Certification Memorandum

Rotor Drive System – Gearbox "TBO Development"

EASA CM No.: CM–RTS-002 Issue 01 issued 28 September 2015

Regulatory requirement(s): **CS-Definitions**
CS 29.571, CS 29.602, CS 29.901, CS 29.917(b), CS 29.923 (b), CS 29.1529
CS 27.571, CS 27.602, CS 27.901, CS 27.923, CS 27.1529

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Log of issues

Issue	Issue	Change description
Issue 01	28.09.2015	First issue.

Table of Content

1. Introduction

1.1. Purpose and scope

The purpose of this Certification Memorandum is to provide guidance for development of Time Between Overhaul (TBO) periods for rotorcraft gearboxes as referenced during the type certification process of CS-27 and CS-29 rotorcraft.

This refers to:

- CS 27.571, CS 27.602, CS 27.901, CS 27.923, CS 27.1529 and associated MoC (AC 27.571, AC 27.602, AC 27.923, AC 27.901, AC 27.1529),
- CS 29.571, CS 29.602, CS 29.901, CS 29.923, CS 29.917, CS 29.1529 and associated MoC (AC 29.571, AC 29.602, AC 29.901, AC 29.923, AC 29.917, AC 29.1529).

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 29.571	Certification Specifications for Large Rotorcraft => Fatigue tolerance evaluation of metallic structure.	CS-29	3*	11/12/12
CS 29.602 (b)	Certification Specifications for Large Rotorcraft => Critical Parts	CS-29	3*	11/12/12
CS 29.901 (b)	Certification Specifications for Large Rotorcraft => PowerPlant Installation	CS-29	3*	11/12/12
CS 29.917 (b)	Certification Specifications for Large Rotorcraft => Rotor Drive System *(design assessment)*	CS-29	3*	11/12/12
CS 29.923	Certification Specifications for Large Rotorcraft => Rotor drive system and control mechanism tests (Endurance Test)	CS-29	3*	11/12/12
CS 29.1529	Certification Specifications for Large Rotorcraft => Instruction For Continued Airworthiness	CS-29	3*	11/12/12
CS-29 Book 2	Acceptable Means of Compliance	CS-29	3*	11/12/12

**Or latest revision as applicable*

1.3. Abbreviations

CM	Certification Memorandum
CS	Certification Specification
EASA	European Aviation Safety Agency
EIS	Entry Into Service
ICA	Instruction for Continued Airworthiness
MoC	Means of Compliance
TBO	Time Between Overhaul

2. Background

A helicopter rotor drive system gearbox is usually a complex assembly composed of many parts of which a significant proportion are Critical Parts. Many are rotating parts which are subject to high torque and fatigue loads, such as bearings, shafts, gears and free wheels with the primary function to transmit power from the engine to the rotors. Non-rotating components have other functions such as support, lubrication, condition monitoring, etc.

Most gearbox components are enclosed inside a gearbox casing, and thus are not accessible nor visible during normal operation and maintenance.

During the type certification process, helicopter gearbox parts are subject to various forms of analyses which will assess their criticality and should ensure a robust design both in terms of structural integrity and parts reliability.

For parts which are classified as “critical parts” in accordance with CS 27.602 or CS 29.602 (“the failure of which could have a catastrophic effect upon the rotorcraft, and have been identified which must be controlled to ensure the required level of integrity”), the objective is to ensure a high level of integrity during the complete life of the component.

The fatigue capability of Critical Parts is assessed during certification against requirement CS 29.571 / CS 27.571. This assessment makes assumptions about the condition of the component in relation to potential modes of degradation such as contact pressure, friction, fretting, wear, load (cyclic and static) and environmental effects such as corrosion. Accordingly, if the condition of these parts is not closely and periodically controlled / monitored, there is a risk that these assumptions could become compromised, which could lead to an in-service catastrophic or hazardous failure.

Overhaul has traditionally been one of the means which allows an in depth and periodic inspection of gearbox components, controlling and limiting development of wear, corrosion, fretting and build-up of wear debris as well as checking for cracks that may be developing. In addition, the inspection findings can determine whether parts are sufficiently protected and whether they remain within specified tolerances.

An overhaul is a complete “restoration” of the gearbox intended to restore each item to a specific standard. This is a recognized maintenance action, which should only be performed by an approved organisation, which then allows re-installation of a gearbox on the rotorcraft and should ensure safe operation up until the following overhaul.

The Time Between Overhaul (TBO), is the periodic interval between two overhauls and is traditionally defined in Flight Hours and Calendar Time.

Considering the complexity of helicopter gearboxes and the difficulty to run a gearbox for a significant period of time before type certification and entry into service (EIS), justification of a suitable TBO at the time of EIS can be challenging. The relevant data acquired during the type certification process are the results of development tests, endurance tests and flight test campaigns, which, when available, can be supported by service experience of similar designs on existing helicopter types.

A final and mature TBO should normally be based on the results of investigations from in-service aircraft, overhauled gearboxes and data acquired during development/ certification/maturity tests substantiating the reliability of the parts and their capability to operate safely.

3. EASA Certification Policy

3.1. EASA Policy

As a result of the certification process a number of maintenance actions may be identified that can only be performed during overhaul. Accordingly, for gearboxes which are essential to drive the main or tail rotors (under CS-27 and CS-29), EASA considers that the TBO at EIS and throughout its development in service should be justified.

The following is considered an acceptable approach:

Initial TBO Period (applicable at EIS for fleet leaders):

This should be based on the results of:

- endurance and development tests,
- flight tests,
- experience on similar design having the same characteristics.

TBO Period Step Increase:

- A TBO increase should only be envisaged when the actual TBO in place has demonstrated acceptable gearbox overhaul inspection results;
- Each step increase should be technically justified from overhauled gearboxes (e.g., condition of inspected parts, evidence from similar designs, etc.);
- Justification of each step should be completed prior to formally increasing the TBO period to verify acceptable behaviour and condition of the gearbox components prior to starting a new increase phase;
- The applicant should define the minimum sample size and should consider the representativeness of operational and environmental aspects.

Management of TBO Interval:

The process of managing the evolution of gearbox TBO should be documented.

This should include:

- Steps and target TBO determination (technical background and justification of the proposed validation plan) (see note 1);
- The sample definition (number of gearboxes and selection criteria considering operation and environment) (see note 1);
- The approach for publication of TBO intervals (steps and target) as part of the Instructions for Continued Airworthiness (ICA) (see note 2);
- The communication process with the operators (e.g., as part of the applicable ICA, Service information letter , Service bulletin, etc.);
- The reporting principles (definition of responsible parties, inspections necessary and information to be reported);
- The analysis process, responsibilities and methods of analysis (potential limits, tolerances, any pass/fail criteria, cross comparison with initial certification data, etc.) (see note 3);

- The validation process and deliverables (see note 4).

Note 1: The plan, and associated validation steps, should be defined by the Type Certificate Holder and accepted during the certification process. Results of the validation steps might lead to revisions of the validation plan.

Note 2: The applicable ICA should only contain validated data consistent with the TBO validation process.

Note 3: When HUMS data are available during a TBO evolution process, they should be reviewed and considered as complementary data prior to confirming a step.

Note 4: The acceptance of each individual step as well as the closure of the validation plan should be formally endorsed by the Type Certificate Holder and duly documented.

Any findings found during the TBO validation process which might limit the applicability of the TBO step or impair the capability of the gearbox to reach the following steps should be reported to the Agency.

3.2. Who this Certification Memorandum affects

All CS-29 / CS-27 applicants and holders.

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.
2. For any question concerning the technical content of this EASA Certification Memorandum, please contact:

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