

Proposed Equivalent Safety Finding on CS 25.675 for “Leading Edge Seal Krueger Flap Actuation”

Applicable to Boeing 787-8 and 787-9

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:

The Boeing 787-8 and 787-9 Leading Edge (LE) Seal Krueger flap surface does not encompass travel motion stops and hence does not directly comply with CS 25.675.

The regulation CS 25.675 Stops Amendment 5 is identical to FAA regulation 14 CFR 25.675 Amdt 25-38, and states:

- (a) Each control system must have stops that positively limit the range of motion of each movable aerodynamic surface controlled by the system.
- (b) Each stop must be located so that wear, slackness, or take-up adjustments will not adversely affect the control characteristics of the aeroplane because of a change in the range of surface travel.
- (c) Each stop must be able to withstand any loads corresponding to the design conditions for the control system.

B787-8 and B787-9 – Equivalent Safety Finding to CS 25.675 -

Leading Edge Seal Krueger Flap Actuation

Design Proposal:

The Seal Krueger is located between the inboard slat and the engine with a span of 23 inches, whereas the combined span of all slats is over 1000 inches. An overdrive condition of the LE slats will occur prior to the LE Seal Krueger flap. The LE slats have CS 25.675 compliant stops, actuator shearouts, and a slat over-travel monitoring to shut down the LE drive system.

Seal Krueger flap actuator has no load limiting device and linkage is not sized to system loads. In the event of overtravel the system/surface would rely on local structural failure of the linkage or secondary structure to alleviate load.

In the particular sequences here below identified, the system behaviour will be as follows ;

- At Overtravel in either direction : Seal Krueger flap will continue to drive until the system is shut down by the slat over-travel monitor.
- Overtravel in Retract Direction : Seal Krueger panel will either float or remain in last position, depending on whether or not the overtravel causes a linkage disconnect.
- Overtravel in Extend Direction : Seal Krueger panel will remain in last position.

Safety Equivalency Demonstration:

The following compensating factors are present for the 787-8 type design and for that proposed for the 787-9.

- The probability of an overtravel event occurring is remote.
- The leading edge drive system is common to the Seal Krueger flap and the leading edge slats. There is no condition in which the Seal Krueger flap can be overdriven by the leading edge drive system without also causing an overdrive condition on the leading edge slats.

Note: The leading edge slats are equipped with stops in compliance with CS 25.675 amendment 5.

- An overdrive condition on the leading edge slats would cause the slats to reach their stops and the shearouts in each slat actuator to be utilized. Continued drive system travel beyond the point of slat actuator shearout causes the slat over-travel monitor to shut the leading edge drive system down and triggers the SLATS DRIVE caution message and at the same time triggers the stall warning to use the slats retracted schedule.
- The Seal Krueger flap following any overdrive event will remain attached to the leading edge drive system and the Seal Krueger flap panel will remain in its last driven position or free float depending on whether the overtravel of the leading edge drive system is sufficient to cause the linkage to disconnect.
- The kinematic properties of the Seal Krueger flap linkage make it impossible for the actuator to overextend. In the retract direction the Seal Krueger flap motion is limited by the fixed-wing structure.
- Maintenance action is required following any flight where the leading edge drive system has shut down. That maintenance action comprehensively covers the entire leading edge drive system including the Seal Krueger flap, its drive linkage and actuator as well as surrounding structure. All potential damage to the Seal Krueger flap, its linkage, its drive actuator and surrounding structure is covered by this maintenance action.

The airplane level effects following an over travel event for the existing 787-8 type design and that proposed for the 787-9 are the same as they would be for a directly compliant design which incorporates surface stops for the Seal Krueger Flap. These are as follows:

- Slats become non-functioning during landing which will change the stall characteristics of the airplane. Pilots will follow non-normal procedure for the SLATS Drive message.