

Podcast 2 B737-Max Podcast

Welcome to today's Podcast where we'll be discussing the 737 max. We will focus on the changes made to the max and the new training required for pilots as a result. At the time of writing this podcast the Max has just been re approved by the FAA with a new Airworthiness Directive 2020-24-02 explaining the changes made. We will try to summarise this for you and also look at the Flight Standardisation Board Report Revision 17 for the new training required. EASA have also added a few stipulations in their Proposal to issue an AD or PAD on 24th November. These possible extra requirements will be highlighted throughout. At the time of writing stakeholders had until the 22nd of December 2020 to comment but we expect all of these extras to the FAA AD to come into effect at that point.

First a quick bit of background into how we got here. The Max was designed to incorporate LEAP-1B engines onto the 737 airframe. These engines are the main reason behind a decrease fuel burn of approximately 15% as well as NOx emissions cuts of 50% and a noise footprint reduction of 75%. The bypass on the LEAP is an impressive 9:1. However, to achieve this the LEAP-1B is a bigger engine than the previous CFM56. The jet intake itself is 21cm larger than the CFM's which meant to maintain ground clearance it had to move further outboard on the wing changing the aircraft's stall handling characteristics and leading to the introduction of the Manoeuvring Characteristics Augmentation System or the MCAS system as we all know it.

The original MCAS was designed to give the MAX the same feel as other 737's and activated when in manual flight with flaps up at an elevated AOA. There was no redundancy built into the system which meant a single faulty AoA sensor could cause erroneous MCAS activation. This fault along with unrestricted MCAS commands to move the stabiliser to its limits were named as contributing factors to the two Max accidents. Another reason highlighted was the absence of guidance on MCAS in flight manuals and flight crew training.

After the Max's grounding investigations into this system lead to numerous changes in order for recertification by the FAA. On 6th August 2020 the FAA published a Notice of Proposed Rule Making or NPRM which listed all the proposed design changes and allowed for Stake Holder comments before the release of the final Airworthiness Directive. We'll now try to summarise these changes for you.

The AD requires a revision to the airplanes flight control laws, in other words the software. The software change will be a complete replacement of the original FCC software, including a new part number. This software now requires inputs from both AOA sensors in order to activate MCAS. This data is compared and if the inputs differ significantly which is termed as greater than 5.5. degrees for a specified time period then the Speed Trim System which includes MCAS will be disabled for the remainder of the flight with a corresponding flight deck indication.

These new flight control laws will also now only allow one activation of MCAS per sensed high AOA event, this resets on return to a low AoA significantly below MCAS activation and the new laws will limit the magnitude of any MCAS command to move the horizontal stabiliser such that the resulting position of the stabiliser will preserve the flight crew's

ability to control the pitch using only the control column. In other words, even without manual trim inputs.

The new software also incorporates FCC integrity monitoring of each FCC and cross FCC monitoring which detects and stops erroneous FCC generated stabiliser trim commands including MCAS.

The AD also mandates some other changes. These are an AoA Disagree alert to be implemented by a revision of the MDS or Max Display System software, this will display on each pilots PFD. Some Max's were accidentally delivered without this originally, but it will now be mandated. Changes to the AFM to add and revise Flightcrew procedures to facilitate recognition and response to undesired horizontal stabiliser movement and the effects of a potential AoA sensor failure. And finally certain aircraft wiring to be adequately separated as well as checks to each aircraft before a return to service to include AoA system check.

In 2007 design standards changed to allow more physical space so that wiring failure wouldn't create a hazard. All previous 737 models were certified under the old standards but the Max will be under the newer standards so the horizontal stabiliser wiring will have to be changed before the aircraft are certified.

Before I hand over to Mark for a look at the AFM changes here's a quick look at the cost of the Max AD changes. Per aircraft, without knowing the cost the operational readiness flight we're looking at up to 15,400 dollars with the re wiring being the main cost by far due to the man hours involved. The FAA estimates the AD affects 72 aircraft of U.S registry so the cost to them alone could be in excess of 835,000 dollars.

There are also a number of changes to the QRH. In the UAS checklist there is the addition of a new line. This will say, in para phrase 'Attempt to determine a reliable airspeed indication. If a reliable airspeed indication can be determined: use it for the remainder of flight. If it's only the standby ASI do not use autopilot auto throttle or flight directors. If it's CP's or FO's indication you can use the onside flight director and autopilot but not the auto throttle. Beware that the AP may not engage or may disengage automatically.

A couple of other additions on the Airspeed unreliable QRH include that if you have a reliable altitude source on the CP or FO side you are to set the transponder to the reliable side as well as selecting TA only AND also some extra GA guidance is available if you have reliable airspeed on the CP or FO side. Previously TO/GA was not to be pressed but now it will state that although the FD Bars may be removed you can press TO/GA and then make an AFDS pitch mode selection such as LVL CHANGE to restore them. Again, this is only in the case of reliable airspeed on the CP or FO side.

Here is where the EASA PAD differs most. In the reference part of the checklist EASA proposes to add a section stating a nuisance stick shaker may be deactivated at the pilots discretion. This improves recognition of stall warning on the opposite side. A note will also be added stating Elevator Feel Shift may be active, resulting in increased control column forces. This goes together with EASA capping the stick shaker circuit breakers in different colours for easy identification.

The next Amended QRH we'll look at is the Runaway Stabiliser Trim. The condition statement will be amended to include the line "or in a manner not appropriate for flight conditions" The Recall will be changed and will now read. Firmly hold control column. Disengage AP if engaged. Use the control column and thrust levers to control airplane pitch attitude and airspeed. Use main electric stabiliser trim to reduce column forces. The rest of the Recall remains unchanged. Some notes will be added to the reference items and will include. 1. A two-pilot effort may be used to correct an out of trim condition. 2. Reducing airspeed reduces air loads on the stabiliser which can reduce the effort needed to trim manually. Anticipate trim requirements. Do not reengage AP or AT.

The Stabiliser Trim inoperative QRH is rewritten and includes in the condition "or when directed by the Stabiliser Out of Trim procedure. There is a rewrite of the procedure but essentially the same items are covered as the current one so we'll leave you to read that.

The Stabiliser out of Trim QRH receives an overhaul as the light now has a ground function too. It reads. The STAB OUT OF TRIM light illuminates for the following conditions. On the ground: A partial failure of a Flight Control Computer. In-flight: The AP does not set the stabiliser trim correctly. If on the ground do not takeoff. End of procedure. The rest of the inflight procedure is then unchanged.

The Speed Trim Fail QRH gets expanded as it now includes the MCAS. The new wording will be. The speed Trim function and MCAS function are inoperative. Continue normal operation. Note: The Speed Trim System will not provide stabiliser trim inputs when deviating from a trimmed airspeed.

The AoA Disagree checklist has fundamentally changed as it will now tell you to Accomplish the Airspeed Unreliable Procedure.

AND FINALLY, from the FAA AD. There are a couple of Additions to the ALT Disagree checklist namely If the IAS DISAGREE alert is also shown on the speed tape of the PFD, accomplish the UAS procedure. Also added is the useful information to only set the BARO minimums on the reliable PFD. Remove the BARO minimums from the unreliable PFD and a helpful Note that: If BARO minimums are only set on the first officers PFD, DA/MDA aural callouts are not provided.

EASA includes all those changes too and goes further with some additional MMEL entries and also 3 other points of interest.

Firstly, EASA will prohibit RNP AR to eliminate the identified risk after a single failure of an AOA sensor during some RNP AR approaches.

Secondly the minimum Usable Height of the AP will be raised from 50ft to 111ft on 737-8 and 130ft on the 737-9. This is due to the demonstrated altitude loss due to a hard-over single channel AP malfunction on the Approach.

And Thirdly a revised paragraph has been added to the SOP for the handling of Non-Normal situations. Company SOP's of course rule but EASA wants included and I'll summarise here. Max use of autoflight system to reduce workload if available and appropriate. The importance of PF to maintain aircraft control and for PM to be monitoring the flight path. Apply good CRM to analyse the condition, prioritise alerts and take proper action doing memory items based on the crew's area of responsibility. Complete the appropriate NNC and review other alerts completing other NNC as required. Evaluate the situation and review options. EASA will also reemphasise the definition of Recall items and Reference items. Recall items are minimum immediate action items. Reference items are accomplished after Recall items have been accomplished.

Right, that's enough of the changes! Let's take a look at what the FAA has recommended for us pilots! There will be both a ground school side and a Full flight sim detail to do. We will outline what that involves but won't go into system descriptions on this podcast. The differences will definitely be one for the future.

Firstly, no pilot will be able to operate the Max unless the ground and flight training have been completed. It will be up to your individual airlines about how to incorporate these into your training. There are three parts to the ground training. The first is Training on NNC's. This will include the ones we've just been talking about but as a recap Runaway Stabiliser, Speed Trim Fail, Stabiliser out of Trim, Stabiliser Trim inoperative, Airspeed Unreliable, Alt Disagree and AoA Disagree.

Section 2 will emphasise the design differences associated with the new FCC software version. This may be done by approved CBT and will include chapters on how the FCC's relate to MCAS, the AFDS, the new Stab out of Trim light function and revised NNC and the function of the SPEED TRIM FAIL light.

In Section 3 Boeing-recommended procedures are reinforced on Manual Trim operation and how to determine a reliable airspeed. This can also be done through approved CBT. Now back to Ian for the FFS side.

Training will be conducted in a 737Max Level C or D FFS and is broken down into 5 different sections. To note some of this training is allowed to be conducted in a NG sim.

Firstly, a demonstration of MCAS activation accomplished by each pilot as PF which will be done in manual flight with a clean aircraft put in an impending or full stall. The recovery is then demonstrated. You will also take a look at the MCAS activation stabiliser trim responses.

Secondly, you will take a look at a Runaway Stabiliser condition requiring use of manual stabiliser trim with each pilot acting as PF

Next you will have a go at using the manual stabiliser trim during approach, Go around and level off again with each pilot having a go as PF.

The fourth scenario will be a cross-FCC Trim motor activation demonstration. This time with either pilot being PF. This condition will result in a landing in order to demonstrate the new STAB OUT OF TRIM light functionality.

Finally, you'll look at Erroneous high AoA during takeoff that leads to an unreliable airspeed condition accomplished by either pilot as PF. You will see the flight deck affects aural, visual and tactile. This must include a Go Around flown with the erroneous high AoA condition to look at FD behaviour when using TO/GA biasing them out of view.

After all that you'll be clear to finally go and enjoy the Max! We hope you've found this useful for your preparation and as Ian alluded to earlier, we'll look at a future podcast being completely focused on the differences that come with operating the Max and its systems. Thanks for listening and we hope to see you next time on Boeing 737 Talk.