THE IMPORTANCE OF STANDARDS
Standards provide benefits such as:

- Defining accurate and necessary measurements
- Lowering product costs
- Improving product performance, quality, uniformity, interoperability and functionality
- Providing a method to improve health, safety, the environment, communications, competition, international trade
- Improving the quality of life
Approximately 1800 SAE International standards are used in the development of a typical aircraft.

The first aerospace standard was written in 1916.

Today there are over 8500 active aerospace standards and over 17500 historical standards in circulation.
OVERVIEW OF SAE STANDARDS
NEW SAE AEROSPACE STANDARDS FOR CUTTING EDGE TECHNOLOGIES

- Composite Materials
- Active RFID Tags
- LED Runway Lighting and EFVS
- Anti-Icing Technology
- Fiber-optic networks
- Additive Manufacturing
- Electronics & Avionics Corrosion Protection
- Hydrogen Fuel Cells
- Human Factors & Cockpit Electronics
- Integrated Vehicle Health Management & Prognostics

Electric & More Electric Aircraft
SAE AEROSPACE STANDARDS PROGRAM TOPICS

- Metals finishes, processes, fluids
- Nonferrous alloys
- Carbon & Low alloy steels
- Specialty steels and alloys
- Corrosion & heat resistant alloys
- Titanium
- Beryllium
- Refractory materials
- Metals engineering
- Elastomers
- Polymers
- Composite materials (fabric & resins)
- Composite repair materials
- Composite inspection
- Composite repair techniques
- Organic Coatings
- Seals and Sealants
- Maintenance chemicals and materials
- Greases
- Lubricants
- Nondestructive testing and inspection
- Mechanical/Electrical/Hydraulic actuators
- Hydraulic fluids
- Filtration
- Tubing
- Hydraulic components
- Fuel, oil, and oxidizer systems
- Pumps
- Couplings, Fittings, Hose
- Tubing installation
- Engine starting systems
- Auxiliary Power
- Nuts/Inserts
- Bolts/studs/screws
- Fluid connectors
- Ignition systems
- Emissions measurement
- Engine condition monitoring
- In-flight propulsion measurement
- Engine controls
- Support equipment and tools
- Helicopter powerplants
- Inlet flow distortion
- Avionics networks
- Aircraft store integration
- Avionic subsystems
- Embedded computing systems
- Architecture description language
- Fiber optics
- Unmanned systems
- Lightning
- Electromagnetic compatibility
- Electrical Power and equipment
- Power management
- Aircraft systems installation
- Protective devices
- Relays
- Electrical connectors
- Terminating Devices
- Wire & cable
- Safety assessment
- Human Factors
- Flight Deck tools and instruments
- Displays
- Human modeling
- Quality system standards
- Fuel operations
- Radio Frequency Identification
- Air cargo handling
- Aircraft ground equipment and systems
- Aircraft servicing
- Aircraft Deicing
- Airport snow and ice removal
- Landing gear systems
- Oxygen equipment
- Aircraft interior/exterior lighting
- Aircraft noise measurement
- Environmental systems
- Aircraft icing
- Safety equipment
- Cabin interiors
- Survival equipment
- Seats
- Maintainability
- Probabilistic Methods
- Reliability
- Structural Health Monitoring and Management
- Air Traffic Management
- Integrated Vehicle Health Management
SAE and NATO

SAE is an officially recognized civilian SDO partner to NATO

Through a Technical Cooperation Agreement, NATO supports and adopts SAE industry standards
Over 1500 Mil-Specs have been converted to SAE standards

The US DoD has adopted more documents SAE from than any other SDO

http://www.sae.org/standardsdev/military/
Regulations and government documents reference SAE standards to certify aircraft before entering the market.

Example FAA TSO
Mandatory compliance

Example FAA AC
Guidance material

Example ICAO Annex
Mandatory compliance

Example EASA ETSO
Mandatory compliance

Example EASA AMC
Guidance material

73 FAA TSOs
75 SAE docs

95 FAA ACs
230+ SAE docs

12 ICAO docs
30 SAE docs

58 EASA ETSOs
61 SAE docs

27 EASA AMCs
62 SAE docs
SAE Aerospace Standards by the Numbers

Systems Groups         10
Steering Groups        2
Technical Committees   181
Standards              8,500+
Document Types         4
  AS, AMS, ARP, AIR
Unique Participants    8,300+
Total Participation    17,600+
Major Global Aerospace Organizations Develop SAE Standards
SAE Aerospace Council, Global Custodians: Oversight and Governance

Airbus
Airbus Group
A4A
AVIC
BAE Systems
Boeing
Bombardier
Aerospace
CAPE
CIRA
COMAC
EASA
Embraer

SAE International
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Large scope of topics:

- Parts, Materials
- Mechanical, Electronic/Avionic/Wireless, ICT
- Platform, Systems, Subsystems
- Cross-cutting technologies
- Management & Process Standards
  - e.g. Safety Assessment, Quality and Counterfeit Avoidance

Through Life Usage:
Design, Certification, Manufacturing, Operation, Maintenance
One Forum, One Standard

Tier 1
Supplier
Govt/Reg
Operator
MRO
Research
Consultant

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Transparent, Efficient, Industry-Managed Standards Development

- The document is proposed
  - By industry
  - By regulator
  - For revision

- The draft is created by the committee

- The draft document is balloted – by committee. 50% Quorum and 75% Approval required

- Required changes made; affirmation ballot and Council Ballot

- The document is published by SAE

~18 months standard development time
Types Of 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.
The Public-Private Partnership: Civil Aviation

1st Tasking Request
List of Intl. Orgs

17 Tasking Requests
Regional Office Support: DC, Europe, China

SAE INTERNATIONAL

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Standards Referenced in EASA & FAA Regulations

EASA

- SAE*, 147
- RTCA*, 85
- EUROCAE*, 77
- ASTM*, 37
- MIL*, 24
- IEC*, 9
- NAS*, 5

FAA

- SAE*, 400
- RTCA*, 194
- EUROCAE*, 68
- ICAO*, 66
- EN*, 3
- CMH-17*, 1
- NAS*, 13
- MIL*, 342
- IEC*, 41
- ISO*, 24
- NAS*, 13

* Denotes referenced standard
SAE And “DefStan Reform”

✓ SAE maintains over 1,500 former US MilSpecs as industry standards – since early 2000s

✓ SAE International has worked with DStan to transfer 17 DefStan's to SAE standards

✓ The first such standard, *Impregnation of Porous Castings & Sintered Metal Components* was converted to SAE AMS03-1 and was published on February 24th 2015

✓ A successful embodiment of DStan’s civil standards campaign

✓ With an agreed process in place and successfully tested, further transfers are anticipated

✓ Partnership on NATO Civil Standards Campaign
Aerospace Standards Landscape

2.1.1 SAE Publications
AS8045 Minimum Performance Standard for Underwater Locating Devices (Acoustic) (Self-Powered)

2.1.2 ASTM Publications
ASTM D1141-98 Standard Practice for the Preparation of Substitute Ocean Water

2.1.3 RTCA Publications
RTCA/DO-160G Environmental Conditions and Test Procedures for Airborne Equipment

2.1.4 ARINC Publications
ARINC 677 Installation Standards for Low Frequency Underwater Locator Beacon (LF-ULB)
SAE Aerospace Standards for New Technologies

- Active RFID Tags
- Additive Manufacturing
- Fiber-optic networks
- Data Interoperability & Big Data
- Electric & More Electric Aircraft
- Integrated Vehicle Health Management & Prognostics
- Cybersecurity
New SAE Committees 2014-16

G-22 Engine Supply Chain Quality
G-26 Helicopter Hoists
Electric Aircraft Steering Group (EASG)
AMS-AM Additive Manufacturing
G-27 Lithium Performance Packaging
A-4 HWD – Head Worn Displays
A-4 EFIS – Electronic Flight Information Displays
SAE G-22 Aerospace Engine Supplier Quality (AESQ) Committee

- **Published 4 standards**
  - AS13000 Problem Solving Requirements for Suppliers
  - AS13001 Supplier Self Release Training Requirements
  - AS13002 Requirements for Developing and Qualifying Alternate Inspection Frequency Plans
  - AS13003 Measurement Systems Analysis Requirements for the Aero Engine Supply Chain

- **Drafting 4 new standards**
  - AS13004 FMEA & Process Planning
  - AS13005 Supplier Internal Audit
  - AS13006 Requirements for Process Control for Aero Engine Parts Manufacture
  - AS13007 Supplier Management
AESQ Strategy Group – an SAE ITC Participant Group

**SAE Training Developed:** *Aerospace Supplier Quality: Common Training for Self-Release Delegates based on AS13001*

- Estimated impact ~4,000 people and growing with a 3-year re-certification cycle

![Aerospace Supplier Quality: Common Training for Self-Release Delegates](Image)
<table>
<thead>
<tr>
<th>Document #</th>
<th>Topic</th>
<th>Update</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS6023</td>
<td>Create MPS for active RFID tags and sensors for use on aircraft</td>
<td>Plan to publish August 2016</td>
</tr>
<tr>
<td>AS6342</td>
<td>Create MPS for helicopter hoists</td>
<td>Plan to publish March 2017</td>
</tr>
<tr>
<td>AS6348</td>
<td>AC to AC conversion standard</td>
<td>Plan to publish April 2017</td>
</tr>
<tr>
<td>AS6377</td>
<td>Develop AS and ARP for head-worn displays</td>
<td>Plan to publish January 2018</td>
</tr>
<tr>
<td>AS6296</td>
<td>Create MPS for electronic flight instrument system display</td>
<td>Published March 2016</td>
</tr>
<tr>
<td></td>
<td>Develop new additive manufacturing committee</td>
<td>Completed January 2016</td>
</tr>
</tbody>
</table>
ICAO Tasking on Lithium Battery Packaging Standard

- Received SAE’s first ICAO tasking request to develop lithium battery packaging performance standard

- Risks associated with the carriage of lithium ion batteries as cargo are not adequately controlled

- Aircraft cargo fire protection systems may not be capable of adequately suppressing a Li battery fire

- “ICAO therefore urges SAE to establish a committee to propose a packaging performance standard for lithium batteries using the high-level standards developed during the third multi-disciplinary lithium battery transport coordination meeting as the basis for this work.”
## Current AMS-AM Works in Progress (WIPs)

<table>
<thead>
<tr>
<th>Project</th>
<th>Title</th>
<th>Date</th>
</tr>
</thead>
</table>

**Next topics – Metallic: Titanium AM (Airbus), Non-metallic: Cabin Parts (IATA)**
2016

- Farnborough International Airshow, July 12th 2016 Operators/MRO Maintenance Credits Workshop
- Keynote – Ian Davies, EasyJet
- Airline focus

IVHM Book Series
Acquired from TechAmerica Group in 2013
Formerly EIA, GEIA standards
Fully Integrated into SAE Aerospace Standards program as SSTC Systems Group
Includes IBIS consortium, which resides in SAE ITC
- 137 Standards; 22 Works in Progress
- Addressing multiple industry sectors
- Avionics, Configuration Management, Systems Engineering, Safety, Lifecycle Logistics, Reliability
- Potential establishment of new cross-sector Council
- New Human Systems Integration standards project under G-45
Engine & Airframe Standards

Acquired from ADS in 2015; history as SBAC standards from 1916

Operates under SAE ITC and includes associated parts qualification programme

- Rebranded as *SAE ITC Engine & Airframe Standards*
- New Website capabilities
- UK-based Technical Standards Committee (TSC) oversight
- New airframe fastener standard in development by Rolls-Royce and Airbus
- Increase in foreign qualifications since SAE acquisition – India, China, Taiwan, USA
- Links made with SAE E-25 and G-3 committees for synergy
Summary

The role standards play in industry and regulation is critical

Industry needs a transparent, robust and efficient process for producing standards

Aerospace industry standardisation is consolidating as organisations focus on core values and services – driving efficiency and connecting global industry

Global industry and regulation plays a leading role in SAE standards – at strategic and technical levels

SAE’s global offices directly support constituents – Europe, Asia and Americas

SAE’s aerospace standards portfolio available online includes SAE International Standards, Engine & Airframe Standards and associated standards products
QUESTIONS?

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Director, Washington Operations
SAE International

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Bruce.Mahone@sae.org
BACKUP:

EXISTING SAE STANDARDS FOR RPAS
The following SAE standards either explicitly state provisions for unmanned systems or are written entirely for unmanned systems.

<table>
<thead>
<tr>
<th>Document</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS50881™</td>
<td>Wiring Aerospace Vehicle</td>
</tr>
<tr>
<td>ARP5724™</td>
<td>Aerospace - Testing of Electromechanical Actuators, General Guidelines For</td>
</tr>
<tr>
<td>ARP5707™</td>
<td>Pilot Training Recommendations for Unmanned Aircraft Systems (UAS) Civil Operations</td>
</tr>
<tr>
<td>AIR6027™</td>
<td>Considerations for Safe Store Operation on Manned and Unmanned Vehicles</td>
</tr>
<tr>
<td>AIR744™</td>
<td>Aerospace Auxiliary Power Sources</td>
</tr>
</tbody>
</table>
The primary goal of AS-4 is to publish standards that enable interoperability of unmanned systems for military, civil and commercial use through the use of open systems standards and architecture development.

Subcommittees include:

- AS-4ALFUS  Unmanned Systems Performance Measures Committee
- AS-4JAUS  Joint Architecture for Unmanned Systems Committee
- AS-4UCS  Unmanned Aircraft System Control Segment Committee
AS-4 was formed as a result of the Joint Architecture for Unmanned Systems Working Group (JAUS WG) migration to SAE.

The objective is to define and sustain a joint architecture for the domain of unmanned systems. JAUS is a message-based architecture that defines data formats and methods of communication among computing nodes.

For example:
All modular components/subsystems, if designed to the JAUS standards, will communicate with the system regardless of manufacturer.
<table>
<thead>
<tr>
<th>SAE Document</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARP6128</td>
<td>Unmanned Systems Terminology Based on the ALFUS Framework</td>
</tr>
<tr>
<td>AIR5645A</td>
<td>JAUS Transport Considerations</td>
</tr>
<tr>
<td>AIR5664A</td>
<td>JAUS History and Domain Model</td>
</tr>
<tr>
<td>AIR5665B</td>
<td>Architecture Framework for Unmanned Systems</td>
</tr>
<tr>
<td>ARP6012A</td>
<td>JAUS Compliance and Interoperability Policy</td>
</tr>
<tr>
<td>ARP6227</td>
<td>JAUS Messaging over the OMG Data Distribution Service (DDS)</td>
</tr>
<tr>
<td>AS5669A</td>
<td>JAUS/SDP Transport Specification</td>
</tr>
<tr>
<td>AS5684B</td>
<td>JAUS Service Interface Definition Language</td>
</tr>
<tr>
<td>AS5710A</td>
<td>JAUS Core Service Set</td>
</tr>
<tr>
<td>AS6009</td>
<td>JAUS Mobility Service Set</td>
</tr>
<tr>
<td>AS6040</td>
<td>JAUS HMI Service Set</td>
</tr>
<tr>
<td>AS6057A</td>
<td>JAUS Manipulator Service Set</td>
</tr>
<tr>
<td>AS6060</td>
<td>JAUS Environment Sensing Service Set</td>
</tr>
<tr>
<td>AS6062</td>
<td>JAUS Mission Spooling Service Set</td>
</tr>
<tr>
<td>AS6091</td>
<td>JAUS Unmanned Ground Vehicle Service Set</td>
</tr>
</tbody>
</table>
The addition of the Performance Measures subcommittee, previously the Autonomy Levels for Unmanned Systems (ALFUS) Working Group, adds a critical dimension to unmanned systems standards.

The AS-4ALFUS committee specifies terms and definitions for the performance of unmanned systems; establish measures for the performance and characterization of unmanned systems, their components, and their interactions.
The AS-4UCS Technical Committee supports the charter of AS-4 (Unmanned Systems) in the field of the Unmanned Aircraft System (UAS) Control Segment (UCS). The UCS is defined as the system or family of systems that controls and monitors one or more unmanned aircraft and their payloads, where an unmanned aircraft is defined as an aerial vehicle that does not convey its pilot or operator, and a payload is defined as a device carried by the unmanned aircraft to support its assigned mission.

- The scope of the AS-4UCS Technical Committee is to define UCS architectures and architecture frameworks, develop associated Technical Reports to support the ecosystem of UCS products, and support alignment of UCS architectures with peer architectures.
<table>
<thead>
<tr>
<th>SAE Document</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIR6514</td>
<td>UAS Control Segment (UCS) Architecture: Interface Control Document (ICD)</td>
</tr>
<tr>
<td>AIR6515</td>
<td>UAS Control Segment (UCS) Architecture: EA Version of UCS ICD Model</td>
</tr>
<tr>
<td>AIR6516</td>
<td>UAS Control Segment (UCS) Architecture: RSA Version of UCS ICD Model</td>
</tr>
<tr>
<td>AIR6517</td>
<td>UAS Control Segment (UCS) Architecture: Rhapsody Version of UCS ICD Model</td>
</tr>
<tr>
<td>AIR6519</td>
<td>UAS Control Segment (UCS) Architecture: Use Case Trace (UCTRACE)</td>
</tr>
<tr>
<td>AIR6520</td>
<td>UAS Control Segment (UCS) Architecture: Version Description Document (VDD)</td>
</tr>
<tr>
<td>AIR6521</td>
<td>UAS Control Segment (UCS) Architecture: Data Distribution Service (DDS)</td>
</tr>
<tr>
<td>AIR6523</td>
<td>Data Dictionary for Quantities Used in Unmanned Systems</td>
</tr>
<tr>
<td>AS6512</td>
<td>UAS Control Segment (UCS) Architecture: Architecture Description</td>
</tr>
<tr>
<td>AS6513</td>
<td>UAS Control Segment (UCS) Architecture: Conformance Specification</td>
</tr>
<tr>
<td>AS6518</td>
<td>UAS Control Segment (UCS) Architecture: Model</td>
</tr>
<tr>
<td>AS6522</td>
<td>UAS Control Segment (UCS) Architecture: Architecture Technical Governance</td>
</tr>
<tr>
<td>ARP6128</td>
<td>Unmanned Systems Terminology Based on the ALFUS Framework</td>
</tr>
</tbody>
</table>
ARP-4754A: Guidelines for Development of Civil Aircraft and Systems

This document discusses the development of aircraft systems taking into account the overall aircraft operating environment and functions.

This includes validation of requirements and verification of the design implementation for certification and product assurance. It provides practices for showing compliance with the regulations and serves to assist a company in developing and meeting its own internal standards by considering the guidelines herein.