[redacted]

The Boeing Company
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MAR 0 1 2019

RA-19-00256

[redacted]
Manager, AIR-860
BASOO Branch
Department of Transportation
Federal Aviation Administration
2200 S. 216 Street
Des Moines, WA 98198-6547

[redacted]

Subject:	Submittal of MCAS Development and Certification Overview
Model:	737MAX
FAA Project No.:	N/A
RA Project No.:	N/A
EASA Project No.:	N/A
EASA Level:	N/A
Response Requested:	None – Informational Only
Expedited Flow:	No
Reference:	FAA/Boeing meeting on December 17, 2018, MCAS Development and Certification Overview
Special Instructions:	Please forward to [redacted]

This letter is to submit:

Updated presentation material from the Reference meeting

This letter is being sent for:

Information only

[redacted]

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[redacted]
RA-19-00256
Page 2

Please contact this office or the following individuals if you have further questions:

Certification Engineer: [redacted]
Program Manager: [redacted]

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Sincerely,

[redacted]
Director, BCA Engineering
[redacted]

GWO

Enclosure: MCAS Development and Certification Overview

cc

Name	SP	Encl	MC	Title
[redacted]			X	FAA Program Mgr., 0600-1222
			X	FAA
			X	FAA
			X	FAA
			X	FAA

MCAS Development and Certification Overview

[redacted]

Compliance Review Summary

737 MAX MCAS Control Law

- All certification deliverables (Cert Plans, ICA Documents, etc…) in support of MCAS control law certification are compliant.
- Review of all Boeing internal analysis in support of MAX development and certification deliverables were completed per process and are compliant.
- Assessment of Compliance Identified Several Areas for Improvement
  - Opportunities to Enhance Records of Decisions
  - Inconsistencies in Documentation
- Aerodynamics Stability & Control completed further evaluation of the Functional Hazard Assessment for loss of MCAS control law function in a corner condition of the normal flight envelope.
  - Confirmation via Flight Test that loss of MCAS rated as minor

Agenda

- Development and Certification Timeline
- MCAS Control Law Design Overview
- System Level Hazard and Safety Assessments
- Flight Controls Certification Deliverables
- Airplane Level Hazard, Safety, and Single & Multiple Fault Assessments
- Instructions for Continued Airworthiness (ICA)
- Flight Crew Training and Documents
- Maintenance Training and Documents
- MCAS Compliance Assessment Summary
- AoA Disagree Flight Deck Indication

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System Design Overview

Summary

Maneuvering Characteristics Augmentation System (MCAS) Description:

- MCAS is a pitch augmentation flight control law implemented on the 737 MAX that commands nose down stabilizer to enhance pitch characteristics with flaps up during elevated angles of attack.
- MCAS is activated without pilot input and only operates when the autopilot is disengaged.
- MCAS control law becomes active and applies automatic nose down stabilizer in increments based on a table schedule as a function of AOA and Mach
    - The maximum command amount at any point in the table schedule is limited to 2.5 degrees
    - Stabilizer is commanded at a rate of 0.27 degrees per second (same rate as flaps down speed trim)
    - Maximum magnitude of stabilizer command is lower at high Mach number and greater at low Mach number (for the same AOA above the activation threshold)
- After AOA falls below the hysteresis threshold (0.5 degrees below the activation angle), MCAS commands nose up stabilizer to return the airplane to the trim state that existed before it entered the MCAS activation region
- MCAS stabilizer operation can be stopped and reversed by a pilot using the electric thumb switches and commanding stabilizer trim in the nose up direction
- If elevated AOA conditions persist and increase, MCAS commands additional incremental stabilizer in accordance with the table schedule referenced above

System Design Overview

MCAS vs. Speed Trim: Pilot Inputs and Effect on MCAS and Speed Trim

Effect of Column Cutout

- Does not inhibit MCAS commands
- Inhibits Speed Trim commands

Effect of Electric Stabilizer Trim (i.e. thumb switch input)

- Overrides both MCAS and Speed Trim commands

Effect of Stabilizer Cutout switches

- Inhibit both MCAS and Speed Trim commands

Effect of Manual Trim (i.e. trim wheel)

- Overrides both MCAS and Speed Trim commands

Effect of Trim Override switches

- Overrides column cutout switches only

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MCAS System Level FHA

Summary

- Development of FHAs for MCAS control law was consistent with process and assumptions used on all Boeing models.
- Loss of MCAS control law function assessed as Minor in the Normal Flight Envelope and Major in the Operational Flight Envelope.
- All FHAs involving unintended MCAS activation were assessed as Major in the Normal Flight Envelope and Hazardous in the Operational Flight Envelope.
- Consistent with FAA regulations and Boeing process MCAS FHA events were not evaluated in the SSA as they were assessed as Major.

Fundamental Assumptions Utilized in Functional Hazard Assessments

- Fundamental assumptions used in flight control FHAs across all Boeing models. Consistent with 25.671, 25.672 and AC 25-7C for compliance evaluation for 25.143.
  - Uncommanded system inputs that are readily recognizable and can be counteracted by overriding the failure by movement of the flight controls in the normal sense by the flight crew do not require specific procedures.
  - Action to counter the failure shall not require exceptional piloting skill or strength
  - The pilot will take immediate action to reduce or eliminate increase control forces by re-trimming or changing configuration or flight conditions
  - Trained flight crew memory procedures shall be followed to address and eliminate or mitigate the failure
- FHA evaluation for MCAS and Stab Trim was consistent with the above fundamental assumptions and resulted in the following.
  - Unintended stabilizer trim inputs are readily recognized by movement of the stab trim wheel, flight path change or increased column forces.
  - Aircraft can be returned to steady level flight using available column (elevator) or stabilizer trim.
  - Continuous unintended nose down stabilizer trim inputs would be recognized as a Stab Trim or Stab Runaway failure and procedure for Stab Runaway would be followed.

System Level Functional Hazard Assessment (FHA)

MCAS Certification Approach

- Determination of functional hazard categories (*e.g.*, Major, Hazardous, Catastrophic) was by Boeing pilot assessment performed in the simulator and aligned with Advisory Circular AC 25-7C.

- Single MCAS unintended activations were inserted via the Stabilizer Trim System in the Simulator to asses impact to handle qualities and associated flight crew actions.

- Accumulation or combination of failures leading to unintended MCAS activation were not simulated nor their combined flight deck effects.

- Upon each design iteration of MCAS, the functional hazard categories were re-assessed. The assessments were validated following each iteration.

- When assessing unintended MCAS activation, the function was allowed to perform to its authority and beyond before pilot action was taken to recover
    - Failures were able to be countered by using elevator alone.
    - Stabilizer trim available to offload column forces.
    - Stabilizer cutouts were available but not required to counter failures.

- Based on this evaluation, unintended MCAS activation was assessed as Major in the Normal flight envelope.

[redacted]

System Level Functional Hazard Assessment (FHA)

MCAS FHAs

- Four failure conditions were evaluated per our FHA process in the Normal flight envelope and in Operational flight envelope and then assessed the effect for each failure condition in both of those envelopes.
- Conditions assessed:
  - Loss of MCAS function
  - Unintended MCAS activation to the control law table limit (accounted for erroneous AoA)

[redacted]

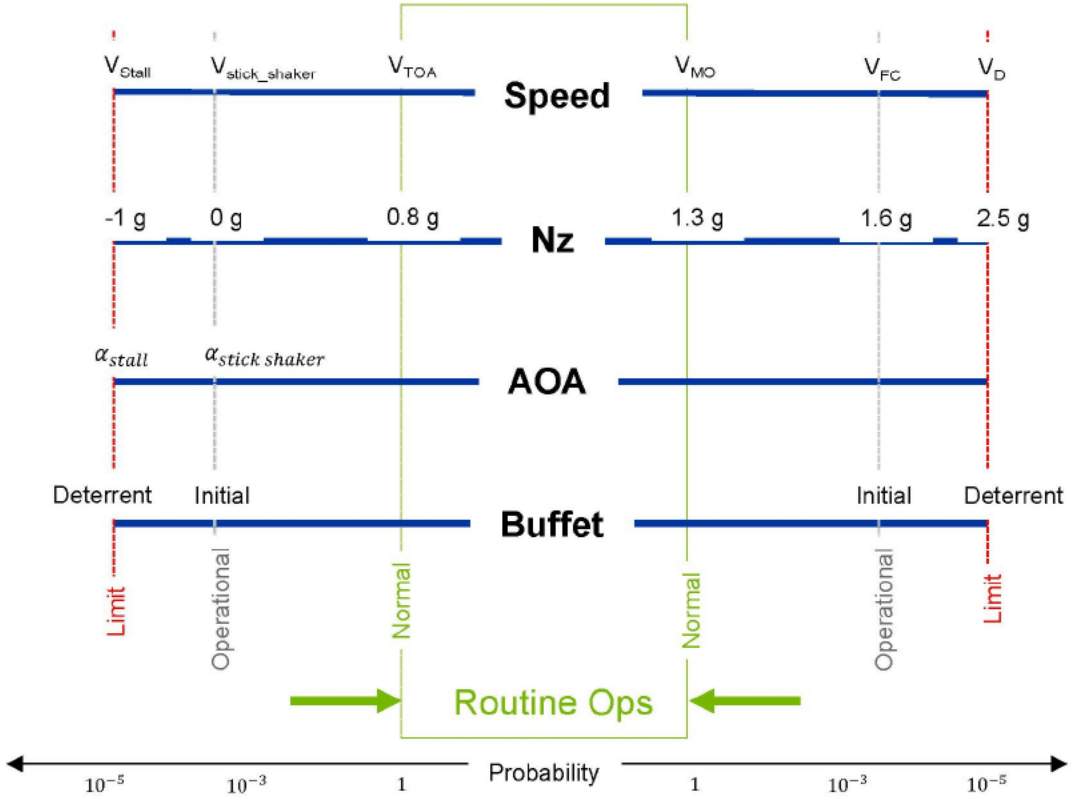
- All four conditions determined to meet hazard assessment / probability requirements.
- Erroneous Angle of Attack (AoA) was accounted for within unintended MCAS activation to control law table limit.

System Level Functional Hazard Assessment (FHA)

Erroneous Inputs to MCAS Control Law

- Erroneous inputs to MCAS control law could result in loss of MCAS function or unintended MCAS activation.
- Unintended MCAS activation due to erroneous input would still be subject to the control law table limits encoded in the MCAS software (2.5 deg maximum incremental stabilizer movement)
- Unintended MCAS activation has previously been shown to be:
  - Major in normal flight envelope.
    - Failure can be countered by using elevator alone.
    - Stabilizer trim available to offload column forces.
    - Stabilizer cutouts available but not required to counter failure.
  - Hazardous in the operational flight envelope.
    - The probability of being outside the normal flight envelope is 10^{-3} (ref AC 25-7C). Therefore, a condition that meets the integrity requirements for a Major within the normal flight envelope also meets the Hazardous integrity requirements for the operational flight envelope.

Flight Envelope Definitions



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MCAS Flight Controls Certification

Summary

- "737 NG/MAX Enhanced Digital Flight Control System, Autothrottle, and Yaw Damper Safety Analysis" showed compliance for [redacted]
- "737 Stabilizer Trim Control System Safety Analysis" showed compliance for [redacted]
- Flight test conducted concurrent with Aero S&C flight testing to demonstrate MCAS control law function and effects of loss of function during Control System Malfunctions Testing.
- During MAX development FCC and MCAS Control Law identified as Development Assurance compliant system following ARP 4754.

MCAS Certification

CP 13474 "737-8 Amended Type Certificate – Flight Controls – Autoflight (EDFCS/FCC)"

- Deliverable 8: D241A018-12, "737 NG/MAX Enhanced Digital Flight Control System, Autothrottle, and Yaw Damper Safety Analysis" for [redacted]
  - Existing catastrophic fault trees modified to account for the MCAS failure contributions to the top event
  - No warning required as a failure of the function did not pose an unsafe condition. In addition, counteraction of failures of the function did not require exceptional pilot skill or strength and is accomplished by movement of the flight controls in the normal sense.
  - Detected failures in MCAS are annunciated by the illumination of the existing SPEED TRIM (caution) light – repurposes existing speed trim structure

MCAS Certification

CP 13471 "737-8 Amended Type Certificate – Flight Controls – Primary, Elevator and Stabilizer Control"

- Deliverable 9: D251A018-6, "737 Stabilizer Trim Control System Safety Analysis" for [redacted]
  AR Recommend Approval
  - Existing catastrophic fault trees modified to account for the MCAS engage discrete failures contributing to loss of the control column cutout function
  - Identification of the established functional hazards in normal and operational flight envelope

G-4.2 FHA Results

Functional Hazard Assessment findings for the 737 MAX Stabilizer Trim Control System are presented in Table G4-1 below. Probabilites are given for both a 1.9 hour standard flight length case as well as for a 9.0 hour maximum duration ETOPS mission. Note the two different flight phases designated for MCAS related hazards – "Normal Flight Envelope" and "Operating Flight Envelope". Operating flight envelope for the MCAS function refers to a wind-up turn.

Effect Category Event Source	Hazard Event	Flight Phase	Contributing Interfacing Systems	Calculated Probability		FTA Reference
				Standard Flight (1.9 FH)	ETOPS Flight (9.0 FH)	
Hazardous	Loss of main electric nose down trim prior to piloted go around, but after stabilizer flare spring on dual channel autoland	Go around	None	[redacted]	[redacted]	G6-4, p. 1, STABGA
Hazardous	Stabilizer trim system uncommanded motion with override, but requires very high flight crew workload for safe landing	Landing	None	[redacted]	[redacted]	G6-2, p. 3, G015
Hazardous	Uncommanded MCAS function operation	All (Operating Flight Envelope)	None	[redacted]	[redacted]	G6-2, p. 8, G047

Flight Test

CP 13471 "737-8 Amended Type Certificate – Flight Controls – Primary, Elevator and Stabilizer Control"

- Deliverable 15: CFTP C1.39.AAC "737-8 Primary Flight Control System" – AR Recommend Approval for 1st Rev
  - [redacted]
  - Test Report Deliverable 17 – AR Approval
  - Test report points to conditions flown concurrently with C1.21.AAL "737-8 Maneuvering Characteristics" (reference CP 13669)

Flight Test

CP 13669 "737-8 Amended Type Certificate –Aerodynamics – Performance, Stability and Control"

- Deliverable 40: CFTP C1.14.ADD "737-8 Stall Characteristics" – AR Recommend Approval
  - [redacted] Demonstrate compliant stall characteristics.
  - Test Report Deliverable 42 – AR Approval
- Deliverable 34: CFTP C1.21.AAL "737-8 Maneuvering Characteristics" – AR Recommend Approval for 1st Rev
  - [redacted] Demonstrate compliant maneuvering characteristics and associated column force characteristics during wind up turns.
  - Test Report Deliverable 36 – AR Approval
- Deliverable 7: CFTP C1.33.AAD "737-8 Control System Malfunctions" - AR Recommend Approval for 1st Rev
  - [redacted] Demonstration of loss of MCAS function
  - Test Report Deliverable 9 – AR Approval

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Airplane Level Hazard, Safety, and Single & Multiple Failure Assessments

Summary

- For the MAX development Single and Multiple Failure analysis was completed and followed BPI-[redacted]
- Per BPI-[redacted], MCAS was not evaluated individually as a new/novel on the MAX as the control law had been previously implemented on 767 GTTA.
- "Erroneous AOA, one source" was identified and not analyzed as part of S&MF assessment per Engineering judgment.
- During case selection per Engineering judgment the worst case multiple failure of "Erroneous L & R Air Data" and "Erroneous L or R Air Data" replaced "Erroneous AOA, one source" failure scenario.
- S&MF analysis completed prior to the design change to MCAS control law during flight test. Reevaluation of design change not required per BPI-[redacted].
- While the version of MCAS included in the S&MF analysis was not reflective of the certified configuration; current assessment is that the S&MF final report would have included the same crew action that is already considered in the S&MF analysis.

Airplane Level Safety Assessments (ASA)

Single and Multiple Failure Accomplishment Summary – D910A010

- Completed by Systems Engineering with input from Safety and Functional Areas
- Developed per BPI-[redacted], "Conducting Single and Multiple Failure Analyses"
  - Step 1 – Team identifies cases based on prior models, changes in airplane/architecture. Cases accepted/rejected in this step. Rationale for rejection reviewed.
  - Step 2 – Analysis performed. Data includes failure effects and cascading effects.
  - Step 3 – Teams determine if failure hazard classification is appropriate for case.
  - Step 4 – Resolve actions in AI database.
  - Step 5 – E-CAB testing.
  - Step 6 – Document results.

[redacted]

Airplane Level Safety Assessments (ASA)

Single and Multiple Failure Accomplishment Summary – D910A010

- AVN-16: Loss of one AOA followed by an erroneous AOA
  - Deemed potentially catastrophic before crew recognition of issue
  - Catastrophic rating consistent with Displays and Air Data system safety assessments and AC 25-11A
  - Acceptability Rationale based on crew training, appropriate flight crew action and the probability of failure being extremely remote.

4.19.2 Analysis Summary

Baseline Configuration: 737-7, -8, and -9 MAX
Significant Flight Phase and Conditions:

- Flight phase of failure occurrence: All flight phases
- Environmental conditions: IMC, Night, wet runway
- Operational conditions: IFR
- Significant flight phase and conditions for follow-on effects: No

Airplane-Level Effects:

- MMEL: No
- Diversion by Procedure: No
- Diversion Expected by Pilot: Not called out by procedure, but flight crew likely would divert

Failure Case Probability	Failure Case Cumulative Hazard Category	Required Probability On the Order Of (Based on Hazard Categorization)
[redacted]	Catastrophic	1E-9 or less

Acceptability Rationale:

- Results in a misleading single source air data situation for primary displays. Potentially catastrophic before flight crew recognition of issue. Crew training supports recognition and appropriate flight crew action.
- Failure event probability is beyond extremely improbable

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Instructions for Continued Airworthiness (ICA)

ICA Documents

- For the MAX development program all ICA documents required for certification were produced to comply with [redacted] and followed Boeing release process BPI-[redacted] "Showing Compliance for Instructions for Continued Airworthiness (ICA)"
- Aircraft Maintenance Manual & Integrated Fault Isolation Manual did not require inclusion of information specific to MCAS as they include all pertinent information required to diagnose MCAS control law input failures in the material that addresses Stab Trim control law input failures.
- MCAS not included in Systems Description Section of AMM.
- Wiring Diagram Manual properly captures the airplane wiring changes for the Stabilizer Column Cutout due to incorporation of the MCAS control law.
- Relay implemented in Stabilizer Column Cutout system to incorporate MCAS is monitored by the FCC and no periodic maintenance is required.

Instructions for Continued Airworthiness (ICA)

ICA Documents

- Airworthiness Limitations Certification Maintenance Requirements (ALCMR)
- Enhanced Zonal Analysis Procedure (EZAP)
- Aircraft Maintenance Manual (AMM) ★
- Configuration, Maintenance and Procedures (CMP)
- Fault Isolation Manual (FIM) ★
- Damage Tolerance Rating (DTR)
- Maintenance Review Board (MRB)
- Non Destructive Testing (NDTG)
- Structural Repair Manual (SRM)
- Standard Wiring Practices Manual (SWPM)
- Task Cards (TC) – data not in AMM
- Weight and Balance Manual (WBM)
- Wiring Diagram Manual (WDM) ★

★Denotes item reviewed for inclusion of MCAS

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Flight Crew Training & Manuals

Summary

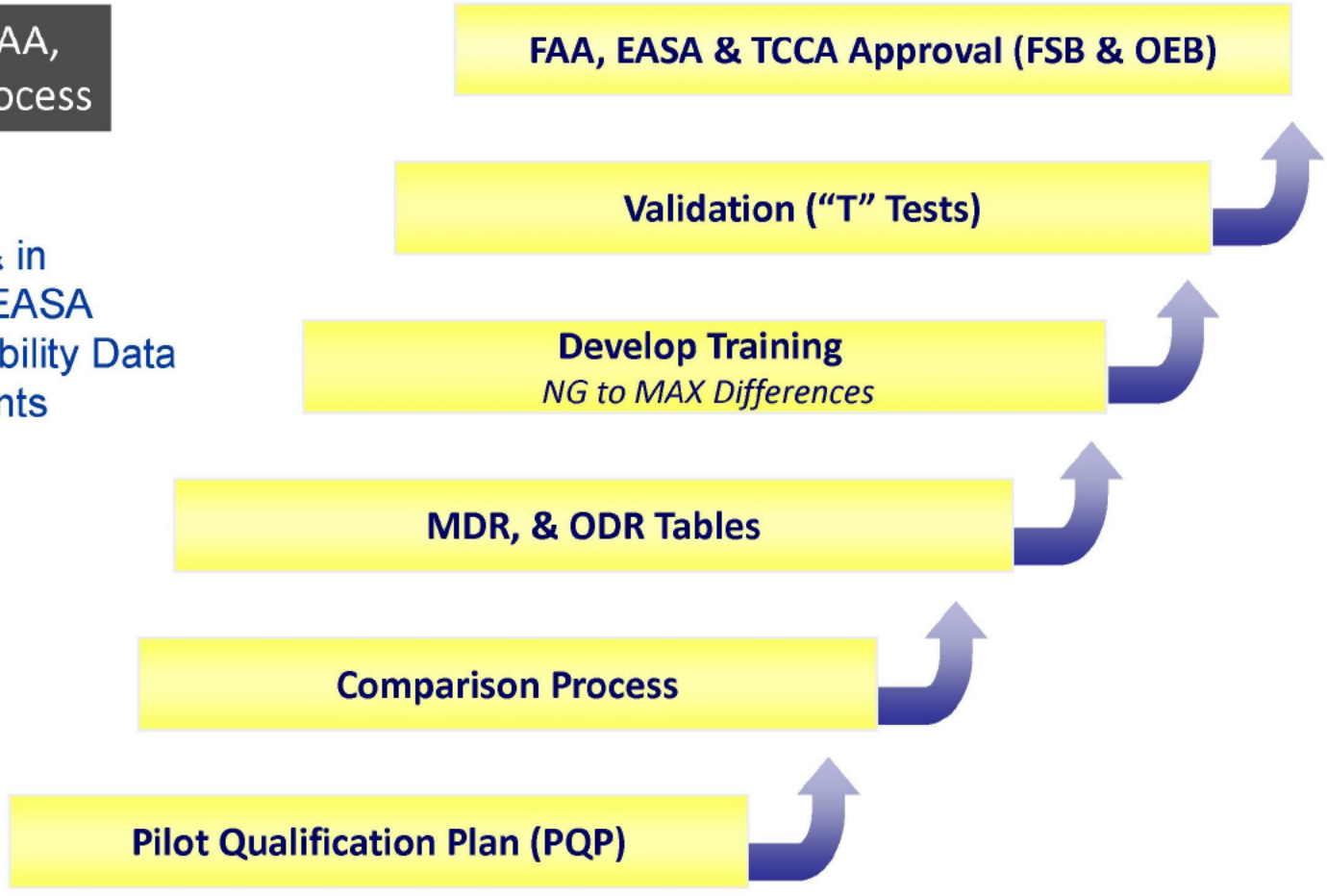
- Pilot Qualification process for the MAX followed AC 120-53B and Issue Paper O-1.
- Final approved FSB Report and Other Differences Requirements (ODR) Tables for the MAX did not include MCAS control law.
- Flight Crew Operations Manual (FCOM) does not include a specific systems description of MCAS control law.
- Boeing and FAA AEG specifically discussed inclusion of MCAS in ODR table and system description in FCOM. FAA concurred with Boeing recommendation that inclusion of MCAS in the ODR table and FCOM was not necessary.

Training and FCOM

Pilot Qualification Plan Process

A Joint Boeing, FAA, EASA and TCCA process

- Gated process
- Per AC120-53B & in compliance with EASA Operational Suitability Data (OSD) requirements



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Maintenance Training and Documents

Summary

- As part of ATA Chapter system description the MCAS control law is referenced including the control law schematic.

HORIZONTAL STABILIZER TRIM CONTROL SYSTEM -- FUNCTIONAL DESCRIPTION - ELECTRIC TRIM

During autopilot operation the stabilizer trim speed changes. When the flaps are up, the low speed trim is 0.09 units per second. When the flaps are not up, the high speed trim is 0.27 units per second.

Stabilizer Trim Cut Out Switch

If there is a stabilizer runaway condition, the pilots move the STAB TRIM PRI (primary) switch to the CUT OUT position. This removes power to the STAB TRIM B/U (backup) switch and these:

[redacted]

Column Cutout Switches and Column Input

The column cutout switches are in the column cutout switch module. There are two modules, captain and F/O. When the pilot moves the elevator column out of the neutral range, the column cutout switches open for trim in a direction opposite to the column movement. One other set of switches let the actuator operate the stabilizer in the same direction as the column movement.

The pilot uses the STAB TRIM override switch to do a bypass of the column cutout switches if the two switches have internal failures.

Maneuvering Characteristic Augmentation System

The maneuvering characteristic augmentation system (MCAS) allows the stabilizer to move in the nose down direction when approaching high angles of attack at high speeds. This requires the stabilizer to move in the opposite direction in which the pilot is pulling the column for nose up pitch. The MCAS only operates at extreme high speed pitch up conditions that are outside the normal operating envelope.

Only the F/Os column cutout switch module is affected because it is the only module that interfaces with the FCCs.

[redacted]

DMC-B737-A-27-41-00-00A-040A-T_000-00

20-Sep-2016

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Assessment Summary

• Opportunities to Enhance Records of Decisions

- MCAS Control Law Removal from Differences Training Table (ODR) and FCOM
  - Boeing and FAA AEG discussed and agreed on removal of MCAS control law during MAX development and certification.
  - Supporting rationale discussed between Boeing and FAA and accepted by FAA, but not formally documented in meeting minutes.
  - Reviewed FCOM and released MAX FSB Report do not reference MCAS.
  - No process violation or non-compliance

- Engineering & Pilot Assessment of Repeated Unintended MCAS Control Law Activation
  - Engineering and Test pilots discussed scenario of repeated unintended MCAS activation during MAX development and deemed no worse than single unintended MCAS activation.
  - Discussion and supporting rationale documented in pilot meeting summary email on June 22, 2016 and not documented in formal certification artifacts
  - No process violation or non-compliance

Assessment Summary

• Inconsistencies

- MCAS Systems Descriptions in Maintenance Training Material and Not Included in ICA Documents
  - Maintenance Training material developed and released prior to ICA documents provide description of pre-flight test MCAS control law.
  - No process violation or non-compliance

- FCOM Acronyms Section Referencing MCAS
  - Artifact left behind from earlier drafts of the FCOM prior to removal of MCAS from FCOM and FAA acceptance.
  - No process violation or non-compliance

- EDFCS SSA Data Document D241A018-13
  - Data Document is a repository for SSA supporting data and is not a certification deliverable nor referenced in SSA Compliance Documents D241A018-12 for the MAX or NG.
  - Supplemental non-certification data documentation updates not yet formally published to include the MAX.
  - EDFCS SSA D241A018-12 document used appropriate data in support of compliance for the MAX.
  - No process violation or non-compliance

Assessment Summary

• Inconsistencies

- D251A018-6, "737 Stabilizer Trim Control System Safety Analysis" Compliance Document
  - Description of functional failure in the Fault Hazard Assessment table referenced preliminary MCAS control law authority limits and was not updated to reflect certified design.
  - Identification of the probability for the Hazardous condition of unintended MCAS activation referenced the incorrect gate within the Fault Tree Analysis for Stabilizer Runway.
  - Compliant probabilistic assessment in Fault Tree Analysis maintained with revision.

- D910A010, "Single and Multiple Failure Accomplishment Summary"
  - "Erroneous AOA, one source" was identified and not analyzed as part of S&MF assessment. Similar to previous derivative development programs like 747-8
  - Supporting rationale provided was, "Covered by Erroneous L&R Air Data, Erroneous L or R Air Data covers single probe loss case".
  - Rationale should have pointed to "Loss of one AOA followed by Erroneous AOA" which was a part of the S&MF assessment during MAX development. Condition was not evaluated in the simulator but deemed acceptable as failure was found to be extremely improbable.
  - S&MF analysis completed prior to the design change to MCAS control law during flight test and not reevaluated. Current reassessment is consistent with previous S&MF analysis which is supported by crew action in acceptability rationale.
  - No process violation or non-compliance

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737 MAX MCAS Control Law

- Review of all certification deliverables (Cert Plans, ICA Documents, etc…) in support of MCAS control law certification are compliant.
- Review of all Boeing internal analysis in support of MAX development and certification deliverables were completed per process and are compliant.
- Assessment of Compliance Identified Several Areas for Improvement
  - Opportunities to Enhance Records of Decisions
  - Inconsistencies in Documentation
- Aerodynamics Stability & Control completed further evaluation of the Functional Hazard Assessment for loss of MCAS control law function in a corner condition of the normal flight envelope.
  - Confirmation via Flight Test that loss of MCAS rated as minor

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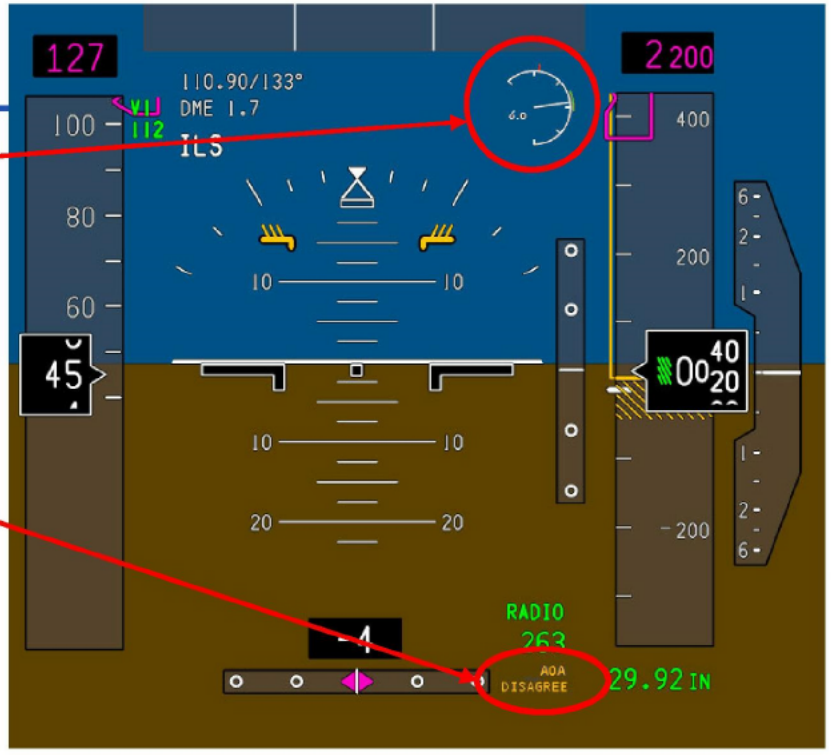
'AOA DISAGREE' and Optional Angle of Attack Flight Deck Indication

Design Overview

- **Optional Angle of Attack Indication**
  - Implemented in BP99 for 737NG - first delivered December 1999.
  - Requirements carried over for 737 MAX.

- **'AOA DISAGREE' disagree**
  - Implemented in BP06 for 737NG - first delivered July 2006.
  - Annunciation was a customer request to assist maintenance troubleshooting.
  - Displayed on PFDs when the left and right AOA disagree 10+ degrees for 10 continuous seconds.
  - [redacted]
  - AOA data received from the ADIRUs via A429.
  - If the data from the ADIRUs are unavailable or invalid, the annunciation will not be displayed.
  - Requirements carried over for 737 MAX.



- AOA DISAGREE alert does not require any pilot action.
- There are other flight deck effects that pilots should understand that may indicate the presence of erroneous AOA data, including the ALT DISAGREE and IAS DISAGREE alerts.

737 MAX 'AOA DISAGREE' Flight Deck Indication

COSP 2018-2116

- MDS PR693 "AOA DISAGREE Annunciation" discovered in October 2017
- AOA DISAGREE is not displayed unless the optional AOA indicator is displayed.
- Determined to be requirements not implemented correctly by supplier in display system software.
- Testing of previous black label software on versions did not discover this issue.
- PR Review Process concluded to resolve the PR with MDS BP2 which is part of MAX-10 ATC (EIS 3Q 2020).

737 MAX 'AOA DISAGREE' Flight Deck Indication

COSP 2018-2116 Summary Rationale

Determined to be Not a Safety Issue (Dec 6, 2018)

- IAS DISAGREE and ALT DISAGREE may be displayed with an AOA DISAGREE. AOA DISAGREE is supplementary information with no additional crew action.
- All appropriate crew action is contained in the IAS DISAGREE and ALT DISAGREE QRH procedures.
- The IAS DISAGREE and ALT DISAGREE annunciations are displayed independent of the AOA DISAGREE annunciation.
- AOA DISAGREE, IAS DISAGREE, and ALT DISAGREE are observed faults and have corresponding IFIM Tasks.
    - Task 34-10-00-810-801 SPEED DISAGREE Shows on PFD – (Captains's) – Fault Isolation
    - Task 34-10-00-810-802 SPEED DISAGREE Shows on PFD – (First Officer's) – Fault Isolation
    - Task 34-20-00-810-801 ALT DISAGREE Shows on PFD – (Captains's) – Fault Isolation
    - Task 34-20-00-810-802 ALT DISAGREE Shows on PFD – (First Officer's) – Fault Isolation
    - Task 34-20-00-810-803 AOA DISAGREE Shows on PFD (Captains's) – Fault Isolation
    - Task 34-20-00-810-804 AOA DISAGREE Shows on PFD (First Officer's) – Fault Isolation
    - The first step in all tasks is to look in OMF Existing Faults, 34 Air Data Inertial Reference System for related maintenance messages.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