
Contents

Preface	xiii
Acknowledgments	xv

Chapter 1. Introduction	1
Fuselage Structure	3
Location Numbering Systems	3
Wing Structure	6
Empennage or Tail Assembly	8
Chapter 2. Tools and How to Use Them	9
Safety Considerations	9
General-Purpose Hand Tools	10
Hammers	10
Screwdrivers	11
Pliers	11
Punches	13
Wrenches	13
Metal-Cutting Tools	17
Hand snips	17
Hacksaws	18
Chisels	20
Files	20
Drilling and countersinking	24
Reamers	24
Layout and Measuring Tools	24
Rules	24
Combination sets	25
Scriber	26
Dividers and calipers	26
Slide calipers	29
Taps and Dies	30
Shop Equipment	32
Holding devices	32
Squaring shears	33

Throatless shears	33
Bar folder	33
Sheet-metal brake	34
Slip roll former	34
Grinders	35
Rotary punch	38
 Chapter 3. Materials and Fabricating	 39
Aluminum and Aluminum Alloys	39
Alloy and temper designations	41
Cast and wrought aluminum alloy designation system	41
Aluminum	42
Aluminum alloys	42
Temper designation system	42
Characteristics of Aluminum Alloys	43
Nonheat-treatable alloys	44
Heat-treatable alloys	44
Clad alloys	45
Annealing characteristics	45
Typical uses of aluminum and its alloys	45
Heat treatment of aluminum alloys	47
Identification of aluminum	48
Handling Aluminum	49
Forming Aluminum Alloys	49
Forming at the factory	49
Blanking	50
Bending	51
Press-Brake Forming	51
Stretch Forming	52
Hydro Press Forming	52
Roll Forming	53
Flexible-Die Forming	53
Machining	55
Drilling	55
Turret Lathes and Screw Machines	55
Milling	56
Routing	56
Forging	56
Casting	57
Chemical Milling	58
Making Straight-Line Bends	58
Bend allowance	59
Brake or sight line	62
J chart for calculating bend allowance	63
Making Layouts	65
Relief holes	65
Miscellaneous shop equipment and procedures	66
Magnesium and Magnesium Alloys	67
Heat treatment of magnesium alloys	69

Titanium and Titanium Alloys	70
Titanium designations	71
Corrosion characteristics	72
Treatment of titanium	72
Working with Titanium	72
Machining of titanium	72
Milling	73
Turning	73
Drilling	74
Tapping	74
Grinding	74
Sawing	74
Cleaning after machining	75
Shop-forming titanium	75
Stress relief	75
Ferrous Aircraft Metals	75
Identification	76
Types, characteristics, and uses of alloyed steels	77
Heat treatment of ferrous metals	79
 Chapter 4. Drilling and Countersinking	 81
Rivet Hole Preparation	81
Rivet hole location	81
Drills	82
Drill sharpening	83
Drill points	87
Drilling equipment	87
Drilling Operations	88
Chucking the drill	88
Drilling holes	88
Drill stops and drill bushings	90
Using an extension drill	91
Drilling aluminum and aluminum alloys	91
Drilling titanium and titanium alloys	92
Drilling stainless steel	92
Deburring	93
Countersinking	94
Types of countersinking cutters	95
Countersinking holes	96
Minimum countersinking depth	97
Form countersinking (dimpling)	97
100° combination predimple and countersink method	101
Hole preparation for form countersinking	101
Shaving Flush Head Fasteners	102
Reamers	103
 Chapter 5. Riveting	 105
Solid-Shank Rivets	105
Material	105
Rivet types and identification	106

Riveting Practice	110
Edge distance	110
Rivet length	111
Rivet spacing	112
Hole preparation	113
Use of clecos	113
Driving solid-shank rivets	114
Rivet sets	115
Bucking bars	116
Riveting procedure	117
Blind bucking	121
Tapping code	121
Hand Riveting	123
Rivet Squeezers	124
Inspection after riveting	126
Rivet Removal	126
NACA Method of Double Flush Riveting	126
Blind Rivets	126
Mechanical locked-stem self-plugging rivets	130
Removal of mechanically locked blind rivets	135
Sheet-Metal Repair	136
Damage removal	136
Repair material thickness	136
Rivet selection	136
Rivet spacing and edge distance	138
Repair approval	138
Typical sheet-metal repairs	139
Patches	139
Flush Patch	140
 Chapter 6. Bolts and Threaded Fasteners	 147
Aircraft Bolts	148
General-purpose bolts	148
Close-Tolerance Bolts	149
Classification of Threads	149
Identification and coding	149
Aircraft Nuts	150
Self-locking nuts to 250°F	153
High-temperature self-locking nuts	154
Miscellaneous nut types	155
Aircraft Washers	156
Plain washers	156
Lock washers	156
Installation of Nuts and Bolts	157
Torque tables	159
Cotter pin hole line-up	159
Safetying of nuts, bolts, and screws	162
Cotter Pin Safetying	162
Installation: Bolts, Washers, Nuts, and Cotter Pins	163
Miscellaneous Threaded Fasteners	163
Screws	164

Dzus Fasteners	166
Camloc Fasteners	167
Hi-Lok [®] , Hi-Tigue [®] , and Hi-Lite [®] Fasteners	169
Hi-Lok [®] fastening system	169
Hi-Tigue [®] fastening system	170
Hi-Lite [®] fastening system	171
Installation of Hi-Lok [®] , Hi-Tigue [®] , and Hi-Lite [®] Fasteners	171
Hole preparation	171
Pin grip length	172
Installation tools	172
Installation steps for an interference-fit hole	173
Inspection after installation	176
Removal of the installed fastener	176
Lockbolt Fastening Systems	177
Installation procedure	178
Lockbolt inspection	178
Lockbolt removal	179
Blind Bolts	179
Cherry Maxibolt [®] blind bolt system	180
Drive-nut-type blind bolt	181
Chapter 7. Aircraft Plumbing	183
Fluid Lines	183
Aluminum alloy tubing	183
Steel	183
Titanium 3AL-2.5V	184
Tubing identification	184
Sizes	185
Flexible Hose	185
Synthetics	185
Rubber hose	186
Teflon hose	186
Identification of hose	187
Size designation	188
Identification of fluid lines	188
Plumbing Connections	188
Flared-tube fittings	190
Flareless-tube fittings	190
Swaged fittings	191
Cryofit fittings	191
Tube cutting	192
Deburring	193
Tube bending	194
Tube flaring	196
Assembling sleeve-type fittings	198
Proof-testing after assembly	198
Installing flexible hose assemblies	201
Installing Rigid Tubing	201
Support clamps	202
Rigid tubing inspection and repair	204

Chapter 8. Control Cables	207
Cable Assembly	207
Fabricating a cable assembly	207
Swaging	208
Micropress process	208
Turnbuckles	211
Safety methods for turnbuckles	211
Double-wrap method	211
Cable Tension Adjustment	214
Cable guides	214
Chapter 9. Electrical Wiring and Installation	217
Material Selection	217
Wire size	218
Stripping insulation	220
Terminals	220
Aluminum wire terminals	223
Connecting terminal lugs to terminal blocks	224
Wiring identification	225
Placement of identification markings	225
Wire Groups and Bundles	227
Spliced connections in wire bundles	228
Bend Radii	229
Routing and installations	229
Protection against chafing	230
Bonding and Grounding	231
AN/MS Connectors	234
Wire inspection	235
Electrical Components	236
Switches	236
Relays and solenoids	237
Fuses	237
Circuit breakers	238
Chapter 10. Aircraft Drawings	239
Orthographic Projection	239
Working Drawings	240
Detail drawing	241
Assembly drawing	241
Installation drawing	241
Title Block	241
Bill of Material	242
Other Data	242
Sectional Views	243
The Lines on a Drawing	243
Rivet Symbols Used on Drawings (Blueprints)	244
Chapter 11. Nondestructive Testing (NDT) or Nondestructive Inspection (NDI)	247
Visual Inspection	247

NDT Beyond Visual Inspection	248
Liquid penetrant inspection	248
Eddy-current inspection	250
Ultrasonic inspection	251
Phased array inspection	253
Magnetic particle inspection	253
Radiography	255
Tap or coin test	256
Thermography	257
Shearography	258
 Chapter 12. Corrosion Detection and Control	 259
Types of Corrosion	260
Direct Chemical Attack	260
Electrochemical Attack	260
Forms of Corrosion	263
Surface corrosion	263
Filiform corrosion	263
Pitting corrosion	263
Intergranular corrosion	264
Exfoliation corrosion	265
Stress corrosion	265
Fretting corrosion	265
Effects of Corrosion	266
Corrosion Control	266
Inspection Requirements	268
Corrosion Prevention	268
Corrosion-Prone Areas	269
Corrosion-Removal Techniques	269
Surface Damage by Corrosion	270
 Chapter 13. Composites	 271
Introduction	271
Definition of Composite Materials	271
Major Components of a Laminate	271
Types of Fiber	272
Fiberglass	272
Carbon	272
Kevlar®	273
Fiber Forms	273
Roving	273
Unidirectional (tape)	273
Bidirectional (fabric)	274
Resin Systems	274
Mixing two-part resin systems	275
Curing stages of thermosetting resins	276
Dry Fiber and Prepreg	276
Adhesives	277
Film adhesives	277
Paste adhesives	277
Foaming adhesives	278

Honeycomb Sandwich Structures	278
Laminate Structures	280
Damage and Defects	281
Delamination and debonds	282
Resin rich or starved	282
Fiber breakage	282
Matrix imperfections	282
Moisture ingress	282
Vacuum Bagging Techniques	283
Release agents	283
Bleeder ply	283
Peel ply	283
Layup tapes	283
Perforated release film	283
Solid release film	284
Breather material	284
Vacuum bag	284
Curing and Curing Equipment	284
Oven	284
Autoclave	285
Heat bonder	285
Types of Layups for Repair	285
Wet layup	286
Prepreg layup	286
Repairs of Honeycomb and Laminate Structures	288
Honeycomb sandwich repair	288
Repair of laminate structure	288
Specialty Fasteners Used for Composite Structures	290
Fastener Materials	291
Drilling	291
Countersinking	292
 Chapter 14. Standard Parts	 293
Standard Parts Identification	293
Standard Parts Illustrations	294
Additional Standard Parts (Patented)	319
 Appendix	 331
Tap Drill Sizes—American (National) Screw Thread Series	331
Wire and Sheet Metal Gage Table	332
Ultimate and Shear Strength of Typical Aluminum Alloys	333
Chemical Flashpoints for Various Liquids Used in the Aircraft Industry	334
 Glossary	 335
Index	341