SAE AIR4938 PART 1

COMPOSITE

Training

ACRATS

DETAILED COURSE OUTLINE ATS2071

GENERAL COMPOSITE STRUCTURAL BONDED REPAIR (SAE AIR4938 PART 1)

Course Title
General Composite Structural Bonded Repair (SAE AIR4938 Part 1)

Course Tag
SAE AIR4938 Composites Level 1

Course ID
ATS2071

Course Duration
10 Working Days

Prerequisites
Prior composites training or experience is not required

Learning Hours
Classroom: 25 Hours
Practical 50 Hours

Highest Standards
Meets EASA, FAA and OEM SRM Standards and is fully compliant with SAE AIR 4938

Scope and Purpose

The ACRATS Level 1 Composites Training Program provides foundational knowledge and skills necessary for working with composite materials. This training covers basic operations, including handling, storage, and repair processes. Participants who complete this program can perform bonded composite repairs in compliance with manufacturers' documentation or other acceptable repair data. This curriculum is a prerequisite for more advanced training. Participants will understand composite materials, their applications, safety practices, and repair techniques, preparing them for advanced training.

Course Module Overview

- Introduction to Composites
- Human Factors
- Reinforcement Fibers
- Matrix Systems
- Safety and Environment
- Pre-Impregnated Materials
- Adhesives
- Structural Design Considerations
- Material Handling and Storage
- Facilities and Equipment
- Vacuum Bagging
- Heating Devices
- Source Documents
- Protective Coatings and Finishes
- Repair Selection Considerations
- Inspection Techniques
- Machining of Composites
- Hands-On Exercises

Selection of the Learning Goals

Upon successful completion of this training, the student will be able to:

- Understand composite materials technology, applications, and failure modes compared to metallic structures;
- Explain "Human Factors" in aviation, including personal minimums and common factors causing accidents and incidents;
- Recognize common composite fibers, their properties, and fabric manufacturing processes;
- Differentiate between thermoplastic and thermosetting matrix materials, including their roles, limitations, and handling requirements;
- Identify hazards of working with polymeric materials, evaluate Safety Data Sheets (SDS), select PPE, and describe waste disposal procedures;
- Describe pre-impregnation manufacturing levels, matrix material stages, and related storage and handling requirements;
- Explain properties and usage of adhesives, surface preparation, bond line control, and common failure modes;
- Distinguish between sandwich and solid laminate structures, materials used, and joint types;
- Properly store and handle composite materials, including storage life, handling concerns, and disposal procedures;
- List equipment needed for a composite facility, and understand their usage and maintenance;
- Understand vacuum bagging principles, materials used, types of vacuum bags, and ply compaction requirements;
- Describe heating devices used in the composite industry, their uses, advantages, and limitations;
- Use repair manuals and documents for composite structures, including OEM manuals, engineering orders, and regulatory documents;
- Discuss protective coating requirements, handling procedures, and determine application and restoration procedures;
- Differentiate between prepreg, wet lay-up, and bolted repairs, and understand repair design, taper sanding, and ply stack-up techniques.

Detailed Module Overview

	Topic	Teaching Level	Classroom Hours	Practical Hours
1	Introduction to Composites	1	1,5	-
2	Human Factors	1	1	-
3	Reinforcement Fibers	1	1	-
4	Metal Forming- and Machining Operations (including Tooling and Equipment) Part 1	1	1	-
5	Matrix Systems	1	1,5	-
6	Safety and Environment	1	1	-
7	Pre-Impregnated Materials	1	1	-
8	Adhesives	1	1	-
9	Structural Design Considerations	1	2	-
10	Material Handling and Storage	1	2	-
11	Facilities and Equipment	1	1,5	-
12	Vacuum Bagging	1	1,5	-
13	Heating Devices	1	2,5	-
14	Source Documents	1	1	-
15	Protective Coatings and Finishes	1	1,5	-
16	Repair Selection Considerations	2	1	-
17	Inspection Techniques	2	2	-
18	Hands-on Exercises and Assessment Criteria	3	-	50
19	Examination	-	1	-
20	Practical Assessment	-	-	-
	Total Hours		25	50
	Course Length		75 Hours	

Teaching Level 1
Teaching level 1 includes the transferring of knowledge from the instructor to the student, through instruction, lecture, demonstration and by having topic-related discussions. Knowledge transfer can take place in a classroom (physical training) as well as through online learning (Computer Based Training (CBT)). The content of e-learning modules should be structured in such a way, keeping in mind that discussions are not possible (it is classified as passive learning), and the participant should be able to understand the material without the intervention of an instructor. Online classes or e-learning modules should be arranged in such a way that the participant has the opportunity to ask questions to the designated instructor or to provide (general) comments. Teaching level A does not include a practical application (hands-on) or the development of practical skills.

Teaching Level 2
Teaching level 2 includes the transferring of knowledge from the instructor to the student, through instruction, lecture, demonstration, topic-related discussions, and limited practical application, but does not include the development of sufficient manipulative skill to perform basic operations. Knowledge transfer can take place in a classroom (physical training) as well as through online learning (Computer Based Training (CBT)). The content of e-learning modules should be structured in such a way, keeping in mind that discussions are not possible (it being classified as passive learning), that the participant should be able to understand the material without the intervention of an instructor. Online classes or e-learning modules should be arranged in such a way that the participant has the opportunity to ask questions to the designated instructor, o to provide (general) comments. Online classes or e-learning modules must contain sufficient demonstration by means of explanatory videos. A high degree of interaction must be built in. Teaching level B requires some hands-on manipulative skills, or practical demonstration of the skills and their accompanying actual or simulated components/equipment, but still may be taught primarily in the classroom environment.

Teaching Level 3
Teaching level 3 includes the transferring of knowledge from the instructor to the student, through instruction, lecture, demonstration, having topic related discussions and a high degree of practical application to develop sufficient manipulative skill to accomplish return to service (normal operation). Teaching level C requires hands-on skill, as well as sufficient and appropriate instructional aides to train the participants 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 participant is expected to develop the required skill levels. A teaching level C subject cannot be taught solely by instruction or lecture in the classroom; the appropriate training aids and hands-on experience must be used. E-learning modules can be used as a guide through practical assignments. Teaching level C includes a high degree of practical application (hands-on) and a strong focus on the development of practical skills.

Module 1 - Introduction to Composites

In Module 1, you'll be introduced to the basics of composite materials technology and their applications in various industries, including aerospace, marine, automotive, civil, energy, and consumer products. You will learn about the definition and history of composites, as well as their advantages and disadvantages compared to other materials. Additionally, you'll explore the conductivity of composites, their various applications, and the different product forms they come in. You will also discuss the merits and general failure modes of composite materials, allowing for a comparison between metallic and composite structures.

Learning Goals

Upon successful completion of this module, the student will be able to:

- Describe the basics of composite materials technology and their applications in aerospace, marine, automotive, civil, energy, and consumer products;
- Explain the definition and history of composites;
- Discuss the advantages and disadvantages of composite materials compared to other materials;
- Understand the conductivity of composite materials;
- Identify various applications of composite materials;
- Recognize different product forms of composite materials;
- Discuss the merits and general failure modes of composite materials and compare them with metallic structures.

Topics

1. Definition of Composites
2. History of Composites
3. Advantages/Disadvantages
4. Conductivity
5. Applications
6. Product Forms

Module 2 - Human Factors

In Module 2, you'll learn about the concept of "Human Factors" in aviation. You will understand how personal minimums and various human factors can influence safety and contribute to accidents and incidents. You will learn that personal minimums are individual thresholds set by aviation professionals to ensure safe operations. These minimums can include factors like fatigue, workload, environmental conditions, and experience with specific tasks. Additionally, you'll explore resources provided by FAA and EASA to help manage and mitigate these factors effectively.

Learning Goals

Upon successful completion of this module, the student will be able to:

- Explain the concept of "Human Factors" in aviation;
- Describe the concept of "personal minimums," which are individual thresholds set by aviation professionals to ensure safe operations;
- Identify at least two human factors that are likely causes of accidents and incidents;
- Utilize FAA and EASA resources to manage and mitigate human factors in aviation.

Topics

1. Definition of Human Factors
2. FAA/EASA Resources
3. Personal Minimums

Module 1 - Introduction to Composites

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Learning Goals

Upon successful completion of this module, the student will be able to:

- Describe the basics of composite materials technology and their applications in aerospace, marine, automotive, civil, energy, and consumer products;
- Explain the definition and history of composites;
- Discuss the advantages and disadvantages of composite materials compared to other materials;
- Understand the conductivity of composite materials;
- Identify various applications of composite materials;
- Recognize different product forms of composite materials;
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Topics

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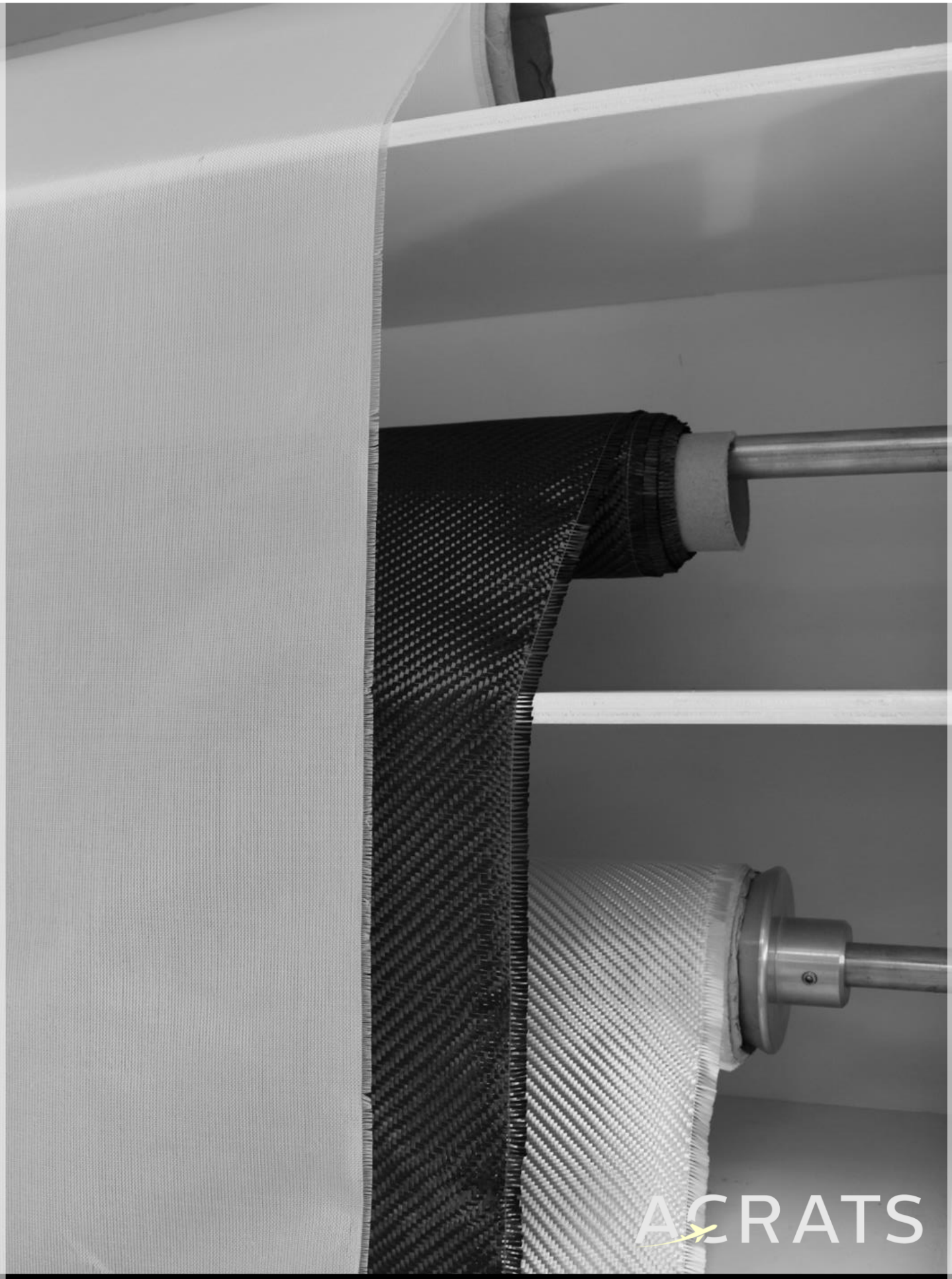
Topics

1. Definition of Human Factors
2. FAA/EASA Resources
3. Personal Minimums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Module 3 - Reinforcement Fibers

In Module 3, you'll learn about the various reinforcement fibers used in composite materials. You'll gain the ability to visually recognize common composite fibers such as fiberglass, aramid, carbon, ceramics, and hybrids. You will learn to list their properties and understand the terminology related to the fabric manufacturing process. Additionally, you'll explore the fiber placement levels used during the manufacturing and repair of composite structures, including fabric weaves, warp direction, and part warp clock. You'll also delve into different forms and configurations of fibers, such as unidirectional tape, non-woven mats, and woven fabrics, and understand the importance of fiber sizing, finishes, balance, and symmetry.

Learning Goals

Upon successful completion of this module, the student will be able to:

- Visually recognize common composite fibers such as fiberglass, aramid, carbon, ceramics, and hybrids;
- List the properties of these fibers and understand the terminology related to their manufacturing processes;
- Describe the fiber placement levels used during manufacturing and repairing of composite structures, including fabric weaves, warp direction, and part warp clock;
- Identify and differentiate between various forms and configurations of fibers, such as unidirectional tape, non-woven mats, and woven fabrics;
- Explain the significance of fiber sizing and finishes in composite materials;
- Understand the concepts of balance and symmetry in fiber placement, including warp clock, tracers, ply orientation, and nesting.

Topics

1. Materials
    a. Fiberglass
    b. Aramid
    c. Carbon
    d. Ceramics
    e. Hybrids
2. Forms Terminology
    a. Filament
    b. Strand
    c. Tow
    d. Yarn
3. Unidirectional Tape
4. Non-Woven
    a. Mat
    b. Chopped
    c. Continuous Filament
    d. Stitched
5. Woven
    a. Plain
    b. Twill
    c. Harness Satin
    d. Biaxial
    e. Triaxial
6. Fiber Sizing and Finishes
7. Balance and Symmetry
    a. Warp Clock
    b. Tracers
    c. Ply Orientation
    d. Nesting

Module 4 - Matrix Systems

In Module 4, you'll learn about matrix systems used in composite materials. You will understand the difference between thermoplastic and thermosetting matrix materials, describe the roles and limitations of matrix materials, and learn about their storage and handling requirements. You'll also determine and calculate various mix ratios, understand the cure cycle, and describe matrix cross-linking terminologies. Additionally, you'll learn to describe and select appropriate filler materials and calculate a given resin system mix ratio with filler materials using an established ratio.

Learning Goals

Upon successful completion of this module, the student will be able to:

- State the difference between thermoplastic and thermosetting matrix materials;
- Describe the roles and limitations of matrix materials;
- Explain the storage and handling requirements for matrix materials;
- Determine and calculate various mix ratios by weight and volume, and understand the mixing process;
- Describe the cure cycle of resins, including the A, B, and C stages, flow versus gelation, glass transition, viscosity, and curing reactions;
- Describe and select appropriate filler materials and calculate mix ratios with fillers.

Topics

1. Thermoplastics
2. Thermosets
3. Mixing and Mix Ratios
    a. Weight
    b. Volume
    c. Mixing Process
4. Curing of Resins
    a. A, B, and C Stages
    b. Flow versus Gelation
    c. Glass Transition
    d. Viscosity
    e. Curing Reactions
5. Potting
    a. Fillers
    b. Micro-Balloons
    c. Chopped Fiber
    d. Fumed Silica

Module 5 - Introduction to Composites

In Module 5, you'll learn about safety and environmental considerations when working with polymeric materials. You will understand the personal hazards associated with these materials and describe the four common paths of entry into the body. You'll evaluate a typical Safety Data Sheet (SDS) and demonstrate how to select proper personal protection equipment (PPE). Additionally, you'll learn about waste disposal procedures, exothermic reactions, and the flammability of materials.

Learning Goals

Upon successful completion of this module, the student will be able to:

- State the personal hazards of working with polymeric materials and describe the four common paths of entry;
- Evaluate a typical Safety Data Sheet (SDS) and select proper personal protection equipment (PPE);
- Describe waste disposal procedures for polymeric materials;
- Understand the risks of fumes, vapors, and dust, and the importance of avoiding skin contact;
- Explain exothermic reactions and their implications for safety;
- Understand the flammability of polymeric materials and appropriate safety measures.

Topics

1. Fumes, Vapors, and Dust
2. Skin Contact
3. Safety Data Sheet (SDS)
4. Personal Protective Equipment (PPE)
5. Exothermic Reactions
6. Waste Disposal
7. Flammability

Module 6 - Human Factors

In Module 6, you'll learn about pre-impregnated (pre-preg) materials used in composite manufacturing. You will describe the pre-impregnation manufacturing levels and state the stages of the matrix material. You'll also understand the storage and handling requirements, re-certification, and disposal procedures for pre-preg materials. By the end of this module, you'll be able to state the correct handling procedures for pre-preg materials.

Learning Goals

Upon successful completion of this module, the student will be able to:

- Describe the pre-impregnation manufacturing levels, including resin bath and hot melt processes;
- State the stages of matrix materials in pre-preg composites;
- Understand the storage and handling requirements for pre-preg materials;
- Explain the re-certification procedures for pre-preg materials;
- Describe the disposal procedures for pre-preg materials;
- State the matrix cure temperatures and their importance in handling pre-preg materials.

Topics

1. Levels
    a. Resin Bath
    b. Hot Melt
    c. Stages
2. Matrix Cure Temperatures


3M
N95
Particulate Respirator N95
粒狀物防護口罩, N95
Partikulat Respirator N95
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Module 7 - Adhesives

In Module 7, you'll learn about the properties and usage of adhesives in composite materials. You will explore different types of adhesives, including film, liquid, and paste, as well as supported and unsupported forms. You'll understand the differences between chemical and mechanical bonding, and the importance of surface preparation and bond line control. Additionally, you'll learn about common failure modes of adhesives and how to select appropriate adhesive materials based on repair documentation.

Learning Goals

Upon successful completion of this module, the student will be able to:

- Explain the properties and usage of various types of adhesives, including film, liquid, and paste;
- Understand the difference between supported and unsupported adhesives;
- Compare chemical bonding to mechanical bonding;
- Describe the importance of surface preparation and the concept of surface energy;
- Understand bond line control techniques, including the use of micro beads and carriers like scrim cloth, knit, and veil;
- Identify common failure modes of adhesives, including adhesion and cohesion failures;
- Explain the use of foams in adhesives, such as core splice applications.

Topics

1. Film
2. Liquid
3. Paste
4. Supported/Unsupported
5. Chemical Bonding Compared to Mechanical Bonding
6. Surface Preparation
7. Surface Energy
8. Bond Line Control
    a. Micro Beads
    b. Carriers
    c. Scrim Cloth
    d. Knit
    e. Veil
9. Failure Modes
    a. Adhesion
    b. Cohesion
    c. Core Splice

Module 8 - Structural Design Considerations

In Module 8, you'll learn about structural design considerations for composite materials. You will describe the differences between sandwich structures and solid laminate structures (including monolithic structures). You'll explore the various materials used in construction, including wood, foam, and honeycomb. Additionally, you'll learn about the advantages and disadvantages of different structural designs, typical sandwich design, solid laminate and monolithic design, and various joint types such as bolted and bonded joints.

Learning Goals

Upon successful completion of this module, the student will be able to:

- Describe the differences between sandwich structures and solid laminate structures (including monolithic structures);
- Explain the advantages and disadvantages of sandwich and solid laminate designs;
- Identify and describe typical sandwich designs;
- Understand solid laminate and monolithic design concepts;
- Describe various joint types, including bolted and bonded joints;
- Understand the materials used in composite structures, including wood, foam, and honeycomb;
- Describe honeycomb materials, including types, densities, cell shapes and sizes, ribbon direction, filleting, cleanliness, and splices.

Topics

1. Advantages/Disadvantages
2. Typical Sandwich Design
3. Solid Laminate and Monolithic Design
4. Joint Types
    a. Bolted
    b. Bonded
5. Wood
6. Foam
7. Honeycomb
    a. Material Types
    b. Densities
    c. Cell Shapes and Sizes
    d. Ribbon Direction
    e. Filleting
    f. Cleanliness
    g. Splices
    h. Septum
    i. Peg/Crush

Module 9 - Material Handling and Storage

In Module 9, you'll learn about the importance of proper storage and handling of materials used in various composites industries. You will explore the requirements for storage containers such as refrigerators, freezers, and flammable storage cabinets, as well as storage life, handling concerns, out times, recertification, and disposal procedures. This module will provide you with a comprehensive understanding of how to manage composite materials to ensure their integrity and safety.

Learning Goals

Upon successful completion of this module, the student will be able to:

- Explain the importance of proper storage and handling of materials used in the composites industries;
- Describe the requirements for storage containers, including flammable storage cabinets, refrigerators, and freezers;
- Understand the shipping, handling, and temperature requirements for composite materials;
- Explain the significance of storage temperatures, thawing procedures, and kitting;
- Describe the concepts of out time, storage life (shelf life), mechanical life, and handling life;
- Understand the handling procedures for polymeric materials and dry goods;
- Explain the process of recertifying polymeric materials and the proper disposal methods.

Topics

1. Flammable Storage Cabinets
2. Refrigerators/Freezers
3. Shipping: Handling and Temperature Requirements
4. Storage Temperatures
5. Thawing
6. Kitting
7. Out Time
8. Storage Life (Shelf Life)
9. Mechanical Life and Handling Life
10. Handling of Polymeric Materials
11. Handling of Dry Goods
12. Recertifying of Polymeric Materials
13. Disposal

Module 10 - Facilities and Equipment

In Module 10, you'll learn about the facilities and equipment necessary for operating a composite facility effectively. You'll explore the various types of equipment needed, including tools, dust extraction systems, trim rooms, and Controlled Contamination Areas (CCA). This module will provide you with a comprehensive understanding of how to manage and maintain a composite facility to ensure safety and efficiency.

Learning Goals

Upon successful completion of this module, the student will be able to:

- List the various equipment needed to properly operate a composite facility;
- Describe the function and setup of trim rooms;
- Understand the different levels of dust extraction equipment, including booths, vacuums, and downdraft tables;
- Explain the importance and maintenance of a Controlled Contamination Area (CCA);
- Describe the requirements for resin mixing areas, including mixing booths and disposal equipment;
- Understand the components and operation of vacuum equipment, including ports, pumps, hoses, and gauges.

Topics

1. Trim Rooms
2. Dust Extraction Levels
    a. Booths
    b. Vacuums
    c. Downdraft Tables
3. Controlled Contamination Area (CCA)
4. Resin Mixing Areas
    a. Mixing Booth
    b. Disposal Equipment
5. Vacuum Equipment
    a. Ports
    b. Pumps
    c. Hoses
    d. Gauges

Module 11 - Vacuum Bagging

In Module 11, you'll learn about the importance of vacuum bagging in the composite manufacturing process. You will understand the principles of vacuum and how it affects laminate properties. Additionally, you'll explore the various materials used in the vacuum bagging process and their specific functions. You'll also learn about different types of vacuum bags and the process of bleeding to control fiber resin ratio, void content, and thickness, as well as ply compaction requirements.

Learning Goals

Upon successful completion of this module, the student will be able to:

- Explain the importance of vacuum bagging and how vacuum/pressure affects laminate properties;
- Understand the principles of vacuum and its relation to altitude;
- Identify and describe the materials used in the vacuum bagging process, including peel ply, bleeders/breathers, release films, bagging films, bag sealant, and cauls;
- Differentiate between types of vacuum bags, including bag to part, bag to tool, and envelope bags;
- Explain the bleeding process and its impact on fiber resin ratio, void content, and thickness;
- Understand the requirements for ply compaction in the vacuum bagging process.

Topics

1. Theory
    a. Vacuum/Pressure
    b. Altitude
2. Materials
    a. Peel Ply
    b. Bleeders/Breather
    c. Release Films
    d. Bagging Films
    e. Bag Sealant
    f. Cauls
3. Types of Bags
    a. Bag to Part
    b. Bag to Tool
    c. Envelope
4. Bleeding
    a. Fiber Resin Ratio
    b. Void Content
    c. Thickness
5. Ply Compaction Requirements

Module 12 - Heating Devices

In Module 12, you'll learn about the different types of heating devices used in the composite industry. You will explore their primary uses, advantages and disadvantages, limitations, and any concerns associated with each device. By the end of this module, you'll have a comprehensive understanding of how these heating devices are applied in composite manufacturing and repair processes.

Learning Goals

Upon successful completion of this module, the student will be able to:

- Explain the primary uses, advantages, and disadvantages of different heating devices used in the composite industry;
- Describe the limitations and concerns associated with various heating devices;
- Understand the applications and functionalities of autoclaves, ovens, hot bonders, heat blankets, hot air blowers, heat lamps, infrared devices, and heat guns.

Topics

1. Autoclave
2. Oven
3. Hot Bonders
4. Heat Blankets
5. Hot Air Blowers
6. Heat Lamps
7. Infrared
8. Heat Guns


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Module 13 - Source Documents

In Module 13, you'll learn about the use of repair manuals and documents for composite structures. You will understand how to navigate and utilize various types of documentation, including structural repair manuals, component maintenance manuals, engineering orders, and regulatory documents. Additionally, you'll explore the limitations of using these documents and the importance of adhering to specified guidelines and standards.

Learning Goals

Upon successful completion of this module, the student will be able to:

- Describe the use of repair manuals and documents for composite structures;
- Understand the limitations of using various repair manuals and documents;
- Navigate and utilize ATA iSpec 2200/S1000D and Original Equipment Manufacturer (OEM) manuals, including structural repair manuals and component maintenance manuals;
- Interpret and apply information from engineering orders, SAE AMS-CACRC ARPs, and regulatory documents;
- Understand the role and application of drawing systems, process specifications, material specifications, data sheets, and vendor manuals.

Topics

1. ATA iSpec 2200/S1000D
2. Original Equipment Manufacturer (OEM)
    a. Structural Repair Manuals
    b. Component Maintenance Manual
3. Engineering Orders
4. SAE AMS-CACRC ARPs
5. Regulatory Documents
6. Drawing Systems
7. Process Specifications
8. Material Specifications
9. Data Sheets
10. Vendor Manuals

Module 14 - Protective Coatings and Finishes

In Module 14, you'll learn about protective coatings and finishes for composite structures. You will discuss the requirements for protective coatings, their handling procedures for fiber-reinforced plastic structures, and how to determine the type, application, and restoration procedures using approved manuals. This module will cover various types of sealants, primers, and finishes, as well as conductive coatings and materials.

Learning Goals

Upon successful completion of this module, the student will be able to:

- Discuss the requirements for protective coatings on composite structures;
- Understand the handling procedures for protective coatings involving fiber-reinforced plastic structures;
- Determine the type, application, and restoration procedures for protective coatings using approved manuals;
- Identify and describe various types of sealants, primers, and finishes;
- Understand the use and application of conductive materials, including metal foil, flame spray, metal-coated fabrics, metal meshes, anti-static paint, and interwoven-wire.

Topics

1. Sealants
2. Primers
3. Finishes
4. Conductive
    a. Metal Foil
    b. Flame Spray
    c. Metal Coated Fabrics
    d. Metal Meshes
    e. Anti-Static Paint
    f. Interwoven-Wire

Module 15 - Repair Selection Considerations

In Module 15, you'll learn about repair selection considerations for composite structures. You will be able to describe the differences between prepreg repairs, wet lay-up repairs, and bolted repairs. Additionally, you'll explore various aspects of repair design, including support tooling requirements, doubler overlays, pre-cured patches, and nonstructural (cosmetic) repairs. You'll also learn about taper sanding, step sanding, part drying requirements, and ply stack-up techniques.

Learning Goals

Upon successful completion of this module, the student will be able to:

- Describe the differences between prepreg repairs, wet lay-up repairs, and bolted repairs;
- Understand the various aspects of repair design, including support tooling requirements, doubler overlays, pre-cured patches, and nonstructural (cosmetic) repairs;
- Explain taper sanding and step sanding techniques;
- Understand part drying requirements, including physical water and absorbed moisture;
- Describe ply stack-up techniques, including small ply down and large ply down.

Topics

1. Repair Design
    a. Prepreg
    b. Wet Lay-Up
    c. Support Tooling Requirements
    d. Doubler Overlay
    e. Pre-Cured Patch
    f. Bolted
    g. Nonstructural (cosmetic)
2. Taper Sanding and Step Sanding
3. Part Drying Requirements
    a. Physical Water
    b. Absorbed Moisture
4. Ply Stack Up
    a. Small Ply Down
    b. Large Ply Down (optional)
5. Repair Area Limitations

Module 16 - Inspection Techniques

In module 16, you'll learn about various Non-Destructive Inspection (NDI) techniques used in the manufacture and repair of composite structures. You will explore the limitations of these techniques and gain practical experience in performing visual and tap test inspections. You will also learn to correctly map damaged areas on sandwich-constructed parts.

Learning Goals

Upon successful completion of this module, the student will be able to:

- List the various types of Non-Destructive Inspection (NDI) techniques and their limitations during the manufacture and repair of composite structures;
- Perform a visual and tap test inspection on a sandwich-constructed part;
- Correctly map the damaged area as evaluated by the instructor;
- Understand the types of damage that can occur in composite structures;
- Conduct pre- and post-repair inspections to ensure structural integrity;
- Compare NDI techniques for metal and composite structures.

Topics

1. Types of Damage
2. Mapping of Damage
3. Pre- and Post-Repair Inspection
4. Visual
5. Tap Testing
6. Ultrasonic (Pulse-Echo, TTU, Bondtesters)
7. Thermography
8. X-Ray
9. Comparison of NDI Techniques for Metal and Composite Structure


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Module 17 - Machining of Composites

In module 17, you'll learn how to select and safely operate various air-powered tools, including drill motors, die grinders, and dual orbital sanders, for machining composite materials. You will determine recommended grinding materials, as well as the appropriate speeds and feeds for machining carbon and fiberglass materials. You will gain practical experience by drilling holes and taper sanding a four-ply face sheet, ensuring no fiber breakout or bond ply damage.

Learning Goals

Upon successful completion of this module, the student will be able to:

- Select and safely operate air-powered tools, including drill motors, die grinders, and dual orbital sanders;
- Determine the recommended grinding materials for machining carbon and fiberglass materials;
- Understand the appropriate speeds and feeds for drilling and grinding composite materials;
- Drill a minimum of 10 holes to the correct size without causing fiber breakout damage;
- Taper sand a four-ply face sheet without causing bond ply damage;
- Describe the techniques and considerations for sanding, drilling, trimming, and core machining of composites.

Topics

1. Sanding
2. Drilling
    a. Speeds and Feeds
    b. Types of Drills
    c. Reamers
3. Tools and Equipment
4. Trimming
5. Core Machining

Module 18 - Hands-on Exercises and Assessment Criteria

In this extensive hands-on module, you'll develop the basic skills necessary to repair fiber-reinforced structures using wet-lay and prepreg materials, vacuum bagging techniques, and hot bond equipment. You'll learn to wear personal protective equipment correctly and accomplish repairs using approved documentation to ensure airworthiness. Through practical exercises, you'll gain experience in symmetrical and asymmetrical lay-ups, core repairs, and scarf repairs with fiberglass, hybrid, or carbon materials.

Learning Goals

Upon successful completion of this module, the student will be able to:

- Develop the basic skills necessary to repair fiber-reinforced structures using wet-lay and prepreg materials;
- Apply vacuum bagging techniques and operate hot bond equipment;
- Wear personal protective equipment correctly during repair processes;
- Perform repairs using approved documentation and ensure the repairs are airworthy;
- Execute symmetrical and asymmetrical lay-up exercises;
- Conduct wet lay-up processes, including resin mixing and bleeder exercises;
- Perform prepreg lay-up, including panel building;
- Conduct core repairs using foaming adhesives, film adhesive, and potting techniques;
- Execute scarf repairs on fiberglass, hybrid, or carbon materials using both wet lay-up and prepreg methods.

Assessment Criteria

- ✓ Core removed without causing additional damage to far side inner skin;
- ✓ Taper sanding meets repair document requirements;
- ✓ Correct material and orientation of original plies identified;
- ✓ Repair plies are positioned and oriented correctly;
- ✓ Cure cycle(s) meets repair document requirements;
- ✓ Repair meets post repair inspection requirements.

Topics (List of Repairs)

1. Symmetrical/Asymmetrical Lay-Up Exercise
2. Wet Lay-Up
    a. Resin Mixing
    b. Bleeder Exercise
3. Prepreg Lay-Up
    a. Panel Build
4. Core Repair
    a. Foaming Adhesives
    b. Film Adhesive
    c. Potting
5. Scarf Repairs - Fiberglass, Hybrid, or Carbon
    a. Wet Lay-Up
    b. Prepreg

19 - Examination

The written examination consists of 50 multiple choice questions. The examination contains questions from each of the topics listed in the outline for each part. The examination will be closed book.

20 - Practical Assessment

The practical assessment will be the last hands-on exercise (see module 18). This practical assessment will test your ability to perform the entire repair process, from damage assessment to post-repair inspection, ensuring that you can apply the skills and knowledge gained throughout the course.

Assessment Criteria

- ✓ Core removed without causing additional damage to far side inner skin;
- ✓ Taper sanding meets repair document requirements;
- ✓ Correct material and orientation of original plies identified;
- ✓ Repair plies are positioned and oriented correctly;
- ✓ Cure cycle(s) meets repair document requirements;
- ✓ Repair meets post repair inspection requirements.

SAE AIR4938 PART 1

COMPOSITE

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DETAILED COURSE OUTLINE ATS2071

GENERAL COMPOSITE STRUCTURAL BONDED REPAIR (SAE AIR4938 PART 1)