EASA	CERTIFICATION MEMORANDUM
	**EASA CM No.: EASA CM – RTS – 001 Issue: 01** **Issue Date: 11th of November 2013** **Issued by: Transmission section** **Approved by: Head of Certification Experts Department** **Regulatory Requirement(s): CS-29**

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Subject

Large Helicopter Main Gearbox Certification Requirements

Log of Issues

Issue	Issue date	Change description
01	11.11.2013	First issue.

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1. INTRODUCTION

1.1. PURPOSE AND SCOPE

The purpose of **this** Certification Memorandum is to provide specific guidance for compliance with CS 29.927(c) – Lubrication System Failure

This Certification Memorandum describes how a previous amendment to CS 29.927(c), (first introduced into FAR Part 29 Amendment 29-26, 1988), has caused confusion in demonstrating compliance. The revised guidance material provided here is intended to clarify the Agency's expectations, until a full review and revision of the Certification Specification can take place.

1.2. REFERENCES

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

Reference	Title	Code	Issue	Date
---	Certification Specifications for Large Helicopters	CS-29	---	---
FAA AC 29-2C	Certification of Transport Category Rotorcraft	---	---	---

1.3. ABBREVIATIONS

The following abbreviations are used in this Certification Memorandum:

Abbreviation	Meaning
AC	**A**dvisory **C**ircular
CM	**C**ertification **M**emorandum
CS	**C**ertification **S**pecification
EASA	**E**uropean **A**viation **S**afety **A**gency
FAA	**F**ederal **A**viation **A**dministration
FAR	**F**ederal **A**viation **R**equirement
MGB	**M**ain **G**ear **B**ox
TCCA	**T**ransport **C**anada **C**ivil **A**viation
TSB	**T**ransportation **S**afety **B**oard

1.4. DEFINITIONS

The following definitions are used in this Certification Memorandum:

Definition	Meaning
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2. BACKGROUND

On March 12, 2009, a Canadian-registered Sikorsky S-92A helicopter experienced an in-flight loss of lubrication of its main gear box (MGB). The MGB eventually failed, contributing to a loss of control and subsequent crash. Investigation revealed that the loss of MGB lubrication was due to failure of the titanium studs for the MGB oil filter. The Canadian Transportation Safety Board (TSB), in its Accident report A09A0016 dated February 2011, made two recommendations for changes to the airworthiness design standard pertaining to the conduct of test of the MGB of Category A helicopters. In addition, the TSB made recommendations directly to the United States' Federal Aviation Administration (FAA), as the Authority of the State of Design for the Sikorsky S-92A.

Transport Canada (TCCA), the FAA and the European Aviation Safety Agency (EASA) have conducted a joint review of the current design standard and guidance material relating to the certification of helicopter MGBs. This joint review has been completed and has made a number of recommendations for future rulemaking. These recommendations will form the terms of reference of an EASA led rulemaking group which will commence its activity in 2014.

FAA Advisory Circular AC 29-2C provides guidance on failures of interest in the oil system sub-components (see section AC 29.927 A). This AC is referenced by all three Authorities as acceptable guidance. However, this AC does not provide any guidance on extremely remote failure criteria. The 3 Authorities have therefore agreed a revised harmonised text that amends AC 29.927 and AC 29.927A. The FAA has issued and published this changed AC section on their website:

http://www.airweb.faa.gov/Regulatory_and_Guidance_Library/rgAdvisoryCircular.nsf/0/47f05fca88b954c686257515006ae03e/$FILE/AC_29-2C_Update_2012-07-06.pdf

3. EASA CERTIFICATION POLICY

3.1. EASA POLICY

Revised guidance material acceptable to the Agency in showing compliance with CS 29.927(c) is provided as follow:

AC 29.927. § 29.927 (Amendment 29-17) ADDITIONAL TESTS.

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c. Section 29.927(c):

(1) Explanation.

(i) This section prescribes a test to demonstrate that any failure resulting in the loss of lubrication pressure to the rotor drive primary oil system will not impair the capability of the rotorcraft to operate under autorotative conditions for 15 minutes.

(ii) The regulation is intended to apply to pressurized lubrication systems and has not been applied to splash lubricated gearboxes since historically their design has not been as critical or complex when compared to pressurized systems. The likelihood of loss of lubrication is significantly greater for transmissions that use pressure lubrication and external cooling. This is due to the increased complexity of the lubrication system and the external components that circulate oil outside the gearbox. A pressure lubrication system is more commonly used in the rotorcraft's main transmission but may also be used in auxiliary transmissions or gearboxes.

(iii) The lubricating system has two primary functions. The first is to provide lubricating oil to contacting or rubbing surfaces and thus reduce friction losses. The

second is to dissipate heat energy generated by friction of meshing gears and bearings thus maintaining surface and material temperature. Accordingly, a loss of lubrication leads to increased friction between components and increased component surface temperatures. With increased component surface temperatures, component surface hardness can be lost resulting in the inability of the component to carry or transmit loads. Thermal expansion in transmission components can eventually lead to the mechanical failure of bearings, journals, gears, shafts, and clutches that are subjected to high loads and rotational speeds. A significant loss of lubrication may result from internal and external failures. Failures include, but are not limited to, oil lines, fittings, seal plugs, sealing gaskets, valves, external pumps, oil filters, oil coolers, accessory pads, etc. A leak caused by a crack in the transmission outer case need not be considered as a source of a loss of lubrication provided the outer case has been structurally substantiated to satisfy the requirements of §§ 29.307, 29.923(m), and 29.571.

(2) Procedures. Conventionally, a bench test (transmission test rig) is used to demonstrate compliance with this rule. Since this is essentially a durability test of the transmission to operate with residual oil, typically the worst case failure (i.e., the undrainable oil or the oil remaining after a severe pressure leak, whichever results in a greater loss of oil in the transmission's normal lubrication system) is used as a critical entry point for the test. The transmission should be stabilized at the torque associated with maximum continuous power (reacted as appropriate at main mast and tail rotor output quills) at a normal main rotor speed, oil temperature that is at the highest limit for continuous operation, and oil pressure that is within the normal operating range. A vertical load should be applied at the mast, equal to the gross weight of the rotorcraft at 1g. Once the transmission oil temperature is stabilized, simulate the worst case failure in the normal use lubrication system. Upon illumination of the low oil pressure warning device (required by § 29.1305), reduce input torque to simulate an autorotation and continue transmission operation for 15 minutes. To complete the test, apply an input torque to the transmission for approximately 10 seconds to simulate a minimum power landing. A successful demonstration may involve limited damage to the transmission, provided it is determined that the autorotative capabilities of the rotorcraft were not significantly impaired.

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AC 29.927A. § 29.927 (Amendment 29-26) ADDITIONAL TESTS.

a. Section 29.927(c):

(1)Explanation.

(i) Amendment 29-26 revised the rotor drive system loss of lubrication test requirements for Category A rotorcraft in § 29.927(c). This requires testing to show that any failures that result in a loss of lubrication in any normal use lubrication system, unless the failures are extremely remote, will not prevent continued safe flight for at least 30 minutes after the flight crew recognizes the loss of lubricant failure.

(ii) The introductory phrase to this amendment to the regulation, "unless such failures are extremely remote" has caused confusion. The NPRM did not contain this expression and the only change documented in the preamble to the final rule (53 FR 34204) explains that the final rule was revised in response to a public comment that the proposed regulation could be interpreted to "preclude credit for auxiliary lubrication systems or to require consideration of lubricant failures to self-lubricated bearings." This was not intended and the final rule was "revised to eliminate this ambiguity." The phrase, "unless such failures are extremely remote," was introduced to resolve the public comment to convey that the applicant does not have to consider failures that may exist in the auxiliary lubrication system prior to performing the loss of lubrication testing. Under the current regulation, the extremely remote language in the final rule means that testing to demonstrate at least 30 minutes continued flight capability (for Category A), following loss of

lubrication in the normal lubrication system, is not required if the failures leading to that loss of lubrication condition are determined to be extremely remote. While this compliance approach is allowed, it may not be achievable due, in part, to the unforeseen variables and complexity associated with predicting potential lubrication failure modes and their associated criticality and frequency of occurrence. This includes considering lubrication failures that may result from improper transmission maintenance and servicing. The expected compliance approach is to assume a failure in the normal lubrication system leading to rapid loss of lubrication and to rely on an auxiliary lubrication system or the robustness of the transmission components to accomplish at least 30 minutes of operation (for Category A) at the prescribed conditions. With this approach, the normal and auxiliary systems must be independent in order to preclude common loss of lubrication failure points and possible cross contamination. Compliance with § 29.1309 would only apply to any electrical and software design aspects of the normal and auxiliary lubrication systems. The auxiliary lubrication system must also be designed, constructed, and functionally tested to show that it can perform its intended function.

(iii) The regulation is intended to apply to pressurized lubrication systems and has not been applied to splash lubricated gearboxes since historically their design has not been as critical or complex when compared to pressurized systems. The likelihood of loss of lubrication is significantly greater for transmissions that use pressure lubrication and external cooling. This is due to the increased complexity of the lubrication system and the external components that circulate oil outside the gearbox. A pressure lubrication system is more commonly used in the rotorcraft's main transmission but may also be used in auxiliary transmissions or gearboxes.

(iv) The lubricating system has two primary functions. The first is to provide lubricating oil to contacting or rubbing surfaces and thus reduce friction losses. The second is to dissipate heat energy generated by friction of meshing gears and bearings thus maintaining surface and material temperature. Accordingly, a loss of lubrication leads to increased friction between components and increased component surface temperatures. With increased component surface temperatures, component surface hardness can be lost resulting in the inability of the component to carry or transmit loads. Thermal expansion in transmission components can eventually lead to the mechanical failure of bearings, journals, gears, shafts, and clutches that are subjected to high loads and rotational speeds. A loss of lubrication may result from internal and external failures. Failures include, but are not limited to, oil lines, fittings, seal plugs, sealing gaskets, valves, pumps, oil filters, oil coolers, accessory pads, etc. A leak caused by a crack in the transmission outer case need not be considered as a source of a loss of lubrication, provided the outer case has been structurally substantiated to satisfy the requirements of §§ 29.307, 29.923(m), and 29.571.

(v) The intent of the rule change for Category A rotorcraft was to assure that these rotorcraft have significant continued flight capability after the loss of lubricant to any single transmission in order to optimize eventual landing opportunities. Extending the bench testing beyond 30 minutes, although not required, is considered highly desirable. Accomplishing this would further improve the capability of the rotorcraft to reach a suitable landing location in order to improve occupant safety when operating in remote geographic areas that include harsh environmental conditions. Indefinite flight with a lubrication system failure is not expected. However, it may be acceptable to include a time interval in the emergency procedures. That time interval should be reduced sufficiently when compared to the bench test demonstration to allow for an adequate safety margin.

(2) Procedures.

(i) Section 29.927(c) prescribes a test to demonstrate that the effects of a loss of lubrication will not impair the ability of category A rotorcraft to continue safe powered operation for at least 30 minutes after illumination of the low oil pressure warning device (required by § 29.1305). For Category B rotorcraft, § 29.927(c)(2) prescribes the tests for safe operation under autorotative conditions must continue for at least 15 minutes.

(ii) An acceptable means of demonstrating compliance with this rule is through the use of a bench test (transmission test rig). Since this is essentially a durability

test of the transmission to operate with residual oil, typically the worst case failure (i.e., the undrainable oil or the oil remaining after a severe pressure leak, whichever results in a greater loss of oil in the transmission's normal use lubrication system) is used as a critical entry point for the test, see paragraph a.(2)(iii).

(iii) The transmission should be stabilized at the torque associated with maximum continuous power (reacted as appropriate at the main mast and tail rotor output quills) at a normal main rotor mast speed, oil temperature that is at the highest limit for continuous operation, and oil pressure that is within the normal operating range. A vertical load should be applied at the mast, equal to the gross weight of the rotorcraft at 1g. Once the transmission oil temperature is stabilized, simulate the worst case failure in the normal use lubrication. Upon illumination of the low oil pressure warning device (required by § 29.1305), reduce the input torque for category A rotorcraft to the minimum torque necessary to sustain flight and continue the test for at least 30 minutes at the maximum gross weight and the most efficient flight conditions. To complete the test, apply an input torque to the transmission for approximately 25 seconds to simulate an autorotation. The last 10 seconds (of the 25 seconds) should be at the torque required for a minimum power landing. A successful demonstration may involve limited damage to the transmission, provided it is determined that the autorotative capabilities of the rotorcraft were not significantly impaired. For category B rotorcraft, upon illumination of the low oil pressure warning device, reduce the input torque to simulate an autorotation and continue transmission operation for 15 minutes. To complete the test, apply an input torque to the transmission for approximately 10 seconds to simulate a minimum power landing. A successful demonstration may involve limited damage to the transmission provided it is determined that the autorotative capabilities of the rotorcraft were not significantly impaired. If compliance with Category A requirements is demonstrated, Category B requirements will have been met.

3.2. WHO THIS CERTIFICATION MEMORANDUM AFFECTS

Designers of large helicopters

4. REMARKS

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