Proposed Special Condition on Automatic Take-Off Compensation (ATOC)

Applicable to A400M

Introductory note:

The hereby presented Special Condition has been classified as important 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

Airbus proposes to install an Automatic Take-Off Compensation (ATOC) feature in the four engined A400M aircraft which in case of outboard engine failure will partially reduce power on the opposite outboard engine in order to reduce the level of yaw asymmetry.

This Special Condition proposes criteria for such a design feature that are today not specifically addressed by CS-25 by introducing additional requirements for aircraft performance, limitations, functioning and reliability of the ATOC and by providing specific acceptable means of compliance for the airworthiness approval of such feature.

The proposed Special Condition assumes that ATOC failure modes and criticality classification for its associated systems are covered as part of the CS 25.1309 analysis and considering the impact on aircraft handling qualities and performances.

A400M – Special Condition B-12
- "Automatic Take-Off Compensation (ATOC)" -

This Special Condition deviates from the indicated CS 25 paragraphs as follows:

1- Amend CS 25.20 with:

(e) If the aeroplane is equipped with an engine control system that automatically reduces the power or thrust on an outboard engine when the opposite outboard engine fails during take-off, additional requirements pertaining to aeroplane performance, limitations, functioning and reliability of the system, contained in Appendix M, must be complied with.

2- Amend CS 25.904 with:

CS 25.904 "Automatic Takeoff Thrust Control System (ATTCS)" and "Automatic Takeoff Compensation (ATOC)"

(a) ATTCS: Aeroplanes equipped with an engine power control system that automatically resets the power or thrust on the operating engine(s) when any engine fails during the takeoff must comply with the requirements of Appendix I.

(b) ATOC: Aeroplanes equipped with an engine control system that automatically reduces the power or thrust on an outboard engine when the opposite outboard engine fails during take-off, must comply with the requirements of Appendix 1 to A400M – Special Condition B-12.

Appendix 1 to A400M – Special Condition B-12
Automatic Take Off Compensation

1 - Definition

This Appendix addresses a novel design feature of the A400M and uses terminology that does not appear in CS-25.

The following definitions shall apply:

(a) Automatic Take Off Compensation (ATOC):
an automatic airplane level function designed such that in case of outboard engine failure, it reduces yaw asymmetry by partially reducing power on the opposite outboard engine. This applies on ground and in flight, in the speed range where rudder only is not sufficient to counter the failure in a continued take-off.
This Appendix assumes that the ATOC function is an integrated part of the electronic flight control system and can neither be armed, selected nor deselected by the pilot.

(b) Critical time interval:
The critical time interval to be considered for ATOC at take-off is between one second before reaching V1, and the point where the speed reached with all engines operative is not less than the minimum control speeds as defined in CS 25.149(b) or (e) determined without ATOC, as appropriate.

2 - Automatic Take Off Compensation failures.

The concurrent existence of an ATOC failure and an outboard engine failure during the critical time interval must be shown to be Extremely Improbable taking into account the minimum V1 speed in all possible take-off conditions.

3 – Flight Deck annunciations

A dedicated flight deck annunciation, in addition to the outboard engine failure warning, must be provided when the thrust setting is reduced by ATOC. This annunciation must display clearly and unambiguously that the Automatic Take Off Compensation (ATOC) function is triggered and must display both the new target thrust and the achieved thrust.

4 – Engine failure detection

If the inherent characteristics of the aeroplane do not provide adequate indication that an engine has failed, an alerting system must be provided to give the pilot a clear indication of engine failure during take-off.

AMC to Appendix 1 to A400M – Special Condition B-12

1 – Performance

1.1 Critical engine

The critical engine shall be identified for compliance demonstration with applicable performance requirements, i.e., the performance shall account for failure of a critical outboard engine with Automatic Take Off Compensation (ATOC) operating, or failure of the critical inboard engine, whichever is more adverse.

1.2 Take-off performance

The performance shall conservatively account for the failure of the critical engine at the critical point in the take-off. The effect of ATOC on the thrust-to-weight ratio at liftoff shall be taken into account for Vmu determination. The take-off distance established in accordance with CS 25.113 shall account for the adverse effect of ATOC on thrust-to-weight ratio. The effect of the ATOC thrust modulation on the gross and net take-off paths shall be modelled into the published performance data.

In addition, in one-outer-engine-inoperative first segment conditions in which ATOC may command a thrust reduction, it must be demonstrated that:

- speed excursions of 5 kts below the scheduled speed can be recovered to the scheduled speed while maintaining a positive climb gradient.
- ATOC does not adversely affect the pilot’s task to control airspeed.

1.3 One engine inoperative climb gradients

The one-engine-inoperative climb gradient requirements of CS 25.121 shall be met at the critical power operating condition for each climb segment. The most critical adverse effect of the ATOC on the thrust-to-weight ratio shall be accounted for in establishing the climb limited weights for all ambient conditions within the approved envelope.

In addition, in one-outer-engine-inoperative second segment conditions in which ATOC may command a thrust reduction, it shall be demonstrated that:

- speed excursions of 5 kts below the scheduled speed can be recovered to the scheduled speed while maintaining the aeroplane's path above the net take-off flight path.
- ATOC does not adversely affect the pilot's task to control airspeed.

2 – Minimum control speeds

The determination of minimum control speeds may be made with ATOC active or, at the option of the applicant, with ATOC deactivated if that leads to conservative minimum control speeds.
The determination of minimum control speeds according to CS 25.149 shall account for the critical failure mode (outboard engine failure or inboard engine failure) and critical airspeed for directional controllability.
In case Vmcg is determined with ATOC active, it shall be demonstrated that the lateral deviation following critical engine failure at all higher speeds at which ATOC operates is not greater than the lateral deviation at Vmcg.
In case Vmca is determined with ATOC active, it shall be demonstrated that it is possible to maintain control of the aeroplane with the critical engine still inoperative, and maintain straight flight with an angle of bank of not more than 5º, at all speeds higher than Vmca at which ATOC operates.

3 – Derated/Uprated thrust (power) take-off

For derated/uprated take-off thrust (power) procedures (if applicable), the compatibility with the ATOC function shall be demonstrated.