



Federal Aviation Administration

Memorandum

Date: December 22, 2015

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

From: Manager, Transport Airplane Directorate, ANM-100

Prepared by: Eric Brown, ANM-150S

Subject: INFORMATION: Equivalent Level of Safety (ELOS) Finding for Cabin Altitude Warning System with Dual Limits for Operations into High Elevation Airports on Boeing Model 737 Airplane;
FAA Project Nos. PS12-0037, PS12-0038 and PS12-0039

ELOS Memo # PS12-0038-S-2

Reg. Ref.: §§ 25.841(a), (b)(6), and (b)(8), Amendment 25-87; 25.1309(c), Amendment 25-41; and 25.1447(c)(1), Amendment 25-116

The purpose of this memorandum is to inform the certificate management 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 Boeing Model 737-7, 737-8, and 737-9 aircraft.

Background

In accordance with the provisions of Title 14, Code of Federal Regulations (14 CFR) 21.21 (b)(1), Boeing submitted a request for an ELOS to the requirements of § 25.841(a) and (b)(6) when applied to the 737-7/-8/-9 take-off and landing operations at airports with field elevations between 8,000 feet and 14,500 feet. Boeing wishes to obtain approval for takeoff and landing operations at airports with elevations up to 14,500 feet and to do so without activation of the 10,000 feet cabin altitude warning. Boeing has designed a dual limit cabin altitude warning system that they believe will provide an ELOS to the requirements of § 25.841(b)(6). Boeing documentation calls this the "High Altitude Operation" system. Also, Boeing provided the results of analysis documenting cabin pressure rate of change and elapsed time under worst case (hot day) conditions during high elevation airport operations which demonstrated ELOS to the requirement in § 25.841(a), that the occupants would not be exposed to a cabin pressure altitude above 8,000 feet in flight for an unacceptable period of time.

Applicable regulation(s)

§§ 21.21(b)(1); 25.841(a),(b)(6), and (b)(8); 25.1309(c); and 25.1447(c)(1)

Regulation(s) requiring an ELOS

§ 25.841(a) and (b)(6)

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

Section 25.841(a) requires that the cabin pressure altitude not exceed 8,000 feet during normal operations. The FAA considers normal operations to include taxi, takeoff, approach and landing. To assure that the cabin pressure controller minimizes the time when the cabin altitude exceeds 8,000 feet during approach into, or departure from a high elevation airport, the applicant provided:

The results of analysis of the duration that the cabin altitude may exceed 8,000 feet during approach into or departure from a high elevation airport depended on the elevation of the departure airfield, the cruise altitude, the airplane rate of climb or descent, and for approaches, when the crew selects the destination landing field elevation. Boeing provided results from this analysis of the duration for the most severe operational condition (i.e., hot day conditions). These results are included in the safety analysis documentation created as part of the certification deliverables for the 737-7, 737-8, and 737-9 airplanes.

Section 25.841(b)(6) requires a warning when the cabin pressure altitude exceeds 10,000 feet. However, the cabin altitude must equal the airport elevation when departing or landing. Boeing has designed and installed a new digital cabin pressure controller, a dual limit cabin altitude warning system, and associated flight deck selector switch for high altitude airport operations, which will allow normal takeoffs and landings at those at elevations between 8,000 feet and 14,500 feet for the 737-7/-8/-9. The dual limit cabin altitude warning system shifts the alarm set point from 10,000 feet to 14,000 ft. or 14,650 ft., or 15,200 ft. (dependent upon three airplane configurations).

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

Boeing provided the results of analysis of the duration that the cabin altitude may exceed 8,000 feet during approach into or departure from a high elevation airport for the most severe operational conditions (i.e., hot day conditions). The FAA finds that these data show that operation of the airplane's environmental control system successfully minimizes the exposure time above 8,000 feet and provides an equivalent level of safety intended by §25.841(a).

The landing altitude of the subject airplanes, when utilizing the High Altitude Operations system, is in excess of the airplane cabin pressure altitude limit established by existing

regulations (i.e., 10,000 feet pressure altitude). To compensate, Boeing has incorporated a design feature that provides cabin pressure control that shifts the warning to a higher altitude (i.e., lower) pressure. The combination of this design change and operational procedures discussed below provides a means to control the cabin pressure upon descent into a high altitude airport, such that upon landing the airplane will be unpressurized and the cabin doors may be opened, as well as the reestablishment of “normal” cabin pressure control following takeoff from a high altitude airport.

If a landing field is selected for a destination field in excess of 8,000 feet and the aircraft holds between 10,000 feet and 15,200 feet, the occupants and crew may be exposed to cabin altitudes of 10,000 feet or greater for duration in excess of that allowed by the operating rules and without cabin altitude warning in the high altitude mode. The operating rules §§ 91.211, 121.329(b), and 135.89(b)(1) address the use of oxygen to prevent hypoxia and related degraded pilot performance.

The Boeing design mitigates this exposure by limiting high altitude crew procedure to only conditions where the High Altitude Operation is required. Pilot procedures to don oxygen address crew exposure. High cabin altitude exposure to passengers (and crew) only exists when High Altitude Operation is invoked (above 10K altitude), which should only occur when crew are preparing for descent into or departure from a high altitude airport, and not during cruise operations. Take-off exposure is mitigated by crew procedure to select normal landing altitude mode (or select landing altitude to destination airport).

The FAA finds that these data show that operation of the airplane’s pressurization control system provides an equivalent level of safety intended by § 25.841(b)(6).

FAA approval and documentation of the ELOS finding

The FAA has approved the aforementioned ELOS as documented in Issue Paper S-2, “Cabin Altitude Warning System with Dual Limits for Operations into High Elevation Airports.” 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. [e.g., Equivalent Safety Findings have been made for the following regulation(s):

§ 25.841(a) and (b)(6) – “High Altitude Landing Operations” (documented in Transport Airplane Directorate ELOS Memo PS12-0038-S-2)]

Original signed by
Christopher Parker
Transport Airplane Directorate,
Aircraft Certification Service

12/22/2015
Date

ELOS Originated by ACO:	BASOO Manager	ANM-100B
-------------------------	---------------	----------