



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 Out-of-Trim Characteristics on Boeing Company Model 787-8/-9/-10 (Project Nos. TC6918SE-T, PS06-0496, PS06-0497, PS13-0546 and PS14-1031)

Memo No.: TC6918SE-T-F-17

Reg. Ref.: § 25.255

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 airplanes.

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

Background

Boeing requested an ELOS finding to Title 14, Code of Federal Regulations (14 CFR) 25.255 for the Models 787-8/-9/-10. Boeing's design does not allow testing per the 14 CFR part 25 procedure to check compliance with the rule which delineates required handling qualities characteristics when the aircraft is in a high speed, out-of-trim condition.

Applicable regulation(s)

§ 25.255

Regulation(s) requiring an ELOS

§ 25.255

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

The 787 has what is called the C*U normal control law. Due to the characteristics of this control law, and the elevator to stabilizer offload function, there are no scenarios where the pilot has to “hold” column force against a mistrim. Column forces and gradients for any out-of-trim conditions would be identical to nominal in-trim conditions.

Another relevant design feature of the 787-8 is the Overspeed Protection (OSP) Function. Overspeed protection is an automatic envelope protection function that generates a nose up elevator command as a result of an overspeed condition. In the event of an external disturbance such as a windshear that causes the airplane to exceed either V_{mo} or M_{mo}, OSP will rapidly return the airplane to V_{mo} or M_{mo} without any pilot input.

The System Safety Analysis fault trees have considered flight control system failures including operation in SECONDARY/DIRECT mode to show compliance to §§ 25.671, 25.672, and 25.1309.

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

The design of the primary control law in addition to the numerous and redundant safety features of the stabilizer control system provide a wide range of compensating features that provide an equivalent level of safety for § 25.255. These are summarized below.

- A sustained stabilizer mistrim cannot occur in Normal mode without a control system failure.
- The pilot does not command the stabilizer via any of the trim input switches.
- Operation of the wheel trim switches or alternate trim switches cannot command a speed higher than V_{mo} or M_{mo}.
- The primary control law provides robust disturbance rejection capability.
- The Overspeed Protection Function provides additional deterrence and protection to exceeding the normal flight envelope.
- There are two independent stabilizer drive channels with separate command paths and monitoring.
- The stabilizer motor will not stall for the most critical condition.
- Even if a sustained mistrim should occur following a control system failure, there will not be any long-term force required by the pilot to trim.

The types of high altitude upsets that originally drove development of § 25.255 will not result in a significant exceedance of the normal flight envelope boundaries. Without pilot action, the airplane will return to V_{mo} or M_{mo}.

FAA approval and documentation of the ELOS

The FAA has approved the aforementioned ELOS finding in project Issue Paper F-17 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): § 25.255, "Out-of-Trim Characteristics" (documented in TAD ELOS Memo TC6918SE-T-F-17).



Transport Airplane Directorate
Aircraft Certification Service

11/24/15

Date

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