

PRELIMINARY INSIGHTS ON DIGITAL INSTRUMENTATION AND CONTROL REGULATORY LESSONS FROM THE BOEING 737 MAX 8 CRASH EVENTS

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Outline

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- Boeing 737 MCAS Development & Certification
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This presentation is not intended to represent formal NRC policy. The information and views presented are those of the authors and do not necessarily represent formal positions of the NRC.

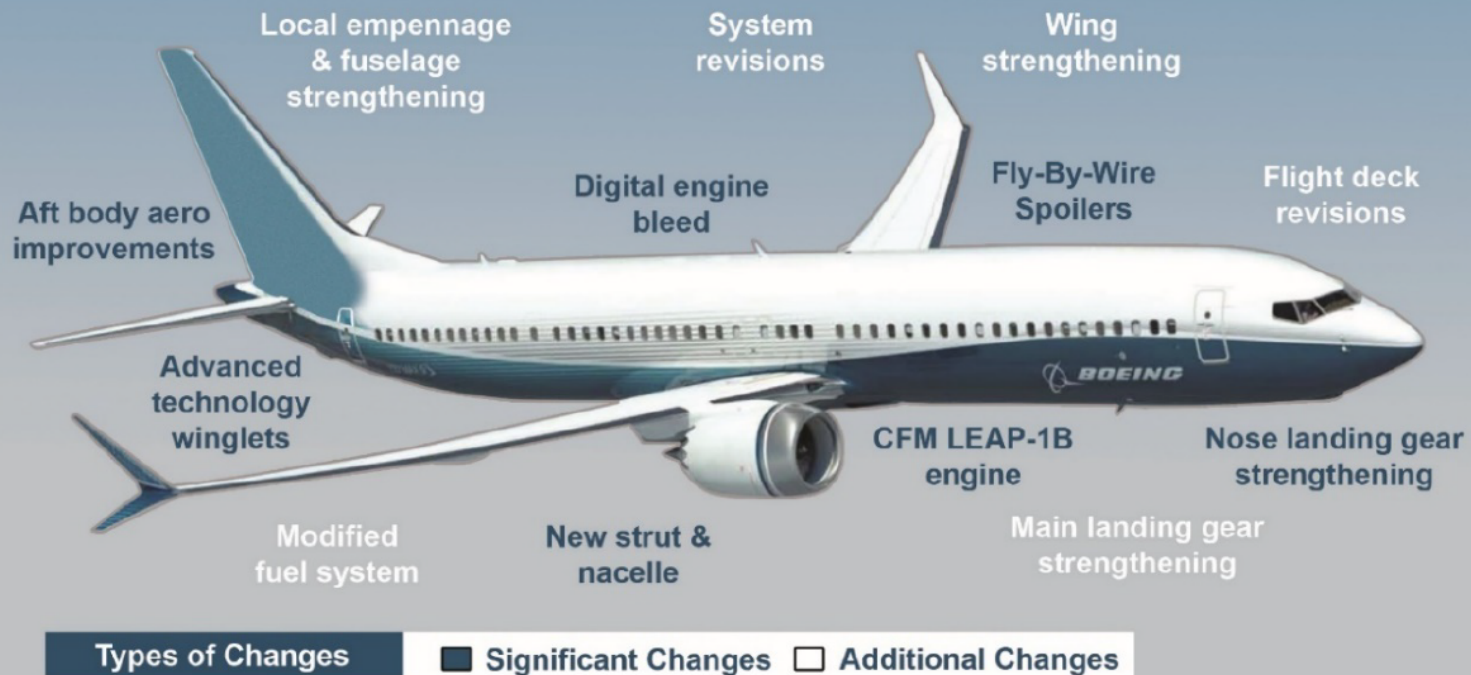
Introduction



Boeing 737 MAX Design

Boeing 737 MAX Changes

The 737 MAX is a derivative of the 737 Next Generation (NG) series

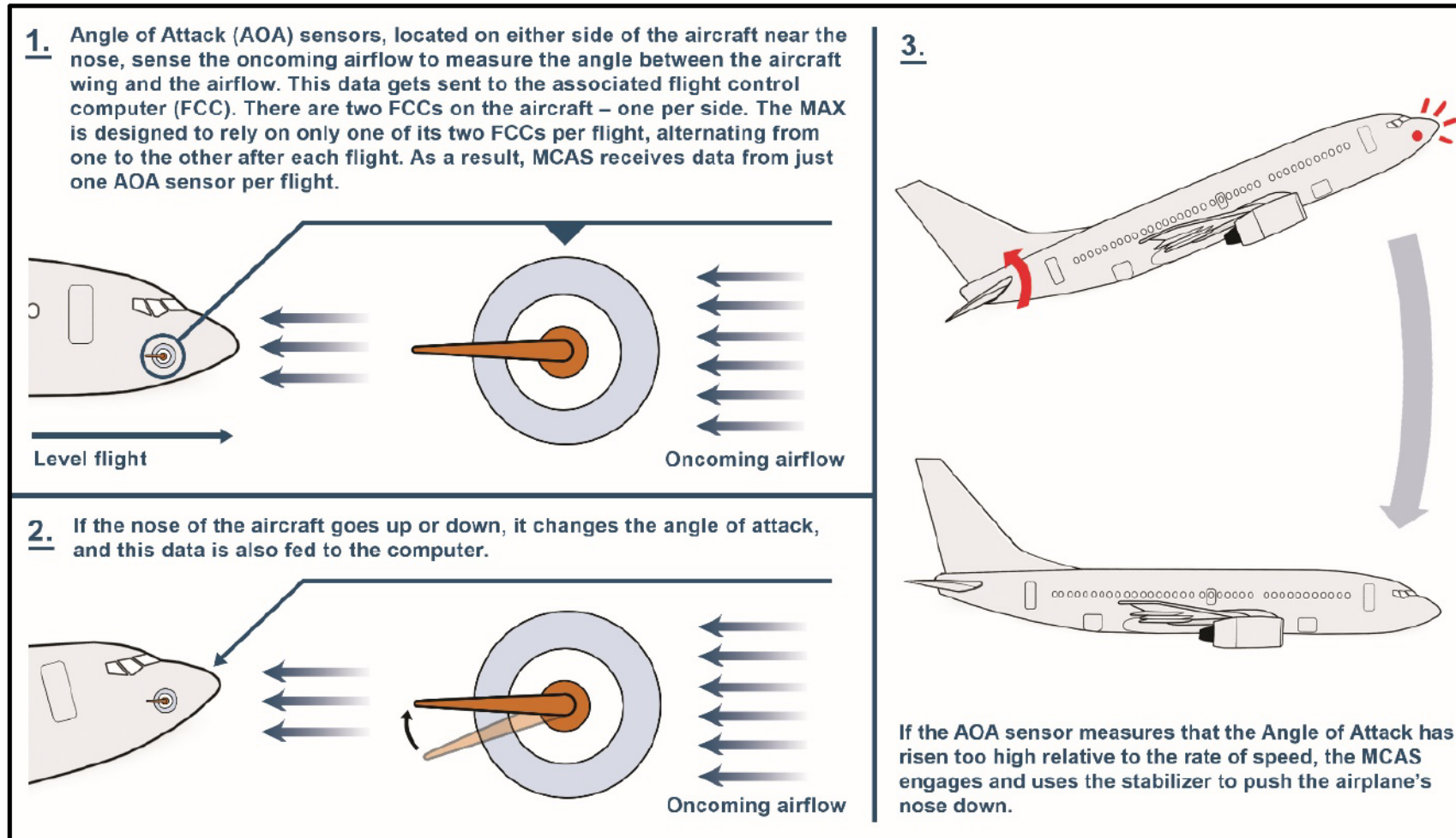


Engine Size and Placement: 737 NG (pictured left) vs. 737 MAX (pictured right)



Source: "U.S. Department of Transportation Office of Inspector General Report - Weaknesses in FAA's Certification and Delegation Processes Hindered Its Oversight of the 737 MAX 8," <https://www.oig.dot.gov/sites/default/files/FAA%20Certification%20of%20737%20MAX%20Boeing%2011%20Final%20Report%5E2-23-2021.pdf>

MCAS Design and Implementation

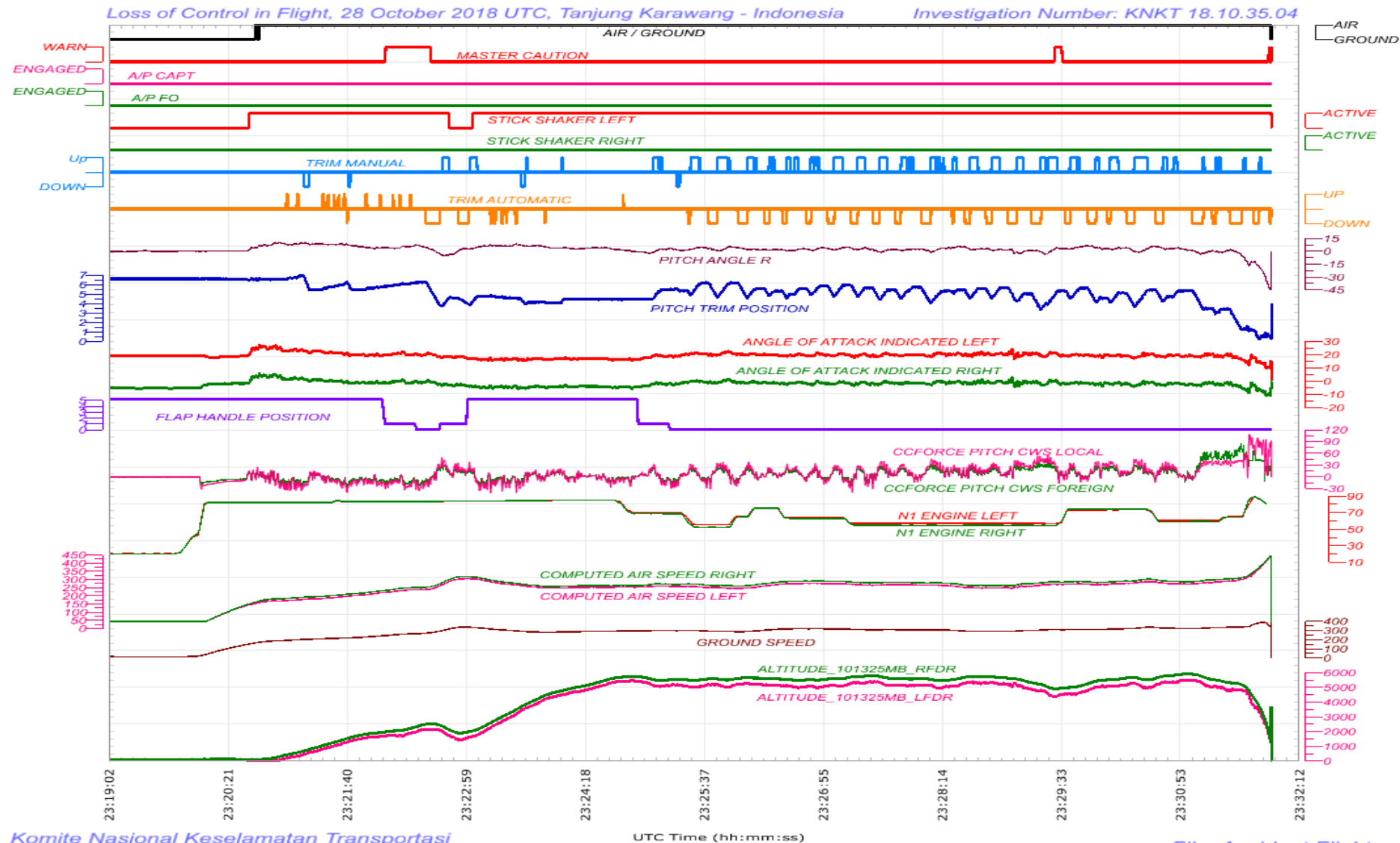


Source: "U.S. Department of Transportation Office of Inspector General Report - Weaknesses in FAA's Certification and Delegation Processes Hindered Its Oversight of the 737 MAX 8," <https://www.oig.dot.gov/sites/default/files/FAA%20Certification%20of%20737%20MAX%20Boeing%2011%20Final%20Report%5E2-23-2021.pdf>

Lion Air 610 Crash Event

Source: "Final KNKT.18.10.35.04 Aircraft Accident Investigation Report," <http://docs.house.gov/meetings/PW/PW00/20191030/110066/HHRG-116-PW00-20191030-SD002.pdf>

PK-LQP Boeing 737-8 (MAX)



Evaluation of Key Technical and Regulatory Issues

Design and Implementation Themes

Design Specifications and Defense-In-Depth	Safety Assessment including Hazard Analysis and Risk	Equipment Design and Implementation
Operational Specifications	Performance Monitoring	Production and Certification

Regulatory Oversight Themes

Certification and Licensing Standards	Amended Certification Processes	Regulating Technical Innovation
Coordination Among Regulatory Standards and Certification Bodies	Delegation of Certification and Post-Certification Design Change Processes	Personnel Capabilities of the Regulator
Safety Culture		

Sample Preliminary Technical Insights

- A robust defense-in-depth approach is an effective engineering means to account for uncertainties in digital equipment and human performance.
- Systematic engineering lifecycle approaches from design to operation, maintenance, and human factors is important for ensuring that an I&C design achieves its intended safety function.

Sample Preliminary Regulatory Insights

- A strong safety culture at NRC remains paramount.
- NRC should maintain integration and communication among digital design and human factors experts during the licensing review and subsequent inspection oversight processes.
- NRC organizational staffing activities should address knowledge management and long-term attrition of expert Agency staff in the digital arena.

Closing Remarks

- The 737MAX has been returned to service with changes to MCAS and pilot training.
- NRC's preliminary review has validated many of our regulatory approaches and processes; and identified potential opportunities for enhancement.
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737MAX Crash Reports

- **“Official Report of the Special Committee to Review the Federal Aviation Administration's Aircraft Certification Process”**
- **“Joint Authorities Technical Review - Observations, Findings, and Recommendations”**
- **“National Transportation Safety Board Report - Assumptions Used in the Safety Assessment Process and the Effects of Multiple Alerts and Indications on Pilot Performance”**
- “Final KNKT.18.10.35.04 Aircraft Accident Investigation Report”
- “U.S. Department of Transportation Office of Inspector General Report - Weaknesses in FAA’s Certification and Delegation Processes Hindered Its Oversight of the 737 MAX 8”
- “Department of Transportation Office of Inspector General - Timeline of Activities Leading to the Certification of the Boeing 737 MAX 8 Aircraft and Actions Taken After the October 2018 Lion Air Accident”
- “The House Committee on Transportation & Infrastructure Final Report on the Design, Development & Certification of the Boeing 737 Max”
- “U.S. Senate Committee on Commerce, Science, & Transportation Investigation Report on Aviation Safety Oversight”