SAE INTERNATIONAL

THE EVOLVING HEALTH MANAGEMENT STANDARDS LANDSCAPE

Laura Feix

SAE Aerospace Standards

SAE IVHM History – And Future…

1905

2015

SAE charter expanded to incorporate aeronautics, 1916

1st SAE Aerospace Standard, 1917

SAE E-32 – EHM committee established, 1975

G-11 SHM is formed – work begins on the SHM guidebook (ARP6461), 2008

IVHM Steering Group established in June, HM-1 Committee in October, 2010

SAE AeroTech, first SAE IVHM Book, 2011

IVHM Business Case Book published, 2012

SAE AeroTech, IVHM and SHM Panel Session @ LHT, 2013

10 HM-1 documents in progress, 7 HUMS/IVHM standards published, No Fault Found Book published, 2015

SAE Standards

AS Aerospace Standards – specific performance requirements used for design standards, parts standards, minimum performance standards, quality and other areas conforming to broadly accepted engineering practices or specs for a material, product, process, procedure or test method

AMS Aerospace Material Specifications – specific performance requirements for material and process specifications

ARP Aerospace Recommended Practices – documentations of practice, procedures, and technology that are intended as guides to standard engineering practices. May be of a more general nature or propound data that have not yet gained broad acceptance.

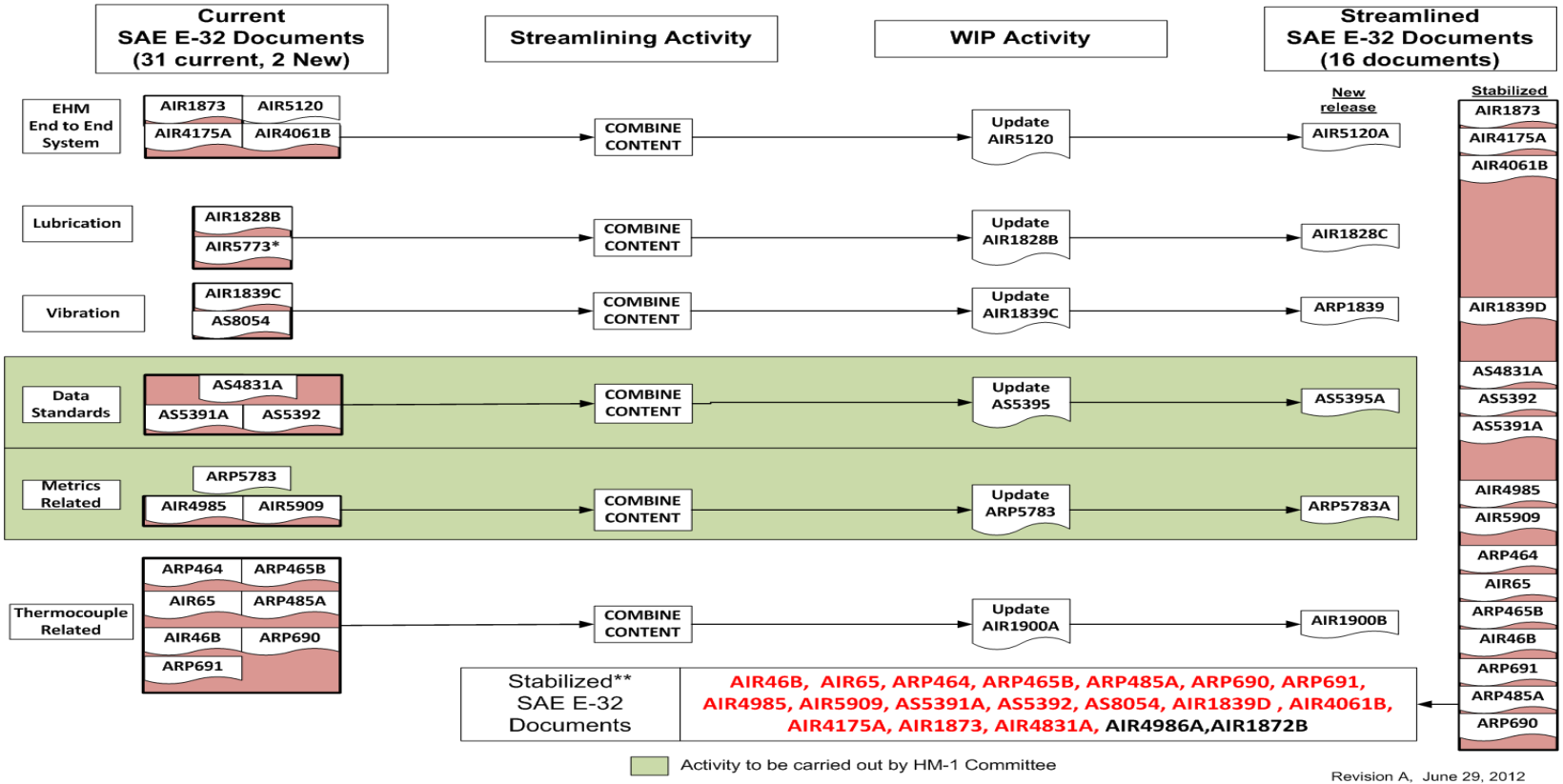
AIR Aerospace Information Reports – compilations of engineering reference data, historical information, or educational material useful to the technical community

Standards Status Categories

Status	Definition	Identifier
Issued	First time published	Issue date
Revised	Updated or modified	Revision letter designator
Reaffirmed	Reviewed and deemed current with no need for immediate revision	Reaffirmation date noted after last active revision level
Stabilized	1) Mature technology not likely to change 2) No known users 3) Retain to support legacy platforms or design reuse but industry moving towards newer technology for new design	Contains Stabilization Notice and Rationale statement including committee recommendations
Cancelled	1) Not fit for use due to technical reasons 2) Technical requirements totally superseded by another document	Cancellation Notice and Rationale statement including supersession information

Five year review is required for all Issued, Revised, and Reaffirmed documents

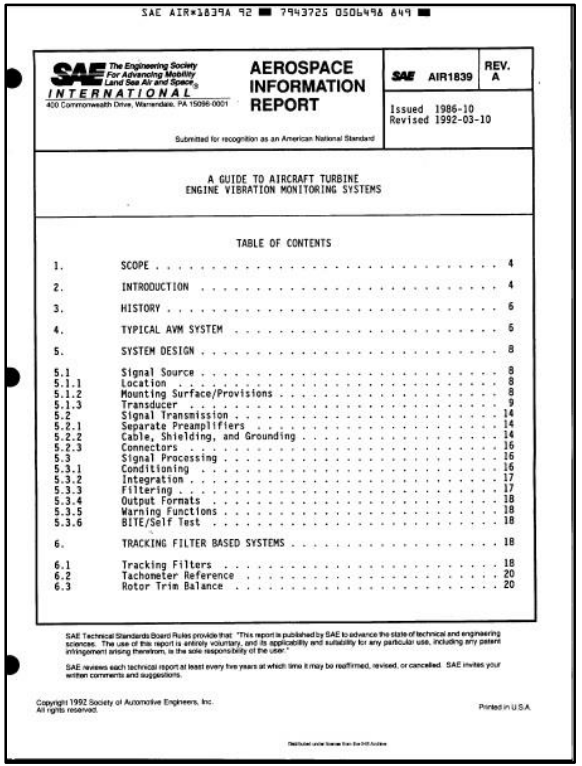
SAE E-32 (EHM) Document Map



Case Study of Standard Adapting to Technology Advancements: AIR1839

- **AIR1839, A Guide to Aircraft Turbine Engine Vibration Monitoring Systems**

- **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
  - Ability to perform on-wing fan trim balance at intermediate stops
- **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)



SAE AIR*1839A 92 ■ 7943725 0506498 849 ■

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AEROSPACE INFORMATION REPORT

SAE AIR1839 REV. A

Issued 1986-10
Revised 1992-03-10

Submitted for recognition as an American National Standard

A GUIDE TO AIRCRAFT TURBINE ENGINE VIBRATION MONITORING SYSTEMS

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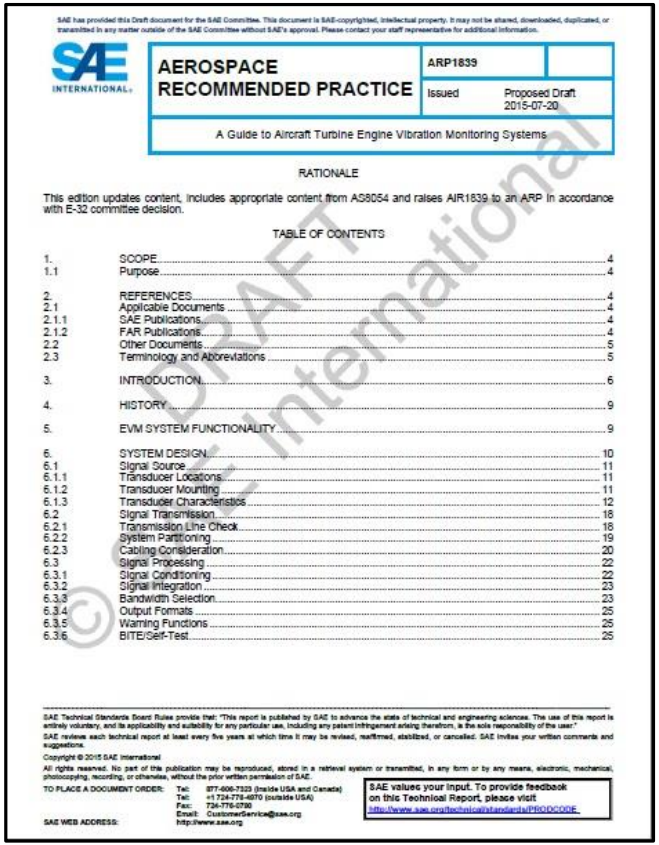
Case Study of Standard Adapting to Technology Advancements: AIR1839

- **2008 – Revision C**
  - New engines with EMU (engine monitoring unit) permit tailoring to engine OEM's EHM program and may be integrated with AHM
  - Hardware & software portioning if EH parameters intended for cockpit display & pilot action
  - 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



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AEROSPACE RECOMMENDED PRACTICE

ARP1839

Issued Proposed Draft 2015-07-20

A Guide to Aircraft Turbine Engine Vibration Monitoring Systems

RATIONALE

This edition updates content, includes appropriate content from AS8054 and raises AIR1839 to an ARP in accordance with E-32 committee decision.

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TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada) Tel: +1 724-776-4970 (outside USA) Fax: 724-776-0790 Email: CustomerService@sae.org http://www.sae.org

SAE WEB ADDRESS:

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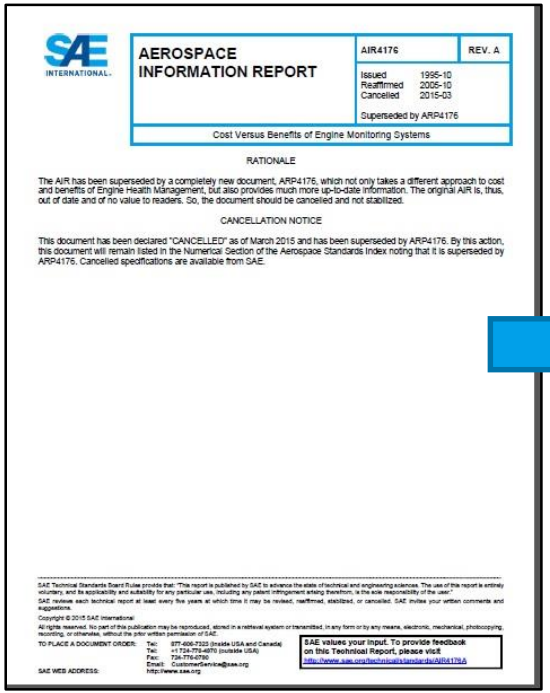
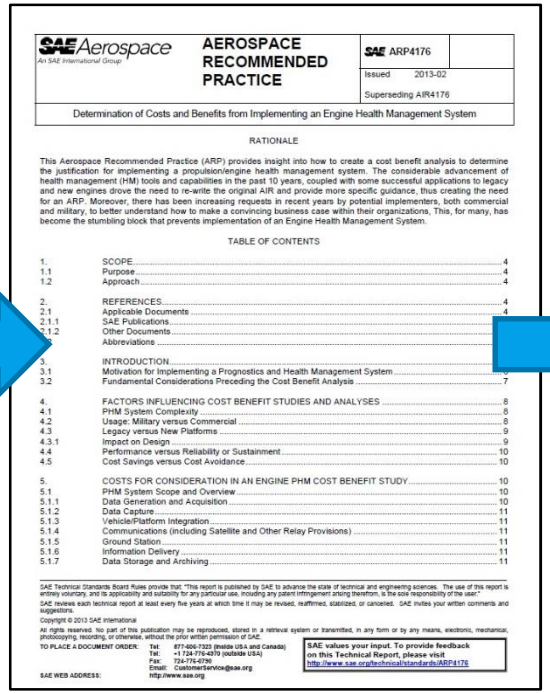
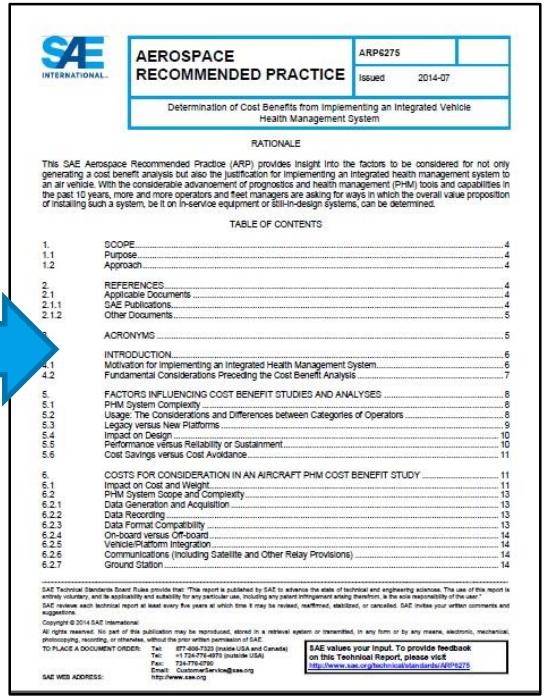
Evolution of Cost Benefits Documents



AIR4176, Cost Versus Benefits of Engine Monitoring Systems (E-32, 1995)



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

Standard	Title	Initial Release	No. of Revisions	Most Recent Revision
J1962	Diagnostic Connector	1992	7	2015
J1850	Class B Data Communications Network Interface	1988	8	2006
J1978	OBD II Scan Tool	1992	3	2002
J1979	E/E Diagnostic Test Modes	1991	8	2014
J2012	Diagnostic Trouble Code Definitions	1992	7	2013

SAE Commercial Vehicle Health Management Standards

J1939, Serial Control & Communications Heavy Duty Network – Top Level Document

- Digital Annex spreadsheet includes lists of all SPN assignments, PGN assignments, NAME Function assignments, Manufacturer Code assignments, and Preferred Address assignments

- Issued in 2000, most recent revision released in 2013 (9th revision)

- Over 75 slash sheets address communication protocols, diagnostics equipment, and sensors

Summary

- **Mechanisms exist to update SAE standards based upon technology advancements**

- **Over 30 year period, engine vibration monitoring evolution from AIR1839 to ARP1839**

  Analog → digital tracking → trim balancing → IVHM

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

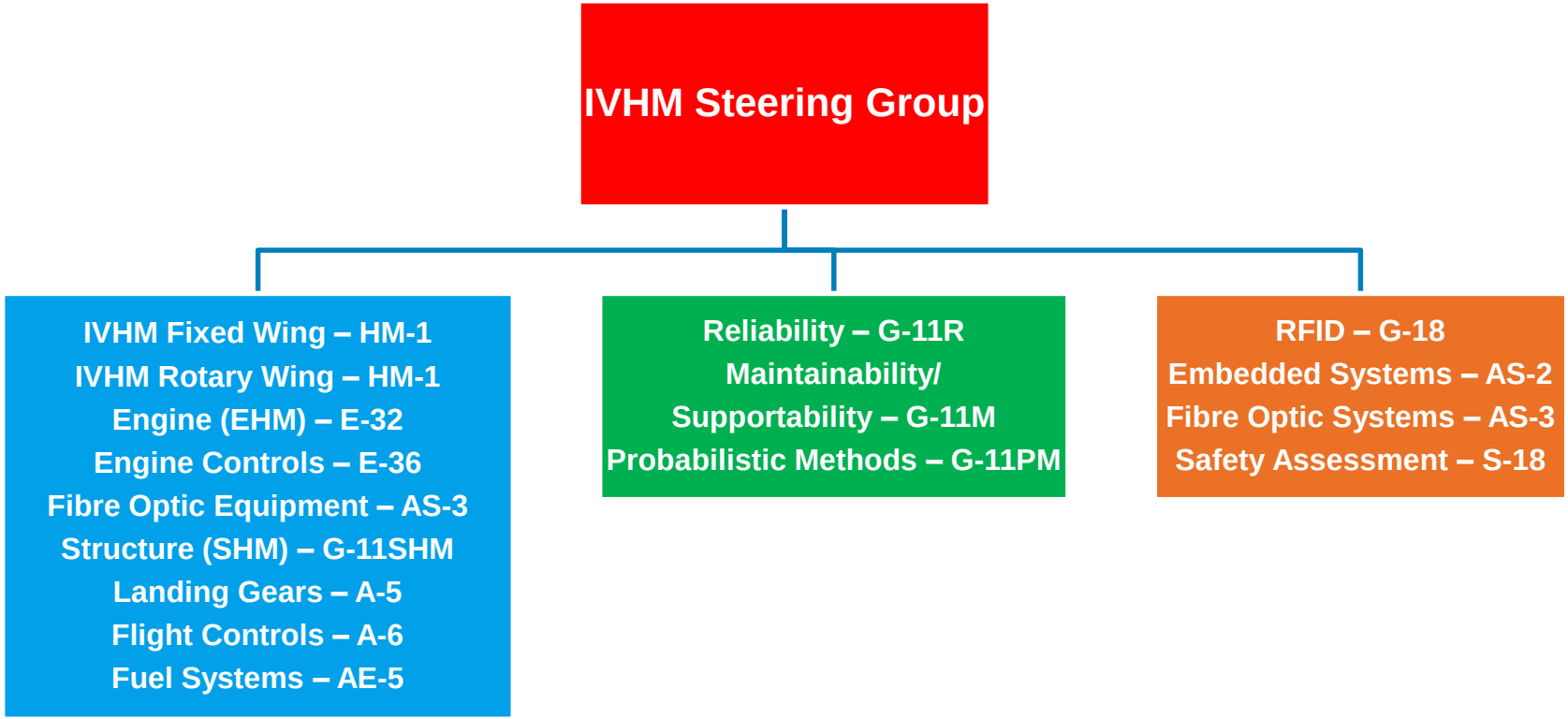
- **SAE Health Management standards are flexible enough to incorporate new technology**

  AND YET

  stable enough to support product development and regulatory requirements

BACKUP SLIDES

The SAE IVHM Initiative



Examples of SAE Health Management Standards

ARP6137 Tire Pressure Monitoring Systems (TPMS) for Aircraft

AIR6168 Landing Gear Structural Health Monitoring

AIR5273 Actuation System Failure Detection Methods

AIR6034 Airborne Hydraulic Monitoring Systems

AIR6552 Measure, Store, and Access Fibre Optic Transceiver Test Data

AIR6552/3 NEEDLES Transceiver Health Monitoring

ARP6461 Guidance on structural health monitoring for aerospace applications

AIR5080 Integration of Probabilistic Methods Into the Design Process

JA1010 Maintainability Program Standard

ARP6204 Condition Based Maintenance (CBM) Recommended Practices

AIR4061B Guidelines for the Integration of Engine Monitoring Functions with On Board Aircraft Systems

AS4831A Software Interface for Ground-Based Monitoring

AIR4175A A Guide to the Development of a Ground Station for Engine Condition Monitoring

AS5393 Health and Usage Monitoring System, Blade Tracker Interface Specification

ARP1587B Aircraft Gas Turbine Engine Health Management System Guide

Health and Usage Monitoring Documents

Originated with RITA

(Rotorcraft Industry Technology Association)

E-32 accepted in 2002

Transferred to HM-1 in 2013

- **AS5391 HUMS Accelerometer Interface**
- **AS5392 HUMS Rotational System Indexing Sensor**
- **AS5393 HUMS Blade Tracker Interface**
- **AS5394 HUMS Advanced Multipoint Interface**
- **AS5395 HUMS Data Interchange**

HM-1 Documents Involving Other SAE Technical Committees

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

SAE IVHM Standards Landscape