Equivalent Safety Finding on CS-E 745 – Engine Acceleration

1 Introductory Note

The following Equivalent Safety Finding (ESF) has been classified as an important ESF and as such has been 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".

2 Statement of Issue

CS-E 745(b) requires an operation test to demonstrate the thrust response to 95% rated takeoff thrust from both minimum ground idle and minimum flight idle. For the applicant's turbofan engine models, the applicant proposes 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 ground idle. The applicant's proposal do not constitute direct compliance with the requirements of CS-E 745(b).

3 Applicant's Proposal

The applicant's proposal identifies compensating factors in lieu of test demonstration to show compliance to the engine operation test requirements for the minimum flight idle condition required by CS-E 745(b), including the load conditions required by CS-E 745(b) (1), (2), and (3). The approach uses engine acceleration test data from minimum ground idle in combination with analysis and compensating factors to demonstrate that testing from minimum flight idle would not be more severe than from minimum ground idle. The applicant's proposal is based on engine design features that:

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

4 Applicants Safety Equivalency Demonstration

The following compensating factors are proposed:

1. Engine acceleration from minimum flight idle to 95% rated take-off thrust presents no adverse effects caused by the turbomachinery maps/operating and stall line shapes, or variable geometry scheduling.
2. Engine acceleration from stabilized minimum flight idle is not more severe than acceleration from minimum ground idle for any engine operating conditions and configuration addressed under CS-E 745 Operation test.
3. The engine core acceleration rate schedule to 95% rated takeoff thrust is the same when initiated from stabilized minimum ground idle versus minimum flight idle, and under the engine load conditions in CS-E 745(b) (1), (2), and (3).

An engine transient Numerical Propulsion System Simulation (NPSS) is used to evaluate the compensating factors in order to demonstrate that acceleration tests conducted from minimum ground idle provide an equivalent level of safety for acceleration tests not performed from minimum flight idle per CS-E 745(b). Consistent with engine testing, the analysis utilizes ground and flight idle schedules for Full Authority Digital Engine Control (FADEC) type design software. The analysis will show 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 High Pressure Compressor (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 the starting idle speeds. In addition, the maximum Exhaust Gas Temperature (EGT) is unaffected by the starting idle speed.

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

The results of the analysis will demonstrate that the engine is capable of accelerating from minimum flight idle to power managed rated thrust without detrimental effects.

5 EASA Position

EASA agrees to the proposal of the applicant. No comment was received during the public consultation period.