Federal Aviation Administration

Memorandum

Date: April 28, 2016

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

From: Ann Mollica, Acting Manager, Engine & Propeller Directorate, ANE-100

Prepared by: Antonio Cancelliere, Aerospace Engineer, ANE-141

Subject: INFORMATION: Equivalent Level of Safety (ELOS) for the Passport 20 Series Engines

ELOS Memo #: TC3323EN-E-P-13

Regulatory Ref: 14 CFR 21.21 and 33.89 Operation Test

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

Background

Title 14, Code of Federal Regulations (14 CFR) 33.89(a)(3) requires an operation test to demonstrate the thrust response to 95% rated takeoff thrust from both minimum idle and minimum flight idle. For the Passport 20 turbofan engine models, General Electric (GE) proposed to comply with this requirement by running an acceleration test from minimum ground idle only and showing that accelerations from minimum flight idle are not more severe than those from minimum idle. The FAA determined that GE's proposal did not constitute direct compliance with the requirements of 33.89(a)(3), and GE proposed an equivalent level of safety (ELOS) to 33.89(a)(3) in accordance with § 21.21(b)(1).

GE's proposal identified compensating factors in lieu of test demonstration to show compliance to the engine operation test requirements for the flight idle condition required by 33.89(a)(3), including the load conditions required by 33.89(a)(3)(i), (ii), and (iii). The approach used Passport 20 engine acceleration test data from minimum idle in combination with analysis and compensating factors to demonstrate that testing from flight idle would not be more severe than ground idle. GE's proposal was based on engine design features that:

1. Run the engine to its core rate schedule regardless of starting idle speed
2. Schedule the Variable Stator Vanes & Variable Bleed Valve the same, regardless starting idle speed

Applicable regulations

14 CFR 21.21, 33.89

Regulation requiring an ELOS finding

§33.89(a)(3)(i), (ii), and (iii).

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 analysis in place of engine test the FAA has agreed with the applicant on the compensating factors for this ELOS finding as identified below:

1. Engine acceleration from minimum flight idle to 95% rated takeoff thrust presents no adverse effects caused by the turbomachinery maps/operating and stall line shapes, or variable geometry scheduling.
2. Acceleration from stabilized minimum flight idle are not more severe than those from the minimum idle for any engine operating conditions and configuration addressed under 33.89 Operation test.
3. The engine core acceleration rate schedule to 95% rated takeoff thrust is the same when initiated from stabilized minimum idle versus minimum flight idle, and under the engine load conditions in 33.89(a)(3)(i), (ii), and (iii).

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

A GE Passport 20 transient Numerical Propulsion System Simulation (NPSS) has been used to evaluate compensating factors to demonstrate that acceleration tests conducted from minimum ground idle provide an equivalent level of safety for acceleration tests that were not performed from minimum flight idle per 33.89(a)(3). Consistent with engine testing, the analysis utilized ground and flight idle schedules for FADEC type design software. The analysis shows that acceleration from minimum flight idle starts from equivalent or higher fan and core speeds when compared to acceleration from minimum ground idle.

In addition, the engine accelerates on a core rate schedule that is independent of starting idle speed and as a result the HPC runs the same transient operating line with adequate margin to stall protection schedules. Except in the case of Icing conditions, the variable

geometry schedules during acceleration are unaffected by starting idle speeds. Maximum EGT is unaffected by the starting idle speed as well.

In conclusion, flight idle bursts have no adverse effects to the safe operation of the engine and are not more severe than ground idle bursts, and core acceleration rate schedule is not affected by bursting from minimum flight idle vs. ground idle conditions. The ability to reach target fan speed is either unchanged or better when running from flight idle conditions.

The results of the analysis demonstrated that the GE Passport 20 is capable of accelerating from minimum flight idle to power managed rated thrust without detrimental effects.

FAA approval and documentation of the ELOS finding:

The FAA has approved the aforementioned ELOS finding in the Passport 20 issue paper P-13. This memorandum provides standardized documentation of the ELOS findings that are nonproprietary and can be made available to the public. This ELOS Memorandum will be listed in the Type Certificate Data Sheet under the Certification Basis. An example of an appropriate statement is provided below.

An Equivalent Level of Safety Finding has been made for the following regulation:

14 CFR 33.89 Operations Test- (documented in ELOS Memo TC3323EN-E-P-13)

This ELOS is initially applicable to the engine model(s) listed herein. When the type certificate for that engine model is amended to include other engine model(s) where we find that the compensating factors described herein constitute an ELOS, we will apply this ELOS to the additional engine model(s). In that case, the complete list of models incorporating this ELOS is included in the certification basis section of the Type Certificate Data Sheet.

For Manager, Engine & Propeller Directorate
Aircraft Certification Service

4/28/16
Date