Composite Safety & Certification Initiatives

Presented at 9/16/02 FAA Workshop (Chicago, IL)

• Overview
  – Background
  – Technical thrust areas
  – Major milestones

• Material and process controls
  – Justification
  – Approach
  – Synopsis of progress
  – Current work

• Material standardization
  – Important organizations for shared databases and material & process specs
  – Industry standards versus TSO

• Summary
Objectives

1) Work with industry, other government agencies, and academia to ensure safe and efficient deployment of composite technologies being pursued for use in aircraft

2) Update policies, advisory circulars, training, and detailed background used to support standardized composite engineering practices

* Efforts started in 1999 to address issues associated with increasing composite applications
FAA Composite Team Members

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<tr>
<th>Represented Group</th>
<th>Team Member Name</th>
<th>FAA Organization Number &amp; Routing</th>
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<tr>
<td>FAA Tech. Center</td>
<td>Curtis Davies</td>
<td>AAR-450 (FAA Technical Center)</td>
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<td>Peter Shyprykevich</td>
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<td>International</td>
<td>John Masters</td>
<td>AEU-100 (Brussels Aircraft Certification Staff)</td>
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<td>Directorates</td>
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<td>Richard Monschke</td>
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<td>Fred Guerin</td>
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<td>Angie Kostopoulos</td>
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<td>David Ostroda</td>
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<td>Richard Noll</td>
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<td>David Swartz</td>
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<td>ANM-115N (CSTA, Composites)</td>
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Names in italics are present at the 9/16 to 9/18/02 FAA Workshop
But we also have some spies present who shall remain nameless

Presented by L. Ilcewicz at 9/16/03 FAA Workshop for Composite Material Control
FAA Approach to Composite Safety and Certification Initiatives

Evolving

Certification and Service History
Focused RE&D

Mature

FARs
Advisory Circulars
Policy Memos

Rules & General Guidance

Training (Workshops, Short Courses, IVTs)

Public Documents and Standards (e.g., Mil-Hdbk-17, SAE AMS, Contractor Reports)

New Technology Considerations
Industry Interface
Detailed Background

Internal Policies
Time
Technical Thrust Areas

Advancements depend on close integration between areas

Material Standardization and Shared Databases

Structural Substantiation
- Advances in analysis & test building blocks
- Environmental effects
- Manufacturing integration

FAA and NASA R&D is currently active in most of these areas

Damage Tolerance and Maintenance Practices
- Critical defects
- Bonded repair issues
- Fatigue & damage considerations
- Quantitative NDE
- Equivalent levels of safety

Advanced Material Forms and Processes

Significant progress, which has relevance to all aircraft products, has been gained to date

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Milestones for Composite Safety and Certification Policy, Guidance and Training

- **2000**: AGATE Shared Databases
- **2001**: Initial static strength substantiation
- **2002**: National Plan* for aircraft products
- **2003**: International M&P specs, database standards and initial environmental effects
- **2004**: Rotorcraft ARAC for fatigue and damage tolerance
- **2005**: Initial process control, design, manufacturing, structural integrity and repair issues for bonded structures
- **2006**: Stiffness, dimensional stability and flutter
- **2007**: Final process control, design, manufacturing, structural integrity and repair issues for bonded structures
- **2008**: Final damage tolerance substantiation & maintenance

* International participation in many of the tasks since 2001

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Long-term Plans for Composite Safety and Certification Initiatives

A multi-year plan has been developed and implemented

- Initially based on recent general aviation applications
- Input for rotorcraft and transport aircraft applications over the last 2 years
- Will be continuously reviewed and updated in public forum (e.g., Mil-Handbook-17, national conferences, “town meetings” and FAA seminars & workshops - input requested)
- To be continuously integrated with FAA strategic and business plans
- Continued support by NASA, other government agencies, and industry are critical to future efforts
Progress to Date in Composite Safety and Certification Initiatives

*Milestones achieved to date*

- FAA policy/training for base material qualification and equivalency testing for shared databases*
- Policy/training for static strength substantiation based on small airplane certification experiences
- New rule & AC for damage tolerance and fatigue evaluation of composite rotorcraft structure have been drafted
- New AC on acceptance guidance for material procurement and process specifications is nearly complete*
- Research in material control, bonded joints, environmental effects, sandwich panel damage tolerance and repair*

* FAA Technical Center reports exist for detailed background on engineering practices
Importance of Stabilizing Composite Materials for Safety and Efficiency

- Stable source of raw material is needed for continued safe and reliable use of composites in aircraft products

- Consistent engineering practices are needed to support requirements essential for base material control
  - Qualification data used as the statistical basis for equivalency (for new users and changes) and QC acceptance requirements
  - Documentation and databases for each unique material
  - Property drift (including upward shifts) minimized

- Databases and specs shared throughout industry will improve the efficiency of suppliers, users and regulators
Approach Used to Stabilize Composite Materials

1) Start with input from certification, production and service experiences
   » Initial research and industry review (light yellow boxes), used to generalize industry experiences and identify longer-term research needs

2a) Focussed research to draft “best engineering practices”
2b) Workshop & industry review to release detailed documentation on “best engineering practices”

3) Rules, policy and/or guidance as necessary
4) Training for industry and government workforce

Presented by L. Ilcewicz at 9/16/03 FAA Workshop for Composite Material Control
This workshop was intended to provide a forum where industry and government can discuss the most efficient ways to achieve composite material control.

We hope to reach general agreement on what is important to safety.

We expect some confusion/disagreement, which relates to specific engineering details, and the scope of shared information being sought.
Synopsis of Progress in Composite Material Control


2002  M&P spec guidelines and recommendations documented with the help of industry (DOT/FAA/AR-02/109 and /110)

2001  WSU Report converted to FAA Document (DOT/FAA/AR-00/47)

2000  WSU Report, initial FAA policy and training on material qualification and equivalency testing for shared databases

1999  FAA/NASA/NIST work to stabilize AGATE method & develop acceptance criteria for equivalency & QC

1998  Chartered Mil-Handbook-17 Data Utilization WG

1997  AGATE material initiative (Tomblin)
Current Work

- **Prepreg fabric**
  - Work on material procurement spec justified by industry recommendations from last year’s workshop
  - 2002 prepreg tape process spec work is still valid
  - Same teammates as involved in 2002 prepreg tape work

- **Liquid resin molding (LRM)**
  - Work on material procurement and process specs justified by industry recommendations from last year’s workshop
  - New teammates selected based on past experiences with LRM
  - Valuable insights derived from prepreg teammates experiences
    - Resin handling/mixing and dry fabric handling
    - Resin impregnation
    - Cured composite requirements

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What Should/Can Be Shared Within the Composite Industry?

Databases and specifications for material control

Databases and specifications for maintenance (repair)

Non-product-specific design databases

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Who Pays the Cost for a Lack of Standardization and Shared Databases?

“Company Specifications: One of the major problems of aircraft repair today is that most airframe and engine manufacturers tend to write their own specifications, especially for adhesives, pre-pregs, potting compounds, and sealants. These are found in the various manuals as …, and others -- almost infinitum. This leads to a vast amount of duplicated testing by suppliers, who may have to test the same batch of material to three or more slightly different requirements and using slightly different test methods.” Page 257 of Care and Repair of Advanced Composite Materials, by Keith B. Armstrong and Richard T. Barrett, SAE International, 1998.
Important U.S. Standards Organizations*

- Mil-Handbook-17 to define/approve database standards and provide overall coordination
  - http://www.mil17.org/
  - Data Utilization Working Group
    Stephen Ward  Curtis R. Davies
    505-758-4489  609-485-8758
    shward@taosnet.com  curtis.davies@tc.faa.gov

- SAE Committee P to establish/approve material and process specifications

- ASTM D30 to establish/approve standard test methods

*Must interface with international standards groups to achieve optimum efficiency

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Industry Standards vs. FAA Technical Standard Order (TSO)

- Coordination within the FAA suggest a TSO is feasible; however, the needs may outweigh the benefits
  - A TSO for composites would have more controls and requirements, i.e., different than how current TSO are viewed in the industry and FAA
  - Use of SAE, Mil-17 and ASTM as organizations to help define the required specs and database standards were considered essential
    Use of these organizations for pre-requisite approval of the data and associated specs is also under consideration
  - Policy, guidance and training will be needed to implement the TSO
- SAE P-17 & Mil-17 efforts may supersede the need for a TSO
  - FAA policy, AC & DOT reports provide a basis for industry standards
    Considerations for minor to major changes from the draft TSO were added
  - FAA has decided to closely monitor the efforts of these organizations and if timely progress is achieved the TSO will not be needed
Summary

• Composite safety & certification initiatives (CS&CI) are progressing with international help
  – Technical areas: material control, structural substantiation, bonded joints, damage tolerance and advanced materials & processes

• Consistent and stable materials are crucial to safe use of composites for expanding aircraft applications
  – New advisory circular will soon be released on acceptance guidance for prepreg material procurement and process specs
  – Detailed guidelines for prepreg tape were released in 2002
  – Draft guidelines for prepreg fabric and LRM will be reviewed and discussed in this workshop

• Future efforts by standards organizations can help facilitate the approval of shared databases and M&P specs