U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Development of Training/Qualification Programs for Composite Maintenance Technicians

Date: 8/3/11 **AC No:** 65-33

Initiated by: AFS-320 **Change:**

1. PURPOSE. This document is intended as a guideline for organizations to develop a formal training program for qualification of composite technicians. This advisory circular (AC) contains recommendations for the experience, training, qualification, and examination of persons performing maintenance and repair of aircraft composite structures or other aviation composite components. It recommends criteria for the qualification of personnel to be able to understand the technical principles involved in the maintenance and repair of aircraft composites. This document applies to those individuals directly responsible for providing training, supervision, or oversight of composite maintenance personnel. Organizations may use the information contained in this AC to develop a written program describing the guidelines used to train and qualify personnel. This AC provides a means, but not the only means, of developing a composite maintenance training program.

2. RELATED TITLE 14 OF THE CODE OF FEDERAL REGULATIONS (14 CFR) PARTS.

- Part 121, § 121.375;
- Part 145, § 145.163; and
- Part 147.

3. RELATED READING MATERIAL (current editions).

- AC 20-107, Composite Aircraft Structure.
- DOT/FAA/AR-09/0, Regional Laboratory Development Composite Maintenance Education, Including Repair Manual, (Dec. 2009).
- Society of Automotive Engineers (SAE) Aerospace, AIR5719, Teaching Points for Awareness Class on "Critical Issues in Composite Maintenance and Repair."

4. BACKGROUND. The use of composites in aircraft structures and other components has increased fuel savings by reducing weight without sacrificing structural strength. These characteristics are vital to meeting the demands of the aerospace industry. Additional properties such as fatigue and corrosion resistance provide expanded design capabilities.

a. Composite Maintenance and Repair. The maintenance and repair of composites is complex and requires knowledge and skills to assure the continued airworthiness of these products. Practical experience is also vital for proper processing and repair of composite structures. Experience, classroom training, hands-on on-the-job training (OJT), and assessments

b. Composite Maintenance Training. As more composite aircraft enter into operation, detailed and documented composite training should be developed to ensure that personnel performing composite maintenance on aircraft structures and components properly repair damage to meet the highest level of safety. Continual emphasis on training program development is essential to keep pace with the changing aerospace industry needs. A detailed and well-developed composite maintenance training program is essential for the continued airworthiness of these products.

5. DISCUSSION. To assure that only qualified persons perform composite maintenance, an organization should develop a written training/qualification program.

a. Training and Qualification Programs. The program should include, at a minimum, the following elements:

- Course training curriculum (see sample in Appendix 1),
- Classroom/written tests,
- Demonstrations, and
- Hands-on training/practical tests.

b. Records and Documentation. An organization's records should include a description of the training required for each qualified individual. Identification of those responsible for developing, administering, and maintaining the organization's qualification program should also be recorded.

c. Recurrent Training. A training program should include provisions for recurrent training to continually update persons on technology, materials, and other changes regarding composite maintenance and repair. Records of recurrent training should be maintained by the organization and the individual.

6. PERSONNEL QUALIFICATIONS.

a. Control and Administration Program. The organization should establish a written program for the control and administration of personnel training, examination, qualification, and documentation. This should include a method for maintaining proficiency, including recurrent training and steps to retrain or requalify, as required.

b. Training Instructors. The organization should provide qualified instructors. Such individuals should have demonstrated practical experience and knowledge of composite maintenance and repair practices. At the option of the organization, and as provided in their written practice, an outside agency may be engaged to provide composite training and testing.

c. Instructor Qualifications. An individual should be qualified and designated, in accordance with this AC, to provide classroom or laboratory training for composite personnel. The instructor should:

(1) Have the necessary skills and knowledge to plan, organize, and present classroom, laboratory, or OJT programs of instruction in accordance with course outlines in the method for which he or she is qualified.

(2) Be thoroughly familiar with the theory and practical applications of the method as utilized by the organization.

(3) Not conduct composite inspections for the acceptance of parts unless he or she is properly qualified.

d. Formal Training. Qualified personnel should have completed sufficient formal training to become familiar with principles and practices of applicable repair methods. The training program should include instructions in basic principles, products, equipment, operating procedures, and test techniques that the individual might encounter in his or her work assignment.

e. Qualification. Qualification of personnel should be based on demonstration of satisfactory performance as determined by the assessments outlined in paragraph 7.

7. ASSESSMENTS. A qualified person should satisfy all of the following criteria applicable to composite maintenance and repair.

a. General Knowledge Assessment. The general knowledge assessment may be an open-book test consisting of questions that cover the basic knowledge of composite repair methods, materials, and procedures. In addition, questions should also cover the repair data, workshop procedures, quality control (QC) requirements, and other aspects of company practice that apply to the composite repair workshop.

(1) The assessment should contain a sufficient number of questions to represent a fair distribution across the subject areas. These may be multiple-choice or short answer, or a combination of both.

(2) A passing score of 80 percent and mandatory correction to 100, shown by 80/100 or 90/100, should be required for written assessment. In other words, failed questions must be reviewed with all students by the instructor in class.

b. Practical Assessment. Documentation is required to show the person can:

(1) Satisfactorily demonstrate that he or she is familiar with, and can operate, the necessary equipment and interpret FAA-accepted or FAA-approved data.

(2) Handle the materials and products correctly in accordance with safety and quality requirements.

(3) Identify the fabric tracers, direction of the warp and fill, and yarn count.

(4) Prepare the components' damaged area for repair in accordance with the approved/accepted data.

(5) Lay up the repair in proper orientation and apply the cure process in accordance with the approved/accepted data.

(6) Assess the integrity of the complete repair in accordance with the approved/accepted data.

8. Recognition of Prior Experience. Prior experience should be considered, provided the person presents documented evidence of training and experience acceptable to the organization. All accepted documentation supporting recognition of prior training and experience will be annotated in the employees training file.

9. Continued Competence. Composite repair personnel should demonstrate continued competence every 2 years by performing a repair or by performing a practical assessment under the direct supervision of an examiner authorized and designated by the organization or by having participated in or performed at least six composite repairs in the 2-year period.

NOTE: In the event of unsatisfactory performance, retraining and reassessment of the technician is required.

for
John M. Allen
Director, Flight Standards Service

APPENDIX 1. SAMPLE COURSE CURRICULUM

NOTE: This is a sample curriculum that may be modified to meet the needs and complexity of an organization.

SAMPLE COURSE CURRICULUM

BASIC KNOWLEDGE OF COMPOSITE TECHNOLOGY

Basic knowledge content provides a basis for composite training. Persons must be familiar with the terminology and basics of composite technology to fully appreciate and understand critical issues in composite maintenance and repair. Understanding the basics of this technology, having an elementary familiarity with composite maintenance, and being aware of other important issues is critical to further study in the course.

1. Objective: Understand the Basics of Composite Materials Technology. The person should be able to:

a. Distinguish among adhesive, resin, fiber, and core (honey-comb, foam, corrugated, and balsa) applications and uses.
b. Describe various composite processing parameters.
c. Describe composite material properties, failure modes, and effects of processing.
d. Describe various machining, assembly, and finishing processes.
e. Describe stiffened laminate and sandwich applications, and structural properties.

2. Objective: Understand the Basics of Composite Materials Maintenance and Repair. The person should be able to:

a. List the basic steps in maintenance procedures from damage detection through repair completion.
b. List key composite and expendable materials needed for a simple laminate structural repair, including the storage requirements.
c. List the necessary tooling and equipment to accomplish a simple laminate structural repair.
d. Understand personnel and safety equipment requirements.
e. Describe the differences between repairing composite and metal bonded structure, including discussions on the special issues related to composite and metal bonding.
f. Discuss the importance of approved or accepted data, methods, and procedures used in product-specific composite maintenance and repair.
g. Describe critical safety aspects of repair design, process planning, and approval**.**
h. Describe the steps in composite damage detection, inspection, and repair processes.
i. List basic nondestructive inspection (NDI) or Nondestructive Testing (NDT) (Visual, Tap Test, Ultrasonic Inspection (A-Scan, C-Scan), X-Ray, Thermal Imaging) methods used for damage assessment and post-repair inspection.

3. Objective: Understand Other Critical Elements of Composite Maintenance and Repair. The person should be able to:

a. Discuss basic issues affecting the selection of repairs.

b. Describe various electrical requirements and effects, including prevention of corrosion, hazards of electromagnetic interference (EMI), electromagnetic shielding (EMS)/electromagnetic field (EMF), and electrostatic discharge (lightning protection systems), and how they need to be considered during repair processing.

c. Understand the need for protective coatings and surface finishing steps used for composite aircraft maintenance.

d. Describe typical paint and surface layer removal techniques for composite parts.

e. Know the issues related to proper disposal of waste from the composite repair process.

f. Know personal skill limits and where to receive assistance during maintenance—this is essential.

g. Discuss the importance of documenting and sharing information about damage scenarios discovered in service between the Original Equipment Manufacturer (OEM), Maintenance Repair Organizations (MRO), and regulators.

4. Objective: Knowledge of Composite Maintenance Research and Industry Developments. The person should be aware of:

a. The special skill requirements of composite maintenance and repair.

b. The differences in quality control (QC) processes for bonded and bolted repairs.

c. Damage and repair inspection technologies, such as bond testing, moisture meters, and interferometer (three-dimensional characterization).

d. The need for a repair and approval to meet regulatory requirements.

5. Objective: Understand Roles and Responsibilities. The person should:

a. Be aware of the vital interface between personnel trained in composites and personnel that may be unaware of a need for damage disposition, such as flightcrew members, operations staff, and line maintenance personnel.

b. Distinguish between the skills needed for structural engineers, inspectors, and technicians dealing with composite maintenance and repair.

6. Objective: Identify and Describe Information in Required Documentation. The person should:

a. Identify documents used in composite maintenance and repair, including those describing acceptable field disposition procedures and the associated regulatory rules that must be followed.

b. Identify limits on the damages and repairs.

c. Describe requirements in material and process specifications and in approved repair information.

d. Demonstrate the use of approved Structural Repair Manuals (SRM) or other approved OEM repair documents.

e. Describe the requirements and engineering approvals necessary for valid sources of technical information and maintenance instructions.

f. Describe the regulatory considerations for damages not covered by approved SRMs or other approved OEM repair documents.

7. Objective: Describe Safe Handing of Advanced Composite Materials. The person should describe procedures for safe handling of advanced composite repair materials.

INSPECTION, DAMAGE DETECTION, AND CHARACTERIZATION

This section of the class is intended to familiarize persons with the typical types of composite damage, characteristics of the damages, and appropriate inspection procedures. It integrates technical information and labs to ensure that persons understand what causes damage in composite materials and the inspection methods needed for detection and complete damage characterization.

1. Objective: Recognize Composite Damage Types and Sources. The person should be able to:

a. Identify sources and characteristics of damage of composite sandwich- and laminate-stiffened structures.
b. Describe damage types and their significance to structural integrity.
c. Understand the information and analysis necessary for repair design and process development and substantiation.
d. Distinguish differences in repair procedures for damages not covered by approved SRMs or other approved OEM repair documents.

2. Objective: Describe Composite Inspection Procedures. The person should:

a. Describe NDI/NDT techniques currently available, including an assessment of their strengths and weaknesses.
b. Describe the critical steps necessary for inspecting a completed bonded repair, including NDI/NDT procedures and interpretation of the results.
c. Describe various damage assessments, including visual inspection, tap test, and ultrasonic pulse echo inspection.
d. Describe various post-repair acceptance inspections, including visual inspection, tap test, and ultrasonic pulse echo inspection.

COMPOSITE REPAIR PROCESSES

Additional training is necessary to develop specific skills and perform tasks on the structural components of a given aircraft type that has unique repair design, process, and inspection details. Inspectors and others involved in repair, planning, and inspection also need the basic composite training provided by this section of the course as a basis for future study.

1. Objective: Describe Composite Laminate Fabrication and Bonded Repair Methods. The person should:

a. Understand the basics of composite laminate fabrication.
b. Describe the key characteristics and processing parameters for laminate fabrication.

c. Understand the basics of composite bonded repair.

d. Describe the detailed processing steps necessary for approved bonded repair.

e. Identify typical processing defects that occur in composite laminate fabrication and bonded repair.

2. Objective: Perform a Simple Bonded Composite Repair. The person should:

a. Demonstrate and apply common drying and surface preparation techniques, including how to inspect for acceptability.

b. Demonstrate and apply material layup and compaction processes for a simple laminate panel repair.

c. Demonstrate how to prepare and cure a simple bonded repair to a laminate panel and explain the types of errors to avoid.

d. Prepare a bonded repair for cure, including bagging and heating apparatus and cure.

e. Describe process parameters that affect bonded repair quality and in-process controls necessary to avoid defects.

3. Objective: Describe Composite Laminate Bolted Assembly and Repair Methods. The person should:

a. Describe the basics of composite bolted structural repairs.

b. Know the differences between drilling and cutting composites and metals.

c. Describe process parameters, which effect bolted composite repair quality, and in-process controls necessary to avoid defects.

d. Describe common damage removal, surface preparation, and drilling and fastening techniques used for bolted composite repairs, and how to inspect the repairs for acceptability.

e. Describe correct fastener selection, inspection of drilled holes, and proper fastener installation for bolted composite repair.

f. Perform a structural laminate panel bonded repair in accordance with the SRM- or OEM-approved repair processes.