



Federal Aviation
Administration

FAA / CAAs “Composite Meeting”

Overview: CMH-17 & Volume 3 (PMC)

Larry Ilcewicz
Lester Cheng
FAA Composite Team

Singapore, Singapore
September 01-04, 2015

Composite Safety & Certification Meeting - CMH-17 & Volume 3 (PMC) -

- Organization and Working groups
- Structure of the CMH-17 Handbooks
 - Polymer Matrix Composites, PMC: Volumes 1 through 3 [Revision G Highlights]
 - Metal Matrix Composites, MMC: Volume 4
 - Ceramic Matrix Composites, CMC: Volume 5
 - Sandwich Composites: Volume 6
- CMH-17 Website
- How to Get Involved in CMH-17



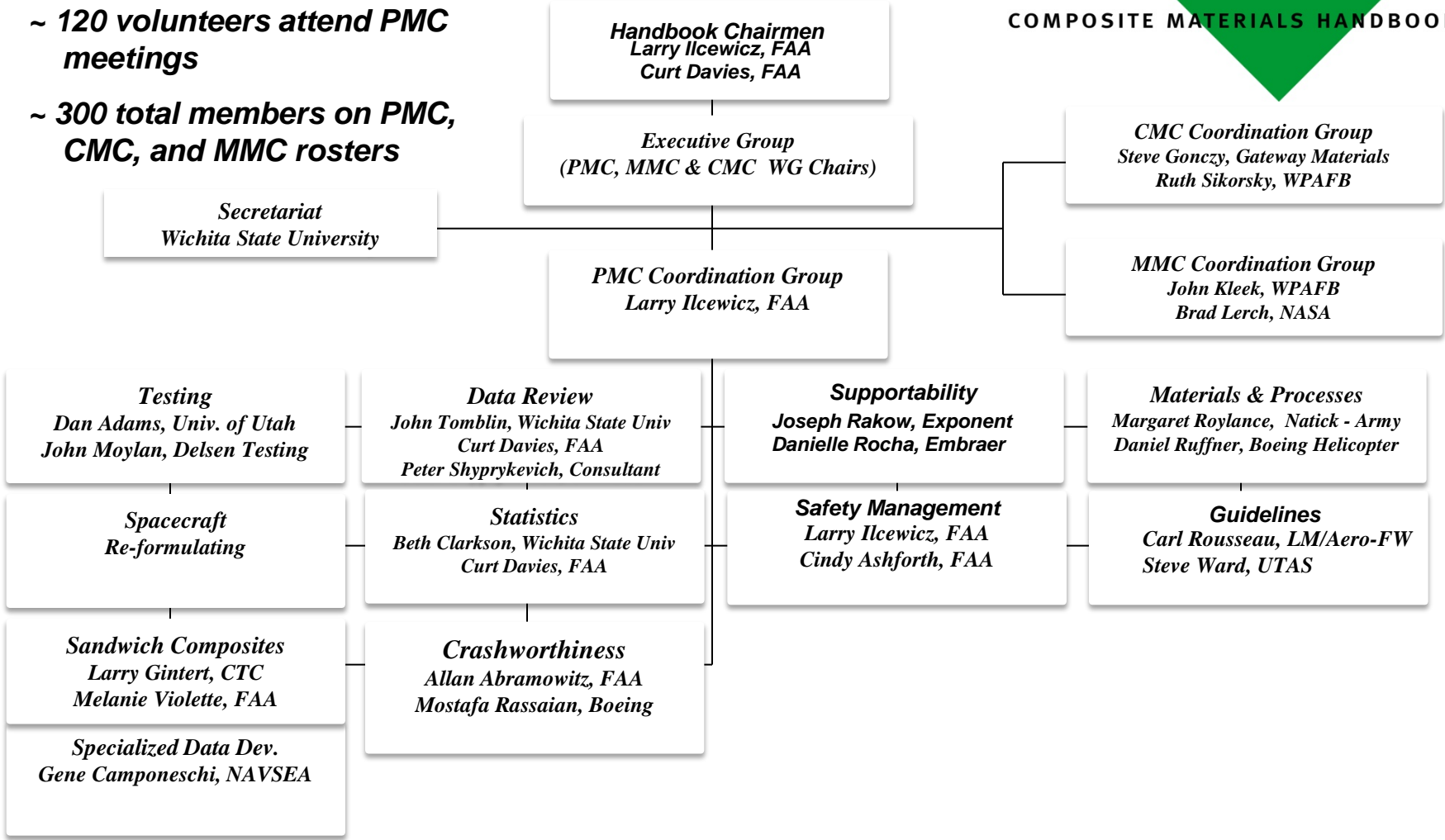
The CMH-17 Organization



~ 120 volunteers attend PMC meetings

~ 300 total members on PMC, CMC, and MMC rosters

Permanent Working Groups



Individual Working Group Goals



Working Group	Goal
Guidelines	To develop and document generic guidance information and data which are essential for the adequate design, certification or qualification, and production of composite parts and assemblies.
Materials & Processes	To provide guidelines, descriptions and case studies of material and processing options for the characterization and fabrication of polymer matrix composite materials
Data Review	<ul style="list-style-type: none"> • To provide the final technical/editorial review of all data prior to review by full coordination group • To provide a review of the application of the data documentation requirements to the actual data being supplied • To develop formats for data presentation in the handbook • To establish the data documentation requirements for the handbook

Individual Working Group Goals

Working Group	Goal
Statistics	Analyzes and/or develops <u>statistical procedures</u> for composite material evaluation and quality control, and provides other statistical support to the Handbook as directed by the Guidelines Working Group. The Statistics working group spans the three coordination groups with co-chairs for metal matrix and ceramic matrix composites.
Testing	To offer descriptive and guidance information relating to the usage of <u>chemical, physical and mechanical test methods</u> for polymer matrix composites and their constituents. <ul style="list-style-type: none">• Inform the reader of advantages and shortcomings of the various methods used in the industry• Provide a basis for test method selection• To identify specific test methods to be used when data is submitted to CMH-17 for consideration for inclusion in Volume 2 of the handbook
Supportability	To provide useful guidelines in the design of repairs for composite structures.

Individual Working Group Goals



Working Group	Goal
Composites for Space	Addresses the special concerns related to the application of polymer matrix composites in a space environment, including the introduction of additional physical property measurements into the Handbook. In addition, the group will encourage the inclusion of material property data of interest to the spacecraft community
Specialized Data Development	Deals with the issues that arise in non-traditional forms of composite materials including textiles, 3-D reinforcements, and thick section composites. In addition, the group deals with the particular technical issues related to non-aerospace applications
Sandwich	Responsible for the creation of a Structural Sandwich Composites Volume. The group is reviewing and revising the material in MIL-HDBK-23. New sections are being created to reflect technology changes since the last revision of MIL-HDBK-23

Individual Working Group Goals



Working Group	Goal
Crashworthiness	<p>Provide support for the development of a new chapter on composite Crashworthiness and Energy Management for vehicle safety certification. The Crashworthiness Working Group will also attempt to address needs of the composites and vehicle safety community at large, and to provide a unique forum of discussion for those working in industry, research institutions, and government agencies. The group will recommend design guidelines and practices for the experimental and numerical characterization of the crash resistance of advanced composites.</p>
Safety Management	<p>Responsible for managing the elements of vehicle structural safety, which include requirements, design criteria, quality control, damage considerations, inspection, education and continuous service data monitoring throughout a vehicle's life cycle. Safety management relies on integration of the efforts by design, manufacturing, maintenance and operations disciplines. It is also driven by service experience and an international mandate to improve safety statistics as future fleets of a given vehicle type expand. The Safety Management WG currently has three Task Groups:</p> <ul style="list-style-type: none"> • Structural Safety • Disbonding and Delamination • Damage Tolerance



Structure of the Handbook



Vol. 1 Polymer Matrix Composites: *Guidelines for Characterization of Structural Materials*

Vol. 2 Polymer Matrix Composites: *Material Properties*

Vol. 3 Polymer Matrix Composites: *Materials Usage, Design and Analysis*

Volumes 1-3: Revision G released by SAE in 2012

Vol. 4 Metal Matrix Composites

Volume 4 updated in 2013

Vol. 5 Ceramic Matrix Composites

Vol. 6 Structural Sandwich Composites

Volume 6 initial release in 2014

Volume 1: Polymer Matrix Composites

Guidelines for Characterization of Structural Materials



Volume 1 documents material characterization data development methodology guidelines adaptable to a wide variety of needs, as well as specific requirements to be met by data published in the handbook

1. Objectives ***Significant Rev. G changes in green italics***

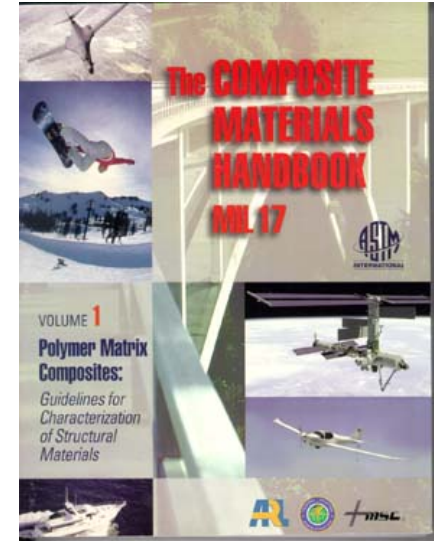
2. Guidelines for Property Testing of Composites
Test Program Planning
Recommended Test Matrices
Material Testing for Submission of Data to CMH-17

3. Evaluation of Reinforcement Fibers

4. Matrix Characterization

5. Prepreg Materials Characterization

6. Lamina, Laminate and Special Form characterization
Thermal/Physical/Electrical Property Tests
Static Uniaxial Mechanical Property Tests
Space Environmental Effects on Material Properties



7. Structural Element Characterization

8. Statistical Methods
Revision of chapter outline
Major revisions to 8.3 Calculation of Statistically-Based Material Properties
Flowchart with detailed notation

Volume 2: Polymer Matrix Composites

Material Properties

Volume 2 provides a repository of material data.

The documented property summaries for material systems provide data meeting the criteria for any of the clearly defined material data classes: robust and reduced A-Basis, robust, reduced and pooled B-Basis, mean, interim, and screening.

1. General Information

Definitions

Material Orientation Codes

Presentation of Data

2. Carbon Fiber Composites

- *Complete Documentation*

- MIL-HDBK-17 Rev F Legacy Data

3. Boron Fiber Composites

- MIL-HDBK-17 Rev F Legacy Data

4. Glass Fiber Composites

- *Complete Documentation*

- MIL-HDBK-17 Rev F Legacy Data

Significant Rev. G changes in green italics

*Material & process spec info
required for new data sets to have
"Complete Documentation"*

5. Quartz Fiber Composites

- MIL-HDBK-17 Rev F Legacy Data

Appendix MIL-HDBK-17A Data

Highlights of Revision G: Volume 2, Materials Properties

Chapter	Update
2, Carbon Fiber Composites	<ul style="list-style-type: none">• HTA 5131 3k/M20 Plain Weave Fabric• T700GC 12k/2510 Unidirectional Tape• T700SC 12k/2510 Plain Weave Fabric• T300 6k/E765 Five-Harness Satin Weave Fabric• AS4C 3k/HTM45 8-Harness Satin Weave Fabric• AS4C 3k/HTM45 Plain Weave Fabric
3, Boron Fiber Composites	B4.0 208/5521 unidirectional tape
4, Glass Fiber Composites	7781/2510 Eight-Harness Satin Weave Fabric

- New data sets analyzed with the latest statistical procedures, including **pooling** across environmental conditions and **modified CV** approach for basis value calculations when appropriate.
- Material and process **specifications** required for Complete Documentation data sets
- **New outline** categorizing materials by documentation and specification requirements

Volume 3: Polymer Matrix Composites

Materials Usage, Design, and Analysis



Volume 3 provides technical guidance on a wide variety of disciplines related to polymer matrix composites, including the use of data for the design and evaluation of composite structures. This volume has recently undergone a major reorganization to increase usability. Four new chapters will be added for the next publication, as well as many additions and revisions throughout.

Significant Rev. G changes in green italics

1. General Information
2. ***Intro to Composite Structure Development***
3. ***Aircraft Structure Certification and Compliance***
4. Building Block Approach for Structures
5. Materials and Processes – The Effects of Variability on Composite Properties
6. Quality Control of Production Materials & Processes
7. ***Design of Composites***
8. ***Analysis of Laminates***
9. Structural Stability Analyses
10. Design and Analysis of Bonded Joints
11. Design and Analysis of Bolted Joints
12. ***Damage Resistance, Durability and Damage Tolerance***
13. ***Defects, Damage and Inspection***
14. ***Supportability, Maintenance & Repair***
15. Thick Section Composites
16. ***Crashworthiness and Energy Management***
17. ***Structural Safety Management***
18. Environmental Management



Highlights of Revision G: Volume 3, Materials Usage, Design and Analysis

Chapter	Update
3, Aircraft Structure Certification and Compliance	ALL NEW CHAPTER
7, Design of Composites	ALL NEW CHAPTER
8, Analysis of Laminates	ALL NEW CHAPTER
12, Damage Resistance, Durability, and Damage Tolerance	Completely updated chapter with all new sections on Fatigue Damage Onset, Damage Growth under Cyclic Loading, and Analysis Methods
13, Defects, Damage and Inspection	ALL NEW CHAPTER
14, Supportability	Revised chapter, new Section on strain energy release rate interlaminar fracture mechanics
16, Crashworthiness and Energy Management	ALL NEW CHAPTER
17, Structural Safety Management	ALL NEW CHAPTER

Volume 4: Metal Matrix Composites

Volume 4 covers technology and materials for metal matrix composites primarily used in aircraft engine components, spacecraft, and other high temperature applications. Material data include fiber, matrix, and composite material properties.

1. Guidelines

Test Plans for Materials Characterization

New testing sections

Corrosion and Corrosion Test Methods

2. Design Guidelines for Metal Matrix Materials

Analysis Approaches (continuous fiber MMC)

New section on Macromechanics

3. Materials Properties Data

3.1 General Information

3.2 Reinforcement Properties

SCS-6 Fiber

3.3 Properties of Matrix Materials

3.4 Fiber Coating Properties

3.5 Aluminum Matrix Composite Properties

3.6 Copper Matrix Composite Properties

Significant Rev. changes in green italics

3.7 Magnesium Matrix Composite Properties

• Corrosion Tables

3.8 Titanium Matrix Composite Properties

3.9 Other Matrix Composites

Appendix A. Typical Pushout Test Data

Appendix B. Raw Data Tables for Matrix Materials

Appendix C. Raw Data Tables for MMC Materials

Volume 5: Ceramic Matrix Composites



Volume 5 includes information on relevant, commercially available CMC composite systems describing: system properties and their process methods; testing and characterization methods, mechanical properties and databases and design guidance tailored to CMCs. Material data summaries of six CMC systems are included.

Part A. Introduction and Guidelines

Part B. Design and Supportability

Reorganization of this section

New section on CMCs for Aircraft Turbine Engines

New section on Design of Attachments for CMCs in Engines

Part C. Testing

Thermo-Mechanical-Physical Test Methods, revision of this chapter

Part D. Data Requirements and Data Sets

CMC Property Data includes SiC/SiC, Carbon/SiC, Oxide/Oxide, SiC/Si₃N₄

Appendix A. Derivation of the Residual Strength Reduction Expressions for LCF and Rupture Loadings



Volume 6: Sandwich Composites



Volume 6 provides an updated living document describing proper design philosophy and guidance for sandwich composite structures. The primary source for this volume is MIL-HDBK-23.

Completely NEW volume including the most up to date guidance on use of sandwich composite materials and critical sections of MIL-HANDBOOK-23

- 1. General Information***
- 2. Guidelines for Property Testing***
- 3. Material Data***
- 4. Design and Analysis of Sandwich Structures***
- 5. Fabrication of Sandwich Structures***
- 6. Quality Control***
- 7. Supportability***



CMH-17 Web Site

- [http\(s\)://www.cmh17.org](http(s)://www.cmh17.org)
 - Working drafts available for active working group members
 - Access to working group bulletin boards
 - Contact information for working group chairs
 - Upcoming meeting info including agendas, discussion topics
 - Past meeting documents including presentations, minutes
- Access
 - Meeting Attendees: CMH-17 attendees receive log-in information as part of meeting registration fee (valid for 16 months)
 - Access ITAR restricted material is available as necessary
 - List of users that have access to ITAR restricted information is updated after each meeting.
 - DD2345 form or copy of government ID required for access to ITAR restricted information



Composites Handbook, CMH-17 - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Refresh Home Search Favorites RSS Mail Print Word Pad Internet Options

Address <http://www.cmh17.org/> Go Links

Google G Go 4 blocked Check AutoLink AutoFill Settings

**The Composite Materials Handbook
CMH-17**

00019717

General Info. Resources Meetings Members FAQ

Welcome to the *Composite Materials Handbook Website*.

The site is maintained by the CMH-17 Organization to disseminate information about the organization and to share information on composite materials.

CMH-17
COMPOSITE MATERIALS HANDBOOK

The Composite Materials Handbook provides information and guidance necessary to design and fabricate end items from composite materials. Its primary purpose is the standardization of engineering data development methodologies related to testing, data reduction, and data reporting of property data for current and emerging composite materials. In support of this objective, the handbook includes composite materials properties that meet specific data requirements. The Handbook therefore constitutes an overview of the field of composites technology and engineering, an area which is advancing and changing rapidly. As a result, the document is constantly changing as sections are added or modified to reflect advances in the state-of-the-art.

How to Get Involved in CMH-17

- Get on the mailing list (info@cmh-17.com)
- Attend Meetings
 - Presentations
 - Industry status and practice
 - Technical talks on topics related to material allowables, qualification, and design practice
 - Discussion and debates on current handbook topics
 - Affect the direction of the handbook
 - Particularly looking for inputs from broader range of industries
 - Provide input of user needs and concerns
- Become an active volunteer for one or more of the Working Groups
 - Be a contributor
- Provide data



Composite Safety & Certification Meeting - CMH-17 & Volume 3 (PMC) -

- **Thanks for Opportunity.**
- **Questions and/or Thoughts?**
- **Further Discussion.**

