

AVIATION MAINTENANCE TECHNICIAN CERTIFICATION SERIES

MATERIALS AND HARDWARE

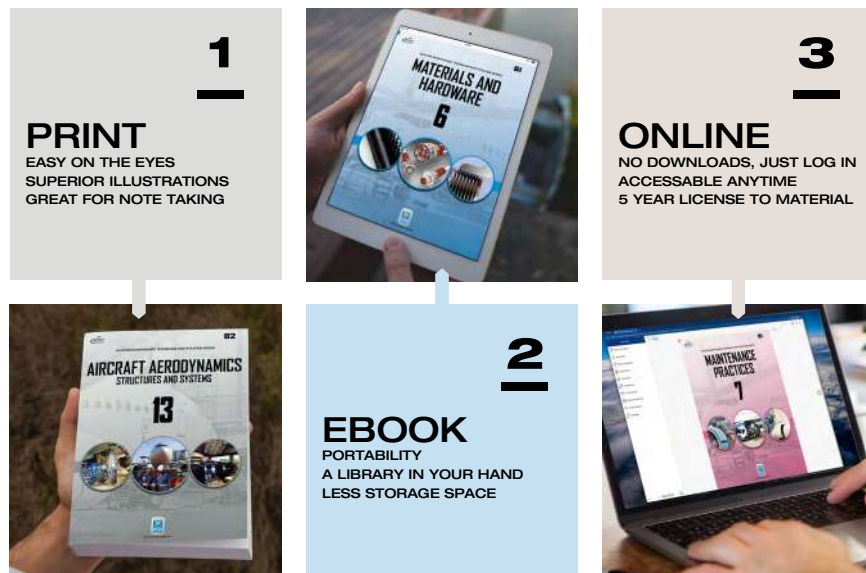
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EASA 2023-889 COMPLIANT

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VERSION	EFFECTIVE DATE
005	2025.09

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VERSION	EFFECTIVE DATE	DESCRIPTION OF REVISION(S)
001	2013.01	Module creation and release.
002	2014.07	Format Updates
003	2018.07	Modified Submodule sequence in accordance to Appendix A. Added content in the following areas: 6.3 – Thixotropic agents; Wood preservation methods; Types of fabric defects. 6.4 – Stress corrosion; Exfoliated corrosion detection; Galvanic corrosion growth; Fretting corrosion. 6.5 – Screw threads; Dowels. 6.6 – Rigid fluid line sizes; Swaged fittings. 6.7 – Laws obeyed by springs. 6.8 – Bearing material and construction. 6.11 – Connector types, Identification codes, and ratings.
003.1	2023.04	Inclusion of Measurement Standards for clarification, page iv. Minor appearance and format updates.
004	2024.04	Regulatory update for EASA 2023-989 compliance.
005	2025.09	Rewrite of Submodule 5.4 and Submodule 11, with other corrections and clarifications.

TABLE OF CONTENTS

MATERIALS AND HARDWARE

Revision Log	iii	Cold Working/Hardening.....	1.13
Measurement Standards	iv	Section B	1.13
Basic Knowledge Requirements	v	Hardness Testing.....	1.13
Part 66 Basic Knowledge Requirements	vi	Brinell Tester	1.13
Table of Contents.....	ix	Rockwell Tester	1.14
		Other Testing.....	1.15
		Fatigue Strength Testing.....	1.15
		Impact Testing.....	1.16
		Electrochemical Testing of Stainless Versus Inconel	1.16
6.1 AIRCRAFT MATERIALS — FERROUS.....	1.1	Section C	1.17
Section A	1.1	Defects	1.17
Properties of Metals.....	1.1	Inspection Procedures	1.17
Hardness	1.1	Visual Inspection	1.17
Strength.....	1.1	Surface Cracks	1.17
Density.....	1.1	Borescopes	1.17
Malleability	1.1	Non-Destructive Inspection (NDI)	1.17
Ductility.....	1.1	Corrosion Control	1.18
Elasticity	1.1	General Repair Methods.....	1.18
Toughness	1.2	Submodule 1 Practice Questions.....	1.19
Brittleness	1.2	Submodule 1 Practice Answers	1.20
Fusibility	1.2		
Conductivity	1.2	6.2 AIRCRAFT MATERIALS — NON-FERROUS.....	2.1
Thermal Expansion	1.2	Section A	2.1
Iron.....	1.2	Characteristics, Properties and Identification of	
Steel and Steel Alloys	1.2	NonFerrous Materials	2.1
Spark Testing	1.2	Aluminum	2.1
Types of Alloyed Steel Carbon Steel.....	1.3	Wrought Aluminum	2.2
Nickel Steel	1.4	Effect of Alloying Element	2.3
Chromium Steel.....	1.4	Hardness Identification	2.3
Stainless Steel.....	1.4	Magnesium	2.3
Chrome-Vanadium Steel	1.4	Titanium	2.4
Chromoly Steel	1.4	Titanium Designations	2.5
Inconel	1.4	Corrosion Characteristics of Titanium	2.5
Substitution of Aircraft Metals	1.4	Copper.....	2.5
Metal Working Processes	1.4	Nickel.....	2.6
Hot Working.....	1.4	Monel.....	2.6
Heat Treating.....	1.6	K-Monel.....	2.6
Internal Structure of Metals	1.6	Inconel	2.6
Heat Treating Equipment	1.6	Substitution of Aircraft Metals	2.6
Furnaces and Salt Baths.....	1.7	Heat Treatment of Non-Ferrous Alloys	2.7
Temperature Measurement and Control.....	1.7	Aluminum Alloys	2.7
Heating	1.7	Alclad Aluminum	2.7
Soaking	1.8	Solution Heat Treatment.....	2.7
Cooling	1.8	Temperature.....	2.7
Quenching Equipment	1.10	Time at Temperature.....	2.7
Heat Treatment and Application of Alloy Steels	1.10	Quenching	2.8
Behavior of Steel During Heating and Cooling	1.10	Cold Water Quenching	2.8
Hardening	1.10	Hot Water Quenching.....	2.8
Hardening Precautions	1.11	Spray Quenching	2.8
Tempering	1.11	Lag Between Soaking and Quenching	2.8
Annealing	1.11	Reheat Treatment	2.8
Normalizing.....	1.11	Straightening After Solution Heat Treatment	2.8
Case Hardening.....	1.12	Precipitation Heat Treating.....	2.8
Carburizing	1.12	Precipitation Practices	2.9
Nitriding	1.12	Annealing of Aluminum Alloys	2.9
Forging.....	1.12	Heat Treatment of Aluminum Rivets	2.9
Casting.....	1.12		
Extruding	1.13		

TABLE OF CONTENTS

Magnesium Alloys	2.10
Solution Heat Treatment	2.10
Precipitation Heat Treatment	2.10
Titanium	2.10
Stress Relieving	2.10
Annealing of Titanium	2.10
Thermal Hardening	2.11
Case Hardening	2.11
Casting	2.11
Extruding	2.11
Cold Working/Hardening	2.11
Section B	2.12
Hardness Testing	2.12
Brinell Tester	2.12
Rockwell Tester	2.12
Barcol Tester	2.13
Tensile, Fatigue and Impact Testing	2.13
Section C	2.13
Defects	2.13
Inspection Procedures	2.13
Visual Inspection	2.13
Surface Cracks	2.14
Borescopes	2.14
Non-Destructive Inspection (NDI)	2.14
Corrosion Control	2.14
General Repair Methods	2.14
Submodule 2 Practice Questions	2.15
Submodule 2 Practice Answers	2.16

6.3 AIRCRAFT MATERIALS — COMPOSITE AND

NON-METALLIC	3.1
6.3.1 Section A	3.1
Characteristics, Properties and Identification	3.1
Composite Materials	3.1
Advantages/Disadvantages of Composites	3.1
Composite Safety	3.2
Fiber Reinforced Materials	3.2
Laminated Structures	3.2
Advanced Laminated Composite Materials	3.2
Major Components of a Laminate	3.3
Strength Characteristics	3.3
Fiber	3.3
Fiber Orientation	3.3
Warp Clock	3.3
Fiber Forms	3.4
Roving	3.4
Unidirectional (Tape)	3.4
Bidirectional Fabric	3.4
Non-woven (Knitted or Stitched)	3.5
Types of Fiber	3.5
Fiberglass	3.5
Kevlar®	3.6
Carbon/Graphite	3.6
Boron	3.6
Ceramic Fibers	3.6
Lightning Protection Fibers	3.6

Dry Fiber Material	3.7
Thermosetting Resins	3.7
Polyester Resins	3.7
Vinyl Ester Resin	3.7
Phenolic Resin	3.7
Epoxy	3.7
Polyimides	3.7
Polybenzimidazoles	3.8
Bismaleimides	3.8
Thermoplastic Resins	3.8
Semicrystalline Thermoplastics	3.8
Amorphous Thermoplastics	3.8
Polyether Ether Ketone	3.8
Curing Stages of Resins	3.8
Thixotropic Agents	3.8
Pre-Impregnated Products (Prepregs)	3.8
Adhesives	3.9
Film Adhesives	3.9
Paste Adhesives	3.9
Foaming Adhesives	3.10
Sandwich Structures	3.10
Properties	3.10
Facing Materials	3.10
Core Materials	3.11
Honeycomb	3.11
Foam	3.11
Balsa Wood	3.12
Plastics	3.12
Reinforced Plastic	3.12
Transparent Plastics	3.12
Optical Considerations	3.13
Storage and Handling	3.13
Forming Procedures and Techniques	3.13
Heating	3.13
Forms	3.13
Forming Methods	3.14
Simple Curve Forming	3.14
Compound Curve Forming	3.14
Stretch Forming	3.14
Male and Female Die Forming	3.14
Vacuum Forming Without Forms	3.14
Vacuum Forming With a Female Form	3.14
Sawing	3.14
Drilling	3.14
Cementing	3.14
Application of Cement	3.14
Repairs	3.15
Cleaning	3.15
Polishing	3.15
Windshield Installation	3.15
Installation Procedures	3.16
Sealant and Bonding Agents	3.16
One Part Sealants	3.16
Two Part Sealants	3.16
6.3.1 Section B	3.17
Detection of Defects/Deterioration in Composite Materials	3.17

TABLE OF CONTENTS

Fiber Breakage	3.17	Bleedout Technique	3.30
Matrix Imperfections	3.17	No Bleedout	3.30
Delamination and Debonds	3.18	Ply Orientation Warp Clock	3.31
Combinations of Damages	3.18	Mixing Resins	3.31
Flawed Fastener Holes	3.18	Saturation Techniques	3.31
In-Service Defects	3.18	Impregnation With a Brush or Squeegee	3.31
Corrosion	3.19	Vacuum Bagging Techniques	3.31
Non-Destructive Inspection of Composites	3.19	Single Side Vacuum Bagging	3.32
Visual Inspection	3.19	Envelope Bagging	3.32
Audible Sonic Testing (Coin Tapping)	3.19	Impregnation Using a Vacuum Bag	3.32
Automated Tap Test	3.20	Alternate Pressure Application	3.33
Ultrasonic Inspection	3.20	Shrink Tape	3.33
Through Transmission Ultrasonic Inspection	3.21	C Clamps	3.33
Pulse Echo Ultrasonic Inspection	3.21	Shotbags and Weights	3.33
Ultrasonic Bond Tester Inspection	3.21	Curing of Composite Materials	3.33
Phased Array Inspection	3.21	Room Temperature Curing	3.33
Radiography	3.21	Elevated Temperature Curing	3.33
Thermography	3.22	Composite Honeycomb Sandwich Repairs	3.34
Neutron Radiography	3.22	Damage Classification	3.35
Moisture Detector	3.22	Minor Core Damage (Filler and Potting Repairs)	3.35
6.3.1 Section C	3.22	Damage Requiring Core Replacement and Repair to One or Both Face Plates	3.35
Repair Procedures for Composite Materials and Structures	3.22	Step 1: Inspect the Damage	3.35
Layup Materials and Tools	3.22	Step 2: Remove Water From Damaged Area	3.35
Air Tools	3.22	Step 3: Remove the Damage	3.35
Caul Plate	3.22	Step 4: Prepare the Damaged Area	3.35
Support Tooling and Molds	3.23	Step 5: Installation of Honeycomb Core (Wet Layup)	3.36
Vacuum Bag Materials	3.23	Step 6: Prepare and Install the Repair Plies	3.37
Release Agents	3.23	Step 7: Vacuum Bag the Repair	3.37
Bleeder Ply	3.24	Step 8: Curing the Repair	3.37
Peel Ply	3.24	Step 9: Post Repair Inspection	3.37
Layup Tapes	3.24	Bonded Flush Patch Repairs	3.37
Solid Release Film	3.24	Step 1: Inspection and Mapping of Damage	3.39
Breather Material	3.24	Step 2: Removal of Damaged Material	3.39
Vacuum Bag	3.24	Step 3: Surface Preparation	3.39
Vacuum Equipment	3.24	Step 4: Molding	3.39
Vacuum Compaction Table	3.25	Step 5: Laminating	3.39
Heat Sources	3.25	Step 6: Finishing	3.39
Ovens	3.25	Trailing Edge and Transition Area Patch Repairs	3.39
Autoclave	3.25	Composite Patch Bonded to Aluminum Structure	3.40
On Aircraft Heating	3.25	Fiberglass Molded Mat Repairs	3.40
Heat Bonder	3.26	Radome Repairs	3.40
Heat Blanket	3.26	External Bonded Patch Repairs	3.41
Hot Air System	3.26	External Bonded Repair With Prepreg Plies	3.41
Heat Press Forming	3.26	Step 1: Investigating and Mapping the Damage	3.41
Thermocouples	3.27	Step 2: Damage Removal	3.41
Thermocouple Placement	3.27	Step 3: Layup of the Repair Plies	3.41
Thermal Survey of Repair Area	3.27	Step 4: Vacuum Bagging	3.41
Temperature Variations in Repair Zone	3.27	Step 5: Curing the Repair	3.41
Thermal Survey	3.28	Step 6: Applying Top Coat	3.41
Solutions to Heat Sink Problems	3.28	External Repair Using Wet Layup and Double Vacuum Debulk Method (DVD)	3.41
Types of Layups	3.28	Double Vacuum Debulk Principle	3.41
Wet Layups	3.28	Patch Installation on the Aircraft	3.42
Prepregs	3.28	External Repair Using Precured Laminate Patches	3.42
Secondary Bonding	3.29	Step 3: A Precured Patch	3.43
Co-Bonding	3.30		
Wet Laminated Layup Techniques	3.30		

TABLE OF CONTENTS

Step 4: For a Precured Patch	3.43	External and Internal Inspection.....	3.54
Bonded Versus Bolted Repairs.....	3.43	Glued Joint Inspection.....	3.55
Bolted Repairs	3.43	Wood Condition	3.56
Bolted Repair Procedures	3.44	Repair of Wooden Structures	3.57
Step 1: Inspection of the Damage	3.44	Gluing Procedures.....	3.57
Step 2: Removal of the Damage	3.44	Preparation of Wood for Gluing.....	3.57
Step 3: Patch Preparation.....	3.44	Preparing Glues for Use.....	3.58
Step 4: Hole Pattern Lay Out	3.44	Applying the Glue/Adhesive.....	3.58
Step 5: Drilling and Reaming Holes in Patch and Parent		Pressure on the Joint	3.58
Structure	3.44	Testing Glued Joints	3.58
Step 6: Fastener Installation	3.44	Structural Repairs	3.59
Step 7: Sealing of Fasteners and Patch	3.44	Wing Rib Repairs	3.59
Step 8: Finish Coat and Lightning Protection Mesh ..	3.44	Bolt and Bushing Holes.....	3.60
Fasteners Used With Composite Laminates	3.44	Finishing Wood Structures.....	3.60
Corrosion Precautions	3.45	Precautions.....	3.61
Fastener Materials	3.45	Finishing Exterior Surfaces.....	3.62
Fastener Systems	3.45	Finishing of End Grain Surfaces.....	3.62
Adjustable Sustain Preload Fastening System (ASP)	3.45	Sealing of Bolt Holes.....	3.62
Hi-Lok® and Huck-Spin® Lockbolt Fasteners.....	3.45	Section 6.3.3	3.62
Eddie Bolt Fasteners	3.46	Fabric Covering	3.62
Cherry's E-Z Buck (CSR90433) Hollow Rivet.....	3.46	General History.....	3.62
Blind Fasteners.....	3.46	Characteristics, Properties and Types of Fabrics.....	3.63
Blind Bolts.....	3.47	Fabric Terms	3.63
Fiberlite	3.47	Approved Materials	3.63
Screws and Nutplates in Composite Structures	3.47	Fabric	3.63
Machining Processes and Equipment	3.47	Anti-Chafe Tape	3.63
Drilling	3.47	Reinforcing Tape	3.63
Equipment	3.48	Rib Bracing	3.63
Processes and Precautions	3.49	Surface Tape.....	3.64
Countersinking	3.49	Rib Lacing Cord	3.64
Cutting Processes.....	3.50	Sewing Thread	3.64
Cutting Equipment	3.50	Special Fabric Fasteners.....	3.64
Repair Safety	3.50	Inspection Rings	3.64
Eye Protection	3.51	Primer	3.65
Respiratory Protection.....	3.51	Fabric Cement	3.65
Downdraft Tables	3.51	Fabric Sealer.....	3.65
Skin Protection	3.51	Fillers.....	3.65
Fire Protection	3.51	Topcoats	3.65
Section 6.3.2	3.51	Types of Defects in Fabrics	3.66
Construction Methods of Wooden Airframe Structures	3.51	Excess Tension.....	3.66
Wood Aircraft Construction and Repairs.....	3.52	Loose Fabric.....	3.66
Characteristics, Properties and Types of Wood and Glue		Coating Cracks	3.66
Used in Aeroplanes	3.52	Deterioration	3.66
Wood	3.52	Inspection Methods for Fabric	3.67
Glues (Adhesives)	3.52	Determining Fabric Condition; Repair or Recover?.....	3.67
Casein Glue	3.52	Fabric Strength	3.67
Plastic Resin Glue	3.52	How Fabric Breaking Strength is Determined	3.67
Resorcinol	3.52	Fabric Testing Devices.....	3.67
Epoxy.....	3.53	Repair of Fabric Covering.....	3.68
Preservation and Maintenance of Wooden Structures	3.53	Blanket Method Versus Envelope Method	3.68
Wood Preservation	3.53	Preparation for Fabric Covering Work	3.68
Care and Maintenance of Wood Frame Structures	3.53	Removal of Old Fabric Coverings.....	3.68
Types of Defects in Wood Materials and Structures	3.54	Preparation of the Airframe Before Covering.....	3.69
Defects Permitted	3.54	Attaching Polyester Fabric to the Airframe	3.70
Defects Not Permitted.....	3.54	Fabric Cement	3.70
Detection of Defects in Wooden Structures	3.54	Fabric Heat Shrinking.....	3.71

TABLE OF CONTENTS

Attaching Fabric to the Wing Ribs	3.71
Rib Lacing	3.71
Rings, Grommets, and Gussets	3.73
Finishing Tapes	3.74
Coating the Fabric	3.74
Polyester Fabric Repairs	3.75
Applicable Instructions	3.75
Repair Considerations	3.75
Submodule 3 Practice Questions	3.77
Submodule 3 Practice Answers	3.80
6.4 - CORROSION.....	4.1
Section A	4.1
Common Corrosive Agents	4.1
Corrosion Formation	4.2
Galvanic Action	4.2
Microbiological Corrosion	4.2
Stress Corrosion	4.3
Section B	4.3
General Surface Corrosion	4.3
Pitting Corrosion	4.3
Concentration Cell Corrosion	4.4
Metal Ion Concentration Cells	4.4
Oxygen Concentration Cells	4.4
Active Passive Cells	4.4
Filiiform Corrosion	4.5
Intergranular Corrosion	4.6
Exfoliation Corrosion	4.6
Galvanic Corrosion	4.6
Stress Corrosion Cracking	4.6
Fatigue Corrosion	4.7
Fretting Corrosion	4.8
Causes of Corrosion	4.8
Material Types	4.9
Aluminum and Aluminum Alloys	4.9
Magnesium and Magnesium Alloys	4.9
Ferrous Metals	4.10
Noble Metals	4.10
Chromium and Nickel Plated Parts	4.10
Cadmium and Zinc Plated Parts	4.10
Titanium and Titanium Alloys	4.10
Susceptibility to Corrosion (Corrosion Prone Areas)	4.10
Exhaust Trail Areas	4.11
Battery Compartments and Battery Vent Openings	4.11
Lavatories, Buffets and Galleys	4.11
Bilge Areas	4.11
Wheel Wells and Landing Gear	4.11
External Skin Areas	4.12
Water Entrapment Areas	4.13
Engine Frontal Areas and Cooling Air Vents	4.14
Electronic Package Compartments	4.14
Miscellaneous Trouble Areas	4.15
Seaplanes and Flooding	4.16
Submodule 4 Practice Questions	4.17
Submodule 4 Practice Answers	4.18

6.5 FASTENERS	5.1
6.5.1 Screw Threads	5.2
Screw Principles	5.2
The Inclined Plane	5.2
Screw Nomenclature	5.2
Bolt and Screw Terminology	5.2
Screw Thread Terminology	5.2
Thread Forms, Dimensions and Tolerances	5.3
Coarse and Fine Pitch Threads	5.3
Single and Multi Start Threads	5.3
Screw Thread Profile	5.3
International Thread System	5.3
Unified Screw Thread	5.3
Metric Screw Thread	5.3
Choosing Threaded Fasteners	5.3
Thread Tolerances	5.4
Measuring Screw Threads	5.4
Screw Thread Pitch	5.4
Go-NoGo Gauges	5.4
6.5.2 - Bolts, Studs And Screws	5.4
Bolt Types: Specifications, Identification, and Marking of Aircraft Bolts, International Standards	5.4
Aircraft Bolt Types	5.4
Identification and Coding	5.4
General Purpose Bolts	5.4
Close Tolerance Bolts	5.5
Internal Wrenching Bolts	5.5
Special-Purpose Bolts	5.5
Clevis Bolts	5.6
Eyebolt	5.6
Jo-Bolt	5.6
Lockbolts	5.6
Nuts: Self-locking, Anchor, Standard Types	5.8
Aircraft Nuts	5.8
Identification and Coding	5.8
Non-Self-Locking Nuts	5.8
Self-Locking Nuts	5.9
Boots Self-Locking Nut	5.9
Stainless Steel Self-Locking Nuts	5.10
Elastic Stop Nuts	5.10
Pal Nuts	5.11
Sheet Spring Nuts	5.11
Internal and External Wrenching Nuts	5.11
Anchor Nuts	5.11
Nutplates	5.12
Sealing Nutplates	5.12
Riveted and Rivetless Nutplates	5.12
Rivnuts	5.13
Machine Screws; Aircraft Specification	5.14
Screws	5.14
Identification/Coding for Screws	5.14
Structural Screws	5.14
Machine Screws	5.14
Studs; Types and Uses	5.14
Standard Studs	5.15
Waisted Studs	5.15

TABLE OF CONTENTS

Stepped Studs	5.15	Hi-Lok Fastening System	5.31
Shouldered Studs	5.15	Hi-Tigue Fastening System	5.32
Self-Tapping Screws, Dowels	5.15	Hi-Lite Fastening System	5.32
Self-Tapping Screws	5.15	Lockbolt Fastening Systems	5.32
Drive Screws	5.16	Installation Procedure	5.33
Dowels	5.16	Lockbolt Inspection	5.33
Thread Repair Hardware	5.16	Lockbolt Removal	5.34
Replacement Bushings	5.16	Blind Bolts	5.34
Helicoils	5.16	Pull Type Blind Bolt	5.34
6.5.3 - Locking Devices	5.17	Cherry Maxibolt Blind Bolt System	5.34
Aircraft Washers	5.17	Huck Blind Bolt System	5.34
Plain Washers	5.17	Drive Nut Type of Blind Bolt	5.34
Lockwashers	5.17	Installation procedure	5.35
Shakeproof Lockwashers	5.18	Tapered Shank Bolt	5.35
Special Washers	5.18	Sleeve Bolts	5.36
LockPlates	5.18	Rivet Nuts	5.36
Pins	5.18	Rivnut Hole Preparation	5.36
Cotter Pins	5.18	Deutsch Rivets	5.36
Cotter Pin Hole Line Up	5.18	Hole Repair Hardware	5.36
Cotter Pin Safetying	5.18	Acres Fastener Sleeves	5.37
Roll Pins	5.19	Identification	5.37
Quick Release (Captive) Fasteners	5.19	Hole Preparation	5.37
Turnlock Fasteners	5.19	Installation	5.37
Dzus Fasteners	5.19	Sleeve Removal	5.37
Camloc Fasteners	5.19	Submodule 5 Practice Questions	5.41
Airloc Fasteners	5.20	Submodule 5 Practice Answers	5.42
Keys	5.20		
Safety Wire Locking	5.21	6.6 PIPES AND UNIONS	6.1
General Safety Wiring Rules	5.21	Section A	6.1
Nuts, Bolts, and Screws	5.21	Rigid Fluid Lines	6.1
Oil Caps, Drain Cocks, and Valves	5.22	Tubing Material	6.1
Electrical Connectors	5.22	Copper Tubing	6.1
Turnbuckles	5.22	Aluminum Alloy Tubing	6.1
6.5.4 Aircraft Rivets	5.23	Steel Tubing	6.1
Standards and Specifications	5.23	Titanium Tubing 3AL-2.5V	6.1
Solid Shank Rivets	5.24	Material Identification	6.1
Solid Rivet Identification	5.24	Tubing Sizes	6.2
Rivet Corrosion	5.25	Flexible Hose Fluid Lines	6.2
Heat Treating Rivets	5.25	Rubber Hose Materials and Construction	6.2
Blind Rivets	5.27	Buna-N	6.2
Friction Locked Blind Rivets	5.27	Neoprene	6.2
Mechanical Lock Blind Rivets	5.28	Butyl	6.2
CherryMAX® Blind Rivets	5.28	Low, Medium, and High Pressure Hoses	6.2
Removal of Mechanically Locked Blind Rivets	5.28	Teflon™ Hose	6.2
Blind Rivet Specifications	5.29	Hose Identification	6.2
Rivet Material	5.29	Size Designations	6.3
Diameters	5.29	Fluid Line Identification	6.3
Blind Rivet Identification	5.30	Section B	6.3
Nonstructural Blind Fasteners	5.30	Fluid Line End Fittings	6.3
Pop rivets	5.30	Universal Bulkhead Fittings	6.4
Pull Through Nutplate Blind Rivets	5.31	AN Flared Fittings	6.4
Special Purpose Rivets and Fasteners	5.31	Flareless Fittings	6.5
Pin Fastening Systems (High Shear Fasteners)	5.31	Swaged Fittings	6.7
Installation of High Shear Fasteners	5.31	Cryofit™ Fittings	6.8
Inspection of Pin Rivets	5.31	Flexible Hose Fittings	6.9
Removal of Pin Rivets	5.31	Submodule 6 Practice Questions	6.11

TABLE OF CONTENTS

Submodule 6 Practice Answers	6.12	Chains and Sprocket	9.7
6.7 SPRINGS.....	7.1	Advantages and Disadvantages of Chain Drives.....	9.7
Types of Springs and Applications	7.1	Leaf Chains	9.8
Flat Springs	7.1	Submodule 9 Practice Questions.....	9.9
Leaf Springs.....	7.1	Submodule 9 Practice Answers	9.10
Spiral Springs.....	7.1	6.10 CONTROL CABLES	10.1
Helical Compression/Tension Springs	7.1	Cable Control Systems.....	10.1
Helical Torsion Springs	7.1	Types of Cables	10.1
Belleville (Cone Disc) Springs.....	7.2	Cable Construction	10.1
Torsion Bar Springs.....	7.2	Cable Material.....	10.1
Spring Materials	7.2	Cable Designations	10.1
Spring Dimensions	7.3	Flexible Cables.....	10.1
Spring Characteristics	7.3	Extra Flexible Cable	10.1
Forces Exerted on, and Applied by Springs	7.3	Non-Flexible Cables	10.2
Law Obeyed by Springs.....	7.3	End Fittings, Turnbuckles and Compensating Devices	10.2
Submodule 7 Practice Questions.....	7.5	Cable End Fittings.....	10.2
Submodule 7 Practice Answers	7.6	Cable Tension.....	10.2
6.8 BEARINGS.....	8.1	Turnbuckles	10.2
Bearing Loads	8.1	Tensiometers	10.2
Bearings Material	8.1	Compensating Devices	10.3
Construction of Ball Bearings.....	8.1	Pulleys and Cable System Components	10.3
Types of Bearings.....	8.2	Pulleys	10.3
Plain Bearings	8.2	Fairleads.....	10.4
Ball Bearings	8.2	Pressure Seals.....	10.4
Roller Bearings	8.2	Cable Connectors.....	10.4
Submodule 8 Practice Questions.....	8.3	Control Surface Travel Adjustment.....	10.4
Submodule 8 Practice Answers	8.4	Rigging Fixtures	10.4
6.9 TRANSMISSIONS.....	9.1	Spring Back	10.4
Driving and Driven Gears.....	9.1	Cable Drums	10.5
Bevel Gears	9.1	Aircraft Flexible Control Systems.....	10.5
Worm Gears	9.1	Bowden Cables.....	10.5
Helical Worm Gears	9.2	Teleflex® Controls	10.5
Planetary Gears	9.2	Control Rods	10.6
Rack and Pinion Gears	9.2	Push Pull Rods	10.6
Gear Systems	9.2	Torque Tubes	10.6
Gear Terms	9.2	Submodule 10 Practice Questions.....	10.7
Backlash (or lash).....	9.2	Submodule 10 Practice Answers	10.8
Idler Gear.....	9.3	6.11 ELECTRICAL CABLES AND CONNECTORS.....	11.1
Intermediate Gear	9.3	Cable (Wire) Types, Construction And Characteristics.....	11.1
Compound Gear	9.3	Wire Types.....	11.1
Pinion Gear	9.3	Conductors.....	11.2
Lay-shaft	9.3	Plating	11.2
Step-Up Drive	9.3	Insulation	11.2
Step-Down Drive.....	9.3	Wire Shielding.....	11.2
Gear Ratio	9.3	Wire Substitutions.....	11.3
Propeller Reduction Gearing.....	9.4	Areas Designated as Severe Wind And Moisture Problem (SWAMP)	11.3
Gear Lash and Pattern.....	9.5	Wire Size Selection	11.3
Non-gear Transmissions	9.6	Current Carrying Capacity	11.6
Belts and Pulleys	9.6	Maximum Operating Temperature.....	11.7
Types of Belt Drives.....	9.6	Single Wire in Free Air	11.7
Open Belt Drives.....	9.6	Wires in a Harness.....	11.7
Crossed Belt Drives	9.6	Harness At Altitude	11.7
Advantages and Disadvantages of Belt Drives	9.6	Aluminum Conductor Wire	11.7

TABLE OF CONTENTS

Computing Current Carrying Capacity	11.7
Example 1	11.7
Example 2	11.8
Allowable Voltage Drop	11.9
Electric Wire Chart Instructions.	11.9
Example A	11.10
Example B	11.10
Wire Identification.	11.10
Placement of Identification Markings	11.10
Types of Wire Markings	11.11
High Tension And Coaxial Cables	11.11
High Tension Cables	11.11
Coaxial Cables.	11.12
Coaxial Cable Connectors.	11.12
Crimping	11.12
Crimping Tools	11.12
Inspection And Testing Of Crimped Joints	11.12
Connectors.	11.14
Types Of Connectors.	11.14
Inline Junctions	11.15
Current And Voltage Rating.	11.15
Coupling And Installation.	11.15
Connector Wiring	11.15
Wire Installation Into The Connector.	11.16
Adjacent Locations	11.16
Sealing	11.16
Drainage.	11.16
Wire Support	11.16
Connector Identification	11.16
Standard.	11.16
Type	11.16
Connector Class.	11.17
Class A.	11.17
Class B	11.17
Class C.	11.17
Class D.	11.17
Class K.	11.17
Shell Size	11.17
Contact Arrangement	11.17
Contact Style	11.17
Insert Rotation	11.17
Submodule 11 Practice Questions.	11.19
Submodule 11 Practice Answers	11.20
Acronym Definitions	A.1

Steel Number	Temperatures			Quenching Medium (n)	Tempering (drawing) Temperature for Tensile Strength (psi)				
	Normalizing Air Cool (°C)	Annealing (°C)	Hardening (°C)		100 000 (°C)	125 000 (°C)	150 000 (°C)	180 000 (°C)	200 000 (°C)
1020	900–955	870–925	855–910	Water	—	—	—	—	—
1022 (x1020)	900–955	870–925	855–910	Water	—	—	—	—	—
1025	870–925	870–900	855–910	Water	(a)	—	—	—	—
1035	855–900	855–885	830–870	Water	470	—	—	—	—
1045	845–870	845–870	800–845	Oil or Water	620	—	—	(n)	—
1095	800–845	790–815	775–815	Oil	(b)	—	595	455	400
2330	800–830	775–800	790–815	Oil or Water	595	510	423	—	—
3135	870–900	815–845	800–830	Oil	675	565	480	400	345
3140	870–900	815–845	800–830	Oil	720	580	495	413	370
4037	870	830–855	830–855	Oil or Water	665	595	525	—	—
4130 (x4130)	870–925	830–855	830–885	Oil (c)	(d)	565	480	370	300
4140	870–900	830–855	830–855	Oil	730	595	550	440	355
4150	845–870	800–830	845	Oil	—	690	635	565	510
4340 (x4340)	845–885	830–855	800–845	Oil	—	650	565	510	455
4640	910–925	830–855	815–845	Oil	—	650	565	400	330
6135	870–925	845–870	855–885	Oil	705	580	495	425	400
6150	870–900	830–855	845–885	Oil	(d)(e)	650	540	480	425
6195	870–900	830–855	815–845	Oil	(f)	—	—	—	—
NE8620	—	—	830–855	Oil	—	540	—	—	—
NE8630	900	830–855	830–855	Oil	—	605	525	415	355
NE8735	900	830–855	830–855	Oil	—	635	550	470	415
NE8740	885	815–845	815–845	Oil	—	650	580	495	455
30905	—	(g)(h)	(i)	—	—	—	—	—	—
51210	830–855	830–855	970–995(j)	Oil	650	595	(k)	400	—
51335	—	830–855	970–1 010	Oil	—	—	—	—	—
52100	885–925	760–790	830–845	Oil	(f)	—	—	—	—
Corrosion resisting (16–2)(1)	—	—	—	—	(m)	—	—	—	—
Silicon chromium (for springs)	—	—	925–940	Oil	—	—	—	—	—

NOTES:

- (a) Draw at 620°C for tensile strength of 70 000 psi.
- (b) For spring temper draw at 425–480°C. Rockwell hardness C-40–45.
- (c) Bars or forgings may be quenched in water from 815–870°C.
- (d) Air cooling from the normalizing temperature produces a tensile strength of approximately 90 000 psi.
- (e) For spring temper draw at 455–510°C. Rockwell hardness C-40–45.
- (f) Draw at 175–230°C to remove quenching strains. Rockwell hardness C-60–65.
- (g) Anneal at 870–925°C to remove residual stresses due to welding or cold work. May be applied only to steel containing titanium or columbium.
- (h) Anneal at 1 040–1 150°C to produce maximum softness and corrosion resistance. Cool in air or quench in water.
- (i) Harden by cold work only.
- (j) Lower side of range for sheet 0.06 inch and under. Middle of range for sheet and wire 0.125 inch. Upper side of range for forgings.
- (k) Not recommended for intermediate tensile strengths because of low impact.
- (l) AN-QQ-S-770—It is recommended that prior to tempering corrosion-resisting (16 Cr–2 Ni) steel be quenched in oil from a temperature of 1 025–1 040°C after a soaking period of 30 minutes at this temperature. To obtain a tensile strength at 115 000 psi the tempering temperature should be approximately 275°C. A holding time at these temperatures of about 2 hours is recommended. Tempering temperatures between 370°C and 595°C is not approved.
- (m) Draw at approximately 425°C and cool in air for Rockwell hardness of C-50.
- (n) Water used for quenching shall be within the temperature range of 25–60°C.

Figure 1-5. Heat treatment procedures for steels.

- 5xxx—magnesium
- 6xxx—magnesium and silicon
- 7xxx—zinc
- 8xxx—other elements

In the 2xxx through 8xxx alloy groups, the second digit in the alloy designation indicates alloy modifications. If the second digit is zero, it indicates the original alloy, while digits 1 through 9 indicate alloy modifications. The last two of the four digits in the designation identify the different alloys in the group. [Figure 2-2]

EFFECT OF ALLOYING ELEMENT

- 1000 series: Made of 99 percent aluminum or higher, excellent for its corrosion resistance, high thermal and electrical conductivity, low mechanical properties, and excellent workability. Iron and silicon are major impurities.
- 2000 series: Copper is the principal alloying element. Solution heat treatment, optimum properties equal to mild steel, poor corrosion resistance unclad. It is usually clad with 6000 or high purity alloy. Its best known alloy is 2024.
- 3000 series—Manganese is the principal alloying element of this group which is generally non-heat treatable. The percentage of manganese which will be alloy effective is 1.5 percent. The most popular is 3003, which is of moderate strength and has good working characteristics.
- 4000 series—Silicon is the principal alloying element of this group, and lowers melting temperature. Its primary use is in welding and brazing. When used in welding heat treatable alloys, this group will respond to a limited amount of heat treatment.
- 5000 series—Magnesium is the principal alloying element. It has good welding and corrosion resistant characteristics. High temperatures (over 65°C) or excessive cold working will increase susceptibility to corrosion.

- 6000 series: Silicon and magnesium form magnesium silicide which makes alloys heat treatable. It is of medium strength, good forming qualities, and has corrosion resistant characteristics. The most popular alloy of the series is 6061. When coupled with magnesium, it results in heat treatable alloys of very high strength. It usually has copper and chromium added.
- 7000 series: Zinc is the principal alloying element. The principal alloy of this group is 7075.

HARDNESS IDENTIFICATION

Where used, the temper designation follows the alloy designation and is separated from it by a dash: i.e., 7075-T6, 2024-T4, and so forth. The temper designation consists of a letter indicating the basic temper which may be more specifically defined by the addition of one or more digits. These designations are as follows:

- F - as fabricated
- O - annealed, recrystallized (wrought products only)
- H - strain hardened
- H1 (plus one or more digits) — strain hardened only
- H2 (plus one or more digits) — strain hardened and partially annealed
- H3 (plus one or more digits) — strain hardened and stabilized

The digit following the designations H1, H2, and H3 indicates the degree of strain hardening, number 8 representing the ultimate tensile strength equal to that achieved by a cold reduction of approximately 75 percent following a full anneal, 0 representing the annealed state.

MAGNESIUM

Magnesium, the world's lightest structural metal, is a silvery white material weighing only two-thirds as much as aluminum. Magnesium does not possess sufficient strength in its pure state

Percentage of Alloying Elements (aluminum and normal impurities constitute remainder)									
Alloy	Copper	Silicon	Manganese	Magnesium	Zinc	Nickel	Chromium	Lead	Bismuth
1100	—	—	—	—	—	—	—	—	—
3003	—	—	1.2	—	—	—	—	—	—
2011	5.5	—	—	—	—	—	—	0.5	0.5
2014	4.4	0.8	0.8	0.4	—	—	—	—	—
2017	4.0	—	0.5	0.5	—	—	—	—	—
2117	2.5	—	—	0.3	—	—	—	—	—
2018	4.0	—	—	0.5	—	2.0	—	—	—
2024	4.5	—	0.6	1.5	—	—	—	—	—
2025	4.5	0.8	0.8	—	—	—	—	—	—
4032	0.9	12.5	—	1.0	—	0.9	—	—	—
6151	—	1.0	—	0.6	—	—	0.25	—	—
5052	—	—	—	2.5	—	—	0.25	—	—
6053	—	0.7	—	1.3	—	—	0.25	—	—
6061	0.25	0.6	—	1.0	—	—	0.25	—	—
7075	1.6	—	—	2.5	5.6	—	0.3	—	—

Figure 2-2. Nominal composition of wrought aluminum alloys.

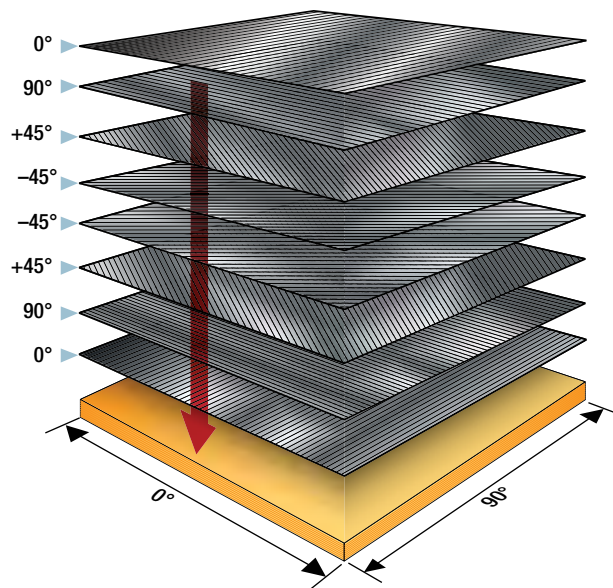


Figure 3-3. Quasi-isotropic material layup.

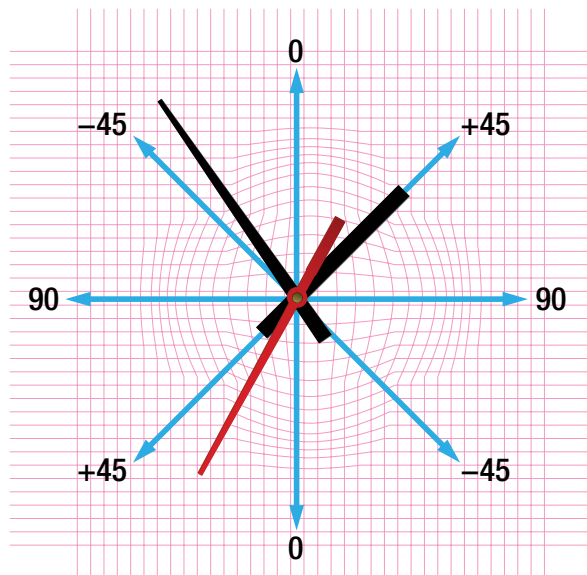


Figure 3-4. A warp clock.

FIBER FORMS

All product forms generally begin with spooled unidirectional raw fibers packaged as continuous strands. An individual fiber is called a filament. The word strand is also used to identify an individual glass fiber. Bundles of filaments are identified as tows, yarns, or rovings. Fiberglass yarns are twisted, while Kevlar® yarns are not. Tows and rovings do not have any twist. Most fibers are available as dry fiber that needs to be impregnated (impreg) with a resin before use or prepreg materials where the resin is already applied to the fiber.

ROVING

A roving is a single grouping of filament or fiber ends, such as 20-end or 60-end glass rovings. All filaments are in the same direction and they are not twisted. Carbon rovings are usually identified as 3K, 6K, or 12K rovings, K meaning 1 000 filaments. Most applications for roving products utilize mandrels for filament winding and then resin cure to final configuration.

UNIDIRECTIONAL (TAPE)

Unidirectional prepreg tapes have been the standard within the aerospace industry for many years, and the fiber is typically impregnated with thermosetting resins. The most common method of manufacture is to draw collimated raw (dry) strands into the impregnation machine where hot melted resins are combined with the strands using heat and pressure. Tape products have high strength in the fiber direction and virtually no strength across the fibers. The fibers are held in place by the resin. Tapes have a higher strength than woven fabrics. [Figure 3-5]

BIDIRECTIONAL FABRIC

Most fabric constructions offer more flexibility for layup of complex shapes than straight unidirectional tapes offer. Fabrics offer the option for resin impregnation either by solution or the hot melt process. Generally, fabrics used for structural applications use like fibers or strands of the same weight or yield in both the warp (longitudinal) and fill (transverse) directions. For aerospace structures, tightly woven fabrics are usually the choice to save weight, minimizing resin void size, and maintaining fiber orientation during the fabrication process.

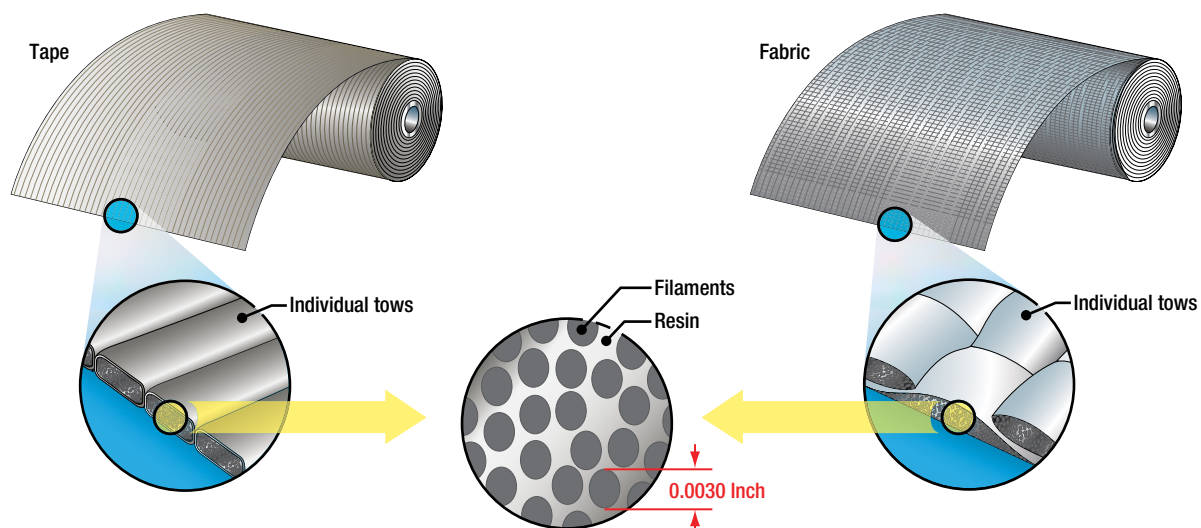


Figure 3-5. Tape and fabric products.

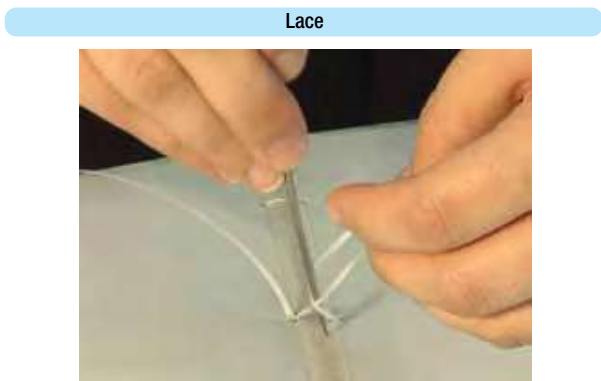
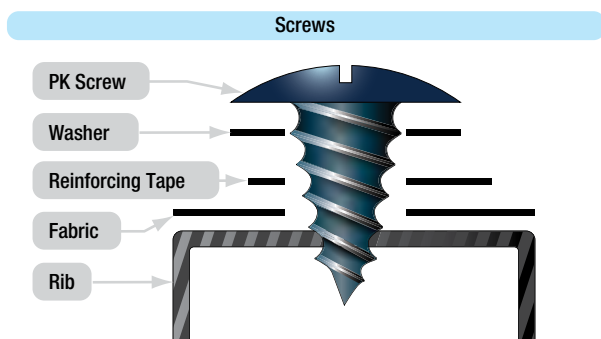
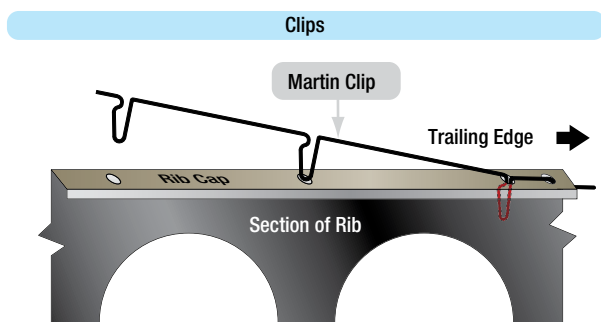


Figure 3-120. Clips, screws, rivets, or lace are used to attach the fabric to wing and empennage ribs.

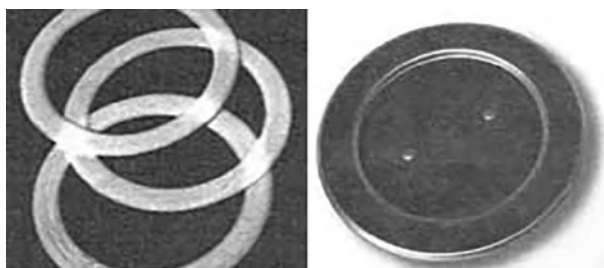


Figure 3-121. Inspection rings and an inspection cover.

The location of inspection rings are specified by the manufacturer. Additional rings are sometimes added to permit access to important areas that may not have been fitted originally with inspection access.

PRIMER

The airframe structure of a fabric covered aircraft must be cleaned, inspected, and prepared before the fabric covering process begins. The final preparation procedure involves priming the structure with a treatment that works with the adhesive and first coats of fabric sealant that are to be used. Each STC specifies which primers, or if a wood structure, which varnishes are suitable. Most often, two part epoxy primers are used on metal structure and two part epoxy varnishes are used on wood structure.

FABRIC CEMENT

Modern fabric covering systems utilize special fabric cement to attach the fabric to the airframe. There are various types of cement. In addition to good adhesion qualities, flexibility, and long life, fabric cements must be compatible with the primer and the fabric sealer that are applied before and after the cement.

FABRIC SEALER

Fabric sealer surrounds the fibers in the fabric with a protective coating to provide adhesion and keep out dirt and moisture. The sealer is the first coat applied to the polyester fabric after it is attached to the airframe and heat shrunk to fit snugly.

FILLERS

After the fabric sealer is applied, a filler is used. It is sprayed on in a number of cross coats as required by the manufacturer or the STC. The filler contains solids or chemicals that are included to block UV light from reaching the fabric. Proper fill coating is critical because UV light is the single most destructive element that causes polyester fabric to deteriorate.

TOPCOATS

Once the aircraft fabric has been installed, sealed, and fill coat protected, finishing or topcoats are applied to give the aircraft its final appearance. It is important to use the topcoat products and procedures specified in the applicable STC to complete an airworthy fabric recovering job.

The use of various additives is common at different stages. The following is a short list of products that facilitate the proper application of topcoats. Note again that only products approved under a particular STC can be used.

- A catalyst accelerates a chemical reaction. Catalysts are specifically designed for each product with which they are mixed and are common with epoxies and polyurethanes.
- A thinner is a solvent added to a product to give it the proper consistency for application.
- A retarder is added to slow drying time. Used mostly in topcoats, a retarder allow more time for a sprayed coating to flow, resulting in a deeper glossier finish. It is used when the working temperature is elevated slightly above the ideal temperature for a product. It also can be used to prevent blushing when high humidity conditions exist.
- Accelerators contains solvents that speed up the drying

bolt to break off when the sleeve is properly seated. These types of bolts are available in many different head styles, including protruding head, 100° flush head, 130° flush head, and hex head.

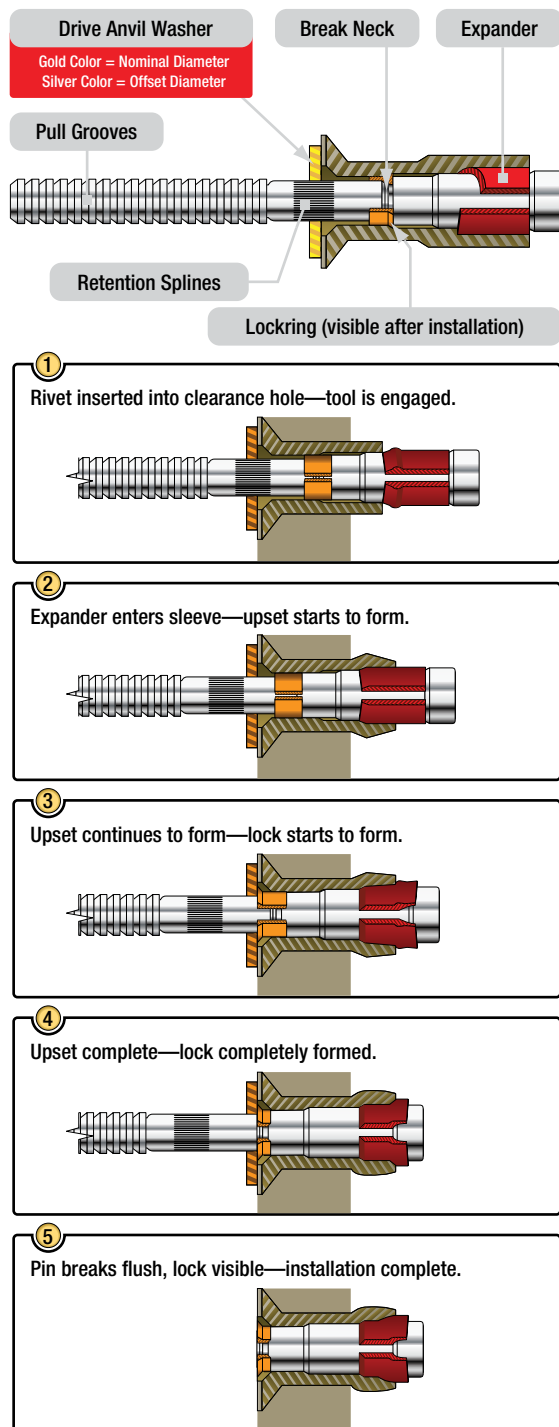


Figure 5-61. Huck Blind Bolt system.



Figure 5-62. A Visu-Lok type of drive nut type blind bolt.

Use the grip gauge available for the type of fastener and select the bolt grip after careful determination of the material thickness. The grip of the bolt is critical for correct installation. [Figure 5-63]

INSTALLATION PROCEDURE

1. Install the fastener into the hole, and place the installation tooling over the screw (stem) and nut.
2. Apply torque to the screw with the installation tool while keeping the drive nut stationary. The screw continues to advance through the nut body causing the sleeve to be drawn up over the tapered nose of the nut. When the sleeve forms tightly against the blind side of the structure, the screw fractures in the break groove. The stem of Jo-bolts, Visu-Lok, and Composi-Lok II fasteners does not break off flush with the head. A screw break-off shaver tool must be used if a flush installation is required. The stem of the Composi-Lok III and OSI bolt break off flush.

TAPERED SHANK BOLT

Tapered shank bolts, such as the Taper-Lok, are lightweight, high strength shear or tension bolts. This bolt has a tapered shank designed to provide an interference fit upon installation. Tapered shank bolts can be identified by a round head (rather than a screwdriver slot or wrench flats) and a threaded shank. The Taper-Lok is comprised of a tapered, conical shank fastener, installed into a precision tapered hole. The use of tapered shank bolts is limited to special applications such as high stress areas of fuel tanks. It is important that a tapered bolt not be substituted for any other type of fastener in repairs. It is equally as important not to substitute any other type of fastener for a tapered bolt.

Tapered shank bolts look similar to Hi-Lok bolts after installation, but the tapered shank bolts do not have the hex recess at the threaded end of the bolt. Tapered shank bolts are installed in precision reamed holes, with a controlled interference fit. The interference fit compresses the material around the hole that results in excellent load transfer, fatigue resistance, and sealing. The collar used with the tapered shank bolts has a captive washer, and so no extra washers are required. New tapered shank bolt installation or rework of tapered shank bolt holes needs to be accomplished by trained personnel. Properly installed, these bolts become tightly wedged and do not turn while torque is applied to the nut.



Figure 5-63. A Jo-Bolt and Visu-Lok pneumatic installation tool.