BEST PRACTICES IN DEVELOPING PHM STANDARDS

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SAE Aerospace Standards
Agenda

• SAE INTERNATIONAL OVERVIEW

• CASE STUDIES

• HARMONIZED GLOBAL STANDARDS
ABOUT SAE

• Not for profit, non-lobbying technical society
• Global, industry-managed, industry-led programmes
• Standards Development Organisation (SDO)
• Wealth of engineering knowledge in books, standards, papers, online content
• Technical conference provider
• Engineering training provider
• Offices in North America, Asia, Europe:
  • World Headquarters – Warrendale PA, USA
  • ARINC HQ – Bowie, MD, USA
  • Aerospace Standards – Washington DC
  • Asia – Shanghai, PRC
  • Aerospace Standards Europe – London, Brussels
THE SAE PORTFOLIO
A Global Association of More Than 140,000 Engineers and Related Technical Experts

PRE-PROFESSIONAL DEVELOPMENT
A full continuum of preK-16 STEM outreach programs servicing over 75,000 students every year.

PROFESSIONAL DEVELOPMENT
400+ course portfolio delivered through eLearning online and classroom courses on an individual and corporate level.

ENGINEERING EVENT
Over 30 global technical events annually for the aerospace, automotive, and commercial vehicle sectors.

PUBLICATIONS
100,000+ collection of technical publications.

MEMBERSHIP
Over 137,000 members worldwide collaborating and using multiple exclusive benefits to advance personally and professionally.

MEDIA
Magazines, eNewsletters, custom publishing, Tech Briefs Media Group.

FOUNDATION
Inspiring Curiosity in STEM. Helping students succeed, educators excel and corporations meet their workforce, business and social responsibility goals by supporting the only Pre-K – College continuum of STEM education.

TECHNICAL STANDARDS
35,000+ aerospace and ground vehicle standards.
Approximately 1800 SAE International standards are used in the development of a typical airliner.

The first aerospace standard was written in 1916.

Today there are over 8500 active aerospace standards and over 17500 historical standards in circulation.
CASE STUDIES
Standard Adapting to Technology Advancements

- **1973** – FAR Part 25.1305 (d) (3) required engine unbalance display
- **1986** – AIR1839 Published
  - Move from analog to digital tracking filter systems
- **1992** – Revision A
  - Economics of vibration monitoring
  - Information for maintenance personnel
- **2001** – Revision B
  - Tracking filter center frequency slaved to engine rotor speed
  - Spectral analysis of vibration signal
  - Comprehensive details on rotor trim balancing (in-flight data collection, balance coefficients & calculations)
2008 – Revision C

- New engines with EMU (engine monitoring unit) permit tailoring to engine OEM’s EHM program and may be integrated with AHM
- Vibration analysis techniques now include Fast Fourier Transform and Pattern Matching
- Improved predictive capability

2015 - Upgraded to ARP1839

- Incorporates content from AS8054, Airborne Engine Vibration Monitoring System, Guidelines for Performance Standard For
- Integration of EVM into IVHM system transmits vibration data files for ground-based data analysis
- Human factors interface
- Measurement uncertainty

2018 – Publish ARP5987 Maintenance Credits Using EHM
Evolution of Cost Benefits Documents


ARP4176, Determination of Costs and Benefits from Implementing an Engine Health Management System (E-32, 2013)

ARP6275, Determination of Cost Benefits from Implementing an Integrated Vehicle Health Management System (HM-1, 2014)
## SAE Automotive Health Management Standards

### Passenger Car & Light-Duty Trucks On-Board Diagnostics

<table>
<thead>
<tr>
<th>Standard</th>
<th>Title</th>
<th>Initial Release</th>
<th>No. of Revisions</th>
<th>Most Recent Revision</th>
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<td>J1962</td>
<td>Diagnostic Connector</td>
<td>1992</td>
<td>7</td>
<td>2015</td>
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<td>J1850</td>
<td>Class B Data Communications Network Interface</td>
<td>1988</td>
<td>8</td>
<td>2006</td>
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<td>OBD II Scan Tool</td>
<td>1992</td>
<td>3</td>
<td>2002</td>
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<tr>
<td>J1979</td>
<td>E/E Diagnostic Test Modes</td>
<td>1991</td>
<td>8</td>
<td>2014</td>
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</tbody>
</table>
Mechanisms exist to update SAE standards based upon technology advancements.

Over 30 year period, engine vibration monitoring evolution from AIR1839 to ARP5987:
Analog ➔ digital tracking ➔ trim balancing ➔ IVHM

Various paths utilized to adapt standards independent of technology:
- Committee collaboration
- Outside organizations
- Consolidation efforts

SAE Health Management standards are flexible enough to incorporate new technology
AND YET
stable enough to support product development and regulatory requirements
ARD6888 Functional Specification of Miniature Connectors for Health Monitoring Purposes
• Specifies functional needs for family of miniature connectors dedicated to health monitoring
• Suitable for severe environments (including engines)
• Prepared as background for AE-8C1, Connectors Committee to develop a new AS

New Work Item with AE-7B, Power Management, Distribution & Storage
• Preparing a Lithium-ion battery health management document

ARP6268 Design & Online Communication Standards for Health Ready Components
• Platform agnostic – ground vehicles or airborne vehicles
Some SAE Standards and Recommended Practices (JA documents) are utilized in both Aerospace and Automotive sectors.

Joint Aero/Auto documents are strongly encouraged and supported by SAE International in order to:
- Leverage our knowledge and applicable best practices across sectors
- Broaden appeal and acceptance of SAE Standards to the benefit of industry
- Support industry trends of cross utilization of technology and supply base across sectors

**JA6268 Joint Recommended Practice:** *Design & Run-Time Information Exchange for Health-Ready Components.*
- Approved March 28, 2018
- Generated within the HM-1 aero committee incorporating both Aerospace and Automotive inputs
- Created to help reduce barriers to implementing Integrated Vehicle Health Management (IVHM) technology in aerospace and automotive sectors.
- Registry of Health-Ready Components will be developed
- Pilot planned by year-end 2018
At present the rate of development of data management and sensing technology is very high. Emergent technologies such as Big Data, the Industrial Internet of Things (IIOT) and forth generation manufacturing means data interoperability will be in a continuous state of flux for some time.

ARP6904 - The purpose of this WIP is to outline the recommended approach to adopt, manage and develop data interoperability. With the number of stakeholders involved and the amount of data sharing required, there is a clear need for data interoperability to support the maintenance, logistics, operation and engineering analysis. This document may require frequent updating to ensure the latest knowledge is incorporated.
CASE STUDY 1 – SAE G-23 MANUFACTURING MANAGEMENT

• Manufacturing issues have been identified as ‘root cause’ of past problems
• Appropriate manufacturing requirements have not been specified in contracts
• Air Force identified need to develop a standard that could be called out in procurement
• SAE G-23 Manufacturing Management Committee created to address these issues through standard development
• AS6500 provides additional focus and details on critical manufacturing processes
• AS6500 aims to ensure tasks are accomplished consistently
• HARMONIZED GLOBAL STANDARDS
• Active Safety
• Threaded Fasteners and the Bolted Joint
• Metal Fatigue
• Sensors and Actuators
• Additive / Advanced Manufacturing
• Counterfeit Parts Control
• Quality Management System Standards
• Accident Reconstruction
• Corrosion / Degradation
• Alternative Fuels and Energy Sources
• Composite Development & Design
• Cybersecurity - Vulnerability
• Connected Aircraft
Comparison of ASME/ISO 1-day

Sector: Automotive
Topic: Standardization, CAD, CAM, and CAE, Design processes

Providing you have a basic understanding of Y14.5 Dimensioning and Tolerancing practices, this course explains the major differences between the ASME and ISO standards in a concise, easily understood manner.

Utilizing the expertise of world-renowned GD&T expert Alex Krulikowski, the course focuses on how the standards compare when dealing with symbols, feature control frames, tolerances, form controls, datums, and more. Newly acquired learning is reinforced throughout the class with numerous practice problems.
Document: CMB7-4A

Title: Glossary of Terms, Acronyms, and Definitions

References
The following standards and handbooks were used to create this glossary.
• ASME Y14.24 -1999 (R2004), Types and Applications of Engineering Drawings
• ASME Y14.34 - 2008, Associated Lists

The information in these listings was extracted from standards and documents prepared by the Systems Engineering (G47), Configuration Management (G33), Life Cycle Logistics Supportability and Enterprise Information Management Interoperability Committees along with other pertinent international, industry and government standards. It is intended that this bulletin be used as a resource to help with harmonization of terms and definitions across standards.
QUESTIONS?

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