

UNITED STATES OF AMERICA  
DEPARTMENT OF TRANSPORTATION  
FEDERAL AVIATION ADMINISTRATION  
BURLINGTON, MA 01803-5229

In the matter of the petition of

**INTERNATIONAL AERO  
ENGINES, LLC**

for an exemption from § 33.94(a)(1)  
of Title 14, Code of  
Federal Regulations

**Regulatory Docket No. FAA-2013-0815**

**DENIAL OF EXEMPTION**

By letters dated September 12, 2013 and September 26, 2013 from Mr. Marshall S. Filler of the law firm of Obada, Filler, MacLeod and Klein, P.L.C., 117 North Henry Street, Alexandria, VA 22314-2903, International Aero Engines, LLC petitioned for exemption from Title 14, Code of Federal Regulations (14 CFR) § 33.94(a)(1), as amended by Amendment 33-10. The proposed exemption, if granted, would permit the petitioner relief of § 33.94 and enable the petitioner to change the fan blade failure location from the blade outermost retention groove to the blade platform for its engine model PW1100G-JM in conducting the blade containment test required by § 33.94.

**The petitioner requests relief from the following regulation:**

Section 33.94(a)(1) at Amendment 33-10, requires the fan blade failure from the blade outermost retention groove.

**The petitioner supports its request with the following information:**

This section quotes the information from the petitioner's request, dated September 12, 2013, and is also available on the Federal Docket Management System at <http://regulations.gov> under Docket No. FAA-2013-0815.

Pursuant to 14 CFR part 11,<sup>1</sup> International Aero Engines, LLC (IAE, LLC) hereby petitions for an exemption from § 33.94(a)(1) for the PW1100G-JM Series Turbofan Engine.

The exemption would allow IAE, LLC to show that its engine is capable of containing damage without catching fire and without failure of its mounting attachments where the most critical fan blade fails at the blade platform (as more particularly defined in technical specifications) rather than at the outermost retention groove. This would result in the liberation of more than 80% of the fan blade which is more material than required by § 33.94(a)(1) for the failure point in integrally-bladed rotors.

For the reasons described below, a grant of exemption would be in the public interest, would not adversely affect safety and would provide an equivalent level of safety to that provided by the rule.

#### Pertinent Regulation

Section 21.21 requires an applicant for a Type Certificate for an aircraft engine to meet certain requirements specified in the Federal Aviation Regulations, including those found in part 33. In pertinent part, § 33.94(a)(1) requires the applicant to demonstrate by engine tests that --

(a) ... the engine is capable of containing damage without catching fire and without failure of its mounting attachments when operated for at least 15 seconds, unless the resulting engine damage induces a self shutdown, after each of the following events:

(1) Failure of the most critical compressor or fan blade while operating at maximum permissible r.p.m. The blade failure must occur at the outermost retention groove or, for integrally-bladed rotor discs, at least 80 percent of the blade must fail.

#### Design Features and Safety Considerations

The PW1100G-JM Series Turbofan Engine employs geared turbofan technology, is manufactured with metallic, composite hybrid fan blades and contains additional strengthening at the fan blade attachment (i.e., fan blade root).

Fan blade containment is a function of fan rotational speed and fan blade weight. The blade operating environment of the geared turbofan is substantially lower in rotational speed with a corresponding lower fan pressure ratio than conventional turbofans. The composite hybrid fan blade construction significantly reduces blade attachment load

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<sup>1</sup> All citations are to 14 CFR unless otherwise noted.

and is designed with significantly higher safety capability. It employs blade root surface treatments making it highly damage tolerant to service loads and wear. In addition, the root area is over-designed to drive any potential blade fracture to the blade airfoils section above the platform. The combination of these characteristics enables IAE, LLC to demonstrate through analysis and test that the fan blade will not fail below the platform over the service life of the blade.

Exhibit A, which contains IAE, LLC confidential and proprietary information and will therefore be submitted separately to the FAA, is an impact assessment of how the requested exemption would affect compliance with other airworthiness standards in part 33.<sup>2</sup> The design features of this engine described above, in combination with the impact assessment, conclusively demonstrates that granting an exemption would not adversely affect safety and would also provide a level of safety equivalent to that provided by the rule.

#### Public Interest

Granting the petition is in the public interest because it would enable IAE, LLC to design and manufacture an engine with a lighter fan case and accessory attachments, and an optimized flange joint design. This results in a lighter-weight engine relative to the engine thrust generated, which leads to (1) a lower fuel burn, and (2) reduced emissions.

More specifically, the engine's reduced weight decreases fuel burn by 26,000 gallons per year. IAE, LLC estimates that approximately 5,000 PW1100G-JM engines will enter into service between 2015 and 2035. Thus, fuel consumption will be reduced by 129.2 million gallons over the 20 year period. This will lead to a savings of approximately \$517 million in lower fuel costs, and will reduce carbon dioxide emissions by 2.7 billion pounds over the 20 year period. The data supporting these substantial cost savings and emission reductions is found in the reference section of Exhibit A. These are significant, tangible benefits to the public as a whole.

In addition, Congress has declared that encouraging and developing civil aeronautics, including new aviation technology, is in the public interest and should be considered by the FAA in carrying out its safety responsibilities under Title 49 U.S. Code.<sup>3</sup> As such, the FAA determined that the carbon fiber composite fan blades of certain GE

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<sup>2</sup> The date of application for the PW1100G-JM type certificate was December 15, 2011. Therefore, the certification basis for the engine (part 33 as amended by Amendment 33-1 through Amendment 33-32) was used as the basis for the regulatory impact assessment. The assessment also considers the FAA Policy Statements included in the PW1100G-JM Compliance Plan PWA-9900, as well as a pending rulemaking proposal to amend, in pertinent part, the icing airworthiness standards for turbine engines. See FAA docket 2010-0636; 75 FR 37311 (June 29, 2010).

<sup>3</sup> 49 U.S.C. § 40101(d)(3)

engines<sup>4</sup> were a novel and unusual design feature that justified the issuance of special conditions.<sup>5</sup> Consequently, in addition to meeting certain other requirements, the special conditions authorized GE to perform a fan blade release test at the blade platform rather than the root. GE therefore enjoys the concomitant benefits, such as a lighter-weight fan case.

Conversely, the FAA determined that similar special conditions were inappropriate for the PW1100G-JM's metallic composite hybrid fan blades. Nevertheless, the design characteristics of the PW1100G-JM geared turbofan engine are such that the most critical fan blade will not fail below the platform over the blade's service life. The part 33 impact assessment and associated engineering data clearly demonstrate that granting the exemption would not adversely affect safety and would also provide an equivalent level of safety to that provided by the rule. This data is similar to what the FAA required of GE to meet the special conditions.

In summary, granting this petition would allow the approval of a fan blade which results in less fuel burn, lower operating costs and reduced emissions. It would be consistent with Congress' desire to encourage the development of new aviation technology which is clearly in the public interest.

#### Summary of Exemption Request

In accordance with § 11.81(f), IAE, LLC offers the following summary suitable for publication in the Federal Register.

IAE, LLC petitions the FAA for an exemption from § 33.94(a)(1) for its specific engine model PW1100G-JM to allow IAE, LLC to show that the PW1100G-JM is capable of containing damage without catching fire and without failure of its mounting attachments where the most critical fan blade fails at the fan blade platform rather than at the outermost retention groove.

#### **Federal Register publication**

A summary of the petition was published in the Federal Register on November 27, 2013 (78 FR 71024). Favorable comments were received from three commenters. The comments are summarized below with the FAA's position. Further details are provided in the FAA's analysis section of this letter.

Three comments stated that granting the exemption would reduce fuel consumption and emissions into the atmosphere. The FAA agrees with the commenters that the exemption would reduce fuel consumption and emissions into the atmosphere, although the fuel savings are small; approximately 2 gallons per flight.

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<sup>4</sup> GE90-75B/-85B/-76B and various GENx-1B and -2B series turbofan engines

<sup>5</sup> Special Conditions No. 33-006-SC, No. 33-007-SC and 33-ANE-08

Three comments stated that granting the exemption would be consistent with other products in airline service. The FAA disagrees. The petition does not provide a level of safety that is consistent with other products since the petitioner does not show that the probability of failure below the platform is extremely improbable as was shown for other products.

One comment stated that granting the exemption would not adversely affect safety and would provide an equivalent level of safety to that provided by the rule. The FAA disagrees. We have accepted blade release from the blade platform (inner flow path line) on certain designs when fan blade failure below the blade platform has been shown to be extremely improbable; a failure rate of  $10^{-9}$  or less. We have determined that a failure rate of this magnitude is consistent with the aircraft requirements for engine installation. Any change to engine containment requirements with a probability of failure rate in excess of extremely improbable is considered to be a lower level of safety.

**The FAA's analysis is as follows:**

The FAA has reviewed the information provided by IAE, LLC and has concluded that IAE, LLC has not shown that granting this exemption is in the public interest for the following reasons:

Turbofan engines are required to contain the damage incurred from a fan blade failure at the outermost retention groove without catching fire, and without failure of its mounting attachments when operated for at least 15 seconds. This limits the significance of a fan blade failure on an airplane to a major event with a loss of power. We have accepted blade release from the blade platform (inner flow path line) on certain designs when fan blade failure below the inner flow path line has been shown to be extremely improbable; a failure rate of  $10^{-9}$  or less. We have determined that a failure rate of this magnitude is consistent with the aircraft requirements for engine installation, since the combination of fan blade reliability and the containment requirements of § 33.94 make it extremely improbable that an uncontained blade will cause a hazard to the aircraft.

Any change to engine containment requirements with a probability of failure rate in excess of extremely improbable is considered to be a lower level of safety for the aircraft and engine installation. Excerpts from some of the special conditions are shown below:

Docket No. 94-ANE-18; Special Conditions No. SC-33-ANE-08  
Special Conditions; General Electric (GE) Aircraft Engines Model(s) GE90-75B/-  
85B/-76B Turbofan Engines

Accordingly, pursuant to the authority delegated to me by the Administrator, the following special conditions are issued as part of the type certification basis for the General Electric Aircraft Engines Model(s) GE-90-75B/-85B/-76B turbofan engines:

.....

(b) It must be shown that the probability of fan blade retention system failure, for any cause, during the service life of the engine to be extremely improbable.

Docket No. NE127; Special Conditions No. 33-006-SC

Special Conditions: General Electric Company GEnx Model Turbofan Engines

Accordingly, the Federal Aviation Administration (FAA) issues the following special conditions as part of the type certification basis for the GEnx series turbofan engines.

1. In lieu of the fan blade containment test with the fan blade failing at the outermost retention groove as specified in § 33.94(a)(1), complete the following requirements:

.....

(d) Substantiate that, during the service life of the engine, the total probability of the occurrence of a hazardous engine effect defined in § 33.75 due to an individual blade retention system failure resulting from all possible causes will be extremely improbable, with a cumulative calculated probability of failure of less than  $10^{-9}$  per engine flight hour.

Docket No. NE129; Special Conditions No. 33-007-SC

Special Conditions: General Electric Company GEnx-2B Model Turbofan Engines (as corrected by Docket No. NE129; Special Conditions No. 33-007-SC)

The Special Conditions Accordingly, pursuant to the authority delegated to me by the Administrator, the following special conditions are issued as part of the type certification basis for the derivative GEnx-2B series turbofan engines.

1. In lieu of the fan blade containment test with the fan blade failing at the outermost retention groove as specified in § 33.94(a)(1), complete the following requirements:

.....

(e) Substantiate that, during the service life of the engine, the total probability of the occurrence of a hazardous engine effect defined in § 33.75 due to an individual blade retention system failure resulting from all possible causes will be extremely improbable, with a cumulative calculated probability of failure of less than  $10^{-9}$  per engine flight hour.

The petition for exemption states that the fan blade will not fail below the platform over the service life of the blade, but does not provide technical data to establish that probability of failure to be at least equivalent to a failure rate of extremely improbable or less. The petitioner has not shown that granting the exemption would not adversely affect safety or shown how the

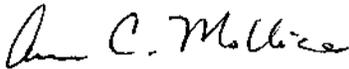
exemption would provide a level of safety at least equal to that provided by the rule or those established by the GE special conditions.

The fuel savings per engine, per year, has also been incorrectly stated in the petition letter. The petition letter states a yearly fuel savings of 26,000 gallons; this is the 20-year fuel savings. The actual fuel savings per engine, per year is 1,292 gallons, which is substantially less. Based on an estimated 1,500 flights per year, this fuel savings equates to approximately 2 gallons per flight.

**The FAA's Decision:**

In consideration of the foregoing, I find that a grant of exemption would not be in the public interest. Therefore, pursuant to the authority contained in 49 U.S.C. §§ 106(f), 40113 and 44701, delegated to me by the Administrator, the petition of International Aero Engines, LLC for an exemption from 14 CFR § 33.94(a)(1) is hereby denied.

Issued in Burlington, MA, on January 9, 2014



for Colleen M. D'Alessandro  
Assistant Manager, Engine and Propeller Directorate  
Aircraft Certification Service