Inclusion of a New Alloy in the Metallic Materials Properties Development and Standardization (MMPDS) Handbook

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Approval Process for Aerospace Design Allowables

- Industry has two courses of action when pursuing FAA approval of all designs for aerospace metallic structures

Course of action #1:
FAA accepts "A-Basis" and "B-Basis" values published in the MMPDS Handbook (formerly the MIL-HDBK-5) as meeting the regulations of Federal Aviation Regulation (FAR) 25.613.

Or

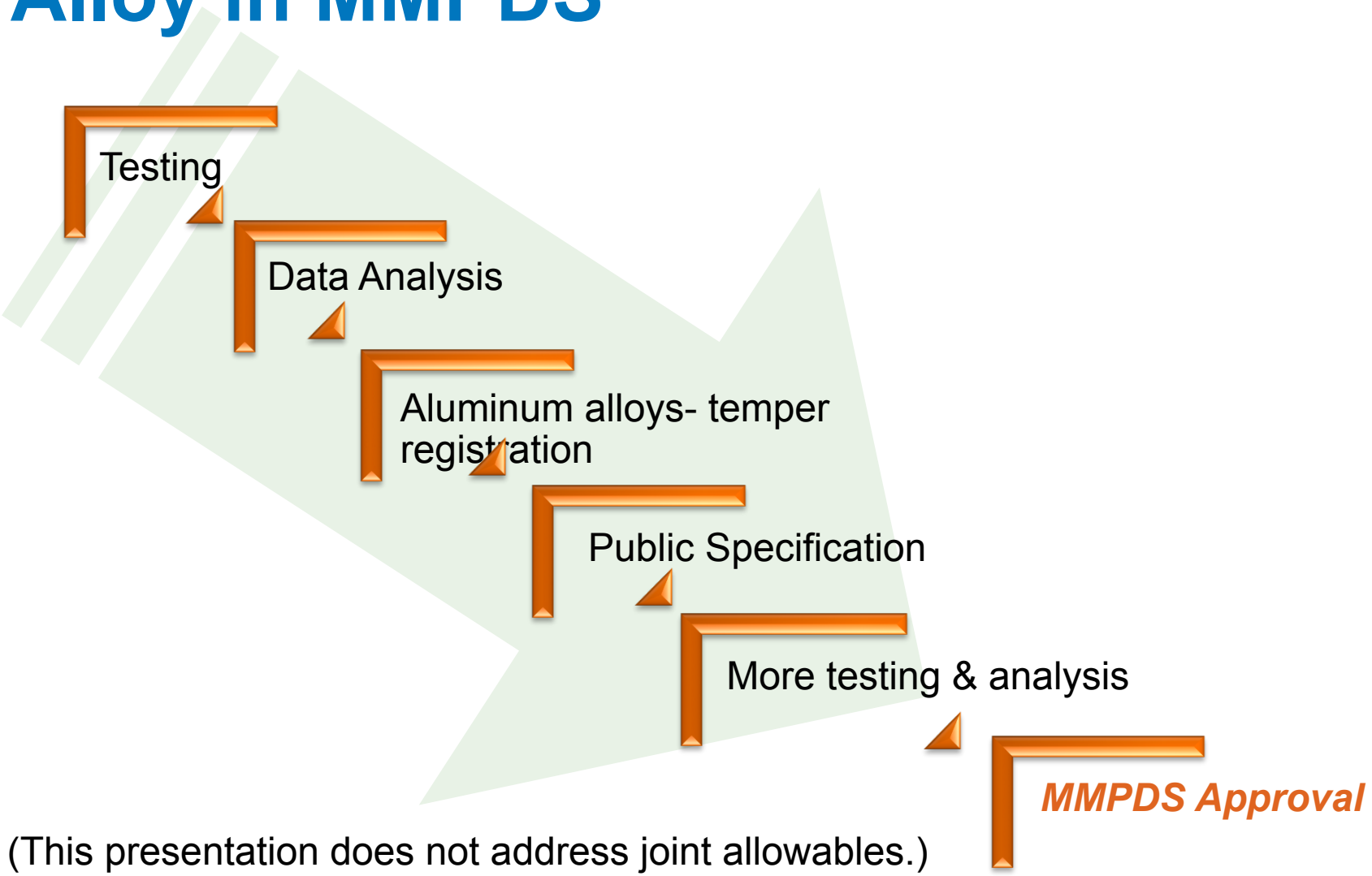
Course of action #2:
Designers must submit sufficient data to allow the FAA to verify the design allowables used.

Design Allowables for Aerospace Industry

- The FAA views the MMPDS handbook as a vital tool for aircraft certification and continued airworthiness activities.
- Without the handbook, FAA review and approval of applicant submittals would become more difficult, more costly, less consistent, and would entail multiple reviews of same or similar material.

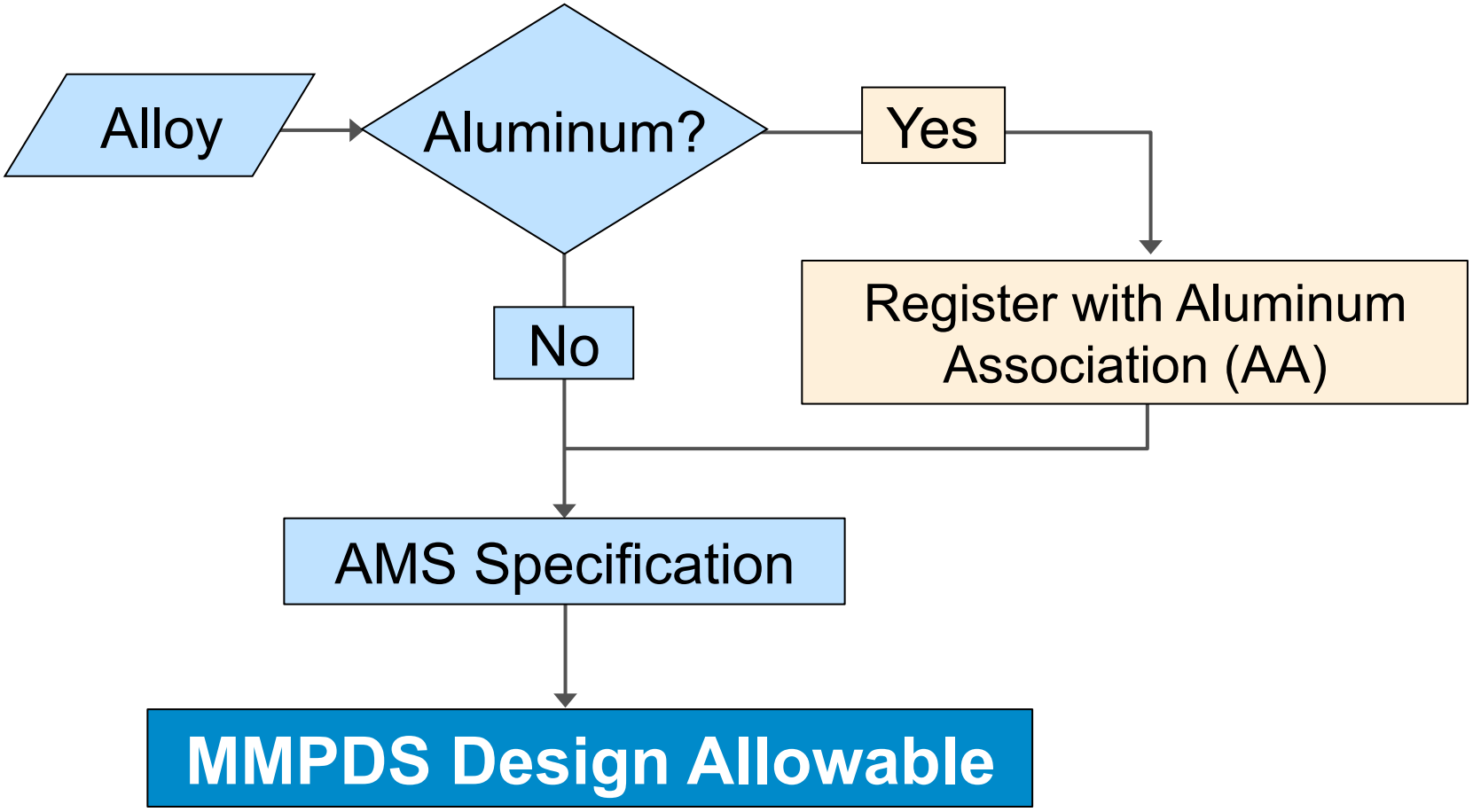
- "The handbook remains the only publicly available U.S. source that the FAA generally accepts specifying material allowances, in compliance with the Federal Aviation Regulations (FARs), for material strength properties and design values associated with aircraft certification and continued airworthiness"
- "Moreover, it is the only publically available source for fastener joint allowables that comply with the FARs".
  - Dr. John Bakuckas, Jr., FAA Program Manager

Steps to Follow in Order to Get an Alloy in MMPDS



(This presentation does not address joint allowables.)

Aluminum vs Non-Aluminum Alloys



Aluminum Alloys

- Alloy and temper must be registered with Aluminum Association (AA)
  - Contact: Lada Bulookbashi, Manager, Alloy and Temper Registration
  - LBulookbashi@aluminum.org
- Aluminum alloy/temper registration requires sample size of 100 tests from 10 lots
- Tentative minimums may be registered for smaller sample sizes
- Aerospace alloys typically use same analysis for AA, AMS and MMPDS as appropriate

All Alloys - AMS Specification

SAE Aerospace
An SAE International Group

- Information about the AMS Metals Group, the AMS NonMetals Group, and each of the individual committees that make up the AMS Division, available at the following URL: <http://www.sae.org/technicalcommittees/aermtd.htm>.
- Public posting of basic information is on line at the following URL: http://www.sae.org/standardsdev
- Contact Maureen Lemankiewicz at SAE <lemankm@sae.org>

Creating an AMS Specification

SAE Aerospace
An SAE International Group

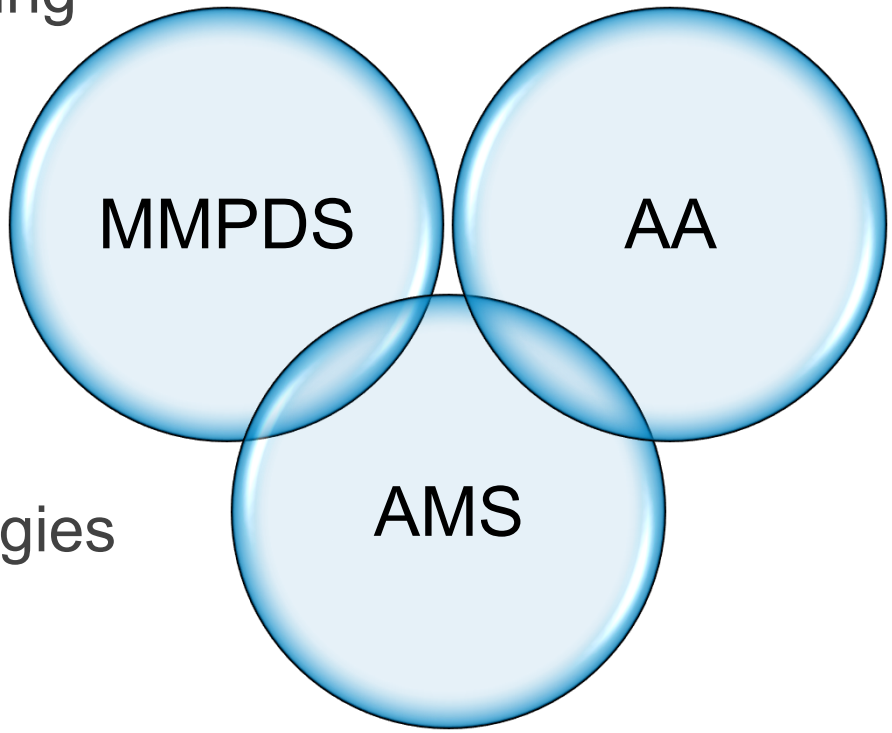
1. Committee/chairperson validates need for specification and assesses the maturity of the material/process
   - Support from at least two aerospace users
   - Proposed properties substantiated by Battelle analysis
2. Sponsor drafts the new specification after obtaining assistance from SAE Editorial Consultant for format, consistency, and technical clarity
3. Draft specification balloted to SAE technical committee of jurisdiction for comment over a 28-Day review period
4. Each technical (requirements-based) comment is debated and resolved by consensus process
5. Final version balloted to SAE Aerospace (industry VPs) for approval
6. Document published by SAE

Committee Interactions

- Specification balloting and debate occurs year-round through committee website, email, and electronic communication tools
- Meetings are open to all interested parties (two meetings each year for most committees)
- Committee officers & membership approved by SAE Aerospace Council
- Committee chairpersons are responsible for maintaining committee membership balance (user, supplier, & liaison members)
- Only committee members vote on draft documents
  - Supplier member participation is highly valued, but final approval votes are “User Member Only” (OEM/transport operator/government).
- Individuals participate on committees as technical experts and not as representatives of their organization/business.

Statistical Analysis (by Battelle)

- Multiple sources for determining minimum properties:
  - Aluminum Association
  - SAE AMS Metals Committees
  - MMPDS
- The sources apply varying statistical analysis methodologies
- Most demanding analysis is MMPDS
- Cooperation between all groups is essential



Minimum Data Requirements

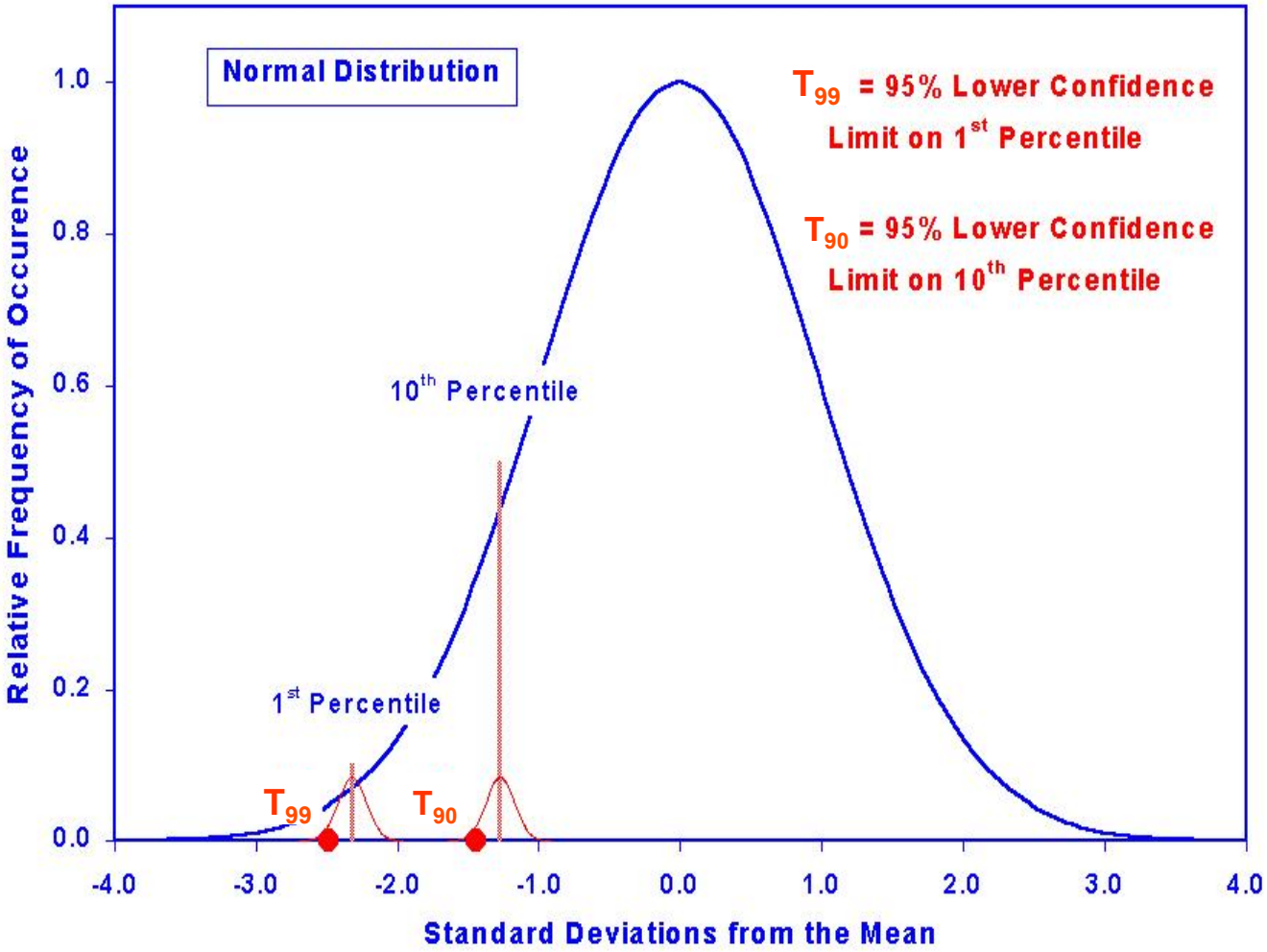
MMPDS

- Primary tensile properties for A- and B-basis
  - 10 Heats/ 10 Lots
  - 100 tests
  - (or 299 for non-parametric)
- Primary tensile properties for S-basis
  - Same as AMS Specification minimums
- Secondary properties
  - 3 Heats/ 10 Lots
  - 20 tests (paired, prefer 2/lot)

AMS Specification

- S-Basis
- For tensile, compression, elongation, RA, fracture toughness
- 3 Heats, Chemistries
- 30 Tests

MMPDS "A-Basis" and "B-Basis"



A-Basis is the lower of the specification minimum or T_{99} value

B-Basis = T_{90} *It is not related to the specification minimum.*

MMPDS Requirements

Public Specification

- Typically AMS for material

Property Tests

- Table 9.2.3 of MMPDS for test methods
- Table 9.2.4 of MMPDS for properties and sample size

Analysis and Review

- Per MMPDS Chapter 9
- Review by Industry and Government

MMPDS Property Requirements

Required

- Tensile
- Compression Yield
- Shear Ultimate
- Bearing
- Modulus
- Stress-Strain curves
- Density
- Elongation

Strongly Recommended

- Coefficient of Thermal Expansion
- Specific Heat
- Thermal Conductivity
- Poisson's Ratio

Recommended

- Fracture Toughness
- Fatigue
- Effect of Temperature & Exposure
- Crack Growth
- Creep & Rupture
- Reduction in Area

Exception: Materials for elevated temperature applications do not require room temperature secondary property tests (see Table 9.2.4).

Battelle Analysis

- All Battelle analysis efforts use SAE AMS or MMPDS guidelines, as appropriate.
- Battelle considers all data received as company confidential and does not share it with any other source (unless it obtains permission from the submitting company)
- Battelle only sends the analysis results to the original data supplier
- The data supplier can decide if it wants to proceed or acquire more data for:
  - AA registration (if aluminum alloy)
  - AMS minimums
  - MMPDS design allowable properties

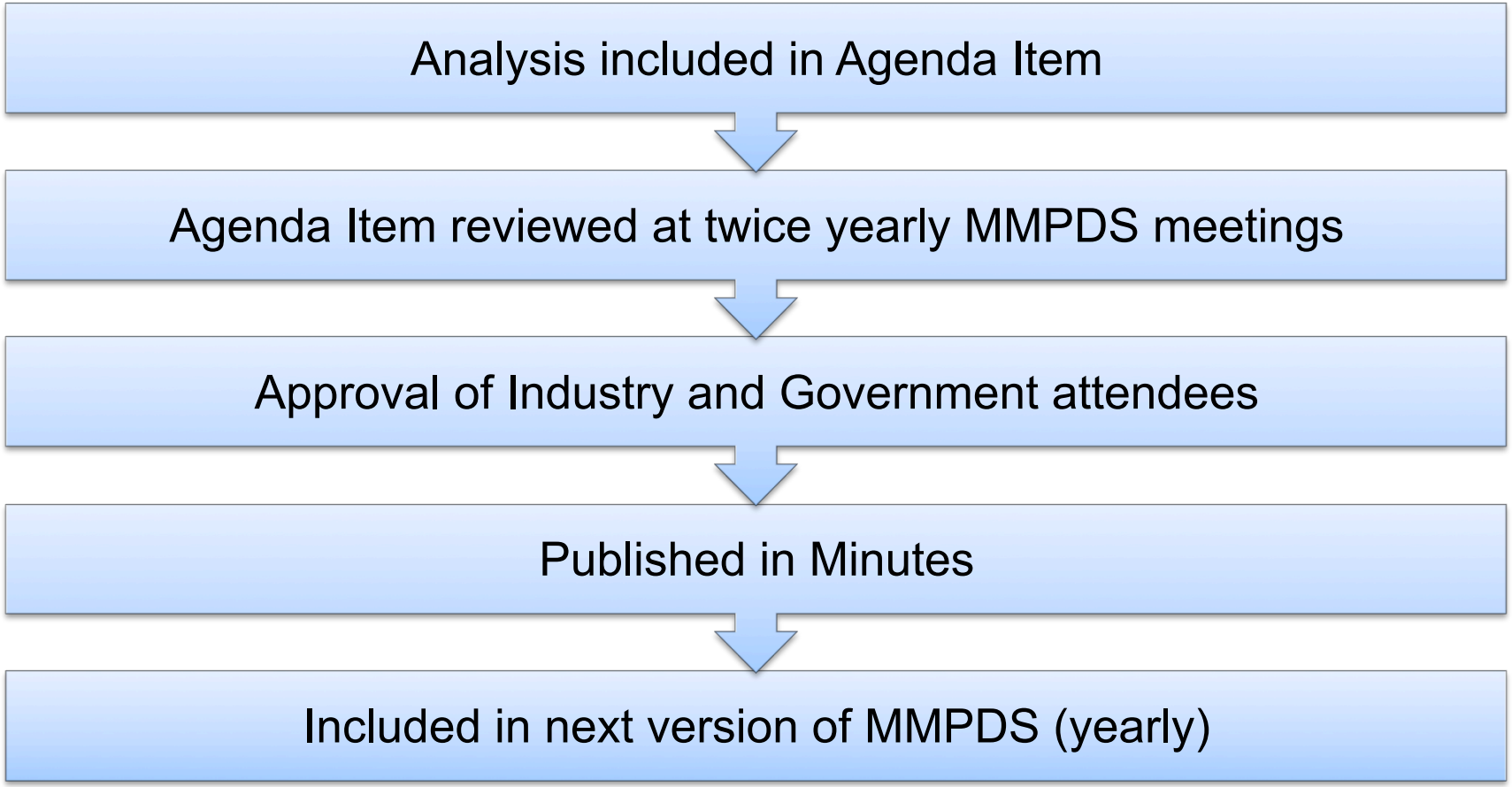
Analysis Methods – Tensile & Elongation (Direct Analysis)

- <100 (used for AMS & MMPDS S-basis)
  - Normal
  - 50% Censored Normal (when not normal)
  - Linear or Quadratic Regression
- ≥100 (MMPDS methods used, A- & B-basis)
  - 3 Parameter Weibull or Pearson Type III
    - Weibull may be censored and apply backoff if needed
    - Pearson may use backoff if needed
  - Linear or Quadratic Regression

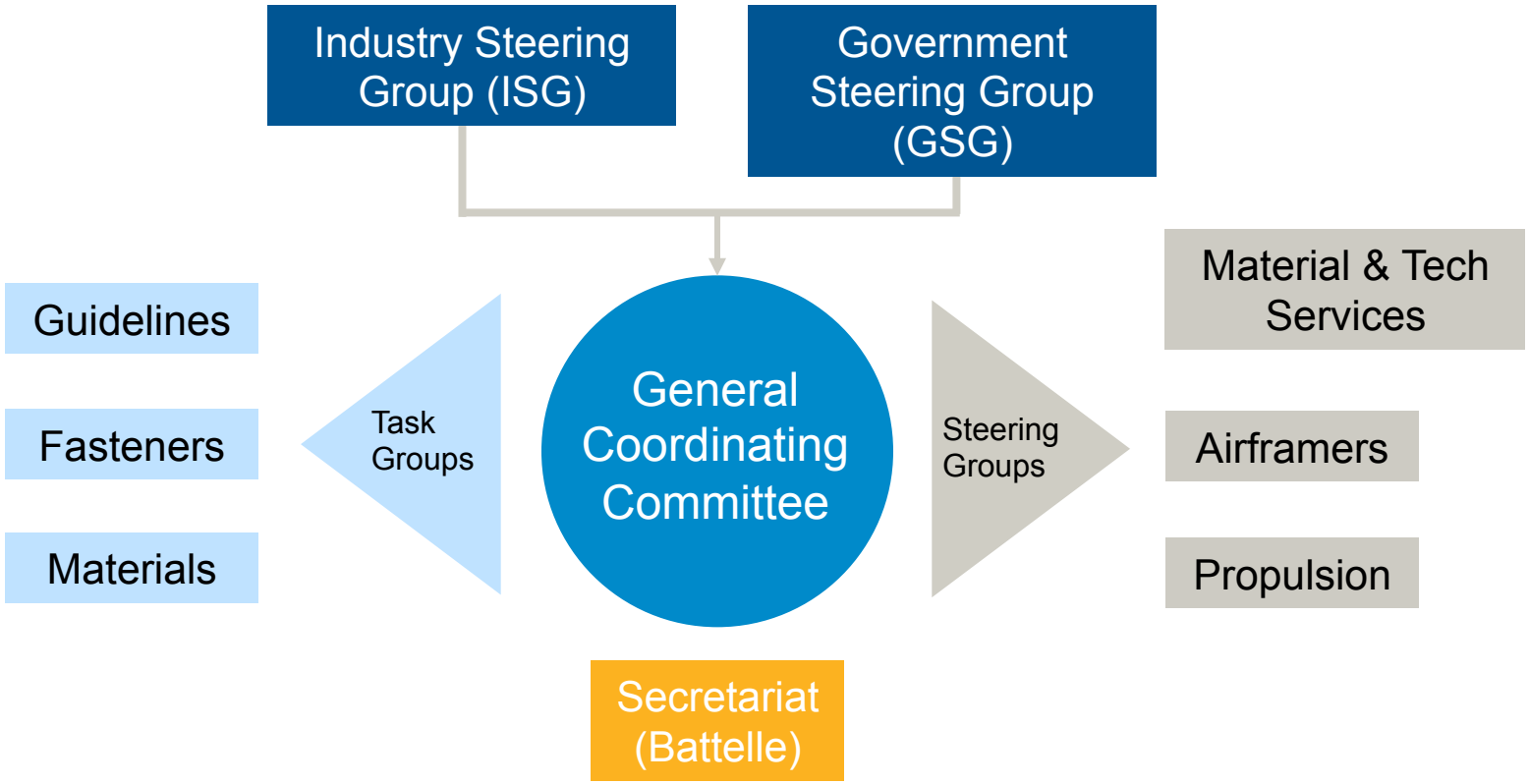
Analysis Methods – Secondary Properties (Indirect Analysis)

- Used primarily for MMPDS design allowable properties – Compression, Shear, and Bearing
- Paired Ratios method
  - Less data required; 20 tests, preferably 2/lot from minimum of 10 lots
  - Paired with tensile in nearby location

MMPDS Approval Process

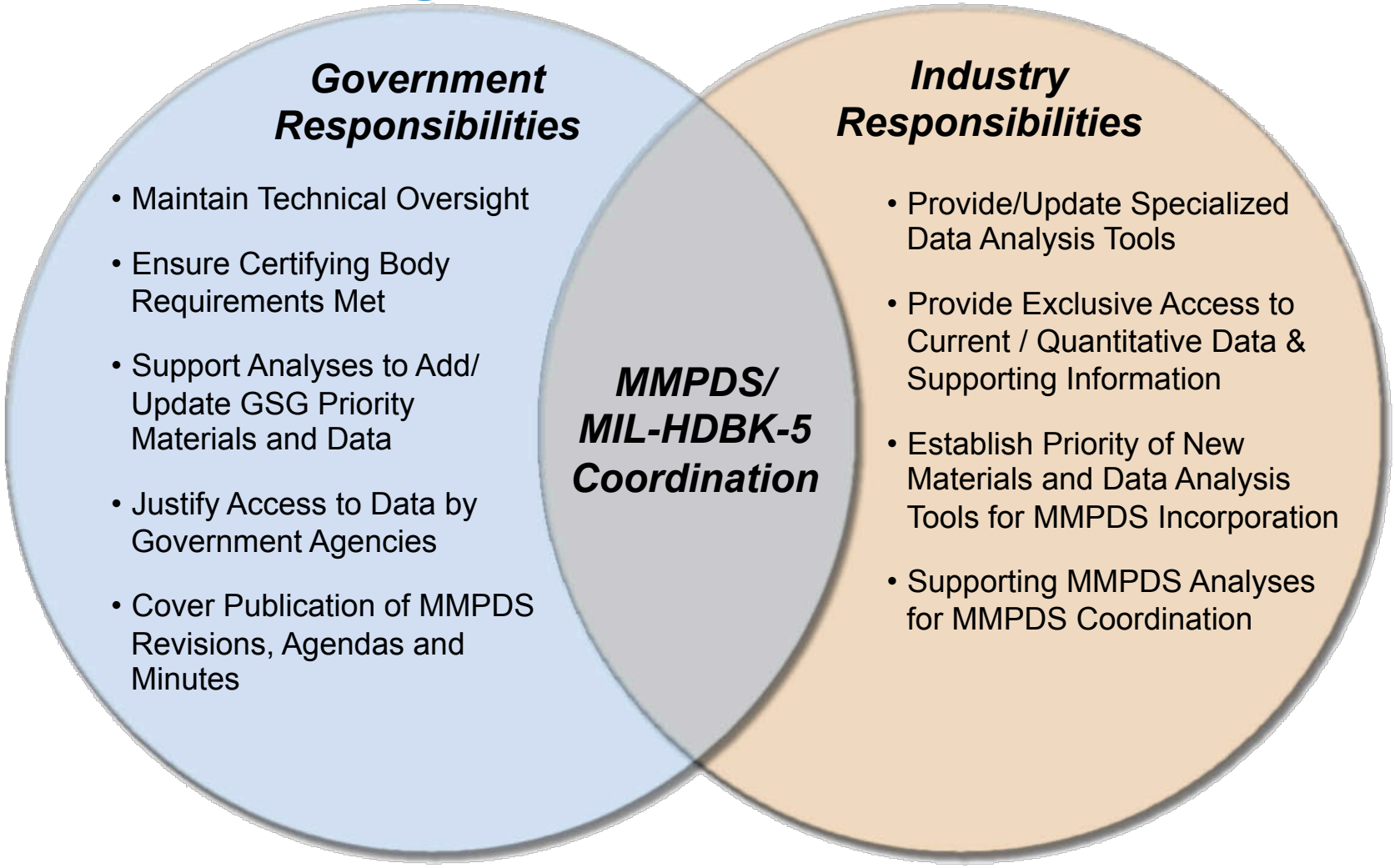


MMPDS Organizational Construct



Great Example of Effective Industry and Government Partnership

MMPDS Organization



https://www.mmpds.org/