Special Condition

Approval of Turbofan Engine "Take-off Thrust at High Ambient Temperature (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 rated Take-off thrust beyond Take-off corner point temperature, to allow an aircraft under specific altitudes and temperatures, to:

- continue the takeoff in One Engine Inoperative (OEI) aircraft configuration after reaching V1,
- use maximum available rated Take-off thrust in All Engines Operating (AEO) aircraft configuration.

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. The final decision shall be published in the Official Publication of the Agency."

Statement of Issue:

This Special Condition defines additional requirements for the TOTHAT rating certification of using two periods of ten (10) minutes in OEI aircraft configuration during takeoff or five (5) minutes in AEO aircraft configuration for a turbine engine installed on a multi-engine airplane.
The TOTHAT rating introduces a new thrust corner point for the engine, compared to the Take-off corner point (see Figure 1).
This rating is intended to be used during any one flight. Accumulated usage time in any one flight is not to exceed twenty (20) minutes for takeoff and go-around scenarios.

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.
The following requirements are affected at least: 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.
In particular, regarding to CS-E 740 Endurance Tests:

- for TOTHAT rating in AEO configuration, an appropriate number of cycles of the standard 150 hour endurance tests has to be modified to include TOTHAT AEO operation, and
- for TOTHAT rating in OEI configuration , a 26th cycle has to be added.

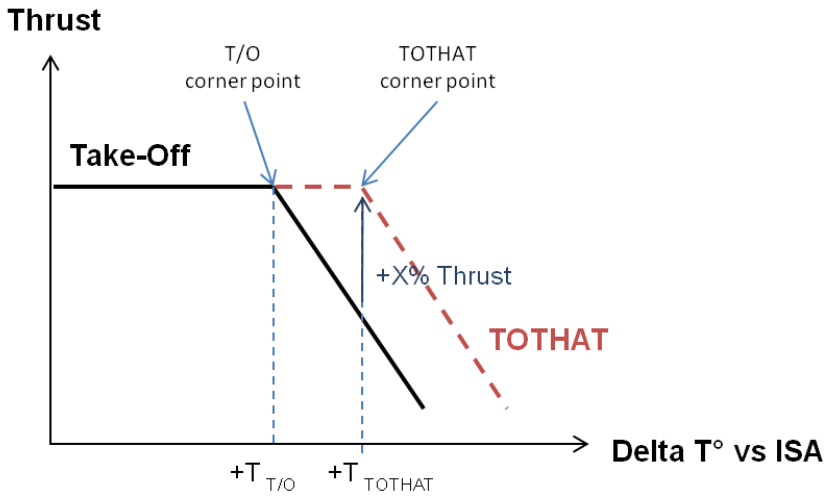

Figure 1

This engine thrust increase (+x% Thrust) beyond Take-off corner point at high ambient temperature (see Figure 1) leads to increase the EGT temperature (+yK) (see Figure 2) and declares a dedicated Max TOTHAT EGT for the new rating.

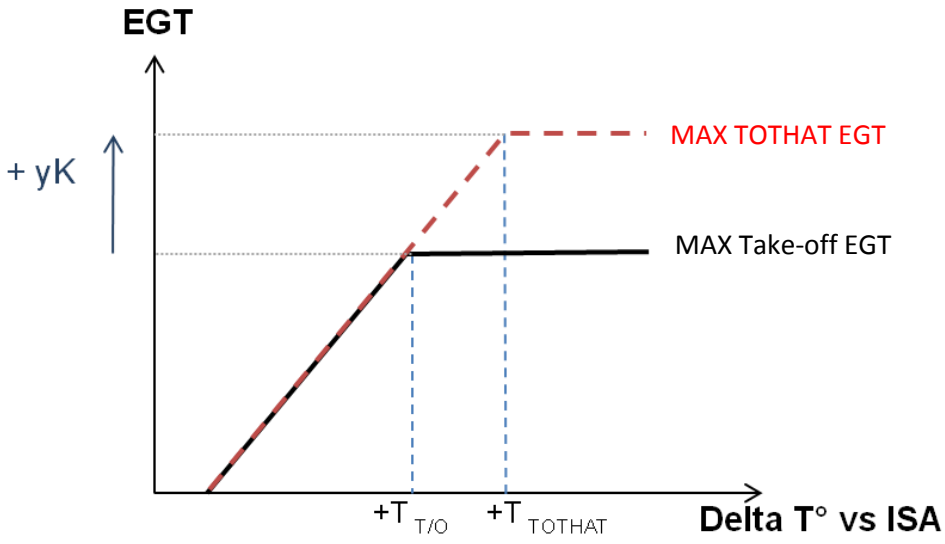

Figure 2

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 Electronic Controller (EEC) of any time spent at 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 the 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 TOTHAT rating.
   - 1.3 The applicant must validate the adequacy of these mandatory post-flight 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 TOTHAT rating.
   - 1.6 All limitations must be included in the engine Type Certificate Data Sheet (TCDS).
   - 1.7 Any usage of the 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 the TOTHAT rating in OEI configuration during the takeoff and the TOTHAT rating in AEO configuration under specific altitudes and temperatures.
   - 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 rated TOTHAT thrust is the same as the engine rated Take-off thrust with extended flat rating corner point (see Figure 1).
   - 1.12 The rated TOTHAT thrust rotational speed limits are the same as those associated with the engine rated Take-off 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 TOTHAT rating is created and defined as follows:

3.1.1 Rated TOTHAT thrust means an approved engine thrust, developed under specified altitudes and temperatures within the engine operating limitations.

3.1.2 This rating is intended to be limited in use:
- for continuation of the takeoff and go-around to a maximum usage after failure or shutdown of one engine (OEI) of two periods no longer than ten (10) minutes each in any one flight during the takeoff or
- for two times of five (5) minutes in all engines operating (AEO) in multi-engine airplane configuration in any one flight during takeoff and go-around.

3.1.3 The maximum accumulated usage time of the TOTHAT rating in any one flight is not to exceed twenty (20) minutes.

4. CS-E 50 Engine Control System

4.1 The engine must incorporate a means, or a provision for means:
- that the engine thrust control system automatically resets the thrust on the operating engine for ten (10) minutes TOTHAT rating in OEI configuration at specified altitude and temperatures during takeoff and go-around
and
- that the engine thrust control system will be authorized on pilot demand to use five (5) minutes in TOTHAT rating in AEO configuration at specified altitude and temperatures .

4.2 The engine control system managing the rated 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.

4.2.2 The TOTHAT rating in OEI configuration is automatically available at specified altitudes and temperatures.

4.2.3 The TOTHAT rating in AEO configuration is on pilot demand available 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 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 TOTHAT rating.

5.1.2.2 Alert maintenance personnel in a positive manner, that the engine has been operated at 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 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 two tests must be performed:

- To run an endurance test schedule as defined in CS-E 740, modified to include in Part 2 (stages 16 to 25, each of thirty (30) minutes duration), five (5) minutes at TOTHAT thrust (corresponding to TOTHAT EGT redline) after one (1) minute at Take-off thrust, the remaining twenty four (24) minutes have to run at Take-off thrust.

- To run an additional 26th cycle. The following test sequence must be performed for a total time not less than 120 minutes:
  Part 1: Ten (10) minutes at rated TOTHAT thrust
  Part 2: Eighty-eight (88) minutes at Maximum Continuous Thrust
  Part 3: One (1) minute at 50 percent of rated Take-off thrust
  Part 4: Ten (10) minutes at rated TOTHAT thrust
  Part 5: Ten (10) minutes at Maximum Continuous Thrust
  Part 6: One (1) minute at Flight Idle

8.2 After completion of the whole endurance test sequences (8.1.1 and 8.1.2), 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.