



# AEROSPACE INFORMATION REPORT

**AIR4938™****REV. D**Issued 1996-09  
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Superseding AIR4938C

## Composite and Bonded Structure Technician/Specialist Training Document

### RATIONALE

Limited scope ballot for adding AIR6291 and AIR6292 as references and adding specific language to highlight the importance of AIR6291 and AIR6292.

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## 1. SCOPE

This document establishes the minimum curriculum requirements for training, practical assessments, and certifying composite structure repair personnel and metalbond repair personnel. It establishes criteria for the certification of personnel requiring appropriate knowledge of the technical principles underlying the composite structural repairs and/or metalbond they perform. Persons certified under this document may be eligible for licensing/certification/qualification by an appropriate authority, in addition to this industry-accepted technician certification.

Teaching levels have been assigned to the curriculum to define the knowledge, skills, and abilities graduates will need to make repairs to composite or metalbond structure. Minimum hours of instruction have been provided to ensure adequate coverage of all subject matter, including lecture and laboratory. These minimums may be exceeded and may include an increase in the total number of training hours and/or increase in the teaching levels.

AIR6291 (for metalbond repair) and AIR6292 (for fiber composite repair) provide repair process flows, cautionary explanation of critical process steps, and industry best practices obtained through service experience and lessons learned. Training organizations should incorporate these into their training course syllabi, as appropriate, to conform with the training standards specified by this report.

Each curriculum is a subpart of this document.

Part 1 is the General Composite Structure Bonded Repair curriculum, independent of the application.

Part 2 is the Commercial Aircraft Composite Structure Bonded Repair curriculum.

Part 3 is the Commercial Aircraft Composite Structure Bolted Repair curriculum.

Part 4 is the Commercial Aircraft Structure Metalbond Repair curriculum.

## 2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

### 2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

|         |                                                                                                |
|---------|------------------------------------------------------------------------------------------------|
| AIR4844 | Composites and Metal Bonding Glossary                                                          |
| AIR5719 | Teaching Points for a Class on "Critical Issues in Composite Maintenance, Repair and Overhaul" |
| AIR6291 | Guidelines for Repair Process Evaluation of Aluminum Bonded Structure                          |
| AIR6292 | Guidelines for Bonded Repair Process Evaluation of Fiber Reinforced Composite Structure        |

### 2.2 Code of Federal Regulations (CFR) Publications

Copies of these documents are available online at <https://www.ecfr.gov/>.

14 CFR Part 147 Aviation Maintenance Technician Schools

## 2.3 EASA Publications

Available from European Union Aviation Safety Agency, Konrad-Adenauer-Ufer 3, D-50668 Cologne, Germany, Tel: +49 221 8999 000, [www.easa.europa.eu](http://www.easa.europa.eu).

EASA AMC 20-29 Composite Aircraft Structure

## 2.4 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, [www.faa.gov](http://www.faa.gov).

FAA AC 20-107B Composite Aircraft Structure

FAA AC 43-214 Repairs and Alterations to Composite and Bonded Aircraft Structure

FAA AC 65-33 Development of Training/Qualification Programs for Composite Maintenance Technicians

## 2.5 A4A Publications

Available from Airlines for America, 1301 Pennsylvania Avenue, NW, Suite 1100, Washington, DC 20004, Tel: 202-626-4000, [www.airlines.org](http://www.airlines.org).

ATA iSpec 2200 Information Standards for Aviation Maintenance

This document contains ATA104 level IV curricula.

## 3. STUDENT PREREQUISITES

Basic technical mathematics, physics, and chemistry are considered to be high school level courses or equivalent. Evaluation of prior education can be accomplished by examination of school transcripts, review of the training received through approved training providers, or a pretest.

### Part 1 - General Composite Structure Bonded Repair

Student success will be in part based on the knowledge and skills possessed prior to course enrollment:

- Basic technical mathematics
- Reading comprehension

### Part 2 - Commercial Aircraft Composite Structure Bonded Repair

### Part 4 - Commercial Aircraft Structure Metalbond Repair

Student success will be in part based on the knowledge and skills possessed prior to course enrollment:

- Part 1 Certification
- And including the following disciplines:
  - Basic technical mathematics
  - Reading comprehension
  - Fundamentals of engineering and technical drawings

- General shop and hand tool usage
- Use of precision measurement tools
- Basic physics
- Basic chemistry
- Aircraft health and safety regulatory awareness (need for personal protective equipment [PPE])

### Part 3 - Commercial Aircraft Composite Structure Bolted Repair

Student success will be in part based on the knowledge and skills possessed prior to course enrollment:

- Part 1 Certification
- And including the following disciplines:
  - Basic aircraft sheet metal skills
  - Knowledge of heat treatment
  - Proper forming and bending of aluminum alloys and titanium alloys
- Fundamentals of engineering and technical drawings
- General shop and hand tool usage
- Use of precision measurement tools
- Basic physics
- Basic chemistry
- Aircraft health and safety regulatory awareness (need for PPE)

## 4. TEACHING LEVELS

The following definitions of minimum teaching levels are derived from 14 CFR Part 147 and may be exceeded.

### 4.1 Level 1

Level 1 requires knowledge of general principles and includes instruction by lecture, demonstration, and discussion, but it does not include practical application or development of manipulative skill. This teaching level generally refers to classroom discussion and does not require practical application. Teaching aids or instructional equipment may include charts, books, diagrams, or other visual teaching aids. If a training organization chooses to teach Level 1 courses incorporating actual components, the components do not have to be operational.

### 4.2 Level 2

Level 2 requires knowledge of general principles and includes instruction by lecture, demonstration, discussion, and limited practical application, but it does not include development of sufficient manipulative skill to perform basic operations. This teaching level requires some hands-on manipulative skills and their accompanying actual or simulated components/equipment but still may be taught primarily in the classroom environment.

### 4.3 Level 3

Level 3 requires knowledge of general principles and includes instruction by lecture, demonstration, discussion, and a high degree of practical application to develop sufficient manipulative skill to accomplish return to service (normal operation). This teaching level requires hands-on skill, as well as sufficient and appropriate instructional aides to train the students to develop manipulative skills sufficient to simulate return to service mechanical skill. At this level, the teaching aids must be similar to or be the actual items of equipment on which the student is expected to develop required skill levels. A Level 3 subject cannot be taught solely by lecture in the classroom; the appropriate training aids and hands-on experience must be used.

## 5. EXAMINATIONS

- Training providers will be required to monitor student performance throughout the program.
- Students will be administered a written certification exam following lecture classes by the certifying agency.
- Students will be administered a practical certification assessment following laboratory classes. It is recommended to use a checklist to evaluate the practical certification assessment.
- The written certification examination and practical certification assessment will cover the principles of the applicable curriculum.
  - Written examination for certification: The exam shall contain approximately eight multiple choice questions per course day with a maximum of 48/50 (see NOTE) per exam. The examination shall contain questions from each of the topics listed in the outline for each part. The examination will be closed book.

NOTE: The number depends on the use of three or four alternative answers per question.

- Practical certification assessment: The student must demonstrate to the approved training provider that they can perform the basic tasks required to perform the applicable repairs.
- Reexamination: If the student fails the written examination, they may request to retake a written examination. The written examination must not contain more than 20% of the questions that were on the failed examination.

## 6. CERTIFICATION

Part 1 certification shall consist of documentation of successful completion of either:

- A repair training program, the required exams, and assessments based on the curriculum of this SAE Aerospace Information Report (AIR) conducted by a training provider in accordance with the guidance set forth in this AIR.
- Successful completion of the required exams and assessments based on the curriculum of this AIR without completion of a training program. Attempting the exam and assessment without training is not recommended for personnel without composite repair experience.

Part 2, Part 3, and Part 4 certification shall consist of successful completion of a repair training program, the required exams, and assessments based on the curriculum of this AIR and conducted by a training provider in accordance with the guidance set forth in this AIR.

## 7. CURRENCY AND RECURRENT TRAINING RECOMMENDATIONS

### 7.1 Currency

Personnel should demonstrate continued competence every 3 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 repairs applicable to the specific certification (i.e., Part 1, Part 2, etc.) in the 3-year period.

## 7.2 Recurrent Training

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

The training program should also incorporate best practices and lessons learned into company internal training and qualification, such as those documented in the process evaluation documents AIR6291 for metalbond repair and AIR6292 for fiber composite repair.

## 8. RECORDS

The certifying agency or their designee shall maintain certification records for as long as certification is in effect and a minimum of 5 years after the certification has expired. Such records shall be available for audit by authorized personnel.

The training agency shall maintain training records for a minimum of 5 years. Such records shall be available for audit by authorized personnel.

## 9. PART 1 - GENERAL COMPOSITE STRUCTURAL BONDED REPAIR CURRICULUM

### 9.1 Scope

Persons who successfully complete this basic training program are considered to be able to perform bonded composite repairs to composite structures in compliance with the manufacturers' repair documentation or other acceptable repair data. This curriculum should be considered a prerequisite for more advanced training.

**Table 1 - Outline for initial composite certification**

|    | Topic                            | Teaching Level | Classroom Hours | Lab Hours |
|----|----------------------------------|----------------|-----------------|-----------|
| 1  | Introduction to Composites       | 1              | 1.5             |           |
| 2  | Human Factors                    | 1              | 1               |           |
| 3  | Reinforcement Fibers             | 1              | 1               |           |
| 4  | Matrix Systems                   | 1              | 1               |           |
| 5  | Safety and Environment           | 1              | 1.5             |           |
| 6  | Pre-Impregnated Materials        | 1              | 1               |           |
| 7  | Adhesives                        | 1              | 1               |           |
| 8  | Structural Design Considerations | 1              | 1               |           |
| 9  | Material Handling and Storage    | 1              | 2               |           |
| 10 | Facilities and Equipment         | 1              | 2               |           |
| 11 | Vacuum Bagging                   | 1              | 1.5             |           |
| 12 | Heating Devices                  | 1              | 1.5             |           |
| 13 | Source Documents                 | 1              | 2.5             |           |
| 14 | Protective Coatings and Finishes | 1              | 1               |           |
| 15 | Repair Selection Considerations  | 1              | 1.5             |           |
| 16 | Inspection Techniques            | 2              | 1               |           |
| 17 | Machining of Composites          | 2              | 2               |           |
|    | Hands-on Exercises               | 3              |                 | 50        |
|    | Written Exam                     |                | 1               |           |
|    | Practical Assessment             |                |                 |           |
|    | Total Hours                      |                | 25              | 50        |
|    | Course Length (Minimum)          |                | 75 hours        |           |



**Documents**

Document Sharing Hub

## 9.2 Topics and Objectives

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1. Introduction to Composites Level 1 1.5 hours

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*Objective:*

*Given discussion, lecture, and feedback, the student will describe the basics of composite materials technology and their applications related to aerospace, marine, automotive, civil, energy, and consumer products. In addition, the student will discuss the merits and general failure modes of composite materials to the extent that a material properties comparison can be established between metallic and composite structures as evaluated by the instructor.*

- A. Definition of Composites
- B. History of Composites
- C. Advantages/Disadvantages
- D. Conductivity
- E. Applications
- F. Product Forms
- G. Critical Issues in Maintenance, Repair, and Overhaul of Aircraft Fiber Reinforced Composite Structure
  - i. AIR6292, Guidelines for Bonded Repair Process Evaluation of Fiber Reinforced Composite Structure
  - ii. AIR5719, Teaching Points for a Class on "Critical Issues in Composite Maintenance, Repair and Overhaul"

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2. Human Factors Level 1 1 hour

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*Objective:*

*Given discussion, lecture, and feedback, the student will explain the concept of "Human Factors" to the extent that a brief explanation of the "personal minimums" and a minimum of two factors that are likely causes of accidents and incidents be given.*

- A. Definition
- B. FAA/EASA Resources
- C. Personal Minimums

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3. Reinforcement Fibers Level 1 1 hour

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*Objective:*

*Given discussion, lecture, and feedback, the student will visually recognize common composite fibers, list the properties, and associate the terms related to the fabric manufacturing process. In addition, the student will describe the fiber placement levels used during manufacturing and repairing of composite structures to the extent that the fabric weaves, warp direction, and part warp clock can be referenced as evaluated by the instructor.*

- A. Materials
  - i. Fiberglass
  - ii. Aramid
  - iii. Carbon
  - iv. Ceramics
  - v. Hybrids
- B. Forms Terminology
  - i. Filament
  - ii. Strand
  - iii. Tow
  - iv. Yarn
- C. Unidirectional Tape
- D. Non-Woven
  - i. Mat
    - a. Chopped
    - b. Continuous Filament
  - ii. Stitched

- E. Woven
  - i. Plain
  - ii. Twill
  - iii. Harness Satin
  - iv. Biaxial
  - v. Triaxial
- F. Fiber Sizing and Finishes
- G. Balance and Symmetry
  - i. Warp Clock
  - ii. Tracers
  - iii. Ply Orientation
  - iv. Nesting

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4. Matrix Systems Level 1 1 hour

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*Objective:*

*Given discussion, lecture, and feedback, the student will state the difference between thermoplastic and thermosetting matrix materials, describe the roles and limitations of matrix materials, describe the storage and handling requirements, determine and calculate various mix ratios, describe the cure cycle, and describe the matrix cross-linking terminologies. In addition, the student will describe and select appropriate filler materials to the extent that a given resin system mix ratio with filler materials can be calculated using an established ratio as evaluated by the instructor.*

- A. Thermoplastics
- B. Thermosets
- C. Mixing and Mix Ratios
  - i. Weight
  - ii. Volume
  - iii. Mixing Process
- D. Curing of Resins
  - i. A, B, and C Stages
  - ii. Flow versus Gelation
  - iii. Glass Transition
  - iv. Viscosity
  - v. Curing Reactions
- E. Potting
  - i. Fillers
  - ii. Micro-Balloons
  - iii. Chopped Fiber
  - iv. Fumed Silica

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5. Safety and Environment Level 1 1.5 hours

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*Objective:*

*Given discussion, lecture, practice, and feedback, the student will state the personal hazards working with polymeric materials and describe the four common paths of entry. The student will evaluate a typical Safety Data Sheet (SDS) and demonstrate they can select proper personal protective equipment (PPE) and describe waste disposal procedures as evaluated by the instructor.*

- A. Fumes, Vapors, and Dust
- B. Skin Contact
- C. Safety Data Sheet (SDS)
- D. Personal Protective Equipment (PPE)
- E. Exothermic Reactions
- F. Waste Disposal
- G. Flammability

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|                              |         |        |
|------------------------------|---------|--------|
| 6. Pre-Impregnated Materials | Level 1 | 1 hour |
|------------------------------|---------|--------|

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*Objective:*

*Given discussion, lecture, and feedback, the student will describe the pre-impregnation manufacturing levels and state the stages of the matrix material, storage and handling requirements, recertification, and disposal procedures to the extent that the correct handling procedures are stated as evaluated by the instructor.*

- A. Levels
  - i. Resin Bath
  - ii. Hot Melt
  - iii. Stages
- B. Matrix Cure Temperatures

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|              |         |        |
|--------------|---------|--------|
| 7. Adhesives | Level 1 | 1 hour |
|--------------|---------|--------|

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*Objective:*

*Given discussion, lecture, and feedback, the student will explain the properties of adhesives and their usage, surface preparation levels, bond line control levels, and their common failure modes to the extent that adhesive materials can be selected given repair documentation as evaluated by the instructor.*

- A. Film
- B. Liquid
- C. Paste
- D. Supported/Unsupported
- E. Chemical Bonding Compared to Mechanical Bonding
- F. Surface Preparation
  - i. Surface Energy
- G. Bond Line Control
  - i. Microbeads
  - ii. Carriers
    - a. Scrim Cloth
    - b. Knit
    - c. Veil
- H. Failure Modes
  - i. Adhesion
  - ii. Cohesion
- I. Foams
  - i. Core Splice

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|                                     |         |        |
|-------------------------------------|---------|--------|
| 8. Structural Design Considerations | Level 1 | 1 hour |
|-------------------------------------|---------|--------|

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*Objective:*

*Given discussion, lecture, and feedback, the student will describe the differences between sandwich structures and solid laminate structures (including monolithic structure) to the extent that the different materials used in construction will be described in detail as evaluated by the instructor.*

- A. Advantages/Disadvantages
- B. Typical Sandwich Design
- C. Solid Laminate and Monolithic Design
- D. Joint Types
  - i. Bolted
  - ii. Bonded
- E. Wood
- F. Foam