

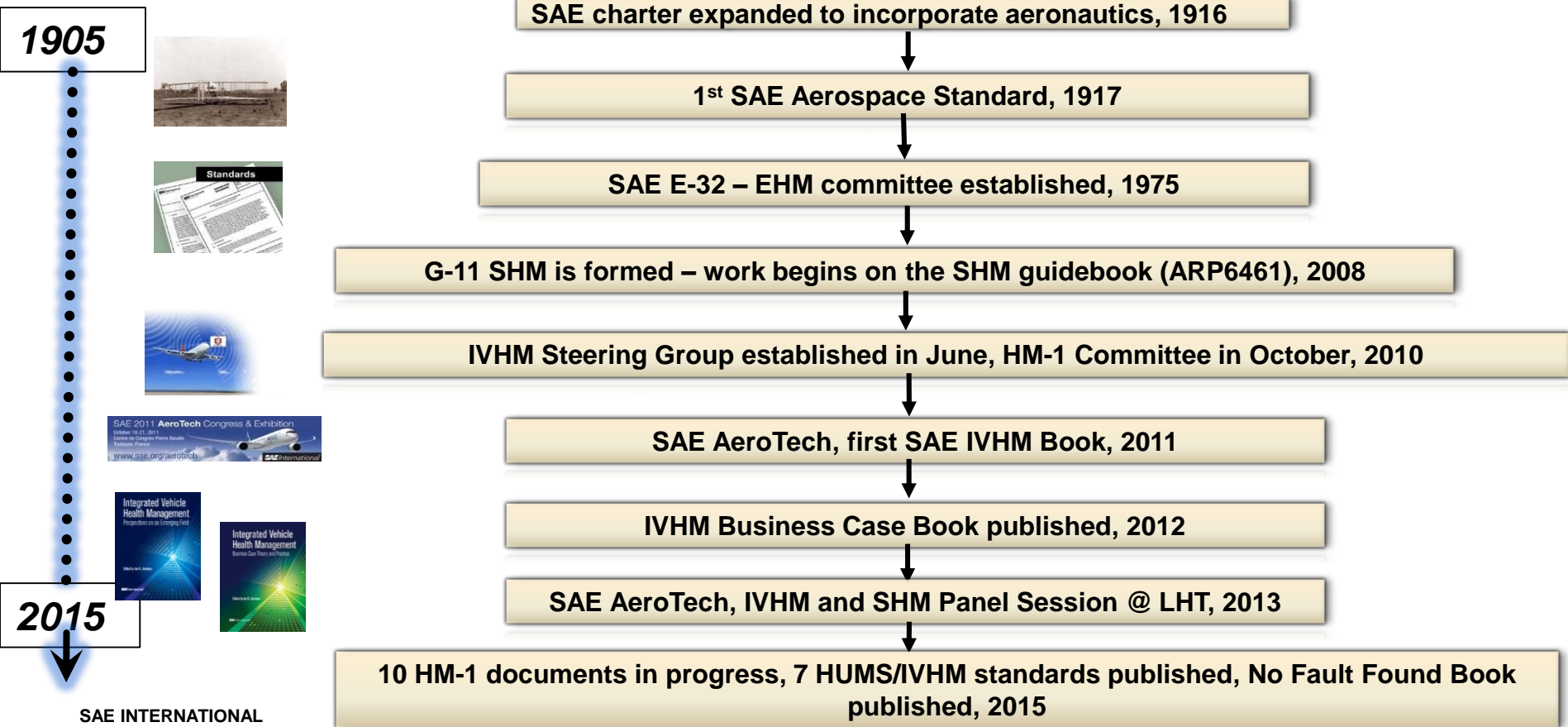
SAE INTERNATIONAL

THE EVOLVING HEALTH MANAGEMENT STANDARDS LANDSCAPE

**Laura Feix
SAE Aerospace Standards**



SAE IVHM History – And Future...



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.

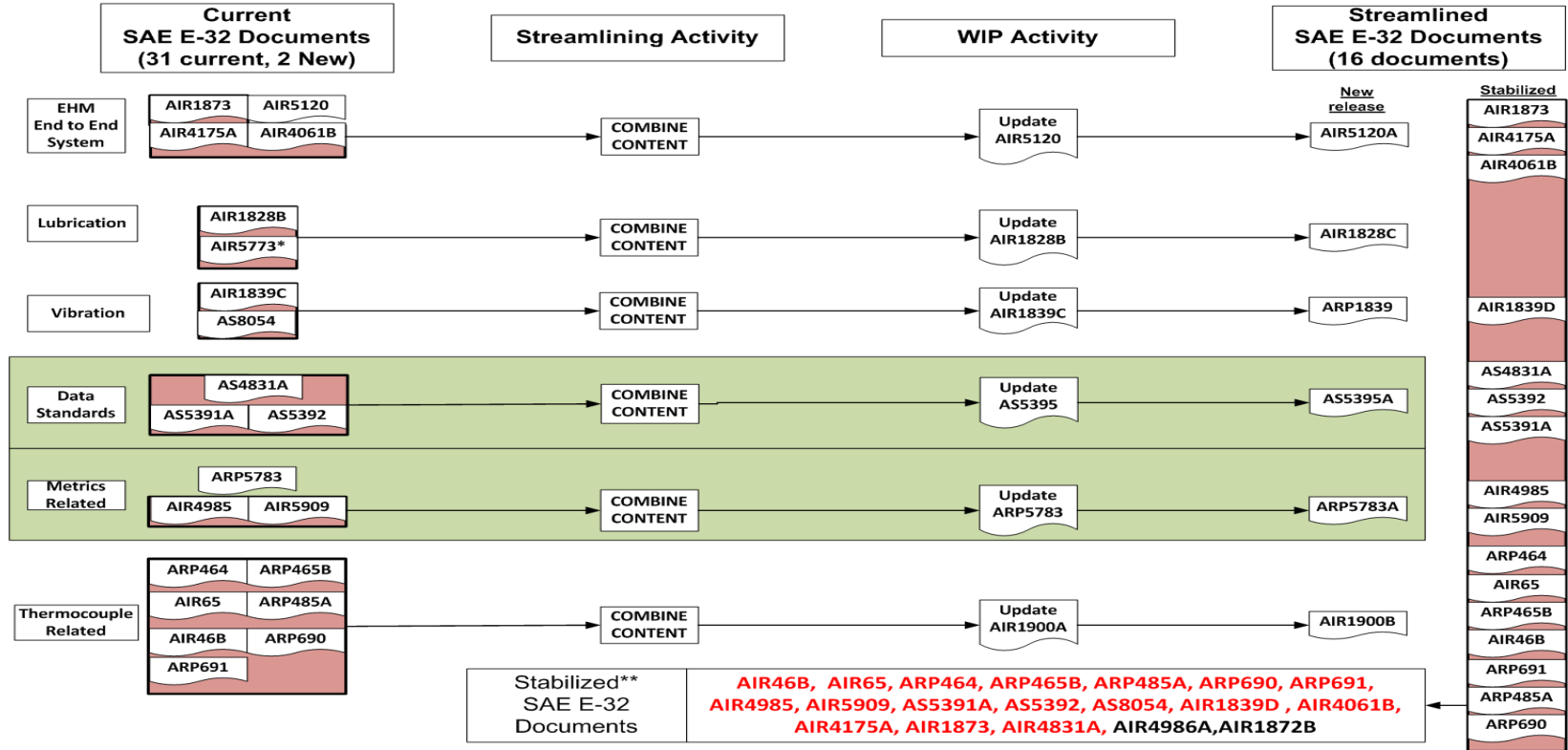
AIR Aerospace Information Reports – compilations of engineering reference data, historical information, or educational material useful to the technical community

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	<ol style="list-style-type: none">1) Mature technology not likely to change2) No known users3) 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	<ol style="list-style-type: none">1) Not fit for use due to technical reasons2) Technical requirements totally superseded by another document	Cancellation Notice and Rationale statement including supersession information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 AIR1839A 92 ■ 7943725 0506498 849 ■

SAE The Engineering Society For Advancing Mobility Land Sea Air and Space INTERNATIONAL 400 Commonwealth Drive, Warrendale, PA 15096-0001	AEROSPACE INFORMATION REPORT	SAE AIR1839 Issued 1986-10 Revised 1992-03-10	REV. A
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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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Evolution of Cost Benefits Documents



AEROSPACE INFORMATION REPORT	AIR4176	REV. A
	Issued 1995-10 Reaffirmed 2005-10 Cancelled 2015-03 Superseded by ARP4176	

Cost Versus Benefits of Engine Monitoring Systems

RATIONALE

The AIR has been superseded by a completely new document, ARP4176, which not only takes a different approach to cost and benefits of Engine Health Management, but also provides much more up-to-date information. The original AIR is, thus, out of date and of no value to readers. So, the document should be canceled and not stabilized.

CANCELLATION NOTICE

This document has been declared "CANCELLED" as of March 2015 and has been superseded by ARP4176. By this action, this document will remain listed in the Numerical Section of the Aerospace Standards Index noting that it is superseded by ARP4176. Cancelled specifications are available from SAE.


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AEROSPACE RECOMMENDED PRACTICE	SAE ARP4176
	Issued 2013-02 Superseding AIR4176

Determination of Costs and Benefits from Implementing an Engine Health Management System

RATIONALE

This Aerospace Recommended Practice (ARP) provides insight into how to create a cost benefit analysis to determine the justification for implementing a propulsion/engine health management system. The considerable advancement of health management (HM) tools and capabilities in the past 10 years, coupled with some successful applications to legacy and new engines drove the need to re-write the original AIR and provide more specific guidance, thus creating the need for an ARP. Moreover, there has been increasing requests in recent years by potential implementers, both commercial and military, to better understand how to make a convincing business case within their organizations. This, for many, has become the stumbling block that prevents implementation of an Engine Health Management System.

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AEROSPACE RECOMMENDED PRACTICE	ARP6275
	Issued 2014-07

Determination of Cost Benefits from Implementing an Integrated Vehicle Health Management System

RATIONALE

This SAE Aerospace Recommended Practice (ARP) provides insight into the factors to be considered for not only generating a cost benefit analysis but also the justification for implementing an integrated health management system to an air vehicle. With the considerable advancement of prognostics and health management (PHM) tools and capabilities in the past 10 years, more and more operators and fleet managers are asking for ways in which the overall value proposition of installing such a system, be it on in-service equipment or fifth-in-design systems, can be determined.

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

SAE INTERNATIONAL

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

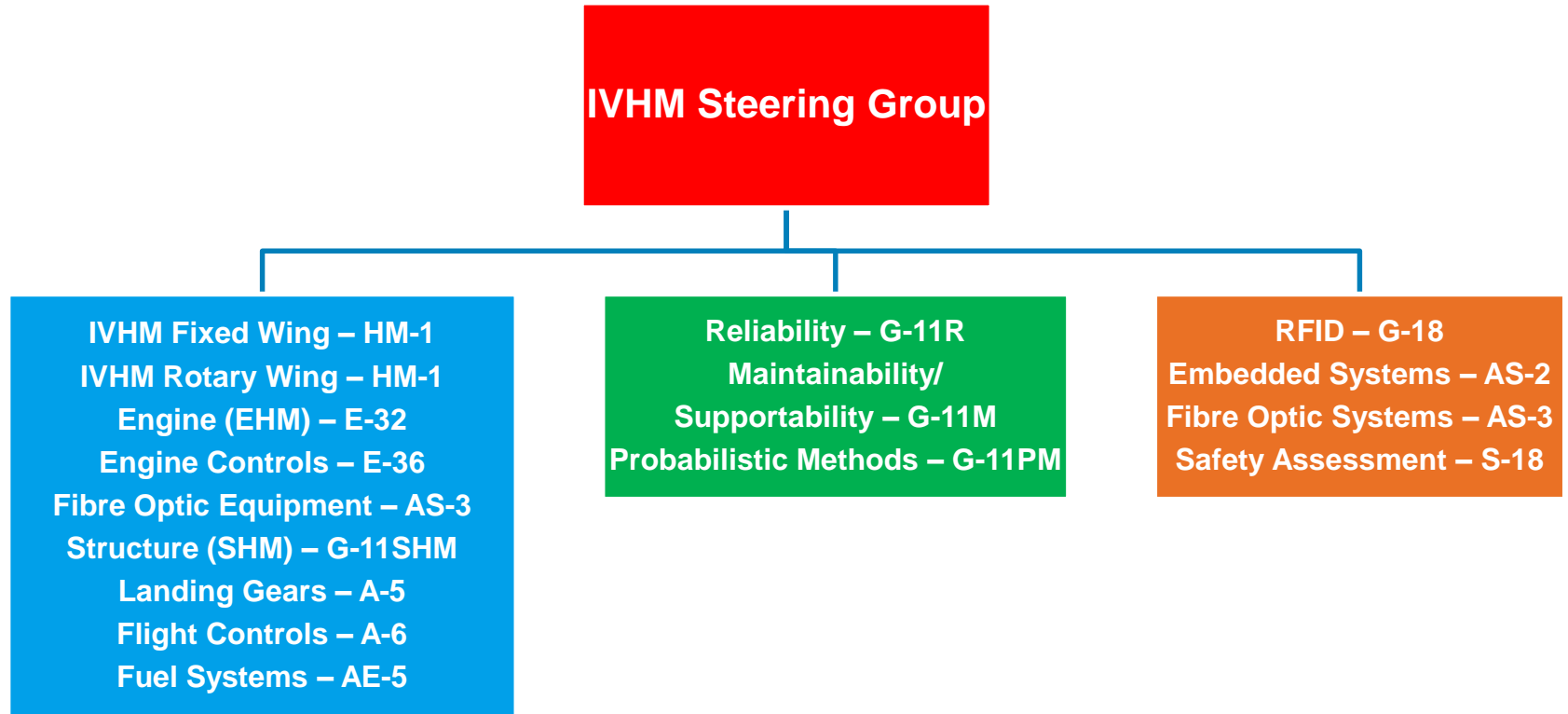
- Digital Annex spreadsheet includes lists of all SPN assignments, PGN assignments, NAME Function assignments, Manufacturer Code assignments, and Preferred Address assignments
- Issued in 2000, most recent revision released in 2013 (9th revision)
- Over 75 slash sheets address communication protocols, 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

