



# Certification Memorandum

## Turbine Engine Relighting In Flight

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**Regulatory requirement(s): CS-E 910**

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## Log of issues

Issue	Issue date	Change description
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## 1. Introduction

### 1.1. Purpose and scope

The purpose of this Certification Memorandum is to provide specific guidance to assess turbine engines for susceptibility to conditions which may prevent their relighting in flight such as rotor-lock.

CS-E 910 "Relighting In Flight" requires that an envelope of conditions must be substantiated for the engine in-flight relight capability, but no AMC E 910 is provided. There is also no consideration of the threats which may compromise engine relighting within this envelope.

### 1.2. References

It is intended that the following reference materials be used in conjunction with this Certification Memorandum:

Reference	Title	Code	Issue	Date
CS-E 910	Relighting In Flight	CS-E	---	---
AMC 25.903(e)(2)	Engines	CS-25	---	---
FAA Policy No. PS-ANE-33.89-1	Policy for Turbofan, Turbojet and Turboprop Engine Rotor Lock	---	---	28/06/2013

### 1.3. Abbreviations

AMC	Acceptable Means of Compliance
CM	Certification Memorandum
CS	Certification Specification
EASA	European Aviation Safety Agency
ESF	Equivalent Safety Finding
RPM	Revolutions per Minute (rotational speed)
TCDS	Type Certificate Data Sheet

### 1.4. Definitions

**Rotor-lock** The condition in which thermal effects following an engine in-flight shut down or an engine flame out lead to the loss of clearances between engine rotating and static components, and then to high-friction contact, thus preventing successful subsequent in-flight restarts, even when inside the certified air start windmill or starter assist envelopes.

**Rotor Drag** A condition caused by engine driven accessory loads and/or rotor/stator friction contact, which slows the engine rotor speed during an in-flight wind milling situation.



## 2. Background

CS-E 910 “Relighting In Flight” requires that an envelope of conditions must be substantiated for the engine in-flight relight capability. The need for addressing engine relighting capability is supported by service experience. Indeed in-flight engine flame-outs have occurred for a number of reasons, including loss of electrical power, fuel mismanagement, crew voluntary or un-voluntary action, mis-trimming of engine idle setting, volcanic ash encounter, inclement weather, ...

Modern aircraft engines incorporate technologies that may reduce the in-flight engine relight envelope and increase the time required to restart the engine. Also, as core-bypass ratio of engines continues to increase, higher airspeeds are generally required to enable unassisted windmill restarting. The inertial effects because of the increased size, mass, and number of engine driven gearbox accessories may also contribute to increased rotor drag loads, decrease starting performance, and possibly contribute to rotor-lock conditions. This may have catastrophic consequences for an airplane. In 2006 the USA NTSB issued the following recommendation:

*“Review the design of turbine-powered engines to determine whether they are susceptible to core lock and, for those engines so identified, require manufacturers of airplanes equipped with these engines to perform high power, high altitude sudden engine shutdowns and determine the minimum airspeed to maintain sufficient core rotation so that all methods of in-flight restart can be accomplished. (A-06-73)”.*

## 3. EASA Certification Policy

### 3.1. Applicability

Though this policy is written for Turbofan, Turbojet and Turboprop engines, it should be considered for Turboshaft projects to determine if similar concerns may exist for each particular turboshaft design. In the absence of guidance specific to turboshaft engines, or to rotorcraft, the objectives of a turboshaft engine demonstration of compliance with CS-E 910 will need to be agreed with EASA.

CS-E 910 “Relighting In Flight” requires that an envelope of conditions must be substantiated for the engine in-flight relight capability. No specific guidance is provided in CS-E however CS-25 contains AMC 25.903(e)(2) which is relevant as it is necessary that the engine design will later support the aircraft certification:

#### *“Engines*

##### *1 General*

##### *1.1 In general the relight envelope required in CS 25.903(e)(2) may consist of two zones –*

- a. One zone where the engine is rotated by windmilling at or beyond the minimum rpm to effect a satisfactory relight, and*
- b. Another zone where the engine is rotated with assistance of the starter at or beyond the minimum rpm to effect a satisfactory relight.*

##### *1.2 The minimum acceptable relight envelope is defined in paragraph 2.*

##### *2 Envelope of Altitude and Airspeed*

- 2.1 Sufficient flight tests should be made over the range of conditions detailed in 2.2 and 2.3, to establish the envelope of altitude and airspeed for reliable engine restarts, taking into account the results of restart tests completed by the engine constructor on the same type of engine in an altitude test facility or flying test bed, if available, and the experience accumulated in other aircraft with the same engine. The effect of engine deterioration in service should be taken into account.*



- 2.2 *Altitude and Configuration. From sea-level to the maximum declared restarting altitude in all appropriate configurations likely to affect restarting, including the emergency descent configuration.*
- 2.3 *Airspeed. From the minimum to the maximum declared airspeed at all altitudes up to the maximum declared engine restarting altitude. The airspeed range of the declared relight envelope should cover at least 30 kt.*
- 2.4 *Delay Tests. The tests referred to in paragraph 2.2 should include the effect on engine restarting performance of delay periods between engine shut-down and restarting of –*
- a. *Up to two minutes, and*
  - b. *At least fifteen minutes or until the engine oil temperatures are stabilised at their cold soak value.”*

The guidance of AMC 25.903(e)(2) can be used to establish the objectives of the engine demonstration of compliance with CS-E 910. Considering that the capability of restarting an engine in flight is also an aircraft certification requirement, for which particular guidance may have been established in addition to AMC 25.903(e)(2), coordination between the engine type certificate and the aircraft type certificate applicants is recommended.

For a new engine type certification, engine altitude testing or engine flight testing are the commonly accepted means of compliance. Nevertheless, as permitted by CS-E 910, other appropriate tests or evidence could be proposed by the applicant.

In addition, after reviewing the safety implications of certain in-flight relight scenarios, the Agency has concluded that specific threats should be considered in the assessment for compliance with CS-E 910. The following aspects should be addressed:

#### 1 Quick engine shut-down and relight:

This is the in-flight situation where the engine functioning is inadvertently shut-down (following an interruption in the fuel supply, or an erroneous shut-down command from the pilot for example) and the pilot quickly initiates a restart command (in not less than 5 seconds). The applicant should justify that the engine design, and in particular the engine control system, will not introduce an unnecessary delay in the engine returning to the previous power setting.

Examples: An engine control system which relights the engine without requiring additional pilot actions would be better than a system requiring additional/multiple pilot actions. An engine control system which initiates the engine relight sequence immediately upon pilot command would be better than a system waiting for the engine to roll-back below a low speed threshold, or to reach a low temperature threshold, or to meet other conditions in addition to the pilot command.

#### 2 Rotor-lock:

Applicants should determine the potential for rotor-lock and its impact on the engine in-flight relight capability using the guidance contained in paragraph 4 of the FAA Policy No. PS-ANE-33.89-1 “Policy for Turbofan, Turbojet and Turboprop Engine Rotor Lock”. All engine rotors should be considered. If a flight test is proposed, it should represent the most adverse conditions for the engine in term of rotor-lock, or must be supplemented by an analysis addressing the most adverse conditions satisfactorily, including minimum cold engine seal and blade tip clearances.

## 3.2. Who this Certification Memorandum affects

Applicants for an engine Type Certificate that need to show compliance with CS-E 910.

Applicants for a change to an engine Type Certificate when this change affects compliance with CS-E 910.



## 4. Remarks

1. Suggestions for amendment(s) to this EASA Certification Memorandum should be referred to the Certification Policy and Safety Information Department, Certification Directorate, EASA. E-mail [CM@easa.europa.eu](mailto:CM@easa.europa.eu) or fax +49 (0)221 89990 4459.

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