



Progress Report of the

ATA / IATA / SAE Commercial Aircraft Composite Repair Committee (CACRC)

Presented at : CACRC Main Committee Meeting

Prepared by Carlos Blohm

Issue : November, 2007



History: The CACRC is an airline maintenance committee, formed in 1991 as a combination of ATA, IATA and SAE committees, with a common charter.

Charter:

"To develop and improve maintenance, inspection and repair of commercial aircraft composite structure and components"

Ultimate goal:

- ◆ Lower maintenance cost of existing composite structures, via standardization among OEMs and airlines.
- ◆ Minimize life cycle cost of future designs.

Philosophy:

- ◆ **Create/establish standard solutions to the most common airline problems.**
- ◆ **Use task groups of industry experts to discuss the existing solutions and write specifications.**

Scope:

- ◆ **Address areas that impact airlines most frequently.**
- ◆ **Consensus documents – Disapproving votes to be resolved**
 - 1. Where consensus is not reached, all options are listed**
 - 2. Not a research organization - best practices are selected**

Organization of CACRC

Entities:

- ◆ Airline Operators
- ◆ Aircraft Original Equipment Manufacturers
- ◆ FAA, EASA / JAA, repair stations, vendors, material suppliers, training institutes, academia, any other interested parties
- ◆ SAE as secretariat and publisher of standards

Meetings:

- ◆ Main Committee: twice per year
(alternating between Europe / N. America)
- ◆ Executive Committee: before and after Main Committee
- ◆ Task Groups: 2 or 3 working meetings per year

Membership of CACRC

USER MEMBER: A commercial transport air operator, a manufacturer of an aerospace vehicle subsystem or part, or a government organization. Only User Members Vote on documents.

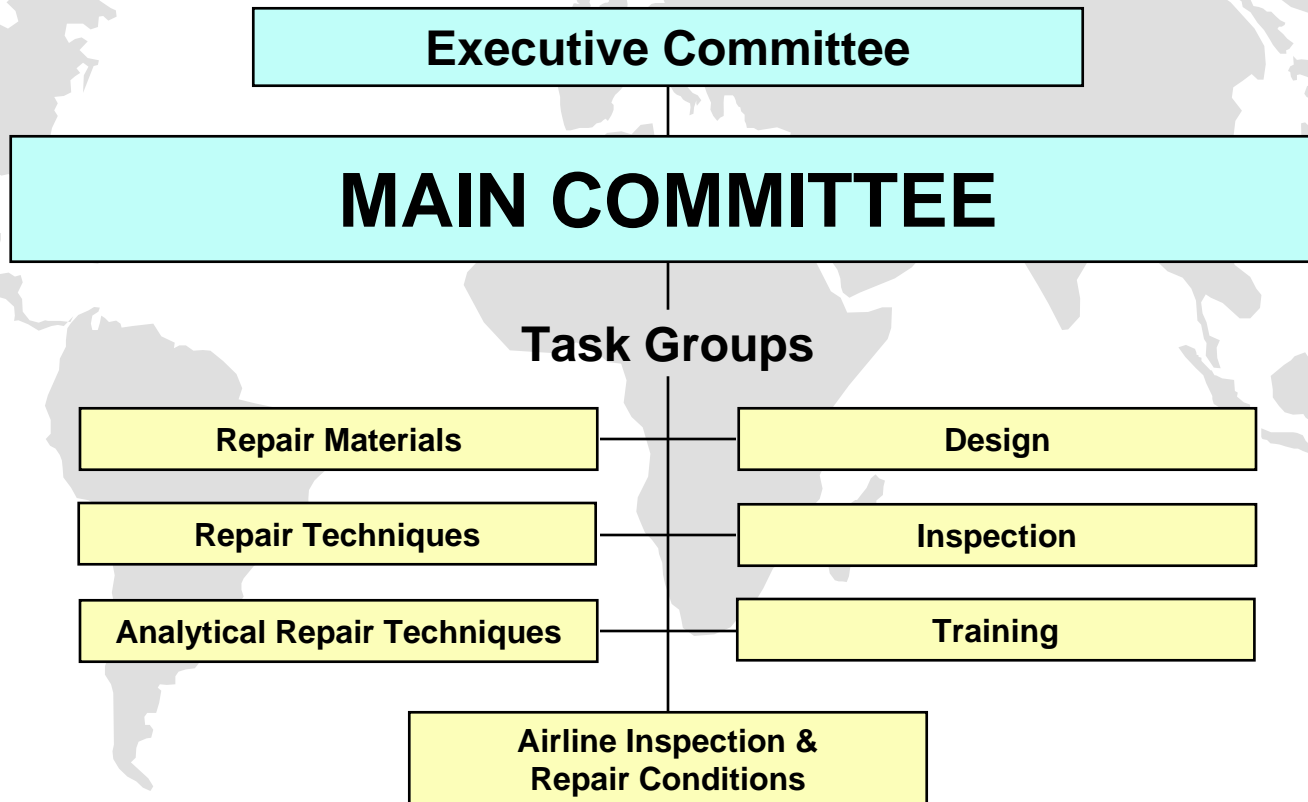
SUPPLIER MEMBER: Producers of the various materials and processes are an integral part of the AMS operation. Supplier members have no formal vote but can comment on documents.

LIAISON MEMBER: Liaisons relay information to and from parallel activities of other committees and organizations. Liaisons have no formal vote but can comment on documents.

CONSULTANT MEMBER: A person having specific technical knowledge. Consultants have no formal vote but can comment on documents.

MAILING LIST: A person that only receives the minutes, agendas, and announcements. Does not receive balloted documents.

Structure of CACRC





Task Group Summary

◆ Repair Materials Task Group

Chairperson: Dr. Ana Rodriguez – Airbus

Charter: To develop "Common Repair Material Specifications" and support the qualification process.

◆ Repair Techniques Task Group

Chairperson: Francois Museux - Airbus

Charter: To develop "Standardized Repair Techniques"

◆ Analytical Repair Techniques Task Group

Chairperson: Tim Harris – Boeing, Ray Kaiser - Northwest

◆ Charter: To develop a guide, for commercial aircraft composite engineers, containing generally accepted analytical techniques to enable a conservative analysis for repair justification, as NAA-approvable data.

Task Group Summary (cont.)

◆ Design Task Group

Chairperson: Eric Chesmar – United Airlines

Charter: **Task 1: To improve composite design through operator feedback.**

Task 2: To develop a “Maintenance Life Cycle Cost Model for Commercial Aircraft Composite”

◆ Inspection Task Group

Chairperson: John Hewitt - Airbus, Dennis Roach - Sandia Laboratories

Charter: **Task 1: To develop a “Standard Guideline for Composite inspection”.**

Task 2: Steering Committee for “Composite Reference Standards” program at FAA and Sandia Labs.

Task Group Summary (cont.)

◆ Training Task Group

Chairperson: Joe Hafenrichter – Boeing

Charter: To develop guidelines for composite training.

◆ Airline Inspection & Repair Conditions Task Group

Chairperson: William F. Cole and John Player – United Airlines, Oksana Bardygula - FedEx

Charter: **Task 1: To define time, equipment, training and materials available for normal airline operation, so OEMs can design inspection and repair schemes for composite structure, with minimum impact.**

Task 2: Prioritize Parts for enlarged Allowable Damage Limits and Repairable Damage Limits.

Progress Status

Published documents

- ◆ 12 SAE / Aerospace Materials Specifications (AMS)
- ◆ 6 SAE / Aerospace Information Reports (AIR)
- ◆ 10 SAE / Aerospace Recommended Procedures (ARP)
- ◆ 1 SAE / Aerospace Engineering Report (AE)

**Documents have been implemented in OEM Manuals and Procedures!!
(see document implementation status)**

7 further documents in development or in revision cycle



Commercial Aircraft Composite Repair Committee

Document implementation status

Document sponsor	Document	Status	Implementation
Main Committee	AC 145-6 Repair Station for Composite and Bonded Aircraft Structure	issued	used as reference by: a) FAA inspectors auditing Repair Stations b) MRO establishing procedures and quality manuals
T/G Repair Materials	AMS 2980, /1, /2, /3, /4 Technical Specification "Carbon Fiber Fabric and Epoxy Resin Wet Lay-Up Repair material"	issued 01.Nov.96 revised	Qualification completed a) A.I.: incorporated in AIMS 08-01-00 b) Boeing : c) P&W : d) GE : e) Goodrich: Certification in 2007 / SRM incorporation after certification.
T/G Repair Materials	AMS 3970, /1, /2, /3, /4 Technical Specification "Carbon Fiber Fabric Repair Prepreg, 125Mdc (250Mdf) Vacuum curing"	issued 01.Dec.99 revision balloted	Material selection for qualification under progress
T/G Repair Materials	AMS 2960, /1, /5 Glass Fabric with Epoxy Resin Wet Lay-Up Repair Material	in progress	
T/G Repair Materials	AMS 2950, /1 Paste Adhesive and Core Restoration	balloted	
T/G Repair Materials	AMS XXXX Glass Prepreg for structural application	in progress	

Document implementation status

Document sponsor	Document	Status	Implementation
T/G Repair Techniques	ARP 4916 Masking and Cleaning of Epoxy and Polyester Matrix Thermosetting Composite Materials.	issued 01.Mar.97 reaffirmed 28.Jun.06	a) A.I. : Methods reflecting AI process included in SRM 51-77 b) Boeing : c) P&W : d) GE : implemented completely in Standard Practices Manual 70-46-01 e) Goodrich: CSSP 540258 Pre-Preg repair (adapted)
T/G Repair Techniques	ARP 4977 Drying of Thermosetting Composite Materials.	issued 01.Aug.96 reaffirmed 28.Jun.06	a) A.I. : implemented b) Boeing : commitment to reference in SRM in near future c) P&W : implemented in Standard Practices Manual 70-46-02 d) GE : used as a resource in the answer of customer questions e) Goodrich: Standard Process CSSP 540252 Moisture Removal / CFM, A1/A5, PW SRM 54
T/G Repair Techniques	ARP 5256 Mixing Resins, Adhesives and Potting Compounds	issued 01.Mar.97 reaffirmed 28.Jun.06	a) A.I. : Used in training course b) Boeing : c) P&W : implemented in 1997 d) GE : used as a resource in the answer of customer questions e) Goodrich: Standard Process CSSP 540222 / V2500 A1/A5 SRM 54-02 (adapted)
T/G Repair Techniques	ARP 4991, A Core Restoration of Thermosetting Composite Materials	issued 01.Dec.98 revised 27.Feb.06	a) A.I. : existing technique in SRM 51-77 very close to ARP b) Boeing : c) P&W : implemented in 1998 d) GE : e) BF Goodrich: Standard Process 540254 / V2500 A1/A5 SRM 54 (adapted)
T/G Repair Techniques	ARP 5143 Vacuum Bagging of Thermosetting Composite Repairs	issued 26.Jul.02	a) A.I. : Methods reflecting AI process included in SRM 51-77 b) Boeing : c) P&W : implemented in 1998 d) GE : implemented in Standard Practices Manual 70-46-03 e) Goodrich: CSSP 540251 Vacuum Bag Process / V2500 A1/A5 SRM 54-02 (adapted)

Document implementation status

Document sponsor	Document	Status	Implementation
T/G Repair Techniques	ARP 5144 Heat Application for Thermosetting Resin Curing	issued 01.Mar.00 reaffirmed 28.Jun.06	a) A.I. : implemented in SRM 51-77 (2000) b) Boeing : c) P&W : implemented in 1998 d) GE : ARP is referenced directly in SPM 70-46-02 and 70-46-03 e) Goodrich: Standard Process CSSP 540221 and 540222 (adapted)
T/G Repair Techniques	ARP 5319 Impregnation of Dry Fabric and Ply Lay-Up	issued 19.Jul.02	a) A.I. : vertical bleeding implemented in SRM 51-77 (2000) b) Boeing : c) P&W : d) GE : e) Goodrich: Standard Process 540256 / V2500 A1/A5 SRM 54 (adapted)
T/G Repair Techniques	AIR 5367 Machining of Epoxy and Polyester Matrix Thermosetting Composite Structures	in progress	a) A.I. : b) Boeing : c) P&W : d) GE : e) Goodrich:
T/G Repair Techniques	AIR 5431 Repair Tooling	Issued 29.Dec.04	a) A.I. : b) Boeing : c) P&W : d) GE : e) Goodrich:
T/G Repair Techniques	ARP 5701 Storage and Handling of Epoxy Thermosetting Composite Materials	in progress	a) A.I. : b) Boeing : c) P&W : d) GE : e) Goodrich:
T/G Repair Techniques	AIR 5702 Lay-up of Prepreg Composite Materials	in progress	a) A.I. : b) Boeing : c) P&W : d) GE : e) Goodrich:

Document implementation status

Document sponsor	Document	Status	Implementation
T/G Training	AIR 4938, A Composite and Bonded Structure Technician / Specialist: Training Doc.	issued 01.Sep.96 revision balloted	Flight Safety: uses as basis (100%) A.I.: Reduced content used, to match course length
T/G Training	AIR 5278 Composite and Bonded Structure Engineers: Training Doc.	issued 01.Mar.99 reaffirmed 26.Jan.06	Flight Safety: uses as basis (100%) A.I.: Reduced content used, to match course length
T/G Training	AIR 5279 Composite and Bonded Structure Inspector: Training Doc.	issued 01.Mar.99 reaffirmed 26.Jan.06	Flight Safety: uses as basis (100%) A.I.: Reduced content used, to match course length
T/G Training	AIR 4844, A, B, C Composites and Metal Bonding Glossary	issued 01.Mar.97 3 rd revision in progress	a) A.I. : Internal use b) Boeing : c) P&W : d) GE : used as a resource in house e) Goodrich: Uses as reference in-house and with customers
T/G Training	Composite Structures Awareness, Video	available	
T/G Training	Proper Handling of Composite Parts, Video	available	
T/G Training	AIR 5719 Teaching Points for an Awareness Class on "Critical Issues in Composite Maintenance and Repair"	balloted	

Document implementation status

Document sponsor	Document	Status	Implementation
T/G Airline Inspection & Repair Conditions	Structural Repair Manual Limitations in Commercial Airline Maintenance, Report	issued 30.Oct.98	
T/G Analytical Repair Techniques	AIR 5946 Design and Application of Composite Repairs for Thermosetting Composites	in Progress	

Other Successes for CACRC to date:

Forum to act as the source for industry to obtain airline input / feedback, such as :

- ◆ **Comments on Advisory Circular Number 145-6 “Repair Station for Composite and Bonded Aircraft Structures”**
- ◆ **Sandia NDT Program Steering group.**
- ◆ **FAR Revisions**
- ◆ **Airline contacts for design reviews.**
- ◆ **Participation at FAA Composite Workshops.**

But,

Most of the issues that existed 20 years ago still exist!

◆ Materials

- **Numerous types, styles and procurement specifications.**
- **Limited and/or untimely availability.**
- **Minimum purchase amounts and cost associated with the expiration of shelf life.**
- **No standard means of determining substitutability.**

◆ Repair Techniques

- **Limited options, Component specific, OEM driven.**
- **Inability to standardize materials and repair processing due to unknown effects on design properties.**
- **Limited independent analysis capabilities.**
- **Denied access to design loads and material allowables necessitating innovative repair solutions.**

Most of the issues that existed 20 years ago still exist! (cont.)

◆ Repair Access

- **Repairability in design.**
- **Self inflicted damage associated with obtaining back side access to damaged areas.**
- **Cost associated with lack of access.**

◆ Tooling and Equipment

- **Inability to obtain OEM loft data.**
- **Concern over exact replication of OEM tooling.**
- **Compatibility of tooling material selection.**
- **Consideration of thermal coefficient of expansion.**
- **Repair spring back vs. manufacturing spring back.**

Most of the issues that existed 20 years ago still exist! (cont.)

◆ Approval Legalities

- **All process and/or material deviations require formal approval.**
- **A DER is the main means of obtaining FAA repair approval.**
- **Repair processing must be approved by the customers engineering department.**
- **Lack of trust in bonded repairs.**

◆ Training

- **Dedicated training and licensing is still not mandatory.**

Summary

- ◆ **Operator input remains absolute necessity. The attendance of airline / MRO personnel has to be encouraged.**
- ◆ **CACRC proved to be effective to improve maintainability of composite structures, but focus has to be extended to primary structures.**
- ◆ **CACRC proves to be worthwhile for operators, OEM's and material supplier, but results must be implemented faster**
- ◆ **CACRC is breaking new ground in industry and regulatory agencies cooperation.**

Next meetings

European Spring meeting:

◆ tbd

North American Fall meeting:

◆ tbd

Main committee detailed meeting information can be found on the SAE web page:

<http://works.sae.org>

You are invited to join CACRC

Please contact:

- ◆ **Kerri L. Rohall**
Aerospace Committee Service Rep.
SAE Technical Standards & Research
400 Commonwealth Dr.
Warrendale, PA 15096-0001
U.S.A.
Phone: +1 (724) 772-7161
Fax: +1 (724) 776-0243
E Mail: kerrir@sae.org
<http://www.sae.org>