U.S. Department of Transportation
Federal Aviation Administration

Memorandum

Subject: **ACTION**: General Electric (GE) CF34-10 Engine Certification Program – Request for Review and Concurrence with Equivalent Level of Safety (ELOS) Finding to 14 CFR Part 33, §33.83 Vibration Test, paragraph (c)(1)

Date: 04 November 2004

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

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To: Branch Manager, Engine and Propeller Standards Staff, ANE-111
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Background

In accordance with the provisions of 14 CFR Part 21, §21.21(b)(1), GE has requested an alternate method of compliance to the requirements of §33.83(c)(1), vibration test, through an ELOS demonstration for the CF34-10E2, -10E5, -10E5A1, -10E6, and –10E6A1 engine models, herein called CF34-10. Analysis has been chosen as the alternate method of compliance. In particular, after GE completed testing of CF34-10 High Pressure Compressor (HPC) with nominal vane angles and without compressor bleeds, GE was unable to complete the remainder of testing required by §33.83(c)(1), for off-schedule variable vane angles and compressor bleed, due to number 4 bearing damage related to its design and associated test facility constraints. GE subsequently proposed to provide analysis rather than test demonstration of vibration characteristics of the HPC blades and vanes, with off-schedule variable vane angles and with compressor bleed.

Affected Regulation

§33.83, "Vibration Test" paragraph (c)(1):

"(c) Evaluations shall be made of the following:
(1) The effects on vibration characteristics of operating with scheduled changes (including tolerances) to variable vane angles, compressor bleeds, accessory loading, the most adverse inlet air flow distortion pattern declared by the manufacturer, and the most adverse conditions in the exhaust duct(s); ..."

GE is proposing compliance by means of an analytical methodology, in lieu of direct compliance through an engine test, for the CF34-10 HPC.

Compensating Factors

The compensating factors considered by the FAA consist of analytical data provided by GE, based on testing of CF34-10E HPC blades and vanes, and based on similarity of the CF34-10 HPC blades and vanes to the CFM56-5B/P engine model HPC blades and vanes. GE showed that the CF34-10 HPC rotor blades are essentially scaled downward in size from the CFM56-5B/P family of engine models. GE also provided the FAA with summaries of component bench testing, and §33.83 engine testing, showing that the CF34-10 and CFM56-5B/P rotor blades have similar vibratory modes and stress levels, at nominal conditions. GE provided data to show that the similarities in response characteristics are inherent in the scale relationships between the geometric and aeromechanical designs of CF34-10 and CFM56-5B/P HPC rotors, in tested and non-tested regimes, for all stages and all vibratory modes.

GE provided analysis of the nominal CF34-10 §33.83 test data, in combination with nominal and off-schedule §33.83 test data obtained from CFM56-5B/P engine models, to show acceptable rotor blade & vane vibration characteristics for the CF34-10 with off-schedule variable vane angles and with compressor bleed. GE also showed light probe data from engineering testing of the CF34-10, which was conducted with off-schedule variable vane angles and with compressor bleed, to further validate their analytical models for prediction of blade vibration characteristics off-schedule and with bleed. GE also showed light probe data for evaluation of the aerodynamic and aeromechanical factors which might induce or influence flutter, as required by §33.83(c)(2), for off-schedule and bleed operation.

GE provided data to show similarity of vibration characteristics at the engine level; these data considered factors including airfoil geometry and count, materials, operating conditions, blade attachment, VSV configuration/scheduling, upstream and downstream features, effects of physical speed differences on system behavior, clearances, casing symmetry, bleed configuration and scheduling, and blade tip rubbing.

Recommendation

The Engine Certification Office (ECO) has reviewed the data and the analysis provided in report R2001AE270, Revision 2, "HPC Blade / Vane Stress Survey", dated September 30, 2004. The ECO assessed that the data contained within that report are acceptable to establish that CF34-10 components vibration characteristics meet the intent of direct compliance with §33.83. Therefore, the ECO has approved R2001AE270, Revision 2.

We therefore recommend the Engine and Propeller Standards Staff concurrence with this finding for an equivalent level safety to the requirements of the §33.83(c)(1).

Upon concurrence, ELOS number 8040-ELOS-04-NE-01 will be listed on the Type Certificate Data Sheet as part of the certification basis for the CF34-10 engine models, for §33.83(c)(1) Vibration Test.

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For Concurrence

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for
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