Proposed Temporary Deviation on Total Engine Flame Out and Propeller Unfeathering Conditions under Aircraft Emergency Electrical Configuration

Applicable to A400M

Introductory note:

The hereby presented Temporary Deviation 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

The A400M aircraft and propulsion system designs are such that in Total Engine Flame Out (TEFO) situations where only engine#1 or engine#3 would restart, unfeathering of the propeller on these engines is not ensured.

This specific aircraft behaviour should not be attributed solely to the electrical power generating system architecture, which will perform adequately if the unfeathering after engine relight could be done in all instances with only the propeller Main Pump, but to the added fact that under situations of low propeller speed with engine at Flight Idle, the Propeller Auxiliary Feathering Pump (AFP) is necessary to supplement the Main Pump to ensure in all instances that the propeller unfeathers when performing an engine restart.

The AFP is electrically powered by the aircraft normal AC electrical network, which is such that two engines are needed to provide power to all AC bus bars, hence to all AFPs. When only one engine is available, electrical power to AFPs is provided in the following manner:

- Eng 1 or 2: AFP 2 & 3

- Eng 3 or 4: AFP 1 & 4

Therefore, in case of an emergency electrical configuration during a Total Engine Flame Out situation and in a situation where only engine 1 or engine 3 would restart, the AFP of this engine would not be powered, so it can be concluded that the ability to unfeather the propeller and produce thrust of engines numbers #1 and #3 has become dependent on the electrical power generated by another aircrafts' engine under the scenario described above.

The CS 25.903(b) requirement states:

> *"Engine isolation. The powerplants must be arranged and isolated from each other to allow operation, in at least one configuration, so that the failure or malfunction of any engine, or of any system that can affect the engine, will not:*
>
> - *(1) Prevent the continued safe operation of the remaining engines; or*
> - *(2) Require immediate action by any crew member for continued safe operation*"

In addition, CS 25.903(e) requires the following*:*

"Restart capability

- *(1) Means to restart any engine in flight must be provided*
- *(2) An altitude and airspeed envelope must be established for in-flight engine restarting, and each engine must have a restart capability, within that envelope. (See AMC 25.903(e)(2)*
- *(3) For turbine engine powered aeroplanes, if the minimum windmilling speed of the engines, following the in-flight shutdown of all engines, is insufficient to provide the necessary electrical power for engine ignition, a power-source independent of the engine driven electrical power generating system must be provided to permit in- flight engine ignition for engine restarting*".

Combining the *engine isolation* and engine *restart capability* requirements as discussed under CS 25.903 (b) and (e), EASA interprets that the restart of any (individual) engine including the ability to produce the thrust, shall not be such, that it is dependent on the restart of any other engine.

It is EASA interpretation also that particularly for turbo-propeller aircraft, the individual engine restart capability shall include the ability of the propeller to unfeather and consequently to provide thrust for aircraft propulsion.

Consequently, it is considered the proposed A400M architecture is not fully compliant with CS 25.903 requirements in case only engines 1 or 3 restart during a TEFO scenario.

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The applicant has identified the following mitigations for the particular scenario described on the statement of issue and the non compliance with CS 25.903:

1. The A400M Aeroplane Flight Manual (AFM) procedure in case of TEFO requires <u>all</u> engine master levers to be set to OFF then FTHR as soon as the windmilling optimum relight point is reached.
2. Specific aircraft design changes are being assessed by Airbus in order to enable to unfeather the propeller of each engine as soon as this engine is restarted in all instances, thus removing the dependence upon the successful restart of any other engine. The selected change should be ready to be implemented before the end of 2012, previous to the delivery of any A400M aircraft.
3. The additional safety risk associated to this specific condition is to be in a TEFO situation where only one engine among four (engine #1 or engine #3) would be restartable. Since, in this particular condition, the propeller of these engines may not unfeather, this could lead to a definitive loss of thrust. It shall be noted however that the A400M Propulsion System Assessment (SSA) assumes that the definitive loss of 75% of thrust has the same categorization (CAT) as the definitive total loss of aircraft thrust. In that respect being able to unfeather the propeller of engine#1 or engine#3 would not change this categorization, therefore not worsening the scenario.
4. The Airbus' A400M Aircraft System Safety Assessment (SSA) shows that the probability of definitive loss of 75% or more of aircraft thrust is extremely improbable. This result has been achieved without considering all possible environmental common causes (e.g. volcanic ash clouds,…), as per usual practice. However Airbus considers that, based on in service experience and operational

precautions, the probability for unexpectedly encountering those environmental conditions would be very low. The probability that these conditions lead to be able to restart only one engine would be even lower and sufficiently low to ensure the safe operation of the aircraft for a limited period of time.

Airbus SAS request EASA a Temporary Deviation for compliance with CS 25.903.

As EASA conclusion, a Temporary Deviation with regards compliance with CS 25.903 for the A400M can be granted by EASA associated to the following condition:

This EASA temporary deviation will be valid since initial A400M certification until 31st December 2012 or first A400M aircraft entry into service, whichever will occur first.