

Status of CMH-17 Vol. 3/Chapters 12-14 (Damage Tolerance & Maintenance)



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Larry Ilcewicz
CS&TA
Federal Aviation
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- *Background*
 - *Airbus & Boeing Meetings*
 - *Chicago & Amsterdam Workshops*
- *Plans and progress to update CMH-17 Chapters*
 - *Data collected to date*
 - *Updated Chapter outlines*

Importance of Linking Damage Tolerance, Maintenance and Operations

- One of the main purposes for damage tolerance is to facilitate safe & practical maintenance procedures
- Structural substantiation of damage tolerance, inspection and repair should be integrated
- Findings from the field help improve damage tolerance and maintenance practices in time
 - *Structural safety, damage threat assessments, design criteria, inspection protocol, documented repairs and approved data all benefit from good communications between OEM, operations and maintenance personnel*



Boeing/Airbus/FAA/EASA WG for Damage Tolerance & Maintenance Objectives

1. Agree on critical technical issues and areas of safety concern for damage tolerance & maintenance of composite structure on transport aircraft.
2. Identify key similarities and differences in methods used to substantiate damage capability for transport aircraft composite structures.
3. Identify the key elements necessary to substantiate maintenance inspection and repair procedures for composite aircraft structures.
4. Identify related content needed to update appropriate approved source (OEM) documentation (MPD, SRM, etc.) focused on field safety issues.
5. Identify related content needed to update the Mil-17 Damage Tolerance and Supportability chapters and the FAA composites maintenance training standards, as appropriate.
6. Identify areas for safety-related standardization of composite damage tolerance & maintenance and related research needed in the future.



Boeing/Airbus/FAA/EASA WG* for Damage Tolerance & Maintenance

Justification: expanding transport applications justify a need for communication on composite damage tolerance and maintenance between OEM and regulatory bodies

- Lack of trained resources with practical experiences
- Cost advantages from common & efficient procedures

Three Meetings

9/05 Toulouse

3/06 Seattle

1/07 Cologne

Two Workshops

7/06 Chicago

5/07 Amsterdam

Approach

- Bring key members of the OEM and regulatory bodies together for initial assessment of objectives 1) thru 3) and define deliverables [*meetings 1 & 2*]
- Prioritize WG deliverables and finalize a working plan [*meetings 1 & 2*]
- Collect more data & review progress with user community (airlines, MRO, AEG, AFS and other regulatory bodies) [*meeting 3 and related 2006 & 2007 workshops*]
- Use existing standards organizations (CMH-17, SAE CACRC) and educational institutions (FAA JAMS COE) to publish standards and provide training

* Expanded to an International WG with workshops and 2007 meetings

Nov. 15, 2007 Main Committee Meeting

Fall 2007 CACRC (Wichita, Kansas)



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Key Working Group Participants for Airbus (9/05) and Boeing (3/06) Meetings

- **FAA**

- Larry Ilcewicz
- Angie Kostopoulos
- Tom Walker (NSE)

*Mil-Handbook-17
Damage Tolerance Task
Group Co-Chairmen*

- **EASA**

- Simon Waite
- Jean Rouchon
- Wim Doeland

- **Airbus**

- Christian Beaufils
- Chantal Fualdes
- Roland Thevenin
- François Smal
- José-Carlos Gomez-Lopez

- **Boeing**


- Al Fawcett
- David Polland
- Gary Oakes

Progress from Meetings at Airbus (9/05) and Boeing (3/06)

- **Boeing and Airbus presented their practices in 3 major areas related to damage tolerance and maintenance**
 - Damage tolerance requirements and design criteria
 - Engineering practices for structural substantiation
 - Maintenance practices
- **Information summarized in an Excel spreadsheet to directly compare and contrast approaches**



2006 FAA Composite Damage Tolerance & Maintenance Workshop

	Wednesday, July 19	Thursday, July 20	Friday, July 21
1 st Hour		Session 2* Substantiation of Structural Damage Tolerance	Session 6 <u>Technical Breakout Sessions</u> <i>(*Separate working meetings covering technical subjects from Sessions 2 - 5)</i>
2 nd Hour			
Break (15 min.)			
3 rd Hour		Session 3* Structural Test Protocol	Session 7 Breakout Team Summary Recap/Actions/Closure/Adjourn
4 th Hour			
Lunch (1 Hour)			
5 th Hour	FAA Initiatives Safety Management Airbus/Boeing/EASA/FAA WG Maintenance Training Update	Session 4* Substantiation of Maintenance Inspection & Repair Methods	
6 th Hour			
Break (15 min.)			
7 th Hour	Session 1 Applications & Service Experiences	Session 5* Damage/Defect Types and Inspection Technology	
8 th Hour			

~150 Participants





2007 FAA/EASA/Industry Composite Damage Tolerance and Maintenance Workshop

	Wednesday, May 9	Thursday, May 10	Friday, May 11
1 st Hour	SAE Commercial Aircraft Composite Repair Committee Overview of Progress & Plans	Session 1 Applications & Field Experiences <i>(continued)</i> Service History of Composite Structure Service Damage & Reliability of Repairs	Session 5* Field Inspection and Repair QC Test Standards & Inspector Qualifications Reliable NDI Technology Advances Material & Process Controls
2 nd Hour			
Break (15 min.)			
3 rd Hour	Airbus and Boeing Perspectives on Safe Industry Practices	Session 2* Damage Tolerance Design Criteria & Objectives Structural Test Protocol	Session 6 Technical Breakout Sessions <i>(*Separate working meetings covering technical subjects from Sessions 2 - 5)</i>
4 th Hour	Airbus & Boeing (continued) SAE CACRC Active Task Group Reports		
Lunch (1 Hour)			
5 th Hour	SAE CACRC Active Task Group Reports	Session 3* Damage in Sandwich Construction Fluid Ingression Growth Mechanisms Analysis & Accelerated Tests	Session 7 Breakout Team Summary Recap/Actions/Closure/Adjourn
6 th Hour	FAA & EASA Initiatives		
Break (15 min.)			
7 th Hour	FAA & EASA Initiatives (cont.) Recent Progress/Safety Management	Session 4* Repair Design and Processes Repair Limits Design Criteria & Process Guidelines Structural Substantiation	~110 Participants
8 th Hour	Session 1 Applications & Field Experiences		

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Summary of 2006 & 2007 Workshops

- Critical safety data shared in unique forum of practitioners
 - Key points collected in an Excel spreadsheet
- Five *categories of damage* were proposed for damage tolerance and maintenance consideration
 - Integrated efforts in structural substantiation, maintenance and operations interface help ensure complete coverage for safety
- Coordinated inspection, engineering disposition and repair is needed for safe maintenance
 - Actions by operations is essential for detection of critical damage from anomalous events
- FAA is committed to CS&CI with industry, academia and government groups (~250 participants in two workshops)
 - Damage tolerance and maintenance initiatives are active
 - Principles of safety management will be used in future developments (policy, guidance and training)



Composite Material Handbook 17 (CMH-17) Chapter 12-14 Updates

- **A major deliverable is to provide related content for CMH-17, Volume 3**

Development questions

Is the content complete?

Is the content balanced?

Is the organization reasonable?

- **Content will be approved for public release by initial Airbus/Boeing/EASA/FAA WG members**
 - Details will probably be generalized and presented as “typical approaches” or “an example approach”
- **Plans to be complete for Rev. G release (2008)**



CMH-17 Volume 3 Outline (Rev. G)

1. General Information
2. Introduction to Composite Structure Development
3. Certification & Compliance
4. Building Block
5. Materials and Processes
6. Quality Control of Production Materials
7. Design of Composites
8. Analysis of Laminates
9. Structural Stability Analyses
10. Bonded Joints
11. Bolted Joints
12. Damage Resistance, Durability and Damage Tolerance
13. Crashworthiness
13. New
14. Maintenance and Support
15. Thick Section Composites
16. Structural Safety
17. Environmental Management

Renumbered



Proposed New Chapter 13

13. Defects, Damage and Inspection

13.1 Defects and Damage

13.1.1 Defect and Damage Sources

13.1.2 Defect and Damage Types

13.2 Inspection Methods

13.2.1 Non-destructive Inspection

13.2.2 Destructive Inspection

- *Central repository for describing these items, so that other sections can refer to them.*
- *For now, populate with existing content
(CMH-17 Chapters 2, 3, 6, 12, 14, as well as FAA Tech Doc)*
- *Eventually expand to improve completeness ... defect/damage details for new material forms, more inspection details, photos, schematics, etc.*
- *Reference CACRC and ASTM documents as appropriate*



Existing Damage Tolerance Chapter 12 Outline

- 12.1 Overview & General Guidelines
- 12.2 Aircraft Damage Tolerance
- 12.3 Types, Characteristics and Sources of Damage
- 12.4 Inspection for Damage

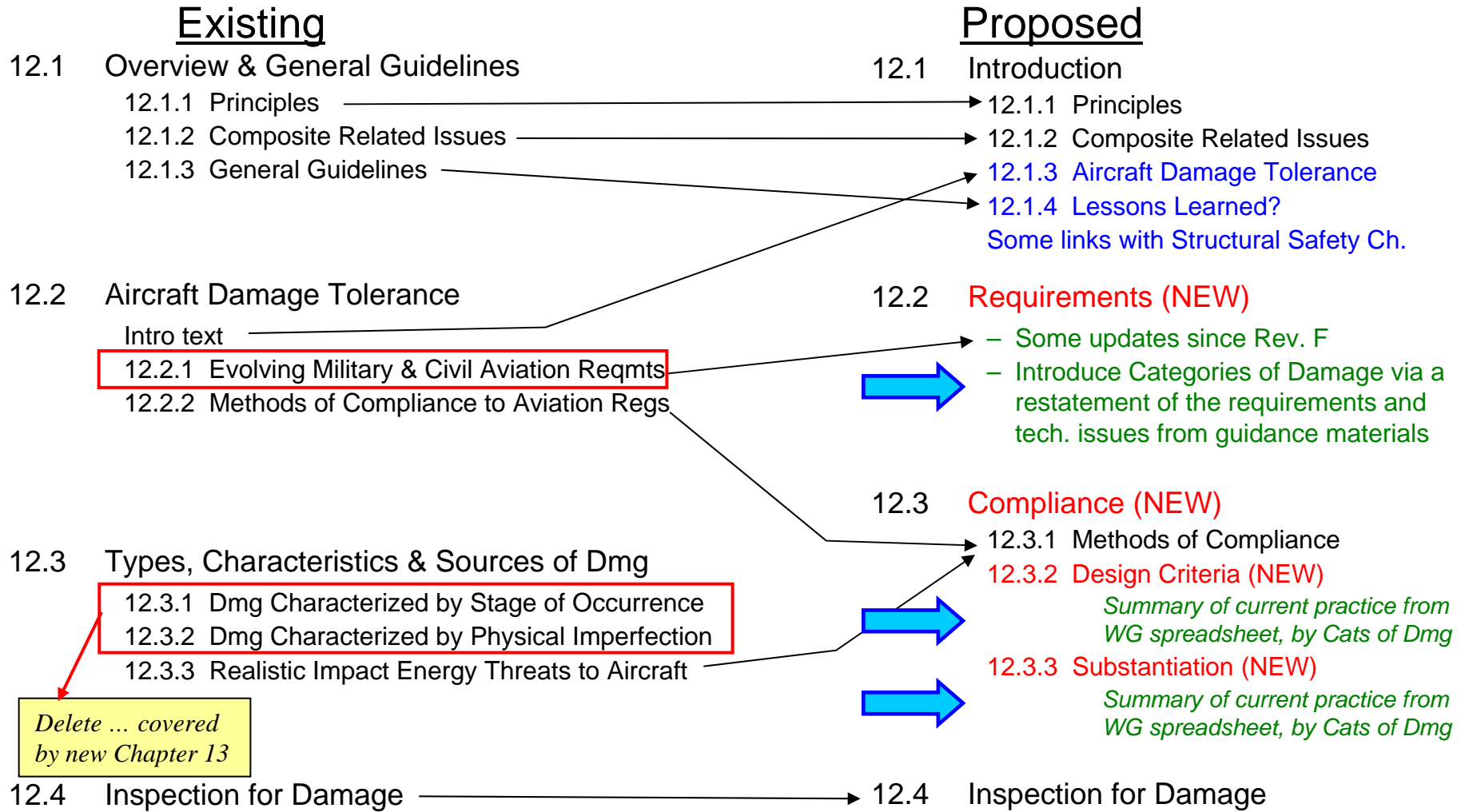
Most Rev. G changes will occur in these sections

- 12.5 Damage Resistance
- 12.6 Durability & Damage Growth under Cyclic Loading
- 12.8 Residual Strength
- 12.9 Applications/Examples
- 12.10 Supporting Discussions

- 12.X.1 Influencing Factors
- 12.X.2 Design Issues and Guidelines
- 12.X.3 Test Issues
- 12.X.4 Analysis Methods

These sections need additional work. Will be addressed after Rev G.

Proposed Chapter 12 Outline Changes



Delete ... covered by new Chapter 13

Major New Content →

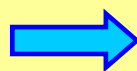
Proposed Chapter 14 Outline Changes (Part 1)

Existing

- Ch 14 - Supportability
- 14.1 Introduction
- 14.2 Design for Supportability
 - 14.2.1 In-service Experience
- 14.3 Support Implementation
 - 14.3.1 Part Inspection
 - 14.3.2 Damage assessment for composite repairs
 - 14.3.3 Repair design criteria
 - 14.3.4 Repair of composite structures
- 14.4 Composite Repair of Metal Structure
- 14.5 Logistics Requirements

Most content moved to by new chapter 13

Major New Content



Proposed

- Ch 14 – Maintenance and Support
- 14.1 Introduction (NEW)
 - Tie between maintenance & safety*
 - Key components = damage assessment, characterization, disposition, repair*
- 14.2 Important Considerations (NEW)
 - Summary (Ch5) from FAA Tech Doc*
- 14.3 In-service Experience
- 14.4 Inspection
- 14.5 Damage Assessment
- 14.6 Repair Design & Substantiation
- 14.7 Repair of Composite Structure
- 14.8 Composite Repair of Metallic Structure
- 14.9 Maintenance Documentation (NEW)
- 14.10 Design for Supportability
- 14.11 Logistics Requirements



Proposed Chapter 14 Outline Changes (Part 2)

Existing

Ch 14 - Supportability

- 14.1 Introduction
- 14.2 Design for Supportability
- 14.3 Support Implementation
 - 14.3.1 Part Inspection
 - 14.3.2 Damage assessment for composite repairs
 - 14.3.3 Repair design criteria
 - 14.3.4 Repair of composite structures
 - 14.3.4.1 Introduction
 - 14.3.4.2 Dmg Removal & Site Prep
 - 14.3.4.3 Bolted Repairs
 - 14.3.4.4 Bonded Repairs
 - 14.3.4.5 Sandwich (H/C) repairs
 - 14.3.4.6 Repair Inspection
 - 14.3.4.7 Repair Validation
- 14.4 Composite Repair of Metal Structure
- 14.5 Logistics Requirements

Proposed

Ch 14 – Supportability and Maintenance

- 14.1 Introduction (NEW)
- 14.2 Important Considerations (NEW)
- 14.3 In-service Experience
- 14.4 Inspection
- 14.5 Damage Assessment
- 14.6 Repair Design & Substantiation
 - 14.5.1 Design Criteria
 - 14.5.2 Repair Sizing
 - 14.5.3 Substantiation
- 14.7 Repair of Composite Structure
- 14.8 Composite Repair of Metallic Structure
- 14.9 Maintenance Documentation (NEW)
- 14.10 Design for Supportability
- 14.11 Logistics Requirements

Major New Content →



Summary of current practice from WG spreadsheet

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Summary of CMH-17, V3, Ch. 12-14 Status

- **Damage Tolerance (Chapter 12) in work**
 - Some additional content prepared for working draft
 - Draft to be completed for TG review (3/08)
- **Defects, Damage and Inspection (Chapter 13) draft completed**
 - To be sent for TG review before Winter, 2008 Meeting
 - To be made ready for CMH-17 Yellow Page Review (1/08)
- **Maintenance and Support (Chapter 14) in work**
 - Working draft for TG review by Winter, 2008 Meeting
 - To be made ready for CMH-17 Yellow Page Review (2/08)