



# Federal Aviation Administration

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## Memorandum

Date: February 23, 2006

To: Manager, Engine & Propeller Standards Staff, ANE-110  
Manager, Engine & Propeller Directorate, ANE-100

From: Manager, Engine Certification Office (ECO), ANE-140

Prepared by: Mark Riley (ECO), ANE-142

Subject: **ACTION:** Engine Alliance - Pratt & Whitney GP7200 Engine  
Certification Program, Project No. TC1900EN-E – Request for Review  
and Concurrence with Equivalent Level of Safety Finding to 14 CFR  
Part 33, § 33.77 Foreign Object Ingestion – Ice

Memo No.: 8040-ELOS-05-NE-05

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### **Background**

In accordance with the provisions of 14 CFR Part 21, § 21.21(b)(1), Engine Alliance - Pratt & Whitney (EA-PW) proposed an Equivalent Level of Safety (ELOS) to the ice slab ingestion requirements of § 33.77(c)&(e) through the use of compensating factors for the GP7270 and GP7277 engine models (herein called GP7200). The proposed method of compliance is based on analysis and component testing that demonstrated that, when accounting for the operating environment, the GP7200 fan blade has the same damage resistance to ice slab impact as a similar, previously certified fan blade that successfully completed an ice slab ingestion engine test.

### **Applicable Regulation(s)**

§ 33.77, Foreign Object Ingestion - Ice, paragraphs (c)&(e):

- (c) Ingestion of ice under the conditions of paragraph (e) of this section may not--
- (1) Cause a sustained power or thrust loss; or
  - (2) Require the engine to be shutdown.
- (e) Compliance with paragraph (c) of this section must be shown by engine test under the following ingestion conditions:
- (1) Ice quantity will be the maximum accumulation on a typical inlet cowl and engine face resulting from a 2-minute delay in actuating the anti-icing system; or a slab of ice which is comparable in weight or thickness for that size engine.
  - (2) The ingestion velocity will simulate ice being sucked into the engine inlet.
  - (3) Engine operation will be maximum cruise power or thrust.

- (4) The ingestion will simulate a continuous maximum icing encounter at 25 degrees Fahrenheit.

### **Regulation(s) requiring ELOS**

§ 33.77(c)&(e)

### **Description of compensating factors or alternate standards that allows the granting of the ELOS (including design changes, limitations, or equipment need for equivalency)**

The EA-PW proposed method of compliance is by means of a P&W analytical methodology for ice slab ingestion and a comparative component bench test, in lieu of direct compliance through an engine test.

1) Pratt & Whitney (P&W) Analytical Methodology - The P&W analytical methodology, which utilizes results from prior engine certification tests, predicts potential damage to fan blades due to ice slab impact. Estimates of ice slab kinetic energy and knowledge of fan blade design features are used to identify the critical spans of the fan blade and predict the potential for airfoil damage. Results from the analysis are then used to determine whether the damage resulting from impact of an ice slab would cause sustained power or thrust loss, or require the engine to be shut down.

2) Comparative component bench testing - EA-PW performed ice impact component bench testing to determine the damage threshold capability of the GP7200 fan blade compared to a similar certified fan blade that successfully completed an ice slab ingestion engine test. Results show that the GP7200 fan blade has equivalent resistance to ice impact damage at the critical spans as the previously certified fan blade.

### **Explanation of how compensating factors or alternative standards provide an equivalent level of safety to the level of safety intended by the regulation**

Results from the analytical methodology predicted no fan blade damage due to ingestion of an ice slab. Results from the comparative ice impact bench test demonstrated that the GP7200 fan blade has equivalent resistance to damage due to ice slab ingestion.

Therefore, the combined results from the analyses and component test show that the GP7200 fan blade will not sustain unacceptable mechanical damage that could result in an engine shutdown, or cause sustained power or thrust loss, thus meeting the criteria of § 33.77(c).

### **FAA approval and documentation of the ELOS**

The FAA approved the proposed Equivalent Level of Safety finding as documented in GP7200 Issue Paper E-3. This memorandum provides standardized documentation of the ELOS that is non-proprietary and can be made available to the public. The Engine and Propeller Directorate has assigned a unique ELOS Memorandum number, 8040-ELOS-05-NE-05, to facilitate archiving and retrieval of this ELOS. This ELOS Memorandum number will be listed in the Type Certificate Data Sheet as part of the certification basis for the GP7200 engine models as follows:

Equivalent Level of Safety Findings:

33.77, Foreign Object Ingestion – Ice, para.(c) and (e), ELOS No. 8040-ELOS-05-NE-05

**ELOS memo issue date discrepancy**

This memo documents that the FAA has concluded that a finding of compliance for the proposed ELOS for § 33.77(c)&(e) has been made, and that the Engine & Propeller Directorate concurred with this finding prior to issuance of the GP7200 Type Certificate on December 29, 2005.

*(Original signed by Thomas Boudreau)*

Thomas Boudreau, Manager  
Engine Certification Office, ANE-140

For Concurrence

*(Original signed by Robert J. Ganley for Peter A. White)*

Peter A. White, Manager  
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