International MRB Policy Board

Issue Paper (IP)

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Title:	Harmonization of AHM Terminology in MSG-3 Volume 1
Submitter:	MPIG AHM Working Group

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

Issue:

There are multiple aircraft health-related terms used in regulatory documents, academia, and industry that are interpreted differently and may result in conflicting information and action taken by the industry.

Problem:

The industry is using different aircraft health-related terminology that may lead to confusion over the level of responsibility for managing the end-to-end process of aircraft health assessment.

Example 1: The industry is interpreting the "M" in various acronyms differently, some mean "monitoring" and others mean "management".

- AHM – Aircraft Health Management (Boeing product)
- AHM – Aircraft Health Monitoring (MSG-3, US Regulatory Documents)
- IAHM – Integrated Aircraft Health Management (US Regulatory Documents)

Example 2: The industry defines the terms "monitoring" and "management" differently when referring to aircraft and vehicle health assessments, depending on the context. The FAA, EASA, and other regulatory agencies differ in their definition and use of these two terms pertaining to their processes and organizations for airworthiness. In Europe, CAMOs "manage" the continued airworthiness whereas in the US, the operators "manage" the continued airworthiness. This can lead to confusion about who manages the "end-to-end" process as defined in US Regulatory Documents.

Example 3: The industry is using many terms to describe similar capabilities. Some capabilities are considered a subset of other overarching terms.

- AHM – Aircraft Health Management
- AHM – Aircraft Health Monitoring
- DPHM - Diagnostics and Prognostics Health Management
- CBM – Condition Based Maintenance
- CBM+ - Condition Based Maintenance Plus
- ECM – Engine Condition Monitoring
- EHM – Engine Health Management
- HFDM – Helicopter Flight Data Monitoring
- HUMS – Health and Usage Monitoring System
- IAHM – Integrated Aircraft Health Management

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- IAHM – Integrated Aircraft Health Monitoring
- IVHM – Integrated Vehicle Health Management
- PHM – Prognostics and Health Management
- Scheduled Health and Usage Monitoring (S-HUM)
- Scheduled Structural Health Monitoring (S-SHM)
- SHM – Structural Health Management
- SHM – Structural Health Monitoring
- VHM – Vibration Health Monitoring
- Predictive Maintenance
- Prescriptive Maintenance
- Preventative Maintenance

Related Discussion:

This CIP is intended to support harmonization across the industry by revising the aircraft health-related terminology used in MSG-3 Volume 1. This CIP does not recommend a name change in cases where terminology is proprietary, has commercial value, or is being used to perform specific health monitoring activities, such as Engine Condition Monitoring (ECM) or Structural Health Monitoring (SHM).

Recommendation (including Implementation):

To support harmonization and avoid conflicting terminology, health-related wording, abbreviations, and definitions used in the MSG-3 document should be selected and agreed upon by the IMRBPB. This CIP proposes that Integrated Aircraft Health Management (IAHM) be the terminology selected and used in the MSG-3 document going forward.

The following changes to the MSG-3 Volume 1 document are proposed.

1. **Chapter 1-3-1. Industry Steering Committee**

   The management of the scheduled maintenance development activities shall be accomplished by an **Industry Steering Committee** composed of members from a representative number of operators and representatives of the prime airframe and engine manufacturers. It shall be the responsibility of this committee to establish policy, decide on IAHM~~AHM~~ consideration, set initial goals for scheduled maintenance check intervals, direct the activities of working groups or other working activity, carry out liaison with the manufacturer and other operators, prepare the final recommendations and represent the operators in contacts with the Regulatory Authority. The ISC should see that the MSG-3 process identifies 100% accountability for

all **Maintenance Significant Items (MSI's)** and **Structural Significant Items (SSI's)**, whether or not a task has been derived from the analysis.

2. **Chapter 2-1-2. IAHM Introduction**

Integrated aircraft health management (IAHM) is an end-to-end concept that encompasses aircraft systems, data transfer, and data analysis/implementation, often involving ground equipment. IAHM uses data generated by specific aircraft systems to determine condition, incipient faults, reduced resistance to failure, or degradation of function for the purpose of timely scheduling of maintenance actions. IAHM typically includes Sensing, Acquisition, Transfer, Analysis, and Action(s) taken: "SATAA").

IAHM in aircraft maintenance has been commonly known by many terms, including:

- Aircraft Health Monitoring (AHM)
- Aircraft Condition Monitoring Systems (ACMS)

To avoid conflicting terminology and increase harmonization, the industry has adopted IAHM as the preferred terminology in the MSG-3 document going forward when referring to the certified for credit, end-to-end health management capability.

3. **Chapter 2-1-2.3~~2~~. Scheduled Maintenance Content**

A group of alternative procedures and/or actions and/or tasks, as related to above (1) to (5), which make use of IAHM~~AHM~~ capability.

4. **Chapter 2-1-2.4~~3~~. Method for Scheduled Maintenance Development**

Items that, after analysis, have no scheduled task specified, may be monitored by an operator's reliability program and/or optionally make use of IAHM~~AHM.~~

5. **Chapter 2-3. Aircraft Systems/Powerplant Analysis Procedure**

The references to and use of IAHM~~AHM~~ throughout this section requires the certification of the associated on-aircraft system features by the type certification staff of the Regulatory Authority. The use of IAHM~~AHM~~ is limited to non-safety tasks provided the tasks are not covering CCMRs.

6. **Chapter 2-3-2. Analysis Procedure**

For systems providing IAHM~~AHM~~ capability, all related functions of the corresponding MSIs and candidate MSIs have to be identified if they are

intended to be used. After the Level 3 analysis exercise is completed, information is to be provided to the ISC in order to show that all systems/sub-systems providing IAHM~~AHM~~ functionality were accounted for and its analyses has been checked for completeness.

Tasks and intervals required in the scheduled maintenance are identified using the procedures set forth herein. Both the economic and safety related tasks are included so as to produce initial scheduled maintenance tasks/intervals.

All available Vendor Recommendations (VR) should be fully considered, discussed in the MWG meetings, and accepted only if they are applicable and effective according to MSG-3 criteria.

Prior to applying the MSG-3 logic diagram to an item, a preliminary work sheet will be completed that clearly defines the MSI, its function(s), functional failure(s), failure effect(s), Failure Cause(s) and any additional data pertinent to the item; e.g., ATA chapter reference, fleet applicability, manufacturer's part number, a brief description of the item, expected failure rate, hidden functions, need to be on M.E.L., redundancy (may be unit, system or system management), IAHM~~AHM~~ capability (including certification considerations), parameters and outputs (data generated), etc. This work sheet is to be designed to meet the user's requirements and will be included as part of the total MSG-3 documentation for the item.

7. **Chapter 2-3-3.1. Level of Analysis**

   The decision logic has two levels (Level 1 and 2) enabling the development of Classic tasks (Ref. [Figure 2-2.1]) and a third level (Level 3) enabling the use of IAHM~~AHM~~ (Ref. [Figure 2-3-9.1]):

8. **Chapter 2-3-3.1.c) Level 3**

   Level 3 - If the system offers IAHM~~AHM~~ capability, a third level decision logic (i.e. Level 3) may be applied. This level enables working groups to assess Failure Causes covered by IAHM~~AHM~~ capability associated with lubrication and servicing, detecting degradation, and detecting hidden failure.

9. **Chapter 2-3-9. IAHM~~AHM~~ Candidate Analysis (Third level)**

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1. General

The IAHM~~AHM~~ Candidate category consists of the Failure Causes for which IAHM ~~AHM~~ capability exists and for which a Classic task was selected following the Level 2 analysis (see definition). All IAHM ~~AHM~~ candidates are processed through the logic diagram of Level 3 analysis. There are three steps associated with the logic diagram. Each step begins with an opening question intended to assess the applicability to the IAHM ~~AHM~~ candidate.

Each Failure Cause covered by IAHM ~~AHM~~ capability is assessed for:

- Need for lubrication and/or servicing (step 1)
- Detecting degradation (step 2)
- Detecting hidden failure (step 3 - for FEC 8 and 9 only)

The methodology assesses:

- IAHM ~~AHM~~ applicability to the Failure Cause(s)
- Time margin between IAHM ~~AHM~~ notification and the respective IAHM ~~AHM~~ procedure / action
- ~~AHM~~ effectiveness related to the Failure Cause(s)
- Whether IAHM ~~AHM~~ presents a full or partial alternative to a Classic task

Three possible outcomes may result from the IAHM ~~AHM~~ candidate analysis (per Figure 2-3-9.1)

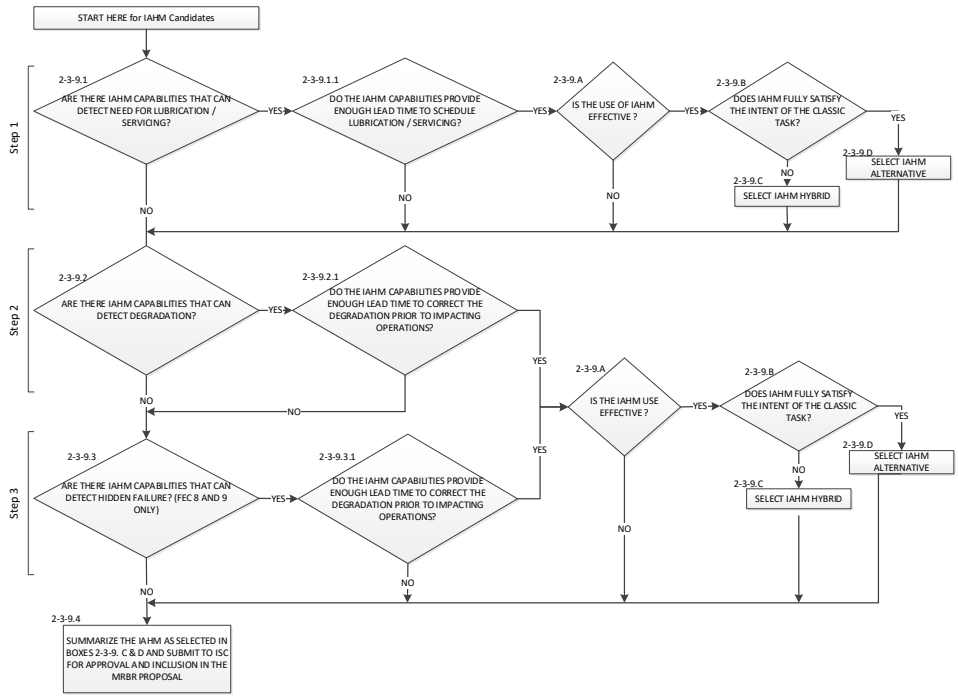
1. No IAHM ~~AHM~~
2. IAHM ~~AHM~~ Alternative(s)
3. IAHM ~~AHM~~ Hybrid(s)

IAHM ~~AHM~~ alternative(s) and IAHM ~~AHM~~ hybrid(s) (i.e. above 2. and 3.) may be used instead of the Classic task. The manufacturer must provide traceability to the Classic task (two way). The PPH will define how these are published in the MRBR and how traceability and the link to detailed procedure documents will be ensured. Except for an IAHM~~AHM~~ applicability note, the Classic task remains unchanged and available. The Classic task, IAHM ~~AHM~~ alternative and IAHM ~~AHM~~ hybrid each fulfil the minimum requirements and may be individually selected by the operator. The manufacturer will provide provisions which allow the operator to switch between the Level 2 and Level 3 outcome throughout the service life of the

aircraft.

The Original Equipment Manufacturer (OEM) must clearly identify IAHM ~~AHM~~ system configuration (e.g. Mod No., Option No., dash-Number) and respective IAHM ~~AHM~~ functionality within the IAHM ~~AHM~~ analysis worksheet in sufficient detail to allow the working groups to answer all questions associated with the logic flow.

10. Figure 2-3-9.1. Systems/Powerplant MSG-3 Logic Diagram – Level 3 Analysis



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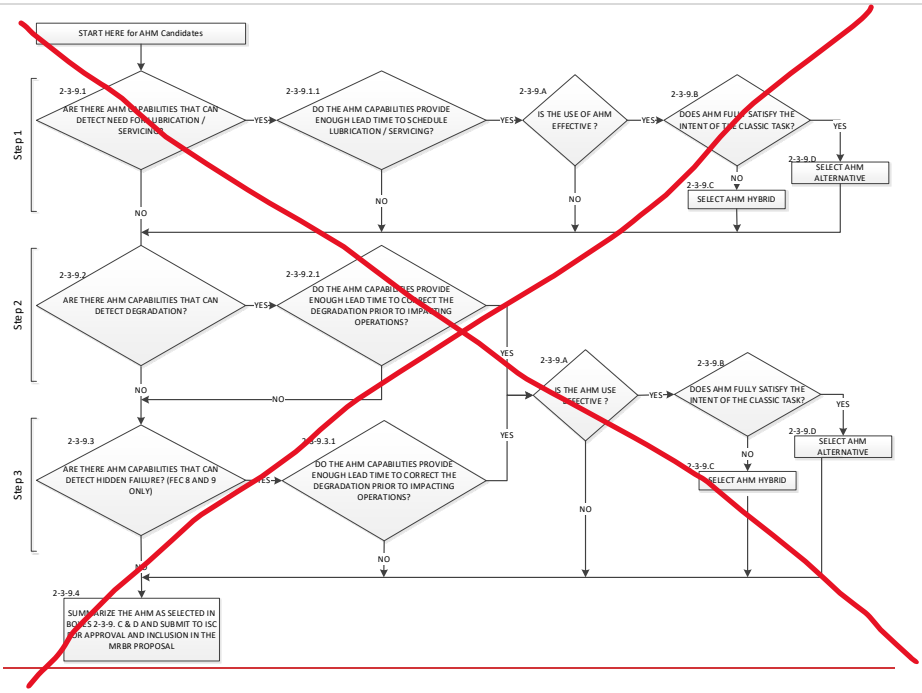

11. Chapter 2-3-9.2 Step 1

Box 2-3-9.1: ARE THERE IAHM~~AHM~~ CAPABILITIES THAT CAN DETECT NEED FOR LUBRICATION / SERVICING?
Parameter(s) indicating (directly or indirectly) the need for lubrication / servicing must be available to IAHM~~AHM~~.

Box 2-3-9.1.1: DO THE IAHM~~AHM~~ CAPABILITIES PROVIDE ENOUGH LEAD TIME TO SCHEDULE LUBRICATION / SERVICING?
The IAHM~~AHM~~ must provide timely awareness to the operator before the loss of the function in order to allow the LUB/SVC task to be scheduled at the next convenient opportunity.

In answering the question, consideration should be given to the ease in which corrective action can be applied and the time required for preparation (e.g. accomplished at an outstation/line maintenance or in a hangar, availability of parts).

Box 2-3-9.A: (as applicable to all three steps) IS THE IAHM~~AHM~~ USE EFFECTIVE?
The same criteria as in Level 2 are used in determining the effectiveness of IAHM~~AHM~~.

The IAHM~~AHM~~ must be as effective as or more effective than the Classic task(s) selected in Level 2 analysis according to the FEC. In assessing the IAHM ~~AHM~~ effectiveness, the following criteria must be satisfied by IAHM~~AHM~~, as applicable, for:

- FEC 8: it reduces the risk of failure to assure safe operations
- FEC 6&9: it reduces the risk of failure to an acceptable level
- FEC 7&9: the cost of IAHM~~AHM~~ is less than the cost of potentially recurring failure

Box 2-3-9.B: (as applicable to all three steps) DOES IAHM~~AHM~~ FULLY SATISFY THE INTENT OF THE CLASSIC TASK?
IAHM~~AHM~~ must address all Failure Causes covered by the Classic task.

NOTE: In assessing the question consideration should include IAHM~~AHM~~ capability beyond those associated with Failure Cause (e.g. functional failure). The way IAHM~~AHM~~ mitigates the Failure Cause does not necessarily have to be the same as the Classic task, for example a Failure Cause covered by a classic qualitative visual check (failure finding task) may be fully covered by quantitative IAHM~~AHM~~ monitoring (potential failure finding).

Box 2-3-9.C: (as applicable to all three steps) SELECT IAHM~~AHM~~ HYBRID
This is a Classic task supplemented by IAHM~~AHM~~ which may change scope, interval or procedure. In this case the IAHM~~AHM~~ does not fully satisfy the intent of the Classic task – not all Failure Causes are covered byIAHM ~~AHM~~.

Examples of combination could be (but are not limited to):

- IAHM~~AHM~~ paired with modified Classic task at different interval (e.g. for partial – not all Failure Causes)
- Classic task scheduled by parameters from IAHM~~AHM~~ (e.g. for delta P – a restore task converted to FC at a reduced interval)
- IAHM~~AHM~~ data applied for scheduled checks (e.g. for Air Cycle Machine – temp records of operational environments allow for a different interval for ACM maintenance)
- IAHM~~AHM~~ may provide usage parameter to aid in task interval definition

The IAHM~~AHM~~ Hybrid is published within the MRBR.

Box 2-3-9.D: (as applicable to all three steps) SELECT THE IAHM~~AHM~~ ALTERNATIVE
This outcome is a fully equivalent IAHM~~AHM~~ alternative to the Classic task. The IAHM~~AHM~~ Alternative is published within the MRBR.

12. Chapter 2-3-9.2 Step 2

Box 2-3-9.2: ARE THERE IAHM~~AHM~~ CAPABILITIES THAT CAN DETECT DEGRADATION?
Parameter(s) indicating (directly or indirectly) functional degradation or deterioration of components must be present.

Box 2-3-9.2.1: DO THE IAHM~~AHM~~ CAPABILITIES PROVIDE ENOUGH LEAD TIME TO CORRECT THE DEGRADATION PRIOR TO IMPACTING OPERATIONS?
In answering the question consideration should be given to the ease in which corrective action can be applied and the time required for preparation (e.g. accomplished at an out-station/line maintenance or in a hangar, availability of parts).

The IAHM~~AHM~~ must provide timely awareness to the operator before the loss of the function in order to allow the corrective action to be scheduled at the next convenient opportunity. The working group must have a satisfactory understanding of the deterioration characteristics (e.g. P to F curve).

13. Chapter 2-3-9.2 Step 3

Box 2-3-9.3: ARE THERE IAHM~~AHM~~ CAPABILITIES THAT CAN DETECT HIDDEN FAILURE? (FEC 8 AND 9 ONLY)
This question is only applicable to Category 8 and 9 functional failures and only if no IAHM~~AHM~~ capability to detect degradation has been identified. Parameter(s) indicating (directly or indirectly) functional failure must be present.

Box 2-3-9.3.1: DO THE IAHM~~AHM~~ CAPABILITIES PROVIDE ENOUGH LEAD TIME TO SCHEDULE CORRECTIVE ACTION?
The IAHM~~AHM~~ must allow the operator to identify the loss of the hidden function in order to prevent a safety, operational or economic impact in combination with a second failure (including back-up). Appropriate lead time will depend on affected function and level of redundancy. Consideration should be similar to those used in determining the interval of a failure finding tasks in level 2 analysis (e.g. consider the length of exposure time to a hidden failure and the potential consequences if the hidden function is unavailable.)

In answering the question consideration should be given to the IAHM~~AHM~~ procedure which must provide detailed instructions about the mitigation action to be launched in

case an alert has been triggered. This action can range from a one-time inspection up to a component replacement and needs to be followed by the operator as defined.

In answering the question consideration should be given to the ease in which corrective action can be applied and the time required for preparation (e.g. accomplished at an out-station/line maintenance or in a hangar, availability of parts).

Documentation and active management of the failure must be addressed by the operator.

Box 2-3-9.4: SUMMARIZE THE IAHM~~AHM~~ AS SELECTED IN BOXES 2.3.9 C & D AND SUBMIT TO ISC FOR APPROVAL AND INCLUSION IN THE MRBR PROPOSAL.
This means that all results produced by the Level 3 analysis, following the logic of boxes C and D per any of the three steps (i.e. Step 1 to 3), should be processed as detailed in the PPH.

14. Chapter 5. Sources of Information

The following information related to IAHM~~AHM~~ capability, such as but not limited to, should be available when evaluating an IAHM~~AHM~~ candidate:

- All IAHM~~AHM~~ parameters and messages associated with the MSI Failure Cause(s)
- How these parameters are expressed to the operator (Maintenance Message, Operation Center monitoring, etc.)
- The frequency the parameters are checked either by automatic (non-human intervention) or manual (human intervention) means
- Vendor/manufacturer test data or related analysis associated with any limitations (e.g. filter contamination, brake wear)
- IAHM~~AHM~~ messaging informing when parameters are unavailable to support the level 3 IAHM~~AHM~~ options.

15. Chapter 6. IAHM~~AHM~~ timing/frequencies

IAHM~~AHM~~ allows operators to identify the need for planning and scheduling maintenance action in order to avoid costly unscheduled maintenance or AOG situations.

Timing associated with the IAHM~~AHM~~ will be contained within the IAHM~~AHM~~ analysis worksheet. Consideration should be given to:

- Message transmittal frequencies,
- Read out frequencies,
- Timing for action, and

Thresholds or limits associated with a parameter.

16. Appendix A. Glossary

~~**Aircraft Health Monitoring (AHM)**~~	~~Aircraft Health Monitoring (AHM) is the use of data generated from specific aircraft systems to determine condition, reduced resistance to failure or degradation of function for the purpose of timely scheduling maintenance actions (the use typically includes Sensing, Acquisition, Transfer, Analysis and Action "SATAA").~~
~~**AHM Alternative**~~	~~AHM that mitigates all Failure Cause(s) covered by a Classic task.~~
~~**AHM Candidate**~~	~~Failure Cause(s) for which AHM capability exists and for which a Classic task exists.~~
~~**AHM Hybrid**~~	~~A combination of AHM and a task resulting in a scheduled action.~~
Integrated Aircraft Health Management (IAHM)	The use of data generated from specific aircraft systems to determine condition, reduced resistance to failure or degradation of function for the purpose of timely scheduling maintenance actions (the use typically includes Sensing, Acquisition, Transfer, Analysis and Action "SATAA").
IAHM Alternative	IAHM that mitigates all Failure Cause(s) covered by a Classic task.
IAHM Candidate	Failure Cause(s) for which IAHM capability exists and for which a Classic task exists.
IAHM Hybrid	A combination of IAHM and a task resulting in a scheduled action.

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