



Federal Aviation Administration

Memorandum

Date: December 19, 2014

To: Manager, Engine Certification Office, ANE-140

From: Manager, Engine & Propeller Directorate, ANE-100

Prepared by: Mark Riley, ANE-142

Subject: INFORMATION: Equivalent Level of Safety (ELOS) Finding for International Aero Engines, LLC (IAE, LLC) project for the PW1133G-JM, Engine Model, FAA Project # TC3289EN-E

ELOS Memo#: TC3289EN-E-P-5

Regulatory Ref: 14 CFR §21.21 and §33.77

This memorandum informs the Engine Certification Office (ECO) of an evaluation made by the Engine & Propeller Directorate on the establishment of an equivalent level of safety finding for the IAE, LLC PW1133G-JM engine model.

Background

On August 3, 2012, IAE, LLC submitted an updated application for Type Certificate to the ECO for the PW1100G-JM series engine model.

Title 14, Code of Federal Regulations (14 CFR) §33.77 requires that the ingestion of an ice slab may not cause sustained power or thrust loss, or require the engine to be shutdown. Compliance to the regulation is demonstration by engine test under specific operating conditions.

IAE, LLC elected to comply with the proposed rule to 14 CFR §33.77 as defined in the Notice of Proposed Rulemaking (NPRM) 2010-0636, Notice No. 10-10 and has therefore proposed an ELOS to the requirements of §33.77 using validated analysis in lieu of an engine test using compensating factors in accordance with the provisions of 14 CFR 21.21(b)(1).

Applicable regulations

14 CFR §21.21, §33.77

Regulation requiring an ELOS finding

14 CFR §33.77

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)

The FAA determined that the following compensating factors used in the validated analysis as an alternative MoC provides an equivalent level of safety with the requirements of §33.77:

1. The analysis considered a half size piece of ice required by NPRM 2010-0636 striking the fan rotor intact. This approach is more conservative than running an engine test where ice slab breakup is relatively uncontrolled.
2. The analysis considered a 0.50" thick piece of ice which is 0.074" thicker than what is required by NPRM 2010-0636. The thicker piece of ice is more challenging to the fan structure than what would have been used in an engine test and therefore provides a conservative result.
3. The analysis considered multiple orientations of the largest piece of ice and provided results for the worst case. This approach is more conservative than running an engine test where ice slab orientation is random and most likely would not result in a worst case orientation.
4. The analysis was validated to an appropriate soft body impact engine test with the same blade geometry, materials, construction and relevant operating parameters, but larger mass.

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 intent of the ice slab ingestion test per §33.77, as defined in NPRM 2010-0636, is to demonstrate tolerance to ice ingestion from ice shedding from the aircraft nacelle surfaces. It also establishes limits for ice released from other aircraft surfaces during part 23 and 25 certification. Ingestion of an ice slab of a specified size must not cause a sustained power or thrust loss, or require the engine to be shutdown. IAE, LLC showed through validated analyses that impact of an ice slab to the PW1100G-JM fan blades is

less severe than impact with a bird, and the predicted damage is insignificant and does not result in measurable thrust loss or require the engine to be shutdown.

The finite element dynamic impact analytical model of the PW1100G-JM fan blades was validated by PW1100G-JM certification engine and rig tests. Damage predicted by the analytical model was conservative compared to results of the actual tests. Therefore the predicted damage from impact from an ice slab would also be considered to be conservative.

FAA approval and documentation of the ELOS finding:

The FAA has approved the aforementioned ELOS finding in the PW1100G-JM series engine model Issue Paper P-5. This memorandum provides standardized documentation of the ELOS finding that is non-proprietary and can be made available to the public. The Engine and Propeller Directorate has assigned a unique ELOS Memorandum number (see front page) to facilitate archiving and retrieval of this ELOS. This ELOS Memorandum number must be listed in the Type Certificate Data Sheet under the Certification Basis section (TCs & ATCs) or in the Limitations and Conditions section of the STC. An example of an appropriate statement is provided below.

Equivalent Level of Safety Findings has been made for the following regulation:

14 CFR §33.77 Foreign Object Ingestion - Ice (documented in ELOS Memo TC3289EN-E-P-5)


 for Manager, Engine & Propeller Directorate
 Aircraft Certification Service

12/19/2014
 Date

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| ELOS Originated by ACO: Engine Certification Office | ACO Manager: Diane Cook | Routing Symbol: ANE-140 |
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