

TERMINAL COURSE OBJECTIVES (TCOs)

September, 2005

Statement at the beginning of each TCO: *At the end of this course, the student will be able to:*

I: Survey Course: Composite Materials Maintenance and Repair

TCO C Module – Understand Roles and Responsibilities

- C1: Identify the steps required in repair design, process planning, inspection and approval.
- C2: Describe the steps in the bonded and bolted repair processes, including details of damage discovery through repair completion and approval.
- C 3: List of basic NDI methods with their limitations for damage assessment and post-repair inspection.
- C 4: Distinguish between skills needed for structures engineers, inspectors and technicians dealing with composite maintenance and repair.
- J 8: Know your skill limits and who to go to for help.

TCO D Module – Recognize Composite Damage Types and Sources

- D1: Identify Sources and Characteristics of Damage to Composite Sandwich and Laminate Stiffened Structures
- D2: Describe Damage Types and their Significance to Structural Integrity
- D3: Understand the information and analysis necessary for repair design and process development/substantiation
- D4: Distinguish differences in repair disposition procedures for those damages covered by source documentation, and those that aren't
- D5: Describe the regulatory approval process for damages not covered by source documentation
- D6: *[LAB #1]:* Damage laminate coupons in a controlled laboratory environment and visually inspect the extent of the front and any back side surface damage

TCO E Module – Identify and Describe Information Contained in Documentation

- E1: Describe Requirements in Material and Process Specifications and Approved Repair Information
- E2: Demonstrate the Use of Source Documents
- E3: Identify and demonstrate the use of regulatory documents
- E4: Understand the requirements and engineering approvals necessary for valid sources of technical information and maintenance instructions

TCO F Module – Describe Composite Laminate Fabrication and Bonded Repair Methods

- F1: Understand the basics of composite laminate fabrication
- F2: Understand the basics of composite bonded repair

- F3: Describe the detailed processing steps necessary for laminate fabrication {factory}, bonded repair {maintenance base or line station}, and Material Review Board {OEM}
- F4: Describe key characteristics and processing parameters for laminate fabrication
- F5: Identify typical processing defects which occur in composite laminate fabrication and bonded repair

TCO G Module – Perform a Bonded Composite Repair

- G7: Describe differences between ‘wet layup’ and ‘prepreg’ bonded repairs to sandwich and laminate parts
- G1: Demonstrate/apply common drying and surface preparation techniques, and how to inspect for acceptability
- G2: Demonstrate and apply material lay down and compaction processes for a simple laminate panel repair.
- G3: Demonstrate how to prepare and cure a simple bonded repair to a laminate panel, and explain the types of errors to avoid
- G5: *[LAB #3]:* Prepare bonded repair for cure, including bagging & heating apparatus & cure
- G4: Describe process parameters which affect bonded repair quality, and in-process controls necessary to avoid defects
- G6: Demonstrate critical in-process quality controls during laboratory bonded repair process trials
- G8: Describe metal bond repairs and differences from composite bonded repairs

TCO H Module – Describe Composite Damage and Repair Inspection Procedures

- H1: Describe NDI techniques currently available in the field
- H2: Describe critical steps necessary for making damage dispositions, including inspection and a draft process for QC plan for repair
- H3: Describe the critical steps necessary for inspecting a completed bonded repair, including NDI and interpretation of results
- H4: *[LAB #2]:* Demonstrate, and have students perform various damage assessments, including visual inspection, tap test and ultrasonic inspection
- H4: *[LAB #4]:* Demonstrate, and have students perform various post-repair acceptance inspections, including visual inspection, tap test and ultrasonic inspection

TCO I Module – Describe Composite Laminate Bolted Assembly and Repair Methods, and Perform and Inspect a Bolted Composite Repair

- I1: Describe the basics of composite bolted structural assembly. Show the differences between composites and metal bolted assembly
- I2: Describe the basics of composite bolted repair. Show the differences between drilling and cutting composites and metals
- I3: Demonstrate composite drilling versus metal drilling

- I4: Describe process parameters which affect bolted composite repair quality and in-process controls necessary to avoid defects
- I5 [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
- I6 Verify correct fastener selection, inspect drilled holes, and check if fasteners were properly installed during bolted composite repair laboratory trials

TCO K Module – Case Team Studies [LAB #6]

- K1: Identify the structural component and understand the specific configuration and materials used for fabrication of the damaged component.
- K2: Perform a damage assessment and map the damage as accurately as possible using visual inspection, the tap test or P/E ultrasonic equipment
- K3: Interrogate the SRM to understand the component allowable damage limits, and review any repair options contained in the SRM based on the mapped damage
- K4: Write an appropriate repair procedure and in-process QC plan based on the chosen repair option.
- K5: Write an appropriate post-repair inspection and approval plan

II: Prerequisite Terminal Course Objectives prior to Attending Survey Course

TCO A Module - Understand basics of composite materials technology.

- A1: Distinguish among resin, fiber and core applications and uses.
- A2: Describe various composite processing parameters.
- A3: Describe composite design parameters and effects of processing
- A4: Describe various composite machining, assembly and finishing processes.
- A5: Describe stiffened laminate and sandwich applications and structural properties.
- A6: Have available and understand composite materials glossary of terms

TCO B Module - Understand the basics of composite materials maintenance and repair

- B1: List the basic steps in maintenance procedures from damage detection through repair completion.
- B2: List key composite and expendable materials needed for simple laminate structure repair including appropriate storage requirements.
- B3: List the necessary tooling and equipment to accomplish a simple laminate structural repair.
- B4: Adhere to personal and equipment safety requirements.
- B5: Describe the differences between repairing composite and metal structures, including discussions about metal bonding,
- B6: Describe the process of metal bonding

TCO J Module -Understand other critical elements of composite maintenance and repair.

- J1: Discuss issues affecting the selection of bonded or bolted repairs.

- J2: Describe various electrical requirements and effects, including prevention of corrosion, hazards of electromagnetic interference and electrostatic discharge (lightning protection systems) and how they need to be considered during the repair processes.
- J3: Understand the need for protective coatings and surface finishing steps used for composite aircraft structure.
- J4: Describe typical paint and surface layer removal techniques for finished composite parts.
- J5: Discuss proper disposal of wastes from the composite repair process, including EPA/OSHA requirements.
- J6: Discuss emerging advances in repair process technologies that may appear for bonded and bolted repair and quality control.
- J7: Discuss emerging damage and repair inspection technologies, such as bond testing, moisture meters, interferometer (3D characterisation).
- J8: Discuss the importance of knowing your skill limits and who to go to for help in completing maintenance tasks.
- J9: Discuss the importance of documenting/ sharing information about damage scenarios discovered in service between OEM and Maintenance Organisations and Regulators.