Special Condition

Approval of Turbofan Engine to use two (2) periods "10 Minutes One Engine Inoperative Take-off Thrust at High Ambient Temperature (10 Minutes OEI TOTHAT)" rating

This Special Condition is raised to support the approval of an additional rating for turbofan engines. This rating ensures the availability of increased engine thrust above Max Take-off corner point, to allow an aircraft to continue the Take-off following one engine inoperative after reaching V1 under High Ambient Take-off temperature conditions.

This rating is not currently defined in CS-E 40.

Introductory note:

The hereby proposed Special Condition shall be subject to public consultation, in accordance with EASA Management Board decision 02/04 dated 30 March 2004, 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."

Statement of Issue:

This Special Condition defines additional requirements for the certification of using two periods "10 Minutes OEI TOTHAT" rating for a Turbine Engine installed in a multi-engine airplane.

The "10 Minutes OEI TOTHAT" rating introduces an OEI thrust corner point for an engine in OEI aircraft configuration, compared to Max Take-off corner point (see Figure 1). This rating is intended to be used during any one flight. It could be necessary to use one period "10 Minutes OEI TOTHAT" rating during Take-off (if one engine becomes inoperative) and in addition one period "10 Minutes OEI TOTHAT" rating for a necessary Go-Around before the aircraft lands.

Commission Regulation (EU) No 748/2012 paragraph 21.A.16B Special conditions has to be addressed as the related airworthiness code does not contain adequate or appropriate safety standards for the product.

At least the following requirements are affected: CS-E 25, CS-E 30, CS-E 40, CS-E 50, CS-E 60, CS-E 515, CS-E 730 and CS-E 740.



Figure 1: AEO: All Engines Operative = Max Take-off Thrust rating per CS-E 40(a) OEI: One Engine Inoperative

This engine thrust increase (+x%FN) above Max Take-off corner point at high ambient temperature (above figure) leads to increase (+yK) the EGT temperature (below figure) and declare a dedicated Max OEI T/O EGT for that rating.



Discussion:

CS-E provides requirements for a number of engine ratings. "Take-off" and "Maximum Continuous" ratings (referred to as "Standard ratings") are listed in CS-E 40(a). "Other ratings" are listed in CS-E 40(b). In particular, CS-E 40(b)(2) lists One Engine Inoperative (OEI) ratings, applicable to Turbine Engines for multi-engine airplane. Requirements, associated usage limitations and conditions for these OEI ratings are clearly described in CS-Definitions and CS-E.

It must be ensured by engine design that the engine deterioration in service will not exceed its acceptable limits, which are either those assumed for declaring the engine Time Between Overhaul (TBO), or any other "on-condition" limits defined in the engine Instructions for Continued Airworthiness (ICA). The applicant must provide therefore any means, which may consist of a manual increment log, or automatic counting through the Engine Control Unit (ECU) of any time spent at the "10 Minutes OEI TOTHAT" rating.

EASA Position:

The Certification Basis for the engine model in addition to the applicable airworthiness code is amended by this Special Condition as follows:

- 1. CS-E 25 Instructions for Continued Airworthiness:
 - 1.1. Operating limitations, instructions for installing and operating the engine and each usage (time and duration) of "10 Minutes OEI TOTHAT" rating must be specified in the Instructions for Continued Airworthiness (ICA).
 - 1.2. To comply with CS-E 25(b)(1), the Airworthiness Limitation Section (ALS) must prescribe the mandatory post-flight inspections and maintenance actions associated with any use of the "10 Minutes OEI TOTHAT" rating
 - 1.3. The applicant must validate the adequacy of these mandatory postflight inspections and maintenance actions.
 - 1.4. An in-service engine evaluation programme must be established to ensure the continued adequacy of the data of CS-E 20(f) pertaining to thrust assurance procedures, instructions for mandatory post-flight inspections and maintenance actions.
 - 1.5. The in-service engine evaluation programme must include service engine tests or equivalent service engine test experience on engines of similar design and evaluations of service usage of the "10 Minutes OEI TOTHAT" rating.
 - 1.6. All limitations must be included in the engine Type Certificate Data Sheet (TCDS).
 - 1.7. Any usage of the "10 Minutes OEI TOTHAT" rating will be followed by mandatory engine inspection and maintenance action.
 - 1.8. Any mandatory engine inspection must be defined in the ICA.

- 1.9. The applicant must specify within the Installation Instructions that the engine thrust control system automatically resets the thrust on the operating engine to the "10 Minutes OEI TOTHAT" rating when one engine fails during Take-off at specified altitudes and temperatures. The "10 Minutes OEI TOTHAT" rating is not available when all engines are operational.
- 1.10. The applicant must provide data within the Operating Instructions on engine performance characteristics and variability to enable the airplane manufacturer to establish airplane thrust assurance procedures.
- 1.11. The thrust is the same as the engine Take-off rated thrust with extended flat rating corner point (see Figure 1).
- 1.12. The rotational speed limits are the same as those associated with the engine Take-off rated thrust.
- 2. CS-E 30 Assumptions
 - 2.1 In the course of establishing this Special Condition, assumptions must be made for installing and operating the engine under CS-E 20(d).
- 3. CS-E 40 Ratings
 - 3.1 In addition to the ratings already listed in CS-E 40, a new "10 Minutes OEI TOTHAT" rating is created and defined as follows:
 - 3.2 Rated "10 Minutes OEI TOTHAT" rating means an approved engine thrust, developed under specified altitudes and temperatures within the engine operating limitations established for the engine, for continuation of flight operation after failure or shutdown of one engine in multi-engine airplane configuration during Take-off operation.
 - 3.3 This rating is intended to be limited in use to a maximum usage of two periods no longer than 10 minutes each in any one flight during the Take-off phase.

- 4. CS-E 50 Engine Control System
 - 4.1 The engine must incorporate a means, or a provision for a means, for automatic availability and automatic control of the "10 Minutes OEI TOTHAT" rating.
 - 4.2 The engine control system managing the "10 Minutes OEI TOTHAT" thrust for all ambient conditions must assure that:
 - 4.2.1 The approved rated Take-off thrust is available to the pilot at all times by throttle selection, and
 - 4.2.2 The "10 Minute OEI TOTHAT" rating is only available in a one engine inoperative condition at specified altitudes and temperatures.
- 5. CS-E 60 Provision for Instruments
 - 5.1 Engines must have means or provision for means:
 - 5.1.1 To alert the pilot when the engine is at "10 Minutes OEI TOTHAT" rating is in use, when the event begins and when the time interval expires.
 - 5.1.2 Which cannot be reset in flight, to:
 - 5.1.2.1 Automatically record each usage and duration of thrust at "10 Minutes OEI TOTHAT" rating.
 - 5.1.2.2 Alert maintenance personnel in a positive manner, that the Engine has been operated at "10 Minutes OEI TOTHAT" rating and permit retrieval of recorded data.
 - 5.1.3 To enable routine verification of the proper operation of the above means.
- 6. CS-E 515 Engine Critical Parts
 - 6.1 A representative usage of the two periods "10 Minutes OEI TOTHAT" rating must be included in the Engine Flight Cycle used for the establishment of the Approved Life of the Engine Critical Parts.
- 7. CS-E 730 Engine Calibration Test
 - 7.1 The applicant must base the calibration test on the thrust check at the end of the endurance test required by paragraph (8) of the special conditions.

- 8. CS-E 740 Endurance Tests
 - 8.1 The following test sequence must be performed for a total time not less than 135 minutes. The test sequence must run continuously. If a stop occurs during this test, the interrupted sequence must be repeated unless it is shown that the severity of the test is not reduced if it were continued:

Part1: Ten minutes at "10 Minutes OEI TOTHAT" Thrust

Part 2: Sixty-five minutes at Maximum Continuous Thrust

Part 3: One minute at 50 percent of Take-off Thrust

Part 4: Ten minutes at "10 Minutes OEI TOTHAT" Thrust

Part 5: One minute at Flight Idle

Part 6: Ten minutes at "10 Minutes OEI TOTHAT" Thrust

Part 7: Five minutes at Maximum Continuous Thrust,

Part 8: One minute at 50 percent of Take-off Thrust

Part 9: Five minutes at "10 Minutes OEI TOTHAT" Thrust

Part 10: One minute at Flight Idle

Part 11: Ten minutes at "10 Minutes OEI TOTHAT" Thrust

Part 12: Five minutes at Maximum Continuous Thrust

Part 13: One minute at 50 percent of Take-off Thrust

Part 14: Nine minutes at "10 Minutes OEI TOTHAT" Thrust

Part 15: One minute at Flight Idle

8.2 After completion of the endurance test sequences, the engine must be subject to a strip inspection, and dimensions measured in accordance with CS-E 740(b)(5) must be re-measured and recorded. Compliance with CS-E 740(h)(1) must be demonstrated.

Any further CS-E paragraphs have to be considered by the applicant for the new rating as/if applicable.

Any other method proposed by the applicant shall be justified and will be subject to the acceptance of the Agency.