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Subject:	SC-E 13: Turboshift Engine Gearbox with Integrated Freewheel and Interconnect shaft	

Introductory Note:

The following Special Condition has been classified as an important Special Condition and as such has been 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.”

All comments received during the consultation period have been reviewed by the Agency. The final EASA decision for each comment is documented in the Comment Response Document (CRD), which is published concurrently with this Special Condition.

Statement of Issue:

EASA has received an application for a turboshaft engine model which incorporates, as part of the engine type design, a gearbox with integrated freewheeling system as well as an interconnect shaft for the helicopter tail rotor drive which aim to provide functions typically addressed by rotorcraft Certification Specifications.

1. The freewheel allows the rotors and rotor drive system to auto-rotate in case of engine failure.
2. The interconnect shaft allows the tail rotor to be directly driven by the helicopter main gearbox (MGB) when the engine is disengaged by the freewheel.

The Certification Specifications for Rotorcraft (CS27 & CS29) assume that freewheels and interconnect shafts are part of the rotor drive system of the rotorcraft and that they will be assessed and certified during the rotorcraft type certification process.

As these parts will be included in the engine configuration they will be the responsibility of the engine type certificate holder. Accordingly, as required by Part 21.A.16B, it is necessary to review CS-E and supplement the engine requirements as needed to address these items. This review has concluded that Certification Specifications for Engine (CS-E) do not include requirements for assessing freewheel and interconnect shaft systems behaviour and integrity.

The aim of this Special Condition is to address these specific rotorcraft technical aspects to be considered by Engine manufacturers. It also aims at defining the appropriate limitations and clarifies the interfaces between engine and rotorcraft in order to facilitate the future integration of the engine.



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EASA Position:

When a turboshift engine design integrates a freewheel and / or interconnect shaft system, the compliance with the technical requirements, as listed in Appendix A, shall be demonstrated.

The elements listed in Appendix A are related to the following CS 27 & 29 paragraphs:

- **Design and construction**

CS 2X.602 - Critical parts

- **Powerplant**

CS 2X.901 - Installation

CS 2X.917 - Rotor drive system - Design

CS 2X.923 - Rotor drive system and control mechanical tests

CS 2X.927 - Additional tests

CS 2X.1027 - Oil system – transmissions and gearboxes

CS 2X.1337 - Powerplant Instruments



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APPENDIX A

The engine applicant shall:

1. CS-E 510 Safety Analysis

Any Engine Failure that could impair the freewheel or interconnect shaft functions, which are necessary for safe flight and landing, must be regarded as potentially having Catastrophic Effects for the rotorcraft.

Guidance Material:

- A. *In addition to the Engine Safety Analysis of CS-E 510, the analysis must comprise the entire Type Design (including the freewheel and interconnect shaft), to ensure that the systems function safely over the full range of conditions for which certification is sought.*
- B. *In addition to CS-E 510, any Engine Failure that could impair the freewheel or interconnect shaft functions, which are necessary for safe flight and landing, must be regarded as potentially having Catastrophic Effects for the Rotorcraft. The Engine Effects associated to these potentially Catastrophic Rotorcraft Effects should be added to the Engine Hazardous Effects already included in CS-E 510(g). Those Engine Effects include, but are not limited to:*
- i. Loss of drive between the Main Rotor and the Tail Rotor,*
 - ii. Freewheel failure to disengage the engine in case of Engine Power Loss,*
 - iii. Impeded rotation of the Engine Output Shaft(s).*

As applicable (see paragraph 5) the analysis must also identify, for those failures potentially leading to Catastrophic Rotorcraft Failure Effects, means to minimize the likelihood of occurrence of these failures (see AMC to CS-29.917(b) in FAA AC 29-2C as reference). Specific failure modes and scenarios for consideration shall at least include:

- Failure of the interconnect shaft*
- Continued operation of the freewheel at the minimum oil pressure*
- Engine Failure leading to freewheel failure (oil starvation, debris resulting from engine failures, etc.)*
- Sliding free wheel in final flair or at high torque demand (wear development)*
- Undetected freewheel loss of lubrication*

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2. CS-E 740 Endurance Tests

A. Apply engagements and disengagements of the freewheel under representative conditions as part of the Engine Endurance Tests.

The number of engagements/disengagements must be appropriate to the intended installation. This number should be appropriately reported in the engine installation manual.

3. CS-E 170 Engine Systems and Component Verification

A. Perform any additional tests necessary to substantiate the safe operation of the freewheel.

This must cover continuous run under continuous minimum oil pressure, complete loss of lubrication and/or loss of oil pressure capability, chip detector performances, etc.

B. Perform over torque tests as follows.

- *If the turbine engine is not directly controlled by the crew (i.e. governor-controlled engine), perform 200 applications for 10s each of torque which is at least equal to the lesser of:*
 - *The maximum torque predicted to be used for Rotorcraft certification when showing compliance with 2X.923 plus 10% or*
 - *the maximum torque attainable under probable operating conditions (transient).*

The maximum torque used for showing compliance with the above paragraph should be included as an engine limitation.

- *15 minutes continued over torque (if applicable – see paragraph 5).*

4. CS-E 60 Provision for Instruments

A. Compliance with CS-E 60 must include, for the freewheel and interconnected shaft, means to identify degradation of their function by detection of ferromagnetic particles resulting from their damage or excessive wear, or generated anywhere else in the lubrication system.

This must allow electrical circuit and signal function check of the detector on ground and in flight when installed on a rotorcraft.

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5. CS-E 30 Assumptions

A. Assess and define any potential limitations with regard to the engine installation assumptions resulting from the proposed freewheel and interconnect shaft design.

Rotorcraft level requirements covering functions proposed to be performed under the type certified engine might drive a limited scope for the engine installation such as single engine installation, installation limited to small Rotorcraft (CS-27), specific inspections or any other as appropriate.

The assessment must compare the proposed design with the rotorcraft certification specifications and determine any potential limitations.

The assessment will consider the oil system independency between the engine and the freewheel and the capability to continue safe flight and landing following an engine in-flight shut down (e.g. disengagement, safe auto-rotation and/or operation with one engine inoperative, continuous run of tail rotor, etc.).