move by hand.

Neither the current 737 flight manual nor any MCAS-related guidance issued by Boeing in the wake of the October 2018 crash of Lion Air Flight 610 (JT610), when MCAS first came to light for most pilots, discuss the roller-coaster procedure for recovering from severe out-of-trim conditions. The 737 manual explains that "effort required to manually rotate the stabilizer trim wheels may be higher under certain flight conditions," but does not provide details.

The pilot who shared the scenario said he learned the roller coaster procedure from excerpts of a 737-200 manual posted in an online pilot forum in the wake of the MAX accidents. It is not taught at his airline.

Boeing's assumption was that erroneous stabilizer nose-down inputs by MCAS, such as those experienced by both the JT610 and ET302 crews, would be diagnosed as runaway stabilizer. The checklist to counter runaway stabilizer includes using the cutout switches to de-power the stabilizer trim motor. The ET302 crew followed this, but not until the aircraft was severely out of trim following the MCAS inputs triggered by faulty angle-of-attack (AOA) data that told the system the aircraft's nose was too high.

Unable to move the stabilizer manually, the ET302 crew moved the cutout switches to power the stabilizer trim motors—something the runaway stabilizer checklist states should not be done. While this enabled their column-mounted electric trim input switches, it also re-activated MCAS, which again received the faulty AOA data and trimmed the stabilizer nose down, leading to a fatal dive.

The simulator session underscored the importance of reacting quickly to uncommanded stabilizer movements and avoiding a severe out-of-trim condition, one of the pilots involved said. "I don't think the situation would be survivable at 350 kt. and below 5,000 ft," this pilot noted.

The ET302 crew climbed through5,000 ft. shortly after de-powering the trim motors, and got to about 8,000 ft.—the same amount of altitude the U.S. crew used up during the roller-coaster maneuvers—before the final dive. A second pilot not involved in the session but who reviewed the scenario's details said it highlighted several training opportunities.

"This is the sort of simulator experience airline crews need to gain an understanding of how runaway trim can make the aircraft very difficult to control, and how important it is to rehearse use of manual trim inputs," this pilot said.

While Boeing's runaway stabilizer checklist does not specify it, the second pilot recommended a maximum thrust of 75% N1 and a 4 deg. nose-up pitch to keep airspeed under control.

Boeing is developing modifications to MCAS, as well as additional training. Simulator sessions are expected to be integrated into recurrent training, and may be required by some regulators, and opted for by some airlines, before pilots are cleared to fly MAXs again. The MAX fleet has been grounded since mid-March, a direct result of the two accidents.

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