



# Federal Aviation Administration

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## Memorandum

Date: FEB 04 2016

To: Thomas Boudreau, Manager, Engine Certification Office, ANE-140

From: Colleen D'Alessandro, Manager, Engine & Propeller Directorate, ANE-100

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Subject: INFORMATION: Equivalent Level of Safety (ELOS) General Electric  
Passport 20-17BB1A, 20-18BB1A, 20-19BB1A Engines. FAA Project  
TC3323EN-E

ELOS Memo #: TC3323EN-E-P-9

Regulatory Ref: 14 CFR 21.21 and 33.83

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The Engine & Propeller Directorate established an equivalent level of safety finding (ELOS) for GE Passport 20-17BB1A, 20-18BB1A and 20-19BB1A.

### Background

During the Passport 20 vibration survey conducted to comply with the requirements of §33.83, GE experienced a gage signal loss for the high pressure compressor (HPC) rotor stage 6 (R6) airfoils and stator stage 9 (S9) vanes at 101% redline nominal conditions. For these components GE did not acquire the test data up to 103% of the maximum physical and corrected speeds, or 105% if there is any indication of stress peaks arising at the highest speeds. In addition, for these components, GE did not acquire the off-nominal data required under §33.83(c)(1). GE proposed to use analysis to generate the data for speed range of 101% to 105% maximum physical and corrected speeds and the data that accounts for the effects of off-nominal operation as required by 33.83(c)(1). GE proposed to calculate the vibratory stresses associated with the missing data based on comparative analysis to LEAP-1A/1C certification test data.

The Passport 20 compressor blades and vanes, including the R6 airfoils and S9 vanes, are an 84% scale of the LEAP-1A/1C compressor. The two engine models have common stagger, camber, tm/C and scaled geometric thicknesses and chords. GE has prior certification experience with the CF34-10E HPC that was substantiated based on the

scale relationship to the CFM56-5B/P family of engine models. For the certification of CF34-10E, GE has demonstrated that a directly scaled compressor exhibits the same aeromechanical behavior as the compressor from which it is scaled. Analysis, component test and engine test measurements from the LEAP-1A/1C and Passport 20 R6 blades and S9 vanes support this assertion.

### **Applicable regulations**

14 CFR 21.21, 33.83

### **Regulation requiring an ELOS finding**

§33.83(a), (b), (c)(1), and (d)

### **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)**

To address the use of comparative analysis in place of engine test for certain airfoils in the Passport 20 high pressure compressor, the FAA has identified the following compensating factors for the ELOS finding:

1. The Passport 20 and LEAP-1A/1C engine models high pressure compressors are similar by scale.
2. Component vibratory stresses are similar between the scaled engines – including validation.
3. Component steady stresses are similar between the scaled engines – including validation.
4. Engine cycle and operating conditions are similar between the scaled engines – including validation.
5. The material characteristics and high cycle fatigue (HCF) strength are the same between the scaled engine models.

### **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**

1. Scale similarity: The Passport 20 engine is similar to the LEAP-1A/1C engine that was used as a test basis for compliance with 33.83. Specifically, the similarity is a 84% scale similarity with regard to:

- a. The geometry of the HPC R6 airfoils and S9 vanes, the geometry of the adjacent components affecting the HPC R6 airfoils and S9 vanes vibratory stresses, such as upstream and downstream flowpath geometry, and any other engine assembly or configuration that may affect the vibratory stresses,
  - b. The test conditions maintained during vibratory surveys, including thrust, and mechanical and corrected speeds as required by §33.83(b),
  - c. The engine operating characteristics with regard to customer bleeds, accessory loading, and the most adverse inlet airflow distortion required by §33.83(c)(1).
2. Vibratory stresses similarity: GE has validated that the component vibratory stresses are the same or similar between the Passport 20 and LEAP-1A/1C scaled engine models. The vibratory stresses equivalency was supported by analysis and validated by both engine and bench tests performed to allow back to back comparison of Passport 20 and LEAP-1A/1C engine models.
3. Steady stresses equivalency: GE provided analytical substantiation that, for the HPC R6 airfoils and S9 vanes, the steady state stresses of the Passport 20 and LEAP-1A/1C engine models are equivalent throughout the declared engine operating conditions, as identified in §33.83(b) and (c)(1). The steady stresses are required by §33.83(d).
4. The engine cycle and operating conditions: GE provided substantiation that the scale relationship for the operating conditions of the Passport 20 and LEAP-1A/1C engine models results in vibratory and steady state stresses that are equivalent for the declared engine operating conditions identified in §33.83(b) and (c)(1). Of particular significance are those operating conditions that affect the component temperatures, pressures, and excitation forces. The operating temperatures are required by §33.83(d); the effects of airfoil pressures and excitation forces are seen in the resulting vibratory amplitude responses.
5. Material characteristics: GE has shown that the applicable material characteristics and HCF strength of Passport 20 HPC R6 airfoils and S9 vanes are the same as those of LEAP-1A/1C engine models.

**FAA approval and documentation of the ELOS finding:**

The FAA has approved the aforementioned ELOS finding in Passport 20 issue paper P-9. This memorandum provides standardized documentation of the ELOS findings that are nonproprietary and can be made available to the public. The Engine & Propeller Directorate has assigned a unique ELOS Memorandum number (see front page) 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, as follows:

