INTEGRATED VEHICLE HEALTH MANAGEMENT: RELIABILITY, SAFETY AND MAINTENANCE CREDITS

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New SAE Aerospace Standards for Cutting Edge Technologies

- Composite Materials
- Active RFID Tags
- LED Runway Lighting and EFVS
- Anti-Icing Technology
- Fibre-optic networks
- Additive Manufacturing
- Electronics & Avionics Corrosion Protection
- Hydrogen Fuel Cells
- Human Factors & Cockpit Electronics
- Integrated Vehicle Health Management & Prognostics
- Electric & More Electric Aircraft
“Integrated Vehicle Health Management is an end to end capability that transforms system data into operational support information enabling:

Optimized maintenance actions
Improved readiness and availability
Enhanced Vehicle safety and reliability
Product life extension
Product improvement and new design paradigms”

Use of diagnostics and prognostics to monitor, assess “health” or condition and manage assets – parts, systems, or (IVHM) – aircraft and fleets

Sense
Acquire
Transfer
Analyse
Act
The History of IVHM at SAE

1975 – Vibration monitoring and E-32

1980s-2000s TPMS, BTMS, Fault Detection

Integration – IVHM Steering Group and HM-1
**The SAE IVHM Steering Group Objectives**

**IVHM Steering Group**

**IVHM Platform Level – HM-1**
- Engine (EHM) – E-32
- Engine Controls – E-36
- Fibre Optic Equipment – AS-3
- Structure (SHM) – G-11SHM
- Landing Gears – A-5
- Flight Controls & Hydraulics – A-6
- Fuel Systems – AE-5

**Reliability – G-11R**
- Maintainability/
  Supportability – G-11M
- Probabilistic Methods – G-11PM

**RFID – G-18**
- Embedded Systems – AS-2
- Fibre Optic Systems – AS-3
- Safety Assessment – S-18
The SAE IVHM Standards Landscape

Organizational Goals
- ARP6275: Cost benefit analysis
- ARP6883: Requirements Analysis
- ARP6887: Verification & Validation
- ARP6268
- ARP6290

System Requirements
- ARP6290: Architectural design

System Architecture
- ARP6407
- ARP6268

Detailed System Design
- ARP6883
- ARP6268

Verification & Validation
- ARP6883
- ARPxxxx

System Implementation
Maintenance Credits?

EASA recommendation: “before generating new regulations, the IVHM Group should first consider how it can utilise or supplement existing regulations for approval of maintenance processes, with the objective to seamlessly integrate the use of IVHM into existing certification & operational practices.”

New SAE AIR document in development on the regulatory framework and pathways in process:

- CAA/EASA/FAA: CS/Part-, AMC/AC, GM
- MSG-3
A supportive reference to facilitate implementation within the operational maintenance framework: ARP6461 discusses

**A4A MSG-3 (revision 2009-1) in which a definition of Scheduled SHM (S-SHM) was added:**

‘S-SHM is the act of using/running/reading out a SHM device at an interval set at a fixed schedule.’

The structure section of the A4A MSG-3 document was revised to select S-SHM tasks and interval in lieu of classic inspections.

**A proposed further revision to MSG-3 (IP 105) which introduces Automated SHM (A-SHM):**

A-SHM: ‘is any SHM technology which does not have a pre-determined interval at which maintenance action must takes place, but instead relies on the system to inform maintenance personnel that action must take place’.

A-SHM technologies have the potential of providing information to operators, OEMs and Authorities to develop ‘on-condition’ or ‘condition-based’ maintenance programs, eliminating several scheduled maintenance inspection tasks.
SAE/RAeS Maintenance Credits Workshop

Nov. 2011
The aircraft that looks after itself

Nov. 2013
Civil Aircraft Technology Enabled Services

Oct. 2014
A First Step Towards Achieving Maintenance Credits

• Three workshops:
  • Working with the regulators
  • Maintenance Credits
  • Data interoperability

• Outputs:
  • Three white papers, becoming
  • Three SAE standards
• Airline Engineering & Maintenance Safety Track: Airlines, Regulatory Authorities and Industry
• SAE presentation delivered by Rolls-Royce Plc
• Outreach to safety management community led to discussions on leveraging & sharing data between safety and maintenance/health monitoring
• Can IVHM actively, or just passively, positively impact aviation safety?
...to determine the potential use of PHM technologies in accident prevention by measuring the health of aircraft systems and preventative and protective defences. PHM technologies would be used to monitor system health and predict component level failures that would impact the operation of the overall system.
System reliability must be at a level acceptable for use

Additional monitoring capability

Safety & operational impacts
IVHM and No Fault Found

No Fault Found:

“Removal of equipment from service for reasons that cannot be verified by the maintenance process (shop or otherwise)”

ARINC 672 Report
Next Steps

- Continued development of SAE IVHM “technology” standards – subsystem and platform levels
- Exploration of regulatory framework
- Interface with MSG-3, MPIG
- Development of guidance for maintenance credits process
- Focus on mitigation of No Fault Found
- Focus on data interoperability and Big Data
- IVHM as an example of IoT
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