Proposed Equivalent Safety Finding on CS 25.161(a) - (c)(3) – Trim

Applicable to Boeing 747-8 / -8F

Introductory note:

The following Equivalent Safety Finding (ESF) has been classified as an important ESF 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 aislestand trim switches can be used to trim the airplane throughout the flight envelope and fully complies with the reference regulation.

Flight Testing has demonstrated that the thumb switch trim does not have enough authority to completely trim the aircraft longitudinally during certain flight conditions. In those cases, longitudinal trim is achieved by using the aislestand (alternate) trim switch to position the stabilizer. This situation is encountered only when all of following conditions occur simultaneously, (1) light weight, (2) aft CG, (3) airspeed near VMO, and (4) altitudes between 10-24,000 feet.

Subsequent to flight testing, the FAA-TAD expressed concern with compliance to the reference regulation based on an interpretation of the intent behind “trim”. The main issue being that longitudinal trim cannot be achieved throughout the flight envelope using thumbswitch trim only.

The reference regulation (CS 25.161 (a) and (c)(3)) and policy do not specify the method of trim, nor do they state that when multiple pilot trim control paths exist that they must each independently be able to trim the airplane throughout the flight envelope.

Boeing 747-8 / -8F – Equivalent Safety Finding B-13

- Trim -

Applicant Proposal:

Boeing believes that the 747-8/-8F longitudinal trim system provides an appropriate level of safety relative to longitudinal trim capability.

The horizontal stabilizer is the primary means for manual longitudinally trimming on the 747-8/-8F. Trim is achieved by varying the incidence of the stabilizer to zero the pilot column force required to maintain the desired flight condition.

The 747-8/-8F stabilizer trim system provides two means to command the desired stabilizer angle for longitudinal trim of the airplane.

1) Thumb switch command (via manual electric trim mode)

   - The manual electric trim mode is selected through the operation of the dual thumb switches on the pilot's or co-pilot's control column.
   - The trim limits for this command path are referred to as the "electric trim limits"

2) Aislestand trim switch command (via alternate trim mode)

   - The alternate trim switch is located on the aisle stand near the first officer.
   - The trim limits for this command path are referred to as the "mechanical limits"

In addition, Boeing has an internal requirement that is integral to the selection of the electric trim limits and part of the internal safety assessment for the airplane. This requirement drove the selection of the thumb switch (manual electric trim mode) trim limits to be less than the mechanical limits.

Applicant Safety Equivalency Demonstration:

1. **Compensating Aircraft Design Factors**

The 747-8/-8F has enough horizontal stabilizer travel available to allow the airplane to be trimmed throughout the flight envelope using the available trim command systems.

Flight test and analysis demonstrate that the pilot is able to statically trim the 747-8F longitudinally throughout the flight envelope using the available trim systems. There is no difference anticipated for the 747-8

For dynamic conditions with the stabilizer at the electrical trim limit (i.e., thumbswitches can no longer command additional nose down trim) or alternate trim limit, sufficient elevator control power has also been demonstrated to exist to allow the pilot to manoeuver the airplane within the limit flight envelope.

2. **Compensating Flight Crew Procedures**

The Flight Crew Operations Manual (FCOM) states that the aisle stand (alternate) trim switches command an increased range of stabilizer travel relative to the thumb switches. Boeing proposes to expand the FCOM wording on the use of the alternate trim switches.

Verbiage on the aisle stand (alternate) trim will also be added to the Flight Crew Training Manual (FCTM).

3. Compensating Airline Operational Factors - Limited GW/CG Exposure Envelope

The conditions during which thumbswitch (manual electric trim mode) electric trim limits are encountered is not very likely to occur in-service based on how operators load the airplane.

Operators will typically load the airplane to mid or forward cg's, especially as the gross weight increases, which limits the exposure area of the GW/CG envelope where aisle stand trim inputs are required.

Passenger airlines tend to load in a similar manner, mostly driven by the fuel loading influence on the GW/CG location.

4. Compensating Airline Operational Factors - Limited Airspeed / Altitude Exposure Envelope

The conditions during which thumbswitch (manual electric trim mode) electric trim limits are encountered is not very likely to occur in-service based on how operators operate the airplane.

Typical climb and descent operating speeds for the 747-8/-8F limit the exposure area of the flight envelope where aisle stand trim inputs are required. These speeds also provide the best performance and lowest fuel burn.

The envelope requiring the use of aisle stand (alternate) trim is limited to a specific region of the airspeed/altitude and the gross weight/centre of gravity envelopes. The exposure to the trim limit decreases as the weight of the airplane or altitude is increased.

The flight condition requiring the greatest amount of aisle stand trim is an extremely light weight aft cg condition near 10,000 feet that cannot be reached during take-off due to existing GW/CG limitations (i.e., can only be reached by burning fuel). This means the Vmo encounter will likely occur during descent. As discussed above, typical descent speeds are below Vmo and do not encounter any trim limits.