EASA	COMMENT RESPONSE DOCUMENT
	Proposed Special Condition on Automatic Take-Off Compensation (ATOC) Applicable to A400M Issue 1

Commenter 1 : CAA-UK

Comment # [1] – Special Condition / 1- Amend CS 25.20 with

Safety significance = *"…in the speed range where rudder only is not sufficient to counter the failure in a continued take-off."*

Comment :
Given its safety significance, would the continuing airworthiness of this item be managed as CMR/ALI?

EASA response:
Noted.

The need or not to include a dedicated CMR/ALI for the ATOC will be determined by the outcome of the CS 25.1309 safety assessment analysis taking in consideration ATOC failure modes and criticality classification for its associated systems, as well as considering the impact on aircraft handling qualities and performances. In addition, the EASA Special Condition specifically requires that concurrent existence of an ATOC failure and an outboard engine failure during critical time interval must be shown to be Extremely Improbable.

Comment # [2] – Appendix 1 / 3 – Flight Deck annunciations

Without indication of failure, or inoperability, the operator would not be in a position to know; whether this safety significant system were available, or the length of time/cycles it were unavailable.

Comment :
As the Special Condition does not appear to address indication, by annunciation or other means, of ATOC in a failed or inoperative condition, how is operator exposure to ATOC failure or inoperability to be managed?

EASA response:

EASA Disagree.

The EASA Special Condition assumes:

- ***a) That the ATOC function is an integrated part of the aircraft electronic flight control system, and can neither be armed, selected nor deselected by the pilot, and***
- ***b) That the ATOC failure modes (both indicated and hidden failure modes) and correct criticality classification of its associated systems are covered as part of the CS 25.1309 analysis, considering the impact on aircraft handling qualities and performances, and***
- ***c) The specific requirement (extremely improbable for concurrent ATOC failure and outboard engine failure during critical time interval) introduced by the EASA Special Condition paragraph 2 on Appendix 1 has been prescribed as an additional requirement with independence of what the real classification of this double failure scenario could be.***

Therefore the need or not to provide a dedicated alert or other feedback to the flight crew for the non-availability of the ATOC function as well as the need or not for any specific CMR/ALI is part of the particular CS 25.1309 FHA/SSA process.

Commenter 2 : TCCA

Comment # [1] – General

Comment :

It is unclear from the proposed Special Condition whether the flight crew can manually increase power on the opposite outboard engine to the failed engine, following ATOC operation.

EASA response:

Noted.

The Special Condition assumes that ATOC function is an integrated part of the electronic flight control system and can neither be armed, selected nor deselected by the pilot.

This means the crew can neither override the ATOC nor manually increase the thrust during the interval the ATOC function needs to reset the power on the applicable outboard engine.

Comment # [2] – Appendix 1 – Paragraph 1 (b)

Comment :
Consideration should be given to establishing the critical time interval based on the time required to reach the VMC limited minimum operational speeds V1, VR and V2 following failure of an outboard engine and ATOC.
These speeds contain a required safety margin above VMC.

For example, consider that the VMCA value without ATOC is 100 KCAS. Minimum V2 would be 110 KCAS based on VMCA. Hence in the event of an outboard engine failure and failure of ATOC at say 105 KCAS, the minimum safety margin for V2 based on VMC, has not been achieved.

EASA response:
Disagreement.
This case does not need to be considered since 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.

Comment # [3] – AMC to Appendix 1 – Paragraph 1.1

Comment :
Suggested addition to address that the critical engine for VMC may not be the critical engine for pilot recognition :
“The time interval between VEF and pilot recognition of Engine failure in accordance with 25.107(a)(2) must take into account the more critical of an inboard engine failure (left or right) and an outboard engine failure (left or right).”

EASA response:
Disagreement.
As for any other aircraft, the critical engine with regards VMC may not be the critical engine for pilot recognition, therefore comment is not specific for the ATOC case.
In addition, Paragraph 1.1 of EASA Special Condition specifies that 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.
This implies that the time interval between VEF and pilot recognition of inner engine failure shall be taken into account in case of inboard engine failure, but not necessarily in case of outboard engine failure.

Comment # [4] – AMC to Appendix 1 –Paragraph 1.2 – 1st subparagraph

Comment :

Suggested addition *"The accelerate stop distance determined in accordance with 25.109 shall account for any possible adverse effect of ATOC."*

EASA response:
Disagreement.
In principle, ATOC does not adversely affect thrust in case of Rejected Take Off (RTO) with engine failure, contrary to the continued take-off case.

Comment # [5] – AMC to Appendix 1 –Paragraph 1.2 – 2nd subparagraph

"First segment conditions" is ambiguous.

Comment :
Although it is commonly used to define the segment between lift-off and the gear up point, the speed varies from VLOF to the scheduled V2. Another definition in common use is from the end of the take-off run to the gear up point and the scheduled speed would be V2.
The intent should be clarified.

EASA response:
Agreement.
This means in the conditions of CS25.121(a). EASA Special Condition's wording has been amended as follows:

"In addition, in one-outer-engine-inoperative first segment conditions (as per CS 25.121(a)) in which ATOC may command a thrust reduction, it must be demonstrated that:……"

Comment # [6] – AMC to Appendix 1 –Paragraph 1.3

The reference to CS 25.121 to be clarified.

Comment :
it would appear that (c) Final Take-off and (d) Approach are not applicable.

EASA response:
Disagreement.
ATOC function may still be engaged for final take-off and/or approach climb phases (Go-Around).
EASA Special Condition AMC to Appendix 1, sub-paragraph1.3 states: "The one-engine-inoperative climb gradient requirements of CS 25.121 shall be met at the critical power operating conditions for each climb segment"
Therefore the AMC part of the EASA SC applies to EASA whole CS 25.121, including all subparagraphs (a)(b)(c)(d).
Otherwise, the EASA SC should have specified to which CS 25.121 subparagraphs is applicable.

Comment # [7] – AMC to Appendix 1 –Paragraph 3

Comment :
It is unclear what “Uprated” take-off thrust (power) is.
The compatibility of the ATOC function with Reduced thrust (power) procedures should be added.

EASA response:
Disagreement
Uprated take-off is the opposite of derated: An increased power compared with normal maximum take-off rating, in case this is possible to be used / available for the specific design architecture by for example introducing additional engine life limitations if needed. EASA consider the meaning in the scope of the Special Condition should be obvious.
Compatibility of ATOC with reduced power procedures is already addressed by requirements related to reduced take-off. There is no impact of ATOC.

Commenter 3 : Private person

Comment # [1] – General comment regarding Regulation

Concerns about the way Vmcg is determined within the current regulatory basis.

Comment :
Regulatory Vmcg basis still assumes zero-wind conditions. Vmcg is therefore determined at 0 kts crosswind. Vmcg needs to be increased by 10 - 20 kts while operating at max crosswind (from the 'wrong' side), depending on the aircraft type (crosswind adding to the required force exerted by the rudder).

Also, there is no compensation in the regulatory basis for late reaction of the pilot during line-operation. While V1 calculations are corrected by 1 second to compensate for late reaction on normal line-operations (versus test conditions), there is no correction for the late reaction of the line-pilot for centerline deviations at Vmcg, potentially significantly adding to the centerline deviation (especially during wet runway conditions when Vmcg and Vr may differ considerably).

Both above-mentioned criteria render regulatory Vmcg basis deficient, as can (and has been) easily be demonstrated in a simulated environment.

Both criteria can be explained from a technological, historical and economical point of view. However, when certification standards are being asked to be amended in order to gain extra performance by further reducing Vmcg, I would like to pose that in the interest of safety and by means of currently available technological progress, it is advisable to review the current legislation with regards to determining Vmcg.

At the very least Vmcg should be crosswind dependent when new legislation is implemented.

EASA response:
Disagreement
This comment is about CS25 content and not about the proposed Special Condition.

Comment # [2] – 1- Amend CS 25.20 with:

CS 25.20 (e) only relates to a reduction in power.

Comment :
ATOC as proposed on the A400M is not only allowed to reduce power, but also allowed to subsequently increase power when inputs of the ATOC system indicate it is possible to automatically increase power. A different situation exists from normal situations in that during an asymmetric power situation the system is - without pilot inputs - allowed to automatically increase (power)asymmetry. There is no urgent need for the system to automatically increase power and asymmetry once airspeed allows for power increase. It is therefore recommended that pilots retain full control over power increase in asymmetric power situations; e.g. pilots having some form of input in which they can command the system to increase control.

EASA response:
Disagreement
ATOC function does not increase power beyond the take-off power rating selected by the flight crew. In addition, current CS 25 requirements do not prohibit automated power changes in case an asymmetry exists.

Comment # [3] – Appendix 1 – Paragraph 2

As a general remark, I would like to add that these days, aircraft systems have become more and more interconnected and interdependent. This interdependency does not correspond with the current legislative philosophy of 'single failures'.
In itself proposed Appendix-1.2 already acknowledges necessity of departure from the single failure principle with the combining of an ATOC failure and an engine failure.

Allowing for system become interdependent without the required comprehensive multi failure certification basis does not do the general public justice. Granted, this is hardly an easy job and most probably legislation requirements will never 100% cover all of the problems. Development of new certification requirements and standards unfortunately historically has also often been shown to be a process of trial and error.
However, effectively merely demanding showing of the existence of a failure to be 'Extremely Improbable', as in the Special Condition at hand, is putting the initiative fully with the manufacturers, potentially reduces effectiveness of EASA and potentially reduces the required checks and balances between legislators an manufacturers.

Up till now, takeoffs on large commercial aircraft only allow for auto-throttle systems to reduce power after passing an altitude of 400 feet or higher. Reasoning for this required system behavior is clear: no failure in any system may put the aircraft in jeopardy during this critical flight phase by inadvertently *reducing* power on any of the aircrafts engines; and maximum independency of the important subsystems is maintained, keeping the operational, design and certification requirements synoptic.

Comment :
The ATOC system is a clear break with this inherently tried and proven design/certification philosophy.

Current proposed legislation does is not sufficiently comprehensive and does not sufficiently cover all the possible variables to allow for a change in the above-mentioned philosophy and certification basis for auto-throttle systems.

Fully independent alternatives are available for aircraft with Vmc problems with only minor reductions in performance. Fixed deration on engines has been applied for over two decades; a new development is the use of differential takeoff thrust/power, whereby outer engines are (fixed) de-rated (inner engines at full rated thrust/power). Although takeoff performance is slightly decreased compared to the ATOC system, inherent systemic safety is significantly increased. Manufacturers are aware of the existence of these alternatives.

EASA response:
Disagreement.
ATOC function is not an auto-throttle system.
The proposed Special Condition is adding more stringent conditions than CS25.1309 by requiring the concurrent existence of an ATOC failure and an outboard engine failure during the critical time interval to be Extremely Improbable.
In addition, CS 25.1309 requirements about single (fail-safe) and combined failure cases are fully applicable.
Equivalency with the safety standard of CS25 is therefore fully ensured.

Comment # [4] – Appendix 1 – Paragraph 2

Only the concurrent existence of an ATOC failure and an outboard engine failure is addressed. Although this covers the low-weight / high-power scenario, it does not cover for instance the high-weight scenario.

Comment :
When an inboard engine fails during the critical time interval when the aircraft is heavy, failure of the ATOC system can result in power-loss of one or more of the outboard engines, generating a highly undesirable situation.

EASA response:

"Disagreement.
ATOC function is defined as an "engine control system that automatically reduces the power or thrust on an outboard engine when the opposite outboard engine fails.

The EASA Special Condition assumes:

a) ***That the ATOC function is an integrated part of the aircraft electronic flight control system, and can neither be armed, selected nor deselected by the pilot, and***
b) ***That the ATOC failure modes (both indicated and hidden failure modes) and correct criticality classification of its associated systems are covered as part of the CS 25.1309 analysis, considering the impact on aircraft handling qualities and performances, and***
c) ***The specific requirement (extremely improbable for concurrent ATOC failure and outboard engine failure during critical time interval) introduced by the EASA Special Condition paragraph 2 on Appendix 1 has been prescribed as an additional requirement to those of CS 25.1309 with independence of what the real classification of this double failure scenario could be.***

Comment # [5] – Appendix 1 – Paragraph 2

Combining "the concurrent existence of an ATOC failure and an outboard engine failure during the time critical interval" will lower the required failure probability level for the ATOC system significantly.

Comment :
When accepting the chance of an outboard engine failure during the time critical interval to be in the order of around 1x10-4, the required probability for an ATOC failure will –in a fully independent situation- be in the order of 1x10-5. The required failure condition probability will have reduced from EXTREMELY IMPROBABLE (1x10-9) for the total event to either IMPROBABLE (<1x10-5) or even to PROBABLE

(>1x10-5) for the ATOC system, depending on the way the numbers are used.

Moreover, if failure of the ATOC system and an outboard engine failure were operationally, technically and statistically completely independent, such a reduction in required failure probability for the ATOC system might be acceptable, however, they are not.

EASA response:

Disagreement.
CS25.1309 only allows probabilities to be combined when events are demonstrated to be fully independent, which is the case. It is part of CS 25.1309 analysis process to check through the Common Cause – Common Mode Analysis tool the independence of failures which combined may lead to catastrophic repercussions

Comment* # *[6] – Appendix 1 – Paragraph 2

Operationally one root cause can generate both failure of the ATOC system and the (outboard) engine.

Comment :
Numerous cases have been documented where birds have caused several systems to fail during takeoff and go-around (damaged pitot-static systems combined with engine failures). Several recorded cases relate to ingestion of volcanic ashes; one thing you don't need is an ATOC system reducing power on the few remaining engines when ashes in the PS system disables airspeed indication.

Several other operational scenarios can be envisioned (and have been demonstrated) where one root cause can lead to several independent and in itself non-fatal failures; however when cross-links between systems are installed these cross-links can significantly aggravate the situation and the impact of the failures.

Statistically it can be considered highly questionable to consider the ATOC system and the (outer) engines independent, especially if the ATOC system requires inputs from a failed engine or from a system monitoring this engine. System wise, one single input (the ATOC system) is now controlling/influencing multiple flight critical systems (engines), whereby one common signal can corrupt multiple flight critical systems.

Proposal : Recommendation to rephrase Appendix-1.2 into:
"*The existence of an ATOC 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*."

EASA response:
Disagreement.
The EASA Special Condition assumes the ATOC function is an integrated part of the aircraft electronic flight control system, not of the engine. The proposed rephrased requirement is significantly more stringent than current CS25.

It is part of CS 25.1309 design and analysis process to check through the Common Cause Analysis (Zonal Safety Analysis, Particular Risk Analysis for events outside the systems concerned and Common Mode Analysis) to check and be sure of the independence of failures or failures and events which combined may lead to catastrophic repercussions.

Comment # [7] – Appendix 1 – Paragraph 2

Theoretically, the current Special Condition would allow for an unlimited power reduction on an engine.

Comment :
In view of a possible failure of the ATOC system, a maximum power reduction authority for the ATOC system is advisable (comparable to the maximum power reduction of 25% in a reduced take-off, as per FAA AC 25-13). Object and requirement would be to guarantee a safe take-off roll and take-off path, should the ATOC system inadvertently fail at Vef/V1, resulting in an all-engines take-off but with the power reduced to the ATOC maximum authority on all relevant engines.

Proposal : Recommendation to add to Appendix-1:
"*Failure of an ATOC system during the critical time interval, resulting in the maximum power reduction authorized by the ATOC system on all relevant engines must be shown to result in a safe all-engines take-off roll and take-off path*."

EASA response:
Disagreement.
Derated takeoff is already allowed without lower limit and affects all engines.
Specifying an arbitrary maximum power reduction for ATOC function would not necessarily increase safety depending on whether the limit is ensured by an independent system or not. In addition and as for any other aircraft function, the ATOC needs to comply with CS 25.1309 requirements for single failures/untimely activation, considering also the impact on aircraft performance and handling qualities, which in fact will impose a limit on the maximum power reduction in case this could have unacceptable safety consequences for a single event.
There are no grounds to require specific design features beyond what is necessary to achieve an equivalent safety level to CS25.

Comment # [8] – Appendix 1 – Paragraph 3

The timeframe required for the crew to recognize and react to an engine failure may be insufficient (Vef-V1).

Comment :

Up to now, reaction time was based on the single failure of an engine.
Now, the crew needs to recognize the engine failure, verify that there is a power reduction on the opposite engine, verify this power reduction is indeed due to the ATOC system, verify the power reduction is accurate and it is therefore considered safe to continue the take-off.
In addition, ATOC system response time has not been included.
The ATOC system needs to detect an outboard engine-failure needs to verify its findings with other parameters in order to preclude false responses, needs to command the opposite engine, and needs to alert the crew

This will require extra time between Vef and V1. Extra recognition time is not addressed in the Appendix.

EASA response:
Disagreement.
CS25 engine failure recognition requirements are not modified by the proposed Special Condition and are still applicable.
Recognition times will be based on actual aircraft behaviour including the effects of ATOC.

Comment* # *[9] – Appendix 1 – Paragraphs 3 & 4

Comment :
In the early days of the tri-engined commercial aircraft, the FAA imposed an crew engine failure recognition time of 2 seconds instead of 1 second, due to the inability of the crew to recognize an engine failure of engine number 2 by means of the aircraft behavior. Later on, the MD11 was able to reduce this recognition time to 1.3 seconds, by installing warning lights on the glare shield within the direct view of the pilots (JAA SC/MD-11/10). FAA and JAA did acknowledge the need for extended recognition times.

EASA response:
Noted.
This is addressed by paragraph 4 of the proposed Special Condition: " 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.
See also answer provided on comment number 8 above."