



Federal Aviation Administration

Memorandum

Date: April 30, 2008

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

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

Prepared by: Amit Patel (ECO), ANE-142

Subject: **ACTION:** Pratt & Whitney (P&W) Global Material Solutions (GMS) Program (Project # ST2509EN-E) – Request for Review and Concurrence with Equivalent Level of Safety Finding to 14 CFR Part 33, § 33.27(c)(2) Turbine, compressor, fan, and turbosupercharger rotors

Memo No.: 8040-ELOS-08-NE-06

Background

In accordance with the provisions of 14 CFR Part 21, § 21.21 (b)(1), P&W GMS requested an alternate method of compliance to the requirements of § 33.27 (c)(2) by demonstrating an Equivalent Level of Safety (ELOS) to determine the test speed.

P&W proposed to use the calculated burst speed of a certified CFM56-3 LPT disk to establish the speed for the test of their most critically stressed GMS LPT component. P&W determined that the certified CFM56-3 LPT disk was made from a lower strength material. Since P&W's GMS proposed replacement LPT disks are made from a material that has improved strength capability when compared to the type design material, testing to the burst speed of the certified lower strength material disk became a viable option to the overspeed conditions of § 33.27(c)(2).

Applicable Regulation(s)

§ 33.27, Turbine, compressor, fan, and turbosupercharger rotors:

(c) The most critically stressed rotor component (except blades) of each turbine, compressor, and fan, including integral drum rotors and centrifugal compressors in an engine or turbosupercharger, as determined by analysis or other acceptable means, must be tested for a period of 5 minutes.

- (1) At its maximum operating temperature, except as provided in paragraph (c)(2)(iv) of this section; and
- (2) At the highest speed of the following, as applicable:

- (i) 120 percent of its maximum permissible rpm if tested on a rig and equipped with blades or blade weights.
- (ii) 115 percent of its maximum permissible rpm if tested on an engine.
- (iii) 115 percent of its maximum permissible rpm if tested on turbosupercharger driven by hot gas supply from a special burner rig.
- (iv) 120 percent of the rpm at which, while cold spinning, it is subject to operating stresses that are equivalent to those induced at the maximum operating temperature and maximum permissible rpm.
- (v) 105 percent of the highest speed that would result from failure of the most critical component or system in a representative installation of the engine.
- (vi) The highest speed that would result from the failure of any component or system in a representative installation of the engine, in combination with any failure of a component or system that would not normally be detected during a routine preflight check or during normal flight operation.

Following the test, each rotor must be within approved dimensional limits for an overspeed condition and may not be cracked.

Regulation(s) requiring ELOS

§ 33.27(c)(2)

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

The FAA determined that an ELOS finding to § 33.27 (c)(2) can be made using the burst speed from a certified CFM56-3 LPT disk made of lower strength material to establish the test speed for P&W's GMS most critically stressed LPT disk design.

The highest speed for the test of the most critically stressed rotor component of a particular module is determined from evaluation of the overspeed conditions listed in § 33.27 (c)(2). At the end of the test the rotor component must be within approved dimensional limits for an overspeed condition and may not be cracked in order to show compliance to § 33.27. Meeting these conditions shows that the disk has margin to burst. Thus, use of the burst speed of the certified CFM56-3 LPT disk to establish the test speed of the most critically stressed GMS LPT disk test can be considered a conservative approach relative to the highest speed overspeed conditions listed in § 33.27 (c)(2).

The burst speed of the certified CFM56-3 LPT disk made of the lower strength material is determined acceptable based on the following:

- Use of scaled P&W stress-strain curves. The scaling factor was developed from the tensile properties obtained from specimens, which were extracted from certified CFM56-3 LPT disks.
- Use of an analytical model to calculate the burst speed of the certified CFM56-3 LPT disk design provided P&W shows the analysis is applicable to the CFM56-3 disk design. To do this P&W must show this rotor component falls within the experience base of the analysis based on established similarity criteria.

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

The FAA found the use of the burst speed from the certified CFM56-3 LPT disk design made of lower strength material to establish the test speed for P&W's GMS most critically stressed LPT disk design to be a conservative approach to the overspeed conditions listed in § 33.27 (c)(2). In addition, the FAA reviewed P&W data, which showed that the CFM56-3 LPT stage disk meets the necessary similarity criteria to support the use of P&W's GMS analysis to determine the burst speed of the certified CFM56-3 LPT disk design.

FAA approval and documentation of the ELOS

The FAA concludes that the use of the burst speed of the certified CFM56-3 LPT disk made of lower strength material is a conservative alternative for establishing the test speed of the most critically stressed GMS LPT disk, and subsequently an ELOS determination relative to the overspeed conditions listed in § 33.27(c)(2) can be made. This memorandum provides standardized documentation of the ELOS that is non-proprietary and can be made available to the public. The FAA has assigned a unique ELOS Memorandum number, 8040-ELOS-08-NE-06, 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 P&W GMS program as follows:

Equivalent Level of Safety Findings:

§ 33.27, Turbine, compressor, fan, and turbosupercharger rotors, par. (c)(2), ELOS No. 8040-ELOS-08-NE-06

"ORIGINAL SIGNED BY:"

Thomas Boudreau, Manager
Engine Certification Office, ANE-140

"ORIGINAL SIGNED BY:"

For Concurrence

Robert J. Ganley, Manager
Engine & Propeller Directorate Standards Staff, ANE-110

"ORIGINAL SIGNED BY:"

FAV

Fran A. Favara, Manager
Engine & Propeller Directorate, ANE-100