Progress Report of the

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

Presented at : FAA Damage Tolerance & Maintenance Workshop

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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.

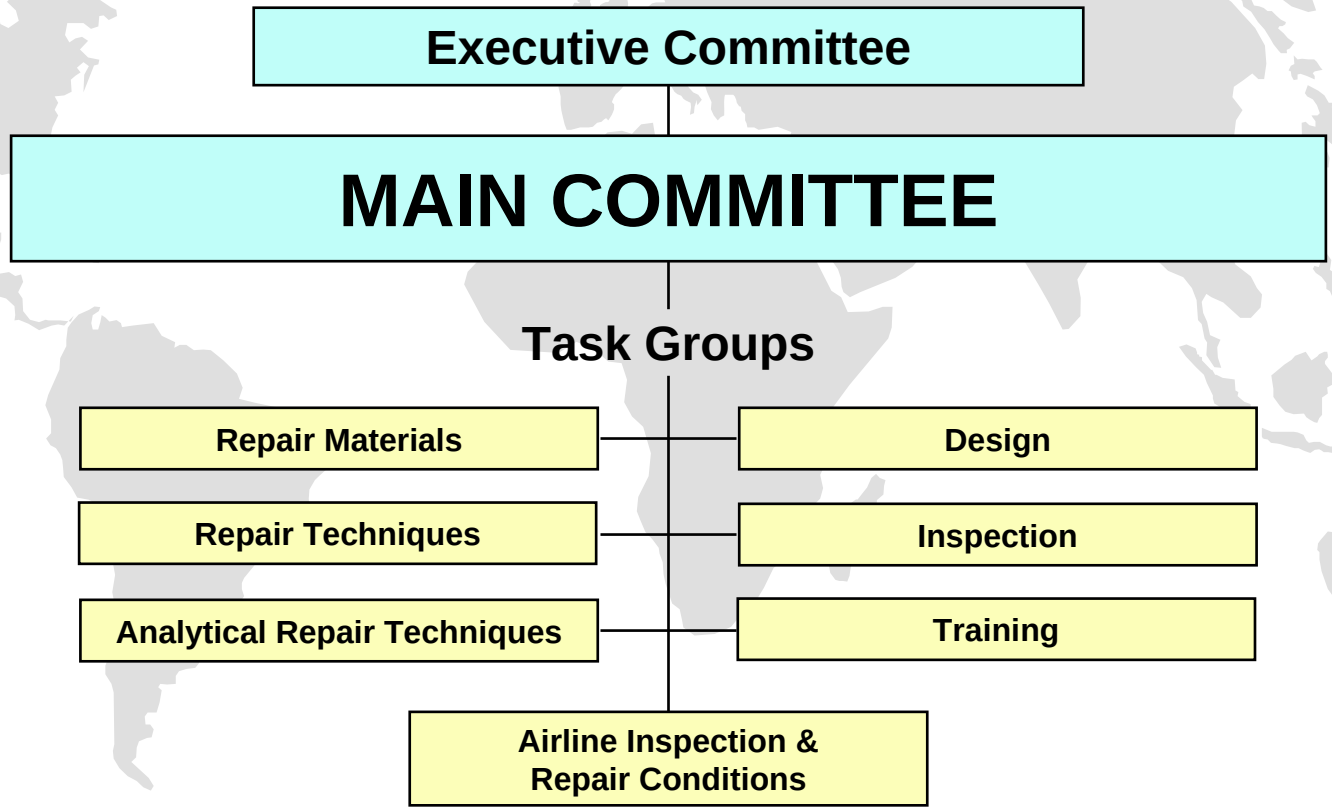
SUPPLIER MEMBER: Producers of the various materials and processes are an integral part of the AMS operation. Supplier members have no formal vote but can comment on documents.

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 Airlnes, 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

- **11 SAE / Aerospace Materials Specifications (AMS)**
- **5 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)

18 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	Qualification completed a) A.I.: incorporated in AIMS 08-01-00 b) Boeing : c) P&W : d) GE : e) Goodrich: Certification in 2005 / 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 in progress	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	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 in1998 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 Lay-up of Prepreg Composite Materials	in progress	a) A.I. : b) Boeing : c) P&W : d) GE : e) Goodrich:
T/G Repair Techniques	AIR 5702 Storage and Handling of Epoxy Thermosetting 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 Inspection	ARP 5089 Composite Repair NDT / NDI Handbook	issued 01.Nov.96	FAA: internal use Boeing: internal use A.I.: Internal use Goodrich: Internal use, CSSP 540258 Pre-Preg repair.
T/G Inspection	ARP 5605 Solid Composite Laminate NDI Reference Standards	issued 01.Sep.01	a) A.I. : Internal use b) Boeing : c) P&W : d) GE : e) Goodrich:
T/G Inspection	ARP 5606 Composite Honeycomb NDI Reference Standards	issued 01.Sep.01	a) A.I. : Range of possible applications under review b) Boeing : c) P&W : d) GE : e) Goodrich:
T/G Design	AE-27 Design of Durable, Repairable and Maintainable Aircraft Composites	issued 11.Jul.97	a) Presentation to European designers Nov.97. b) Presentation to BF Goodrich Aerospace designers Feb.98. c) Presentation to Boeing designers May 98. d) Presentation at SAMPE conference e) Goodrich: implemented in Design & Best Practice Nacelle manuals. f) P&W: implemented in Nacelle Design Handbook. g) Boeing: implemented in Design Handbook. h) A.I.: presented to partners and implemented in Design Hbk. i) Presentation at EADS Stade Sep 01.
T/G Design	AIR 5416 Maintenance Life Cycle Cost Model	in Progress	

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 in progress	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 3rd 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"	In progress	

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.**

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

North American Fall meeting:

- **Mid November, 2007**
  Wichita, USA (to be confirmed)

European Spring 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

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