



Federal Aviation Administration

Memorandum

Date: June 14, 2012

To: Manager, Engine Certification Office, ANE-140

From: Manager, Engine and Propeller Directorate, ANE-100

Prepared by: Tomasz Rakowski, ANE-141

Subject: INFORMATION: Equivalent Level of Safety (ELOS) Finding for General Electric Company's project on GENx-1B75/P1 Series Engine Models, FAA Project# AT3024EN-E

ELOS Memo#: 8040-ELOS-12-NE01

Regulatory Ref: 14 CFR 21.21 and 33.27

This memorandum informs the Engine Certification Office of an evaluation made by the Engine and Propeller Directorate on the establishment of an equivalent level of safety finding (ELOS) for the GENx-1B75/P1 series engine models, including GENx-1B54/P1, GENx-1B58/P1, GENx-1B64/P1, GENx-1B67/P1, GENx-1B70/P1, GENx-1B70/72/P1, GENx-1B70/75/P1, GENx-1B74/75/P1, and GENx-1B75/P1.

Background

The General Electric Company (GE) submitted a request for an ELOS to Title 14 Code of Federal Regulations (CFR) section 33.27 Turbine, compressor, fan, and turbosupercharger rotor overspeed, for the GENx-1B75/P1 series engine models. The ELOS is based on the original GENx-1B70 certification tests and analyses instead of a test. GE established the relevance of the data for the most critically stressed components from prior tests. The analyses substantiated that all rotating disks and drums were designed to have adequate rotor burst speed margin and an acceptable growth at the overspeed conditions specified in §33.27(c).

Applicable regulation(s)

14 CFR 21.21, 33.27

Regulation(s) requiring an ELOS finding

14 CFR 33.27

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)

FAA determined that the following compensating factors provide an equivalent level of safety with the requirements of 33.27(c):

1. Compliance by similarity to a previously certified test or by analysis supported by a previously certified test, is based on the following principles of similarity:
 - (a) Each critical rotor must have geometric and mechanical characteristics similar to a previously tested and certified rotor.
 - (b) The analytical method was validated by an overspeed and/or burst test of the same material,
 - (c) The component to be certified has more design margin (test speed relative to burst speed) than a similar part certified by component test.

2. Analytical methods are validated using relevant FAA approved certification overspeed component test data. The validation must demonstrate that the analytical model can accurately predict rotor burst and identify the most critical rotors; that it can accurately predict the dimensional growth versus rotor speed at critical rotor locations; and that can reliable predict applicable results from engine tests or rig tests.

GE used their Design Practice Burst Methodology to identify the most critical component in each of the affected rotor modules and predict the overspeed growth and burst speeds. The most critical component in each rotor modules are identified below. The analyses established that the critical components' capabilities exceeded those demonstrated in prior certification test of similar parts.

GE showed compliance to the overspeed requirements of § 33.27(c) for the stage 2 blisk in the high pressure compressor (HPC) rotor module with the GENx-1B70 HPC rotor § 33.27(c) certification which was assessed to the GENx-1B75/P1 red line limits and remained valid for GENx-1B75/P1 certification as the HPC stage 2 blisk was unchanged from the original GENx-1B70 type design.

GE showed compliance to the overspeed requirements of § 33.27(c) for the stage 1 and stage 2 disks in the high pressure turbine (HPT) rotor module with previous certification tests. The overspeed capabilities of the HPT stage 1 and stage 2 disks were comparable and both parts were considered critical components. GE showed compliance for the stage 1 disk using the original GENx-1B70 certification test, and for stage 2 disk using analysis instead of test. GE used an analytical method developed during the GENx-1B70 product improvement program (PIP) and validated based on data from the GE90-94B HPT

stage 2 disk § 33.27(c) certification test. Both prior assessments were done using GENx-1B75/P1 redlines and had the same HPT rotor as the GENx-1B75/P1 series engine.

GE showed compliance to the overspeed requirements of § 33.27(c) for the stage 4 disk in the redesigned low pressure turbine (LPT) rotor module by an analysis that was validated using the data from prior GE90-115B LPT stage 3 disk § 33.27(c) certification test.

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

GE substantiated which of the overspeed conditions listed in § 33.27(c) was the most critical with respect to rotor integrity for each rotor module (fan, booster, HPC, HPT, and LPT). This substantiation considered the entire flight envelope. Once these conditions and the critical rotor stages have been identified, GE submitted a validated analysis acceptable to the FAA to substantiate these ELOS findings. In the case of GE's proposed analyses validated by prior certification test, the criteria for component similarity to the previously tested article were met. Since GE proposed an analysis in lieu of a test, GE based the calibration and validation of the analytical technique on prior overspeed test that met the compensating factors. The validation of the analysis demonstrated the ability to develop data specific to the individual rotor component and operating environment, accurately predict rotor burst speed and identify the rotor stage or component with the lowest burst margin in each rotor module, develop a correlation to the new rotor design so it can accurately predict the dimensional growth versus rotor speed at critical rotor locations, and reliably predict applicable results from engine tests or rig tests.

FAA approval and documentation of the ELOS finding:

The FAA has approved the aforementioned equivalent level of safety finding in GENx-1B75/P1 Issue Paper P-1. This memorandum provides standardized documentation of the ELOS finding that is nonproprietary and can be made available to the public. The Engine and Propeller Directorate has assigned a unique ELOS Memorandum number (see front page) to facilitate archiving and retrieval of this ELOS. This ELOS Memorandum number must be listed in the Type Certificate Data Sheet under the Certification Basis section (TCs & ATCs) or in the Limitations and Conditions section of the STC. An example of an appropriate statement is provided below.

Equivalent Level of Safety Findings have been made for the following regulation:

14 CFR 33.27 Turbine, Compressor, Fan, and Turbosupercharger Rotor Overspeed
(documented in ELOS Memo 8040-ELOS-12-NE01)

// Original signed by Robert Ganley
for ANE-100 //

6/14/12

Manager, Engine and Propeller Directorate
Aircraft Certification Service

Date

ELOS Originated by ACO: Engine Certification Office	ACO Manager: Thomas Boudreau	Routing Symbol: ANE-140
--------------------------------------------------------	---------------------------------	----------------------------