PREMISE

• SAE PHM RELATED STANDARDS

• TYPES OF SAE STANDARDS

• DEVELOPED FOR INDUSTRY SPECIFIC USE

• SAE MANUFACTURING STANDARDS

• RECOGNIZED FOR INTENDED RIGOR
### SAE PHM RELATED STANDARDS

#### SAE A-6A3, E-32, G-11R
- **AIR5273** Actuation System Failure Detection Methods
- **AIR5120** Engine Monitoring System Reliability and Validity
- **ARP5580** Recommended Failure Modes and Effects Analysis (FMEA) Practices for Non-Automobile Applications

#### SAE AISC-SHM Structural Health Monitoring and Mgmt
- **ARP6461** Guidelines for Implementation of Structural Health Monitoring on Fixed Wing Aircraft
- **AIR6892** Guidelines for Implementation of Structural Health Monitoring on Rotorcraft (WIP)

#### HM-1 Integrated Vehicle Health Management Committee
- **ARD6888** Functional Specification of Miniature Connectors for Health Monitoring Purposes
- **ARP6275** Determination of Cost Benefits from Implementing an IVHM System
- **JA6268** Design & Online Communication Standards for Health Ready Components (WIP)
ISO 9001
• International Standard intended to be usable by any organization, service or manufacturing, in any industry sector

AS9100
• Global Industry Standard intended for exclusive use by aviation, space, and defense organizations. Committees are comprised of SMEs from all areas of Aerospace quality community that represent themselves and are often supported by their companies

Additional Requirements
• Project management, risk management, configuration management of the products
• Design verification and validation
• Verification of production processes and control of the changes to production processes
• Criteria for rejection and special measurement instructions
• Full standards and certification suite
• G-23 Manufacturing Management
  • AS6500 Manufacturing Management Program
    – Encourages the use of best manufacturing management practices aimed at promoting the timely development, production, modification of affordable products

• G-33 Configuration Management
  • EIA511 Manufacturing Message Specification Service Definition and Protocol

• AMS-B Finishes Process and Fluids
  • AMS3084C Lubricant, Solid Film Minimal Outgassing
  • AMS2689B Fusion Welding Titanium and Titanium Alloys

• AMS-F Corrosion Heat Resistant Alloys
  • AMS2774E Heat Treatment Wrought Nickel Alloy and Cobalt Alloy Parts
  • AMS2241S Tolerances, Corrosion and Heat-Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Bars and Wire
Aerospace industry and regulatory bodies have required a specific set of specifications needed for aerospace applications.

SAE AMS-AM committee is writing the standards needed to develop acceptable industry-wide aerospace standards and qualification/certification guidelines for AM materials and processes, or for design, manufacturing, and maintenance/repair of aircraft and engine components using AM.

There are currently 4 SAE AMS specifications in process for pre-cursor material, process and post processing of AM.
MANUFACTURING SMART

Smart Sensors

- Sensors that not only collect data but also analyze and communicate with other systems.

- The manufacturing process has the opportunity to embed sensors for manufacturing PHM

- AND for smart operational use (e.g. embedded SHM sensors in additively manufactured or composite structures)

- These will require standards to address the safety requirements for aviation use
QUESTIONS?

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# Current AMS-AM Works in Progress (WIPs)

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The Specification Framework...
AMS7000
Additive Manufacture of Aerospace parts from Ni-base Superalloy 625 via the Laser Powder Bed Process

Scope
This Aerospace Standard cover the additive manufacture of parts from Ni-base superalloy 625 via the laser powder bed process. It will contain the technical requirements for chemistry, microstructure, heat treatment, and mechanical properties along with quality assurance provisions to ensure quality and compliance.

Rationale
This Aerospace Standard is intended to provide technical requirements and quality assurance provisions and to reference additional required specifications for precursor materials, process and all secondary operations for the laser powder bed processing of the Ni-base superalloy 625. No such standard currently exists.
AMS7001

Ni Base 625 Super Alloy Powder for use in Laser Powder Bed Add Mfg Machines

Scope
This material specification will cover both the precursor or feedstock Ni base 625 powder and part specifications for material to be used in the manufacture of aerospace parts under SAE Aerospace Standard AMS7000.

Rationale
The Aerospace Material Specification is intended to provide the technical requirements such as alloy composition, particle size distribution for both feedstock and as-built part materials via the laser powder bed additive manufacturing process. No such specification currently exists.
Scope
This material specification will cover both the production of precursor Ni base 625 powder feedstock for material to be used in the manufacture of aerospace parts under SAE Aerospace Standard AMS7000. This process/practice specification is necessary to define standard practices for topics that may include training, powder handling, process cleanliness, process environment, packaging, storage, shipping, material changes, traceability, calibration, maintenance, etc. This specification is to be production process agnostic and non-prescriptive.

Rationale
The Aerospace Material Specification is intended to provide the process requirements for production of Ni-base 625 precursor powder for use in production of aerospace parts via the laser powder bed additive manufacturing process. No such specification currently exists.
AMS7003
Laser Powder Bed Fusion Process

Scope
This specification will be used in conjunction with AMS 7000, Additive Manufacturing of Aerospace Parts from 625 via Laser Powder Bed process. It is intended to provide required specifications and best practices for process parameters, NDI and post processing of the aerospace parts.

Rationale
The manufacturing process is unique relative to traditional or 'subtractive' methods and this document is intended to provide technical information on laser powder bed process specifications, NDI methods, and generally accepted best practices to produce parts capable of service in critical and non-critical aerospace service. No such document currently exists.
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.