FAA/EASA/Boeing/Airbus Damage Tolerance and Maintenance Working Group

Damage Tolerance and Maintenance Workshop
Chicago, IL
July 19, 2006
Tom Walker – NSE Composites
Outline

• Overview

• Progress to Date

• Future Plans

• Day 1 Wrap-up
Working Group Charter: Background

• Use of composite materials in transport aircraft is rapidly expanding.

• Damage tolerance and maintenance practices are key aspects of safety for composite primary structure

• Approaches are not standardized, with OEMs often using different design criteria, structural substantiation methods, and maintenance practices
  ▶ An understanding of composite behavior is still evolving
  ▶ Service history is limited
  ▶ Composites have some substantially different attributes than metal, requiring unique considerations and procedures

• Different approaches are acceptable, but they should not lead to confusion and inconsistent field practices by operations and maintenance personnel.

• OEM coordination is needed to facilitate consistent communication with regulatory agencies, airline customers, and maintenance organizations.
  ▶ Necessary to ensure that safety issues are well understood and adequate training is achieved
Working Group Charter: Objectives

1. Agree on the critical technical issues and areas of safety concern for transport aircraft with composite structure related to damage tolerance and maintenance

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 needs for appropriate approved source (OEM) documentation (MPD, SRM, etc.) focused on field safety issues.

5. Identify related content needs for the Mil-17 Damage Tolerance, Supportability, and Structural Safety chapters and the FAA composites maintenance training standards.

6. Identify areas for safety-related standardization of composite damage tolerance and maintenance approaches to be addressed by future working groups.
Key Participants

• FAA
  ‣ Larry Ilcewicz
  ‣ Angie Kostopoulos
    ‣ Tom Walker (NSE)

• 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

Mil-Handbook-17
Damage Tolerance Task
Group Co-Chairmen
**Approach and Timelines**

- **Meeting 1** 
  - Sept. 21-22
  - Summer/Fall ’05
  - Achieve consensus on Charter & Deliverables
  - Agree on critical technical issues & areas of safety concern to be addressed
  - Compare and contrast DT & maintenance practices

- **Meeting 2** 
  - March 7-8
  - Winter/Spring ‘06
  - Review draft standards for maintenance training
  - Finish review of DT & maintenance practices. Assign final actions to draft deliverables

- **Meeting 3** 
  - TBD
  - Winter ‘07
  - Review deliverables with users
  - Complete actions
  - Document future needs

- **Airbus Experts**
- **Boeing Experts**
- **Mil-17 DT Chairs**
- **EASA Specialists**
- **FAA Specialists**
- **CACRC Training TG**

- **WG develop and recommend safety standards**

- **FAA Workshop** 
  - July 19-21
  - Summer/Fall ‘06
  - Review draft text to update Mil-Hdbk-17 damage tolerance & supportability chapters
  - Complete final actions to draft deliverables
  - Identify users to invite to last WG meeting

- **Share standards with selected industry focals**
Progress to Date

• Held two working group meetings
  ▸ September 2005, Toulouse
  ▸ March 2006, Seattle

• 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
**Compare & Contrast Spreadsheet**

- One sheet for each major subject area

- Address major aspects of approaches
  - Not all-inclusive

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Requirements and Design Criteria

• Damage Threat Assessment
• Ultimate Load Residual Strength
  ‣ Explicit Considerations
  ‣ BVID Implementation Details
• Limit Load Residual Strength
  ‣ Explicit Considerations
  ‣ VID Implementation Details
• Fail Safe & Obvious Damage
  ‣ Large Damage Capability
  ‣ Fail Safe Assessments
  ‣ Bonded Joints
  ‣ Attachments
• Continued Safe Flight and Landing
  ‣ Explicit Considerations
  ‣ Damage Details

Category 1: Damage that may go undetected by field inspection methods

Category 2: Damage detected by field inspection

Category 3: Obvious damage detected within a few flights by operations

Category 4: Discrete source damage and pilot limits flight maneuvers

Category 5: Severe damage created by anomalous ground or flight events
Engineering Practices for Structural Substantiation

• Strength Substantiation
  ‣ Acceptable Manufacturing Anomalies
  ‣ BVID
  ‣ VID
  ‣ Discrete Source Damage
  ‣ Large-Scale Repeated Load Demonstration

• Repair Substantiation
  ‣ Building Block Tests
  ‣ Repair Analysis Correlation
  ‣ Repeated Load Demonstration
Maintenance Practices

- Visibility / POD Approach
- Inspection Procedures
- Guidelines for ADL and Repair Limits (bonded and bolted)
- Fleet Leader Programs
- Inspection interval = f(damage criticality)
- Unsubstantiated maintenance repair/rebuilding in the field
- Engineer, Inspector, & Technician Training
Link with Mil-Handbook-17

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

- Content will be approved for public release by WG members
  - Details will probably be generalized and presented as “typical approaches” or “an example approach”
Damage Tolerance Chapter Outline

- 12.1 Overview & General Guidelines
- 12.2 Aircraft Damage Tolerance
- 12.3 Types, Characteristics and Sources of Damage
- 12.4 Inspection for Damage
- 12.5 Damage Resistance
- 12.6 Durability (Damage Initiation)
- 12.7 Damage Growth under Cyclic Loading
- 12.8 Residual Strength
- 12.9 Applications/Examples
- 12.10 Supporting Discussions

Most of changes will probably occur here

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

14.1 Introduction

14.2 Design for Supportability

14.2.1 In-service experience
14.2.2 Inspectability
14.2.3 Material selection
14.2.4 Damage resistance, damage tolerance, and durability
14.2.5 Environmental compliance
14.2.6 Reliability and maintainability
14.2.7 Interchangeability and replaceability
14.2.8 Accessibility
14.2.9 Repairability

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

14.5.1 Training
14.5.2 Spares
14.5.3 Materials
14.5.4 Facilities
14.5.5 Technical data
14.5.6 Support equipment
Mil-17 Updates: Key Additions

• Safety is achieved through the combined effort of design, manufacturing, maintenance, operations, and regulatory agencies
  ‣ Each must understand the roles and responsibilities for all areas

• Each application must develop its own plan to achieve safety over the aircraft’s lifetime, considering its unique aspects (design, threats, etc.)
  ‣ Details associated with demonstrating compliance are not standardized
  ‣ Damage threats and responses are not fully understood, so regulatory guidance material is necessarily general in nature, and must be interpreted for the specific application.

• All possible damages and their related requirements must be addressed
  ‣ In general, 5 categories of damage exist. Their attributes are …
  ‣ Strategies for addressing damage not considered during design (i.e., Category 5) are very important
  ‣ Details associated with addressing different damage categories are interrelated
    ‣ e.g., considering more severe damage states for large damage may allow less conservatism in small damage
Mil-17 Updates: Key Additions (con’t)

- Areas of safety concern that are beyond what is included in current design and certification practice are …
- Typical industry practice for design criteria and demonstrating compliance is …
- To ensure safety, OEMs should be involved in the substantiation of all significant repairs
  - Significant amounts of data are needed for repair substantiation
  - OEMs are generally reluctant to share supporting databases
    - loads, allowables, etc
Mil-17 Updates: Other Needs

- Inspection
  - Clarification that “non-visible” does not imply “no action required”. Directed inspections are needed when “rogue” events occur (i.e., those beyond what was considered during design).
  - Need for inexpensive, quick methods to find non-visible damage that threatens Limit Load capability between flights

- Criteria and Compliance Issues
  - Additional emphasis on need to identify and address impact events that cause severe damage with low detectability … and some thoughts on what types of events might cause this (e.g., high-energy blunt impact)

- Training
  - Necessity for awareness training for operations and maintenance personnel
**Mil-17 Updates: Other Needs (con’t)**

• Repair Sizing & Substantiation
  - Necessity for allowables (parent and repair materials) in repair design/substantiation
  - Clear description of requirements for test validation of repair materials, process, and concepts. It should address full spectrum of repairs (i.e., SRM to AOG), as well as practical compliance suggestions.
  - Desire / requirement to maintain Limit load capability if (bonded) repair departs the aircraft

• Structural Repair Manual
  - Clear explanation and/or example of process for determining ADLs, including zoning considerations
  - Description of the considerations in determining RSLs, including zoning
Comments & Discussion
Day 1 Wrap-Up

• FAA has two major research initiatives related to composites
  ‣ Structural Integrity of Composites
  ‣ Maintenance and Inspection

• Accomplishments have been summarized

• Remainder of workshop intended to expand the discussions on critical composite damage tolerance and maintenance issues
  ‣ Thursday: Invited speakers on a range of applicable subjects
  ‣ Friday: Breakout sessions allow for additional perspectives
  ‣ “Categories of Damage” are good framework for discussions

• Input will help guide future FAA activities
  ‣ Focus of existing research initiatives
  ‣ Development of additional regulatory and guidance material