



Composite Material Control

FAA Efforts in 2002

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2nd FAA Workshop on Composite Material Control
September 16-18, 2003
Westin O'Hare
Chicago, IL





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 database should be the statistical basis for equivalency (for new users and changes) and QC acceptance requirements
 - Documentation and databases should exist for each unique material
 - Property drift (including upward shifts) should be minimized
- Composite databases and specs shared throughout industry will improve the efficiency of suppliers, users and regulators



FAA Interest in Material Control

- FAA Certification Engineers are called on to review and approve an increasing number of composite development programs for aircraft.
- Lack of common databases, standard practices, materials, and processes stretches the resources within the FAA which oversee these programs.
- Common criteria will provide a means to review more programs, more efficiently with less delays.



Technology Always Reinvents Itself





List of Recent Certification Programs with Significant Composite Structure



- Raytheon, Horizon (Part 25, Wichita, KS ACO)
- Bell, BA609 Tilt Rotorcraft (Part 29, Fort Worth RCO)
- Sikorsky, S92 Rotorcraft (Part 29, Boston ACO)
- Carson Services Inc., Main Rotor Blades (Part 29, NY ACO)
- 737 Business Jet and 747, Winglets (Part 25 STC, Seattle, WA ACO)
- Airbus, A340 -500/-600 (Part 25, Seattle Transport Airplane Directorate)
- Airbus, A380 (Part 25, Seattle Transport Airplane Directorate)
- General Electric, GE90-115B fan blades (Part 33, Boston, MA ACO)
- Cirrus Design Corp., SR20 and SR22 (Part 23, Chicago, IL ACO)
- Pacific Aviation, Lancair LC40-550FG (Part 23, Seattle, WA ACO)
- Euro-ENAER, Eaglet (Part 23, Dutch/Chile aircraft, KC Small Airplane Directorate)



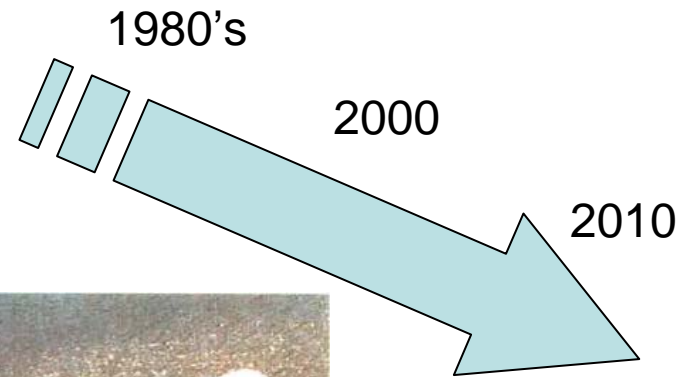
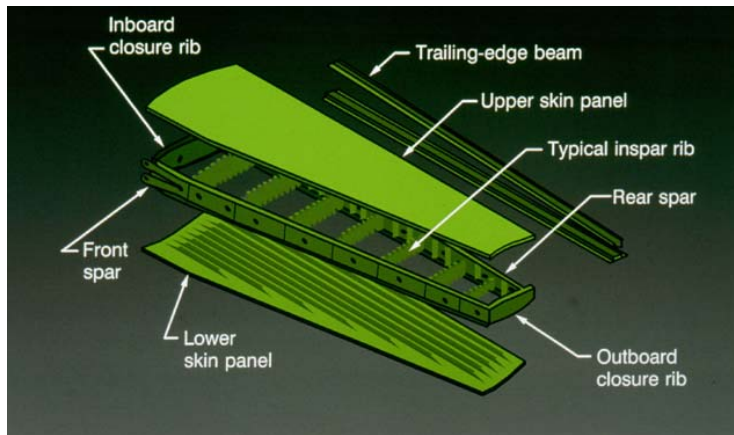
List of Recent Certification Programs with Significant Composite Structure



- Flight Dynamics, Seawind (Part 23, New York, NY ACO/Transport Canada)
- Morrow, Boomerang (Part 23, Seattle, WA ACO)
- Diamond, DA-40 (Part 23, Austrian aircraft, KC Small Airplane Directorate)
- CAP Aviation, 222 (Part 23, French aircraft, KC Small Airplane Directorate)
- Robin Aviation, DR400/500 (Part 23, French aircraft, KC Small Airplane Directorate)
- STW Composites, Liberty XL-2 (Part 23, Denver, CO ACO)
- Adam Aircraft, A500 (Part 23, Denver, CO ACO)
- Raytheon, Premier I, Model 390 (Part 23, Wichita, KS ACO)
- AASI, Jetcruzer 500 (Part 23, Los Angeles, CA ACO)



Progression of Composites



- First materials changed
now processes are changing



FAA Initiatives in Material Control



- Best practices for development of Material and Process Specifications
 - 2002 review and develop criteria for unidirectional composite prepreg
 - 2003 develop criteria for:
 - Liquid Resin Molding (LRM)
 - VARTM
 - RTM
 - RFI
 - Fabric
 - Continuing work to develop alternate product forms
 - Others as defined by industry needs



Composite Material Control Guidelines



- Identify philosophy of procurement and processing specifications for FAA acceptance.
- Determine minimum acceptable criteria which assures the expected level of repeatability and reliability.
- Make recommendations for FAA acceptance of procurement and processing specifications.
- Use to develop FAA guidance for certification. Will complement Quality Assurance Policy AC21-26.
- Identify where criteria and technology are missing.



2002 Efforts for Material Control

Guidelines and Engineering Practice



- Industry experts develop detailed control criteria in two FAA Technical Center Reports
 - Recommendations and guidelines for the development of pre-impregnated composite material specifications
 - Recommendations and guidelines for the development of an associated process specification
- August 2002 workshop provided industry review (gathered additional comments from those not able to attend)



1st FAA/NASA Workshop on Composite Materials Control



- Gathered 80 Industry and Government Experts on Composite Materials
- Identified Strategic Needs for Composite Material Procurement and Processing Specifications.
- Reviewed Two Draft Documents proposing specific Criteria for Composite Material Procurement and Composite Material Processing
- Developed a Starting Point for Standardization of Composite Materials Control within Industry and Government
- Involved Composite Material Producer Industry and Aviation Manufacturers in Standardization of Composite Materials Control.



1st FAA/NASA Workshop on Composite Materials Control



- 2002 Workshop Demographics
 - 11 Aviation Technical Consultants
 - 2 Academia
 - 17 Aviation Suppliers
 - 21 Aircraft Industry
 - 4 Rotorcraft
 - 6 Small Aircraft
 - 10 Large Transport
 - 1 Aircraft Engine
 - 16 Government
 - 1 Transport Canada
 - 1 U.K. Civil Aviation
 - 2 Air Force
 - 2 NASA
 - 10 FAA
 - 13 Material Producers



1st FAA/NASA Workshop Invited Industry Reviewers



- 13 Reviews from cross-section of industry
 - **Manufacturers**
 - Dan Ruffner, Boeing
 - Molly Stone, Cirrus Design
 - Cindy Cole, PACAIR
 - Mark Chris, Bell Textron
 - John Adelman, Sikorsky
 - **Government**
 - Larry Coulter, Air Force
 - **Material Producers**
 - Steve Peake, FiberCote
 - Sam Tiam, Toray
 - Mike Stuart, Cytec
 - **Consultant**
 - Ric Abbott, Raytheon
 - Rich Moulton, Hexcel
 - Cecil Schneider, Lockheed Martin



1st FAA/NASA Workshop Group Discussions



Document/ Concern	Concern Category				Issue Area		
	General guidelines and engineering practice for standards	Specific comments unique to industry standard	Safety issues relevant to FAA Policy	Other	Economic	Time Monitoring/ Database Linkage	Specification Oversight
Testing Details(are ASTM adequate including coupon machining)	X		X				
Easily allow for users to apply only part of requirements	X		X		X		
Who is approving body? (FAA, DOD, SAE) or industry group		X					X
How does standard database get approved?		X					X
Repair industry needs access to data	X		X				
Allow for different requirements based on risk (equivalence of risk)	X		X		X		
Allow for reduced testing	X		X		X		
Spec does not address producibility	X		X				
Harmonization	X		X				X
Database is used to control material	X		X			X	
Materials are controlled independently	X		X			X	
Too many requirements raise material cost			X		X		
Use metal model to drive discussion		X					
NEED DOD buy in?		X					X
Is FAA the right one to oversee?		X					X
FAA involvement in PCD		X					X
Relationship with SAE & past attempts		X					X
Should we bundle QPL, Database, Spec.		X				X	
Need to address cost	X				X		
Change in allowables, how do we handle?	X		X			X	
Generating data at corners of the processing window (Investigate by appropriate means)	X		X			X	
Retest Issues	X					X	
AMS 3894E /1B/18, It relationship to effort. (Past Attempts)							

2nd FAA Workshop on Composite Material Control



1st FAA/NASA Workshop Group Discussions



Material Processing Document	Concern Category				Issue Area		
	General guidelines and engineering practice for standards	Specific comments unique to industry standard	Safety issues relevant to FAA Policy	Other	Economic	Time Monitoring/ Database Linkage	Specification Oversight
Processing spec. should be primarily address making test panels to be used to establish equivalency	X					X	
Identify manufacturer and supplier responsibility	X					X	
Overview of criteria required for process specification (FAA checklist)	X						X
Goal is standardization within the FAA	X						X
How will this harmonize across DoD and other civil agencies (International)	X						X
Test panel processing guidelines (Scope)	X					X	
Add 5.3 definitions, acronyms, etc.		X					
Review personnel for deletion, add statements as to need for trained personnel		X			X		
Change 5.3 title instead of requirements		X					
Instead of personnel use method of fabrication should be repeatable (to be assigned on a per company basis)		X			X		
Personnel should be in guideline for training perspective		X			X		
Guidelines and recommendations for trained personnel		X			X		
Expand into fabric		X					
Placement of 5.3.2 "Required Materials"		X				X	
Out-time, control from date of manufacture instead of date of receipt		X				X	
Reference material specification in applicable documents (governing document should be material specification?)		X					
No reference to clean room specification		X					
Checklist for Quality Assurance		X				X	
NDI/ Defects should correspond to part fabrication		X				X	
Inspection of panel should be added		X					
Verification of required cure		X					

2nd FAA Workshop on Composite Material Control



1st FAA/NASA Workshop Specific Comment Resolution



- Compiled comments
- Addressed all comments
- Put final action on Website
- Disposition
 - Accept
 - Reject
 - Modified

Resolution to Comments for DOT/FAA/AR-02/110	
Comment	Resolution
1 5.3.2 - Change C-stage to B-stage.	Dropped C-stage and B-stage terminology.
2 5.3.2 - Add thawing practices.	Done.
3 5.3.3 - Define tool materials so chemical interaction with part material is avoided.	Since document now is focused on test panel fabrication and is not specific to any given material, specifics on tooling materials for parts is not

Resolution to Comments for DOT/FAA/AR-02/110	
Comment	Resolution
1 5.3.2 - Change C-stage to B-stage.	Dropped C-stage and B-stage terminology.
2 5.3.2 - Add thawing practices.	Done.

13 5.3.2 - Need more detail on determining shelf life.	Beyond scope of document.
14 A specification for processing panels would be good. The scope of fabrication of all CEP structures seems too big.	Scope changed to test panel fabrication.
15 1.3 - Material spec says three batches.	Changed to match material spec.
16 Fabricator qualification tests - what do they consist of?	Beyond scope of document.
17 Is this document for making panels or parts.	Document rewritten for fabrication of panels.
18 Should also reference full-scale or sub-component test in addition to discriminator panel.	Discriminator panel is part of material qualification, which is well before fabrication of full-scale test articles.
19 Table 1 contains information that MIDO would prefer to	Document does not specify where

- 1 -

- 2 -



1st FAA/NASA Workshop Future Material Control



- Forms -
 - Tape
 - Fabric
 - Prepreg Tow
 - Tow Flex (TP)
 - Slit tape
 - Semi-preg
 - Tackified Fabric
 - Braiding
 - 3D Weave
 - Core
- Reinforcement Material
 - Fiberglass
 - Aramid
- Matrix Material
 - Epoxy
 - BMI
 - Polyimide
 - Cyanate Ester
 - Vinyl Ester
 - Thermoplastic
- Process
 - Separate resin processes:
 - RTM
 - VARTM
 - Wet Lay-up
 - Wet Winding
 - RFI
 - E-Beam curing
 - Sandwich
 - AFP
 - CTLM
 - Hot drape forming
 - Injection molding
 - Hot stamping
 - E-Beam curing
 - Pultrusion
 - Prepreg Winding
 - Repair



Conclusion of 2002 Efforts for Material Control



- Updated the documents per industry review
- Release the documents as “**Guidelines**” to industry (March 2003)
 - Each program will have freedom to pursue:
 - i) release of databases and specs shared by industry or
 - ii) traditional proprietary databases and specs or
 - iii) some combination (e.g., business arrangement between funding partners)
 - Scope of associated database will self-limit the benefit to applications
- Forwarded the criteria for consideration in updates to Mil-Hdbk-17
- Details of contents will be given in next two presentations