Federal Aviation Administration

Memorandum

Date: January 12, 2011

To: Manager, Transport Standards Staff, International Branch, ANM-116

From: Manager, Transport Airplane Directorate, ANM-100

Prepared by: Douglas Bryant, ANM-112

Subject: INFORMATION: Equivalent Level of Safety (ELOS) Finding for the Airbus Model A350 airplane (FAA Project Number TC0544IB-T)

ELOS Memo#: TC0544IB-T-P-10

Reg. Ref.: §§ 25.933(a)(1)(ii) and 25.1309(b)(1)

This memorandum informs 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 Airbus Model A350 airplane.

Background

Title 14 Code of Federal Regulations section 25.933(a)(1)(ii) requires that "The airplane is capable of continued safe flight and landing under any possible position of the thrust reverser." Airbus declared that Model A350 airplane will not demonstrate compliance with § 25.933(a)(1)(ii). However, Airbus states that the A350 airplane thrust reverser design protects against in-flight reverser deployment to an extent that provides a level of safety equivalent to that provided by direct compliance with the rule. Compliance with § 25.933(a)(1)(ii) is intended to completely eliminate all risk of catastrophic in-flight reverser deployment from normal operation. Under § 25.933(a)(1)(ii), any residual risk of catastrophic in-flight reverser deployment would be limited to scenarios involving unusual aircraft configurations, abnormal flight conditions or inappropriate flight crew actions. Therefore, any design intended to provide an equivalent level of safety to the subject rule must limit the residual risk of catastrophic in-flight reverser deployment to a similar level.

In general, the catastrophic risks from other aircraft system hazards are identified and managed through compliance with § 25.1309(b)(1). Therefore, compliance with this

standard by the means delineated in the related FAA Advisor Circular (AC) 25.1309-1A should be part of any equivalent safety finding utilizing probability that a catastrophic in-flight deployment will not occur. However, as documented in the docket justification for the subject § 25.933 rule, "A review of the past operating history of airplane engine thrust reversers indicates that fail-safe design features in the reverser systems do not always prevent unwanted deployment in flight. Many of these unwanted deployments are not caused by deficiencies in design but can be attributed to maintenance omissions, wear and other factors that cannot be completely accounted for in the original design and over which the manufacturer generally has no control even when comprehensive maintenance programs are established." This perspective has been reinforced by an Aerospace Industries Association/FAA review of transport service history, which indicated that many of the reverser in-flight deployment incidents involved inadequate maintenance or improper operations. Other factors such as uncontained engine failure, unanticipated system failure modes and effects, and inadequate manufacturing quality have also played a role in in-service deployment incidents.

Therefore, in addition to the traditional reliability predictions provided in demonstrating compliance with § 25.1309, the equivalent safety finding to § 25.933(a)(1)(ii) will require that the influences which could render that prediction invalid be identified and acceptable means for managing these influences be defined. To this end, compensating design assurance and continued airworthiness features must be provided.

Applicable regulation(s)

§§ 25.933(a)(1)(ii) and 25.1309(b)(1)

Regulation(s) requiring an ELOS finding

§ 25.933(a)(1)(ii)

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 thrust reverser actuation system architecture has three independent lines of defense to prohibit inadvertent in-flight deployment of the thrust reverser sleeves. The actuation system has two primary locks per thrust reverser sleeve. The thrust reverser tertiary lock is the third line of defense to avoid an inadvertent thrust reverser deployment in-flight. It prevents movement of the translating sleeve in case of failure of the primary locks. There is one tertiary lock per translating sleeve.

Airbus has demonstrated that in normal operation throughout the fleet life the Model A350 airplane is protected against catastrophic in-flight reverser deployment including:

1. A rigorous qualitative safety analysis to show that no single failure or malfunction, regardless of the probability, can result in a catastrophic in-flight reverser deployment. In addition to the traditional failure modes and effects analysis (FMEA), a top-down analysis, at least to the assembly level, was performed to assure that any obscure single failure modes were identified.
2. An average risk analysis in accordance with AC 25.1309-1A, which predicts that catastrophic in-flight reverser deployment will not occur in the fleet life of the Model A350 airplane.
3. A specific risk analysis which predicts that at the beginning of each flight the aircraft will continue to meet the "no single failure" criteria of analysis #1 above and that the risk of catastrophic in-flight deployment is less than 1x10-6 / flight-hour. This analysis was only required if the design can have contributory faults present for more than one flight. This analysis considered any aircraft configuration (including latent faults) anticipated to occur in the fleet life of the airplane type which is not proposed to be precluded from dispatch by the master minimum equipment list (MMEL). For the purpose of this analysis a configuration whose probability of occurrence is greater than 1x10-8 must be assumed to occur unless a lower total fleet exposure time was justified by prescribing either production or utilization limits.
4. Verification that the influences which could render these predictions invalid have been identified and acceptable means for managing these influences throughout the fleet life of the Model A350 airplane have been defined and implemented.

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

Although noncompliant with the regulation, a rigorous system safety analysis of the Airbus Model A350 airplane has demonstrated the risk of an inadvertent in-flight thrust reverser deployment is extremely improbable and is considered to provide an equivalent level of safety to demonstrating that the airplane is capable of continued safe flight and landing under any possible position of the thrust reverser.

FAA approval and documentation of the ELOS finding

The FAA has approved the aforementioned equivalent level of safety finding in the Model A350 project issue paper P-10, titled "Flight Critical Thrust Reverser." This memorandum provides standardized documentation of the ELOS finding 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:

Equivalent Level of Safety Findings have been made for the following regulation(s):
14 CFR 25.933(a)(1)(ii), Reversing Systems
(documented in TAD ELOS Memo TC0544IB-T-P-10)

FEBRUARY 11, 2014

Manager, Transport Airplane Directorate,
Aircraft Certification Service

Date

ELOS Originated by Transport Standards Staff:	Project Engineer Douglas Bryant	Routing Symbol ANM-112