



Federal Aviation Administration

Memorandum

Date: November 20, 2015

To: Manager, Boeing Aviation Safety Oversight Office, ANM-100B

From: Manager, Transport Airplane Directorate, ANM-100

Prepared by: John Hed, ANM-160S

Subject: INFORMATION: Equivalent Level of Safety Finding for Trim Displays on Boeing Company Model 787-8/-9/-10 (Project Nos. TC6918SE-T, PS06-0496, PS06-0497, PS13-0546 and PS14-1031)

ELOS Memo#: TC6918SE-T-F-14

Regulatory Ref: § 25.677(b)

The purpose of this memorandum is to inform the aircraft certification office of an evaluation made by the Transport Airplane Directorate (TAD) on the establishment of an equivalent level of safety (ELOS) finding for the Model 787-8 airplane.

This memo was subsequently revised to extend this ELOS to the Boeing Model 787-9 and 787-10 airplanes.

Background

Boeing has submitted a request for an ELOS finding to Title 14, Code of Federal Regulations (14 CFR) 25.677(b) for the Models 787-8/-9/-10. Boeing's design does not literally comply with the rule which states that the trim control should be near the indicator, and that the trim indication should be displayed full time.

Applicable regulation(s)

§ 25.677(b)

Regulation(s) requiring an ELOS

§ 25.677(b)

Description of compensating design features or alternative standards which allow the granting of the ELOS (including design changes, limitations or equipment need for equivalency)

787 Design: For the 787, the stabilizer and rudder trim position indications on the engine indication and crew alerting system (EICAS) display are provided full time on the ground and part-time in the

air. The trim indications are located in a dedicated position on the display, so there is no conflict with the display of other information, and the EICAS display itself is always present. The EICAS trim indications are removed after takeoff under normal conditions, but are automatically displayed for specific non-normal conditions. The automatic display logic takes precedence over the normal display removal logic after takeoff.

The stabilizer and rudder trim position indications are also displayed on the flight controls synoptic (pilot selectable), so the trim information is always available to the pilots if desired.

The stabilizer and rudder trim position indications on the EICAS display are provided full time on the ground. After takeoff both trim indications blank.

In the air, the stabilizer and rudder trim position indications are automatically displayed when any associated failures are detected.

In the air, the rudder trim indication is also automatically displayed when the rudder trim is moved off center more than a designated amount.

After landing, the stabilizer and rudder trim position indications are displayed when groundspeed is less than 40 knots. Additionally, the stabilizer position is displayed after landing if any pitch trim switch is used. This supports training touch and go operations.

The design for the display of the trim indications meets the Boeing quiet/dark flight deck philosophy – a visual indication is not needed to identify a system that is operating normally; however, a fault indication is required when a system is not operating normally and the pilots need to take action. In general, information is provided to the pilots to safely and efficiently operate the airplane. Each item must earn its way onto a display. Reducing the information displayed improves the visibility of the remaining items and emphasizes the importance of those items. Based on these criteria, the stabilizer and rudder trim position indications are provided on the EICAS display full time on the ground where the pilots need to verify the positions for takeoff, and are provided in the air under related non-normal conditions where a pilot may want to reference the trim indication, although there is no procedure to do so.

The following information shows the equivalent level of safety for the new location and part-time application of the stabilizer and rudder trim position indications.

Equivalent level of safety for location: The first sentence of FAR 25.677(b) addresses the location of the trim indications: “*There must be means adjacent to the trim control to indicate the direction of the control movement relative to the airplane motion.*”

On current production Boeing airplanes the controls and indications of the trim systems are not co-located in most cases. The stabilizer trim switches are on the outboard horn of the control wheel, with the stabilizer position indication on the forward aislestand. The aileron trim switches are on the aft aislestand with the indication on the top of the control column. And the rudder trim switches and the indicator are co-located on the aft aislestand. These systems have been operating safely on the Boeing airplanes for many years. The change for the 787 is to simply move the stabilizer position from the forward aislestand to the EICAS display and move the rudder trim indication from the aft aislestand to the EICAS display. There is no aileron trim on the 787.

The only pilot procedures for use of the stabilizer or rudder trim position indications is on the ground where these indications are displayed full time on EICAS. For the stabilizer position, the crew procedure is to set the appropriate value for takeoff and to ensure it is in the greenband. For the rudder trim, the crew procedure is to ensure the rudder trim is zero before takeoff. These trim operations can be accomplished as safely with the position indication on the EICAS display as with the position indication on the aislestand.

In the air, there are no procedures for pilots to reference the trim position indications. For the stabilizer, pilots reference the column forces to identify the stabilizer/pitch trim requirements. There is no normal use of the rudder trim switches in the air for the 787. For the non-normal conditions such as engine failures or other aerodynamic asymmetries, the flight control system automatically adds sufficient rudder to counter the situation, so there is no need for the pilot to manually trim.

Equivalent level of safety for part-time display: FAA Advisory circular (AC) 25-11, “Transport Category Airplane Electronic Display Systems”, addresses part-time displays in paragraph 7(h):

(h) Full-Time vs. Part-Time Displays. Some airplane parameters or status indications are required by the regulations to be displayed; yet they may only be necessary or required in certain phases of flight. If it is desired to inhibit some parameters from full-time display, an equivalent level of safety to full-time display must be demonstrated. Criteria to be considered include the following:

- (1) Continuous display of the parameter is not required for safety of flight in all normal flight phases.*
- (2) The parameter is automatically displayed in flight phases where it is required.*
- (3) The inhibited parameter is automatically displayed when its value indicates a non-normal condition, or when the parameter reaches a non-normal value.*
- (4) Display of the inhibited parameter can be manually selected by the crew without interfering with the display of other required information.*
- (5) If the parameter fails to be displayed when required, the failure effect and compounding effects must meet the requirements of 25.1309 and any other applicable regulations.*
- (6) The automatic, or requested, display of the inhibited parameter should not create unacceptable clutter on the display; simultaneous multiple "pop-ups" must be considered.*
- (7) If the presence of the new parameter is not sufficiently self-evident, suitable alerting must accompany the automatic presentation.*

The following addresses each sub-paragraph directly regarding the part-time display of the indications on the EICAS display.

- (1) Continuous display of the parameter is not required for safety of flight in all normal flight phases.*
- (2) The parameter is automatically displayed in flight phases where it is required.*

The trim indications are displayed on ground for the pilot to set the takeoff values. The indications are not required by any normal or non-normal procedure in any phase of flight, however, the indications are displayed automatically for non-normal conditions where the pilot may want to reference the trim position.

- (3) The inhibited parameter is automatically displayed when its value indicates an abnormal condition, or when the parameter reaches an abnormal value.*

For stabilizer failures (EICAS messages PITCH UP AUTHORITY, PITCH DOWN AUTHORITY, STABILIZER, STABILIZER CUTOUT) the stabilizer position will automatically be displayed on EICAS. Any time the rudder trim is non-zero (manually or automatically) the rudder trim position will be displayed on EICAS.

(4) Display of the inhibited parameter can be manually selected by the crew without interfering with the display of other required information.

The trim indications are displayed full time on the flight controls synoptic. The pilot can select the flight control synoptic and display it on one of five multi-function displays when desired.

(5) If the parameter fails to be displayed when required, the failure effect and compounding effects must meet the requirement of § 25.1309.

The trim indications are only required for pre-flight, and the EICAS display is required for dispatch.

(6) The automatic, or requested, display of the inhibited parameter should not create unacceptable clutter on the display; simultaneous multiple “pop-ups” must be considered.

The trim indications have dedicated space on EICAS, so they can always be displayed when the logic is satisfied.

(7) If the presence of the new parameter is not sufficiently self-evident, suitable alerting must accompany the automatic presentation.

Automatic display of the trim indicator in the air is always accompanied by a related EICAS message as listed earlier.

Explanation of how design features or alternative standards provide an equivalent level of safety to the level of safety intended by the regulation

The above design features meet the intent of § 25.677(b) in the following ways:

- 1) The trim positions are available at all times when desired.
- 2) The trim positions are automatically provided when needed.
- 3) The trim display location design is consistent with both the Boeing design philosophy and previously certified Boeing airplanes.
- 4) The design meets the standards set forth in AC 25-11, paragraph 7(h).

FAA approval and documentation of the ELOS

The FAA has approved the aforementioned ELOS finding in project Issue Paper F-14 or Administrative Collector Issue Paper G-6. This memorandum provides standardized documentation of the ELOS that is non-proprietary and can be made available to the public. The TAD has assigned a unique ELOS Memorandum number (see front page) to facilitate archiving and retrieval of this ELOS. This ELOS Memorandum number should be listed in the type certificate data sheet under the Certification Basis section. An example of an appropriate statement is provided below.

Equivalent Safety Findings have been made for the following regulation(s): § 25.677(b), “Trim Systems” (documented in TAD ELOS Memo TC6918SE-T-F-14).



Transport Airplane Directorate
Aircraft Certification Service

11/24/15

Date

ELOS Originated by Seattle ACO:	John Hed	ANM-160S
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