



U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

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

Date: 6/27/17

AC No: 65-33A

Initiated by: AFS-300

Change:

- 1 PURPOSE.** This advisory circular (AC) is intended as a guideline for repair organizations to develop a formal training program for qualification and certification of composite technicians that they employ. This 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, qualify and certify personnel. This AC provides a means, but not the only means, of developing a composite maintenance training program.
- 2 CANCELLATION.** AC 65-33, Development of Training/Qualification and Certification Programs for Composite Maintenance Technicians, dated August 3, 2011, is canceled.
- 3 RELATED TITLE 14 OF THE CODE OF FEDERAL REGULATIONS (14 CFR) PARTS:**
 - Part 23, § 23.573.
 - Part 121, § 121.375.
 - Part 135, § 135.433.
 - Part 145, § 145.163.
 - Part 147 Appendix C.
- 4 DEFINITIONS.** Terms included in this document are defined as follows:
 1. Certification. Written testimony of qualification that the employer typically issues as a written statement that the individual has met the requirements of an accepted standard.

Note: Certification as presented in this AC refers to a certification issued by an employer/organization, not a recognized National Certification program.

2. Certification Based on Previous Experience. Certifications of individuals who were certified under a previous qualification program supported by documented prior training and hands-on experience that is acceptable to the certifying organization.
3. Documentation. Written or printed record furnishing verifiable information or evidence. A legal or official record in paper or electronic form.
4. Examination. A formal, controlled, and documented evaluation conducted in accordance with a procedure defined in an organization's program to determine the degree of knowledge and the application of learned skills.
5. Experience. Actual performance or observation conducted in the work environment of specific task-related skills, resulting in the acquisition of knowledge and skill. Knowledge and skills that a person acquires while working in a specific field or occupation gained over time, by actual involvement and performance of specific tasks in that field. This does not include classroom or laboratory training but does include on-the-job training (OJT).

Note: Experience should be validated by actual performance or observation conducted in the work environment to demonstrate knowledge and skills if used to demonstrate prior experience in lieu of formal training.

6. On-The-Job Training (OJT). Structured, documented training in the work environment. Learning objectives should include damage evaluation and determination of proper repair and demonstrated ability to perform various repair processes and should be accomplished under the technical guidance of an experienced composite technician.
7. Practical Examination. The hands-on examination used to demonstrate an individual's knowledge and skills to accomplish repairs that may be performed for the organization. A checklist should be used and observations and results should be documented.
8. Nondestructive Testing/Inspection (NDT/NDI). NDT/NDI is defined as inspections, tests, or evaluations which may be applied to a structure or component to determine its integrity, composition, electrical or thermal properties, or dimensions without causing a change in any of these characteristics.
9. Qualification. Demonstrated skill, training, knowledge, and experience required for personnel to properly perform the duties of a specific job.
10. Qualification Certificate. A certificate issued by the organization/employer as evidence of qualification to composite proficiency standards as defined in this document.
11. Training. An organized and documented program of activities designed to impart the knowledge and skills necessary for qualification. This program may be a mix of classroom, laboratory, programmed self-teaching, and OJT.

5 RELATED READING MATERIAL (current editions):

- AC 20-107, Composite Aircraft Structure.
- AC 21-26, Quality System for the Manufacture of Composite Structures.
- AC 23-20, Acceptance Guidance on Material Procurement and Process Specifications for Polymer Matrix Composite Systems.
- AC 43-214, Repairs and Alterations to Composite and Bonded Aircraft Structure.
- AC 65-31, Training, Qualification and Certification of Nondestructive Inspection Personnel.
- DOT/FAA/AR-09/3, Regional Laboratory Development Composite Maintenance Education, Including Repair Manual, (Dec. 2009).
- SAE Aerospace, AIR5719, Teaching Points for an Awareness Class on “Critical Issues in Composite Maintenance and Repair.”

6 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.

6.1 Composite Maintenance Repair and Evaluation. 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 OJT, and assessments all work together to ensure that the necessary skills are developed to perform effective composite maintenance and repairs that will be equal to its original or properly altered condition.

6.2 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 evaluate and 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.

7 DISCUSSION. To ensure that only qualified persons perform composite maintenance, an organization should develop a written training/qualification program. The composite training curriculum presented in this AC is considered the basic/minimum composite knowledge and skills that a repair technician should have related to composites. Each Maintenance Organization (MO) should evaluate the specific types of composite repairs that the organization performs and include the knowledge and skill requirements in the organization’s composite training.

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

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

7.2 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. The organization should maintain appropriate personnel training records in accordance with its qualification program for as long as a technician's qualification is in effect. Records must be available for audit by authorized personnel, and should at a minimum specify the date, time, and place of qualification, the employing organization, and the particular details applying to the certificate holder, such as special qualifications or limitations, and standards under which the holder is qualified. In addition, the records must include a copy of any Federal Aviation Administration (FAA) repairman certificates issued to the individual.

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

8 PERSONNEL QUALIFICATIONS.

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

8.2 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 its written practice, an outside agency may be engaged to provide composite training and testing.

8.3 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:

- Have the necessary skills and knowledge to plan, organize, and present classroom, laboratory, or OJT programs of instruction in accordance with course outlines.
- Be thoroughly familiar with the theory and practical applications of the techniques utilized by the organization to perform satisfactory composite repairs.
- Be qualified to perform actual repairs.

8.4 Formal Training. The formal training should be sufficient to familiarize personnel with principles and practices of applicable composite damage evaluation and repair methods that result in the qualification of an individual. 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.

8.5 Qualification. Qualification of personnel should be based on demonstration of satisfactory performance as determined by the assessments outlined in paragraph 9.

Note: See Appendix A for a sample course curriculum.

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

9.1 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.

9.1.1 Number of Questions. 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.

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

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

- Satisfactorily demonstrate that he or she is familiar with and can operate the necessary equipment and interpret FAA-accepted or FAA-approved data.
- Handle the materials and products correctly in accordance with safety and quality requirements.
- Identify the fabric tracers, direction of the warp and fill, and yarn count.
- Prepare the components' damaged areas for repair in accordance with the approved/accepted data.

- Lay up the repair in proper orientation and apply the cure process in accordance with the approved/accepted data.
- Assess the integrity of the complete repair in accordance with the approved/accepted data.

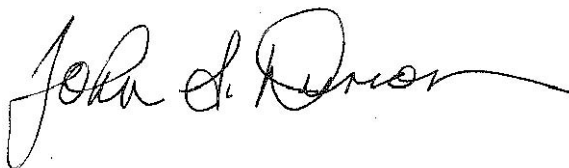
Note: See Appendix B, Sample Repair Curriculum Practical Skills Evaluation.

10 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 employee's training file.

11 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.

12 AC FEEDBACK FORM. For your convenience, the AC Feedback Form is the last page of this AC. Note any deficiencies found, clarifications needed, or suggested improvements regarding the contents of this AC on the Feedback Form.



John S. Duncan
Director, Flight Standards Service

APPENDIX A. 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 (honeycomb, 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 Handling 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 affect 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.

APPENDIX B. SAMPLE REPAIR CURRICULUM PRACTICAL SKILLS EVALUATION

This practical evaluation is designed for the trainee to demonstrate his or her knowledge learned through this coursework material. This evaluation will present situations that a composite repair technician will encounter and allow the trainee's skills to be evaluated through the physical performance of the required composite repair processes identified within this evaluation.

The following definitions should be considered when administering this practical skill evaluation:

Identify. The ability to visually recognize the item or process without assistance.

Demonstrate. The validation of the knowledge and skills by physical execution of a repair process by the student.

Determine. Using the information taught within this course and other practical experience, make the best evaluation and repair decision for the situation presented.

PRACTICAL SKILLS EVALUATION

1. Identify a delamination repair which requires a structural repair process.
 - a. Identify types of delamination within a repair.
2. Determine which type of repair is required using a standard repair manual.
 - a. Demonstrate drilling techniques (both ends of the repair site).
 - b. Demonstrate injection (resin) techniques.
 - c. Demonstrate injection techniques between composite layers.
 - d. Demonstrate clamping techniques.
 - e. Demonstrate structural repair process on delamination repair.
 - Determine if the situation is a sacrificial ply situation.
 - f. Demonstrate filling procedures.
 - g. Demonstrate sealing procedures.
 - h. Determine if the situation requires ply removal and replacement.
 - i. Demonstrate ply removal technique.

- j. Demonstrate ply replacement per structural repair techniques.
 - k. Demonstrate sanding skills to remove finish.
3. Apply problem-solving skills to determine if a part is actually damaged or just needs to be refinished.
- a. Identify the step removal process.
 - b. Demonstrate step damage removal process.
 - c. Identify the scarf removal process.
 - d. Demonstrate the scarf removal process.
 - e. Identify plug removal process.
 - f. Demonstrate the plug removal process.
4. Identify when a cosmetic refinish is needed.
- a. Demonstrate refinish filler skills.
5. Demonstrate a honeycomb core repair using the following parameters:
- a. Core plug removal technique.
 - b. Scarf sanding technique.
 - c. Wet lay-up repair patch.
6. Demonstrate a solid laminate repair using the following parameters:
- a. Scarf repair technique, machined steps.
 - b. Applying film adhesive.
 - c. Prepreg material handling and preparation for the repair.
 - d. Use of bagging and heating apparatus and proper cure.

This completes the practical skills evaluation.

REPAIR CURRICULUM PRACTICAL SKILLS EVALUATION GRADING RECOMMENDATIONS

There are six sections to this practical evaluation. Here are some recommendations for grading the practical skills evaluation broken up by section.

Section 1 – The student should be able to identify delamination; this is a critical step in composite repair related to the removal of delamination/damage from a part. This is a critical path for a passing score.

Section 2 – Determining what repair to use is key, but if the student were to miss a couple of these, recommend the student passes provided he or she is able to demonstrate the techniques in Sections 2a–2k.

Section 3 – Problem-solving techniques are important to understand and be able to work through; the student should demonstrate good problem-solving skills. In Section 3, the student’s ability to identify the process called out is more important than the demonstration. With practice, the execution of the identified process will improve, but without understanding the process, the practice will not be beneficial.

Section 4 – This is a skill versus a necessary trait, but an understanding of the difference between cosmetic repairs versus an actual damage repair is more important than an exact demonstration of the skill.

Sections 5 and 6 are two of the most important sections on this practical skills evaluation. The proper demonstration of a honeycomb core repair and a solid laminate repair are a must to pass the skill evaluation. These two skills and processes encompass several composite techniques which would make the student a good technician in the industry.

Advisory Circular Feedback Form

If you find an error in this AC, have recommendations for improving it, or have suggestions for new items/subjects to be added, you may let us know by contacting the Flight Standards Directives Management Officer at 9-AWA-AFS-140-Directives@faa.gov.

Subject: 65-33A, Development of Training/Qualification and Certification Programs for Composite Maintenance Technicians

Date: _____

Please check all appropriate line items:

An error (procedural or typographical) has been noted in paragraph _____ on page _____.

Recommend paragraph _____ on page _____ be changed as follows:

In a future change to this AC, please cover the following subject:
(Briefly describe what you want added.)

Other comments:

I would like to discuss the above. Please contact me.

Submitted by: _____

Date: _____