European Union Aviation Safety Agency

Comment-Response Document (CRD) 2022-03

RELATED NPA: 2022-03 – RMT.0711

26.11.2024

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1. Summary of the outcome of the consultation

225 comments were received from 12 stakeholders. Table 1 shows the number of comments received per commentator:

COMMENTATORS	**# OF COMMENTS**
Airbus Helicopters	34
DGAC France	1
FOCA Switzerland	1
GE Aviation	1
GAMA	161
GMPS International	1
LBA	1
Leonardo	1
Patrick Wills	1
Swedish Transport Agency	1
FAA	21
TCCA	1
Total	225

Table 1

Table 2 shows the number of comments per topic:

NPA 2022-03 Segments	**# OF COMMENTS**
General Comments	17
About this NPA	1
AMC1 29.1465 VHM	188
GM1 29.1465 VHM	19

Table 2

85 % of the comments came from industry and the rest from national competent authorities (NCAs) including the FAA and the TCCA. Apart some general comments, industry and NCAs mainly commented on the proposed AMC1 29.1465.

20 % of the comments received were not accepted, 15 % were noted and the remaining 65 % were accepted or partially accepted as shown in Table 3:

	Accepted	**Partially accepted**	**Noted**	**Not accepted**	**Total**
# of comments	57	96	28	48	229
percentage	24.9 %	41.9 %	12,3 %	20.9 %	100 %

Table 3

The individual comments and the responses to them are contained in Chapter 2 of this Comment-Response Document (CRD) 2022-03.

2. Individual comments and responses

In responding to the comments, the following terminology is applied to attest EASA's position:

(a) **Accepted** — EASA agrees with the comment and any proposed change is incorporated into the text.

(b) **Partially accepted** — EASA either partially agrees with the comment or agrees with it but the proposed change is partially incorporated into the text.

(c) **Noted** — EASA acknowledges the comment, but no change to the text is considered necessary.

(d) **Not accepted** — EASA does not agree with the comment or proposed change.

(General Comments)	-

comment	*1* comment by: *DGAC FR (Mireille Chabroux)* DGAC France would like to thank EASA for this consultation, and inform EASA that we have no position or comment on the proposed document.
response	Noted Thank you for your comment.

comment	*2* comment by: *FOCA Switzerland* The Federal Office of Civil Aviation (FOCA) in Switzerland thanks the EASA for the opporunity to comment on this NPA 2022-03. FOCA has no comment.
response	Noted Thank you for your comment.

comment	*210* comment by: *Swedish Transport Agency, Civil Aviation Department (Transportstyrelsen, Luftfartsavdelningen)* Thank you for the opportunity to comment on NPA 2022-03. Please be advised that there are no comments from the Swedish Transport Agency.
response	Noted Thank you for your comment.

comment	*211* comment by: *GPMS International, Inc.* Attachment #1

GPMS Response to NPA for CS 29.1465

GPMS International, Inc., developers of Foresight MX, is a leading rotorcraft VHM (HUMS) manufacturer. We are submitting comments on RMT.0711 and the proposed amendment on the acceptable means of compliance for CS 29.1465 'Vibration Health Monitoring'.

We applaud EASAs effort to better use HUMS and to create a path for CBM

GPMS is excited to see EASA take up the issue of Vibration Health Monitoring. We live in an age where all machines are getting smarter and more connected. Rotorcraft have lagged in this trend, in part because the regulatory framework didn't provide a path by which players could take advantage of new technologies like VHM. Condition Based Maintenance, via credits, is the standard toward which all should be working and the RMT.0711 does the public and the industry a great service by providing a clear and reasonable way for VHM to achieve this long-sought reality.

HUMS is well recognized as an availability, cost and safety enhancing technology, even without credits

While there is great value for the industry in maintenance credits, we would like to emphasize the substantial value in systems that stop short of credits but allow operators the ability to detect anomalies before they impact availability, cost, or safety. In 2014, the European Safety Promotion Network Rotorcraft (ESPN-R) conducted a sweeping analysis of helicopter safety technologies and produced a report titled "The Potential of Technologies to Mitigate Helicopter Accident Factors". Group II: Emerging or advancing technologies included 'Lightweight Health and Usage Monitoring System (HUMS).' This endorsement for the category has been echoed by others, including the International Helicopter Safety Foundation.

HUMS, then, even if fitted under the 'No hazard No credit' policy, clearly provide efficiency and safety benefits and Section (b)(1)(ii) Note 1's requirement that systems installed on this basis state that "No safety benefit is obtained from the installation of the system" promotes a falsity and does a disservice to the industry. While the scheduled maintenance requirements of Type Certified aircraft ensure airworthiness, is there any doubt that "supplemental" HUMS data can aid in this process by providing insights needed to trigger maintenance prior to potentially catastrophic situations?

HUMS is more valuable and accessible today than ever before

The aforementioned ESPN-R report states that "Due to cost, weight and complexity, HUMS installations have been limited to transport helicopters and as an expensive option on Part 27 aircraft. However, anticipated technological advances . . . may enable development of low-cost HUMS capable of predicting imminent [failures] ... in all classes of helicopters." Happily, the 2014 predictions have come to pass. Recent advances in sensors, computational power, cloud architecture, connectivity, and predictive analytics have meant that the value and usability of HUMS products have increased while the weight is down and the cost is reduced. Put simply, HUMS has never been so useful or so accessible.

The NPA adds burden for VHM's seeking credit and VHMs needed to meet an operational requirement

As we understand it, the proposed AMC lays out frameworks for three scenarios:
Where a VHM seeks to be used for airworthiness (credit);
Where there is an operational requirement for HUMS but no credit sought;
And where there is no operational requirement and no seeking of credit.
Regulations in sections d, e, f, g, I, j, k, l, m, and n apply in the first instance where the VHM is to be used to gain credits and determine airworthiness. But, significantly,

regulations in sections d, e, f, h, I, j,k , l, m, and n still apply in the second instance. This is new and dramatically increases the certification burden of HUMS (not for credit) in Part 29.

[see picture attached]

We believe these additional requirements for no-credit HUMS will raise costs, disincentivizing adoption

GPMS believes in making HUMS safety, operational, and efficiency benefits more accessible. Absent (or even in conjunction with) a mandate, we think regulators should balance the desire to improve standards with the goal of promoting affordability in order to promote more aircraft flying with HUMS. Upping the burden for compliance so substantially, for instance requiring a Controlled Service Introduction, will raise both initial and ongoing certification costs. Given these other requirements, even in cases where credits are NOT requested, it's not clear that a DAL E system can be maintained and still get a compliant VHM. Higher DAL requirements will be costly to HUMS providers who will raise costs to operators, pushing adoption in non-credit seeking applications out of reach. We believe an unintended consequence of *RMT.0711* is that fewer operators may choose to outfit aircraft with HUMS, negatively impacting safety.

Credits do provide enhanced value, but it's not clear that the promised benefits will be worth the cost

It's clear that *RMT.0711* intends to raise the VHM standard (impacting cost), but through the possibility of credit, expects to also raise the potential benefit (return). But past efforts at credit, notably done at Sikorsky, resulted in millions spent in return for minimal extensions of TBO. Put another way, the way to induce the adoption of HUMS isn't only through credits. In fact, we think HUMS without credit is sufficiently attractive for operators to adopt given the significant advancements in HUMS over the last 10 years. But these benefits are balanced by system costs. And if regulators raise costs by raising standards too high, they risk making HUMS *less* appealing and *reducing* adoption.

Recommendation: Either mandate HUMS across Part 29 or make it attractive by restraining the requirements for Compliant HUMS (no credit)

Given HUMS's ability to spot availability, cost, and safety impacting anomalies, we think the goal should be to get this technology on the most aircraft possible. It seems to us that this could be done EITHER with a mandate for a non-credit seeking HUMS (but with guidance on what would be required to get a credit) OR by making HUMS both attractive and affordable. To do the latter, EASA could retain the schema in *RMT.0711* (No HUMS, NHNC HUMS, Compliant HUMS, Compliant HUMS for Credit), but carefully review requirements to reduce the burden on Compliant HUMS. We understand the interest in defining the capabilities of HUMS, even those not used for credit, more stringently in the past. Our suggestion is to carefully review requirements in d, e, f, h, I, j, k , l, m, and n to ensure that none increase the DAL level or dramatically affect the certification process. The focus should be on showing HUMS performance toward its intended functionality. And the test, we believe, is not *only* whether the standards would benefit a 100 ship operator but whether they would result in a feasible and affordable product for a 5 ship operator as well.

Real-time and especially in-cockpit alert requirements increase costs to limited benefit

HUMS detection capabilities have improved and can provide 50+ hours advanced warning of mechanical issues. Providing such advanced warning obviates the need

for “real-time” reporting. The benefit of real-time and especially in-cockpit alerts would be limited and the increased cost and certification burdens are substantial. Requirements in these areas go against all the safety recommendations promoted above by making HUMS unaffordable without a regulatory requirement.

These same principles should apply to Part 27

Part 27 aircraft need VHM systems for the same reasons as Part 29 aircraft, but in the past there were significant weight, cost, and operational loads involved in the use of VHM, which made their use in Part 27 infeasible. Those barriers have effectively been removed. Modern HUMS systems reduce weight sufficiently to make VHM on single engine aircraft possible (on the H125 HUMS is available with as little as 3KG weight and balance); new sensor technology makes kits virtually maintenance free; automated data transfer via LTE eliminates the effort involved in getting data; and the interface can be intuitive enough to be used by those with no experience or expertise in vibration analysis or HUMS. In short, regulators can help industry realize the potential of new systems by providing guidance similar to RMT.0711 for lighter weight aircraft.

Conclusion: It doesn’t benefit the public or the industry to have operators doing nothing

GPMS’s HUMS technology is cutting edge and we believe it is one of a handful of systems that could -- with time, money, and engineering -- be certified as compliant under the standards currently set out in the NPA. At the same time, we don’t believe the industry or the public would be served by having un-mandated VHM systems certified at a far higher level. So, whether a mandate is issued or not, the risk of over-prescribing the scope introduces the potential for reducing adoption for a product we see being embraced voluntarily.

response

Not accepted

It should first be noted that no requirements are added or modified, as only AMC has been updated. The purpose of this AMC is to provide guidance to support the CS 29.1465 demonstration of compliance in accordance with the intended use of the VHM system, in particular when the system is intended for credit.

Systems installed on a ‘no safety/no hazard’ basis remain acceptable and, as clearly stated in AMC1 29.1465, do not need to follow the guidance provided. For systems for intended credit or compliance with an operational rule, the AMC reflects a valid approach and key considerations that EASA would expect applicants to follow to demonstrate compliance with CS 29.1465. These are being developed with the support from industry members within the rulemaking group.

Since CS 29.1465 is a ‘voluntary’ requirement and the same guidance would apply for VHM systems installed on CS-27 rotorcraft for the same purposes, applicants are expected to elect to comply with the CS-29 requirement. No certification specification or AMC are considered needed for CS-27. Nevertheless, EASA will consider the possibility of adding CS 29.1465 to Appendix C to CS-27.

comment *213* comment by: *General Aviation Manufacturers Association (GAMA)*

	The General Aviation Manufacturers Association (GAMA) and the Aerospace and Defence Industries Association of Europe (ASD) greatly appreciate the opportunity to provide comments on NPA 2022-03. The comments below were developed and agreed by the joint GAMA/ASD-Europe Rotorcraft (RTR) committee, comprising all the major civil rotorcraft OEMs from the EU, USA and Canada. GAMA's staff remain at the Agency's disposal at any time if there are any questions regarding any of the comments provided below.
response	Noted Thank you for your comment.

comment	*214* comment by: *General Aviation Manufacturers Association (GAMA)* Given the nature and magnitude of the comments provided it is apparent that the rulemaking group for RMT.0711 was not able to reach a consensus on a mature draft of the AMC prior to issuance of the NPA. It is highly recommended that the comments provided be reviewed and dispositioned by the rulemaking group for RMT.0711 and not be unilaterally dispositioned by EASA.
response	Noted EASA has organised teleconferences and workshops with the working groups to update the proposed AMC.

comment	*218* comment by: *Airbus Helicopters* Airbus Helicopters, Airbus Commercial and Airbus Defense and Space have reviewed this NPA. From this review, several comments were produced and harmonised before being forwarded to ASD/GAMA group for further coordination with other TC holders. Airbus Helicopters acting for all other Airbus entities have supported the coordination and alignement of ASD/GAMA comments. Airbus Helicopters, Airbus Commercial and Airbus Defense and Space support all ASD/GAMA comments.
response	Noted Thank you for your comment.

1. About this NPA p. 3

comment	*215* comment by: *General Aviation Manufacturers Association (GAMA)* **RATIONALE** 1st sentence of the 2nd paragraph in the Executive Summary (1st page) **PROPOSED ACTION/TEXT** EASA to replace *"continued airworthiness"* by *"continuing airworthiness".*

response | Accepted

The text will be corrected in the final documents.

AMC 1 29.1465 Vibration health monitoring p. 7

comment | *37* comment by: *Airbus Helicopters*

AMC1 29.1465(c)(2)

Comment harmonised within Airbus Group - Non-concur position

Proposed text:
The text is proposed to be amended as below: "Paragraph (d) provides specific guidance on the determination of the safety objectives to be fulfilled by the **VHM** system **considered at helicopter level in combination with** the severity of the failure being monitored and other considerations."

Justification:
"Paragraph (d) provides specific guidance on the determination of the safety objectives to be fulfilled by the system **based on the** severity of the failure being monitored and other considerations." Safety assessment always relies on effects on rotorcraft, flight crew and occupants as per AC 291309 Figure 1309-2 in one hand and as per ARP 4754A/ED-79A §5.1.1 "The functional hazard assessments (FHAs) should be carried out at both the aircraft and system levels." in the other hand. Therefore, providing guidance based on the severity of the failure being monitored but without considering the mechanical failure in combination with the VHM system failure at helicopter level seems inadequate.

response | Noted

This section has been deleted in accordance with other comments, so the comment is no longer relevant.

comment | *47* comment by: *Airbus Helicopters*

AMC1 29.1465(c)(11)

Comment:
Provide the references of AMC/GM intended at addressing VHM systems that include in-flight cockpit indications requiring severe pilot actions.

Justification:
"If cockpit indications are part of any of the VHM applications to be approved, the applicant should consider this guidance and note that this AMC and GM1 29.1465 are not intended at addressing VHM systems that include in-flight cockpit indications requiring severe pilot actions such as landing immediately or landing within a limited interval." This AMC informs readers that it is not intended at addressing VHM systems that include in-flight cockpit indications requiring severe

	pilot actions, but it does not indicate where to find the appropriate AMC/GM.
response	Noted This section has been deleted in accordance with other comments, so the comment is no longer relevant.

comment	*54* comment by: *Airbus Helicopters* AMC1 29.1465(d)(2) Airbus Group harmonised comment - Non-concur position Proposed text: please refer to text below where improvements/clarifications are proposed for paragraph (d) - please note that enclosure feature seems inoperative Concerns and Justifications: "- evaluate the severity of their ultimate failure consequences when undetected, and - assign it to the VHM system function for the purpose of establishing its safety requirements" This is not a "conventional" safety method. A method more in line with EUROCAE ED-79A/SAE ARP4754A would be to address the combination "mechanical failure" and "VHM failure" in a PASA and then to evaluate the severity of the VHM based on usual criteria such as: - reduction of safety margin - reduction of functional capabilities - physical effects (discomfort, injuries, etc) - crew worload The proposed (A) and (B) could be a guideline to evaluate the reduction of safety margins, resulting finally in a severity. Besides, there is inconsistency between Table 1 severities and AC29.1309 severities/safety objectives (A) and (B) correspond respectively to Mitigation actions and Probability of occurence. The case "Catastrophic" on the left column, combined with (B) alone implies Hazardous for the VHM. According to (B) explanation, the mechanical system cannot be greater than 1E-7/Fh. Considering the Hazardous for the VHM, the VHM quantitative safety objective will be also 1E-7/Fh. The combination (preceding condition affecting the mechanical system AND VHM failure), which results in an ultimate Catastrophic situation shall not be greater than 1E-14/Fh according to the proposed method. This is very far from extremely improbable / 1E-9/Fh usual safety objectives Similar results are obtained for others cells of the table 1. In addition, objectives deduced from table 1 put very high constraints on the VHM. It will be necessary for some cases to duplicate or even triple the VHM, while developing with a FDAL A or FDAL B. As a result, such systems will not be implemented by OEMs considering associated costs and weight. This contradicts the §2.4 because as overall, it will not improve safety if not implemented. Such systems, should not be penalyzed by excessive safety constraints.

Finally the probability of occurrence considerations, in section AMC1 29.1465(d)(2)(i)(B) and the sentence taht follows:
"For this purpose, the applicant should consider that the probability of occurrence of any preceding condition should be no greater than 1E-07 per flight hour for catastrophic failures, 1E-05 per flight hour for the hazardous ones, and 1E-03 per flight hour for those that are major."

Having a targeted probability no greater than 1E-07 / FH (for CAT event) on any preceding degradation, directly implies that the start of the scenario of degradation (e.g. raceway spalling) should be no greater than 1E-07 / FH. This may not be consistent with FMECA.

Usually regarding raceway spalling, it is expected to substantiate as a minimum the probability of 1E-05/FH even if leading to CAT FCs as it is also known that such raceway spalling shall be monitored using chip detectors (CS 29.1337) and that these chip detectors will sustain a probability of occurence up to 1E-04/FH. Conjunction of both probabilities of raceway spalling and chip detectors fulfil the quantitative objective of 1E-09/FH for the CAT FC.

Fully indenpendent compasenting provisions should be fully taken into consideration in the probability of occurence assessment, otherwise this would lead to increase the demonstration effort on VHM while not considering the safety benefit of compensating provisions.

Besides, such quantitative outcome seems impossible to be provided for new design whereas it can be foreseen by OEM to claim credit for new development.

Therefore Airbus recommend modifying the text by mitigating this sentence as follows (also encompassed in the alternative text below):
"For this purpose, the applicant should consider that the probability of occurence of any preceding state, which includes maintenance tasks or alternative means of monitoring (fully independent from VHM), should be no greather than ...."

Alternative text:
(d) VHM System Safety Requirements

(1) Scope
This section provides guidance regarding the determination of the VHM system failure severity and the identification of its corresponding safety requirements, complementing CS 29.1309 and associated guidance. As previously stated, VHM systems typically consist of onboard and ground-segments and this section shall be considered as applicable for the complete system for the purpose of establishing its safety requirements. The compliance demonstration should then be completed in accordance as follows:

(i) The qualification procedures for airborne equipment and the associated installation to be followed as part of the VHM system compliance demonstration are the same as for any other airborne equipment.
(ii) For the ground-segment, paragraph (i) provides guidance regarding the determination of compliance with the corresponding system safety requirements considering that CS-29 certification specifications are typically not applicable. This section also considers that the ground-segment of VHM systems typically contains COTS hardware and software.
(1(2) Establishment of VHM system safety requirements
Safety assessment methods should be applied to identify the severity category at helicopter level of the combination of both potential failures of the components being monitored and of the VHM system functions. Based on their intended function, the applicant should consider that, for the purpose of establishing its safety requirements, the effect on the rotorcraft of any VHM system failure impacting applications for Credit should not be lower than minor.
In the frame of applications for Credit, the combination of both VHM system features failures and mechanical failures, which may be Catastrophic or Hazardous, the applicant should, as a starting point:
- identify possible degraded conditions (i.e. damage or degradations) to be monitored,
- evaluate the severity of their ultimate failure consequences when undetected, and
- assign to the VHM system the adequate safety objectives (quantitative and qualitative objective) as defined in Table 1 which includes consideration at helicopter level
Note: Due to the peculiarity of VHM system which are combined with mechanical parts on which no FDAL can be assigned and for which probability of occurrence can be difficult to determine due to uncertainty of natural phenomena like corrosion, this AMC will define the safety objectives in terms of:
- severity of the worst failure conditions,
- quantitative objectives so that the aircraft quantitative objectives meets the acceptable quantitative objectives defined in AC29 2C 29.1309,
- qualitative objectives so that aircraft qualitative objective is met acknowledging that mechanical parts cannot be assigned with FDAL.
In addition, the applicant may then consider alleviating these safety requirements relative to this starting point. For this purpose, the applicant may consider elements of the rotorcraft design, associated maintenance and/or established failure probability of occurrence of the monitored components. These are summarized in (A) Mitigating Actions and (B) Probability of occurrence of the preceding degraded state. These aspects are considered to reduce the extent of reliance on the VHM system towards ensuring the airworthiness of the rotorcraft.
Following the evaluation of (A) and (B), as described below, the applicant may propose tailored system qualitative safety requirements for VHM systems featuring applications for Credit as follows:

Severity of the mechanical failure being monitored by the VHM system	VHM system worst failure conditions classification, quantitative objective and qualitative objective (FDAL) considering (A) Mitigating Actions and (B) Probability of occurrence			
	(A) and (B)	(B) without (A)	(A) without (B)	Neither (A) nor (B)
Catastrophic	Minor	Major 1E-03 / FH	Hazardous 1E-09 / FH	Catastrophic 1E-09 / FH

	1E-03 / FH FDAL C	FDAL B	FDAL B	FDAL A
Hazardous	Minor 1E-03 / FH FDAL D	Major 1E-03 / FH FDAL C	Hazardous 1E-07 / FH FDAL C	Hazardous 1E-07 / FH FDAL B
Major	Minor 1E-03 / FH FDAL D	Minor 1E-03 / FH FDAL D	Major 1E-05 / FH FDAL D	Major 1E-05 / FH FDAL C

Table 1 – VHM system worst failure conditions classification, quantitative objective and qualitative objective (FDAL) as supported by the implementation of mitigating actions and/or the demonstrated low occurrence probability of preceding degraded state

Note: for credit applications, it is expected that no failure conditions has quantitative objective higher than 1E-03/FH independently from failures categories.

(i) Sections (A) and (B), below, provide additional guidance regarding these aspects that may be proposed by the applicant in support of an alleviation of the VHM system safety requirements and their justification.

(A) Mitigating Actions
This term refers to maintenance tasks or alternative means of monitoring that are fully independent from VHM. These may be implemented and demonstrated to adequately monitor the affected part(s) in combination with VHM monitoring in support of preventing any Hazardous or Catastrophic failure conditions addressed by the Credit application.
This term does not refer to monitoring means that are explicitly mandated by CS-29 (e.g. chip detectors requested by CS 29.1337, …).
Any Mitigating Action implemented in parallel to a VHM application for Credit should be demonstrated to be capable of detecting the mechanical states that may indicate incipient failure given their characteristics. The applicant should consider the probability of detection, the time between clear detection and the failure and periodicity of the Mitigating Actions to demonstrate that, given the behaviour of the mechanical failure progression, a minimum of one opportunity to detect the degrading state of the part is ensured. This should be understood as the completion of one inspection or one review of any indications from alternative monitoring means, within an interval in which they are justified to clearly detect the incipient failure condition.
For this evaluation, the applicant should consider:
1. The worst foreseeable failure progression scenario taking into account the considerations provided in (g)(2)(i).
2. The detection capability of the Mitigating Action in question, derived from service data and/or test results, to establish the point at which the incipient failure will be detected.

(B) The probability of occurrence of any preceding degraded conditions.

Typically, VHM system relies on the principle that a degraded state which precedes the failure will generate a mechanical response that can be detected by the vibration signals acquired and processed by the VHM system. The preceding degraded state typically initiates naturally due to the normal operation of dynamic components and particularly in the presence of minor defects (e.g., indents, micropits etc) or slightly altered operating conditions (e.g., misalignment, wear, etc). By means of continuous operation this degraded state usually progresses, potentially becoming detectable at certain point and, if not detected, it may eventually lead to ultimate failure.
The applicant may choose to justify that the likelihood of initiation of any degraded state that may progress and ultimately lead to Hazardous or Catastrophic failure consequences is sufficiently low to support an alleviation of VHM system safety objectives (as per Table 1). For this purpose, the applicant should consider that the probability of occurrence of any preceding state, which includes maintenance tasks or alternative means of monitoring (fully independent from VHM), should be no greater than 1E-07 per flight hour for Catastrophic failures, 1E-05 per flight hour for Hazardous ones, and 1E-03 per flight hour for those that are Major.
When applicable, it is acceptable to include means required by CS-29 (like chip detectors) in the assessment of the probability of missed detection of the preceding degradation condition of the monitored component.
In order to complete this demonstration, the applicant should:

(a) Identify all degraded states that may, due to continuous operation, lead to the failure(s) being ultimately prevented by the VHM application. For this purpose, it may not be possible to establish whether a specific degraded condition will certainly lead to a Hazardous or Catastrophic failure due to the way and conditions of operation of dynamic components. Therefore, the objective should be to identify those for which it is considered probable that such failure may develop within the exposure time of the affected parts to operation. For this purpose, the applicant should rely on all available data, including but not limited to service experience, incidents and accidents on other types, literature review and applicable test data. In addition, the applicant should consider that dedicated testing may be needed in support of confirming that specific degraded conditions are not likely to lead to such Hazardous or Catastrophic failure.

(b) Rely on directly applicable service experience. Service experience from similar designs may be used when no or limited data is available on a specific design, but it should be justified as applicable considering the design characteristics, manufacturing and quality controls, and operating conditions. In addition, an appropriate safety factor should be taken into account for any uncertainties on the comparison between designs and/or to compensate when only limited data is available.

(c) Detail the parameters and controls of the affected part that support the probability of occurrence of the preceding degraded condition demonstrated at the time of the approval. These should confirm that this probability is the result of adequate design, manufacturing, quality, assembly, handling and maintenance practices and support that it will not increase during the life of the product. The applicant should describe these parameters and controls and justify their adequacy based on service experience, state-of-the-art practices, and safety margins.

(d) Take into consideration any changes implemented within the period of time used to gather the necessary service experience for this demonstration to the replacement, inspection or overhaul intervals of the affected components. The purpose of this is to verify that none of these changes may impact the validity of the probability of occurrence demonstrated. For example, the affected part may be replaced at a certain interval, which in turn would affect its exposure to operation in the presence of defects. As a result, the data being considered for this evaluation may not be conservative for cases where the affected part is planned to be replaced at a greater interval following introduction of VHM.
Note: When any of these aspects is used to support an alleviation of the safety requirements of the VHM system, the applicant should implement the necessary means to continuously verify in service the probability of occurrence of the preceding degraded condition and/or the Mitigating Actions detection capability.

(ii) The VHM system failure severities described in Table 1 above for the purpose of establishing the system safety requirements address both loss of function and malfunction of the VHM system. The associated Safety Objectives should consider the quantitative (numerical probabilities) and qualitative (FDAL) requirements.

(3) Implementation of safety requirements
The qualitative objectives to be met by the VHM system should establish confidence that development errors have been minimized with an appropriate level of rigor and system failure rates have been reduced to acceptable levels in accordance with CS 29.1309. EUROCAE ED-79A / SAE ARP 4754A is recognised as providing additional guidelines for establishing both safety assessment and development assurance processes. Further guidance regarding expected validation and verification activities are provided in section (f), (g), (h), (i) and (j).

response

Not accepted

The comment is very broad and, although some of the points raised have been dealt with, it is considered that some key elements of the comment and the associated proposed changes are not in line with EASA's view on the topic and do not represent the consolidated view from the industry.

In any case, changes to AMC1 29.1465(d) have been introduced following further discussion and alignment with the rulemaking group.

comment

69 comment by: *Airbus Helicopters*

AMC1 29.1465 (e)(2)

Comment:
Data record keeping requirement to be complemented for supporting investigation and defining proper corrective actions of in-service VHMS deficiencies.

Justification:

	No retention period is specified for data sets acquired once transferred for analysis. Same comments applies for records of analysis results. Such records might be necessary for improving VHMS or for defining proper corrective actions following occurence report.
response	Accepted Data record-keeping considerations have been added.

comment	*70* comment by: *Patrick WILLS* Fourrie analysis of sound waves We sponsored a team from Imperial College engineeering department to come up with a system using sound waves only. The project was originally targetting rotor overspeeds (eg on helicopters without sensors like the Robinsons). The goal was to create a device that did not requite an STC and was simply mounted under the seat magnetically. The result was that the system was able to record individual vibration frequencies and then send an alert if any of them exited a range. I wanted to mention this because the text seems not to consider such an invention.
response	Noted AMC1 29.1465 does not address any specific technology. Any system relying on vibration signals for the evaluation of the 'health' (i.e. state) of rotorcraft components would typically be considered as a VHM system from EASA's perspective.

comment	*71* comment by: *Airbus Helicopters* AMC1 29.1465 (e)(2) Comment: Requirement about the downloading interval should be objective-oriented. Justification: With regard to the last sentence of the 3rd paragraph: "The maximum download interval should not be greater than 15 flight hours." We can expect on-board recording capable of more than 15 hours. Downloading every 15 FH could have adverse impacts on flight operations. Note: This comment is consistent with comment#68 of AMC1 29.1465 (e)(1)
response	Partially accepted This is best practice in line with Heli-Offshore, which has now been moved to GM.

comment	*72* comment by: *Airbus Helicopters*

AMC1 29.1465(e)(2)

Comment:
It is unclear why this provision has been introduced. The applicant should be free to select a solution to address a period for which no record is available: the requirement should use broader language.

Justification:
"The storage capacity should be sufficient to support the needs of the intended VHM applications and should not be less than 15 flight hours." "The applicant should define a recommended and a maximum interval between VHM data reviews that ensure that the objective of each application of the VHM system is fulfilled." There are other alternatives such as credit cannot be taken from the VHM system when the memory is full (i.e. it has not recoded data for a period).

response

Partially accepted

This is best practice in line with Heli-Offshore, which has now been moved to GM.

comment *73* comment by: *Airbus Helicopters*

AMC1 29.1465(e)(2)

Proposed text:
It is proposed to amend the sentence to read: "In the event that a complete data set is not recorded, the data transfer process should be capable of downloading a partial data set to the ground-based system and highlight it as such to alert the Continuing Airworthiness Management Organisation maintenance personnel. The necessary procedures to be followed should be provided in the ICA."

Justification:
"In the event that a complete data set is not recorded, the data transfer process should be capable of downloading a partial data set to the ground-based system and highlight it as such to alert maintenance personnel. The necessary procedures to be followed should be provided in the ICA." The maintenance personnel is probably not the personnel that will analyse the subject data.

response

Partially accepted

The point made by the comment is now addressed by replacing ‘maintenance personnel’ by ‘personnel involved in continuing airworthiness’.

comment *76* comment by: *Airbus Helicopters*

AMC1 29.1465(e)(4)

Proposed text:
It is proposed to amend this paragraph to read: "For each alert generated by the VHM system, the applicant should ensure that: (i) The CAMO and/or maintenance personnel, as appropriate, are provided with the information needed to isolate and

address the fault through the instructions included in the ICA (see paragraph (k) of this AMC), addressing: [...] (ii) an indication is clearly prompted upon to the crew and CAMO or maintenance personnel any time an alert is generated; and [...]"

Justification:
Reference to 'maintenance personnel' may unintentionally lead the applicant to provide instructions to an organisation approved under Regulation (EU) No 1321/2014 that is not responsible for the management of maintenance. Point CAMO.A.315 states that the CAMO shall in particular order maintenance, supervise activities, and coordinate related decisions to ensure that any maintenance is carried out properly and is appropriately [certified] for the determination of aircraft airworthiness.

response

Partially accepted

The point made by the comment is now addressed by replacing 'maintenance personnel' by 'personnel involved in continuing airworthiness'.

comment

77 comment by: *Airbus Helicopters*

AMC1 129.1465(f)(1)

Proposed text:
It is proposed to amend the text as follows: "The applicant should design the VHM system and define a monitoring approach that achieves an adequate fault detection performance for each of the intended function(s) system applications."

Justification:
"The applicant should design the VHM system and define a monitoring approach that achieves an adequate fault detection performance for each of the intended system applications." The monitoring approach definition is part of VHM system design, hence it is redundant to explicitely mention it. The wording system applications is unclear. Why not sticking to 29.1301 terminology and using the notion of "intended function"?

response

Not accepted

The term 'VHM application' is clearly defined in GM. Now also 'application' is considered with the same meaning as clarified in GM definitions.

comment

79 comment by: *Airbus Helicopters*

AMC1 29.1465(f)(1)

Proposed text:
It is proposed to amend the ext as follows: "The fault detection performance should be demonstrated for each VHM intended function application by appropriate means, as defined in (2) below, addressing the following aspects: [...]"

Justification:

	"The fault detection performance should be demonstrated for each VHM application by appropriate means, as defined in (2) below, addressing the following aspects:" The wording application is unclear. Why not sticking to 29.1301 terminology and using the notion of "intended function"?
response	Not accepted The term 'VHM application' is clearly defined in GM. Now also 'application' is considered with the same meaning.

comment	*84* comment by: *Airbus Helicopters* AMC1 29.1465 (f)(1)(iv) Proposed text: '"(iv) The computed Indicators are stable, reliable, and representative of the state condition of the parts or assembly elements monitored providing a high probability of discriminating between 'healthy' and 'degraded' parts or assembly elements (i.e. probability of fault detection)." Justification: '"(iv) The computed Indicators are stable, reliable, and representative of the condition of the elements monitored providing a high probability of discriminating between 'healthy' and 'degraded' elements (i.e. probability of fault detection)."
response	Accepted

comment	*85* comment by: *Airbus Helicopters* AMC1 29.1465 (f)(1)(v) Comment: Clarification or guidance should be provided about acceptability criteria for false alarm rate or refer paragraph GM1 29.1465 (a)(6). Justification: With regard to the sentence: "The capability of the monitoring approach to, in addition, deliver an adequate false alarm rate."
response	Accepted

comment	*87* comment by: *Airbus Helicopters* AMC1 29.1465(f)(1)(vi) Note Comment: Define separately VHM system failure objectives and VHM system performance objectives. Justification:

	"— VHM system self-diagnostics capability, and" The note introduces a notion of VHM self diagnostics. Self diagnostics intend to cover VHM hardware failures whereas all the previous text of the paragraph address functional performance aspects. These are two different notions. Usualy: - failures are covered by techniques such as Fault Tree Analysis, using failure rates for the various items failures. - performance is demonstrated through other techniques which depend on the nature of the system Finally, it is not clear if the objective is to merge both approaches, and then how.
response	Accepted The note has been deleted.

comment	*89* comment by: *Airbus Helicopters* AMC1 29.1465 (f)(2) Proposed text: The text is proposed to be amended as follows: "The applicant should demonstrate how the monitoring approach provides an acceptable performance for each of its intended function(s) applications. This section provides additional details regarding means and methodologies to be used to complete this demonstration prior to its approval by the Agency." Justification: "The applicant should demonstrate how the monitoring approach provides an acceptable performance for each of its intended applications. This section provides additional details regarding means and methodologies to be used to complete this demonstration prior to its approval by the Agency. "
response	Not accepted The term 'VHM application' is clearly defined in GM. Now also 'application' is considered with the same meaning.

comment	*90* comment by: *Airbus Helicopters* AMC1 29.1465 (f)(2)(i) Proposed text: The text is proposed to be amended as follows: "This methodology should define the means proposed for the demonstration of performance and justify that it is adequate in order to ensure that the functions of the VHM system are fulfilled for each of its intended function(s) applications." Justification: "This methodology should define the means proposed for the demonstration of performance and justify that it is adequate in order to ensure that the functions of the VHM system are fulfilled for each of its intended applications." Wording of 29.1301 should be promoted by using "intended function" and not application

	which is ambiguous.
response	Not accepted The term 'VHM application' is clearly defined in GM. Now also 'application' is considered with the same meaning. In any case the purpose of the comment is understood, and the sentence has been simplified.

comment	*92* comment by: *Airbus Helicopters* AMC1 29.1465 (f)(2)(i) Proposed text: The text is proposed to be amended as follows: "The applicant should ensure that these assumptions are conservative and well supported by experience from tests or service experience defined, validated and verified as per SAE ARP 4754A/EUROCAE ED-79A objectives 2.1, 2.3, 2.4, 4.2." Justification: "The applicant should ensure that these assumptions are conservative and well supported by experience from tests or service experience." Such assumptions are design assumption which also impact safety assessment, hence they can be assimilated to safety assumptions. SAE ARP4754A/EUROCAE ED-79A require safety assumptions to be validated and verifed before the design is approved (i.e. design change approval).
response	Accepted The purpose of the comment has been addressed.

comment	*94* comment by: *Airbus Helicopters* AMC1 29.1465 (f)(2)(i) Proposed text: The text is proposed to be amended as follows: "For applications for credit, a minimum set of data from dedicated tests or directly applicable service experience is expected in addition, given that these applications are relied upon to ensure the airworthiness of the rotorcraft. For applications in support of compliance with an operational regulation, given the purpose of the system, Depending on the intended function of VHM system (credit or support to operational regulation (i.e. Regulation (EU) No 965/2012) or supplementary information, the demonstration of performance may be completed with or without dedicated tests or directly applicable service experience. Further details are provided in paragraphs (g) and (h) respectively. Justification: "For applications for credit, a minimum set of data from dedicated tests or directly applicable service experience is expected in addition, given that these applications

	are relied upon to ensure the airworthiness of the rotorcraft. For applications in support of compliance with an operational regulation, given the purpose of the system, the demonstration of performance may be completed without dedicated tests or directly applicable service experience. Further details are provided in paragraphs (g) and (h) respectively." The wording applications is not adequate as it refers here to the applicant's application for the major design change.
response	Not accepted Application here also refers to specific VHMS intended functions. The term 'VHM application' is clearly defined in GM. The definition in GM now also refers to 'application'.

comment	*98* comment by: *Airbus Helicopters* AMC1 29.1465(g)(1) Proposed text: The text is proposed to be amended as follows: "(i) Part/assembly Elements being monitored and parts specific damage to be monitored for which the credit approval is sought. Justification: "(i) Elements being monitored and parts for which the credit approval is sought." The wording "elements" and "parts" are ambiguous with respect to the rest of the AMC as it is understood here that parts means somehow "specific damage to be monitored" and elements reasonably stands for "Part/assembly"
response	Partially accepted The first part of the comment has been implemented. The second, proposing to add 'specific damage to be monitored', is already included in (iii) within the same section.

comment	*103* comment by: *Airbus Helicopters* AMC1 29.1465(g)(2) Comment: Probability of detection is impossible to establish with a limited number of tests: a quantification of the confidence in the detection performance should be preferred. Justification: "(2) Performance demonstration methodology The applicant should define a performance demonstration methodology considering that a minimum set of direct evidence should be provided for VHM applications for credit. The methodology should consider the severity of the failure being prevented, the characteristics of the preceding degraded condition as it progresses to failure, and the probability of detection to be demonstrated."
response	Accepted

comment	*118* comment by: *Airbus Helicopters* AMC1 29.1465(g)(2)(iii)(B)(a) Comment: No use of the dedicated "Prognostic Interval" wording in this § !? Is it intentionnal or an omission?
response	Noted The comment does not clearly indicate where 'prognostic interval' is considered potentially missing. This section, however, does not address the prognostic interval since this parameter involves two characteristics, the rate of failure progression and the point at which the condition becomes detectable. This section only addresses the former. Nevertheless, the use of terminology alternative to 'prognostic interval' has been reviewed.

comment	*135* comment by: *Airbus Helicopters* AMC1 29.1465(h)(2)(iii)(D) Proposed text: The text is proposed to be amended as follows: "(D) include in the design assessment required by CS 29.1465(b)(1) consideration of the characteristics of the failure progression for each part to support the existence of an adequate prognostic interval prior to ultimate failure. These characteristics should be derived from the applicant's experience and industry know-how. This consideration should be taken into account at the time of defining the recommended and maximum intervals of VHM data acquisition and review defined in accordance with points (e)(1) and (2) of this AMC. Note: in peculiar cases, where failure progression characteristics gives a prognostic interval which might be shorter or close to the minimum recommended VHM data review interval (i.e to the order of 5 to 10 flight hours), it is considered that VHM system provides an adequate safety benefit compared to the absence of systematic digital monitoring even if the VHM data review interval remains set to 15FH." Justification: "(D) include in the design assessment required by CS 29.1465(b)(1) consideration of the characteristics of the failure progression for each part to support the existence of an adequate prognostic interval prior to ultimate failure. These characteristics should be derived from the applicant's experience and industry know-how. This consideration should be taken into account at the time of defining the recommended and maximum intervals of VHM data acquisition and review defined in accordance with points (e)(1) and (2) of this AMC." This sub-paragraph seems quite difficult to achieve especially in the perspective of operational regulation context. Typically, in case a fault propagation duration is less than 15FH, it might be difficult to sustain the evidences for the adequated prognostic interval priori to ultimate failure. Meaning that applicants will not be compliant for such fault and no

	ealry detection will be proposed whereas, even if the opportunity is reduced due to the time propagation, it still brings a safety benefit for operators compared to no monitoring situation.
response	Partially accepted The comment has been addressed more generically, without making specific reference to the case specified by Airbus Helicopters. In any case, unless it is appropriately justified that VHM would not bring any safety benefit and an alternative health monitoring means is proposed, the interval of VHM data review would need to be adequate for any failure mode to be covered by a VHM system for compliance with an operational regulation, regardless of its progression rate.

comment	*151* comment by: *Airbus Helicopters* AMC 29.1465 (j)(2)(i)(ii) Comment: Write in full text the accronym CRC. An entry in GM1 29.1465(a) might need necessary to define this term. Justification: "[...], e.g. by means of CRC protection of the data files or any other adequate means." The meaning of the accronym "CRC" is not defined.
response	Accepted

comment	*153* comment by: *Airbus Helicopters* AMC1 29.1465(k) Proposed text: It is proposed to delete the following sentence: "ICA and other supporting data should be available to operators and maintenance organisations before entry into service and should be updated whenever necessary during the service life of the system." Rely on point 21.A.7. Justification: "ICA and other supporting data should be available to operators and maintenance organisations before entry into service and should be updated whenever necessary during the service life of the system." This aspect is already addressed by point 21.A.7. Note: this sentence refers to operators. It does not address all cases. The CAMO and the operator are not in the same company in all cases.
response	Not accepted It is clear that the requirement is already addressed by Part 21. Nevertheless, the purpose of this sentence in AMC1 29.1465 is to emphasise the importance of

	complete ICA at the time of entry into service. The sentence has been reworded to avoid the need to mention to whom the ICA needs to be available.

comment	*160* comment by: *Airbus Helicopters* AMC1 29.1465(l) Comment: Does it imply that the VHM system with credit approval should be postoned after the CSI phase confirm those assumptions? Origin: "Unless the necessary activities can be completed during the certification programme, ensuring that any assumption made as part of the compliance demonstration is adequately verified, the applicant should conduct a CSI when a new VHM system is introduced or modified in compliance with CS 29.1465."
response	Noted This is described in the text addressing the CSI. Also, dedicated sections in paragraphs (g) and (h) have been added to address this point. The fact that confirmation from data gathered in service is expected does not mean that the approval of credit is conditional on the completion of the CSI.

comment	*169* comment by: *Airbus Helicopters* AMC 29.1465 (l) Table 4 Proposed text: To modify the sentence as follows. "The ground-based system may include COTS hardware and software part of the platform on which applicative software is running." Justification: It is not clear here if the control is applying to any ground-based system as sson as a piece of COTS SW is used (e.g. the operating system) or if it is applying only when the applicative Sotware implementing the VHM system is a COTS. For KPI-6.1 Here all the error affecting a system functionality even not linked with VHM system objectives are logged. Only the ones affecting a VHM objectives should be. For KPI-6.2 What is a Consistent positive feedback?
response	Partially accepted The text has been corrected to refer to ‘application software’, which is now defined in GM.

comment	*173* comment by: *Airbus Helicopters* AMC1 29.1465(l)(6)

Comment:
What are the time and the conditions to inform EASA? Rely on CAW and Part 21.A.3 principle? How does the Agency intend to ensure that the organisations responsible for the management of the aircraft continuing airworthiness will systematically report to the TC holder? (with due consideration for organisations not governed by the EU regulation, the average reporting rate for AD containing a reporting requirement, etc.)

response

Noted

The point is clear and understood by EASA. The need to update Part-M, Part-CAMO and/or Part-145, as applicable, will be evaluated by EASA to ensure that CSI is adequately supported.

comment *174* comment by: *Airbus Helicopters*

AMC1 29.1465(l)(7)

Comment:
The possibility of trade-off between the different parameters could be offered.

Justification:
"Table 5: CSI minimum in-service experience requirements" An adjustment between the different parameters should be acceptable to reach the minimum in-service experience. e.g.: A higher number of rotorcraft for less Calendar time.

response

Partially accepted

This point has been addressed in the text by clarifying that these are generally expected data requirements, which may be adjusted depending on the characteristics of the VHM application in question.

Note: For some cases, limiting the calendar time may not be justified. For example, cases where incipient failure conditions may develop from extended exposure to certain environmental conditions.

comment *184* comment by: *Airbus Helicopters*

AMC1 29.1465(n)

Comment:
Is reference to MEL appropriate?
It is proposed to refer to Master MEL.

response

Accepted

comment *207* comment by: *Airbus Helicopters*

AMC1 29.1465(d)(2)(i)(B)

Airbus Group harmonised comment - Non-concur position

Proposed text:
This note is proposed to be removed, but if it remains it should be 're-indented' to AMC 29.1465(d)(2)(i) as it applies to both (A) and (B).

Justification:
With regards to the note: "Note: When any of these aspects is used to support an alleviation of the safety requirements of the VHM system, the applicant should implement the necessary means to continuously verify in service the probability of occurrence of the preceding degraded condition and/or the mitigating actions detection capability" It is not clear why the Agency is assuming that the demonstration of either the probability of occurrence of any preceding degraded condition or the probability of detection of the mitigation actions will not be complete at the time of approval and therefore it shoudl be required to verify them in service. It is not clear what is the exact meaning of 'should implement'. Is it mandatory in all cases or not? If not, is there any objective criteria to define its need?. Additionally, it does not provide any guidance on what kind of verification would be expected. It is proposed to remove this note.

response

Accepted

The note has been removed.

comment *208* comment by: *Airbus Helicopters*

AMC1 29.1465(f)(1)(vi)

Comment:
Clarification on what is the purpose of the mitigating actions is required.

Justification:
The use of term "mitigating actions" in the note may be misleading. It seems clear that they are not the same mitigating actions as defined in AMC1 29.1465(d)(2)(i)(A), but it is not clear what kind of mititgating actions are requested and what is it specific purpose.

response

Not accepted

The meaning of mitigating actions is the same throughout the AMC and defined in GM. In addition, this note has now been deleted.

comment *209* comment by: *LBA*

LBA comment:
"On page 10 (AMC1 29.1465 (c) (1)) an overview of the AMC content is included. This overview mentions "(xii) Related documents". But the last chapter of the AMC is "Minimum equipment list (MEL) recommendation". Therefore one chapter seems to be missing.

	Furthermore I recommend to include also the chapter letter in this content overview (e.g. "VHM system safety requirements" is chapter (d) and ""Ground-based system" is chapter (i))."
response	Partially accepted The references to the different sections of the AMC are now provided in Figure 1.

comment	*212* comment by: *GE Aviation* GE Aviation Comment 1: On Page 19, AMC1 29.1465 (e)(4)(iii) implies automatic reset of alerts (“removed when alerting condition no longer exists”). GE Aviation considers that it is preferable for alerts to be shown as applicable to a certain period of time but for the alert to be “active” until a user decides to move it to a different state. Proposed Change: The wording should be updated to clarify that alerts relating to transient conditions that no longer exist should still be displayed to a user. Classification: Major/conceptual GE Aviation Comment 2: On Page 34, AMC1 29.1465 (j) says “All software that makes up the VHM processing, whether airborne or ground-based, is to be produced to the software quality standard required to achieve the necessary level of system integrity” despite section (d)(1)(ii) saying “CS-29 certification specifications are typically not applicable”. Proposed Change: (j) should be reworded to “produced to software quality standards” since as this section goes on to clarify multiple standards are likely to be applicable depending on whether they apply to embedded or ground software and whether the software is COTS. Classification: Minor GE Aviation Comment 3: On Page 35, AMC1 29.1465 (j)(2)(ii) should specify the means by which the ground software development assurance approach is communicated by the applicant. Proposed Change: As DO-178/278 are provided as an example a Plan for Software Aspects of Certification (PSAC) and following family of documents (SDVP, SCMP etc.) would be a consistent example but would need modification for this application.

Classification:
Minor

response

Comment 1:

Accepted

The text of AMC1 29.1465 has been amended taking this comment into consideration.

Comment 2:

Not accepted

The need for software to 'be produced to the software quality standard required to achieve the necessary level of system integrity' does not imply that certification specifications from CS-29 are automatically applicable. As clarified in the dedicated subparagraph (2), this may be achieved in different ways depending on the actual software application and platform.

Comment 3:

Not accepted

At this point, EASA is not in the position to provide further specific guidance on this point. Nevertheless, the guidance provided is considered sufficient for the purpose of the AMC. Any additional clarifications can be discussed on a case-by-case basis.

comment

216 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465 (a)(1)

Priority: High

RATIONALE / REASON / JUSTIFICATION
In relation to the following statement: "by providing timely indications of potential failures."

It is unclear how failures are related to the "increase of likelihood of detection" which is the ultimate target of the RMT.0711. In ED-79A/ARP 4754A, "failure" definition is defined as follows: "FAILURE: An occurrence which affects the operation of a component, part or element such that it can no longer function as intended, (this includes both loss of function and malfunction)."

In ISO13306, failure is defined as follows: "Failure: Termination of the ability of an item to perform a required function"

PROPOSED ACTION/TEXT
The paragraph is proposed to be amended as below:

"(1) VHM systems are typically intended at increasing the likelihood of detection of dynamic component incipient faults in the rotors and rotor drive systems prior to progression that could prevent continued safe flight or safe landing by providing timely indications of progressing degradation potential failures."

Besides, the definition of failure is to be added with the two perspectives in GM1 29.1465(a).

response

Partially accepted

The text has been adjusted taking into consideration the comment raised. In addition, terminology has been established and included in the definitions within GM1 29.1465.

comment

217 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465 (a)(1)

Priority: High

RATIONALE / REASON / JUSTIFICATION
With respect to the following statement in (a)(1):

"by providing timely indications of potential failures."

The wording "potential" strongly indicates that the VHM are there to improve situation without being able to provide an absolute assurance of preventing dynamic components incipients faults.

The VHM systems are there to add safety benefit with respect to usual inspection means on such complex parts

PROPOSED ACTION/TEXT
The intention of bringing additional safety and not replacing adequate design of parts is key and should a driver in the definition of objectives to be met, as otherwise, if too much reliance and assurance is expected on such means (typically if worst failure condition is not considered in combination with both mechanical and VHM system at helicopter level as being to the maximum extent Catastrophic with quantitative objective to 1E-09/FH as per AC 29.1309 Figure AC 29.1309-2 definition), industry might not foster it as it could be very costly.

In addition, EASA should consider the following proposed amendment:

"by providing timely indications of incipient potential failures."

response

Partially accepted

The text has been adjusted taking into consideration the comment raised.

comment

219 comment by: *Leonardo Helicopters*

page 14 (d) (2) (i) (B):
"The applicant may choose to justify that the likelihood of initiation of any degraded condition that may progress and ultimately lead to hazardous or catastrophic failure consequences is sufficiently low to support an alleviation of system safety requirements. For this purpose, the applicant should consider that the probability of occurrence of any preceding condition should be no greater than 1E-07 per flight hour for catastrophic failures, 1E-05 per flight hour for the hazardous ones, and 1E-03 per flight hour for those that are major."

Comment:
The reported probabilities of occurrence are too conservative.

Assuming we want to monitor with credit an item whose failure cause a Catastrophic failure condition; and assuming that it is possible to calculate the probability of the preceding failure condition (i.e. random failure mode) and this probability is 1E-07.
In this case, the VHM shall meet an Hazardous severity classification (i.e. 1E-07). The catastrophic failure condition is the AND combination of the preceding failure condition not detected by the HUMS and have a probability of occurrrence of 1E-07 X 1E-07 = 1E-14, that is very conservative to reach.
Based on that, we propose to apply the SAE ARP4754A §5.2.4 FDAL Assignment Taking Credit for External Events (Figure 11) and update as follow: "The probability of occurrence of any preceding condition should be no greater than 1E-05 per flight hour for catastrophic failures, 1E-04 per flight hour for the hazardous ones, and 1E-03 per flight hour for those that are major."
Appling this probabilities of occurrence to the above example: the catastrophic failure condition will be met with 1E-05 X 1E-07 = 1E-12, that continues to be 3 order of magnitude below the Catastrophic severity requirements.

Rationale for the comment (and reference):
Consistency with SAE ARP4754A §5.2.4 FDAL Assignment Taking Credit for External Events Figure 11

Proposed solution:
“….For this purpose, the applicant should consider that the probability of occurrence of any preceding condition should be no greater than 1E-05 per flight hour for catastrophic failures, 1E-04 per flight hour for the hazardous ones, and 1E-03 per flight hour for those that are major.”

response | Accepted

comment *220* comment by: *Airbus Helicopters*

AMC1 29.1465(g)

Reminder:
Paragraph g) is articulated around the 2 main aspects of VHM performance demonstration:
g)2)(i)(A) Characteristics of failure progression
g)2)(i)(B) Fault detection probability.
Table 3 of g)2)(iii) is used to determine the number of direct evidences (e.g. tests) required for each of these aspects. It is intended to be used independently for each aspect, highlighting the fact that they might be of different natures.

Background:
Characteristics of failure progression aspects are by nature not linked to the monitoring/inspection method. In addition, they should be addressed to ensure the adequate level of safety whatever the monitoring approach. It is recommended §29.1465 does not specify requirements which may introduce discrepancies/contradictions with already existing requirements such as §29.571 or AMC25.19 (state-of-the-art requirement baseline addressing CMR) and/or the way OEMs are demonstrating compliance with those requirements.
Therefore, the definition of specific tests and safety factors requirements for failure progression aspects through §29.1465 in the case of a VHM system claiming for airworthiness-related purpose credit is not deemed acceptable.
Anyhow, such definition of specific tests and safety factors is deemed acceptable on the other hand for probability of detection aspects, which are specific to VHM system claiming for airworthiness-related purpose credit and not already described in other regulation § nor in other acceptable means of compliance.

AH statement of issue:
When applying for VHM system claiming for airworthiness-related purpose credit, there are 2 possible situations:
- No existing maintenance task has already been substantiated for the targeted failure condition. The VHM system is a candidate compensating factor amongst others (e.g. sensitive inspections).
The proposed revision of AMC 29.1465 provides a specific framework for VHM system claiming for airworthiness-related purpose credit regarding failure progression aspects. This might lead to different testing requirements when using VHM monitoring with regards to manual inspections for equivalent failure characteristic properties. In a worst case scenario, testing requirement for failure propagation characteristics would be more demanding for a VHM system claiming for airworthiness-related purpose credit than for a manual inspection substantiation. This could lead OEM not to develop VHM system claiming for airworthiness-related purpose credit despites a safety benefit is expected versus a sensitive inspection.
- An existing maintenance task has already been substantiated for the targeted failure condition. The VHM system might replace or complement this maintenance task.
In such case, the sensitive inspection has already been approved and justified as providing the appropriate level of safety for the targeted failure condition. A VHM system claiming for airworthiness-related purpose credit for the replacement of this

sensitive inspection should not systematically lead to new test requirements for failure progression aspects. Detectability tests might be used in combination with existing failure progression tests to substantiate the VHM system clearly detects degradation and meets adequate prognostic interval accordingly.

AH position:
As a consequence, Table 3 shall be applicable only to probability of detection demonstration aspects. Testing requirements relating to failure progression characteristics shall be removed from g)2)(i)(A) in order to avoid inconsistencies or discrepancies with existing demonstrations principles on these aspects present in other applicable airworthiness requirements and/or related acceptable means of compliance.

response

Partially accepted

It is now clarified in AMC1 29.1465(g)(2)(iii) that the determination of the number of tests for the failure mode characteristics can be addressed following established methods, such as those described in this comment. In addition, AMC1 29.1465(g)(2)(v) states that the number ofdirect evidence data points defined in Table 3 (now Table 2) are applicable also for evaluation of the failure progression characteristics, but that it is understood that for certain VHM applications these may be conservatively assessed with high safety margins, thus reducing the number needed.

comment

221 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(a)(2)
GM1 29.1465(a)(20)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation with paragraph AMC1 29.1465(a)(2) and the definition of VHM in GM1 29.1465(a)(20):

a) The definition of the system is uncomplete and not accurate. Instructions are not part of the system design itself even though they are compulsory for the VHM system to be operated. Typically, the VHM system specification will not capture the instructions that will be provided to operators as the instructions will have no direct influence on the system design unless explicitly, for instance, expressed by the final customers.

b) The terminology of "hardware for data acquisition" is very vague and not related to the kind of function described.

c) The following statement: "and all the associated instructions for operation of the system" seems confusing.

d) There should be consistency throughout the text in relation to the use of the term ‘transferring’ rather than ‘downloading.

PROPOSED ACTION/TEXT

In consideration of the listed points above, GAMA would like to propose the following alternative text:

AMC1 29.1465(a)(2) A VHM system typically features airborne and ground segments. and consists of the necessary equipment to acquire, process, store, transfer and display the VHM data. Depending on the VHM intended function this should include vibration sensors and the associated wiring, airborne electronic hardware (AEH) for data acquisition hardware for data acquisition, processing, and storage means for downloading transferring and/or displaying data. Associated instructions for operation of the VHM system should be prepared by the applicant.

GM1 29.1465(a)(20) VHM system: Typically features airborne and ground segments, which depending on the VHM intended function may include vibration sensors and associated wiring, airborne electronic hardware (AEH) for data acquisition, processing, and storage means for transferring and/or displaying data from the rotorcraft, and all associated instructions for the VHM system operation prepared by the applicant.

response

Partially accepted

The text has been adjusted taking into consideration the comment raised. However, the exact wording proposed has not been incorporated.

comment

222 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #2

AMC1 29.1465 (a)(3)

Priority: Editorial

RATIONALE / REASON / JUSTIFICATION
There seems to be a typo, as the word 'damages' does not mean the same as 'damage':

- damage: injury or harm that reduces value or usefulness
- damages: Law. the estimated money equivalent for detriment or injury sustained.

Note: multiple occurrences in the NPA.

PROPOSED ACTION/TEXT
It is proposed to amend this paragraph to read:
"(3) [...], each including a range of components and their associated damages/failures being monitored.[...]."

Please note the attached file for better conceptual understanding.

response

Accepted

	'Damages' is no longer used.

comment	*223* comment by: *General Aviation Manufacturers Association (GAMA)* AMC1 29.1465 (a)(3) Priority: Low RATIONALE / REASON / JUSTIFICATION Is "VHM system applications" a synonym for "VHM system functions". If yes : why introducing an additionnal term? if no, what would be the difference between those terms? PROPOSED ACTION/TEXT Please clarify the difference between VHM systems applications and "VHM system functions".
response	Not accepted 'VHM application' is clearly defined in GM1 29.1465(a) and in line with the meaning intended in this sentence. Also, this is not new terminology as it was already used in the previous version of AMC 29.1465.

comment	224 comment by: General Aviation Manufacturers Association (GAMA) Attachment #3 AMC1 29.1465 (a)(3) Priority: Medium RATIONALE / REASON / JUSTIFICATION For the sake of accuracy (failure conditions are not monitored). PROPOSED ACTION/TEXT It is proposed to amend this paragraph to read: "(3) [...]: (i) [...] VHM system applications providing 'supplementary information' are considered those that monitor failure health conditions of rotorcraft components whose failure occurrence is adequately mitigated by other compensating provisions specified at the time of certification of the product. [...]" Please note the attached file for better conceptual understanding.
response	Partially accepted The text has been adjusted taking into consideration the comment raised.

comment	*225* comment by: *General Aviation Manufacturers Association (GAMA)* Attachment #4 AMC1 29.1465 (a)(3)(i) **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** in relation to the following statement: *"Therefore, they are not required as part of the initial airworthiness approval in accordance with CS-29."* The sentence is misleading as it may give the impression to the reader that such a system can be installed on aircraft without any certification activity under Part-21/CS-29. Besides, please refer to the definition of the term 'certification' in Article 3 of Regulation (EU) 2018/1139 **PROPOSED ACTION/TEXT** It is proposed to amend the sentence to read: *"Therefore, they are not required as part of the* ***minimum type design definition to be certified. When such a VHM system is installed, it has to be approved in accordance with the applicable certification basis.****[...]."* Please note the attached file for better conceptual understanding.
response	Partially accepted The text has been adjusted taking into consideration the comment raised.

comment	*226* comment by: *General Aviation Manufacturers Association (GAMA)* Attachment #5 AMC1 29.1465 (a)(3)(i) **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** In relation to the following paragraph: *"(3) A VHM system may be used to fulfil a number of functions (VHM applications), each including a range of components and their associated damages/failures being monitored. The two main VHM system purposes or kinds of VHM applications considered within the scope of this AMC are the following:* *(i) Supplementary information [...]* *(ii) Airworthiness-related purposes (credit applications) [...]"*

Clarification of CS 29.1465 is requested regarding "supplementary information" case as it encompasses two folds:
* No Hazard / No credit applications
* Applications claiming compliance to operational regulation

PROPOSED ACTION/TEXT
For better clarity, it is proposed to amend the paragraph, and order, as below:

"(3) A VHM system may be used to fulfil a number of functions (VHM applications), each including a range of components and their associated damages/failures being monitored. The two main VHM system purposes or kinds of VHM applications considered within the scope of this AMC are the following:
(i) Airworthiness-related purposes (credit applications) [...]
(ii) Compliance with operational regulation (i.e. Regulation (EU) No 965/2012)"
(iii) Supplementary information (no hazard/ no credit) [...]

Please note the attached file for better conceptual understanding.

response Accepted

comment *227* comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #6

AMC1 29.1465 (a)(3)(i)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation to the following sentence:

"This typically refers to VHM applications installed for compliance with an operational regulation [...]. The scope of this AMC and GM1 29.1465 addressing VHM applications for supplementary information is focused on those to be approved in support of compliance with an operational regulation".

The term "operational regulation" may take different meanings. Some may understand that Regulation (EU) No 1321/2014 is an operational regulation as it applies to aircraft that are in service. Some understand the term 'operational regulation' applies only in the context of Regulations (EU) No 965/2012, 2018/395, 2018/1976, and 2019/947.

Note: comment valid for multiple locations in the AMC.

PROPOSED ACTION/TEXT
Please clarify the sentence by referring to the relevant Regulation(s)/requirement(s). For example, GAMA would propose to include every time there is a reference to 'operational regulation' the following clarification: **'operational regulation (i.e. Regulation (EU) 965/2012)'**, as proposed:

	*"This typically refers to VHM applications installed for compliance with **an operational regulation (i.e. Regulation (EU) 965/2012)** [...]. The scope of this AMC and GM1 29.1465 addressing VHM applications for supplementary information is focused on those to be approved in support of compliance with **an operational regulation (i.e. Regulation (EU) 965/2012)**".* Please note the attached file for better conceptual understanding.
response	Partially accepted This is now clarified once in the AMC text but also clearly recorded in the definitions in GM1 29.1465.

comment	*228* comment by: *General Aviation Manufacturers Association (GAMA)* Attachment #7 AMC1 29.1465 (a)(3)(ii) **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** For the sake of consistency with a previous comment. **PROPOSED ACTION/TEXT** It is proposed to amend this paragraph to read: *"(3) [...]:* *(ii) [...]* *(A) to minimise the likelihood of occurrence of hazardous or catastrophic failures **of** the rotor and/or rotor drive systems **components**, as identified in the design assessments of CS 29.547(b) and/or CS 29.917(b), [...]"* Please note the attached file for better conceptual understanding.
response	Accepted

comment	*229* comment by: *General Aviation Manufacturers Association (GAMA)* AMC1 29.1465(a)(4) **Priority:** Low **RATIONALE / REASON / JUSTIFICATION** Certification Specifications are rather for design certification than design. **PROPOSED ACTION/TEXT** It is proposed to amend this paragraph to read: *"(4) The purpose of this AMC is to provide an acceptable means of compliance for the design ~~and~~ certification of VHM applications. [...]"*
response	Not accepted

Evidently some of the aspects to be substantiated at the time of certification will necessarily drive certain elements of the design of the system.

comment *230* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(a)(4)

Priority: High

RATIONALE / REASON / JUSTIFICATION
In relation to the following note:

"Note: FAA AC 29-2C Miscellaneous Guidance (MG)15, which addresses the use of health and usage monitoring systems (HUMS) in maintenance, is no longer recognised as valid guidance for the purpose of VHM system certification within the EASA framework. The scope of MG 15 is now addressed by this AMC."

This statement is contradicted by the current AMC1 SPA.HOFO.155 which recognizes FAA AC 29-2C MG15 for application with credit.

Furthermore, GAMA does not agree with argumentative phrase in note that states MG15 is no longer recognized as valid guidance. Guidance is still valid just not to be recognized as authority under EASA VHM certification framework. U.S. OEMs have long history of using MG15 and see it as valid guidance.

PROPOSED ACTION/TEXT
Ensure AMC1 SPA.HOFO.155 is corrected concurrently with publication of this proposed AMC so as to avoid inconsistencies in certification approaches.

Also, amend the following statement as follows:

"Note: FAA AC 29-2C Miscellaneous Guidance (MG)15, which addresses the use of health and usage monitoring systems (HUMS) in maintenance, is no longer recognised as ~~valid guidance~~ for the purpose of VHM system certification within the EASA framework. The scope of MG 15 is now addressed by this AMC."

response Accepted

comment *231* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465 (b)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
All the AMC1 29.1465 (b) is used to interpret CS 29.1465 and does not provide any criteria or method of compliance.

PROPOSED ACTION/TEXT
Therefore, it is suggested to move this sub-paragraph to a Guidance Material.

response

Not accepted

This section of the AMC explains in more detail CS 29.1465 and each of its subparagraphs; this is considered valid content for AMC.

comment

232 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #8

AMC1 29.1465 (b)(1)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation with the following sentence:

"if a VHM system is installed on the rotorcraft in compliance with a certification specification or an operational regulation,[...]"

The wording is ambiguous. Is it meant to address the installed parts on the rotorcraft which have to fulfil applicable certification basis? or does it also encompass the off-board aspects if any? Besides, the operational regulation mentioned should be clarified as targeting Regulation (EU) No 965/2012.

PROPOSED ACTION/TEXT
It is proposed to amend the sentence to read:

*"if a VHM system is installed on the rotorcraft a**s part of the type design definition (including off-board aspects if any)*~~*in compliance with a certification specification*~~ *or **is mandated by** an operational regulation **(i.e. Regulation (EU) No 965/2012)**, then compliance is required."*

Please note the attached file for better contextual understanding.

response

Partially accepted

The purpose of the comment has been addressed but the text proposed has not been adopted.

comment

233 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #9

AMC 29.1465 (b)(1)(ii)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation to this note:

	"Note 1: Systems installed for supplementary information purposes, as described in (a)(3)(i) above, but not required in support of compliance with an operational regulation (i.e. installed on a 'no hazard/no credit basis'), do not need to comply with CS 29.1465. In such cases, the VHM system's documentation for operators, including at least the ICA, should clearly:.... Language as proposed seems not clear enough. **PROPOSED ACTION/TEXT** EASA should consider that Note 1 should not be a Note but a sub-section dealing with "No hazard / no credit" applications. The new sub-section should address in one hand "Supplementary information" and in the other hand "Compliance with operational regulation (i.e. Regulation (EU) 965/2012". Please note the attached file for better contextual understanding.
response	Accepted

comment	*234* comment by: *General Aviation Manufacturers Association (GAMA)* Attachment #10 AMC1 29.1465 (b)(1)(ii) **Priority:** Low **RATIONALE / REASON / JUSTIFICATION** In relation with the following sentence: *"The VHM system is used as a means of demonstrating compliance with an operational regulation requiring [...]"* The operational regulation mentioned should be clarified as targeting Regulation (EU) No 965/2012. **PROPOSED ACTION/TEXT** It is proposed to amend the sentence as below: *"The VHM system is used as a means of demonstrating compliance with an operational regulation **(i.e. Regulation (EU) No 965/2012)** requiring [...]"* Please note the attached file for better contextual understanding.
response	Partially accepted As mentioned in previous comments addressing the same point, this is now clearly stated in the AMC1 29.1465 (a)(3)(ii) and (h)(1) and then recorded in the definitions in GM1 29.1465.

comment

235 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465 (b)(1)(ii)

Priority: Low

RATIONALE / REASON / JUSTIFICATION
The term 'serviceability' is not defined. It is also used in Regulation (EU) No 1321/2014 in parallel of the term 'airworthiness'. Using the term 'serviceability' in addition to 'airworthiness' requires prior clarifications in order for the reader to identify the difference(s) existing between these terms.

Note: consideration may be given to a wording similar to the one recurrently used in the NPA 2014-27, which is 'the determination of the airworthiness status of the aircraft before each flight takes place', in order to differentiate cases under (b)(1)(i) and the others under (b)(1)(ii). For example, "... the VHM system is required to perform specific functions used for the determination of the aircraft airworthiness status in accordance with Regulation (EU) No 1321/2014."

PROPOSED ACTION/TEXT
The use of the term 'serviceability' is confusing.

response

Partially accepted

The term ‘serviceability’ has been replaced.

comment

236 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465 (b)(1)(ii)(Note 1)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation with the following sentence:

"Systems installed for supplementary information purposes [...] do not need to comply with CS 29.1465."

The sentence is misleading as it may give the impression to the reader that such a system can be installed on aircraft without CS 29.1465 compliance demonstration and even without any certification activity under Part-21/CS-29

PROPOSED ACTION/TEXT
It is proposed to amend the sentence as below:

*"Systems installed for supplementary information purposes [...] do not need to comply **specifically** with CS 29.1465, **but still need to comply with applicable requirements of the applicable certification basis.***

response

Not accepted

The sentence is quite clear in indicating that compliance is not required with CS 29.1465; no other Part 21/CS-29 requirements may be inferred. In addition, AMC1 29.1465(a)(3)(i) already highlights that compliance with other applicable requirements applies. This is then also reminded in AMC1 29.1465(c).

comment

237 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465 (b)(1)(ii)(Note 1)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
Point 21.A.7 defines ICA as *"the instructions which are necessary for ensuring that the airworthiness standard related to the aircraft type and any associated part is maintained throughout the operational life of the aircraft, when demonstrating compliance with the applicable type-certification basis"*.

There may be no ICA for systems installed for supplementary information purposes (i.e. installed on a 'no hazard/no credit basis'). It may be appropriate to use the term 'other maintenance instructions' as in point M.A.401(b).

It is recommended not to refer to 'documentation for operators'. The management of the aircraft continuing airworthiness may not be managed by an operator, depending on the nature of the air operations (refer to point M.A.201). Reference to CAMO is an option.

PROPOSED ACTION/TEXT
It is proposed to amend this note to read:

*"**In addition** ~~In such cases~~, the VHM system's documentation ~~for operators~~, including at least the ICA **(if any) or other maintenance instructions,** should clearly: [...]"*

Please note the attached file for better contextual understanding.

response

Accepted

comment

238 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #11

AMC1 29.1465 (b)(1)(ii)(Note 1)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation with the following sentence:

"- ensure that there is no possible interpretation resulting in complete or partial replacement of other existing maintenance requirements upon which the airworthiness of the rotorcraft depends."

The sentence is confusing. By definition of such VHM system application 'no hazard/no credit", there shall be no impact on existing ICA but specific additional ICA will be created. Is it meant to request a kind of "disclaimer" on those new ICA as not replacing partially or completely any of existing ICA?

PROPOSED ACTION/TEXT
EASA should consider to remove the sentence. Alternatively, EASA should clarify the expectations of the applicant.

The Note 3 proposed in the NPA seems to be more explicit on the concern expressed in the bullet point.

Please note the attached file for better contextual understanding.

response

Partially accepted

The text could not be deleted since the sentence addressed in the comment focuses on the content of the instructions of the VHM system, while Note 3 refers to the installation. In any case, the text has been adjusted to improve clarity.

comment

239 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #12

AMC1 29.1465 (b)(3)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation to paragraph (3):

a) *"safety benefit"* is confusing with respect to safety credit and the kind of VHM system application mentioned in this section.

b) The following statement: *"and a system safety assessment undertaken to identify failure modes where VHM[..]"* is usually used in the frame of compliance to CS29.1309. The VHM SSA will not be able to identify failures modes of a monitored system (because it analyses Failure Conditions from VHM FHA (and not monitored parts). Woud it be a SSA related to the monitored system? A FMECA or FMECA like document would be better to work at part and part failure mode level. If this SSA is not an ARP 4754 SSA it should be mentioned in this section or be given a different name.

c) The wording 'the scope of the VHM system monitoring [...] provide a safety benefit' is ambiguous.Clarify if reference is made to 1) the scope of the monitoring of the VHM system (to identify the failures of the VHM system), or 2) the scope of the monitoring performed by the VHM system (to identify the failures of the rotorcraft components being monitored).

PROPOSED ACTION/TEXT

The text is proposed to be amended as follows, as it is not necessary and becomes redundant with (b)(4):

"(3) In addition, where a VHM system is used as a means of demonstrating compliance with an operational regulation ***(I.e. Regulation (EU) No 965/2012)****, CS 29.1465(b) is also applicable. This paragraph aims to ensure that the scope of the* ***monitoring performed by the*** *VHM system ~~monitoring~~ and the monitoring techniques used provide* ***reliable advise for maintenance personnel of the need to intervene and help determine what type of intervention is required.*** ~~*safety benefit. All typical VHM indicators and signal processing techniques should be considered in the VHM design, and a system safety assessment undertaken to identify failure modes where VHM could provide early detection of incipient failures.*~~

Please note the attached file for better contextual understanding.

response

Partially accepted

Some of the changes proposed have been adopted. The purpose of the comment is considered addressed. The point raised on 'safety benefit' being considered ambiguous is not shared; nevertheless, the term has been removed from this sentence.

comment

240 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #13

AMC1 29.1465 (b)(1)(ii)(Note 3)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
It may be difficult, if not impossible, to develop a VHM system that will not interfere at all with the existing maintenance procedures: e.g. one may anticipate that the wiring necessary to a VHM system will interfere with the maintenance procedure for the removal of the components to which such wiring is connected. Therefore, it is recommended to soften the wording.

PROPOSED ACTION/TEXT
It is proposed to amend Note 3 to read:

"Note 3: In any case, the applicant should ensure that the installation of any VHM system does not **significantly** interfere:
- with the existing **procedures for air operations,** ~~operational~~ and/or
- **in a contradicting manner with existing** maintenance procedures of the rotorcraft."

Please note the attached file for better contextual understanding.

response

Partially accepted

The changes proposed have been incorporated with some adjustments.

comment	*241* comment by: *General Aviation Manufacturers Association (GAMA)* Attachment #14 AMC1 29.1465 (b)(3) **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** The nature of CS is not accurately reflected in this paragraph. **PROPOSED ACTION/TEXT** It is proposed to amend the first sentence of this paragraph to read: *"In addition, where a VHM system is used as a means of demonstrating compliance with [...], CS 29.1465(b) ~~is also applicable~~ an acceptable means to comply."* Please note the attached file for better contextual understanding.
response	Not accepted It is not clear if the comment tries to infer that for systems for compliance with an operational regulation, only 29.1465(b) applies. In any case, the proposed change is not supported.

comment	*242* comment by: *General Aviation Manufacturers Association (GAMA)* Attachment #15 AMC1 29.1465(c)(3) to (c)(13) **Priority:** Editorial **RATIONALE / REASON / JUSTIFICATION** Paragrahps (c)(3) to (c)(13) would be better allocated at the beggining of each applicable section, rather than in this specific point (c), as it would provide better clarity and introduction. **PROPOSED ACTION/TEXT** Please see attached proposed reorganisation.
response	Partially accepted These sections have been deleted from AMC1 29.1465(c).

comment	*243* comment by: *General Aviation Manufacturers Association (GAMA)* Attachment #16 AMC1 29.1465(c)(3) **Priority:** Editorial

RATIONALE / REASON / JUSTIFICATION
"(3) The system should be designed to meet an acceptable level of fault detection performance. This performance is determined by the monitoring approach implemented by the VHM application, which includes the signal processing performed [...]"

The adequate wording is not application but rather system.

PROPOSED ACTION/TEXT
The text is proposed to be moved at the beggining of section (e) and be amended as below:

'(3) The system should be designed to meet an acceptable level of fault detection performance. This performance is determined by the monitoring approach implemented by the VHM ***system*** ~~*application*~~*, which includes the signal processing performed, as well as some characteristics of the VHM system and criteria for the generation and management of VHM data. P~~aragraph (e) of this AMC specifies certain aspects of the monitoring approach to help ensure that this level of performance is achieved consistently.~~*

Please note the attached file for better contextual understanding.

response

Noted

This section has been deleted as requested in comment #242 so the comment is no longer considered relevant.

comment

244 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #17

AMC1 29.1465(c)(4)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
"The main topic addressed by this AMC is the fault detection performance of the system."

Fault detection performance is not the main topic addressed by this proposed AMC. The sentence is misleading.

PROPOSED ACTION/TEXT
The text is proposed to be moved at the beggining of section (f) and be amended as below:

~~*The main*~~ ***One important*** *topic addressed by this AMC is the fault detection performance of the system. This corresponds to the capability of the system to indicate the presence of an abnormal condition on a monitored component, which*

may indicate the presence of an incipient failure. ~~The process and means used for the demonstration of performance are addressed in paragraph (f).~~

Please note the attached file for better contextual understanding.

response

Noted

This section has been deleted as requested in comment #242 so the comment is no longer considered relevant.

comment

245 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #18

AMC1 29.1465(c)(5)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
With regard to the first sentence : *"Performance objectives and details regarding the compliance demonstration for VHM applications that are airworthiness related [...]"*. It does not add value to assist the interpretation of paragraph (g), therefore it is proposed to be deleted. Furthermore, it is proposed to change 'credit application' to specify it relates to 'an airworthiness-related credit'.

Furthermore, there seems to be a typo in the use of the word 'damages' instead of 'damage' (Note: multiple occurrences in the NPA):
- damage: injury or harm that reduces value or usefulness
- damages: Law. the estimated money equivalent for detriment or injury sustained.

PROPOSED ACTION/TEXT
The text is proposed to be moved at the beggining of section (g) and be amended as below:

*"~~Performance objectives and details regarding the compliance demonstration for VHM applications that are airworthiness related are provided in paragraph (g) of this AMC. In addition,~~ This section provides details on how to define **an airworthiness-related credit**, how to evaluate the damage~~s~~/failures being monitored for credit in support of the justification of an adequate performance, and how to establish the minimum number of tests required for the demonstration of performance"*

Please note the attached file for better contextual understanding.

response

Noted

This section has been deleted as requested in comment #242 so the comment is no longer considered relevant.

comment

246 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #19

AMC1 29.1465(c)(6)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
This paragraph seems to not add value to assist the interpretation of paragraph (h)

PROPOSED ACTION/TEXT
It is proposed to remove the paragraph (c)(6)

Please note the attached file for better contextual understanding.

response: Accepted

comment: *247* comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #20

AMC1 29.1465(c)(7)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
This paragraph could be deleted as it does not add value to assit the interpretation of either paragraph (d) or (i).

PROPOSED ACTION/TEXT
It is proposed to delete the paragraph (c)(7):

~~In addition to the VHM system failure severity identification and determination of the associated safety objectives provided in paragraph (d) of this AMC, paragraph (i) provides details regarding how to interpret these safety requirements for the system's ground segment. This section clarifies how to ensure the fulfilment of the objectives of the VHM applications considering the role of the ground segment .~~

And include the following statement at the beggining of paragraph (i):

"This section clarifies how to ensure the fulfilment of the objectives of the VHM system applications considering the role of the ground segment."

Please note the attached file for better conceptual understanding.

response: Accepted

comment: *248* comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #21

AMC1 29.1465(c)(8) and (9)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
This paragraph could be deleted as it does not add value to assit the interpretation of either paragraph (j) or (k).

PROPOSED ACTION/TEXT
It is proposed to remove the following paragraphs (8) and (9)

~~"(8) Certification aspects of the VHM system on-board and ground-based software are addressed in paragraph (j). This section also provides guidance on how to ensure that COTS software does not compromise the overall integrity of the system."~~

~~"(9) The VHM system should be supported with the necessary system documentation including ICA. The objectives to be fulfilled by this documentation are detailed in paragraph (k)."~~

Please note the attached file for better conceptual understanding.

response | Accepted

comment | *249* comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #22

AMC1 29.1465(c)(10)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation with the following sentence:

"When a VHM system is introduced into service, a CSI phase is typically needed to validate assumptions made at the time of the approval in support of the system's demonstration of compliance."

It is unclear why assumptions made at the time of approval have to be validated through CSI. Especially what kind of assumptions made which cannot be validated and verified during the development phase. Because it is not acceptable that key assumptions like failure progression are not validated and verified before approval; whereas the fault detection performance can be kind of difficult to quantify and CSI phase could be useful to confirmed the demonstrated performance.

It shall be clear what is approved, is it the airworthiness-related purpose (credit) or a supplementary information (no credit)?

This shall be clarified.

PROPOSED ACTION/TEXT
The paragraph is proposed to be moved to the beggining of section (l) and amended as below:

"When a VHM system is introduced into service, ***after approval of the VHM systems is granted (including assumptions are validated and verified)****, a CSI phase is typically needed to* ~~*validate*~~ ***confirm*** ~~*assumptions and*~~ ***demonstrated performances related to Fault detection*** ~~*made at the time of the approval in support of the system's demonstration of compliance.Paragraph (l) addresses the criteria under which a CSI phase is considered needed and the objectives to be fulfilled during it, as well as how to define its requirements and targets ."*~~

Please note the attached file for better conceptual understanding.

response

Partially accepted

This section has been deleted as requested in comment #242 so the comment is no longer considered relevant.

Regarding the concerns raised on the CSI, the reasons for a CSI are clearly explained in paragraph (k). Also, dedicated text has been added in paragraphs (g) and (h) dealing with this point. In addition, it is clear in the aforementioned section that a CSI is not systematically required. The applicant is welcome to ensure that no open question remains at the time of certification and all assumptions are fully validated and verified with fully representative data. However, realistically speaking, it is not considered feasible to approve a substantial credit with limited testing and expect not to do a CSI.

comment

250 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #23

AMC1 29.1465(c)(11)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
Paragraph (c)(11) could be placed under section (m) tu ensure proper interpretation.

PROPOSED ACTION/TEXT
The paragraph is proposed to be moved to the beggining of section (m) and amended as below:

"Although VHM systems do not strictly require a cockpit interface for pilot interaction or for providing VHM alerts, such a feature may be introduced. ~~*Paragraph (m) of this AMC*~~ ***This section*** *addresses this functionality focusing on cockpit indications generated by the VHM system.* ~~*If cockpit indications are part of any of the VHM applications to be approved, the applicant should consider this guidance and note that this AMC and GM1 29.1465 are not intended at actions such as landing immediately or landing within a limited interval"*~~

Please note the attached file for better conceptual understanding.

response

Accepted

comment

251 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #24

AMC1 29.1465(c)(12) & (13)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
Paragraph (c)(12) and (c)(13) seem to not add value to assist the interpretation of paragraphs (n) or GM1 29.1465.

PROPOSED ACTION/TEXT
The paragraph is proposed to be removed as it does not add value to assist the interpretation of paragraphs (n) or the GM1 29.1465:

~~(12) Considerations regarding the potential impact of VHM systems on the rotorcraft's MEL are addressed in paragraph (n) of this AMC.~~

~~(13) Additional guidance in support of this AMC is provided in GM1 29.1465. This guidance provides clarifications on aspects addressed by this AMC as well as considerations on other aspects typically supporting the VHM system in its intended functions, but that are not part of the compliance demonstration with CS 29.1465. These are, therefore, information aimed at clarifying aspects associated with customer needs and standardising applicant approaches on elements providing support to the operation of VHM systems. The following aspects are addressed:~~
~~(i) Definitions~~
~~(ii) System design considerations~~
~~(iii) Alert generation and management~~
~~(iv) Interfaces for maintenance personnel and fleet diagnostics~~
~~(v) Training~~
~~(vi) Product support~~

Please note the attached file for better conceptual understanding.

response

Accepted

comment

252 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #25

AMC1 29.1465(d)(1)

Priority: Low

RATIONALE / REASON / JUSTIFICATION
In relation with the following sentence:
"[...]VHM systems typically consist of on-board and ground segments,[...]"

GAMA members have already proposed several VHM applications which do not rely on ground segments. So this sentence might be slightly reworded to focus on the on-board aspects that are always in the scope and consider ground-segment or off-board aspects as a possibility of architecture.

PROPOSED ACTION/TEXT
The sentence is proposed to be amended as below:

"VHM systems typically consist of on-board ~~and~~ ***that can be complemented with*** *ground segments"*

Please note the attached file for better conceptual understanding.

response

Not accepted

The comment is understood but it is not considered to add any value. It is agreed that the on-board segment is the key system and the ground one complements it. However, in this context, it is not considered to ease the understanding of the guidance provided.

comment

253 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #26

AMC1 29.1465(d)(1)

Priority: Editorial

RATIONALE / REASON / JUSTIFICATION
In relation to the following sentence:

"and this section shall be considered as applicable for the complete system for the purpose of establishing its safety requirements. The compliance demonstration should then be completed in accordance with the following:"

The word "complete" is quoted very often.

PROPOSED ACTION/TEXT
The sentence is proposed to be amended as below:

"and this section shall be considered as applicable for the ~~complete~~ ***end-to-end*** *system for the purpose of establishing its safety requirements. The compliance demonstration should then be ~~completed~~* ***achieved*** *in accordance with the following:"*

Please note the attached file for better conceptual understanding.

response

Partially accepted

comment

254 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #27

AMC1 29.1465(d)(1)(i)

Priority: Editorial

RATIONALE / REASON / JUSTIFICATION
In relation to the following sentence:

"(i) The qualification procedures for airborne equipment and the associated installation to be followed as part of the VHM system compliance demonstration are the same as for any other airborne equipment."

The wording "qualification" in the industry framework makes reference to a contractual specification, meaning that there is always room for negotiation between stakeholders if some aspects are not meet.

In the context of the AMC1 29.1465, is it meant here certification specifications? if so, why using this word as it does not reflect the expected activities which are compliance demonstration against applicable airworthiness requirements.

PROPOSED ACTION/TEXT
The text is proposed to be amended as follows:

"(i) The ~~qualification procedures~~ ***compliance demonstration activities*** *for airborne equipment and the associated installation to be followed as part of the VHM system compliance demonstration are the same as for any other airborne equipment."*

Please note the attached file for better conceptual understanding.

response | Accepted

comment | *255* comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #28

AMC1 29.1465(d)(1)(ii)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
This subparagraph indicates that CS-29 requirements are (typically) not applicable to ground/off-board segment.

Note: paragraph (i) of this AMC indicates that "[a]ny ground-based system architecture requirements should be specified as part of the ICA for VHM system, including man-machine interfaces". ICA are governed by the CS-29 Appendix A. Therefore, do CS-29 apply or not, or partially?

PROPOSED ACTION/TEXT
Could the Agency make explicit the origin of the system safety requirements used to determine the compliance of the ground/off-board segment?

It is proposed to amend the text as follows:

"For the ground segment, paragraph (i) provides guidance regarding the determination of compliance with the corresponding system safety requirements considering that CS-29 certification specifications are ~~typically~~ not applicable."

Please note the attached file for better conceptual understanding.

response

Partially accepted

The CS-29 specifications are not directly applicable. However, the ground segment may have to fulfil certain objectives which are derived from CS-29 specifications. The text has been amended accordingly.

comment

256 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(d)(2)

Priority: Non Concur

RATIONALE / REASON / JUSTIFICATION
GAMA/ASD Rotorcraft Subcommittee members have discussed paragraph (d)(2) in detail without the possibility to reach a common industry response on these specific items:

- VHM system features applications for credit addressing mechanical failures which may be catastrophic or hazardous.
- the VHM system safety requirements, as supported by the implementation of mitigating actions and/or the demonstrated low occurrence probability of preceding degraded state (table 1).
- the probability of occurrence limits for the likelihood of initiation for any degraded state that may progress and ultimately lead to Hazardous or Catastrophic failure consequences.

The reason behind the lack of consensus resides in:

A) There seems to be still a lack of maturity in the VHM system safety requirements discussions among industry stakeholders, which leads to disbalanced/unproportionate applicability among the different rotorcraft OEMs. So far, no standard procedures have been developed for the calculation of the probability of occurrence of structural failures, which should mean that a forum for

standardisation and coordination might have been needed ahead of EASA's encroachment of this requirement into the EU's regulatory framework.

B) The associated weight and costs that this requirement can entail, which can have a big effect and varies considerable between OEMs. Companies shouldn't be penalized by excessive safety constraints, specially when it will not improve safety if not implemented. The right balance between achieving the highest safety standards and not imposing an excessive burden to companies should be taken into consideration.

Despite the lack of an industry position, individual OEMs will be submitting their own alternative proposals to some of the mentioned issues. However, it is highly desirable that GAMA/ASD's proposal below be taken into consideration for the benefit of all involved stakeholders.

PROPOSED ACTION/TEXT
Considering the above reasons, GAMA/ASD would propose that this paragraph **be further discussed among specialists at an appropriate forum (i.e. reopening of the working group, and specifically its safety panel)** before it is included as acceptable means to comply with CS 29.1465. Notably, the above mentioned topics would heavily benefit from further talks between the regulator and OEMs.

response

Partially accepted

The working group has met and this section has been rediscussed.

The discussion was reopened, and alignment has been reached. In any case, this is AMC and any OEM that is willing to pursue a different approach is welcome to do it.

In addition, a note has been added to clarify that this text has been proposed with certain assumptions in mind, which would support the proposal of adjustments in cases where these assumptions do not apply.

comment

257 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #29

AMC1 29.1465(d)(2)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation with this sentence:

"Based on their intended function, the applicant should consider that, for the purpose of establishing its safety requirements, the severity of any VHM system failure impacting applications for credit or in support of compliance with an operational regulation should not be lower than minor."

One may have the understanding that safety requirements (term used at different locations in the NPA - in particular, read at the bottom of page 15) are defined in the regulatory material such as Part-21, CS-29, etc...

The qualitative severity category lower than 'minor' is 'no safety effect'. So, the current wording seems to imply that the severity of any VHM system failure should be either minor, major, hazardous or catastrophic. It is probably not the intent.

PROPOSED ACTION/TEXT
It is proposed to amend this sentence to read:

*"Based on their intended function, the applicant should consider that, for the purpose of establishing **the safety objectives to achieve** ~~its safety requirements~~, the severity of any VHM system failure impacting applications for credit **should not be lower than minor** or in support of compliance with an operational regulation should not be lower **than No Safety Effect (NSE).**"*

Please note the attached file for better conceptual understanding.

response

Partially accepted

The first part of the proposed changes has been accepted and incorporated. However, EASA does not agree with the proposal to consider VHM systems in support of compliance with an operational regulation as NSE. This does not reflect the intent of SPA.HOFO.155 of Regulation (EU) No 965/2012, which was clearly introduced to mitigate the increased risk of offshore helicopter operations. Thus, considering also that this not a demanding consideration, EASA maintains the minor classification proposed.

comment

258 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #30

AMC1 29.1465(d)(2)

Priority: High

RATIONALE / REASON / JUSTIFICATION
The term 'condition' is used for two different meanings making ambiguous the message passed onto readers:
- failure condition: i.e. a combinaison of different parameters (/assumptions)
- degraded condition: i.e. referring to a health state

Note: multiple occurrences in the NPA, specially within (d)(2)

PROPOSED ACTION/TEXT
It is recommended to keep the term 'condition' for wordings such as 'failure condition' and to use the term 'state' for wordings about the health state.

Please note the attached file for better conceptual understanding.

response | Partially accepted

'Failure condition' is no longer used in AMC1 29.1465 or GM1 29.1465. The terms 'condition' and 'degraded condition' are now clearly defined in GM.

comment | *259* comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #31

AMC1 29.1465(d)(2)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation to the following sentece:

"assign it to the VHM system function for the purpose of establishing its safety requirements"

It could be further clarified

PROPOSED ACTION/TEXT
Amend the sentence as proposed:

"assign ~~it~~ to the VHM system ~~function for the purpose of establishing it's the~~ adequate safety ~~requirements~~ ***objectives*** *as defined in Table 1* ***considering (A) Mitigating actions and/or (B) probability of occurrence as applicable"***

Please note the attached file for better conceptual understanding.

response | Partially accepted

The text has been adjusted taking into consideration the comment raised.

comment | *260* comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #32

AMC1 29.1465(d)(2)

Priority: High

RATIONALE / REASON / JUSTIFICATION
Language can be improved to ensure proper and acurate interpretation. Furthermore, although referring to 'maintenance' is not incorrect, it reduces the array of solutions.

Note: every time there is the word *'safety requirements'* it should be substituted by '*safety objectives*'.

PROPOSED ACTION/TEXT

It is proposed to amend the following sentence:

*"In addition, the applicant may then consider alleviating these safety ~~requirements~~ **objectives** relative to this starting point. For this purpose, the applicant may consider elements of the rotorcraft design, associated c**ontinuing airworthiness actions including** maintenance, and/or established ~~reliability of the monitored components.~~ **failure probability of ocurrence of the preceding degraded state to be monitored.** These are summarised in (A) Mitigating actions and (B) The probability of occurrence of any preceding degraded **state** ~~conditions~~. These aspects are considered to reduce the extent of reliance on the VHM system towards ensuring the airworthiness of the rotorcraft.*
[...]
*Following the evaluation of (A) and (B), as described below, the applicant may propose ~~alleviated~~ **tailored** ~~system safety requirements~~ **system safety objectives** for VHM systems featuring applications for credit as follows:*
*Table 1: VHM system safety ~~requirements~~ **objectives**, as supported by the implementation of mitigating actions and/or the demonstrated low occurrence probability of preceding degraded conditions*
[...]"

Please note the attached file for better conceptual understanding.

response

Partially accepted

The text has been adjusted taking into consideration the comment raised.

comment

261 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #33

AMC1 29.1465(d)(2)(i)(A)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
Although referring to 'maintenance' is not incorrect, it reduces the array of solutions. Note: multiple occurrences in the NPA.

Furthermore, mitigating actions should include addition of inspections and validation of critical features either by supplier or OEM. Recommend to also include acceptance testing performed.

PROPOSED ACTION/TEXT
It is proposed to amend the following sentences to read:

"This term refers to **continuing airworthiness tasks including** maintenance tasks, **inspections, acceptance tests such as activities performed prior to the installation on the rotorcraft,** or alternative means of monitoring that are fully independent from VHM. These may be implemented and demonstrated to adequately monitor the affected part(s) in combination with VHM monitoring in

support of preventing any hazardous or catastrophic failures ~~conditions~~ addressed by the credit application.
[...]
This should be understood as the completion of one ~~inspection~~ **continuing airworthiness task** or one review of any indications from alternative monitoring means, within an interval in which they are justified to clearly detect the incipient failure ~~condition~~."

Please note the attached file for better conceptual understanding.

response

Partially accepted

The complete list is not accepted since activities that are not continuously performed cannot be considered as mitigating actions since these will not be capable of detecting an abnormal condition in service. Acceptance tests are now covered in (d)(2)(ii)(A)(3).

comment

262 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(d)(2)(i)(A)

Priority: High

RATIONALE / REASON / JUSTIFICATION
In relation with the following sentence:

"The applicant should consider the probability of detection, prognostic interval, and periodicity of the mitigating actions to demonstrate ..."

Taking into account to definition of "prognostic interval" in GM1 29.1465(a)(13) page 43, it refers to VHM application while this section adresses independent alternative means of monitoring.

PROPOSED ACTION/TEXT

*"The applicant should consider the probability of detection, ~~prognostic interval~}~~ **the time between detection by any means and the failure,** and periodicity of the mitigating actions to demonstrate ..."*

response

Partially accepted

In this point, only the time between detection by the mitigation means and failure is to be considered. The text has been amended to take the comment into account.

comment

263 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #34

AMC1 29.1465(d)(2)(i)(B)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
The term 'operation' (and/or its derivatives) is used for two different meanings making ambiguous the message passed onto readers:
- in the sense of an activity: air operations, maintenance operations, etc...
- in the sense of performance/functioning: operation of an aircraft system.

Note: multiple occurrences in the NPA, specially within paragraph (d)(2).

PROPOSED ACTION/TEXT
It is recommended to keep the term 'operation' for wordings such as 'air operations' and to find a synonym like 'functioning' for wordings such as:

*"The **early signs of degradation or damage** ~~preceding degraded condition~~ typically initiate~~s~~ naturally due to the normal ~~operation~~ **functioning** of dynamic components and particularly in the presence of minor defects (e.g. indents, micropits, etc.) or slightly altered ~~operating conditions~~ **working circumstances** (e.g. misalignment, wear, etc.). By means of continuous **functioning** ~~operation~~, this state ~~degraded condition~~ usually **further degrades** ~~progresses~~, potentially becoming detectable at a certain point and, if not detected, it may eventually lead to ultimate failure.*

Please note the attached file for better conceptual understanding.

response

Partially accepted

'Operation' is the preferred term; the other changes have been incorporated.

comment

264 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #35

AMC1 29.1465(d)(2)(i)(B)(c)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
The term 'preceding degraded condition' may mean little to the reader after several paragraphs.

For the sake of clarity it is proposed to replace it. The second subparagraph of paragraph (f)(1) is referred to in order to identify an appropriate term.

Note: Multiple occurrences in the NPA.

PROPOSED ACTION/TEXT
It is proposed to amend the sentence to read:

*"(c) detail the parameters and controls of the affected part that support the probability of occurrence of **the early signs of damage or degradation** ~~preceding degraded condition~~ demonstrated at the time of the approval."*

Please note the attached file for better conceptual understanding.

response

Not accepted

The term is used consistently when referring to this concept. It is not considered justified to use alternative terms that may lead to misinterpretation.

comment

265 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #36

AMC1 29.1465(d)(2)(i)(B)(d)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
The meaning of this sentence seems unclear:

"In order to complete this demonstration, the applicant should: [...]
(d) take into consideration any changes implemented within the period of time used to gather the necessary service experience for this demonstration to the replacement, inspection or overhaul intervals of the affected components."

PROPOSED ACTION/TEXT
It is proposed to amend the sentence to read:

*"(d) take into consideration any changes to t**he replacement, inspection or overhaul intervals of the affected components that were** implemented within the period of time used to gather the necessary service experience for this demonstration ~~to the replacement, inspection or overhaul intervals of the affected components."~~*

Please note the attached file for better conceptual understanding.

response

Accepted

comment

266 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #37

AMC1 29.1465 (d)(2)(i)(B)(d)

Priority: High

RATIONALE / REASON / JUSTIFICATION
It is not clear why the Agency is assuming that the demonstration of either the probability of occurrence of any preceding degraded condition or the probability of detection of the mitigation actions will not be complete at the time of approval and therefore it shoud be required to verify them in service. It is not clear what is the exact meaning of 'should implement'. Is it mandatory in all cases or not? If not, is

there any objective criteria to define its need?. Additionally, it does not provide any guidance on what kind of verification would be expected.

Furthermore, the statement in the note to continuously verify is too extreme and should not be used generically. If a specific rate is required due to risk mitigation then it should be defined in cert plan. Requirement in generic applicatoin is more accurately captured as should monitor.

PROPOSED ACTION/TEXT
EASA to remove the following note:

~~Note: When any of these aspects is used to support an alleviation of the safety requirements of the VHM system, the applicant should monitor implement the necessary means to continuously verify in service the probability of occurrence of the preceding degraded condition and/or the Mitigating Actions detection capability.~~

Alternatively, to amend as proposed, and 're-indent' in AMC 29.1465(d)(2)(i) as it applies to both (A) and (B) :

Note: When any of these aspects is used to support an alleviation of the safety requirements of the VHM system, the applicant should ***monitor*** ~~*implement the necessary means to continuously verify*~~ *in service the probability of occurrence of the preceding degraded condition and/or the Mitigating Actions detection capability.*

Please note the attached file for better conceptual understanding.

response Accepted

comment *267* comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #38

AMC1 29.1465 (d)(2)(i)(B)(d)

Priority: Non Concur

RATIONALE / REASON / JUSTIFICATION
Language as proposed does not clarify that the loss of function cannot lead to the same effects of misleading data.

This requirement seems too strong and could potentially drive a triplex configuration. Loss of the VHM data means that the Operator does not receives data on one or more items being monitored. Based on what is reported in “(n) Minimum equipment list (MEL) recommendation” of NPA 2022-03: the applicant should instruct the operator to “revert to the maintenance procedures applicable for the rotorcraft without the VHM application for credit”. Therefore, the loss of VHM data only results in an additional maintenance action, with no decrease in safety margin.

Based on the above, it is not justified to classify the “loss of the VHM data” as Catastrophic, Hazardous or Major, which would be the same classification of “misleading failure”.

PROPOSED ACTION/TEXT
A) propose deletion of the (ii)

~~The VHM system failure severities described in Table 1 above for the purpose of establishing the system safety requirements address both loss of function and malfunction of the VHM system. The associated Safety Objectives should consider the quantitative (numerical probabilities) and qualitative (FDAL) requirements.~~

B) Alternatively, consider the following rewording:

The VHM system failure severities described in Table 1 above for the purpose of establishing the system safety requirements address ~~both loss of function~~ and the malfunction of the VHM system. ***With respect to the detected loss of function VHM data, it can be classified as Minor if the applicant is able to restore the same mitigating action and/or maintenance tasks that the credit application would replace.*** *The associated Safety Objectives should consider the quantitative (numerical probabilities) and qualitative (FDAL) requirements.*

Please note the attached file for better conceptual understanding.

response

Partially accepted

The wording proposed is not implemented but the purpose of the comment is addressed. It is not considered needed to address cases of loss of function which would not lead to potentially missing the detection of an incipient failure prior to it reaching ultimate consequences.

comment

268 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #39

AMC1 29.1465(d)(2)(i)(B)(d)(3)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
For the sake of consistency.

AMC1 29.1465(d)(1)(ii) indicates that CS-29 certification specifications are typically not applicable to ground/offboard segment.

PROPOSED ACTION/TEXT
It is proposed to amend the first sentence to read:

*"The safety **objectives** ~~requirements~~ to be met by the **onboard** VHM system should establish confidence that development errors have been minimised with an appropriate level of rigour, and system failure rates have been reduced to acceptable levels in accordance with CS 29.1309."*

Please note the attached file for better conceptual understanding.

response

Partially accepted

The proposal is not in line with the intent of the AMC which clearly identifies safety objectives for the VHM system as a whole. As stated in AMC1 29.1465(i), the reliability of the ground-based system should not compromise end-to-end system integrity and safety. As such, the applicant should propose adequate means to ensure this, even if not demonstrating compliance with CS-29 specifications for this part of the system.

comment

269 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #40

AMC1 29.1465(d)(3)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
Implementation of safety requirements. The proposed entry through table 1 is not consistent with ED-79A/ARP 4754A which expects an entry at aircraft level instead of system level

PROPOSED ACTION/TEXT
Because it is recognized that FDAL allocated to mechanical parts is not systematically appropriate, it is proposed to have a FDAL for the whole function (whatever is the technical nature of this function), then to allocate a FDAL to the VHM through the table 1 (PASA activity) and evaluate the severity of the VHM based on the usual 29.1309 criterion.
Finally the retained FDAL and quantitative objectives will have to ensure compliance with both objectives given by the aircraft layer and system layer.

response

Partially accepted

The proposal is not in line with the intended approach of the AMC, which is to provide more specific guidance for a monitoring system whose safety objectives may be impacted by a combination of mechanical and system failures. This is known to required further guidance and this is what this section is attempting. Nevertheless, the text of this section has been substantially reworded to improve clarity and achieve greater alignment with stakeholders.

comment

270 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(e)(1)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION

The notions of acquisition cycle, interruption, frequency, etc... described in this paragraph should be detailed through definitions or with an illustration.

PROPOSED ACTION/TEXT
It is recommended to add definitions and/or illustrations depicting different cases.

response

Partially accepted

'Acquisition cycle' is now defined in GM. No definition is considered needed for the other words suggested.

comment *271* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465 (e)(1)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
With regard to the last sentence of the 2nd paragraph : *"[...] the applicant should define a recommended and a minimum frequency of data collection, which should not be greater than once every 15 flight hours."*

What is the rationale of 15 FH ? This requirement is solution-prescriptive.

The 15 FH maximum interval for data collection is proposed in Heli offshore best practices, and could be provided in Guidance Material.
PROPOSED ACTION/TEXT
It is proposed to amend the text as follows:
"[...] the applicant should define a recommended ~~and a minimum frequency~~ ***interval*** *of data collection, ~~which should not be greater than once every 15 flight hours."~~*

response

Accepted

This has been moved to GM.

comment *272* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465 (e)(3)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
"After introduction into service, the applicant should regularly review data produced in service to evaluate the need to modify the alerting criteria in order to ensure that an adequate performance of the system is maintained. This need should be actively reviewed during CSI and at regular intervals after the CSI. The process of ensuring mature VHM alerting criteria may involve setting missing or fine-tuning existing fixed thresholds, development of new or improved algorithms for learnt thresholds, and introduction of additional or modified indicators."

These sentences are related to the lifecycle of VHM system while operated in real-life, meaning after VHM system installation approval. This is not to be placed in the section (e). To the maximum extend, those sentences could be placed in seciton (l) or in GM1.
PROPOSED ACTION/TEXT
The text is proposed to be deleted:
~~"After introduction into service, the applicant should regularly review data produced in service to evaluate the need to modify the alerting criteria in order to ensure that an adequate performance of the system is maintained. This need should be actively reviewed during CSI and at regular intervals after the CSI. The process of ensuring mature VHM alerting criteria may involve setting missing or fine-tuning existing fixed thresholds, development of new or improved algorithms for learnt thresholds, and introduction of additional or modified indicators."~~

response | Accepted

comment | *273* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(d)(3)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
With regard to the sentence of the paragraph (iii) :
"this indication is readily and easily accessible and intelligible at any point and removed when the alerting conditions no longer exist."

Clarify the meaning "at any point"

This requirement could be too much solution-prescriptive depending of the meaning of "at any point". It should be up to the applicant to define the means to access the indication in acccordance with the alerting leadtime objectives.
PROPOSED ACTION/TEXT
The text is proposed to be amended as follows:

"this indication is readily and easily accessible and intelligible ~~at any point~~ and removed when the alerting conditions no longer exist."

response | Accepted

comment | *274* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(f)(1)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
"For this purpose, the applicant should evaluate the capability of key elements of the monitoring approach, such as signal acquisition, processing techniques, indicators and alerting criteria selected to identify any abnormal mechanical response that may

indicate the presence of damage or degradation. The role of other elements that help ensure that VHM data is acquired, indications are provided at appropriate intervals, and allow the processing of these indications should also be taken into consideration as part of this evaluation."

This paragraph seems redundant with section AMC1 29.1465(e) and does not bring additional value, therefore it is proposed to remove it.
PROPOSED ACTION/TEXT
The paragraph is proposed to be amended as follows:

"[...]achieves an adequate fault detection performance for each of the intended function(s) ~~system applications.~~

~~For this purpose, the applicant should evaluate the capability of key elements of the monitoring approach, such as signal acquisition, processing techniques, indicators and alerting criteria selected to identify any abnormal mechanical response that may indicate the presence of damage or degradation. The role of other elements that help ensure that VHM data is acquired, indications are provided at appropriate intervals, and allow the processing of these indications should also be taken into consideration as part of this evaluation.~~

The fault detection performance should be demonstrated for each VHM [...]

response | Accepted

comment | *275* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(f)(1)(i)(ii)(iii)(iiii)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation to the following paragraph:

"The fault detection performance should be demonstrated for each VHM application by appropriate means, as defined in (2) below, addressing the following aspects:
(i) The progression of the failure conditions to be prevented by the VHM system are well understood and justified to feature a detectable stage of damage or degradation that will systematically precede the failure.
(ii) This preceding degraded condition will produce a clear mechanical response, whose signal(s) may be acquired and processed into indicators that are capable of highlighting an abnormal behaviour in case of incipient failure by means of the proposed monitoring approach.
(iii) The indications provided by the system highlighting abnormal behaviour of the part or assembly are capable, in combination with the associated management procedures, of detecting and isolating the fault at an adequate point within the failure progression (i.e. prognostic interval).
(iv) The computed Indicators are stable, reliable, and representative of the condition of the elements monitored providing a high probability of discriminating between 'healthy' and 'degraded' elements (i.e. probability of fault detection)."

PROPOSED ACTION/TEXT
The term "Demonstration" is used for all kind of VHM applications but it is confusing since the way of substantiating the performance is really different depending if the VHM system intends to provide a credit or simply provides supplementary information for CAMO or is installed to support compliance with Regulation (EU) No 965/2012.

EASA to please clarify which of the listed aspects have to be applied, depending on the application or if the aspects to be addressed by the fault detection performance to be demostrated are always valid. GAMA would suggest to graduate the deph of investigation conmesurate to the intended function of the VHM system.

response

Partially accepted

This is clearly addressed in dedicated sections of the AMC. In any case, some minor clarifications have been introduced in (f)(2) to better indicate that the expected demonstration effort is to be commensurate with the intended VHMS applications. The aspects to be addressed do nonetheless remain the same regardless of the kind of application.

comment *276* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(f)(1)(i)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation to the following statement:
"The fault detection performance should be demonstrated for each VHM application by appropriate means, [...], addressing the following aspects:
(i) The progression of the failure conditions to be prevented by the VHM system are well understood and justified to feature a detectable stage of damage or degradation that will systematically precede the failure."

The aspect to address is not clear. The VHM detects damage or degradation, the continuing airworthiness action or maintenance action prevents the failure.
PROPOSED ACTION/TEXT
It is proposed to amend the point (i) to read:
"(i) The progression of ***damage or degradation*** ~~*the failure conditions*~~ *to be* ~~*prevented*~~ ***detected*** *by the VHM system* ~~*are*~~ *is well understood and justified to feature a detectable stage of damage or degradation that will systematically precede the failure."*

response

Partially accepted

The proposal to use ‘damage or degradation’ has been replaced by ‘degraded condition’ which is now supported by a definition in the GM.

comment *277* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(f)(1)(ii)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation to the following paragraph:

" (ii) This preceding degraded condition will produce a clear mechanical response, whose signal(s) may be acquired and processed into indicators that are capable of highlighting an abnormal behaviour in case of incipient failure by means of the proposed monitoring approach."

The term preceding degraded condition seems not adequate.
PROPOSED ACTION/TEXT
The text is proposed to be amended as follows:
"(ii) This ~~preceding degraded condition~~ **incipient damage** will produce a clear mechanical response, whose signal(s) may be acquired and processed into indicators that are capable of highlighting an abnormal behaviour in case of incipient failure by means of the proposed monitoring approach."

response

Partially accepted

'Degraded condition' is now clearly defined in GM. The term 'preceding' has been removed as it is not considered needed here.

comment

278 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(f)(1)(iii)

Priority: High

RATIONALE / REASON / JUSTIFICATION
In relation to the following paragraph:

"(iii) The indications provided by the system highlighting abnormal behaviour of the part or assembly are capable, in combination with the associated management procedures, of detecting and isolating the fault at an adequate point within the failure progression (i.e. prognostic interval)."

The word behavior does not have a clear meaning. May the part have a normal behavior with regard to its functions and present signs/clues allowing to predict a future failure.

PROPOSED ACTION/TEXT

It is proposed to amend the text as follows:
"(iii) The indications provided by the **VHM** system ~~highlighting abnormal behaviour of the part or assembly~~ are capable, in combination with the associated management procedures, of detecting and isolating the fault at an adequate point within the failure progression (i.e. prognostic interval)."

response | Partially accepted

The purpose of the comment has been addressed, but the exact wording proposed is not kept.

comment | *279* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(f)(1)(vi)

Priority: High

RATIONALE / REASON / JUSTIFICATION
The term "Reliability of the end to end process" should be defined
PROPOSED ACTION/TEXT
EASA to clarify further the intent of the following statement as it can provide a basis to misinterpretation:

"Reliability of the end-to-end process"

It is important to note that the demonstration would be on the product and not the process.

response | Accepted

Definition of 'end-to-end process' is now provided in GM.

comment | *280* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(e)(3)

Priority: High

RATIONALE / REASON / JUSTIFICATION
In relation with the following paragraph:

"Approval of VHM systems may be granted, in accordance with the approach described in this AMC, with limited or no supporting data from service. In such cases, the applicant should take into consideration that an additional step of demonstration of the system's performance will typically need to be completed in service (post-approval) during the CSI."

Is this statement applicable to Maintenance Credit application ? if Yes, is the credit granted before CSI is completed?
PROPOSED ACTION/TEXT
It is proposed to remove the following sentences:

~~"Approval of VHM systems may be granted, in accordance with the approach described in this AMC, with limited or no supporting data from service. In such cases, the applicant should take into consideration that an additional step of demonstration~~

~~of the system's performance will typically need to be completed in service (post-approval) during the CSI."~~

The statement above can be misleading for applicants and is redundant with the content of AMC1 29.1465(f)(2)(i) *"For applications for credit, a minimum set of data from dedicated tests or directly applicable service experience is expected in addition, given that these applications are relied upon to ensure the airworthiness of the rotorcraft. For applications in support of compliance with an operational regulation, given the purpose of the system, the demonstration of performance may be completed without dedicated tests or directly applicable service experience. Further details are provided in paragraphs (g) and (h) respectively."*

response Partially accepted

This text has been moved and amended to ensure clarity as indicated by the comment.

comment *281* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465 (f)(2)(i)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation to the following paragraph:

"Given the nature and configurations of systems monitored by VHM and the complexity of the mechanical signals being monitored, it is typically not practical to fully validate the performance of the system for all components and associated failure modes by means of representative tests or in-service data."

The term "system" is used to address various kind of items and is confusing.
PROPOSED ACTION/TEXT
The text is proposed to be amended as follows:

*"Given the nature and configurations of parts or assembly systems monitored by VHM **system** ~~and the complexity of the mechanical signals being monitored~~, it is typically not practical to fully **verify** ~~validate~~ the performance of the **VHM** system for all **parts or assembly** ~~components~~ and associated ~~failure modes~~ **damage** by means of representative tests or in-service data.*

response Partially accepted

The purpose of the comment has been addressed, but the exact wording proposed is not kept.

comment *282* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465 (f)(2)(i)

Priority: Non Concur

RATIONALE / REASON / JUSTIFICATION
In relation to the following statement:

"In addition, the applicant should ensure that these assumptions are validated within the CSI phase (see paragraph (l) for more details)."

This statement contradicts SAE ARP4754A/EUROCAE ED-79A objective 4.2 which requires assumption validation.
Either the use of validation is not intentional with respect to SAE ARP4754A/ED-79A definition of validation and then as it is confusing, it should be modified.
Or the wording is intentional with respect to SAE ARP4754A/ED-79A definition of validation but this creates a deviation to CS 29.1309 compliance demonstration.
PROPOSED ACTION/TEXT
Assuming the use of validation is not intended, the text is proposed to be amended as follows:

*"In addition, **in case VHM systems provide supplementary information or support compliance with an operational regulation (i.e. Regulation (EU) No 965/2012), it is acceptable that** the applicant ~~should ensure~~ **confirm** that these assumptions are **correct** ~~validated~~ within the CSI phase (see paragraph (l) for more details).*

response

Partially accepted

As stated for other comments, these comments seem to indicate that applicants are confident of being able to validate and verify all assumptions at the time of the approval, considering all factors that may have an impact on the performance demonstration of applications for credit while relying only on limited testing. This is not feasible and, thus, a CSI is considered needed. In any case, applicants are welcome to propose a comprehensive performance demonstration methodology that does not require from any confirmation using data from service.

Nevertheless, the term 'validate' is removed to avoid misunderstanding with the SAE ARP 4754A/EUROCAE ED-79A process.

comment

283 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(f)(2)(i)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation to the following paragraph:

"[...] Considering this, the performance demonstration methodology should focus on providing evidence substantiating how:
(A) a degraded condition producing a repeatable and detectable vibratory response will systematically precede the failure;

(B) the processing of the signals acquired will generate appropriate indicators capable of indicating the presence of an abnormal condition, at an acceptable point prior to the failure.
[...]"

Amendments proposed for the sake of consistency with a previous comment.

PROPOSED ACTION/TEXT
It is proposed to amend the following paragraph to read:
"[...] Considering this, the performance demonstration methodology should focus on providing evidence substantiating how:
(A) ***an incipient damage or degradation*** ~~*degraded condition*~~ *producing a repeatable and detectable vibratory response will systematically precede the failure;*
(B) the processing of the signals acquired will generate appropriate indicators capable of indicating the presence of ***an incipient damage*** ~~*abnormal condition*~~*, at an acceptable point prior to the failure.*
[...]"

response

Partially accepted

Terminology has been established and included in the definitions within GM1 29.1465.

comment

284 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(g)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
"(g) VHM applications for credit"

THe way the title is written is a bit confusing as the application addresses the request of an application for a VHM system installation for which a credit is sought.
Not the VHM which provides an application itself.
PROPOSED ACTION/TEXT
Title is proposed to be amended as follows:

"(g) ~~*VHM*~~ *Application for* ***VHM system installation with airworthiness-related*** *credit* ***sought****"*

response

Partially accepted

The title has been clarified.

comment

285 comment by: *General Aviation Manufacturers Association (GAMA)*

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
"(1) Definition of the intended application

As an initial step, the applicant should clearly define the intended function of any VHM application for credit for which approval is sought."

The wording "VHM application" and "intended application" are ambiguous.
PROPOSED ACTION/TEXT
The text is proposed to be amended as follows:

"(1) Definition of the intended ***airworthiness-related credit sought*** ~~*application.*~~

As an initial step, the applicant should clearly define the intended ***airworthiness-related credit*** ~~*function*~~ ***provided by the*** ~~*of any*~~ *VHM system* ~~*application for credit*~~ *for which approval is sought."*

response | Partially accepted

The purpose of the comment has been addressed, but the exact wording proposed is not kept.

comment | *286* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(g)(1)(ii)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
"(ii) Failure modes to be prevented and associated severity."

The terminology is confusing as no VHM system will prevent by itself a failure but to the maximum extend will detect the incipient damage of the failure modes.
PROPOSED ACTION/TEXT
The text is proposed to be amended as follows:
"(ii) Failure modes ***of the related part/assembly that are monitored*** ~~*to be prevented*~~ *and associated severity."*

response | Accepted

comment | *287* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(g)(1)(iii)
Priority: Medium

RATIONALE / REASON / JUSTIFICATION
"(iii) Preceding degraded condition and associated mechanical response of the part/assembly that will be monitored to detect the incipient failure conditions identified as per (ii) directly above."

The wording "condition" here is confusing
PROPOSED ACTION/TEXT

The text is proposed to be amended as follows:
*"(iii) Preceding degraded **state** ~~condition~~ and associated mechanical response of the part/assembly that will be monitored to detect the incipient **damage** ~~failure conditions~~ identified as per (ii) directly above.*

response

Partially accepted

The wording proposed has not been incorporated. Nevertheless, terminology has been established and included in the definitions within GM1 29.1465.

comment

288 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(g)(1)(iv)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation to the following point (iv)

"(iv) Description of the credit sought, including the kind of credit (i.e. as described in (a)(3)(ii)) and its objectives. Objectives should be defined at initial approval, as well as at foreseen developments through the availability of service data."

The wording "objectives" is unclear. The second sentence and its purpose is not understood
PROPOSED ACTION/TEXT
The text is proposed to be amended as follows:
"(iv) Description of the credit sought, including the kind of credit (i.e. as described in (a)(3)(ii)). ~~and its objectives. Objectives should be defined at initial approval, as well as at foreseen developments through the availability of service data."~~

response

Accepted

comment

289 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(g)(1)(v) and AMC1 29.1465(g)(1)(vi)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation with the following points:

"(v) Description of the proposed monitoring approach including any mitigating actions.
(vi) Rationale for the proposed monitoring approach as an adequate means for the intended credit application and basis for the demonstration of performance."

It is not clear at this stage of the AMC what is concreatly expected in terms of evidences. The monitoring approach is consituent to the VHM system design, this is clearly a choice of design which is to be managed by applicant (TC holder).

Where is this description expected to be captured? in the certification programme? in the application form (as per 21.A.15)?
PROPOSED ACTION/TEXT
Those two points (AMC1 29.1465(g)(1)(v) and AMC1 29.1465(g)(1)(vi) are proposed to be removed as they seem redundant with paragraph (e).

~~"(v) Description of the proposed monitoring approach including any mitigating actions.~~
~~(vi) Rationale for the proposed monitoring approach as an adequate means for the intended credit application and basis for the demonstration of performance."~~

response

Not accepted

The purpose of these two bullets points has been clarified, and they are now presented as information that will be beneficial at this initial step rather than required.

comment

290 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(g)(2)(i)(A)(c)

Priority: Non Concur

RATIONALE / REASON / JUSTIFICATION
(1) requires a test in the "worst foreseeable scenario", with "conservative test conditions", what may be really severe, provided the "worst scenario" could be defined.

Management of (2) is not clear, and (3) finally proposes to simplify with additional conservatism/safety factors.
PROPOSED ACTION/TEXT
As a general comment concerning this section:

The demonstration of failure progression time should be considered in certification requirements dedicated to conventional maintenance substantiation. If this section was maintained, at least:

1) is likely to be difficult to define and the way it should be used is unclear-> To be removed
(2) It should be possible to evaluate the variability with other means than tests.

response

Accepted

From the comment and the discussion with the working group, it was evident that the point of this section was not clear. The section has been maintained but has been substantially reworked to ensure clarity.

comment

291 comment by: *General Aviation Manufacturers Association (GAMA)*

Priority: Non Concur

RATIONALE / REASON / JUSTIFICATION
With regard to the paragraph:

"At least one test should be performed attempting to represent the worst foreseeable scenario and simulate its progression. For this purpose, the applicant should ensure that conservative test conditions are defined. This minimum of one test may not be replaced by service data since it is generally not realistic to consider that the worst foreseeable scenario has been observed in service. "

The worst foreseeable scenario should be clarified. Does it consider only the severity of the failure condition effect ? The worst case scenario to be tested should be commensurate with the probability of such scenario. Any added value for testing a scenario having a probability of 10E-9 ?

GAMA does not concur with requirement to perform worst scenario testing. This is not clearly defined and not necessarily required to substantiate detection capability if intended to detect prior to seeing worst case. Confidence with detection of modes that lead to worst case is more critical and should be able to be demonstrated by field experience. Recommend statement be amended/deleted as it is inconsistent with remaining section on ability to use existing data for credit.

PROPOSED ACTION/TEXT
Suggested change:
"At least one test should be performed attempting to represent the worst foreseeable scenario **in terms of rate of failure progression, unless the applicant can provide adequate service data instead of the test**. ~~For this purpose, the applicant should ensure that conservative test conditions are defined. This minimum of one test may not be replaced by service data since it is generally not realistic to consider that the worst foreseeable scenario has been observed in service.~~

response

Partially accepted

It is considered that a minimum of one test is needed even if service data is available. This is now clarified and the basis for this request added. In any case, the whole section has been reworked to improve clarity.

comment

292 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465 (g)(2)(i)(A)(c)(2)

Priority: High

RATIONALE / REASON / JUSTIFICATION
With regard to the sentence:

"The parameters considered should include any operating, assembly, manufacturing, or environmental related aspect that may impact the rate and way in which the failure progresses."

How to address manufacturing dispersion? Safety margins about failures due to stress and fatigue should already cover such dispersion and the rate in which the failure progresses.

Note: this concern should be addressed by the next paragraph AMC1 29.1465 (g)(2)(i)(A)(c)(3)
PROPOSED ACTION/TEXT
This scattering is already accounted for by the required 3 opportunities for detection (page 26 PI >3*MIDR), isn't it ? If yes, **this sentence should be removed.**

response

Not accepted

VHM may monitor several kinds of failure modes and not only those associated with stress and fatigue. The minimum of three maximum intervals of data review (MIDR) within the prognostic interval is not a provision to cover for the impact of parameters that are known to have a significant impact on the failure progression. The impact from these parameters should be quantified and accounted for.

comment

293 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(g)(2)(i)(A)(c)(3)

Priority: High

RATIONALE / REASON / JUSTIFICATION
The demonstration that *"the safety factors applied are appropriately justified"* is optimistic, and it could take a long time to answer (since not consistent with the state-of-the-art) such a requirement which suffers from the absence of framework for CMR of "impending wear-out" type.

NOTE: when CMR-dedicated requirement will be defined, link with §1465 should be defined, and redundancy/conflict should be avoided.
PROPOSED ACTION/TEXT
Safety factors may be required, but their demonstration should not be explicitely requested (in other words: to be negociated on a case-by-case basis, depending on the available experience, the concerned technology and the targetted failure modes, ...).

GAMA/ASD would suggest to remove the sentence ~~*"the applicant should ensure that the safety factors applied are appropriately justified".*~~

response

Partially accepted

It is now clarified that safety factors only need to be justified when they are applied to cases of failure progression for which conservative testing conditions could not be applied.

comment

294 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(g)(2)(i)(B)(d)

Priority: Editorial

RATIONALE / REASON / JUSTIFICATION
Second sentence. Self-explanatory.
PROPOSED ACTION/TEXT
EASA to amend as follows:

*"They applicant may demonstrate that these do not significantly affect the probability of detection of the incipient **damage** ~~failure condition~~."*

response | Partially accepted

The wording proposed has not been incorporated. Nevertheless, terminology has been established and included in the definitions within GM1 29.1465.

comment | *295* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(g)(2)(i)(B)(e)(1)

Priority: High

RATIONALE / REASON / JUSTIFICATION
With respect to the following paragraph:

(1) The variability of the mechanical response and the resulting vibration signal acquired by the sensors should be evaluated by test. These tests should include preceding degraded conditions with a representative range of different characteristics that may affect the probability of detection.
PROPOSED ACTION/TEXT
Replace "Tests" by "Direct Evidence", as proposed:

*(1) The variability of the mechanical response and the resulting vibration signal acquired by the sensors should be evaluated by ~~tests~~ direct evidence. ~~These tests~~ **The direct evidence** should include preceding degraded conditions with a representative range of different characteristics that may affect the probability of detection.*

response | Partially accepted

This is now clearly described in AMC1 29.1465(g)(2)(iii), all direct evidence should, as a starting point, be considered as individual tests. However, when possible and justifiable, these may be replaced by data from in-service events. Additionally, the term 'test' has been removed from this context in favour of 'direct evidence data point'.

comment | *296* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(g)(2)(i)(B)(e)(3)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
"[...]. Since obtaining sufficient testing and/or service data representing the indicator dispersion for the degraded condition is generally not feasible, the applicant is expected to systematically consider safety factors."
PROPOSED ACTION/TEXT
Proposed text:

"[...]. Since obtaining sufficient testing and/or service data representing the indicator dispersion for the degraded condition is ~~generally~~ not **always** feasible, the applicant ~~is expected to systematically~~ **may alternatively** consider safety factors."

response

Partially accepted

This section has been substantially reworked. In any case, this comment has been taken into consideration.

comment

297 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(g)(2)(ii)(A)

Priority: Editorial

RATIONALE / REASON / JUSTIFICATION

typo: MDIR instead of MIDR.

response

Accepted

comment

298 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(g)(2)(ii)(B)

Priority: Non Concur

RATIONALE / REASON / JUSTIFICATION
The probability should be justified to be at least equivalent to 90 % with 95 % confidence. POD = 90% with 95% confidence is unrealistic with a number of tests limited to 5 to 7 max: A qualitative approach should be preferred.

The reference/statement to 'individual acquisiton' is too specific and speaks to implementation. Recommend striking that detail from the proposed statement. Overall document refers to opportunities of detection. Depending on implementation alert may be based on multiple acquisitions to reduce false alarm rate.

Furthermore, in relation to this paragraph: *"The probability of detection should be demonstrated by means of a statistical evaluation of the available data. SAE ARP5783 includes additional guidance regarding the statistical evaluation of VHM data."* . ARP5783 does not provide any guidance for statistical evaluation of performance with a limited dataset, therefore its application is questionable.

PROPOSED ACTION/TEXT

It is proposed to amend the text in AMC1 29.1465(g)(2)(ii)(B) as follows:

"[...]

The applicant should evaluate the probability of the computed indicator(s) ~~from an individual acquisition~~ from any ~~applicable preceding degraded condition~~ ***incipient failure*** *triggering the defined alerting criteria. This probability should be justified to be at least equivalent to 90 % ~~with 95 % confidence.~~ For this purpose, it should be ensured that the degraded condition will be detected at a certain stage within the failure progression, and continuously after this point, with no decrease of this probability."*

The level of confidence is considered acceptable by justifying this probability on a minimum number of direct evidences depending on the application. The required number of direct evidences for a given application is detailed further in Table 3.

~~The probability of detection should be demonstrated by means of a statistical evaluation of the available data. SAE ARP5783 includes additional guidance regarding the statistical evaluation of VHM data.~~"

[...]"

response Partially accepted

This point has been rediscussed with the group and the proposal has been amended to a more qualitative assessment.

comment *299* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(g)(2)(iii)(B)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
(B) tries to provide a definition of "complex" application.
(B)(b)(3) introduces the notion of complexity of architecture/sensors/advanced processing techniques.
ARP4754A fully relevant to cover architecture/sensors/advanced processing techniques already provides a definition of complexity.
Despite not necessarily conflicting, this notion is different from the notion developed in the (B)
This may be confusing.
PROPOSED ACTION/TEXT
Use another term than "complexity" to avoid mismatch with ARP4754A/ED79A.

Remove the notion of architecture/sensors/advanced processing techniques to keep the focus on the function itself.

Maybe "repeatability" notion is more adequate or "predictability" instead of complexity which goes beyond the definition of ED-79A.

response

Not accepted

Repeatability and predictability do not cover the intended scope of complexity. Even if the word is defined elsewhere for a particular purpose, there is no reason why it should not be used within this AMC. In addition, it is already highlighted with inverted commas, to indicate that a particular meaning is given to the word in this context.

comment

300 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(g)(2)(iii)

Priority: High

RATIONALE / REASON / JUSTIFICATION
Sentence :
"In order to determine the performance demonstration 'class' of a VHM application from the point of view of its failure progression characteristics and its fault detection probability, the following aspects should be taken into consideration:..."

The VHM application should not have failure progression characteristics. There is no specific "application", we should refer to the VHM system.
PROPOSED ACTION/TEXT

Propose to amend as follows:

"In order to determine the performance demonstration 'class' of a VHM **system with an airworthiness-related credit sought** ~~application~~ from the point of view of **the** failure progression characteristics **it monitors** and its fault detection probability, the following aspects should be taken into consideration:..."

response

Partially accepted

This paragraph has been modified. In any case, the performance demonstration is to be determined for each specific application of the VHM system, and not for the complete system as proposed by the changes suggested.

comment

301 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(g)(2)(iii)(B)(a)

Priority: High

RATIONALE / REASON / JUSTIFICATION

The rationale requires many tests to objectivate the number of required tests. Safety factors are mentioned in (ii), while nb of tests are mentionned here in (iii). The overall consistency is not clear.
PROPOSED ACTION/TEXT
Please clarify the influence of safety factors vs the minimum number of tests requested.

response

Not accepted

Conservative measures should be applied during the demonstration of performance regardless of the number of tests. It is clear that the more tests are done, the less conservatism will need to be added, but this may not be generically defined in AMC. The minimum number of tests is considered independent of the safety factors used. Obviously, for cases where the safety factors are not considered sufficient, the minimum number of tests described will not be applicable. Unfortunately, this may only be assessed on a case-by-case basis.

comment

302 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(g)(2)(iii)(B)(a)

Priority: High

RATIONALE / REASON / JUSTIFICATION
A scenario involving an already approved prognostic interval (e.g. from a former compliance demonstration wrt. other CS requirements) is not anticipated.
PROPOSED ACTION/TEXT
It should be possible to claim the relevance of an already approved prognostic interval (e.g. from a former compliance demonstration wrt. other CS requirements)

response

Accepted

The AMC focuses on the complete demonstration of compliance. Nevertheless, this has been taken into consideration and AMC1 29.1465(g)(2)(iii) now states that aspects already demonstrated may be read across for the VHM performance demonstration. In addition, additional text has been added in the Note in AMC1 29.1465(g)(2)(v) to address the potential for less testing when addressing the failure progression characteristics.

comment

303 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(g)(2)(iii)(B)(b)(1)

Priority: High

RATIONALE / REASON / JUSTIFICATION
In relation with the following paragraph:

"(b) 'Complexity' from a fault detection point of view In order to justify a VHM application for credit as 'non-complex', the applicant should ensure that the computed indicator values well represent the condition of the component(s) monitored, and the mechanical response targeted is well understood and covered by the monitoring approach taking into account every significant source of variability. ***In addition, it should be clearly established that the computed indicator(s) for the degraded condition result in clearly differentiated distributions from those obtained for normal behaviour with limited dispersion.***
(1) demonstrate that the computed values for the indicator(s) used in the monitoring approach are clearly and effectively representing normal behaviour and degraded condition accordingly;"

This paragraph does not express criteria for "non-complex" applications but only minimum requirements for any application for credit. Criteria for non-complex application should be limited to:
"In addition, it should be clearly established that the computed indicator(s) for the degraded condition result in clearly differentiated distributions from those obtained for normal behaviour with limited dispersion. For these purposes, the applicant should:
(2) quantify any significant source of variability impacting the fault detection probability. [...]
(3) evaluate the aspects of the monitoring approach adding complexity to the VHM application. [...]

Therefore it is proposed to remove the paragraph AMC1 29.1465(g)(2)(iii)(B)(b)(1).
PROPOSED ACTION/TEXT
It is proposed to remove AMC1 29.1465(g)(2)(iii)(B)(b)(1).

Alternatively, it is proposed to be reworded as follows:
"(b) 'Complexity' from a fault detection point of view In order to justify a VHM application for credit as 'non-complex', the applicant should ensure that the computed indicator values well represent the condition of the component(s) monitored, and the mechanical response targeted is well understood and covered by the monitoring approach taking into account every significant source of variability. ~~In addition, it should be clearly established that the computed indicator(s) for the degraded condition result in clearly differentiated distributions from those obtained for normal behaviour with limited dispersion.~~
~~(1) demonstrate that the computed values for the indicator(s) used in the monitoring approach are clearly and effectively representing normal behaviour and degraded condition accordingly; In addition, typically,~~ ***it should be clearly established that the computed indicator(s) for the degraded condition result in clearly differentiated distributions from those obtained for normal behaviour with limited dispersion;"***

response

Partially accepted

The purpose of the comment has been addressed. However, the wording proposed has not been kept.

comment

304 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(g)(2)(iii)(B)(b)(2)

Priority: High

RATIONALE / REASON / JUSTIFICATION
In relation with the following paragraph:

"(2) quantify any significant source of variability impacting the fault detection probability. More than two significant sources of variability should lead to considering this application as 'complex'. The sources of variability should be evaluated by applicable tests and/or service experience;"

Such approach is very prescriptive, the amount of sources of variability is not always synonyms to "complexity", to the maximum extend it can have an impact on the predictability but not on the complexity.

Amount of sources of variability is not a criteria for complexity and therefore should be removed.
PROPOSED ACTION/TEXT
AMC1 29.1465(g)(2)(iii)(B)(b)(2) is proposed to be removed.

Alternatively, it is proposed to amend the text as follows:
"(2) quantify any significant source of variability impacting the fault detection probability. ***An application can be considered as non-complex when significant sources of variability have been characterized and accounted for in the probability of detection demonstration.***

~~*More than two significant sources of variability should lead to considering this application as 'complex'. The sources of variability should be evaluated by applicable tests and/or service experience;"*~~

response

Partially accepted

The purpose of the comment has been addressed in the updated text. However, the wording proposed has not been kept.

comment

305 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(g)(2)(iii)(B)(b)(3)

Priority: High

RATIONALE / REASON / JUSTIFICATION
In relation to the following paragraph (3):

"(3) evaluate the aspects of the monitoring approach adding complexity to the VHM application. These aspects include but are not limited to:
— complex system architectures and/or sensors,
— advanced processing techniques,
— requiring to monitor a number of mechanical responses with different characteristics, and
— absence of a clear increase of the probability of detection as the failure progresses."

These criteria should be expressed in order to define non-complex aspects rather than complex aspects.
PROPOSED ACTION/TEXT
This statement should capture the maturity of the system as opposed to just the complexity. Therefore, It is proposed to amend the text as follows:

"(3) evaluate the aspects of the monitoring approach ~~adding~~ related to its complexity. ~~to the VHM application~~. T~~hese aspects include but are not limited to:~~
~~— complex system architectures and/or sensors,~~
~~— advanced processing techniques,~~
~~— requiring to monitor a number of mechanical responses with different characteristics, and~~
~~— absence of a clear increase of the probability of detection as the failure progresses.~~

A non-complex monitoring approach should include, but would not be limited to, the following aspects:

— Simple or industry proven system architecture and/or sensors,

— Basic or industry proven processing techniques

— clear increase of the probability of detection as the failure progresses."

response

Partially accepted

The purpose of the comment has been addressed in the updated text. However, the wording proposed has not been kept.

comment

306 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(g)(2)(iii)(C)

Priority: High

RATIONALE / REASON / JUSTIFICATION
In relation to the following statement:

"(C) The applicant should also establish the 'category' of the VHM application, which defines whether 'standard' or 'enhanced' performance objectives are achieved."

What is the benefit to claim for "enhanced VHM" category?
It is quite difficult to understand the point of both complexity and category whereas if the outcome (table 2 and Table 3 were given before the introduction of this notions, it will be easier to follow.

Also, the statement in paragraph (D) could be placed before (iii)(A)/(B)/(C)/(D) :

"Based on these criteria, the performance demonstration 'class' of a VHM application can be identified as follows: [...] Table 3: Minimum number of test points required for the demonstration of VHM applications for credit according to their 'class'

classification. [Reminder: Applicable for both failure mode characteristics and probability of detection independently (including table 3)"
PROPOSED ACTION/TEXT
It is proposed to re-arrange paragraph AMC1 29.1465(g)(2)(ii) so that the tables 2 and 3 of (D) either either before sub-paragraphs (A)/(B)/(C)/(D) to favour a good level of interpretation and conceptual integration of the proposed section (iii). Another introductory verbiage or text layout (i.e flow chart, schematic, etc.) would help the reader understand the concepts better.

response

Accepted

A schematic of the process described has been added.

comment

307 comment by: *General Aviation Manufacturers Association (GAMA)*

Attachment #41

AMC1 29.1465 (g)(2)(iii)(D)
Table 3

Priority: Non Concur

RATIONALE / REASON / JUSTIFICATION
Table 3: Minimum number of test points required for the demonstration of VHM applications for credit according to their 'class' classification. Reminder: Applicable for both failure mode characteristics and probability of detection independently

The required tests number may result in a huge financial and time effort for the industry, especially on the failure progression. It should be weighted by the demonstrated margin through variable safety factors applicable to the prognostic interval (similarly with the safety factors already used wrt §571/573). On top, too severe requirements may jeopardize the number of VHM applications and may not foster the achievement of NPA objectives (§2.2).

In addition, it should be possible to claim the relevance of an already approved prognostic interval (e.g. from a former compliance demonstration wrt. other CS requirements).

PROPOSED ACTION/TEXT

The minimum number of test points might be relevant for detection performance tests but is considered high for failure progression tests: The confidence in conservatism means (e.g. safety factors) is likely to be higher for failure progression tests than to detectability tests.

For failure progression: Rules to be applied should be the same than CS 29.571/CMR

For detectability tests: Table should range from 1 to 5 tests instead from 2 to 7

The following rewording/additions are proposed:

I*n accordance with the identified performance validation 'class' of the VHM application for each of the performance demonstration aspects, the applicant should provide a minimum of the following number of test points:*

Table 3: Minimum number of test points required for the demonstration of ***the probability of*** *detection of VHM applications for credit according to their 'class' classification.* ~~*Reminder: Applicable for both failure mode characteristics and probability of detection independently*~~

Failure severity of monitored component	***Minimum number of test points according to VHM application 'Class'***		
	Class 1	*Class 2*	*Class 3*
Catastrophic	~~*7*~~ ***5***	~~*5*~~ ***4***	*4* ***3***
Hazardous	~~*5*~~ ***4***	*4* ***3***	~~*3*~~ ***2***
Major	*4* ***3***	~~*3*~~ ***2***	~~*2*~~ ***1***

Note 1: Methods and means that are acceptable for compliance demonstration with CS 29.571/573 requirements can be used to determine failure progression characteristics, therefore no minimum number of test points are defined. Should applicant not consider those conventional methods and means, then the Table 3 should also be considered for the purpose of determining failure progression characteristics.

Note 2: It is reminded that failure progression characteristics and probability of detection aspects can also be assessed by relying on actual service experience (refer to section (g)(2)(iii)).

(iv) Considerations for use of the minimum direct evidence requirements from Table 3:

[...]"

Please see the attached file for better contextual understanding of this comment.

response

Partially accepted

The number of tests is considered already very low, so the comment is not considered justified. In addition, this is an AMC, so any alternative proposal that is properly justified could also be applied.

The purpose of the changes proposed in Notes 1 and 2 has been addressed although the suggested text has not been kept.

comment

308 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465 (g)(2)(iv)(A)

Priority: Non Concur

RATIONALE / REASON / JUSTIFICATION
With respect to the following paragraph:

"(A) The minimum numbers of test points specified in Table 3 have been conceived considering certain assumptions: [...] The minimum number of test points specified in Table 3 is provided on the assumption that the VHM application does not involve novel VHM system characteristics or processing techniques for which no experience is available."

This sub-paragraph does not provide any objective to be demonstrated but rather rationale on the table 3, therefore, it should be removed from the AMC1 and to the maximum extend placed into GM1.
PROPOSED ACTION/TEXT
The paragraph AMC1 29.1465 (g)(2)(iv)(A) is proposed to be removed or placed in GM1.

response Accepted

This has been moved to GM.

comment *309* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465 (g)(2)(iv)(A)(b)

Priority: Non Concur

RATIONALE / REASON / JUSTIFICATION
"(b) The monitored vibration signal generated and the resulting indicator values indicate an increase of the degraded conditions as the failure progresses, providing continuously improved detection capabilities"

Not consistend with previous requirement AMC1 29.1465 (g)(B)(c) p25: "the probability of fault detection does not reduce..." does not means that the indicator value has to increase.
PROPOSED ACTION/TEXT
It is proposed to amend the text as follows:

*"**(b) probability of fault detection does not reduce from the point the condition first becomes clearly detectable until ultimate failure.** ~~The monitored vibration signal generated and the resulting indicator values indicate an increase of the degraded conditions as the failure progresses, providing continuously improved detection capabilities"~~*

response Not accepted

These two paragraphs do not address the same issue. The point proposed to be reworded clarifies the assumptions that support the use of the proposed limited number of tests. The reason for mentioning that the likelihood of detection increases as the failure progresses is that this is a mitigation in case there is some level of error

in the calculations. In such case, this will not have a great impact since the likelihood of detection increases continuously. However, when this is not the case, any error may result in some cases experienced not being not detectable at all, which has a much higher impact on safety, so using very limited testing is not considered justified.

comment *310* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(h)

Priority: High

RATIONALE / REASON / JUSTIFICATION
"This paragraph provides specific Acceptable Means of Compliance for VHM systems used for supplementary information purposes that are relied upon to support compliance with an operational regulation."

It should clarified in consistency with the rest of the paragraph that Regulation No 965/2012 is meant here.
PROPOSED ACTION/TEXT
The text is proposed to be amended as follows:
"This paragraph provides specific Acceptable Means of Compliance for VHM systems used for supplementary information purposes that are relied upon to support compliance with an operational regulation ***(i.e. Regulation (EU) No 965/2012).****"*

response Partially accepted

This point has been addressed as per the responses in previous comments. However, the wording proposed has not been incorporated.

comment *311* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(h)(1)

Priority: High

RATIONALE / REASON / JUSTIFICATION
In relation to the following statement:

"In order to substantiate that the VHM system provides the aforementioned additional safety, the applicant should demonstrate that the scope of components being monitored is in line with that defined in the operational regulation that the system is intended to support compliance with."

It should be clarified that compliance demonstration intended here clearly matches the Regulation (EU) 965/2012 SPA.HOFO.155 as in the AMC1 SPA.HOFO.155 clear relationship between CS 29.1465 requirement is made.

Nevertheless, it is barely acceptable to consider any operational regulation from foreign countries than Europe sky that might require different objectives than the

ones covered by CS 29.1465 and related AMC1 29.1465, therefore, it is requested to remove this sentence which can be misleading.
PROPOSED ACTION/TEXT
The text is proposed to be amended as follows:

"In order to substantiate that the VHM system provides the aforementioned additional safety, the applicant should demonstrate that the scope of components being monitored is in line with that defined in ~~the operational regulation~~ ***Regulation (EU) No 965/2012*** *~~that the system is intended to support compliance with.~~ "*

response | Partially accepted

This point has been addressed as per the responses in previous comments. However, the wording proposed has not been incorporated.

comment | *312* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(h)(1)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
"*[...]*
For point SPA.HOFO.155 from Commission Regulation (EU) 2016/1199, the scope is defined as 'critical rotor and rotor drive systems' and further clarified in associated AMC as 'rotating critical components'. [...]"

Regulation's references evolve in time. Rather than citing the amending regulation (Reg. (EU) 2016/1199), it would be more appropiate to cite the amended regulation (Reg. (EU) 965/2012) as whilst the requirements may change through amending regulations, the regulation to be amended is more likely to stay the same.
PROPOSED ACTION/TEXT
It is proposed to amend the sentence to read:

"For point SPA.HOFO.155 from Commission Regulation ~~(EU) 2016/1199~~ ***No 965/2012****, the scope is defined as 'critical rotor and rotor drive systems' and further clarified in associated AMC as 'rotating critical components'."*

response | Accepted

comment | *313* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(h)(1)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation to the following statement:

"[...]. This should be understood as parts of the rotors and rotor drive systems, the failure of which could prevent continued safe flight or safe landing, or parts with catastrophic and/or hazardous failure conditions."

For the sake of clarity, the sentence deserves an amendment.
PROPOSED ACTION/TEXT
It is proposed to amend this sentence to read:

"[...]. This should be understood as parts of the rotors and rotor drive systems, the failure of which could prevent continued safe flight or safe landing, or parts with catastrophic and/or hazardous failure ***consequences.*** *~~conditions~~."*

response | Accepted

comment | *314* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(h)(1)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation to the following statement:

"or maintenance tasks which are demonstrated to adequately identify the presence of incipient failure conditions of these components."

the wording failure conditions is not adequate, it is proposed to replace it by "damage".
PROPOSED ACTION/TEXT
It is proposed to amend the text as follows:

"or maintenance tasks which are demonstrated to adequately identify the presence of incipient ***damage*** *~~failure conditions~~ of these components.*

response | Partially accepted

Terminology has been established and included in the definitions within GM1 29.1465.

comment | *315* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(h)(2)

Priority: High

RATIONALE / REASON / JUSTIFICATION
"An adequate performance should be demonstrated following the approach described in paragraph (f). In addition, the applicant should take into account the following considerations:"

Paragraph (f) of AMC1 29.1465 is requiring very detailed approach to understand failure progression/damage initiation. Even if it is clearly understood that VHM system to support compliance with operational regulation (typicially Regulation (EU) No 965/2012) shall provide safety benefit, it appears too demanding with respect to applications for airworthiness-related purposes.

Where the approach provided in paragraph (f) makes meaning, the objectives defined in paragraph (f) seem not applicable to the support of operational regulation (EU) NO 965/2012 context. Therefore it is requested to mitigate the reference to paragraph (f) to a commensurate approach only.
PROPOSED ACTION/TEXT
The text is proposed to be amended as follows:

"An adequate performance should be demonstrated following the approach described in paragraph (f) ***commensurate to the operational regulation needs (i.e. Regulation (EU) No 965/2012).*** ~~*In addition*~~***Typically****, the applicant should take into account the following considerations:"*

response Partially accepted

The comment has been taken into consideration and the text amended accordingly.

comment *316* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(h)(2)(i)

Priority: Low

RATIONALE / REASON / JUSTIFICATION
In relation to the following statement:

"Therefore, in support of the definition of alerting criteria for VHM applications for compliance with an operational regulation, the applicant should consider the following:"

Clarification of the intended operational regulation needed
PROPOSED ACTION/TEXT
Text proposed to be amended as follows:

"Therefore, in support of the definition of alerting criteria for VHM applications for compliance with an operational regulation ***(i.e. Regulation (EU) No 965/2012)****, the applicant should consider the following:"*

response Partially accepted

This point has been addressed as per the responses in previous comments. However, the wording proposed has not been incorporated.

comment *317* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(h)(2)(iii)(D)(Note)

Priority: High

RATIONALE / REASON / JUSTIFICATION
"Note: When showing compliance with CS 29.1465(b)(2), the applicant may choose to use Table 1 of GM1 29.1465 for reference. However, it is not always necessary for the VHM system to cover the complete capability defined in this table. Nevertheless, absence of any of these areas, and/or techniques, should be justified. If alternative methods are proposed, which can be shown to be effective and reliable and which are to the satisfaction of the Agency, then these can also be accepted."

The first sentence is sufficient. The other sentences seem to make mandatory the justification of the use or non-use of GM1 29.1465 Table 1 which is not understood, as it is guidance material by definition.

PROPOSED ACTION/TEXT
The text is proposed to be amended as follows:

"Note: When showing compliance with CS 29.1465(b)(2), the applicant may choose to use Table 1 of GM1 29.1465 for reference. However, it is not always necessary for the VHM system to cover the complete capability defined in this table. ~~Nevertheless, absence of any of these areas, and/or techniques, should be justified.~~ If alternative methods are proposed, which can be shown to be effective and reliable and which are to the satisfaction of the Agency, then these can also be accepted."

response | Accepted

comment | *318* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC 29.1465 (i)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
The use of the term "application" in the first sentence of the first paragraph is introducing ambiguity with other uses in the current AMC. It is proposed to change it as indicated.
PROPOSED ACTION/TEXT
To modify the sentence as follows:

*"The ground-based system may include COTS hardware and software that is **part** ~~as part~~ of the platform on which **applicative** software ~~application~~ is running."*

response | Partially accepted

The ambiguity has been addressed by defining 'application software'.

comment | *319* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(i)

Priority: High

RATIONALE / REASON / JUSTIFICATION
The ground/off-board system will be used, in some cases, as the source of data to determine the airworthiness status of the aircraft (before each flight). Therefore, it would be appropriate to explicitly indicate how it will have to be considered by the end users: e.g. is it a special tool (ref. CS-29 Appendix A, point A29.3(g), which appropriately connects with point 145.A.40(a)(i))?

It is worth noting that the notion of special tools has established so far a connection between CS-29 and Part-145. But, when the ground/off-board system is used to determine the airworthiness status of the aircraft (before each flight), CAMO will be the first and foremost user. Nothing comparable with point 145.A.40(a)(i) exists in Part-M/Part-CAMO.

PROPOSED ACTION/TEXT

This paragraph provides the aim "to ensure the end-to-end system integrity and safety". This paragraph should be checked against the exisiting regulatory requirements (end-to-end) for compatibility and for any need to adapt and/or complement these other regulatory requirements: a VHM system may be adequately certified under Regulation (EU) No 748/2012, but not compatible with the environment ruled by Regulation (EU) No 1321/2014 for example.

Nothing currently requires that where the manufacturer specifies a particular tool or equipment, the organisation responsible for the aircraft continuing airworthiness (CAMO) must use that tool or equipment, unless the use of alternative tooling or equipment is agreed by the competent authority (which frequently is not the Agency). The statement "[a]ny ground-based system architecture requirements should be specified as part of the ICA for VHM system, including man-machine interfaces" may appear sufficient to address the issue, but it does not: organisations in the Continuing Airworthiness domain are authorised and used to deviate from certain ICA (e.g. refer to point M.A.302(d) & (e) or point 145.A.45(d)).

In other words, a CAMO regulated under Regulation (EU) No 1321/2014 may intentionally or unintentionally use non-qualified hardware and software platforms because no or poor consideration will be given to CS-29 in the Continuing Airworthiness environment.

response

Noted

It is understood that the comment does not address AMC1/GM1 29.1465. Instead, it is considered to point at the need to ensure that the VHM system ground-segment architecture requirements defined by the applicant within the ICA are followed at continuing airworthiness level. This remark will be shared internally to consider the need of any changes within the CAMO regulation or the associated documentation.

comment	*320* comment by: *General Aviation Manufacturers Association (GAMA)* AMC1 29.1465(i) & AMC1 29.1465(j) **Priority:** High **RATIONALE / REASON / JUSTIFICATION** In relation to the following statement: *"the use of non-qualified hardware and software platforms should be limited in order to ensure the end-to-end system integrity and safety."* It is difficult to understand what will be allowed and what will be the associated conditions. Either ground systems are developed following airbone rules, or COTS are used (laptops, Operating Systems, etc) and conventional airbone rules cannot apply. Despite a very high level of confidence can be granted through for example mitigations introduced in the ground VHM function supported by COTS, no acceptance criteria is given **PROPOSED ACTION/TEXT** Provide some guidance for acceptance of COTS beyond the software verification activities described in section (j).
response	Not accepted This is clearly stated in the text: 'non-qualified platforms should not be solely relied upon for the processing of VHM data and/or determining the need to provide indications regarding the condition of the components monitored. Alternatively, for VHM systems with non-qualified platforms that are solely relied upon for VHM applications for which qualitative safety objectives higher than DAL C have been identified in accordance with paragraph (d) of this AMC, adequate independent verification means should be implemented to ensure the end-to-end system integrity and safety.' This text has been reviewed internally. It has been concluded that EASA is not in a position to provide more detailed guidance on this subject.

comment	*321* comment by: *General Aviation Manufacturers Association (GAMA)* AMC1 29.1465 (i) **Priority:** Non Concur **RATIONALE / REASON / JUSTIFICATION** In relation to the following paragraph: *"However, for VHM system applications for which a failure severity greater than major has been identified in accordance with paragraph (d) of this AMC, the use of non-qualified hardware and software platforms should be limited in order to ensure the end-to-end system integrity and safety."*

EASA have already approved approaches like electronic Flight Manual which failure severities can be up to Major without "qualification" of the COTS HW and SW platforms. It is not understood why in one hand it is acceptable to display emergency procedures or performances computation in flight on a non-qualitifed platform and on the other hand displaying on ground the state of a monitored part or assemble which failure severity is major or hazardous would need a qualified platform.

Besides, no distinction is made between VHM systems which claim credit and VHM systems which only provide supplementary information.
Last hint, there is also no distingtion made regarding Ground segment which are only there to display values computed within rotorcraft and Ground segment which are used to compute and display indicators.

PROPOSED ACTION/TEXT

The text below is proposed to be deleted:

~~"However, for VHM system applications for which a failure severity greater than major has been identified in accordance with paragraph (d) of this AMC, the use of non-qualified hardware and software platforms should be limited in order to ensure the end-to-end system integrity and safety. Therefore, for such applications, non-qualified platforms should not be solely relied upon for the processing of VHM data and/or determining the need to provide indications regarding the condition of the components monitored"~~

Alternatively, the text is proposed to be amended as follows:

"However, for VHM system applications for which a failure ~~severity~~ ***condition classification*** *greater than major has been identified in accordance with paragraph (d)* ***table 1*** *of this AMC, the use of non-qualified hardware and software platforms should be limited in order to ensure the end-to-end system integrity and safety.*

Therefore, for such applications, non-qualified platforms should not be solely relied upon for the processing of VHM data and/or determining the need to provide indications regarding the condition of the components monitored ***without incorporation of sufficient additional validity checks in the process to ensure the end-to-end system integrity and safety."***

response

Partially accepted

The text has been reworded considering this comment. However, the exact wording proposed has not been incorporated.

comment

322 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(j)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation to the following text:

"All software that makes up the VHM processing, whether airborne or ground-based, is to be produced to the software quality standard required to achieve the necessary level of system integrity. All COTS software should be identified and should be of a quality standard that does not compromise the overall system's integrity."

It is recommended to eliminate any ambiguity.
PROPOSED ACTION/TEXT
It is proposed to amend these sentences to read:

"All software that makes up the VHM processing, whether airborne or ground/off board-based, is to be produced to the software quality standard required to achieve the ~~necessary level of system integrity~~ ***safety objectives of the VHM system safety assessment.***

All COTS software should be identified and should be of a quality standard that does not compromise the overall ***VHM*** *system's integrity.*

VHM software development level needs to be compatible with the VHM system safety assessment. *For the ground/****off board****-based systems, which are not certified as part of the airborne functions of the VHMS unlike the embedded software, a verification process might however be necessary if the system is COTS-based."*

response

Partially accepted

The last paragraph proposed to be amended by this comment has been deleted in accordance with comment No 323.

comment

323 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465 (j)

Priority: High

RATIONALE / REASON / JUSTIFICATION
In relation with the following text:

"VHM software development level needs to be compatible with the VHM system safety assessment. For the ground-based systems, which are not certified as part of the airborne functions of the VHMS unlike the embedded software, a verification process might however be necessary if the system is COTS-based."

This paragraph seems to be redundant with respect to the senteneces just above as well as paragraphs (j)(2)(i) & (ii) and is proposed to be removed.
PROPOSED ACTION/TEXT
It is proposed to delete the text as follows:

~~"VHM software development level needs to be compatible with the VHM system safety assessment. For the ground-based systems, which are not certified as part of~~

~~the airborne functions of the VHMS unlike the embedded software, a verification process might however be necessary if the system is COTS-based."~~

response: Accepted

comment: *324* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(j)(1)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation with the following text:

"The development assurance level (DAL) objectives should be achieved to a level commensurate with the failure effects identified in the safety assessment. For this purpose, the considerations described in paragraph (d) of this AMC should be taken into account."

For the sake of precision, it is proposed to clarify that what is meant is the severity of failure conditions, not failure effects.
PROPOSED ACTION/TEXT
It is proposed to amend the text to read:

*"The development assurance level (DAL) objectives should be achieved to a level commensurate with the **severity of** failure **conditions** ~~effects~~ identified in the safety assessment. For this purpose, the considerations described in paragraph (d) of this AMC should be taken into account."*

response: Partially accepted

Paragraphs (i) and (j) have been merged. As part of this, this section has been deleted.

comment: *325* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(j)(1)

Priority: High

RATIONALE / REASON / JUSTIFICATION
In relation to the following sentence:

"As a reference, EUROCAE ED-12C/RTCA DO-178C or later issue should be considered in accordance with AMC 20-115()."

This paragraph is redundant with first of AMC1 29.1465(j)(1) as DO-178()/ED-12() and AMC 20-115() are acceptable means of compliance for 29.1309.
PROPOSED ACTION/TEXT
It is proposed to delete the text as follows:

	~~*"As a reference, EUROCAE ED-12C/RTCA DO-178C or later issue should be considered in accordance with AMC 20-115()."*~~
response	Accepted

comment	*326* comment by: *General Aviation Manufacturers Association (GAMA)* AMC1 29.1465(j)(2) **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** The term 'operator' is misleading as it has different meanings. It is recommended to refer to the organisations responsible for the aircraft continuing airworthiness, or CAMO. **PROPOSED ACTION/TEXT** It is proposed to amend the sentence to read: *"Therefore, the specifications of the host platform configuration characteristics and their authorised range for which the applicant guarantees the VHM performance and integrity should be provided through ICA or necessary set of tests procedures allowing ~~operators~~* ***organisations responsible for the aircraft continuing airworthiness*** *to check VHM ground/off board-based software compatibility with their host platforms should be provided through ICA, in case configurations characteristics cannot be easily identified."* In addition, a new requirement in Part-M and/or Part-CAMO is probably necessary to ensure this new kind of ICA will be taken into account (it is not a maintenance action, but something about tools used by CAMO. Reference to what is done with the aircraft technical log system in point M.A.306(b) and its AMC can help drafting this requirement).
response	Partially accepted The rewording proposal is not incorporated but the meaning of 'operator' in this AMC is now defined in GM. In addition, the point raised regarding Part-M/Part-CAMO rulemaking has been forwarded to the relevant Agency department.

comment	*327* comment by: *General Aviation Manufacturers Association (GAMA)* AMC1 29.1465(j)(2)(ii) **Priority:** High **RATIONALE / REASON / JUSTIFICATION** With regard to the term "operator" in the title: *"verification at VHM end-user level (operator)"*

The title could be misinterpreted as referring the Operator as the applicant in this paragraph
PROPOSED ACTION/TEXT
It is suggested to change the title as follows :

*"verification of the VHM **applicative software used by the** end-user ~~level~~ (operator)"*

response

Not accepted

The proposed change is not considered needed since the title is clear and there is no room for misinterpretation as the text below describes the purpose and scope of the verification. In addition, the alternative title proposed could be understood as limiting the scope of the verification.

comment

328 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(j)(2)(ii)

Priority: High

RATIONALE / REASON / JUSTIFICATION
"AMC1 29.1465(j)(2)(ii)
The applicant should define and implement a software development assurance process for the ground-based software of VHM application. It should include in particular extensive verification/testing (meaning that all possible functionalities of the ground segment of the VHM application are covered by the verification activities; tests are expected for these verifications) of the ground-based VHM functionality, including robustness test cases, in a repeatable and standardised manner and for the worst-case authorised platform configurations when identified. This could be achieved by means of development assurance processes (e.g. RTCA DO 178()/EUROCAE ED 12(), RTCA DO-330/EUROCAE ED-215, RTCA DO-278()/EUROCAE ED-109(), etc.) or other appropriate means to be proposed by the applicant."

This paragraph should be located below AMC1 29.1465(j)(2)(i) and not below AMC1 29.1465(j)(2)(ii)

PROPOSED ACTION/TEXT
It is proposed to change the position of the text as follws:

*"AMC1 29.1465(j)(2)**(i)***
The applicant should define and implement a software development assurance process for the ground-based software of VHM application. It should include in particular extensive verification/testing (meaning that all possible functionalities of the ground segment of the VHM application are covered by the verification activities; tests are expected for these verifications) of the ground-based VHM functionality, including robustness test cases, in a repeatable and standardised manner and for the worst-case authorised platform configurations when identified. This could be achieved by means of development assurance processes (e.g. RTCA DO 178()/EUROCAE ED 12(), RTCA DO-330/EUROCAE ED-215, RTCA DO-278()/EUROCAE ED-109(), etc.) or other appropriate means to be proposed by the applicant."

response | Partially accepted

This section is now directly under (i)(2).

comment | *329* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(j)(2)(ii)

Priority: High

RATIONALE / REASON / JUSTIFICATION
In relation to the following text:

"As part of the ICA, an installation procedure of the ground-based software should be developed by the applicant to be provided to end users, to verify the correct behaviour of software on the end-user ground-based platform configuration(s). It is intended to be also used to ensure the compatibility and the correct behaviour in case new platforms (e.g. new OS, new processors, etc.) or new software application versions are released.

The end-to-end system integrity of the VHM information (including possible conversion means) should be ensured, e.g. by means of CRC protection of the data files or any other adequate means."

Those two paragraphs should be aligned with the rest of the text and not considered as constituting the AMC1 29.1465(j)(2)(ii). Please ensure indentation is aligned with the paragraphs above ('As part of the ICA, an installation procedure [...] protection of the data files or any other adequate means.")
PROPOSED ACTION/TEXT
Please ensure indentation is aligned with the paragraphs above *('As part of the ICA, an installation procedure [...] protection of the data files or any other adequate means.")*

response | Accepted

comment | *330* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465 (j)(2)(ii)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
With regard to the sentence : *"the worst-case authorised platform configurations when identified."*

This requirement is solution-prescriptive. That requires the applicant to provide a list of authorised platforms which cannot be maintained up to date because of the fast IT evolution.
PROPOSED ACTION/TEXT

It is suggested to remove the following wording from the paragraph:

***"and for** the worst-case authorised platform configurations when identified."*

response

Not accepted

This is a conditional statement, so the applicant should do this verification/testing in the worst-case authorised platform configurations only when identified.

comment

331 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC 29.1465 (j)(2)(i)(ii)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
The use of the term "application" here is also introducing ambiguity with other uses in the current AMC. It is proposed to change it as indicated
PROPOSED ACTION/TEXT
To modify the sentences as follows:

*"As the ground-based **applicative** software of the VHM system is intended...*
*(i) development assurance at **applicative** software level.*
[...]
*(ii) The applicant should define and implement a software development assurance process for the ground-based **applicative** software of VHM system. It should include in particular extensive verification/testing (meaning that all possible functionalities of the ground segment of the VHM system ...*
[...]
As part of the ICA, an installation procedure ... (e.g. new OS, new processors, etc.) or new applicative software versions are released."

response

Partially accepted

The purpose of the comment has been addressed. However, the term 'application software' is kept in line with GM definitions. This has been discussed during the workshops with the working group.

comment

332 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(k)

Priority: High

RATIONALE / REASON / JUSTIFICATION
This paragraph describes what the ICA should include. But it does not:

- distribute information in line with Appendix A... what is recommended, what is mandatory, what is scheduled, what is unscheduled, etc...

	- give the possible format(s) of these instructions **PROPOSED ACTION/TEXT** It is proposed to move these contents in an AMC to Appendix A: - to distribute the requirements in accordance with the current/adapted categories of instructions, and - to make sure nothing is missing, and these contents will evolve at the same time as the other ICA-related requirements EASA should note that Section K relates to CS 29's appendix A. If there is a need to create additional instructions due to the VHM system, then it is necessary to make sure we do not overlap Appendix A through this AMC1 to CS 29 1465.
response	Not accepted Amendment of CS-29 Appendix A is not in line with the ToR for this RMT. In addition, the purpose of the AMC is to clarify which elements are expected to be needed as part of the ICA when a VHM system is installed. It is not intended to replace or add anything relative to Appendix A.

comment	*333* comment by: *General Aviation Manufacturers Association (GAMA)* AMC1 29.1465 (k) **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** In relation to the following statement: *"ICA should include the following:"* The list that comes after this sentence is to be moduled depending on the VHM system architecture, the safety assessment outcomes. The way the list is captured seems very prescriptive in terms of design. **PROPOSED ACTION/TEXT** The text is proposed to be amended as follows: ***"Based on VHM system design (including monitoring approach and related VHM system architecture) and safety assessment outcomes, when relevant,*** *ICA should include the following:"*
response	Partially accepted It is clear that the intent is not to systematically prescribe all these elements as part of the ICA. This has been addressed in the text but the wording proposed has not been kept.

comment *334* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(k)(5) and AMC1 29.1465(k)(9)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
§(5) & (9) are not always applicable and should be considered on a case-by-case
PROPOSED ACTION/TEXT
§ (5) & (9) should be completed with the mention "when applicable" as follows:

"(5) Provisions to support the mitigation of potential misleading information, missing or failed acquisitions, and conflicting data from redundant sensors, ***if applicable and identified through safety assessment****"*

"(9) Instructions to calibrate the system and verify that the computed indicators are representative of the condition of the monitored components, ***if applicable and identified through safety assessment.****"*

response Not accepted

This is an AMC; if there is any element listed in the ICA that is properly justified to not be needed, that is perfectly fine. Unless they add value, there is no need to add exceptions in AMC.

comment *335* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(k)(10)

Priority: Non Concur

RATIONALE / REASON / JUSTIFICATION
In relation with the following text:

"(10) Installation instructions for retrofit VHM systems addressing all aspects of VHM system integration with the rotorcraft"

This aspect does not concern ICA and cannot be planned by default in ICA. Should a retroft be needed, it will be managed using Service Bulletin principle.
PROPOSED ACTION/TEXT
(10) to be removed:

~~*"(10) Installation instructions for retrofit VHM systems addressing all aspects of VHM system integration with the rotorcraft"*~~

response Accepted

comment *336* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(k)(11)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation with the following text:

"(11) A maximum period of unavailability for each of the VHM system functionalities for inclusion in the rotorcraft MEL or maintenance instructions, as required."

The MEL is derived from the MMEL, which is not an ICA in accordance with point 21.A.7 definition.
PROPOSED ACTION/TEXT
It is proposed to remove the reference to MEL or to amend the sentence to read:

"(11) A maximum period of unavailability for each of the VHM system functionalities for inclusion, as required, in the rotorcraft ~~MEL or~~ maintenance instructions ***while taking into account the instructions of the MMEL,*** *~~as required.~~*

response

Partially accepted

The purpose of the comment has been addressed. However, the exact wording proposed has not been kept.

comment *337* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(k)(13)

Priority: Non Concur

RATIONALE / REASON / JUSTIFICATION
In relation to the following statement:

"(13) Required flight manual instructions when direct interface exists between the flight crew and the VHM system"

The rotorcraft flight manual is not an ICA in accordance with point 21.A.7 definition.
PROPOSED ACTION/TEXT
It is proposed to remove point (13):

~~"(13) Required flight manual instructions when direct interface exists between the flight crew and the VHM system"~~

response

Partially accepted

This point has been moved outside the ICA and into 'other supporting documentation'.

comment *338* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(k)(14)

Priority: Non Concur

RATIONALE / REASON / JUSTIFICATION
In relation with the following paragraph:

"(14) A mechanism for ensuring maintenance feedback with respect to component failure/degradation and resulting/missing VHM indications from the system. The following cases should be addressed:
(i) verification of the condition of a component following its rejection after an alarm, in order to establish the diagnostic accuracy, probability of detection and the false alarm rate;
(ii) communication to the TC holder of any failure monitored by the VHM, where the VHM fails to provide an alarm, to determine the missed alarm rate."

This request is out of initial airworthiness activities, it is also beyond the boundaries of continuing airworthiness as if the part has been rejected and replaced the helicopter is still airworthy, and even beyond the boundaries of continued airworthiness process (Part 21.A.3) as if the part is identified as a part which is subject to usage/damage, there is no occurrence to be reported. Besides, CIVP process is also considering such aspects.

PROPOSED ACTION/TEXT

The text is proposed to be removed as follows:
~~"(14) A mechanism for ensuring maintenance feedback with respect to component failure/degradation and resulting/missing VHM indications from the system. The following cases should be addressed:~~
~~(i) verification of the condition of a component following its rejection after an alarm, in order to establish the diagnostic accuracy, probability of detection and the false alarm rate;~~
~~(ii) communication to the TC holder of any failure monitored by the VHM, where the VHM fails to provide an alarm, to determine the missed alarm rate.~~

response Accepted

comment *339* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(l)(1)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
KPI-3.1 requires the availability of data dealing the customers actions (really peformed, not only planned): i.e. ths KPI deals with the respect of the ICA by the customer...

KPI-3.1: Average VHM data review interval

PROPOSED ACTION/TEXT
This is customer dependant, not to be hold by TC holder.

How does the Agency intend to ensure that the organisations responsible for the management of the aircraft continuing airworthiness will systematically report to the TC holder?

(with due consideration for organisations not governed by the EU regulation, the average reporting rate for AD containing a reporting requirement, etc.)

response

Noted

The intent is to use this measure to identify issues for customers when adhering to the minimum VHM data review interval.

comment

341 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(l)(1) & (3)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
CSI about 'data review' may imply that the organisation responsible for the management of the aircraft continuing airworthiness has to report (provide data) to the Type Certificate holder
PROPOSED ACTION/TEXT
How does the Agency intend to ensure that the organisations responsible for the management of the aircraft continuing airworthiness will systematically report to the TC holder?
(with due consideration for organisations not governed by the EU regulation, the average reporting rate for AD containing a reporting requirement, etc.)

response

Noted

It is understood that applicants have some reservations regarding having to implement a programme in service, with specific objectives and targets, that needs to be supported by operators to ensure that the relevant data is collected.

This RMT is the first step and does not ignore the need to address this concern at other levels within the aviation industry. The comment will be forwarded to the relevant Agency department.

comment

342 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(l)(1), (l)(1)(note), (l)(1)(table 4) and l(4):

Priority: High

RATIONALE / REASON / JUSTIFICATION
In relation to (l)(1), (l)(1)(note), (l)(1)(table 4) and l(4):

Indeed, Table 4 is really prescriptive in terms of KPI and aspects to be cheked. It somehow implies that all applications have the same assumptions which obviously is not correct. Should CSI targets not be defined case by case?

Also, what is the relation between each CSI target and the VHM safety objectives? Those targets should be commensurate with the criticality of the associated failure condition. If the list should be complemented by the applicant, there is a need of consistency between the different KPI targets

Furthermore, there seems to be a high risk to never close the CSI:

- All KPI target to be demonstrated (big stake to check the required data will be gathered!),
- No preliminary defined duration,
- Operators agreement to be granted (all? an additional difficulty to get approval?)
- Completed with (7) that raises also types of operations investigation, ageing effect, 5000FH minimum duration (>10Y for H160?), ...

PROPOSED ACTION/TEXT

It is proposed to place Table 4 in the GM aspect and to only list the characteristics which could to be considered in CSI, meaning:

- acquisition,
- data availability
- data review
- fault detection performance
- VHM system 'hardware' reliability
- ground based systel software reliability
- maintenance and troubleshooting burden
- VHM usability and maintanability
- effectiveness and completeness of ICA

Alternatively, EASA should identify the ones which are mandatory for VHM system with credit sought and approved, the ones mandatory for support operational regulation compliance (i.e. Regulation (EU) No 965/2012), the ones recommended for supplementary information ("no hazard/no credit").

In addition, it is necessary that EASA explains the process of determination of the proposed CSI targets.

response

Accepted

Table 4 has been moved to GM as requested; only objectives are now dealt with within the AMC.

comment

343 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(l)(1)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation with the following text:

"The applicant should note that the list of objectives provided in Table 4 is not exhaustive and should be complemented, when necessary, to complete the VHM system validation. In addition, the KPI targets provided are only generic reference values and should be adapted considering the characteristics and needs of each VHM system, its applications and the objectives of the CSI phase."

The wording is too prescriptive, no distinction is made between the various kind of application (credit, support to operation regulation, supplementary information ''no hazard/no credit'') for which TC holder has applied for.
PROPOSED ACTION/TEXT
It is proposed to amend the text as follows:

"The applicant should note that the list of objectives provided in Table 4 is not ~~exhaustive~~ **mandatory** and should be ~~completed~~ **adapted**, when necessary, to complete the VHM system validation. In addition, the KPI targets provided are only generic reference values and should be adapted considering the characteristics and needs of each VHM system, its applications and the objectives of the CSI phase. **Some KPIs might not be relevant for some applications with respect to paragraph (a)(3) of this AMC."**

response

Partially accepted

Please note that your previous comment (No 342) has been accepted. Therefore, the purpose of this comment is considered addressed.

comment

344 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(l)(1)

Priority: Medium

PROPOSED ACTION
KPI-4.2: clarify "assumed distribution" and "continuous verification".

response

Accepted

This has been reworded for clarity.

comment

345 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(l)(1)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
KPI-7.1 requires acurate and detailed customer-usage-related data, very difficult to gather. What is the relevance of the target??

PROPOSED ACTION/TEXT
How does the Agency intend to ensure that the organisations responsible for the management of the aircraft continuing airworthiness will systematically report to the TC holder?

response

Noted

Please see the response to comment No 341.

comment

346 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(l)(4)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
Reference to 'operators' may not reflect all cases.
PROPOSED ACTION/TEXT
It is proposed to amend some sentences to read:

"[...]. For this purpose, the applicant should document how this is demonstrated, considering the evaluations of KPIs, the targets listed and feedback from the ~~operators~~ ***organisations responsible for the aircraft continuing airworthiness management*** *involved in the CSI plan. [...];*
(ii) agreed with the ~~operator(s)~~ ***organisation(s) responsible for the aircraft continuing airworthiness management*** *involved, for any other CSI activities. The Agency should be informed and consulted in case of disagreement between the applicant and t****his/these organisation(s)*** *~~the operator(s).~~"*

response

Partially accepted

The comment has been addressed by defining term ‘operator’ in GM.

comment

347 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(l)(5)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
Reference to 'operators' may not reflect all cases.
PROPOSED ACTION/TEXT
It is proposed to amend some sentences to read:

	"(5) The CSI activities should typically be performed in close collaboration with a number of ***organisations responsible for the aircraft continuing airworthiness management*** ~~*operators*~~*. In addition,* ~~*operator*~~ *feedback from* ***these organisations*** *should be used in the evaluation of some CSI objectives, as detailed in Table 4. Therefore, the applicant should consult the* ~~*operators*~~ ***organisations responsible for the aircraft continuing airworthiness management*** *involved for the definition and evaluation of the progress of the CSI activities. [...]"*
response	Partially accepted The comment has been addressed by defining term 'operator' in GM.

comment	*348* comment by: *General Aviation Manufacturers Association (GAMA)* AMC1 29.1465(m)(1) **Priority:** High **RATIONALE / REASON / JUSTIFICATION** In relation to the following text: "*Such actions typically involve the requirement to land immediately or within a limited period of time. It is considered that any failure monitored by VHM that would require such immediate and drastic pilot action should be prevented through robust design methodologies, ensuring that the probability of occurrence is in line with the safety objective."* It is unclear if the robust design methodologies address the untimely/erroneous alert and/or mechanical design. **PROPOSED ACTION/TEXT** It is proposed to amend the text as follows: "Such actions typically involve the requirement to land immediately or within a limited period of time. It is considered that any failure monitored by VHM that would require such immediate and drastic pilot action **should not be recommended**.~~ should be prevented through robust design methodologies, ensuring that the probability of occurrence is in line with the safety objective."~~
response	Partially accepted The point has been clarified in the final text of AMC1 29.1465 by clarifying that this refers to the mechanical design.

comment	*349* comment by: *General Aviation Manufacturers Association (GAMA)* AMC1 29.1465(m)(1) **Priority:** High **RATIONALE / REASON / JUSTIFICATION**

In relation with the following text:

"Nevertheless, real-time VHM alerting could be considered feasible for VHM applications where the cockpit indication will instruct the pilot to perform less severe actions such as reducing power, monitoring other instruments, or landing as soon as practicable."

Obviously, real-time VHM alerting is feasible, the sentence is not adequate.
PROPOSED ACTION/TEXT
It is proposed to amend the text as follows:

"~~Nevertheless~~, Real-time VHM alerting could be ~~considered feasible~~ **implemented** ~~for VHM applications~~ where the cockpit indication will instruct the pilot to perform less severe actions such as reducing power, monitoring other instruments, or landing as soon as practicable."

response: Accepted

comment *350* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465 (m)(1)(i)

Priority: High

RATIONALE / REASON / JUSTIFICATION
With regard to the sentence :

"It should be justified that the probability of occurrence of any preceding degraded condition that may ultimately lead to the failure should not be greater than 1E-05 per FH."

This probability of occurrence of 1E-05 per FH should be commensurate with the criticality of the associated failure condition.
PROPOSED ACTION/TEXT
EASA to provide rationale for the probability of 1E-05 per FH as well as a link to paragraph (d).

response: Accepted

The text has been amended to address this comment.

comment *351* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(m)(1)(ii)

Priority: Non Concur

RATIONALE / REASON / JUSTIFICATION
In relation with the following text:

"(ii) Dedicated testing activities should be performed to validate the monitoring performance and capability of detection, including seeded flaw tests and validation on the rotorcraft."

Prescriptions provided in AMC1 29.1465(m)(1)(ii) are redundant with AMC1 29.1465(g) which addresses the performance demonstration and therefore, should be removed.

Besides, it requests to test in flight where other tests could be considered.
PROPOSED ACTION/TEXT
The text is proposed to be deleted:

~~"(ii) Dedicated testing activities should be performed to validate the monitoring performance and capability of detection, including seeded flaw tests and validation on the rotorcraft."~~

response

Not accepted

Although applications for credit are probably the main focus for real-time alerts, other kinds of VHM applications should not be excluded. Also, validation on the rotorcraft is not specified as needed in (g).

comment

352 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465 (m)(1)(iv)

Priority: High

RATIONALE / REASON / JUSTIFICATION
In relation with the following text:

"(iv) The false alert rate should be minimised and justified at the time of compliance demonstration by means of flight testing and analysis of the acquired signals, considering possible variations in the dynamic response of the system derived from service experience on similar designs, as well as noise and variability sources. Confidence should be demonstrated in that the false Alert rate is commensurate with the criticality of such failure condition, as per CS 29.1309, taking into account the possible operational scenarios."

The objective to be demonstrated is unclear. It is proposed to map the false alert rate to the quantitative objective of the related FC.

Confidence aspect commensurate with the criticality of such FC, as per CS 29.1309, is unclear.
PROPOSED ACTION/TEXT
The text is proposed to be amended as follows:

"(iv) The false alert rate should be minimised and justified ***to be consistent with the related quantitative objective of the FC****.* ~~*at the time of compliance demonstration by means of flight testing and analysis of the acquired signals, considering possible*~~

~~*variations in the dynamic response of the system derived from service experience on similar designs, as well as noise and variability sources. Confidence should be demonstrated in that the false Alert rate is commensurate with the criticality of such failure condition, as per CS 29.1309, taking into account the possible operational scenarios."*~~

response

Partially accepted

The purpose of the comment has been addressed. However, the wording proposed has not been kept considering that 'FC' (failure condition) might be unclear.

comment

353 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(m)(2)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
Reference to 'operators' may not reflect all cases.
PROPOSED ACTION/TEXT
It is proposed to amend a sentence to read:

"This approach can be considered for degradation modes for which the demonstrated time between detection and failure is limited, to support ~~operators~~ ***organisations responsible for the aircraft continuing airworthiness management*** *without the capabilities to perform regular downloads and reviews of VHM data, or to ensure that the VHM system does not solely rely on the ground-based system for the generation of alerts. [...]"*

response

Partially accepted

As mentioned in responses to previous comments, this has been addressed by clarifying the meaning of 'operator' in the definition in the GM.

comment

354 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(m)(2)

Priority: High

RATIONALE / REASON / JUSTIFICATION
"In addition, regardless of the exact use of a VHM application relying on near real-time VHM alerting, the applicant should evaluate the need to implement some of the aforementioned elements due to the potential impact on the operability of the helicopter."

To the maximum extent, the sentence can be considered as a Note, but most probably should be removed as operability of the helicopter is out of the scope of initial airworthiness.

Obviously, TC holder will support their customers.

PROPOSED ACTION/TEXT

The text is proposed to be deleted:

~~*"In addition, regardless of the exact use of a VHM application relying on near real-time VHM alerting, the applicant should evaluate the need to implement some of the aforementioned elements due to the potential impact on the operability of the helicopter."*~~

response | Partially accepted

This is now presented as a recommendation.

comment | *355* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(m)(3)

Priority: Non Concur

RATIONALE / REASON / JUSTIFICATION
In relation to the following text:

"Alternatively, when a real-time VHM processing application is intended at computing an indicator, which, due to computing power requirements, could not be computed by the hardware on board the rotorcraft, and providing personnel on ground with information that may require them to contact the crew to take action, the considerations described for real-time VHM alerting also apply."

Such alternative sounds very hazardous as current avionics means for such communications would rely on SATCOM equipment which are not designed to provide adequate reliability and integrity (usually most severe FC for SATCOM are MAJ, DAL C). Therefore, this should be removed or reworked as it is not sufficiently described.
PROPOSED ACTION/TEXT
The text is proposed to be removed:

~~*"Alternatively, when a real-time VHM processing application is intended at computing an indicator, which, due to computing power requirements, could not be computed by the hardware on board the rotorcraft, and providing personnel on ground with information that may require them to contact the crew to take action, the considerations described for real-time VHM alerting also apply."*~~

response | Accepted

comment | *375* comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465(f)(2)

Priority: High

RATIONALE / REASON / JUSTIFICATION
In relation to the following statement:

"For applications for credit, a minimum set of data from dedicated tests or directly applicable service experience is expected in addition, given that these applications are relied upon to ensure the airworthiness of the rotorcraft"

It is not clear whether the additional dedicated tests or directly applicable service experience is expected before approval or can be gathered after approval. This needs to be clarified.

PROPOSED ACTION/TEXT
It is proposed to amend the text as follows:

"**In addition,** for applications for credit, a minimum set of data from dedicated tests or directly applicable service experience is expected **prior to approval,** given that these applications are relied upon to ensure the airworthiness of the rotorcraft"

response

Partially accepted

The comment has been taken into consideration and the text amended accordingly.

comment

376 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465 (g)(2)(i)(B)(c)

Priority: High

RATIONALE / REASON / JUSTIFICATION
In relation with the following text:

It should be verified that this detectable mechanical response will be generated at a specific point in the failure progression and continue to be generated from that point up to ultimate failure.

Verbiage inconsistent with overall document on opportunities of detection and section on Prognostic interval.
PROPOSED ACTION/TEXT
"It should be verified that this detectable mechanical response will be generated at a specific point in the failure progression and continue to ***provide sufficient opportunities of detection*** ~~*be generated*~~ *from that point up to ultimate failure."*

response

Not accepted

The proposed rewording changes the meaning of the sentence. If the failure mode that is monitored by VHM may stop producing the mechanical response (i.e. vibration signal) that is targeted for detection, the demonstration of performance moves to a

different scenario, one for which some of the details within this AMC may not be sufficient.

Nevertheless, the sentence has been amended reflecting further discussions with the rulemaking group on this topic.

comment

377 comment by: *General Aviation Manufacturers Association (GAMA)*

AMC1 29.1465 (g)(2)(iii)

Priority: High

RATIONALE / REASON / JUSTIFICATION
Best practice from industry is use combination of field return parts and new parts. This allows opportunity to start test with naturally progressed fault. This statement is limiting and GAMA recommends it be deleted as it goes against best practice.

PROPOSED ACTION/TEXT
EASA to consider the following amendment:
~~"The applicant should consider that each test should be performed on new tested parts. These tested~~ ***Tested*** *parts should include, as a minimum, the monitored component(s) and any surrounding elements that, when replaced, may significantly influence the test results from a failure progression characteristics and/or probability of fault detection point of view"*

response

Partially accepted

The intent was not to mean ‘new’ as in parts that have never been used. Instead, it refers to parts that have not been tested for such purpose before. The text has been reworded to avoid such misunderstanding.

comment

379 comment by: *General Aviation Manufacturers Association (GAMA)*

General Comment - CRT function on adding general comments not working.

RATIONALE / REASON / JUSTIFICATION
The language in the NPA has in ocassions been identified as inconsistent or not used coherently and harmoniously, which should be addressed by ensuring that all occurrences throughout the text are amended. In this line, and in order to not log comments repeteadly on the same issued, GAMA/ASD would like to note the following:

- The wording system applications is unclear. Why not sticking to 29.1301 terminology and use the notion of "intended function"?
- The term 'condition' is used for two different meanings making ambiguous the message passed onto readers. Please use one term consistently.

- Failure condition: i.e. a combinaison of different parameters (/assumptions)
- Degraded condition: i.e. referring to a health state

- The term 'operation' (and/or its derivatives) is used for two different meanings making ambiguous the message passed onto readers. It is recommended to keep the term 'operation' for wordings such as 'air operations' and to find a synonym like 'functioning' for other meanings.
  - in the sense of an activity: air operations, maintenance operations, etc...
  - in the sense of performance/functioning: operation of an aircraft system.
- The term 'preceding degraded condition' may mean little to the reader after several paragraphs. For the sake of clarity it is proposed to replace it by other terms such as 'early signs of degradation or damage' or 'incipient failure' or 'incipient failure', depending on the exact context.
- The use of the word 'damage' vs 'damages'. Please stick with the word 'damage'.:
  - damage: injury or harm that reduces value or usefulness
  - damages: Law. the estimated money equivalent for detriment or injury sustained.
- The use of the word 'application' is not accurate and provides basis for ambiguous interpretation in multiple occasions. It is recommended to find other terms, depending on the context, such as 'applicative' or 'system' or 'function'.

PROPOSED ACTION/TEXT
EASA should pick the appropiate verbiage to use throughout the NPA in order to ensure an adequate, coherent lecture, which contributes to better interpretation and implementation. GAMA/ASD have given EASA various options through the many comments submitted, and we encourage the Agency to take into good consideration those alternative proposals.

response

Partially accepted

'Application' is used with just one meaning in the AMC, which is provided in the definitions in the GM. This meaning is not new and is maintained from the previous version of the AMC.

'Failure condition' is no longer used.

'Operations' is used to refer to air operations, 'operation' is only used to mean functioning/working.

The term 'preceding degraded condition' is now defined in the definitions provided in GM.

'Damages' is no longer used in the AMC.

'Applicative software' has been discarded since it does not seem to be used to refer to application software at all. 'Application software' is now defined in GM to avoid misunderstandings.

comment *380* comment by: *General Aviation Manufacturers Association (GAMA)*

General Comment - CRT function on adding general comments not working.

RATIONALE / REASON / JUSTIFICATION
Every time there is a reference to 'operational regulation' it should be clarified it is ment to make a reference to Reg. (EU) 965/2012. Some may understand that Regulation (EU) No 1321/2014 is an operational regulation as it applies to aircraft that are in service. Some understand the term 'operational regulation' applies only in the context of Regulations (EU) No 965/2012, 2018/395, 2018/1976, and 2019/947. It has to be clarified.

PROPOSED ACTION/TEXT
EASA to add ***"(i.e. Reg. (EU) 965/2012)"*** after *'operational regulation*' every time this is cited in the text. Some instances of this occurrence have been identified in other comments, nonetheless, this should be applied consistently throughout the whole NPA.

response Not accepted

This will result in adding the regulation references many times along the document along the AMC and GM for no use. It is now clearly stated at the beginning of the AMC that referring to 'operational regulation' in this AMC and GM currently refers Regulation (EU) 965/2012. In the future, other regulations may mandate VHM systems, and the idea is that a similar approach will be followed, as making every point in the AMC and GM strictly linked to one regulation is considered counterproductive.

GM1 29.1465 Vibration health monitoring p. 42

comment *187* comment by: *Airbus Helicopters*

GM1 29.1465(a)(4)

Proposed text:
The definition is proposed to be amended as follows: "(4) Commercial off-the-shelf (COTS): This term defines a **purchased** equipment **containing** hardware and**/or** software that **was** not **developed following aeronautics** standards."

Note: this should be adjusted in consistency with comment #186

Justification:

	"Commercial off-the-shelf (COTS): This term defines equipment hardware and software that is not **qualified** to aircraft standards." "Qualified" wording is not adequate as by definition there is no contractual specification but an already existing equipment, usually digital ones.
response	Partially accepted The definition proposed by GAMA in comment No 357 has been used.

comment	*191* comment by: *Airbus Helicopters* GM1 29.1465(a)(10) Proposed text: It is proposed to amend this definition to red: "(10) Mitigating actions: **Maintenance Continuing airworthiness** tasks or alternative means of monitoring used in combination with a VHM application, which are demonstrated to be capable of adequately monitoring the associated failure as a means to reduce the reliance on a VHM application for credit towards ensuring airworthiness." Justification: For the sake of flexibility.
response	Accepted

comment	*356* comment by: *General Aviation Manufacturers Association (GAMA)* GM1 29.1465(a)(2) **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** Reference to 'operators' may not reflect all cases. **PROPOSED ACTION/TEXT** It is proposed to amend the definition to read: *"Alert: An indication produced by the VHM system in the event of any alerting criteria of the VHM application being fulfilled. Any alert is managed by specific instructions defined by the applicant, which may include further processing or investigation by the ~~operator~~* ***organisation responsible for the aircraft continuing airworthiness management*** *to determine if maintenance action is required."*
response	Accepted

comment	*357* comment by: *General Aviation Manufacturers Association (GAMA)* GM1 29.1465 (a)(4) **Priority:** High **RATIONALE / REASON / JUSTIFICATION**

The definition of COTS should be consistent with the one existing in aeronautical standard e.g. ED-12C/DO-178C
PROPOSED ACTION/TEXT
This term defines *"Commercially available equipment hardware and software sold by vendors through public catalog listings that is not qualified to aeronautical development assurance standards."*

response: Accepted

comment *358* comment by: *General Aviation Manufacturers Association (GAMA)*

GM1 29.1465(a)(5)

Priority: Editorial

RATIONALE / REASON / JUSTIFICATION
In relation to the following text:

"(5) Credit: Demonstrated capability of the system to perform a relevant function towards ensuring the airworthiness of the aircraft in accordance with AMC1 29.1465 (a)(3)(ii)."

"VHM" word is missing, VHM could fulfil several functions and therefore should be plural.
PROPOSED ACTION/TEXT

*"(5) Credit: Demonstrated capability of the **VHM** system to perform a relevant function**(s)** towards ensuring the airworthiness of the aircraft in accordance with AMC1 29.1465 (a)(3)(ii)."*

response: Accepted

comment *359* comment by: *General Aviation Manufacturers Association (GAMA)*

GM1 29.1465(a)(6)

Priority: Editorial

RATIONALE / REASON / JUSTIFICATION
In relation to the following text:

(6) False alarm: An alarm whose preceding alert and/or additional processing or investigation has incorrectly indicated the need for maintenance action. This is typically determined following investigations of the findings associated with the consequent maintenance action."

The bold aspect of the sentence "and/or additional processing or investigation" is redundant with the definition of Alarm versus Alert and should be removed especially as we also define "false alert".
PROPOSED ACTION/TEXT

	The definition is proposed to be amended as follows: *"(6) False alarm: An alarm whose preceding alert ~~and/or additional processing or investigation~~ has incorrectly indicated the need for maintenance action. This is typically [...]"*
response	Accepted

comment	*360* comment by: *General Aviation Manufacturers Association (GAMA)* GM1 29.1465(a)(8) **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** For the sake of flexibility. **PROPOSED ACTION/TEXT** It is proposed to amend this definition to read: *"(8) ~~Ground-based~~ **Off-board** system: ~~Off-board means~~ **items** of the VHM system **located on ground or in a collaborative workspace such as web-based services** (also referred to as ground **off-board** segment) used by the **organisation responsible for the aircraft continuing airworthiness management** ~~operator~~ to:* *— transfer VHM data from the on-board system,* *— store, access, **process**, display and review this data, and* *— perform additional VHM data analysis.*
response	Partially accepted The term 'off-board system' has not been kept since this terminology is kept from the existing AMC 29.1465. The other changes proposed have been incorporated.

comment	*362* comment by: *General Aviation Manufacturers Association (GAMA)* GM1 29.1465(a)(11) **Priority:** Editorial **RATIONALE / REASON / JUSTIFICATION** The sentence below is difficult to understand and should be clarified: *" - Characteristics of the VHM system allowing reliable indicators consistently representative of the condition of the monitored components to be computed at an adequate frequency to be timely available and adequately interpreted by maintenance personnel with sufficient margin before any failure may occur, including sensor locations and characteristics, acquired signals and processing, VHM indicators computed, etc."* Furthermore, the second bullet point is slightly redundant with the first bullet point:

"— Alerting criteria of the system allowing indication to maintenance personnel of anomalous behaviour indicating that damage or degradation may be present on any monitored component."

And the third bullet should be consistent with the previous ones:

— Procedures to be implemented by the operator and/or maintenance personnel in support of fulfilling the functions of a VHM system application.

PROPOSED ACTION/TEXT

1 The first bullet point is proposed to be amended as follows:

"- Characteristics of the VHM system allowing reliable indicators consistently representative of the condition of the monitored components; ***these characteristics are*** *to be computed at an adequate frequency so* ***that there are*** ~~*to be*~~ *timely available and adequately interpreted by* ~~*maintenance personnel*~~ ***the organisation responsible for the aircraft continuing airworthiness management*** ~~*with sufficient margin before any failure may occur*~~*; it includes*~~*ing*~~ *sensor locations and characteristics, acquired signals and* ***related*** *processing, VHM indicators computed, etc."*

2 The removed part of first bullet can be inserted at the end of the second bullet point as follows:

"— Alerting criteria of the system allowing indication to maintenance personnel of anomalous behaviour indicating that damage or degradation may be present on any monitored component ***with sufficient margin before any failure may occur.****"*

3 Make the third bullet consistent:

"— Procedures to be implemented by the ~~*operator and/or maintenance personnel*~~ ***organisation responsible for the aircraft continuing airworthiness management*** *in support of fulfilling the functions of a VHM system application.*

response

Partially accepted

The changes proposed have been incorporated with some adjustments.

comment

363 comment by: *General Aviation Manufacturers Association (GAMA)*

GM1 29.1465(a)(11)

Priority: High

RATIONALE / REASON / JUSTIFICATION
The term "Mitigating actions" makes the perimeter unclear as it should be disconnected from the monirtoring approach.
PROPOSED ACTION/TEXT
Remove "Mitigating actions" from Monitoring Approach.

response | Not accepted

Why the perimeter is unclear is not understood. In addition, mitigating actions are part of the monitoring approach.

comment | *364* comment by: *General Aviation Manufacturers Association (GAMA)*

GM1 29.1465(a)(13)

Priority: Low

RATIONALE / REASON / JUSTIFICATION
In relation to the following text:

"(13) Prognostic interval: The demonstrated operating time between the point at which an alert will be generated and the component becoming unairworthy."

Besides, the aircraft is airworthy, part or assembly are not airworthy by themselves, therefore it is proposed to refocus on the aircraft.
PROPOSED ACTION/TEXT
The paragraph is proposed to be amended as follows:
"(13) Prognostic interval: The demonstrated operating time between the point at which an alert will be generated and the ***aircraft*** ~~*component*~~ *becoming unairworthy."*

response | Partially accepted

'Rotorcraft' is used instead in line with the rest of AMC and GM.

comment | *365* comment by: *General Aviation Manufacturers Association (GAMA)*

GM1 29.1465(a)(14)

Priority: Low

RATIONALE / REASON / JUSTIFICATION
In relation to the following definition:

"(14) Real-time VHM alerting: The term real-time VHM alerting refers to VHM applications that perform signal acquisition and indicator processing in flight, and that are used for a cockpit indication requiring immediate or nearly immediate action by the crew."

It should be indicated that the crew is only flight crew.

PROPOSED ACTION/TEXT
The definition is proposed to be amended as below:

"(14) Real-time VHM alerting: The term real-time VHM alerting refers to VHM applications that perform signal acquisition and indicator processing in flight, and

	*that are used for a cockpit indication requiring immediate or nearly immediate action by the **flight** crew."*
response	Accepted

comment	*366* comment by: *General Aviation Manufacturers Association (GAMA)* GM1 29.1465(a)(15) **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** In relation to the following definition: *"(15) Real-time VHM data transfer and analysis: The term real-time VHM data transfer and analysis refers to VHM system applications that rely on the transfer of data during flight to the ground. The transferred data may correspond to the indicator processed on the rotorcraft or raw data for computation of the indicators on the ground-based system."* "Analysis" makes the definition confusing. For the sake of consistency, it is proposed to also use the wording "off-board" instead of ground-segment. **PROPOSED ACTION/TEXT** The definition is proposed to be amended as below: "(15) Real-time VHM data transfer ~~and analysis~~: The term real-time VHM data transfer ~~and analysis~~ refers to VHM system applications that rely on the transfer of data during flight to the ground. The transferred data may correspond to the indicator processed on the rotorcraft or raw data for computation of the indicators on the ~~ground-based~~ **off-board** system."
response	Partially accepted It has been decided to stick to 'ground-based system', in line with the existing AMC 29.1465.

comment	*367* comment by: *General Aviation Manufacturers Association (GAMA)* GM1 29.1465(a)(19) **Priority:** Editorial **RATIONALE / REASON / JUSTIFICATION** In relation to the following definition: *"(19) VHM indicator (indicator): A VHM indicator is the result of processing sampled data by applying an algorithm to achieve a single value, which relates to the health of a component with respect to a particular failure mode."*

Is it meant to address "health" or "condition" also used elsewhere in the document.
PROPOSED ACTION/TEXT
The definition is proposed to be amended as below:

"(19) VHM indicator (indicator): A VHM indicator is the result of processing sampled data by applying an algorithm to achieve a single value, which relates to the ***condition*** ~~*health*~~ *of a component with respect to a particular failure mode."*

response Accepted

comment *368* comment by: *General Aviation Manufacturers Association (GAMA)*

GM1 29.1465(d)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
Maintenance personnel is responsible for the accomplishment and the certification of the maintenance performed by the Approved Maintenance Organisation (AMO).

The organisation responsible for the aircraft continuing airworthiness management (CAMO) is responsible for the determination of the airworthiness status of an aircraft before each of its flight.
PROPOSED ACTION/TEXT
It is proposed to amend the first sentence to read:

"The VHM system typically includes the means to allow the ~~*person*~~ ***organisation*** *responsible* ***for the aircraft continuing airworthiness management*** *for releasing a rotorcraft into service the necessary VHM data, maintenance recommendations and VHM system built-in test data necessary."*

response Partially accepted

This section has been reworded The purpose of the comment is considered addressed.

comment *369* comment by: *General Aviation Manufacturers Association (GAMA)*

GM1 29.1465 (d)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
With regard to the sentence :

"These capabilities are provided locally to maintenance personnel for immediate post-flight fault diagnosis by means of the on-board or ground segment of the system."

This guidance, prescribing a location and an immediate diagnosis, is too prescritive and not systematically commensurate with the ICA to be defined by the applicant.
PROPOSED ACTION/TEXT

It is suggested to change the sentence as follows :

"These capabilities are provided ~~locally~~ to maintenance personnel for ~~immediate~~ post-flight fault diagnosis by means of the on-board or ground segment of the system."

response

Partially accepted

This section has been reworded. The purpose of the comment is considered addressed.

comment

370 comment by: *General Aviation Manufacturers Association (GAMA)*

GM1 29.1465(e)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation to the following text:

"(e) Fleet diagnostic support interface Where an operator has multiple rotorcraft of the same type, VHM system facilities are typically made available to the operator to support the analysis of all data acquired by the VHM systems in the operator's fleet. Remote, multi-user and timely access to the data and the diagnostic processes may be considered for the operator and supporting parties in order to assist in determining the continued airworthiness of their fleet."

It is unclear which benefit is brought by this paragraph with respect to initial airworthiness activities, even if it is clear that TC holders will take into account their customers constraints as far as possible.

Therefore, it is proposed to remove this paragraph.
PROPOSED ACTION/TEXT
The paragraph (e) of GM1 is proposed to be removed:

~~"(e) Fleet diagnostic support interface Where an operator has multiple rotorcraft of the same type, VHM system facilities are typically made available to the operator to support the analysis of all data acquired by the VHM systems in the operator's fleet. Remote, multi-user and timely access to the data and the diagnostic processes may be considered for the operator and supporting parties in order to assist in determining the continued airworthiness of their fleet."~~

response

Not accepted

It is understood that this section is considered to be of lesser importance. Nevertheless, it was a subject addressed in the previous version of AMC 29.1465 and it is considered to still be of use.

comment

371 comment by: *General Aviation Manufacturers Association (GAMA)*

GM1 29.1465(f)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
In relation to the following text:

"(f) Suitable training is typically made available with respect to operation and maintenance of the VHM system. This training may be provided prior to the initial delivery of the VHM system. [...]; (5) any data analysis and reporting functions that are expected to be performed by the operator."

This paragraph describes common sense approach towards customers, nevertheless, training by the TC holder of organisation responsible for the continuing airworthiness management beyond the ICA is not mandated by any regulation. Therefore, it is proposed to remove this paragraph.

PROPOSED ACTION/TEXT
The paragraph (f) of GM1 is proposed to be removed:

~~*Suitable training is typically made available with respect to operation and maintenance of the VHM system. This training may be provided prior to the initial delivery of the VHM system. Training material and training courses may need to evolve to include lessons learnt from service experience and appropriate diagnostic case studies. Training material and training courses typically cover:*~~
~~*(1) installation of the VHM system;*~~
~~*(2) line maintenance of the VHM system (including VHM system fault-finding and any calibration necessary);*~~
~~*(3) use of the VHM system during line maintenance to monitor the rotorcraft, including the data transfer, interface with data analysis, response to alerts and alarm processing, rotorcraft fault-finding and other line diagnostic actions;*~~
~~*(4) necessary system administration functions, covering operational procedures relating to data transfer and storage, recovery from failed downloads, and the introduction of hardware and software modifications;*~~
~~*(5) any data analysis and reporting functions that are expected to be performed by the operator.*~~

response Not accepted

Even if not mandated by any regulation, training is considered as a relevant subject within GM to highlight its importance towards ensuring that the objectives of a VHM system are fulfilled in service.

comment *372* comment by: *General Aviation Manufacturers Association (GAMA)*

GM1 29.1465(g)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION

In relation to the following text:

(g) Product support — system data and diagnostic support The product support is typically provided to operators to ensure that the VHM system remains effective and compliant with any applicable requirements throughout its service life. The support provided may cover both the [...] components, the characterisation of rotorcraft fleet behaviour, and VHM performance assessment."

The paragraph addresses common sense relationship between TC holders and customers but makes no reference to any applicable requirement on TC holder side. Therefore, it is proposed to remove paragraph (g).

PROPOSED ACTION/TEXT

The paragraph (g) of GM1 is proposed to be removed.

~~The product support is typically provided to operators to ensure that the VHM system remains effective and compliant with any applicable requirements throughout its service life. The support provided may cover both the VHM system itself (i.e. system support), and the data generated (data and diagnostic support). The data and diagnostic support provided typically ensures that:~~
~~(1) the operator has timely access to approved external data interpretation and diagnostic advice. It is the responsibility of the approval holder to provide this information; however, this may also involve the rotorcraft TC holder or, through formal agreement, another suitably qualified organisation;~~
~~(2) there is a defined protocol for requesting and providing diagnostic support, including response times that meet VHM system operational requirements, with traceability of all communications;~~
~~(3) the organisation providing diagnostic support to an operator has a defined process for training and approving all personnel providing that support;~~
~~(4) VHM performance is periodically assessed, with an evaluation of alerting criteria, and a controlled process for modifying those criteria if necessary;~~
~~(5) sufficient historical VHM data is retained and collated to facilitate the identification of trends on in-service components, the characterisation of rotorcraft fleet behaviour, and VHM performance assessment.~~

response

Not accepted

Even if not linked to any initial airworthiness requirement, product support is considered as a relevant subject within GM to highlight its importance towards ensuring that the objectives of a VHM system are fulfilled in service.

comment

378 comment by: *General Aviation Manufacturers Association (GAMA)*

GM1 29.1465(a)(20)
AMC1 29.1465(a)(2)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION

In relation with paragraph AMC1 29.1465(a)(2) and the definition of VHM in GM1 29.1465(a)(20):

a) The definition of the system is uncomplete and not accurate. Instructions are not part of the system design itself even though they are compulsory for the VHM system to be operated. Typically, the VHM system specification will not capture the instructions that will be provided to operators as the instructions will have no direct influence on the system design unless explicitly, for instance, expressed by the final customers.

b) The terminology of "hardware for data acquisition" is very vague and not related to the kind of function described.

c) The following statement: "and all the associated instructions for operation of the system" seems confusing.

d) There should be consistency throughout the text in relation to the use of the term 'transferring' rather than 'downloading.

PROPOSED ACTION/TEXT

In consideration of the listed points above, GAMA would like to propose the following alternative text:

GM1 29.1465(a)(20) VHM system: **Typically features airborne and ground segments, which depending on the VHM intended function may include vibration sensors and associated wiring, airborne electronic hardware (AEH) for data acquisition, processing, and storage means for transferring and/or displaying data from the rotorcraft, and all associated instructions for the VHM system operation prepared by the applicant.**

AMC1 29.1465(a)(2) A VHM system typically features airborne and ground segments~~. and consists of the necessary equipment to acquire, process, store, transfer and display the VHM data.~~ **Depending on the VHM intended function this should** include vibration sensors and the associated wiring, a**irborne electronic hardware (AEH) for data acquisition** ~~hardware for data acquisition~~, processing, and storage means for ~~downloading~~ transferring and/or displaying data. **Associated instructions for operation of the VHM system should be prepared by the applicant.**

response

Partially accepted

The text has been adjusted taking into consideration the comment raised.

comment

400 comment by: *TCCA*

General

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
VHM is a good tool for post certification activities but it is not suitable for certification since one has to rely on data from in-service (CSI) for validation of the

system. This is like a post certification commitment every time you would certify this VHM system.

In addition, vibration monitoring is not the only parameter which can be used for predication failures, other parameters such oil debris monitoring, speeds, pressures etc. can also be used for health monitoring. Having a health monitoring system is great tool for preventing/predicating failures in-service, however it is not suitable tool for basic certification.

PROPOSED ACTION/TEXT
-

response

Noted

EASA and, in EASA's understanding, all major rotorcraft TCHs do not share the TCCA's opinion that health monitoring is not suitable for certification.

comment

401 comment by: FAA – Rao Edupuganti

General

Priority: Medium

RATIONALE / REASON / JUSTIFICATION
Like to know if there is a regulatory requirements change if so, please identify these specific changes. If the MOC is revised, please show the specific improvement changes compared to existing MOC to address SR 2018-007. One more comment, since the accident is related to tail rotor which is part of drive system and part of CS29.917 (b) and CS29.571, why you are including CS 29.547 which is a structural part that has nothing to do with this accident. Please clarify which part is inscope and which part is out of scope while the SR is being addressed.

PROPOSED ACTION/TEXT

"Primary objectives of this task is to update the existing acceptable means of compliance (MOC)". Please highlight or underline these updates on the existing MOCs or show revisions to the existing MOCs and how are addressing the SR. Our main focus should be on SR and EASA's response to SR..

response

Noted

The changes are so substantial that it was considered clearer to simply present it as a new AMC and GM replacing the existing AMC 29.1465.

Safety recommendation UNKG-2018-007 is addressed in paragraph (m) of the new AMC, where EASA specifies the specific uses of VHM with real-time and near-real-time uses.

CS 29.547 is mentioned since the AMC is generic and does not simply address the parts associated with the accident that led to the safety recommendation.

comment	402 comment by: FAA – Kevin Gildea, Slava Guznov, Carrie Smith P 40 paragraph (m) **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** Reference text : Pilot interface and cockpit indications Pilot interaction with the VHM system, if any, should be specified and should not adversely impact on pilot workload in flight. Where applicable, the applicant should perform a crew workload assessment and a human factors evaluation in accordance with CS 29.1302 and associated AMC and GM from CS-29. CS 29.1302 and associated AMC/GM from CS-29 are good references, but not an exhaustive list of references associated with workload. **PROPOSED ACTION/TEXT** Suggest the following:*in accordance with CS 29.1302 and associated AMC and GM from CS-29 and other associated guidance related to workload.* Or state that this is not an exhaustive list of references associated with workload (e.g., 29.1523).
response	Partially accepted The purpose of the comment has been incorporated but does not focus only on workload but also on HF elements, as specified in the sentence.

comment	403 comment by: FAA – Liz Brandli *Section 2.1* **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** Is there empiracal evidence showing what and how the different VHMs (approved and in use since 2012) are monitoring, and the effectiveness since 2012 (i.e., comparative differences in robustness and/or accuracy)? **PROPOSED ACTION/TEXT** -
response	Noted It is understood that this comment requests evidence proving that existing VHM systems are capable of performing adequately to support airworthiness credit. This is a broad question, difficult to answer in a CRD. Nevertheless, EASA is aware of a

number of VHM systems which have been demonstrated to precisely monitor specific failures in rotor or rotor drive systems, providing clear indication well before a failure occurs.

comment 404 comment by: FAA – Liz Brandli

Section 2.1

Priority: Medium

RATIONALE / REASON / JUSTIFICATION

Is there any evidence or projected modeling that shows the impact the new changes to policy/guidance will have on the targeted problem? Would VHMs developed under such changes have prevented or minimized the recent accident sited for the changes, or any other recent accidents attributed directly to the "**... components that are being monitored"**? In short, are the changes in policy going to actually help, or is making the industry more reliant on VHM technologies, simply covering for flawed designs, shortfalls in system safety analysis methods, and/or ineffective maintenance routines?

PROPOSED ACTION/TEXT

-

response Noted

VHM applications have been recently developed following in-service events, which have been proven to be capable of preventing the event.

None of the existing requirements have been modified. Thus, the proposed policy changes are only a means to foster the introduction of VHM systems that may further improve inherently safe designs and/or reduce or replace proven continuing airworthiness activities.

comment 405 comment by: FAA – Liz Brandli

Section 2.2

Priority: Medium

RATIONALE / REASON / JUSTIFICATION

Reference text :

With respect to VHM systems taking a more **"integral part of the continued airworthiness regime",** the NPA states the role would "... **allow VHM systems to support the optimisation of maintenance**".

	If such optimization includes allowing software (i.e., internal or external to a VHM or aircraft) to process VHM collected data and make recommendations that could include continued use of systems and/or materials in contradiction to life-limits or usage restrictions set at the time of product approval, then VHMs should be developed in accordance with the existing harmonized MG-15 approach whereby the Design Assurance Level for monitor systems is set to equal the components being monitored **PROPOSED ACTION/TEXT** See comments in statement or harmonize as default solution.
response	Not accepted VHM applications for credit are not a means to exceed life and/or usage limits set at certification. When applicable, they will be certified as a safe means to determine the applicable life and/or usage limits for any individual rotorcraft following the monitoring process prescribed by the VHM system. MG-15 does not clearly address the definition of the system safety requirements for VHM systems. This is one of the reasons why paragraph (d) of this AMC has been introduced, proposing a clear and complete approach to establish these objectives.

comment	406 comment by: FAA – Liz Brandli *Section 2.3* **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** Reference text : With respect to **"- defining criteria for the acceptance of VHM systems as an airworthiness approved means for enabling the possibility for on-condition maintenance"** Since the market is growing everyday for monitoring systems that report back health and other operational conditions, I suggest we put together an Industry Committee and use bullets like these to drive discussion, derive appropriate criteria, and update the MG-15 harmonized agreement. If "**on condition maintenance**" includes allowing software (i.e., internal or external to a VHM or aircraft) to process VHM collected data and make recommendations that could include continued use of systems and/or materials in contradiction to life-limits, usage restrictions, or maintenance activities set at the time of product approval, then VHMs should be developed in accordance with the existing harmonized MG-15 approach whereby the Design Assurance Level for monitor systems is set to equal the components being monitored. **PROPOSED ACTION/TEXT** See comments in statement or harmonize as default solution.
response	Not accepted VHM applications for credit are not a means to exceed life and/or usage limits set at certification. When applicable, they will be certified as a safe means to determine the applicable life and/or usage limits for any individual rotorcraft following the monitoring process prescribed by the VHM system. The FAA was invited to this rulemaking group but elected not to participate. In the interest of harmonisation, the FAA is welcome to contact EASA and share any expectations on reaching a common ground regarding VHM.

comment	407 comment by: FAA – Liz Brandli *Section 2.4* **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** No drawbacks; and yet later in the document this NPA recommends breaking away from harmonized guidance that was created through an Industry Working Group with Regulators (i.e., Section 3.1.a.4). . **PROPOSED ACTION/TEXT** See comments in statement or harmonize as default solution.
response	Not accepted One of the main purposes of this rulemaking task was to update the content of AMC 29.1465 covering the topic of credit validation for VHM systems, replacing MG-15 within the EASA framework, which is considered, to some extent, incomplete and outdated. The FAA was invited to this rulemaking group but elected not to participate. In the interest of harmonisation, the FAA is welcome to contact EASA and share any expectations on reaching a common ground regarding VHM.

comment	408 comment by: FAA – Liz Brandli *Section 3.1.A.3.II.B* **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** Airworthiness-related purposes (credit applications) ... **"(B) in support of airworthiness decisions by assisting or replacing maintenance or flight procedures"** This section directly states the possibility of software (i.e., internal or external to a VHM or aircraft) processing VHM collected data and making recommendations that could include pilot actions maintenance actions, and/or continued use of systems and/or materials in contradiction to life-limits or usage restrictions set at the time of product approval. This means VHMs should be developed in accordance with the existing harmonized MG-15 approach whereby the Design Assurance Level for monitor systems is set to equal the components being monitored. . **PROPOSED ACTION/TEXT**

See comments in statement or harmonize as default solution.

response | Please see the response to comment #406.

comment | 409 comment by: FAA – Liz Brandli

Section 3.1.a.4

Priority: Medium

RATIONALE / REASON / JUSTIFICATION

With respect to **"... provide an acceptable means of compliance for the design and certification"** ...
Is there empirical evidence suggesting the MG-15 guidance is not working or inadequate? It was harmonized and created by an Industry Working Group with Regulators, and has been in operation for years.

With respect to: "The scope of MG 15 is now addressed by this AMC."

This is an incorrect statement because the harmonized MG-15 Health Usage Monitoring Systems (HUMS) is for all systems covering both usage and maintenance credit. This NPA is discussing VHMs and is derived from CS 29.1465 which has a scope covering VHMs only. "CS 29.1465 Vibration health monitoring (a) If certification of a rotorcraft with vibration health monitoring of the rotors and/or rotor drive systems ..."
.
PROPOSED ACTION/TEXT

See comments in statement or harmonize as default solution.

response | Partially accepted

It is true that HUMS is a broader topic than VHM. This has been amended.

In any case, this does not change the fact that EASA saw a need to update AMC 29.1465 covering the topic of credit validation for VHM systems, thus, replacing MG-15 within the EASA framework, which is considered, to some extent, incomplete and outdated. The guidance provided by the new AMC and GM should still be considered as relevant for HUMS, even if some sections would require adaptations. This is now reflected in the note.

comment | 410 comment by: FAA – Liz Brandli

Section 3.1.d.2

Priority: Medium

RATIONALE / REASON / JUSTIFICATION

Regarding **Establishment of VHM system safety requirements**
MG-15 calls out 29.1309 which addresses the System Safety process. This section is re-stating that same information with the exception of "**... applicant may then consider alleviating these safety requirements**" by "**(B) The probability of occurrence of any preceding degraded conditions.**". There should be no need to state preceding conditions in the evaluation of a DAL since the 29.1309 Systems Safety process is expected to take into account all conditions during assessment and while setting the DAL.

The harmonized MG-15 does not allow a 'Catastrophic' failure condition without a mitigating action. This NPA appears to be allowing it. I again suggest the MG-15 be harmonized and updated should Industry agree to this change.
.
PROPOSED ACTION/TEXT

See comments in statement or harmonize as default solution.

response

Not accepted

From the comment, it is unclear whether the commentator understood the intent of paragraph (d) of the AMC. Considering that VHM systems are, to some extent, similar to a protection system as described in 5.2.4 from ED-79A/ARP4754A, the idea of this paragraph was to describe an equivalent process for VHM which is not considered a standard approach under CS-29.1309. As such, the statements from this comment highlighting that 'there should be no need to sate preceding conditions in the evaluation of a DAL' and 'MG-15' does not allow a 'Catastrophic' failure conditions without a mitigating action' are not shared by EASA.

In the interest of harmonisation, the FAA is welcome to contact EASA and share any expectations on reaching a common ground regarding the application of the system safety process to VHM systems.

comment	410b comment by: FAA – Liz Brandli *Section 3.1.d.2.I.B* **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** With respect to: **"VHM relies on a degraded condition that precedes the failure to generate a mechanical response"** As mentioned, this section is a deviation from the harmonized MG-15 guidance. Furthermore, the content alludes to a specific design and functionality. Other systems may not work this way and efforts were made in the harmonzed MG-15 to keep design details out and generic non-prescriptive guidance in. Al kinds of HUMS should be expected by Applicants. Recommendation, harmonize and update MG-15. **PROPOSED ACTION/TEXT** See comments in statement or harmonize as default solution.
response	Please see the response to comment #410.

comment	411 comment by: FAA – Liz Brandli *Section 3.1.e.1* **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** The wording in many sections is very prescriptive. For example, the data collection frequencies in section **3.1.e.1 Signal Acquisition,** the storage requirements in section **3.1.e.2 Data storage, transfer**, etc. **PROPOSED ACTION/TEXT** -
response	Noted It is understood that this comment refers to the 15 FHs intervals prescribed for signal acquisition and data storage and review. This reflected a best practice from HeliOffshore, and was not intended to be prescribed. These intervals have now been moved to GM.

comment	412 comment by: FAA – Liz Brandli *Section 3.1.e.2* **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** With respect to: **"In the event that a complete data set is not recorded, the data transfer process should be capable of downloading a partial data set to the ground-based system and highlight it as such to alert maintenance personnel. The necessary procedures to be followed should be provided in the ICA."** The guidance should address data quality, integrity, and security more robustly. For instance, If bad data is coming off a fully-qualified airborne system, then there should be guidance to provide assurance the on-board sensors, software, and/or contributing sysems are not failing. In addition, there should be guidance addressing what the VHM does in the presence of erroneous and/or partial data sets, such as the VHM defaulting to original design regulations and conservatism. **PROPOSED ACTION/TEXT** See comments in statement or harmonize as default solution.
Response	Not accepted The comment refers to erroneous or misleading data, and not simply to a partial set of correct data, as the text quoted. In the interest of harmonisation, the FAA is welcome to contact EASA and share any expectations on reaching a common ground regarding VHM.

comment	413 comment by: FAA – Liz Brandli *Section 3.1.e.3* **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** With respect to **"VHM alert generation"** I would think the better approach here would be to update the harmonized MG-15 guidance and re-harmonize with Industry coordination. **PROPOSED ACTION/TEXT** See comments in statement or harmonize as default solution.
response	Not accepted This NPA has been developed with the support of major rotorcraft TCHs and a representative of an offshore operator. The FAA was invited to this rulemaking group but elected not to participate. In the interest of harmonisation, the FAA is welcome to contact EASA and share any expectations on reaching a common ground regarding VHM.

comment	414 comment by: FAA – Liz Brandli *Section 3.1.g* **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** Regarding "**VHM applications for credit**" ... I believe the content, integrity, analysis, and resulting decisions on the data being collected needs more harmoinized discussion. CS/CFR 29.1461.b.2 states "**Equipment control devices, systems, and instrumentation must reasonably ensure that no operating limitations affecting the integrity of high energy rotors will be exceeded in service**". Operating limitations are established during certification via CS/CFR 29.1501-1503 and on. "HUMS for credit" could possibly make defined limitations a moving target. Current AMC 29.1465.m.1 states the following: "**For the case where the VHM system is stand alone**: "**Should a design be proposed where greater reliance was placed solely on VHM, this would not be in compliance with the "minimise" target of CS 29.917(b) and CS 29.547(b).**" Furthermore, VHM 'for credit' would likely also be non-compliant to this: CS/CFR 29.571.i ... "**If inspections for any of the damage types identified in sub-paragraph (e)(4) cannot be established within the limitations of geometry, inspectability, or good design practice, then supplemental procedures, in conjunction with the PSE retirement time, must be established to minimize the risk of occurrence of these types of damage that could result in a catastrophic failure during the operational life of the rotorcraft.**" **PROPOSED ACTION/TEXT** See comments in statement or harmonize as default solution.
response	Not accepted The purpose of the comment is not understood. In the interest of harmonisation, the FAA is welcome to contact EASA and share any expectations on reaching a common ground regarding VHM.

comment	415 comment by: FAA – Liz Brandli *Section 3.1.i* **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** With respect to the NPA ammending the guidance with **"... VHM system applications for which a failure severity greater than major has been identified in accordance with paragraph (d) of this AMC, the use of non-qualified hardware and software platforms should be limited in order to ensure the end-to-end system integrity and safety. Therefore, for such applications, non-qualified platforms should not be solely relied upon for the processing of VHM data and/or determining the need to provide indications regarding the condition of the components monitored."** Non-qualified hardware and/or software platforms should not be relied upon for any issue above minor. This position would then be consistent with the currently approved AMC guidance and the harmonized MG-15. I also suggest MG-15 be updated to specify (in addition to DO-178) that DO-330 or DO-278 can be used for ground-based application software/systems that feedback into aircraft operation and/or maintenance. **PROPOSED ACTION/TEXT** See comments in statement or harmonize as default solution.
response	Not accepted The statement quoted by the FAA specifies that EASA considers that non-qualified hardware and software platforms can be adequate up to a major VHMS failure severity (beyond this failure severity, additional means should be provided if non-qualified platforms are used). Nevertheless, adequate provisions need to be substantiated by the applicant to ensure the reliability of the ground-based software and hardware platforms do not compromise the end-to-end system integrity and safety. Thus, the text limits the use of non-qualified platforms as the only means for platforms that contribute to more than major FC. The proposal to update FAA AC 29-2C MG-15 as a comment to an EASA NPA on CS-29 seems out of context.

comment	416 comment by: FAA – Liz Brandli *General comment* **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** Many of the CS/CFR regulations I reviewed along with this NPA (i.e., 29.301-309, 29.571-573, 29.601-603, 29.659, 29.907, 29.917-923, 29.1461-29.1465. and the part on limitations starting in section 29.1501), made it clear that the NPA is engaging in over-reach. However, it could also be said, that in some areas, MG-15 is doing the same thing. The difference is that MG-15 is harmonized at this point and efforts to use HUMS 'for credit' (if ever allowed), should be harmonized with Industry. In addition, should it become clear during the harmonization that the CS/CFR regulations need to be re-worked, they too should be harmonized and updated. **PROPOSED ACTION/TEXT** See comments in statement or harmonize as default solution.
response	Not accepted The comment about this rulemaking activity engaging in over-reach is not understood. There is nothing in any certification specifications that prevents a VHM system from being installed and certified for credit. In fact, only AMC and GM are amended as part of this task, which, by definition, cannot alter the scope/intent of existing certification specifications. In addition, EASA does not understand why other certification specifications may need to be updated. In the interest of harmonisation, the FAA is welcome to contact EASA and share any expectations on reaching a common ground regarding VHM.

comment	417 comment by: FAA – Deepak Kamath *General comment* **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** "Overall, its good to see this document addressing safety related alerting using vibration signatures. It could benefit from some simplification in some areas discussed below." **PROPOSED ACTION/TEXT** Pls see comments below.
response	Noted

comment	418 comment by: FAA – Deepak Kamath *Table 1* **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** Clarify the meaning of the combinations (A) and (B); (A) or (B) and Neither (A) nor (B). Currently the document describes A has Mitigating Actions; and B as Probability of occurrence. It will be good to define the criteria for When "A" and "B" are 'true' and 'false'. **PROPOSED ACTION/TEXT** It would be useful to include 1-2 examples of mitigating actions for A; and probability threshold for B.
response	Partially accepted This section has been reworked to improve clarity. A and B are true when their respective conditions, described directly below in the AMC, are met. Also, a new GM section has been added to clarify the use of AMC1 29.1465(d).

comment	419 comment by: FAA – Deepak Kamath *Section 3.1(g) p 29* **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** What was the rationale for selecting the Prognostic interval scalers of 3 for Standard and 10 for Enhanced ? This question will likely come up from applicants. **PROPOSED ACTION/TEXT** Requesting clarification as background info for supporting interactions with industry.
response	Noted The logic behind the factor of 3 for Standard is derived from the general rule used for structural inspections generally targeting 3 opportunities for detection from detectable damage to complete failure. The factor of 10 for Enhanced was proposed by members of the rulemaking group as a value that clearly justified a substantial improvement in the system capabilities relative to the factor of 3 for Standard.

comment	420 comment by: FAA – Deepak Kamath *Overall MoC General Moc approach* **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** This MoC has many categories and subcategories - For Airworthiness Credit vs Supplementary Information - Standard vs Enhanced Performance - Complex or Non-complex - Class 1,2,3 for Verification levels Will these be annotated on the TC or STC ? Is the Complex or Non-Complex delineation necessary ? It is making the document more confusing. **PROPOSED ACTION/TEXT** Please consider simplification of the MoC approach.
response	Noted The structure has been kept. Nevertheless, the sections have been reworked and diagrams have been added to improve clarity.

comment	421 comment by: FAA – Deepak Kamath Overall MoC General Moc approach Priority: Medium RATIONALE / REASON / JUSTIFICATION The acceptance of the vibration health monitoring (VHM) system as an equivalence means of compliance with CS 29.571/573 may have the effect of reducing safety. The proposed change would allow applicants to install VHM systems without performing a fatigue tolerance evaluation of Principal Structural Elements. The fatigue tolerance evaluation includes, but is not limited to, performing a threat assessment to determine probable locations, types, and sizes of damage taking into account fatigue, environmental effects, intrinsic and discrete flaws, or accidental (and impact) damage that may occur during manufacture or operation. The evaluation is required to be supported by test evidence. The VHM system should be supplemental to any inspection or retirement program established by analyses and test. PROPOSED ACTION/TEXT Recommend CS 29.571/573 be retained and the VHM system could be integrated with the inspection and retirement programs, as applicable, of parts. It isn't a good idea to rely on inspection alone without an evaluation to support it and any other procure necessary to address the possible threats.
response	Noted The proposed AMC1 29.1465 indicates that VHM may be used as an approved equivalent means in support of compliance with CS 29.571/573 (as described in AC29-2C 29.571 (f)(10)). Thus, this AMC does not remove the need for a fatigue tolerance evaluation; it simply introduces the possibility of using VHM in conjunction with or as a replacement for inspections and/or retirement times.

comment 422 comment by: FAA – Andy Shaw and Martin Crane

General

Priority: Medium

RATIONALE / REASON / JUSTIFICATION

The proposed expansion of EASA CS 29.1465 and AMC 29.1465 to be applied to VHM/HUMS approved on a for "credit" basis is unnecessary and not acceptable to the FAA. Per the existing AMC 29.1465 guidance, any VHM/HUMS approved as a for "credit" system must follow the FAA/EASA harmonized guidance of AC 27-1B, MG-15 & AC 29-2C, MG-15. Replacing MG-15 with this proposed guidance presents the FAA with significant safety concerns. This will create a new Significant Standards Difference that does not exist with the current AMC 29.1465. The FAA would expect any future incoming validations to follow the existing harmonized guidance of MG-15. This NPA proposes to expand VMS systems to allow their approval as for "credit" systems. The existing AMC 29.1465 states that “VHM applications with hazard severity level Major or higher are addressed by MG15 and not AMC 29.1465.” and “Where a VHM application is identified as a compensating provision in order to comply with CS 29.547(b) and/or CS 29.917(b), then the failure criticality is considered to be ‘Minor’. A proposed design that places greater reliance on VHM would not be deemed compliant with the “minimise” target of CS 29.547(b) and CS 29.917(b).”
NPA Section 2.3. states “In particular, AMC1 29.1465 is proposed to be improved and amended by:
— defining criteria for the acceptance of VHM systems as an airworthiness approved means for enabling the possibility for on-condition maintenance;…”
Based on the existing FAA/EASA harmonized acceptance and application of CS29.1465 and HUMS for credit, if a VMS system was to have a hazard severity of Major or higher, MG-15 guidance would apply. The NPA intends to replace the harmonized MG-15 HUMS for credit means of compliance and bring 29.571, 29.573 compliance under the VMS umbrella.
Any extension of VHM applications to replace HUMS for credit under MG-15 should be removed throughout the document. Otherwise, this will result in a new FAA/EASA Significant Standards Difference.

PROPOSED ACTION/TEXT

EASA's proposal to apply the existing certfication approach/process for VHM applications to the approval of HUMS for "credit" should be removed since the long established FAA/EASA harmonized guidance in AC 27-1B, MG-15 & AC 29-2C, MG-15 were previously determined by FAA and EASA to be appropriate. The Rotorcraft industry acknowledged the appropriateness of the FAA/EASA harmonized guidance in MG-15 at a HUMS Summitt held in conjunction with a prior anual EASA Rotorcraft Safety Symposium in Cologne, Germany. The purpose of the HUMS Summitt was to solicit industry's feedback on MG-15. Industry's feedback was that the guidance and approach for HUMS certifcaitons is appropriate. The EASA proposal in the NPA will result in an FAA/EASA Significant Standards Difference for HUMS approvals.

response

Not accepted

FAA AC 29 MG 15 was published 20 years ago and, to EASA's knowledge, never used for the certification of HUMS for credit. EASA has been faced with the need to certify VHM systems for credit and saw a need to update AMC 29.1465 covering the topic of credit validation for VHM systems, thus, replacing MG-15 within the EASA framework, which is considered, to some extent, incomplete and outdated.

The FAA was invited to this rulemaking group but elected not to participate. In the interest of harmonisation, the FAA is welcome to contact EASA and share any expectations on reaching a common ground regarding VHM.

comment

423 comment by: FAA – Andy Shaw and Martin Crane

General

Priority: Medium

RATIONALE / REASON / JUSTIFICATION

This NPA creates a Significant difference for validation and certification programs between EASA and the FAA.harmonized guidance in AC 27-1B, MG-15 & AC 29-2C, MG-15 when applied to HUMS for "credit" approvals. This harmonized guidance was released over 15 years ago. The first item addressed in the NPA is that EASA will no longer be using the MG15 guidance for certification of HUMS for credit, and in its place the NPA will be used. The methodology and information in many parts of EASAs NPA guidance goes directly against the long standing FAA position on the use and certification of HUMS. MG15 prohibits certification of HUMS systems higher than DAL B, this is because the HUMS approach must include other additional mitigation strategies in addition to the systems DAL levels in order to deal with catastrophic failure conditions. The EASA NPA proposal relies solely on DAL A HUMS without the need for any additional mitigations to protect against Catastrophic failure. This is a significant departure from what has been allowed in the past by MG15. Furthermore, the proposed NPA allows additional DAL reduction requirements based on the likelihood that a critical structural element will fail. The FAA has never accepted a probability of an ALS part failing vs others as an acceptable approach in determining the appropriate DAL level for systems development requirements. MG15 prohibits any systems that would provide the flight crew with annunciations of real-time impending HUMS alerts that would require flight crew action. The EASA NPA proposes the acceptability of real-time monitoring of critical parts, and providing the flight crew with warning or caution messages to divert their flight plan or land immediately. MG-15 prohibits this level of real-time prognosticating HUMS systems due to the fact that such systems are inherently much more complex to verify and validate. The idea that there would be a flight by flight continuous re-lifing of structural element who's failure would result in catastrophic failure, and to allow that part's life to be used up to a point that would require the flight crew to land immediately greatly reduces the existing margins of safety to an unacceptable level. It also exhibits and unsafe reliance on a HUMS system.
Any aircraft certification program that utilizes the EASA NPA methodology would

need to have significant review by the FAA prior to issuing a Validation of certification certificate .
PROPOSED ACTION/TEXT

Any extension of VHM applications to replace HUMS for credit under MG-15 should be removed throughout the document. The EASA NPA will result in a new FAA/EASA Significant Standards Difference.

response

Not accepted

Please see the response to comment #422.

In addition, this comment states that 'MG15 prohibits certification of HUMS systems higher than DAL B'. This is not the case as MG15 prohibits the certification of HUMS systems with catastrophic failure consequences, which is substantially different.

The NPA never states that VHM systems with catastrophic failure consequences can be designed and certified. It states that for the purpose of designing VHM systems for credit, under certain circumstances, the system safety requirements should be those applied to a system whose failure consequences would be catastrophic. Thus, this point is completely misunderstood by the FAA.

The comment also states: 'The EASA NPA proposes the acceptability of real-time monitoring of critical parts, and providing the flight crew with warning or caution messages to divert their flight plan or land immediately.'. This is, once again, not the case since the proposed AMC1 29.1465(m)(1) clearly states that 'it is very difficult to design and demonstrate that a VHM system has sufficient capability and reliability to provide cockpit indications in flight requiring immediate pilot actions which may result in hazardous or catastrophic consequences for the rotorcraft. Such actions typically involve the requirement to land immediately or within a limited period of time. It is considered that any failure monitored by VHM that would require such immediate and drastic pilot action should be prevented through robust design methodologies, ensuring that the probability of occurrence is in line with the safety objective.'

In general, this comment is considered too broad and difficult to answer in the CRD. In the interest of harmonisation, the FAA is welcome to contact EASA and share any expectations on reaching a common ground regarding VHM.

comment

424 comment by: FAA – Andy Shaw and Martin Crane

P8 3.1(a)(4)

Priority: Medium

RATIONALE / REASON / JUSTIFICATION

Note:FAA AC 29-2C Miscellaneous Guidance (MG)15, which addresses the use of health and usage monitoring systems(HUMS)in maintenance, is no longer recognised

	as valid guidance for the purpose of VHM system certification within the EASA framework. The scope of MG15 is now addressed by this AMC MG-15 is the approved, accepted and harmonized guidance for the use of Health and Usage Monitoring. If a VHM system is intended to be used in support of a CS 29.571/573 approved equivalent means, MG-15 must be used. The proposed AMC guidance is not an acceptable replacement. **PROPOSED ACTION/TEXT** Change the note to: Note: FAA AC 29-2C Miscellaneous Guidance (MG)15 is the acceptable means to be used for any VHM system intended for credit use against any other CS 29 requirements (571/573/etc).
response	Not accepted The note has been amended to read: 'FAA AC 29-2C Miscellaneous Guidance (MG)15, which addresses the use of health and usage monitoring systems (HUMS) in maintenance, is no longer recognised for the purpose of VHM system certification within the EASA framework. The scope of MG 15 for what refers to VHM systems is now addressed by this AMC. For other health and usage monitoring systems (HUMS), applicants should consider this AMC as relevant guidance, although sections may require adaptations.' In any case, it is clearly EASA's intent to apply the new AMC1 29.1465 for VHM systems intended for any kind of credit. In the interest of harmonisation, the FAA is welcome to contact EASA and share any expectations on reaching common ground regarding VHM.

comment	425 comment by: FAA – Michael McGuire and Walter Sippel *P8 3.1(a)(3)ii* **Priority:** Medium **RATIONALE / REASON / JUSTIFICATION** Any application where the VHM system is integrated into inspection and retirement under the fatigue evaluations in CS 29.571/29.573 must meet the requirements in the 29.571/29.573 guidance. Other procedures are likely necessary to address other possible threats. The acceptance of the vibration health monitoring (VHM) system as an equivalent means of compliance with CS 29.571/573 may have the effect of reducing safety. The proposed change would allow applicants to install VHM systems without performing a fatigue tolerance evaluation of Principal Structural Elements. The fatigue tolerance evaluation includes, but is not limited to, performing a threat assessment to determine probable locations, types, and sizes of damage taking into account fatigue, environmental effects, intrinsic and discrete flaws, or accidental (and impact) damage that may occur during manufacture or operation. The evaluation is required to be supported by test evidence. The VHM system should be supplemental to any inspection or retirement program established by analyses and test. Please see additional comment on page 8 (a)(3)(ii) **PROPOSED ACTION/TEXT** For VHM systems with airworthiness-related purposes, use MG-15. Remove paragraph 3.1 (a)(3)(ii).
response	Not accepted The proposed AMC1 29.1465 indicates that VHM may be used as an approved equivalent means in support of compliance with CS 29.571/573 (as described in AC29-2C 29.571 (f)(10)). Thus, this AMC does not remove the need for a fatigue tolerance evaluation; it simply introduces the possibility of using VHM in conjunction with or as a replacement for inspections and/or retirement times.