Title: Make the Boeing 737 MAX safe again

Revision History: 1. 2020Jan01 - First printing 2. 2020Jan08 - Added flight simulator training required.

Make the Boeing 737 MAX safe again

by Ben Wiens 2020Jan01

1. Introduction

The Boeing 737 MAX can be made safe again with some "keep it simple stupid" changes. Bascially the main thing that is required is to change the wiring of one of the power cut off switches back to how it works on the Boeing 737 NG model and include some optional instrumentation in all the Boeing 737 MAX aircraft. Yes, it could be that simple.

2. One fatal crash every 1 month in the USA

It is my own estimation that if all commercial aircraft flying in the USA today had (a) angle of attack sensors tied in to automated anti stall or anti pitch up software such as the Boeing 737 MAX and most Airbus aircraft have, (b) with no way of turning the anti stall or anti pitch up2 software off while still retaining power assist manual trim control, (c) there would be about 1 fatal commercial aircraft crash killing on average 300 people in every 1 month period in the USA.

3. The cut off switch

The only reason that there isn't 1 fatal crash killing on average 300 people in every 1 month period in just the USA is that every aircraft other than the Boeing 737 MAX has a cut off switch that can disable the anti stall or anti pitch up software while still retaining manual power assist trim control. Todd C. Frankel in his article "Not just the 737: Angle-of-attack sensors have had problems" suggests that there have been many Airbus near crashes averted by doing this very thing.

My estimation of 1 fatal crash killing on average 300 people every 1 month period is based on the statistic that USA Angle-of-attack sensors have been flagged as having problems more than 50 times on U.S. commercial airplanes over the past five years as stated in the above article. This is about once every month.

4. Hand crank option not workable

The Boeing 737 MAX procedure for dealing with automated anti pitch up errors is to turn off both the anti pitch up software and the manual power assist trim control at once with single function Stab Trim cut out switches. This leaves just the hand crank mechanical trim control available. It is widely known that the forces generated with a sudden MCAS malfunction would make it nearly impossible to turn the hand crank trim control. This is stated on the webpage written by Peter Lemme, a former Boeing avionics supervisor. He doesn't understand why Boeing did not retain the separate functions of the Stab Trim cut out switches from Boeing 737 Classic and NG models.

5. Over automation isn't working

We have all heard the term "keep it simple stupid". Over automation isn't working. What isn't needed is a fix for the Boeing 737 MAX that involves even more automation when there is a failure in the automated system. Computers, sensors, and switches can all become defective. There needs to be a backup system that reverts to pilot control. I doubt if the 35 year old Intel 286 computer design used for the Boeing 737 MAX flight computer can handle anything more than the workload of the Boeing 737 NG model.

6. The new fix for the Boeing 737 Max should be

The new physical fixes for the Boeing 737 MAX would only involve a few items:

- Angle of attack sensor disagree warning system. (this was already available as an option)
- Angle of attack instrument panel gauges to aid pilots in checking for accuracy. (this was already available as an option)
- Separate Stab Trim cut out switches, one to disable all auto trim controls, the other to disable all power assist manual trim controls in case of electrical malfunction. (this is already available on Classic and NG models)

- Retain one angle of attack sensor input to a single one of the two redundant flight computers. (this was the original 737 MAX configuration)

7. No new parts

And that's it. No new parts except for going back to some older systems. The problem is not the new MCAS system, or less stable characteristics of the Boeing 737 MAX but that the separate Stab Trim cut out switches were not retained. An MCAS computer system that compares the two angle of attack indicators and shuts down MCAS if there is a disagreement is not a good idea as it would simply shut down the MCAS without allowing the pilots to manually switch to the alternate angle of attack indicator and flight computer with an active MCAS.

8. Flight Simulator, training, and new manual

Of course the Boeing 737 MAX improvemements I suggest here should result in a new pilot Type Rating due to the added feature of the MCAS. However the Type Rating should incorporate the Classic, NG, and MAX models as the differences would be minimal. The new training should be as follows:

- There should be flight simulator training largely to make pilots comfortable with flying the improved 737 MAX considering the amount of publicity there has been on the plane and questions pilots must have.
- There needs to be a new computer based training refresher that mentions the angle of attack sensor disagree warning system and the instrument panel gauges with the
- instruction that if the disagree light comes on to disable the Stab Trim cut out switch for auto trim controls and to
- manually fly the aircraft with manual power assist trim control very carefully to the next landing and have the system repaired
- or alternately while flying in manual mode with auto trim disengaged, determine which angle of attack sensor is most likely accurate and switch to the alternate flight computer and then turn on the auto trim control and fly to the next airport and have the system repaired.

9. The FAA and is Boeing 737 MAX unsafe to fly?

The Boeing 737 MAX is not inherently unsafe to fly. True, it has a slightly greater tendency to nose up with high angle of attacks with the new engines but that doesn't mean it will have such a great tendency to stall that pilots can't control the aircraft. All commercial aircraft have stall warning systems. The MCAS system is more about creating a similar feel with the Classic and NG models. This means that the Boeing 737 MAX should not be considered unsafe to fly with the MCAS disabled, as would be required with a malfunctioning angle of attack sensor. Dhierin Bechai writes more about these issues in his article "The Boeing 737 MAX Misconceptions: An Engineer's View"

The only things that makes the Boeing 737 MAX unsafe to fly is if there is no cut out switch for disabling all types of auto trim controls while retaining manual power trim controls, if there are not instruments for comparing the indicators, and if pilots are not made aware of the various types of auto trim controls used on the aircraft. Having a cut out switch for disabling all types of auto trim controls while retaining manual power trim controls I am sure would satisfy the FAA as there are a variety of auto trim controls used on aircraft. With this just stated configuration, the Boeing 737 MAX is safer than most Airbus aircraft, as the Boeing 737 MAX still has a totally mechanical backup system for many of the flight controls which aren't available on the Airbus aircraft. This should be stressed to the FAA and other regulatory agencies.

With the pilots monitoring the angle of attack indictors, the disagree light, the separate stab trim cut out switches, and the ability to switch to a functioning indicator and flight computer would reduce the slightly unsafe flying time period compared to total flight hours due to the new engines on the Boeing 737 MAX to an incredibly low figure.

It appears that both Boeing 737 MAX fatal accidents were due to a faulty angle of attack indicator. If the MCAS actual computer system was inherently unreliable there would have been many fatal crashes due to software issues.

10. References

- Frankel, Todd C. Not just the 737: Angle-of-attack sensors have had problems, https://www.heraldnet.com/nation-world/not-just-the-737-angle-of-attack-sensors-have-had-problems/
- Lemme, Peter Trim Cutout with Severe Out-of-Trim Stabilizer, https://www.satcom.guru/2019/04/stabilizer-trim-loads-and-range.html
- Bechai, Dhierin The Boeing 737 MAX Misconceptions, https://seekingalpha.com/article/4286602-boeing-737-max-misconceptions-engineers-view

11. Revision history

2020Jan01 First printing.

2020Jan08 Added flight simulator training required.