



Federal Aviation Administration

Memorandum

Date: October 28, 2010

To: Manager, New York ACO, ANE-170

From: Manager, Transport Airplane Directorate, ANM-110

Prepared by: Rocco Viselli, ANE 172

Subject: **INFORMATION**: Equivalent Level of Safety (ELOS) Finding for
Bombardier Aerospace project on a CL-600-2E25 Thrust Reverser
System, FAA Project # AT5627NY-T.

ELOS Memo#: AT5627NY-T-P-1

Regulatory Ref: Title 14, Code of Federal Regulations (14 CFR) sections 21.21(b)(1),
25.933(a)(1)(ii), and 25.1309(b)(1), Advisory Circular (AC) 25.1309-1A

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 Bombardier Aerospace (BA) Model CL-600-2E25.

Background:

Bombardier is requesting an ELOS Finding for the Bombardier CL-600-2E25 (CRJ-1000) as the aircraft does not intend to demonstrate compliance with an applicable airworthiness requirement [§25.933(a)(1)(ii)] which states, "The airplane is capable of continued safe flight and landing under any possible position of the thrust reverser." Therefore, in accordance with the provisions of § 21.21(b)(1) a type certificate cannot be issued for the Bombardier CL-600-2E25 unless the airworthiness provision not complied with is compensated for by factors that provide an equivalent level of safety.

Applicable Regulations:

14 CFR §§ 21.21(b)(1), 25.933(a)(1)(ii), and 25.1309(b)(1)

Regulation Requiring an ELOS:

14 CFR §§ 25.933(a)(1)(ii), and 25.1309(b)(1)

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

In a letter to Transport Canada dated February 3, 2010, (RDIMS #5415191) Bombardier Aerospace (BA) provided following information and their position:

BA has reviewed the criteria provided by the FAA and has confirmed that it is similar to the FAA Position documented via an Issue Paper of the same subject for the CL-600-2D24 (CRJ-900). Therefore since the CL-600-2E25 (CRJ-1000) has been declared a derivative of the CRJ-900 and incorporates the same thrust reverser system and logic, the agreement and conclusion approved for the CRJ-900 are also applicable.

BA proposes that in lieu of using the criteria as outlined in 14 CFR §§ 25.933(a)(1)(ii), and 25.1309(b)(1), the FAA adopt the current proposed harmonized rulemaking as described in the minutes of 20th Powerplant Integration Harmonization Working Group (HWG) meeting, November 1998, Cannes, France - .933 Task Team - Thrust Reverser Harmonization, "FAR/JAR 25.933" draft rule and advisory material (AC/J), Draft 10, Phase II). This rulemaking represents a harmonized position between industry and airworthiness authority members of the aviation rulemaking advisory committee (ARAC) HWG, eliminating any differences in interpretations that require additional work on the part of the applicant.

BA proposes that compliance by equivalent safety finding be established based on the guidance provided by the ARAC HWG. BA will demonstrate compliance in the following manner:

1) System Safety Analysis:

A quantitative system safety analysis will be produced to identify critical failure paths and malfunctions. The analysis will show that no single failure or malfunction can result in an inadvertent in-flight reverser deployment (i.e. average probability per hour of flight on the order of 1×10^{-9} /flight hour or less). In addition, BA will provide a traditional failure modes and effects analysis (FMEA) with a top down analysis, at least to the assembly level, assuring that there are no obscure failure modes.

The analysis will also consider any combination of failures that could lead to a catastrophic in-flight deployment.

It will be demonstrated that for any combination of 2 failures:

- Neither failure will be pre-existing (dormant or undetected for more than one flight)
- Occurrence of either failure will result in warning (indication) to the crew, or will be self-evident to the crew so that appropriate action can be taken.
- The analysis will also consider failure of the detection means, inspection intervals and procedures.

It will be demonstrated that for any combination of 3 or more failures:

- All pre-existing failure scenarios will have a probability of $1 \text{ E}10^{-3}$ or less when related to the frequency with which they are expected to occur. The time each failure situation is expected to be present will take into account the expected delays in detection, isolation, and repair of casual failures.

2) Structural Considerations:

All structural load paths that affect thrust reversal will be shown to comply with the static strength, fatigue, damage tolerance and deformation requirements of 14 CFR part 25, thus ensuring that unwanted thrust reversal is not anticipated to occur due to failure of a structural load path, or due to loss of retention under ultimate load throughout the operational life of the airplane.

3) Uncontained Rotor Failure:

BA will produce a rotorburst analysis, which will include the effects of rotor failure on the thrust reverser system. Compliance will be demonstrated to the requirements of § 25.903(d)(1), using the harmonized advisory material of AC 20-128A, dated March 25, 1997.

The analysis will address the effects of an uncontained rotor failure on the structural aspects of the powerplant, including the thrust reverser. Substantiation will be provided to demonstrate that such an event will not result in a thrust reverser deployment.

Explanation of how design features or alternative Methods of Compliance (MoC) provide an equivalent level of safety to the level of safety intended by the regulation:

The compensating design features described above, provide an equivalent level of safety and meet the intention of the regulation.

FAA approval and documentation of the ELOS finding:

The FAA has approved the aforementioned equivalent level of safety finding in project issue paper P-1. This memorandum provides standardized documentation of the ELOS finding that is non-proprietary and can be made available to the public. The Accountable 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. An example of an appropriate statement is provided below.

Equivalent Level of Safety Findings have been made for the following regulations(s):

14 CFR § 25.933(a)(1)(ii) Reversing Systems (documented in ELOS memo AT5627NY-T-P-1



NOVEMBER 3, 2010

Manager, Transport Airplane Directorate,
Aircraft Certification Service

Date