Proposed Equivalent Safety Finding on CS-E 740 – Endurance Test

Introductory Note

The following Equivalent Safety Finding (ESF) has been classified as an important ESF 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

An Applicant, having applied for Validation by EASA of their FAA Certificate of Compliance to Part 33 for a large high bypass turbofan engine, requests an Equivalent Safety Finding against CS-E 740 (Endurance Test) which requires: *"The test must be made in the order defined in the appropriate schedule and in suitable non-stop stages. An alternative schedule may be used if it is agreed as being at least as severe."*

Applicant's Proposal

The Endurance Test requires simultaneous demonstration of maximum rotor speeds and Turbine Entry Temperature (TET) in both Take-off (T/O) and Maximum Continuous (MC) conditions. In order to achieve this various specific engine configuration changes are necessary. To carry out the configuration changes between each T/O and MC element of the prescribed schedule would require many mid stage stoppages.

Also problematic is achievement of simultaneous maximum rotor speeds in MC conditions whilst maintaining representative TET and turbine cooling as engine deterioration occurs.

The Applicant proposes test re-sequencing to prevent excessive unrepresentative conditions and to reasonably reduce the configuration changes.

The Applicant argues that hardware life consumption and durability demonstration is governed by overall exposure time at temperature, speed and thrust (creep) and the quantity of excursions to the triple redline operating conditions. Overall, for high bypass turbofan engine designs, engine deterioration is less dependent on test order than it is on overall time-at-temperature exposure durations and accumulated cycle count (low temperature/rpm –to– high temperature/rpm, and reverse, excursions). This argument is supported by the

Applicant's experience of such testing which has exposed several initial design durability limitations.

The Applicant proposes to revise the test order but to maintain the severity of the test and to respect as much as possible the intent of the specified test ordering. To achieve this adherence to certain rules is proposed, as detailed below. The Applicant request the agreement of the Agency.

Applicants Safety Equivalency Demonstration

The applicant proposes to break up the Stages and run a new ordering of the Parts to allow T/O and MC Parts to be grouped. The Parts of any stages may be completed in any order or combination that complies with the rules below. The definitions of the Parts are those defined in CS-E 740.

The following rules will be applied:

1) Two Blocks of Endurance Test Parts are defined: Block 1 consists of Part 2s and Part 3s; Block 2 consists of Part 1s and Part 5s. Block 1 shall be completed before Block 2 with the exception for rule 11) below;

2) Part 4s may be completed in either Block;

3) Each Part 1 shall start with 5 minutes at Ground Idling;

4) The time-on-condition (T/O) for Part 1s shall commence when red line shaft speeds and EGT have been achieved;

5) The time-on-condition for Part 2s and Part 3s shall commence when red line shaft speeds, EGT and oil temperature stabilisation have been achieved;

6) All Part 2Bs (T/O 30 min stabilisation) shall be followed by a subsequent Part 3;

7) Part 2s and Part 3s may be run consecutively without returning to idle power or commenced following a stepped rise to the power condition (for optimised oil temperature stabilisation) provided all the omitted accelerations (one per Part 2) are substituted for, prior to completion of the test, by additional accelerations of at least equal severity commenced from a stabilised Ground Idling condition;

8) Each Part 5 shall start with 4.5 minutes at Ground Idling;

9) The time-on-condition (T/O) for Part 5s shall commence when red line shaft speeds and EGT have been achieved;

10) Each Part shall be run without interruption;

11) A complete low oil pressure Stage shall be performed between 85 and 138 hours endurance;

12) At the conclusion of the test all Parts defined by the Requirement and additional accelerations must have been completed.

EASA Position

While this aspect of CS-E compliance is not identified as a Significant Standard Difference for validation purposes, it is an aspect of Means of Compliance which

goes beyond previous scope provided by EASA, the issue has therefore been raised as a Validation Item.

EASA acknowledge that the requirement allows scope for re-ordering of the test schedule but is only prepared to consider this when a genuine necessity has been demonstrated and justified, as is the case here.

The proposed ordering differs from that agreed for applicants who are primarily complying with CS-E. This difference relates to primary adherence to FAR Part 33 where the requirement for clearance of temperature limitations and temperature stabilisation on test point drive different necessities in the test ordering. This difference also relates to constraints arising from specific engine designs.