

Proposed Temporary Deviation on CS-E 780 – Tests in Ice Forming Conditions

Introductory Note

The following Temporary Deviation has been classified as an important Temporary Deviation and as such shall be subject to public consultation in accordance with EASA Management Board decision 12/2007 dated 11 September 2007, Article 3 (2.) of which states:

"2. Deviations from the applicable airworthiness codes, environmental protection certification specifications and/or acceptable means of compliance with Part 21, as well as important special conditions and equivalent safety findings, shall be submitted to the panel of experts and be subject to a public consultation of at least 3 weeks, except if they have been previously agreed and published in the Official Publication of the Agency. The final decision shall be published in the Official Publication of the Agency".

Statement of Issue

General Electric Company (GE), having applied for CS-E validation of their Federal Aviation Administration (FAA) Certificate of Compliance to 14 CFR Part 33 for the GEnx-2B67/P high bypass turbofan engine, requests an equivalent safety finding against CS-E 780 (d) to address vulnerability of the engine in ice crystal cloud conditions. GE has proposed compensating factors detailed below.

Applicant's Proposal

During in-service operation the GEnx-2B67B has experienced high altitude ice crystal operational effects in areas of meso-scale convective system activity. All flights continued to the original destination with normal landings. After sustained operation in ice crystals, there have been four types of encounters; 1) no effect, 2) elevated fan vibration, 3) momentary N1 roll-backs above idle followed immediately by auto-engine recovery to commanded power, and 4) high pressure compressor (HPC) distress. Because of the similar design of the GEnx-2B67/P to the GEnx-2B67B, and until such time as a change to the engine is proven to be effective, the following compensating factors will be invoked at certification to mitigate the N1 roll-backs and mechanical distress for the GEnx-2B67/P.

1) Operating limitation: For engine operation at or above 30,000 feet altitude, prohibit engine exposure for more than 3 minutes while in instrument meteorological conditions or visible moisture that can produce moderate to severe concentrations of ice crystals. Moderate to severe ice crystal icing is a condition at steady-state cruise, where a difference between dry engine cycle based T3 temperature and actual measured T3 temperature exceeds 20°C.

Boeing and GE have substantiated the effectiveness of the engine usage limitation and the associated aircraft operational measures to the satisfaction of

the Authorities by detailed analysis and correlation of satellite weather data, ground radar data and engine data from over 3000 GENx powered flights.

2) Durability: Damage tolerance of HPC stage 1 blades installed in GENx-2B67/P engines compared to GENx-2B67B (base) configuration has been improved by about 20% at 70% span, and about 96% at 90% span. GE has substantiated these improvements by comparative impact testing and modelling. This measure alone has been carefully considered and concluded to be not sufficient to fully mitigate the risk.

3) Detailed inspections: After any uncommanded engine thrust loss of 10% or more, for 2 seconds or more, experienced while operating in ice crystal icing conditions, the high pressure compressor (HPC) stage 1 airfoils must be inspected for damage before the next revenue service flight.

4) A limitation is defined in the Airworthiness Limitations Section of the Engine Manual requiring replacement of GENx-2B67/P software no later than July 31, 2014. Replacement software will open booster bleed valves to extract ice crystals in front of the compressor when logic detects ice crystal exposure that results in a difference exceeding 20 degrees C between dry engine cycle based T3 and actual measured T3. Replacement software Service Bulletin is scheduled for release to the airlines on April 30, 2014. This measure has been shown analytically to provide a significant improvement to the engines capability.

Applicants Safety Equivalency Demonstration

Recognising that the GENx-2B67B (base) configuration has demonstrated a certain degree of ice crystal cloud capability the EASA considers the compensating factors are adequate to substantiate the equivalent safety for the purposes of a Temporary Deviation to CS-E 780 (d) compliance until such time as full compliance is substantiated for the derivative GENx-2B67/P model.