



U.S. Department
of Transportation

**Federal Aviation
Administration**

Memorandum

Subject: INFORMATION: Equivalent Level of Safety Finding for Use of Analysis to Demonstrate Safe Flight in Icing Conditions, Allied Partners Boeing (APB) Model 757-200 Winglet Project ST8664SE-T
FAA Project Number ST8664SE-T

Date: May 12, 2005

Reg Ref: § 21.21(b)(1), 25.1419

From: Manager, Transport Airplane Directorate, ANM-100

Reply to: Don Eiford,
Attn of: ANM-150S

To: Manager, Seattle ACO, ANM-100S

ELOS: ST8664SE-T-S-1
Memo #:

The purpose of this memorandum is to inform the certificate management aircraft certification office of an evaluation made by the Transport Airplane Directorate on the establishment of an equivalent level of safety finding for the Model 757-200 series of aircraft.

Background

APB has submitted a request for an Equivalent Safety Finding to FAR § 25.1419 for the model 757-200 with the installation of winglets. APB proposes that the 757-200 with winglets use analysis in place of both dry air flight tests and flight tests in measured natural atmospheric icing conditions to demonstrate compliance to the icing certification requirements of § 25.1419.

Applicable regulation(s)

§ 25.1419

Regulation(s) requiring an ELOS

§ 25.1419

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

14 CFR Part 25.1419 (b) states “To verify the ice protection analysis, to check for icing anomalies, and to demonstrate that the ice protection system and its components are effective, the airplane or its components must be flight tested in the various operational configurations, in measured natural atmospheric icing conditions.” Provided that a sufficiently conservative analysis is performed, use of analytical methods may, in part, be an acceptable substitute for flight testing in measured natural atmospheric icing conditions in order to establish the small incremental differences between the baseline (unmodified) airplane configuration, and the

winglet-equipped airplane. In order to substantiate that an equivalent level of safety exists for the winglet installation from the standpoint of flight testing in measured natural icing conditions, the applicant must show that the analysis, along with the validation methodology, provide a reliable alternative to flight testing in measured natural atmospheric icing conditions. This does not constitute a general FAA position regarding the value of flight testing in measured natural icing conditions, but is considered appropriate for evaluating the small incremental differences resulting from the APB winglet installation.

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

With regard to the omission of flight tests in dry air, using artificial ice shapes to verify airplane handling and performance characteristics, the applicant asserts there are several mitigating factors in this program that add conservatism to the analysis, rendering flight tests unnecessary. APB has found during flight testing of the 737-700IGW and 737-800 with winglets that the winglet installation results in improved handling and performance characteristics, or, as a minimum, no detriment to the airplane handling and performance characteristics, but does not intend to take certification credit for any improvements for dispatch into forecast icing conditions, except for low speed takeoff climb. APB expects, and wind tunnel results indicate, that drag increases associated with ice accretion on the additional unprotected surfaces are offset by the drag reduction and lift/drag (L/D) ratio improvements gained with the winglets installed. In other words, a winglet equipped 757 with accreted ice on the unprotected surfaces will still show lift and drag improvements when compared to the baseline airplane with accreted ice, up to the maximum accumulations required to be addressed for enroute, approach, holding, and landing conditions.

APB has stated that the clean (non-iced) winglet may often operate near its maximum lift capability. With ice accretion, the winglet may stall at reduced winglet angles of attack (small sideslip angles), but, APB states, a winglet stall will not degrade airplane handling qualities. APB intends to validate this assertion by a combination of clean airplane flight testing, wind tunnel testing, and analysis. Aerodynamic data (wind tunnel and flight test) show that the winglet effect on the vertical lift component, especially with flaps extended, is insignificant. With flaps extended (approach and landing configurations), the majority of the wing lift is produced by the portion of the wing from which the flaps extend (inboard on the 757). With a fully stalled winglet, the measured lift does not change, therefore, performance should not be degraded in the event that the winglets become stalled due to ice accretion. Further, it will be shown that handling qualities are not degraded and that no unacceptable buffet results from stalled winglets. Ice accretion will influence the local angle of attack at which winglet flow separation, and stall, occur. In this program, APB asserts that the ice accretion shape on the winglets is relatively unimportant.

APB should establish that the analysis is sufficiently conservative to justify use of an independent computer code to predict ice shapes instead of flight testing in measured natural atmospheric icing conditions. To support this position the applicant should show that even if the clean winglet is operating near its maximum lift, it would still exhibit acceptable handling qualities. The applicant should show that the drag increase resulting from the contaminated winglets does not exceed the wing's drag benefit resulting from the uncontaminated winglets. The applicant should also show that the contaminated winglets have acceptable handling qualities within the normal operating envelope with expected roll, sideslip, yaw and sideslip and

yaw rates. If the effects of the stalled uncontaminated winglet are to be used for the contaminated winglet, the applicant should show that the characteristics of the stalled winglets are similar (for example, the extent and nature of separated airflow and any induced flow effects on the aileron and inboard wing surfaces). Flutter should be addressed. The applicant should provide these showings for icing in a flutter report, a performance report, and a handling qualities report.

FAA approval and documentation of the ELOS

The FAA has approved the aforementioned Equivalent Level of Safety Finding in project issue paper S-1. This memorandum provides standardized documentation of the ELOS that is non-proprietary and can be made available to the public. The Transport Directorate 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 (TC’s & ATC’s) or in the Limitations and Conditions Section of the STC Certificate. An example of an appropriate statement is provided below.

An Equivalent Safety Finding has been made for the following regulation:
 § 25.1419, “Ice Protection” (documented in TAD ELOS Memo xxx).

Original signed by Steve Boyd

5/12/05

 Manager, Transport Airplane Directorate,
 Aircraft Certification Service

 Date

ELOS Originated by Seattle ACO:	Don Eiford	ANM-150S
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