European Union Aviation Safety Agency

COMMENT RESPONSE DOCUMENT

EASA Preliminary SD No. 20-185

[Published on 24 November 2020 and officially closed for comments on 22 December 2020]

Commenter 1: B737 TRI/TRE (IE.FCL.281697) – Michikian Krikor – 25/11/2020

Comment # 1

Background Information: It is true that an AoA sensor failure during an RNP AR approach (as well as with all other types of approaches) will result to loss of flight guidance. This outcome, however, can be caused as a result of other malfunctions and NOT only due to an AoA sensor failure. For the scenario of an AoA failure, at least 'pitch' and 'thrust' information will be available and reliable to be used. Consequently, as long as an Operator demonstrates that mitigations and contingency procedures are in place for discontinuing the approach and safely flying away of potential terrain/obstacles, there may NOT be the need to restrict the B737 -8 and -9 aeroplanes on performing RNP-AR approach operations.

Suggestions:

EXISTING TEXT:

(page 2 of 3) For the reasons described above, after the actions required by this SD have been accomplished, the affected Boeing 737-8 and 737-9 aeroplanes can be used to perform flights under the TCO authorisation, with the limitation not to perform RNP-AR approach operations.

SUGGESTED TEXT:

(page 2 of 3) For the reasons described above, after the actions required by this SD have been accomplished, the affected Boeing 737-8 and 737-9 aeroplanes can be used to perform flights under the TCO authorisation, with the limitation not to perform RNP-AR approach operations, ***unless*** *the Operator produces substantial proof (i.e. risk assessment, contingency procedures, etc.) to its Competent Authority, providing mitigation(s) for the scenario of failures resulting in the total loss of flight guidance allowing the pilot to guide the aeroplane along the intended flight path.*

EASA response:

Comment noted, but not agreed.

EASA has identified failure conditions that may lead to a loss of guidance, which is not acceptable for RNP-AR approaches. Additionally, EASA has not received sufficient data from Boeing to ensure that performance under failure condition actually meets the RNP-AR objectives and that RNP-AR operations can be safely conducted.

No changes have been made to the Final SD in response to this comment.

Commenter 2: CAA Netherlands – Ties van Zanten – 17/12/2020

Comment # 2

EASA issued a Preliminary Safety Directive for 28-day consultation. This will require non-European airlines which are holders of EASA third country operator (TCO) authorisation to implement equivalent requirements, including aircrew training. This will allow for the return to service of the 737 MAX when the aircraft concerned are operated under an EASA TCO authorisation into, within or out of the territory of the EASA Member State.

A. Can EASA provide a detailed description of differences between the requirements of final EASA AD and the FAA AD?
B. Will the final SD be published at the same time as the final EASA AD?

EASA response:

A. Comment noted. Regarding design and procedural aspects, the EASA AD clarifies where it is different compared to FAA AD or when there is no corresponding FAA requirement. Regarding training aspects, there is no difference in nature.

B. EASA confirms that AD and SD are published on the same date.

No changes have been made to the Final SD in response to this comment.

Commenter 3: IATA – Stefano Prola – 22/12/2020

Comment # 3

IATA supports the PSD. There is one statement that we think should be clarified.

The “Required Action(s) and Compliance Time(s): (1) gives the options to implement all elements in the FAA AD or the EASA AD or, where applicable, in an AD issued by the State of Registry that contains the same elements. We believe that the wording “that contains the same elements” is not clear enough because, since the FAA and EASA ADs are not exactly the same, a doubt remains as to which elements should be contained in the State of Registry AD. With the present wording, it might be understood that all elements of the EASA AD must be implemented by the TCO in order to contain the “same elements” (since EASA adds elements to the AD compared to the FAA one). If the implementation of the FAA AD is acceptable to EASA for TCOs, it should be clarified that a State of Registry AD that contains the same elements of the FAA AD is acceptable as well.

A suggested alternative wording could be: “in an AD issued by the State of Registry that contains the same elements of the FAA AD 2020-24-02 or of the EASA AD [TBD…].”.

EASA response:

Comment agreed. The Final SD has been amended accordingly.

Commenter 4: Anonymous – 21/12/2020

Comment # 4

Here are some concerns regarding the re-certification of the Boeing 737 MAX that murdered 350 people for reasons suspected to be related to corporate greed:

A. You do not require a third AOA sensor. This should be the number one priority. These sensors should also be mandated to be active at all times during flight.

B. You do not require a physical off switch that will disable the MCAS system in a mechanical fashion. If this requires separate physical redundant computers, so be it.

C. You do not require physical indicator lights that show AOA sensor disagreement.

D. The wire changes do not appear to have anything to do with the murder of 350 people. This fix will resolve nothing and is unrelated to the grounding.

E. You claim the MAX has no tendency to ever pitch-up. If this is true, there is no need for MCAS. You should require its removal, but you choose not to because the plane does indeed need it.

F. Training is irrelevant when you do not require Boeing to provide the tools that allow the pilots to make relevant decisions.

G. As long as there is a single fucking screw left of the original 737 MAX design, you should have as a requirement that Boeing can NEVER modify/change the name of this plane. Not making this a requirement indicates agreement that Boing should be able to hide the type of plane people fly on.

H. Every airline company using the 737 MAX should be required to inform passengers that they will be flying on a 737 MAX. If you are confident in your inadequate changes, this should not be a problem. Should you not require this, you believe the only way people would fly on it is through the withholding of information. This reminds me of a certain company.

I. One would think that self-certification was no longer on the table, but it appears that the changes you have requested are as cheap as possible. This seems completely in line with what Boeing would want.

I will never fly on any version of the 737 MAX. This also applies to everyone I know. If you think you are rebuilding trust by doing the bare minimum, you are wrong.

EASA response:

As a general comment, it should be clear that EASA does not prescribe or propose design solutions; instead, EASA reviews design solutions proposed by the design approval holder and checks that these are compliant with the applicable safety standards, and that they are safe. Any question related to design choices as specified in the AD should be addressed to Boeing directly.

A. Comment noted, but not agreed. When a single angle of attack (AoA) vane failed or provided erroneous data in the original design, the effects in the cockpit were disproportionate. There were multiple alerts, the stick shaker operated and the MCAS made large inputs to the horizontal stabilizer. This presented the flight crews with a confusing situation: they did not know which airspeed indications were correct; they had indications that the aircraft was stalling; and the aircraft kept pitching down. The most arresting failure that a pilot can have is a perceived inability to control his aircraft; the pilot becomes focused on regaining control to the exclusion of everything else. When this is combined with incorrect data that difficulties the flightpath evaluation and the distraction of the stick shaker, the situation can become overwhelming. In order to increase flight crews' capacity to cope with this single AoA failure scenario, the following mitigations have been put in place by Boeing:

- ***modifications to the Speed Trim System (which includes the MCAS) so that erroneous AoA does not cause flightpath control problems;***
- ***a simplified Airspeed Unreliable non-normal checklist (NNC) to reduce the associated crew workload;***
- ***a step in the Airspeed Unreliable NNC to give crews the option to disable the erroneous continuous stick shaker;***
- ***reinforced training for air data failure scenarios (including the unreliable airspeed case).***

EASA considers that with the application of the four mitigations, the effect of AoA failure in the 737 MAX is restored to an acceptably safe level.

However, EASA requested Boeing to evaluate design enhancements to further reduce crew workload and improve AoA integrity related to the single AoA sensor failure scenario, as further safety enhancements, but with no intention and no grounds to mandate those.

In order to evaluate the completeness of the design improvements to be brought to the 737 MAX, EASA requested Boeing to consider the pros and cons of the installation of a third AoA sensor. Boeing evaluated the feasibility of the installation of a third AoA source but decided not to retain this solution. Boeing has however agreed to develop a design improvement, different than the installation of a third AoA source but enabling to achieve the same objectives.

B. Comment noted, but not agreed. The failure cases of the MCAS have been exhaustively identified and extensively analysed (including from the Human Factor standpoint), then tested at the simulator or in actual flight tests, with the conclusion that no specific MCAS ON/OFF switch is needed for the aircraft to be compliant with safety standards and safe.

C. *Comment noted, but not agreed. One of the provision required to return the 737 MAX to operation is the installation/verification of MAX Display System (MDS) Software. The MDS Display Processing Computer (DPC) Operational Program Software (OPS) BP 1.5.1 includes a revision to the display of the AoA DISAGREE alert message on the PFD to be independent of the AoA Round Dial option.*

D. *Comment noted, but not agreed. One of the provision required to return the 737 MAX to operation is the Horizontal Stabilizer Trim Wire Bundle Routing Change. This modification is required to correct a non-compliance with CS 25.1707 and potential unsafe condition identified due to the lack of separation of the wiring activating the stab trim actuator. While this was not a cause or contributing factor to the accidents of the JT610 and ET302 flights, the potential effects (uncontrolled aircraft nose down) are similar.*

E. *Comment noted, but not agreed. Conventional aircraft, that means aircraft not equipped with a 'fly-by-wire' flight control system, are required by Certification Specifications for Large Aeroplanes (CS-25) to have a certain level of longitudinal (pitch) stability. If the aircraft's natural characteristics are such that it does not meet that minimum level on its own, then stability augmentation systems may be fitted to artificially increase the level of stability. In that case, if the stability augmentation system(s) fail, then a degraded level of stability may be accepted based on the probability of the system failing. The level of degradation is evaluated by the EASA test pilots; at no point must the aircraft require exceptional piloting skill or strength. It should be noted at this point that an unstable aircraft would never be certified, even for failure conditions.*

The 737 MAX is a conventional aircraft, but the longitudinal static stability was not expected to meet the requirements in two key areas; in the approach to the stall, and during manoeuvres at high altitude. These two cases will be explained in turn. For the approach to stall, control column force is one of the most important cues to a pilot that the aircraft is slowing down from the in-trim condition. It is the aircraft's longitudinal stability that provides that force. If the aircraft has very strong positive stability, then it will try very hard to return to the speed it was at before slowing down. It will naturally pitch down to increase airspeed and the pilot has to pull to stop it from losing altitude; in other words, the pilot feels a force that alerts him to the fact that the aircraft has slowed down. During manoeuvres, such as turns, the pilot must pull on the control column to keep the aircraft level and to make the aircraft turn. Once again, the pilot feels a force on the column. This force, which is generated by the aircraft's natural longitudinal manoeuvre stability, must neither be too high, or the aircraft will be difficult for the pilot to manoeuvre, nor must it be too low, or the pilot could once again lose the cue to deceleration or be able to overstress the aircraft (by pulling too much 'g-force'). In both cases, what is important is not so much the actual stability of the aircraft, but how much force the pilot feels at the control column (the apparent stability).

Previous versions of the 737 did not have enough natural longitudinal stability to meet the certification requirements for approach to stall and the aircraft had already been fitted with a stability augmentation system, the Speed Trim System (STS). The STS uses the horizontal stabilizer trim to increase the control forces for a given condition. As an example, assume a pilot trims the aircraft, which means he is holding no force on the control column, in straight and level flight at a speed of 120 knots. Also assume the pilot inadvertently allows the speed to reduce to 110 knots. Since he has slowed down but still wants to maintain his straight and level trajectory, he has to pull on the column and he will thus notice that the speed has decreased. On the 737, the change in force with speed (stick force gradient) of the natural aircraft was not high enough, so the STS trims the aircraft nose-down, which means that the pilot has to pull harder. The STS has augmented the apparent stability of the aircraft (i.e.

what the pilot feels to be the aircraft stability). On the 737 MAX the aircraft's natural stability was reduced even further, so the STS software was modified to introduce the Manoeuvring Characteristics Augmentation System (MCAS). From this point, the STS contains the Speed Trim Function (STF), encompassing the functions developed for the 737 NG, and the new MCAS function developed for the 737 MAX. The MCAS takes AoA data from the vanes and, at high AoA values, increases the amount of stabilizer trim that the STS would apply to increase the control column forces. The MCAS also works during manoeuvres, for which in certain specific combinations of Mach number and high altitude, the manoeuvre stability does not offer sufficient margin as required to meet the certification specifications; the force requiring the pilot to turn or pull g was not high enough. The MCAS works using the same principle as in level flight, using stabilizer trim to increase the forces at the control column. In the absence of failures, the STS and MCAS in the original design worked effectively.

Since the protection features in the new design would make it more likely that the STS would be unavailable, the EASA test crew evaluated the aircraft both STS (and MCAS) on and off.

As expected, when operating, the MCAS augmented the aircraft stability and operated appropriately. For flight with the STS off (including MCAS), handling qualities during 1-g stalls with STS and MCAS off were acceptable. The longitudinal stability, as perceived by the pilot, was noticeably reduced as the aircraft approached stall speed but the aircraft was not unstable and there was no tendency to pitch-up. The test pilot considered that for the situation in which STS is failed , the combination of cues, although diminished relative to the normal case, provided an acceptable indication of stall and that an average pilot would be able to recover from the situation without exceptional skill. Handling qualities at high Mach and high altitude were assessed through a series of constant-Mach wind-up turns. There was a small but perceptible difference between the stick forces with MCAS operational and MCAS off. However, in all cases, the aircraft had very strong apparent manoeuvre stability and the combination of high control forces and Mach buffet were judged by the test pilot to be sufficient to discourage inadvertent excursions to high levels of g or AoA.

In conclusion, the handling qualities of the 737 MAX both with and without MCAS are safe. When MCAS fails, the effects are no worse than Major; i.e. the capability of the flight crew to continue the flight and perform a safe landing is not under question.

F. *Comment noted, but not agreed. The RTS training consists of a specific training module based on the identified training needs as defined in the Operational Suitability Data for Flight Crew (OSD-FC). Pilots who were rated on the 737 MAX have to complete the RTS training prior to their first flight when the 737 MAX returns to service. The objective of the training is to ensure that type-rated pilots, before they operate the aircraft again, are properly familiarized with and exposed to the novel procedural and training elements. This will increase the probability that they will be able to properly respond and cope with the consequences of specific failures. Nevertheless, the criticality and occurrence probability of the failures linked to the past accidents has mostly been reduced by design.*

G. *Comment noted, but not agreed. EASA has no authority regarding how an aircraft model is named commercially.*

H. *Comment noted. This comment is outside the scope of the AD.*

I. *Comment noted, but not agreed. EASA defined an RTS strategy designed to ensure the safety of the design; the associated technical activities encompassed two aspects: (i) a fully independent review of all certification activities associated with the design changes required to address the*

direct causes of the accidents, and (ii) an extended independent design review of the 737 MAX flight control system and associated functions.This work was enabled by the understanding achieved on the causes and circumstances leading to the two accidents; the progress made in this area and the ensuing EASA technical investigation paved the way for the precise definition of the conditions necessary to bring the model back into service safely. Indeed, EASA was fully engaged in the process that yielded the set of acceptable technical modifications of the 737 MAX and the operational and training updates that came with it. Furthermore, the extended design review by EASA provided additional confidence and, in some cases, generated additional operational limitations for the safe return to service of the 737 MAX.

No changes have been made to the Final SD in response to this comment.

Commenter 5: American Airlines – Sergio Rocha – 05/01/2021

Comment # 5

The limitation reads:

"The operator shall not conduct RNP-AR approach operations during flights performed under the TCO authorisation and shall disseminate appropriate information to crew and operations staff."

American Airlines (AAL) reached out to Boeing regarding this limitation, their response is shown below:

"During the 737 MAX Return to Service (RTS) efforts, Certification Management Team (CMT) regulators and Boeing agreed to perform specific RNP AR certification activities, to include demonstrations described in EASA AMC 20-26. These demonstrations typically take place in Boeing's Seattle based Engineering CAB (E-CAB) due to the need to simulate specific failure conditions. While a small number of conditions were able to be conducted in a Full Flight Simulator (FFS) in Gatwick, restrictions due to COVID-19 impacted the ability of EASA representatives to travel to Seattle to complete the demonstrations in the E-CAB. As a result, EASA, the FAA and Boeing agreed to restrict RNP AR aircraft eligibility through an AFM limitation applicable to EASA and third party EASA operators. This limitation does not impact operators which gain RNP AR approval through the United States or third party US operators as the FAA completed its reassessment of 737 MAX RNP AR, and finds the aircraft safe and compliant with all applicable US RNP AR regulatory guidance. When travel restrictions subside, Boeing, EASA and the FAA will resume EASA AMC 20-26 activities to complete the required demonstrations and remove the AFM limitation applicable to EASA and third party EASA operations."

AAL interprets this response to mean that the PSD limitation is **not** applicable to AAL as a result of having FAA RNP AR approval; However the language in the PSD appears to conflict with this interpretation.

As a Third Country Operator, AAL respectfully requests that EASA clarify this limitation so we can appropriately prepare for any applicable 737 MAX routes in the future. Please be aware that AAL does not presently operate any 737 MAX RNP AR approved routes into EASA airports.

EASA response:

Comment noted and partially agreed.

As per the PSD, the limitation not to perform RNP-AR approaches applies to all flights performed under the EASA third country operator (TCO) authorisation. Regulation (EU) No. 452/2014, so-called Part-TCO, sets out the requirements to be followed by TCO Authorisation holders. Pursuant to article TCO.100, the requirements of Part-TCO have to be followed by third country operators engaged in commercial air transport operations into, within and out of the territory subject to the provisions of the EU Treaty.

In practice, this means that a TCO Authorisation holder may not perform an RNP-AR approach to an aerodrome in an EASA Member State on B737 Max aircraft. A TCO authorisation holder may also not conduct an RNP-AR approach to an aerodrome that is <u>not</u> located in an EASA Member State, when the flight originates from a territory in which the EU Treaty applies (e.g. a flight from Guadeloupe to Denver).

No changes have been made to the Final SD in response to this comment.