

Boeing 737 MAX

Boeing 737 MAX: How MCAS, Certification and Organisational Failures Contributed to Two Fatal Crashes

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Key Facts

Cost: \$20B+

Date: 2026-06-01

Duration: 10:59

Category: Billion Dollar Failures

Executive Summary

In October 2018 and March 2019, two Boeing 737 MAX aircraft crashed, killing 346 people. MCAS was a central factor in both crashes. Accident investigations identified MCAS design, erroneous angle-of-attack inputs, certification assumptions, training and other contributing factors. This investigation reveals how commercial pressure overrode engineering integrity and what project leaders must learn.

Executive Lessons

- Never Hide Hardware Problems with Software Patches

Boeing introduced MCAS as part of the MAX flight-control architecture following aerodynamic changes associated with the aircraft's configuration. with the MCAS software system. When physics and software collide, physics always wins. If your project has a fundamental design flaw, address it at the source - never build a workaround that end-users do not know exists.

- Competitor Panic Destroys Project Governance

The House Transportation Committee documented significant competitive and production pressures during the MAX programme. to compete with the Airbus A320neo, and Boeing employees raised safety concerns about the programme; the House committee found that production pressure took precedence, according to congressional investigators. A delayed project is expensive; a compromised project is fatal. When competitive pressure overrides your quality gates, you are not accelerating - you are accumulating catastrophic risk.

- Compliance Teams Must Have Veto Power

Boeing employees raised safety concerns about the MAX programme, and the House committee found that production pressure took precedence, according to congressional investigators. When the compliance function reports to the people it is supposed to police, you do not have oversight - you have theatre.

Timeline

- 2011-08: Boeing launches the 737 MAX programme as a re-engined derivative of the 737NG to compete with the Airbus A320neo.
- 2016-03: Boeing expands MCAS authority during flight testing so it can command larger, repeated stabilizer movements at low speed; the change is not fully briefed to FAA technical staff.
- 2017-03: FAA grants the amended type certificate for the 737 MAX 8; MCAS is omitted from flight crew manuals and differences training.
- 2017-05: The 737 MAX enters commercial passenger service with Malindo Air.
- 2018-10-29: Lion Air flight JT610 crashes into the Java Sea 13 minutes after takeoff from Jakarta, killing all 189 people on board; erroneous AOA data triggers repeated MCAS nose-down trim.
- 2018-11: FAA issues Emergency Airworthiness Directive 2018-23-51 and Boeing issues an operations manual bulletin warning of uncommanded stabilizer trim from erroneous AOA input.
- 2019-03-10: Ethiopian Airlines flight ET302 crashes six minutes after takeoff from Addis Ababa, killing all 157 people on board, again after MCAS activation from erroneous AOA data.
- 2019-03-13: FAA issues an Emergency Order of Prohibition grounding the 737 MAX; the worldwide fleet remains grounded for roughly 20 months.

- 2019-09: NTSB issues safety recommendation report ASR-19-01 criticizing the assumptions about pilot response used in the 737 MAX system safety assessment.
- 2019-10: JATR publishes findings on the flawed certification of the 737 MAX flight control system; KNKT publishes its final JT610 report citing MCAS design, certification, maintenance and crew factors.
- 2020-01: Boeing discloses that the 737 MAX crisis is expected to cost about \$18.6 billion (compensation, production and abnormal costs), later commonly cited as \$18.7 billion and counting.
- 2020-09: U.S. House Transportation & Infrastructure Committee publishes its final investigative report documenting technical design failures, lack of transparency, and FAA oversight breakdowns.
- 2020-11: FAA rescinds the grounding order and issues an airworthiness directive allowing the 737 MAX to return to service with mandated design changes and training.
- 2021-01: Boeing enters a deferred prosecution agreement with the U.S. Department of Justice over the 737 MAX fraud conspiracy, agreeing to pay more than \$2.5 billion.

Sources

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- Investigation Report on Accident to the B737-MAX8 Reg. ET-AVJ Operated by Ethiopian Airlines, Report No. AI-01/19 (final report) (Federal Democratic Republic of Ethiopia, Aircraft Accident Investigation Bureau (EAIB); hosted by French BEA, 2022-12-23)
- Safety Recommendation Report ASR-19-01: Assumptions Used in the Safety Assessment Process and the Effects of Multiple Alerts and Indications on Pilot Performance (U.S. National Transportation Safety Board (NTSB), 2019-09-19)
- Emergency Order of Prohibition (grounding of Boeing 737-8 and 737-9 aircraft) (U.S. Federal Aviation Administration (FAA), 2019-03-13)
- Summary of the FAA's Review of the Boeing 737 MAX (U.S. Federal Aviation Administration (FAA), 2020-11)
- Boeing 737 MAX Flight Control System: Observations, Findings, and Recommendations (JATR report) (Joint Authorities Technical Review (JATR), submitted to the FAA, 2019-10-11)
- Deferred Prosecution Agreement, United States v. The Boeing Company (737 MAX fraud conspiracy, >\$2.5 billion) (U.S. Department of Justice, 2021-01-07)