Airlines for America™

We Connect the World

AHM Working Group updates

May 8, 2023

AHM WG Timeline

- Working Group established following 2022 IMRBPB meeting to explore future developments of AHM in MSG-3.

- December 6, 2022: Kick-off meeting
  - AC 43-218 and its relation to MSG-3.
  - Needed CIPs

- January 30, 2023 meeting
  - Hybrid Logic deficiency discussion
  - Terminology alignment sub-group created

- February 28, 2023 meeting
  - CIP MPIG 2023-02 “Level 3 Analysis – AHM Effectiveness Determination” finalized

Kick-Off Meeting

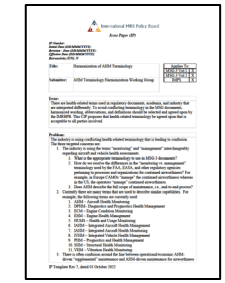
- AC 43-218 Interpretation
  - Applicable documentation for showing approval of the IAHM system
  - Relationship between AC and Level 3 analysis vis-à-vis “criticality of root system”

- Hybrid Logic Revision
  - Problem statement reviewed for possibility of selecting an ineffective AHM Hybrid.
  - Need of CIP vs PPH only

January 30, 2023 Meeting

- CIP 2023-02 Review
  - Change from Hybrid-only revision to broader change
  - Logic diagram revision

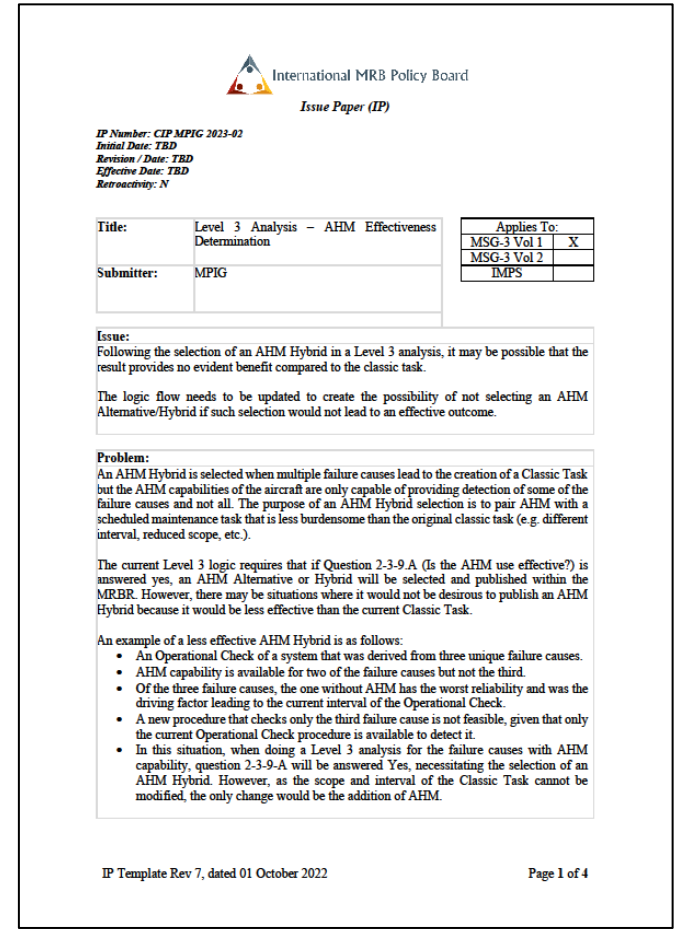
- Terminology Alignment
  - Differences in terminology related to AHM in the industry makes significant risk for misinterpretation or confusion
  - AHM: Aircraft Health – Monitoring or Management?
  - AHM vs ECM vs IAHM vs IVHM
  - Need to consolidate verbiage with common meaning to limit possibility of misinterpretation
  - Sub-group created to draft CIP – Rhonda Walthall (Collins Aerospace) leading effort.



Airlines for America™
We Connect the World

February 28, 2023 Meeting

- CIP MPIG 2023-02 Review
  - Finalized CIP



International MRB Policy Board

Issue Paper (IP)

IP Number: CIP MPIG 2023-02
Initial Date: TBD
Revision / Date: TBD
Effective Date: TBD
Retroactivity: N

Title:	Level 3 Analysis – AHM Effectiveness Determination
Submitter:	MPIG

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

Issue:
Following the selection of an AHM Hybrid in a Level 3 analysis, it may be possible that the result provides no evident benefit compared to the classic task.

The logic flow needs to be updated to create the possibility of not selecting an AHM Alternative/Hybrid if such selection would not lead to an effective outcome.

Problem:
An AHM Hybrid is selected when multiple failure causes lead to the creation of a Classic Task but the AHM capabilities of the aircraft are only capable of providing detection of some of the failure causes and not all. The purpose of an AHM Hybrid selection is to pair AHM with a scheduled maintenance task that is less burdensome than the original classic task (e.g. different interval, reduced scope, etc.).

The current Level 3 logic requires that if Question 2-3-9.A (Is the AHM use effective?) is answered yes, an AHM Alternative or Hybrid will be selected and published within the MRBR. However, there may be situations where it would not be desirous to publish an AHM Hybrid because it would be less effective than the current Classic Task.

An example of a less effective AHM Hybrid is as follows:

- An Operational Check of a system that was derived from three unique failure causes.
- AHM capability is available for two of the failure causes but not the third.
- Of the three failure causes, the one without AHM has the worst reliability and was the driving factor leading to the current interval of the Operational Check.
- A new procedure that checks only the third failure cause is not feasible, given that only the current Operational Check procedure is available to detect it.
- In this situation, when doing a Level 3 analysis for the failure causes with AHM capability, question 2-3-9-A will be answered Yes, necessitating the selection of an AHM Hybrid. However, as the scope and interval of the Classic Task cannot be modified, the only change would be the addition of AHM.

IP Template Rev 7, dated 01 October 2022 Page 1 of 4

Future Considerations

- Terminology Alignment continuation
- Safety FEC (5/8) inclusion
- MSG-X/4 WG Interface

Airlines for America™

We Connect the World

AHM WORKING GROUP
AHM Terminology Subgroup

May 2023

AHM Terminology Subgroup

Members:

EASA: Ralf Schneider, Luca Tosini
Honeywell: Chris Hickenbottom
Collins Aerospace: Rhonda Walthall

Charter:

To create a CIP that addresses conflicting AHM terminology used by the industry with recommendations on how to achieve harmonization

Three Targeted Areas of Concern

- The terms “monitoring” and “management” are used interchangeably regarding aircraft and vehicle health assessments
- There are many terms that are used to describe similar capabilities
- There is often confusion around the line between operational/economic AHM-driven “supplemental” maintenance and AHM-driven maintenance for airworthiness credit

Monitoring vs. Management

The industry is using the terms “monitoring” and “management” interchangeably regarding aircraft and vehicle health assessments.

- What is the appropriate terminology to use in MSG-3 documents?
- How do we resolve the differences in the “monitoring vs. management” terminology used by the FAA, EASA, and other regulatory agencies pertaining to processes and organizations for continued airworthiness?
    - European CAMOs “manage” the continued airworthiness whereas in the US, the operators “manage” continued airworthiness.
- Does AHM describe the full scope of maintenance, i.e., end-to-end process?

Terms Describing Similar Capabilities

Currently there are many terms that are used to describe similar capabilities.

- AHM – Aircraft Health Monitoring
- DPHM - Diagnostics and Prognostics Health Management
- ECM – Engine Condition Monitoring
- EHM – Engine Health Management
- HUMS – Health and Usage Monitoring
- IAHM – Integrated Aircraft Health Management
- IAHM – Integrated Aircraft Health Monitoring
- IVHM – Integrated Vehicle Health Management
- PHM – Prognostics and Health Management
- SHM – Structural Health Monitoring
- VHM – Vibration Health Monitoring

AHM Activities for Continued Airworthiness

There is often confusion around the line between operational/economic AHM-driven “supplemental” maintenance and AHM-driven maintenance for airworthiness credit.

- Can we introduce a term that differentiates the two, such that it is clear when AHM activities are required for continued airworthiness and when they are optional?

Recommendations

- Create an MPIG WG to coordinate with international parties, including regulators, operators, OEMs, Suppliers, SAE, other standards development organizations, third-party software service providers for maintenance organizations, major vendors, etc.
- Align on health-related terminology to be used in the MSG-3 documents.
- Encourage standard usage of this terminology across the aviation industry worldwide.

Airlines for America™

We Connect the World

AHM WORKING GROUP
AHM – SAE Standards Mapping Subgroup

May 2023

AHM Terminology Subgroup

Members:

Airbus: Khaldoun Bellakhal, Oliver Weiss
Rolls-Royce: Nicole Elders
Collins Aerospace: Rhonda Walthall

Charter:

To map SAE standards to the MSG-3 and MSG-X documents

Activities

- Surveyed SAE documents for relevance
- Reviewed descriptions and rationales for 81 SAE documents
- Identified which of the 81 SAE documents were relevant to MSG-3 Volume 1, MSG-3 Volume 2, MSG-X, and Scheduled Maintenance (MSG-3/X)

Example Mapping

SAE IVHM-Related Documents

Committee	Document *	Title	MSG-3 Volume 1	MSG-3 Volume 2	MSG-X	Relevant to Scheduled Maintenance (MSG-3/X)	Description:
HM-1	AIR6334	A Guide to Extending Times Between Overhaul for Rotorcraft Power Train Transmissions Using Monitoring Data	X	X	X	Yes	Time in Service (TIS), or flight hours, logged in maintenance records against an installed rotorcraft transmission is normally used as the "official" time on wing metric for the transmission's component wear out inspection interval requirement and, in some instances, retirement change on life limited parts. This AIR addresses traditional methods of transmission TBO extensions and introduces rotorcraft transmission monitoring usage metrics that could be used to modify TIS inspections by tracking torque to determine both loads on life limited parts and component wear. This is a document of the SAE HM-1 Committee intended to be used as a technical information source and is not intended as a legal document or standard. This AIR does not provide detailed implementation steps, but does address general implementation, past experience, concerns and potential benefits.
HM-1	AIR6915	Human Factor Considerations in the Implementation of IVHM	X	X	X	Yes	This SAE Aerospace Information Report (AIR) offers information on how human factors should be considered when developing and implementing IVHM capabilities for both military and civil fixed wing aircraft. These considerations will cover the perception, analysis, and action taken by the flight crew and the maintenance personnel in response to outputs from the IVHM system. These outputs would be onboard realtime for the flight crew and post flight for maintenance. This document is not intended to be a guideline; it is intended to provide information that should be considered when designing and implementing future IVHM systems.
HM-1	AIR6970	Environment Spectra and Corrosivity Monitoring Using Electrochemical and Electrical Resistance Sensors	X	X	X	Yes	Rationale: The purpose of this document is to describe available environmental electrochemical, and electrical resistance sensor technologies and techniques for on-board air-vehicle environmental spectra and corrosivity monitoring, along with outlining data processing and handling methods. This document provides a system-level approach, covering sensor selection, data management, data reporting, and deployment.
HM-1	ARP5783	Health and Usage Monitoring Metrics, Monitoring the Monitor	X	X	X	Yes	This recommended practice applies to vibration monitoring systems for rotorcraft and fixed-wing drive trains, airframes, propulsion systems, electric power generators, and flight control systems. It addresses all aspects of metrics, including what to measure, how to measure, and how to evaluate the results.
HM-1	ARP6275	Determination of Cost Benefits from Implementing an Integrated Vehicle Health Management System	X	X	X	Yes	This Aerospace Recommended Practice (ARP) provides insights on how to perform a cost versus benefit (C/B) analysis (CBA) to determine the return on investment that would result from implementing an integrated health management (HM) system on an air vehicle. The word "integrated" refers to the combination or "roll up" of sub-systems health management tools to create a platform-centric system. This document describes the complexity of features that can be considered in the analysis and the different tools and approaches for conducting a CBA, and it differentiates between military and commercial applications. This document is intended to help those who might not have a deep technical understanding or familiarity with HM systems but want to either quantify or understand the economic benefits (i.e., the value proposition) that an HM system could provide. Prognostics is a capability within some HM systems that provides an estimation of remaining useful life (RUL) or time to failure and so prognostic health management (PHM) is used where this predictive element exists. IVHM refers to an integrated vehicle level system deployed on a fleet of platforms and might, but not necessarily, include predictive elements.
HM-1	ARP6290	Guidelines for the Development of Architectures for Integrated Vehicle Health Management Systems	X	X	X	Yes	Rationale: This ARP provides guidelines for development of the architecture for the design of an integrated vehicle health management system. The purpose of this document is to insure that the architecture design covers the utilization of information disseminated by each function contained in the design requirements and to define and document an optimum architecture for an IVHM solution that is in line with the organization's business goals and objectives. Architecture is "the structure of components, their relationships, and the principles and guidelines governing their design and evolution over time." (IEEE STD 610.12 as stated in the DoD Architecture Framework (DoDAF)). It is useful for designing unprecedented, complex systems. In general a system architectural design needs to consider physical components, functions, performance, technologies, cost, risk, constraints, boundaries, and internal and external interfaces. Some efforts have tried to standardize the process of architecture development. ISO 13374 "Condition monitoring and diagnostics of machines - Data processing, communication and presentation" defined functional layers in building a CBM system. In addition, frameworks like DoDAF outline an architecture development process. This document will incorporate these suggested standard practices into specific guidelines for IVHM architecture development. For the purposes of clarity and in keeping with the needs of the IVHM architecture, the guidelines will be divided into sections that address each possible tier of the end to end architecture. This architecture may include: • The On-Vehicle Tier: which addresses the capture, processing and packaging of on-board data • The Data Transfer Tier: which provides guidelines in the movement of data • The At-Vehicle Tier: which includes maintenance support through data analysis and presentation equipment (such as a ground station or portable maintenance aid) • The Fleet Data Services and Application Tier - Which includes a central, ground-based Data Center and provides guidelines on the transformation, analysis and exchange of that data to the user community. Since each application of this tier is specific to a particular organization's needs, the various uses of the data by the user community will not be addressed in this document.

Next Steps

- Mapping created as a resource for archival purposes
- Conduct a deep dive on most relevant SAE documents to assess whether they should be referenced in MPIG documents
- Provide access to most relevant SAE documents to a wider group in the MPIG

Airlines for America™

We Connect the World

Rhonda Walthall
Senior Fellow, Collins Aerospace
Rhonda.walthall@collins.com