Equivalent Safety Finding F-17 MAX on CS 25.1322(a)(1)(i) [Amdt 11] : Flight Crew Alerting

Applicable to Boeing 737-7, B737-8 and 737-9

Introductory Note:

The hereby presented Equivalent Safety Finding has been classified as an important Equivalent Safety Finding and as such shall be subject to public consultation, in accordance with EASA Management Board decision 12/2007 dated 11 September 2007, Article 3 (2.) of which states:

"*2. Deviations from the applicable airworthiness codes, environmental protection certification specifications and/or acceptable means of compliance with Part 21, as well as important special conditions and equivalent safety findings, shall be submitted to the panel of experts and be subject to a public consultation of at least 3 weeks, except if they have been previously agreed and published in the Official Publication of the Agency. The final decision shall be published in the Official Publication of the Agency.*"

Statement of Issue:

Through the Boeing 737MAX architecture, the 'LE FLAPS TRANSIT' indication is located on the engine display immediately below the trailing edge flap position indicator and illuminates during leading edge device transit (Leading Edge - LE not having reached the commanded position) and extinguishes when the leading edge devices are in their commanded position.
In the event of a leading edge failure to reach commanded position, the 'LE FLAPS TRANSIT' indication remains amber illuminated.
On the 737-700, -800, and -900/-900ER (hereafter referred to as 737 NG), this indication is a dedicated amber light on the forward panel, whereas on the 737 MAX programme, this indication is an emulated amber light on the forward engine display. The functional behavior of the transiant indication is unchanged from the model 737 NG.

The hazard addressed by the applicable requirement CS 25.1322(a)(1)(i), at Amendment 11, is a failure of the alerting system to properly communicate the non-normal operational or airplane system condition to the flight crew, such that the flight crew fails to take the appropriate mitigating action within the appropriate time frame. This requirement states :

> CS 25.1322(a) Flightcrew alerts must:
> (1) Provide the flightcrew with the information needed to:
> (i) Identify non-normal operation or airplane system conditions, […]

EASA has identified that the 737 MAX 'LE FLAPS TRANSIT' alert could not comply with CS 25.1322 (a)(1)(i) because the indication doesn't differentiate between normal and non-normal leading edge flap conditions.

Boeing believes that the 'LE FLAPS TRANSIT' indication provides a fundamentally safe means of providing the flight crew with the information needed to identify non-normal leading edge flap conditions, from which the flight crew can determine the appropriate actions.
Boeing further believes that changing the conditions which trigger this crew alert, or the presentation of the crew alert within the bounds of the 737 MAX crew alerting system, will not improve the overall safety benefit of this crew alert.

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Applicant Proposal:

Boeing believes there are sufficient compensating factors associated with this crew alert to pursue an equivalent level of safety. Indication features, functions and operation of the high lift leading edge flaps in the 737 airplane which provide the compensating factors for an equivalent level of safety are the following :

1. The color amber used for the 'LE FLAPS TRANSIT' indication implies a flight envelope limitation that must be complied with until the indication extinguishes.
2. For a leading edge device failure when the airplane is decelerating, there are multiple layers of low speed awareness provided (low airspeed amber band, AIRSPEED LOW voice alert, lower barber pole displays, and eventually stick shaker) that are still in effect.
3. The 'LE FLAPS TRANSIT' indication has an established meaning to flight crews on the 737.
4. 'LE DEVICES' indicator on the overhead panel provides specific position information for the leading edge devices.
5. Operating procedures specifying that flight crews confirm 'LE FLAPS TRANSIT' is extinguished when devices are in commanded position.

Applicant Safety Equivalency Demonstration:

From AMC 25.1322: "The purpose of flight crew alerts on aeroplanes is to attract the attention of the flight crew, to inform them of specific non-normal aeroplane system conditions or certain non-normal operational events that require their awareness, and, in modern alerting systems, to advise them of possible actions to address these conditions."

The primary purpose of the amber 'LE FLAP TRANSIT' indication is to indicate failure of leading edge flap system. The non-normal conditions which trigger the crew alert are:

- Continuous disagreement of the leading edge flaps position with the commanded position.
- Leading edge in incorrect position.
- Leading edge slat skew.
- Leading edge uncommanded motion.

A consequence of the first failure condition is that the 'LE FLAP TRANSIT' indication will illuminate for normal operation of the leading edge flaps as they are commanded to a new position and their position disagrees with the command until they move to the new position.

Compensating factors on the 737 MAX work together to help differentiate between normal and non-normal leading edge flap conditions.

1. AMC 25-11 provides a functional meaning and a recommended use for the color amber, which includes use for flight envelope limits, cautions and non-normal sources. When the amber 'LE FLAPS TRANSIT' indication is illuminated for a normal condition then there are airspeed limitations that the flight crew must abide by until the indication extinguishes, and these are indicated on the airspeed tape with the high speed barber pole, in this case being set at the flap placard speed. When the amber 'LE FLAPS TRANSIT' indication is illuminated for a non-normal condition then there is a non-normal limit operating speed described in the Quick Reference Handbook Non-Normal Checklist. While the color amber alone doesn't help differentiate between normal and non-normal leading edge flap conditions, the color amber will help the flight crew determine the appropriate actions while the indication is illuminated. One of the key actions is to limit the airplane's speed until the non-normal condition is recognized and actioned upon.

2. The low airspeed amber band, 'AIRSPEED LOW' voice alert, lower barber pole displays, and eventually stick shaker add to flight crew awareness of a potentially low airspeed condition. The thresholds for all of these indications take into account the actual leading edge flap position. Should the 'LE FLAPS TRANSIT' indication illuminate for a failure condition during flap extension, then these other indications help assure the flight crew is accomplishing necessary actions to accommodate the failure.

3. Flight crew training for the 737 MAX clearly describes the conditions which will cause the amber 'LE FLAPS TRANSIT' indication to be presented. It is well understood to 737 pilots that this indication will illuminate for both normal and non-normal conditions. Knowing this, the flight crew is prepared to differentiate the normal conditions from the non-normal conditions which cause the indication to occur. Further, the normal conditions are reinforced multiple times every flight cycle, and the flight crew becomes very familiar with the normal duration for which this indication is presented.

4. 'LE DEVICES' indicator on the overhead panel provides specific position information for the individual leading edge flaps and slats. With the flight crew's knowledge of the commanded flap position, and the expected leading edge position for that commanded position, the flight crew can readily determine if the leading edge flap/slat position is normal or non-normal.

5. Normal operating procedures have the flight crew call for and monitor flap operation and specifically confirm in the After Takeoff and Landing checklists that the leading edge system indications are appropriate for the phase of flight. If any of the leading edge or trailing edge flap indications are not correct for the phase of flight it would be recognized by the flight crew that a non-normal condition exists.