



# Repair Processes Presentation

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**The Joint Advanced Materials and Structures Center of Excellence**



# Repair Processes



**Composite Laminate Fabrication and Bonded Repair Methods  
(TCO Module F)**

**Perform a Bonded Composite Repair  
(TCO Module G)**

**Bolted Assembly and Repair Methods  
(TCO Module I)**



# Repair Processes



## Composite Laminate Fabrication and Bonded Repair Methods [Module F]

- Understand the basics of composite laminate fabrication [F1]
- Understand the basics of composite bonded repair [F2]
- Describe the detailed processing steps necessary for laminate fabrication {factory}, bonded repair {maintenance base or line station}, and Material Review Board {OEM} [F3]
- Describe key characteristics and processing parameters for laminate fabrication [F4]
- Identify typical processing defects which occur in composite laminate fabrication and bonded repair [F5]
- [LAB #1]: Damage laminate coupons in a controlled laboratory environment and visually inspect the extent of the front and any back side surface damage [F6]



# Composite Laminate Fabrication and Bonded Repair Methods



## Understand the basics of composite laminate fabrication [F1]

- Step by Step Overview of the Layup Process
- Emerging Developments in Composites Processing

## Understand the basics of composite bonded repair [F2]

- Comparison of Prepreg vs. Wet Layup Repairs
- Permanent, Temporary and Time-Limited Repairs
- Depot and Field Repairs



# Correct Repair Processing and Documentation



## Flight Safety Message #4

**The correct processing of composite components is critical to the elimination of processing defects. Inspection of bonded composite and metal-bond assemblies using appropriate NDI techniques together with in-process quality control is essential to the delivery of defect free composite components for assembly to the aircraft.**

**In-service inspections of composite components are necessary for safe flight operations just as they are for those components fabricated from metals. In-service damages from various sources are likely to occur during an aircraft's operational life. If damages are detected using visual inspection or by directed NDI inspection, the correct use and the interpretation of NDI inspections are required to accurately define the extent of damages so that correct damage dispositions can be made.**

**In the event of processing defects or in-service damage, misuse of equipment or misinterpretation of in-process quality control and NDI results may be detrimental to flight safety.**



# Composite Laminate Fabrication and Bonded Repair Methods



**Describe the detailed processing steps necessary for laminate fabrication {factory}, bonded repair {maintenance base or line station}, and Material Review Board {OEM} [F3]**

- Lay-up with Cobonded Components**
- Bonded Repair (including prepreg layup)**
- Material Review Board**



# Composite Laminate Fabrication and Bonded Repair Methods



**Describe key characteristics and processing parameters for laminate fabrication [F4]**

- Important Processing Parameters for ensuring quality components

**Identify typical processing defects which occur in composite laminate fabrication and bonded repair [F5]**

- Fabrication Processing Defects and how to avoid them
- Bonded Processing Defects and how to avoid them



# Composite Laminate Fabrication and Bonded Repair Methods



**[LAB #1]: Damage laminate coupons in a controlled laboratory environment and visually inspect the extent of the front and any back side surface damage [F6]**

**– Peter, where is Lab #6 in the latest set of Modules?**





# Repair Processes



## Perform a Bonded Composite Repair [Module G]

- Demonstrate drying and surface preparation and inspection [G1]
- Demo material lay down and compaction processes for laminate repair. [G2]
- Demo prep and cure for laminate bonded repair, and explain errors to avoid [G3]
- Describe process parameters affecting bonded repair quality, and controls to avoid defects [G4]
- Compare ‘wet layup’ and ‘prepreg’ bonded repairs for sandwich and laminate parts [G7]
- Demo quality controls during repair bonded lab[G6]
- Describe metal bond repairs vs. composite bonded repairs [G8]
- [LAB #3]: Layup and Bag Prepreg and Wet Lay-up Repairs [G5]



# Perform a Bonded Composite Repair



**Demonstrate/apply common drying and surface preparation techniques, and how to inspect for acceptability [G1]**

- Demo of Sandwich Drying process**
  - Point of discussion: Full drying time will be demonstrated (rather than moisture meters)**
- Demo of Laminate Scarfing**



# Perform a Bonded Composite Repair



**Demonstrate and apply material lay down and compaction processes for a simple laminate panel repair. [G2]**

- Demo of Prepreg Layup for Bonded Repair**
- Demo of Wet Layup for Bonded Repair**



# Perform a Bonded Composite Repair



**Demonstrate how to prepare and cure a simple bonded repair to a laminate panel, and explain the types of errors to avoid [G3]**

- Demo of Bonded Repair Vacuum Bagging**
- Demo of Hot Bonder w/ Heat Blanket Curing**



# Correct Repair Processing and Documentation



## Flight Safety Message #4

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**In-service inspections of composite components are necessary for safe flight operations just as they are for those components fabricated from metals. In-service damages from various sources are likely to occur during an aircraft's operational life. If damages are detected using visual inspection or by directed NDI inspection, the correct use and the interpretation of NDI inspections are required to accurately define the extent of damages so that correct damage dispositions can be made.**

**In the event of processing defects or in-service damage, misuse of equipment or misinterpretation of in-process quality control and NDI results may be detrimental to flight safety.**



# Perform a Bonded Composite Repair



**Describe process parameters which affect bonded repair quality, and in-process controls necessary to avoid defects [G4]**

- Maintain Proper Vacuum Pressures and Temperatures

**Demonstrate critical in-process quality controls during laboratory bonded repair process trials [G6]**

- Process monitoring with checks and complete documentation is essential



# Perform a Bonded Composite Repair



**Describe differences between ‘wet layup’ and ‘prepreg’ bonded repairs to sandwich and laminate parts [G7]**  
– Prepreg and Wet Layup Pros and Cons



# Perform a Bonded Composite Repair



**Describe metal bond repairs and differences from composite bonded repairs [G8]**

- Successful Metal Bonding Parameters**
- Comparison of Metal Bonding and Composite Bonding**





# Perform a Bonded Composite Repair



- [LAB #3]: Prepare bonded repair for cure, including bagging & heating apparatus & cure [G5]**
- Perform a 250°F Prepreg Bonded Repair**
    - Ply Kitting through Start of Hot Bonder**
  - Perform a 200°F Wet lay-up Bonded Repair**
    - Impregnation through start of Hot Bonder**



# Repair Processes



## Describe and Perform Composite Bolted Repair [Module I]

- Describe basics of composite bolted structural assembly. [I1]
- Describe the basics of composite bolted repair. [I2]
- Demo composite drilling versus metal drilling [I3]
- Describe parameters which affect bolted composite repair quality and in-process controls to avoid defects [I4]
- [LAB #5]: Demo damage removal, surface preparation, drilling, fastening and inspection techniques [I5]
- [LAB #6]: Verify correct fastener selection, inspect drilled holes, and check installation [I6]



# Describe and Perform Composite Bolted Repair



**Describe the basics of composite bolted structural assembly. Show the differences between composites and metal bolted assembly [I1]**

- Compare Composite vs. Metal Bolted Assembly

**Describe the basics of composite bolted repair. Show the differences between drilling and cutting composites and metals [I2]**

- Discuss Drilling Cutting Machining Differences

**Demonstrate composite drilling versus metal drilling [I3]**

- Demo Drilling of Ti vs. CFRP



# Describe and Perform Composite Bolted Repair



**Describe process parameters which affect bolted composite repair quality and in-process controls necessary to avoid defects [I4]**

- Describe Critical Processing Parameters**
- Describe In-Process controls to avoid defects**



# Describe and Perform Composite Bolted Repair



**[LAB #5]: Demonstrate and apply common damage removal, surface preparation, drilling and fastening techniques used for bolted composite repairs and how to inspect them for acceptability [I5]**

**– Demo Bolted repair on CFRP part**



# Correct Fastener Selection and Installation



## Flight Safety Message #8

**The tolerances for installation of fasteners during composite bolted repairs are, in the main, more critical than for fastener installation of fasteners during the repair of metal parts. Drilling of composites is more difficult, and fasteners needed to be selected that due not cause delamination during installation. The bolted repair design is of great importance in that a bad repair design may cause problems for component margins of safety, while restoring the damaged component adequately. Fastener installation equipment such as torque wrenches etc., must be correctly calibrated and standards kept up to date.**

**The design of the bolted repair, selection of incorrect fasteners, poorly drilled holes and incorrect fastener installation can all contribute to a defective repair, and hence flight safety may be impaired.**



# Describe and Perform Composite Bolted Repair



- [Lab #6] Verify correct fastener selection, inspect drilled holes, and check if fasteners were properly installed during bolted composite repair laboratory trials [I6]**
- Students inspect and reject improperly installed fasteners**



# Repair Processes Conclusion



**Mixture of Discussion, Demonstration  
and Lab Practicals will create  
Awareness of Composites Repair  
Processing Issues among Repair  
Practicioners**