International Maintenance Review Board Policy Board (IMRBPB)
Issue Paper Rotorcraft (IPR)

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Title: HUMS for credit

Submitter: Industry **(**Airbus Helicopters, HAI)

Applies To:	
MSG-3 Vol 1	
MSG-3 Vol 2	X
IMPS	

Issue:

Due to the wide spectrum of missions that a helicopter can perform, the exposure of some systems to the conditions that cause their failure varies significantly from a helicopter to the other, depending on their missions and local operating conditions.

As an example, the mechanical play of the tail rotor drive bearings is often related to the transmitted power and applied stresses, including control efforts, cumulated over time. The flight profile and the instantaneous power usage are completely different between a rotorcraft operated for Oil & Gas service (including, typically, take-off, maneuver for taking course, transit in straight line, maneuver for landing on the oil rig, then fly back) and the same rotorcraft operated for sightseeing tours over the Colorado Canyon, for instance (with a large number of turns performed on a rather short distance). The more accurately one is able to measure or assess these efforts, the more one can relax the constraints inherent to worst case scenarios.

In legacy fleets of helicopters, the cumulated efforts were not practically recordable and were therefore not used for the scheduling of maintenance. Instead, this figure was converted in flight hours thanks to a flight spectrum that takes in consideration the most constraining/penalizing mission profiles likely to be encountered by the rotorcraft by the whole range of operators.

This conversion leads to non-optimized task intervals, since all rotorcraft of a given fleet “inherit” the most penalizing task interval. Compelling all operators to perform scheduled tasks on their systems at intervals derived from the most penalizing profile necessarily leads to over-maintenance, with all the drawbacks of unnecessary disassembles.

New technologies such as Health and Usage Monitoring (HUM) have emerged and matured in the recent years and now propose alternative methods to traditional scheduling of tasks. Certification procedures FAA AC 29-2C Chg3 MG15 and EASA AMC 29.1465 / CS-29 Book 2 now allow credit to be taken from Health and Usage Monitoring Systems (HUMS) in certain conditions.

These HUMS technologies typically use two complementary approaches:

1- The degradation-related, observable and monitored state measures an effect of the degradation. This state may be, for instance, a vibration level measured on a play-prone bearing, an operating temperature or the value of the command current of a jam-prone actuator (list not limitative). Such states are monitored on some MSI’s by a Health Monitoring System (HMS), if such a system is installed with adequate sensors installed at appropriate locations on the rotorcraft. Health Monitoring is intended to detect and characterize symptoms

of incipient degradation of the monitored MSI's. The acquired data may be processed onboard the rotorcraft or on a ground station (or a combination of both) providing the means to measure defined criteria and generate instructions for the maintenance staff for intervention.

2- The monitored state can also be representative of the cumulated causes that generate degradation. This state may be, for instance, the cumulated number of cycles of a fatigue-prone rotating shaft, the number of starts-stops of an electrical motor, the number of starts-stops of a rotor brake, the number of landings, the number of rotor turn-hours, or the applied power/torque cumulated over time. This corresponds to the primary function of a Usage Monitoring System (UMS), intended to characterize, quantify and record the actual aircraft usage based on the monitoring of the aircraft flight conditions, pilots' maneuvers and system operating data. The analysis of cumulated usage in context with in-service inspection results can be used to anticipate significant degradation. Usage tracking can also be used to trigger subsequent actions.

Both approaches using HUMS data lead to a series of use/run/read-out analysis tasks. When these tasks are scheduled, they fall into the category of Inspection/Functional Checks of MSG-3.

Note: these HUMS tasks are not intended to eliminate restorations and discards of monitored systems, but to optimize their triggering events, e.g. measure of play after scheduled disassembly.

The benefit of replacing a conventional inspection/functional check by a HUMS task needs to be assessed. Moreover, the fact that this replacement does not impair flight safety is demonstrated as part of the certification activities on the HUMS.

Problems:

1. The HUMS technologies are not fully addressed in the MSG-3 document.

   a) Structural Health Monitoring (SHM) already exists in MSG-3, but no equivalent exists for systems and powerplant. SHM only addresses structural damage, does not capture functional degradation and does not take into account the "Usage" data. The MSG-3 Volume 2 Revision 2015.1 states at the end of section 2-4-2.1 that: "Emerging technology, such as SHM may be an option to check or watch for Accidental Damage (AD), Environmental Deterioration (ED) and /or Fatigue Damage (FD) where demonstrated to be applicable and effective. For the time being, MSG-3 Volume 2 only takes into account Scheduled SHM (S-SHM). Dedicated analysis procedures need to be developed and approved/accepted at the level of the PPH for such technology."

   b) Current version of the MSG-3 Volume 2 document does not allow taking credit of HUMS for scheduled maintenance on MSI's.

2. Structural Health Monitoring is not addressed in this CIPR, therefore Section **2-4 Aircraft Structural Analysis Procedure** of the MSG-3 document has been left as it is. It is however understood that structural degradation of a MSI part of Rotors and Drive systems is analyzed in the Supplemental Analysis of the MSI and can be monitored by a HUMS.

Recommendation (including Implementation):

1) In section **2-1-2.2, Scheduled Maintenance Content**, item a), sub-item (3) "Inspection/Functional Check (IN*/FC or */FNC)", introduce a Scheduled Health and Usage Monitoring for MSI's by adding a bullet in the list:
"** Scheduled Health and Usage Monitoring (S-HUM)*"

2) In section **2-3-2 Analysis Procedure**, add a new paragraph between the two last ones of the current revision of MSG-3:

"If system failure may affect structural integrity then details relating to the failure should be passed to the Structures Working Group (or equivalent body) for consideration in accordance with established transfer policies and procedures. Examples could include, but are not limited to, failure of load limiting devices, hydraulic leaks and bleed air leaks.

New technologies such as Health and Usage Monitoring have emerged and matured in the recent years and now propose alternative methods to traditional scheduled tasks. Provided that the Health and Usage Monitoring System is Certified for Credit in accordance with relevant aircraft certification regulations, the outputs may be an option to detect selected incipient failure or degradation and/or selected aspects of service history considered as initiators or accelerators of degradation.

The approach taken in the following procedure is to provide a logic path for each functional failure. Each functional failure and failure cause must be processed through the logic so that a judgment will be made as to the necessity of a task. The resultant tasks and intervals will form the initial scheduled maintenance."

3) In section **2-3-7 Task Development (Second Level), sub-section 4** (or 3 in Revision 2013) **Inspection/Functional Check (All Categories)**, add the sentences in italic to the definition of a Functional Check:
"A Functional Check is a quantitative check to determine if one or more functions of an item performs within specified limits. *Scheduled Health and Usage Monitoring (S-HUM) may be an option for carrying out a Functional Check, provided that the HUMS is certified for credit for the concerned failures. Dedicated analysis procedures need to be developed and approved/accepted at the level of the PPH for such technology. The PPH will also explain if S-HUM tasks are meant to replace other tasks that would have*

been applicable and effective without the HUMS, or if the decision to take credit from HUMS or not is left at the operator's choice after the end of the Controlled Service Introduction (see Section 2-3-8.8)."

4) At the end of **Section 2-3-8**., after subsection **7. Sampling**, add a new subsection:

8. Controlled Service Introduction
A Controlled Service Introduction (CSI) is a period of in-service time where capabilities and functions that could not be verified prior to entry into service (including support functions) are evaluated in the frame of the Certification for Credit of the HUMS.
The CSI can be used to prove that the HUMS provides acceptable defect detection and localization performances. During this period, conventional maintenance and S-HUM can be performed in parallel to assess the performance of the HUMS.
At the end of the CSI period, all analysis reports in which S-HUM tasks have been selected need to be updated and reviewed by the appropriate Working Groups.

5) In **Appendix A Glossary**, add six definitions:

Controlled Service Introduction (CSI)	*A period of in-service time where capabilities and functions that could not be verified prior to entry into service (including support functions) are evaluated.*
Health monitoring	*Procedures by which selected incipient failure or degradation can be determined.*
Health and Usage Monitoring (HUM)	*Procedures by which selected incipient failure or degradation (Health monitoring) and/or selected aspects of service history (Usage monitoring) can be determined.*
Usage Monitoring	*Procedures by which selected aspects of service history can be determined.*
Health and Usage Monitoring System (HUMS)	*Equipment by which selected incipient failure or degradation (Health monitoring system) and/or selected aspects of service history*

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(Usage monitoring system) can be determined. HUMS does not name any specific method or technology; it typically consists in a variety of onboard sensors and data acquisition systems. The acquired data may be processed onboard the rotorcraft or on a ground station (or a combination of both) providing the means to measure defined criteria and generate instructions for the maintenance staff for intervention.

Scheduled Health and Usage Monitoring (S-HUM)

The act to use/run/read-out a HUMS and analyze its data at an interval set at a fixed schedule.

IMRBPB Position:

Date: 28/Apr/2017
Position: IMRBPB agrees to CIPR IND 2013-01 with the changes implemented at the IMRBPB Meeting 2017, which becomes IP170

Date:
Position:

Status of Issue Paper and date:
Active 28/Apr/2017

Recommendation for implementation:
IP170 will be included into the next revision of Volume 2 of the MSG-3 document

Retroactive: NO

Important Note: The IMRBPB IPs are not policy. An IP only becomes policy when the IP is adopted into the processes of the appropriate National Aviation Authority. However, before formal adoption, the IP content may be incorporated by the MRB applicant on a voluntary basis with the agreement of all parties as detailed in the program PPH.