

1st Joint Coordination Meeting

April 22-26 2024 Scottsdale, AZ



Distribution Statement A: APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED.

**PROCEEDINGS OF THE SEVENTY-SIXTH POLYMER MATRIX
COMPOSITE MATERIALS HANDBOOK MEETING**

TABLE OF CONTENTS

	Page
JOINT COORDINATION MEETING SCHEDULE	4
COORDINATION MEETING SLIDES	7
CLOSING COORDINATION	117
SUMMARY OF MEETING MINUTES	161
WORKING GROUP REPORTS	163
AM DATA REVIEW	163
AM DESIGN AND ANALYSIS	163
AM GUIDELINES	163
AM MATERIALS AND PROCESS	163
AM TESTING	163
CMC DATA REVIEW	164
CMC MATERIALS AND PROCESSES	164
CMC TESTING	164
JOINT ENGINE APPLICATIONS	165
JOINT STATISTICS	171
JOINT STATISTICS WORKING GROUP FILES LOCATED HERE	172
PMC BONDING	173
PMC CRASHWORTHINESS	173
PMC DAMAGE TOLLERANCE	173
PMC DATA REVEIW	173
PMC DESIGN	173
PMC GUIDELINES	173
PMC MATERIALS AND PROCESSES	173
PMC SAFETY MANAGEMENT	173
PMC SANDWICH	173
PMC SPACECRAFT	173
PMC SUPPORTABILITY	173
PMC WORKING GROUP FILES LOCATED HERE	173
FINAL ATTENDANCE LIST	174
INFORMATION ACCESS	180
CMH-17 LEADERSHIP	181
AM WORKING GROUP CHAIRS	182
CMC WORKING GROUP CHAIRS	184
PMC WORKING GROUP & TASK GROUP CHAIRS	185

NOTE

The data contained in these proceedings should not be used for design purposes. This information was presented at the hybrid April 2024 Composite Materials Handbook (CMH-17) meeting for discussion purposes only. The material contained in these proceedings may be subject to export control.

Joint Coordination Meeting Schedule

April 22-26, 2024 – Scottsdale, AZ

NOTE: Registration was setup outside the Grand Ballroom Foyer

MONDAY 4/22/2024

Time (MST)	Center Ballroom	Palomas/ Coronado	San Carlos	Sedona
7:30	Check-In Opens			
8:00	Aircraft Certification with Composite or AM Parts Tutorial	Statistics Tutorial	Bonding M&P Tutorial	Ceramic Matrix Composites Overview
9:00				
10:00	Break			
10:15	Cert Cont'd	Stats Cont'd	Bonding Cont'd	CMC Cont'd
11:15				
12:15	Lunch			
1:15	Cert Cont'd	Stats Cont'd	Bonding Cont'd	CMC Cont'd
2:15				
3:15	Break			
3:30	Cert Cont'd	(Open)	(Open)	(Open)
4:30				
5:30	End of Day			

TUESDAY 4/23/2024

Time (MST)	Center Ballroom	Sonora/Rio
7:30	Check-In Opens	
8:00	WG/TG Chair Hybrid Meeting Tutorial	New Member Orientation
9:00	Opening Coordination	
10:00	Break	
10:15	Opening Coordination cont'd	
11:15		
12:15	Lunch	
1:15	Opening Coordination cont'd	
2:15	Joint Guidelines	
3:15	Break	
3:30	PMC Design	
4:30		
5:30	Social Hour (5:30-7:30) (Paradise Park)	

WEDNESDAY 4/24/2024

Time (MST)	Center Ballroom	Palomas/Coronado	Sonora/Rio
7:30	Check-In Opens		
8:00	PMC GWG	Joint Statistics	DTTG
9:00			
10:00	Break		
10:15	Supportability WG (SoBR)	AM GWG	Engine Application
11:15			
12:15	Lunch		
1:15	Sandwich Volume WG / TG	AM M&P	CMC Testing
2:15			
3:15	Break		
3:30	Safety Management WG	AM Data Review	PMC M&P
4:30			
5:30	End of Day		

THURSDAY 4/25/2024

Time (MST)	Center Ballroom	Palomas/Coronado	Sonora/Rio
7:30			
8:00	PMC Design	Spacecraft	CMC Data Review
9:00			
10:00	Break		
10:15	Crashworthiness WG	AM Testing	CMC M&P
11:15			(open)
12:15	Lunch		
1:15	Bond TG	AM Design and Analysis	PMC Data Review
2:15			
3:15	Break		
3:30	Closing Coordination (Center Ballroom)		
4:30			
5:30	End of Day		

GWG = Guidelines Working Group

M&P = Materials and Processing

DTTG = Damage Tolerance Task Group

FRIDAY 4/26/2024

Time	Sonora/Rio
7:30	
8:00	Exec
9:00	
10:00	
10:15	Exec cont'd
11:15	
12:15	End of Day

COORDINATION MEETING SLIDES

5/9/2024



1st CMH-17 Joint Coordination Meeting

April 22-25, 2024
Scottsdale, AZ
8:00 am – 5:30 pm MST

*Spring 2024 – Hybrid
New Member Orientation
(8:00-9:00am MST)*

1



1st CMH-17 Joint Coordination Meeting

Marks the:

- 11th CMH-17 AM Meeting
- 35th CMH-17 CMC Meeting
- 77th CMH-17 PMC Meeting

2

5/9/2024

Virtual Meeting Reminders



- ONE Virtual meeting link and dial in number for this week's meeting
 - Sent to all registered attendees
 - Utilizing Breakout Session on WebEx for Working/Task Group meetings
 - Instruction are in the E-booklet
- Reminders for virtual meetings:
 - Join 5-10 mins early
 - Disable video and mute audio unless speaking
 - Use "Raise Hand" or the "Chat" feature for questions/comments
- Presentations will be available to all attendees in meeting proceedings
- Questions/comments? Please email: info@cmh17.org

3

New Member Orientation



- Introducing CMH-17 Organization – Michelle Man, WSU
 - What is CMH-17
 - Our Handbooks
 - The Organization
 - Websites we use
- Participating in CMH-17 – Cindy Ashforth, FAA
 - Handbook Goals
 - How to get involved
 - FAA Guidance Philosophy and Role of CMH-17
- Continue with Open Coordination Meeting

4

5/9/2024

Introduction to CMH-17

Recorded Video Available:
<https://www.cmh17.org/RESOURCES/IntroductiontoCMH-17.aspx>



5

What is CMH-17?

- CMH-17 stands for the Composite Material Handbook, which is supported by a Composite Material Handbook *Organization*
- The Handbook itself consists of 6 volumes (with a 7th planned on non-metallic additive manufacturing)
- The Handbook content was originally in Mil-Hdbk-17 (Vol 1-5) and Mil-Hdbk-23 (Vol 6) but the military stopped supporting content
- The FAA took over management of the Organization and Handbook and adopted the new name
 - The Handbook is directly referenced in regulation (§ 2x.613) and guidance, such as AC20-107B
 - The FAA provides annual funding to the Secretariat, together with revenues from handbook sales
 - Handbook volumes are published by SAE
 - Actively working in PMC (includes sandwich structure), CMC, and Non-Metallic AM Materials; MMC is currently Inactive



6

3

<https://www.cmh17.org/RESOURCES/IntroductiontoCMH-17.aspx>

5/9/2024

What is the Composite Materials Handbook?



CMH-17 Mission

The Composite Materials Handbook organization creates, publishes and maintains proven, reliable **engineering information and standards**, subjected to thorough technical review, **to support the development and use of advanced materials and structures.**

CMH-17 Vision

The Composite Materials Handbook will be the **authoritative worldwide focal point for technical information** on composite materials and structures.

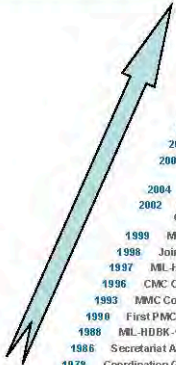
The current vision, scope, mission, objectives, etc. are inconsistent between the website, various volumes, and what is shown here. They are all under review and will be discussed later today in the opening coordination session

Objectives

- The Composite Materials Handbook-17 (CMH-17) provides information and guidance necessary to design, fabricate, and use end items from advanced materials such as composites and additive manufacturing.
- Its primary purpose is the standardization of engineering methodologies (e.g. data collection, data development, design analysis, screening procedures, criteria, guidelines, quality control, etc.) related to design, fabrication, maintenance, testing, data reduction, data reporting of property data, and use of that data for current and emerging composite materials.
- In support of this objective, the Handbook includes advanced materials properties that meet specific data requirements, and engineering methods that have been subject to rigorous review.
- The Handbook constitutes an overview of the field of composites and other advanced materials technology and engineering, an area which is advancing and changing rapidly. As a result, the document is constantly being updated as sections are added or modified to reflect advances in the state-of-the-art.

Handbook History





2024 and Beyond: Release of Vol. 5 Rev B (CMC), Vol 6 Rev A (Sandwich), and Vol 7 Initial Release (Non-Metallic AM)

2024 Release of Vol. 3H – CMH-17 Handbook PMC: Materials Usage, Design, and Analysis

2022 Release of Vol. 1H – CMH-17 Handbook Guidelines for Characterization of Structural Materials

2016 AM Coordination Group Formed

2018 Release of Vol. 2H – CMH-17 Handbook PMC: Material Properties

2017 Release of Vol. 5A – CMH-17 Handbook for CMC

2013 Release of Vol. 6, 4B – CMH-17 Handbooks for sandwich structure and MMC, respectively

2012 Release of Volumes 1-3 Rev G – CMH-17 Handbooks for PMC

2005 Transition from Army to FAA as Primary Sponsor Established Roadmap to New Composite Materials Handbook "Release G"

2004 Joint Meetings with CACRC, SAE-IP17

2002 MIL-HDBK-17 Vol. 1F, 2F, 3F, 4A, 5 Commercial Publication through ASTM

1999 MIL-HDBK-17 Vol. 2E, Vol. 4

1998 Joint Meetings with ASTM D-30

1997 MIL-HDBK-17 Vol. 1E, 3E

1996 CMC Coordination Group Formed

1993 MMC Coordination Group Formed

1990 First PMC Data Set Approved

1988 MIL-HDBK-17B Vol. 1 Release

1986 Secretariat Added

1978 Coordination Group Formed

1971 MIL-HDBK-17A Plastics for Aerospace Vehicles

1959 MIL-HDBK-17 Plastics for Air Vehicles

1943 AWC Bulletin 17 Plastics for Aircraft

PMC: Polymer Matrix Composites

MMC: Metal Matrix Composites

CMC: Ceramic Matrix Composites

AM: Additive Manufactured Materials

8

5/9/2024

Structure of Handbook

CMH-17

COMPOSITE MATERIALS 8840800

- | | |
|-----------|---|
| Vol 1 (H) | Polymer Matrix Composites: <i>Guidelines for Characterization of Structural Materials</i> |
| Vol 2 (H) | Polymer Matrix Composites: <i>Material Properties</i> |
| Vol 3 (G) | Polymer Matrix Composites: <i>Materials Usage, Design and Analysis (Rev H –WIP)</i> |
| Vol 4 (B) | Metal Matrix Composites |
| Vol 5 (A) | Ceramic Matrix Composites (Rev B –WIP) |
| Vol 6 | Structural Sandwich Composites (PMCs) (Rev A –WIP) |
| Vol 7 | Additive Manufacturing (Initial Release) |



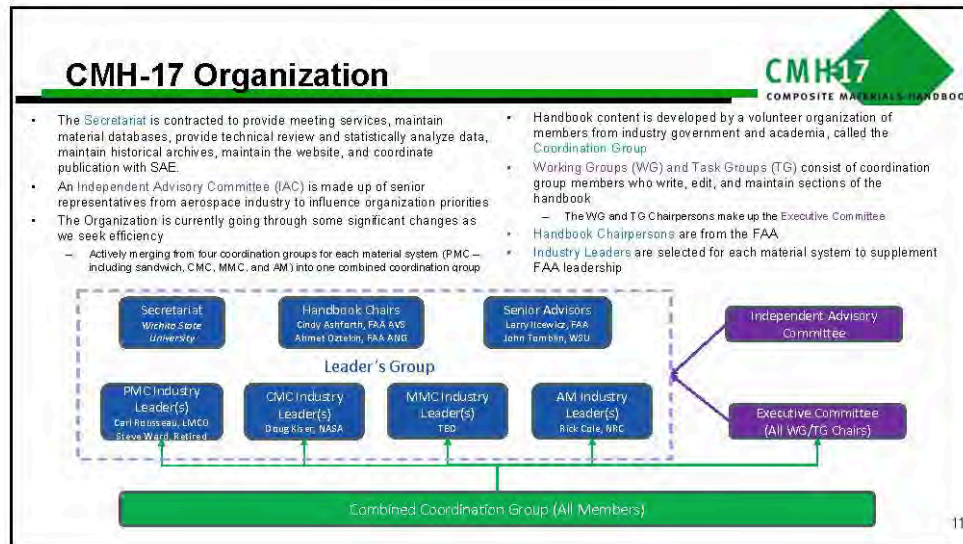
<https://www.sae.org/publications/books/content/r-540.set6/>

Hint: Don't search by "CMH-17"

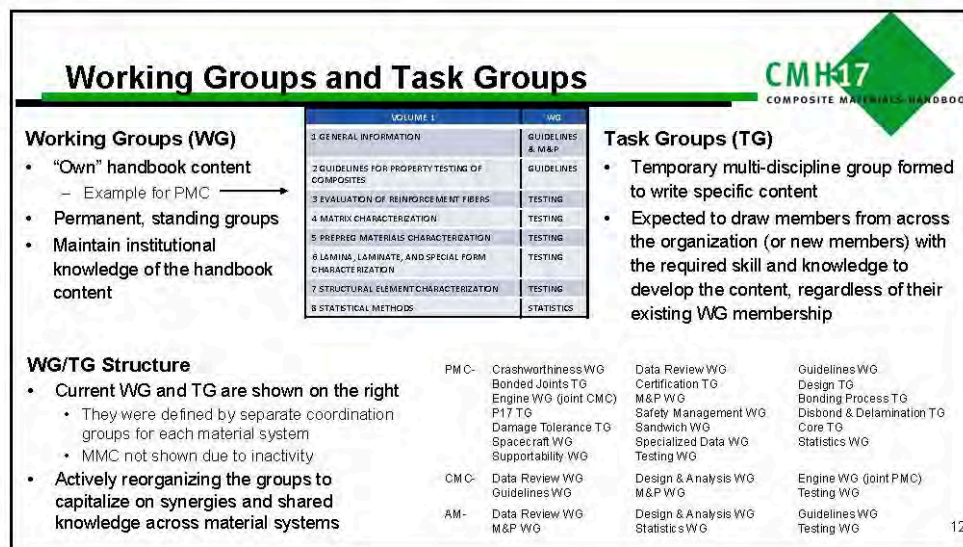
VOLUME 1	VOLUME 3	VOLUME 5	VOLUME 6	VOLUME 7
1 GENERAL INFORMATION	1 GENERAL INFORMATION	1 CMH-17 GUIDELINES AND PROCEDURES	1 GENERAL INFORMATION	1 CMH-17 INTRODUCTION AND GUIDELINES
2 GUIDELINES FOR PROPERTY TESTING OF COMPOSITES	2 INTRODUCTION TO COMPOSITE STRUCTURE DEVELOPMENT	2 INTRODUCTION, HISTORY AND OVERVIEW	2 GUIDELINES FOR PROPERTY TESTING	2 CHARACTERIZATION CONSIDERATIONS
3 EVALUATION OF REINFORCEMENT FIBERS	3 AIRCRAFT STRUCTURE CERTIFICATION AND COMPLIANCE	3 PROCESSING, CHARACTERIZATION, AND MANUFACTURING	3 MATERIAL DATA	3 EVALUATION OF FEEDSTOCK
4 MATRIX CHARACTERIZATION	4 BUILDING BLOCK APPROACH FOR COMPOSITE STRUCTURES	4 QUALITY CONTROL OF PRODUCTION MATERIALS AND PROCESSES	4 FABRICATION OF SANDWICH STRUCTURES	4 PROCESSING AND MANUFACTURING
5 PREPREG MATERIALS CHARACTERIZATION	5 MATERIALS AND PROCESSES—THE EFFECT OF VARIABILITY ON COMPOSITE PERFORMANCE	5 APPLICATIONS, CASE HISTORIES AND LESSONS LEARNED	5 QUALITY CONTROL	5 QUALITY CONTROL OF PRODUCTION MATERIALS AND PROCESSES
6 LAMINA, LAMINATE, AND SPECIAL FORM CHARACTERIZATION	6 QUALITY CONTROL OF PRODUCTION MATERIALS AND PROCESSES	6 DESIGN AND ANALYSIS	6 DESIGN AND SUBSTITUTION FOR SANDWICH STRUCTURES	6 MATERIAL TESTING & CHARACTERIZATION FOR SUBMISSION OF DATA TO CMH-17
7 STRUCTURAL ELEMENT CHARACTERIZATION	7 DESIGN OF COMPOSITES	7 MAINTAINABILITY AND SUPPORTABILITY	7 INTERNAL LOADS AND STRESSES	7 PROPERTY TESTING OF ACTIVELY OR MANUFACTURED MATERIALS
8 STATISTICAL METHODS	8 ANALYSIS OF LAMINATES	8 THERMO-MECHANICAL/PHYSICAL TEST METHODS—OVERVIEW	8 ANALYSIS AND STRUCTURAL DESIGN	8 STATISTICAL METHODS
	9 STRUCTURAL STABILITY ANALYSES	9 MATERIAL TESTING & CHARACTERIZATION FOR SUBMISSION OF DATA TO CMH-17	9 DAMAGE ASSESSMENT OF SANDWICH STRUCTURES	9 EVALUATION OF AM PARTS
	10 DESIGN AND ANALYSIS OF BONDED JOINTS	10 EVALUATION OF REINFORCEMENTS	10 SUPPORTABILITY	10 ELEMENT LEVEL TESTING
VOLUME 4	11 DESIGN AND ANALYSIS OF BOLTED JOINTS	11 EVALUATION OF MATRIX MATERIALS	11 SANDWICH DESIGN CASE STUDIES	11 DESIGN AND ANALYSIS
1 GUIDELINES	12 DAMAGE RESISTANCE, DURABILITY, AND DAMAGE TOLERANCE	12 EVALUATION OF INTERFACE MATERIAL	12 SUPPORTING DATA AND DISCUSSIONS	12 MAINTAINABILITY AND SUPPORTABILITY
2 DESIGN GUIDELINES FOR METAL MATRIX MATERIALS	13 DEFECTS, DAMAGE, AND INSPECTION	13 EVALUATION OF COMPOSITES		13 APPLICATIONS, CASE HISTORIES, AND LESSONS LEARNED
3 MATERIALS PROPERTIES DATA	14 SUPPORTABILITY, MAINTENANCE, AND REPAIR	14 SUBCOMPONENT TESTING—OVERVIEW OF PROBLEM	VOLUME 2	14 AM PROPERTY DATA
APPENDIX A TYPICAL PUSHOUT TEST DATA	15 THICK-SECTION COMPOSITES	15 MACHINING & GRINDING	1 GENERAL INFORMATION	
APPENDIX B RAW DATA TABLES FOR MATRIX MATERIALS	16 CRASHWORTHINESS AND ENERGY MANAGEMENT	16 DATA SUBMISSION, FORMAT AND REQUIREMENTS	2 CARBON FIBER COMPOSITES	
APPENDIX C RAW DATA TABLES FOR METAL MATRIX COMPOSITE MATERIALS	17 STRUCTURAL SAFETY MANAGEMENT	17 STATISTICAL METHODS	3 BORON FIBER COMPOSITES	
	18 ENVIRONMENTAL MANAGEMENT	18 CMC PROPERTY DATA	4 GLASS FIBER COMPOSITES	
	19 SPACE APPLICATIONS	19 ENGINE APPLICATIONS	5 QUARTZ FIBER COMPOSITES	
	20 ENGINE APPLICATIONS		APPENDIX A1 CMH-17A DATA	

Current Working Outlines

5/9/2024

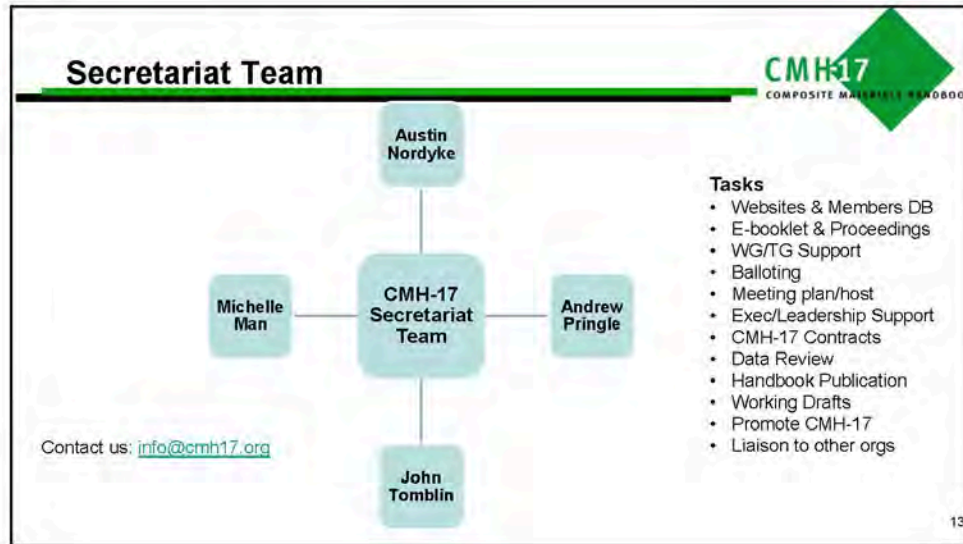


11



12

5/9/2024



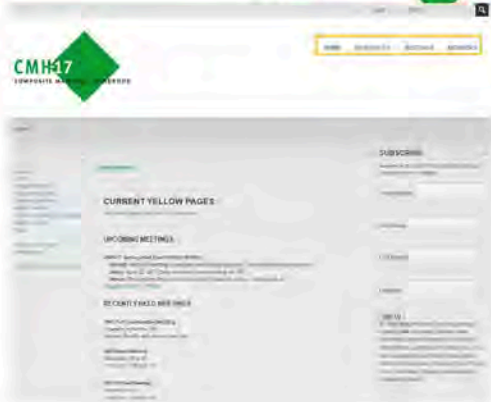
CMH-17 Website



<http://www.cmh17.org>

- Public and Member Areas
- Public area:
 - Home
 - Introduces Volumes
 - Coordination groups and their WG/TG Chairs
 - Resources
 - [Intro to CMH-17 video](#)
 - Handbook purchase
 - Statistics Software
 - Data Submission
 - Tutorial information
 - Meetings
 - Info on upcoming Meetings and registration

Update and Makeover in Progress!

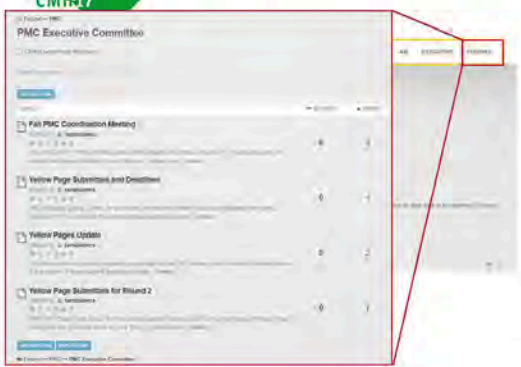


5/9/2024

CMH-17 Website Collaboration Area



- Members Access:
 - Documents
 - Archive of Proceedings
 - Yellow Page Balloting
 - Working Draft (Active Members only)
 - Coordination Group Contact
 - Forums
 - Used by some WG/TG
 - Communication between Chairs and Members
 - Share and discuss content



15

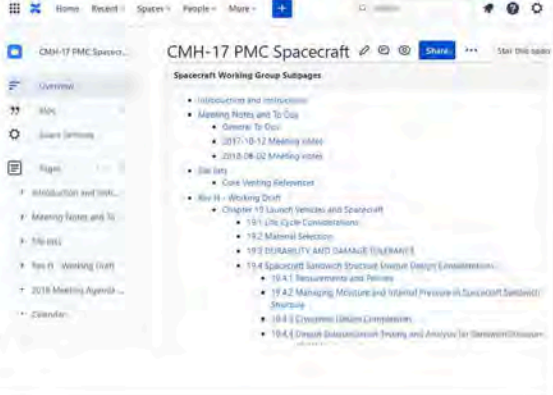
Additional CMH-17 Collaboration Area



<https://cmh17.atlassian.net/wiki/home>

ACTIVE working members only

- Each Working Group has a separate area, that is visible to all members
 - PMC – Engine App and Spacecraft AC10
 - AM WG
 - CMC WG
 - Only some WG/TG utilize this space
- Collaboration tools:
 - Ability to edit and comment on posted content
 - Automated updates when changes are made
 - Ability to create tasks
 - Link to other documents/file storage
 - Content draft
 - Meeting minutes



5/9/2024



CMH-17
COMPOSITE MATERIALS HANDBOOK

Questions?

17



CMH-17
COMPOSITE MATERIALS HANDBOOK

Participating in CMH-17

Cindy Ashforth, FAA Senior Technical Specialist for Composites

18

5/9/2024

Outline



- Handbook Goals
- Member Involvement
- FAA Guidance Philosophy and Role of CMH-17

19

CMH-17 Goals



The handbook has three goals/purposes:

1. Provide material data
 - Physical and mechanical properties
 - Tied to a single material specification AND a single process specification (published elsewhere, but publically available)
2. Describe how to generate material data
 - Material and process control
 - Test matrices
 - Statistical methods
3. Describe how to use material data
 - Design guide based on:
 - Proven methods / best practices
 - Includes information on manufacturing and maintenance

20

10

5/9/2024

Member Involvement

CMH17

COMPOSITE MATERIALS HANDBOOK

- If you are a new member you may be asking "What do I do here?"
- This meeting is different than other conferences where you attend presentations that show the work of a few individuals on various technical subjects
- Here we share and collect information, and write and approve content that goes in the handbook
- Are you unsure if you know enough to contribute? Are you here primarily to learn?



That's fine!
We still want your involvement!

21

Meeting Format

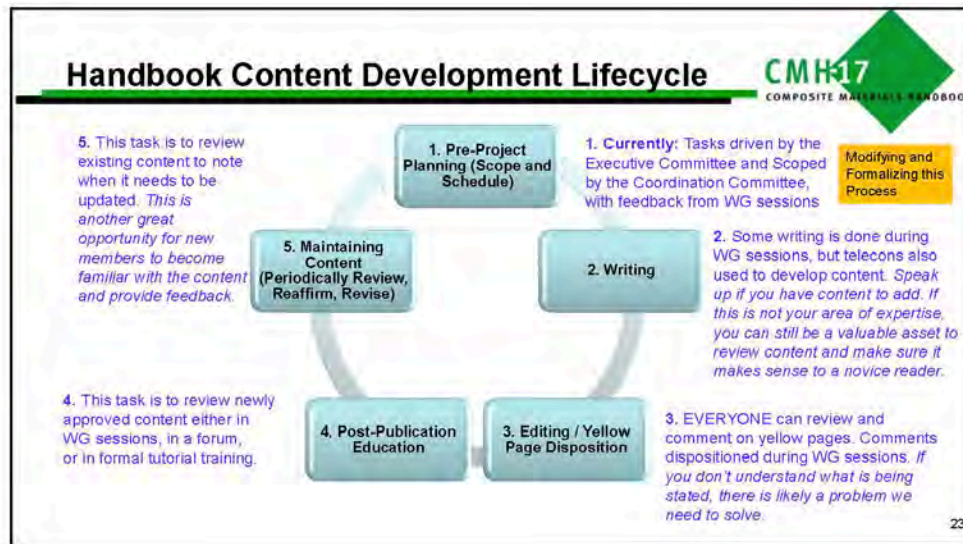
CMH17

COMPOSITE MATERIALS HANDBOOK

- Meetings always include:
 - Opening and Closing Coordination
 - Working Group and Task Group Sessions
 - Try to limit to a maximum of 3 parallel sessions at a time
 - WG/TG sessions are open for everyone to attend
 - Some WG/TG hold additional "closed" sessions to focus on specific writing or editing tasks with a small group of people
- Meetings can include:
 - Tutorials
 - Forum (Discussion of relevant topics of interest to entire audience)
 - Side Events (like a tour of local industry)
 - Executive Committee Meeting
- Intended to provide a balance of significant handbook development/updates, education, and strategic discussions of topics important to several WG/TG

22

5/9/2024



FAA Guidance Philosophy

CMH-17
COMPOSITE MATERIALS HANDBOOK

- The FAA is moving toward performance-based standards, such as the new part 23
- Due to FAA Reauthorization Act of 2018, *we are also moving away from prescriptive FAA guidance*
 - SEC. 329. PERFORMANCE-BASED STANDARDS. The Administrator shall, to the maximum extent possible and consistent with Federal law, and based on input by the public, ensure that regulations, *guidance, and policies* issued by the FAA on and after the date of enactment of this Act *are* issued in the form of *performance-based standards*, providing an equal or higher level of safety.
- Therefore, *we will increasingly rely on industry documentation* to provide means of compliance, which we can "accept"
 - Would like CMH-17 to provide the appropriate details to address many key principles*

24

5/9/2024

Example of Relationship Between FAA Regulation, Guidance, and CMH-17

CMH-17

COMPOSITE MATERIALS HANDBOOK

- Regulation
- General FAA Guidance
 - AC 20-107B "Composite Aircraft Structure"
 - No change planned to the scope and scale of what this AC covers
- Focused Guidance / Guidelines
 - FAA Guidance or Industry Guidelines
(I personally use the terminology "guidance" for FAA publications and "guidelines" for anyone else.)
- Detailed Background Information
 - CMH-17 *Provides Foundation* for Guidelines and Guidance, supplementing key safety messages with proven best industry practices

25

Example of Relationship Between FAA Regulation, Guidance, and CMH-17

CMH-17

COMPOSITE MATERIALS HANDBOOK

Regulation

§25.603 Materials.

The suitability and durability of materials used for parts, the failure of which could adversely affect safety, must—

- (a) Be established on the basis of experience or tests;
- (b) Conform to approved specifications (such as industry or military specifications, or Technical Standard Orders) that ensure their having the strength and other properties assumed in the design data; and
- (c) Take into account the effects of environmental conditions, such as temperature and humidity, expected in service.

What tests are required to "establish suitability and durability"?
What information should be in specifications to ensure consistent properties?
How does one "take into account" environmental conditions?

26

5/9/2024

Example of Relationship Between FAA Regulation, Guidance, and CMH-17

CMH-17

COMPOSITE MATERIALS HANDBOOK

General FAA Guidance

- AC 20-107B "Composite Aircraft Structure"
- 1.5 pages for material and process control
- Applicable to all composite material types and forms, but based on behaviors of continuous fiber thermoset prepreg
- Portion for materials on right

(3) Material requirements identified in procurement specifications should be based on the qualification test results for samples produced using the related process specifications. Qualification data must cover all properties important to the control of materials (composites and adhesives) and processes used for production of composite structure. Carefully selected physical, chemical, and mechanical qualification tests are used to demonstrate the formulation, stiffness, strength, durability, and reliability of materials and processes for aircraft applications. It is recommended that material suppliers work closely with airframe manufacturers to properly define material requirements.

(4) To provide an adequate design database, environmental effects on critical properties of the material systems and associated processes should be established. In addition to testing in an ambient environment, variables should include extreme service temperature and moisture content conditions and effects of long-term durability. Qualification tests for environmental effects and long-term durability are particularly important when evaluating the materials, processes, and interface issues associated with structural bonding (refer to paragraph 6.c for related guidance).

What "physical, chemical, and mechanical qualification tests" should be performed? How does one "establish environmental effects on critical properties"? What environments? What critical properties?

27

Example of Relationship Between FAA Regulation, Guidance, and CMH-17

CMH-17

COMPOSITE MATERIALS HANDBOOK

Focused Guidance / Guidelines

- AC 23-20 "Acceptance Guidance on Material Procurement and Process Specifications for Polymer Matrix Composite Systems" provides more detail than the general guidance in AC20-107B
 - Specific for PMC
 - 10 pages of content for a material specification
 - *In the future this would likely be an industry publication, such as an SAE AS or AIR*

This older AC refers to FAA technical reports for details on M&P controls, test matrices, and environmental requirements. This content (and more!) has since been incorporated into CMH-17.

(c) Discussions and tables in the DOT/FAA/AR-02/109 recommend a minimum set of cured laminate physical and mechanical property tests to establish the material specification. This test matrix is similar to the AGATE test matrix in DOT/FAA/AR-00/47 and DOT/FAA/AR-03/19. (The primary difference relates to a recommended change in laminate lay-up in DOT/FAA/AR-02/109, which allows a less operator sensitive test for determining consistent longitudinal tension and compression strength data.)

(d) The physical properties include fundamental material characteristics such as cured ply thickness, laminate density, and constituent volume fractions, which are controlled to ensure a repeatable product. The void content and glass transition temperature tests provide additional confidence that the prepreg material is under control. Mechanical tests are able to detect changes in the fiber, resin, fiber/resin interface, and the response of the prepreg to the baseline cure process. They include basic material moduli and strength tests for fiber and matrix-dominated properties. A combination of tension, compression, and shear tests for a range of environmental conditions provide a minimum set for qualification purposes.

(e) Discussions and tables in the DOT/FAA/AR-02/109 recommend additional tests be run at some frequency to keep the test methodology current and to further populate the database. Some of these tests are used periodically to update the material acceptance and equivalency requirements in the specification to better represent the population. Others are used to expand the utility of the database for multiple applications. For example, additional laminate test data is recommended for layups and details (e.g., open hole, filled hole, and pin bearing), which are characteristic of design. Other test recommendations help characterize solvent sensitivity, laminated sandwich panels, interlaminar fracture toughness, laminate fatigue, post-impact residual strength, flammability, moisture diffusion, and thermal cycling. These additional tests are optional for inclusion in the material specification, but they may be required for the design and certification of an end-user's product. As a result, there is a potential for cost savings if the additional tests are shared among several end users.

28

5/9/2024

Example of Relationship Between FAA Regulation, Guidance, and CMH-17

CMH-17

COMPOSITE MATERIALS HANDBOOK

Detailed Background Information

- CMH-17
- Volume 3 has 129 pages dedicated to "Materials and Processes – The Effects of Variability on Composite Properties" discussing all aspects of material characterization and control
 - Includes break-down requirements for constituent materials of fiber, fabric, and resin
- Another chapter brings in details on material supplier quality control (requirements often included in a material specification)
- Volume 1 (700+ pages) has test matrices for material characterization of various PMC material forms along with test methods and statistical reduction methods
- Volume 4 has same information for MMC
- Volume 5 has same information for CMC

TABLE 2.3.2.4(a) Alternate cured (lamina mechanical property tests – unidirectional tape)

Layer	Mechanical Property	Number of Batches x No. of Panels x No. of Specimens			
		Test Temperature/Moisture Condition			
		CTD	RTD	ETD	ETW
[B] ₁	In-Plane Tensile Strength, Modulus and Poisson's Ratio	3x2x3	3x2x3		3x2x3
[B] ₂	In-Plane Compressive Modulus ¹	3x2x3	3x2x3	3x2x3	3x2x3
[B] ₃ ₁	In-Plane Tensile Strength and Modulus	3x2x3	3x2x3		3x2x3
[B] ₃ ₂	In-Plane Compressive Strength and Modulus ²	3x2x3	3x2x3		3x2x3
[B] ₃ ₃	In-Plane Tensile Strength and Modulus	3x2x3	3x2x3		3x2x3
[B] ₃ ₄	In-Plane Compressive Strength and Modulus ²	3x2x3	3x2x3	3x2x3	3x2x3
[45/-45] ₁	In-Plane Shear Strength and Modulus	3x2x3	3x2x3		3x2x3
[B] ₄	Short Beam Strength (Out-of-Plane Shear)	3x2x3	3x2x3	3x2x3	3x2x3

¹ Test Methods per Table 2.3.2.4² Back-to-back strain gauges are recommended on at least the first two specimens of each environment. If no buckling is observed, the remaining modulus specimens may be tested with a strain gauge on one side of the specimens only. An appropriate extensometer may be used in place of the strain gauge.

One line of regulation turns into a page of general guidance, 10 pages of focused guidance/guidelines, and over 1000 pages of detailed information

29

This Meeting

CMH-17

COMPOSITE MATERIALS HANDBOOK

- This meeting is all about becoming familiar with the entirety of the CMH-17 organization and handbook content
 - PMC is finishing Volume 3 Rev H, revving up activity on Volume 6 Rev A, and starting toward next rev of Volume 2
 - CMC is finishing Volume 5 Rev B
 - AM is working toward initial release
- Consider attending sessions from other material systems, particularly if they are related to your interests in M&P, design, testing, etc.
- Find a WG that interests you, whether you are an expert or not and [Participate](#) moving forward
 - Help write, review, and edit content



Let's populate CMH-17 with content to address the needs of:

- Industry for design best practices, certification efficiency, and application guidelines,
- FAA and other regulators for safety, and
- Everyone for training and education

30

5/9/2024



1st CMH-17 Joint Coordination Meeting

April 22-25, 2024
Scottsdale, AZ
8:00 am – 5:30 pm MST

*Spring 2024 – Hybrid
Open Coordination
(9:00 am - 2:15 pm MST)*

31



1st CMH-17 Joint Coordination Meeting

Marks the:

- 11th CMH-17 AM Meeting
- 35th CMH-17 CMC Meeting
- 77th CMH-17 PMC Meeting

32

5/9/2024

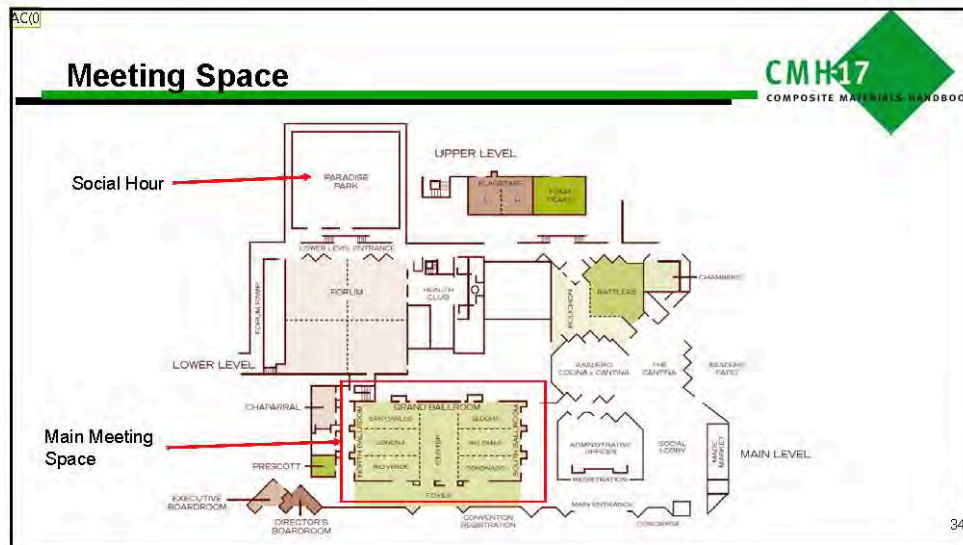
AC(1)

Meeting Schedule



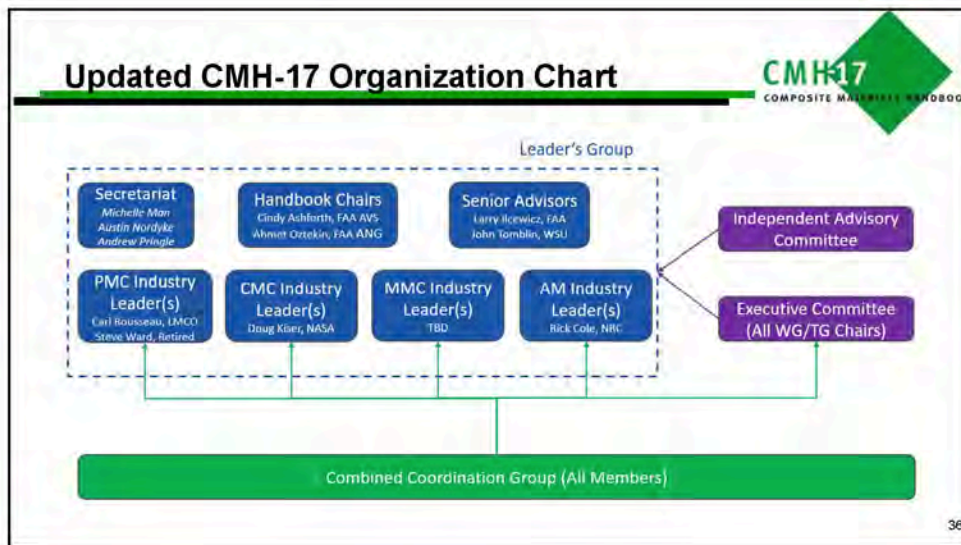
Time	Monday, April 22				Tuesday, April 23		Wednesday, April 24			Thursday, April 25			Friday, April 26	
	Center Ballroom	Palomas/ Coronado	San Carlos	Sedona	Center Ballroom	Sonora/Rio	Center Ballroom	Palomas/ Coronado	Sonora/Rio	Center Ballroom	Palomas/ Coronado	Sonora/Rio	Sonora/Rio	
7:30														
8:00	Aircraft Certification with Composites or AM Parts Tutorial	Statistics Tutorial	Bonding M&P Tutorial	Ceramic Matrix Composites Overview	WG/TG Chair Hybrid Meeting Tutorial	New Member Orientation				PMC Design	Spacecraft	CMC Data Review	Exec	
9:00					Opening Coordination		PMC GWG	Joint Statistics	DTG					
10:00	Break													
10:15	Cert Cont'd	Stats Cont'd	Bonding Cont'd	CMC Cont'd	Opening Coordination cont'd		Supportability WG (SoBR)	AM GWG	Engine Application	Crash WG	AM Testing	CMC M&P (open)	Exec cont'd	
11:15							Lunch							
12:15					Opening Coordination cont'd		Sandwich Volume WG / TG	AM M&P	CMC Testing	Bond TG	AM Design and Analysis	PMC Data Review	End of Day	
1:15	Cert Cont'd	Stats Cont'd	Bonding Cont'd	CMC Cont'd	Joint Guidelines									
2:15							Break							
3:15														
3:30	Cert Cont'd	Joint	Joint	Joint	PMC Design		Safety Management WG	AM Data Review	PMC M&P	Closing Coordination (Center Ballroom)				
4:30														
5:30	End of Day				Social Hour (5:30-7:30) (Paradise Park)		End of Day							

33



5/9/2024

Open Coordination Agenda			
9:00-9:15 Welcome, New Organizational Roles and Responsibilities, <i>Larry Ilciewicz and John Tomblin</i>			
9:15-10:00 Secretariat Update, <i>Michelle Man, Austin Nordyke and Andrew Pringle</i>			
10:15-12:15 WG/TG Introductions, TG and WG Chairs			
PMC-	Crashworthiness WG Bonded Joints TG Engine WG (joint CMC) P17 TG Damage Tolerance TG Spacecraft WG Supportability WG	Data Review WG Certification TG M&P WG Safety Management WG Sandwich WG Specialized Data WG Testing WG	Guidelines WG Design TG Bonding Process TG Disbond & Delamination TG Core TG Statistics WG
CMC-	Data Review WG Testing WG	Design & Analysis WG	M&P WG
AM-	Data Review WG M&P WG	Design & Analysis WG Statistics WG	Guidelines WG Testing WG
1:15-1:30 Awards			
1:30-2:15 Future of CMH-17, <i>Cindy Ashforth</i>			



5/9/2024

Leader Roles and Responsibilities

CMH-17

COMPOSITE MATERIALS HANDBOOK

- **Handbook Chairs:** Leads CMH-17 decision making on technical, logistical and financial budgets, including organizational structure, handbook initiatives, contracts, meetings, secretariat tasks, and related challenges, striving for what's best to advance the organization.
- **Senior Advisors:** Support CMH-17 decision making on organization structure, technical, logistical and financial needs, including special projects, organizational coordination and any related challenges, to directly help Handbook Chairs.
- **Industry Leaders:** Support CMH-17 decision making on technical and logistical needs, including organizational WG or TG interfaces and any related challenges in their areas of specialty, to benefit discussions at *Leader meetings*.
- **Secretariat:** Conduct specified CMH-17 technical, logistical and financial tasks, including handbook publication, website maintenance, organize meetings, continuous outside interfaces, and related challenges, performing work authorized within the FAA and other sponsor contracts.

37

Other Roles and Responsibilities, cont.

CMH-17

COMPOSITE MATERIALS HANDBOOK

- **Independent Advisory Committee (IAC):** Support CMH-17 leadership with advice at regular IAC meetings on technical, logistical and financial interests or challenges, including review of organizational decisions, CMH-17 content, and IAC studies to identify application needs.
- **WG and TG Chairs:** Support handbook content development as described in approved taskings. WG chairs also have responsibility to maintain knowledge of handbook content assigned to their WG, to assist in evaluating proposed writing tasks and identifying needs for new or revised content.
- **Executive Committee:** This committee has all active WG and TG Chairs. Supports CMH-17 with identification/proposal/approval of initiatives that follow the content development process, yielding updated, merged and new content for the seven volumes of technical information that comprise CMH-17 handbooks.

38

19

5/9/2024

Other Roles and Responsibilities, cont.

CMH-17

COMPOSITE MATERIALS HANDBOOK

- **CMH-17 Membership:** Membership comprises the resources needed to recommend, develop, review and maintain CMH-17 handbook content. Members may join selected WG and TG to participate in the interdisciplinary teams that perform CMH-17 Handbook tasks. There are currently only two types of CMH-17 members identified in our Standard Operating Procedures, but future needs may document changes to better meet needs.

39

ACQ

Secretariat Update

CMH-17

COMPOSITE MATERIALS HANDBOOK

- Virtual meeting reminders
- Secretariat Team
- Status
 - AM Volume 7
 - CMC Volume 5
 - PMC Volume 3
- Website Update
- Mission, Vision, Goals, etc.

40

20

5/9/2024

Virtual Meeting Reminders



- ONE Virtual meeting link and dial in number for this week's meeting
 - Sent to all registered attendees
 - Utilizing Breakout Session on WebEx for Working/Task Group meetings
 - Instruction are in the E-booklet
- General Reminders :
 - Join 5-10 mins early
 - Disable video and mute audio unless speaking
 - Use "Raise Hand" or the "Chat" feature for questions/comments
- Presentations will be available to all attendees in meeting proceedings
- Questions/comments? Please email: info@cmh17.org

41

Secretariat Team





Michelle
Man



Austin
Nordyke



CMH-17
Secretariat
Team



Andrew
Pringle



John
Tomblin

Tasks

- Websites & Members DB
- E-booklet & Proceedings
- WG/TG Support
- Balloting
- Meeting plan/host
- Exec/Leadership Support
- CMH-17 Contracts
- Data Review
- Handbook Publication
- Working Drafts
- Promote CMH-17
- Liaison to other orgs

Contact us:
info@cmh17.org

42

5/9/2024



AM Volume 7 Status

43



AM - Fall 2023 Yellow Page Cycle 1 (YP1)

Volume	Section	Title	Affirmative	Affirmative with Comment	Negative	Abstain	Total
7	1.9	DEFINITIONS	6	3	2	0	11
7	2.1	INTRODUCTION TO NON-METALLIC AM DESIGN AND DEVELOPMENT	9	1	1	0	11
7	2.2	SOURCES OF VARIABILITY	7	2	2	0	11
7	2.3	BUILDING BLOCK	10	1	0	0	11
7	6.5	DATA SUBMISSION REQUIREMENTS	5	1	4	1	11
7	8.2.3	STATISTICAL GRAPHING	9	0	1	1	11
7	8.2.8	COMPARISON BETWEEN TRADITIONAL AND GENERIC APPROACHES	7	2	1	1	11
7	8.3.2	GENERAL LINEAR STATISTICAL MODELS	5	0	3	3	11
7	8.3.2.2	ULTEM 9085 EXAMPLE ANALYSIS	8	0	2	1	11
7	8.6.1	AVERAGE STRESS-STRAIN CURVES AND BEARING LOAD-DEFORMATION CURVES	8	2	0	1	11
7	14.3.1	AM MATERIAL DATA TABLE	4	1	5	1	11

44

5/9/2024

AM - Fall 2023 Yellow Page Cycle 2 (YP2)**CMH-17**

COMPOSITE MATERIALS HANDBOOK

Volume	Section	Title	Affirmative	Affirmative with Comment	Negative	Abstain	Total
7	2.1	INTRODUCTION TO NON-METALLIC AM DESIGN AND DEVELOPMENT	9	0	1	2	12
7	2.2	SOURCES OF VARIABILITY	8	1	1	2	12
7	3.1	Evaluation of Feedstock	7	3	2	1	13
7	4.1-4.3	PROCESS AND MANUFACTURING	4	3	2	3	12
7	5.3-5.5	QUALITY CONTROL OF PRODUCTION MATERIALS AND PROCESSES	6	2	1	3	12
7	7.1-7.2	GUIDELINES FOR PROPERTY TESTING OF ADDITIVELY MANUFACTURED MATERIALS	7	1	3	1	12
7	8.2	BACKGROUND	8	2	1	1	12
7	8.2.9	COMPARISON BETWEEN TRADITIONAL AND GENERIC APPROACHES	4	4	0	4	12
7	8.3.1	ALLOWABLES	6	1	1	4	12
7	8.3.2.2	ULTEM 9085 EXAMPLE ANALYSIS	6	0	0	4	12
7	8.4.1	EQUIVALENCY	7	1	1	3	12
7	11.3.2	ANALYSIS FOR AM	9	2	0	1	12
7	11.4.1	POINT DESIGN VERIFICATION FRAMEWORK	7	2	2	1	12

45

AM – Vol 7 draft progress**CMH-17**

COMPOSITE MATERIALS HANDBOOK

WG Responsible	Chapter	Title	% drafted	% approved
Guidelines	1	CMH-17 AM INTRODUCTION AND GUIDELINES	90	85
Guidelines	2	CHARACTERIZATION CONSIDERATIONS	50	40
Testing	3	EVALUATION OF FEEDSTOCK	50	0
Materials and Processes	4	PROCESSING AND MANUFACTURING	0	0
Materials and Processes	5	QUALITY CONTROL OF PRODUCTION MATERIALS AND PROCESSES	0	0
Testing	6	MATERIAL TESTING & CHARACTERIZATION FOR SUBMISSION OF DATA TO CMH-17	12	4
Testing	7	PROPERTY TESTING OF ADDITIVELY MANUFACTURED MATERIALS	70	0
Statistics	8	STATISTICAL METHODS	90	55
Testing	9	EVALUATION OF AM PARTS	0	0
Testing	10	ELEMENT LEVEL TESTING	0	0
Design and Analysis	11	DESIGN AND ANALYSIS	90	80
Design and Analysis	12	MAINTAINABILITY AND SUPPORTABILITY	0	0
Design and Analysis	13	APPLICATIONS, CASE HISTORIES, and LESSONS LEARNED	0	0
Data Review	14	AM PROPERTY DATA	25	5

46

23

5/9/2024



CMC Volume 5 Status

47



CMC - Fall 2023 Yellow Pages

- No CMC Yellow Page activity since last meeting
- At least one more yellow page expected before Rev B
 - 3.1.3.4 Hybrid CVI/Slurry Cast/Melt Infiltration SiC/SiC Composites
 - Testing Content
 - Data Review / Statistics
 - Engine Applications

48

5/9/2024

CMC – Vol 5 review progress					
WG Responsible	Part	Chapter	Title	Page count	
Guidelines	Part A	1	CMH-17 Guidelines and Procedures	46	- Page count at 1217 May need two parts for Vol 5
Materials & Processes	Part A	2	Introduction, History and Overview	55	
Materials & Processes	Part A	3	Processing, Characterization, and Manufacturing	262	- 1 page entries have Section Title and "Reserved for future use" comment
Materials & Processes	Part A	4	Quality Control of Production Materials and Processes	280	
Materials & Processes	Part A	5	Applications, Case Histories and Lessons Learned	307	- Process moving forward:
Design & Analysis	Part B	6	Design and Analysis	11	
Design & Analysis	Part B	7	Maintainability and Supportability	1	1. WG Chairs submit "final" chapter to Secretariat 2. Secretariat Review 3. WSU Copy Edit 4. SAE Review 5. WG Chair Final Review 6. Publish!
Testing	Part C	8	Thermo-mechanical-Physical Test Methods - Overview	17	
Testing	Part C	9	Material Testing & Characterization for Submission of Data to CMH-17	62	
Testing	Part C	10	Evaluation of Reinforcements	20	
Testing	Part C	11	Evaluation of Matrix Materials	3	
Testing	Part C	12	Evaluation of Interface Material	1	
Testing	Part C	13	Evaluation of Composites	42	
Testing	Part C	14	Subcomponent Testing – Overview of Problem	1	
Testing	Part C	15	Machining & Grinding	1	
Data Review	Part D	16	Data Submission, Format and Requirements	11	
Data Review	Part D	17	Statistical Methods	19	
Data Review	Part D	18	CMC PROPERTY DATA	49	
Engine Applications	Part E?	19	Engine Applications	29	
Design & Analysis	N/A	Appendix A	Derivation of the Residual Strength Reduction Expressions for LCF and Rupture Loadings	5	

49

PMC Volume 3 Status					
WG Responsible	Part	Chapter	Title	Page count	

50

25

5/9/2024

PMC - Fall 2023 Yellow Page Cycle 1 (YP1)						CMH17		COMPOSITE MATERIALS HANDBOOK	
Volume	Section	Title	Affirmative	Affirmative with Comment	Negative	Abstain	Total		
3	5.4.2	Resins	20	7	0	7	34		
3	5.9.1	General Considerations	15	10	4	6	35		
3	5.9.4	Application and Assembly Processes for Secondary Bonding	17	7	1	7	32		
3	5.9.8	Considerations in Bond Quality Assurance	15	10	2	6	33		
3	5.9.9	Considerations for a Bonding Process Specification	18	8	1	6	33		
3	5.9.10	Structural Bond Certification	13	12	3	6	34		
3	12.3	Design Development and Substantiation	19	9	1	9	38		
3	12.5	Damage Resistance	21	7	1	9	38		
3	12.8.8	Wing Demonstrator Case Study	17	7	0	11	35		
3	14.7.3	Analysis of a Bonded Repair for Composite Structure	12	9	0	12	33		
3	14.12.3	Case Study #2 Fuselage Skin – Bonded Repair	22	1	0	10	33		
3	14.12.10	Case Study #9 – Normal Category Airplane Bonded Wing Skin Damage	10	3	4	15	32		
3	16.5-16.6	URBAN AIR MOBILITY VEHICLES CRASHWORTHINESS	9	6	1	18	34		
3	17.7	Structural Safety Awareness Course Structure	11	3	3	17	34		

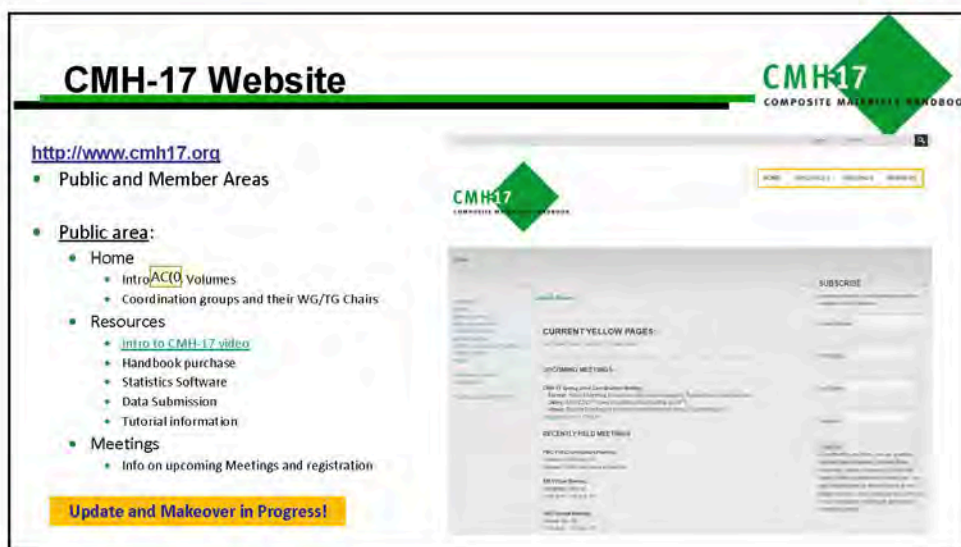
51

PMC – Vol 3 review progress						CMH17		COMPOSITE MATERIALS HANDBOOK	
WG Responsible	Chapter	Page count	Ready for Secretariat?	Initial Content review (at least 2 reviews)	Formatting	WSU (Copyedit)	SAE		
				Nicole Stahl	APV	MM	AP	Kristie Boby	Review of edits by MM
								Kathy Bratton	Review of Chair final review
Guidelines	1	44	Yes	Completed			Completed		
Guidelines	2	43	Yes	Completed		WIP	Completed		
Guidelines	3	36	Yes	Completed			Completed		
Guidelines	4	81	Yes	WIP	WIP				
M&P	5	204							
M&P	6	32	Yes	Completed					
Guidelines	7	26							
Guidelines	8	227	Yes		Completed				
Guidelines	9	32	Yes	Completed	Completed	Completed	WIP		
Guidelines	10	57	Yes	Completed	WIP				
Guidelines	11*	113	Yes			Completed			
Dam Tol	12*	252							
Dam Tol	13	30	Yes	WIP					
Supportability	14	160							
Sp Data	15	16	Yes	Completed	Completed	Completed	WIP		
Crashworthiness	16	85							
Safety Mgmt	17	80							
M&P	18	18	Yes	Completed	WIP	Completed			
Spacecraft	19	53	Yes		Completed	WIP			
Engine Apps	20	60	Yes			Completed			

- Vol 6 planning to be developed this week

52

5/9/2024



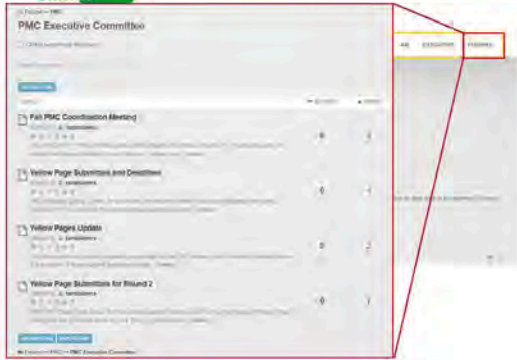
27

5/9/2024

CMH-17 Website & Collaboration Area

CMH17
COMPOSITE MATERIALS HANDBOOK

- Members Access:**
 - Documents**
 - Archive of Proceedings
 - Yellow Page Balloting
 - Working Draft (Active Members only)
 - Coordination Group Contact**
 - Forums**
 - Used by some WG/TG
 - Communication between Chairs and Members
 - Share and discuss content



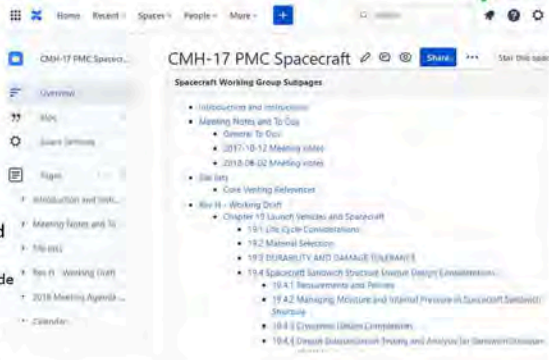
Additional CMH-17 Collaboration Area

CMH17
COMPOSITE MATERIALS HANDBOOK

<https://cmh17.atlassian.net/wiki/home>

ACTIVE working members only

- Each Working Group has a separate area that is visible to all members
 - PMC – Engine App and Spacecraft
 - AM WG
 - CMC WG
 - Only some WG/TG utilize this space
- Collaboration tools:**
 - Ability to edit and comment on posted content
 - Automated updates when changes are made
 - Ability to create tasks
 - Link to other documents/file storage
 - Content draft
 - Meeting minutes



5/9/2024

Plans for New Website



Public space – WSU Hosted

- Be ADA compliant
- Registration page
- Introduction to organization
- Description of WG/TG, awards, etc.
- Purchasing Handbook and Software
- General Announcements

Working Space – Separate Site

- Any content available after log-in
- Forums
- Balloting
- Proceedings, documents, archives
- Will reach out to clean up members list

57

Members Working Space



Takes you to Manage your account settings

Manage



The navigation pane for menus

List of open ballot will show here. Title, dates and if you've voted

58

5/9/2024

Members Working Space

CMH-17
COMPOSITE MATERIALS HANDBOOK

BALLOT

PMC Yellow Page 2nd Cycle
PMC Yellow Page 2nd Cycle - September 2022 Meeting
Click Day: 12/11/2024
Date: 04/13/2024

DOCUMENTS

Chapter/Section 5.4.2
Materials and Processes Review

Vote options

- AFFIRMATIVE
- NEGATIVE**
- ABSTAIN

Uploading files with comments

Input Document Description

Add Document

Input a comment and/or upload a supporting document (max 10MB) (Required for negative votes)

Downloading content

Comments must accompany negative votes

59

CMH-17 Mission, Vision, Goals, etc.

CMH-17

About CMH-17

The Composite Materials Handbook-17 (CMH-17) provides information and guidance necessary to design and fabricate and 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 Overview 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.

Mission

Composite Materials Handbook creates, publishes and maintains proven, reliable engineering information and standards, supported by thorough technical review, to support the development and use of composite materials and structures.

Vision

Composite Materials Handbook will be the authoritative worldwide focal point for technical information on composite materials and structures.

Goals and Objectives

- Periodically meet with experts from the field to discuss critical technical issues for composite structural applications, with an emphasis on increasing overall product safety.
- Provide comprehensive, practical engineering guidance that has proven reliable for the design, fabrication, characterization, test and maintenance of composites.
- Provide reliable data, linked to control of processes and raw materials, thereby being a comprehensive source of material property values and design information that can be shared within the industry.
- Provide a resource for composites education with examples, applications and references to supporting engineering work.
- Establish guidelines for use of information, identifying the limitations of the data and methods.
- Provide guidelines with references to proven standards & engineering practices.
- Provide for periodic updates to maintain the all-inclusive nature of the information.
- Provide information in formats best-suited for user needs.
- Serve the needs of the international composite community through member industries represented, which link teamwork and the diverse member engineering skills to provide information for the hand.

- The CMH-17 website provides organizational Mission, Vision, and Goals
- The Standard Operating Procedure provides different Mission, Vision and Goals
- The beginning of each volume also includes different variations of this information
- Need to update
 - Include AM
 - Need to decide: aviation focus, level of emphasis on data
 - Will send through a joint yellow page vote

30

5/9/2024

Proposal – First Strawman

CMH-17

COMPOSITE MATERIALS HANDBOOK

About CMH-17

The Composite Materials Handbook (CMH-17) provides information and guidance necessary to design and fabricate end items from composite and non-metallic additively manufactured (AM) materials. Its primary purpose is the standardization of engineering methodologies related to testing, data development, reduction, and reporting of current and emerging composite and non-metallic AM materials. In support of this objective, the handbook includes material properties that meet specific data requirements. In addition to providing material data and instructions on how to develop it, the Handbook provides industry best practices for design, manufacture, substantiation, and sustainability. The Handbook therefore constitutes an overview of composites and non-metallic AM technology and engineering, an area which is advancing and changing rapidly. As a result, the document is continuously being updated as sections are added or modified to reflect advances in the state-of-the-art.

Mission

The Composite Materials Handbook organization creates, publishes and maintains proven, reliable engineering information and standards, subjected to thorough technical review, to support the development and use of composite and non-metallic additively manufactured materials and structures.

61

AC(0)

Proposal – First Strawman (continued)

CMH-17

COMPOSITE MATERIALS HANDBOOK

Vision

The Composite Materials Handbook will be the authoritative worldwide focal point for technical information on composite and non-metallic additively manufactured materials and structures.

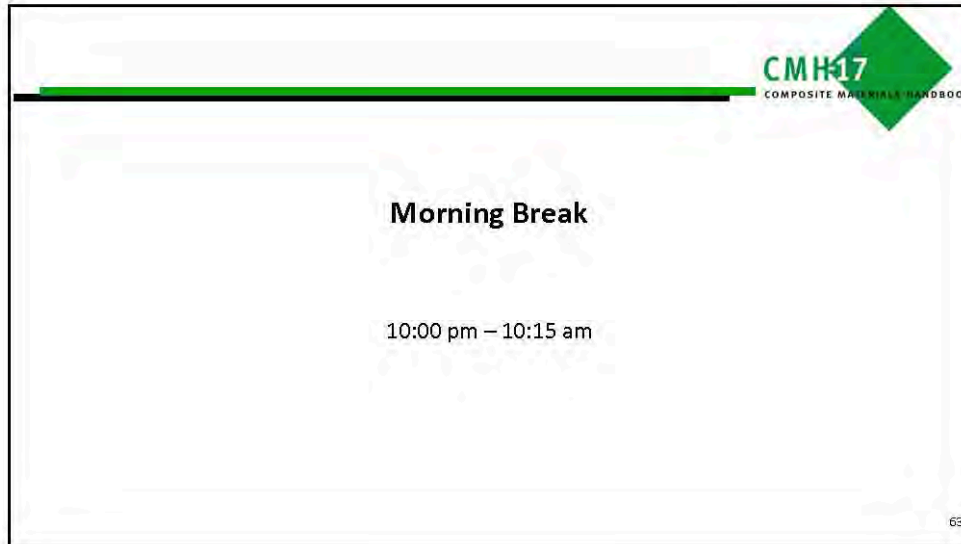
Goals and Objectives

- Provide comprehensive, practical engineering guidance that has proven reliable for the design, fabrication, characterization, test and maintenance of composites and AM
- Provide reliable data, linked to control of processes and raw materials, thereby being a source of material property basis values and design information that can be shared within the industry
- Evaluate the content, including examples, applications, lessons learned and supporting engineering guidelines that outline limitations, strengths and weaknesses
- Promote safe use of composites and AM
- Promote efficient methods for design, test, analysis, and quality assurance
- Provide **educational resources**, both through the handbook content and in-person training/content review
- Establish relationships with other standards organizations and engineering handbooks with similar goals to jointly develop and maintain consistent information to benefit applications

62

31

5/9/2024



CMH17
COMPOSITE MATERIALS HANDBOOK

Morning Break

10:00 pm – 10:15 am

63

This slide features a green horizontal bar at the top. In the top right corner, there is a green diamond logo containing the text 'CMH17' and 'COMPOSITE MATERIALS HANDBOOK' below it. The main content area is white with the text 'Morning Break' in bold black font, followed by '10:00 pm – 10:15 am' in a smaller black font. The slide number '63' is in the bottom right corner.



CMH17
COMPOSITE MATERIALS HANDBOOK

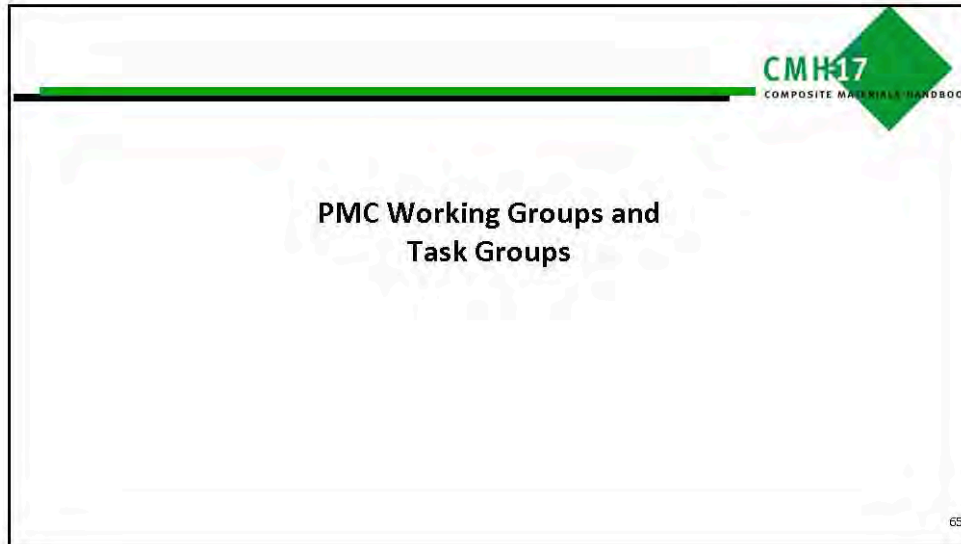
**Working Group Overview
and Activities This Week**

64

This slide features a green horizontal bar at the top. In the top right corner, there is a green diamond logo containing the text 'CMH17' and 'COMPOSITE MATERIALS HANDBOOK' below it. The main content area is white with the text 'Working Group Overview and Activities This Week' in bold black font. The slide number '64' is in the bottom right corner.

32

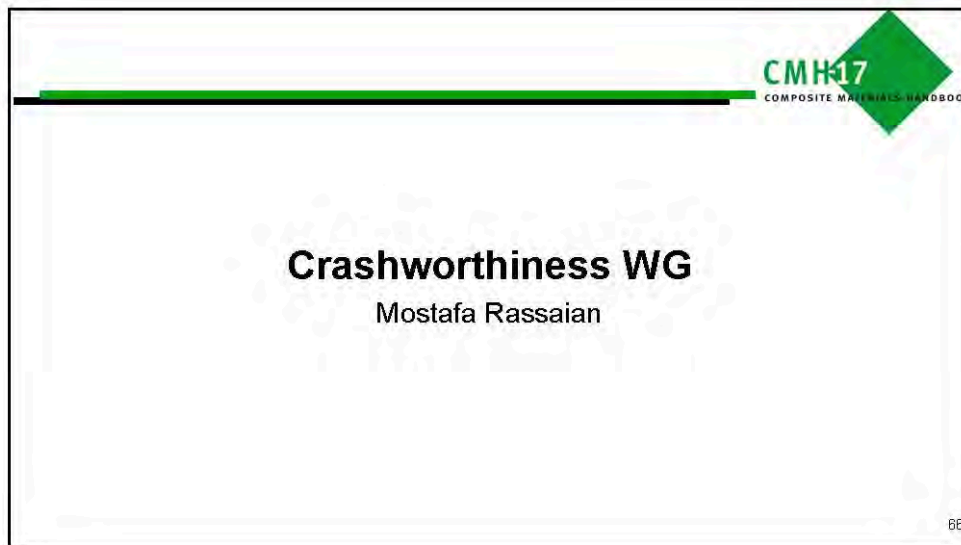
5/9/2024



CMH17
COMPOSITE MATERIALS HANDBOOK

**PMC Working Groups and
Task Groups**

65



CMH17
COMPOSITE MATERIALS HANDBOOK

Crashworthiness WG
Mostafa Rassaian

66

33

5/9/2024

CRASHWORTHINESS WG

CMH17

COMPOSITE MATERIALS HANDBOOK

Task group charter:

- Benchmark industry practices to demonstrate compliance with rules and special conditions developed for the crashworthiness of composite transport aircraft structure
- Evaluate and benchmark the current SOA commercially available FEA tools for simulating composite structures under crash conditions based on experimentally validated approach
- Inform reader of capabilities and shortcomings of various analysis methods in use
- Publish descriptive guidelines and best practices for the experimental and numerical characterization of the crash resistance of composites structures

Task group could be expanded to new subtask groups in focus areas of Rotorcraft and UAM crashworthiness

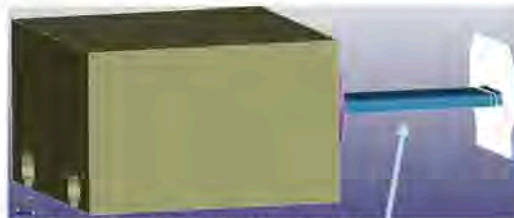
67

CHAPTER 16 – WORKING SESSION AGENDA

CMH17

COMPOSITE MATERIALS HANDBOOK

- Spring 2023 YP Review Outcomes -- Vol. 3, Sections 16.1-16.6 (~20 mins)
- Fall 2023 YP1 Results – Vol. 3, Sections 16.5-16.6.1 (~40 mins)
- Stanchion Design Simulation Results (Byar-Boeing) (20 mins)
- NASA Tech Memo Documentation Status (Pereira-NASA) (20 mins)
- Current and Future Activities (All) (20 mins)



Stanchion Design Simulation in Sled Crush Testing
10 inches unsupported length plus potting



68

5/9/2024

CHAPTER 16 – PUBLIC SESSION AGENDA



Intro, CWG Charter (10 mins)

- C-channel Crush Simulations, Test-Analysis Correlation:
 - LS-DYNA MAT54 (Aswini Kona- NIAR) (15 mins)
 - LS-DYNA MAT58 and MAT261 (Alan Byar-Boeing) (15 mins)
 - LS-DYNA MAT213 (Rudy Haluza- SNL) (15 mins)
 - ABAQUS VPS (PAM-CRASH) Pineda-Waas Implementation (Maria Pia Falaschetti (University of Bologna) (15 mins)
 - LS-DYNA Modified Ladeveze (Rajaneesh Anantharaju/ Michael Bruyneel -GDTech) (15 mins)
- ML-Enabled Application Composite Failure Analysis And Calibration Suites (CFACS) For Material Characterization (Humayun Kabir-Boeing) (20 mins)
- Initiating Rotorcraft and UAM Crashworthiness Task Groups (Volunteers?) (10 mins)
- Summary and POST Rev. H Plans (5 mins)

69

CWG – CONTENT FOR VOL. 3 REV. H



CHAPTER 16 – CRASHWORTHINESS AND ENERGY MANAGEMENT [1]

- **16.1 OVERVIEW AND GENERAL GUIDELINES**

Guidelines

 - 16.1.1 Section Organization
 - 16.1.2 Principles of Crashworthiness
 - 16.1.3 Composite-Related Considerations
 - 16.1.4 Terminology
 - 16.1.5 Existing Research and Development
 - 16.1.6 Overview of Regulating Bodies and Safety Standards
- **16.2 DESIGN FOR CRASHWORTHINESS**
 - 16.2.1 Overview
 - 16.2.2 Impact Conditions
 - 16.2.3 Coupon/element testing
 - 16.2.4 Designs for energy absorption
 - 16.2.5 Trigger Mechanisms to initiate crush
- **16.3 AIRCRAFT CRASHWORTHINESS**

Application

 - 16.3.1 Regulatory Requirements
 - 16.3.2 Crashworthiness Roadmap and Building Block Approach
 - 16.3.3 Crashworthiness Modeling Challenges

[1] Spring 2023 YP2 for sections 16.1 to 16.6 – received 1/3 feedback

70

5/9/2024



CWG – CONTENT FOR VOL. 3 REV. H RELEASE

CHAPTER 16 -CRASHWORTHINESS AND ENERGY MANAGEMENT (CONT'D) [3]

- 16.4 ROTORCRAFT CRASHWORTHINESS [1]
- 16.5 URBAN AIR MOBILITY VEHICLES CRASHWORTHINESS [1,2]
- 16.6 MODELING AND SIMULATION FOR CRASHWORTHINESS - PROGRESSIVE DAMAGE AND FAILURE ANALYSIS [2]
 - 16.6.1 Analysis Methods and Tools
 - 16.6.2 Modeling Features and Implications for Impact Analysis
 - 16.6.3 Examples of Calibration for Composite Material - Energy Absorption
 - 16.6.4 Modeling Capabilities and Limitations
 - 16.6.5 Modeling Strategies and Guidelines
- REFERENCES

Design

Analysis

Testing

[1] New task group(s) to continue content development
 [2] Fall 2023 YP1 results for sections 16.5 to 16.6.1
 [3] Spring 2023 YP2 for sections 16.1 to 16.6 – received 1/3 feedback

71



Crashworthiness Meeting Agenda (Day 1)

Working Group Meeting, Wed. April 24 (Scottsdale AZ)
 10:15AM - 12:15PM

- Spring 2023 YP Review Outcomes -- Vol. 3, Sections 16.1-16.6
- Fall 2023 YP1 Results – Vol. 3, Sections 16.5-16.6.1
- Stanchion Design Simulation Results (Alan Byar-Boeing)
- Current/Planned Activities (All)

72

5/9/2024

Crashworthiness Meeting Agenda (Day 2)

Crashworthiness WG Session, Thur. April 25 (Scottsdale AZ)

10:15 -12:15 pm MST

- CWG Charter
- C-channel Crush Simulations using PDFA, Test-Analysis Correlation:
 - LS-DYNA MAT54 (Aswini Kona- NIAR)
 - LS-DYNA MAT58 and MAT261 (Alan Byar-Boeing)
 - LS-DYNA MAT213 (Rudy Haluza- SNL)
 - ABAQUS VPS (PAM-CRASH) Pineda-Waas Implementation (Maria Pia Falaschetti (University of Bologna)
 - LS-DYNA Modified Ladeveze (Rajaneesh Anantharaju/ Michael Bruyneel -GDTech)
- ML-Enabled application composite failure analysis and calibration suites (CFACS) for material characterization (Humayun Kabir-Boeing)
- Starting Rotorcraft and UAM New Subtask Groups (Volunteers?)
- NASA Tech Memo Documentation Status (Mike Pereira-NASA)
- Summary & POST Rev. H Plans



73



Data Review WG

Royal Lovingfoss

Michael Hempowicz

74

5/9/2024

Data Review Working Group (DRWG)



Goal

- Establishes data documentation requirements, develops formats for data presentation, and provides the final technical and editorial review of all data prior to inclusion in the Handbook.

Activities

- Data Review Working Group (DRWG) performs data review according to a set of published procedures that have been developed by the working group.
- To facilitate the data review process, the DRWG has established an electronic voting protocol that allows data reviews between CMH-17 formal meetings.
- DRWG works closely with NCAMP in order that the data generated by that organization meets the requirements of CMH-17.
- Future tasks will address data requirements and formats for data presentation for adhesives, core, and other new material forms.

75

Data Review Working Group (DRWG) Agenda



Introduction and Welcome – Royal Lovingfoss, Michael Hempowicz

1. **Overview of Data Review Working Group (DRWG)**
 - a. DRWG Voting Members – Voting Group Expectations
 - b. DRWG Data Source Data Submittal – Data Confidentiality – Data Approval Process
2. **Data Review Schedule**
 - a. Data in Ballot/ Review/ Upcoming
 - Fracture Toughness tables– Additional Voters Needed
 - Toray 3900-2C/T800s Slit Tape
 - Victrex AE 250 T-071 AS4 12k Unitape
 - b. Available Datasets
 - c. Additional Datasets
3. **Old/ New Business**

76

5/9/2024



Guidelines WG

Carl Rousseau
Amanda Bastian

77



PMC Guidelines WG Rev H Content

WG Goal: To develop and document generic guidance information and data which is essential for the adequate design, certification or qualification, and production of composite parts and assemblies.

HDBK Sections (Rev H status):

Vol 1	Ch 1 Introduction ✓ (copied to V2, V3)
	Ch 2 Material Characterization ✓
Vol 3	Ch 2 Intro to Composites ✓
	Ch 3 Certification ✓
	Ch 4 Building Block ✓
	Ch 7 Design – in work
	Ch 8 Analysis ✓
	Ch 9 Stability ✓
	Ch 10 Bonded Joints ✓
	Ch 11 Bolted Joints ✓

78

5/9/2024

PMC Guidelines WG Agenda		
		
PMC Guidelines Working Group Meeting Agenda		
Wednesday, 24-April-2024, 8am – 10am MT		
Rousseau	Call to Order	8:00am
Bastian	Approval of Fall 2023 GWG WG Minutes	8:05am
Yellow Page Review – none for GWG this cycle		
Old Business and Open AIs		
Rousseau	[09-10] Adhesive Data inclusion in Handbook (in-work for Rev J) • Status of FAA/NAR and D14-80 D1656 RR projects • DRWG GIC and GIC data format development – Tables now in DRWG Review; for next YP	8:10am
Bastian	Post-Rev-H PMC GWG Issues (need champion names) • Younghi/New Member Outreach • Seats Interiors TG (feedback from Coord?) • eVTOL TG? • Review of PMC-GWG v1-v3 Sections • Continuation of v3ch7 Design TG • Streamlining of v3ch15 (integrate into v3ch8) • Adv Buckling, v3ch9 (Engino/Mabson) • Bonded Joint Cert Example, v3ch10 (Farrert) • Bonded Joints, Shared Database Tutorials • Cross-WG Assistance with V6 • V1ch2.8 def'n of major process change (Emberien)	8:15am
New Business		
All	TBD	9:30am
All	Topics to elevate to PMC Coordination	9:45am
Adjourn		10:00am

79

	
Bonded Joints TG Carl Rousseau Rick Cole	

80

5/9/2024

PMC Bonded Joints TG Rev H Content

CMH17

COMPOSITE MATERIALS HANDBOOK

Vol 3 Chapter 10 "Design and Analysis of Bonded Joints" Task Group

TG started Nov 2017. Work declared complete in Apr 2021 (only editorial corrections left) & TG disbanded.

Complete rewrite of entire chapter. Increased 54 to 78 pages.

Rev H Change Summary

- New content completely recasts Rev G version in more a more useful airframe structural design/analysis/certification format.
- Documents current SOTA in aerospace bonded joint engineering practice.
- Limitations/weaknesses of current SOTA include the fact that it is very dependent on in-house subject-matter expertise at each OEM (relatively little standardization of methods/allowables) and that it remains semi-empirical and reliant on significant testing at multiple building-block levels.
- CMH17 experts include but are not limited to Carl Rousseau, Rick Cole, Greg Kress, Steve Ward, DM Hoyt, Paul Brey, Eric Pomerleau, Mark Chris, Jean Luc Leon-Dufour, etc.

81

CMH17

COMPOSITE MATERIALS HANDBOOK

Certification TG

Cindy Ashforth

Simon Waite

82

5/9/2024

Certification Task Group (under PMC Guidelines WG)



Chairs:

- Dr. Simon Waite, EASA Senior Expert – Materials
- Cindy Ashforth, FAA Senior Technical Specialist for Advanced Composite Materials

Overall Goal:

- The task group was initially formed to create a new chapter in Rev G to present harmonised (FAA/EASA/TCCA) certification guidance and identify issues of concern when using composite materials and showing compliance with Design, Production, and Continued Airworthiness Requirements
 - Provide a global industry/regulator interface
 - Increase awareness of regulatory interests regarding composite issues
 - Help to standardise the subject

Content:

- Volume 3 Chapter 3 “Aircraft Structure Certification and Compliance”

For Rev H (complete):

- Complete rewrite of the chapter to describe certification processes for the FAA, EASA and TCCA, remove duplication of content now in AC20-107B, and highlight topics of regulatory emphasis

83

Certification Task Group (under PMC Guidelines WG)



Problem statement:

- This chapter is developed to provide general information on the regulatory and technical issues that need to be addressed when showing compliance with certification requirements relating to composite civil aircraft structure.
- To achieve aviation safety, certifying agencies require certification of design, production, maintenance and operation at different stages in the aircraft program development.
- Certifications of design and production are to ensure the initial airworthiness of the aircraft. The compliance with maintenance requirements is necessary to ensure the continued airworthiness of the aircraft and thus its safe operation. To effectively achieve aviation safety, integrated considerations involving design, manufacturing, maintenance and operations are critical. Due to the inherent nature of composites, these integrated considerations are more complex compared to that for metal.

Chapter Outline (top 3 levels only):

- 3.1 Introduction
- 3.2 Civil Aircraft Certification
 - 3.2.1 Types of Certification and Approvals
 - 3.2.1.1 Important Considerations
 - 3.2.1.2 Design Approval
 - 3.2.1.3 Production Approval
 - 3.2.1.4 Airworthiness Approval
 - 3.2.1.5 Product Change Approvals
 - 3.2.2 Certification and the Regulators
 - 3.2.2.1 Regulatory Organizations
 - 3.2.2.2 The Structure of the Regulations and Guidance
 - 3.2.3 The Regulations
 - 3.2.4 Civil Aviation Guidance Documentation
 - 3.2.4.1 Primary Composite Guidance – AC 20-107B and AMC 20-29
 - 3.2.4.2 Other Guidance
 - 3.2.5 Further Considerations for Civil Aviation Applications
 - 3.2.5.1 Workforce Knowledge, Training, and Teamwork
 - 3.2.5.2 Reporting, Forensics, and Database Taxonomy

84

5/9/2024

Certification Task Group (under PMC Guidelines WG)



Potential future work:

- Content on performance-based regulations and expectations in means and methods of compliance
- Content on the relationship between novelty / criticality / complexity and the degree of rigor in demonstrating compliance
- Additional points of emphasis for new technology and configurations (materials, processes, and products)
 - Snap-cure thermosets, AM, infusion, thermoplastics, etc.
 - GA, Rotorcraft, VTOL, eVTOL, STOL, UAS, Supersonic, Space
- Discuss effects of new system, such as vehicle health monitoring and structural health monitoring, on certification practices
- Modeling and simulation for certification credit
- Military and other certification applications

85



Design TG

Larry Ilcewicz

Patrick Enjuto

86

43

5/9/2024

Design Task Group



- **Purpose** Develop an appreciation for the phases of design from the start of product development through life cycle challenges, including product value assessments of related costs and performance objectives essential for certifiable applications. These efforts started with an introduction to *Composite Design Criteria, Requirements and Other Constraints* as related to design development and structural substantiation. Principles of size and product scaling will be applied, including the necessary success criteria to attain product readiness and complete product definition, certification, production and service needs during the product life cycle.
- **Volume 3, Chapter 7, Revision H**
 - Sections 7.1 (Design Requirements, Criteria and Constraints) through 7.2.2.3 (Design Phase Success Criteria for *Product Design Readiness*), 7.2.2.4 (Differences for Aircraft Types) and Section 7.2.5.1 (Transport Aircraft Design Process Example)
- **Post Revision H**
 - Section 7.2.3 (Integrated Product Team, IPT), Section 7.2.4 (Integrated Product Team Challenges), 7.2.5 (Design Process Examples), 7.3 (Material and Process Selection), 7.4 (Structural Concepts), 7.5 (Detailed Part Design) and 7.6 (Optimization)
 - **Post-Rev H sections will benefit from more team members with diverse product value needs**

87



Engine Applications WG

Scott Finn
James Finlayson
(Joint with CMC Engine Applications WG)

88

44

5/9/2024

Engine Applications Working Group



Charter

Improve the usefulness of CMH17 to the aircraft engine technical community by:

- developing new CMH17 content specific to aircraft engines for both rotating and stationary parts (excluding nacelles and pylons);
- summarizing how existing CMH17 content applies to typical design, materials, manufacturing, maintenance, and certification activities for aircraft engine composite parts;
- documenting industry best practices for the use of composites in aircraft engines; and
- ensuring consistent content across PMC and CMC volumes.

CMH17 Sections

- Volume 3, Chapter 20 (new to Rev. H)
- Volume 5, Chapter 19 (new to Rev. B)

Operating Cadence

- Monthly phone calls; 2nd Tuesday of each month 11:00-12:00 US Eastern time.

Current Contributors

Scott Finn GE(Ret.), WG Co-Chair	Jason Hamp P&W
James Finlayson RR, WG Co-Chair	DM Hoyt NSE Composites
Cindy Ashforth FAA	Nick Kray GE
Michelle Man NIAR, CMH-17	Greg Gemeinhardt GE
Andrew Pringle NIAR, CMH-17	Tim Mouzakis FAA
Barry Barnett P&W	Jeff Stillinger FAA
Gary Bond P&W	Ariza Oscar P&W
Todd Bullions GE	Kevin Rugg P&W
Rick Cole NRC	Simon Waite EASA
Steve Connor P&W	Matthew Zsunkan P&W
Mathieu Gimat SAFRAN	

If you are interested in actively participating in the working group, please contact:
Scott Finn (scottfinn@gmail.com) or
James Finlayson (james.finlayson@rolls-royce.com)

Spring 2024 Coordination Meeting 89

Engine Applications Working Group



Working Group Meeting Agenda

- Working Group Overview - Mission, Membership, Rhythm
- Vol. 3 Rev H and Vol. 5 Rev. B Submissions
- Review Current WG Scope and Discuss Whether Expanded Scope is Desired
- Review Chapter Outline and Status of Planned Sections
- 2024 Working Group Plans
- Summary & Actions

Spring 2024 Coordination Meeting 90

5/9/2024

Engine Applications Working Group



Status & Plans

- Submitted content for next revisions of Vol. 3 and Vol. 5
 - Adding new chapters: Vol. 3, Chapter 20 and Vol. 5, Chapter 19
- Developing work plan for incomplete sections
 - 2024 focus will be finishing Design Considerations Section. Some of note include:
 - o Fatigue – coordinate with D&DT working group
 - o CMC erosion – coordinate with CMC M&P
 - o Lightning – engaging Rob Steinle (FAA)
- Will Discuss whether adjustments to scope are warranted
 - Currently limited to engines only (certified under Part 33)

Spring 2024 Coordination Meeting

81



Materials and Process WG

Margaret Roylance
Dan Ruffner

92

5/9/2024

Materials and Process WG

CMH17

COMPOSITE MATERIALS HANDBOOK

- Characterization and control of continuous fiber reinforced composite materials (including adjacent ones like film adhesive and core, and processing materials), so expected, consistent properties are delivered, and
- Developing and managing the associated manufacturing processes, both for fabrication of the structural non-metallic materials themselves, and completing the material's final transformation into parts
- Task groups for major activities:
 - P-17 – Industry specifications for V2 published materials
 - Bonding – New Rev H content on structural adhesive bonding
- Contacts: Dr. Margaret Roylance, Dan Ruffner

93

Other M&P Tasks

CMH17

COMPOSITE MATERIALS HANDBOOK

- Resins Content - Howard Creel
- Shipping and Storage Processes – Nathan Collins
- Proposed Tasks post Rev H
 - Shared database tutorial
 - Nested qualification statistics
 - Additional shelf life out-time content
 - Lot Testing - adding and/or setting aside coupons
 - Specification acceptance values and allowables
 - Heat surveys
 - Process control traveler coupons
 - Other suggestions?

94

47

5/9/2024

M&P WG, P17 TG and Bonding TG

CMH17

COMPOSITE MATERIALS HANDBOOK

- **M&P Working Group** - Margaret Roylance and Dan Ruffner
Wednesday 3:30p – 4:20p
 - **Resins Content** - Howard Creel
 - **Shelf Life and Out-time** - Nathan Collins, Margaret Roylance
 - **New M&P Content beyond Rev H**
- **Joint M&P/P-17/QPG Meeting** - Shannon Jones and Margaret Roylance - Wednesday 4:30p to 5:30p
 - **Status update of P-17 Specification Activities** - Shannon Jones
 - **P-17 Qualified Product Group Updates** - Shannon Jones
- **Bonding Process Task Group Working Joint Meeting**
Howard Creel and Molly Stone, Thursday 1:15p to 3:15p Open
 - **Finalize Rev H bonding M&P content**

95

Major M&P Efforts/Task Groups

CMH17

COMPOSITE MATERIALS HANDBOOK

- **Bond Process Task Group**
 - Howard Creel, Molly Stone
- **SAE P-17 (and QPG – NDAs required)**
 - P-17: Shannon Jones, Margaret Roylance
 - P-17 QPG: Shannon Jones, David Pate

96

5/9/2024



Bonding Process TG

Howard Creel
Molly Stone

97



Bonding Process Task Group

Howard Creel (hcreel@mmm.com) and Molly Stone (molly@mttechnologies.com)

The Bonding Process Task Group was formed in the M&P Working Group to create all new content covering bonding of materials for aerospace structures.

The BPTG is focused on completing **Section 5.9 Assembly Processes for Bonded Joints** in Volume 3 for Rev H. All new content - not currently in the Handbook. The BPTG is on track for completion of the section for Rev H.

Bonding Process Task Group Working Meeting
Thursday April 25 1:15-3:15PM

Agenda

- 30 Min Overview of the BPTG and the development of Section 5.9 for Rev H**
- 45 Min Status of remaining Section 5.9 content to be completed for Rev H**
- 45 Min Future focus for BPTG post Rev H tasks with areas of interest that include defining adhesive chemistries; developing testing recommendations for amine blush screening; issues related to wet peel ply (WPP) compatibility, wettability, material handling, etc...; process verification travelers; Tg DOE approach; and other aspects of the bonding process.**

98

5/9/2024

Bonding Process Task Group			
Howard Creel (hcreel@mmm.com) and Molly Stone (molly@mttechservices.com)			
CMH17 COMPOSITE MATERIALS HANDBOOK			
Section	Title	Primary Author(s)	Status
5.9	Introduction	Howard Creel	Complete
5.9.1	General Considerations	Dan Ruffner	Resolve comments from F23 YP1
5.9.2	Adhesive and Substrate Selection	Chad Franks	Complete
5.9.3	Surface Preparation for Secondary Bonding	Ashley Tracey, Will Grace, Jim Mazza, Kara Storage	Complete
5.9.4	Application and Assembly Processes for Secondary Bonding	Scott Leeman, Molly Stone	Resolve comments from F23 YP1
5.9.5	Curing	Dan Ruffner	Incorporate YP
5.9.6	Cobonding	Dan Ruffner	Complete
5.9.7	Multi-stage Bonding	Dan Ruffner	Complete
5.9.8	Bond Quality Assurance	Lisa McHugh	Resolve comments from F23 YP1
5.9.9	Considerations for a Bonding Process Specification	Lisa McHugh	Resolve comments from F23 YP1
5.9.10	Structural Bond Certification	Chad Franks, Molly Stone	Resolve comments from F23 YP1
Sections in Bold may be discussed in the BPTG Working Meeting			

99

CMH17 COMPOSITE MATERIALS HANDBOOK	
P17 TG Shannon Jones	
100	

50

5/9/2024

SAE P17 Task Group

Shannon Jones (sjones@bellflight.com)

CMH-17
COMPOSITE MATERIALS HANDBOOK

Task Group under M&P Working Group

- Not responsible for any content in the handbook itself.
- Focused on the creation and maintenance of material specifications in support of materials with approved datasets in Volume 2.

101

Agenda

CMH-17
COMPOSITE MATERIALS HANDBOOK

SAE P17 Task Group Working Meeting
(concurrent with M&P Working Group)
Wednesday April 24th, 2024
3:30 – 5:30 pm

Status update of P-17 Specification Activities

- WIP Review
- Five Year Document Review Status
- Coordination of data review and specification generation
- New business
- P17 QPG highlights

102

5/9/2024



Safety Management WG

Cindy Ashforth
Larry Ilcewicz

103



Safety Management Working Group

Chairs:

- Dr. Larry Ilcewicz, FAA Chief Scientific and Technical Advisor for Advanced Composite Materials
- Cindy Ashforth, FAA Senior Technical Specialist for Advanced Composite Materials
- + Significant assistance from Charlie Seaton, FAA contractor, supporting content development and industry reviews

Overall Goal:

- Describe safety management principles and how they are applied to aviation products and document best practices to promote standardization in aircraft certification and in aviation workforce education

Content:

- Volume 3 Chapter 17 "Structural Safety Management"

Task Groups: (currently writing content in V3 Chapters 6, 12, and 13)

- Durability and Damage Tolerance
- Disbond and Delamination

For Rev H:

- Highlight content in other sections of the handbook that support safety management needs
- Define standards for a composite structural engineering technology (CSET) safety awareness course

104

5/9/2024

V3 Chapter 17 Outline

CMH17

COMPOSITE MATERIALS HANDBOOK

- Chapter 17 addresses Safety Management Principles, which are used by industry and regulatory agencies to ensure continued operational challenges and other indications of safety concerns
- Some significant additions were made to Chapter 17 in several locations (shown in red) to reference Revision H content that helped fill previously identified needs
- Section 17.7 is new content

17.1 Introduction
 17.1.1 Background
 17.1.2 Purpose and scope
 17.2 Safety risk management overview
 17.2.1 Definitions
 17.2.2 Process of safety risk management
 17.2.3 Hazard identification and initial safety assessment
 17.2.4 Risk analysis and strategies
 17.2.5 Risk assessment and mitigation actions
 17.3 Structural safety and regulations
 17.3.1 Sources of information
 17.3.2 Regulations
 17.3.3 Guidance documents
 17.4 Structural safety assessment considerations
 17.4.1 Design
 17.4.2 Manufacturing
 17.4.3 Maintenance
 17.4.4 Operations
 17.4.5 Airworthiness requirements
 17.4.6 Structural integrity
 17.4.6.1 Life cycle considerations
 17.4.7 Illustration
 17.4.7.1 Right 281
 17.5 Structural safety management procedure
 17.5.1 Describe structure
 17.5.2 Identify unsafe conditions and damage threats
 17.5.3 Analyze risk
 17.5.4 Assess risk
 17.5.5 Mitigate risk
 17.6 Structural safety management applications
 17.6.1 Application: implication of less reliance on DBMs for repaired parts
 17.6.2 Application: nonconforming extensive repair in on-wing must bonding
 17.6.3 Application: nonconforming extensive repair in on-wing must bonding repair
 17.7 Structural safety awareness course structure

105

V3 Section 17.7

CMH17

COMPOSITE MATERIALS HANDBOOK

- New Section, 17.7 "Structural Safety Awareness Course Structure" provides a standard, including major discussion points by topic, for developing a course in composite structural engineering technology (CSET)
- Parties developing CSET courses should cover the content in Section 17.7, highlighting the key points for each section

17.7 Structural Safety Awareness Course Structure

CSET Subject 1. Introduction and Challenges

17.7.1.1 Composites Overview
 17.7.1.2 Challenges
 17.7.1.3 Integrated Product Development Teams (IPD/ IPT)

CSET Subject 2. Materials and Processes

17.7.2.1 Material and Process (M&P) Control
 17.7.2.2 Defects and Damage
 17.7.2.3 Protection of Structure

CSET Subject 3. Design

17.7.3.1 Structural Design Details
 17.7.3.2 Design Considerations for Manufacturing and Maintenance
 17.7.3.3 Other Design Considerations
 17.7.3.4 Design Requirements, Criteria and Objectives
 17.7.3.5 Lamination Theory and Design
 17.7.3.6 Composite Analysis Methods
 17.7.3.7 Composite Material Allowables, Design Values, and Knockdown Factors
 17.7.3.8 Structural Bonding
 17.7.3.9 Structural Bolted Joints

CSET Subject 4. Structural Substantiation

17.7.4.1 Regulations and Guidance
 17.7.4.2 Certification Approaches and Related Considerations
 17.7.4.3 Damage and Defects
 17.7.4.4 Building Block Testing and Analysis
 17.7.4.5 Large Scale Testing Considerations

CSET Subject 5. Manufacturing Considerations

17.7.5.1 Quality Control
 17.7.5.2 Certification Conformity Process
 17.7.5.3 Manufacturing Defect Disposition

CSET Subject 6. Maintenance Considerations

17.7.6.1 Inspection and Maintenance
 17.7.6.2 Structural Repair Development and Substantiation

CSET Subject 7. Other Subjects

17.7.7.1 Flutter and other aeroelastic instabilities
 17.7.7.2 Crashworthiness
 17.7.7.3 Fire Safety
 17.7.7.4 Lightning Protection

106

5/9/2024

Safety Management Working Group



- **Other Goals:**
 - Add guidelines for structural modifications involving composites
 - Moved to SAE Tasking
 - May still require CMH-17 detailed background in the future
 - Add guidelines for composite design process (moved to GWG Chapter 7)
 - Add guidelines for technology readiness (moved to GWG Chapter 7)
- **For This Meeting, 3:30-5:30 Wednesday:**
 - Welcome
 - Disposition of 2023 Fall YP1 Reviews, with a focus on Negative Votes and other significant changes
 - Efforts to complete the Final Rev H Content
 - Candidate Safety and Certification Efficiency Proposals for future Initiatives
 - Closure/Actions

107



Disbond and Delamination TG

Ronald Krueger
Lisa McHugh

108

5/9/2024

Disbond/Delam TG under Safety Management WG

CMH17

COMPOSITE MATERIALS HANDBOOK

Task group charter:

The Disbonding and Delamination is a Task Group under Safety Management. The group will determine an overall strategy for the handbook to address disbonding and delamination. The task group will examine methodologies needed to assure through-thickness integrity of bonds and laminations in polymer matrix composites. The group will review the existing document to assure that the sections related to delamination and disbonding are up-to-date. The group will inherit maintenance responsibility for sections on bonded joints written by the Joints WG. Appropriate interfaces will be made with existing groups to address identified gaps, in particular a strong interface will be created with the Damage Tolerance Task Group. The creation of new sections may be recommended if the current outline does not meet the needs of the strategic approach.

Task group could be disbanded and activities taken over by existing and/or new task groups

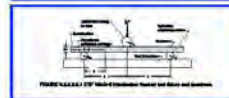
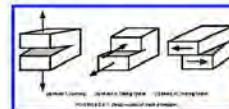
109

DDTG – UPDATED CONTENT IN VOLUME 1H

CMH17

COMPOSITE MATERIALS HANDBOOK

- 6.8.6 Interlaminar Fracture toughness
 - Overview
 - Mode I DCB test (ASTM 5528 and ISO 15024)
 - Mode II ENF test (ASTM 7905) and C-ELS test (ISO 15114)
 - Mode III test methods
 - Mixed-mode I/II MMB test (ASTM D6671)
 - Other mixed-mode tests
 - Failure criterion
 - Through thickness and intra ply fracture tests
- 6.9.4 Fatigue Fracture toughness



Testing WG to continue to monitor content and update as new ASTM standards become available

110

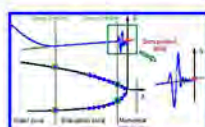
110

5/9/2024

DDTG – NEW CONTENT IN VOLUME 3H

- CHAPTER 8 ANALYSIS OF LAMINATES (G)
- 8.1 INTRODUCTION
- 8.2 LAMINA PROPERTIES AND MICROMECHANICS
- 8.3 LAMINATE STIFFNESS ANALYSIS
- 8.4 LAMINATE IN-PLANE STRESS ANALYSIS
- 8.5 GENERAL LAMINATE STRENGTH CONSIDERATIONS
- 8.6 LAMINATE IN-PLANE STRENGTH PREDICTION
- 8.7 INTRA- AND INTER-LAMINAR STRESS AND FAILURE ANALYSIS
 - 8.7.1 Out-of-plane loads
 - 8.7.2 Interlaminar stresses
 - 8.7.3 Delamination
 - 8.7.3.2 Mechanics of delamination onset and propagation (new to rev. H)
 - 8.7.4 Calculation of strain energy release rate interlaminar fracture mechanics
 - Existing section on VCCT - (Introduced in rev. G)
 - 8.7.5 Other linear elastic fracture mechanics based methods (new to rev. H)
 - Virtual Crack Extension Method (VCE)
 - Crack Surface Displacement Extrapolation (CSDE)
 - 8.7.6 Simulation of delamination failure using cohesive zone models (new to rev. H)





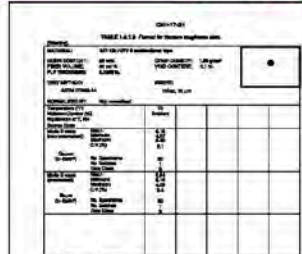

Damage Tolerance TG to continue to monitor content and update as new information becomes available

111

DDTG – CONTENT UNDER DEVELOPMENT FOR VOL. 2

- NASA Langley provided test data from ASTM round robin exercises
- Material (IM7/977-3, G40-800/5276-1, S2/5216) was donated at the time and plates were manufactured by Cytec (now Solvay).
- proceed with publication of ENF G_{IIC} results first
 - Carl Rousseau submitted information to Data Review WG
 - decided to move forward
 - complete data review
 - CMH-17 yellow page cycle
 - make changes as necessary to tables in Vols. 1 and 2 and data sheet
- follow with publication of DCB G_{IIC} results
- submit other data as it becomes available

Data Review WG to continue review.

112

5/9/2024

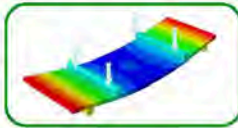
DDTG – CONTENT UNDER DEVELOPMENT FOR VOL. 6A



- Chapter 01 General Information
- Chapter 02 Guidelines for Property Testing
- Chapter 03 Material Data
- Chapter 04 Fabrication of Sandwich Structures
- Chapter 05 Quality Control
- Chapter 06 Certification and Design Criteria for Sandwich Structures
- Chapter 07 Internal Loads and Stresses
- Chapter 08 Analysis and Structural Design
- Chapter 09 Damage Assessment of Sandwich Structures
- Chapter 10 Supportability
- Chapter 11 Sandwich Design Case Studies
- Chapter 12 Supporting Data and Discussions

New task group(s) to continue content development






113



Durability and Damage Tolerance TG

Douglas Cairns

Allen Fawcett

Simon Waite

Patrick Enjuto

Mike Smeets

114

57

5/9/2024

CMH-17 Durability & Damage Tolerance Task Group

April 2024 TG Overview

Scottsdale

Prepared for:



CMH-17 Damage Tolerance Task Group

Scottsdale Meeting
April 2024

Prepared by:



NSE Composites
1101 North Northlake Way, Suite 4
Seattle, WA 98103
(206) 545-4888
www.nsecomposites.com

**Allen Fawcett
DM Hoyt**


CMH-17 Damage Tolerance Task Group | Scottsdale, AZ | April 22-26, 2024 | 115

CMH-17 D&DT TG – Task Group Definition

Task Group Definition

- The Durability and Damage Tolerance group is a Task Group under Safety Management.
- The group determines an overall strategy for the handbook to address durability and damage tolerance.
- The task group will examine methodologies in support of AC20-107B, FAA policy memos, ARAC material and other documentation focusing on polymer matrix composites.
- Benchmarking our approach includes the work done by the IRCWG (Industry Regulatory Composite Working Group) as well as industry best practices done at FAA/FASA/TOCA workshops over the years.
- The group will review the existing documents to assure that the sections related to durability and damage tolerance- are up-to-date and provide maintenance for those sections.
- Appropriate interfaces will be made with existing groups to address identified gaps, in particular Bonding under Material and Process WG and the Disbonding and Delamination task-group. The creation of new sections may be recommended if the current outline does not meet the needs of the strategic approach.

D&DT group formed in 2001 with Tom Walker (NSE) as chair.

Focus = benchmarking accepted industry practice and providing expanded guidance


CMH-17 Damage Tolerance Task Group | Scottsdale, AZ | April 22-26, 2024 | 116

5/9/2024

CMH-17 D&DT Task Group – Co-chairs/Contributors

Co-chairs (active):

Allen Fawcett (NSE)	afawcett@nsecomposites.com
Patrick Enjuto (Boeing)	patrick.enjuto2@boeing.com
Mike Smeets (Fokker)	mike.smeets@fokker.com
Simon Waite (EASA)	simon.waite@easa.europa.eu
Doug Cairns	dcairns@me.montana.edu

Significant contributors:

Hoyt (NSE)	hoyt@nsecomposites.com
Larry Ilcewicz (FAA)	larry.ilcewicz@faa.gov

NSE COMPOSITES

CMH-17 D&DT Task Group – Co-chairs/Contributors | 117

CMH-17 Volume 3 Chapters

1. General Information
2. Introduction to Composite Structure Development
3. Aircraft Structure Certification and Compliance
4. Building Block Approach For Composite Structures
5. Materials and Processes
6. Quality Control of Production Materials and 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, and Repair
15. Thick-section Composites
16. Crashworthiness and Energy Management
17. Structural Safety Management
18. Environmental Management
19. Launch Vehicles and Spacecraft
20. Engine Applications

Supporting discussions

Main D&DT content

Supporting discussions

NSE COMPOSITES

CMH-17 D&DT Task Group – Co-chairs/Contributors | 118

5/9/2024

Chapter 12: Damage Resistance, Durability, and Damage Tolerance

Chapter 12: Damage Resistance, Durability, and Damage Tolerance

- 12.1 Introduction
- 12.2 Rules, Requirements and Compliance for Aircraft
- 12.3 Design Development and Substantiation
- 12.4 Inspection for Defects and Damage
- 12.5 Damage Resistance
- 12.6 Durability and Damage Growth Under Cyclic Loading
- 12.7 Residual Strength
- 12.8 Application/Examples
- 12.9 Supporting Discussions

← **Chapter 12 Section Outline**

Related Topics Covered Elsewhere

- Bonded joints and bonded repairs – Chapter 10
- Bonded joint M&P – Chapter 5
- Supportability and bonded repair – Chapter 14
- Sandwich disbond – Volume 6

← **Related topics in other chapters**

JN SE COMPOSITES CMH17 Damage Resistance Test Spec. | Scottsdale, AZ | Rev 2020/1/24 | 119

CMH-17 D&DT TG – Key Accomplishments for Rev H

- **Aging, LOV, and Damage Accumulation**
 - New section summarizing aging issues with input from ARAC; other new content including sections on environmental cycling and visco-elastic effects.
- **Hybrid Issues & Thermal Loads**
 - Extensive new sections for hybrid structure, large scale testing, and use of analysis for thermal load substantiation.
 - Two applications examples for addressing thermal loads.
- **Repeated Load Tolerance & LEF Guidance**
 - LEF guidance for complex structures and hybrids.
 - Test spectrum development, 5 x 5 blocking approach.
- **Damage Threat Assessment & Damage Resistance**
 - New introduction relating damage threat assessment to criteria and substantiation.
 - Extensive new section covering all types of damage and defect threats.
 - Includes Part 25 and Part 23 application examples.
 - Updates to damage resistance sections.
- **Categories of Damage & SDC**
 - Updated design criteria and substantiation sections for Categories of Damage, including specific updates for bonded joints.
 - SDC and fail-safe design explained, minimum damage sizes discussed.
 - New section on relationship among categories.
- **Category 5 & HEWABI**
 - HEWABI policy statement incorporated with updated sections on addressing Category 5 damage, including damage resistance.
- **Inspection for Defects & Damage**
 - Inspection programs, EDR/ADR, MSG-3 and fleet leader programs discussed.
 - Chapter 13: Defects, Damage, and Inspection – updated.
- **Additional Topics**
 - Added discussion of AC 25.307-1.
 - Analysis - Industry practices section complete.
 - Residual Strength - Rewrite of analysis section complete.
 - Other application examples mostly complete.

JN SE COMPOSITES CMH17 Damage Resistance Test Spec. | Scottsdale, AZ | Rev 2020/1/24 | 120

5/9/2024

CMH-17 D&DT TG – Future Initiatives Post Rev H (1 of 2)

- 12.3.1 – Add bonded repair processing threats to Damage Threat Assessment
 - Add new sub-section for post-Rev H
 - May be partly covered in Chapter 14 (14.3)
- 12.3.2 – Updates to address comments to approved text that don't make Rev H.
- 12.3.3 – Updates to address comments to approved text that don't make Rev H.
 - Helicopter example of full-scale test sequence (updates per Airbus comment)
- 12.4 – Generalize inspection protocols and practices to all categories of aircraft
 - Current write-up is Transport Category (Part 25) centric and based on MSG-3/ADR/EDR and Part 25 ARAC activities
- 12.5 – Damage resistance test issues and analysis methods
 - 12.5.2 Design Issues and guidelines – Fire section?
 - 12.5.3 Test issues – Intro, impact under load, and HEWABI testing Input from UCSD/Bishop
 - 12.5.4 Analysis methods – Industry practice, analysis examples including HEWABI

Additional initiatives may be added based on recent YP comments that will be addressed in next revision.

Blue – highest priority post-Rev H D&DT
Red – high post-Rev H for Design
Black – other post-Rev H D&DT priority

JN SE COMPOSITES

CMH-17 Damage Tolerance Task Group | Scottsdale, AZ | April 25th, 2024 | 121

CMH-17 D&DT TG – Future Initiatives Post Rev H (2 of 2)

- 12.6.3 – Fatigue testing – update with additional guidance for multi-LEF and deferred spectrum approach (more emphasis and/or training, WFE)
- 12.6.4 – Fatigue analysis methods updates
 - Coordinate with Engines Working Group
- 12.8.8 – ILOT Case Study?
 - Initial draft being reworked to focus on damage tolerance aspects and to include caveats where demonstrator project deviated from best practices.
- Lightning – Add more content to cover design practices and protection
 - 12.5 has a significant write-up moved from Volume 3, Chapter 3
 - Also currently covered in 12.3.1, 12.3.2, and 12.4.4.2
 - Possibly add more detailed systems-related content in Chapter 7 (see placeholder in section 7.5.10 in detailed design section), possibly a new initiative?
- SLP vs. MLP
 - ARAC inputs on single load path (SLP) and multi-load path (ML) structures

Blue – highest priority post-Rev H D&DT
Red – high post-Rev H for Design
Black – other post-Rev H D&DT priority

JN SE COMPOSITES

CMH-17 Damage Tolerance Task Group | Scottsdale, AZ | April 25th, 2024 | 122

5/9/2024



Sandwich WG

Larry Gintert (Sandwich WG)

Zhi Ming, Chen (Sandwich WG)

Shannon Jones (Core TG)

123



Sandwich WG Charter

Overall Goals: Develop comprehensive sandwich structures guidance document including material and processing, testing, design and analysis items unique to sandwich structures. Content parallels content in Volumes 1 and 3 which primarily covered laminated composite materials and structures.

Handbook Sections: Volume 6 in its entirety (currently Chapters 1-8 – outline being updated to 12 chapters)

Status of Sections For Next Revision:

- Volume 6 Outline expanded to a proposed 12 chapters - Plans for updating content to align with expanded outline – NOT REV H
- Development plan updated with focused Task Groups initiated

Challenges to Issuing Next Revision:

- Reorganization of Design and Analysis content is extensive
- New content for Damage Assessment is being documented based on recent accomplishments
- Core Data TG focused on creating protocol; paced by funded activity
- Considerable new content focused on damage tolerant sandwich design and tools

124

5/9/2024

Sandwich WG Activities

CMH17

COMPOSITE MATERIALS HANDBOOK

Revision A Initiatives: Development of new content, including expanded discussion on damage tolerance and sandwich disbond phenomena as primary design considerations; the data review and acceptance protocols for published pedigree core data; revision of all chapters; reorganization to align with Vol 3; coordination with new content from Vol 3 (new disbond analyses tools, repair, adhesive bonding and adhesives data, improved cross reference to/from other volumes), a new Chapter 11 for sandwich structures design case studies. Modified outline proposed expanding Design and Analysis chapter into three chapters and adding a Chapter 9 for damage assessment of sandwich structures; resulting in 12 chapters proposed for Rev A.

Revision A Implementation: Proposed plan to establish 5 Task Groups for content development and update; virtual strategic planning meetings held to identify prospective team leadership and members; focused initial topics have been listed and monthly virtual team meetings planned

125

Sandwich WG Agenda

CMH17

COMPOSITE MATERIALS HANDBOOK

Proposed Agenda (2 hr)

Scottsdale, AZ 4/24-25/2024

(Wednesday 4/24, 1:15 – 3:15 PM MST)

- Introductions and Agenda Review - 5 min
- Brief overview of Vol 6 past, present and future - 20 min
- Volume 6A Proposed Task Groups and Plans - 25 min
- Results of Strategic Meetings, Team Plans/Discussion - 60 min
- Planning/Wrap-up - 10 min

126

5/9/2024



Core

Shannon Jones (Core TG)

127



Core Data Task Group

Shannon Jones (ssjones@bellflight.com)

Task Group under Sandwich Working Group

- Responsible for overseeing inclusion of statistically valid core properties into the handbook
- Initial activity was focused on how to analyze existing known datasets for several core materials
- Scope has evolved with other efforts underway related to sandwich structures (disbond/delam, new test methods, core characterization effort, etc.)
- Task group may be further re-scoped as Volume 3, Revision H wraps up and there is a renewed focus on Volume 6, Revision A

128

5/9/2024



Spacecraft and Launch Vehicle Working Group

Jeff Eichinger
Jeremy Jacobs

129



Spacecraft & Launch Vehicles Working Group

Actually a very broad category

- Satellites (fragile, minimal weight, not human rated)
- Launch vehicles (some single use, some re-enter, some are human rated)
- Human rated capsules (weight critical, exit and re-enter atmosphere, people on board)

No standard “certification” process

- Requirements come from many sources
- Structural substantiation approaches vary significantly



Note: When we say “Spacecraft” we generally mean all of these

130

5/9/2024

Who We Are (Spacecraft Group)

CMH17

COMPOSITE MATERIALS HANDBOOK

What's Unique About Us:

- We are generally not commercial airplane experts
- We focus on areas where CMH-17 guidance could be misleading in our industry
- We network, follow the accomplishments of our team-mates companies, and share lessons learned...

Our Activities:

- We recently submitted a new chapter for Rev H (Chapter 19)
- We're currently developing a proposal to create a new section on the topic of pressurized composite structure for spacecraft
- At this meeting we are holding a working group collaborative meeting to brainstorm and outline the proposed section (no presentations)

Current Primary Contributors

Aerospace Corp
Blue Origin
Boeing
Lockheed
Paragon Space
Sierra Space
SpaceX
Firefly
NASA JSC
NASA KSC
NASA MSFC
Northrop Grumman
Airbus
Gulfstream

131

The New Frontier: Commercial Space

CMH17

Goal: Foster development of a robust, competitive U.S. commercial space industry



Crew Dragon



Starliner



HALO/Gateway



Dream Chaser



Orbital Reef



Axiom Station



Orion



Starship

132

5/9/2024

Spacecraft & Launch Vehicles Agenda




Spacecraft Working Group Meeting

Background
The spacecraft group meets monthly by telecon and several of us met in person at the October 2023 meeting in Wichita. Having finished a large new section for Rev H, the group has spent much of our time in recent meetings discussing what guidance material our group could create that would be most useful for the industry and CMH-17. The group has tentatively settled on the topic of pressurized composite structure for spacecraft as an area of interest where design guidance could be particularly useful.

Working Group Meeting Plan
The plan for this meeting is to brainstorm and develop a preliminary outline for a new CMH-17 section that specifically addresses composite pressurized structure for spacecraft. This will be a focused collaborative meeting and no presentations are expected. To inform this effort, spacecraft working group members have been asked to bring public domain literature that addresses topics related development of pressurized human habitable volumes, propellant tanks, permeation & microcracking, and damage threats associated with these types of structures.

Specific External Help Requested
Areas that we've struggled with include navigating the export control restrictions on data relating to pressurized composite spacecraft structure. We are also seeking guidance from CMH-17 leadership on how to collaborate with leadership and other groups while establishing a plan to propose.

133



Specialized Data

Carl Rousseau

134

5/9/2024

PMC Specialized Data WG Information

CMH-17

COMPOSITE MATERIALS HANDBOOK

HDBK Content: Thick Section Composites

- Rev D (1994) – v3ch7, 12 pp of 3D composite mechanics and data tables, including 2 sub-sections “reserved for future use”.
- Rev E (1997) – v3ch7, 31 pp of 3D composite mechanics and biaxial testing info, including 6 sub-sections “reserved for future use”.
- Rev F (2002) – v3ch10, 29 pp unchanged from Rev E.
- Rev G (2012) – v3ch15, 15 pp of 3D composite mechanics info (biaxial testing info removed), still including same 6 sub-sections “reserved for future use”.
- Rev H – v3ch15, unchanged from Rev G.

WG History: Mainly populated by DoD ground and marine composites SMEs in 1990's. May have also had automotive participation? TBD when WG stopped meeting.

PMC GWG Recommendation: Mechanics content should be added to v3ch8 and ch15 removed from v3-Rev J future versions.

135

CMH-17

COMPOSITE MATERIALS HANDBOOK

Statistics WG

Stefan Kloppenborg

Jorge Chavez-Salas

136

5/9/2024

Statistics WG

CMH17
COMPOSITE MATERIALS HANDBOOK

Analyzes and/or develops statistical procedures for composite materials evaluation and quality control and provides other statistical support to the Handbook as requested.

PMC	AM
Volume 1, Chapter 8 Volume 3, Section 5.13	Volume 7, Chapter 8
Co-Chairs Stefan Kloppenborg <i>De Havilland Aircraft</i> Jorge Chavez-Salas <i>WSU-NIAR</i>	Co-Chairs Stefan Kloppenborg <i>De Havilland Aircraft</i> Lindsay Jones <i>Boeing</i> Elizabeth Clarkson <i>WSU-NIAR (Ret.)</i>

137

Statistics WG – Current Activities

CMH17
COMPOSITE MATERIALS HANDBOOK

- Develop & ballot Volume 7, Chapter 8 content (AM)
 - Includes both “traditional” (Vol 1 methods) and “generic” method
- Groupings for material allowables computed using ANOVA (affects all material forms, including CMC)
- Software

138

5/9/2024

Statistics WG – Meeting Agenda



- Wednesday April 24, 8:00 – 10:00 am
 - Call to order & introductions
 - Meeting minutes
 - Status of Volume 1 Chapter 8 and Volume 7 Chapter 8
 - SPC vs. Acceptance Requirements
 - Possible bugs in CMH17-STATS software
 - Data groupings for ANOVA
 - Introduction
 - Properties of ANOVA method for various grouping strategies (simulation study)
 - Experience with analysis of AXIOM CMC data
 - cmstatr R package

139



Supportability WG

Joseph Rakow
Stephen Starnes

140

5/9/2024

Supportability WG Charter



Overall Goals: Update V3, Ch. 14 to document best industry practices for bonded and bolted composite repair substantiation, while updating other sections as needed for critical structures (defined in FAA AC 20-107B) other parts. *See FAA Composite TSO Initiative for certification efficiency adding product value.*

Handbook Sections: Volume 3, Chapter 14 Supportability, Maintenance and Repair

Status of Sections Remaining For Next Revision:

- Section 14.7.3 – Bonded Repair Analysis – Yellow Page comments being addressed
- Section 14.12.10 – Case study #9 – Yellow Page comments being addressed

Challenges to Issuing Next Revision:

- Content developed over a long period of time needs a thorough complete review with all new content

141

Supportability WG Activities



Near-term Goals

- Section 14.7.3 Bonded Repair Analysis – Publication in Rev H
- Section 14.12.10 Case Study #9 – Publication in Rev H
- FINAL SCRUB CHAPTER 14 – (PARTIAL DRAFT POSTED TO FORUM 01/22/23)

Longer-term Goals

- Section 14.12.3 - Case Study #2– Post-Rev H COMPLETION planned
- Section 14.3 Service Experience – Post-Rev H UPDATE planned
- Chapter 14 Post-Rev H topics identified

142

5/9/2024

Supportability WG Agenda



Proposed Agenda (2 hr)
Scottsdale, AZ 4/24-25/2024
(Wednesday 4/24, 10:15 – 12:15 PM MST)

- Introductions and Overview 5 min
- YP Comments/Ch 14 Status 75 min
 - 14.7.3 Bonded Repair Analysis
 - 14.12.10 CS #9
- CS#2 Volunteers and Plan 20 min
- Other Post Rev H plans 15 min
- Planning/Wrap-up 5 min

143



Testing WG

Dan Adams

John Moylan

144

72

5/9/2024

Testing WG



Goals:

- Publish descriptive and guidance information relating to usage of test methods for PMCs and their constituents
- Inform reader of advantages and shortcomings of various methods in use
- Provide basis for test method selection, identify specific test methods to be used for data submitted to CMH-17 (Volume 2)

Handbook Sections: Volumes 1; Chapters 3, 4, 5, 6, and 7

Summary of Recent Efforts:

- Updated Volume 1 Chapters 3-7 for Revision H (Published by SAE in September 2022)
- New work will include review and update of Sandwich Working Group draft for Volume 6, Chapter 2

145



CMC Working Groups

146

73

5/9/2024



Data Review WG

Rajiv Naik
(hosted by Matt Opliger)

147



Data Review WG

Vision:

- To be the primary and authoritative source for data documentation, data archival and data analysis methods for CMC design data.

Goals / Objectives:

- Formulate guidelines and requirements for data submission, data documentation, statistical data analysis, and data review for CMC data submitted to CMH-17.
- Perform technical review of the data and check for completeness, quality, consistency and pedigree.
- Develop and document statistical methods for CMC data analysis.
- Develop formats for presentation of data in the handbook.
- Work closely with CMC Testing WG and CMH-17 Statistics WG to develop and update test data documentation and data analysis methods for CMC data.

148

74

5/9/2024

Data Review WG



Plans for This Meeting

- Provide overview and status of our Working Group activities
- Overview and discussion of Axiom Ox-Ox CMC test data and statistical data analysis
- Add to our Working Group
 - Generate interest in the CMC community to provide input to our Working Group

149

Data Review WG



Agenda

- Introductions
- Vision and Goals
- Data Review process
- Overview of Sections 16-18 in the Handbook
- Guest speaker – Mr. Matthew Opliger, NIAR, WSU.
 - “Axiom CMC test methods and test data insights”.
- Guest speaker – Mr. Jorge Chavez-Salas, NIAR, WSU.
 - “Statistical Analysis of Axiom CMC test data ”
- Discuss going forward plan

150

75

5/9/2024



Design and Analysis WG

Dr. Kevin Rugg
Dr. Arun Bhattacharya

151



VISION & GOALS

- **Vision Statement**
 - To be an authoritative source for design, analysis, and verification information for the validation and certification of CMC engineered structures
- **Goals**
 - To provide information on design and analysis certification methods and options, the level of substantiation information required, and formats required in validation and certification processes.
 - To specify material property and performance input and validation data needed for design and analysis of CMC components
 - To identify test parameters to produce those data, and identify analysis considerations in interpreting such data, and to ensure compatibility with design needs
 - To identify approach options for the design and analysis of CMC structures and joints
 - To ensure future relevancy of the handbook by maintaining an up to date survey of the current state of the art capabilities within the design, analysis and lifing communities for CMCs

152

76

5/9/2024



Planned Activities

- Refresh list of attendees, get people committed in doing it
- Call meeting of the new team
- Review assigned sections
- Progress on Maintainability & Supportability (Section 7)
- Progress on Inspectability, Repair & Certification Sections
- Reconvene before June end; consider NSMMS 2024 (starting June 24) at Madison, WI for in-person meeting

153



Materials and Process WG

Doug Kiser
Leanne Lehman

154

77

5/9/2024

Materials & Processes WG



CMC Materials & Processes Working Group

April 25, 2024

2024 CMH-17 PMC/CMC/AM Coordination Meeting
Scottsdale, AZ

Leanne Lehman, Boeing Research & Technology
Doug Kiser, NASA Glenn Research Center

155

CMC M&P WG Agenda



Overall WG goal: To document information on the composition, fabrication, and characterization of CMC engineering materials and structures.

Presenter	Topic	Time
Leanne Lehman	Call to order and introductions	5 min
Doug Kiser	Old Business Review Rev A content Review Rev B updates	20 min
Leanne Lehman	New Business: Plan Rev C content updates and identify authors	20 min
All	Action items	15 min

156

5/9/2024

Materials & Processes WG



Vision:
To be the primary and authoritative source for information on the composition, fabrication, and characterization of CMC engineering materials and structures.

Note: Focus is currently on SiC/SiC and Ox/Ox CMCs (for aircraft engines/exhaust systems)

Goals:

- To provide a comprehensive overview of ceramic matrix composite (CMC) technology, outlining the types of CMCs, commercial aircraft applications, benefits, methods of fabrication, quality control, and supportability.
- To identify the essential information on composition, constituents/structure, and processing of CMCs necessary to support design, selection, fabrication, certification, and utilization of CMC structures.
- To specify the methods and procedures to be used in the characterization of ceramic matrix composites, their coatings, and their constituents. Efforts need to be coordinated with the Testing Working Group.

157

M&P Section Chapters are Informative and Could be Used by Researcher



Materials & Processes Content

Revision A (published 2017)

- (2) Introduction, History and Overview
- (3.1) CMC Systems, Processing, Properties & Applications
- (3.2) Fiber Reinforcement Types and Technology
- (3.3) Interphase / Interface Technology and Approaches
- (3.4) Fabrication and Forming of Fiber Architectures
- (3.5.1) External Protective Coatings for Non-Oxide CMCs
- (3.5.2) External Protective Coatings for Oxide CMCs
- (3.6) Characterization Methods
- (3.7) NDE Methods for CMCs
- (3.8) Machining
- (4) Quality Control of Production Materials and Processes
- (5) Applications, Case Histories, and Lessons Learned




- Significant improvements made in all sections
- Good advocacy from FAA/FAA CLEEN
- Good participation at Cocoa Beach Conf. (which has now become more Hypersonics focused)
- Did not maintain good momentum after Vol 5A published

158

5/9/2024

M&P Section Chapters are Informative and Could be Used by Aerospace, etc.

Materials & Processes Content

CMH17
COMPOSITE MATERIALS HANDBOOK

Revision B (planned updates for 2023 / 2024)

- Need additional help in these areas—want to improve those sections
- Progress made on Vol 5B

- 2.0 Introduction, History and Overview (updated with 35 additional references) Has gone through YP review.
- Hybrid SiC/SiC Composites (Slurry Cast MI SiC/SiC) (added to Chapter 6) Review status?
- Attachments (new content added to Chapter 6—needs to be reviewed by Chapter 6 WG Leads)
- (3.2) Status of Commercial SiC Fiber Types for High-Temperature CMC Applications (status: GE fiber production in the US)
- (3.3) Interphase/Interface Technology and Approaches (Multilayer fiber coating for Prepreg MI SiC/SiC-- patent)
- (3.4) Fiber Architectures: Use of large oxide fiber tows for reducing oxide CMC fabrication costs (Articles to reference and summarize?)
- (3.5.1) External Protective Coatings (coatings for high temperature SiC/SiC and CMAS research) Text and references for recent EBC development/studies will be added
- (3.6) Characterization Methods (review existing content) Could be improved—compare with PMC version.
- (3.7) NDE (add info. about NDE of shapes/components and identify most widely used techniques)
- (3.8) Machining (review existing content—list vendors? Create draft list—improve, discuss with testing)

159

Materials & Processes WG

CMH17
COMPOSITE MATERIALS HANDBOOK

Individuals interested in contributing to the CMC M&P Working Group should please contact:

Leanne Lehman, Boeing R&T: leanne.l.lehman@boeing.com
 Doug Kiser, NASA Glenn: james.d.kiser@nasa.gov

160

5/9/2024



Testing WG

Matt Opliger
Bob Zhou

181



CMC Testing WG

Vision:
To be the primary and authoritative source for recommended/ required methods for testing characterization of CMCs & their constituents

Goals:

- To identify appropriate existing consensus standard test methods (such as ASTM Standards) for CMCs and their constituent materials
- To assist in the identification/development of appropriate standard test methods for CMCs and their constituent materials, where no such standards exist

182

5/9/2024

CMC Testing WG – Overview

CMH17

COMPOSITE MATERIALS HANDBOOK

Handbook Sections – Part C. Testing:

- Chapter 8 – Thermo-Mechanical-Physical Test Methods – Overview
- Chapter 9 – Material Testing & Characterization for Submission of Data to CMH-17
- Chapter 10 – Evaluation of Reinforcements
- Chapter 11 – Evaluation of Matrix Materials
- Chapter 12 – Evaluation of Interface Material
- Chapter 13 – Evaluation of Composites
- Chapter 14 – Subcomponent Testing – Overview of Problem
- Chapter 15 – Machining and Grinding

Chapter	Status of Sections			
	Published (Rev A)	Draft in Progress	Yellow Pages	Reserved for Future Use
8	18			18
9	110			6
10			12	
11		12		
12				1
13	4	1	3	11
14				3
15				4

15 new sections
for Rev B

183

CMC Testing WG – Updates for Rev B

CMH17

COMPOSITE MATERIALS HANDBOOK

Chapter	Section	New/Revised	Scope	Targeted Yellow Page Ballot	Status	Priority
Chapter 10 – Evaluation of Reinforcements:	10.1 Introduction	New	New section	Q4 2022	Approved	3
	10.2 Physical Properties	New	New section	Q4 2022	Approved	3
	10.2.1 Filament Diameter	New	New section	Q4 2022	Approved	3
	10.2.2 Density of Fibers	New	New section	Q4 2022	Approved	3
	10.2.3 Electrical Resistivity	New	New section	Q4 2022	Approved	3
	10.2.4 Coefficient of Thermal Expansion	New	New section	Q4 2022	Approved	3
	10.2.5 Thermal Conductivity	New	New section	Q4 2022	Approved	3
	10.2.6 Specific Heat	New	New section	Q4 2022	Approved	3
	10.3 Mechanical Testing of Fibers	New	New section	Q4 2022	Approved	3
	10.3.1 Tensile Properties	New	New section	Q4 2022	Balloted - Needs minor clarification	3
	10.3.2 Fiber Creep /Creep Rupture Test	New	New section	Q4 2022	Approved	3
	10.3.3 Fiber Fatigue Test	New	New section	Q4 2022	Approved	3
	13.2 Fiber Volume Fraction	New	New section	Q3 2022	Approved	1
Chapter 13 – Evaluation of Composites:	13.10 Interlaminar Tension	New	New section	Q4 2022	Approved	1
	13.11 Notched Testing	Revised	Add new content for DHT, including new ASTM standard for CMCs	Q4 2022	Approved	1
	13.12 Interlaminar Fracture Toughness	New	New section	Q2 2024	Approved - Submitting New Changes for Ballot	1

Priority Scale

- 1 High
- 2 Medium-High
- 3 Medium
- 4 Medium-Low
- 5 Low

*Additionally, will align ASTM version/year referencing throughout the testing sections

164

5/9/2024

CMC Testing WG – Plans for New Sections							CMH#17 COMPOSITE MATERIALS HANDBOOK	
Chapter	Section	New/Revised	Scope	Targeted Yellow Page Ballot	Status	Priority		
Chapter 11 – Evaluation of Matrix Materials	11.1 Introduction	New	New section	Next Revision	In-Progress	5	1 2 3 4 5	Priority Scale High Medium-High Medium Medium-Low Low
	11.2 Mechanical Properties	New	New section	Next Revision	In-Progress	5		
	11.2.1 Tensile Properties	New	New section	Next Revision	In-Progress	5		
	11.2.2 Compressive Properties	New	New section	Next Revision	In-Progress	5		
	11.2.3 Flexural Properties	New	New section	Next Revision	In-Progress	5		
	11.2.4 Fracture Toughness	New	New section	Next Revision	In-Progress	5	6 7 8 9 10 11 12 13 14 15	
	11.2.5 Creep / Creep Rupture	New	New section	Next Revision	In-Progress	5		
	11.2.6 Fatigue	New	New section	Next Revision	In-Progress	5		
	11.3 Physical Properties	New	New section	Next Revision	In-Progress	5		
	11.3.1 Specific Heat	New	New section	Next Revision	In-Progress	5		
	11.3.2 Thermal Expansion	New	New section	Next Revision	In-Progress	5		
	11.3.3 Thermal Diffusivity and Conductivity	New	New section	Next Revision	In-Progress	5		
	13.3 CTE	New	New section	Next Revision	Planned	2		
	13.4 Thermal Conductivity	New	New section	Next Revision	Planned	2		
	13.5 Specific Heat	New	New section	Next Revision	In-Progress	1		
	13.7 Compression Testing	New	New section	Next Revision	In-Progress	1		
	13.8 Resins	New	New section	Next Revision	In-Progress	1		
Chapter 13 – Evaluation of Composites	13.13 Crack Growth	New	New section	TBD	Not Started	5		
	13.14 Creep Testing	New	New section	Next Revision	In-Progress	2		
	13.15 Fatigue Testing	New	New section	TBD	Not Started	3		
	13.16 TMF – Thermo-mechanical Fatigue	New	New section	TBD	Not Started	5		
	13.17 Wear Testing	New	New section	Next Revision	Planned	5		
	13.18 Bearing Testing	New	New section	TBD	Not Started	3		
	13.19 Biaxial Testing	New	New section	TBD	Not Started	5		

185

CMC Testing WG – Agenda

CMH17

COMPOSITE MATERIALS HANDBOOK

- Introductions
- Vision and Goals
- Overview of CMC Testing WG Sections (Volume 5, Part C, Chapters 8-15)
- Review and Discuss:
 - Finished Sections Requiring Changes and/or Balloting
 - Sections Currently being Worked
 - Future Plans

186

186

5/9/2024



AM Working Groups

167



Data Review WG

Facilitated by Michelle Man

168

5/9/2024

Data Review Working Group



- Goal:
 - Establishes data documentation requirements, develops formats for data presentation, and provides the final technical and editorial review of all data prior to inclusion in the Handbook.
- Objectives:
 - **Develop** data table **formats** including recommended reduced data for presentation.
 - Data reduction and **draft data tables** for the Handbook.
 - **Work with** potential **data sources** for the Handbook and review documentation/pedigree of potential data sets.
 - **Maintain** data section of the CMH17 AM volume.
 - Work with Statistics Working Group to ensure the methods used for data analysis are captured in the Statistics chapter.

169

Agenda



- Introduction:
 - What it means to be a DRWG member
 - Overview of Volume 7 content
- Content Development & Progress
 - Draft to date and work needed
- Available Data
- Call for Volunteers; members and chairs
- Work through Yellow Page comments

AM Data Review WG Session

- Wednesday April 24th
- 3:30 – 5:30 PM in
- Palomas/Coronado

170

85

5/9/2024



Design and Analysis WG

Elisa Buckner
Sung Park

171



Design and Analysis Working Group - Charter

Purpose and Expectations:

Establish design and analysis guidelines, methodologies, and basic engineering requirements to increase first-time success and enable substantiation and predictive capabilities for parts fabricated with polymer based additive manufacturing processes.

Objectives and Outcomes:

- Provide guidelines and requirements for the design and analysis of parts fabricated with polymer based additive manufacturing technologies.
 - Establish best practices for design definition and documentation.
 - Establish best practices for analytical verification methodologies and substantiation/prediction criteria.
 - Identify additional guidelines and requirements unique to specific processes.

Working Group Operations

- Monthly virtual meeting to review tasks.
- D&A Excel Task Tracker used for assigning tasks, keeping schedule.
- Confluence will be used for documenting final content.
- Decision making method will majority consensus of the group.

Working Group Leaders:

- Co-Chair – Elisa Buckner
- Co-Chair – Sung Park

Working Group Members:

Doug Hall	Charles Evans
Gregory Jones	Raymond McCauley
Marc Desmit	Martin White
Beth Clarkson	William Bielawski
Erdal Bayseckin	Pierre Harter
Cindy Ashforth	Nathan Ball
Matt Soja	Tommy Hyatt
Bijan Deris	Chul (Charles) Park
Linda Jahner	Bill Bihlman
Rick Cole	Jason Kapsner
Joseph Costanzo	Michael Puzin
Curtis Davies	Tim Spahr
Brian Kitt	Stefan Kloppenborg
Nav Murali	Eric Moyer
Michelle Man	Steve Ward

172

5/9/2024

D&A Overview of Content to Date			
CMH17 COMPOSITE MATERIALS HANDBOOK			
Chapter and Section	Title	Notes	Next Steps
11.1	Introduction		
11.1.1	When to Utilize AM	Submitted to YP	Re-submit to YP
11.1.2	Which AM Material/Process to Choose?	Submitted to YP	Re-submit to YP
11.1.3	Decision Tree and Qual Matrix	Submitted to YP	Re-submit to YP
11.1.4	AM Risk Assessment	Submitted to YP	Re-submit to YP
11.2	Definition of Requirements		
11.2.1	Establishment of Design Requirements	Submitted to YP	Re-submit to YP
11.2.2	Guidance for Material and Process Specifications	Submitted to YP	Re-submit to YP
11.2.3	Considerations Related to Part Criticality	Submitted to YP	Re-submit to YP
11.2.4	Planning for Substantiation/Verification	Submitted to YP	Re-submit to YP
11.2.5	Data Collection and Categorization by Application	Submitted to YP	Re-submit to YP
11.2.5.1	Table Format of Excel sheet		
11.3	AM Component Design and Analysis Considerations, Options, Methods		
11.3.1	Design for AM	In work	Submit to YP
11.3.2	Analysis for AM	Submitted to YP	Awaiting comments
11.4	Design Verification for Material and Component		
11.4.1	Point Design Verification framework	Submitted to YP	Awaiting comments
11.4.2	Building Block Part Verification framework	In work	Submit to YP

173

Work That Needs to Be Done	
CMH17 COMPOSITE MATERIALS HANDBOOK	
• Submit 2 more subsection to first round of YP. • Disposition of YP2 and YP3 comment and resubmittal. • Discussion on content for Chapter 12.	

174

87

5/9/2024

WG Session Agenda

- Introductions
- FFF Design Content Review
- PBF Design Content Review
- Content comparison between ASTM Design Guide and CMH-17
- YP Comments Review
- Cross Working Group Collaboration Topics



CMH-17
COMPOSITE MATERIALS HANDBOOK

175



CMH-17
COMPOSITE MATERIALS HANDBOOK

Guidelines WG

Rick Cole
Bijan Deris

176

5/9/2024

AM Guidelines Working Group - Charter

CMH-17

COMPOSITE MATERIAL HANDBOOK

Purpose and Expectations:

Coordinate activities across all CMH-17 AM Working Groups, to address overlaps and gaps in AM Volume content, to ensure the AM Volume fulfills its vision of being the authoritative reference for engineering guidance on material properties, design, manufacture, and application of non-metallic additively manufactured parts for regulated applications.

Objectives and Outcomes:

- Coordinate AM Working Groups to resolve overlaps and gaps in content.
- Coordinate AM Volume Table of Contents to ensure rational organization.
- Prepare introductory and overview content for AM Volume to establish guidelines for handbook users:
 - FRONT MATTER
 - Chapter 1 CMH-17 AM INTRODUCTION AND GUIDELINES
 - Chapter 2 CHARACTERIZATION CONSIDERATIONS

Plan for Progress:

- Coordinate overall outline for the AM Volume
- Coordinate definitions for common terms across Chapters
- Prepare introductory and over-arching content

Working Group Operations:

WAS >> Virtual meeting 11:00am ET on
2nd Thursday of each month
IS NOW >> TBD

Working Group Leaders:

- Co-Chair – Rick Cole
- Co-Chair – Bijan Deris

Working Group Members:

Cindy Ashforth	Abraham Avalos Postigo
Rick Cole	Stefan Kloppenborg
Bijan Deris	Chul (Charles) Park
Jesse Boyer	Matthew Soja
Elisa Buckner	Alexandros Stefanakis
Sung Park	Beth Clarkson
Joseph Costanzo	Jeffrey Luo
Brian Kitt	Eduardo Rigo
Michelle Man	Nicole Stahl
Eric Moyer	Danielle Stephens
Nav Muraliraj	Stephen Ward
Chloe McGuffin	Andrew Pringle
Royal Lovingfoss	Fei Liang

AM Guidelines Working Group - Meeting		CMH-17 COMPOSITE MATERIAL HANDBOOK
Wednesday, 24-April-2024, 10:15am – 12:15pm		
CALL TO ORDER		Finish by 10:15am
Content Preparation:		
Cole	Fall 2023 Yellow Page #1 Results Review	10:30am
Cole	Chapter 1 – Section Status Review	
	• Review status sections 1.1 through 1.8 • Review bulk of 1.9 Definitions • Discuss definition for “Build”	11:00am
Deris	Chapter 2 – Section Status Review	
	• Review status sections 2.1, 2.2, 2.3 • Determine plan for 2.4 Data Classes • Determine plan for 2.5 Qualification vs Equivalency vs Interchangeability • Determine plan for 2.6 Recommended Test Matrices >> Stefan & Rick to draft • Determine plan for 2.7 Data Substantiation for Use of CMH-17 Basis Values >> Move to Design & Analysis or Testing chapter ??	11:30am
		178

5/9/2024

AM Guidelines Working Group - Meeting



Wednesday, 24-April-2024, 10:15am – 12:15pm (cont'd)

Finish by

New Business:		
Cole	Title for CMH-17 Volume 7	11:45am
Cole	Reset monthly GWG meeting date/time	
Cross-WG Coordination Activities:		
Deris	Statistics support in drafting content for 2.5.1 Qualification and 2.5.2 Equivalency	
Cole	Statistics support in drafting 2.6 Recommended Test Matrices	
Deris	Guidelines support to M&P in drafting content on sources of variability	
Cole	REMINDER: All WG Chairs to provide inputs on Definitions + Symbols and Abbreviations for inclusion in Chapter 1	
ADJOURN		12:15pm

179



Materials and Process WG

Fei Liang

Chloe McGuffin

Eric Moyer

180

90

5/9/2024

Non-Metallic AM Material & Process WG

CMH-17

COMPOSITE MATERIALS HANDBOOK

CMH-17 Non-Metallic AM Material & Process WG – Spring 2024 Joint Coordination Meeting
Wednesday, April 24th @ 1:15pm – Room 2

Material & Process WG group meets the 2nd Thursday of the Month @ 10am EST / 7am PST
Next Meeting (Virtual) May 2nd @ 10am EST / 7am PST

Co-Chairs:

Chloe McGuffin – Markforged
Eric K Moyer – Boeing
Fei Liang - Gulfstream

181

Non-Metallic AM Material & Process WG

CMH-17

COMPOSITE MATERIALS HANDBOOK

CMH-17 Non-Metallic AM Material & Process WG – Spring 2024 Joint Coordination Meeting
Wednesday, April 24th @ 1:15pm – Room 2

Material & Process Working Group Objectives:

- Provide the framework of the overall process flow for polymer AM material qualification, machine qualification, facility qualification and part qualification.
- Provide guidance on key performance variable (KPV) identification and necessary KPV controls for polymer AM material qualification, machine qualification, facility qualification and part qualification.
- Provide guidance on employee training and quality assurance procedures for polymer AM material qualification, machine qualification, facility qualification and part qualification.
- Provide guidance on the use and incorporation of CMH-17 AM volume published data and processes into a company's production system.
- Update sections accordingly when developments in new feedstock materials and/or new polymer AM fabrication processes become available and mature for use in regulated applications

182

91

5/9/2024

Non-Metallic AM Material & Process WG

CMH-17 Non-Metallic AM Material & Process WG – Spring 2024 Joint Coordination Meeting
Wednesday, April 24th @ 1:15pm – Room 2

Material & Process Working Group Key Future Work:

- Writing content for Selective Laser Sintering section(s) – need volunteers
- Complete terminology, abbreviations & nomenclature section(s) for M&P

Material & Process Working Group Planned Meeting Agenda:

- Review M&P Chapter/Section progress tracker
- Fall YP2 Yellow Page Summarization w/ Proposed Disposition

CMH17
COMPOSITE MATERIALS HANDBOOK

183

Statistics WG

Elizabeth Clarkson
Lindsay Jones
Stefan Kloppenborg

CMH17
COMPOSITE MATERIALS HANDBOOK

184

92

5/9/2024



Testing WG

Joe Costanzo
Brian Kitt
Royal Lovingfoss

185



Testing Working Group

- **Objective:** Give guidance on appropriate test methods and test conditions for use with AM materials while taking into account, material type, machine capabilities, process information, industry desired data, statistical analysis requirements, and available standards. Test standard creation and/or appropriate changes may be necessary by working with applicable industry leaders and standards organizations to ensure the test method is understood, usable, appropriate, and repeatable for use with AM materials. Working with other groups of the CMH17 AM community to ensure proposed test methods are applicable for their purposes and can help in harmonizing all aspects that control a data set prior to submission and inclusion into the CMH17 AM volume.
- **Working Group Chairs:** Royal Lovingfoss-NIAR, Brian Kitt-Spirit, Joe Costanzo-Boeing
- **Recap:**
 - Sections 7.1 through 7.2.4 (Introduction) are written and submitted to YP.
 - Sections 3.1 through 3.2.1 (Evaluation of feedstock) are written and submitted to YP.
 - Sections 9.8 and 9.11 (Tensile testing and Shear testing) are in draft and will be headed to "internal" review by the group during the WG working group meeting.
 - Testing AM Outline was updated with new section numbers and header/titles.
 - Multiple sections were removed from the Testing AM Outline and placed in different areas

186

93

5/9/2024

Testing Working Group

CMH17

COMPOSITE MATERIALS HANDBOOK

• Recap Continued:

- Section 7.3 (Data Reduction and Documentation), will most likely be moved. A discussion with Statistics AM WG needs to take place to make a final decision on where it will be placed and how the testing section should note any new placement location. Would like to have that discussion this week.

• Agenda:

- Go through the outline, point out changes that have been made: some sections have been moved, numbering has been updated, notes have been updated.
- Update the items that were previously assigned but not completed (for example, things assigned to Charles Park should probably be re-assigned).
- We will go through the roster and make sure we have all up to date contact information.
- Rick Cole to present on modulus calculations.
- Review any section updates or new content ready for WG review. I think we will have Tensile Testing and Shear Testing to go over.
- Deep dive discussion of sub-component and component testing (best practices). We will need to decide where we want to place this in the outline and what “types” of testing we want to discuss, and what types of things need to be thought about when thinking of testing these types of articles.
- Revitalize the WG members, look to assign more sections for authoring. Recruiting new members. We will ask each member to try and get one more new member to join who is willing to write.

187

Lunch Break

12:15 pm – 1:15 pm

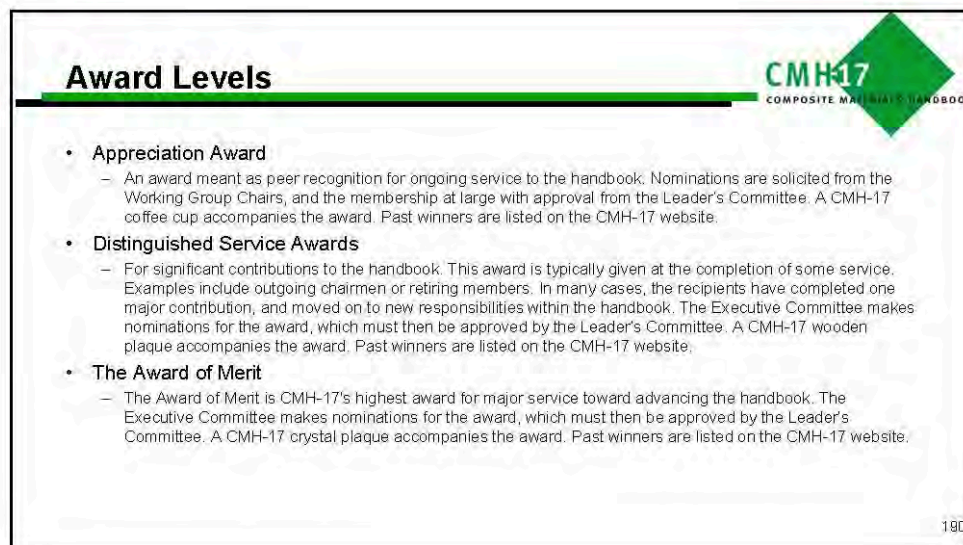
CMH17

COMPOSITE MATERIALS HANDBOOK

188

94

5/9/2024



95

5/9/2024

Award Ceremony



- Please come up to receive your award
 - Award of Merit
 - Distinguish Service Award
- Please rise in place
 - Appreciation Award
 - Come by the Check-In desk for your award
 - Group picture at Social Hour

191

Award of Merit



Steve Ward

- Nominated by Carl Rousseau and Rick Cole
- Over 25 years of contributions to CMH-17
- Became a PMC Guidelines WG co-chair in 2001
 - Contributions in authoring/updating content in: Damage Tolerance; Vol 1 roadmaps, test matrices, and Failure Criteria; documentation and specification requirements for Vol 2; reorganization of Vol 1 & 2 subsections; rewriting various chapters in Vol 3; overall content review of entire volume.
- Contributed in CMH-17 organization and planning as an Executive Leaders Member

192

5/9/2024

Distinguish Service Award

CMH17
COMPOSITE MATERIALS HANDBOOK

Rachael Andrulonis

- Nominated by John Tomblin

183

Distinguish Service Award

CMH17
COMPOSITE MATERIALS HANDBOOK

Howard Creel

- Nominated by Dan Ruffner
- Co-chair of BPTG beginning 2016
- Steadfast leadership
 - Identifying content coverage for bonding process section
 - Leading experts and overcoming challenges in content development

184

5/9/2024

Appreciation Award



Nominated by Howard Creel

- Dan Ruffner
- Lisa McHugh
- Chad Franks
- Molly Stone
- Scott Leemans
- Kara Storage
- Ashley Tracey
- Will Grace

Nominated by Cindy Ashforth and Larry Ilcewicz

- Charlie Seaton

Nominated by Ronald Krueger

- Laura Carreras
- Albert Turon
- Carlos G. Davila

Nominated by Larry Gintert

- Nihar Desai
- David Stone
- Paul Brey
- Brock Strunk
- Eric Stenne
- Steve Starnes

185



CMH-17 WG Reorganization

98

5/9/2024

Outline

CMH-17

COMPOSITE MATERIALS HANDBOOK

- Reorganization Goals
- Working Group and Task Group Definitions
 - Current Arrangement and Discussion Points for Future Consolidation
- Content Development Process
- Future Publications
- Other Topics
- This Week Activities
- Next Actions

Reorganization Goals

CMH-17

COMPOSITE MATERIALS HANDBOOK

- We plan to investigate and implement several changes to the CMH-17 organization and publication
 - ✓ 1. Combine all four coordination groups into one CMH-17 group
 - ✓ 2. Hold meetings semi-annually, in person in the spring and virtually in the fall
 - 3. Incrementally combine and reduce the number of "standing" working groups
 - 4. Increase the use of task groups to write specific content (beyond current Vol 3, 5, and 7 releases)
 - 5. Change publication methods to: (a) better support quicker electronic release cycles; and (b) improve content arrangement and availability
 - 6. Revamp yellow page process to simplify and automate balloting procedures and publication
 - 7. Consider different membership structure
 - 8. Investigate becoming an ANSI-certified SDO, or joining an SDO

} Accomplished for this meeting, but need to evaluate if it's effective and desirable for the future

5/9/2024

Future WG and TG Roles and Responsibilities

CMH-17

COMPOSITE MATERIALS HANDBOOK

Working Group

- "Own" handbook content
- Permanent, standing group
- May be a joint (multiple material systems) or material system-specific group
- Maintain institutional knowledge of the handbook content
- Identify new or revised content needs
- Write updates for any topics that are wholly within that WG purview
 - Editorial corrections
 - Relevant technical content that doesn't require specialist input from outside the WG (eg, engine group probably doesn't need a TG, Guidelines wouldn't need a TG to update definitions or abbreviations)
- Remove or caveat obsolete content
- Hold sessions at the semi-annual CMH-17 meeting; may or may not require WG meetings between CMH-17 meetings

Task Group

- Temporary multi-discipline group formed to efficiently write specific content
- Expected to draw members from across the organization (or new members) with the required skill and knowledge to develop the content, regardless of their existing WG membership
- Formed during coordination meetings where TG leaders are selected, members solicited, and a timeline proposed
- Report out at the semi-annual CMH-17 meeting; may or may not have a session at the CMH-17 semi-annual meeting; expected to hold TG meetings between CMH-17 meetings

VOLUME 1	VOLUME 3	VOLUME 5	VOLUME 6	VOLUME 7
1 GENERAL INFORMATION	1 GENERAL INFORMATION	1 CMH-17 GUIDELINES AND PROCEDURES	1 GENERAL INFORMATION	1 CMH-17 AM INTRODUCTION AND GUIDELINES
2 GUIDELINES FOR PROPERTY TESTING OF COMPOSITES	2 INTRODUCTION TO COMPOSITE STRUCTURE DEVELOPMENT	2 INTRODUCTION, HISTORY AND OVERVIEW	2 GUIDELINES FOR PROPERTY TESTING	2 CHARACTERIZATION CONSIDERATIONS
3 EVALUATION OF REINFORCEMENT FIBERS	3 AIRCRAFT STRUCTURE CERTIFICATION AND COMPLIANCE	3 PROCESSING, CHARACTERIZATION, AND MANUFACTURING	3 MATERIAL DATA	3 EVALUATION OF FEEDBACK
4 MATRIX CHARACTERIZATION	4 BUILDING BLOCK APPROACH FOR COMPOSITE STRUCTURES	4 QUALITY CONTROL OF PRODUCTION MATERIALS AND PROCESSES	4 FABRICATION OF SANDWICH STRUCTURES	4 PROCESSING AND MANUFACTURING
5 PREPREG MATERIALS CHARACTERIZATION	5 MATERIALS AND PROCESSES - THE EFFECT OF VARIABILITY ON COMPOSITE PROPERTIES	5 APPLICATIONS, CASE HISTORIES AND LESSONS LEARNED	5 QUALITY CONTROL	5 QUALITY CONTROL OF PRODUCTION MATERIALS AND PROCESSES
6 LAMINA, LAMINATE, AND SPECIAL FORM CHARACTERIZATION	6 QUALITY CONTROL OF PRODUCTION MATERIALS AND PROCESSES	6 DESIGN AND ANALYSIS	6 DESIGN AND SUBSTANTIATION FOR SANDWICH STRUCTURES	6 MATERIAL TESTING & CHARACTERIZATION FOR SUBMISSION OF DATA TO CMH-17
7 STRUCTURAL ELEMENT CHARACTERIZATION	7 DESIGN OF COMPOSITES	7 MAINTAINABILITY AND SUPPORTABILITY	7 INTERNAL LOADS AND STRESSES	7 PROPERTY TESTING OF ADDITIVELY MANUFACTURED MATERIALS
VOLUME 4	8 ANALYSIS OF LAMINATES	8 THERMO-MECHANICAL PHYSICAL TEST METHODS - OVERVIEW	8 ANALYSIS AND STRUCTURAL DESIGN	8 STATISTICAL METHODS
1 GUIDELINES	9 STRUCTURAL STABILITY ANALYSES	9 MATERIAL TESTING & CHARACTERIZATION FOR SUBMISSION OF DATA TO CMH-17	9 DAMAGE ASSESSMENT OF SANDWICH STRUCTURES	9 EVALUATION OF AM PARTS
2 DESIGN GUIDELINES FOR METAL MATRIX MATERIALS	10 DESIGN AND ANALYSIS OF BOLTED JOINTS	10 EVALUATION OF REINFORCEMENTS	10 SUPPORTABILITY	10 ELEMENT LEVEL TESTING
3 MATERIALS PROPERTIES DATA	11 DESIGN AND ANALYSIS OF BOLTED JOINTS	11 EVALUATION OF MATRIX MATERIALS	11 SANDWICH DESIGN CASE STUDIES	11 DESIGN AND ANALYSIS
APPENDIX A TYPICAL PUSHOUT TEST DATA	12 DAMAGE RESISTANCE, DURABILITY, AND DAMAGE TOLERANCE	12 EVALUATION OF INTERFACE MATERIAL	12 SUPPORTING DATA AND DISCUSSIONS	12 MAINTAINABILITY AND SUPPORTABILITY
APPENDIX B RAW DATA TABLES FOR MATRIX MATERIALS	13 DEFECTS, DAMAGE, AND INSPECTION	13 EVALUATION OF COMPOSITES		13 APPLICATIONS, CASE HISTORIES, AND LESSONS LEARNED
APPENDIX C RAW DATA TABLES FOR METAL MATRIX COMPOSITE MATERIALS	14 SUPPORTABILITY, MAINTENANCE, AND REPAIR	14 SUBCOMPONENT TESTING - OVERVIEW OF PROBLEM		14 AM PROPERTY DATA
	15 THICK-SECTION COMPOSITES	15 MACHINING & GRINDING	VOLUME 2	
	16 CRASH WORTHINESS AND ENERGY MANAGEMENT	16 DATA SUBMISSION, FORMAT AND REQUIREMENTS	1 GENERAL INFORMATION	
	17 STRUCTURAL SAFETY MANAGEMENT	17 STATISTICAL METHODS	2 CARBON FIBER COMPOSITES	
	18 ENVIRONMENTAL MANAGEMENT	18 OMC PROPERTY DATA	3 BORON FIBER COMPOSITES	
	19 SPACE APPLICATIONS	19 ENGINE APPLICATIONS	4 GLASS FIBER COMPOSITES	
	20 ENGINE APPLICATIONS		5 QUARTZ FIBER COMPOSITES	
			APPENDIX A1 CMH-17A DATA	

Current Working Outlines

5/9/2024

Topic: Introduction			
CMH17 COMPOSITE MATERIALS HANDBOOK			
Volume	Chapter	Current WG	Future WG
1	1 General Information	PMC Guidelines (+M&P, Specialized Data)	Joint Guidelines
2	1 General Information (1.1-1.4, 1.7, 1.8, 1.9)	PMC Guidelines (+Data Review)	Joint Guidelines
3	1 General Information	PMC Guidelines	Joint Guidelines
4	1 Guidelines (1.1, 1.2)	N/A	Joint Guidelines
5	1 Guidelines and Procedures 2 Introduction, History and Overview	CMC Guidelines CMC M&P	Joint Guidelines ???
6	1 General Information	Sandwich	Joint Guidelines
7	1 Guidelines and Procedures	AM Guidelines	Joint Guidelines

- **Proposal: Joint Guidelines WG for all material systems / volumes**
 - They own Chapter 1 in all volumes (handbook introduction, overview, purpose, scope, definitions, abbreviations, etc.)
 - They filter work proposals and identify the proper WG(s) who owns the content and if a new WG or TG is needed (will discuss later when we get to Content Development Process)
- **Vol 5 has a unique chapter on "Introduction, History and Overview"**
 - Should other materials have something similar?
 - Who should own the content?

Topic: Guidelines for Property Testing			
CMH17 COMPOSITE MATERIALS HANDBOOK			
Volume	Chapter	Current WG	Future WG
1	2 Guidelines for Property Testing of Composites	PMC Guidelines (+Spacecraft)	
2	N/A		
3	N/A		
4	N/A		
5	8 Thermo-Mechanical-Physical Test Methods – Overview	CMC Testing	
6	N/A	Sandwich	
7	2 Characterization Considerations	AM Guidelines	

- **Includes building block approach, test program planning, and recommended test matrices**
 - Although Vol 6 Chapter 2 has this title, the content focuses on testing of individual sandwich components (e.g., "evaluation of core materials," "evaluation of face sheet properties," etc., not overall test planning the way Chapter 2 appears in Vol 1 and 7 and Chapter 8 appears in Vol 5)
- **Who should own this? A joint group? A different group for each material system?**
 - If Guidelines becomes a joint group, is there also a need for individual material system-specific guidelines WG to own content such as this?

5/9/2024

Topic: Testing

Volume	Chapter	Current WG	Future WG
1	3 Evaluation of Reinforcement Fibers 4 Matrix Characterization 5 Prepreg Materials Characterization 6 Lamina, Laminate, and Special Form Characterization 7 Structural Element Characterization	PMC Testing	
2	N/A		
3	N/A		
4	1 Guidelines (1.3-1.10)	N/A	
5	3 Processing, characterization and manufacturing (3.6) 10 Evaluation of Reinforcements 11 Evaluation of Matrix Materials 12 Evaluation of Interface Materials 13 Evaluation of Composites 14 Subcomponent Testing – Overview of Problem 15 Machining & Grinding (assume this is for test specimens)	CMC M&P CMC Testing CMC Testing CMC Testing CMC Testing CMC Testing CMC Testing	Chapters 11, 12, 14 and 15 have no content
6	2 Guidelines for Property Testing	Sandwich*	*See next slide
7	3 Evaluation of Feedstock 6 Material Testing & Characterization for Submission of Data to CMH-17 7 Property Testing of Additively Manufactured Materials 9 Evaluation of AM Parts 10 Element Level Testing	AM Testing	

- WG defines test methods at all levels of the building block, although coupon-level tests have the most information, due to their standard methods and requirements to develop handbook datasets
- Can this be managed by a joint group, or should each material system have a WG?

Special Case: Sandwich Structure

CMH-17
COMPOSITE MATERIALS HANDBOOK

- Spoiler Alert: Sandwich WG currently owns all of Volume 6, yet that volume has a full range of topics including M&P, testing, design, analysis, repair, etc.
- Is it reasonable to have one WG for all of that, or should it be divided?
 - This is a matrix problem that we can slice and dice multiple ways
 - Option 1 is to create TG for Volume 6, but keep the sandwich WG as the content "owner" except for Chapter 1
 - Option 2 is to use existing topical WG to own all the content and disband the sandwich WG
- This will be discussed in the Sandwich WG sessions Wednesday afternoon

Option 1 (Keep Sandwich WG as overall owner, with multiple TG)	V6 Chapter	Option 2 (Disband Sandwich WG and have other WG own content)
Guidelines WG	1 General Information	Guidelines WG
Sandwich TG 1	2 Guidelines For Property Testing	Testing WG
	3 Material Data	Data Review WG
Sandwich TG 2	4 Fabrication Of Sandwich Structures	M&P WG
	5 Quality Control	M&P WG
Sandwich TG 4	6 Design And Substantiation For Sandwich Structures	D&A WG
Sandwich TG 3	7 Internal Loads And Stresses	D&A WG
	8 Analysis And Structural Design	D&A WG
Sandwich TG 4	9 Damage Assessment Of Sandwich Structures	Supportability WG
Sandwich TG 5	10 Supportability	Supportability WG
	11 Sandwich Design Case Studies	D&A WG
Sandwich TG 3	12 Supporting Data And Discussions	D&A WG

The sandwich TG are a firm proposal. The WG are just examples of how things could be divided into existing or future topic-based WG.

5/9/2024

Topic: Submitting Data

CMH-17

COMPOSITE MATERIALS HANDBOOK

Volume	Chapter	Current WG	Future WG
1	N/A		
2	1 General Information (1.5, 1.6, 1.10-1.12)	PMC Data Review (+M&P, Testing)	
3	N/A		
4	N/A		
5	8 Material Testing and Characterization for Submission of Data to CMH-17 16 Data Submission, Format and Requirements	CMC Testing CMC Data Review	
6	2 Guidelines for Property Testing (2.2)	Sandwich	
7	6 Material Testing & Characterization for Submission of Data to CMH-17	AM Testing (6.1-6.4) and AM Data Review (6.5)	

- A specific subset of information that defines requirements for material to be included in the handbook
 - May include requirements for M&P specs/controls, may define test requirements, or may only discuss data requirements and presentation
- Currently managed by a variety of WG Should this be standardized across the material systems? Should it be a joint group? Individual groups?

Topic: Statistics

CMH-17

COMPOSITE MATERIALS HANDBOOK

Volume	Chapter	Current WG	Future WG
1	8 Statistical Methods	PMC Statistics	Joint Statistics
2	N/A		
3	N/A		
4	1 General (1.11)	N/A	
5	17 Statistical Methods	CMC Data Review	Joint Statistics
6	N/A		
7	8 Statistical Methods	AM Statistics	Joint Statistics

- Propose that this be managed by a single joint WG, as the statistical principles are common across the material systems, even when sources of variability differ, and some details may be different

103

5/9/2024

Topic: Material Data **CMH17**
COMPOSITE MATERIALS HANDBOOK

Volume	Chapter	Current WG	Future WG
1	N/A		
2	2 Carbon Fiber Composites 3 Boron Fiber Composites 4 Glass Fiber Composites 5 Quartz Fiber Composites Appendix A1 CMH-17A Data	PMC Data Review	
3	N/A		
4	3 Materials Property Data Appendix A Typical Pushout Test Data Appendix B Raw Data Tables for Matrix Materials Appendix C Raw Data Tables for Metal Matrix Composite Materials	N/A	
5	18 CMC Property data	CMC Data Review	
6	3 Material Data	Sandwich	
7	14 AM Property Data	AM Data Review	

- This WG has a different process for approving content than other yellow pages to ensure proper data pedigree
- Should this be a joint group, or a different group for each material system?

Topic: Processing and Manufacturing **CMH17**
COMPOSITE MATERIALS HANDBOOK

Volume	Chapter	Current WG	Future WG
1	N/A		
2	N/A		
3	5 Materials and Processes – the effect of variability on composite properties 6 Quality Control of Production Materials and Processes	PMC M&P PMC M&P	
4	N/A		
5	3 Processing, Characterization and Manufacturing (3.1-3.5) 4 Quality Control of Production Materials and Processes	CMC M&P CMC M&P	
6	4 Fabrication of Sandwich Structures 5 Quality Control	Sandwich Sandwich	
7	4 Processing and Manufacturing 5 Quality Control of Production Materials and Processes	AM M&P AM M&P	

- **Currently each material system has their own M&P WG**
 - Should they be combined?
 - Should Sandwich have a separate Sandwich M&P WG or TG?

104

5/9/2024

Topic: Design

CMH17

Volume	Chapter	Current WG	Future WG
1	N/A		
2	N/A		
3	2 Introduction to Composite Structure Development 7 Design of Composites 10 Design and Analysis of Bonded Joints (10.1-10.3) 11 Design and Analysis of Bolted Joints (11.1-11.3)	PMC Guidelines	
4	2 Design Guidelines for Metal Matrix Materials (partial 2.1-2.3)	N/A	
5	6 Design and analysis (6.1-6.3)	CMC D&A	
6	6 Design and Substantiation for Sandwich Structures (6.1, 6.2) 8 Analysis and Structural Design (8.3-8.6)	Sandwich	
7	11 Design and Analysis (partial)	AM D&A	

- Design content is scattered throughout Volume 3, but more concise in the other volumes
- Some design content is often combined with analysis
- V3C7 could be applicable to other material systems, parts and applications
- V3C2 is written for PMC, but could be generalized for other material systems
- Should Sandwich have a separate specific WG or TG for this topic?
- How do we want to manage this moving forward? Will not be part of Joint Guidelines

Topic: Structural Substantiation and Analysis

Volume	Chapter	Current WG	Future WG
1	N/A		
2	N/A		
3	3 Aircraft Structure Certification and Compliance 4 Building Block Approach for Composite Structures 8 Analysis of Laminates 9 Structural Stability Analysis 10 Design and Analysis of Bonded Joints (10.4-10.6) 11 Design and Analysis of Bolted Joints (11.4-11.6) 12* Damage Resistance, Durability, and Damage Tolerance 14* Supportability, Maintenance, and Repair 15 Thick-Section Composites	PMC Guidelines PMC Guidelines PMC Guidelines PMC Guidelines PMC Guidelines PMC Guidelines PMC DT (some DD)** PMC Supportability PMC Specialized Data	
4	2 Design Guidelines for Metal Matrix Materials (partial 2.1-2.3)	N/A	
5	3 Processing, Characterization and Manufacturing (3.8) 6 Design and analysis (6.3-6.5) Appendix A Derivation of the Residual Strength Reduction Expressions for LCF and Rupture Loadings	CMC M&P CMC D&A CMC D&A	
6	6 Design and Substantiation for Sandwich Structures (6.3, 6.4) 7 Internal Loads and Stresses 8 Analysis and Structural Design (8.1, 8.2, 8.6) 9 Damage Assessment of Sandwich Structures	Sandwich	
7	11 Design and Analysis (partial)	AM D&A	

*This chapter could go in multiple categories

** These are both task groups. In the future we should either identify an existing WG or change one or both of the TG into WG

- Analysis and substantiation content is scattered throughout Volume 3, but more concise in the other volumes
 - Is it possible our content is out of balance in this subject?
- Design content is often combined with analysis
- V3C3 could be applicable to other material systems
- V3C4 Building Block Approach is written for PMC, but all other material systems have similar content Can/Should it be combined?
- Should Sandwich have a separate specific WG or TG for this topic?
- How do we want to manage this moving forward? Will not be part of Joint Guidelines

105

5/9/2024

Topic: Inspection and Maintenance				
CMH17 COMPOSITE MATERIALS HANDBOOK				
Volume	Chapter	Current WG	Future WG	
1	N/A			
2	N/A			
* This chapter could go in multiple categories	12* Damage Resistance, Durability, and Damage Tolerance	PMC DT		
	13 Defects, Damage and Inspection	PMC DT		
	14 Supportability, Maintenance, and Repair	PMC Supportability		
4	N/A			
5	3 Processing, characterization and manufacturing (3.7)	CMC M&P		
	7 Maintainability and Supportability	CMC D&A		
6	10 Supportability	Sandwich		
7	12 Maintainability and Supportability	AM D&A		

- Inspection and Maintenance is related to damage tolerance for numerous damage threats (environmental defects, corrosion, manufacturing escapements, all categories of accidental factory/field damage, fatigue)
- Currently owned by a variety of WG
 - Should they be combined into one or more WG dedicated to this topic?
 - Should Sandwich have a separate specific WG or TG for this subject?

Topic: Applications				
CMH17 COMPOSITE MATERIALS HANDBOOK				
Volume	Chapter	Current WG	Future WG	
1	N/A			
2	N/A			
3	19 Space Applications	Space		
	20 Engine Applications	Engine		
4	2 Design Guidelines for Metal Matrix Materials (2.4)	N/A		
5	5 Applications, Case Histories and Lessons Learned	CMC M&P		
	19 Engine Applications	Engine		
6	11 Sandwich Design Case Studies	Sandwich		
7	13 Applications, Case Histories, and Lessons Learned	AM D&A		

- Recommend keeping separate WG that own content for applications such as Space, Engine, and Interiors
 - Applications are likely to cover multiple material systems
- CMC, Sandwich and AM have "case histories and lessons learned" that are not segregated that way in PMC
 - SoBR, Design, and other V3 chapters have examples/case histories
 - How do we want to organize this in the future and how will we manage the content?

5/9/2024

Special Topics			
Volume	Chapter	Current WG	Future WG
1	N/A		
2	N/A		
3	12* Damage Resistance, Durability, and Damage Tolerance 16 Crashworthiness and Energy Management 17 Structural Safety Management 18 Environmental Management	PMC DT (some DD)** PMC Crashworthiness PMC Safety Management PMC M&P	** These are both task groups. In the future we should either identify an existing WG or change one or both of the TG into WG
4	N/A		
5	N/A		
6	12 Supporting Data and Discussions	Sandwich	
7	N/A		

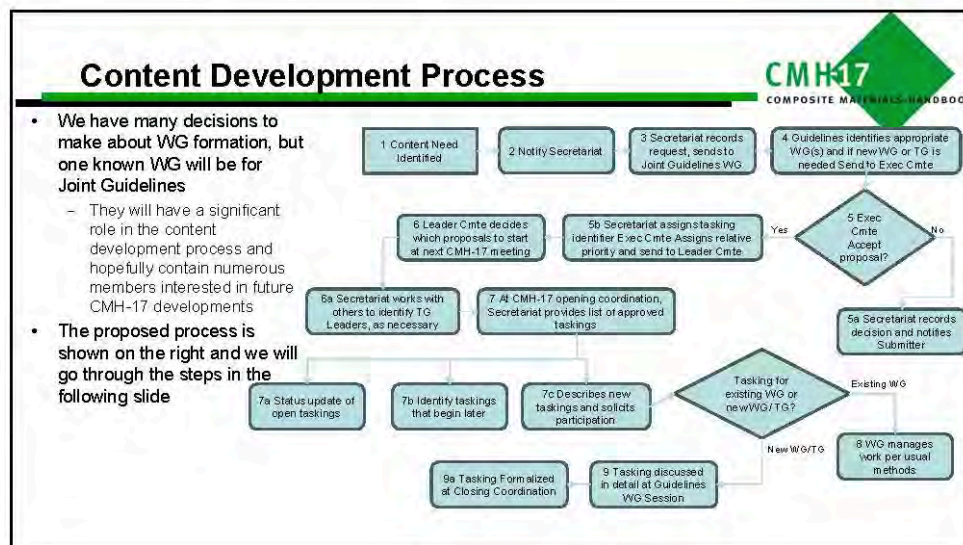
* This chapter could go in multiple categories

• Volume 3 has chapters with content that is not segregated in the other volumes

- In some cases, information on these topics is integrated with other chapters, but for the others there is no similar information
- Is the content applicable to other materials, or can it be generalized?
- Should these be joint WG?

• Sandwich Ch 12 may align with another topic

• Will other volumes have "special topics" in the future outside of applications?



107

5/9/2024

Content Development Process

CMH17

COMPOSITE MATERIALS HANDBOOK

1. Any WG or individual identifies the need for new or revised content or, obsolete content that should be removed or given a caveat
2. Submit proposal to the Secretariat
3. The Secretariat records the proposal and sends to the (Joint) Guidelines WG
4. The Guidelines WG identifies the appropriate WG(s) who owns the content and identifies if a multi-discipline TG or new WG is needed
5. Guidelines brings the proposal to the Exec Committee who decides whether to approve the proposal
 - a. If not approved, the Secretary records the decision and notifies the Submitter
 - b. If approved, the Exec Committee assigns a relative priority to the task and the Secretariat provides a tasking identifier
6. The Leader Committee decides which proposals will be started at the next semi-annual meeting
 - a. The Secretariat will work with the Leader Committee, the Exec Committee, and the Submitter to identify new WG/TG leaders prior to the next semi-annual meeting, as necessary
7. At the semi-annual meeting opening coordination session, the secretariat provides a list of all taskings
 - a. Status updates of active taskings
 - b. Identify tasks that will begin later (i.e., other approved proposals)
 - c. Describe new taskings that will begin now and request participants
8. If the tasking is assigned to a current WG, they will begin work and manage per their usual methods
9. If the tasking is assigned to a new TG or WG, the tasking will be discussed in detail at the Guidelines WG session
 - a. The tasking will be formalized at the closing coordination meeting with TG/WG leaders, membership roster, identified sections, and proposed timeline

Future Publication

CMH17

COMPOSITE MATERIALS HANDBOOK

- **Nothing Changes until Volume 3 Rev H, Volume 5 Rev B and Volume 7 Initial Release are published in their current volume formats (not waiting for V6 Rev A)**
 - Beginning to track metadata to identify author (for internal records only) and date a section was written (to be added to future publications)
- **Vision for future publications:**
 - Updates annually or biannually
 - Greater emphasis on digital version and ease of use (that is, right now the "handbook" isn't necessarily "handy")
 - Improve CMC and AM access to PMC content that has general applicability
- **Some options that have been discussed:**
 1. Publishing chapters instead of volumes
 - One option would be to combine content from all material systems together. Each topic (e.g. building block, data submittal requirements, quality control) would have a chapter with a beginning section of information that is common to all material systems, followed by sections that provide material-specific information. Could create "volumes" (compendiums) by pulling all information that is generally applicable and appropriate material sections
 2. Keep volumes as-is, except re-organize and divide Volume 3 into Volume 3a and 3b
 - Volume 3a could be for content that is generally applicable information and Volume 3b could be for PMC-specific information
 - Or reorganize to emphasize providing information in the order it would be used in a development program
 - Note: Vol 3 will have to be split for Rev H because it's too long. Currently planning to split into approximately equal number of pages between two existing chapters

108

5/9/2024

Other Topics

CMH17

COMPOSITE MATERIALS HANDBOOK

- Revamp yellow page process to simplify and automate balloting procedures and publication
 - Secretariat provided an update
- Consider different membership structure
 - No action in this area right now, until we determine if the merged organization works and what kind of publication we will offer in the future
 - Goals are to reward active members, allow organizational/corporate membership, and increase voting participation
- Investigate becoming an ANSI-certified SDO, or joining an SDO
 - Currently no action in this area

For This Meeting

CMH17

COMPOSITE MATERIALS HANDBOOK

- Joint Guidelines kick-off (1 hour this afternoon)
 - Further describe future activities
- Separate PMC and AM Guidelines sessions Wednesday
 - PMC Guidelines focusing on post-Rev H activities, identifying taskings (*beginning new task identification process*)
 - AM Guidelines addressing yellow pages and other committee business
- AM and CMC WGs are meeting to continue content development
- PMC WG and TGs are meeting to disposition yellow pages, finalize Rev H content and some future planning
- Sandwich WG is meeting and will identify WG/TG for specific Vol 6 content needs
- **Would like to emphasize cross-pollination of knowledge across material systems and identify content that is applicable to more than one material system**
 - For example, if you are a member of one M&P WG or have skills in that area, consider attending M&P sessions for the other material systems

109

5/9/2024

Next Actions



- Short Term
 - Finalize V3 Rev H, V5 Rev B, V7 Initial Release
 - PMC to identify post-Rev H taskings in a formal manner and establish any new WG or TG (including for Vol 6 Sandwich)
 - Update website and voting
 - Evaluate effectiveness of merged organization
- Longer Term
 - Propose and decide on new WG/TG structure
 - Propose and decide on new membership structure
 - Propose and decide on new publication methods
 - Investigate becoming or joining an SDO

Volume 6 Rev A publication is also a priority, but not certain where it will fall on this timeline

CLOSING COORDNATION

5/9/2024



1st CMH-17 Joint Coordination Meeting

April 22-25, 2024
Scottsdale, AZ
8:00 am – 5:30 pm MST

*Spring 2024 – Hybrid
Closing Coordination
(3:30-5:30 pm MST)*

1



Closing Coordination Meeting Agenda

- Tutorial Report Out
- WG/TG Report Out
- Secretariat Updates
 - Dates for fall virtual meeting
 - Handbook release goals
 - New taskings
- Hearing from you

2

5/9/2024

AC0

Tutorial Report Out



- Certification
- Statistics
- Bonding M&P
- CMCs

3

CMC Tutorial



- Immediate comments:
 - Include content on NDE of CMC
 - Videos of different CMC fabrication methods
- Survey Input:
 - Ox/Ox or rocket applications
 - Post processing methods (ex. machining)
- Positive input on quality of overall content and length of tutorial

4

5/9/2024

WG/TG Report Out (quick 1-2 min)



Joint Sessions

- Guidelines
- Statistics
- Engine Applications

CMC WG

- Data Review
- Materials and Process
- Testing

AC0 AM WG

- Data Review
- Design and Analysis
- Guidelines
- Materials and Process
- Testing

5



Joint Statistics Meeting Recap

6

5/9/2024

Statistical Process Control (SPC)

CMH17

COMPOSITE MATERIALS HANDBOOK

- Recommended some changes to Volume 1 Section 8.4.5
- Recommended some improvements to Volume 3 Section 6.2.2.2 (section owned by M&P – proposed Post-Rev H)

7

Apparent Bugs in CMH17-STATS Software

CMH17

COMPOSITE MATERIALS HANDBOOK

- The software performs a normality test on each condition before pooling (not in the Vol 1 Ch 8 flowchart). This may incorrectly prevent pooling of conditions unless the user overrides the Anderson-Darling normality test.
- Very minor numerical accuracy issue for the ANOVA method. Does not appear to have any engineering significance.
- Apparent bug affecting Levene's test after the Mod CV transformation. May affect whether pooling is recommended.

8

5/9/2024

Grouping Strategies for ANOVA (Basis Values)

- Proposal to group data by **batch+panel** combinations, instead of **batch**
- Grouping the data by batch (only) produces “correct” B-Basis results
- Grouping the data by batch+panel (ignoring the nested structure of the data) produces non-conservative B-Basis values except when true batch variance is small (batch variance $\ll$ panel variance)
- Statistical tests have low power for determining sources of variance
- Recommendation was that grouping strategy needs to be based on judgement informed by experience with similar material systems, graphical techniques, etc.

9

WG/TG Report Out (quick 1-2 min)

Joint Sessions

- Guidelines
- Statistics
- Engine Applications

CMC WG

- Data Review
- Materials and Process
- Testing

AM WG

- Data Review
- Design and Analysis
- Guidelines
- Materials and Process
- Testing

10

5/9/2024

Engine Applications Working Group



Summary of 4/24 Working Group Meeting

- Reviewed mission statement & current list of contributors
- Provided overview of content being submitted for next revisions (Vol. 3, Rev. H & Vol. 5, Rev. B)
- Reviewed outline of other planned content, including 2024 Plans
 - Received good comments/suggestions, but nothing that would significantly change plans
- Discussed whether propellers should be added to scope – **After Rev. H**
 - One attendee from propeller OEM; Simon and Hoyt also have some familiarity with recent propeller activity
 - Does not seem to be covered elsewhere in the Handbook
 - Not all current content would apply to propellers, but there does seem to be significant overlap with other content (e.g. fan blade topics)

Recommendation: Working Group to investigate addition of propellers and bring findings back to leadership

- Identify additional propeller stakeholders and possible contributors; attendees provided good leads
- Reach out to ASTM F44 committee to understand their efforts
- Draft list of topics that could be included
- Bring summary back to CMH17 leadership at future meeting for decision on whether/how to proceed

Engine Applications Working Group

Spring 2024 Coordination Meeting

11

WG/TG Report Out (quick 1-2 min)



Joint Sessions

- Guidelines
- Statistics
- Engine Applications

CMC WG

- Data Review
- Materials and Process
- Testing

ACQ AM WG

- Data Review
- Design and Analysis
- Guidelines
- Materials and Process
- Testing

12

5/9/2024

CMC Data Review WG

CMH17

COMPOSITE MATERIALS HANDBOOK

Progress at Meeting (Co-hosted by Rajiv Naik (virtual) and Matt Opliger (in-person))

Reviewed

- Vision and Goals
- Data Review process
- Sections 16-18 in the Handbook
- Really good and informative presentation by Matt Opliger, NIAR, titled, "Axiom CMC test methods and test data insights".
- Second guest speaker was Jorge Chavez-Salas, NIAR, titled, "Statistical Analysis of Axiom CMC test data"
- Lots of good discussion during and after both presentations
- In-person attendees: 15
- Virtual attendees: 7

CMC Data Review WG

CMH17

COMPOSITE MATERIALS HANDBOOK

Discussed

- Processing (panel-to-panel) variability of Axiom Ox-Ox CMC data
- Multivariate regression model to isolate statistically significant processing parameters
- Test methods and specimen geometries
- High temperature testing challenges
- Strain range determination for modulus
- Grouping test data by batch and by batch-panel (processing cycle)
- CMG-17 Volume 1 sections on batches, panels and confounding
- Basis values using the ANOVA method as it relates to the Axiom CMC data
- Statistical analysis of Axiom CMC test data and learning from simulated data

5/9/2024

CMC Data Review WG



Going Forward Plan

- Monthly meetings to continue discussion topics related to Data Review
 - Meetings held second Wednesday of the month, 9:00 AM EST
 - Next meeting scheduled for May 8, 2024
 - Join us if you wish to participate
- Meeting agenda will include:
 - Revision and addition of new content to Sections 16 and 17
 - Guest speakers from other CMH-17 CMC and PMC WGs for better alignment with rest of CMC Handbook content
- Plan to review NIAR Axiom CMC data package later this year

CMC Data Review WG



Roster (in-person)

[illegible][illegible]

122	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2113	2114	2115	2116	2117	2118	2119	2120	2121	2122	2123	2124	2125	2126	2127	2128	2129	2130	2131	2132	2133	2134	2135	2136	2137	2138	2139	2140	2141	2142	2143	2144	2145	2146	2147	2148	2149	2150	2151	2152	2153	2154	2155	2156	2157	2158	2159	2160	2161	2162	2163	2164	2165	2166	2167	2168	2169	2170	2171	2172	2173	2174	2175	2176	2177	2178	2179	2180	2181	2182	2183	2184	2185	2186	2187	2188	2189	2190	2191	2192	2193	2194	2195	2196	2197	2198	2199	2200	2201	2202	2203	2204	2205	2206	2207	2208	2209	2210	2211	2212	2213	2214	2215	2216	2217	2218	2219	2220	2221	2222	2223	2224	2225	2226	2227	2228	2229	2230	2231	2232	2233	2234	2235	2236	2237	2238	2239	2240	2241	2242	2243	2244	2245	2246	2247	2248	2249	2250	2251	2252	2253	2254	2255	2256	2257	2258	2259	2260	2261	2262	2263	2264	2265	2266	2267	2268	2269	2270	2271	2272	2273	2274	2275	2276	2277	2278	2279	2280	2281	2282	2283	2284	2285	2286	2287	2288	2289	2290	2291	2292	2293	2294	2295	2296	2297	2298	2299	2300	2301	2302	2303	2304	2305	2306	2307	2308	2309	2310	2311	2312	2313	2314	2315	2316	2317	2318	2319	2320	2321	2322	2323	2324	2325	2326	2327	2328	2329	2330	2331	2332	2333	2334	2335	2336	2337	2338	2339	2340	2341	2342	2343	2344	2345	2346	2347	2348	2349	2350	2351	2352	2353	2354	2355	2356	2357	2358	2359	2360	2361	2362	2363	2364	2365	2366	2367	2368	2369	2370	2371	2372	2373	2374	2375	2376	2377	2378	2379	2380	2381	2382	2383	2384	2385	2386	2387	2388	2389	2390	2391	2392	2393	2394	2395	2396	2397	2398	2399	2400	2401	2402	2403	2404	2405	2406	2407	2408	2409	2410	2411	2412	2413	2414	2415	2416	2417	2418	2419	2420	2421	2422	2423	2424	2425	2426	2427	2428	2429	2430	2431	2432	2433	2434	2435	2436	2437	2438	2439	2440	2441	2442	2443	2444	2445	2446	2447	2448	2449	2450	2451	2452	2453	2454	2455	2456	2457	2458	2459	2460	2461	2462	2463	2464	2465	2466	2467	2468	2469	2470	2471	2472	2473	2474	2475	2476	2477	2478	2479	2480	2481	2482	2483	2484	2485	2486	2487	2488	2489	2490	2491	2492	2493	2494	2495	2496	2497	2498	2499	2500	2501	2502	2503	2504	2505	2506	2507	2508	2509	2510	2511	2512	2513	2514	2515	2516	2517	2518	2519	2520	2521	2522	2523	2524	2525	2526	2527	2528	2529	2530	2531	2532	2533	2534	2535	2536	2537	2538	2539	2540	2541	2542	2543	2544	2545	2546	2547	2548	2549	2550	2551	2552	2553	2554	2555	2556	2557	2558	2559	2560	2561	2562	2563	2564	2565	2566	2567	2568	2569	2570	2571	2572	2573	2574	2575	2576	2577	2578	2579	2580	2581	2582	2583	2584	2585	2586	2587	2588	2589	2590	2591	2592	2593	2594	2595	2596	2597	2598	2599	2600	2601	2602	2603	2604	2605	2606	2607	2608	2609	2610	2611	2612	2613	2614	2615	2616	2617	2618	2619	2620	2621	2622	2623	2624	2625	2626	2627	2628	2629	2630	2631	2632	2633	2634	2635	2636	2637	2638	2639	2640	2641	2642	2643	2644	2645	2646	2647	2648	2649	2650	2651	2652	2653	2654	2655	2656	2657	2658	2659	2660	2661	2662	2663	2664	2665	2666	2667	2668	2669	2670	2671	2672	2673	2674	2675	2676	2677	2678	2679	2680	2681	2682	2683	2684	2685	2686	2687	2688	2689	2690	2691	2692	2693	2694	2695	2696	2697	2698	2699	2700	2701	2702	2703	2704	2705	2706	2707	2708	2709	2710	2711	2712	2713	2714	2715	2716	2717	2718	2719	2720	2721	2722	2723	2724	2725	2726	2727	2728	2729	2730	2731	2732	2733	2734	2735	2736	2737	2738	2739	2740	2741	2742	2743	2744	2745	2746	2747	2748	2749	2750	2751	2752	2753	2754	2755	2756	2757	2758	2759	2760	2761	2762	2763	2764	2765	2766	2767	2768	2769	2770	2771	2772	2773	2774	2775	2776	2777	2778	2779	2780	2781	2782	2783	2784	2785	2786	2787	2788	2789	2790	2791	2792	2793	2794	2795	2796	2797	2798	2799	2800	2801	2802	2803	2804	2805	2806	2807	2808	2809	2810	2811	2812	2813	2814	2815	2816	2817	2818	2819	2820	2821	2822	2823	2824	2825	2826	2827	2828	2829	2830	2831	2832	2833	2834	2835	2836	2837	2838	2839	2840	2841	2842	2843	2844	2845	2846	2847	2848	2849	2850	2851	2852	2853	2854	2855	2856	2857	2858	2859	2860	2861	2862	2863	2864	2865	2866	2867	2868	2869	2870	2871	2872	2873	2874	2875	2876	2877	2878	2879	2880	2881	2882	2883	2884	2885	2886	2887	2888	2889	2890	2891	2892	2893	2894	2895	2896	2897	2898	2899	2900	2901	2902	2903	2904	2905	2906	2907	2908	2909	2910	2911	2912	2913	2914	2915	2916	2917	2918	2919	2920	2921	2922	2923	2924	2925	2926	2927	2928	2929	2930	2931	2932	2933	2934	2935	2936	2937	2938	2939	2940	2941	2942	2943	2944	2945	2946	2947	2948	2949	2950	2951	2952	2953	2954	2955	2956	2957	2958	2959	2960	2961	2962	2963	2964	2965	2966	2967	2968	2969	2970	2971	2972	2973	2974	2975	2976	2977	2978	2979	2980	2981	2982	2983	2984	2985	2986	2987	2988	2989	2990	2991	2992	2993	2994	2995	2996	2997	2998	2999	3000
-----	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------

5/9/2024

CMC Data Review WG



Roster (virtual)





WG/TG Report Out (quick 1-2 min)



Joint Sessions

- Guidelines
- Statistics
- Engine Applications

CMC WG

- Data Review
- Materials and Process
- Testing

AM WG

- Data Review
- Design and Analysis
- Guidelines
- Materials and Process
- Testing

18

5/9/2024

CMC M&P WG

CMH17

COMPOSITE MATERIALS HANDBOOK

- Overall WG goal
 - To document information on the composition, fabrication, and characterization of CMC engineering materials and structures
- Progress at meeting
 - Provided overview of CMC M&P WG goals and objectives
 - Reviewed the content that has been approved for rev. B yellow pages so far, and near-term plans
- Next steps
 - Discussed longer term plans for revising content for rev. C and adding additional CMC materials
 - Looking for more volunteers to write and review new/revised content

19

CMC Testing WG Closing Coordination Notes

CMH17

COMPOSITE MATERIALS HANDBOOK

Discussed the following during the WG meeting:

- Vision and Goals
- Overview of CMC Testing WG Sections (Volume 5, Part C, Chapters 8-15)
- Finished Sections Requiring Changes and/or Balloting
- Sections Currently being Worked
 - Discussed sections currently being drafted and reviewed by the WG
 - Discussed YP ballot schedule and plans for getting new sections balloted
- Future Plans
 - Discussion of Priorities
 - Collaboration with ASTM C28

20

5/9/2024

WG/TG Report Out (quick 1-2 min)



Joint Sessions

- Guidelines
- Statistics
- Engine Applications

CMC WG

- Data Review
- Materials and Process
- Testing

ACQ AM WG

- Data Review
- Design and Analysis
- Guidelines
- Materials and Process
- Testing

21

AM Data Review WG



- Small turnout
- Shared PMC's voting process
 - Discussed if it made sense to have Joint Data Review
 - General thoughts was positive
 - Hope to propose at Exec meeting
- Reviewed YP comments for data tables (Ch 14)
 - Discuss some elements on the tables
 - What's important to capture
 - Necessary vs 'nice to have' information

22

5/9/2024

WG/TG Report Out (quick 1-2 min)



Joint Sessions

- Guidelines
- Statistics
- Engine Applications

CMC WG

- Data Review
- Materials and Process
- Testing

AC0 AM WG

- Data Review
- Design and Analysis
- Guidelines
- Materials and Process
- Testing

23

WG/TG Report Out (quick 1-2 min)



PMC WG/TG

- Bond Process
- Crashworthiness
- Data Review
- Damage Tolerance
- Design
- Guidelines
- Materials and Process (P17)
- Safety Management

- Spacecraft
- Sandwich
- Supportability (SoBR)

24

5/9/2024

Bond Process Task Group

CMH17

COMPOSITE MATERIALS HANDBOOK

- Final Stages for Rev H Sect 5.9 content
- Sections 2, 3, 5, 6, and 7 either closed or only editorial comment incorporation remaining
- YP content from last meeting – sections 1, 4, 8, 9, & 10
 - Comments reviewed and revisions made
 - New drafts posted to forum and sent to negative voters.
 - Opportunity for feedback - final resolution of remaining issues on the forum requested by end of next week
- Final steps include
 - Assembly of all sections into one document (Howard Creel)
 - Cross-referencing of sections (BPTG and Secretariat)
 - Continuity check for full document– looking for volunteers

25

WG/TG Report Out (quick 1-2 min)

CMH17

COMPOSITE MATERIALS HANDBOOK

PMC WG/TG

- | | |
|-------------------------------|-------------------------|
| • Bond Process | • Spacecraft |
| • Crashworthiness | • Sandwich |
| • Data Review | • Supportability (SoBR) |
| • Damage Tolerance | |
| • Design | |
| • Guidelines | |
| • Materials and Process (P17) | |
| • Safety Management | |

26

5/9/2024

YP Review Status

CMH-17

COMPOSITE MATERIALS HANDBOOK

Spring 2023 YP2 (Vol. 3 Secs 16.1-16.6): Received ~50% feedback from commenters

TOTAL VOTES	34
• Affirmative	4
• Affirmative with Comment	10
• Negative with Comment	3
• Abstain	17

Fall 2023 YP1 (Vol. 3 Secs 16.5-16.6.1) : Will address all the outstanding issues by May 31

TOTAL VOTES	36
• Affirmative	10
• Affirmative with Comment	6
• Negative with Comment	2
• Abstain	18

27

CWG Post Rev. H Content Development Tasks

CMH-17

COMPOSITE MATERIALS HANDBOOK

Near term-

- A. Bazle to participate as part of the CWG and contribute MAT162 evaluation.
- B. C-channel test data from UoU drop tower and NASA Glen sled test.
- C. C-channel test-analysis correlation to enhance best practices using CMH-17 success criteria.
- D. Stanchion design simulation to guide sled crush testing at NASA.
- E. Evaluate NASA ACC HEDI benchmark problems for applicability in V&V process in mid 2024.
- F. Additional OEMs examples or case studies for aircraft certification, e.g., Boom trade studies.
- G. New TGs to further enhance Rotorcraft CW (§16.4) and AAM Vehicles CW (§16.5) (Beta Technologies and Wisk Aerospace volunteered for AAM TG).

Long-term-

- i. Double stanchion test results to incorporate in §16.6.2.4.6.
- ii. Double stanchion model validation to substantiate best practices from building blocks.
- iii. Revisit PDFA best practices & simulation guidelines based on emerging predictive capabilities.
- iv. NIAR effects of defects on energy absorbers test & analysis best practices.
- v. Potential application of CFACs for material characterization.
- vi. Aircraft CW test & analysis guidelines for ditching.

28

5/9/2024

WG/TG Report Out (quick 1-2 min)**CMH17**

COMPOSITE MATERIALS HANDBOOK

PMC WG/TG

- Bond Process
- Crashworthiness
- Data Review
- Damage Tolerance
- Design
- Guidelines
- Materials and Process (P17)
- Safety Management
- Spacecraft
- Sandwich
- Supportability (SoBR)

29

Materials and Process WG**CMH17**

COMPOSITE MATERIALS HANDBOOK

- Characterization and control of continuous fiber reinforced composite materials (including adjacent ones like film adhesive and core, and processing materials), so expected, consistent properties are delivered, and
- Developing and managing the associated manufacturing processes, both for fabrication of the structural non-metallic materials themselves, and completing the material's final transformation into parts
- Task groups for major activities:
 - P-17 – Industry specifications for V2 published materials
 - Bonding – New Rev H content on structural adhesive bonding
- Contacts: Dr. Margaret Roylance, Dan Ruffner

30

5/9/2024

Other M&P Tasks

CMH17

COMPOSITE MATERIALS HANDBOOK

- Resins Content (Howard Creel)
 - A draft was balloted in the last YP with new paragraphs on the fiber resin interface
 - All affirmative votes
 - Currently reconciling comments for final draft
 - No further action for Rev H
- Shipping and Storage Processes (Nathan Collins) – Balloted and comments resolved
- Proposed Tasks post Rev H – lively discussion

31

Proposed M&P WG Tasks post Rev H

CMH17

COMPOSITE MATERIALS HANDBOOK

- | | |
|---|--|
| <ul style="list-style-type: none"> • Shared database tutorial • Nested qualification statistics • Additional shelf life out-time content – SLOT extensions, porosity as metric for processability, rheology, mfr w (tack, drape), non-epoxy react diff, fiber v resin sl, • Lot Testing - adding and/or setting aside coupons, Specification acceptance values v allowables | <ul style="list-style-type: none"> • Heat surveys (tool) – cure vessel, then tool, then family (vessel loading, position), soft upgr, thermal profile (part)?, tool plate, simulation accept, TC placement, tool matl chg, order of opns, • Process control traveler coupons, witness (cure), diff stat approaches for accept values, wean off from R&D to production, do and do not represent • Other suggestions? |
|---|--|

32

5/9/2024

P17 Status



- Looking for cochairs
- Restarting efforts on V2 specifications
- 6565 IM7 PW fabric NSN for composite repair wet layup – new Navy potential user
- AMS3846 E quartz fabric std (Eric Smith) - proposed changes and feedback being coordinated w affected parties. Expect to happen for end of May
- Additional topics discussed
 - No chrome adhesive bond primer
 - UD tape slit down to AFP
 - PFAS Forever Chemical phaseout and affected structural non-metallic materials
 - AMS6891 longer shelf-life data review and acceptance
- Trying to return to meetings at least every other month

33

WG/TG Report Out (quick 1-2 min)



PMC WG/TG

- Bond Process
- Crashworthiness
- Data Review
- Damage Tolerance
- Design
- Guidelines
- Materials and Process (P17)
- Safety Management

- Spacecraft
- Sandwich
- Supportability (SoBR)

34

5/9/2024

Spacecraft & Launch Vehicles –Report Out

CMH#17
COMPOSITE MATERIALS HANDBOOK

Proposing New Task Group – Composite Pressurized Structures for Space

- Discussed goals for new sections
 - Reference for proposing and evaluating proposals
 - Useful for companies without significant certification experience
 - Repository for lessons learned
- Brainstormed content
 - Presented list of topics and added several additional topics
 - Decided to organize content into three independent sections (and sub task groups)
 - Habitable Volumes
 - Unlined tanks (propellant, storage, etc)
 - Composite overwrapped pressure vessels
- Reviewed reference literature
 - Summarized topics that are (and are not) covered in unrestricted literature
- Composite LOx tank case study
 - Mike Holt presented certification process for composite LOx tank flown on LauncherOne

Spacecraft & Launch Vehicles –Report Out

CMH#17
COMPOSITE MATERIALS HANDBOOK

Topics

<u>Applications</u> - Propellant/Storage tanks (LH2, LOX, SRB, Storage Depot) - COPV - Unlined - Human Habitation (Spaceflight, Lunar Habitat, Deep Space Transportation) <u>Standards & Guides</u> - AIAA-S-081A - AIAA-G-082 - ISO 14623 <u>Design & Analysis</u> - Tank geometry - Load introduction/stress concentrations - Ply stacking sequence - Bonded/bolted joints - Bearing/bypass loads	<u>Fracture Control</u> - Leak before burst - Safe life - Stress rupture - Protective covers <u>Damage/Environmental Resistance</u> - Fluid compatibility (LOx, urine) - Environmental effects (AO, Radiation, UV) - Flammability (%oxygen) - High oxygen environment oxidation - Cleanliness <u>Damage Tolerance</u> - Workmanship verification - Damage threats (MMOD, astronaut kick loads, etc.) - Damage categories - Limiting damage case (like 2-bay crack in airplanes)	<u>Containment</u> - Microcracking - Acceptable leak rates <u>Manufacturing</u> - Continuous vs multi-piece shell - Tooling considerations
---	--	--

36

5/9/2024

WG/TG Report Out (quick 1-2 min)



PMC WG/TG

- Bond Process
- Crashworthiness
- Data Review
- Damage Tolerance
- Design
- Guidelines
- Materials and Process (P17)
- Safety Management

- Spacecraft
- Sandwich
- Supportability (SoBR)

37



**Closing Coordination
PMC Sandwich Working Group
L. Gintert 04/25/24**

38

5/9/2024

Volume 6 (Sandwich WG) 4/24 MTG


- Presented the evolution of Volume 6 and current status
- Shared Volume 6A Proposed Task Groups and Plans with individual names and scope of each TG
- Discussed strategies for development and asked for volunteers
 - Very successful recruiting – numerous volunteers have signed up!
- Plan forward is to follow up with group of volunteers and develop a proposal for leadership consideration
 - TG membership
 - Scope
 - Target completion date

39



**Closing Coordination
PMC Supportability Working Group
L. Gintert 04/25/24**

40

5/9/2024

Supportability WG 4/24 MTG

CMH17

COMPOSITE MATERIALS HANDBOOK

- Primary focus for majority of the meeting was addressing YP Comments
 - 14.7.3 Bonded Repair Analysis – resolved all negatives and team is incorporating final updates for working draft
 - 14.12.10 Case Study #9 – Bonded Repair of GA Wing
- Case Study #2 Fuselage Bonded Repair (emphasis on prerequisites)
 - Reviewed status of content and asked for volunteers (Nihar and Eric on board for completion of analysis section)
 - SME team needed for prerequisites (Brock and AI?)
- Reviewed other Post Rev H plans

41

A Look Ahead

CMH17

COMPOSITE MATERIALS HANDBOOK

- Fall Meeting - Joint
 - Virtual format
 - Probably over the course of 2 weeks (not necessarily every day), max 4 hours/day
 - Dates TBD
 - Late September/Early October
 - Early November
 - Tutorials unlikely
- Spring 2025
 - Joint meeting, in-person (only)
 - May 12-16, Wichita State University
- Yellow Page needs
 - Vol 2: new dataset submission
 - Vol 5: content update, data inclusion
 - Vol 6: dependent on planned activity
 - Vol 7: draft for initial release
 - To be discussed at Exec

42

5/9/2024

Handbook Release Goals



Current Revisions

Volume 1, Rev H, published 2022

Volume 2, Rev H, published 2018

Volume 3, Rev G, published 2012

Volume 5, Rev A, published 2017

Volume 6, Rev IR, published 2013

Volume 7, working on draft for IR

Handbook release goals			
	Volume	Last YPs	Projected Release
PMC	1 rev H	Done!	Done!
PMC	2 (next rev)	TBD	TBD
PMC	3 rev H ^{AC(0)}	Fall 2023	Winter 2024
CMC	5 rev B	TBD	Early 2025
PMC	6 rev A	TBD	2026 ^{AC(1)}
AM	7 rev IR	Ongoing	2025

- Vol 2: exploring options for document revision
- Projected release dates are dependent on YP activity and Secretariat review capacity.

43

Feedback and Content Proposals



Thoughts on Joint Meeting and Future of CMH-17 proposals

- Generally positive
- 3 concurrent meetings:
 - No more than 3
 - Joint WG/TG will help
 - Be mindful of not having too many TG
 - Maybe increase # of days?
- Would like to see Forum again
 - Some topic of interest to the industry
 - Maybe to do during Virtual only?

- Consider too the focus of the forum
- There weren't many attendees from CMC coordination groups
 - Has been an existing challenge
- Faster/different publication approach
- Create a CMH-17 page on LinkedIn.

Email your thoughts to : info@cmh17.org

44

5/9/2024

Feedback and Content Proposals

CMH-17

COMPOSITE MATERIALS HANDBOOK

Content Proposals

- make a list of tasks expected post volume revisions
- Proposals should come from everyone

45

Conclusion

CMH-17

COMPOSITE MATERIALS HANDBOOK

- Few weeks from now
 - CMH-17 log-in will be provided to new members
 - Proceedings – minutes and presentations will be posted to the website
- Post meeting and tutorial survey (CAC(1) Code)
 - Emailing links on Friday; we look forward to your input
- We welcome you to participate
 - Various WG/TG
 - Authors, editors, reviewers, and/or YP voters
- Reminders
 - Executive Meeting Friday
- Contact us at: info@cmh17.org

46

23

5/9/2024

Thank you for your attendance and participation!

CMH-17
COMPOSITE MATERIALS HANDBOOK

- We value your input to improving the event.
Please take this quick Meeting Survey



<https://www.surveymonkey.com/r/CMH17SPRING24>

47

CMH-17
COMPOSITE MATERIALS HANDBOOK

1st CMH-17 Joint Coordination Meeting

April 22-25, 2024
Scottsdale, AZ
8:00 am – 5:30 pm MST

*Spring 2024 – Hybrid
Exec Meeting
(8:00-12:00 pm MST)*

48

5/9/2024

Agenda

- Vol 3 Rev H
- Yellow Page Needs
 - Planning for dates
- New Taskings
- Discussion
 - What's new
 - Website, Statistics Software, Awards
 - CMH-17 Mission, Vision, Goals, etc.
 - Meeting feedback
 - Fall meeting planning
- Actions
- Wrap up & Adjourn



AC(1)

49

Volume 3 Rev H

- When will final content be ready to send to the secretariat?
 - Chapter 5 – First week of June
 - Chapter 7 – Mid July
 - Chapter 12 – End of May
 - Chapter 14 – End of May (14.7.3); End of June (Brock - 14.12.10- need CAD Support for figures)
 - Chapter 16 – End of May
 - Chapter 17 – June 14th



AC(0)

50

5/9/2024

What's left? – Vol 5



- Chapter 3 – content update (completed in May, YP after)
 - Some content submitted for Chapter 6
- Section 13.12 – Interlaminar Fracture Toughness (submitted to ST)
 - 13.7 Compression testing (mid May)
 - 13.14 Creep testing (May)
 - Maybe data
- Statistics guidance on data groupings
 - Axiom data submittal
- ~~Chapter 19 – Engine Applications~~


Microsoft Excel Worksheet

CMC Tracker

51

Planning Yellow Pages – Vol 5 (CMC)



Yellow Page Ballot Cycle	Submissions due to Secretariat	Posted for Ballot	Ballot Closes	Planned content from:
Spring 2023 YP1	June 14 th			

WG	Content	Submitted Items
	Testing	
	M&P	
	Statistics	
	D&A	
	Data Rev	

52

5/9/2024

Planning Yellow Pages – Vol 7 (AM)

CMH17
COMPOSITE MATERIALS HANDBOOK

Yellow Page Ballot Cycle	Submissions due to Secretariat	Posted for Ballot	Ballot Closes	Planned content from:
Spring 2023 YP1	May 31 st			

- 5-6 YP
- Last YP in Summer 2025
- Publish end of 2025.

WG	Content	Submitted Items
Guidelines		
Testing		
M&P		
Statistics		
D&A		
Data Rev		

53

Minutes from Closing Coord. & Discussion notes

CMH17
COMPOSITE MATERIALS HANDBOOK

- Task groups for Sandwich
- Vol 6 has older content (data) that needs validated
 - How can we do that? Do we want to? Should it be segregated?
 - For the TG to review the content and make a recommendation
- What to do when content is close to ready but changes are more extensive than expected
 - Email commenter → resolve negative
 - Make updates as needed to the sections
 - Post final version on forum → review updated content
 - To also email updated version to all voters of that specific ballot cycle

Note: Purple font indicates notes typed during the meeting

54

27

5/9/2024

Discussion notes

CMH17

COMPOSITE MATERIALS HANDBOOK

- Do we want to revisit how balloting goes out?
 - Might be helpful to update attendee /member list. Not all attendees are active enough to provide meaningful comments.

55

Minutes form Discussion

CMH17

COMPOSITE MATERIALS HANDBOOK

- Do we want HDBK to be aerospace centric
 - History of hdbk goes beyond aerospace
 - No
- Who do we want to reach out to
 - Who is buying the handbook? That will be helpful
 - What's the interest in AM. Some AM are not structural. Would people be looking at less critical components.
 - Current use of AM is not structural but not necessarily non-critical
- NM - AM: biomed industry?

Note: Purple font indicates notes typed during the meeting

56

28

5/9/2024

Minutes form Discussion

CMH17

COMPOSITE MATERIALS HANDBOOK

- Our business cycle may be too long for certain industry use. We don't meet their needs
 - They come in, see the slow turnaround, leave and do not return.
- Thoughts on manufacturing/processing guidance vs use of data
- Who are we targeting – when we write AM mission goals.
- We are still the source of information despite different techs having different requirements.

57

Some descriptors for Mission, Vision & Goals

CMH17

COMPOSITE MATERIALS HANDBOOK

- High pedigree data
- Primarily aero, and applications with similar rigor
- Want to include info on non flyaway content
 - AM: tooling, large format printing
 - To have classes of material for tooling. To provide guidance to do some of these thing.
- RL – he sends them CMH17 data and NCAMP content and they use it regularly. SSYS work with majority of auto industry. There's lots of entities that use the data and the specs that being generated in aviation world
- MVG – go to exec then YP
 - Who do we target and where to put efforts

58

5/9/2024

Minutes on Yellow Pages

CMH17

COMPOSITE MATERIALS HANDBOOK

- Should we keep them segregated by material system or just have a cycle with all content
 - Somewhat negative – some thinks that they should be different/independent
 - In part the coord group has different content readiness cycles
 - General thought: to group them, but to segregate them in sections so it's easy for the reviewer
- One thought to have them more frequently with less content
- Test:
 - June 30th for first cycle; every 2-3 months
 - To segregate by AM, CMC, PMC
 - Ballot cycle 4-6 weeks

59

Discussion on Volume Publication

CMH17

COMPOSITE MATERIALS HANDBOOK

- Easiest approach: to release with year instead of by revision - do by dates
- Consider also purchase of the hdbk whether annually by small company or subscriptions by larger organizations
 - Cost per year – to get release copies
- Vol 2: CA would like to implement new publication method so we don't have anything beyond Rev H.
 - Will plan to discuss this in Fall

60

5/9/2024

Discussion Membership



- Cleanup of roster needed
- Active chairs
 - To update the people who are active
 - Or to email all members
 - Two tiers of membership – active and general
- Cleanup
 - Secretariat to make list of bounce back emails
 - Send to chairs for their review
 - Cleanup as needed
 - 3 years attendance then remove

61

Future Taskings



- Moving forward, we will review proposed tasks, determine if we accept them or not, and develop timelines
 - Flow is going to be a little different right now until we can fully implement the new task approval process with Joint GWG
- We also have some tasks that we already know we will do post-Rev H (and even after Vol 5 Rev B and Vol 6 IR)
 - Let's talk about timelines and WG/TG
- New tracking spreadsheet

62

5/9/2024

Shared proposal and task spreadsheet

CMH17

COMPOSITE MATERIALS HANDBOOK

- Joint guidelines – will decide if we want a new TG created for it
- No objections
- Want to use post Vol 3 Rev H, Vol 5B, Vol7 IR
 - Will use this after all of that
- WG/TG to email secretariat
 - Send a reminder to chairs about all this

83

Exec Meetings

CMH17

COMPOSITE MATERIALS HANDBOOK

- Independent exec meeting for AM, CMC and PMC
- One or two joint exec before fall meeting
- Add column to proposal worksheet:
 - Level of effort and a duration tied to it
 - Proposed completion – in proposal worksheet

84

5/9/2024

Known New Taskings - Example				
Vol	Section	Description	TG/WG	Timeline
1	8.3.X	Proposed updates for clarity of explanation for use and sampling of ANOVA analysis	Statistics	
2	2.2.1.12 & 13 (Tape) 2.2.2.13 (Fabric)	Data to be submitted: Toray 3900-2C/T800s Slit Tape Vitrex AE250 T-071 AS4 12k Unitape (Thermoplastic) Hexcel 8552 8HS	PMC Data Review	
3		(What do we have that will begin immediately post Rev H)		

85

Known New Taskings - Example				
Vol	Section	Description	TG/WG	Timeline
5	3.1.3.4	Addition to prepare section on Hybrid CMI/Slurry Cast/Melt Infiltration SiC/SiC Composites	CMC M&P	
5	V5 3.1.4	Addition/Change to review and update ox/ox processing section	CMC M&P	
5	3.2.3.4	Update commercial processing of SiC fiber	CMC M&P	
5	3.2.3.x	Add summary of SiC fiber creep testing	CMC M&P	
5	3.2.2	Find POC for updating oxide	CMC M&P	
5	3.3	Review for completeness, update as needed.	CMC M&P	
5	3.5	Add content for higher temp EBC, EBC for CMAS	CMC M&P	
5	3.6	Review existing content and update with PMC M&P relevant info	CMC M&P	
5	3.9	Coordinate with Design WG to determine scope of new section on CMC-metal attachments	CMC M&P	

86

5/9/2024

Known New Taskings - Example

CMH-17

COMPOSITE MATERIALS HANDBOOK

Vol	Section	Description	TGNWG	Timeline
6	V6 C2, C3	Guidelines for property testing and material data for core and sandwich structure	Sandwich TG 1	
8	V6, C4, C5	Fabrication of sandwich structure and quality control	Sandwich TG 2	
6	V6 C7, C8, C12	Internal loads and stresses, analysis and structural design, supporting data and discussions	Sandwich TG 3	
8	V6 C8, C9	Design and substantiation for sandwich structures, damage assessment of sandwich structures	Sandwich TG 4	
6	V6 C10, C11	Supportability, Sandwich design case studies	Sandwich TG 5	
7		Any known?		

67

Proposed New Taskings - Example

CMH-17

COMPOSITE MATERIALS HANDBOOK

Description	Approve?	Notes
<i>Any interest in Volume 4 activity?</i>		
High pressure Composite Overwrapped Pressure Vessels. NASA + DoD + the greater space community use the AIAA-S-081 standard for Type 3 (metallic liner) composite tanks. At the moment, there is a lot of ongoing consternation about adopting Type 4 (polymer liner) and Type 5 (no liner) composite tanks, where we are struggling to agree on requirements, let alone flight certification milestones. The input we keep hearing from our Spacecraft Working Group teammates is that there isn't enough guidance out there on actually HOW to develop + test & certify. CMH-17 Volume 1 has some stuff in there about fiber and filament winding... but virtually nothing in Volume 3. We added a subsection on this topic, but it's terribly weak. And, as we consider the future... this is an area that warrants more work.		
Composite Pressurized Habitable Volumes. This is an area that apparently has been successfully addressed for aviation, as you have already certified composite fuselage structures. For space, gas LEAKAGE due to matrix microcracking after proof/acceptance testing & cyclic fatigue is a huge challenge for us. Design features like penetration seals are also very challenging. For us, we need VERY LOW leak rates in order to minimize expendables. For aviation, I assume one must simply validate that you can "feed the leak" with the ECLSS system... and if things go bad, you can always reduce altitude in flight.		
"Liner-less" cryogenic storage (e.g. H ₂ , O ₂). NASA has spent considerable \$\$\$s on tech development for our launch vehicle applications, and have made great strides over the years. Our lunar and mars exploration programs demand even more mass-efficient solutions. For aviation, I keep hearing about Hydrogen for combustion and H ₂ + O ₂ for fuel cells. Composite storage systems are here to "help"... But, how far away is this?		

68

5/9/2024

Proposed New Taskings - Example		
CMH-17 COMPOSITE MATERIALS HANDBOOK		
Description	Approve?	Notes
Vol 5 Engines - Large list of V5C19 topics may be applicable to PMC. 19.1.1.1 Material Properties 19.1.2 Thermal degradation (Consider whether additional subsections are warranted for CMCs. Alternatively, there may be a reference to other V5 sections) 19.6 Defects and Damage Tolerance 19.6.1 General Considerations 19.6.2 Manufacturing Defects & Damage 19.6.3 Service Induced Damage 19.2.1.3 Thermal Stresses 19.2.1.4 Design Procedures 19.2.3 Blade Containment and Rotor Imbalance (may not have much, if any, CMC-oriented content) 19.2.4.4 Hard Body Threats 19.2.4.5 Rotor-Stator Clashing 19.2.5 Erosion (Currently includes two very basic paragraphs and a reference to Volume 3 for information on PMCs and their erosion coatings) 19.2.6 Wear (current content is oriented to PMCs) 19.2.8 Lightning 19.3.4 Non-Prepreg Systems (PMC-specific information is limited to Volume 3) 19.3.5 Advanced Fiber Architectures (PM C-specific information is limited to Vol 3) 19.3.8 Hybrid Composite-Metal Designs 19.4.1 Aging (current content on aging of PMCs is limited to Vol 3) 19.4.3 Impact and High Strain Rate 19.4.4 Vibration 19.5 Analysis 19.5.1 Role and Analysis in Certification and Continued Airworthiness 19.5.2 Types of Analysis Having Special Usage for Engines 19.5.3 Components and Design Examples 19.5.4 Analysis Validation		

69

Proposed New Taskings		
CMH-17 COMPOSITE MATERIALS HANDBOOK		
Description	Approve?	Notes

70

5/9/2024

Planned approach



Last YP cycle (by WG/TG Chairs)	Receipt & Check (by Secretariat)	Secretariat & WSU Review	Content review (by WG/TG Chairs)
- Resolve all comments and negative votes - Send draft, images, YP resolution comments to Secretariat	- Receipt of draft from Chairs with all incorporated content - Request record of YP resolution - Verify that YP sections have been included - Compile Summary of Changes <i>Submit draft to Chairs who need a pre-edit review (by request)</i>	- Content Flow - Formatting - Grammar & spelling - References, links, formulas - Any additional Proof Read that may be needed - WSU to review – Spell check & general formatting - Content to be returned to WG/TG chairs for approval of edits	- Any sentence/text/reference corrections will be provided to Chairs for approval/acceptance - Formatting will be changed as needed unless it alters the flow of the content (i.e. whether smaller sub sections have header numbers or not, etc.) - This is also expected to be final review of the chapter by the Chairs .

71

Planned approach - continued



Return of reviewed content to Secretariat	Volunteer Volume review	SAE Publications
Completion of edit review with WG/TG chairs	Review of entirety of Volume by Volunteers	- Conversion of files to SAE - Final lookover of content by SAE - Submit for publication

72

5/9/2024

AC(1)

What's New



- Website
- Statistics Software
- Awards Process
 - Nomination Form

73

Website



- Public site should be up and running by fall
- Members site might take more time
 - May need to run trials on some pages
 - Will reach out for member roster updates

74

5/9/2024

Discussion on Websites

CMH17

COMPOSITE MATERIALS HANDBOOK

- **Confluence:**
 - Steep learning curve; accessibility issues (firewall)
 - Likes live editing
 - Confluence for file transfer (Forum can supplement this)
- **Sharepoint maybe?**
- **! Accessibility from all companies**
 - Harder access to platforms with a lot of file sharing

75

Plans for New Website

CMH17

COMPOSITE MATERIALS HANDBOOK

- Public space – WSU hosted
- Be ADA compliant
 - Registration page
 - Introduction to organization
 - Description of WG/TG, awards, etc.
 - Purchasing Handbook and Software
 - General Announcements

- Working Space – separate site
- Any content available after log-in
 - Forums
 - Balloting
 - Proceedings, documents, archives
 - Will reach out to clean up members list

76

5/9/2024

Members Working Space

CMH17 COMPOSITE MATERIALS HANDBOOK

Takes you to your account settings

Manages

CMH17 Composites Material Handbook

Home Search Announcements Introduction Organization Contribution Dashboard Descriptive **Ballot** Feedback

Documents Research Materials Awards Members

Show All Documents

Ballot: PMAC Yellow Page 2nd Cycle
PMAC Yellow Page 2nd Cycle - September 2022 Meeting

Close Date: 12/31/2024
Voting Completed: NO

View Ballot

List of open ballot will show here. Title, dates and if you've voted

77

Members Working Space

CMH17 COMPOSITE MATERIALS HANDBOOK

BALLOT

PMAC Yellow Page 2nd Cycle
PMAC Yellow Page 2nd Cycle - September 2022 Meeting

Close Date: 12/31/2024 Date: 04/13/2024

DOCUMENTS

Chapter/Section 5.4.2
Materials and Procedures Review

Vote options

AFFIRMATIVE
NEGATIVE
ABSTAIN

Input Document Description

Upload Document File

Add Document

Uploading files with comments

Download content

Comments must accompany negative votes

78

5/9/2024

Statistics Software

CMH17

COMPOSITE MATERIALS HANDBOOK

- Python based
 - Making it more robust to accommodate different groupings
- In trial/validation phase (beta testing)
 - Small groups of users testing the program
 - Verification of numerical results and formulas
 - Still gathering volunteers to test
- Unsure of UI at this time
 - Windows or web-based
 - Need to ensure security of data

79

Awards

CMH17

COMPOSITE MATERIALS HANDBOOK

- Award criteria/guidelines for evaluation of nominees
 - Encourage WG/TG chairs to recognize contributors – Appreciation Award
- Form for nomination
 - Submit to info@cmh17.org
- Post on site for download once new sites are up

80

5/9/2024

Awards



Award Categories (select one):

☐ **Appreciation Award**
An award given to persons regardless of signing service to the handbook. Nominations are submitted from the Working Group Chairs, and the membership at large with approval from the Leader's Committee. A CMH-17 lettering accompanies the award. Four awards are listed on the CMH-17 website.

☐ **Interdisciplinary Service Awards**
For exceptional contributions to the handbook. This award is typically given at the completion of some service. Examples include writing chapters, or editing sections with major contributions. In many cases, the nominees have organized and/or participated in, and served as a key responsibility within the handbook. The Executive Committee makes recommendations for the award, which must then be approved by the Leader's Committee. A CMH-17 website. Please accompany the award. Four winners are listed on the CMH-17 website.

☐ **The Award of Merit**
The Award of Merit is CMH-17's highest award for major service toward advancing the handbook. The Executive Committee makes recommendations for the award, which must then be approved by the Leader's Committee. A CMH-17 website. Please accompany the award. Four winners are listed on the CMH-17 website.

Secretariat Use Only:

Leader Review: _____

Approval of Signature: _____

Date: _____ Approved ☐ Denied ☐

Comments: _____

Approval of Award Title: _____

Approved ☐ Denied ☐

Comments: _____

Printer of Award: _____

Nominator: _____ **Issue Identification:** _____

Affiliated VTC (if any): _____

Witness: _____

Affiliated VTC (if any): _____

Description of Contribution (must contain sign is document): _____

81

CMH-17 Mission, Vision, Goals, etc.



- The CMH-17 website provides organizational Mission, Vision, and Goals
- The Standard Operating Procedure provides different Mission, Vision and Goals
- The beginning of each volume also includes different variations of this information
- Need to update
 - Include AM
 - Need to decide: aviation focus, level of emphasis on data
 - Will send through a joint yellow page vote

About CMH-17

The Composite Materials Handbook-17 (CMH-17) provides information and guidance necessary to design and fabricate and 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.

Mission

Composite Materials Handbook creates, publishes and maintains proven, reliable engineering information and standards, supported by thorough technical review, to support the development and use of composite materials and structures.

Vision

Composite Materials Handbook will be the authoritative worldwide focal point for technical information on composite materials and structures.

Goals and Objectives

- Periodically meet with experts from the field to discuss critical technical issues for composite structural applications, with an emphasis on increasing overall product safety.
- Provide comprehensive, practical engineering guidance that has proven reliable for the design, fabrication, characterization, test and maintenance of composites.
- Provide reliable data, linked to control of processes and raw materials, thereby being a comprehensive source of material property values and design information that can be shared within the industry.
- Provide a resource for composites education with examples, applications and references to supporting engineering work.
- Establish guidelines for use of information, identifying the limitations of the data and methods.
- Provide guidelines with references to proven standards & engineering practices.
- Provide for periodic updates to maintain the all-inclusive nature of the information.
- Provide information in formats best-suited for user needs.
- Serve the needs of the international composite community through member industries represented, which use teamwork and the diverse member engineering skills to provide information for the handbook.

2

5/9/2024

Proposal – First Strawman

CMH-17

COMPOSITE MATERIALS HANDBOOK

About CMH-17

The Composite Materials Handbook (CMH-17) provides information and guidance necessary to design and fabricate end items from composite and non-metallic additively manufactured (AM) materials. Its primary purpose is the standardization of engineering methodologies related to testing, data development, reduction, and reporting of current and emerging composite and non-metallic AM materials. In support of this objective, the handbook includes material properties that meet specific data requirements. In addition to providing material data and instructions on how to develop it, the Handbook provides industry best practices for design, manufacture, substantiation, and sustainability. The Handbook therefore constitutes an overview of composites and non-metallic AM technology and engineering, an area which is advancing and changing rapidly. As a result, the document is continuously being updated as sections are added or modified to reflect advances in the state-of-the-art.

Mission

The Composite Materials Handbook organization creates, publishes and maintains proven, reliable engineering information and standards, subjected to thorough technical review, to support the development and use of composite and non-metallic additively manufactured materials and structures.

83

Proposal – First Strawman (continued)

CMH-17

COMPOSITE MATERIALS HANDBOOK

Vision

The Composite Materials Handbook will be the authoritative worldwide focal point for technical information on composite and non-metallic additively manufactured materials and structures.

Goals and Objectives

- Provide comprehensive, practical engineering guidance that has proven reliable for the design, fabrication, characterization, test and maintenance of composites and AM
- Provide reliable data, linked to control of processes and raw materials, thereby being a source of material property basis values and design information that can be shared within the industry
- Evaluate the content, including examples, applications, lessons learned and supporting engineering guidelines that outline limitations, strengths and weaknesses
- Promote safe use of composites and AM
- Promote efficient methods for design, test, analysis, and quality assurance
- Provide **educational resources**, both through the handbook content and in-person training/content review
- Establish relationships with other standards organizations and engineering handbooks with similar goals to jointly develop and maintain consistent information to benefit applications

84

5/9/2024

Feedback



- *Feedback on this Joint Meeting (What worked and what didn't)*
 - Most liked joint meeting
 - Need detailed schedule sooner for travel
 - Small CMC attendance – to identify why
 - Do we want to allow WG/TG member to attend that session only? No.
 - Distinguish monthly meeting vs recurring meeting
 - How to make a meeting valuable
 - In Joint meet – identify the CG focus, like a header/footer on slide
 - Please get coffee through the day!
 - Food and IT support was good.

85

Fall Meeting Dates



• Fall Meeting – Joint – Virtual format – Tutorial? – Dates TBD • Late September – Week around Sept 30 • Early November – Week of 11 and 18 – Nov 11 is Veterans day • Secretariat unavailable Oct 10th to Nov 1st.	• Proposed Dates? • Spring 2025 set week of May 12 at Wichita State Univ. – In person only
---	---

To do tutorials on request, independent of the meeting.

86

43

5/9/2024

Actions



- Submit your WG slides & Minutes to Secretariat Due May 3rd
- Meeting survey
- Move towards YP target dates
- Submit completed draft to Secretariat
 - Make sure all comments have been resolved
 - Format as best you can, we'll take care of the rest
 - If you have multiple sections in a Chapter, please consolidate!
 - Email as a complete
 - Section (heading 2) – if only one or two sections have been edited
 - Chapter (heading 1) – if content in chapter has been edited
 - FTP can be set up for larger files
- Mission/Vision/Goals Actions

AC(0)
87



Thank you for your
continued support!

88

SUMMARY OF MEETING MINUTES

The following minutes are mainly from discussions during the CMH-17 Executive Committee meeting on Friday

Re: Joint meeting

- General reception of the joint meeting was positive
- There are still requests to have coordination group specific meeting to discuss topics relevant to their industry/volumes
- To evaluate how we can better improve attendance by increasing value of the meeting

Re: Handbook audience

- We do not want to limit ourselves to aerospace only
- To consider who the current audience is and to seek additional contributors that may be in different fields of application
- Our publication cycle may be too long for some users/industries (change to publication process may help with this)
- We are the source of information despite different technologies and their varying requirements
- As we re-work our mission, vision, and goals, we can focus that to reflect who are target audience is and where our focus lies

Re: Yellow Pages

- Yellow pages will now run on a pre-determined cycle
 - o A date shall be set for when content is due to the Secretariat
 - o There will be a ballot cycles every 2-3 months (this will depend on chairs input and how well the first ballot cycle works)
 - o Review period for a ballot will be 6 weeks
 - o One email with ballot content for AM, CMC, and PMC coordination groups will be emailed to the CMH-17 community
 - o Ballots will be organized in section by coordination group to allow ease of download/review by reviewers
 - o Any input can be submitted to info@cmh17.org

Re: Publication process

- Ideas are still being discussed
- One option is to release the handbook by date instead of alphabetical revisions
- To consider how the handbook would be purchased; by release or subscription format

Re: Members accounts

- Efforts will be made to update members roster. This includes clearing old/inactive accounts

Re: Future Taskings

- A discussion was had on how to manage new taskings for the handbook; proposals for content updates/edits, new topics, etc.
- A new process will be implemented to obtain and track suggestions for proposed changes/edits
- A spreadsheet will be used to track proposals and tasks for the handbook
 - o Proposals can be submitted by any member to the Secretariat
 - o New proposals will be review by Joint Guidelines WG and if accepted will be assigned relevant information to track the life of the task
 - o Secretariat will communicate the acceptance/rejection of the task to the proponent

Re: Future Meetings

- Fall 2024 meeting will be virtual – Dates are TBD
- Spring 2025 meeting will be in-person only in Wichita, KS during the week of May 12th

WORKING GROUP REPORTS

(listed Alphabetically)

Working group reports are provided as a separate document to help with management of file size. Available reports from each working group is listed below following by the link where they can be downloaded.

Content for Joint Working Groups are *included* in this document.

AM DATA REVIEW

AM DESIGN AND ANALYSIS

AM GUIDELINES

AM MATERIALS AND PROCESS

AM TESTING

[AM WORKING GROUP FILES LOCATED HERE](#)

CMC DATA REVIEW

CMC MATERIALS AND PROCESSES

CMC TESTING

[CMC WORKING GROUP FILES LOCATED HERE](#)

JOINT ENGINE APPLICATIONS

5/16/2024

Engine Applications Working Group

CMH17

COMPOSITE MATERIALS HANDBOOK

Working Group Meeting Agenda

- Working Group Overview - Mission, Membership, Rhythm
- Vol. 3 Rev H and Vol. 5 Rev B Submissions
- Review Current WG Scope and Discuss Whether Expanded Scope is Desired
- Review Chapter Outline and Status of Planned Sections
- 2024 Working Group Plans
- Summary & Actions

Engine Applications Working Group

Spring 2024 Coordination Meeting

1

Mission

CMH17

COMPOSITE MATERIALS HANDBOOK

Charter:

Improve the usefulness of CMH17 to the aircraft engine technical community by:

- developing new CMH17 content specific to aircraft engines for both rotating and stationary parts (excluding nacelles and pylons);
- summarizing how existing CMH17 content applies to typical design, materials, manufacturing, maintenance, and certification activities for aircraft engine composite parts;
- documenting industry best practices for the use of composites in aircraft engines; and
- ensuring consistent content across PMC and CMC volumes.

Note that current scope is intentionally limited to engines only.

- for commercial applications, this is the part of the powerplant certified under FAA Part 33 rules
- for example, does not include the nacelle or propellers
- content developed to date has been oriented to gas turbine engines, but that is because it is dominant engine type and not because of intentional scope limitation

CMH Chapters: Vol. 3, Chapter 20 and Vol. 5, Chapter 19

Engine Applications Working Group

Spring 2024 Coordination Meeting

2

5/16/2024

Membership & Rhythm

Engine Applications Working Group



Current Contributors

Scott Finn GE(Ret.), WG Co-Chair	Jason Hamp P&W
James Finlayson RR, WG Co-Chair	DM Hoyt NSE Composites
Cindy Ashforth FAA	Nick Kray GE
Michelle Man NIAR, CMH-17	Greg Gemeinhardt GE
Andrew Pringle NIAR, CMH-17	Tim Mouzakis FAA
Barry Barnett P&W	Jeff Stillinger FAA
Gary Bond P&W	Ariza Oscar P&W
Todd Bullions GE	Kevin Rugg P&W
Rick Cole NRC	Simon Waite EASA
Steve Connor P&W	Matthew Zsunkan P&W
Matthieu Gimat SAFRAN	

Operating Cadence

- Monthly phone calls, 2nd Tuesday of each month 11:00-12:00 US Eastern time.

*If you are interested in actively participating in the working group, please contact:
 Scott Finn (finn@ge.com) or
 James Finlayson (james.Finlayson@rolls-royce.com)*

Engine Applications Working Group

Spring 2024 Coordination Meeting

3

Next CMH Revisions – Submission Status



- Content for Volume 3 and Volume 5 went through their respective Yellow Pages ... and all negative votes have been successfully resolved
- No further update is planned for next revisions (Vol. 3: Rev H; Vol. 5: Rev B)
- Final text incorporating all comments has been submitted to CMH17 Secretariat

Will do a quick walk-through of submitted content after reviewing the outline later in this session

Engine Applications Working Group

Spring 2024 Coordination Meeting

4

5/16/2024

Scope Discussion - Background



- Current scope of working group is **limited to engines** with a particular focus on gas turbine engines
 - Need for engines-focused working group was identified in 2019 FAA Workshop on Composites in Engines and was formed as a result
 - does not include nacelle or propellers (consistent with part of powerplant covered by FAA Part 33)
 - current industry contributors are all from engine OEMs (GE, Rolls Royce, Pratt & Whitney, SAFRAN); so are consistent with scope
- During working group meetings, questions have come up on whether we should increase scope
 - Propellers for electric aircraft, in particular, have drawn attention

Soliciting any feedback on whether expanded scope is warranted and how that might be accomplished (e.g. engagement of new members from those communities)

Engine Applications Working Group

Spring 2024 Coordination Meeting

5

Propeller Discussion – Pending Audience Interest



Some Propeller Background:

- Composite Propellers have been certified and in revenue service on commercial and military aircraft for 30-40 years
- FAA Part 35 provides airworthiness standards for propellers
- ASTM F44 Committee works on standards for propeller systems
- FAA Advisory Circulars covering composite propellers exist (for example 35-1, 35-37 specifically include composite propellers)
- Growing interest in electric aircraft may be expanding propeller usage into new design spaces and different industrial players than legacy propeller systems.

6

5/16/2024

Review Chapter Outline – Section Level Overview



Chapter 20 Engine Applications

- 20.1 Introduction
- 20.2 Design Considerations
- 20.3 Typical Materials and Manufacturing Processes
- 20.4 Specialized Testing
- 20.5 Analysis
- 20.6 Defects and Damage Tolerance

Key:
Black – Complete
Blue - Partial Content
Red - Planned

Note: Engine Applications will be Chapter 20 in Vol. 3, Rev. H; most of the same content will be in Chapter 19 of Vol. 5, Rev. B

Engine Applications Working Group

Spring 2024 Coordination Meeting

7

Section Walk-Through



- Open Confluence pages and do a brief walk-through

<https://cmh17.atlassian.net/wiki/spaces/EA/overview>

Engine Applications Working Group

Spring 2024 Coordination Meeting

8

5/16/2024

2024 Working Group Plans

CMH-17

COMPOSITE MATERIALS HANDBOOK

➤ Primary 2024 Goal is to complete Section 20.2 Design Considerations*

Subsection	Status	Current Status	Focal
20.2.1 Thermal	Some content, but more needed	Added bullet points for possible additional content and references to Confluence page	Finn
20.2.2 Fatigue and Vibration	Some content, but more needed	Should coordinate with Vol. 3 Chapter 12, Scott hopes to discuss with Hoyt at Coordination Meeting?	Finn
20.2.3 Blade Containment and Rotor Imbalance	Placeholder only	James added some additional bullet point to Confluence. Received additional thoughts from Nick.	Finlayson/Kray
20.2.4 Impact	Mostly complete, but want some additional content	To be addressed after blade-out started	Finlayson/Kray
20.2.5 Erosion	PMC section complete, want section on CMC	Scott sent Greg some thoughts on content, identified some recent NASA work that could be useful (or coordinate with Vol. 5 M&P if they want it in their section)	Gemeinhart
20.2.6 Wear	Complete section; no update currently planned		
20.2.7 Fire	Complete section; no update currently planned		
20.2.8 Lightning	Placeholder only	Confirmed with Rob Steinle (FAA) on his willingness to participate. Scott and James looking at possible dates for discussion with Rob	Steinle/TBD

**will be appreciative of any help on other sections from interested parties though :)*

Engine Applications Working Group

Spring 2024 Coordination Meeting

9

Summary

CMH-17

COMPOSITE MATERIALS HANDBOOK

Summary:

- Working Group is active and has regular monthly meetings; ***new contributing members are welcome***
- Planned Content for Vol. 3, Rev. H and Vol. 5, Rev. B is fully approved and sent to CMH-17 secretariat for final editing, formatting, and incorporation
- Approximately ½ of planned engine content is now complete
- 2024 focus will be to complete Design Considerations section
- Will review WG scope as need arises

Engine Applications Working Group

Spring 2024 Coordination Meeting

10

5/16/2024

Meeting Notes pg. 1 of 2

CMH17

COMPOSITE MATERIALS HANDBOOK

Propeller related comments:

Any content would be developed for future revisions (not Rev H)

Olivier Picot (Ratier-Collins) participated by phone

- Ratier starting to get into small aircraft propellers
- Not currently engaged in ASTM F44
- Olivier noted that there was a significant enough difference between our content and what was more appropriate for propellers, providing justification for scoping additional content.
- Agreed to continue to participate in scoping activity

ASTM F44 comments:

- **May** be more focused on integration and less on propellers themselves

Next steps discussed (pending leadership agreement at closing coordination):

- Identify additional propeller stakeholders
 - Suggestions: Hartzell, Hamilton, Dowty
 - Attendee from A&P offered to provide contacts
- Reach out to ASTM F44
 - Understand what efforts are underway or being contemplated
 - Hoyt provided name and email of ASTM focal for F44
 - Once we identify other propeller people, we could determine how they interact with F44
- Identify propeller topics that should be included somewhere in the Handbook
- Develop recommendation & bring back to leadership at future meeting

11

Meeting Notes pg. 2 of 2

CMH17

COMPOSITE MATERIALS HANDBOOK

Section Walkthrough

- There was a good discussion on the basis for what Factors of Safety (temperature and strength) are appropriate in Engine Applications. These can be 1.5 – 2 for propellers and critical parts of the Airframe. It was discussed how these vary in on engines components dependent on the criticality of failure. Rather than just listing these, it was proposed that it would be good to have a new sub-section in Design Considerations that discussed potentially hazardous engine failure modes and what components are key to preventing these. From this, it would lead to a more general, performance based principles approach which would be more useful and future-proof.

Other Comments

- Consider adding additional references to other Handbook chapters – particularly in materials section. Could even still get this into Volume 3 Rev. H and Volume 5 Rev. B if we wanted.
- A better definition about where the division is between "engine" and "nacelle" would be useful. (Note: there is some definition of "engine" at the following FAA link: <https://www.ecfr.gov/current/title-14/chapter-I/subchapter-A/part-1/section-1.1>. It also explicitly includes "nacelle" as part of airframe and states that propellers are not part of engine).
- Post WG meeting: Ken Kawanishi (IH) discussed how IH might be more engaged. He will identify possible participants from their design groups. The time of our monthly meetings will be a challenge for participation. I suggested that after he identifies interested parties, we could have a phone call to discuss with them how best to interact.

12

JOINT STATISTICS

Statistics Working Group (Joint) 24 April 2024 Scottsdale, AZ

- Minutes from 2023 Wichita meeting were reviewed and approved. Shannon Jones moved to accept, Michael Hempowicz seconded.
- Status of Volume 7 Chapter 8 content was reviewed.
- Brice Langston gave presentation on SPC and recommended some changes to improve the discussion of SPC in the Handbook.
 - Some changes to Volume 1 Section 8.4.5 were recommended, as well as some improvements to Volume 3 Section 6.2.2.2 [n.b: this section is owned by M&P].
 - Brice also noted that additional discussion of process capability would be beneficial.
- Jorge Chavez-Salas gave a presentation on some apparent bugs in the current CMH17-STATS software.
 - He noted that the software performs a normality test on each condition before pooling and performing a normality test on the pooled data: the first test for normality for each condition is not in the Volume 1 Chapter 8 flowchart. This may incorrectly prevent pooling of conditions unless the user overrides the Anderson-Darling normality test.
 - He also noted that the current software has a very minor numerical accuracy issue for the ANOVA method (for example, 95.053 vs. 95.055): it was noted by an audience member that such a magnitude of inaccuracy has no engineering significance.
 - Jorge noted that there is no option in the current software to compute single-point normal Basis values using Modified CV.
 - Jorge noted that there is an apparent bug in the “Fcalculated” values computed by the current software for Levene’s test after the Mod CV transformation.
- There was a discussion of grouping strategies for the ANOVA method of computing Basis values. The proposal of grouping data according to batch/panel combinations, rather than grouping by material batch was discussed.
 - This topic is of particular interest to CMC where there is significant between-panel/cycle variance.
 - Jorge Chavez-Salas presented some experience with analyzing the Axion AX-7800 dataset.
 - Stefan Kloppenborg presented a simulation study to investigate the properties of the ANOVA approach when there are nested sources of variance. He found that the grouping the data by batch/panel (ignoring the nested structure of the data) produces non-conservative B-Basis values except when batch variance is small. He also found that a proposed “flowchart” approach that uses the ADK test to determine how to group the data produces non-conservative B-Basis values due to

the low statistical power of the ADK test. The key recommendation was that grouping strategy needs to be based on judgement informed by experience with similar material systems, graphical techniques, etc.

- Stefan Kloppenborg briefly introduced the cmstatR package, which provides an implementation of the CMH-17 statistical methods for the R language.

PRESENTATION

[JOINT STATISTICS WORKING GROUP FILES LOCATED HERE](#)

PMC BONDING

PMC CRASHWORTHINESS

PMC DAMAGE TOLLERANCE

PMC DATA REVEIW

PMC DESIGN

PMC GUIDELINES

PMC MATERIALS AND PROCESSES

PMC SAFETY MANAGEMENT

PMC SANDWICH

PMC SPACECRAFT

PMC SUPPORTABILITY

[PMC WORKING GROUP FILES LOCATED HERE](#)

FINAL ATTENDANCE LIST

First Name	Last Name	Attendee Email
Aaron	Buchok	abuchok@renegadematerials.com
Ahmet	Oztekin	oztekin.ahmet@faa.gov
Akhil	Bhasin	akhil.bhasin@idp.wichita.edu
Alan	Byar	alan.d.byar@boeing.com
Alexander	Bartoletti	alex.bartoletti@wisk.aero
Alexandra	Desautels	adesautels@bellflight.com
Alice	MARIN	alice.marin@airbus.com
Allen	Fawcett	allen7e7@msn.com
Allison	Clark	allison.clark@airbus.com
Allison	Horner	allison.horner@idp.wichita.edu
Alyssa	Zamora	alyssa.zamora.civ@us.navy.mil
Amanda	Bastian	amanda.bastian@jobyaviation.cm
Amanda	Panikowski	amanda.panikowski@henkel.com
Amanda	Cordes	amanda.cordes@hexcel.com
Amit	Chib	amit.chib@gulfsteram.com
Amy	Jenkins	amy.jenkins@teijinaramid.com
Andre	De Jesus	andre.dejesus@collins.com
Andrew	Foose	andrew.foose@gulfstream.com
Andrew	Pringle	awpringle8@gmail.com
Andries	Buitenhuis	andries.buitenhuis@boom.aero
Angie	Kostopoulos	Evangelia.kostopoulos@faa.gov
Ashley	Holcombe	ashley.m.romans@boeing.com
Aswini	Kona	aswini.konaravi@idp.wichita.edu
Austin	Nordyke	austin.nordyke@idp.wichita.edu
Aziz	Ahmed	aziz.ahmed@faa.gov
Bassam	Ishak	Bassam.ishak@compositesone.com
Bazle	Haque	bazle.z.haque@nasa.gov
Ben	Names	ben.names@wisk.aero
Benoit	Morlet	benoit.morlet@dassault-aviation.com
Bijan	Deris	bijan.deris@boeing.com
Bob	Zhou	yuanxin.zhou@ge.com
Brian	Kitt	Brian.kitt@spiritaero.com
Brice	Langston	blangston@teijincarbon.us
Brock	Strunk	brock@epicaircraft.com
Caitlin	Duffner	caitlin.duffner@us.af.mil
Canaan	Gebru	Canaan.GeBru@collins.com
Carl	Rousseau	carl.q.rousseau@lmco.com
Cecilia	Wilson	cecilia.l.wilson@lmco.com
Center	Ballroom	anordyke@niar.wichita.edu

Cezar	Moisiade	cezar.moisiade@gulfstream.com
Chad	Franks	chad.franks@ga-asi.com
Chaiane	Wiggers	chaiane.souza@wisk.aero
Charles	Hill	charles.hill@axiomspace.com
Chelsea	Pickett	Chelsea.c.pickett@nasa.gov
Chris	Croshaw	Chris.Croshaw@collins.com
Christine	Mills	christine.j.mills@nasa.gov
Christos	Kassapoglou	c.kassapoglou@tudelft.nl
Cindy	Ashforth	cindy.ashforth@faa.gov
Claude	Boucher	claudio.boucher@airbus.com
Dan	Adams	Dan@wyomingtestfixtures.com
Dan	Ruffner	danielruffner@gmail.com
Daniel	Harris	daniel.p.harris@nasa.gov
Daniel	Rust	Daniel.rust@ngc.com
Danielle	Stephens	danielle.stephens@faa.gov
Dave	Stone	david.l.stone8.civ@army.mil
Dm	Hoyt	hoyt@nsecomposites.com
Doug	Kiser	james.d.kiser@nasa.gov
Ed	Harris	edward.w.harris.1981@gmail.com
Eileen	Kutscha	eileen.o.kutscha@boeing.com
Elisa	Buckner	elisa.buckner@ngc.com
Ellen	Steffes	ellen.steffes@delta.com
Elliott	Schulte	eschulte@bellflight.com
Engin	Sabuncu	esabuncu@txtav.com
Eric	Moyer	eric.k.moyer@boeing.com
Eric	Pomerleau	eric.pomerleau@aero.bombardier.com
Eric	Stenne	stenne@videotron.ca
Errick	Robles	errick.robles@idp.wichita.edu
Evelyn	Lian	evelyn.lian@idp.wichita.edu
Fadi	Iskander	fadi.iskander@ga-asi.com
Fei	Liang	fei.liang@gulfstream.com
France	Theriault	france.theriault@aero.bombardier.com
Frank	Dixon	fdixon@ups.com
Fred	Caplan	frederick.n.caplan@faa.gov
Gilberto	Niitsu	gilberto.niitsu@embraer.com.br
Gina	Miller	gina.m.miller@boeing.com
Govind	Raj	govind.b.raj@spiritaero.com
Greg	Gemeinhardt	gregory.gemeinhardt@ge.com
Greg	Schmidt	Greg.Schmidt@TorayCMA.com
Guillaume	MASSE	guillaume.masse@airbus.com
Hangki	Lee	hangki.lee@boeing.com
Heidi	Zierden	heidi.zierden@mttechservices.com
Holly	Thomas	holly.j.thomas@boeing.com

Hossein	Ghiasi	mhghiasi@beta.team
Hossein	Namazfard	Hossein.Namazfard@Honeywell.com
Howard	Creel	hscreel@mmm.com
Humayun	Kabir	mohammed.h.kabir@boeing.com
Isaac	Rusch	isaacr@epicaircraft.com
Isaiah	Kaiser	isaiah.kaiser@ltaresearch.com
Jake	Gibbs	jacob.gibbs@hexcel.com
James	Finlayson	james.finlayson@rolls-royce.com
James	Matheson	James.Matheson@aero.bombardier.com
Jan	Waleson	jan.waleson@fokker.com
Janna	Mckenna	jmckenna@txtav.com
Jason	Gibson	jason.gibson@compositesone.com
Jason	Hamp	jason.hamp@prattwhitney.com
Jay	Yeakle	jyeakle@cirrusaircraft.com
Jeff	Bozak	jeffrey.a.bozak@boeing.com
Jeff	Eichinger	jeffrey.d.eichinger@boeing.com
Jeff	Johnson	jeffrey.d.johnson@faa.gov
Jennifer	Galvin	jennifer.m.galvin@dupont.com
Jennifer	Lemmers	Jennifer.LemmersEspana@toraycma.com
Jennifer	Mckeegan	jmckeegan@paragonsdc.com
Jeremy	Jacobs	jeremy.b.jacobs@nasa.gov
John	Keune	john.n.keune@boeing.com
John	Moylan	john.moylan@element.com
John	Nibe	john.r.nibe@boeing.com
John	Shaw	john.shaw@prattwhitney.com
John	Tomblin	john.tomblin@idp.wichita.edu
Jonathan	John	jonathan.john@idp.wichita.edu
Jorge	Chavez-Salas	jorge.chavez-salas@idp.wichita.edu
Joseph	Costanzo	joseph.c.costanzo@boeing.com
Joshua	Graham	joshua.graham@delta.com
Justin	Massey	justin.t.massey4.civ@us.navy.mil
Kara	Storage	kara.storage@us.af.mil
Keith	Friedman	kfriedman@friedmanresearch.com
Ken	Kawanishi	kawanishi6001@ihi-g.com
Kevin	Dupuis	kevin.dupuis@syensqo.com
Kevin	Stonaker	kevin.stonaker@faa.gov
Kyle	Hamlin	Kyle.r.hamlin.civ@army.mil
Kyohei	Otani	otani8715@ihi-g.com
Larry	Foster	larry.foster@wisk.aero
Larry	Gintert	gintertl06@gmail.com
Larry	Ilcewicz	larry.ilcewicz@faa.gov
Lawrence	Goedrich	L.Goedrich@gmail.com
Leanne	Lehman	leanne.l.lehman@boeing.com

Leon-Dufour	Jean-Luc	jean-luc.leon-dufour@airbus.com
Lindsay	Jones	lindsay.l.jones@boeing.com
Lisa	Mchugh	lisa.mchugh@ngc.com
Louis	Gauthier	lgauthier@beta.team
Lynn	Pham	lynn.pham@faa.gov
Małgorzata	Zalewska	Malgorzata.Zalewska@ilot.lukasiewicz.gov.pl
Maria Pia	Falaschetti	mariapi.falaschetti2@unibo.it
Mathieu	Comeau	mcomeau01@bellflight.com
Matthew	Opliger	matthew.opliger@idp.wichita.edu
Melanie	Herman	melanie.herman@easa.europa.eu
Michael	Bruyneel	michael.bruyneel@gdtech.eu
Michael	Gorelik	michael.gorelik@faa.gov
Michael	Hempowicz	michael.hempowicz@toraycma.com
Michael	Rush	michael.r.rush@boeing.com
Michelle	Man	michelle.man@idp.wichita.edu
Mike	Holt	mikeholt2112@gmail.com
Mike	O'Sullivan	mike.osullivan@spiritaero.com
Mike	Pereira	mike.pereira@nasa.gov
Mike	Smeets	mike.smeets@fokker.com
Moises	B	moises.buelna@joby.aero
Molly	Stone	molly@mtechengservices.com
Monica	Nogueira	monica.noguiera@sae.org
Monique	Wallace	wallace.k.monique@gmail.com
Mostafa	Rassaian	mostafa@rassaianllc.com
Naoya	MICHII	michii-n01wg@mlit.go.jp
Naresh	Sharma	naresh@nashero.com
Nathan	Jessie	njessie@braider.com
Nav	Muraliraj	nav.muraliraj@ngc.com
Nick	Kray	nick.kray@ge.com
Nicole	Stahl	Nicole.Stahl@idp.wichita.edu
Nihar	Desai	nihar.a.desai@boeing.com
Olivier	Picot	olivier.picot2@collins.com
Paige	Noble	pnoble@metcutctl.com
Paolo	Ballocchi	paolo.ballocchi@collins.com
Patrick	Phelan	patrick.phelan@collins.com
Paulo	Lourenco	paulo.lourenco@boeing.com
Philippe	Robert	probert@bellflight.com
Pooja	Shah	pooja.shah@delta.com
Purusottam	Sahoo	purush.sahoo@wisk.aero
Rachael	Andrulonis	rachael.andrulonis@idp.wichita.edu
Rajaneesh	Anantharaju	raja0037@ntu.edu.sg
Rajiv	Naik	rajiv.naik@uconn.edu
Ralf	Hilgers	ralf.hilgers@airbus.com

Ralph	Ocampo	ralph.ocampo@henkel.com
Richard	Cole	Rick.Cole@nrc-cnrc.gc.ca
Richard	Liou	richard.liou@collins.com
Riley	Harden	r.harden@toraytac-usa.com
Robert	Downs	robert.r.downs@spiritaero.com
Robert	Fu,	robert.fu@aero.org
Ronald	Krueger	ronald.krueger-1@nasa.gov
Royal	Lovingfoss	rlovingfoss@niar.wichita.edu
Rudy	Haluzza	rthaluzza@gmail.com
Russell	Kirkman	r.kirkman@toraytac-usa.com
Ryan	Andrade	ryan.andrade@wisk.aero
Ryan	Fahsbender	ryan.fahsbender@sierraspace.com
Ryan	Robinson	ryan.robinson@ngc.com
Ryo	Higuchi	higuchi@aastr.t.u-tokyo.ac.jp
Saadia	Naqvi	saadia.naqvi@toraycma.com
Sam	Cordner	samuel.m.cordner@nasa.gov
Samadi	Yoeuth	samadi.yoeuth@ga-asi.com
Samuel	Jasper	samuel.o.jasper@nasa.gov
Sarah	Cox	sarah.b.cox@nasa.gov
Scott	Finn	scottrfinn@gmail.com
Scott	Leemans	sjleemans@gmail.com
Sean	Killingsworth	skillingsworth@txtav.com
Shannon	Jones	ssjones@bellflight.com
Shunichi	Morishima	shunichi.morishima.ah@mhi.com
Silvio	Martino	Silvio.Martino@gulfstream.com
Simon	WAITE	simon.waite@easa.europa.eu
Sorin	Burlacu	sorin.burlacu@boom.aero
Stanley	Ng	Stanley.ng4.civ@us.navy.mil
Stefan	Kloppenborg	stefan@kloppenborg.ca
Stephanie	Kramig	skramig@braider.com
Stephanie	Svetlik-Haley	stephanie.svetlik-haley@fireflyspace.com
Steve	Starnes	stephen.d.starnes2.civ@us.navy.mil
Steven	Kyriakides	steven.a.kyriakides@boeing.com
Sung	Park	s.park@gmail.com
Sungin	Cho	sicho@ktl.re.kr
Susan	Danley	Susan.E.Danley@nasa.gov
Sylvina	Castillo	Sylvina.Castillo@idp.wichita.edu
Takahiro	Fukumaru	fukumaru6080@ihi-g.com
Tanila	Faria	tanila.faria@embraer.com.br
Tiffany	Radford	tiffany.m.radford2@boeing.com
Tim	Chavez	tcmk.timc@mail.com
Todd	Bullions	todd.bullions@ge.com
Toshiyasu	Fukuoka	toshiyasu.fukuoka.rt@mhi.com

Travis	Cope	travis.cope@gulfstream.com
Trent	Thorson	tthorson@beta.team
Trevor	Gundberg	tgundberg@vectorply.com
Tsubasa	Kawamoto	kawamoto-t97kf@mlit.go.jp
Vasileios	Lelos	vasileios.lelos@gulfstream.com
Vernon	Benson	vern.benson@ngc.com
Vinay	Goyal	vinay.k.goyal@nasa.gov
Vincent	Tanoto	Vinsensius.Tanoto@idp.wichita.edu
Virat	Mathur	virat.mathur@gulfstream.com
Walt	Sippel	walter.sippel@faa.gov
Waruna	Seneviratne	waruna.seneviratne@idp.wichita.edu
Wyatt	Taylor	w.taylor@toraytac-usa.com
Xiang	Li	xiang.li@wisk.aero
Xiaomei	Fang	xiaomei.fang@prattwhitney.com
Ying	Shi	ying.shi@boeing.com
Yongzhe	Tian	yongzhe.tian@faa.gov

INFORMATION ACCESS

HOMEPAGE

The World Wide Web homepage for the handbook is located at <http://www.cmh17.org>.

The Working Group Web Site is located at <https://www.cmh17.org>. A password can be obtained through the Secretariat (info@cmh17.org). Any active participant can obtain a password.

Coordination Group approved Proceedings, meeting information, RECIPE and other information are available at the website.

Select Coordination and Working Groups use a separate website for handbook development known as Confluence: <https://cmh17.atlassian.net/>. Any active participant of one of these groups can obtain an account from the Secretariat.

OBTAINING CMH-17

VOLUME 1 REVISION H (2022), VOLUME 2 REVISION H (2018) and VOLUME 3 REVISION G (2012), Volume 4B (2013), Volume 5A (2017) Volume 6 (2013)

Copies of published versions of CMH-17 Volumes 1, 2, 3, 4, 5 and 6 can be obtained from SAE only. (Link here: <https://www.cmh17.org/RESOURCES/Purchase-Handbook>) SAE offers a hardcopy version of the five volumes of the handbook (Volumes 1 and 2 – H, 3-G, 4-B, 6). Print and e-book versions are available.

SOFTWARE – CMH17-STATS

The statistical methods included in the Composite Materials Handbook are available in the newly released software - CMH17 STATS. This software (Excel based) is approved for use in CMH-17. For more information or to purchase CMH17 STATS, visit the online store –

<https://www.cmh17.org/RESOURCES/Statistics-Software>

Updated: 10/26/2022

CMH-17 LEADERSHIP

CMH-17 Handbook Co-Chair

Ms. Cindy Ashforth
FAA Aircraft Certification Service,
Policy and Innovation Division
2200 S. 216th Street
Des Moines, WA 98198
Tel: 206-231-3239
Email: cindy.ashforth@faa.gov

CMH-17 Senior Advisor

Dr. Larry Ilcewicz
FAA Aircraft Certification Service,
Policy and Innovation Division
2200 S 216th St, 3W-450
Des Moines, WA 98198
Tel: 206-231-3147
Email: larry.ilcewicz@faa.gov

CMH-17 AM Industry Leader

Mr. Rick Cole
NRC Aerospace
National Research Council Canada
(NRC)
Building M-3, 1200 Montreal Road,
Ottawa, Ontario, Canada K1A 0R6
Tel: 613-993-4058
E-mail: rick.cole@nrc-cnrc.gc.ca

CMH-17 PMC Industry Leader

Dr. Carl Q. Rousseau
Lockheed Martin Aeronautics
P.O. Box 748, MZ 6516
Fort Worth, TX 76101
Tel: 817-763-7727 Fax: 817-762-
5673
Email: carl.q.rousseau@lmco.com

CMH-17 Secretariat

Wichita State University
1845 Fairmount
Wichita, KS 67260-0093
Tel: 316-218-2773
Email: info@cmh17.org

CMH-17 Handbook Co-Chair

Dr. Ahmet Oztekin
FAA Research Program Manager
CCXQ+22 Atlantic City International
Airport, Egg Harbor Township, NJ 08405
Tel: 609-742-5532
Email: oztekin.ahmet@faa.gov

CMH-17 Senior Advisor

Dr. John S. Tomblin
Wichita State University
1845 Fairmount
Wichita, KS 67260-0093
Tel: 316-978-5234 Fax: 316-978-3175
Email: john.tomblin@wichita.edu

CMH-17 CMC Industry Leader

Mr. Doug Kiser
NASA Glenn Research Center
Cleveland, OH 44135
Tel: 216-433-3247
Fax: 216-433-5544
Email: james.d.kiser@nasa.gov

CMH-17 PMC Industry Leader

Mr. Stephen H. Ward
Email: shward@taosnet.com

AM WORKING GROUP CHAIRS

Data Review Chair

Seeking WG co-chair

Design and Analysis Cochair

Dr. Sung Park
NGC Aerospace Systems
One Hornet Way, M/S: L044DH, W2
El Segundo, CA 90245
Tel: 310-331-1836
Email: s.park@ngc.com

Design and Analysis Cochair

Ms. Elisa Buckner
NGC Aerospace Systems
Tel: 858-618-8733
Email: Elisa.Buckner@ngc.com

Guidelines Cochair

Mr. Rick Cole
NRC Aerospace
National Research Council Canada
(NRC)
Building M-3, 1200 Montreal Road,
Ottawa, Ontario, Canada K1A 0R6
Tel: 613-993-4058
E-mail: rick.cole@nrc-cnrc.gc.ca

Guidelines Cochair

Mr. Bijan Deris
Boeing
3003 Casino
Everett, WA, 98201
Tel: 425-309-6233
E-mail: bijan.deris@boeing.com

Materials & Processes Cochair

Dr. Fei Liang
Gulfstream Aerospace
Tel: 912-251-3012
Email: fei.liang@gulfstream.com

Materials & Processes Cochair

Ms. Chloe McGuffin
Markforged
Email: chloe.mcguffin@markforged.com

Materials & Processes Cochair

Mr. Eric Moyer
The Boeing Company
Tel: 610-597-1551
Email: eric.k.moyer@boeing.com

Statistics Cochair

Dr. Elizabeth Clarkson
WSU/NIAR
1845 Fairmount
Box 93
Wichita, KS 67260
Tel: 316-978-3952
Email: bclarkson@niar.wichita.edu

Statistics Cochair

Dr. Lindsay Jones
Boeing
Tel: +1 256-519-5700
Email: lindsay.l.jones@boeing.com

Statistics Cochair

Stefan Kloppenborg
7757 8th Street NE
Calgary, AB
Canada
T2E 8A2
Email: stefan@kloppenborg.ca

Testing Cochair

Mr. Joe Costanzo
Boeing
Tel: 425-750-6201
Email: joseph.c.costanzo@boeing.com

Testing Cochair

Mr. Brian Kitt
Spirit AeroSystems
PO Box 780008
Wichita, KS 67278
Tel: 316-523-3672
Email: brian.r.kitt@spiritaero.com

Testing Cochair

Mr. Royal Lovingfoss
National Institute for Aviation Research
1845 Fairmount
Wichita, KS 67260-0093
Tel: 316-978-5317
Email: rlovingfoss@niar.wichita.edu

CMC WORKING GROUP CHAIRS

Data Review Chair

Dr. Rajiv A. Naik
School of Engineering, Professional
Education
University of Connecticut
Storrs, CT 06269-4031
Email: rajiv.naik@uconn.edu

Design and Analysis Cochair

Mr. Arun Bhattacharya
Boeing
Tel: (714) 330-0053
Email: arunabh.bhattacharya@boeing.com

Design and Analysis Cochair

Mr. Arun Bhattacharya
Boeing
Tel: (714) 330-0053
Email: arunabh.bhattacharya@boeing.com

Engine Applications Cochair

Mr. Scott Finn
GE(Ret.)
Tel: (518) 207-7578
Email: scottrfinn@gmail.com

Engine Applications Cochair

Mr. James Finlayson
Rolls-Royce
Email: james.finlayson@rolls-royce.com

Materials & Processes Cochair

Mr. Doug Kiser
NASA Glenn Research Center
Cleveland, OH 44135
Tel: 216-433-3247
Fax: 216-433-5544
Email: james.d.kiser@nasa.gov

Materials & Processes Cochair

Ms. Leanne Lehman
The Boeing Company
14441 Astronautics Dr
Huntington Beach, CA 92647
Tel: 714-330-7190
Email: leanne.l.lehman@boeing.com

Testing Cochair

Mr. Matt Opliger
National Institute for Aviation Research
1845 Fairmount
Wichita, KS 67260-0093
Tel: 316-978-6672
Email: Matthew.Opliger@idp.wichita.edu

Testing Cochair

Dr. Bob Zhou
GE Aviation
Tel: 513-243-4497
Email: yuanxin.zhou@ge.com

PMC WORKING GROUP & TASK GROUP CHAIRS

Bonding Process Cochair

(Task Group under M&P)

Dr. Howard Creel

3M Automotive and Aerospace Solutions
Division

3M Center, 280-2W-21 |

St. Paul, MN 55144

Tel: 651-737-9955

Email: hscreel@mmm.com

Bonding Process Cochair

(Task Group under M&P)

Ms. Molly Stone

MTech Engineering Services, LLC

Tel: +1 218-260-9054

Email: molly@mtechengservices.com

Bonded Joints Cochair

(Task Group under Guidelines)

Mr. Rick Cole

National Research Council Canada
(NRC)

Building M-3, 1200 Montreal Road,
Ottawa, Ontario, Canada K1A 0R6

Tel: 613-993-4058

Fax: 613-998-8609

E-mail: rickcole@nrc-cnrc.gc.ca

Bonded Joints Cochair

(Task Group under Guidelines)

Dr. Carl Q. Rousseau

Lockheed Martin Aeronautics

P.O. Box 748, MZ 6516

Fort Worth, TX 76101

Tel: 817-763-7727 Fax: 817-762-5673

Email: carl.q.rousseau@lmco.com

Certification Cochair

(Task Group under Guidelines)

Ms. Cindy Ashforth

Federal Aviation Administration

2200 S. 216th Street

Des Moines, WA 98198

Tel: 206-231-3239

Email: cindy.ashforth@faa.gov

Certification Cochair

(Task Group under Guidelines)

Dr. Simon Waite

European Aviation Safety Agency
(EASA)

1 Ottoplatz

Koln 50679

GERMANY

Tel: 49-221-89990 4082

Fax: 49-221 89990 4582

Email: simon.waite@easa.europa.eu

Composites for Spacecraft Cochair

Mr. Jeffrey D. Eichinger

Boeing

5301 Bolsa Avenue

Huntington Beach, CA 92647

Tel: 714-317-0394 Fax:

Email: jeffrey.d.eichinger@boeing.com

Composites for Spacecraft Cochair

Mr. Jeremy Jacobs

NASA Johnson Space Center

2101 Nasa Parkway, M.S. ES4

Houston, TX 77058

Tel: 281-483-8825 Fax:

Email: jeremy.b.jacobs@nasa.gov

Core Data Chair
(Task Group under Sandwich)
Mr. Eric Stenne
Airbus
Tel: 450-419-9514
Email: stenne@videotron.ca

Core Materials Chair
(Task Group under Sandwich)
Mr. Shannon Jones
Bell Textron
Tel: 817-280-6665
Email: ssjones@bellflight.com

Crashworthiness Cochair
Dr. Mostafa Rassaian
PO Box 6683
Bellevue, WS 98008-0683
Tel: 206-715-6358
Email: mostafa@rassaianllc.com

Damage Tolerance Cochair
(Task Group under Safety Management)
Dr. Douglas S. Cairns
Montana State University
Mechanical & Industrial Engineering
220 Roberts Hall
Boseman, MT 59717
Tel: 406-994-0393 Fax: 406-539-6292
Email: dcairns@me.montana.edu

Damage Tolerance Cochair
(Task Group under Safety Management)
Mr. Patrick Enjuto
The Boeing Company
Everett, WA
Tel: 206-369-9250
Email: patrick.enjuto2@boeing.com

Damage Tolerance Cochair
(Task Group under Safety Management)
Mr. Allen Fawcett
Boeing/BCA
621 Cedar Ave So
Renton, WA 98057
Tel: 425-342-2399
Email: allen.j.fawcett@boeing.com

Damage Tolerance Cochair
(Task Group under Safety Management)
Mr. Mike Smeets
Fokker Landing Gear
Grasbeemd 28
Helmond
5705 DG
The Netherlands
Tel: 31 0 492-575286
Email: mike.smeets@fokker.com

Damage Tolerance Cochair
(Task Group under Safety Management)
Dr. Simon Waite
European Aviation Safety Agency
(EASA)
Postfach 10 12 53
Koln D-50452
GERMANY
Tel: 49-221-89990 4082 Fax: 49-221
89990 4582
Email: simon.waite@easa.europa.eu

Data Review Cochair
Mr. Michael Hempowicz
Toray CMA
Tel: 251-382-8320
Email:
michael.hempowicz@toraycma.com

Design Co-Chair
(Task Group under PMC Guidelines)
Dr. Larry Ilcewicz
FAA Aircraft Certification Service, Policy
and Innovation Division
2200 S 216th St, 3W-450
Des Moines, WA 98198
Tel: 206-231-3147
Email: larry.ilcewicz@faa.gov

Disbonding and Delamination Cochair
(Task Group under Safety Management)
Ms. Lisa McHugh
Northrop Grumman
1 Hornet Way M/C 902/W2
El Segundo, CA 90245
Tel: 310-332-6352 Fax:
Email: lisa.mchugh@ngc.com

Damage Tolerance Cochair
(Task Group under Safety Management)
Mr. DM Hoyt
NSE Composites
1101 North Northlake Way, Suite 4
Seattle, WA 98103
www.nsecomposites.com
Tel: (206)-545-4888
Email: hoyt@nsecomposites.com

Data Review Cochair
Mr. Royal Lovingfoss
Wichita State University - NIAR
1845 Fairmount
Wichita, KS 67260-0093
Tel: 316-978-5317 Fax: 316-978-3175
Email:
Royal.Lovingfoss@idp.wichita.edu

Design Co-Chair
(Task Group under PMC Guidelines)
Mr. Patrick Enjuto
The Boeing Company
Everett, WA
Tel: 206-369-9250
Email: patrick.enjuto2@boeing.com

Disbonding and Delamination Cochair
(Task Group under Safety Management)
Dr. Ronald Krueger
National Institute of Aerospace (NIA)
NASA Langley Research Center
Mail Stop 188E
Hampton, VA 23681-2199
Tel: 757-864-3482 Fax: 757-864-8911
Email: rkrueger@nianet.org

Engine Applications Cochair

Dr. Scott R. Finn
GE Aviation
One Newmann Way
Mail Drop E-163
Cincinnati, OH 45215
finn@ge.com
513-243-3415

Guidelines Cohair

Dr. Carl Q. Rousseau
Lockheed Martin Aeronautics
P.O. Box 748, MZ 6516
Fort Worth, TX 76101
Tel: 817-763-7727 Fax: 817-762-5673
Email: carl.q.rousseau@lmco.com

Materials & Processes Cochair

Dr. Margaret E. Roylance
Nano Tech Labs
Tel: 617- 930-6572
Email: mroylance@nanotechlabs.com

P17 Chair

(Task Group under M&P)
Mr. Shannon Jones
Bell Textron
Email: ssjones@bellflight.com

Safety Management Cochair

Ms. Cindy Ashforth
FAA Aircraft Certification Service, Policy
and Innovation Division
2200 S. 216th Street
Des Moines, WA 98198
Tel: 206-231-3239
Email: cindy.ashforth@faa.gov

Sandwich Cochair

Mr. Lawrence A. Gintert
Independent Consultant
3 Cross St, Apt 1
Jaffrey, NH 03452
Tel: 727-403-5769
Email: GintertL06@gmail.com

Engine Applications Cochair

James Finlayson
Rolls Royce
Moor Lane D3, PO Box 31, Derby, DE24
8BJ
ames.finlayson@rolls-royce.com
+44 (0) 7585 881070

Guidelines Cohair

Ms. Amanda Bastian
Joby Aviation
333 Encinal St
Santa Cruz, CA 95060
Tel: 802-989-8706
Email: amandabastian@gmail.com

Materials & Processes Cochair

Mr. Daniel R. Ruffner
Email: danielruffner@gmail.com

Safety Management Cochair

Dr. Larry Ilcewicz
FAA Aircraft Certification Service, Policy
and Innovation Division
2200 S 216th St, 3W-450
Des Moines, WA 98198
Tel: 206-231-3147
Email: larry.ilcewicz@faa.gov

Sandwich Cochair

Dr. Zhi Chen
Email: zhiming.chen@aero.org

Statistics Cochair

Stefan Kloppenborg

Email: stefan@kloppenborg.ca

Statistics Cochair

Mr. Jorge Chavez-Salas

WSU/NIAR

1845 Fairmount, Box 93

Wichita, KS 67260

Tel: 316-978-6427 Fax: 316-978-3175

Email: [Jorge.Chavez-](mailto:Jorge.Chavez-Salas@idp.wichita.edu)

Salas@idp.wichita.edu

Supportability, Maintenance, and Repair Cochair

Dr. Joseph Rakow

Exponent Failure Analysis Associates

149 Commonwealth Drive

Menlo Park, CA 94025

Tel: 650-688-7316 Fax: 650-688-7231

Email: jrakow@exponent.com

Supportability, Maintenance, and Repair Cochair

Mr. Stephen Starnes

US Navy

101 Wasp Street

Jacksonville, FL 32212-0016

Tel: 904-790-6410

Email: stephen.starnes@navy.mil

Testing Cochair

Dr. Daniel O. Adams

University of Utah

50 S. Central Campus Drive

Room 2110 MEB

Salt Lake City, UT 84112

Tel: 801-585-9807 Fax: 801-585-9826

Email: adams@mech.utah.edu

Testing Cochair

Mr. John Moylan

Element Materials Technologies

1857 Business Center Dr

Duarte, CA 91010

Tel: 818-296-0444

Email: john.moylan@element.com

