T.O. 1T-28A-3

TECHNICAL MANUAL
STRUCTURAL REPAIR

USAF MODEL

T-28A, T-28B, T-28C & AT-28D

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Page No.	*Issue*
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1-6A thru 1-6B	10 Apr 64
1-6C thru 1-6D	5 Jun 69
1-7 thru 1-8	5 Jun 69
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1-11 thru 1-13	Original
1-14 thru 1-14D	19 Jun 59
1-14E	10 Apr 64
1-14F	19 Jun 59
1-15	19 Jun 59
1-16 thru 1-18C	11 May 62
1-18D thru 1-18G	5 Jun 69
1-18H thru 1-18J	11 May 62
1-18K Blank	11 May 62
1-19	11 May 62
1-20 thru 1-22	Original
1-23 thru 1-24	1 Mar 72
1-25 thru 1-55	Original
1-56	29 Apr 60
2-1 thru 2-2	24 Sep 65
2-2A thru 2-2B	13 May 70
2-3 thru 2-4	13 May 70
2-4A	10 Apr 64
2-4B	13 May 70
2-4B-1 thru 2-4B-2	24 Sep 65
2-4C	24 Sep 65
2-4D thru 2-4H	10 Apr 64
2-5 thru 2-6	Original
2-6A	20 Jul 73
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2-8B Blank Added	1 Mar 72
2-9 thru 2-14	Original
2-14A	1 Mar 72
2-14B Blank	29 Mar 71
2-14C thru 2-14D Added	1 Sep 72
*2-14E thru 2-14H Added	20 Jul 73
2-15	5 Jun 69
2-16	10 Apr 64
2-17 thru 2-18	Original
2-18A Added	1 Sep 72
2-18B Blank Added	1 Sep 72
2-19	1 Sep 72
2-20	5 Jun 69
2-20A thru 2-20C	1 Mar 72
2-20D Blank	5 Jun 69
2-21 thru 2-28	Original
2-28A thru 2-28B	19 Jun 59
2-29 thru 2-32	Original
2-32A	13 May 70
2-32B Blank	13 May 70
2-33 thru 2-34	Original
2-34A thru 2-34B	13 May 70
2-35	29 Apr 60
2-36 thru 2-40	Original
3-1	Original
3-2	10 Apr 64
3-2A	23 Aug 71
3-2B	10 Apr 64
3-2C thru 3-2D	23 Aug 71
3-3	10 Apr 64
3-4 thru 3-14	Original
3-14A thru 3-14D	19 Jun 59
3-15	19 Jun 59
3-16 thru 3-20	Original
4-1	Original
4-2 thru 4-2C	5 Jun 69
4-2D	10 Apr 64
4-3	10 Apr 64
4-4	Original
4-5	10 Apr 64
4-6 thru 4-13	Original
4-14 thru 4-14B	29 Apr 60
4-15	Original
4-16 thru 4-18	10 Apr 64
4-18A Added	1 Sep 72
4-18B Blank Added	1 Sep 72
4-19 thru 4-20A	10 Apr 64
4-20B	29 Apr 60
4-21	10 Apr 64
4-22	Original
4-22A	5 Jun 69
4-22B Blank	5 Jun 69
4-23	5 Jun 69
4-24 thru 4-26	Original
4-26A thru 4-26E	1 Sep 72
4-26F Blank Added	1 Mar 72
4-27	Original
4-28 thru 4-28B	29 Apr 60
4-29 thru 4-31	10 Apr 64
4-32 thru 4-36	Original
5-1 thru 5-2	Original
5-3	29 Apr 60
5-4	23 Aug 71
5-5 Added	1 Mar 72
5-6 Blank Added	1 Mar 72
5-7 Added	1 Mar 72
5-8 Blank Added	1 Mar 72
*6-1	20 Jul 73
6-2	1 Sep 72
6-2A	10 Apr 64
6-2B Blank	10 Apr 64
6-3	10 Apr 64
6-4 thru 6-5	Original
6-6	29 Apr 60
7-1 thru 7-2A	24 Sep 65
7-2B Blank	24 Sep 65
7-3 thru 7-4A	24 Sep 65
7-4B Blank	24 Sep 65
7-5 thru 7-8	Original
8-1	10 Apr 64
8-2 Blank	10 Apr 64
9-1 thru 9-4 Deleted	10 Apr 64
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LIST OF EFFECTIVE PAGES

Page No.	*Issue*
1A-3 thru 1A-4A	29 Apr 60
1A-4B	24 Sep 65
*1A-4C	1 Mar 72
1A-4D	29 Apr 60
*1A-5	1 Mar 72
1A-6	Original
2A-1 thru 2A-66	30 Jan 59
3A-1 thru 3A-2	30 Jan 59
4A-1 thru 4A-4	29 Apr 60

*The asterisk indicates pages changed, added, or deleted by the current change.

TABLE OF CONTENTS

Section		Page
	INTRODUCTION	vii
I	GENERAL	1-1
	Type of Construction	1-1
	Alignment	1-1
	Leveling	1-1
	Elevation and Horizontal Check Dimensions	1-1
	Rebalancing Control Surfaces	1-1
	Balancing Procedure for Control Surfaces	1-8
	Example	1-12
	Control Surface Horizontal Position	1-12
	Aileron	1-12
	Rudder	1-12
	Elevator	1-12
	Sealing	1-12
	Watertight Sealing	1-12
	Air and Gasoline Fumetight Sealing	1-13
	Materials Used in Repair	1-14
	Aluminum Alloys	1-14
	Corrosion-resistant Steel	1-14C
	Chrome Molybdenum Steel	1-14C
	Repair Jigs and Support Structures	1-14D
	Repair Jigs	1-14D
	Fuselage Supports	1-14E
	Emergency Removal of Airplane From Runway	1-14E
	Causes and Types of Damage	1-14E
	Collision or Impact Damage	1-14E
	Stress Damage	1-14E
	Fatigue Damage	1-16
	Corrosion Damage	1-16
	Fire Damage	1-16
	Negligible Damage	1-16
	Corrosion	1-17
	Uniform Etch Corrosion	1-17
	Pitting Corrosion	1-17
	Intergranular Corrosion	1-17
	Exfoliation Corrosion	1-17
	Galvanic Corrosion	1-17
	Consequences of Corrosion	1-18
	Corrosion Control	1-18
	Preventive Maintenance	1-18
	Corrosion Treatment	1-18D
	Paint Removal	1-18D
	Corrosion Treatment of Steel and Aluminim Landing Gear	1-18D
	Corrosion Treatment of Rocket Blast and Exhaust Areas	1-18E
	Corrosion Treatment of Battery Compartment	1-18E
	Corrosion Treatment of Control Cables	1-18F
	Corrosion Treatment for Mated Surfaces of Two Dissimilar Metals	1-18F
	Areas Requiring Special Corrosion Inspection	1-18G
	Corrosive Effects of Aircraft Fire-extinguishing Agents and Methods of Removal	1-18G
	Corrosive Effects and Removal of Dry Chemical Powder	1-18G
	Corrosive Effects and Removal of Mechanical Foam	1-18G
	Corrosive Effects and Removal of Other Extinguishing Agents	1-18G

Section		Page
	Corrosion Control Materials	1-18H
	Investigating Structural Damage	1-19
	Preliminary External Inspection	1-19
	Detailed Visual Inspection	1-19
	Skin Buckling	1-20
	Fire Damage Evaluation	1-20
	Primer Discoloration Evaluation	1-22
	Chemical Testing and Inspection	1-22
	Identification of Materials by Chemical Testing	1-22
	Penetrant Inspection Method	1-23
	Hand-forming	1-25
	Flanges and Angles	1-25
	Stop Drilling	1-25
	Locating Skin Trim Lines	1-25
	Locating Skin Trim Lines With Skin Scribe	1-25
	Locating Skin Trim Lines With Masking Tape	1-25
	Locating Blind Holes	1-25
	Locating Blind Holes With Hole Finder	1-25
	Locating Blind Holes With a Scale	1-25
	Filling Dimpled Holes	1-25
	Trimming Fastener Heads	1-25
	Draw Dimpling	1-28
	Blind Fasteners	1-28
	Holes for Blind Fasteners	1-28
	Handling and Storage of Blink Fasteners	1-28
	Installation of Blind Fasteners	1-28
	Olympic and Cherry Blind Rivets	1-28
	Deutsch Drive Pin Blind Rivet	1-32
	Jo-bolts	1-32
	Threaded Inserts	1-32
	Heli-Coil Inserts	1-32
	Rosan Inserts	1-35
II	WING GROUP	2-1
	Wing Group	2-1
	Wing	2-1
	Wing – Armament-modified Airplanes	2-1
	Ailerons	2-1
	Landing Flaps	2-1
	Pylons – Armament-modified Airplanes	2-1
	Gun Package	2-1
	Fixed Gun Enclosure	2-2
	315-round Gun Package	2-2
	Corrosion or Damage Removal Procedure at W.S. "0" Wing Lug Mating Holes	2-6B
III	TAIL GROUP	3-1
	Tail Group	3-1
	Horizontal Stabilizer	3-1
	Elevators	3-1
	Vertical Stabilizer	3-1
	Rudder	3-1
IV	FUSELAGE	4-1
	Fuselage	4-1
	Fuselage Forward Section	4-1
	Tail Cone Section	4-1
	Windshield	4-1
	Canopy	4-1
V	LANDING GEAR	5-1
	Main Landing Gear	5-1
	Nose Gear	5-1

Section		Page
	Inspection for Damage to Landing Gear Structural Members	5-1
	Cracks	5-1
	Loose or Worn Bolts	5-1
	Negligible Damage to Landing Gear Assembly	5-1
	Reparable Damage	5-1
	Damage Necessitating Replacement	5-1
	Landing Gear Fairing Doors	5-1
	Negligible Damage to Doors	5-2
	Repair of Skin Areas	5-2
	Wheels, Tires, and Tubes	5-2
	Landing Gear Bungee Mount Bracket Repair	5-4
VI	ENGINE SECTION	6-1
	Engine Mount	6-1
	Magnetic Inspection (Preferred Method) (Refer to T.O. 1T-28A.36, Sec VI and MIL-I-6868D)	6-1
	Dye Penetrant Inspection	6-1
	Oil and Whiting Inspection	6-1
	Negligible Damage	6-1
	Reparable Damage	6-1
	Damage Necessitating Replacement	6-1
	Engine Cowling Assembly	6-1
	Negligible Damage	6-1
	Cowling Repairs	6-1
VII	FABRIC REPAIR AND ATTACHMENT	7-1
	General	7-1
	Repairing Aileron Seals	7-1
	Handling of Cement	7-1
	Clean-up After Cementing	7-1
	Glass-fabric-reinforced Plastic	7-1
	Repairing Glass-fabric-reinforced Plastic	7-1
	Glass-fabric Repair of Acrylic Plastic Canopy	7-5
	Repair Materials	7-5
	Repair Procedures	7-5
VIII	EXTRUSION CHART	8-1
	Extrusion Chart	8-1
IX	(Deleted)	
Appendix I	REPAIR MATERIALS	1A-1
	Repair Material List	1A-1
	Repair Materials and Uses	1A-4
	Sources of Commercial Products	1A-4C
Appendix II	TYPICAL REPAIRS	2A-1
	General	2A-1
	Typical Repair Index	2A-1
	Selecting Typical Repairs	2A-1
	Selecting Fastener Table	2A-1
	Fastener Distribution Patterns	2A-2
Appendix III	BIBLIOGRAPHY	3A-1
	Bibliography	3A-1
Appendix IV	GLOSSARY OF AIRPLANE AND AIRPLANE REPAIR TERMS	4A-1
	Introduction	4A-1
	Definitions	4A-1

LIST OF ILLUSTRATIONS

Number	Title	Page
1-1	Airplane Dimensions — T-28A Airplanes	1-2
1-1A	Airplane Dimensions — T-28B and T-28D Airplanes	1-2A
1-1B	Airplane Dimensions — T-28C Airplanes	1-2B
1-2	Major Assemblies	1-2C
1-2A	Major Assemblies — Armament-modified Airplanes	1-2D
1-2B	Blueprint Numbering System for Major Components	1-3
1-3	Airplane Stations — T-28A and T-28D Airplanes	1-4
1-3A	Airplane Stations — T-28B and T-28C Airplanes	1-6
1-4	Airplane Alignment	1-6B
1-6	Rebalancing Control Surfaces	1-9
1-7	Airplane Sealing	1-10
1-7A	Emergency Removal of Crashed Airplane From Runway	1-15
1-8	Stress Concentration at Nicks and Scratches	1-16
1-9	Blending Scratches	1-16
1-10	Color Hardness Strength Correlations — 7075-T6 Aluminum Alloy	1-21
1-11	Penetrant Inspection	1-24
1-12	Hand-forming	1-26
1-13	Stop Drilling	1-28
1-14	Chip Chaser	1-29
1-15	Locating Skin Trim Lines	1-30
1-16	Locating Blind Holes	1-31
1-17	Filling Dimpled Holes	1-32
1-18	Trimming Fastener Heads	1-33
1-19	Removing Hi-Shear Rivets	1-34
1-20	Draw Dimpling	1-35
1-21	Olympic Rivets	1-36
1-22	Installation of Deutsch Drive Pin Rivets	1-38
1-23	Removal of Deutsch Drive Pin Rivets	1-39
1-24	Installation of Jo-bolts	1-40
1-25	Removal of Jo-bolts	1-42
1-26	Heli-Coil Inserts	1-44
1-27	Rosan Inserts	1-46
1-28	Rivet Hole Sizes	1-48
1-29	Conventional-type Rivets and Applications	1-49
1-30	New Designations of Aluminum Alloys	1-50
1-31	Standard Sheet-metal Thickness	1-51
1-32	Bend Allowance Chart	1-52
1-33	Setback Chart	1-53
1-34	Tap Drill Suzes and Decimal Equivalents	1-54
1-35	Torque Table	1-55
1-36	Bolthead Identification	1-56
2-1	Wing Repair Index — T-28A and T-28D Airplanes	2-2A
2-1A	Wing Repair Index — T-28B and T-28C Airplanes	2-4
2-1B	Pylon and Gun Package Repair Index	2-4B-1
2-1B-1	Fixed Gun Enclosure Repair Index	2-4B-2
2-1B-2	315-round Gun Package Repair Index	2-4C
2-1C	Internal Modifications — Armament-modified Wings	2-4D
2-1D	Modified Aero 15C-1 Bomb Rack and Rocket Launcher — Armament-modified Airplanes	2-4E
2-1E	Skin Stress Diagram — Wing Lower Surface — T-28B and T-28C Airplanes	2-4F
2-1F	Skin Stress Diagram — Wing Upper Surface — T-28B and T-28C Airplanes	2-4G
2-1G	Skin Stress Diagram — Wing Upper Surface — Armament-modified T-28B and T-28C Airplanes	2-4H
2-2	Wing Extrusion (Alcoa Die No. 22897) Splice	2-5
2-3	Front Spar Upper Cap Repair — Station 198 to 233.5	2-5
2-4	Front Spar Lower Cap Repair — Station 206 to 233.5	2-6
2-5	Rear Spar Upper Cap Repair — Station 10 to 24	2-6
2-5A	Repairing Upper Left Rear Spar Cap Fitting	2-6A
2-5B	Wing Lug Ream Repair Procedures	2-6C
2-5C	Front Spar Cap at Vertical Wing — Station 26-86 Repair Procedures	2-6E

Number	Title	Page
2-6	Rear Spar Lower Cap Repair – Station 32 to 66	2-7
2-7	Front Spar Web Splice – Station 59 to 75	2-7
2-8	Rear Spar Web Splice – Station 31 to 66	2-8
2-9	Main Landing Gear Beam Upper Cap Repair	2-8
2-9A	Repairing Rib Web Adjacent to Main Gear Forward Trunnion Plate	2-8A
2-10	Wing Flap Leading Edge Skin Repair	2-9
2-11	Main Landing Gear Beam Web Splice — Station 59 to 67.4	2-9
2-12	Former Repair	2-10
2-13	Tank Bay Former Repair	2-10
2-14	Flap Stringer Splice	2-11
2-15	Wing Skin Repair Aft of Front Spar	2-12
2-16	Nonflush Wing Skin Repair Aft of Front Spar	2-14
2-17	Large-area Skin Splice Aft of Front Spar	2-14
2-17A	Skin Repair for Fatigue Crack at WS154 Inboard of Lower Forward Spar Cap Splice Fitting	2-14A
2-17B	Lower Wing Skin Repair	2-14C
2-17C	Doubler Assembly Ammo Chute (Modification)	2-14E
2-18	Wing Leading Edge Skin Repair	2-15
2-19	Installation of Access Hole to Front Spar Close-out Skin Rivets — Station 32.5 — T-28A Airplanes	2-16
2-20	Cracked Rib Bead Repair	2-17
2-21	Lightening Hole Flange Crack Repair	2-17
2-22	Buckled Rib Web Repair	2-18
2-23	Rib Flange Repair	2-18
2-24	Wing Leading Edge Rib Splice	2-19
2-25	Formed Stringer Splice — NAA No. 1S40	2-19
2-25A	Repair Stringer 3L Between Wing Stations 135.6 and 143.5	2-19
2-26	Formed Stringer Splice — NAA No. 1S23	2-20
2-26A	Repairs for All Cracking Conditions Magnesium Alloy Extension	2-20A
2-26B	Repairs for Cracking Conditions 1 and 2, Installation of Doublers	2-20A
2-26C	Repair for Cracking Conditions 1 and 2, Rivet Placement with Doubler	2-20A
2-26D	Repair for Cracking Condition 5, Installation of Fitting 159-14297	2-20B
2-26E	Repair for Cracking Condition 2, Placement of Rivets	2-20B
2-26F	Repair for Cracking Condition 5, Placement of Rivets	2-20B
2-27	Wing Extrusion Splice	2-20C
2-28	Flange and Lightening Hole Repair	2-21
2-29	Flap Rib Flange and Web Repair	2-21
2-30	Aileron Rib Splice	2-22
2-31	Aileron and Flap Rear Beam and Web Repair	2-22
2-32	Aileron and Flap Stringer Splice	2-23
2-33	Trailing Edge Extrusion Repair	2-23
2-34	Flap Main Stringer Splice	2-24
2-35	Flap Upper Stringer Repair Near Center Hinge	2-25
2-36	Aileron Stringer Repair	2-26
2-37	Flap Rib Repair at Stringer Cutout — Station 66.2 and 73.2	2-27
2-38	Aileron Trim Tab Hinge Repair	2-28
2-39	Aileron Trim Tab Front Beam Repair	2-28
2-39A	Skin Splice — Aileron and Flap	2-28A
2-40	Flush Skin Repair — Aileron and Flap	2-29
2-41	Nonflush Skin Repair — Aileron and Flap	2-29
2-42	Gun Camera Access Doubler Repair	2-30
2-43	Flush Repair of Aft Skin Near Front Beam of Aileron and Flap	2-31
2-44	Flush Repair of Leading Edge Skin Near Front Beam of Aileron and Flap	2-31
2-45	Nonflush Repair of Aft Skin Near Front Beam of Aileron and Flap	2-32
2-46	Nonflush Repair of Aileron Leading Edge Skin	2-32
2-47	Spar and Rib Web Repair	2-33
2-48	Outer Panel Rear Spar Repair	2-34
2-49	Former Repair — Station 101 and 110	2-34
2-50	Intercostal Repair — Station 153.875	2-34A
2-50A	Landing Assembly Typical Repair — Main Landing Gear Doors	2-34A
2-50B	Cap Strip Typical Repair — Auxiliary Main Landing Gear Beam	2-35
2-50C	Cap Strip Typical Repair — Main Landing Gear Beam	2-35
2-51	Wing Inner Panel Repair Jig	2-36
2-52	Wing Outer Panel Repair Jig	2-37

Number	Title	Page
2-53	Aileron Repair Jig	2-38
2-54	Flap Repair Jig	2-39
3-1	Tail Group Repair Index — T-28A and T-28D Airplanes	3-2
3-1A	Tail Group Repair Index — T-28B and T-28C Airplanes	3-2B
3-1B	Skin Stress Diagram — Horizontal Stabilizer and Elevator— T-28B and T-28C Airplanes	3-2D
3-1C	Skin Stress Diagram — Vertical Stabilizer and Rudder — T-28B and T-28C Airplanes	3-3
3-2	Rib Flange and Lightening Hole Repair	3-4
3-3	Rib Flange and Web Repair	3-4
3-4	Vertical Stabilizer Nose Rib Splice — Station 17.9	3-5
3-5	Vertical Stabilizer Nose Rib Splice	3-5
3-6	Rib Flange and Web Repair — Vertical Stabilizer Intermediate Rib — Station 32.1	3-6
3-7	Elevator Cap Angle Repair	3-6
3-8	Rudder Cap Angle Repair	3-7
3-9	Vertical Stabilizer Front Beam Cap Splice	3-8
3-10	Horizontal Stabilizer Front Beam Flange and Web Repair	3-9
3-11	Vertical Stabilizer Rear Upper Beam Repair	3-9
3-12	Vertical Stabilizer Rear Lower Beam Repair	3-10
3-13	Vertical Stabilizer Front Beam and Horizontal Stabilizer Rear Beam Web Repair	3-10
3-14	Rudder and Elevator Trim Tab Hinge Repair	3-11
3-15	Elevator and Rudder Trim Tab Beam Repair	3-11
3-16	Elevator and Rudder Rear Beam Repair	3-12
3-17	Flush Repair of Control Surface Skins	3-12
3-18	Nonflush Repair of Control Surface Skins	3-13
3-19	Flush Repair of Control Surface Aft Skins at Front Beams	3-13
3-20	Flush Repair of Control Surface Leading Edge Skins at Front Beams	3-14
3-21	Nonflush Repair of Control Surface Aft Skins at Front Beam	3-14
3-22	Nonflush Repair of Leading Edge Skins	3-14A
3-22A	Vertical Stabilizer Leading Edge Skin Splice	3-14B
3-22B	Horizontal Stabilizer Skin Splice	3-14C
3-22C	Elevator Skin Splice	3-15
3-23	Horizontal Stabilizer Repair Jig	3-16
3-24	Elevator Repair Jig	3-17
3-25	Vertical Stabilizer Repair Jig	3-18
3-26	Rudder Repair Jig	3-19
4-1	Body Group Repair Index — T-28A, T-28B, and T-28D Airplanes	4-2
4-1A	Body Group Repair Index — T-28C Airplanes	4-2B
4-1B	Skin Stress Diagram — Fuselage — T-28B and T-28C Airplanes	4-2D
4-2	Nonflush Skin Repair for Small Holes	4-4
4-3	Skin Repair — Station 78 to 169 — T-28A and T-28D Airplanes	4-5
4-4	Skin Repairs — General	4-6
4-5	Dorsal Fin Skin Repair	4-14
4-6	Nose Gear Beam Web Repair	4-14A
4-7	Bulkhead Web Repair	4-15
4-8	Floor Web Repair	4-15
4-9	Hydraulic Hand-pump Mount Reinforcement — T-28A and T-28D Airplanes	4-16
4-9A	Control Stick Socket Repair	4-18A
4-10	Seat Assembly Repair — T-28A and T-28D Airplanes	4-19
4-10A	Fire Wall Cap Angle Repair — Lower Right Cowl Lock Fitting — T-28A and T-28D Airplanes	4-20
4-11	Fire Wall Cap Angle Splice — Lower Right Side — T-28A and T-28D Airplanes	4-20A
4-12	Engine Fixed Cowl Torque Box Seal Repair — T-28A and T-28D Airplanes	4-21
4-13	Lower Longeron Repair — Angle	4-22
4-14	Frame Repair — Station 59.1	4-22
4-15	Lower Frame Repair — Station 317 — T-28A, T-28B, and T-28D Airplanes	4-23
4-15A	Frame Splice and Repair	4-23
4-16	Lower Longeron Repair — Channel	4-24
4-17	Floor Beam Repair	4-25
4-18	Upper Longeron Repair — Station 289 to 338	4-25
4-19	Upper Longeron Repair — Station 138 to 289	4-26
4-20	Upper Longeron Repair — Station 70 to 130	4-26

Number	Title	Page
4-20A	Upper Longeron Repair – Station 1to 6	4-26A
4-20B	Upper Longeron Repair – Station 49.5 to 60.0	4-26C
4-20C	Upper Longeron Repair – Station 49.5 to 60.0	4-26E
4-21	**Nose Gear Beam Repair – Upper Cap**	**4-27**
4-22	**Nose Gear Beam Repair – Lower Left Cap**	**4-27**
4-23	**Nose Gear Beam Repair – Lower Right Cap**	**4-28**
4-23A	**Installation of Wear Strips and Gussets – Nose Landing Gear Beams**	**4-28A**
4-24	**Canopy Track Support Channel Repair – T-28A and T-28D Airplanes**	**4-29**
4-25	**Frame Repair – General**	**4-29**
4-26	Channel Assembly Repair – Flap Actuating Cylinder – T-28A and T-28D Airplanes	4-30
4-27	Bulkhead Cap Repair – Station 93.75	4-32
4-28	Fuselage Forward Section Repair Jib	4-33
4-29	Fuselage Rear Section Repair Jig	4-34
4-30	Fuselage Supports	4-35
5-1	Landing Gear Door Repairs	5-2
5-2	Landing Gear Door Edge Repair	5-3
5-3	Nose Landing Gear Box Beam Repair	5-5
6-1	Engine Repair Index	6-2
6-1A	Strake Installation – Armament-modified T-28C Airplanes	6-2A
6-2	Engine Fixed Cowl Repair – T-28A and T-28D Airplanes	6-3
6-3	Engine Cowl Skin Repairs	6-4
6-4	Engine Cowl Beam and Frame Repairs	6-4
6-5	Engine Cowl Former Repairs	6-5
6-6	Engine Cowling Edge Repair	6-6
7-1	Glass-fabric Repair	7-2
7-2	Glass-fabric Repair of Acrylic Plastic Canopy	7-6
	(Deleted)	
2A-1	Typical Repair Index	2A-4
2A-2	Fastener Distribution Patterns	2A-7
2A-3	Fastener Tables – Conventional and Hi-Shear, Flush, 2024-T4, Tension	2A-11
2A-4	Fastener Tables – Conventional and Hi-Shear, Flush, 2024-T4, Shear	2A-12
2A-5	Fastener Tables – Conventional and Hi-Shear, Flush, 7075-T6, Tension	2A-13
2A-6	Fastener Tables – Conventional and Hi-Shear, Flush, 7075-T6, Shear	2A-14
2A-7	Fastener Tables – Conventional, Protruding Head, 2024-T4 and 7075-T6, Tension	2A-15
2A-8	Fastener Tables – Conventional, Protruding Head, 2024-T4 and 7075-T6, Shear	2A-16
2A-9	Fastener Tables – Conventional, Protruding Head, Extrusions, Tension	2A-17
2A-10	Fastener Tables – Flush, Protruding Head and Blind, 1/2 Hard CRES, Tension	2A-18
2A-11	Fastener Tables – Cherry, Flush, 2024-T4 and 7075-T6, Tension	2A-19
2A-12	Fastener Tables – Cherry, Flush, 2024-T4 and 7075-T6, Shear	2A-20
2A-13	Fastener Tables – Hi-Shear and AN Bolts, Protruding Head, Shear and Tension	2A-21
2A-14	Fastener Tables – Huck Lock Bolt, 7075-T6, Shear and Tension	2A-23
2A-15	Fastener Tables – Jo-bolt, Flush and Protruding Head, 2024-T4, Tension	2A-24
2A-16	Fastener Tables – Jo-bolt, Flush and Protruding Head, 2024-T4, Shear	2A-25
2A-17	Fastener Tables – Jo-bolt, Flush and Protruding Head, 7075-T6, Tension	2A-26
2A-18	Fastener Tables – Jo-bolt, Flush and Protruding Head, 7075-T6, Shear	2A-27
2A-19	Rivet Hole Sizes	2A-28
2A-20	Conventional-type Rivets and Applications	2A-29
2A-21	Negligible Damage – Sheet Metal Shapes and Extrusions	2A-30
2A-22	Skin Repair – Shear and Tension	2A-31
2A-23	Skin Repair – Shear and Tension, Temporary	2A-32
2A-24	Skin Repair – Blind – Shear and Tension	2A-33
2A-25	Skin Repair – Blind, Secondary Structure	2A-36
2A-26	Skin End Repair – Shear and Tension	2A-40
2A-27	Skin End Repair – Shear and Tension, Temporary	2A-41
2A-28	Skin End Repair – Corner, Shear and Tension	2A-42
2A-29	Skin End Repair – Corner, Shear and Tension, Temporary	2A-43
2A-30	Skin Over Substructure Repair – Shear and Tension	2A-44
2A-31	Skin Repair Adjacent to Substructure – Shear and Tension	2A-47
2A-32	Skin Repair Adjacent to Substructure – Shear and Tension, Temporary	2A-50
2A-33	Cracked Skin and Web Repair	2A-51

Number	Title	Page
2A-34	Cracked Dimple Repair	2A-52
2A-35	Minor Hole Repairs	2A-53
2A-36	Access Door – Installation of – Shear and Tension	2A-54
2A-37	Sheet-metal Shapes and Extrusions – Crack Repairs	2A-55
2A-38	Web and Web Flange Repair	2A-57
2A-39	Double Formed Flange Repairs	2A-58
2A-40	Formed Flange Crack Repairs	2A-59
2A-41	Stringer Cutout Repair	2A-60
2A-42	Angle Repairs	2A-61
2A-43	Flanged Web Repairs	2A-64

INTRODUCTION

NOTE

Data presented in this handbook is applicable to T-28A, T-28B, T-28C, and T-28D Airplanes except as noted.

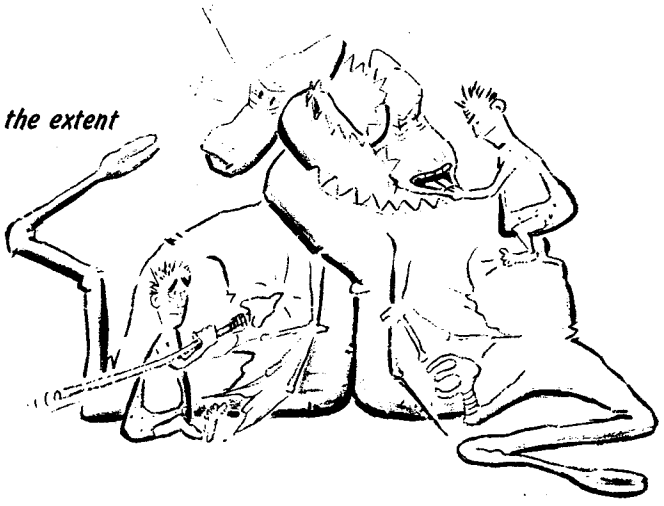
A complete table of contents and list of illustrations is provided in the front of the manual. Figures 1-2 and 1-2A depict the major structural assemblies and serve as master repair indexes. Repair index illustrations for each major structural group are provided in the front of each structural group section (Sections II through VI). Typical repairs, i.e., repairs that are applicable to more than one structural group, are presented in Appendix II. To select repairs from this section, refer to instructions in the front of the section.

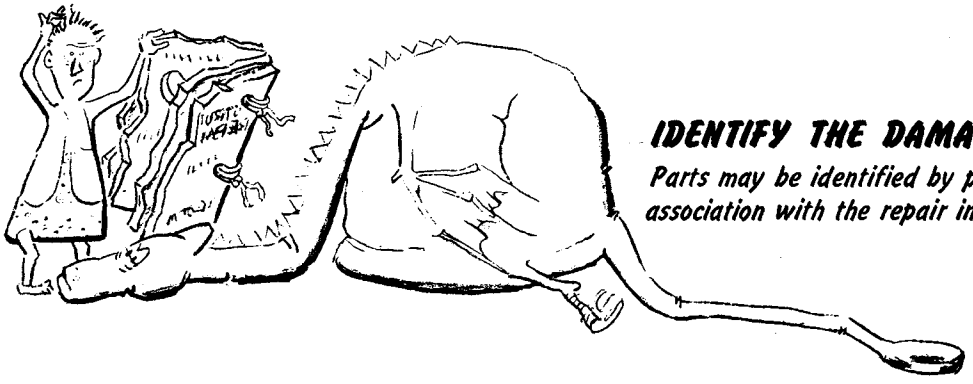
LET THE HANDBOOK HELP YOU...

WHEN DAMAGE OCCURS

INSPECT AND EVALUATE DAMAGE

Careful inspection of the airplane will determine the extent of damage





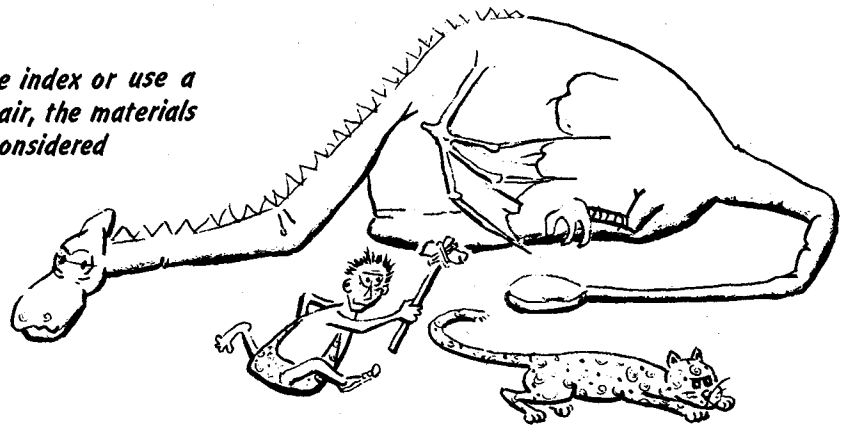
IDENTIFY THE DAMAGED PARTS

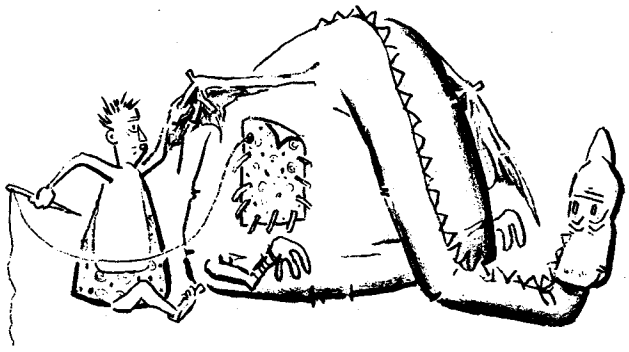
Parts may be identified by part number or by association with the repair index illustrations

T-28A-3-00-1A

CHOOSE REPAIR

Choose repair from those listed in the index or use a general repair. When choosing a repair, the materials and equipment available should be considered





MAKE REPAIRS

Follow the instructions contained in the repair illustration along with applicable general information. Refer to Appendix II, Bibliography, for a guide to publications which contain a general type of repair information

FLY AWAY

Let the handbook help you to keep the airplanes in the air

T-28A-3-00-2

View of Airplane

SECTION I

GENERAL

T-28 Series Airplanes, built by North American Aviation, Inc are two-place trainers with tandem seating. T-28D Airplanes (modified from the T-28A) and certain T-28B and T-28C Airplanes have had armament provision modifications that have extended those airplanes' offensive and defensive capabilities beyond the initial trainer requirements.

Major structural components consist of the fuselage, which carries a radial engine forward of station 49; wing, with ailerons and flaps; vertical stabilizer and rudder; horizontal stabilizer and elevator; and tricycle landing gear.

TYPE OF CONSTRUCTION.

The wing is a semimonocoque, full-cantilever structure consisting of the center section (divided into halves), two outer panels, wing flaps, and ailerons. The internal structure of the wing consists of a front and rear spar, a landing gear beam, stringers, formers, and full ribs as required. A single beam, stringers, and ribs make up the internal structure of each aileron and flap. The fuselage is semimonocoque and consists of two sections which are bolted together with four tension attachment bolts. The internal structure consists of longerons, intercostals, frames, and the pilot's floor, which serves as an integral structural member. A front and rear beam and ribs comprise the internal structure of the vertical stabilizer. The internal rudder structure consists of ribs, two stringers which take the bending loads, and a rear beam forward of the trim tab cutout. The horizontal stabilizer internal structure consists of a rear beam, front spar, and ribs. The elevators are of the same type construction as the rudder. The landing gear consists of a main gear which retracts into the wing center section, and a nose gear which retracts into the forward section of the fuselage. The details of the structure for the components of the airplane are described in the corresponding sections of this handbook. (See figures 1-2 and 1-2A.)

ALIGNMENT.

Alignment of the airframe structure is the position relationship of each component structure (the wing, tail, and fuselage) to the other. The alignment of the airplane is important since it is directly related to the aerodynamic performance. Misalignment of the airplane may affect the flight characteristics and in turn affect the efficiency of the pilot-airplane combination. Alignment should be checked when an airplane has encountered excessive G in flight, when it has made a "hard" landing, or when it has been subjected to extensive damage. The alignment check under these conditions brings to light damage that may not be found otherwise. When alignment checks are made, the airplane should be suitably housed to prevent air currents from interfering with the accuracy of the readings. The horizontal check is made from points projected to a plane represented by the floor. However, the elevation checks are made from points projected to a level plane established by a surveyor's transit or level. It is therefore extremely important that the alignment check be done on a floor that is hard, smooth, and level. It is suggested that masking tape be used on the floor at the location of drop points and that the drop points be placed on the masking tape. It is recommended that jacks be used to control the attitude of the airplane during the alignment check. (See figure 1-4.)

NOTE

If alignment measurements do not exceed limits specified in figure 1-4, and if no structural damage is found, test flight the aircraft for adverse flying characteristics. If no adverse flying characteristics are noted, aircraft may be released for flight. If measurements exceed limits specified in T.O. 1T-28A-3, send complete alignment results (actual measurements) along with results of structural inspection and aircraft flight characteristics (if known) to SMAMA, McClellan AFB, California, ATTN: SMNAT. Remove aircraft from flight status until disposition is received from SMAMA.

LEVELING.

Before alignment of the airplane is checked the airplane shall be leveled both laterally and longitudinally. Jacks shall be used to support the airplane and to control minute adjustments required to level aircraft. For correct jacking procedures, refer to applicable 1T-28( )-2 technical manuals. Level the aircraft with a surveyor's level or transit using points X, Y, and Z as shown in figure 1-4.

ELEVATION AND HORIZONTAL CHECK DIMENSIONS.

The elevation and horizontal check dimensions are the dimensions associated with the original airframe structure. These dimensions, plus or minus the tolerances, must be maintained during the repair of the airframe. The elevation check dimensions are measured from the checkpoints to a level plane established by a surveyor's level or transit. The horizontal check dimensions are measured from one point described by the plumb bob, along the reference plane (floor), to another point. The plus and minus tolerances follow the dimensions. If the tolerances described in the alignment illustrations are exceeded, then for all practical purposes, the airplane must be considered non-airworthy until such time that special dispensation may be made by authorized personnel.

REBALANCING CONTROL SURFACES.

In order to prevent flutter during flight, the balancing of the ailerons, elevators, and rudder must be maintained within the tolerances specified in the following table. Following the repair of damage or

(All data deleted from page 1-2)

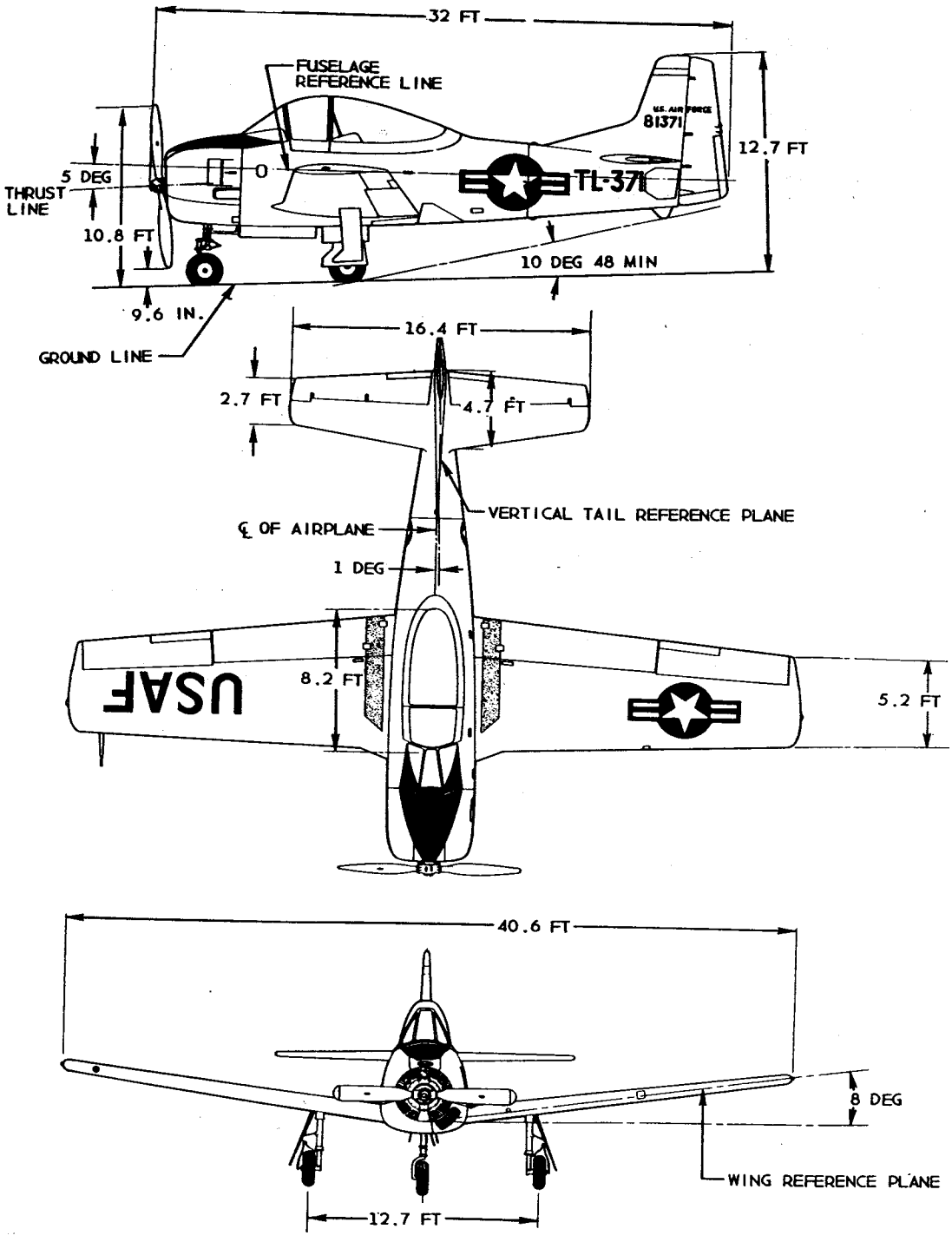


Figure 1-1. Airplane Dimensions — T-28A Airplanes

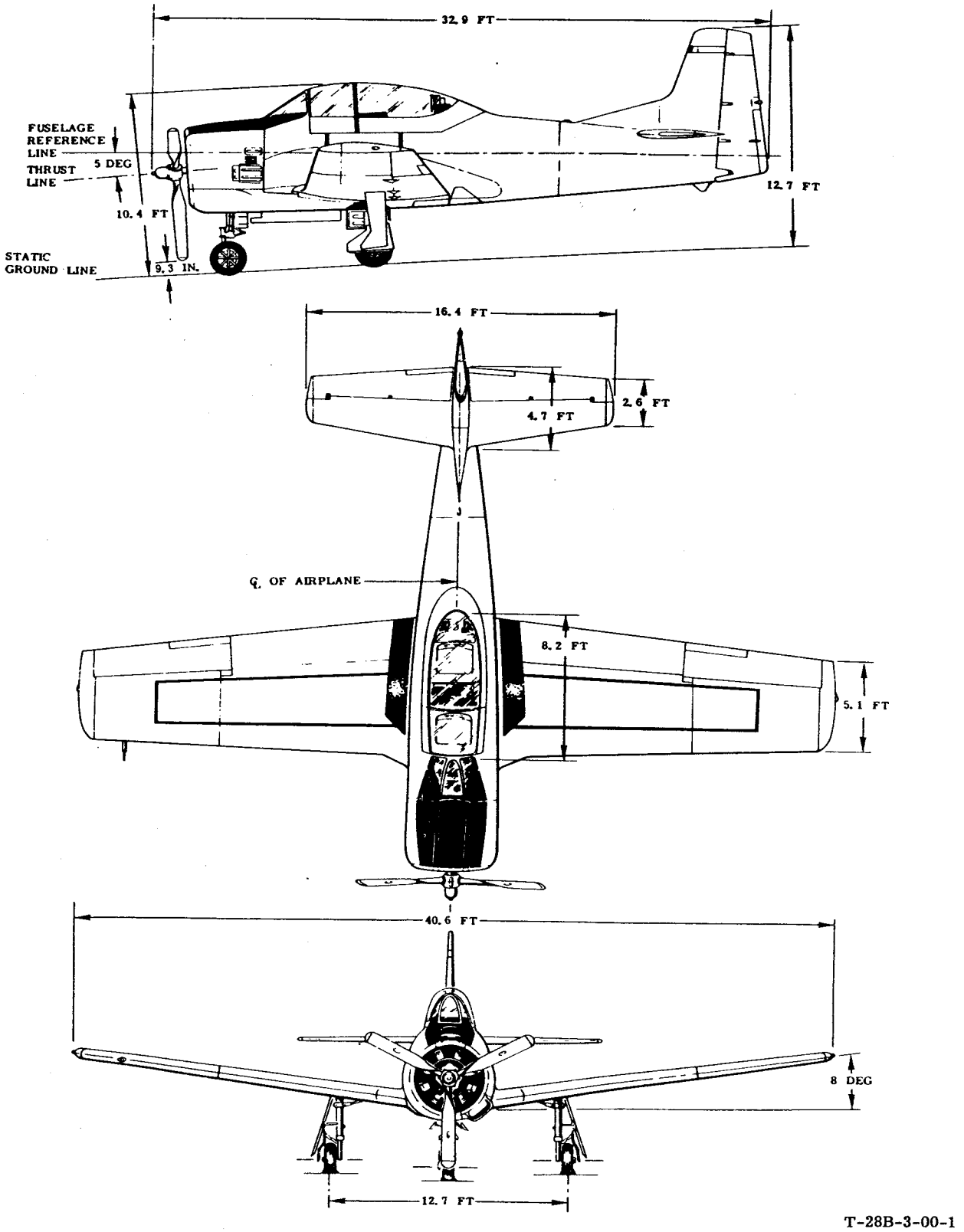


Figure 1-1A. Airplane Dimensions — T-28B and T-28D Airplanes

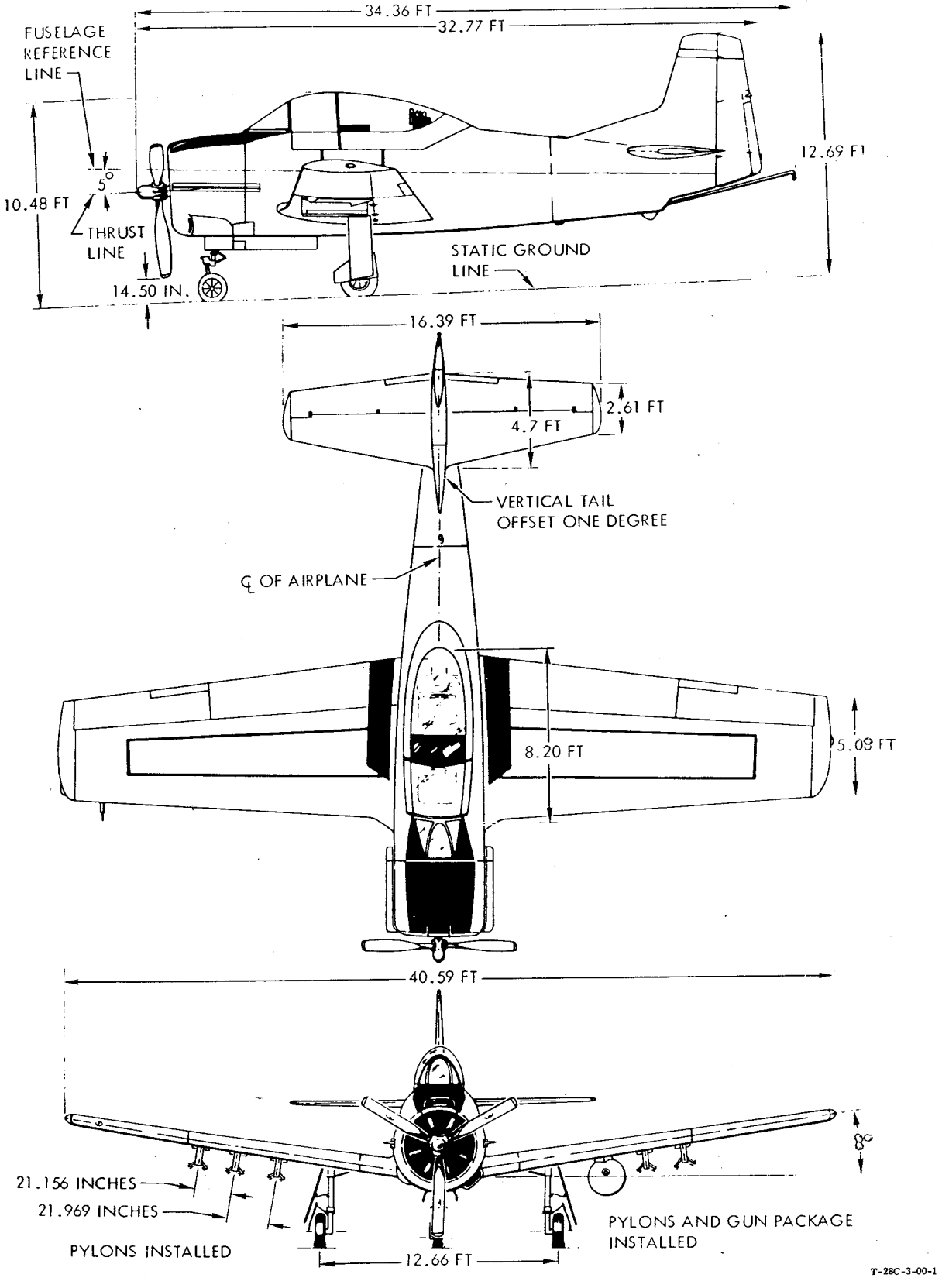
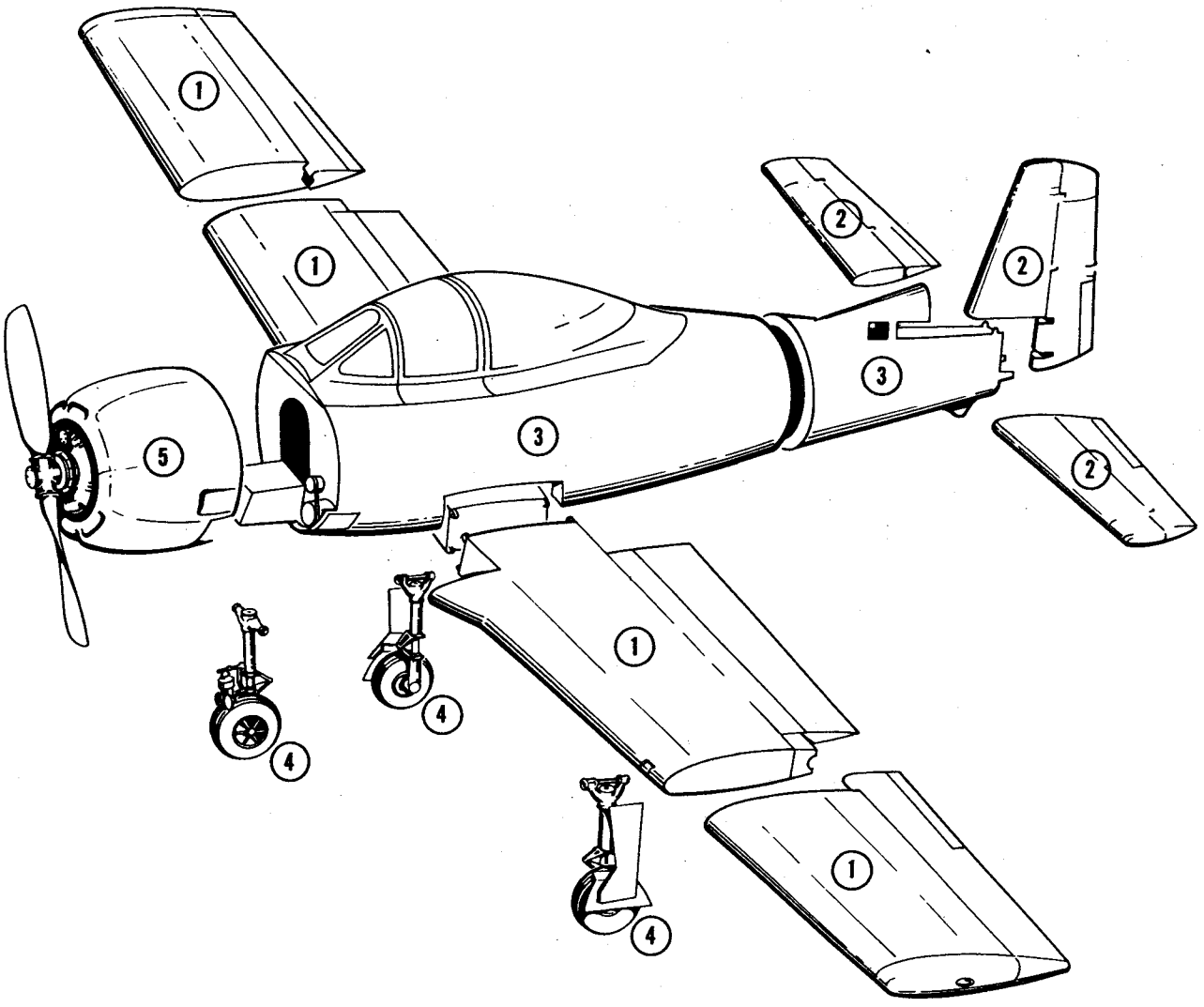


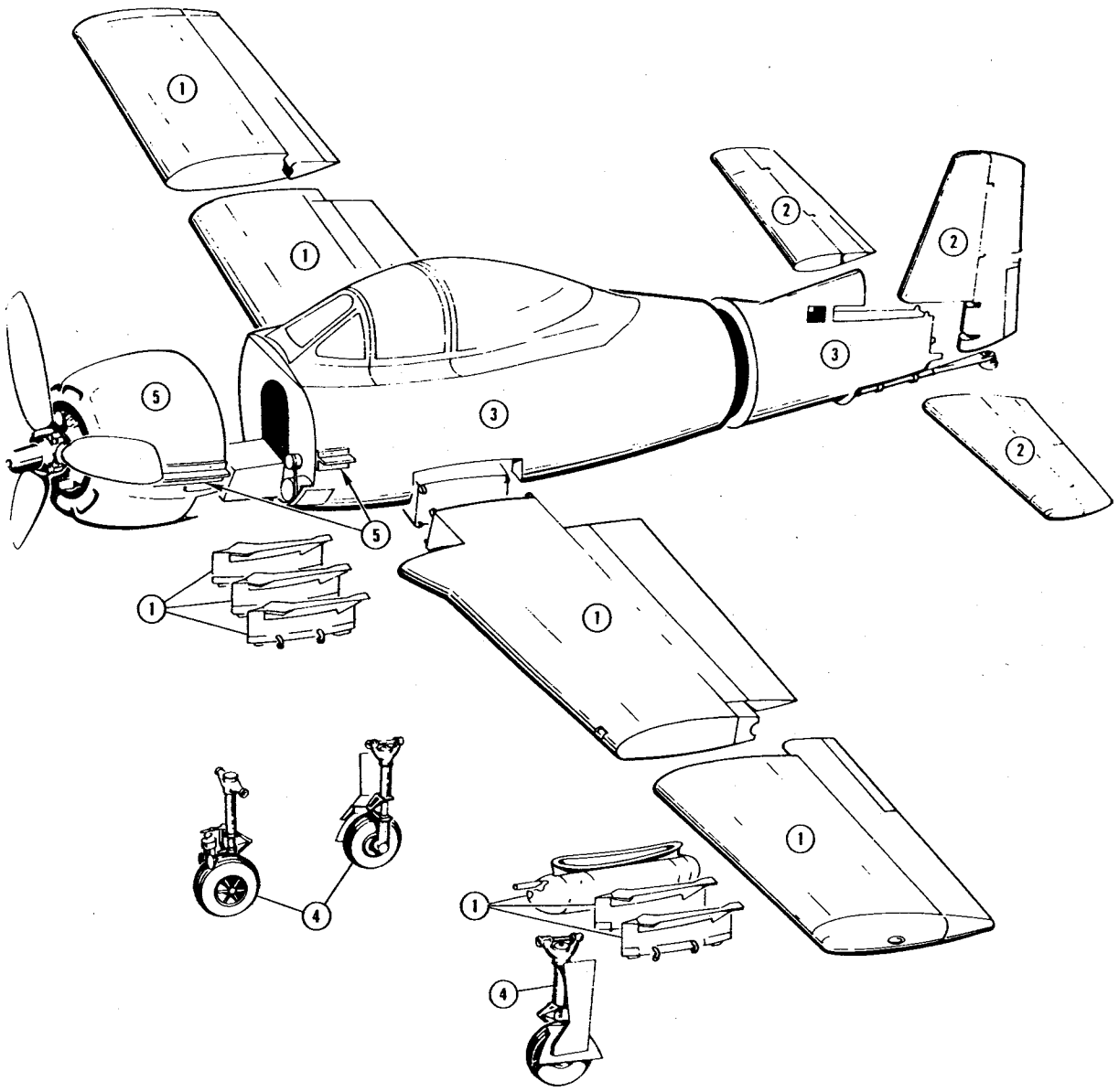
Figure 1-1B. Airplane Dimensions — T-28C Airplanes



INDEX	NOMENCLATURE	SECTION
1	WING GROUP	II
2	TAIL GROUP	III
3	BODY GROUP	IV
4	LANDING GEAR GROUP	V
5	ENGINE SECTION	VI

T-28A-3-00-5

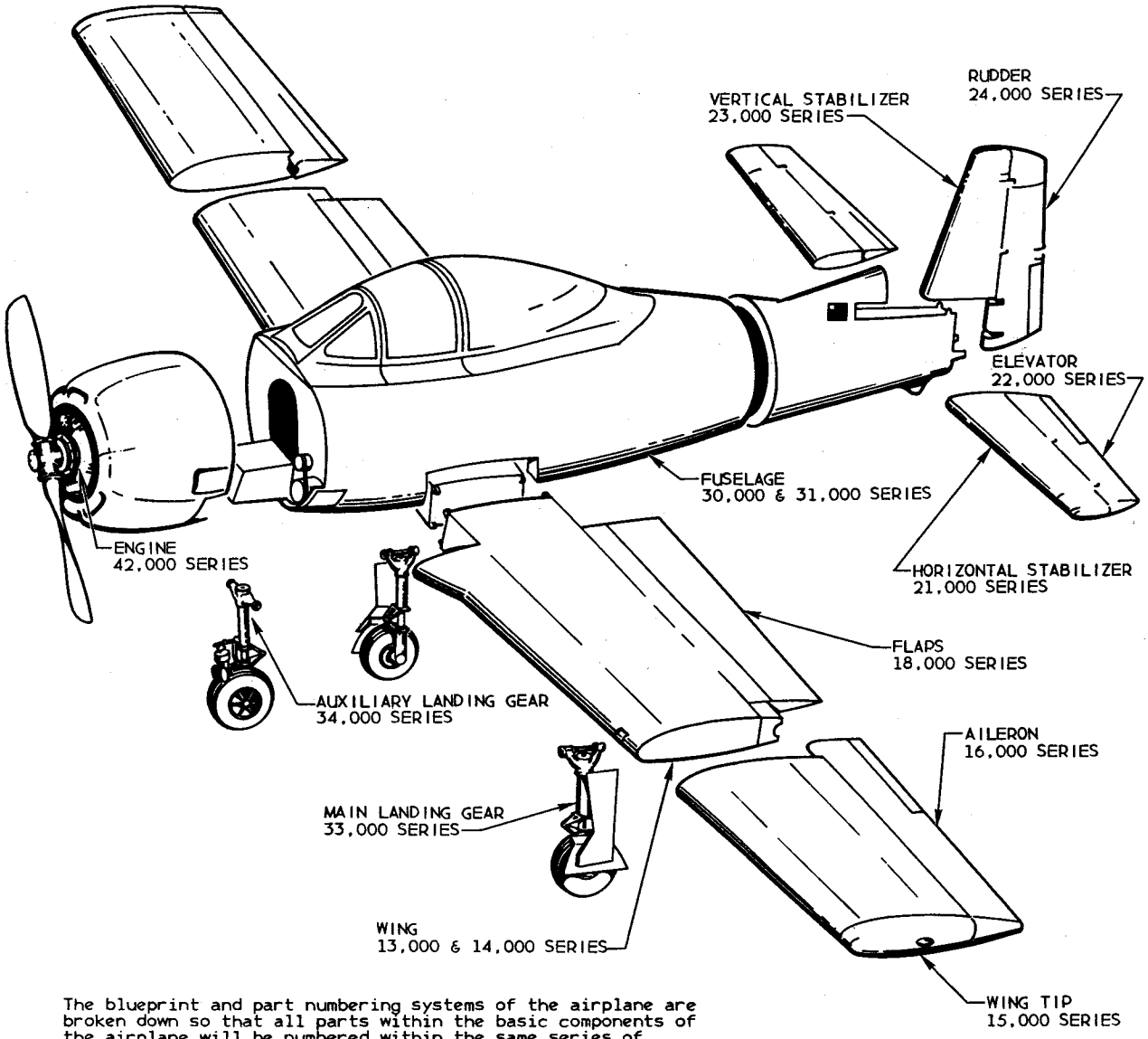
Figure 1-2. Major Assemblies



INDEX	NOMENCLATURE	SECTION
1	WING GROUP	II
2	TAIL GROUP	III
3	BODY GROUP	IV
4	LANDING GEAR GROUP	V
5	ENGINE SECTION	VI

T-28D-3-00-1

Figure 1-2A. Major Assemblies – Armament-modified Airplanes



The blueprint and part numbering systems of the airplane are broken down so that all parts within the basic components of the airplane will be numbered within the same series of numbers.

Prefix numbers are used to indicate under which contract the part was originally designed.

Basic part numbers assigned to a part or blueprint are determined by the component for which the part has been designed, flap, 18,000 Series; aileron, 16,000 Series.

Dash numbers are used to identify detail parts used in an assembly and to indicate right- and left-hand parts. Left-hand parts have an odd-numbered dash number, and right hand parts are identified with an even-numbered dash number.

For example, a part with a number of 159-16130-3 would indicate that the part had been designed under the 159 contract, that the part was designed for the aileron, and that it was for the left-hand assembly.

This illustration shows the basic airplane components and the number series assigned to them.

T-28A-3-00-19

Figure 1-2B. Blueprint Numbering System for Major Components

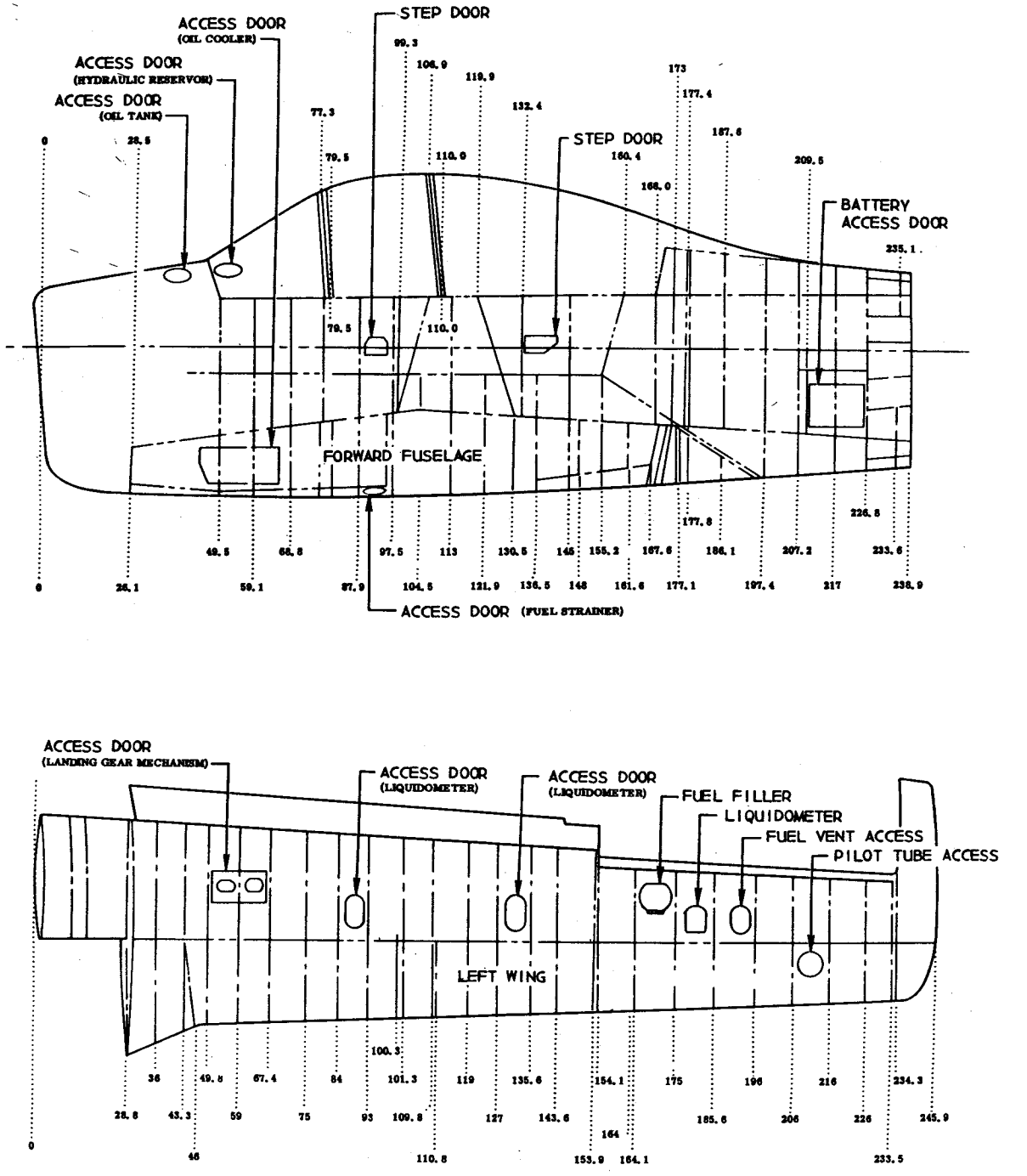
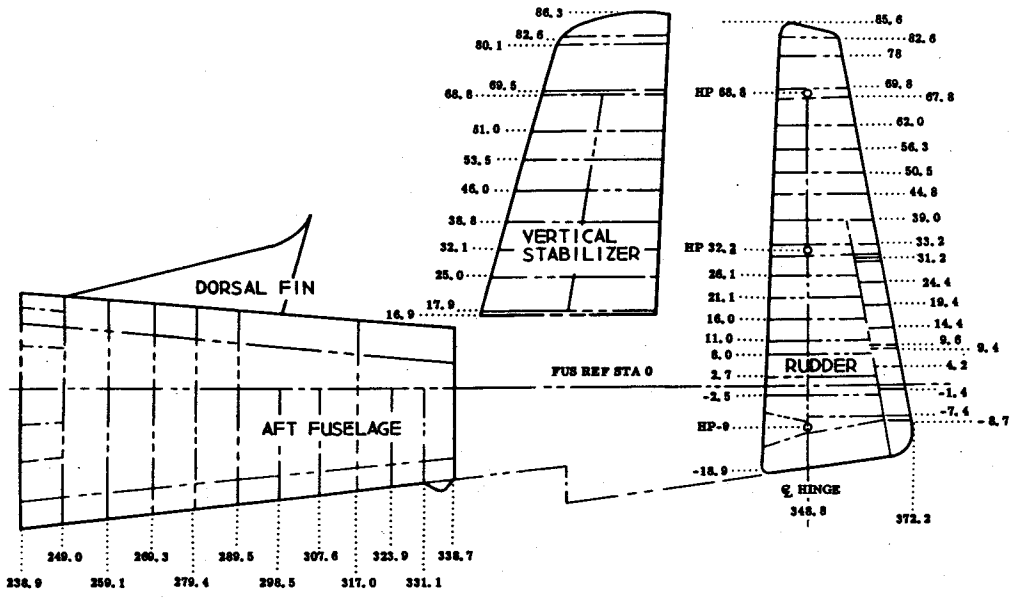


Figure 1-3. Airplane Stations — T-28A and T-28D Airplanes (Sheet 1 of 2)



T-28A-3-00-7A

Figure 1-3. Airplane Stations — T-28A and T-28D Airplanes (Sheet 2 of 2)

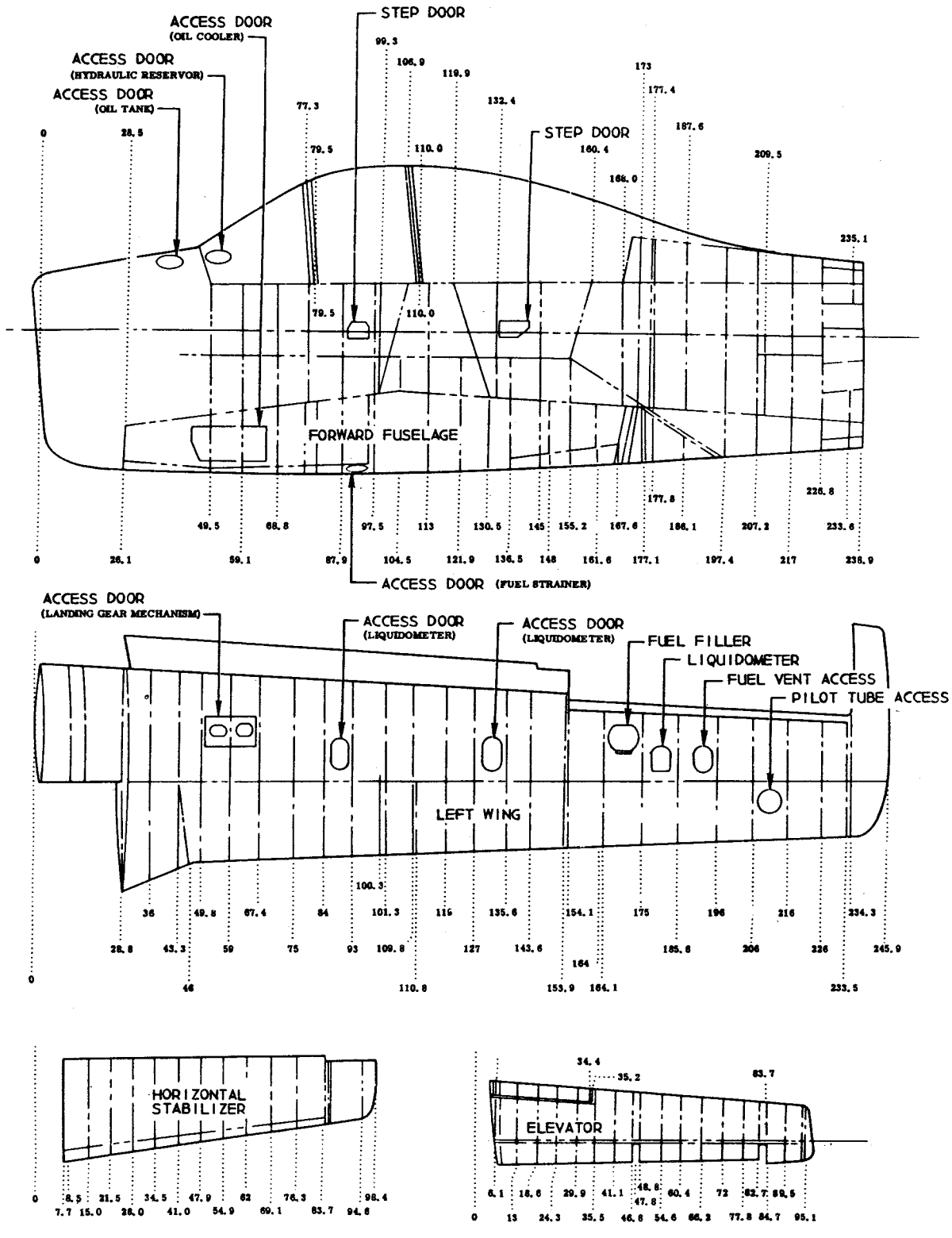


Figure 1-3A. Airplane Stations — T-28B and T-28C Airplanes (Sheet 1 of 2)

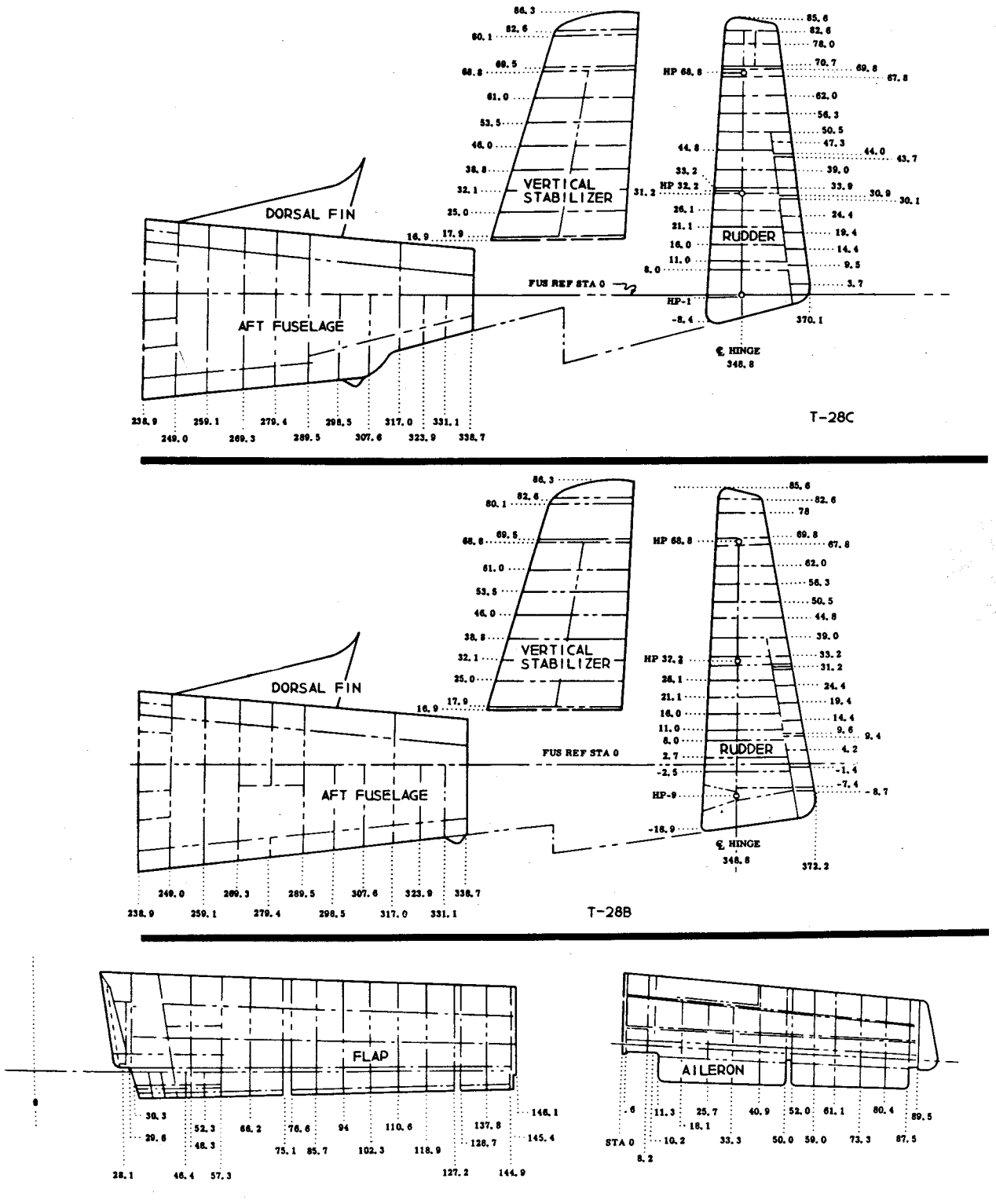


Figure 1-3A. Airplane Stations — T-28B and T-28C Airplanes (Sheet 2 of 2)

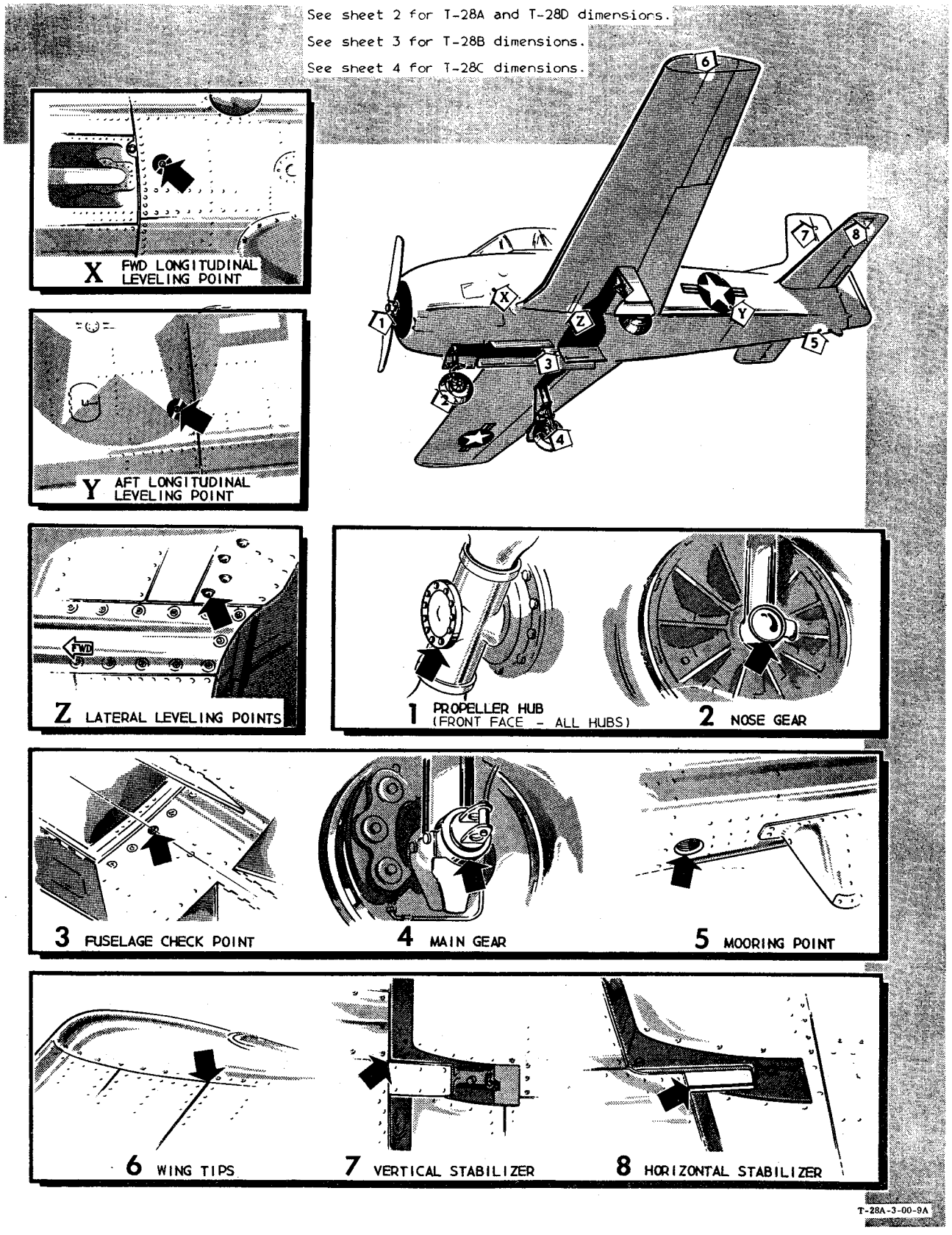
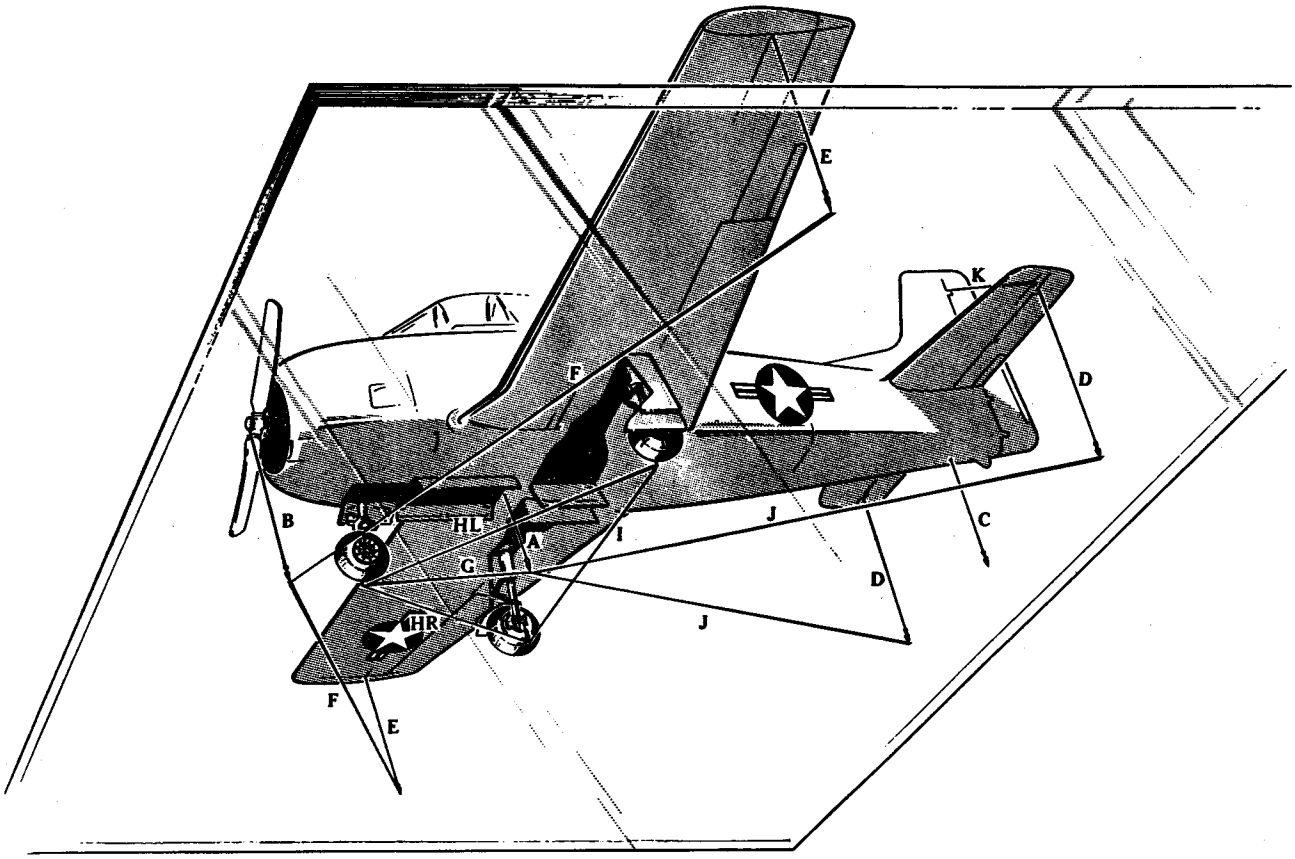


Figure 1-4. Airplane Alignment (Sheet 1 of 4)



ELEVATION CHECK

DROP SCALE OR STEEL TAPE FROM CHECK POINTS, AND SIGHT THROUGH SURVEYOR'S TRANSIT OR ALONG A FIXED LEVEL SURFACE. SUBTRACT ACTUAL "A" READING FROM OTHER VALUES FOR PROPER CHECK DIMENSIONS.

A = ZERO POINT ON AIRPLANE THROUGH WHICH GEOMETRIC PLANE IS ASSUMED TO PASS.
B = 22-1/2 (±1/2) IN.
*B = 24-17/32 (±1/2) IN.
C = 18-1/2 (±1/2) IN.
D = 51 (±3/4) IN.
E = 37-1/2 (±2) IN.

HORIZONTAL CHECK

DROP PLUMB BOBS FROM CHECK POINTS AND MEASURE HORIZONTAL DISTANCE ON GROUND PLANE.

F = 260-3/4 (±7/8) IN.
*F = 265-21/32 (±7/8) IN.
G = 68-7/8 (±5/8) IN.
HL = 120-7/32 (±13/16) IN.
HR = 112-1/32 (±13/16) IN.
I = 135-19/32 (±13/16) IN.
J = 239-15/32 (±11/16) IN.
KL = 100-7/8 (±7/16) IN.
KR = 101 (±7/16) IN.

NOTE: LEVEL AIRPLANE LONGITUDINALLY AND LATERALLY BEFORE MAKING ALIGNMENT CHECK: USE A TRANSIT AND LEVELING POINTS X, Y AND Z. TOLERANCES ON DIMENSIONS D, E, F, AND J EQUAL ±½ DEGREE.

FOR K DIMENSIONS, USE CHECK POINT "8" ON UPPER SURFACE OF HORIZONTAL STABILIZER.

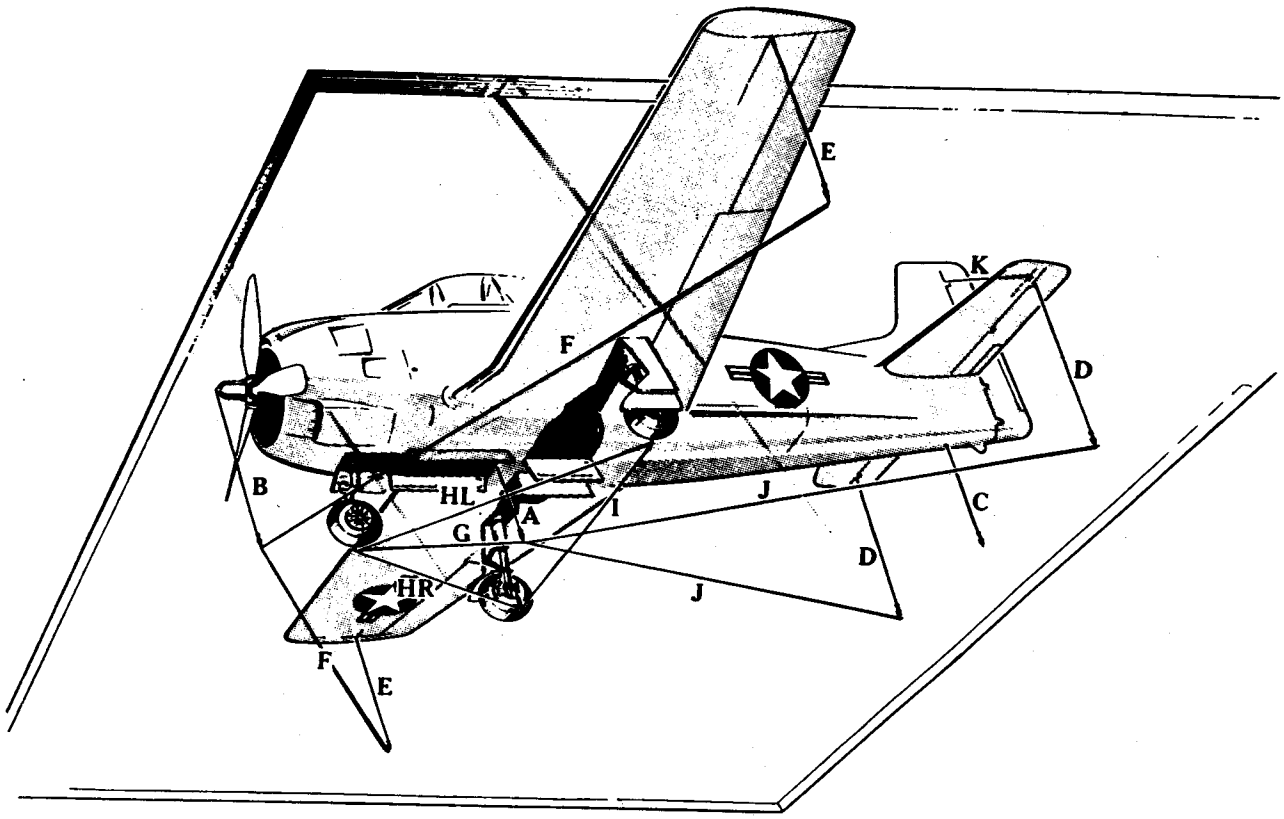
SET NOSE GEAR PARALLEL TO CENTERLINE OF AIRPLANE BEFORE CHECKING G, HR AND HL DIMENSIONS.

IF THERE IS A VARIATION IN ANY DIMENSION, IT IS DESIRABLE THAT IT BE LESS THAN 50% OF THE GIVEN TOLERANCE: IF THIS VALUE IS EXCEEDED, CHECK THE STRUCTURE FOR DEFLECTIONS OR DAMAGE.

*T-28D AIRPLANES

T-28A-3-00-8A

Figure 1-4. Airplane Alignment (Sheet 2 of 4)



ELEVATION CHECK

DROP SCALE OR STEEL TAPE FROM CHECK POINTS, AND SIGHT THROUGH SURVEYOR'S TRANSIT OR ALONG A FIXED LEVEL SURFACE. SUBTRACT ACTUAL "A" READING FROM OTHER VALUES FOR PROPER CHECK DIMENSIONS.

B	24-17/32	(±1/2)	IN.	D	51	(±3/4)	IN.
*B	24-3/8	(±1/2)	IN.	*D	51-7/32	(±1/2)	IN.
C	18-1/2	(±1/2)	IN.	E	37-1/2	(±2)	IN.
*C	18-7/32	(±1/2)	IN.				

HORIZONTAL CHECK

DROP PLUMB BOBS FROM CHECK POINTS AND MEASURE HORIZONTAL DISTANCE ON GROUND PLANE.

F	265-7/8	(±7/8)	IN.	HR	112-1/32	(±13/16)	IN.
*F	265-21/32	(±7/8)	IN.	*HR	112-1/8	(±13/16)	IN.
G	68-7/8	(±5/8)	IN.	I	135-19/32	(±13/16)	IN.
*G	69	(±5/8)	IN.	J	239-15/32	(±11/16)	IN.
HL	120-7/32	(±13/16)	IN.	*J	239-13/32	(±11/16)	IN.
*HL	120-5/16	(±13/16)	IN.	KL	100-7/8	(±7/16)	IN.
				KR	101	(±7/16)	IN.

NOTE LEVEL AIRPLANE LONGITUDINALLY AND LATERALLY BEFORE MAKING ALIGNMENT CHECK: USE A TRANSIT AND LEVELING POINTS X, Y AND Z. TOLERANCES ON DIMENSIONS D, E, F, AND J EQUAL ±½ DEGREE.

FOR K DIMENSIONS, USE CHECK POINT "8" ON UPPER SURFACE OF HORIZONTAL STABILIZER.

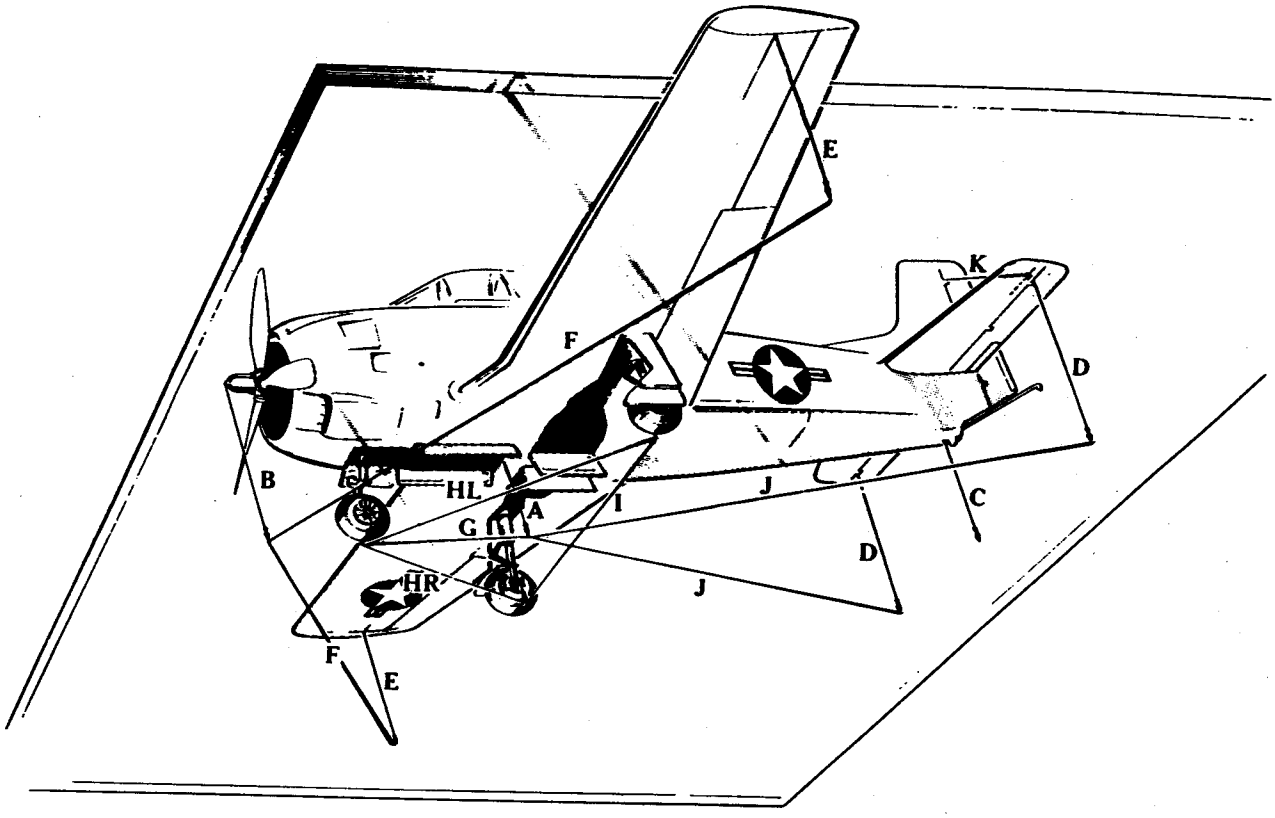
SET NOSE GEAR PARALLEL TO CENTERLINE OF AIRPLANE BEFORE CHECKING G, HR AND HL DIMENSIONS.

IF THERE IS A VARIATION IN ANY DIMENSION, IT IS DESIRABLE THAT IT BE LESS THAN 50% OF THE GIVEN TOLERANCE: IF THIS VALUE IS EXCEEDED, CHECK THE STRUCTURE FOR DEFLECTIONS OR DAMAGE.

* T-28B AIRPLANES 138190 AND SUBSEQUENT AND T-28B AIRPLANES ON WHICH SERVICE CHANGE 6 HAS BEEN ACCOMPLISHED.

T-28B-3-00-2

Figure 1-4. Airplane Alignment (Sheet 3 of 4)



ELEVATION CHECK

DROP SCALE OR STEEL TAPE FROM CHECK POINTS, AND SIGHT THROUGH SURVEYOR'S TRANSIT OR ALONG A FIXED LEVEL SURFACE. SUBTRACT ACTUAL "A" READING FROM OTHER VALUES FOR PROPER CHECK DIMENSIONS.

A = ZERO POINT ON AIRPLANE THROUGH WHICH GEOMETRIC PLANE IS ASSUMED TO PASS.

B = 24-3/8 (±1/2) IN.
C = 15-3/4 (±1/2) IN.
D = 51-7/32 (±3/4) IN.
E = 37-1/2 (±2) IN.

HORIZONTAL CHECK

DROP PLUMB BOBS FROM CHECK POINTS AND MEASURE HORIZONTAL DISTANCE ON GROUND PLANE.

F = 265-21/32 (±7/8) IN.
G = 69 (±5/8) IN.
HL = 120-5/16 (±13/16) IN.
HR = 112-1/8 (±13/16) IN.
I = 135-19/32 (±13/16) IN.
J = 239-13/32 (±11/16) IN.
KL = 100-7/8 (±7/16) IN.
KR = 101 (±7/16) IN.

NOTE: LEVEL AIRPLANE LONGITUDINALLY AND LATERALLY BEFORE MAKING ALIGNMENT CHECK: USE A TRANSIT AND LEVELING POINTS X, Y AND Z. TOLERANCES ON DIMENSIONS D, E, F, AND J EQUAL ±½ DEGREE.

FOR K DIMENSIONS, USE CHECK POINT "8" ON UPPER SURFACE OF HORIZONTAL STABILIZER.

SET NOSE GEAR PARALLEL TO CENTERLINE OF AIRPLANE BEFORE CHECKING G, HR AND HL DIMENSIONS.

IF THERE IS A VARIATION IN ANY DIMENSION, IT IS DESIRABLE THAT IT BE LESS THAN 50% OF THE GIVEN TOLERANCE: IF THIS VALUE IS EXCEEDED, CHECK THE STRUCTURE FOR DEFLECTIONS OR DAMAGE.

T-28C-3-00-2

Figure 1-4. Airplane Alignment (Sheet 4 of 4)

Figure 1-5. Deleted.

the rework of any of the control surfaces, check the balance to determine whether the specified tolerances of the control surfaces have been exceeded. (See figure 1-6.) When a surface is mounted on a balance stand, a downward displacement of the trailing edge below the horizontal position indicates a positive unbalanced moment (+), and an upward displacement of the trailing edge above the horizontal position indicates a negative unbalanced moment (-).

TABLE 1-1

BALANCE MOMENT REQUIREMENTS AND TOLERANCES

CONTROL SURFACE	MANUFACTURING AND SERVICE TOLERANCE
Aileron	
Airplanes AF49-1492 thru -1573	-3 to 0 in. lb
Airplane AF49-1574 and all later airplanes	+31 (±3) in. lb
Rudder	0 to +35 in. lb
Elevator	0 to +3 in. lb

NOTE

All control surfaces must be complete with tab assembly attached before balance check is made. When balancing an aileron, lay seal back on top of paddle with seal extended toward trailing edge.

BALANCING PROCEDURE FOR CONTROL SURFACES.

1. Mount control surface on a balance stand, using end hinge brackets to mount the surface. Make certain that centerlines of hinges are leveled laterally.

2. Suspend a container from leading edge or trailing edge of surface and add weight to container until control surface is in a horizontal position.

3. Measure distance from point of suspension of container to control surface hinge line. This distance is designated as "X." Distances forward of the hinge line indicate "+X," and distances aft of the hinge line indicate "-X," for the location of the container and its contents.

4. Remove container and determine weight of container and its contents. This weight is designated as "W."

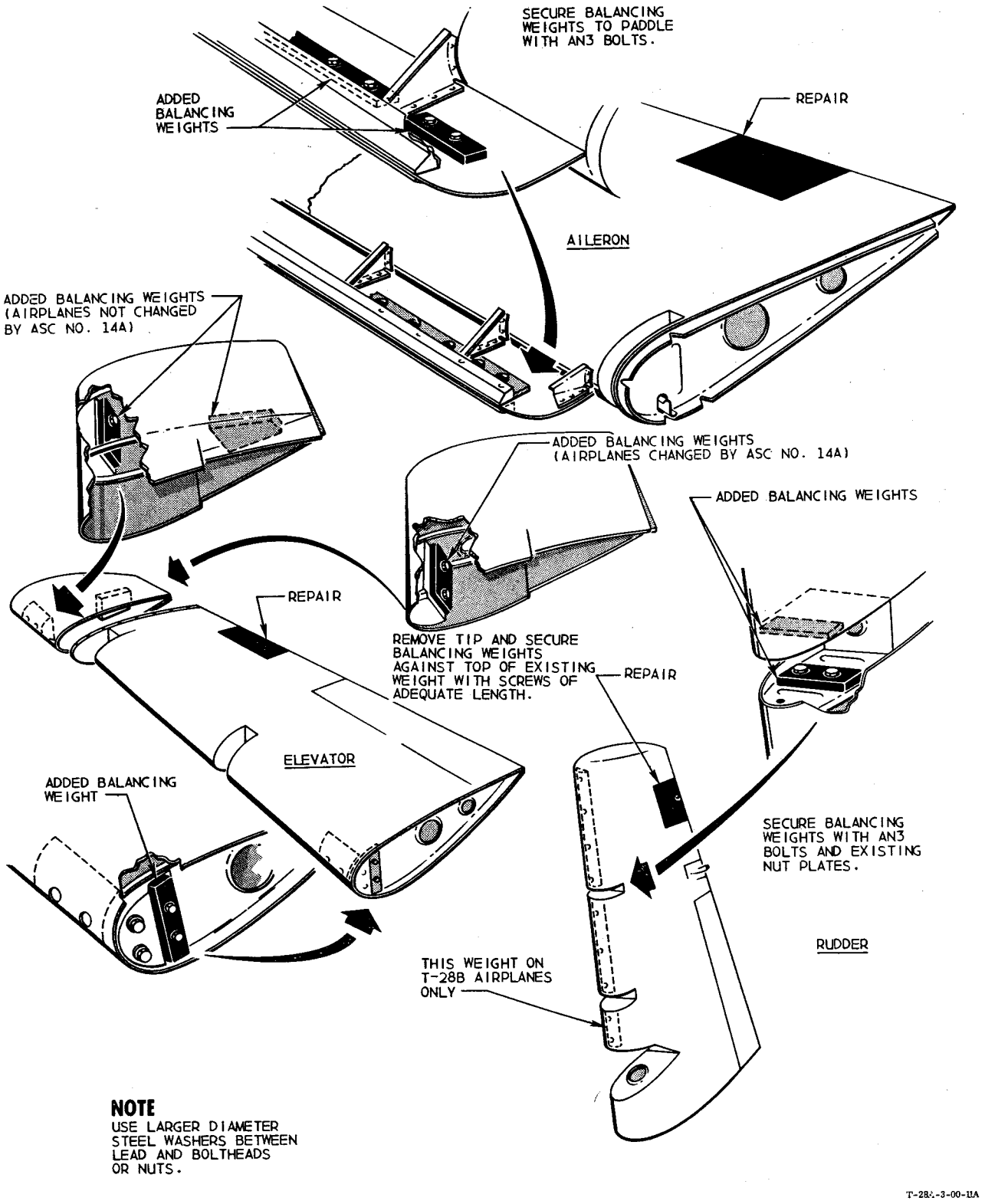
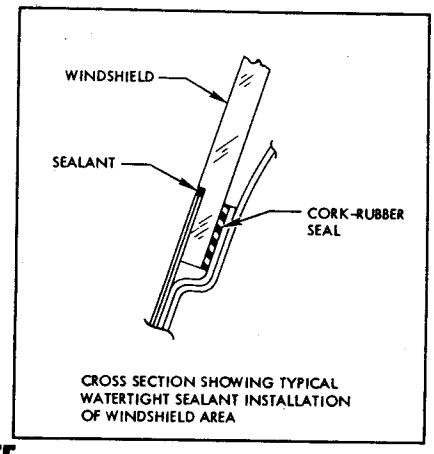
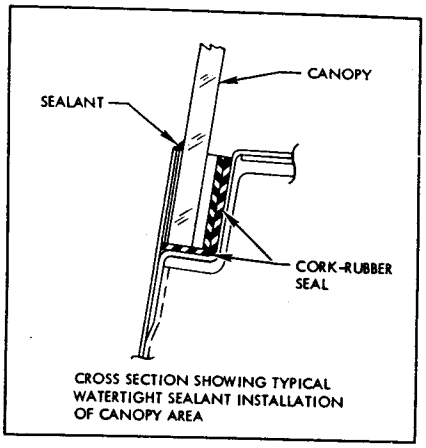


Figure 1-6. Rebalancing Control Surfaces



CROSS SECTION SHOWING TYPICAL WATERTIGHT SEALANT INSTALLATION OF WINDSHIELD AREA



CROSS SECTION SHOWING TYPICAL WATERTIGHT SEALANT INSTALLATION OF CANOPY AREA

NOTE:

FOR WATERTIGHT SEALING, USE SPECIFICATION MIL-S-7124 SEALING COMPOUND.

FOR FUMETIGHT SEALING, USE SPECIFICATION MIL-S-7502 SEALING COMPOUND FOR HOLES UP TO 1/8 INCH IN DIAMETER; USE SPECIFICATION MIL-S-7126 SEALING COMPOUND, TYPE I, FOR HOLES 1/8 TO 1/4 INCH IN DIAMETER; AND APPLY SPECIFICATION MIL-S-7502 COMPOUND OVER SPECIFICATION MIL-S-7126 COMPOUND, TYPE I, FOR OPENINGS OVER 1/4 INCH IN DIAMETER.

FOR A SIMPLIFIED METHOD, COVER HOLE WITH TAPE (FEDERAL SPECIFICATION PP-T-60, TYPE II, CLASS I), AND COVER TAPE WITH SPECIFICATION MIL-S-7502 SEALING COMPOUND, AS SHOWN BELOW.

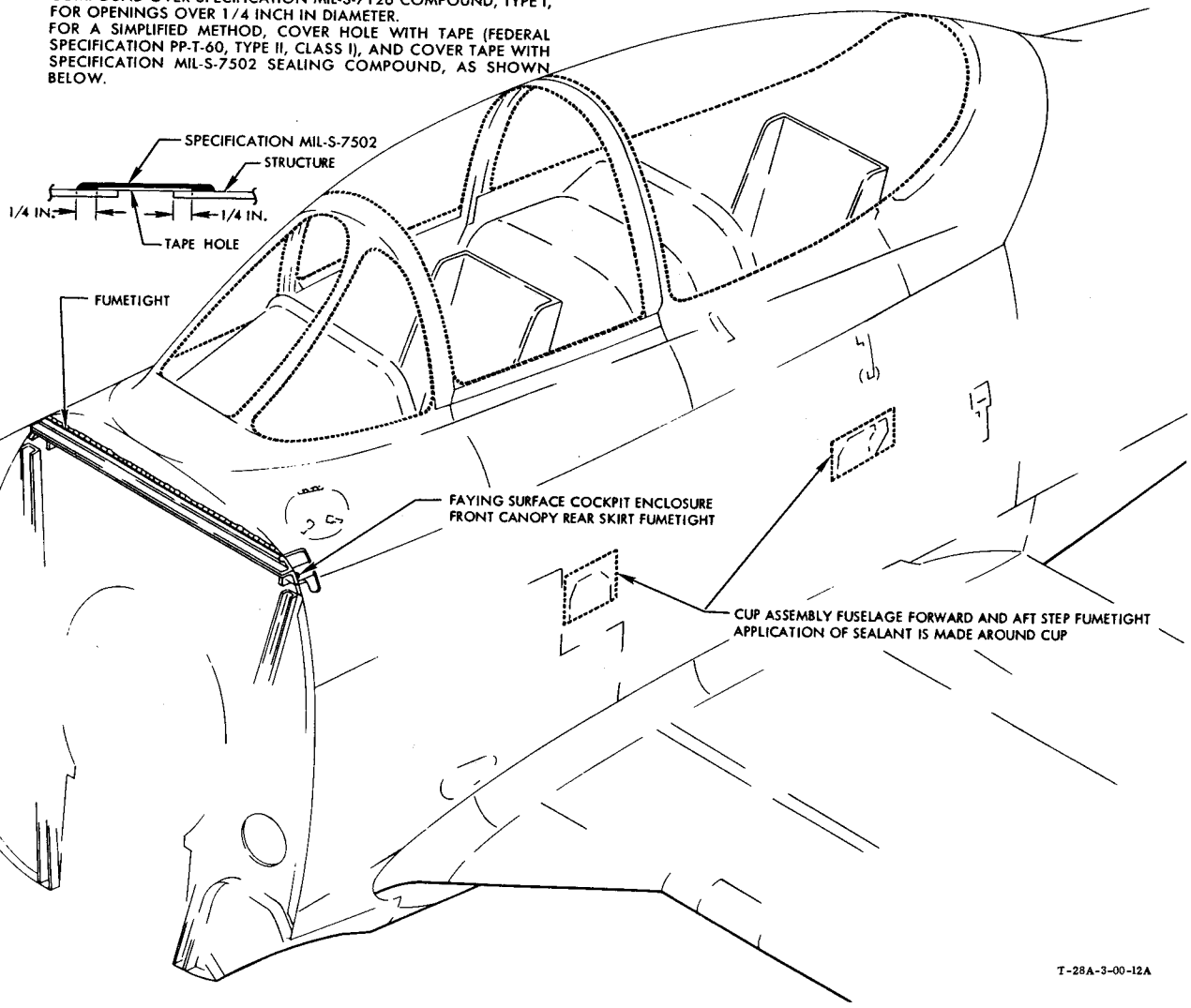


Figure 1-7. Airplane Sealing (Sheet 1 of 2)

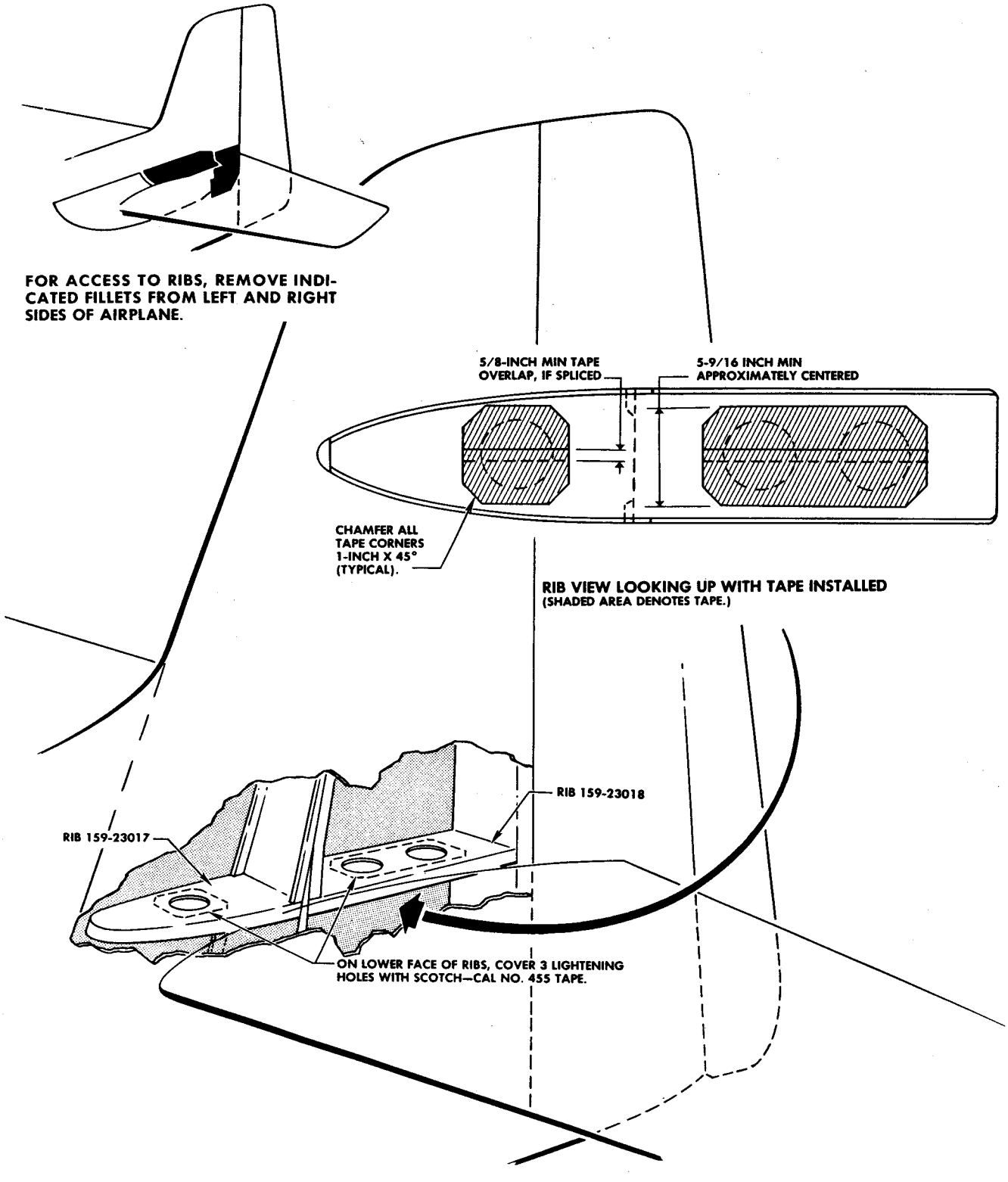


Figure 1-7. Airplane Sealing (Sheet 2 of 2)

5. The total weight, "W," multiplied by the distance "X," is equal to the calculated unbalanced moment.

6. Refer to Table 1-1, and determine whether calculated unbalanced moment exceeds allowable tolerance. If the allowable tolerances are not exceeded, no correction is necessary. However, if allowable tolerances are exceeded, add to or remove from original counterbalance weight, or weights, enough weight to restore unbalanced moment within allowable tolerances. If it becomes necessary to increase or decrease original counterbalance weight to obtain a moment within allowable tolerances, take care of distribute this weight change to leading edge in approximate proportion to distribution of repaired damage areas. Figure 1-6 illustrates methods of adding balance weight to control surfaces.

EXAMPLE.

An elevator in a balance stand requires a 4-ounce weight of container and contents located 6 inches forward of the hinge line to balance the elevator in a horizontal position. This indicates an unbalanced moment of +1.5 inch-pounds, which is within the tolerance of 0 to +3 inch-pounds; therefore, no correction of balance weight is necessary.

CONTROL SURFACE HORIZONTAL POSITION.

Each control surface is a symmetrical section, and the hinge points are located on the centerline; therefore, each surface is in its horizontal position when its trailing edge is on a horizontal plane (or line) which passes through the hinges.

AILERON.

On Airplanes AF49-1492 through -1573, the counterbalance weight for each aileron consists of four lead alloy castings riveted to the paddle plate along the aileron span. On Airplane AF49-1574 and all later airplanes, the counterbalance weight of each aileron consists of three lead alloy castings riveted to the paddle plate. Aerodynamic balance is obtained by a fabric seal that is held in place by retaining strips which are bolted to the paddle plate of the aileron and to the rear wing spar.

RUDDER.

The counterbalance weight for the rudder consists of three lead alloy castings. The castings are held in place inside the leading edge of the surface with NAS screws that screw into nut plates fixed to the weights. Rebalance weights may be added as shown in figure 1-6.

ELEVATOR.

The elevator counterbalance weight for the T-28A Airplane consists of three lead alloy castings. One is located at the inboard leading edge and held in place with NAS screws and rivets. Another is fastened to the inboard forward end of the inboard rib. The third is secured in the elevator tip assembly with NAS screws and rivets.

SEALING.

The sealing of the T-28A Airplane is divided into two types, defined as follows:

1. Watertight Sealing - sealing of external surfaces against water leakage. (See figure 1-7.)

2. Air, Gasoline, Gasoline Fumes and Smoke Seal - sealing joggles, cutouts, holes, slots and other openings in areas where excessive leakage of air, gasoline fumes or smoke might prove dangerous. (See figure 1-7.)

WATERTIGHT SEALING.

Damage to the airplane structure which results in the break of the watertight seal will require repairing the area, resealing, and inspecting the area for leaks. This information applies only to exterior surfaces of the airframe.

PREPARATION FOR WATERTIGHT SEALING.

To prepare for watertight sealing, proceed as follows:

1. Prepare sealing compound (Specification MIL-S-7124 in accordance with the instructions prescribed by the manufacturer. Stir mixture thoroughly for approximately 5 to 10 minutes, making certain that all accelerator particles are thoroughly absorbed by compound.

2. Load mixed sealing compound into applicator and use as soon as possible.

NOTE

At room temperature [approximately 25°C (77°F)], the accelerated compound must be used within a period of 4 hours. If necessary, the compound may be stored for a period of 24 hours, provided the temperature is maintained within a range of -18°C to -12°C (0°F to 10°F). Extensive storage of the sealant for periods of up to 4 days may be accomplished by storing the mixture in a dry-ice compartment.

WATERTIGHT SEALING REPAIR PROCEDURES.

To repair watertight sealing, proceed as follows:

1. Use stripping compound [Specification MIL-R-8633 (Aer)] to strip primer and all other paint coatings from area to be sealed. Limit stripping as much as is practical to minimize amount of bare surface left exposed.

CAUTION

Mask off any rubber or plastic material very carefully to prevent contact with stripper [Specification MIL-R-8633 (Aer)].

2. Check all areas to be sealed. If area is dirty or greasy, clean by wiping with a clean cloth damped with Stoddard solvent or naphtha and then wipe dry with a clean, dry cloth. With air pressure, clean area of all chips and dirt.

NOTE

It is important that the area be perfectly clean before the application of sealing compound.

3. If airplane is to remain unpainted, use only aluminum pigmented sealant; if airplane is to be painted, either aluminum pigmented sealant or standard sealant (Specification MIL-S-7124) may be used.

4. Leaving 1/8 inch of joint exposed, apply 3/4-inch or one-inch masking tape on either side of joint.

5. Place opening of nozzle flat against joint and apply a slightly excessive amount of compound while moving gun as joint fills.

6. After compound has been applied, use a spatula or similar tool and press compound into joint and remove excess compound from area.

7. Remove masking tape as soon as preceding operation is completed. Fair out edges of compound. This may be done by drawing one finger along the edge of the joint. Moisten finger with water to minimize sticking of compound to finger.

INSPECTION FOR EVIDENCE OF LEAKAGE.

1. Place airplane in a normal parked condition and remove all protective coverings.

2. Use a simulated heavy to excessive rain spray (1.5 inches per hour) to check weather tightness of area. Direct spray to all affected areas from all overhead directions for a period of 20 minutes.

3. Immediately after spraying has been completed, inspect all areas for evidence of leakage; mark all areas found to be leaking to facilitate location of leaking area at a later time.

CLEANING UP.

Compound applicators and equipment must be cleaned within one hour after using to preclude the possibility of the compound setting up. Use Stoddard solvent or naphtha for cleaning.

NOTE

It is recommended that workers engaged in the cleaning operation use suitable synthetic rubber gloves because prolonged contact with the cleaning compound can cause dermatitis.

AIR AND GASOLINE FUME-TIGHT SEALING.

Damage to the airplane structure which results in the breaking of air and gasoline seals requires repairing, resealing, and inspecting the area for leaks. This type of seal is designed to keep air and gasoline fumes from areas where leakage of these elements would be considered dangerous.

PREPARATION.

To prepare for sealing, proceed as follows:

1. Before sealing compound is applied, the entire area to be sealed must be thoroughly cleaned. Dirt from handling, oil, grease, or any foreign matter must be removed. An air hose or clean, dry cloth can be used to remove dust and chips. All surfaces must be wiped with a clean cloth dampened with solvent or naphtha. Before the solvent has evaporated, the surface should be wiped completely dry with a clean, dry cloth.

NOTE

It is important that clean, dry cloths be used in cleaning. Also, it should be remembered that to avoid contaminating solvent, always pour solvent on cloth and never dip cloth into solvent.

2. Repeat cleaning procedure until it is certain no oil, grease, or any other contaminating material is left on surface to be sealed.

3. When preparing primed area for sealing, it is necessary to use the thumbnail check to determine whether primer area is adhering properly. If the primer does not adhere properly, the primer should be removed only from the area to be sealed. If the primer cannot be easily removed by scraping with the thumbnail, primer should not be removed.

4. To locate holes that cannot be readily seen, shine a bright light on unsealed side of bulkhead and inspect side requiring sealing for passage of light. Rivets, riveted joints, and seams do not require sealing.

SEALING HOLES, SLOTS, JOGGLES, ETC.

To seal holes, slots, joggles, etc, proceed as follows:

1. Holes up to 1/8 inch wide should be sealed by filling with sealant (Specification MIL-S-7502) and building up a fillet on the inside which is approximately 1/8 inch high.

2. Holes 1/8 to 1/4 inch wide can also be plugged by using sealer (Specification MIL-S-7126, Type I).

This sealer is applied by means of a spatula or putty knife, making sure that the hole is tightly filled. The fillet is applied to the inside of the area. Since Specification MIL-S-7126, Type I sealer remains soft and pliable, accelerated Specification MIL-S-7502 sealant may be applied over it immediately, making sure it extends at least 1/8 inch beyond the Specification MIL-S-7126 sealer.

REMOVING SEALING COMPOUND.

When it is necessary to remove fillets or beads of semicured sealing compound because of rework or repairs, scrape compound off with wood or Plexiglas scrapers. To remove the cured compound, a sharpened putty knife is recommended. It is necessary to remove only the major portions of the fillet and beads. Areas where primer is removed along with the sealer need not be reprimed if no further finishing is specified.

NOTE

When removing cured compound with a putty knife, extreme care is necessary to prevent cutting through the clad aluminum surface.

CAUTION

Ethylene dichloride and the solvents used in the cleaners are highly flammable and toxic. Safety precautions must be observed during their use, to prevent fires. If they are used in a closed area, forced ventilation must be provided to prevent harm to personnel using materials.

MIXING AND HANDLING SEALING COMPOUND.

1. Mix Specification MIL-S-7502 sealant according to manufacturer's instructions on container.

2. Immediately after mixing, load accelerated Specification MIL-S-7502 sealing compound into tubes for use in pressure application.

The following table outlines various storage times allowed after mixing.

TABLE 1-2

TEMPERATURE (°C)	TEMPERATURE (°F)	STORAGE LIFE (HOURS)
21 to 27	70 to 80	4
-7 to -1	20 to 30	36
-12 to -7	10 to 20	48
-18 to -12	0 to 10	60
-23 to -18	-10 to 0	72
-29 to -23	-20 to -10	96
-29 and below	-20 and below	120

Sealant may be softened for easier application by warming in an oven at 38°C to 43°C (100°F to 110°F), or working with the hands. Be sure hands are clean and free of grease and oil. Compound applicators and equipment must be cleaned within one hour after using. They may be cleaned with ethylene dichloride LAR 1634 or LAR 2489 cleaners or deseal "A."

VERTICAL STABILIZER TAPE SEALING.

To help prevent carbon monoxide from entering the cockpit area, the lightening holes in the vertical stabilizer close-out rib should be sealed. This sealing is accomplished by using plastic tape to cover the lightening holes as follows:

1. Remove necessary fillets to gain access to vertical stabilizer close-out rib. (See figure 1-7.)

2. Remove any primer that is loose enough to be scraped off with fingernail, and thoroughly clean areas to be taped with a clean cloth moistened in naphtha or Stoddard solvent.

3. Cut tape to size and allow for lapping if necessary. (The lap joint should be made before tape is placed over the holes.)

4. Remove protective liner from tape and apply A-2 activator with a clean cloth moistened in this liquid. Do not dip cloth into container. Either pour fluid onto cloth or use a small amount poured into a shallow pan. Tape must be applied within 5 minutes after activation; however, it is permissible to reactivate the tape. Start at one end of tape and apply tape gradually with a smooth, rounded straightedge. Work out air pockets by wiping toward outside edges of tape.

5. Replace fillets. The airplane may be flown immediately without affecting the tape seal.

NOTE

Scotch-Cal No. 455 tape is supplied with adequate quantities of the A-2 activator and is available from Minnesota Mining and Manufacturing Company, St. Paul, Minnesota. Tape conforming to Specification MIL-D-8634 (primarily used for insignia decalcomanias on aircraft exteriors) is equivalent and may be more readily available. This tape is also shipped with the proper activator. The tape is available in a number of widths and may be painted after application if desired. Tape should be stored at room temperature of about 25°C (77°F). Avoid inhaling activator vapors and do not unnecessarily expose skin to the liquid. Make tape application in a well-ventilated area.

MATERIALS USED IN REPAIR.

ALUMIMUM ALLOYS.

There are four basic aluminum alloy shapes used in the construction and repair of aircraft. These are

extrusions or roll-formed sections, bar stock, sheet stock, and plate stock.

Sheet stock is available in various gages up to 0.250 inch in thickness. It may be obtained in both the clad state and the bare state. Gages heavier than 0.250 inch are plate stock. Bar stock is a material from which parts may be machined. Shapes made from bar stock are generally not quite as strong as extruded shapes of the same alloy. Therefore, the cross-sectional area of a repair part machined from bar stock should be about 10 percent greater than that of the original part to compensate for this lower strength factor. Extrusions are die-formed shapes that can be made to any specific cross-sectional area.

DESIGNATION AND PROPERTIES OF ALUMINUM ALLOYS.

The aluminum industry has changed the alloy designations for all wrought aluminum alloys. The new designation is a four-digit number whose last two digits usually conform to the old standard alloy number. The letter "S" is eliminated in the new designations. For example, the designation for aluminum alloy formerly known as 75S is now 7075. The temper designations have not been changed. For example, material marked 7075-O is the same as material previously marked 75S-O. The basic temper designation is a letter. When the temper must be subdivided, a number follows the letter, for example, T4. The alloy number and the temper designation are separated by a dash (2024-T4).

The general system of designation is as follows:

ALLOY DESIGNATIONS

FORMER DESIGNATION	ALLOY NO.	DESCRIPTION
2S	1100	Used where forming is severe—weldable—not heat-treatable—can be work-hardened.
3S	3003	Forms nearly as well as 1100—weldable—not heat-treatable—can be work-hardened.
52S	5052	More formable than 2024—less formable than 3003—weldable—not heat-treatable—can be work-hardened.
24S	2024	Heat-treatable—may be spot- or seam-welded in heat-treated condition, but not fusion-welded—can be formed in the heat-treated condition.
61S	6061	Weldable and heat-treatable —may be spot-welded or seam-welded in the heat-treated condition —may also be fusion-welded if the resultant annealed condition bordering the weld is acceptable.
75S	7075	Heat-treatable—may be spot- or seam-welded inheat-treated condition, but not fusion-welded—does not form as readily as 2024 in heat-treated condition.

LETTER	INDICATES	DESCRIPTION
F	As fabricated	Applies to products that acquire some temper qualities in the shaping processes but are not later heat-treated or intentionally work-hardened.
O	Annealed	Applies to the softest temper of wrought alloy products.
H	Strain-hardened	Applies to products that have their strength increased by work-hardening. The "H" is always followed by a number of two or more digits which subdivides this temper designation. The first digit indicates specific combination of basic operations. The final digit or digits indicate the degree of hardness.

LETTER	INDICATES	DESCRIPTION
		SUBDIVISIONS OF "H" TEMPER H1—Work-hardened only. The number following this designation indicates the degree of work-hardening. H2—Work-hardened and then partially annealed. The number following this indicates the degree of work-hardening remaining after partial annealing. H3—Work-hardened and then stabilized. The number following this designation indicates the degree of work-hardening remaining after having been work-hardened a specific amount and then stabilized. BREAKDOWN OF HARDNESS 1/4 hard, indicated by 2 — 3/4 hard, indicated by 6 1/2 hard, indicated by 4 — Full hard, indicated by 8 The digit "3" would indicate a degree of hardness between 1/4 hard and 1/2 hard, etc.
W	The unstable condition following solution heat-treatment	This designation, because of natural aging, is specific only when the period of aging is indicated; for example, 2024-W 1/2 hr, etc.
T	Treated to produce a stable temper (other)	This designation applies to alloys when treated thermally to produce stable tempers with or without supplementary strain-hardening. The "T" is followed by a number of one or two digits which indicates a specific combination of operations. SUBDIVISIONS OF "T" TEMPER T2—Annealed. (Applies to cast products only.) T3—Solution heat-treated and then cold-worked. This designation applies to products that are cold-worked after heat-treating chiefly to increase their strength; however, it also applies to alloy sheets as they come from the mill, since the flattening process after heat-treating is recognized as cold-working, and does increase the strength of the material. T4—Solution heat-treated and then naturally aged to a substantially stable condition. This designation applies when the alloy is not cold-worked in any manner after heat-treatment. When the user heat-treats an alloy, the flattening process does not follow. Therefore, sheet stock received from the mill in the "T3" condition, which is annealed and re-heat-treated by the user, becomes "T4." Unless specifically noted, "T4" can be substituted for "T3." T5—Artificially aged only. This designation applies to products that are artificially aged without prior solution heat-treatment. T6—Solution heat-treated and then artificially aged. This designation applies to products that are not cold-worked after heat-treatment, and any flattening, even at the mill, is not recognized as cold-working. T7—Solution heat-treated and then stabilized. This designation applies to products in which the temperature and time conditions for stabilizing are such that the aging is carried beyond that required to produce maximum strength and hardness in order to control growth and distortion resulting from casting or quenching strain. T8—Solution heat-treated, cold-worked, and then artificially aged. This designation applies when cold-working is done for improving strength and the flattening process at the mill is recognized as cold-working.

LETTER	INDICATES	DESCRIPTION
		T9—Solution heat-treated, artificially aged, and then cold-worked.
		T10—Artificially aged and then cold-worked.

CORROSION-RESISTANT STEEL.

Following are listed some of the most frequently used types of corrosion-resistant steels and their properties.

1. Specification MIL-S-5059, Comp 301, annealed and 1/2 hard. This material is not to be heat-treated, fusion-welded, or brazed, but may be spot-welded or seam-welded. In the annealed condition, this is a nonmagnetic material. In the 1/2-hard condition, it is slightly magnetic and is considerably harder to form. Maximum service temperature is 700°F.

2. Specification MIL-S-6721, Comp 321. This material should be used when it is not feasible to use Specification MIL-S-5059 steel or when a part requires fusion welding. Specification MIL-S-6721, Comp 321, steel forms very easily and is nonmagnetic. It may not be heat-treated, but it can be spot-welded, seam-welded, fusion-welded, and silver-brazed. Specification MIL-S-6721, Comp 321, steel should be used where temperatures are to exceed 700°F.

3. Specification MIL-S-25043, 17-7PH. This material may be used where higher strength or better formability is required than can be obtained from Specification MIL-S-5059, 1/2 hard, steel and in all cases must be heat-treated to 180,000 to 200,000 psi in accordance with Specification MIL-H-6875 after forming. This material may be spot-welded or seam-welded after heat-treatment, or fusion-welded before heat treatment, but it cannot be silver-brazed or copper-brazed. Specification MIL-S-25043, 17-7PH, steel is a magnetic material with a maximum service temperature up to 550°F.

CHROME MOLYBDENUM STEEL.

Following are listed three of the most commonly used types of chrome molybdenum steel and their properties.

1. **4130.** This material may be copper-brazed or fusion-welded, but not spot-welded or seam-welded; it also may be silver-brazed if the part is not to be heat-treated after silver brazing. 4130 steel should not be surface-hardened, but it can be heat-treated to 160,000 to 180,000 psi.

2. 4140. This material may be fusion-welded or copper-brazed, but not spot-welded, seam-welded, or silver-brazed. This material is not to be surface-hardened, but may be heat-treated to 180,000 to 200,000 psi.

3. 4340. This material may be fusion-welded or copper-brazed, but not spot-welded, seam-welded, or silver-brazed. This material is not to be surface-hardened, but may be heat-treated to 200,000 to 220,000 psi.

A low alloy steel to meet repair requirements can be selected from the following chart, using full hardening thickness and the strength range required.

THICKNESS FOR FULL HARDENING (INCHES)	TENSILE STRENGTH REQUIRED (PSI)				
	125,000 THRU 140,000	140,000 THRU 160,000	160,000 THRU 180,000	180,000 THRU 200,000	200,000 THRU 220,000
0.000 thru 0.250	4130	4130	4130	4130	4340
0.251 thru 0.500	4130	4130	4130	4140	4340
0.501 thru 0.750	4130	4130	4140	4140	4340

THICKNESS FOR FULL HARDENING (INCHES)	TENSILE STRENGTH REQUIRED (PSI)				
	125,000 THRU 140,000	140,000 THRU 160,000	160,000 THRU 180,000	180,000 THRU 200,000	200,000 THRU 220,000
0.751 thru 1.000	4140	4140	4140	4140	4340
1.001 thru 1.250	4140	4140	4140	4340	4340
1.251 thru 1.500	4140	4340	4340	4340	4340
1.501 thru 3.000	4340	4340	4340	4340	4340
3.001 thru 3.500	4340	4340	4340	4340	-
3.501 thru 4.000	4340	4340	4340	-	-

NOTE

4140 steel may be used in place of 4130 steel, and 4340 steel may be used in place of either 4130 or 4140 steel.

REPAIR JIGS AND SUPPORT STRUCTURES.

Airframe structure is flexible and "springy" if not properly supported. If an appreciable number of components are removed, there is a tendency for the structure to become distorted or misaligned. This is especially true when an excessive amount of skin is removed. To overcome this tendency, the use of repair jigs, designed to hold and maintain the damaged structure in a static condition during the repair procedure, is recommended. For this reason, data covering the field fabrication of repair jigs has been made a part of this handbook. Field reports have indicated that some field damage may be attributed to improper handling and storing of structure which has been removed from the airplane. To aid in minimizing this type of damage, data covering the fabrication of supports has also been made a part of this section.

REPAIR JIGS.

Fabrication data covering repair jigs are presented in this handbook. No attempt has been made to become specific in regard to the materials which should be used in the fabrication of the jigs. It is felt that local conditions will dictate, on the basis of availability, the final selection of materials to be used. The use of spare assemblies as templates is recommended provided these assemblies are known to be structurally sound and in full alignment.

WING INNER PANEL ASSEMBLY COMPLETE.

Figure 2-51 illustrates the left-hand repair jig.

WING OUTER PANEL REPAIR JIG.

Figure 2-52 illustrates the left-hand outboard wing repair jig.

AILERON REPAIR JIG.

Figure 2-53 illustrates the left aileron repair jig.

WING FLAP REPAIR JIG.

Figure 2-54 illustrates the left wing flap repair jig.

HORIZONTAL STABILIZER REPAIR JIG.

Figure 3-23 illustrates the left horizontal stabilizer repair jig.

ELEVATOR REPAIR JIG.

Figure 3-24 illustrates the left elevator repair jig.

VERTICAL STABILIZER REPAIR JIG.

Figure 3-25 illustrates the vertical stabilizer repair jig.

RUDDER REPAIR JIG.

Figure 3-26 illustrates the rudder repair jig.

FUSELAGE FORWARD REPAIR JIG.

Figure 4-28 illustrates the forward fuselage repair jig.

FUSELAGE AFT REPAIR JIG.

Figure 4-29 illustrates the aft fuselage repair jig.

FUSELAGE SUPPORTS.

Fabrication data for fuselage field supports is provided in this handbook. No attempt has been made to become specific in regard to the materials which are to be used. The weight which each of the supports will have to carry has been made part of figure 4-30 to aid the mechanic in making his selections. These weights are based on empty fuel tanks. If it is desired to store these components with fuel in the tanks, revise these figures accordingly.

FABRICATION.

All dimensions called out in the repair jig and field support illustrations are given in inches unless otherwise specified. Standard angles, pipe, channels and drill rod have been called out to simplify the requisitioning. All of the wood used in the construction of the repair jigs and field supports should be dry and well seasoned. The use of either soft or hard wood is acceptable and selection should be made on the basis of availability, storage location, and the length of the time and frequency of anticipated usage. If the storage is to be outside or in a climate which is critical and the anticipated usage is considered to be high, it is recommended that a hard wood be used. The jigs may be painted for preservation if desired. The make-up of a relatively large wood member by assembling smaller component parts is permissible when it is determined that the structural design will not be affected. Fastening of the primary structural members is made with 3/8-inch diameter carriage bolts, lag bolts, or machine bolts as required. Fasteners for secondary structural members are selected at the discretion of the repairman unless specifically called out in the illustration. Where basic welding information is required for the fabrication of a repair jig, refer to the General Handbook of Structural Repair, T.O. 01-1A-1.

EMERGENCY REMOVAL OF AIRPLANE FROM RUNWAY.

At times, it is necessary to remove a crashed airplane from a runway in the shortest possible time. Even when the operation is being performed under emergency conditions, every effort should be made to minimize handling damage of a reparable airplane. The emergency removal method shown in figure 1-7A should be used only when a runway must be cleared in the shortest possible time. In all other instances, methods which will not create additional damage should be employed. Towing an all-gear-up airplane with a cable installed as shown will add damage but is considered the least damaging method of attachment when an airplane is in this configuration.

CAUSES AND TYPES OF DAMAGE.

There are many causes and degrees of damage which may occur to an airplane. However, for purposes of description, some of the causes are collision or impact, stress, fatigue, corrosion, and overheat.

COLLISION OR IMPACT DAMAGE.

This type of damage varies from minor damage, such as a small hole or dent, to extensive damage, such as torn, crushed, or burned skin and structural members, and misalignment of the airplane. Damage such as this can occur at any point on the airplane.

STRESS DAMAGE.

This type of damage generally consists of loosened, sheared, or popped fasteners, wrinkled skin or webs, and cracked or deformed structural members. Damage such as this is caused by abnormal stresses imposed upon the members.

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EMERGENCY REMOVAL

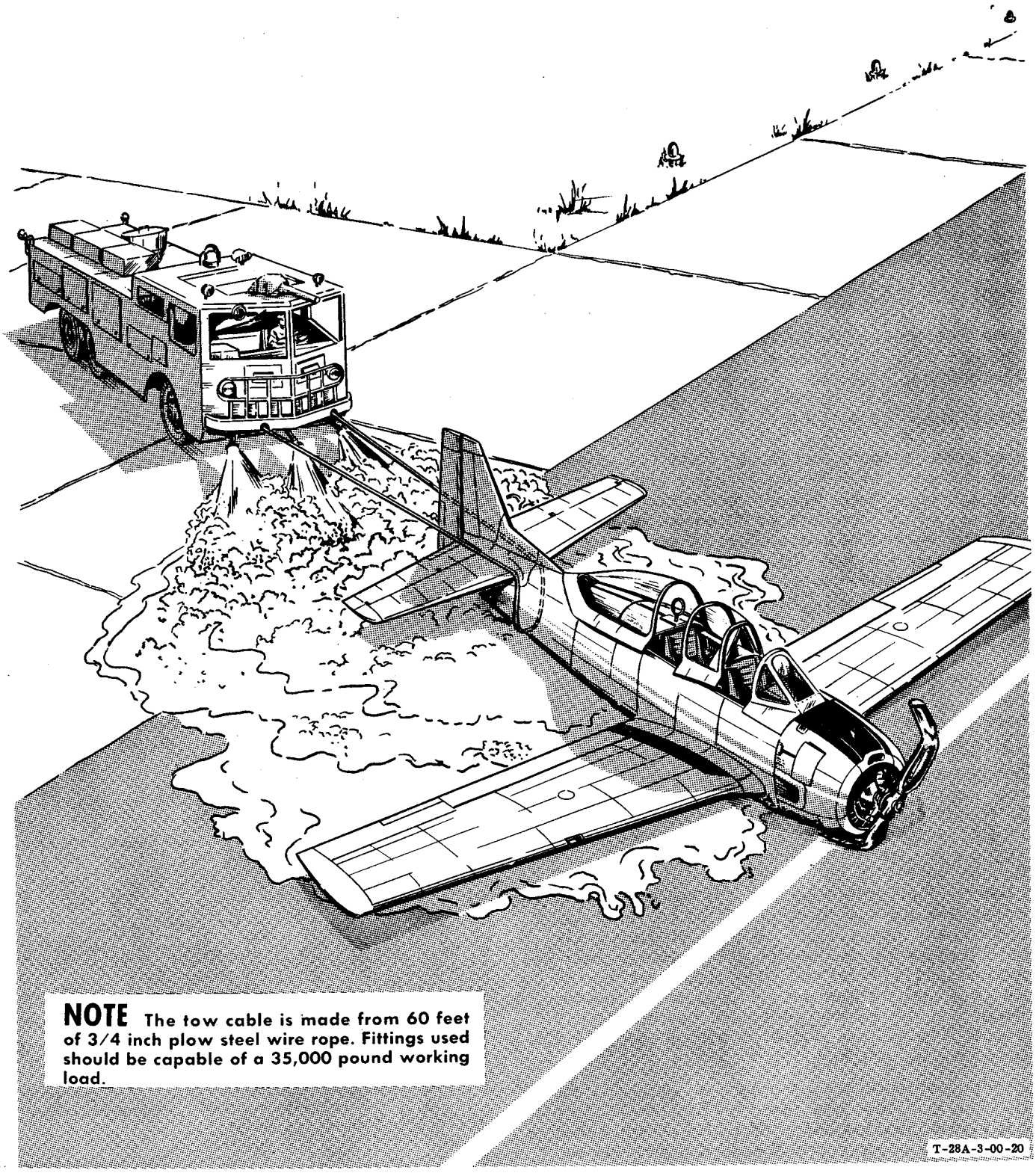


Figure 1-7A. Emergency Removal of Crashed Airplane From Runway

FATIGUE DAMAGE.

This type of damage generally consists of small cracks which are caused by vibration, oil cans, and variable loads imposed on skin, fittings, and load-bearing members where fittings are attached. Damage of this type occurs more frequently as the total operation time of the airplane accumulates.

CORROSION DAMAGE.

This type of damage may occur where dissimilar metals come in contact with each other or where certain alloys or steel are exposed to moisture. Corrosion damage may be detected on aluminum alloys by the presence of white powdery spots or deposits, and pitting of the metal. Rust is a form of corrosion on steel surfaces.

FIRE DAMAGE.

This may or may not be the result of fire after collision or impact damage, landing accidents, or fire in flight.

NEGLIGIBLE DAMAGE.

Negligible damage is that damage which can be permitted to exist as is, or which may be corrected by a simple procedure, without restricting flight. In most cases, a corrective action must be taken to keep the damage from spreading. Frequent inspection of areas with negligible and minor damage is necessary to ensure that the damage does not spread. Some examples of negligible damage are:

DENTS.

Minor dents with no damage to structure which may be left as is, and large dents after being bumped back to mold line dimension, provided there are no sharp dents or wrinkles.

SCRATCHES AND NICKS

A damage which does not go through the protective coating of the material, or through the cladding on alclad sheet, is not considered a scratch. To determine whether the damage has gone through the cladding, thoroughly clean the surface with methyl ethyl ketone and apply a 10 percent solution of sodium hydroxide to the damage area. If the damage has gone through the cladding and into the parent material, a black or dark brown discoloration will appear. This solution should not remain on the area for longer than two minutes because of its corrosive action. The solution must be thoroughly washed from the area with water.

Scratches or nicks are not considered negligible until after they have been reworked by blending or other prescribed methods. Scratches or nicks may reduce the cross-sectional area of a material and produce localized stress concentration. This condition can lead to fatigue cracks and possible failure of the component. (See figure 1-8.)

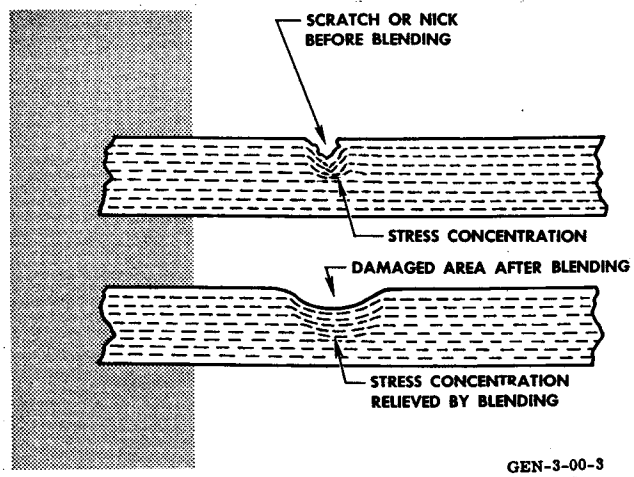
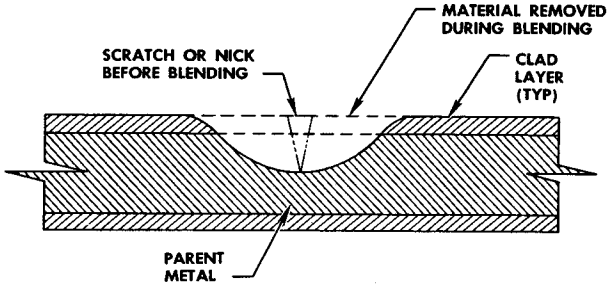


Figure 1-8. Stress Concentration at Nicks and Scratches

Blending of scratches or nicks is the process of smoothing out the damaged area. To blend properly, a fine grit (400 or finer) abrasive cloth or paper, or aluminum wool should be used. Do not use crocus cloth or steel wool since it tends to cause corrosion. Scratches or nicks should be smoothed out with the abrasive to remove all damage. The reworked area must be kept as small as possible. (See figure 1-9.)

In certain highly stressed areas, it is necessary to use a dye-penetrant check after blending to reveal any cracks which may be undetected. (Refer to "Penetrant Inspection Method.")

After blending, the damaged area must be chemical film treated (refer to "Protective Treatment for Aluminum and "Corrosion Protection for Magnesium Alloys.")



NOTE Blending scratch or nick in machined bar or extrusion may be accomplished in same manner.

Figure 1-9. Blending Scratches

CRACKS.

Short cracks in cowling and other nonstructural areas may be stop-drilled to prevent growth. If a crack spreads beyond the drilled hole, a repair should be made. Leaving stop-drilled cracks unrepaired in structural areas must be approved by the Structural Repair Officer.

CORROSION.

Corrosion can be defined as the deterioration of a metal by direct chemical or electrochemical reaction with its environment. The conditions necessary for corrosion are the same for all metals and alloys, differing in degree, but not in kind. Corrosion is not only a surface condition, but is sometimes directed along grain boundaries or other lines of least resistance.

There are two general types of corrosion: one is direct chemical attack, where the reaction is similar to that of an acid on a metal and where its environment can be likened to the acid; the other is electrochemical attack, where anodic and cathodic changes between two different metals occur in the presence of its environment, where the action is similar to that of a battery with an electrolyte present, and where its environment can be likened to the electrolyte.

Both types of corrosion depend on an atmospheric environment containing moisture; the degree or rate of corrosion is dependent on the temperature of the atmosphere and the quantity of impurities present, such as dust, salt, smoke, etc. Other variables that affect the degree of corrosion are material section size, type of material, quality of material heat-treatment, and quality of corrosion preventive maintenance. The various forms of corrosion are evident by their distinctive appearance and are commonly known as uniform etch, pitting, intergranular, exfoliation, and galvanic.

UNIFORM ETCH CORROSION.

Uniform etch corrosion may be recognized by a uniform dull appearance of a polished surface. If the surface is allowed to corrode further, it becomes rough and frosty or icy in appearance. This type of corrosion is the result of direct chemical attack.

PITTING CORROSION.

Pitting corrosion may be recognized by a white or gray powdery deposit blotching the surface of aluminum or magnesium alloys, and a brown or red powdery deposit on steel. When the deposit is cleaned away, tiny pits or holes can be seen on the surface. This type of corrosion is the result of direct chemical attack or electrochemical attack between the metal and foreign materials on the surface of the metal in the presence of moisture.

INTERGRANULAR CORROSION.

Intergranular corrosion may be recognized by a streaky or discolored appearance of aluminum alloy surfaces. Alloys consist of quantities of individual grains, each separated from the other with clearly defined grain boundaries which chemically differ from the element within the grain center. The adjacent grains of different elements can react with each other as anode and cathode in the presence of moisture to produce rapid selective electrochemical attack at the grain boundaries. 2024, 7075, and 7178 aluminum alloys are the most susceptible to intergranular corrosion, since their alloying constituents are ideal for electrochemical attack.

EXFOLIATION CORROSION.

Exfoliation corrosion is intergranular, predominates in aluminum alloys, and may be recognized by a blistering or actual separation of metal around or near rivet or bolt holes. Electrochemical attack originates in the previously unprotected surface of the rivet or bolt hole and preceeds along grain boundaries until the metal can no longer contain the corrosive products, resulting in blistering of the outer surface.

GALVANIC CORROSION.

Galvanic corrosion may be recognized around fittings, lap joints, rivet connections, etc, by a build-up of powdery white, gray, or red corrosive products. Galvanic corrosion is the direct result of mating two dissimilar metals that are far enough apart in the galvanic series of metals and alloys. Of the two mated metals, electrochemical attack will occur on the metal closer to the anodic end of the series.

GALVANIC SERIES OF METALS AND ALLOYS

Corroded End (Anodic)

Group 1	Magnesium Magnesium alloys
Group 2	Zinc Clad 7075 Clad 6061
Group 3	5052 Clad 2024
Group 4	6061-T6 7075-T6 7178
Group 5	Cadmium
Group 6	2017-T4 2024-T4 2014-T6
Group 7	Steel and iron Cast iron Chromium

Group 8	18-8 stainless steel (CRES)
Group 9	Lead Tin Nickel
Group 10	Brass Copper Bronze Titanium Monel
Group 11	Silver Gold Platinum

Protected End (Cathodic)

CONSEQUENCES OF CORROSION.

Corrosive deterioration combined with service loading of an airplane can have serious effects on the structural integrity or service life of primary structural members. Stress corrosion cracking and corrosion fatigue are the results of the effects of corrosive deterioration. Loss of effective material, concentration of stress around the affected area, and acceleration of corrosion as a result of internal stresses are the causes for premature failure of a structural member. Loss of effective material will increase the stress on a member carrying the same load as previously carried. Abrupt changes in cross section, such as surface irregularities caused by corrosion, will increase stress in the affected area. Internal stresses, as induced by cold deformation of material, press and shrink fits, unequal cooling form high temperature, etc, will not only accelerate corrosion, but in certain instances add to the applied atresses, thereby increasing the probability of cracks and failure. Since stress and corrosion are interactive when combined, cracking may occur at as low a stress as the yield strength of the material. The combination of stress and corrosion may also cause fatigue failure long before the normal service life of a material by diminishing the number of allowable stress cycles.

CORROSION CONTROL.

The necessity for corrosion control is never felt more strongly than when corrosive deterioration has gone as far as to require a major structural repair. The time and expense lost in airplane down time, in procurement of materials, and in personnel, not to mention engineering man-hours required to provide an adequate repair, are prohibitive. In certain instances, relatively minor damage in a critical or inaccessible area becomes a major repair. Of all the factors governing the probability and degree of corrosion, preventive maintenance by field personnel is the only substantial control over corrosion. Since the prime requirement for corrosive conditions to exist is a high-temperature, moisture-filled atmosphere (high humidity), field maintenance depots can be considered forewarned as to the necessity for increased corrosion surveillance and preventive maintenance schedules. If other factors besides high humidity are known regarding the area, such as concentration of industrial smoke or chemicals or a salt-water atmosphere, further vigilance is necessary. Preventive maintenance as a means of controlling corrosion is normally accomplished by a step-by-step procedure.

First, the airplane must be thoroughly cleaned to rid it of all atmospheric and induced impurities, such as salt spray, dirt, gun blast, urine spray, or fuel exhaust deposits. Second, an inspection should be made for the various forms of corrosion, externally and where possible internally. Third, if corrosion is found, the areas should be cleaned of all corrosive products and treated in the manner prescribed for the individual metals.

PREVENTIVE MAINTENANCE.

CLEANING.

Airplane cleaning serves the purpose of eliminating foreign deposits, as previously discussed, and preparing the surfaces for a final corrosion inspection. Either one of two types of cleaners may be used: alkaline or solvent. These cleaners may be utilized by means of hand-cleaning, tank-cleaning, or spray-washing, whichever is most suitable. Use of a 20-gallon portable spray cleaner with nozzle attachment (Federal Stock No. 4940-567-9558) is recommended for spray-cleaning.

ALKALINE CLEANING. Before cleaning, all natural entrapments and exposed lubricated parts should be masked, using masking tape such as Federal Stock No. 7510-266-6710. Lubricated parts may be flap and control actuators, bearings, wheels, brakes, etc. Natural entrapments may be louvers, scoops, wheel wells, etc. In addition, main and nose gear tires should be protected by enclosing them in a vinyl plastic tarpaulin (Federal Stock No. 8340-262-3769).

1. Mix one part alkaline water-base cleaner (Specification MIL-C-25769) by diluting with three to seven parts of water, depending on the amount and degree of foreign matter adherence.

2. Use soft brush (Specification MIL-B-5612) to completely clean surface, including tight places around laps and fasteners. Environmental temperature will govern increments of area to be cleaned before alkaline cleaner will dry. If at all possible, cleaning should be accomplished in shaded areas when hot-weather temperatures are above 80°F. Allowing alkaline cleaner to dry before rinsing causes stains and leaves residue on surface. The cleaner must not be allowed to dry on plastics, plate glass, and painted surfaces.

3. Rinse surface thoroughly with clean water.

NOTE

In PACAF areas where clean, salt-free water may be a rationed commodity, strict control of rinse water will be necessary. If this is not possible, a solvent-cleaning method should be used.

SOLVENT CLEANING. When conditions (weather, lack of equipment, etc) prevent use of an alkaline cleaner, then dry-cleaning solvent (Federal Specification P-S-661) or kerosene solvent (Federal Specification VV-K-211C) should be used.

WARNING

In areas of oxygen storage and transfer system, do not use solvent. This material and oxygen (liquid or gas) are highly flammable or explosive.

1. Apply solvent with a wiping cloth, sponge, or soft brush (Specification MIL-B-5612) to area being cleaned.

2. Allow solvent to remain on the surface for about 30 seconds; then agitate area, using cloth, sponge, or brush.

3. Wipe surface thoroughly with clean, dry cloth. Surface should be dried as much as possible by wiping. Blowers or low-pressure air may be used to speed evaporation in areas such as engines, bays, etc.

ACID BRIGHTENING FOR CLAD ALUMINUM ALLOYS ONLY. Before application of acid, all surfaces and areas to be protected (refer to "Alkaline Cleaning") should be masked, using tape (Federal Stock No. 7510-266-6710), and main and nose gear tires should be enclosed in a vinyl plastic tarpaulin. If spray-cleaning equipment is to be used, make sure equipment is thoroughly flushed clean.

1. Mix one part metal conditioner and brightener (Specification MIL-C-25378) with one part water. (This dilution ratio should not be varied for brightening.)

WARNING

Keep acid brightener from contacting magnesium, plate glass, and noncorrosive-resistant metals. This can best be done by masking areas; however, if contact is made, flushing immediately with water will prevent damage to material.

2. Treatment of surface should be limited to small areas for each application to prevent drying before rinsing and should not be accomplished when environmental temperatures are below 50°F or above 100°F. Apply acid brightener with spray equipment or brush, being sure to use face shield.

CAUTION

If brightener gets into eyes, immediately flush them thoroughly with water and report to dispensary.

3. Agitate acid brightener by scrubbing with brush (Specification MIL-B-5612). Depending on weather conditions (hot, cold, or windy) and the amount of foreign deposits present, allow about 5 to 12 minutes from application before rinsing.

4. Rinse acid brightener from surface, starting from lower surface and working up; this permits water to flow over previously brightened areas. The procedure should then be reversed, rinsing from the upper surface to the lower. All traces of acid brightener should be removed when the rinse water stops bubbling or foaming at the surface.

5. Wipe rinsed surface dry with clean, dry cloth.

NOTE

Acid brightening should not be performed more than four times a year. To ensure that this limit is maintained, an entry on DD For 781-2 as to date and activity accomplishing the brightening shoud be made.

CORROSION REMOVAL

If, at any time, there is doubt as to what type of metal is being examined or treated, a metal spot check should be performed, using inspection kit No. 4920-831-5932. The use of this kit employs two methods of identification: primary classification of metals and chemical spot analysis. Detailed instructions on the use of the kit may be found in Corrosion Control and Treatment of Aircraft and Missiles, T.O. 1-1-2, dated 15 May 1961 and subsequent. Certain protective coatings make identification of metals absolutely mandatory.

Certain metals limit the method of corrosion removal. Depending on the metal involved, mechanical methods that may be used are hand scraping, rotary filing, sandpapering, or abrading with aluminum or steel wool. Chemical methods that may be used are applications of metal conditioner and brightener (Specification MIL-C-25378), chromic acid (Federal Specification O-C-303), or metal conditioner and rust remover (Specification MIL-M-10578B).

NOTE

- If corrosion is discovered in a painted area, all paint must be removed from the area before a corrosion removal method can be used. (Refer to paint stripping procedures.)

- If more than 5 percent of metal thickness is removed in a critical structural area,

the damage must be evaluated. If a repair is decided to be necessary and this repair manual cannot provide a solution, a structural engineer from the prime AMA must be consulted.

REMOVAL OF CORROSION FROM CLAD ALUMINUM ALLOYS. The only time corrosion should be removed mechanically from clad aluminum alloys is when the metal is attacked by exfoliation corrosion; otherwise, the following chemical removal will apply.

1. Mask off nearby plated steel and magnesium, as well as cracks and overlapping surfaces.

2. Apply thickened (undiluted) metal conditioner and brightener (Specification MIL-C-25378) to corroded area, using brush or clean cloth. A wet rag should be handy to immediately remove acid splashes.

CAUTION

Rubber gloves are required while working with acid solutions. If acid contacts skin or eyes, immediately flush thoroughly with fresh water and report to dispensary.

3. As an aid to this chemical surface treatment, lightly agitate surface with aluminum wool (Specification MIL-A-4864), being careful not to remove too much clad material. The acid should not be left on longer than 20 minutes in one application.

4. Sponge off acid material and waste with a damp cloth rinsed frequently with clean water. After corrosion is removed, the surface should be uniformly bright.

5. Finally rinse with clean water and dry with compressed air or clean, dry cloth.

6. If clad material is heavily attacked by exfoliation corrosion, use hand scraper, rotary file, or abrasive wheel to remove corrosion. (Refer to "Removal of Corrosion From Bare Aluminum Alloys.")

REMOVAL OF CORROSION FROM BARE ALUMINUM ALLOYS. Light pitting corrosion can be removed, using the chemical removal method for clad aluminum alloys; however, the following mechanical method is recommended.

1. Remove corrosion products with a hand scraper, rotary file, or abrasive wheel.

2. After all visible corrosion has been removed, blend scraped area into surrounding area.

3. Finally, polish until surface is smooth, using No. 280 grit abrasive paper (Federal Stock No. 5350-721-8119) and then No. 400 grit abrasive paper (Federal Stock No. 5350-721-8118).

REMOVAL OF CORROSION FROM MAGNESIUM ALLOYS. Except when there is light pitting corrosion, the mechanical method (same as used for bare aluminum alloys) is recommended for magnesium. The chemical removal method is as follows:

1. Mask off nearby operating mechanisms, aluminum alloys, plated steel, and cracks.

2. Prepare chromic acid solution (Federal Specification O-C-303) by diluting 10 percent by weight in water. When practical, apply solution hot.

3. Apply solution sparingly to corroded surface with a brush.

4. Allow acid to stand for 5 minutes. Agitating the surface with a brush (nonmetallic bristle) may be necessary to help loosen the corrosive deposits.

5. Thoroughly rinse with clean water.

6. Dry surface with a clean, dry cloth.

REMOVAL OF CORROSION FROM STEEL AND STAINLESS STEEL. A combination of chemical and mechanical means is recommended for the removal of corrosion from steel. However, when there is danger of chemicals becoming trapped and when rinsing is difficult, only mechanical means of removal should be used as indicated in steps 2 and 3.

1. Protect nearby plated areas, copper-bronze alloys, aluminum, braided flexible lines, and operating mechanisms with masking tape.

2. Remove as much corrosion as possible by hand brushing, scraping, or rotary filing.

3. Loosen corrosion further by agitating surface with steel wool or No. 400 grit abrasive paper. Remove loose particles by wiping with cloth or using low-pressure air.

4. Mix one part by volume of metal conditioner and rust remover (Specification MIL-M-10578B) with one part water in an acid-resistant steel or earthenware container.

WARNING

Proper personnel protection should be used when working with acids. Rubber gloves must be worn; the use of a face mask is dependent on ventilation conditions. Protective clothing at all times is advisable.

5. Apply solution to corroded area with brush and allow one minute for solution to take effect. Thoroughly rinse surface with water (preferably hot) and wipe dry with clean, lint-free cloth.

WARNING

In areas of oxygen storage and transfer system, do not use this rust remover. This material and oxygen (liquid or gas) are flammable or explosive.

REMOVAL OF CORROSION FROM COPPER AND COPPER ALLOYS. Mechanical removal of corrosion is recommended on copper and copper alloys where chemical removal would be impractical because of rinsing difficulties or danger of trapping chemicals.

1. Since copper is normally masked during general cleaning operations, remove oil, grease, and dirt from corroded area by wiping with a clean cloth dampened with dichloromethane (Specification MIL-D-6998) or trichloroethylene (Specification MIL-T-7003).

2. Remove corrosion by abrading with brass wire brush or No. 400 grit abrasive paper.

3. Remove loose particles with pressurized air or bristle brush. If part has been removed and is threaded, wipe threaded area with fingerprint remover (Specification MIL-C-15074), applied with a clean cloth.

4. For chemical removal, use the same method given in steps 4 and 5 of "Removal of Corrosion From Steel and Stainless Steel."

CORROSION PROTECTION.

Protection from further corrosion is accomplished by treating the affected area chemically. The surface treatment not only provides protection but provides the proper surface for a paint finish, if required.

There are two types of protective chemical surface treatments, one for bare and clad aluminum alloys and one for magnesium and magnesium alloys. Stainless steel and titanium require no protective treatment; steel requires only a paint finish.

CAUTION

Both chemical surface treatments consist of acid solutions and require proper protective covering. Personnel must wear rubber gloves, goggles, and protective covering. If acid contacts skin or eyes, flush immediately with water and report to dispensary.

The combination of protective treatment and final paint finish gives the surface the best possible protection. However, unless the airplane is painted or will be painted, a final paint finish should not be considered except in special cases, such as steel landing gears and their components.

PROTECTIVE TREATMENT FOR ALUMINUM ALLOYS. Surface treatment consists of applying chemical films for aluminum alloys (Specification MIL-C-5541) to the affected area. Most solutions conforming to this specification leave a stain which may be considered objectionable in appearance, but in no way does the stain detract from the protective value of the treatment. Solutions of Specification MIL-C-5541 must be mixed according to the instructions on its container. Use a rubber pail (Federal Stock No. 7249-125-9060) is recommended for mixing.

1. Apply Specification MIL-C-5541 solution to affected surface by using a nylon brush or a clean, lint-free cloth. Keep surface wet with solution until a dark yellow or orange stain is evident. Keep solution confined as much as possible to affected area, off operating mechanisms and plated steel, and away from cracks and crevices.

2. Remove excess solution by blotting with a soft, clean cloth. Then rinse with clean water.

3. Allow surface to air-dry or blot dry with clean, lint-free cloth. To speed drying, a low-pressure air stream may be directed onto the surface.

4. Mix fresh Specification MIL-C-5541 solution when solution darkens or becomes contaminated. Keep solution in closed polyethylene container when not in use. Brushes and cloths should not be left in the solution.

CORROSION PROTECTION FOR MAGNESIUM ALLOYS. Surface protection for magnesium alloys consists of a chrome pickle treatment conforming to Specification MIL-M-3171, Type I, or a Dow Process 19. The chrome pickle treatment consists of two types of solution depending on the type of magnesium treated.

1. For magnesium alloys other than magnesium alloy castings, mix the following quantities of chemicals according to Specification MIL-M-3171:

- Sodium dichromate ($NaCr_2O_72H_2O$), 1-1/2 pounds
- Concentrated nitric acid (HNO_3, specific gravity 1.42), 1-1/2 pints
- Water to make one gallon of solution

2. For magnesium sand, permanent mold, or die castings, mix the following quantities of chemicals according to Specification MIL-M-3171:

- Sodium dichromate ($NaCr_2O_72H_2O$), 1-1/2 pounds
- Concentrated nitric acid (HNO_3, specific gravity 1.42), one to 1-1/2 pints
- Sodium, potassium, or ammonium acid fluoride ($NaHF_2$, KHF_2, NH_4, HF_2), 2 ounces
- Water to make one gallon of solution

NOTE

Mix solution in a rubber pair or polyethylene or glass container to avoid contamination of the solution by the container.

3. Apply applicable solution to affected area with a soft bristle brush or a clean, lint-free cloth. Prevent area from drying too rapidly by reapplying solution for approximately one to 3 minutes. Application temperature must be between 65°F and 90°F. Application time will vary; a brassy or dark brown finish color should be obtained in no less than 30 seconds and no more than 3 minutes. Overextending the time of application will allow powdery deposits to form, thus seriously affecting paint adhesion.

4. Immediately rinse treated area with clean running water after obtaining desired finish color. Rinsing may also be accomplished by wiping area with wet, lint-free cloth frequently rinsed in clean water. Surface drying should be accomplished by normal air or by directing low-pressure air onto the surface.

5. The Dow Process 19 may also be used for magnesium castings. Mix the following quantities of chemicals in one gallon of water:

- Chromic acid (CrO_3), 1-1/3 ounces
- Calcium sulfate ($CaSO_4$), one ounce

Slowly add chromic acid and then calcium sulfate while stirring. Stir for 15 minutes to ensure that chemicals are dissolved.

6. Apply this solution to affected area with a swab and allow to remain for one minute. Add more solution if necessary to maintain wetness during time interval.

7. Thoroughly rinse with clean water and allow to dry.

FINAL PROTECTIVE PAINT FINISH.

In case a final paint finish is required, application of the finish must be made within 2 hours after the chemical surface treatment is dry. The surface to be painted must be thoroughly clean and free from contamination. A stained surface resulting from a chemical surface treatment is not considered contamination. Attempts to remove this stain destroy the benefits of the surface treatment. Because of the limited use of paint finishes on prime aircraft, this manual only covers quantities and identification of material requirements for final paint finishes. Details regarding the use of final paint finishes can be found in T.O. 1-1-2 and 1-1-636. Wet dip all fasteners (rivets, bolts, high-shear, etc.) regardless of type, or material, as follows:

1. On fasteners not to be torqued immediately, dip in MIL-P-8585 zinc chromate.

2. On fasteners to be torqued or driven immediately, dip in MIL-P-23377B strontium chromate.

3. On fasteners in a sealed area, dip in MIL-S-8802 sealant.

CORROSION TREATMENT.

PAINT REMOVAL.

If the airplane is painted in an area where corrosion is detected, the paint should be completely removed. The method of paint removal will depend on the ease of accessibility to the corroded area.

NOTE

For complete airplane paint removal procedures, refer to T. O. 42A2-1-1.

PAINT STRIPPING IN ACCESSIBLE AREAS.

1. Apply solvent-type paint and lacquer remover (Specification MIL-R-25134) with a long-handled brush (Specification MIL-B-5612).

CAUTION

This paint remover is toxic and should be used in a well-ventilated area.

2. Let stripper remain on surface for approximately 5 to 15 minutes to allow paint finish to soften and wrinkle.

3. Wash surface with water under high pressure if possible; otherwise, paint should be removed using a clean, damp cloth.

4. Repeat these steps as necessary to completely remove paint.

PAINT STRIPPING IN CONFINED AREAS.

1. Apply ethyl acetate (Federal Specification TT-E-751) or lacquer thinner (Federal Specification TT-T-266) to corroded area, using a soft-bristled brush or clean cloth.

2. Agitate surface until paint is thoroughly loosened.

3. Wipe surface clean and allow to dry.

CORROSION TREATMENT OF STEEL AND ALUMINUM LANDING GEAR.

Care should be taken in all phases of corrosion treatment of landing gear if the treatment is to be performed on assembled gears. Since landing gear usually consist of a combination of steel, aluminum, and/or magnesium parts besides cracks and crevices, appropriate masking tape applications are

necessary to protect individual parts and moving surfaces. The extent of corrosion will determine whether the gear should be treated on the airplane or removed and disassembled. If the gear is heavily corroded, the most effective and economical means of treatment is accomplished after removal and disassembly.

CLEANING, CORROSION REMOVAL, AND CORROSION PROTECTION. Cleaning, corrosion removal, and corrosion protection are accomplished as indicated in previous applicable paragraphs and dependent on the type of metal treated. Since there is no surface treatment for steel and copper, a final paint finish will serve as corrosion protection except when the parts are inside the gear and in contact with hydraulic fluid.

FINAL PROTECTIVE PAINT FINISH.

1. External steel and aluminum are given a final protective paint finish consisting of the following:

- One coat pretreatment wash primer (Specifition MIL-C-15328)
- Two coats zinc-chromate primer (Specification MIL-P-8585)
- Two coats gray enamel (Specification MIL-E-7729) or two coats aluminized lacquer (Specification MIL-L-7178)

2. External copper and magnesium are given a final protective paint finish consisting of the following:

- One coat pretreatment wash primer (Specification MIL-C-15328)
- One coat vinyl zinc-chromate primer (Specification MIL-P-15930)
- Two coats gray vinyl topcoat (Specification MIL-P-15936)

CORROSION TREATMENT OF ROCKET BLAST AND EXHAUST AREAS.

CLEANING.

Rocket blast and exhaust areas should be cleaned as indicated by the alkaline cleaning method, except the solution should be mixed in the following proportions: one part alkaline water-base cleaner (Specification MIL-C-25769), diluted with one to three parts water.

PAINT REMOVAL.

Stripping of paint should be accomplished as given in "Paint Stripping in Accessible Areas" or "Paint Stripping in Confined Areas."

CORROSION REMOVAL AND PROTECTION.

Depending on metal involved in rocket blast or exhaust area, use appropriate corrosion removal and protection methods given under "Corrosion Control." If the metal involved is steel, a final paint finish is the only corrosion protection necessary.

FINAL PROTECTIVE PAINT FINISH FOR ALUMINUM OR STEEL.

For areas subjected to temperatures up to 300°F, aluminum and steel are given a final protective paint finish consisting of the following:

- One coat pretreatment wash primer, Specification MIL-C-15328
- Two coats zinc-chromate primer, Specification MIL-P-8585
- Two coats aluminized lacquer, Specification MIL-L-7178

For areas subjected to temperatures of 300°F to 400°F, aluminum and steel are given a final protective paint finish consisting of the following:

- One coat pretreatment wash primer (Specification MIL-C-15328)
- Two coats zinc-chromate primer (Specification MIL-P-8585)
- Three coats aluminized lacquer (Specification MIL-L-7178)
- One coat aluminized varnish (Specification MIL-V-6894)

CORROSION TREATMENT OF BATTERY COMPARTMENT.

REMOVING BATTERY ALKALI OR ACID.

1. Wash affected areas with plenty of white vinegar (Federal Specification Z-V-401B) or a 5 percent solution of water and acetic acid (Federal Specification O-A-76C), using brush dipped in the solution. Care must be taken not to splash acid solution onto surrounding surfaces.

WARNING

If alkali or acid gets into eyes or on hands, immediately flush with water and report to dispensary.

2. Rinse affected areas with plenty of clean water to dilute and remove sediment. Care must be taken not to splash water onto surrounding areas.

3. Treat affected areas with plenty of 20 percent solution of water and sodium bicarbonate (Federal Specification O-S-576B), applied with brush or cloth. Finally, allow solution to remain on surface for 5 minutes.

4. Remove sodium bicarbonate solution by rinsing with clean water and wipe dry.

CORROSION REMOVAL.

Corrosive deposits should be removed by the method governed by the type of metal involved as indicated under "Corrosion Control."

FINAL PROTECTIVE PAINT FINISH

The affected surface should be clean, dry, and free from contaminants before final paint finish is applied. The paint finish should consist of the following:

- One coat pretreatment wash primer (Specification MIL-C-15328)
- Two coats zinc-chromate primer (Specification MIL-P-8585)
- Two-mil coat of alkali and acid-resistant coating (Specification MIL-C-7439)

CORROSION TREATMENT OF CONTROL CABLES.

1. Move surface controls to reveal concealed areas of cable.

2. Clean cable with cloth, using dry-cleaning solvent (Federal Specification P-S-661, Type II).

WARNING

In areas of oxygen storage and transfer system, do not use solvent. This material and oxygen are highly explosive.

3. If cable looks rusted, relieve tension and inspect thoroughly.

4. Replace internally rusted cables.

5. If cable shows no evidence of rust, reapply corrosion-preventive compound (Specification MIL-C-16173, Grade 4), and adjust cable to proper tension.

CORROSION TREATMENT FOR MATED SURFACES OF TWO DISSIMILAR METALS.

LAP JOINTS.

All dissimilar lap joint surfaces, other than magnesium should be treated with two coats of zinc-chromate primer (Specification MIL-P-8585) on each surface. The first coat should be allowed to dry before the second coat is applied. Where magnesium is one of the dissimilar metals, the metals should be separated by an approved barrier tape such as Federal Stock No. 8030-200-9179. The tape must extend not less than 1/4 inch beyond the joint edges.

RIVETED AND BOLTED JOINTS.

All dissimilar metal applications involving bolt or rivet hole and fasteners, other than when magnesium is involved, should be treated as follows:

1. Clean hole surface, using an appropriate piece of No. 280 and then No. 400 abrasive grit paper. Clean outer surface surrounding hole, using rotary abrading wheel (Federal Stock No. 3460-528-3106). Wipe surface, using cloth slightly dampened with clean water and then dry. If grit paper has not removed hole surface corrosion or if too much metal surface has been removed, replace part.

2. If material removed is within limits and the metal is aluminum, carefully treat hole surface and surrounding area with chemical films for aluminum alloys (Specification MIL-C-5541), as indicated under "Corrosion Control."

3. Apply one coat of zinc-chromate primer (Specification MIL-P-8585), corrosion-preventive petrolatum (Specification MIL-C-11796, Class 3), or corrosion-preventive compound (Specification MIL-C-16173, Grade I) to surface of hole with brush or swab.

4. In case a protective paint finish is required, apply the following to the outer surface:

- One coat wash primer (Specification MIL-C-8514), 0.2 to 0.3 mil thick
- One coat zinc-chromate primer (Specification MIL-P-7962), 0.3 to 0.4 mil thick
- Two coats acrylic nitrocellulose lacquer (Specification MIL-L-19537), 0.4 to 0.5 mil per coat

NOTE

Use Specification MIL-P-7962 zinc-chromate primer with Federal Specification TT-T-266 lacquer thinner and Specification MIL-L-19537 acrylic nitrocellulose lacquer with Specification MIL-T-19544 lacquer thinner in the following proportion:

- Three parts by volume of Federal Specification TT-T-266 to two parts by volume of Specification MIL-P-7962.
- One part by volume of Specification MIL-T-19544 to one part by volume of Specification MIL-L-19537. (For pigmentation, add 12 ounces of Federal Specification TT-A-468, Type II, Class A, to every gallon of Specification MIL-L-19537.

Allow zinc-chromate primer to dry at least one hour between coats, and allow acrylic lacquer to dry at least 45 minutes between coats.

Dissimilar metal applications involving bolt or rivet hole and fastener, where the hole surface metal is magnesium, should be treated in the following manner:

1. Clean hole surface with an appropriate piece of No. 280 and then No. 400 grit abrasive paper. Clean outer surface surrounding hole with rotary abrading wheel (Federal Stock No. 3460-528-3106). Wipe surface with cloth slightly dampened with clean water, and then dry. If grit paper has not removed hole surface corrosion or if too much metal surface has been removed, replace part.

2. If material removed is within limits and metal is magnesium, carefully treat hole surface and surrounding area according to Specification MIL-M-3171 and as indicated under "Corrosion Control."

3. Apply sealing compound (Specification MIL-S-8802 or MIL-S-7502) to surface of hole as indicated on compound container. After rivet has been bucked or bolt has been tightened, clean excess material from area with damp cloth.

4. In case a protective paint finish is required, apply the following to outer surface:

- One coat wash primer (Specification MIL-C-8514), 0.2 to 0.3 mil thick
- Two coats zinc-chromate primer (Specification MIL-P-7962), 0.3 to 0.4 mil per coat
- Three coats acrylic nitrocellulose lacquer (Specification MIL-L-19537), 0.4 to 0.5 mil per coat

NOTE

Since Specifications MIL-S-7502 and MIL-S-8802 sealing compounds have a maximum application time (pot life) of 2 hours, judgment should be used on the quantity of compound to be mixed.

AREAS REQUIRING SPECIAL CORROSION INSPECTION.

See applicable repair index to determine the variation between metals in contact. Critical corrosive areas are located where dissimilar metals are in contact and have an algebraic difference of four or more between metallic groupings as shown by the following examples:

7075-T6 (Group 4) in contact with 18-8 stainless steel (Group 8) is critical 8 - 4 = 4.

6061-T6 (Group 4) in contact with steel (Group 7) is not critical, 7 - 4 = 3.

NOTE

As the difference in metallic groupings becomes greater, the degree of corrosiveness is higher.

CORROSIVE EFFECTS OF AIRCRAFT FIRE-EXTINGUISHING AGENTS AND METHODS OF REMOVAL.

CORROSIVE EFFECTS AND REMOVAL OF DRY CHEMICAL POWDER.

This type of extinguisher uses a specially prepared grade of sodium bicarbonate as the extinguishing agent. Heat causes the bicarbonate to decompose, releasing carbon dioxide gas and water vapor to smother the fire. A powdery residue of sodium carbonate (soda ash) will usually remain on and around the heat-affected area.

Dry sodium bicarbonate is nonabrasive and noncorrosive. In water solution, it will cause mild corrosion of most metals by either electrolytic or chemical means. However, its rate of corrosion is so slow that it can be cleaned up with little chance of damaging delicate parts. The decomposition product, sodium carbonate, will cause little damage if kept dry, but in solution with water is strongly caustic and will rapidly attack many common aircraft materials. For this reason, when water is used to clean up after a fire, thorough rinsing is absolutely necessary to eliminate any pockets of strong carbonate solution from the airplane. Care should be taken to prevent sodium carbonate dust from entering the eyes, nose, or mouth during the following cleanup procedure.

In areas of the airplane which are free of electrical equipment, or where it is hermetically sealed, such as in wheel wells, blow any powder residue away with compressed air. Wash the area thoroughly with fresh water and then dry with clean rags and compressed air. When nonsealed electrical and electronic equipment is present, the decision to use water should be determined by how readily this equipment can be removed or dried. (Large bundles of wire will have to be loosened and blown dry.) If it is decided that water would be harmful to any of the airplane equipment, sodium carbonate can be removed satisfactorily by a combination of brushing, vacuum cleaning, and careful blowing with compressed air.

When the powdery residue sticks to hydraulic oil or grease, it should be removed with the solvent approved for removing the oil or grease alone.

CORROSIVE EFFECTS AND REMOVAL OF MECHANICAL FOAM.

This fire-extinguishing agent is harmless to all materials not damageable by water alone. It is normally used on major fires that will damage the airplane extensively. The foam may be removed with a high-velocity jet of fresh water and scrubbing with a fiber brush. Dry the airplane thoroughly with clean rags and compressed air. Remove all affected, nonsealed electrical and electronic components immediately. Dry and prepare them for overhaul in accordance with current directives.

CORROSIVE EFFECT AND REMOVAL OF OTHER EXTINGUISHING AGENTS.

Carbon dioxide and carbon tetrachloride evaporate rapidly and normally require no cleanup. Chlorobromomethane is highly corrosive. It evaporates rapidly, but if any of the substance is trapped in pockets it must be cleaned out.

CORROSION CONTROL MATERIALS.

FEDERAL STOCK NO.	NOMENCLATURE	SPECIFICATION	SOURCE	APPLICATION
	CLEANING MATERIALS AND EQUIPMENT			
7930-543-4552	Alkaline water base cleaner	MIL-C-25769	AF stock	Cleaning
6810-290-0053	Dry-cleaning solvent	Fed. Spec P-S-661B	Local purchase	Cleaning
7920-281-7009	Nonmetallic brush	MIL-B-5612	Local purchase	Cleaning
9140-242-6750	Kerosene	Fed. Spec VV-K-211C	Local purchase	Cleaning
6810-285-4318	Trichloroethylene	MIL-T-7003	AF stock	Cleaning copper
6810-223-2737	Dichloromethane	MIL-D-6998	AF stock	Cleaning copper
6810-281-2762	Methyl ethyl ketone	Fed. Spec TT-M-261	AF stock	Cleaning metal
8010-160-5787	Lacquer thinner	Fed. Spec TT-T-266	Local purchase	Cleaning metal
4940-567-9558	Portable air pressure spray cleaner, 20-gallon	—	AF stock	Applying cleaner or acid
6850-527-2426	Metal conditioner and brightener	MIL-C-25378	Local purchase	Cleaning clad aluminum alloys
7510-266-6710	Masking tape	—	Local purchase	Protecting surface while cleaning
8340-262-3679	Vinyl plastic tarpaulin	—	AF stock	Protecting landing gear tires and wheels
	CORROSION REMOVERS AND EQUIPMENT			
6850-527-2426	Metal conditioner and brightener	MIL-C-25378	Local purchase	Removing corrosion from aluminum
5350-286-4851	Aluminum wool	MIL-A-4864	Local purchase	Removing corrosion from aluminum
7920 N/L	Aluminum brush	—	Local purchase	Removing corrosion from aluminum
7920 N/L	Stainless steel brush	—	Local purchase	Removing corrosion from steel
5350-721-8119	No. 280 emery cloth	—	Local purchase	Removing corrosion from bare aluminum and magnesium
5350-721-8118	No. 400 emery cloth	—	Local purchase	Removing corrosion from bare aluminum and magnesium
5350-186-8812	No. 500 emery cloth	—	Local purchase	Removing corrosion from bare aluminum and magnesium
6810-587-5775	Chromic acid	Fed. Spec O-C-303	Local purchase	Removing corrosion from magnesium
5350-242-4405	Steel wool	—	Local purchase	Removing corrosion from steel
6850-201-1218	Phosphoric acid	MIL-M-10578B	Local purchase	Removing corrosion from steel
7920-633-9911	Sponge cellulose	—	Local purchase	Rinsing
7240-125-9060	Rubber pail, 3-gallon	—	Local purchase	Used with acid
3460-528-3106	1-1/2-inch abrading wheel (soft)	—	AF stock	Removing corrosion
3460-528-3105	2-inch abrading wheel (soft)	—	AF stock	Removing corrosion
3460-528-3102	2-inch abrading wheel (tough)	—	AF stock	Removing corrosion
	PAINT REMOVERS			
8010-165-5535	Paint remover	MIL-R-25134	AF stock	Removing paint
8010-165-5536	Paint remover	MIL-R-25134	AF stock	Removing paint

FEDERAL STOCK NO.	NOMENCLATURE	SPECIFICATION	SOURCE	APPLICATION
6810-209-8091	Ethyl acetate	Fed. Spec TT-E-751	AF stock	Removing paint
6810-209-8093	Ethyl acetate	Fed. Spec TT-E-751	AF stock	Removing paint
7920-281-7009	Fiber brush	MIL-B-5612	Local purchase	Removing paint
		CORROSION-PROTECTIVE TREATMENT		
8030-099-1052	Chemical films for aluminum alloys	MIL-C-5541	Local purchase	Protecting aluminum
6810-281-2686	Sodium dichromate	Fed. Spec O-S-595a	Local purchase	Protecting magnesium
6810-N/L	Sodium acid fluoride	—	Local purchase	Protecting magnesium
6810-N/L	Potassium acid fluoride	—	Local purchase	Protecting magnesium
6810-N/L	Ammonium acid fluoride	—	Local purchase	Protecting magnesium
8030-231-2354	Corrosion-preventive petrolatum	MIL-C-11796A	Local purchase	Protecting metal
8030-526-1605	Corrosion-preventive compound	MIL-C-16173B	Local purchase	Protecting metal
6810-271-1410	Nitric acid (specific gravity 1.42)	—	Local purchase	Protecting magnesium
8030-200-9178	Zinc-chromate barrier tape	—	AF stock	Protecting dissimilar metals
8030-200-9179	Zinc-chromate barrier tape	—	AF stock	Protecting dissimilar metals
		PAINTS AND FINISHES		
8010-246-0872	Zinc-chromate primer	MIL-P-8585A	AF stock	Protecting metals
8010-165-8626	Zinc-chromate primer	MIL-P-8585A	AF stock	Protecting metals
8010-597-7864	Gray enamel	MIL-E-7729	AF stock	Additional protection
8010-241-8406	Aluminized lacquer	MIL-L-7178	AF stock	Additional protection
8010-168-8810	Aluminized varnish	MIL-V-6894	AF stock	Additional protection
8010-221-2777	Fuel-resistant lacquer	MIL-L-6047	AF stock	Protecting inside fuel tanks
8010-221-2773	Alkali- and acid-resistant lacquer	Fed. Spec TT-L-54	AF stock	Protecting battery compartments
8030-506-4030	Elastometric coating	MIL-C-7439	Local purchase	Protecting battery compartments
8010-664-4966	Wash primer	MIL-C-15328A	AF stock	Pretreat coating
8010-634-7324	Vinyl topcoat	MIL-P-15936	AF stock	Special area finish
8010-664-0018	Vinyl primer	MIL-P-15930A	AF stock	Special area finish
8030-597-0892	Wash primer	MIL-C-8514	AF stock	Pretreat coating
8010-526-2523	Zinc-chromate primer	MIL-P-7962	AF stock	Protecting metals
8010-527-1508	Acrylic nitrocellulose lacquer	MIL-L-19537	AF stock	Final paint finish
8010-527-2897	Lacquer thinner	MIL-T-19544	AF stock	Thin lacquer
8010-687-4019	Aluminum pigment	Fed. Spec TT-A-468	AF stock	Pigmenting clear lacquer

FEDERAL STOCK NO.	NOMENCLATURE	SPECIFICATION	SOURCE	APPLICATION
		PERSONNEL EQUIPMENT		
8405-265-6058	Vinyl-coated fiber glass apron, Type C1-A	—	AF stock	Protecting personnel
8405-268-8003	Rubberized coveralls	—	AF stock	Protecting personnel
8405-268-8049	Wet-weather trousers	—	AF stock	Protecting personnel
8430-147-1022	Boots, size 9	—	AF stock	Protecting personnel
8430-160-8587	Boots, size 7	—	AF stock	Protecting personnel
8415-634-6522	Oil- and chemical-resistant gloves	—	AF stock	Protecting personnel
4240-278-9646	Plastic safety goggles	—	AF stock	Protecting personnel
		MISCELLANEOUS MATERIALS AND EQUIPMENT		
8030-723-2746	Sealing compound	MIL-S-8802	AF stock	Coating lap surfaces and holes
8030-270-8144	Sealing compound	MIL-S-7502	AF stock	Coating lap surfaces and holes
8030-243-3285	Antiseize compound	MIL-T-5544	AF stock	Coating bolt threads
4920-831-5932	Metal identification kit USAF Dwg 61B25042	—	AF stock	Identifying metals and surface finishes
8950-223-5849	White vinegar	Fed. Spec Z-V-401B	Local purchase	Neutralizing alkali
6810-275-1215	Acetic acid	Fed. Spec O-A-76C	Local purchase	Neutralizing alkali
6810-237-2914	Sodium bicarbonate	Fed. Spec O-S-576B	AF stock	Neutralizing acid

INVESTIGATING STRUCTURAL DAMAGE.

The primary structure of an airplane is designed to resist variable forces imposed upon it in operation. The structure must distribute these forces to the principal structural strength members of the wing and fuselage. When a member has been damaged, a complete and thorough inspection must be made. This inspection should include the damaged structural member and the adjacent or attaching members. It is possible that the damaging force might have been transmitted over the surrounding structure causing secondary damage in areas other than the primary damage area. If the secondary damage is not discovered, forces distributed through the structure during normal airplane operation may cause this structure to fail. Careful investigation of all structure across which the forces must travel must be made, and parts must be checked for possible misalignment.

PRELIMINARY EXTERNAL INSPECTION.

A great deal may be learned about the condition of the internal structure of an airplane by a careful examination of the skin on the wings, stabilizers, and fuselage. Some indications might be buckle patterns on surface skin of stabilizers and along the sides, top and bottom of fuselage. Loose, tipped, or sheared fasteners, and joggles or bulges in the skin at structural points or where heavy fittings are attached, indicate that a thorough inspection of the underneath structure should be made. Inspect fairings and other nonstructural parts for tears, cracks, buckles, and misalignment. Any unusual appearance of these parts is reason for a close inspection of the structures they cover.

Check also the fit of doors, covers, canopy, etc. Anything unusual about their fit or alignment may indicate a warped or sprung structure, and will be cause for inspection of that structure.

When possible, actuate control surfaces, flaps, speed brakes, etc. Observe these units closely throughout their travel. They should operate freely and without binding or chafing. In the zero or closed positions, check the units for proper alignment with adjacent members.

DETAILED VISUAL INSPECTION.

Carefully inspect all areas adjacent to the obvious damage, remove access panel and doors (figures 1-2 through 1-4), and inspect structure, forgings, and other machined parts for cracks and for evidence of having been moved. This can often be done

by observing the paint around the edges, tipped bolt or rivet heads, or a slight space at the edge of faying surfaces. When possible, remove two bolts from a suspected fitting. Examine bolts for evidence of shearing or bending. Check bolt holes for elongation.

Inspect supporting structures for buckling, warpage, and joggles. Check for sheared, loose, or tipped fasteners. Alignment with adjacent members is also important.

Using a straightedge, check known flat areas such as spar webs, frame webs, and bulkheads. Any deviation should be thoroughly investigated.

When an airplane has been damaged, or damage is suspected, a close examination is justified for all areas where major components are joined, or where heavy weights are supported. The principal areas of this nature, with their supporting structures, are as follows:

- Wing center section to outer wing panel
- Wing-to-fuselage attachment points
- Fuselage rear section attachment point
- Horizontal stabilizer attachment point
- Vertical stabilizer attachment point
- Rudder hinge
- Aileron and rudder balance weight attachment point
- Landing gear trunnion and braces
- Engine mount

Continue the inspection throughout the disassembly and repair of the airplane. During this time, indications of unsuspected damage are often revealed. When new parts being installed do not fit properly, find out why. It may be because of damage which has been overlooked.

After movable members have been installed, move them through their full range of travel as soon as possible. Check closely for freedom of movement and proper clearances and alignment. It is often helpful to install a control surface or other mechanism on a temporary basis while the structural repair in in progress. It will aid in the alignment of parts being repaired or replaced and may also reveal unnoticed damage.

SKIN BUCKLING.

The mere presence of wrinkled or buckled skin is not positive evidence of an overloaded structure. It is not uncommon to find permanently buckled skin on an airplane which has never been overloaded. These buckles may appear on new airplanes because of manufacturing tolerances, or on others merely as evidence of age. In many examples of present-day design, the vital importance of saving weight has led to types of structure in which the skin is designed to buckle, even to a large degree, under normal loading within the established flight limits of the airplane. Under perfect circumstances, these buckles disappear each time the loads are removed. It is therefore important to remember that buckled structure is not necessarily weakened structure. However, it is also important to remember that, although buckles themselves do not generally detract from the strength of the structure, their presence may be an external indication of trouble elsewhere. Unfortunately, since no hard and fast rules can be laid down, it must be left to experience and judgment to determine when an internal inspection should be made. For example, the sudden appearance of buckles after any one flight, where there were no buckles before, justifies an examination. Buckles that cross rows of rivets should be investigated. These are often a sign of tension failure in the rivets straddling the buckle, or a crippling failure in the flange of the internal member. Unusually severe buckles or sharp creases in the skin often lead to cracks after repeated flexing and, therefore, should be investigated.

FIRE DAMAGE EVALUATION.

Three methods are used in checking airplane structures after a fire: visual inspection for buckles, canning, and primer discoloration; hardness testing of questionable parts with portable or stationary hardness tester; and tension testing of specimens taken from areas of doubtful values.

In visually inspecting an airplane, the search for buckles or canning is primarily concerned with the possibly weakened condition of primary internal structures. This is especially important when the fire has been in the wing area. It is possible that an area unaffected by the fire directly may have been bent enough to receive a permanent set.

Large (or thick) aluminum parts, such as forgings, are not as quickly affected by heat as are thinner and smaller components. However, when heat has been great enough to injure sheet and extruded parts, all heavy fittings in the area should be removed and hardness tested. Similar parts from unaffected areas may be used for a comparison.

It is often necessary to remove sample disks from sheet-metal parts in order to test them on a bench-type hardness tester. Disks for this purpose should be removed with a one-inch hole saw. If the part is to be retained in use, make repairs as directed in the applicable section of this handbook.

Access hole covers in the fire area are excellent samples for hardness sampling. They also provide an easily replaceable part for destructive testing.

COLOR-HARDNESS-STRENGTH CORRELATIONS

GENERAL

SAMPLES FROM ONE FIRE-DAMAGED AIRPLANE

	ROCKWELL HARDNESS	PRIMER COLOR	ULTIMATE TENSILE STRENGTH	YIELD STRENGTH	ELONGATION PERCENT IN 2 INCHES
1	B38-40	BLACK	43,000 43,400	23,100 17,950	11 12
2	B38-40	BLACK	47,700 47,100	24,000 24,600	11 12
3	B52-56	BLACK	53,800 54,200	27,500 27,100	16.5 16
4	B-57	BLACK	54,000 54,300	27,500 28,600	14.5 15
5	B61-64	BROWN	56,100 56,500	41,700 43,300	6.5 7.5
6	B78-80 B68-72	TAN BROWN	64,500 61,600	51,600 47,700	6 6
7	B80-82	YELLOW (NORMAL)	74,800 74,100	63,400 65,400	13.5 12
Minimum values for 7075-T6 Federal Spec QQ-A-287			72,000	62,000	8

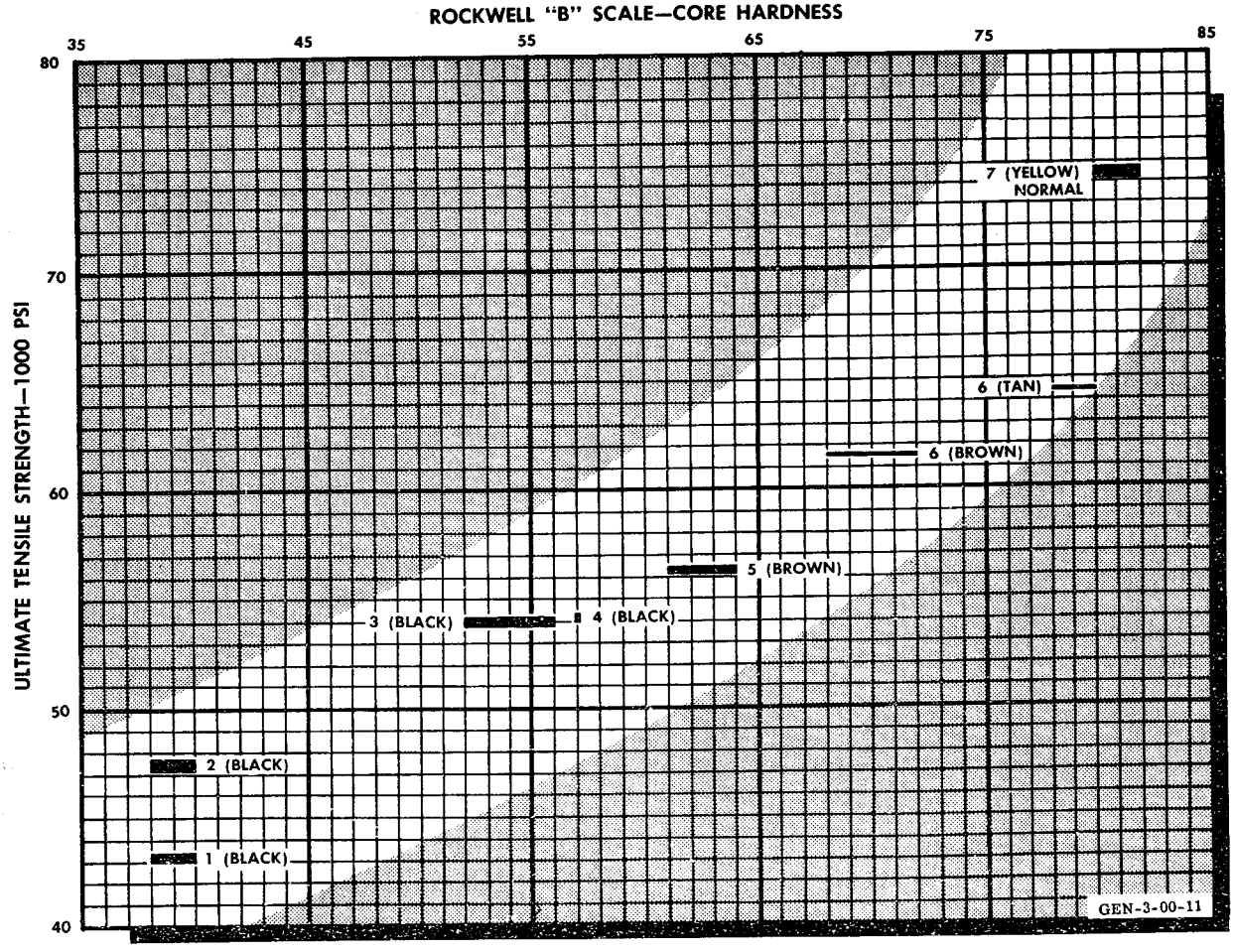


Figure 1-10. Color Hardness Strength Correlations - 7075-T6 Aluminum Alloy

When tension bars from sheet-metal parts are taken for laboratory testing, the blanks removed should measure 1 X 7 inches. However, pieces measuring 1 X 5 inches are acceptable. They should be cut with the long edges in line with the grain whenever possible. When parts or samples are sent to a laboratory for analysis, information about the type and duration of the fire should be included.

PRIMER DISCOLORATION EVALUATION.

Determining the extent of fire damage by zinc-chromate primer comparison can be reliable when used carefully. A clean sample of the primer known to be unaffected by heat is compared with chromate in the heated area. The sample should be from the same general area of the structure in question. The suspected area must be free of dirt, oil, and smoke.

Untinted chromate primer is a slightly greenish yellow. When exposed to about 300 degrees of heat for a few minutes, it turns a light tan color. Temperatures which discolor chromate primers will change the physical properties of 2024-T4 and 7075-T6 materials. The 7075 which is already in the T6, or artificially aged, condition will be softened and weakened. The 2024-T4 will be artificially aged and hardened, until the temperature reaches 500 degrees; then, with increased heat, this metal also softens and weakens. (See figure 1-10.) When the temperature of 2024-T4 is raised to 300 to 500 degrees for a short period under uncontrolled conditions, as is the case in an airplane fire, the inherent corrosion-resisting properties are seriously affected.

Both 2024-T4 and 7075-T6 materials are of questionable value and should be subjected to more accurate methods of testing when the slightest discoloration of the primer is evident.

Reliable limits of correlation between hardness tests and tensile tests have been established for 7075-T6, using hardness testers. Material which gives readings of 84 to 94 in the Rockwell "B" scale is normal. Material which falls below the minimum should be replaced, or specimens should be removed from the areas with the lowest Rockwell readings and sent to a laboratory for tension tests.

Hardness test readings are not accurate indications of heat damage on 2024-T4 material because of the corrosion factor. A quick heating to 300 degrees may not raise the hardness number above normal but will affect the corrosion resistance. Therefore, if chromate primer discoloration indicates heat has affected the material, it should be replaced or a specimen removed and sent to a laboratory for tension and corrosion-susceptibility tests.

If a decision is made to retain in use a section of 2024-T4 material which has undergone slight mechanical change due to fire, every effort should be made to protect the metal. Painted areas should be stripped, treated with phosphoric cleaner, Iridite No. 14, and repainted. Surfaces not normally painted should be treated with phosphoric cleaner.

CHEMICAL TESTING AND INSPECTION.

IDENTIFICATION OF MATERIALS BY CHEMICAL TESTING.

It is often necessary to distinguish 7075 from the other aluminum alloys, and magnesium alloys from those of aluminum.

IDENTIFICATION OF 7075 ALUMINUM ALLOY BY CHEMICAL TEST.

A chemical spot-test kit, containing the solutions and equipment which will aid in this type of inspection can be made up. The formula for preparing the 7075 spot-test solution, with specification numbers of chemicals used, is as follows:

- 5 grams of cadmium sulphate (commercial)
- 5 milliliters of hydrochloric acid (Federal Specification O-A-86)
- 3 grams of sodium chloride (commercial)
- 100 milliliters of distilled water

Other materials and specification numbers are as follows:

- Chemical film solution (Specification MIL-C-5541)
- 20 percent solution chromic acid (Federal Specification O-C-303)
- Phosphoric acid cleaner (Specification MIL-C-5410, Type I)
- Silver nitrate crystals (commercial)
- Methyl ethyl ketone (Federal Specification TT-M-261)
- Nitric acid (Federal Specification O-A-88)

Most of the solutions are both poisonous and corrosive. Reasonable precautions should be taken in handling them. If any solution is spilled on the skin, immediately wash the area well with cold, running water. If the area feels irritated (stings or feels warm) after washing, report to the dispensary for treatment.

Because 7075 is an aluminum alloy which contains zinc, it is quickly and accurately identified by a simple chemical test. Because there is one percent zinc in the cladding of 7075, this test will work on either bare or clad material.

Remove paint, if present, from an area about the size of a dime. Clean area thoroughly with methyl

ethyl ketone (Federal Specification TT-M-261). Remove surface film by lightly sanding with No. 320 grit abrasive cloth. To avoid contamination, use a fresh piece of abrasive cloth for each test.

Place one drop of 7075 spot-test solution on the prepared surface. Allow to stand one minute; then rinse off the test solution with water and examine the spot. If the alloy is 7075, a dark gray deposit of cadmium will be seen. It is recommended that the sample pieces of 7075 and 2024 included in the kit be run with the test piece for comparison.

After the alloy is identified, it should be refinished as follows if material is to remain unpainted:

1. Remove any dark deposit with Bon Ami or very fine abrasive cloth.

2. Swab the area with phosphoric acid cleaner (Specification MIL-C-5410, Type I) and keep wet for 3 to 5 minutes.

3. Rinse thoroughly with water. Dry to avoid spotting.

After the alloy has been identified, it should be refinished as follows if material is to be painted:

1. Clean area as outlined in the three preceding steps.

2. Swab cleaned area with chemical film solution (Specification MIL-C-5541) and keep wet for 3 to 5 minutes.

3. Rinse thoroughly with water and allow to dry. (Do not rub.)

4. Apply two coats of zinc-chromate primer and any colored finish coats required.

IDENTIFICATION OF MAGNESIUM ALLOYS BY CHEMICAL TEST.

Magnesium alloy parts may be separated from those made of aluminum alloys by using the following spot-test procedure. Remove paint, if present, from an area about the size of a dime. Wipe area clean with methyl ethyl ketone (Federal Specification TT-M-261). If methyl ethyl ketone (MEK) is not available, lacquer thinner may be substituted.

Dissolve a few silver nitrate crystals in a small amount of distilled water. Place one or two drops of the silver nitrate solution on the test area. If the material is magnesium, the clear liquid will immediately turn black. If the material is an aluminum alloy, there will be no reaction. It is recommended that the operator check the aluminum and magnesium samples included in the test kit to familiarize himself with these reactions.

Silver nitrate in solution cannot be stored for long periods. However, if tests are to be made frequently, a small bottle of solution may be made up and used until it starts to darken or become cloudy.

The area tested must be thoroughly washed with water and treated as follows: If the material is an aluminum alloy, refinish as directed in "Identification of 7075 Aluminum Alloy by Chemical Test."

If material is a magnesium alloy:

1. Wash test area thoroughly with water.

2. Remove black stain with Bon Ami or fine abrasive paper.

3. Swab with 20 percent solution of chromic acid (Federal Specification O-C-303). Allow to stand 2 minutes.

4. Rinse with water and dry.

5. Apply one coat wash primer (Specification MIL-C-15328 or Specification MIL-C-8514).

6. Apply two coats of zinc-chromate primer (three coats on areas containing dissimilar metals).

7. Apply colored finish as required.

CHEMICAL TEST FOR DAMAGED CLADDING.

To determine if the cladding on clad aluminum alloy has been penetrated by scratches or nicks, thoroughly clean the surface with methyl ethyl ketone (Federal Specification TT-M-261) and apply a 10-percent solution of sodium hydroxide (Specification MIL-S-11795) to the surface. If the damage has gone through the clad coating, a black or dark brown discoloration will appear. Because of its corrosive action, the solution should not remain on the surface more than 2 minutes. After test is completed, the area must be thoroughly washed with water.

PENETRANT INSPECTION METHOD.

Penetrant inspection materials are flourescent and glow strongly when exposed to black light.

The penetrant method of inspection may be used for detection of surface defects or indications on nonabsorbent nonporous materials and parts which will not be harmed by chemical or physical reaction with the inspection materials. Typical examples of items which may be inspected are machined steel parts, aluminum castings, glazed ceramic and glass items, and certain plastic parts.

Parts to be inspected must be free of paint and thoroughly cleaned with approved paint removers and cleaning solvents. Chemicals should be handled and stored in accordance with applicable Technical Orders.

The surface to be inspected should be dry and free of dirt, scale, oil, or grease. Parts may be vapor-degreased or cleaned with solvent.

Apply penetrant by brush or spray and allow to stand for about 2 minutes. Recover the same area with additional penetrant and allow to stand for another 3 minutes. For extremely small flaws such as grinding checks, apply penetrant three times and allow 5 minutes penetration time after each application.

Wipe off as much penetrant as possible with a clean, dry rag and follow with a rag impregnated with solvent. The surface should then be wiped dry with another clean rag. It is important to thoroughly remove all penetrant so as to avoid false indications. A cotton swab dipped in solvent is helpful in drying drilled holes, threads, re-entrant angles, etc. Do not soak parts by immersing them in cleaner, as this might weaken indications. Do not dry parts with strong air blast.

The developer must be kept thoroughly mixed while in use. Before applying developer, shake the bottle vigorously. Apply a thin, even coat of developer and observe part closely as the developer dries. Blowing on the part gently with the mouth speeds the drying and is sometimes helpful in detecting small cracks. Make only one application of developer, as repeated applications tend to wash away small indications.

Cracks or voids will exude dye (figure 1-11) and cause a bright red indication. A red line indicates a crack, cold shut, or lap. Random red dots show pits or porosity. A series of red dots in a line indicates a very tight crack. The extent or volume of the discontinuity can be estimated by the indication, or amount of spreading out. A diffused pink color shows that all of the penetrant was not thoroughly cleaned off before the developer was applied. If a very tight crack is suspected, allow several minutes for the indications to appear.

It is important to avoid contaminating the solvent and developer with the penetrant. This is oil-soluble and can be removed from the hand, etc, with ordinary solvents. All four solutions are chemically noncorrosive and can be left in contact with metals as long as desired. Keep all solutions tightly capped to minimize evaporation when not in use.

Fluorescent penetrant Type I Method C is used in the procedures contained in this manual. Refer to MIL-I-6866, TO 33B-1-1, and TO 1T-28A-36.

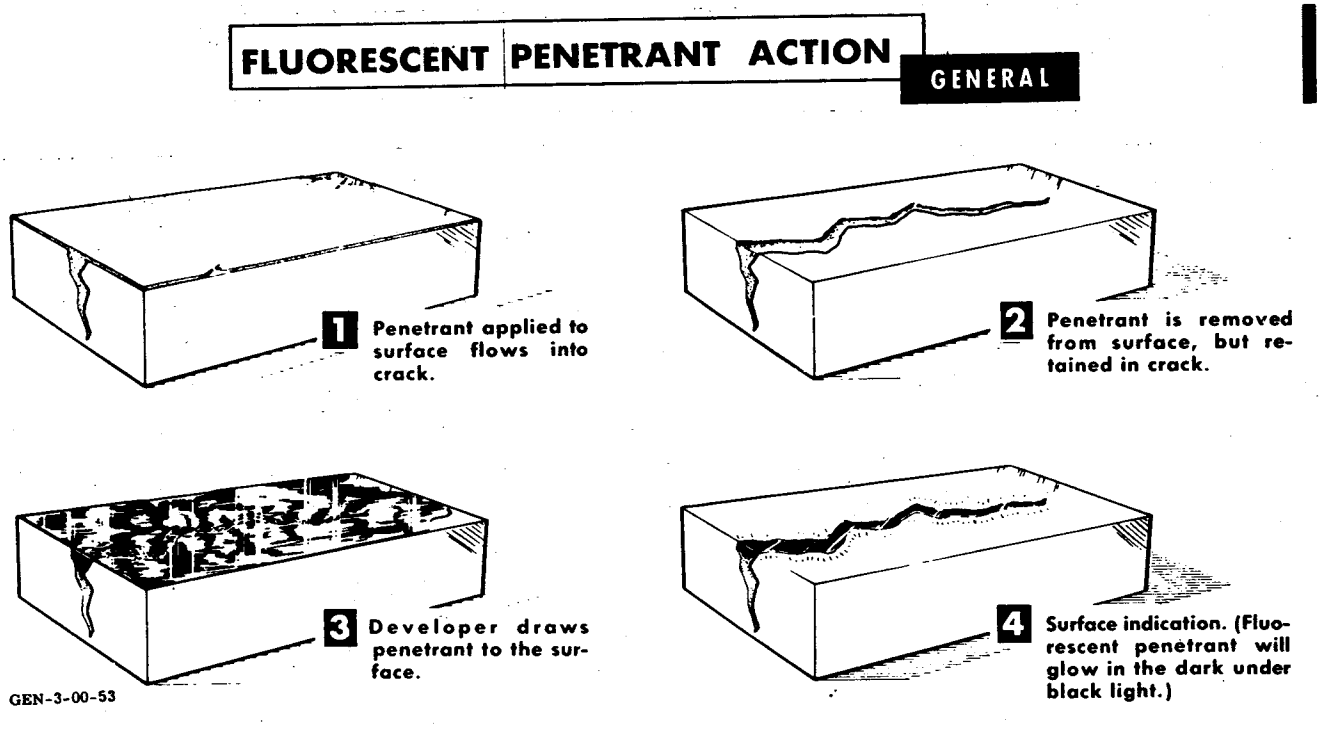


Figure 1-11. Penetrant Inspection

- Zyglo developer ZP-3
- Black light — Magnaflux ZB-26

(Refer to Appendix I for sources of commercial products.)

HAND-FORMING

FLANGES AND ANGLES.

When making repairs, it is often necessary to make a part when replacement parts are not available. Several different methods of hand-forming concave and convex flanges and angles are shown in figure 1-12.

STOP DRILLING.

See figure 1-13.

LOCATING SKIN TRIM LINES.

LOCATING SKIN TRIM LINES WITH SKIN SCRIBE.

The skin scribe shown in figure 1-15 is made of any steel that is handy, but a material that will take and hold a good scribing edge will last longer and give the most satisfactory results.

This tool is equally useful for marking the "cut lines" of irregular as well as straight-lined flush patches, cover plates, doors, etc. The turned-down tip on the lower strap is bent as sharply as possible; then the inside edge is rounded to about a 1/4-inch radius. It should be polished so that it will slide smoothly along the inside edge of the cutout being matched. The scribe point on the upper strap is set 1/32 inch outside the inner edge of the guide to allow for the desired skin gap.

The edges of cutout to be matched should be filed or sanded smooth. The oversized filler sheet should be placed over the hole and held firmly in place while the scriber is drawn around it as illustrated in figure 1-15.

LOCATING SKIN TRIM LINES WITH MASKING TAPE.

Locating the trim lines for flush patch fillers, access covers, etc, when there is no access to the back side for marking, may be done with masking tape as shown in figure 1-15. This method is best when used on rectangular openings.

The cutout to be matched is filed or sanded smooth. The filler sheet is cut slightly oversize and formed to match the mold line of the repair area. Strips of masking tape are aligned along the edges of the opening to form a frame. The filler sheet is centered over the opening and taped down with tape of the same width as used underneath. Carefully align outer edges of outer or second tape with the first layer, and pull it tightly up over the filler. (Do not press tape into corners formed by edges of filler and base structure.) When thinner gages of filler material are used, the inner edge of the outer tape will closely match the edges of the cutout. When the filler material is thick, the outer tape will fall a little short of matching the edges of the cutout and, unless this is compensated for when marking, the filler will be too large for the opening. Unless otherwise specified, the skin gap is 1/32 (+1/32, —0) inch.

LOCATING BLIND HOLES.

LOCATING BLIND HOLES WITH HOLE FINDER.

The fastest and most accurate method of locating blind fastener holes is with the hole finder. They may be made of various materials and in special shapes and sizes when the conditions of the job do not permit the use of a hole finder such as is shown in figure 1-16. Although a temporary or one-time-use tool may be fabricated in a few minutes from any scrap of hardened aluminum alloy and a rivet of the desired size, it is urged that each sheet-metal worker provide himself with a complete set of well-made tools similar to the one shown in figure 1-16. A complete set will consist of a hole finder for each size sheet-metal fastener used, usually 3/32 inch through 5/16 inch.

When blind holes are being located with a hole finder, it is important that the material being marked or pilot-drilled does not move. It is usually advisable to fasten it to the understructure with two temporary fasteners and move them as necessary as the marking or drilling progresses.

LOCATING BLIND HOLES WITH A SCALE.

Two methods of locating blind holes with a steel scale are shown in figure 1-16.

FILLING DIMPLED HOLES.

See figure 1-17.

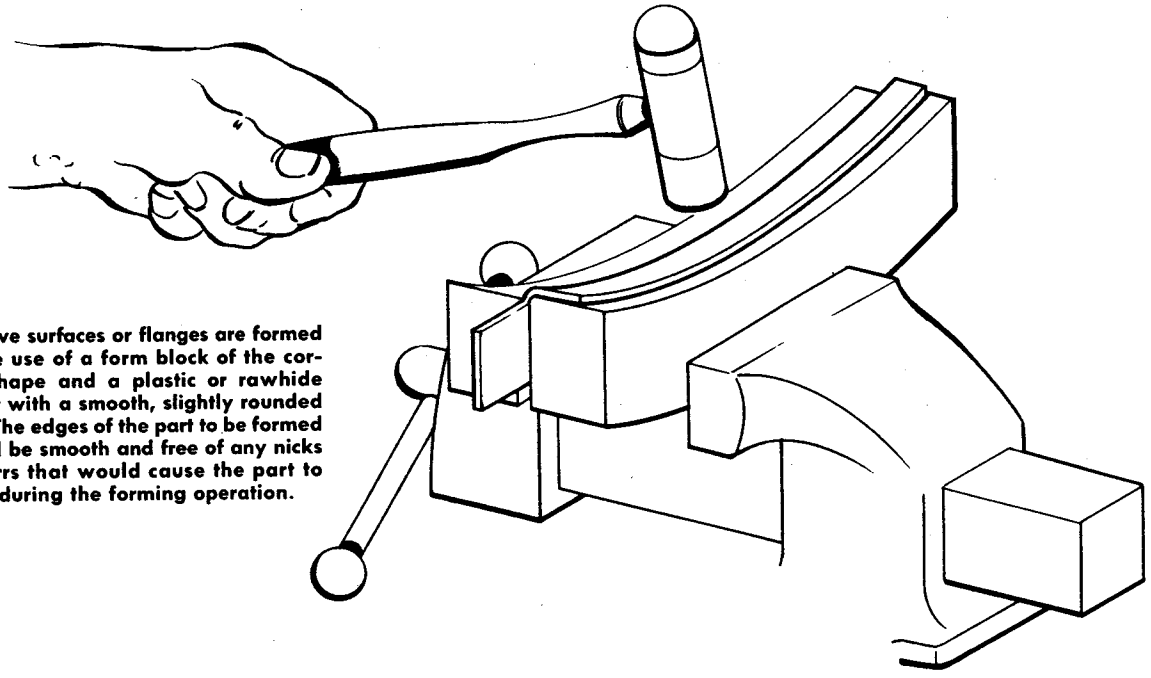
TRIMMING FASTENER HEADS.

When an outer skin has been repaired or replaced, all new flush rivets should be inspected for flushness. In the event that some of the rivet heads protrude excessively, they should be milled with either an electric or pneumatic rivet mill to meet the flushness requirements shown in figure 1-18.

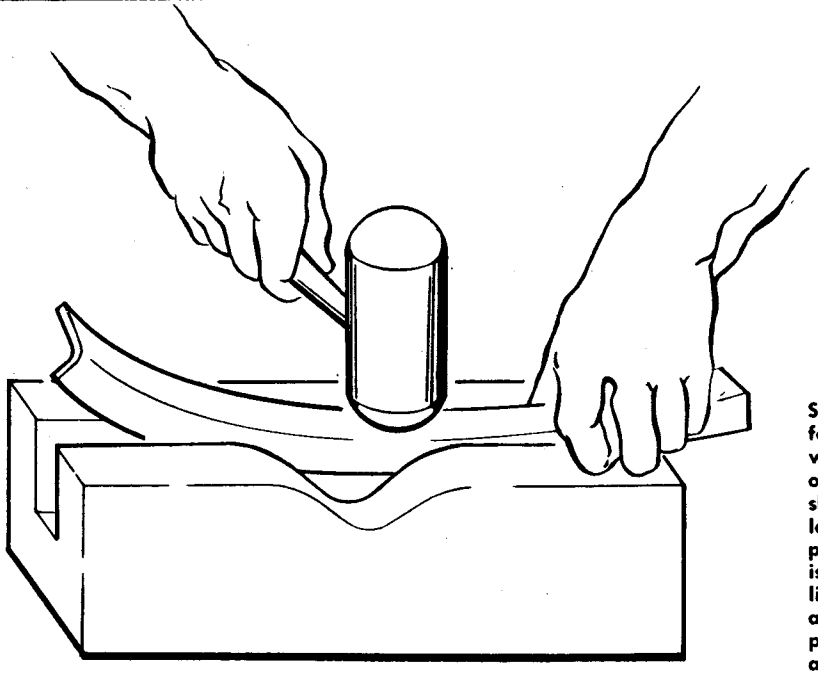
When the rivet hole sizes are not within the tolerances shown for standard rivets in figure 1-28, an oversized rivet should be used. However, if oversized rivets are not available, the next larger standard size must be used. Redimpling titanium for the next size larger rivet is prohibited. When using the next size larger rivet in titanium, the head must be trimmed to match the existing dimple.

HAND-FORMING

GENERAL



Concave surfaces or flanges are formed by the use of a form block of the correct shape and a plastic or rawhide mallet with a smooth, slightly rounded face. The edges of the part to be formed should be smooth and free of any nicks or burrs that would cause the part to crack during the forming operation.



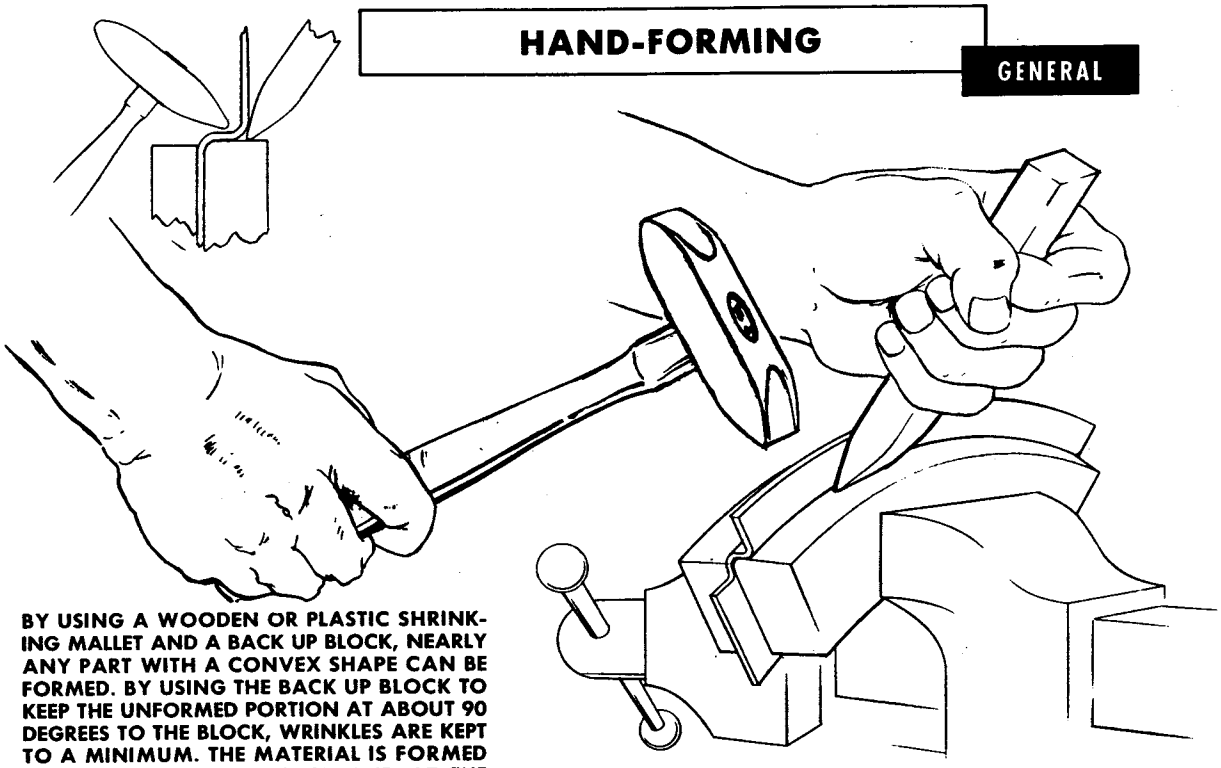
Sheet metal or extruded angles can be formed by hand with the use of a wooden block, slotted so that one leg of the angle will fit into it. The slot should be just wide enough so that the leg of the angle fits it snugly. This will prevent the angle from wrinkling as it is formed. To form the angle, tap it lightly with a plastic or rawhide mallet as it is moved along over the relieved portion of the block. Channels, "T's," and various other shapes can be formed in the same way by varying the size and number of slots cut into the block.

GEN-3-00-63

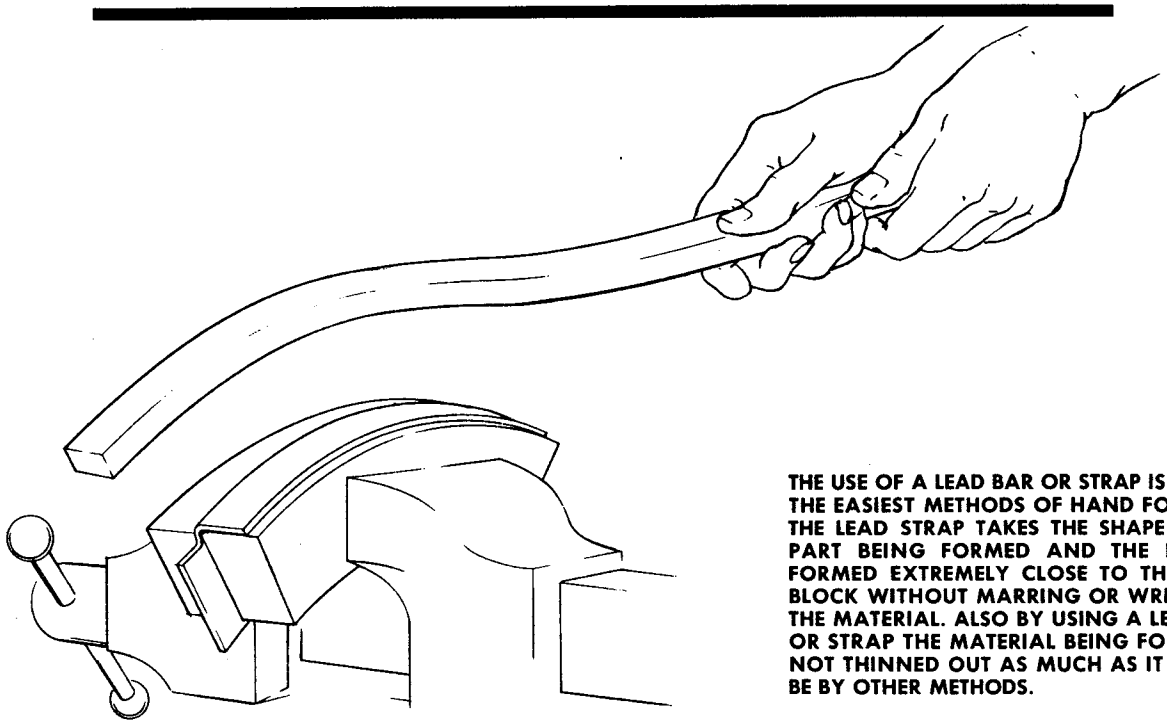
Figure 1-12. Hand-forming (Sheet 1 of 2)

HAND-FORMING

GENERAL



BY USING A WOODEN OR PLASTIC SHRINKING MALLET AND A BACK UP BLOCK, NEARLY ANY PART WITH A CONVEX SHAPE CAN BE FORMED. BY USING THE BACK UP BLOCK TO KEEP THE UNFORMED PORTION AT ABOUT 90 DEGREES TO THE BLOCK, WRINKLES ARE KEPT TO A MINIMUM. THE MATERIAL IS FORMED DOWN AGAINST THE BLOCK AND AT THE SAME TIME AWAY FROM THE RADIUS OF THE FORM BLOCK.



THE USE OF A LEAD BAR OR STRAP IS ONE OF THE EASIEST METHODS OF HAND FORMING. THE LEAD STRAP TAKES THE SHAPE OF THE PART BEING FORMED AND THE PART IS FORMED EXTREMELY CLOSE TO THE FORM BLOCK WITHOUT MARRING OR WRINKLING THE MATERIAL. ALSO BY USING A LEAD BAR OR STRAP THE MATERIAL BEING FORMED IS NOT THINNED OUT AS MUCH AS IT WOULD BE BY OTHER METHODS.

GEN-3-00-64

Figure 1-12. Hand-forming (Sheet 2 of 2)

DRAW DIMPLING.

See figure 1-20.

BLIND FASTENERS.

HOLES FOR BLIND FASTENERS.

Hole sizes for blind fasteners are critical because of the amount of expansion built into the fastener. Holes to be dimpled for blind fasteners must be pilot drilled, dimpled, and redrilled to size. (See figure 1-28.) All holes should be checked with "go, no-go" gages before installing fasteners.

HANDLING AND STORAGE OF BLIND FASTENERS.

The protective film on blind explosive and pull rivets should never be removed. On explosive rivets, this film is necessary for proper heating, firing, and expansion of the rivet. Prevent dirt or grit from contacting pull rivets. A clean lubricated surface is necessary for proper stem installation and expansion.

Store explosive rivets in a cool, dry place, avoiding temperatures in excess of 100°F. Do not throw explosive rivets into trash containers. If rivets are not usable, place them in a wire basket and burn them.

Keep blind fasteners in boxes in which they are received, or in moistureproof containers properly labeled and giving all information that appears on the manufacturer's box.

INSTALLATION OF BLIND FASTENERS.

The following blind fasteners are covered in detail in the "Aircraft Structural Hardware" manual, T.O. 01-1A-8: Cherry rivets, Huck rivets, Drill Lok-Rivets, Rivnuts, and explosive rivets.

OLYMPIC AND CHERRY BLIND RIVETS.

Olympic and Cherry rivets may be used interchangeably. They are identical in all details except for the tool-gripping portion of the stems. They do however require different tooling for installation. Both rivets are procured under the same military specification. When the Cherry rivet is desired, the letter "K" is included in the specification. When the Olympic rivet is desired, the letter "W" is used. When there is no choice as to stem type, the letters are omitted.

Example: MS20600BK5 is a 5056 aluminum alloy sleeve, 0.156-inch diameter knob stem, with a 0.251- to 0.312-inch grip range. When the letter "W" is used in place of the "K" a serrated stem is indicated. "Knob stem" indicates a Cherry rivet. "Serrated stem" indicates an Olympic rivet. (See figure 1-21.)

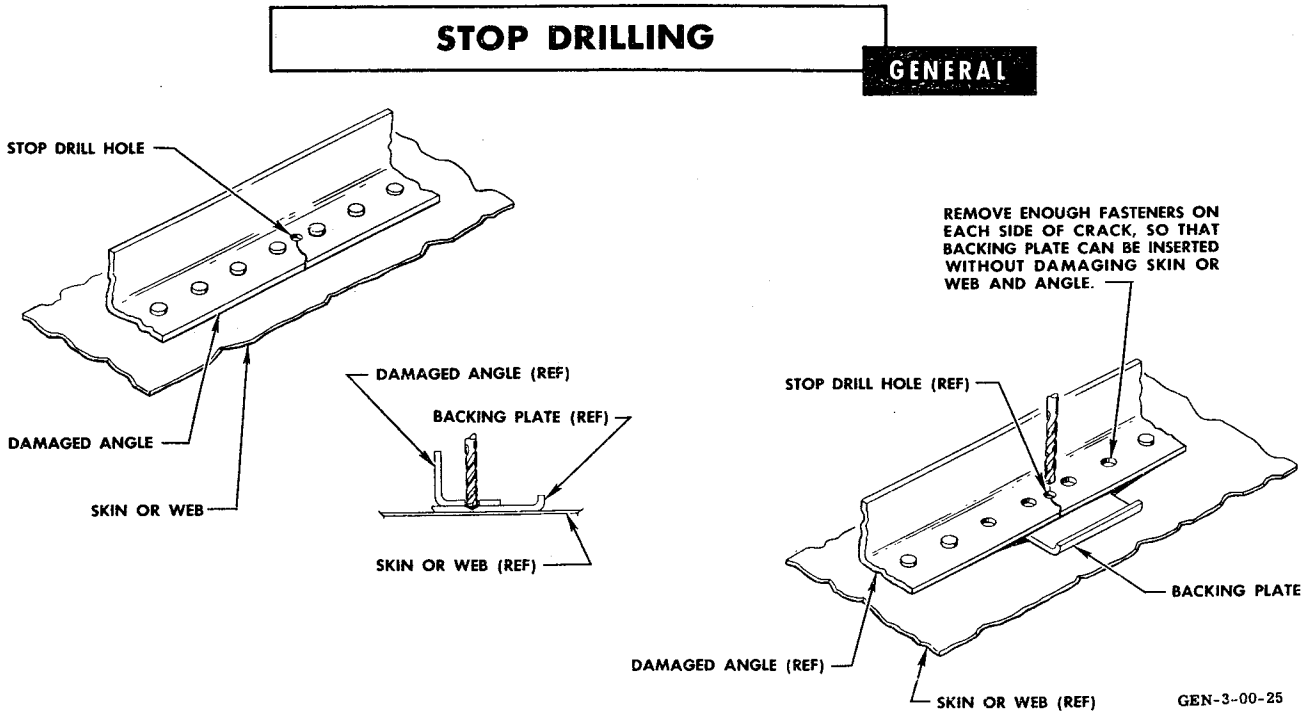
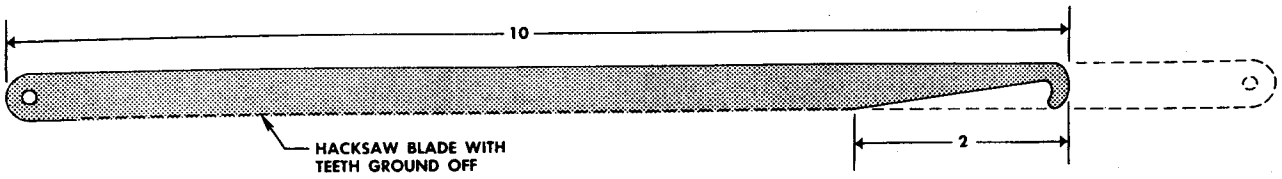
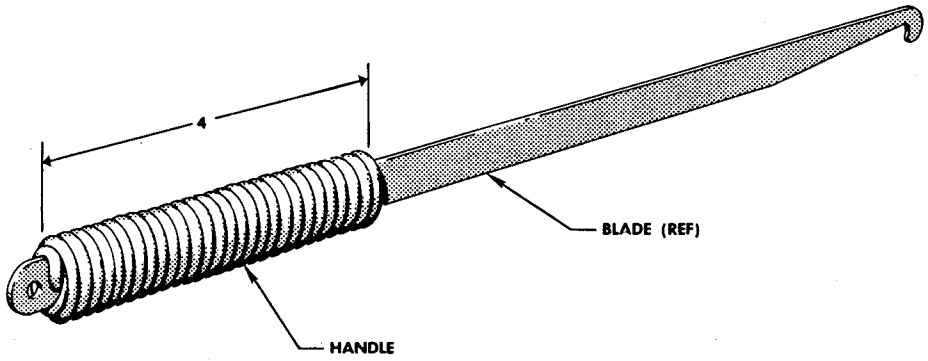


Figure 1-13. Stop Drilling

CHIP CHASER

GENERAL





NOTE Any thin steel may be used; however, a springy material will give more satisfactory service.

Handle may be made of wood, phenolic, scrap Plexiglas, etc. Rivet or tape to blade.

Use chip chaser to remove drill chips, etc, from between assemblies which cannot be separated after cutting operations.

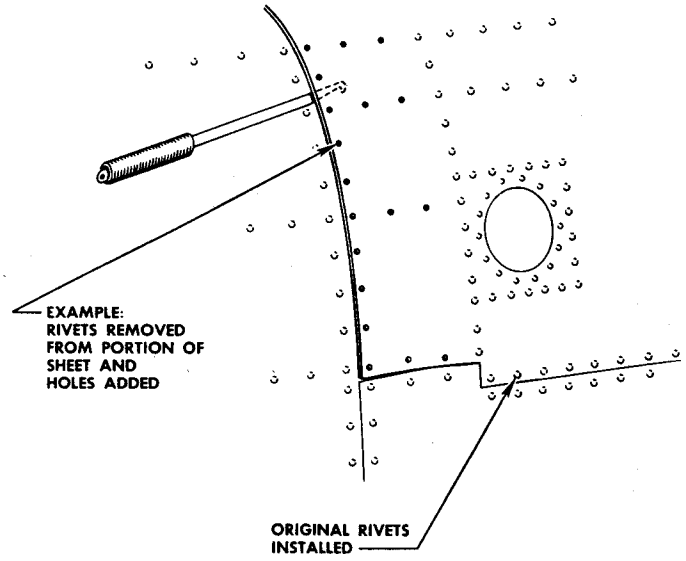


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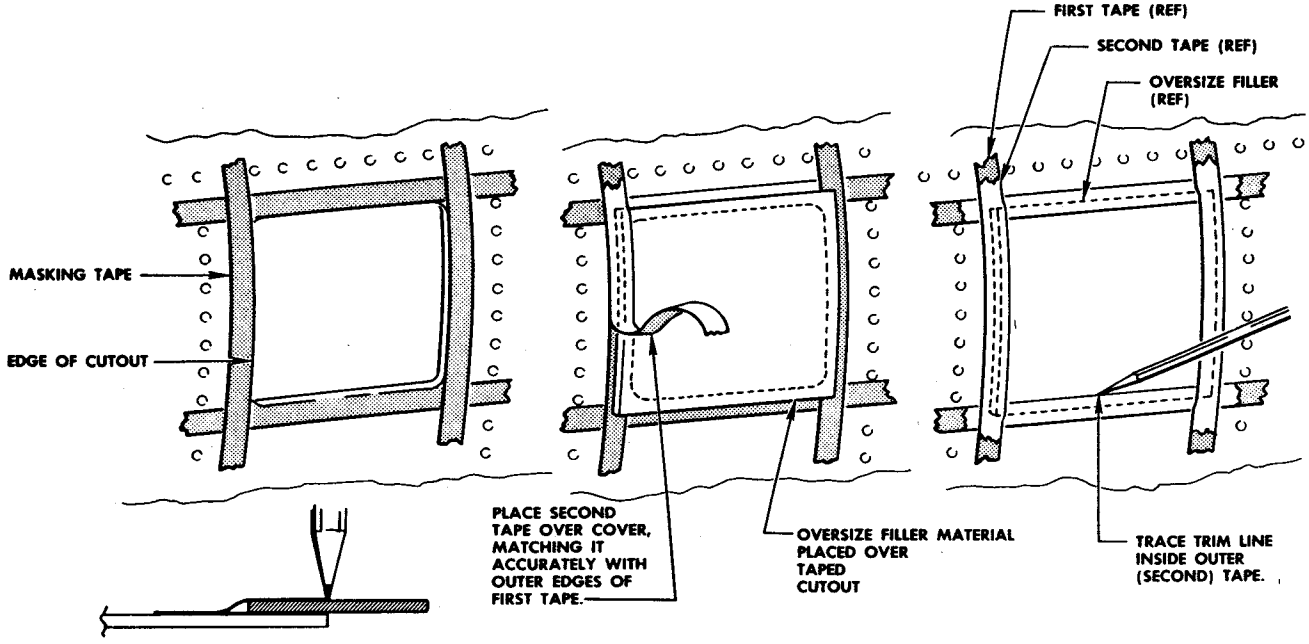
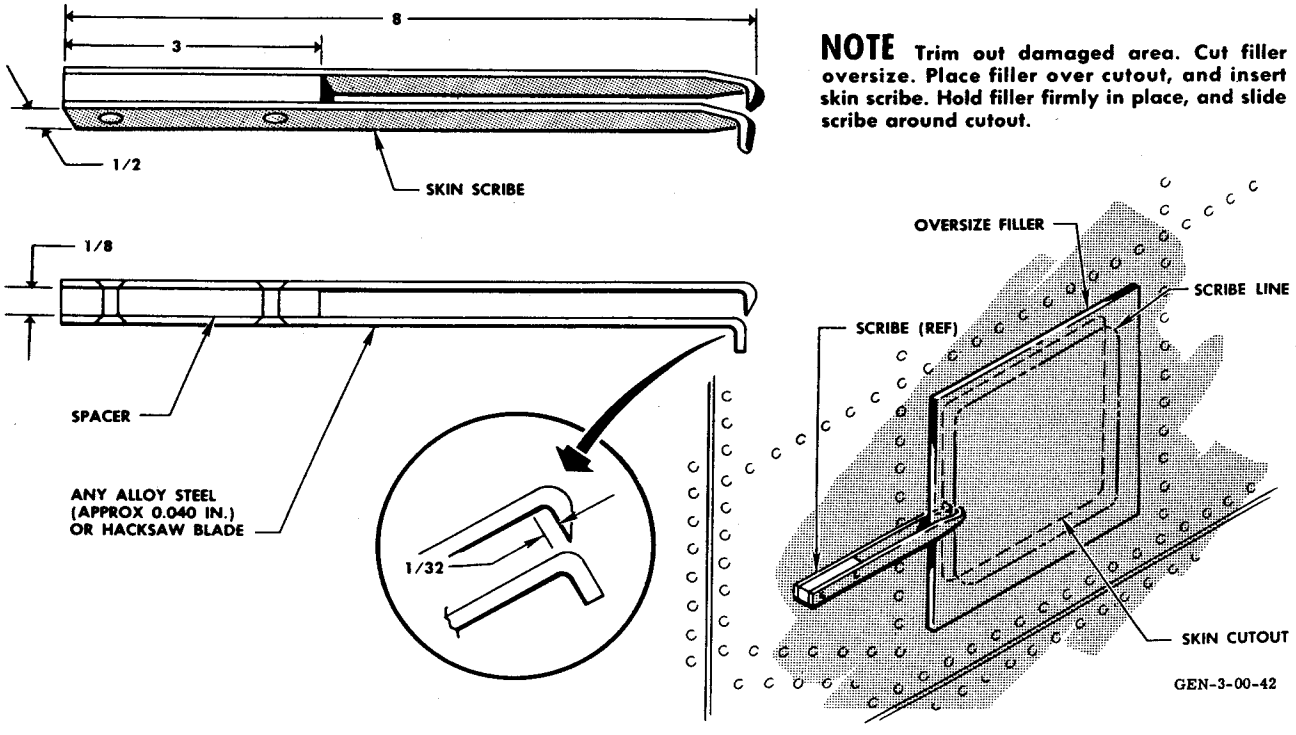
Figure 1-14. Chip Chaser

LOCATING TRIM LINES WITH MASKING TAPE

GENERAL



LOCATING TRIM LINES WITH SKIN SCRIBE

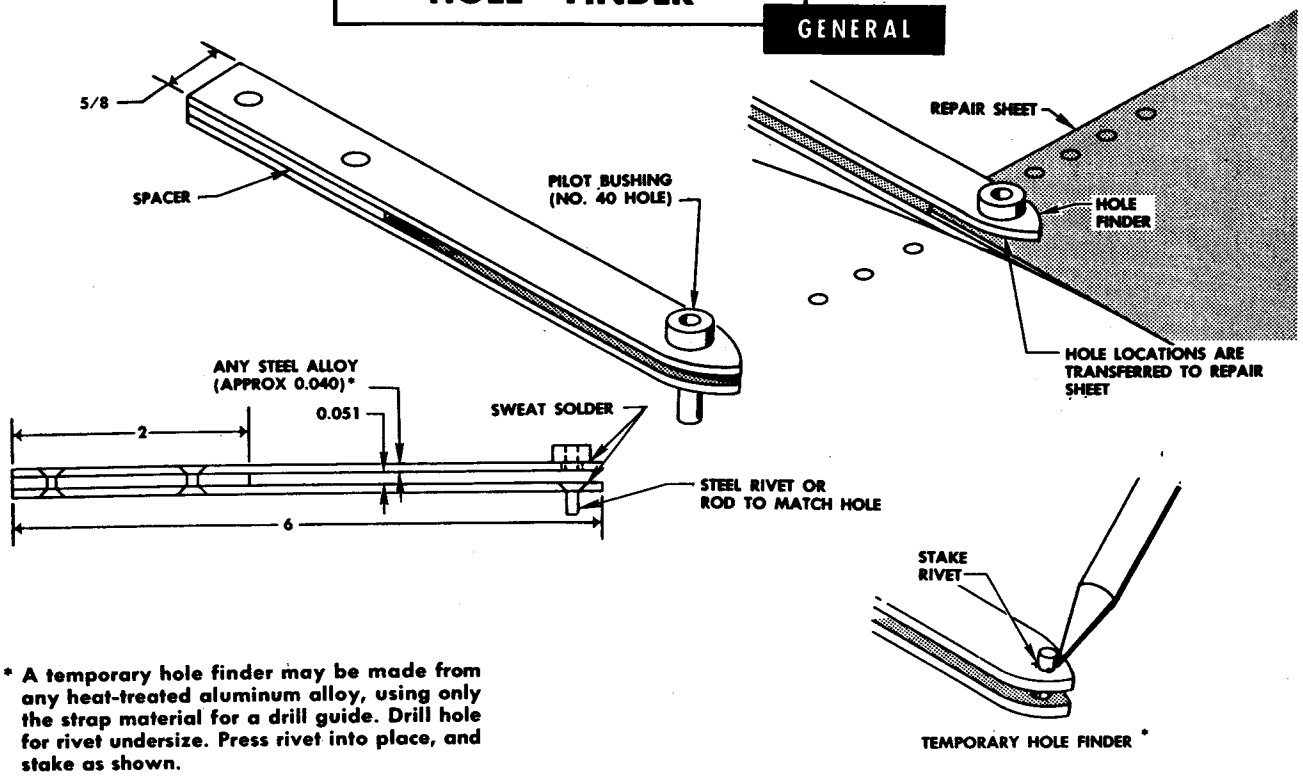


NOTE Trim out damaged area. Cut filler oversize. Place filler over cutout, and insert skin scribe. Hold filler firmly in place, and slide scribe around cutout.

Figure 1-15. Locating Skin Trim Lines

HOLE FINDER

GENERAL



* A temporary hole finder may be made from any heat-treated aluminum alloy, using only the strap material for a drill guide. Drill hole for rivet undersize. Press rivet into place, and stake as shown.

TWO METHODS WITH A SCALE

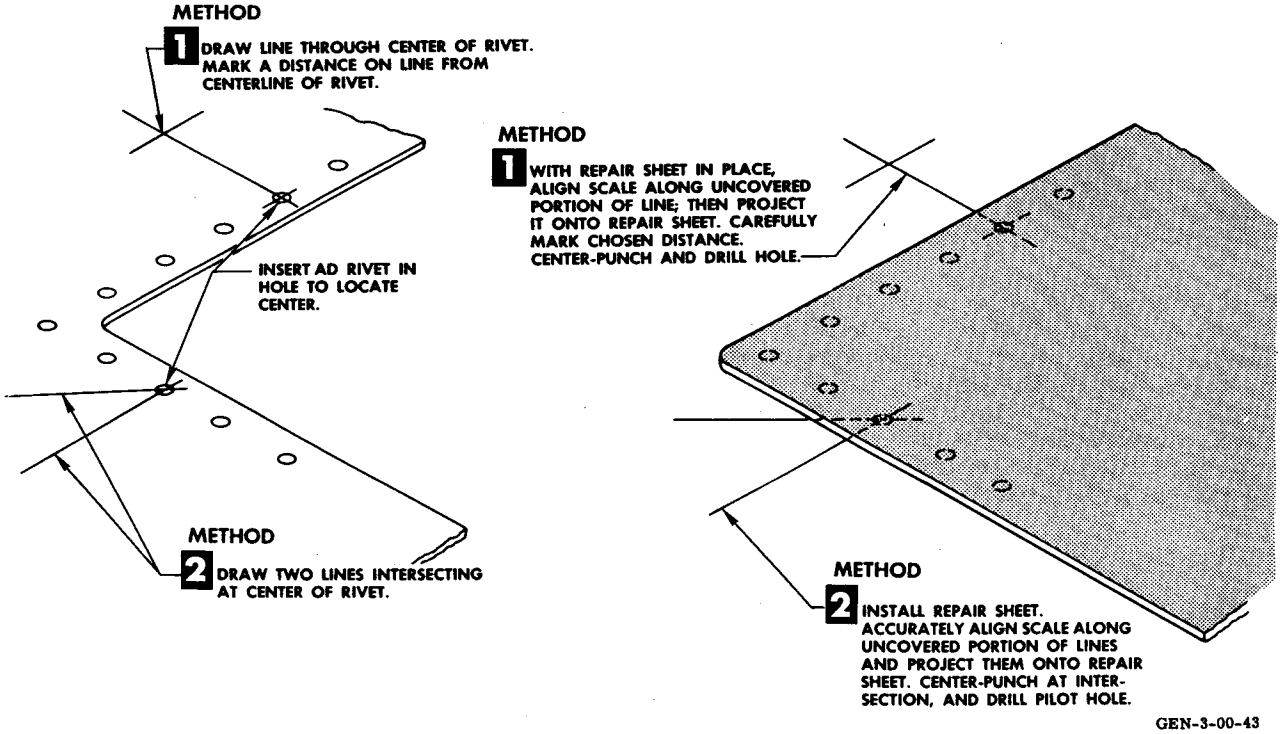


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Figure 1-16. Locating Blind Holes

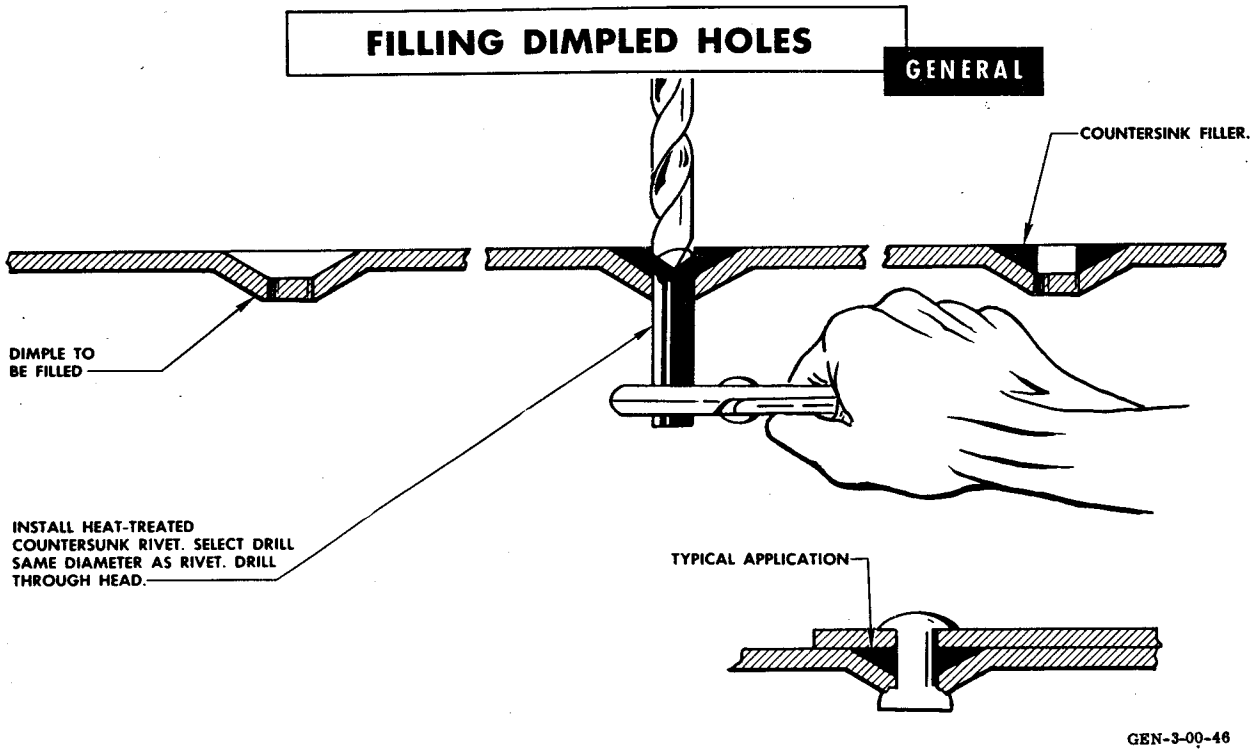


Figure 1-17. Filling Dimpled Holes

DEUTSCH DRIVE PIN BLIND RIVET.

This fastener consists of two parts, either a flush or protruding brazier, a head sleeve of corrosion-resistant steel, and a hardened steel pin. (See figure 1-22.) The pin is driven into the sleeve after the rivet is firmly seated in the drilled or reamed hole. The action of the pin pushing out the restricting walls of the sleeve forms the upset, beginning with a swelling action in the second sheet and progressing into a definite shop-formed head on the blind side.

The protruding ridge on top of the sleeve head locks the pin in the rivet. The final strokes of the hammer form the locking material into the area provided by the chamfer on the drive pin head. After the pin is seated in the head recess, a rotary action of the upsetting tool (hammer) smooths out the pin locking ring for improved flushness and locking action. For the removal of Deutsch rivets, see figure 1-23.

JO-BOLTS.

Jo-bolts (figure 1-24) are blind fasteners of relatively high shear strength. They are used in many areas of the airplane where the installation of standard fasteners is difficult or impractical. Special tools are required for Jo-bolt installation. A wide range of grip length is available. Close-tolerance, reamed holes are required for good installation.

Three types of Jo-bolts are available: protruding (hex) head, 100-degree countersunk head, and millable head. The millable-head fastener has a protruding (hex) head with a 100-degree taper on its lower side. After installation in a countersunk hole, the protruding part of the head is milled off.

For installation and removal of Jo-bolts, see figures 1-24 and 1-25.

THREADED INSERTS.

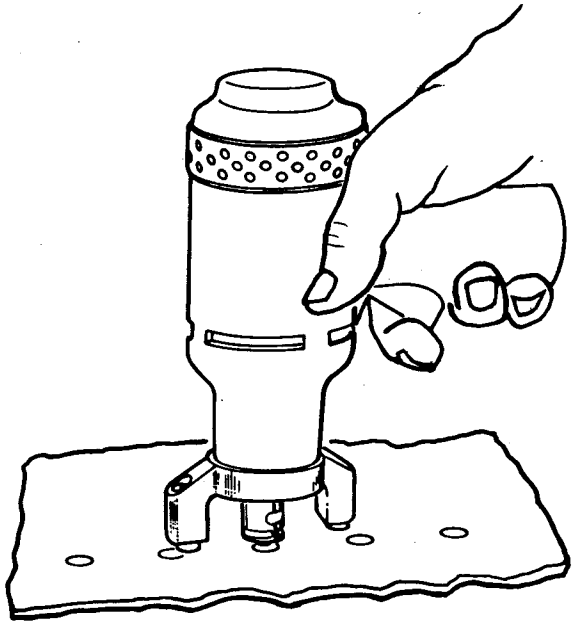
HELI-COIL INSERTS.

Heli-Coil inserts are made of 18-8 stainless steel (AMS-7245) helically coiled wire. The wire has a diamond-shaped cross section which accommodates internal and external threads at the same time. When assembled in a Heli-Coil tapped hole, the insert becomes a permanent standard internal thread with a Class B tolerance. The same insert will produce other classes of fit depending upon tapped-hole dimensions.

Heli-Coil inserts are available in two types: plain nonself-locking and self-locking mid-grip. Both types of inserts are made with a tang which is a portion of the bottom coil. The tang is offset to provide a driving member. The insert has a notch adjacent to the tang; this provides a break-off point for removing the tang after installation.

SHAVING FASTENER HEADS

GENERAL



NOTE The fastener heads may be milled with either the electric or pneumatic rivet mill to meet the flushness requirements below. The surface of the sheet must not be damaged, and the fastener head must not be reduced more than 5 percent of the head diameter.

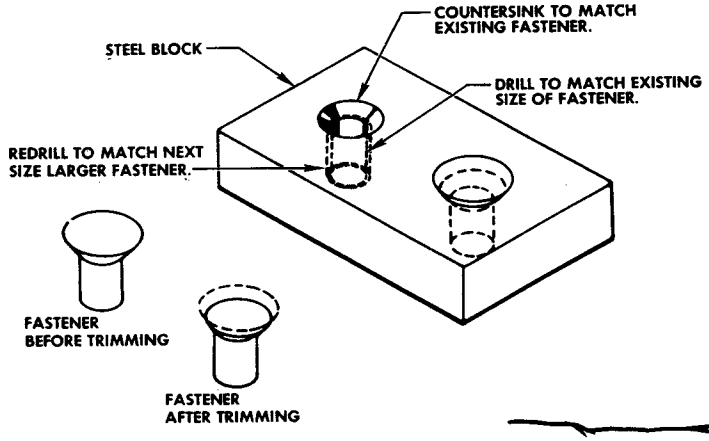
- Do not mill or shave the heads of Deutsch drive pin rivets or Jo-bolts.

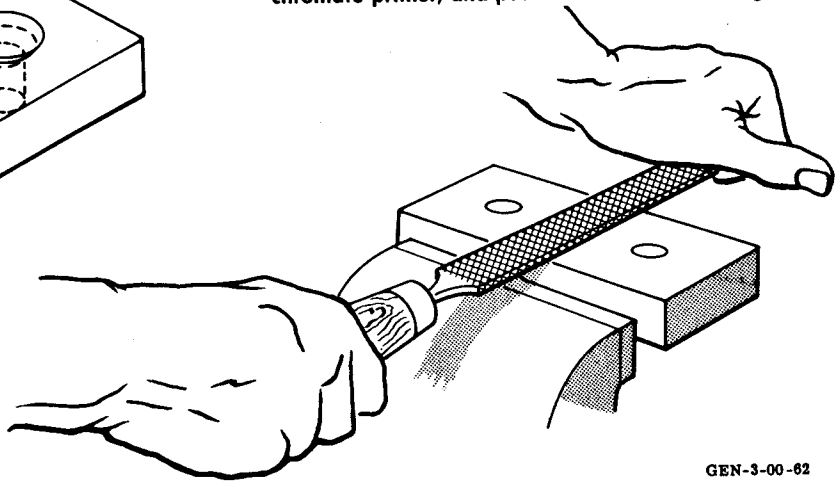
FLUSHNESS REQUIREMENTS		
	COUNTERSUNK HOLES	DIMPLED HOLES
BELOW SURFACE	0.002	0.002
ABOVE SURFACE	0.000	0.002

REDUCING FASTENER HEAD SIZE

In cases where a dimpled or countersunk hole has become enlarged, and it is not possible to redimple or countersink for the next size larger fastener, the following method may be used to trim the next size larger fastener head to match the existing dimples or countersinks.

1. Drill a hole in a steel block the same size as the existing fastener.
2. Countersink the drilled hole so that the existing size fastener head is flush with the surface of the steel block.
3. Redrill hole to next size larger fastener diameter.
4. Place the fastener to be used in the countersunk hole in the steel block, and file or grind off head flush with the surface of the block.
5. Install the fastener to be used in redrilled holes. After installation, coat head of fastener with two coats of zinc-chromate primer, and paint to match surrounding area.





NOTE This method is to be used only for the next size larger fastener.

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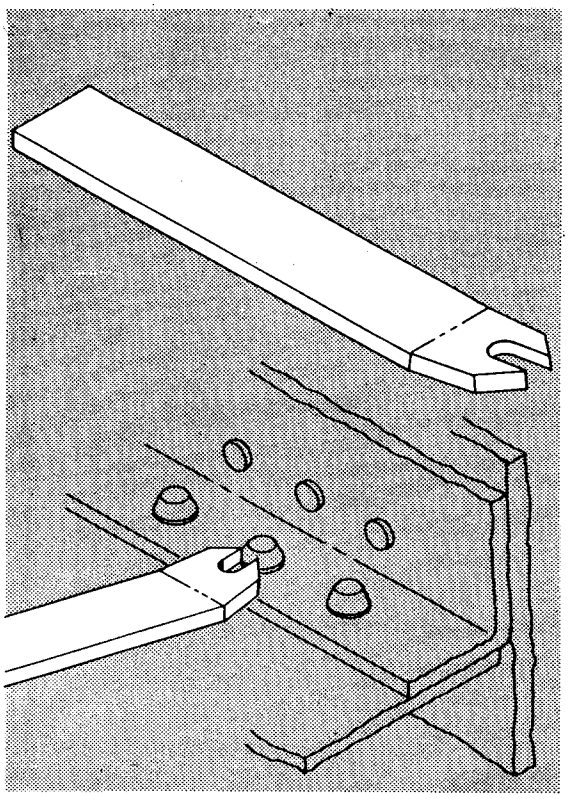
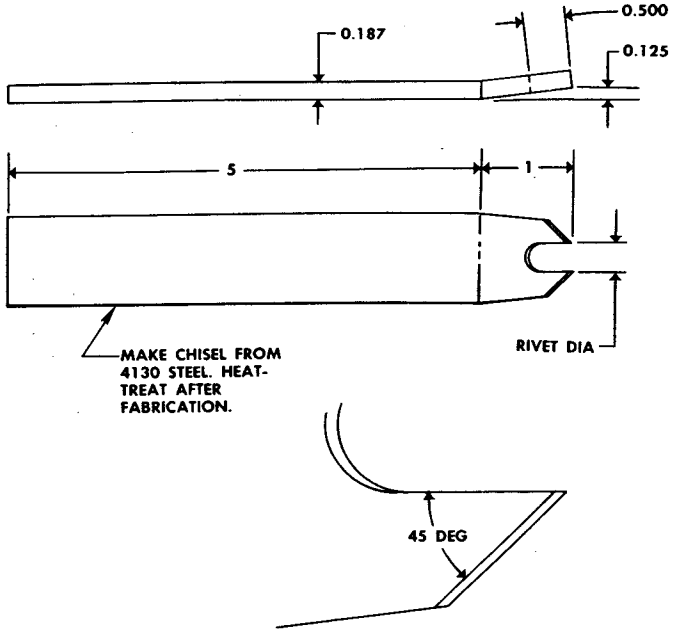
Figure 1-18. Trimming Fastener Heads

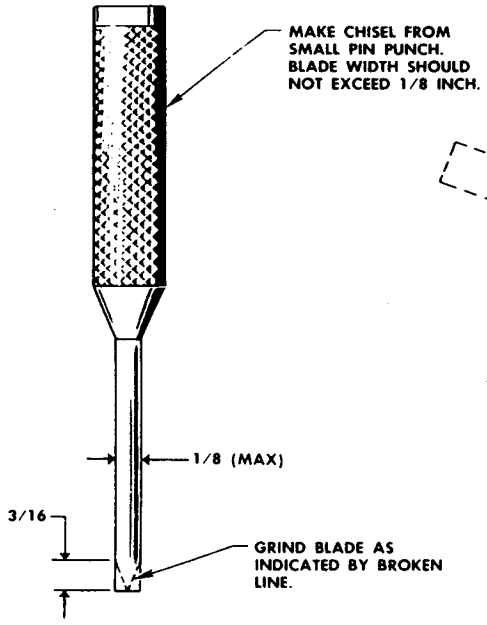
FORKED CHISEL

GENERAL





NARROW-BLADE CHISEL



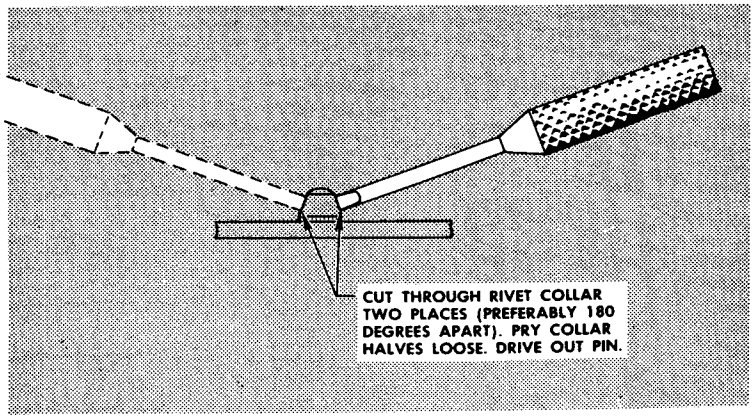


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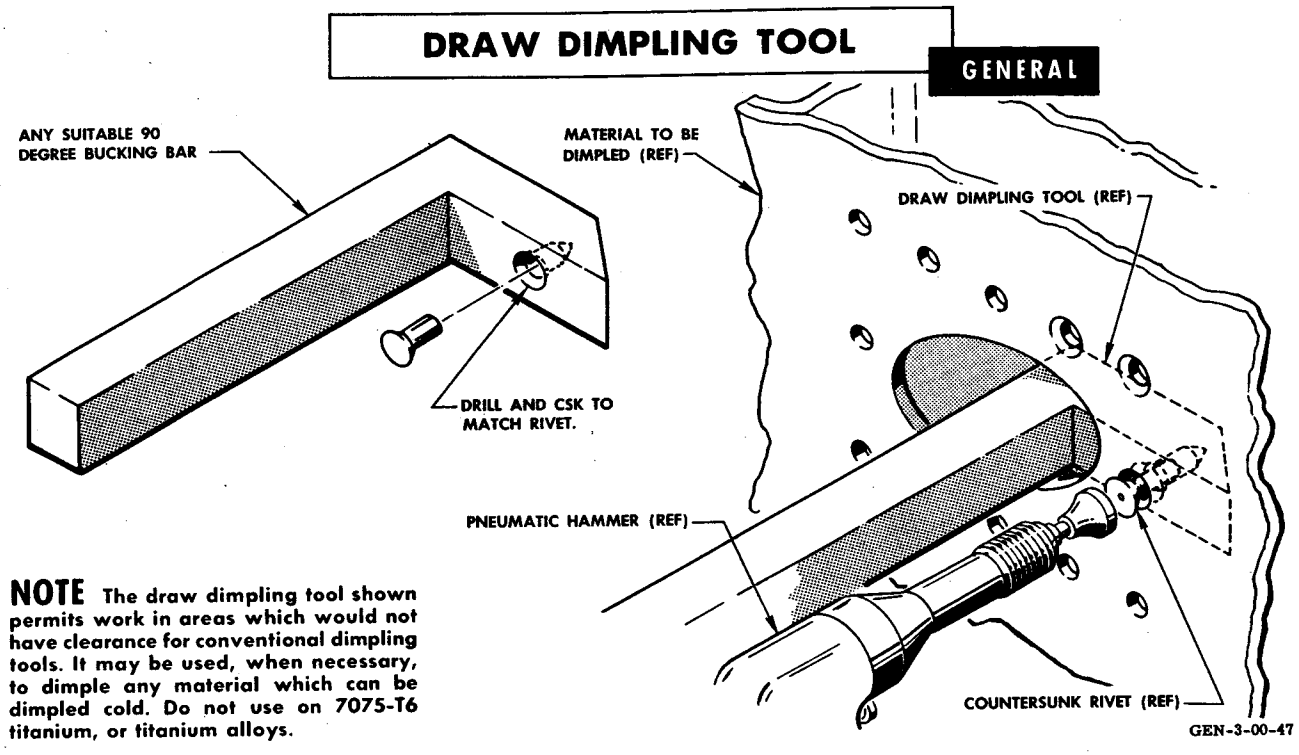
Figure 1-19. Removing Hi-Shear Rivets



NOTE The draw dimpling tool shown permits work in areas which would not have clearance for conventional dimpling tools. It may be used, when necessary, to dimple any material which can be dimpled cold. Do not use on 7075-T6 titanium, or titanium alloys.

Figure 1-20. Draw Dimpling

If a mid-grip type insert is removed, the same type should be reinstalled.

The mid-grip insert is dyed red for identification and has a specially formed grip coil, or coils, in the center which have a gripping effect on the engaging screw. (See figure 1-26.) For detailed information on installation and removal, refer to "General —Installation of Heli-Coil Inserts," T.O. 44H1-1-117. Although the mid-grip type insert is not covered in this Technical Order, the information is applicable for both types, except for some of the tools used. The mid-grip inserts require a different inserting and tang break-off tool than those used for plain inserts. The differences in basic tool numbers are noted in the table below.

TABLE 1-6

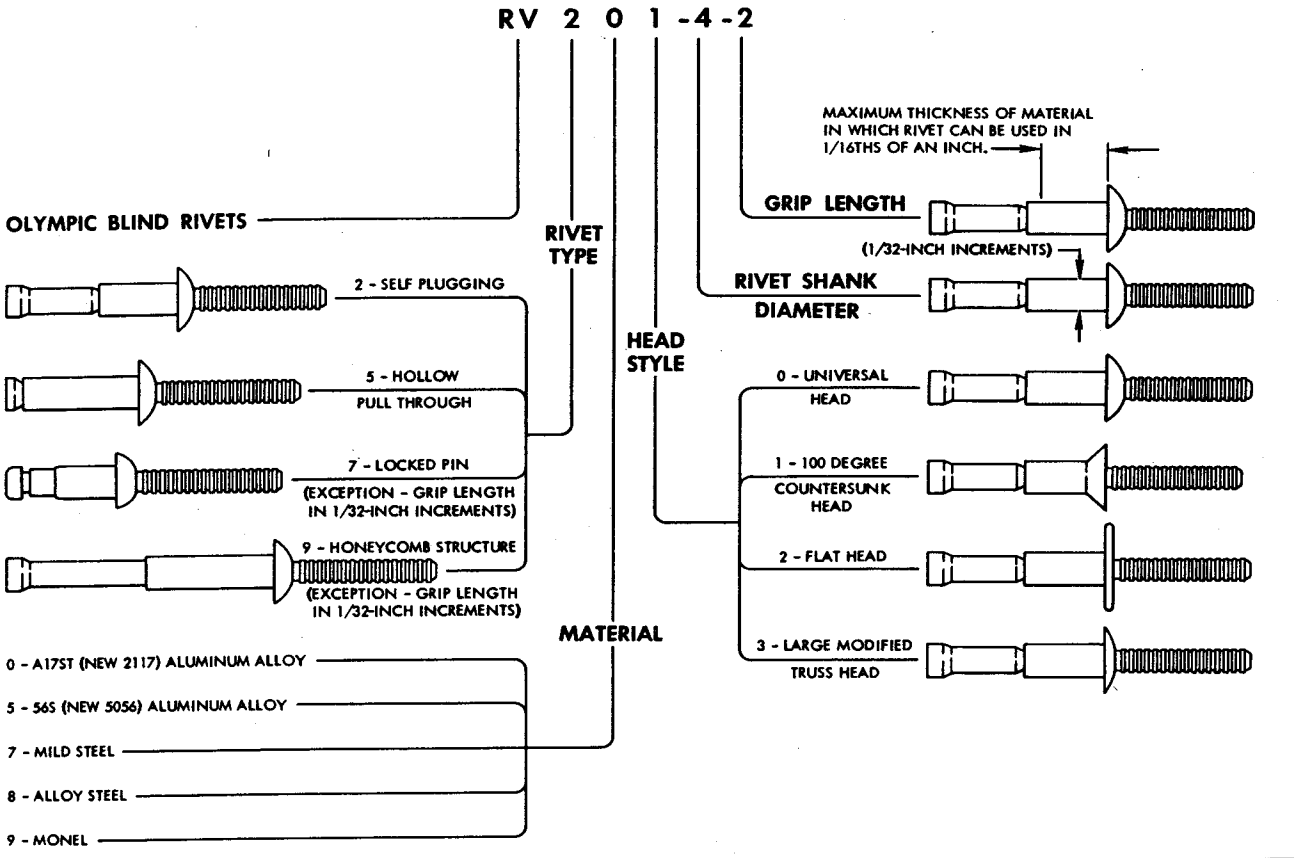
NAME OF TOOL	BASIC TOOL NUMBERS	
Prewinder inserting tool	Plain Insert 528	Mid-grip Insert 3551
Prewinder inserting tool	535	3552
Tang break-off tool	1195	3580
Tang break-off tool	1196	3581

The size dash numbers are identical to those outlined in the Technical Order.

ROSAN INSERTS.

Threaded inserts with the Rosan locking feature are available in several types. The type in most common use consists of an internally and externally threaded and externally serrated insert with a matching internally and externally serrated ring. Variations include plain holes, taper pipe threads, gasket seals, solid plugs, dowels, and studs. Design information for the internally threaded type is shown in figure 1-27. The insert is available either plain or with a slotted lower end for self-locking.

If a self-locking feature is used with an AN. standard bolt, the insert shown in figure 1-27 must be specified, rather than the longer types which are illustrated in the Rosan catalog. The insert is counterbored, as shown by the "M" dimension, for No. 10 sizes and over to prevent interference with the imperfect threads on the bolt, and to allow the threaded area of the bolt to penetrate through the locking device by at least a portion of the first thread past the chamfer. The letter "L" is omitted from the part number when the self-locking feature is not required. The insert and ring are made of carbon steel; the ring is casehardened. However, if the tensile strength of the material into which the ring is to be inserted is 125,000 psi or above, the counterbore diameter, "C," shown for aluminum alloy in figure 1-27, must be increased by 0.015 inch. The material code "SB" in columns "H" and "J" indicates either C1117 or B1113 low-carbon steel for the insert and B1113 low-carbon steel for the ring. The code "SB" supersedes "SH." However, identical material will be furnished for either call-out.



SUGGESTED DRILL AND PUNCH SIZES

RV200C (-4) -2			
RIVET SHANK DIAMETER	FIRST DASH NO.	DRILL	PUNCH
(3/32)	-3	NO. 40	0.097 TO 0.101
(1/8)	-4	NO. 30	0.128 TO 0.132
(5/32)	-5	NO. 20	0.160 TO 0.164
(3/16)	-6	NO. 10	0.192 TO 0.196
(7/32)	-7	NO. 2	
(1/4)	-8	F	0.256 TO 0.261
(9/32)	-9 *	L	0.289 TO 0.295
(9/32)	-9 **	M	0.295 TO 0.301
* (ALUMINUM ALLOY AND STEEL)		** (MONEL)	

RV2200 AND RV2201 OVERSIZE SHANK DIAMETER RIVETS

(1/8)	-4	NO. 29	0.137 TO 0.141
(5/32)	-5	NO. 16	0.177 TO 0.181
(3/16)	-6	NO. 5	0.206 TO 0.210

MATERIAL THICKNESS CHART

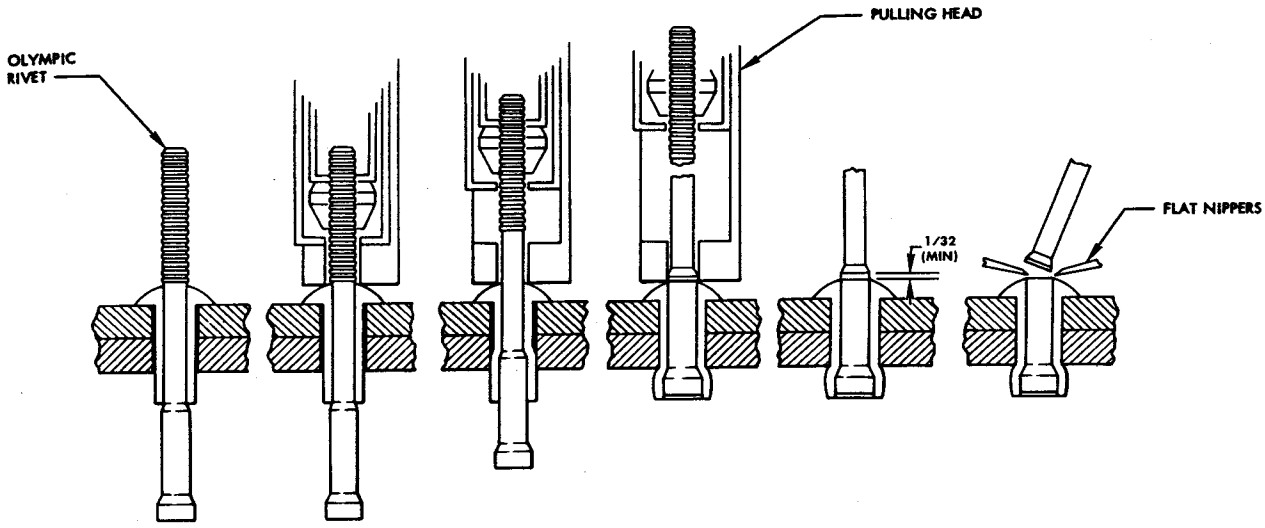
RV200C -4 (-2)		
SECOND DASH NO.	GRIP RANGE	
	MINIMUM	MAXIMUM
-1	0.015	0.062 (1/16)
-2	0.063 (1/16)	0.125 (1/8)
-3	0.126 (1/8)	0.187 (3/16)
-4	0.188 (3/16)	0.250 (1/4)
-5	0.251 (1/4)	0.312 (5/16)
-6	0.313 (5/16)	0.375 (3/8)
-7	0.376 (3/8)	0.437 (7/16)
-8	0.438 (7/16)	0.500 (1/2)
-9	0.501 (1/2)	0.562 (9/16)
-10	0.563 (9/16)	0.625 (5/8)
-11	0.626 (5/8)	0.687 (11/16)
-12	0.688 (11/16)	0.750 (3/4)
-13	0.751 (3/4)	0.812 (13/16)
-14	0.813 (13/16)	0.875 (7/8)

ALL GRIPS ARE TEST PROVEN FOR USE IN MATERIAL THICKNESS 1/64 OR 0.015 INCH THICKER THAN MAXIMUM GRIP INDICATED

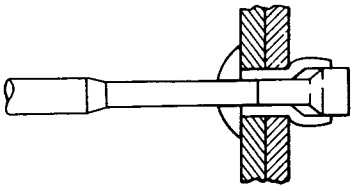
T-28A-3-00-14

Figure 1-21. Olympic Rivets (Sheet 1 of 2)

OLYMPIC BLIND RIVET—INSTALLATION

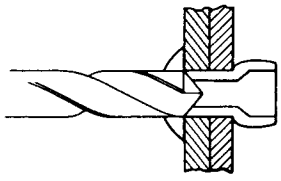


BLIND RIVET REMOVAL



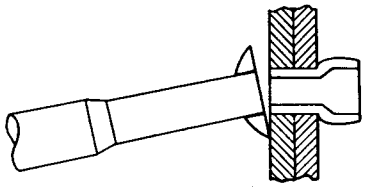
STEP I

USING A PUNCH, DRIVE OUT THE STEM



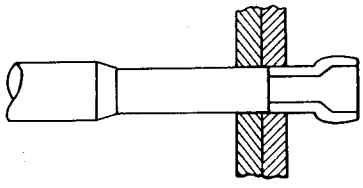
STEP II

DRILL THROUGH THE HEAD OF THE RIVET ONLY, USING THE FACTORY-MADE HOLE IN THE RIVET AS A PILOT. THE DRILL SHOULD BE THE SAME SIZE AS THE RIVET SHANK.



STEP III

PRY THE HEAD OFF THE RIVET WITH A PUNCH



STEP IV

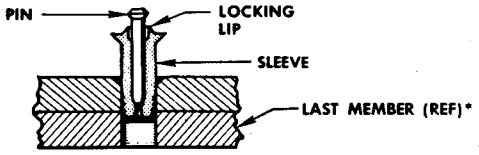
USING A PUNCH, PUSH OUT THE REMAINDER OF THE RIVET SHANK. IF THE SHANK WILL NOT PUSH OUT, DRILL IT OUT. AVOID ENLARGING THE HOLE. IF HOLE IS ENLARGED, AN OVERSIZED OR NEXT LARGER DIAMETER RIVET MAY BE USED.

T-28A-3-00-15

Figure 1-21. Olympic Rivets (Sheet 2 of 2)

DEUTSCH RIVET INSTALLATION

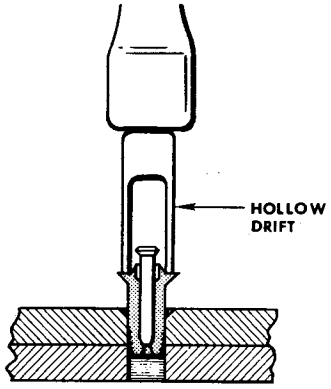
GENERAL



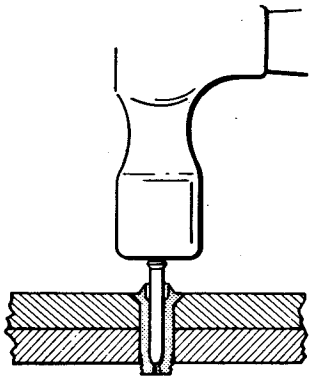
NOTE Total thickness of material being joined should be measured to determine correct length rivet to use. If measurement shows a borderline case between two different lengths, always use shorter length rivet. Dimpling tools for Hi-shear rivets may be used for Deutsch blind rivets.

1 Select proper length rivet (refer to note) and place in hole.

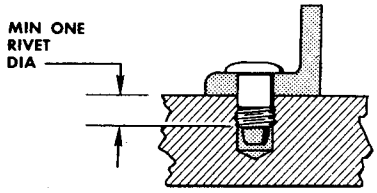
FASTENER SIZE—INCH	MIN THICKNESS OF LAST MEMBER*
3/16	0.125
1/4	0.188
5/16	0.250

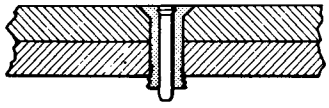


2 Use a hollow drift that will clear locking lip. Do not drive Deutsch drive pin blind rivets into tight holes by hammering on pin.



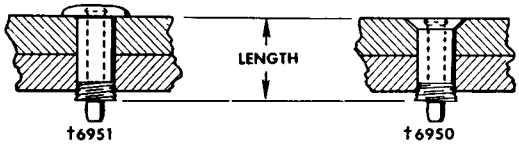
3 Rivets may be driven with air gun or hammer.





4 After pin has been seated in recess, smooth out the locking lip with a rotary or rolling action of the driving tool. If shaving is necessary for flushness, make certain that locking lip is not cut away to extent that lock is damaged or destroyed.

NOTE When rivet is installed in a buried hole, at least one times the rivet diameter (including locking rings) must extend into the hole.



CODING FOR SELECTION OF PROPER FASTENERS

6950 designates flush head.
6951 designates protruding brazier head.
First letter indicates sleeve material.
S—Steel
First dash number indicates rivet diameter in 1/32nds.
Second dash number indicates nominal grip in 1/16ths.

EXAMPLE:

6950-S-06-10 flush head—Cres—3/16 dia—5/8 nominal grip

FINAL HOLE SIZES

RIVET SIZE	DIAMETER	REAM
3/16	0.1915	0.191-0.193
1/4	0.260	0.259-0.262
5/16	0.316	0.315-0.318
3/8	0.386	0.385-0.388

LENGTH AND GRIP RANGE CHART

DASH NO.	NOMINAL GRIP	GRIP RANGE	LENGTH			
			3/16 DIA	1/4 DIA	5/16 DIA	3/8 DIA
-3	3/16	0.166—0.227	0.233			
-4	1/4	0.227-0.290	0.295	0.315	0.329	
-5	5/16	0.290-0.353	0.357	0.379	0.391	
-6	3/8	0.353-0.415	0.420	0.437	0.453	0.468
-7	7/16	0.415-0.478	0.482	0.500	0.516	0.530
-8	1/2	0.478-0.540	0.545	0.562	0.578	0.593
-9	9/16	0.540-0.603	0.607	0.625	0.641	0.656
-10	5/8	0.603-0.665	0.670	0.687	0.703	0.718
-11	11/16	0.665-0.728	0.732	0.749	0.766	0.780
-12	3/4	0.728-0.790	0.795	0.817	0.828	0.843
-13	13/16	0.790-0.853	0.857	0.877	0.891	0.905
-14	7/8	0.853-0.915	0.920	0.940	0.953	0.968
-15	15/16	0.915-0.978	0.982	1.000	1.016	1.030
-16	1.	0.978-1.040	1.045	1.062	1.078	1.093

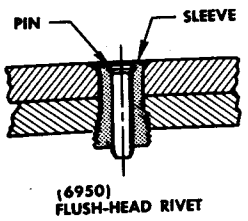
† The Deutsch Co. Refer to index for source of commercial products.

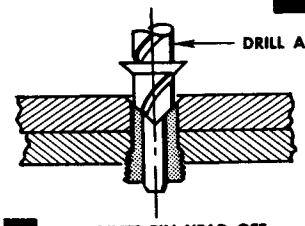
GEN-3-00-34

Figure 1-22. Installation of Deutsch Drive Pin Rivets

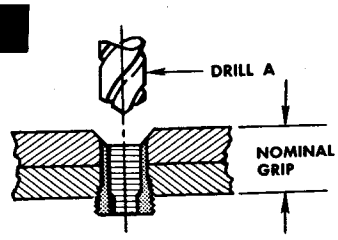
DEUTSCH RIVET REMOVAL

GENERAL

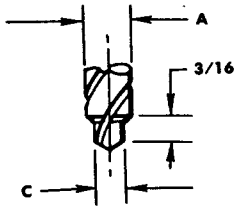




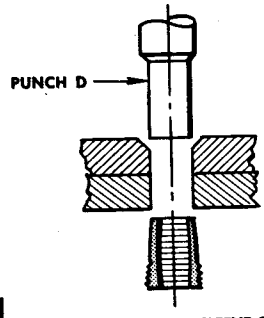
1 DRILL RIVET PIN HEAD OFF, USING DRILL SIZE A.



2 DRILL SLEEVE, USING DRILL SIZE A. DRILL TO NOMINAL GRIP DEPTH ONLY.



A PILOTED DRILL MAY BE USED.



3 DRIVE REMAINDER OF SLEEVE THROUGH.

DEUTSCH RIVET DASH NO.	DRILL SIZE A	PIN SIZE C	PUNCH SIZE D
-06 (3/16)	NO. 21 (0.1590)	0.1215	5/32
-08 (1/4)	NO. 1 (0.2280)	0.1625	7/32
-010 (5/16)	9/32 (0.2812)	0.1975	1/4
-012 (3/8)	NO. 5 (0.3480)	0.2425	11/32
-16 (1/2)	15/32 (0.4687)	0.3235	7/16

PROCEDURE FOR REMOVAL WHERE RIVET DOES NOT EXTEND THROUGH MATERIAL

1 Drill out rivet pin about half the depth, using recommended drill size.

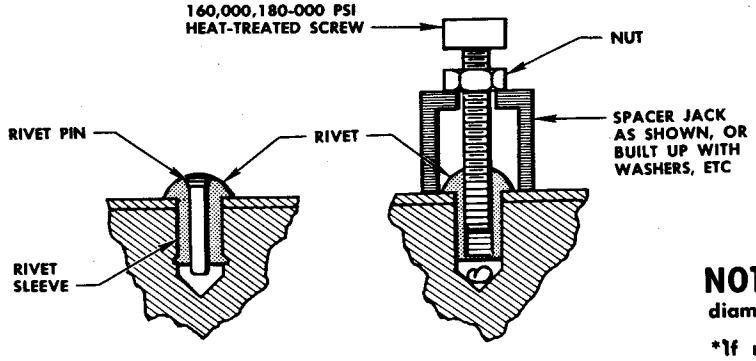
2 Tap sleeve, using recommended tap size.*

3 Drill out remainder of pin.

4 Insert Allen-head screw through spacer into tapped sleeve, and tighten nut.

5 Continue tightening nut until rivet sleeve is removed from work.

6 Hole is re-usable with same size rivet.



RIVET DIA (INCHES)	DRILL SIZE	SCREW AND TAP SIZE
3/16	29	8-32
1/4	19	10-32
5/16	3	1/4-28
3/8	I	5/16-24
7/16	Q	3/8-24
1/2	25/64	7/16-20

NOTE Use minimum of 1-1/2 times screw diameter thread engagement in rivet sleeve.

*If rivet sleeve rotates during tapping operation, use slightly larger drill for step 1, providing less cutting effort of tap.

GEN-3-00-35

Figure 1-23. Removal of Deutsch Drive Pin Rivets

JO-BOLT INSTALLATION

GENERAL

PART NO.	DIAMETER	DRILL SIZE	REAM DIA	COUNTERSINK
200	No. 10	No. 15 (0.180)	0.199-0.202	100 deg x 0.375 to 0.390
260	1/4	D (0.246)	0.260-0.263	100 deg x 0.495 to 0.510

CODING FOR SELECTION OF PROPER FASTENERS

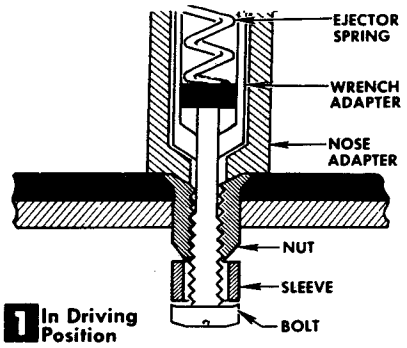
F indicates flush head.
P indicates protruding head.
260 indicates diameter in thousands.
Last dash number indicates nominal grip length in 1/16ths.
EXAMPLE: F260-4 flush head—0.260 dia—1/4 nominal grip

National Screw & Mfg Co of Calif.
Refer to index for source of commercial products.

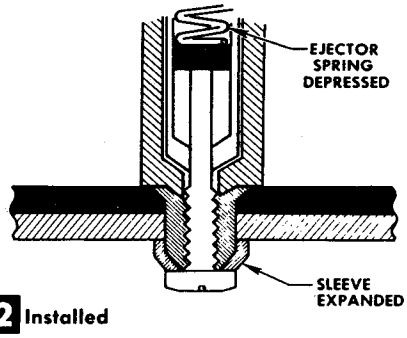
HEAD STYLE	STEM BREAK-OFF TOLERANCES				
	5/32	3/16	1/4	5/16	3/8
FLUSH	+0.010 −0.068	+0.000 −0.078	+0.000 −0.078	+0.000 −0.083	+0.000 −0.083
PROTRUDING	+0.078 +0.000	+0.093 +0.015	+0.115 +0.037	+0.130 +0.047	+0.142 +0.059

TABLE OF GRIP LENGTHS

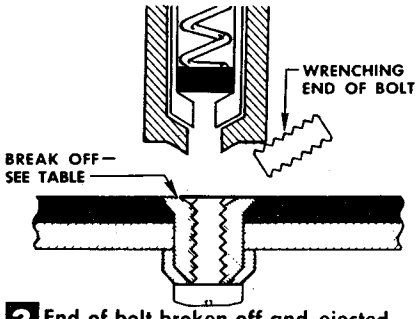
DASH NO.	2	3	4	5	6	7	8	9	10
GRIP LENGTH MIN	0.094	0.156	0.219	0.281	0.344	0.406	0.469	0.531	0.594
GRIP LENGTH MAX	0.156	0.219	0.281	0.344	0.406	0.469	0.531	0.594	0.656



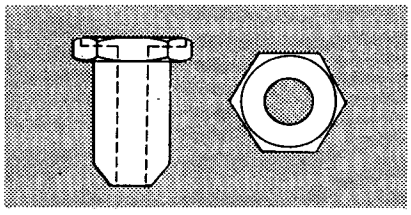
1 In Driving Position

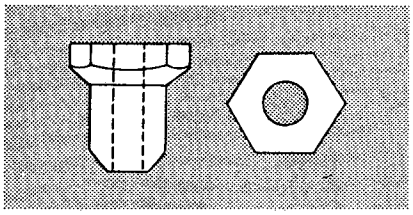


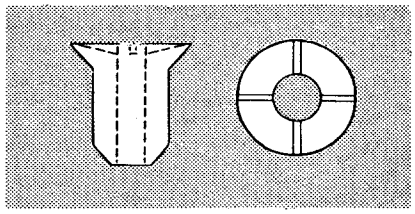
2 Installed

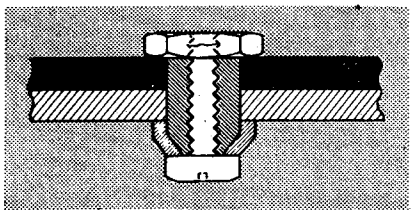


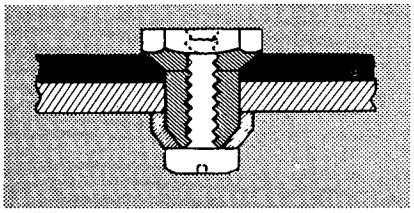
3 End of bolt broken off and ejected from tool

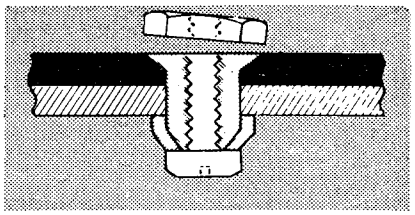

PROTRUDING HEAD


MILLABLE


FLUSH HEAD


PROTRUDING HEAD INSTALLED


MILLABLE HEAD INSTALLED


HEAD MILLED

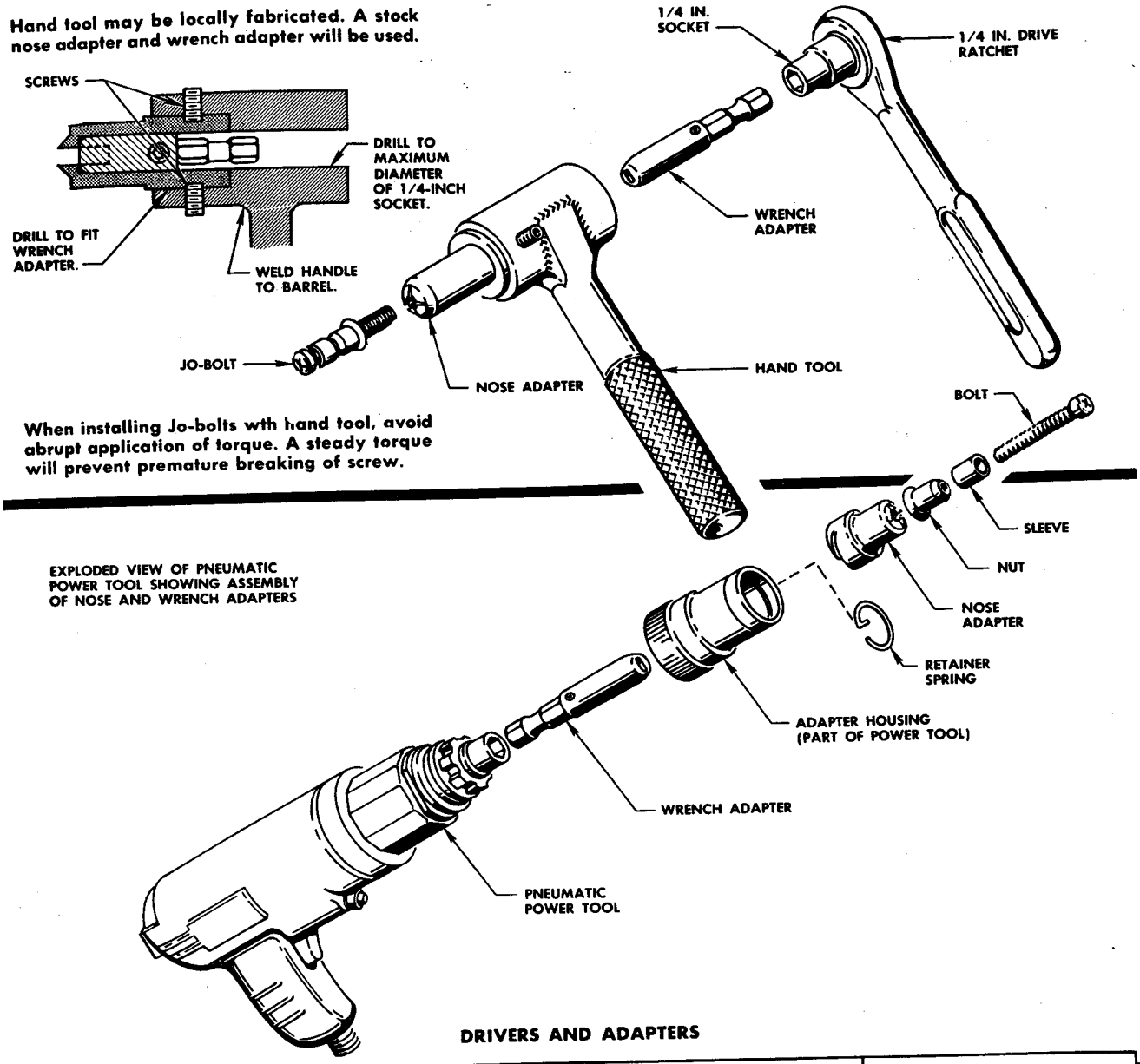
GEN-3-00-36

Figure 1-24. Installation of Jo-bolts (Sheet 1 of 2)

JO-BOLT INSTALLATION TOOLS

GENERAL

Hand tool may be locally fabricated. A stock nose adapter and wrench adapter will be used.



When installing Jo-bolts wth hand tool, avoid abrupt application of torque. A steady torque will prevent premature breaking of screw.

EXPLODED VIEW OF PNEUMATIC POWER TOOL SHOWING ASSEMBLY OF NOSE AND WRENCH ADAPTERS

DRIVERS AND ADAPTERS

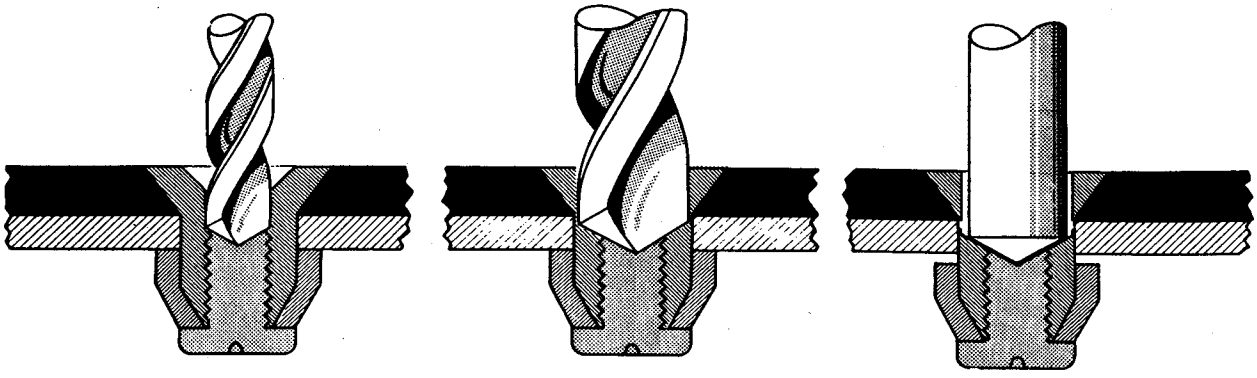
HAND TOOLS	AIR FORCE STOCK NO.	POWER TOOLS	AIR FORCE STOCK NO.
HAND DRIVER	9 DLF-HW 300	POWER DRIVER	9 DLF-302
HAND ADAPTER (F200)	9 DLF-HW 2000	POWER ADAPTER (F200)	9 DLF-PW 300
HAND ADAPTER (P200)	9 DLF-HW 2000P	POWER ADAPTER (P200)	9 DLF-PW 300P
HAND ADAPTER (F260)	9 DLF-HW 2600	POWER ADAPTER (F260)	9 DLF-PW 360
HAND ADAPTER (P260)	9 DLF-HW 2600P	POWER ADAPTER (P260)	9 DLF-PW 360P
HAND ADAPTER (F312)	9 DLF-HW 3120	POWER ADAPTER (F312)	9 DLF-PW 312

Lok-Fast Inc. Refer to index for source of commercial products. GEN-3-00-37

Figure 1-24. Installation of Jo-bolts (Sheet 2 of 2)

JO-BOLT REMOVAL

GENERAL

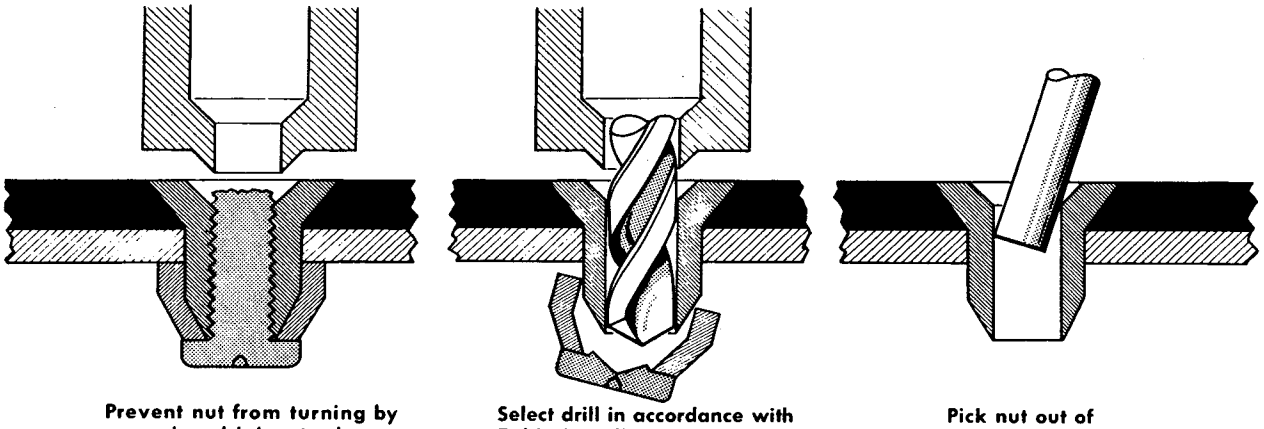


Select drill in accordance with Table I. Drill to below head-shank juncture.

Select drill in accordance with Table II. Drill to depth of pilot hole.

With hammer and nominal size punch, sever head and drive out shank and blind head.

REMOVAL WHEN BOLT TURNS IN HOLE WHILE DRILLING



Prevent nut from turning by engaging driving tool nose adapter. Hold nose adapter with hand tool handle or vise-grip pliers.

Select drill in accordance with Table I. Drill through shank, severing bolthead.

Pick nut out of hole with punch.

SELECT DRILL WITH 500 RPM MAXIMUM

	TABLE I	TABLE II
JO-BOLT SERIES	DRILL SIZE	DRILL SIZE
F- OR P-164	NO. 43 (0.089)	5/32 (0.1562)
F- OR P-200	NO. 35 (0.110)	12 (0.189)
F- OR P-260	NO. 24 (0.152)	D (0.246)
F- OR P-312	NO. 17 (0.173)	M (0.295)
F- OR P-375	NO. 5 (0.2055)	23/64 (0.3594)

GEN-3-00-38

Figure 1-25. Removal of Jo-bolts

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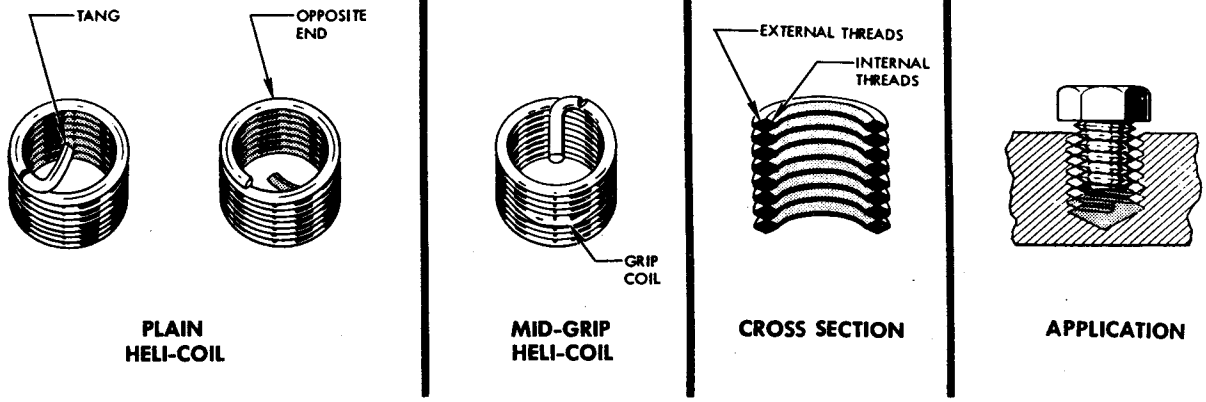


A	B					C	D	E	F	G**	H	
FASTENER THREAD SIZE	INSERT					DRILL SIZE	DRILL HOLE DEPTH	COUNTER-SINK DIM.	HELI-COIL PLUG	DEPTH CLEAR-ANCE	HOLE THREAD GAGE	PITCH DIAMETER
	PLAIN TYPE		MID-GRIP TYPE									
	FOR BLIND HOLES	FOR THRU HOLES		1-1/2 DIA	2 DIA							
#4-40	1185-04C - *	1185-04CN - *				#31 (0.1200)	0.168	0.140	04CSB	0.025	1688-04	0.1283 (+.0016/-.0000)
#6-32	1185-06C - *	1185-06CN - *	3585-06CN - *	0.207	0.276	#26 (0.1470)	0.203	0.173	06CSB	0.032	1688-06	0.1583 (+.0018/-.0000)
#8-32	1185-2C - *	1185-2CN - *	3585-2CN - *	0.246	0.328	#17 (0.1730)	0.205	0.199	2CSB	0.032	1688-2	0.1843 (+.0019/-.0000)
#10-32	1191-3C - *	1191-3CN - *	3591-3CN - *	0.285	0.380	#8 (0.1990)	0.205	0.225	3FSB	0.032	1694-3	0.2103 (+.0020/-.0000)
1/4-28	1191-4C - *	1191-4CN - *	3591-4CN - *	3/8	1/2	G (0.2610)	0.229	0.290	4FSB	0.036	1694-4	0.2732 (+.0022/-.0000)
5/16-24	1191-5C - *	1191-5CN - *	3591-5CN - *	15/32	5/8	21/64	0.262	0.360	5FSB	0.042	1694-5	0.3395 (+.0026/-.0000)
3/8-24	1191-6C - *	1191-6CN - *	3591-6CN - *	9/16	3/4	W (0.3860)	0.262	0.422	6FSB	0.042	1694-6	0.4020 (+.0027/-.0000)
7/16-20	1191-7C - *	1191-7CN - *	3591-7CN - *	21/32	7/8	29/64	0.307	0.494	7FPB	0.050	1694-7	0.4700 (+.0031/-.0000)
1/2-20	1191-8C - *	1191-8CN - *	3981-8CN - *	3/4	1	33/64	0.307	0.556	8FPB	0.050	1694-8	0.5325 (+.0032/-.0000)
9/16-18	1191-9C - *	1191-9CN - *				37/64	0.337	0.625	9FPB	0.056	1694-9	0.5986 (+.0034/-.0000)
5/8-18	1191-10C - *	1191-10CN - *				41/64	0.337	0.688	10FPB	0.056	1694-10	0.6611 (+.0035/-.0000)
3/4-16	1191-12C - *	1191-12CN - *				49/64	0.374	0.820	12FPB	0.062	1694-12	0.7906 (+.0039/-.0000)

TABLE I

* REFER TO (TABLE II) FOR LENGTH

** G PLUS THE INSERT LENGTH (TABLE II) EQUALS THE TAP DEPTH. USE THE NEAREST 1/32-INCH.

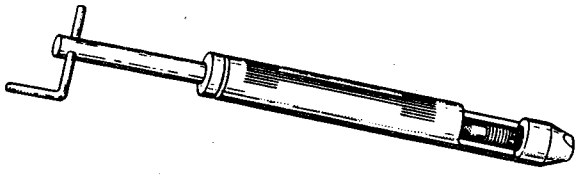
STANDARD LENGTHS (DASH NUMBER)						
THREAD SIZE	1 DIA	1-1/2 DIA	2 DIA	2-1/2 DIA	3 DIA	PLAIN HELI-COIL NO.
4 - 40	-112	-168	-224	-280	-336	1185-04
6 - 32	-138	-207	-276	-345	-414	1185-06
8 - 32	-164	-246	-328	-410	-492	1185-2
10 - 32	-190	-285	-380	-475	-570	1191-3
1/4 - 28	-1/4	-3/8	-1/2	-5/8	-3/4	1191-4
5/16 - 24	-5/16	-15/32	-5/8	-25/32	-15/16	1191-5
3/8 - 24	-3/8	-9/16	-3/4	-15/16	-1-1/8	1191-6

NOTE: USE THE NUMBERS IN THIS CHART AS THE DASH NUMBERS FOR THE BASIC HELI-COIL DESIGNATION WHEN ORDERING INSERTS.

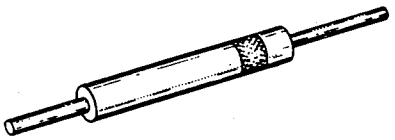
TABLE II

T-28A-3-00-16

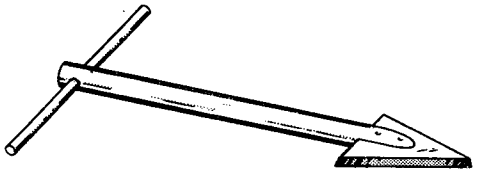
Figure 1-26. Heli-Coil Inserts (Sheet 1 of 2)



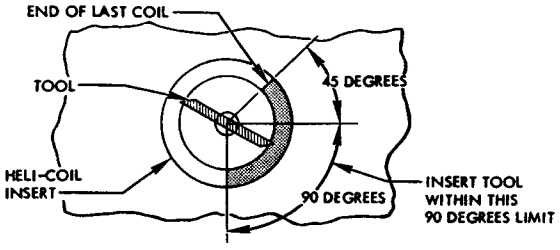
INSERTING TOOL



TANG REMOVER



EXTRACTING TOOL



EXTRACTING

A	B		C		D	E	F
FASTENER THREAD SIZE	INSERTING TOOL		TANG BREAK-OFF TOOL		INSERT THREAD GAGE	FINAL PITCH DIAMETER	EXTRACTING TOOL
	PLAIN	MID - GRIP	PLAIN	MID - GRIP			
#4-40	528-04N		1194-04		#4-40NC-3B	0.0958 (+.0027/-.0000)	1227-06
#6-32	528-06N	3551-06	1194-06	3580-06	#6-32NC-3B	0.1177 (+.0027/-.0000)	
#8-32	528-2N	3551-2	1194-2	3580-2	#8-32NC-3B	0.1437 (+.0028/-.0000)	
#10-32	535-3N	3552-3	1196-3	3581-3	#10-32NF-3B	0.1697 (+.0029/-.0000)	1227-6
1/4-28	535-4N	3552-4	1196-4	3581-4	1/4-28UNF-3B	0.2268 (+.0032/-.0000)	
5/16-24	535-5N	3552-5	1196-5	3581-5	5/16-24UNF-3B	0.2854 (+.0036/-.0000)	
3/8-24	535-6N	3552-6	1196-6	3581-6	3/8-24UNF-3B	0.3479 (+.0037/-.0000)	
7/16-20	535-7N	3552-7	1196-7	3581-7	7/16-20UNF-3B	0.4050 (+.0041/-.0000)	1227-16
1/2-20	535-8N	3552-8	1196-8	3581-8	1/2-20UNF-3B	0.4675 (+.0042/-.0000)	
9/16-18	535-9N		1196-9		9/16-18UNF-3B	0.5264 (+.0044/-.0000)	
5/8-18	535-10N		1196-10		5/8-18UNF-3B	0.5889 (+.0045/-.0000)	
3/4-16	535-12N		1196-12		3/4-16UNF-3B	0.7094 (+.0049/-.0000)	

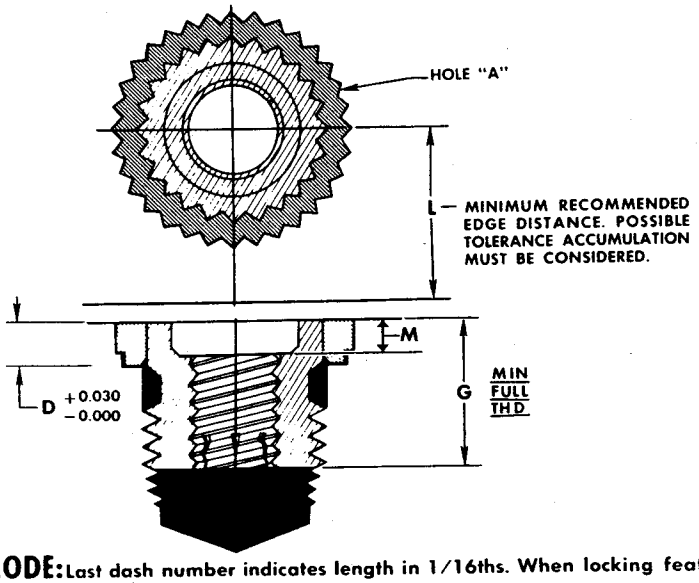
TABLE III

T-28A-3-00-17

Figure 1-26. Heli-Coil Inserts (Sheet 2 of 2)

ROSAN INSERTS

GENERAL

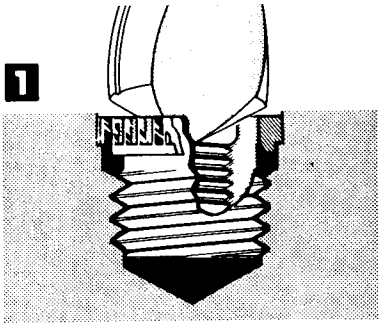


1. Drill hole shown in column "A" to depth shown in column "B."
2. Counterbore diameter shown in column "C" (+0.003, −0.000 inch), to depth shown in column "D." Fillet radius 0.010 to 0.020 inch. Counterbore to be concentric with thread pitch diameter within 0.006-inch total indicator reading.
3. Countersink 90 degrees to full diameter of counterbore.
4. Tap for thread size shown in column "K" to depth shown in column "G."
5. Select applicable insert from column "H." Install from 0.010 to 0.020 inch below the surface.
6. Select applicable lock ring from column "J." Install from flush to 0.010 inch below the surface.

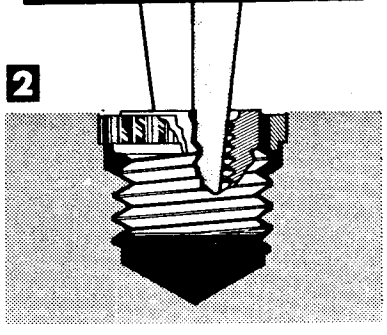
CODE: Last dash number indicates length in 1/16ths. When locking feature is not required, omit letter "L" after part numbers.
Example: RD206SB-8

INSERT INTERNAL THREAD	TAP DRILL A	DRILL DEPTH B	CBORE DIA C		CBORE DEPTH D	MIN FULL THD G	INSERT PART NUMBER H	LOCK RING PART NUMBER J	TAP THREAD K	MIN EDGE DISTANCE L	CBORE FOR AN BOLT M	REMOVAL DRILL X
			AL ALLOY	MAG								
4-40 NC-3B	25(0.149)	15/32	0.250	0.258	0.094	1/4	R102SB-4L	RL16SB-5	10-24 NC-3B	11/64	.....	11/64
6-32 NC-3B	16(0.177)	17/32	0.281	0.290	0.109	5/16	R103SB-5L	RL18SB-6	12-24 NC-3	13/64	.....	13/64
8-32 NC-3B	7(0.201)	9/16	0.328	0.337	0.109	3/8	R104SB-6L	RL21SB-6	1/4-20 UNC-3B	7/32	.....	15/64
10-32 NF-3B	F(0.257)	19/32	0.375	0.381	0.140	11/32	RD205SB-5.5L	RL24SB-7	5/16-18 UNC-3B	1/4	0.062	9/32
1/4-28-UNF-3B	5/16	21/32	0.438	0.448	0.156	13/32	RD206SB-6.5L	RL28SB-8	3/8-16 UNC-3B	5/16	0.080	11/32
5/16-24 UNF-3B	27/64	23/32	0.516	0.526	0.172	15/32	RAD207SB-7.5L	RL33SB-9	1/2-13 UNC-3B	3/8	0.095	27/64
3/8-24 UNF-3B	31/64	13/16	0.594	0.601	0.172	9/16	RD2098SB-9L	RL38SB-9	9/16-12 UNC-3B	7/16	0.100	31/64
7/16-20 UNF-3B	17/32	13/16	0.734	0.747	0.188	9/16	RD2089SB-9L	RL47SB-10	5/8-11 UNC-3B	1/2	0.100	19/32
1/2-20 UNF-3B	41/64	15/16	0.875	0.888	0.203	11/16	RD210SB-11L	RL56SB-11	3/4-10 UNC-3B	5/8	0.109	23/32

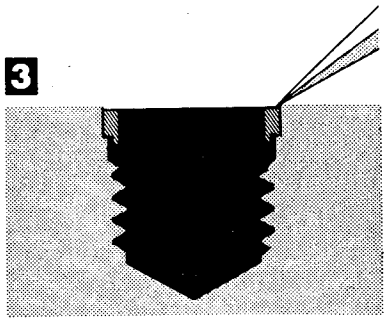
TO REMOVE INSERT



1. Drill out serrated collar of insert. Use drill same diameter as serrations. Drill to depth of lock ring only. Use drill at high speed. For correct drill sizes, see column "X" in table above.



2. Drive in square-type "ease-out" tool or similar square tool. Screw out insert.



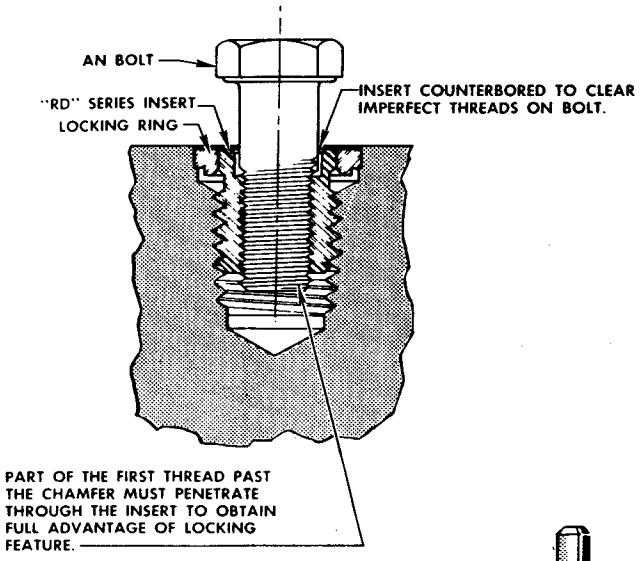
3. If lock ring fails to come out as insert is unscrewed, collapse remaining portion of ring with punch.

GEN-3-00-40

Figure 1-27. Rosan Inserts (Sheet 1 of 2)

ROSAN INSERTS

GENERAL



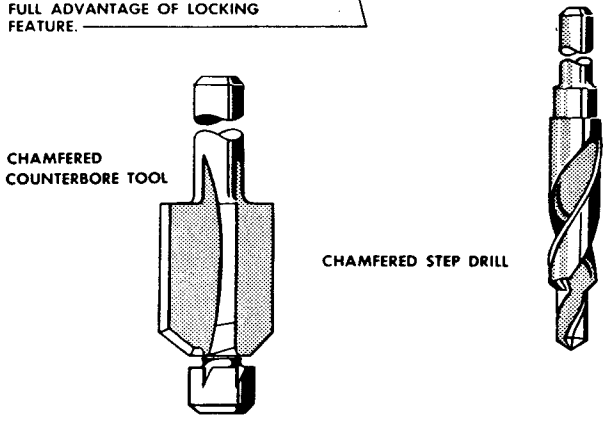
NOTE Sequences of operation for the installation of Rosan inserts.

1. Tap drill
2. Counterbore
3. Countersink.
4. Tap

Operations 1, 2, and 3 can be combined into one operation by using a chamfered step drill.

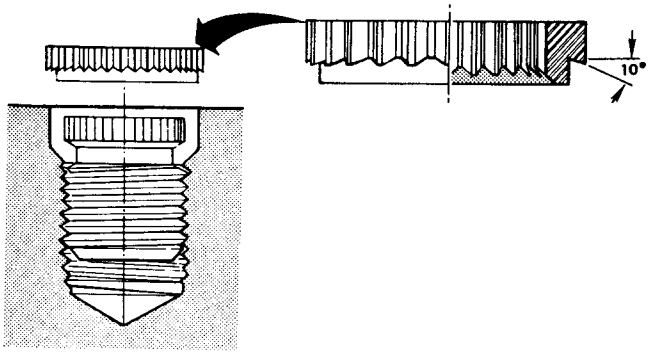
Operations 2 and 3 can be combined into one operation by using a chamfered counterbore tool with pilot.

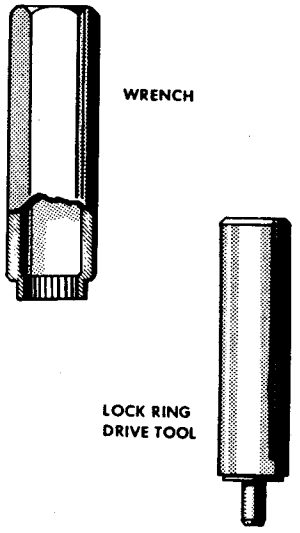
All operations may be accomplished with separate tools.



NOTE

Lock ring is designed to broach its own way into parent material. Ring should be driven straight with flat tool.





GEN-3-00-41

Figure 1-27. Rosan Inserts (Sheet 2 of 2)

RIVET HOLE SIZES

TYPICAL REPAIR

HOLE SIZE												
FASTENER SIZE	BLIND FASTENERS									DRIVE PIN RIVET (DEUTSCH)		
	CONVENTIONAL RIVET*	FINAL HOLE SIZE						JO-BOLT		PILOT-DRILL BEFORE DIMPLING	FINAL HOLE SIZE	
		EXPLOSIVE (DUPONT)	PULL			HUCK						
			CHERRY & OLYMPIC			BL SERIES BLIND LOCK BOLT	OS & OSR SERIES RIVET					
			STANDARD RIVET	OVERSIZE RIVET								
3/32	0.097-0.100 (NO. 40)											
1/8	0.1290-0.1305 (NO. 30)	0.135-0.139 (NO. 29)	0.128-0.132 (NO. 30)	0.137-0.141 (NO. 29)						0.097-0.100 (NO. 40)	0.1255-0.1265	
5/32	0.160-0.162 (NO. 21)	0.172-0.176 (NO. 17)	0.160-0.164 (NO. 20)	0.177-0.181 (NO. 16)				0.164-0.166		0.128-0.132 (NO. 30)	0.1565-0.1575	
3/16	0.192-0.194 (NO. 11)	0.203-0.207 (NO. 6)	0.192-0.196 (NO. 10)	0.204-0.210 (NO. 5)				0.199-0.202		0.172-0.176 (NO. 17)	0.191-0.193	
1/4	0.256-0.261 (F)		0.256-0.261 (F)			0.260-0.265 (G)	0.271-0.276 (I)	0.260-0.263		0.227-0.231 (NO. 1)	0.259-0.262	
3/8								0.312-0.315		0.2802-0.2852 (9/32)	0.315-0.318	
								0.375-0.379			0.385-0.388	

*Holes after dimpling must not exceed the nominal drill size by more than 15 percent.

Holes to be dimpled for explosive and pull fasteners must be pilot-drilled using nominal drill size given for conventional rivets, dimpled, and redrilled to size.

If the hole size exceeds the limits given for the standard rivet but is within the limits given for the oversize rivet, use the oversize rivet.

GEN-3-91-12A

Figure 1-28. Rivet Hole Sizes

CONVENTIONAL RIVET TYPES AND APPLICATIONS

TYPICAL REPAIR

	RIVET MATERIAL	AL ALLOY 2117-T4 (1)	AL ALLOY 2024-T4 (2)	AL ALLOY 5056-F (1)	AL 1100-F (1) (3)	MILD STEEL CAD-PLATED (1) (5)	MONEL (1)
IDENTIFICATION	HEAD MARKINGS	DIMPLE	RAISED DOUBLE DASH	RAISED CROSS	PLAIN	RECESSED TRIANGLE	DIMPLES / PLAIN
	UNIVERSAL HEAD	AN470AD	AN470DD	AN470B	AN470A		NAS508M
	ROUND HEAD					AN435	
	FLUSH HEAD	AN426AD	AN426DD	AN426B	AN426A	AN427	AN427M
	MAXIMUM TEMPERATURE	200°F	200°F	200°F		550°F	1000°F
	SIZES	3/32, 1/8, & 5/32 DIA	3/16 DIA & OVER			5/16 DIA MAX	3/16 DIA MAX
APPLICATION	AL ALLOY TO AL ALLOY	PREFERRED	PREFERRED	PERMISSIBLE BUT UNDESIRABLE	(3)	PROHIBITED	PROHIBITED
	AL ALLOY TO CAD PLATED STEEL	(4)	(4)	PROHIBITED	PROHIBITED	PREFERRED (5)	PERMISSIBLE BUT UNDESIRABLE
	AL ALLOY TO CRE STEEL						
	AL ALLOY TO TITANIUM						
	CAD PLATED STEEL TO CAD PLATED STEEL	PERMISSIBLE BUT UNDESIRABLE	PERMISSIBLE BUT UNDESIRABLE				
	CAD PLATED STEEL TO CRE STEEL						
	CAD PLATED STEEL TO TITANIUM						
	CRE STEEL TO CRE STEEL	PROHIBITED	PROHIBITED	PROHIBITED	PROHIBITED	PROHIBITED	PREFERRED
	CRE STEEL TO TITANIUM						
	TITANIUM TO TITANIUM						
	MAGNESIUM ALLOY TO AL ALLOY	PROHIBITED	PROHIBITED	PREFERRED	PROHIBITED	PROHIBITED	PROHIBITED
	MAGNESIUM ALLOY TO CAD PLATED STEEL						
	MAGNESIUM ALLOY TO MAGNESIUM ALLOY						
	SOFT MATERIAL	ACCEPTABLE	PROHIBITED	PERMISSIBLE BUT UNDESIRABLE	PREFERRED	PROHIBITED	PROHIBITED

(1) Use rivets in "as received" condition.

(2) Rivets should be reheat-treated and refrigerated before using, in accordance with Specification MIL-H-6088.

(3) May be used for welding, where extra softness is required, or for plugging holes.

(4) May be used for weight saving or strength.

(5) Not recommended for structural applications.

GEN-3-91-13

Figure 1-29. Conventional-type Rivets and Applications

WROUGHT ALUMINUM ALLOY DESIGNATIONS	
OLD DESIGNATION	NEW DESIGNATION
2S	1100
3S	3003
14S	2014
17S	2017
A17S	2117
24S	2024
52S	5052
56S	5056
61S	6061
75S	7075
79S	7079

TEMPER DESIGNATIONS

The temper designation system in effect since 31 December 1947 is being continued without change. The temper designation follows the alloy designation and is separated from it by a dash. Example: 3S-O is now 3003-O, Alclad 24S-T3 is Alcad 2024-T3, and 75S-T6 is 7075-T6.

Alloy designations and temperature designations for aluminum alloy castings have not been changed.

NOTE

2024-T3 may be substituted for 2024-T4 for Repair, except as specified.

T-28A-3-00-18

Figure 1-30. New Designations of Aluminum Alloys

STANDARD SHEET METAL THICKNESS

GENERAL

ALUMINUM AND MAGNESIUM		STEEL	
OLD STANDARD	NEW STANDARD	OLD STANDARD	NEW STANDARD
	0.006	0.010	0.010
	0.008	0.012	0.012
0.010	0.010	0.016	0.016
0.012	0.012	0.018	0.018
0.016	0.016	0.020	0.020
	0.018	0.025	0.025
0.020	0.020	0.028	0.028
	0.022	0.032	0.032
0.025	0.025	0.035	0.036
	0.028	0.036	0.036
0.032	0.032	0.040	0.040
	0.036	0.042*	0.040
0.040	0.040	0.045	0.045
	0.045	0.050	0.050
0.051	0.050	0.060	0.060
	0.056	0.063	0.063
0.064	0.063	0.065*	0.063
0.072	0.071	0.071	0.071
0.081	0.080	0.078	0.080
0.091	0.090	0.080	0.080
0.102	0.100	0.083*	0.080
	0.112	0.090	0.090
0.125	0.125	0.093*	0.090
	0.140	0.094*	0.090
0.156*	0.160	0.100	0.100
	0.180	0.109	0.112
0.188	0.190	0.112	0.112
	0.200	0.125	0.125
	0.244	0.156	0.160
		0.187	0.190
		0.188	0.190

NOTE Reading across the chart, thicknesses may be used interchangeably except as noted. GEN-3-00-18

*Reading across the chart, the thicker material may be substituted for the thinner material. Substitution of the thinner material for the heavier material must be approved by the structural repair officer.

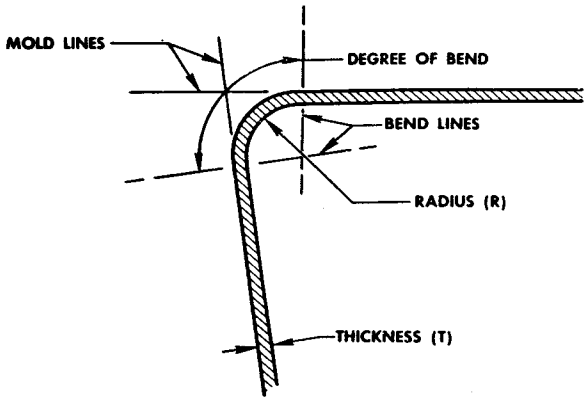
Figure 1-31. Standard Sheet-metal Thickness

BEND ALLOWANCE CHART

GENERAL

The empirical formula for finding the bend allowance of material required for a bend = (0.01743 × radius) × (0.0078 × thickness)

This equals the material required for one degree of bend.



1 Multiply the numbers in the table by the degrees of bend to determine the amount of material required for the bend.

Example:
95 deg bend, 1/8 in. radius, 0.040 in. material
0.00249 × 95 = 0.2365 in.

2 For bends larger than one inch radius, the amount of material required for the bend is calculated as the arc of a circle, the radius of which is taken to the center of the material.

Example:
90 deg bend, 1 in. radius, 0.064 in. material.
Radius to center of material = bend radius (1 in.) + 1/2 material thickness = 1 + 0.032 = 1.032 in.

$$\text{Circumference of arc} = \frac{2\ \pi\ R \times \text{degree of bend}}{360\ \text{(total degrees in circle)}}$$

BEND ALLOWANCE COEFFICIENTS FOR ALUMINUM ALLOYS, BASED ON ONE-DEGREE ANGLE

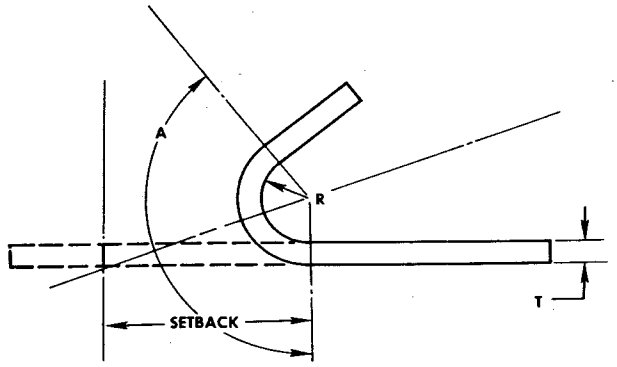
RADII	METAL THICKNESS											
	0.016	0.020	0.022	0.025	0.032	0.040	0.050	0.063	0.080	0.090	0.125	0.180
1/32	0.00067	0.00070	0.00072	0.00074	0.00079	0.00086	0.00094	0.00104	0.00117	0.00125	0.00154	0.00200
1/16	0.00121	0.00125	0.00126	0.00129	0.00135	0.00140	0.00149	0.00159	0.00171	0.00180	0.00209	0.00255
3/32	0.00176	0.00179	0.00180	0.00183	0.00188	0.00195	0.00203	0.00213	0.00226	0.00234	0.00263	0.00309
1/8	0.00230	0.00234	0.00235	0.00238	0.00243	0.00249	0.00258	0.00268	0.00281	0.00289	0.00317	0.00364
5/32	0.00285	0.00288	0.00290	0.00292	0.00297	0.00304	0.00312	0.00322	0.00335	0.00343	0.00372	0.00418
3/16	0.00339	0.00342	0.00344	0.00347	0.00352	0.00358	0.00367	0.00377	0.00390	0.00398	0.00426	0.00473
7/32	0.00394	0.00397	0.00398	0.00401	0.00406	0.00412	0.00421	0.00431	0.00444	0.00452	0.00481	0.00527
1/4	0.00448	0.00451	0.00454	0.00456	0.00461	0.00467	0.00476	0.00486	0.00499	0.00507	0.00535	0.00582
9/32	0.00503	0.00506	0.00507	0.00510	0.00515	0.00521	0.00530	0.00540	0.00553	0.00561	0.00590	0.00636
5/16	0.00557	0.00560	0.00562	0.00564	0.00570	0.00576	0.00584	0.00595	0.00608	0.00616	0.00644	0.00691
11/32	0.00612	0.00615	0.00616	0.00619	0.00624	0.00630	0.00639	0.00649	0.00662	0.00670	0.00699	0.00745
3/8	0.00666	0.00669	0.00671	0.00673	0.00679	0.00685	0.00693	0.00704	0.00717	0.00725	0.00753	0.00800
13/32	0.00721	0.00724	0.00725	0.00728	0.00733	0.00739	0.00748	0.00758	0.00771	0.00779	0.00808	0.00854
7/16	0.00775	0.00778	0.00780	0.00782	0.00787	0.00794	0.00802	0.00812	0.00826	0.00834	0.00862	0.00908
15/32	0.00829	0.00833	0.00834	0.00837	0.00842	0.00848	0.00857	0.00867	0.00880	0.00888	0.00917	0.00963
1/2	0.00884	0.00887	0.00889	0.00891	0.00896	0.00903	0.00911	0.00921	0.00935	0.00943	0.00971	0.01017
17/32	0.00938	0.00942	0.00943	0.00946	0.00951	0.00957	0.00966	0.00976	0.00989	0.00997	0.01025	0.01072
9/16	0.00993	0.00996	0.00998	0.01000	0.01005	0.01012	0.01020	0.01030	0.01043	0.01051	0.01080	0.01126
19/32	0.01047	0.01051	0.01052	0.01055	0.01058	0.01065	0.01073	0.01083	0.01098	0.01105	0.01133	0.01179
5/8	0.01102	0.01105	0.01107	0.01109	0.01114	0.01121	0.01129	0.01139	0.01152	0.01160	0.01189	0.01235
21/32	0.01156	0.01160	0.01161	0.01164	0.01170	0.01175	0.01183	0.01193	0.01207	0.01214	0.01245	0.01289
11/16	0.01211	0.01214	0.01216	0.01218	0.01223	0.01230	0.01238	0.01248	0.01261	0.01269	0.01298	0.01344
23/32	0.01265	0.01268	0.01269	0.01273	0.01276	0.01283	0.01291	0.01301	0.01316	0.01322	0.01351	0.01397
3/4	0.01320	0.01323	0.01324	0.01327	0.01332	0.01338	0.01347	0.01357	0.01370	0.01378	0.01407	0.01453
25/32	0.01374	0.01378	0.01379	0.01381	0.01386	0.01392	0.01401	0.01411	0.01425	0.01432	0.01461	0.01507
13/16	0.01429	0.01432	0.01433	0.01436	0.01441	0.01447	0.01456	0.01466	0.01479	0.01487	0.01516	0.01562
27/32	0.01483	0.01486	0.01487	0.01490	0.01494	0.01501	0.01509	0.01519	0.01534	0.01540	0.01569	0.01615
7/8	0.01538	0.01541	0.01542	0.01545	0.01550	0.01556	0.01565	0.01575	0.01588	0.01596	0.01625	0.01671
29/32	0.01592	0.01595	0.01596	0.01599	0.01604	0.01610	0.01619	0.01629	0.01643	0.01650	0.01679	0.01727
15/16	0.01646	0.01650	0.01651	0.01654	0.01659	0.01665	0.01674	0.01684	0.01697	0.01705	0.01734	0.01780
31/32	0.01701	0.01704	0.01705	0.01708	0.01712	0.01718	0.01727	0.01737	0.01752	0.01756	0.01787	0.01833
1	0.01755	0.01759	0.01760	0.01763	0.01768	0.01774	0.01783	0.01793	0.01806	0.01814	0.01843	0.01888

GEN-3-00-19

Figure 1-32. Bend Allowance Chart

SETBACK CHART

GENERAL



Example:
Angle of bend (A) = 140 deg
Material thickness (T) = 0.064 in.
Radius (R) = 0.125 in.
K—from table = 2.7475

SETBACK = K × (T + R) =
2.7475 × (0.064 + 0.125) =
2.7475 × 0.189 = 0.509
SETBACK = 0.509 IN.

ANGLE DEGREE	K	ANGLE DEGREE	K	ANGLE DEGREE	K	ANGLE DEGREE	K	ANGLE DEGREE	K	ANGLE DEGREE	K
1	0.00873	31	0.27732	61	0.58905	91	1.0176	121	1.7675	151	3.8667
2	0.01745	32	0.28674	62	0.60086	92	1.0355	122	1.8040	152	4.0108
3	0.02618	33	0.29621	63	0.61208	93	1.0538	123	1.8418	153	4.1653
4	0.03493	34	0.30573	64	0.62487	94	1.0724	124	1.8807	154	4.3315
5	0.04366	35	0.31530	65	0.63707	95	1.0913	125	1.9210	155	4.5107
6	0.05241	36	0.32492	66	0.64941	96	1.1106	126	1.9626	156	4.7046
7	0.06116	37	0.33459	67	0.66188	97	1.1303	127	2.0057	157	4.9151
8	0.06993	38	0.34433	68	0.67451	98	1.1504	128	2.0503	158	5.1455
9	0.07870	39	0.35412	69	0.68728	99	1.1708	129	2.0965	159	5.3995
10	0.08749	40	0.36397	70	0.70021	100	1.1917	130	2.1445	160	5.6713
11	0.09629	41	0.37388	71	0.71329	101	1.2131	131	2.1943	161	5.9758
12	0.10510	42	0.38386	72	0.72654	102	1.2349	132	2.2460	162	6.3137
13	0.11393	43	0.39391	73	0.73996	103	1.2572	133	2.2998	163	6.6911
14	0.12278	44	0.40403	74	0.75355	104	1.2799	134	2.3558	164	7.1154
15	0.13165	45	0.41421	75	0.76733	105	1.3032	135	2.4142	165	7.5957
16	0.14054	46	0.42447	76	0.78128	106	1.3270	136	2.4751	166	8.1443
17	0.14945	47	0.43481	77	0.79543	107	1.3514	137	2.5386	167	8.7769
18	0.15838	48	0.44523	78	0.80978	108	1.3764	138	2.6051	168	9.5144
19	0.16734	49	0.45573	79	0.82434	109	1.4019	139	2.6746	169	10.385
20	0.17633	50	0.46631	80	0.83910	110	1.4281	140	2.7475	170	11.430
21	0.18534	51	0.47697	81	0.85408	111	1.4550	141	2.8239	171	12.706
22	0.19438	52	0.48773	82	0.86929	112	1.4826	142	2.9042	172	14.301
23	0.20345	53	0.49858	83	0.88472	113	1.5108	143	2.9887	173	16.350
24	0.21256	54	0.50952	84	0.90040	114	1.5399	144	3.0777	174	19.081
25	0.22169	55	0.52057	85	0.91633	115	1.5697	145	3.1716	175	22.904
26	0.23087	56	0.53171	86	0.93251	116	1.6003	146	3.2708	176	26.636
27	0.24008	57	0.54295	87	0.94896	117	1.6318	147	3.3759	177	38.188
28	0.24933	58	0.55431	88	0.96569	118	1.6643	148	3.4874	178	57.290
29	0.25862	59	0.56577	89	0.98270	119	1.6977	149	3.6059	179	114.590
30	0.26795	60	0.57735	90	1.00000	120	1.7320	150	3.7320	180	INFINITE

GEN-3-00-20

Figure 1-33. Setback Chart

TAP DRILLS AND DECIMAL EQUIVALENTS

GENERAL

TAP DRILL SIZES

NC Coarse Thread		NF Fine Thread	
SCREW SIZE	TAP DRILL	SCREW SIZE	TAP DRILL
7/16-14	U	7/16-20	25/64
1/2-13	27/64	1/2-20	29/64
9/16-12	31/64	9/16-18	33/64
5/8-11	17/32	5/8-18	37/64
11/16-11	19/32	11/16-11	5/8
3/4-10	21/32	3/4-16	11/16
13/16-10	23/32	7/8-14	13/16
7/8- 9	49/64	1 -14	15/16
15/16- 9	53/64	1-1/8-12	1-3/64
1 - 8	7/8	1-1/4-12	1-11/64
1-1/8- 7	63/64	1-1/2-12	1-27/64
1-1/4- 7	1-7/64		
1-1/2- 6	1-11/32		

MACHINE SCREW

SCREW SIZE	DRILLS FOR	
	TAP	CLEARANCE
2 -56	No. 50	No. 43
3 -48	No. 47	No. 40
4 -40	No. 43	No. 32
6 -32	No. 36	No. 28
8 -32	No. 29	No. 19
10 -24	No. 25	No. 10
10 -32	No. 21	No. 10
12 -24	No. 16	7/32
1/4 -20	No. 7	1/4
1/4 -28	No. 3	1/4
5/16 -18	F	5/16
5/16 -24	I	5/16
3/8 -16	5/16	3/8
3/8 -24	Q	3/8

PIPE

DIAMETER OF TAP	DRILLS FOR	
	TAP	CLEARANCE
1/8- 27	11/32	7/16
1/4- 18	7/16	7/16
3/8- 18	37/64	3/4
1/2- 14	23/32	7/8
3/4- 14	59/64	1-3/16
1 -11-1/2	1- 5/32	1-7/16
1-1/4-11-1/2	1- 1/2	1-3/4
1-1/2-11-1/2	1-47/64	2
2 -11-1/2	2- 7/32	2-1/2
2-1/2- 8	2- 5/8	3
3 - 8	3- 1/4	3-3/4
3-1/2- 8	3- 3/4	4-1/4
4 - 8	4- 1/4	4-3/4

DECIMAL EQUIVALENTS

NUMBER, LETTER, AND FRACTIONAL SIZE DRILLS

SIZE DRILL	DECIMAL	SIZE DRILL	DECIMAL	SIZE DRILL	DECIMAL
80	0.0135	1/8	0.1250	21/64	0.3281
79	0.0145	30	0.1285	Q	0.3320
1/64	0.0156	29	0.1360	R	0.3390
78	0.0160	28	0.1405	11/32	0.3437
77	0.0180	9/64	0.1406	S	0.3480
76	0.0200	27	0.1440	T	0.3580
75	0.0210	26	0.1470	23/64	0.3594
74	0.0225	25	0.1495	U	0.3680
73	0.0240	24	0.1520	3/8	0.3750
72	0.0250	23	0.1540	V	0.3770
71	0.0260	5/32	0.1562	W	0.3860
70	0.0280	22	0.1570	25/64	0.3906
69	0.0292	21	0.1590	X	0.3970
68	0.0310	20	0.1610	Y	0.4040
1/32	0.0313	19	0.1660	13/32	0.4062
67	0.0320	18	0.1695	Z	0.4130
66	0.0330	11/64	0.1719	27/64	0.4219
65	0.0350	17	0.1730	7/16	0.4375
64	0.0360	16	0.1770	29/64	0.4531
63	0.0370	15	0.1800	15/32	0.4687
62	0.0380	14	0.1820	31/64	0.4843
61	0.0390	13	0.1850	1/2	0.5000
60	0.0400	3/16	0.1875	33/64	0.5156
59	0.0410	12	0.1890	17/32	0.5312
58	0.0420	11	0.1910	35/64	0.5469
57	0.0430	10	0.1935	9/16	0.5625
56	0.0465	9	0.1960	37/64	0.5781
3/64	0.0469	8	0.1990	19/32	0.5937
55	0.0520	7	0.2010	39/64	0.6094
54	0.0550	13/64	0.2031	5/8	0.6250
53	0.0595	6	0.2040	41/64	0.6406
1/16	0.0625	5	0.2055	21/32	0.6562
52	0.0635	4	0.2090	43/64	0.6719
51	0.0670	3	0.2130	11/16	0.6875
50	0.0700	1/32	0.2187	45/64	0.7031
49	0.0730	2	0.2210	23/32	0.7187
48	0.0760	1	0.2280	47/64	0.7344
5/64	0.0781	A	0.2340	3/4	0.7500
47	0.0785	15/64	0.2344	49/64	0.7656
46	0.0810	B	0.2380	25/32	0.7812
45	0.0820	C	0.2420	51/64	0.7969
44	0.0860	D	0.2460	13/16	0.8125
43	0.0890	1/4	0.2500	53/64	0.8281
42	0.0935	F	0.2570	27/32	0.8437
3/32	0.0937	G	0.2610	55/64	0.8594
41	0.0960	17/64	0.2656	7/8	0.8750
40	0.0980	H	0.2660	57/64	0.8906
39	0.0995	I	0.2720	29/32	0.9062
38	0.1015	J	0.2770	59/64	0.9219
37	0.0140	K	0.2811	15/16	0.9375
36	0.0165	9/32	0.2812	61/64	0.9531
7/64	0.1093	L	0.2900	31/32	0.9687
35	0.1100	M	0.2950	63/64	0.9844
34	0.1110	19/64	0.2968	1	1.000
33	0.1130	N	0.3020		
32	0.1160	5/16	0.3125		
31	0.1200	O	0.3160		
		P	0.3230		

GEN-3-00-21

Figure 1-34. Tap Drill Sizes and Decimal Equivalents

TORQUE TABLE

GENERAL

The torque table is to be used as a guide in tightening nuts, bolts, and screws whenever specific torque values are not called out in maintenance procedures. Using the proper torque allows the structure to develop its designed strength and greatly reduces the possibility of failure due to fatigue. There are a few items you should be aware of when using this table:

1 To convert to foot-pounds, divide inch-pounds by 12.

2 Threads must be free from grease or oil. Lubrication changes the torque value and will result in overtorquing.

3 When castellated nuts are used, tighten them to the lower torque limit. Then continue tightening until cotter pin hole is aligned with slots in nut. Do not back off nut to align hole.

4 When it is necessary to tighten from the bolthead, use the high side of the torque range. If necessary, the maximum allowable tightening torque may be used.

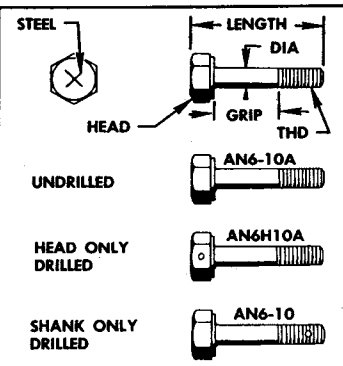
5 When corrosion-resistant steel bolts are used, they should be lubricated with an anti-seize compound. Corrosion-resistant steel bolts and nuts must be used together. Use shear nut torque values when tightening these bolts.

HEX NUTS

AN. NUMBER AND DESCRIPTION	STEEL CAD PLATED	STEEL CAD PLATED	CORR RESISTANT STEEL	STEEL CAD PLATED	CORR RESISTANT STEEL
AN363 REG HEIGHT 550°F MAX					
AN363C REG HEIGHT 800°F MAX					
AN364 THIN 250°F MAX					
AN365 REG HEIGHT 250°F MAX					
AN320 THIN 250°F MAX					
AN310 REG HEIGHT 250°F MAX					

BOLTS

BASIC NUMBER	DIAMETER	THREADS PER INCH
AN173	10*	32
174	1/4*	28
175	5/16	24
176	3/8	24
177	7/16	20
178	1/2	20
179	9/16	18
180	5/8	18
182	3/4	16
184	7/8	14
186	1	14



*BOLT SHANK SHOULD BE WITHOUT COTTER PIN HOLE WHEN USED WITH SELF-LOCKING NUTS.

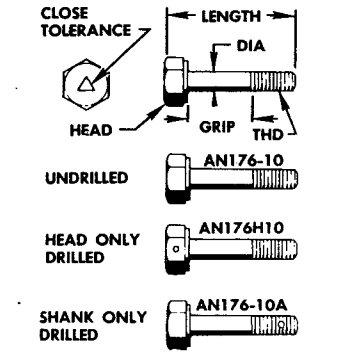
TORQUE VALUES IN INCH-POUNDS

STANDARD NUTS, BOLTS, AND SCREWS

WRENCH SIZE	BOLT, STUD, OR SCREW SIZE	TENSION-TYPE NUTS AN310 AND AN365	SHEAR-TYPE NUTS AN320 AND AN364
11/32	8-36	12 – 15	7 – 9
3/8	10-32	20 – 25	12 – 15
7/16	1/4-28	50 – 70	30 – 40
1/2	5/16-24	100 – 140	60 – 85
9/16	3/8-24	160 – 190	95 – 110
5/8	7/16-20	450 – 500	270 – 300
3/4	1/2-20	480 – 690	290 – 410
7/8	9/16-18	800 – 1000	480 – 600
15/16	5/8-18	1100 – 1300	660 – 780
1-1/16	3/4-16	2300 – 2500	1300 – 1500
1-1/4	7/8-14	2500 – 3000	1500 – 1800
1-7/16	1-14	3700 – 5500	2200 – 3300

CLOSE-TOLERANCE BOLTS

BASIC NUMBER	DIAMETER	THREADS PER INCH
AN3	10*	32
4	1/4*	28
5	5/16	24
6	3/8	24
7	7/16	20
8	1/2	20
9	9/16	18
10	5/8	18
12	3/4	16
14	7/8	14
16	1	14



*BOLT SHANK SHOULD BE WITHOUT COTTER PIN HOLE WHEN USED WITH SELF-LOCKING NUTS.

GEN-3-00-22

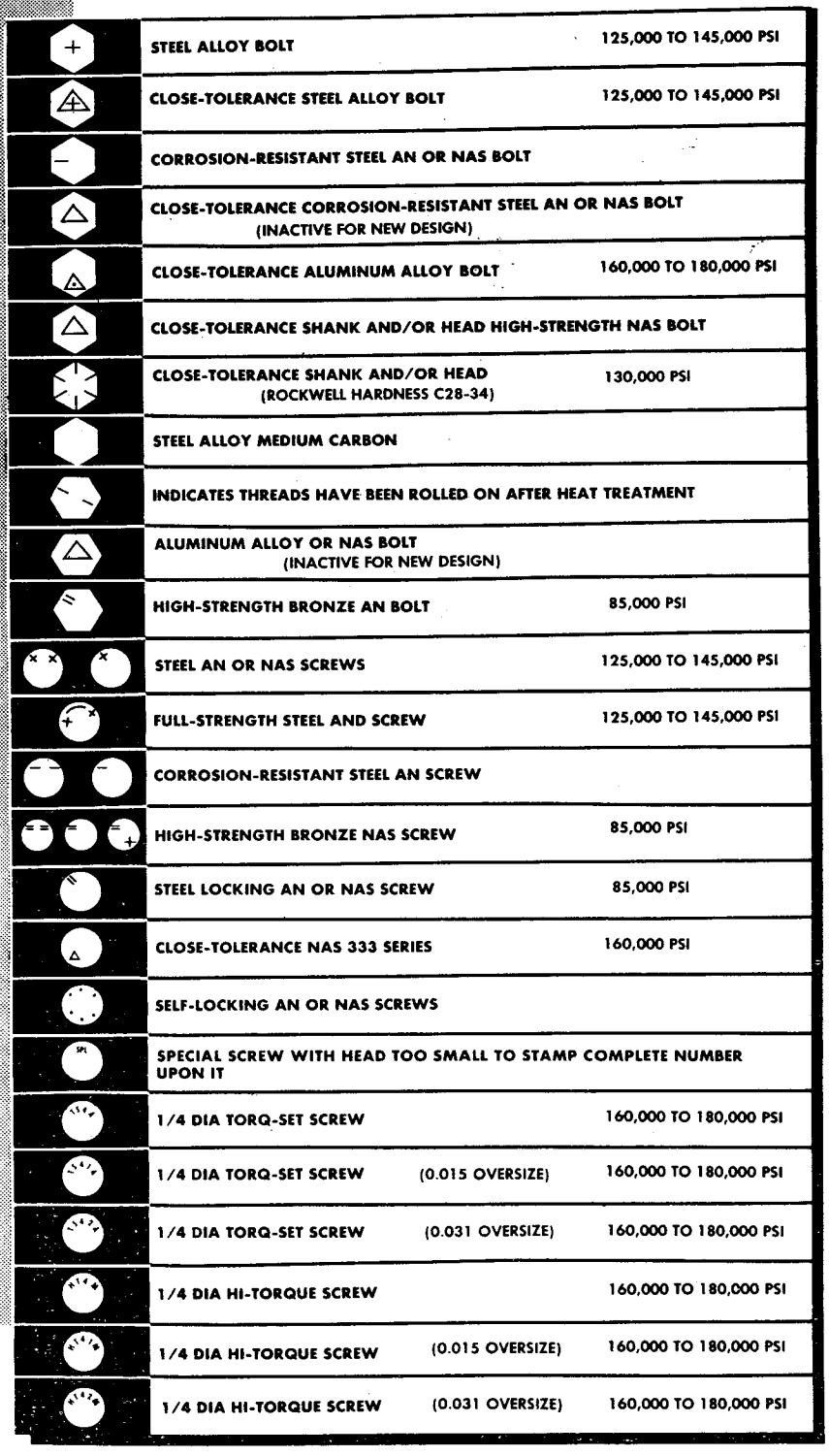
Figure 1-35. Torque Table

BOLT HEAD IDENTIFICATION

GENERAL

NOTE The head slots have been left off the screw and boltheads for clarity.

The figure "1" after the figure indicating the diameter of both Hi-Torque and Torq-Set bolts indicates that the screw is 0.015 inch oversize, and the figure "2" after the figure indicating the diameter indicates that the bolt is 0.031 inch oversize.



GEN-3-00-92

Figure 1-36. Bolthead Identification

SECTION II

WING GROUP

WING GROUP.

WING.

The wing is of full-cantilever, all-metal, semi-monocoque design and construction. The two spars are built up of 2014-T6 machined cap sections and 7075-T6 and 2024-T4 clad sheet webs, and are interconnected by chordwise formers and pressed-type ribs fabricated from 2024-T4 clad sheet. Stringers, consisting of formed 2024-T4 clad sections and 2024-T4 extruded sections, are used extensively to provide skin attachment and to provide bending strength. All skins are made of 2024-T4 clad sheet, and are dimpled and machine countersunk for attachment with countersunk rivets forward of the 23 percent chord line. Modified brazier head rivets are used for attachment of the skins aft of the 23 percent chord line. The center section is built in halves that are bolted together at the airplane centerline by four bolts. The complete center section is attached to the fuselage lower longerons with four bolts at the front and rear spars and by two adjustable links at the leading edge. Landing gear fittings which are attached to the rear spars and landing gear beams at wing stations 70, and side brace fittings which are attached to the landing gear beams at wing stations 51.5, carry the landing loads into the wing structure. The outer panels bolt to the center section at wing stations 154, where the front spar is connected by two tension bolts in the lower cap and one in the upper cap. Shear pins at the rear spar and leading edge transfer torsion from the outer panel to the center section. Glass fabric (left-hand) and 5052-O aluminum alloy (right-hand) tips are attached with screws to each outer panel. The flaps, ailerons, and main landing gear are attached to the wing. Access to the wing tank bay areas is provided by lower surface doors.

WING — ARMAMENT-MODIFIED AIRPLANES.

On armament-modified airplanes, the wings have been modified to satisfy the additional store stations requirements. Fittings, stiffeners, doublers, etc, and doors have been added to provide the necessary strength and accessibility. (See figure 2-1C.) The additional store stations are symmetrically located (wing stations 127.469 and 148.625) on the undersurface of each inboard wing panel outboard of the existing store station (wing station 105.5). Also, on T-28D-5 Airplanes, a fixed gun is under each wing just outboard of station 75.

AILERONS.

The ailerons are fabricated from 2024-T4 clad sheet, with the exception of three short lengths of magnesium alloy extrusion used as stiffening members in the inboard leading edge area of each aileron, and the trailing edge extrusion which is also made of magnesium alloy. The ailerons are single-cell structures with a framework consisting of closely spaced pressed-type ribs and a rear spar covered with skins which are reinforced by spanwise stringers. Rivet attachments of 2024-T4 clad members are made with 2117-T4 and 2024-T4 aluminum alloy rivets. Attachment of magnesium alloy extrusion is made with 5056 aluminum alloy rivets. Each aileron is supported by three hinge fittings. The center and outboard hinge fittings are magnesium alloy forgings; the inboard hinge fitting is an aluminum alloy casting. The left aileron is equipped with a trim tab, and the right aileron is equipped with a ground boost tab; the tabs are identical one-cell structures consisting of a single spar and ribs, made from 2024-T4 clad sheet, which support 2024-T4 clad skins. A continuous-type aluminum alloy hinge is used. The trailing edge extrusion and the actuating fitting are made of magnesium alloy. All 2024-T4 parts are attached with 2117-T4 aluminum alloy rivets; all magnesium parts are attached with 5056 aluminum alloy rivets.

LANDING FLAPS.

The landing flaps are one-cell structures and, with a few exceptions, are similar in construction to the ailerons. Corrosion-resistant steel sheet is used to cover the upper leading edges. The three hinge fittings on each flap are made from 2014-T6 aluminum alloy extrusion. Spring-loaded doors in the inboard end of the left flap provide steps to aid in boarding the airplane on Airplanes AF49-1491 through -1528. On Airplanes AF49-1529 and later, the steps are provided in both the left and the right flaps.

PYLONS — ARMAMENT-MODIFIED AIRPLANES.

Three pylon assemblies (Part No. 252-63015) may be installed on the undersurface of each inboard wing panel. The pylon assemblies consist of an adapter (TENS 50-T6 casting) (Part No. 252-63021) and a modified bomb rack (Aero 15C-1). For trimming and fitting unmodified pylons and bomb racks, see figure 2-1D. For removal, installation, and maintenance procedures, refer to Technical Manual of Maintenance, T.O. 1T-28B-2 and 1T-28D-2.

GUN PACKAGE.

See figure 2-1B.

GUN PACKAGE FAIRING REPAIR DATA.

FILLET FAIRING ASSEMBLY. The gun package fillet fairing is made from 5052-O aluminum alloy. This material is weldable, and cracks may be repaired by stop-drilling and welding and/or with a general-type repair.

NOSE FAIRING ASSEMBLY. The nose fairing is made from 6061-O aluminum alloy heat-treated to the -T6 condition. The external skin is 0.030 inch stiffened by a 0.040-inch doubler spot-welded to the inside surface.

TAIL FAIRING. The tail fairing is made from 0.030-inch. 6061-O aluminum alloy, heat-treated to the -T6 condition.

EXTERIOR SKINS. The five skin panels which enclose the gun package are 0.032-inch 2024-T4 aluminum alloy.

SKIN REPAIRS. Since the 6061 and 2024 aluminum alloy skins are heat-treated, no welding can be permitted. External-type repairs are acceptable, 0.040-inch 2024-T4 or -T42 aluminum alloy doublers. Use 1/8-inch flush rivets (MS20601AD-4 or AN426AD-4), countersink, and bevel edges of doubler.

NOTE

Should damage occur on the upper half of the nose fairing, it will be necessary to use a 0.080-inch 2024-T4 or -T42 aluminum alloy doubler.

FIXED GUN ENCLOSURE.

See figure 2-1B-1.

315-ROUND GUN PACKAGE.

See figure 2-1B-2.

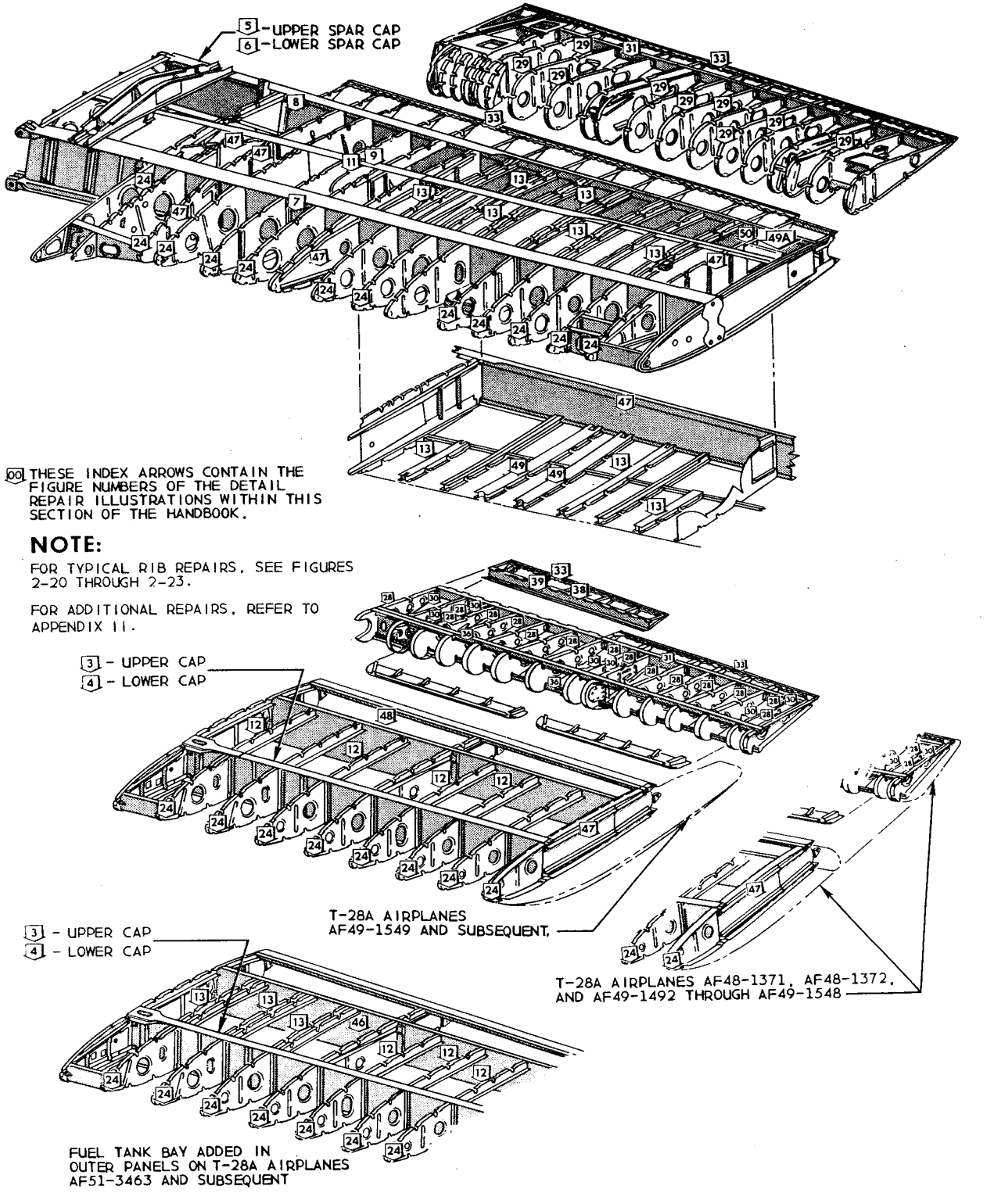


Figure 2-1. Wing Repair Index – T-28A and T-28D Airplanes (Sheet 1 of 3)

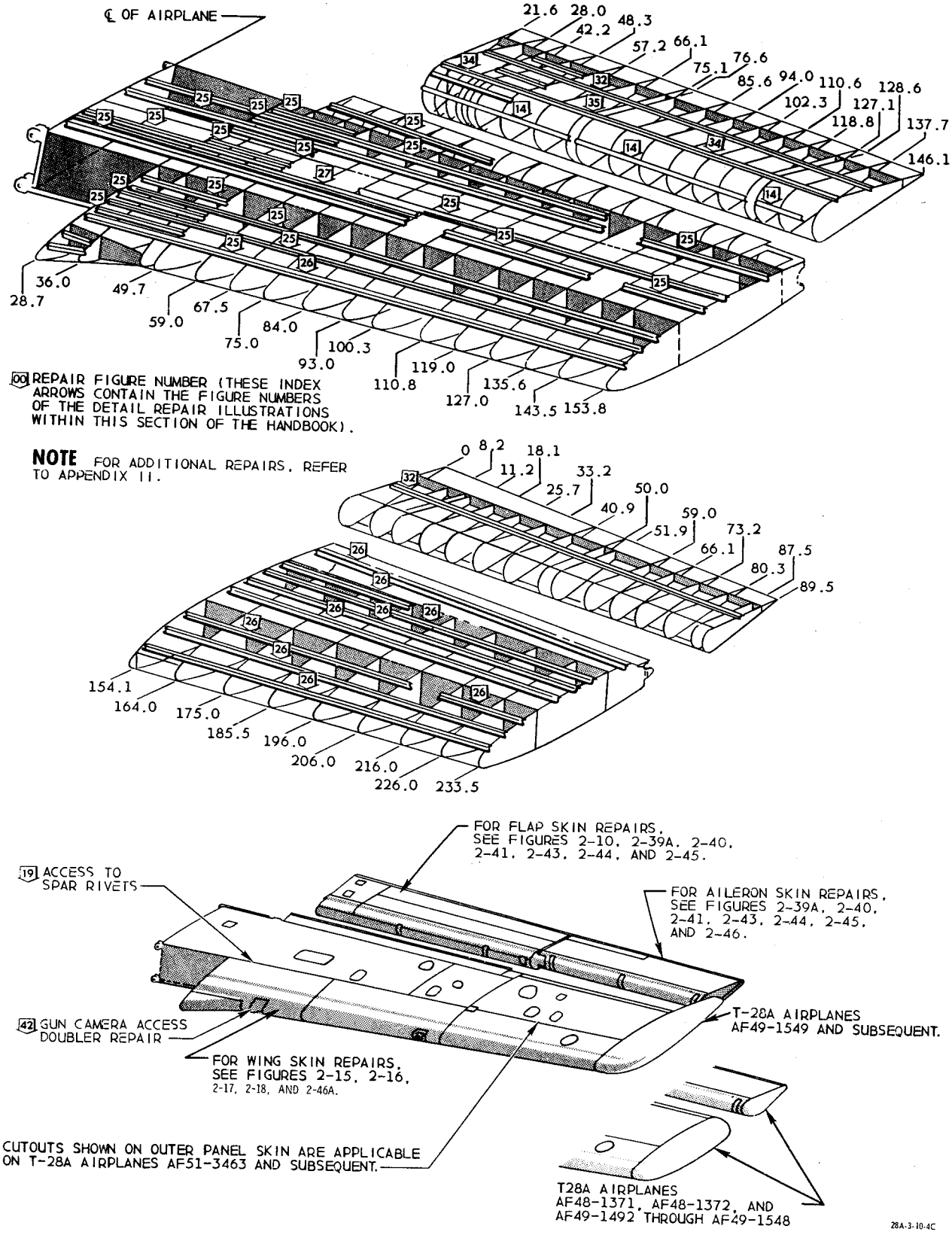


Figure 2-1. Wing Repair Index – T-28A and T-28D Airplanes (Sheet 2 of 3)

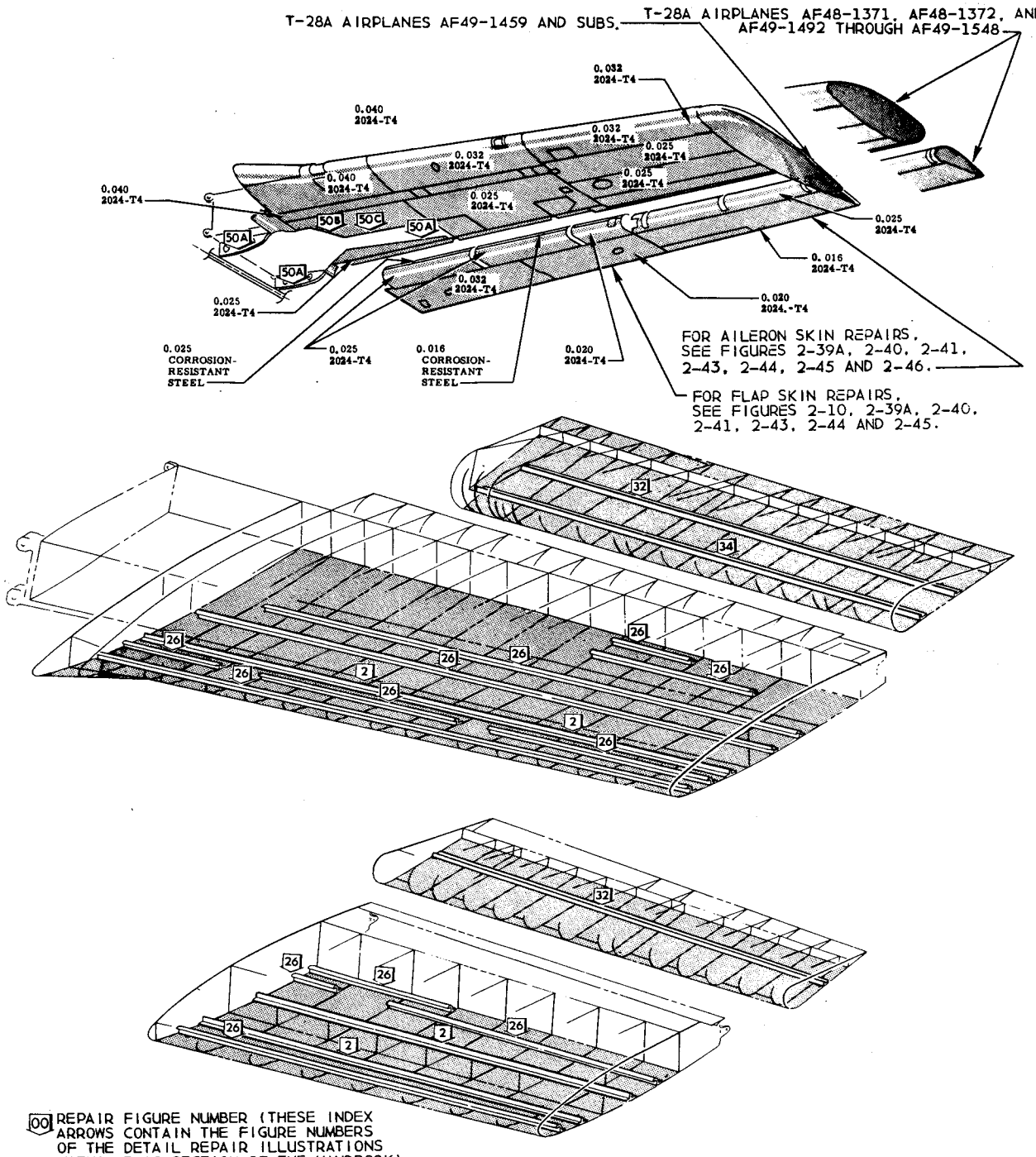


Figure 2-1. Wing Repair Index – T-28A and T-28D Airplanes (Sheet 3 of 3)

[80] THESE INDEX ARROWS CONTAIN THE FIGURE NUMBERS OF THE DETAIL REPAIR ILLUSTRATION WITHIN THIS SECTION OF THE HANDBOOK.

NOTE

FOR TYPICAL RIB REPAIRS, SEE FIGURES 2-20 THROUGH 2-23.

FOR SPAR AND RIB WEB REPAIR, SEE FIGURE 2-47.

FOR ADDITIONAL REPAIRS, REFER TO APPENDIX II.

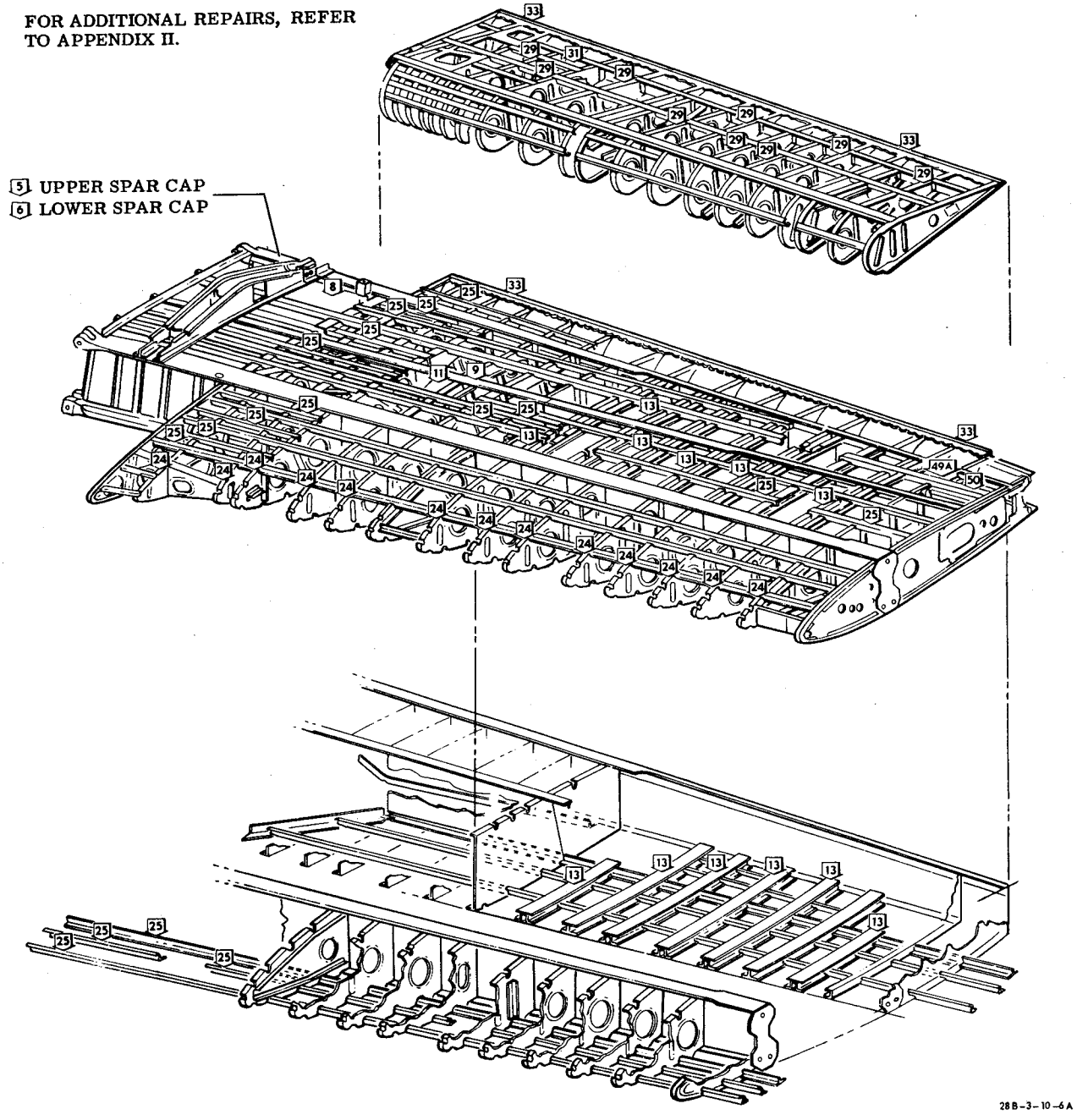


Figure 2-1A. Wing Repair Index – T-28B and T-28C Airplanes (Sheet 1 of 3)

[99] THESE INDEX ARROWS CONTAIN THE FIGURE NUMBERS OF THE DETAIL REPAIR ILLUSTRATIONS WITHIN THIS SECTION OF THE HANDBOOK.

NOTE

FOR TYPICAL REPAIRS, SEE FIGURES 2-20 THROUGH 2-23.

FOR ADDITIONAL REPAIRS, REFER TO APPENDIX II.

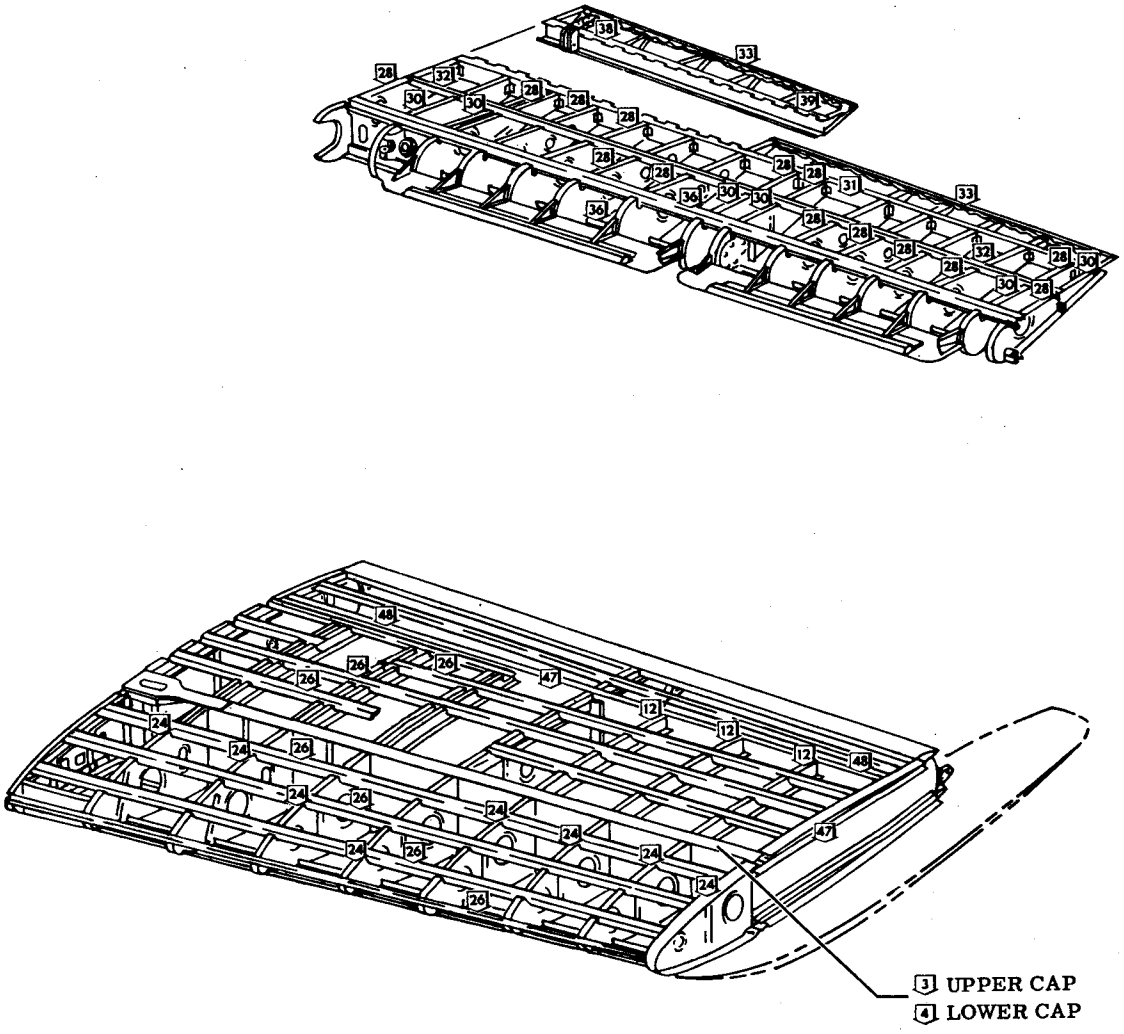


Figure 2-1A. Wing Repair Index — T-28B and T-28C Airplanes (Sheet 2 of 3)

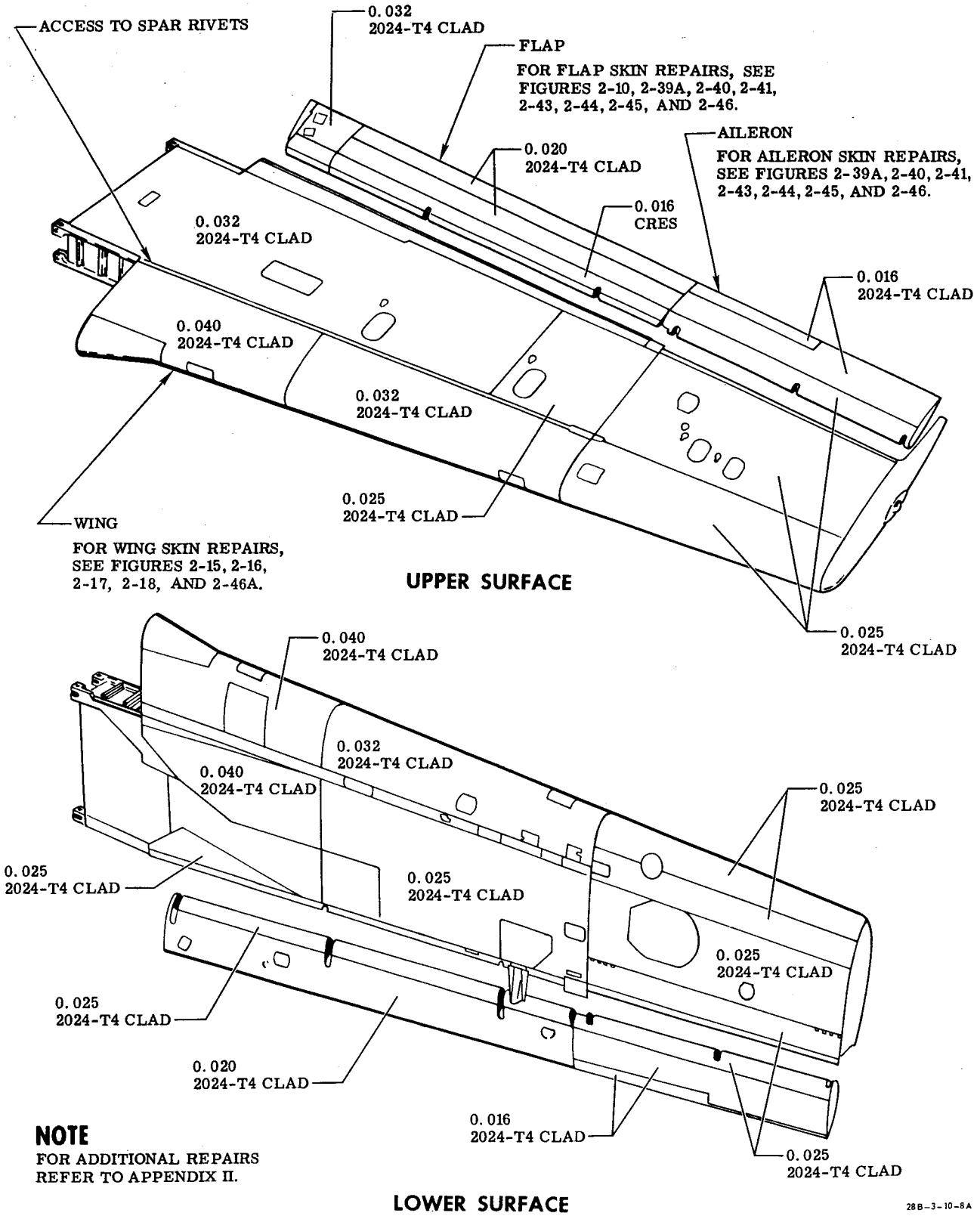
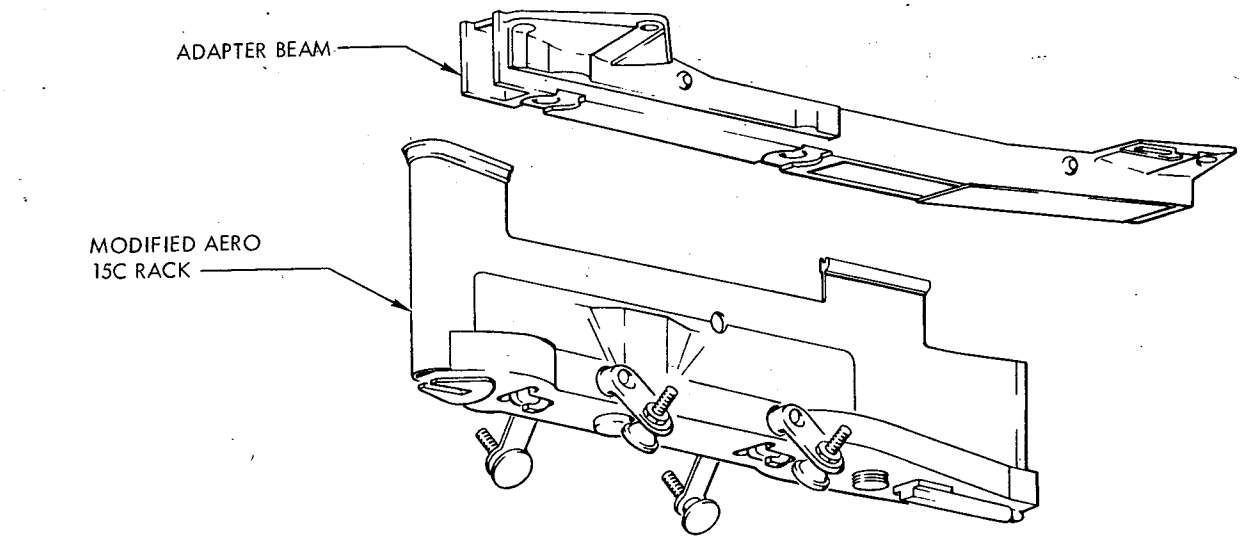
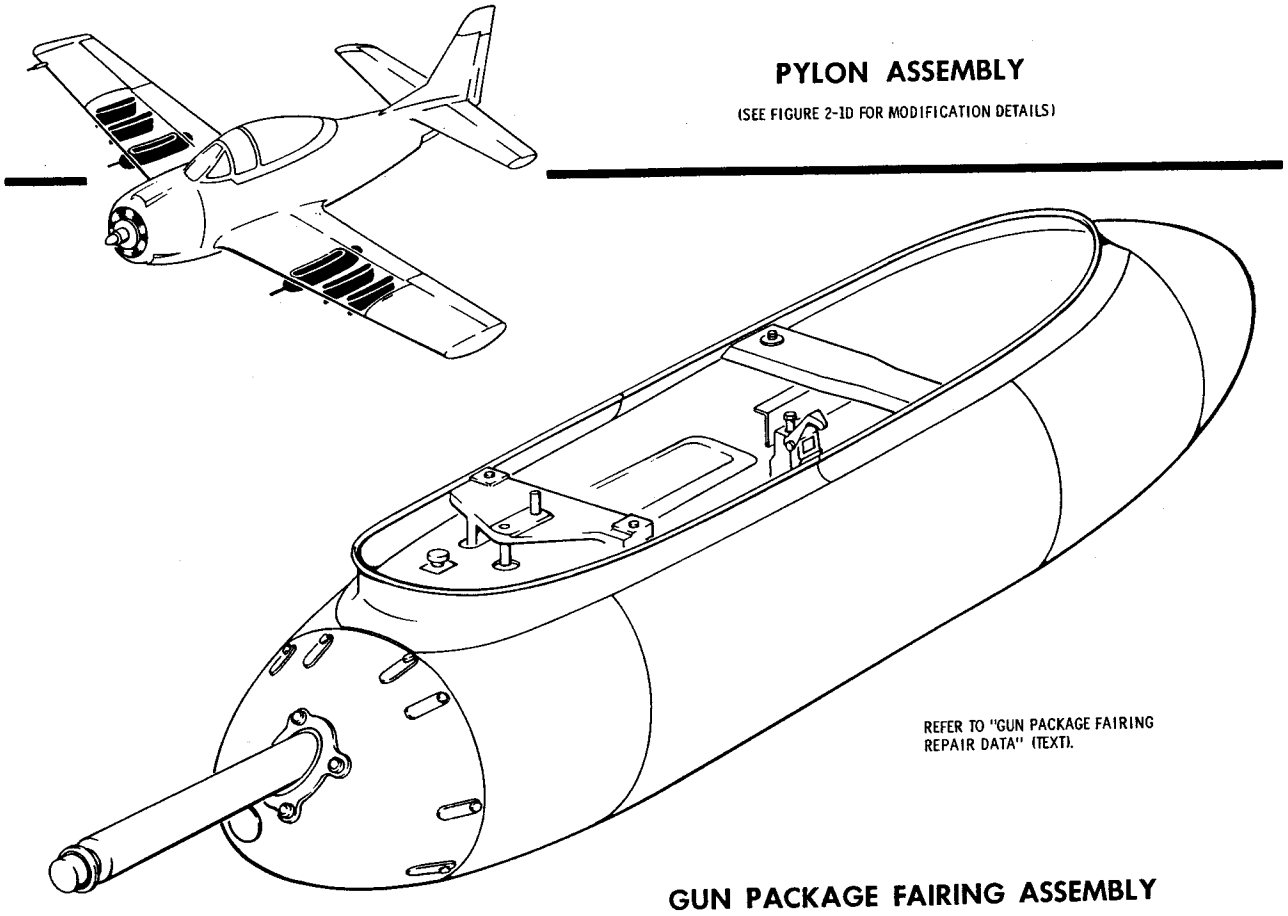


Figure 2-1A. Wing Repair Index – T-28B and T-28C Airplanes (Sheet 3 of 3)



PYLON ASSEMBLY

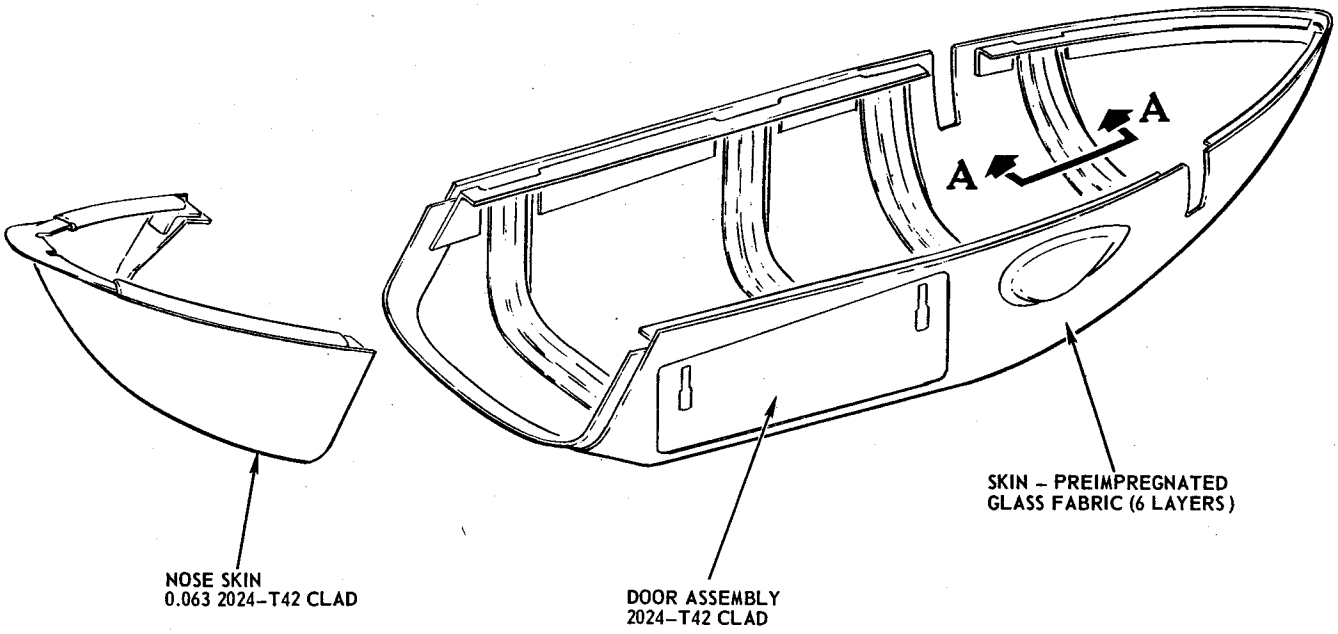
(SEE FIGURE 2-1D FOR MODIFICATION DETAILS)

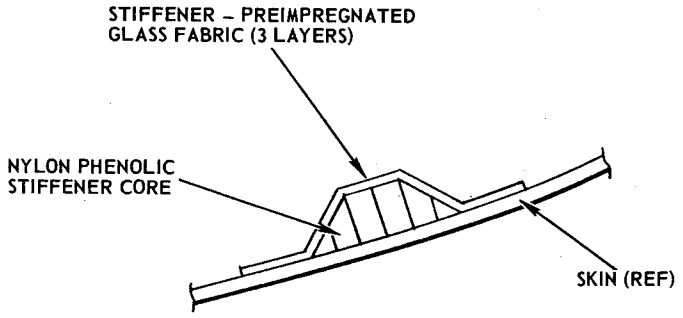


GUN PACKAGE FAIRING ASSEMBLY

T-28B-3-10-5

Figure 2-1B. Pylon and Gun Package Repair Index





SECTION A-A

NOTE

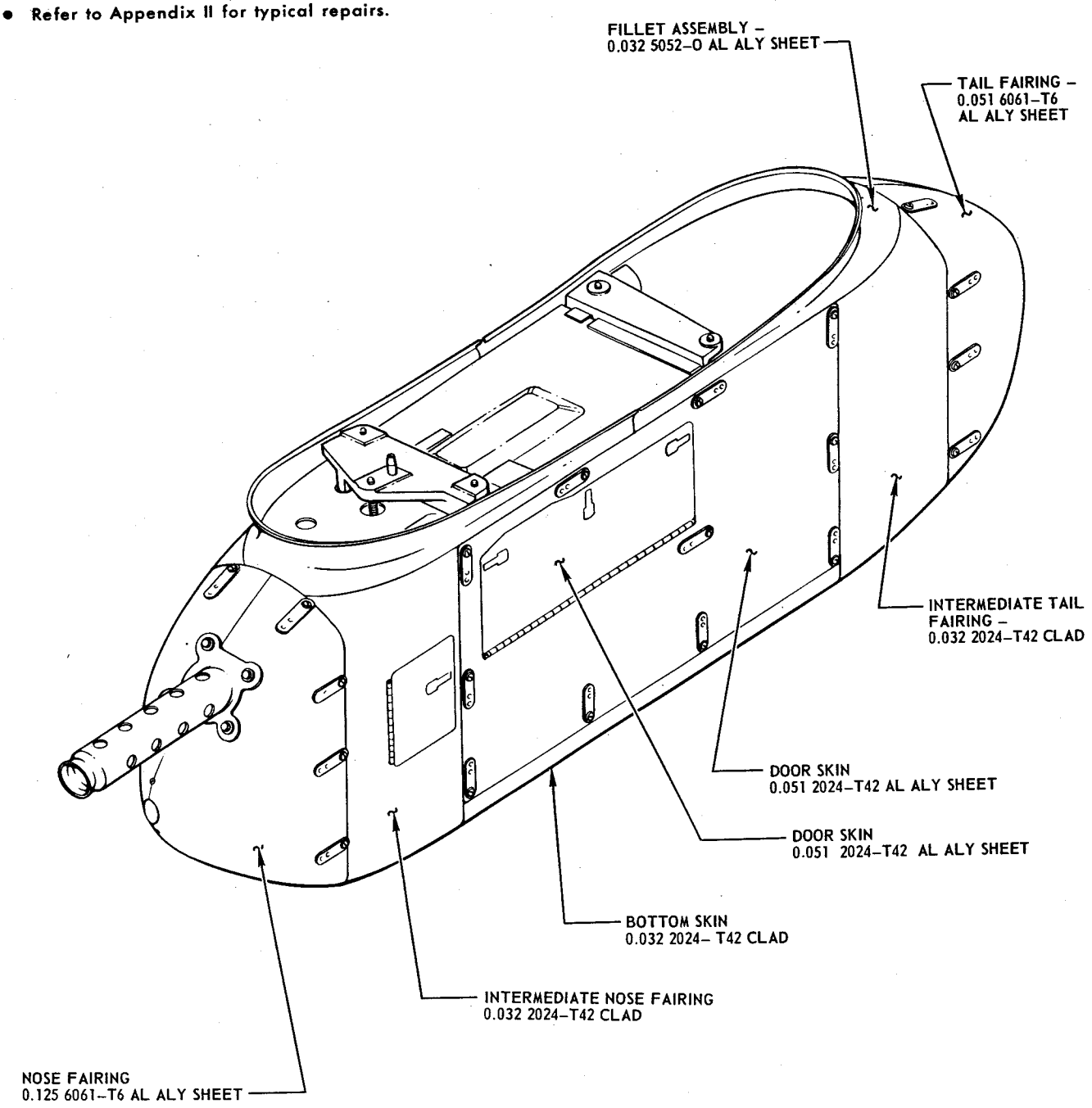
- Refer to Section VII for repair of reinforced glass fabric.
- Refer to Appendix II for typical repairs of metal structure.

T-28D-3-10-1

Figure 2-1B-1. Fixed Gun Enclosure Repair Index

NOTE

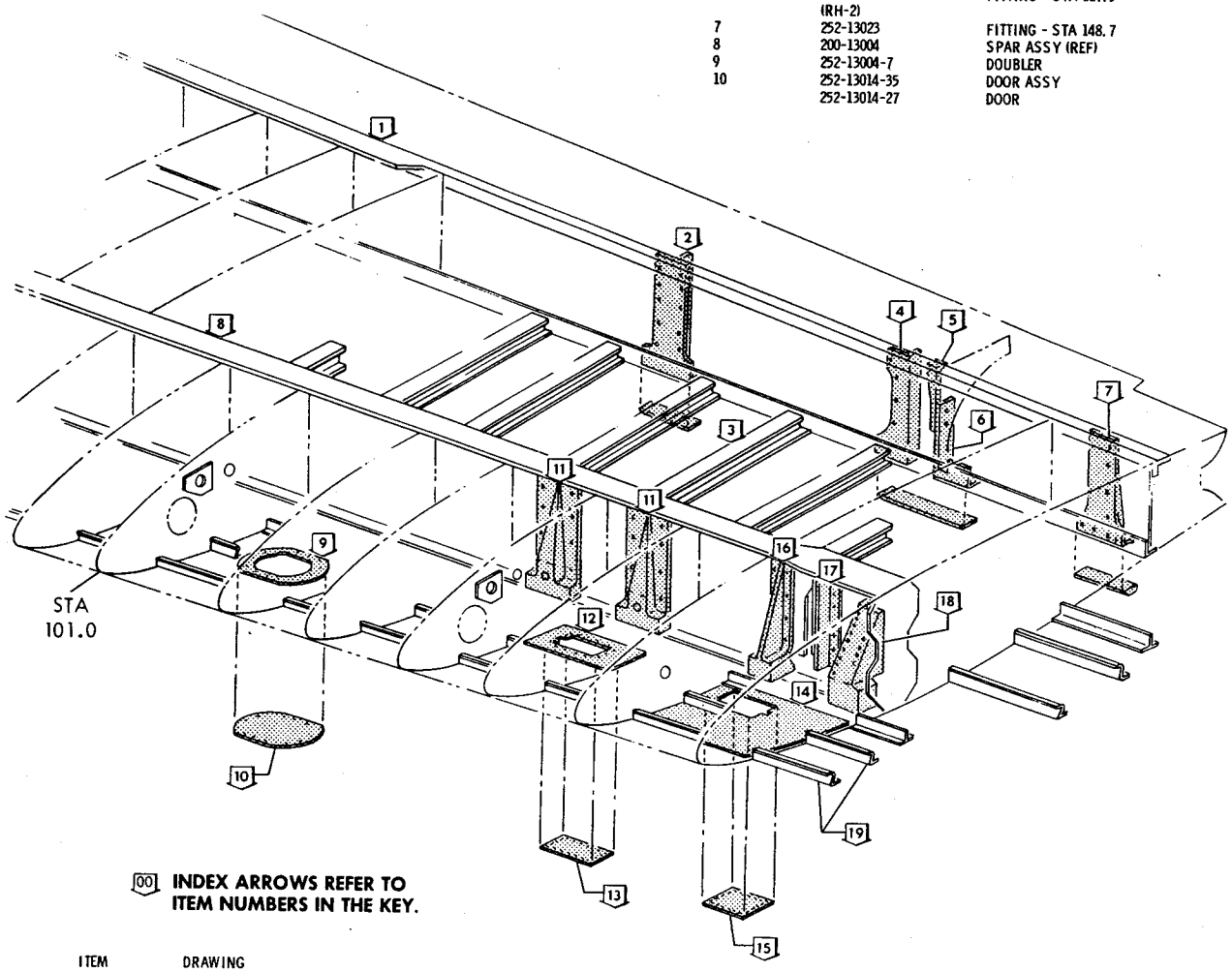
- Cracks in the fillet assembly may be repaired by stop-drilling and welding and/or with a general type repair.
- Typical external skin repairs are acceptable. Use flush rivets and bevel edges of doubler.
- Refer to Appendix II for typical repairs.



T-28D-3-10-2

Figure 2-1B-2. 315-round Gun Package Repair Index

ITEM NO.	DRAWING NO.	DESCRIPTION
1	200-13005	SPAR ASSY (REF)
2	252-13020	FITTING - STA 101.25
3	159-13120	FORMER (REF - TYP)
4	252-13021-1 (RH-2)	FITTING - STA 127.5
5	252-13024-1 (RH-2)	FITTING - STA 127.5
6	252-13022-1 (RH-2)	FITTING - STA 127.5
7	252-13023	FITTING - STA 148.7
8	200-13004	SPAR ASSY (REF)
9	252-13004-7	DOUBLER
10	252-13014-35	DOOR ASSY
	252-13014-27	DOOR

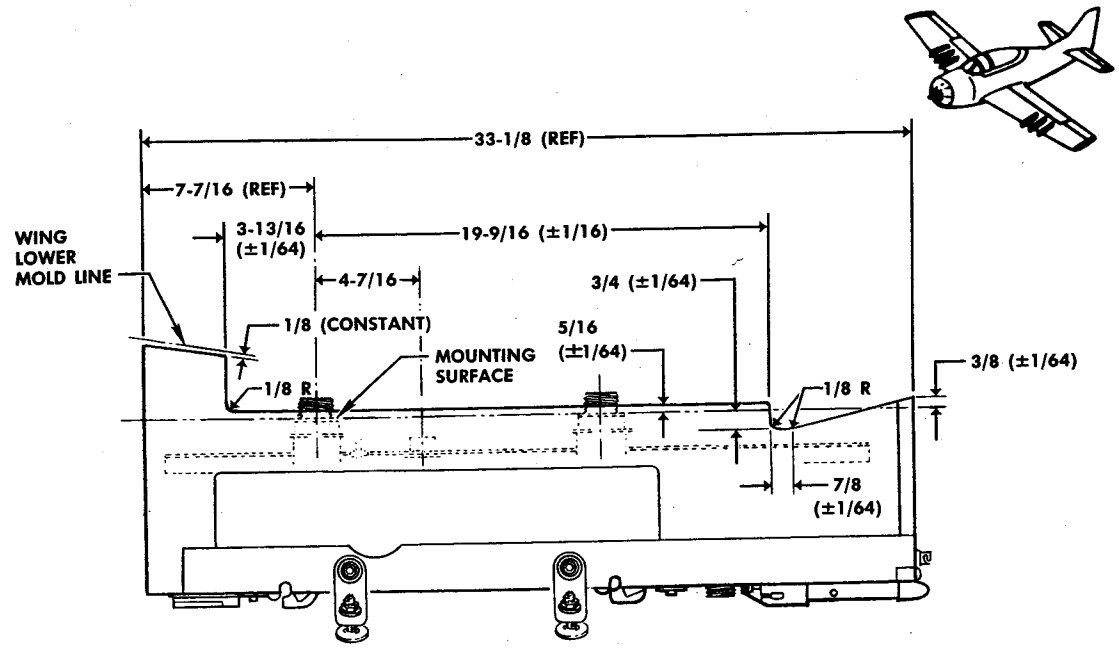


00 INDEX ARROWS REFER TO ITEM NUMBERS IN THE KEY.

ITEM NO.	DRAWING NO.	DESCRIPTION
11	252-13010	FITTING
12	252-13004-3 (RH-4)	DOUBLER
13	252-13014-33	DOOR ASSY
	252-13014-25	DOOR
14	252-13004-5 (RH-6)	DOUBLER
15	252-13014-31	DOOR ASSY
	252-13014-23	DOOR
16	252-13011-11 (RH-12)	FITTING - STA 148.6
17	252-13013	STIFFENER
18	252-13012-11 (RH-12)	FITTING ASSY
19	200-13006-37-37	STRINGER (REF - TYP)

T-28B-3-10-4

Figure 2-1C. Internal Modifications — Armament-modified Wings

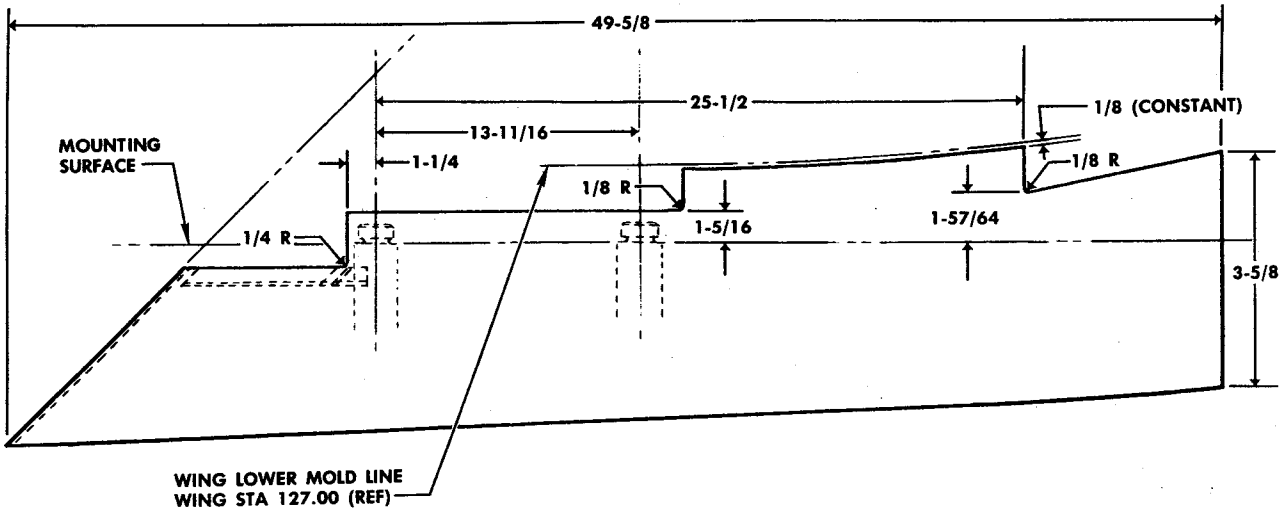


AERO 15C-1 BOMB-ROCKET RACK
(AERO 15C MAY BE SUBSTITUTED FOR AERO 15C-1)

NOTE

1. Trim dimensions shown are for modified Aero 15C-1 or Aero 15C racks.

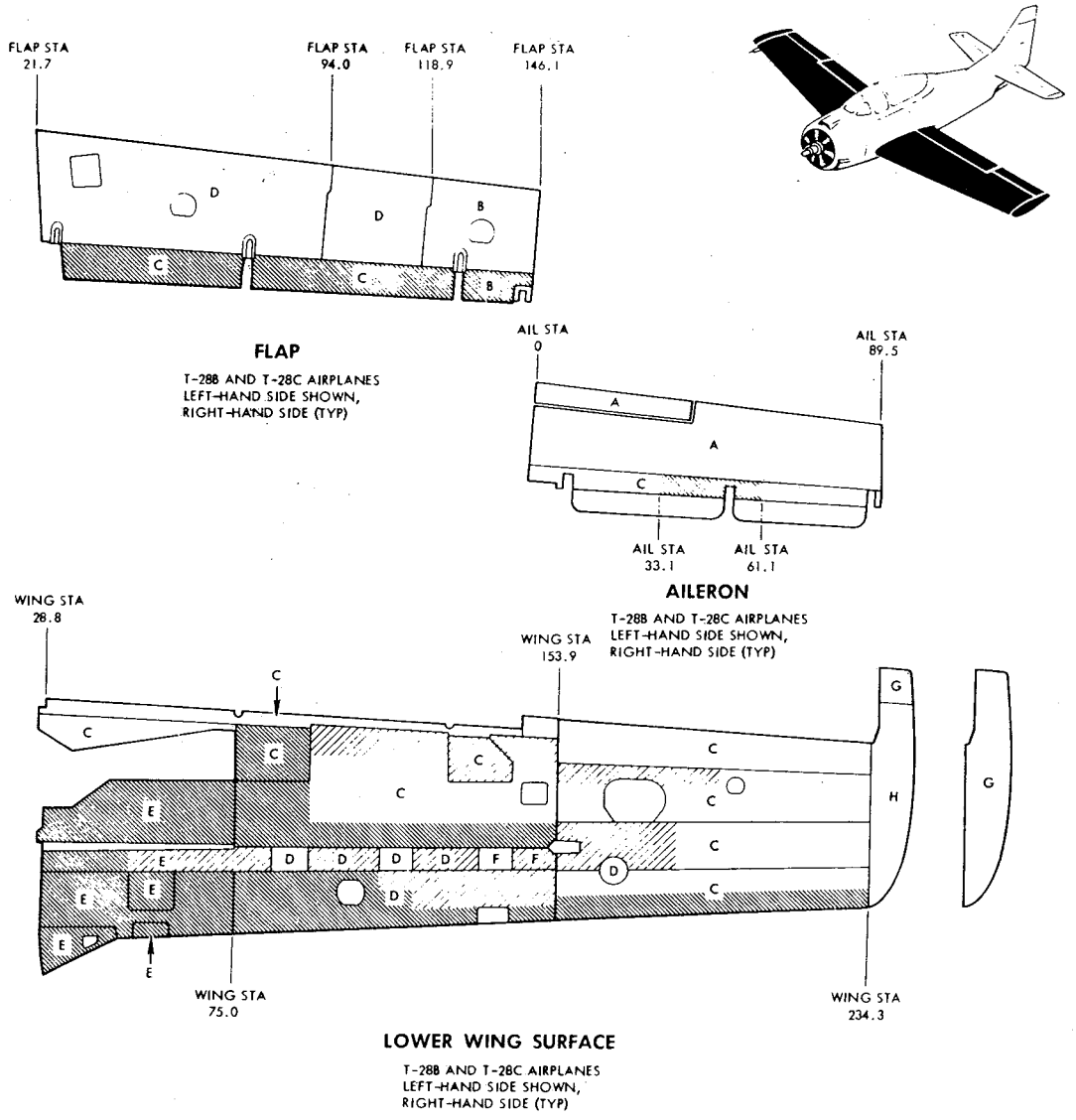
2. Rubber gaskets (55A82A 158) furnished with racks are to be used on modified racks.



AERO 3A PYLON ASSEMBLY

T-28D-3-63-1

Figure 2-1D. Modified Aero 15C-1 Bomb Rack and Rocket Launcher — Armament-modified Airplanes

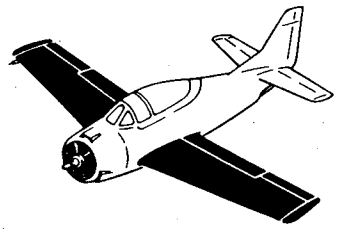


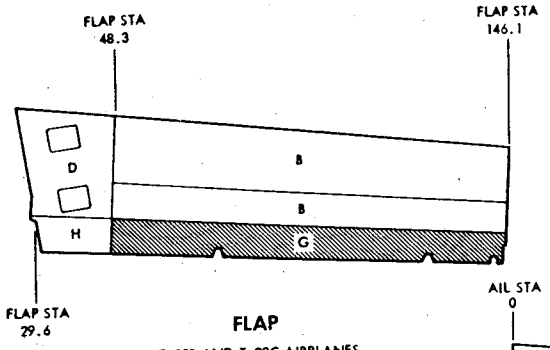
REF NO.	GAGE	MATERIAL
A	0.016	2024-T4 CLAD
B	0.020	2024-T4 CLAD
C	0.025	2024-T4 CLAD
D	0.032	2024-T4 CLAD
E	0.040	2024-T4 CLAD
F	0.051	2024-T4 CLAD
G	0.040	5052-O AL ALLOY
H	0.025	GLASS FABRIC

LOW STRESS
MEDIUM STRESS
HIGH STRESS

T-28B-3-10-1

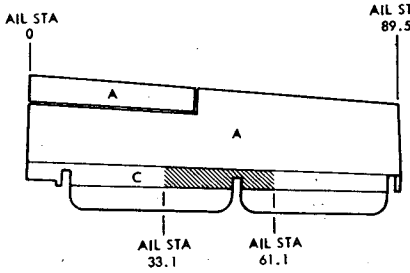
Figure 2-1E. Skin Stress Diagram — Wing Lower Surface — T-28B and T-28C Airplanes





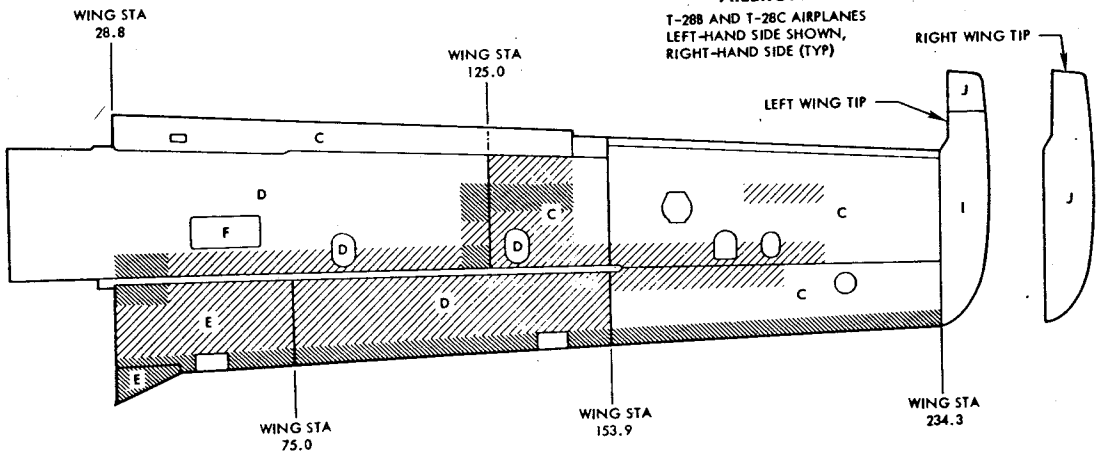
FLAP

T-28B AND T-28C AIRPLANES
LEFT-HAND SIDE SHOWN,
RIGHT-HAND SIDE (TYP)



AILERON

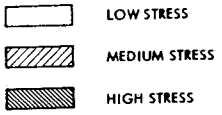
T-28B AND T-28C AIRPLANES
LEFT-HAND SIDE SHOWN,
RIGHT-HAND SIDE (TYP)



UPPER WING SURFACE

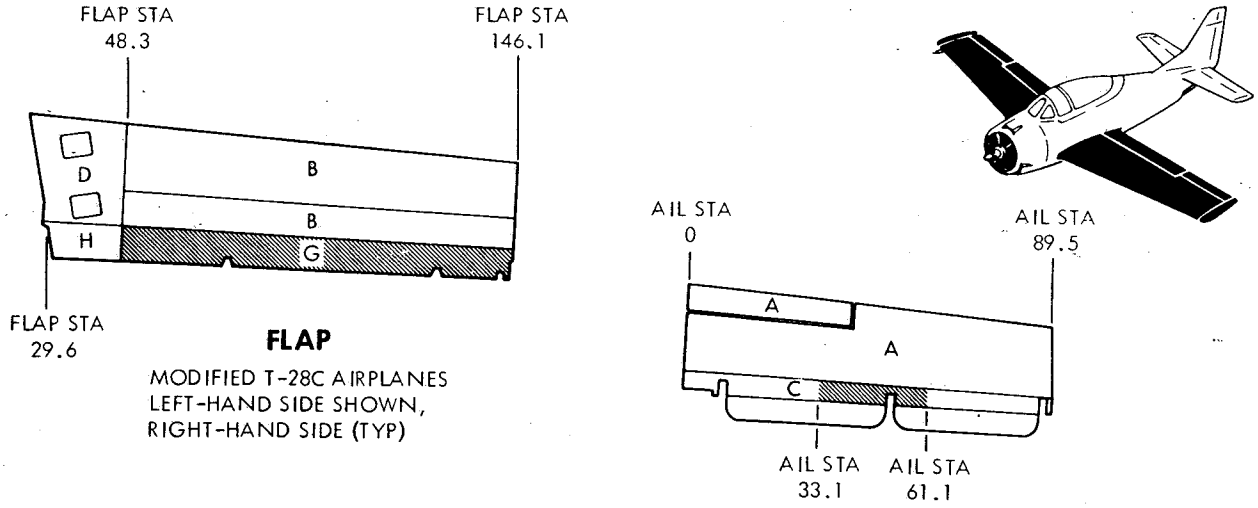
T-28B AND T-28C AIRPLANES
LEFT-HAND SIDE SHOWN,
RIGHT-HAND SIDE (TYP)

REF NO.	GAGE	MATERIAL
A	0.016	2024-T4 CLAD
B	0.020	2024-T4 CLAD
C	0.025	2024-T4 CLAD
D	0.032	2024-T4 CLAD
E	0.040	2024-T4 CLAD
F	0.064	2024-T4 CLAD
G	0.016	CRES
H	0.025	CRES
I	0.025	GLASS FABRIC
J	0.040	5052-O AL ALLOY



T-28B-3-10-2

Figure 2-1F. Skin Stress Diagram — Wing Upper Surface — T-28B and T-28C Airplanes

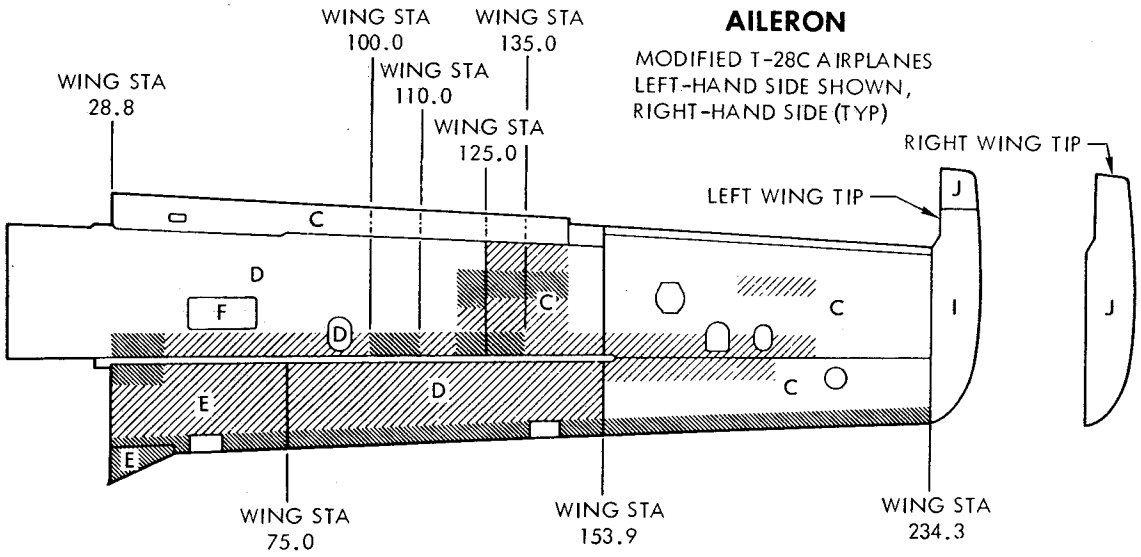


FLAP

MODIFIED T-28C AIRPLANES
LEFT-HAND SIDE SHOWN,
RIGHT-HAND SIDE (TYP)

AILERON

MODIFIED T-28C AIRPLANES
LEFT-HAND SIDE SHOWN,
RIGHT-HAND SIDE (TYP)



UPPER WING SURFACE

MODIFIED T-28C AIRPLANES
LEFT-HAND SIDE SHOWN,
RIGHT-HAND SIDE (TYP)

REF NO.	GAGE	MATERIAL
A	0.016	2024-T4 CLAD
B	0.020	2024-T4 CLAD
C	0.025	2024-T4 CLAD
D	0.032	2024-T4 CLAD
E	0.040	2024-T4 CLAD
F	0.064	2024-T4 CLAD
G	0.016	CRES
H	0.025	CRES
I	0.025	GLASS FABRIC
J	0.040	5052-O AL ALLOY

LOW STRESS
MEDIUM STRESS
HIGH STRESS

T-28B-3-10-3

Figure 2-1G. Skin Stress Diagram — Wing Upper Surface — Armament-modified T-28B and T-28C Airplanes

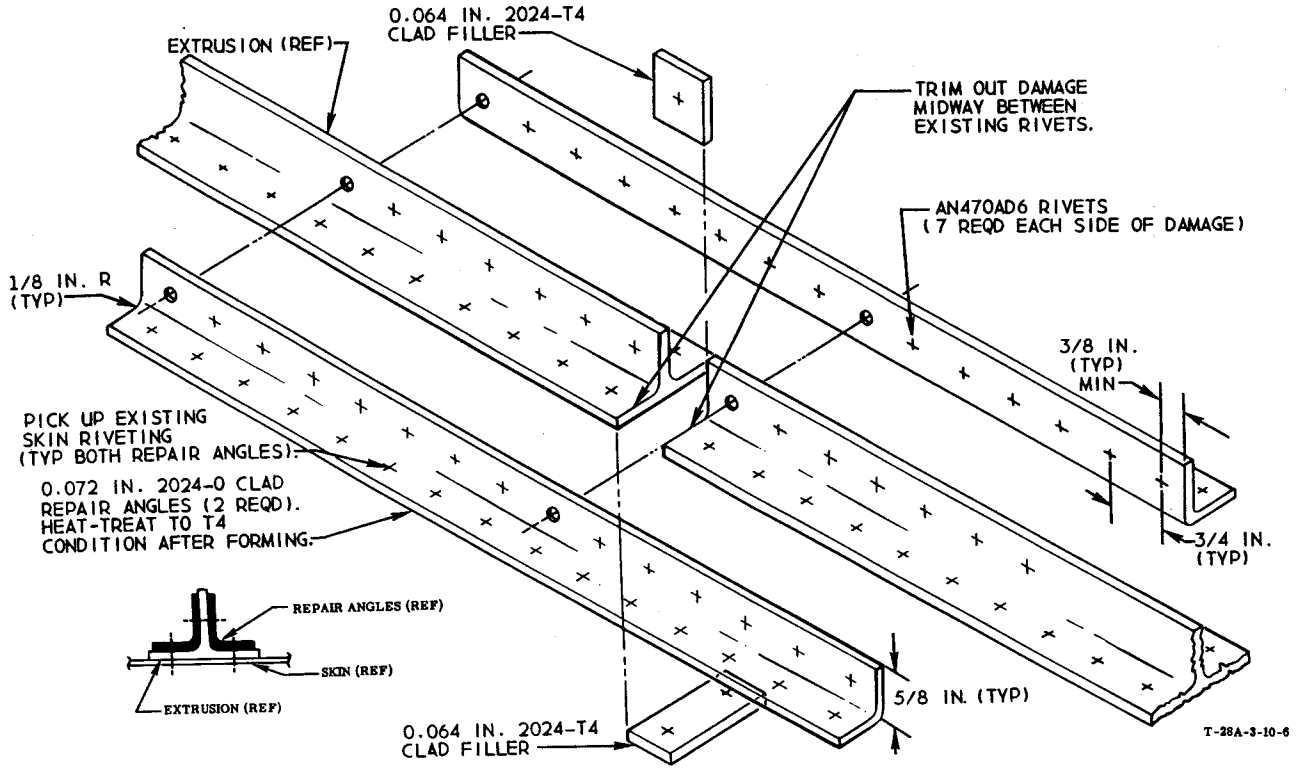


Figure 2-2. Wing Extrusion (Alcoa Die No. 22897) Splice

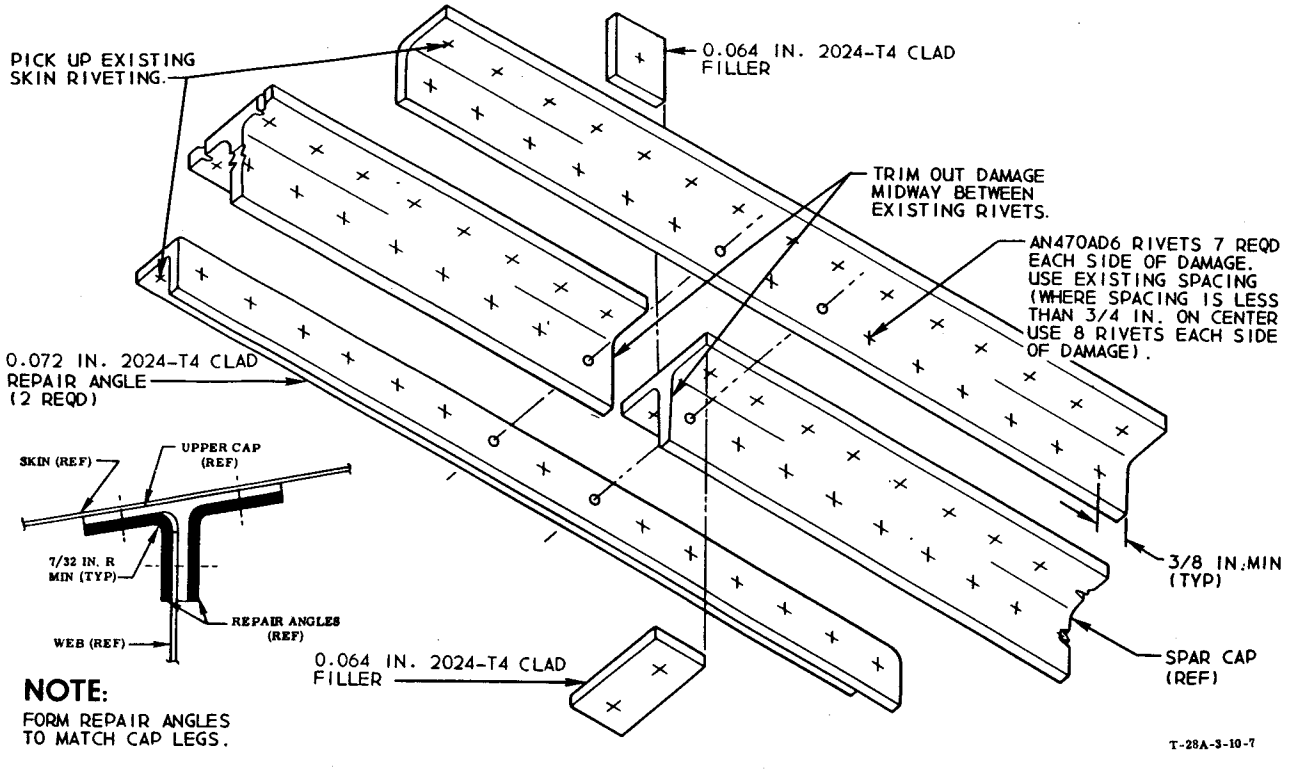


Figure 2-3. Front Spar Upper Cap Repair - Station 198 to 233.5

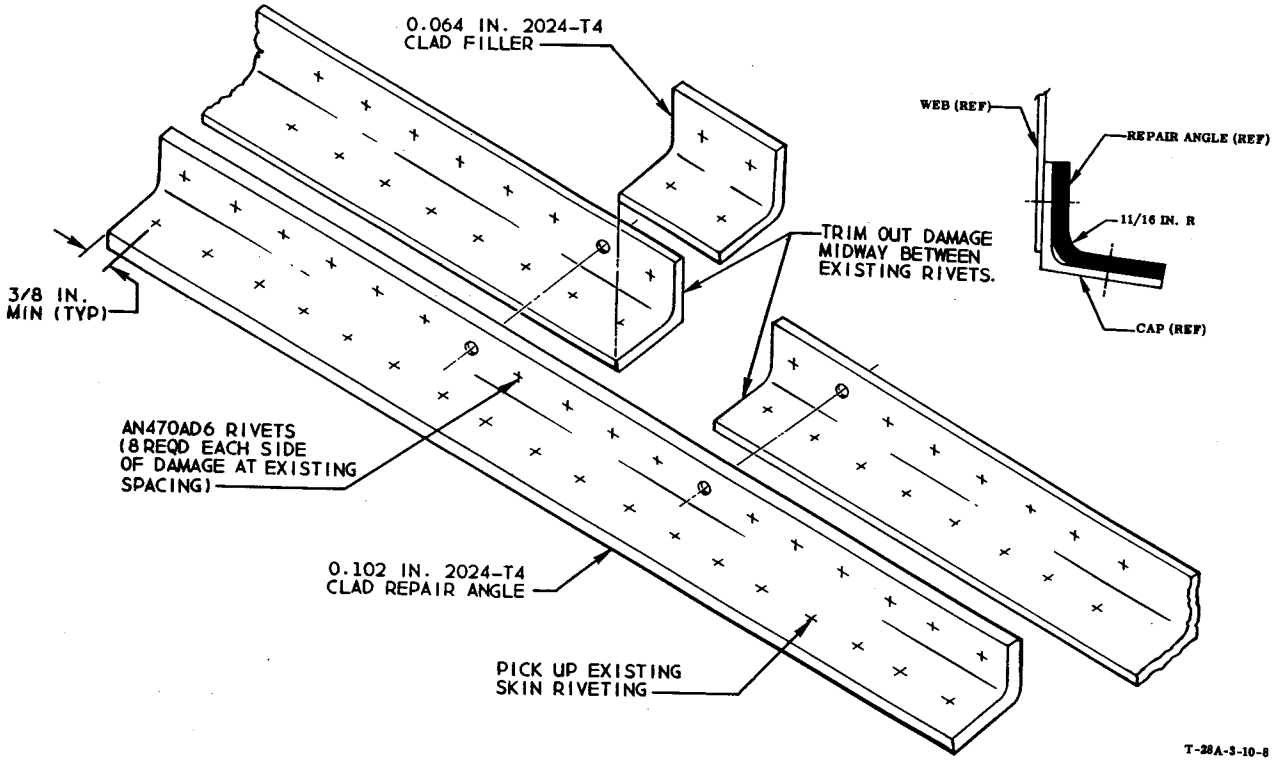


Figure 2-4. Front Spar Lower Cap Repair - Station 206 to 233.5

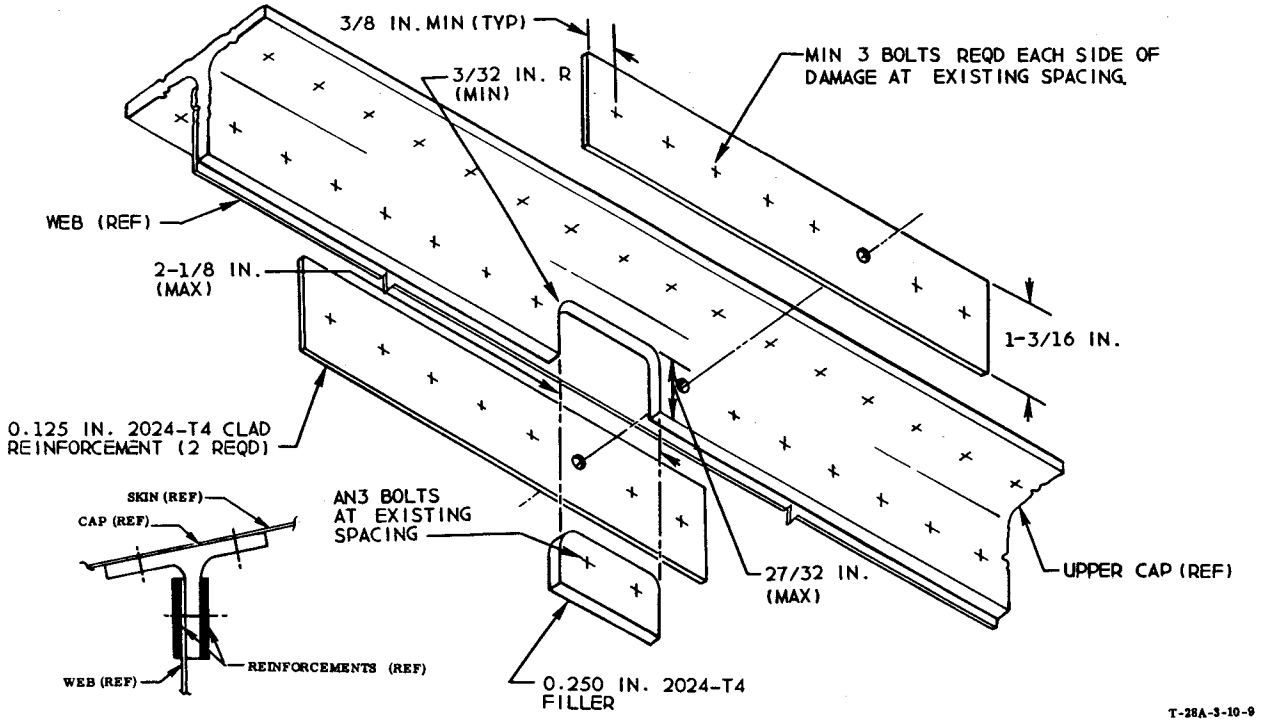
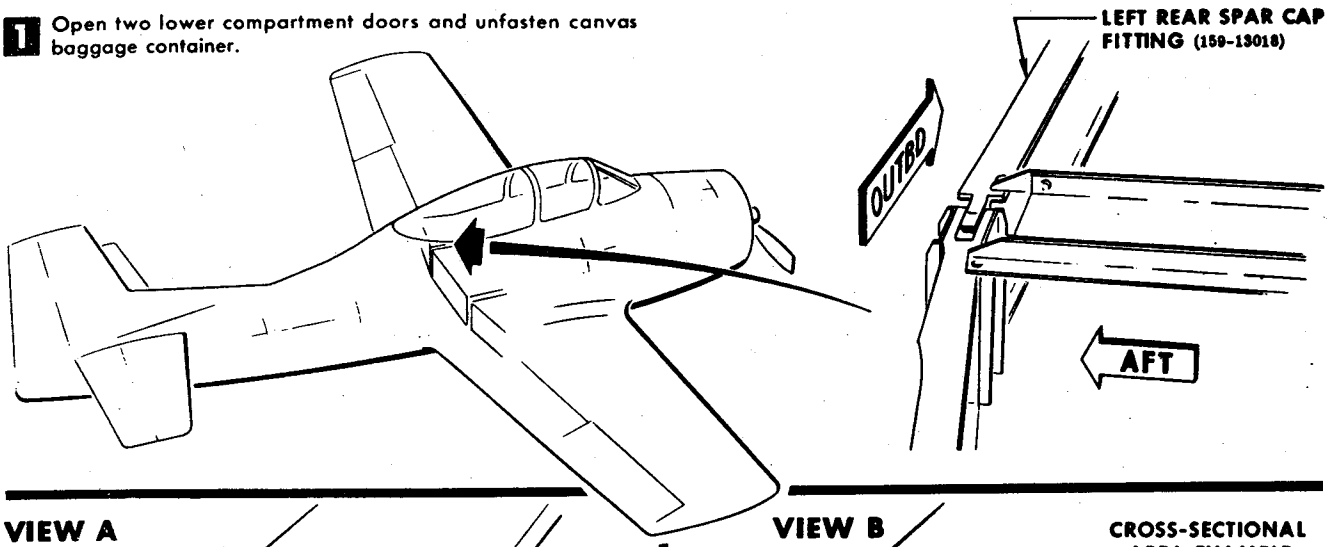
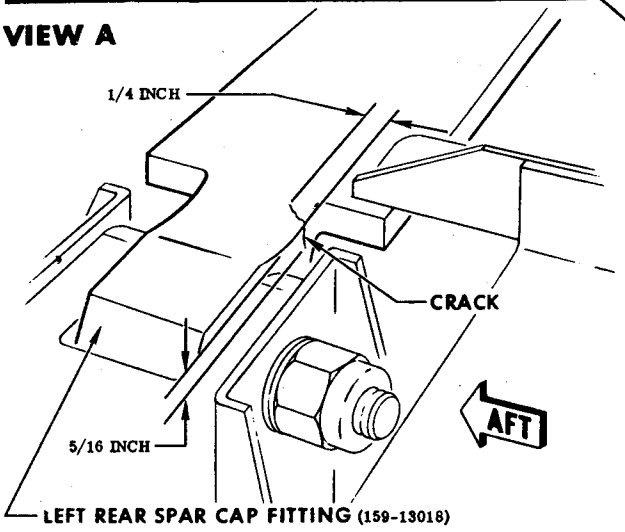


Figure 2-5. Rear Spar Upper Cap Repair - Station 10 to 24

1 Open two lower compartment doors and unfasten canvas baggage container.

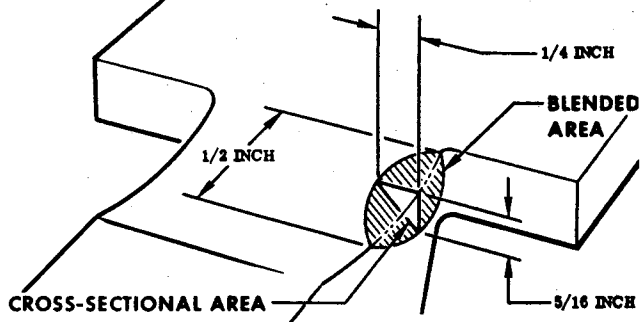


VIEW A



VIEW B

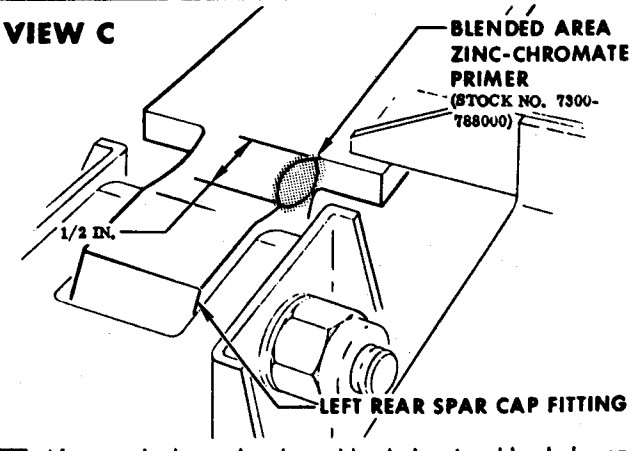
CROSS-SECTIONAL AREA EXAMPLE



$$\text{CROSS-SECTIONAL AREA} = \frac{\text{BASE X HEIGHT}}{2}$$

EXAMPLE { 1/4 X 5/16 IN. = 5/64 IN.; 5/64 IN. = 0.078 IN.; 0.078 IN. / 2 = 0.038 IN.

VIEW C



2 Thoroughly remove paint from cracked area in upper left rear spar fitting (Part No. 159-13018). (See view A.)

3 Check dimensions of crack, and see whether crack exceeds dimensions in view A. If the crack exceeds the dimensions, the left wing center section must be removed and replaced.

4 Mark crack limits with pencil; then file on crack with either a cylindrical rotary file or a hand file (hand file preferred) until crack disappears. Be sure dimensions do not exceed those shown in view A.

Caution Do not exceed cross-sectional area of 0.040 square inch. (See view B.)

NOTE The vertical 5/16 inch dimension can be exceeded where the maximum cross-sectional area does not exceed 0.040 square inch.

5 Remove file marks with crocus cloth before dye-check. A dye-penetrant inspection must be made to assure removal of crack. (Refer to T.O. 33B1-2-1-2.)

6 If dye-check shows the crack has been removed, blend in the cut and be sure the blended area is no more than dimension shown in view C. Remove file marks with crocus cloth.

NOTE A pencil line around the blended area would help as a guide when filing.

7 After cracked area has been blended, prime blended area with zinc-chromate primer.

8 Check each repair with dye-penetrant after every 10 hours of flight until at least five inspections have been made to assure that no further cracking has developed.

T-28A-2-33-7

Figure 2-5A. Repairing Upper Left Rear Spar Cap Fitting

CORROSION OR DAMAGE REMOVAL PROCEDURE AT W.S. "0" WING LUG MATING HOLES.

1. Remove corrosion or damage at the Wing Center Section W.S. "0" lug holes by using the following procedure and tooling as shown in Figure 2-5B (Sheet 1 of 2).

2. After corrosion removal, replace the appropriate bushing with an oversize bushing manufactured in accordance with Figure 2-5C (Sheet 2 of 2).

3. Install bushings wet using chromate primer per MIL-P-8585.

FRONT SPAR UPPER & LOWER CAP REAMING SET-UP	
ALIGNMENT SET-UP REQUIREMENTS	1. BUSHING S-88-12-1.000 2 REQD 2. ALIGNMENT ROD 7236080-01 1 REQD 3. FIXTURE ASSY 7236081-10 1 REQD
REAMING SET-UP REQUIREMENTS	1. REAMER BUSHING S-88-12-1.0312 1 REQD 2. PILOT BUSHING S-88-12-.8750 1 REQD 3. REAMER 7236063-01 1 REQD
REAR SPAR LOWER CAP REAMING SET-UP	
ALIGNMENT SET-UP REQUIREMENTS	1. BUSHING S-88-12-.7500 2 REQD 2. ALIGNMENT ROD 7236080-05 1 REQD 3. FIXTURE ASSY 7236082-10 1 REQD
REAMING SET-UP REQUIREMENTS	1. REAMER BUSHING S-88-12-.7500 2 REQD 2. PILOT BUSHING S-88-12-7187 1 REQD 3. REAMER 7236063-05 1 REQD
REAR SPAR UPPER CAP REAMING SET-UP	
ALIGNMENT SET-UP REQUIREMENTS	1. BUSHING S-88-12-.8750 2 REQD 2. ALIGNMENT ROD 7236080-03 1REQD 3. FIXTURE ASSY 7236082-10 REF
REAMING SET-UP REQUIREMENTS	1. REAMER BUSHING S-88-12-.9062 1 REQD 2. PILOT BUSHING S-88-12-.7500 1 REQD 3. REAMER 7236063-03 1 REQD

NOTES:

(1) PRIOR TO FIXTURE INSTALLATION COAT INTERIOR OF FIXTURE, EXCEPT BASE (AS INDICATED), AND SPAR CAP WITH A THIN FILM OF OIL.

2 LOCAL MANUFACTURE PROTECTIVE SHIMS AS REQD. USE A SUITABLE BONDING AGENT TO HOLD SHIMS IN PLACE.

3 AFTER ALIGNMENT HAS BEEN COMPLETED ALIGNMENT ROD MUST SLIDE FREELY.

(4) USE PUTTY OR A LOCAL MANUFACTURED RUBBER STRIP (AS SHOWN) TO CONTAIN THE VEL MIX CEMENT.

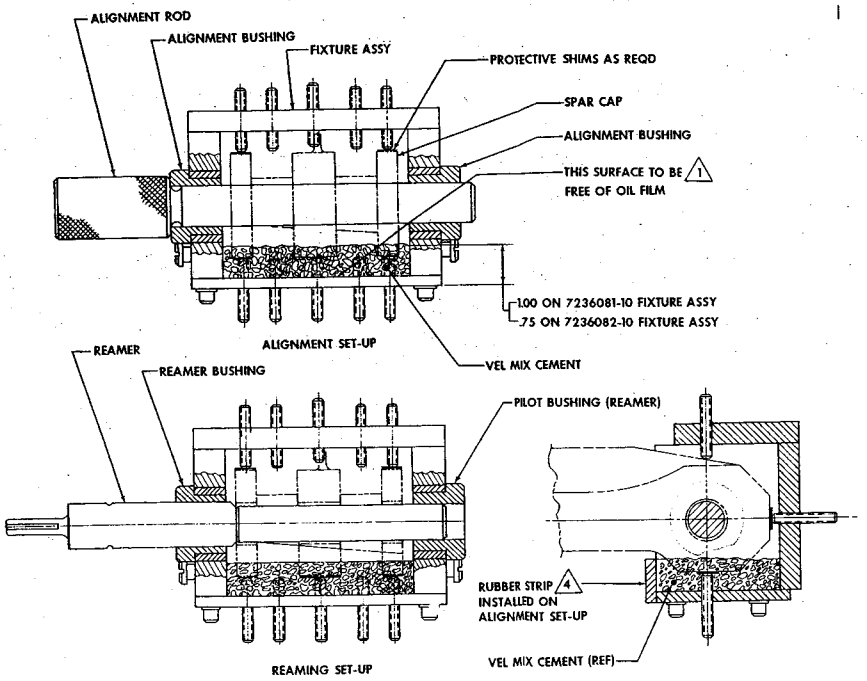
5 REAM AT 150 - 300 RPM.

6 TO REMOVE FIXTURE REMOVE BASE AND BREAK AWAY VEL MIX CEMENT USING CAUTION NOT TO DAMAGE THE SPAR CAP.

7 TO PREVENT CORROSION AFTER USE, ALL FIXTURE PARTS AND REAMERS SHOULD BE COATED WITH A THIN FILM OF OIL.

WING POSITION FOR REWORK OF SPAR LUG			
WING	LUG TO BE REWORKED	WING POSITION	REMARKS
RIGHT HAND	LOWER FORWARD	LOWER SURFACE UP	
	UPPER FORWARD	LOWER SURFACE UP	
	LOWER AFT	UPPER SURFACE UP	TO ACCOMODATE TOOL INSTL REMOVE MLG DOOR HINGE
	UPPER AFT	LOWER SURFACE UP	
LEFT HAND	LOWER FORWARD	UPPER SURFACE UP	
	UPPER FORWARD	LOWER SURFACE UP	
	LOWER AFT	UPPER SURFACE UP	TO ACCOMODATE TOOL INSTL REMOVE MLG DOOR HINGE
	UPPER AFT	LOWER SURFACE UP	

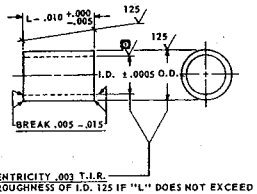
Figure 2-5B. Wing Lug Ream Repair Procedures (Sheet 1 of 2)



FABRICATION OF OVERSIZE BUSHING

MODIFIED BUSHING IDENTIFICATION	ORIGINAL BUSHING I.D. ± 0005	NEW BUSHING O.D. +.0000 −.0005	LENGTH IN 32NDS INCHES
−01	.6250	DETERMINE AFTER LUG HOLE REWORK O.D. = HOLE I.D. +.0015	−015
−02	.7500		−015
−03	.8750		−015
−04	.8750		−031
−05	.6250		−031
−06	.7500		−031

BUSHING SPECIFICATIONS



1 MAX. ECCENTRICITY .003 T.I.R. SURFACE ROUGHNESS OF I.D. 125 IF "L" DOES NOT EXCEED THREE TIMES I.D., 250 OTHERWISE.

DIMENSIONS APPLY BEFORE PLATING

FABRICATE FROM 4130 STEEL TUBING, SPEC MIL-T-6736 COND N. 4135 STEEL TUBING, SPEC AMS 6372.

HEAT TREAT:

HEAT TREAT STEEL 125 − 145KSI PER SPEC MIL-M-6875(LA0111−003).

FINISH:

CADMIUM PLATE PER SPEC QQ-P-416, TYPE II, CLASS 3(LA0109−015) ALL SURFACES EXCEPT ID, OMIT PLATING ON ID.

MAGNETIC INSPECTION PER SPEC MIL-I-6868 (LQ0501−003).

Figure 2-5B. Wing Lug Ream Repair Procedures (Sheet 2 of 2)

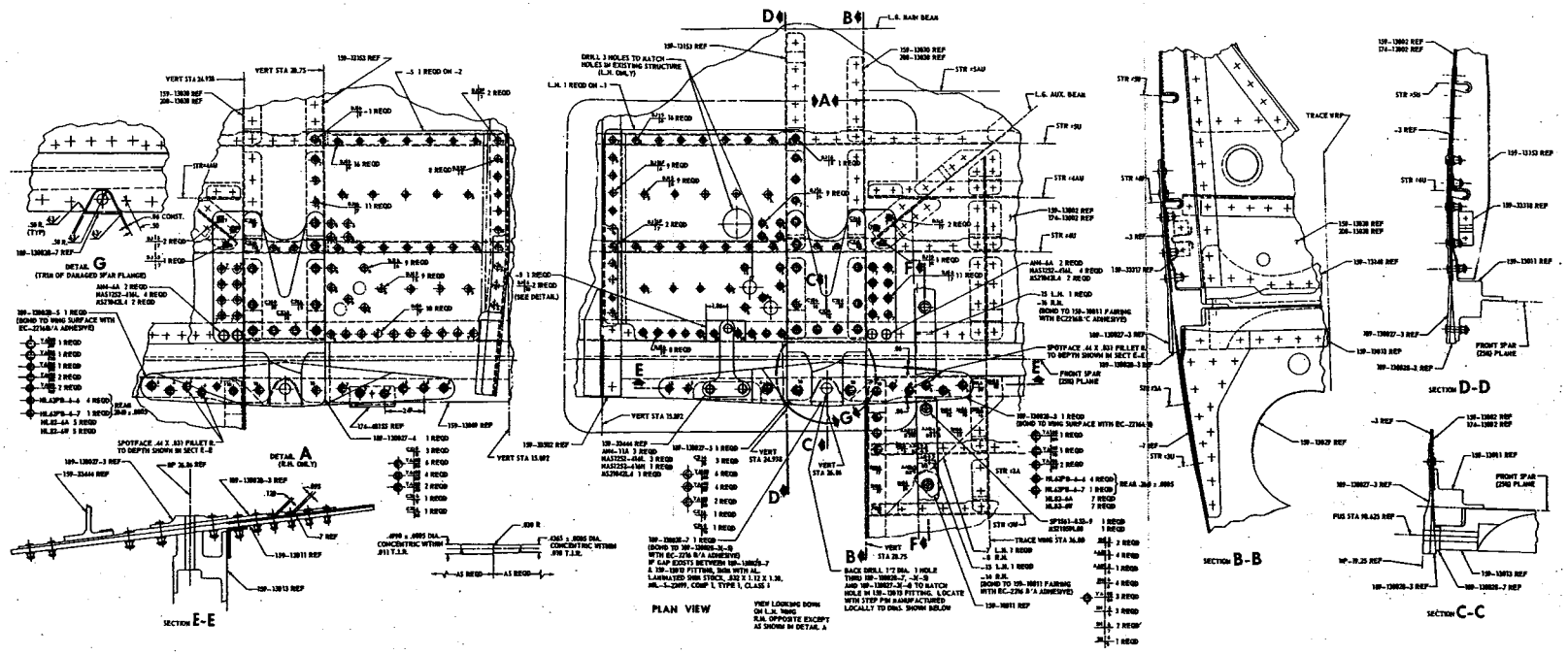


Figure 2-5C. Front Spar Cap at Vertical Wing Sta. 26.86 Repair Procedures (Sheet 1 of 4)

FRONT SPAR CAP REPAIR AT VERTICAL STA 26.86

1. REMOVE WING FROM FUSELAGE WITH MAIN LANDING GEAR LOWERED. REMOVAL TO BE IN ACCORDANCE WITH T.O. 1T-28D-2, SECTION A, PAGE 2-25, PARA 2-97.
2. REMOVE THE THREE FASTENERS THRU 159-33444 FITTING. SEE PLAN VIEW E-E.
3. REMOVE THE FOLLOWING DOUBLERS: 42-22253-3, -4 AND -5, -6, 189-130220-3, -4, -5, -6, -7, -8, -9 & -10 AND ANY OTHER DOUBLERS WHICH MAY BE ON THE WING UPPER SURFACE IN THE AREA OF THE NEW -3, -5 DOUBLER.
4. REMOVE THE 159-13022-1, -2 DRAG FITTING.
5. REMOVE 189-130220-13 DOUBLER FROM UNDER THE LEADING EDGE SKIN.
6. INSPECT DRAG FITTING AND WING TO FUSELAGE ATTACH AREA PER T.O. 1T-28A-36 PARAGRAPHS 4-179 THRU 4-196.
7. POSITION -7, -8 DOUBLER AND INSTALL ALL FASTENERS EXCEPT DO NOT INSTALL FASTENERS COMMON TO 189-130028-3, -5 STRAP.
8. REMOVE DAMAGED AREA OF SPAR CAP FLANGE AROUND 1/2 DIA. ATTACH HOLE AS SHOWN IN DETAIL G, ZONE 22. FINISH CUT EDGE TO RMS 63 MICROINCHES.

CAUTION

USE EXTREME CARE NOT TO DAMAGE THE 159-13013 FITTING WHEN REMOVING MATERIAL FROM SPAR CAP.

9. POSITION 189-130028-7 FILLER AND 189-130028-3, -5 STRAP. CLAMP FILLER TO STRAP AND REMOVE FROM WING. DRILL 7/16 DIA HOLE IN 189-130028-7 FILLER THRU THE 7/16 DIA STRAP HOLE, TAKING CARE TO MAINTAIN HOLE ANGULARITY. BOND 189-130028-7 FILLER TO 189-130028-3, -5 STRAP WITH EC-2216 B/A ADHESIVE.
10. REMOVE ALL EXISTING UPPER SURFACE FASTENERS WITHIN OUTLINE OF -3, -5 DOUBLER.
11. POSITION -3, -5 DOUBLER. INSTALL ALL FASTENERS EXCEPT DO NOT INSTALL FASTENERS COMMON TO -9 SHIM OR 189-130027-3, -4 FITTING. IF EXISTING HOLE IS TOO LARGE FOR FASTENER CALLED USE A SIMILAR FASTENER OF LARGER DIAMETER.
12. POSITION -9 SHIM (L.H. WING ONLY) AS SHOWN IN PLAN VIEW E-E. INSTALL TWO RIVETS AND DRILL HOLE FOR 1/4 DIA BOLT.
13. POSITION 189-130028-3, -5 STRAP (WITH ATTACHED FILLER) AS SHOWN IN ZONES 13 AND 19. LOCATE STRAP BY ALIGNING 7/16 DIA HOLE IN STRAP AND FILLER WITH 1/2 DIA HOLE IN 159-13013 FITTING. DRILL FOR ALL FASTENERS EXCEPT DO NOT DRILL FOR FASTENERS COMMON TO 189-130027-3-4 FITTING. BOND 189-130028-3, -5 STRAP TO WING SURFACE WITH EC-2216 B/A ADHESIVE. (USE A STEP BOLT TO FACILITATE LOCATING STRAP).
14. INSTALL 189-130028-3, -5 STRAP FASTENERS IN THE HOLES DRILLED. ATTACH 159-33444 FITTING.
15. POSITION 189-130027-3, -4 FITTING AS SHOWN IN PLAN VIEW E-E & DETAIL A. LOCATE BY ALIGNING THE 7/16 DIA HOLE WITH LIKE HOLE IN THE 189-130028-3, -4 STRAP AND ROTATING FITTING TO EQUALIZE EDGE DISTANCE WITH FASTENER HOLES IN VERT STA 24.938 AND 28.75 RIBS. INSTALL ALL FASTENERS.
16. ENLARGE 7/16 DIA HOLE IN FILLER, STRAP, AND FITTING BY DRILLING 1/2 DIA UP THRU 159-13013 FITTING AS SHOWN IN PLAN VIEW E-E.
17. BOND 189-130026-13, -14 AND -15, -16 WEDGES TO 159-10011-1, -2 FAIRING AS SHOWN IN PLAN VIEW F-F. BOND WITH EC-2216 B/A ADHESIVE.
18. REPLACE THE FASTENERS REMOVED AT ANY OPEN HOLES.
19. REINSTALL WING TO FUSELAGE IN ACCORDANCE WITH T.O. 1T-28D-2, SECT II, PAGE 2-25, PARA 2-99.

NOTE

(6) ONE FAIRING FASTENER HAS BEEN REPLACES WITH SP1561-832-9. SEE ZONE 13.

DELETION LIST OF MATERIALS

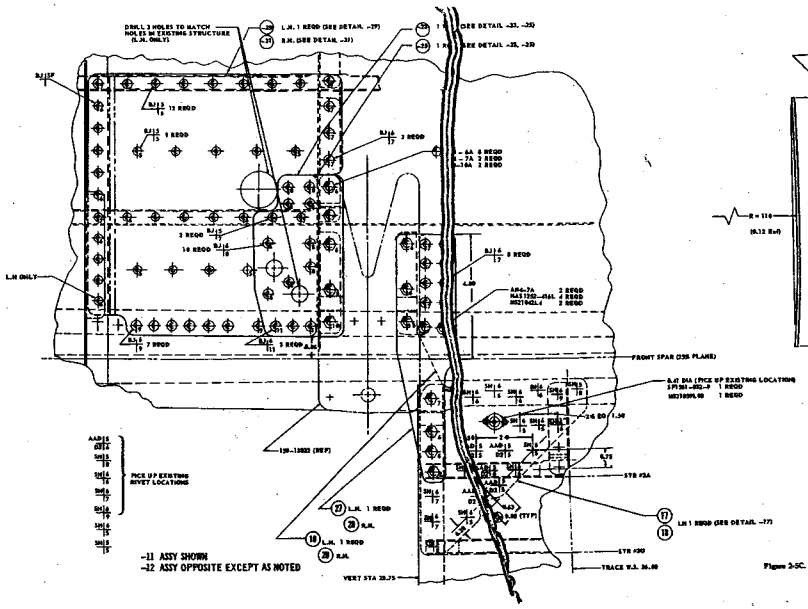
QUANTITY -1	QUANTITY -2	QUANTITY -11	QUANTITY -12	PART OR IDENTIFYING NUMBER	NOMENCLATURE
	1			189-130220-7	DOUBLER
1				189-130220-8	DOUBLER
	1			189-130220-9	SHIM
1				189-130220-10	SHIM
	1			159-13022-1	FITTING
1				159-13022-2	FITTING
1	1			189-130220-13	DOUBLER
	1			42-22253-3	DOUBLER
1				42-22253-4	DOUBLER
	1			42-22253-5	DOUBLER
1				42-22253-6	DOUBLER
		1		189-130220-3	DOUBLER
			1	189-130220-4	DOUBLER
		1		189-130220-5	SHIM
			1	189-130220-6	SHIM

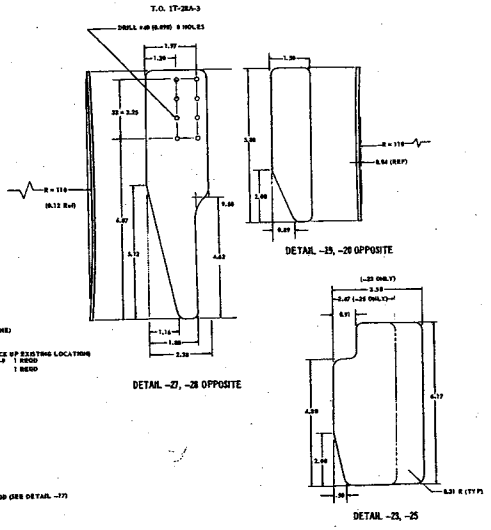
(1) 1. IDENTIFY IN ACCORDANCE WITH MIL-STD-130
(1) 2. USED FOR REPAIR OF T-28 AIRCRAFT
3. FOR FASTENER CODING SEE MAS 523
4. FASTENERS NOT LOCATED ARE AT EXISTING FASTENER HOLES
(5) 5. INSTALL FASTENERS PER MIL-STD-403
(3) 6. MAY BE PURCHASED FROM HI-SHEAR CORP. (CODE IDENT NO. 73197), VOI-SHAN DIV., VSI CORP (CODE IDENT NO. 92215) OR STD PRESSED STEEL CO. (CODE IDENT NO. 56878)
7. SPOTFACE .44 DIA X .031 R. FOR 3/16 DIA HI-LOK BOLT & .56 DIA X .062 R. FOR 1/4 DIA HI-LOK BOLT AS REQD TO INSTALL FASTENERS WITH .005 MAX. ALLOWABLE GAP BETWEEN HEAD OF BOLT AND 189-130027-3(-4) OR 189-130028-3(-5)
(4) 8. PART NO. OF MINNESOTA MINING AND MFG. CO. ADHESIVE COATING AND SEALER DIVISION, SAINT PAUL, MINNESOTA
(2) 9. PART NO. OF ILLINOIS TOOL WORKS INC. SHAKEPROOF DIVISION ELGIN, ILLINOIS
(6) 10. USED FOR REPAIR OF T-28 AIRCRAFT

-12 QTY REQD	-11 QTY REQD	-2 QTY REQD	-1 QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	CODE IDENT	MATERIAL	DATA SPECIFICATION SIZES, NOTES, VENDORS
				189-130026	INSTL			
			1	-3	DOUBLER		2024-T3 CLAD AL SHT.	.050 X 10.26 X 14.38 QQ-A-250/5
		1		-5	DOUBLER		2024-T3 CLAD AL SHT.	.050 X 10.20 X 14.38 QQ-A-250/5
			1	-7	DOUBLER		301 CRES SHT	.025 X 5.81 X 6.75 MIL-S-5059 1/2 HARD
		1		-8	DOUBLER		301 CRES SHT	.025 X 5.81 X 6.75 MIL-S-5059 1/2 HARD
			1	-9	SHIM		2024-T3 CLAD AL SHT	.050 X 1.00 X 1.94 QQ-A-250/5
			1	-13	WEDGE		PHENOLIC COTTON SHT	.188 X 1.00 X 3.00 MIL-P-15035 TYPE FBM
		1		-14	WEDGE			.188 X 1.00 X 3.00 MIL-P-15035 TYPE FBM
			1	-15	WEDGE			.125 X 1.00 X 1.81 MIL-P-15035 TYPE FBM
		1		-16	WEDGE		PHENOLIC COTTON SHT	.125 X 1.00 X 1.81 MIL-P-15035 TYPE FBM
	1			-17	DOUBLER		301 CRES SH	.020 X 5.81 X 6.75 MIL-S-5059 1/2 HARD
1				-18	DOUBLER		301 CRES SH	.020 X 5.81 X 6.75 MIL-S-5059 1/2 HARD
			1	189-130027-3	FITTING			
		1		189-130027-4	FITTING			
			1	189-130028-3	STRAP			
		1		189-130028-5	STRAP			
			1	189-130028-7	FILLER			
		AR	AR	EC-2216 B/A	ADHESIVE	04963	(4)	FSN 8040-788-2839
		1	2	HL18PB-6-5	BOLT	73197		(3)
		2		HL18PB-6-6				
		2		HL18PB-6-7				
		3	3	HL18PB-8-4				
		6	6	HL18PB-8-5				
			1	HL18PB-8-6				
		5	4	HL18PB-8-7				
		3	3	HL18PB-8-10	BOLT	73197		(3)
1	1	1	1	SP1561-832-9	SCREW	78189		(5)
		5	7	HL82-6A	NUT	73197		(3)
		5	7	HL82-6W	WASHER			
		5		HL70-6	NUT			
		17	17	HL70-8	NUT			
		4	4	HL62PB-6-6	BOLT			
		1	1	HL62PB-6-7	BOLT	73197		(3)
8	8	2	2	AN4-6A	BOLT	88044		
			3	AN4-17A	BOLT	88044		

-12 QTY REQD	-11 QTY REQD	-2 QTY REQD	-1 QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	CODE IDENT	MATERIAL	DATA SPECIFICATION SIZES, NOTES, VENDORS
2	2	2	3	MS21042L4	NUT	96906		
1	1	1	1	MS21059L08	NUTPLATE	96906		
4	4	4	7	MAS1252-416L	WASHER	80205		
			1	MAS1252-416H	WASHER	80205		
2	2	2	2	MS20426AD3-4	RIVET	96906		
4	4	4	4	MS20427M5C3				
1	1	1	1	MS20427M5C6				
9	9	9	9	MS20470AD5-5				
20	21	24	25	MS20470AD5-6				
2	2	4	4	MS20470AD5-7				
		1	1	MS20470AD5-8	RIVET	96906		
	1			-19	SHIM		7075-T6 CLAD AL SH	.090 X 1.50 X 5.88 QQ-A-250/13
1				-20	SHIM		7075-T6 CLAD AL SH	.090 X 1.50 X 5.88 QQ-A-250/13
		9	9	MS20470AD6-6	RIVET	96906		
3	3	11	11	MS20470AD6-7				
10	10	1	1	MS20470AD6-8				
15	15	10	8	MS20470AD6-9				
		2		MS20470AD6-10				
		3	3	MS20470DD6-8				
		1	1	MS20470DD6-9				
		1	1	MS20470DD6-10				
2	2	2	2	MS20615-5MP8				
4	4	4	4	MS20615-6MP5				
7	7	3	3	MS20615-6MP6				
3	3	2	2	MS20615-6MP7				
1	1	1	1	MS20615-6MP9	RIVET	96906		
1	1			-23	DOUBLER		7075-T6 CLAD AL SH	.032 X 3.90 X 6.17 QQ-A-250/13
1	1			-25	SHIM		7075-T6 CLAD AL SH	.032 X 2.47 X 6.17 QQ-A-250/13
	1			-27	DOUBLER		7075-T6 CLAD AL SH	.080 X 2.38 X 9.38 QQ-A-250/13
1				-28	DOUBLER		7075-T6 CLAD AL SH	.080 X 2.38 X 9.38 QQ-A-250/13
	1			-29	DOUBLER		2024-T3 CLAD AL SH	.050 X 9.88 X 10.20 QQ-A-250/5
1				-31	DOUBLER		2024-T3 CLAD AL SH	.050 X 9.88 X 10.20 QQ-A-250/5
4	4		—	AN4-7A	BOLT	88044		
2	2			AN4-10A	BOLT	88044		
3	3			MS20470AD6-11	RIVET	96906		

Figure 2-5C. Front Spar Cap at Vertical Wing Sta. 26.86 Repair Procedures (Sheet 2 of 4)





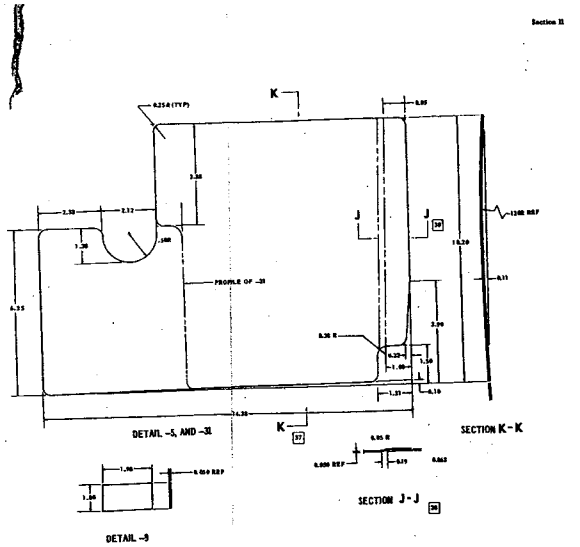
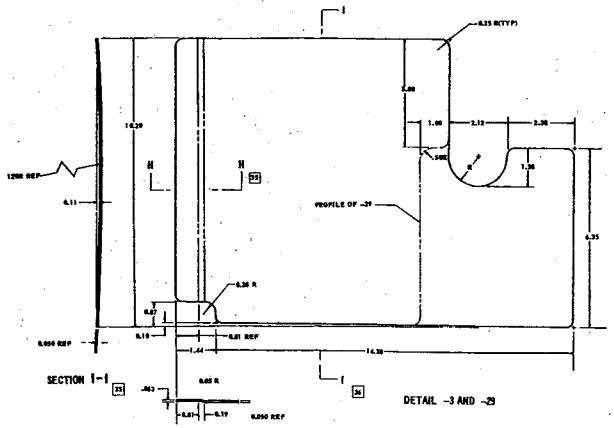
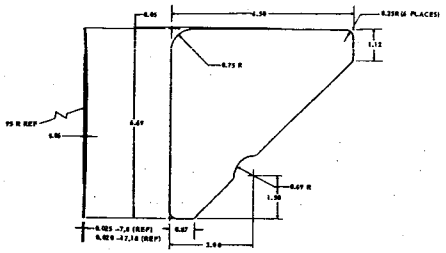


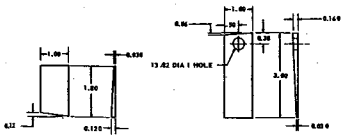
Figure 2-5C. Front Spar Cap at Vertical Wing Sta. 26.86 Repair Procedures (Sheet 3 of 4)



DETAIL -3 AND -29

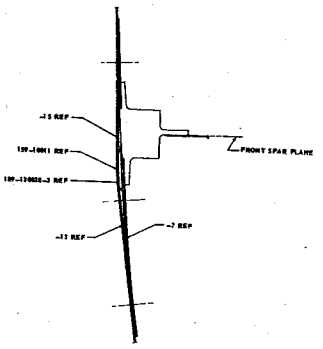


DETAIL -7, 17 SHOWN
-8, 18 OPPOSITE



DETAIL -15 SHOWN
-16 OPPOSITE

DETAIL -13 SHOWN
-14 OPPOSITE



SECTION F-F
13

④ WING REPAIR ON DRAG FITTING AREA

1. REMOVE WING FROM FUSELAGE WITH MAIN LANDING GEAR LOWERED. REMOVAL TO BE IN ACCORDANCE WITH T.O. 1T-28D-2, SECTION II, PAGE 2-25, PAR. 2-97.
2. REMOVE THE THREE FASTENERS THRU 159-33444 FITTING. SEE PLAN VIEW E-E.
3. REMOVE THE FOLLOWING DOUBLERS: 189-130226-3, -4, -5, -6 AND ANY OTHER DOUBLERS WHICH MAY BE ON THE WING UPPER SURFACE IN THE AREA OF THE NEW -29 AND -31 DOUBLERS.
4. AIRCRAFT WITH THE 189-130226-7, -8, -9, -10 AND -13 DOUBLERS INSTALLED NEED NOT BE REWORKED TO INSTALL THE -17, -18, -19, -20, -27 AND -28 DOUBLERS UNLESS THE EXISTING PARTS ARE DAMAGED. REPLACE DAMAGED EXISTING PARTS WITH CORRESPONDING PART PER THIS DRAWING.
5. INSPECT DRAG FITTING AND WING TO FUSELAGE ATTACH AREA PER T.O. 1T-28A-36 PARAGRAPHS 4-179 THRU 4-196.
6. AIRCRAFT WITHOUT 189-130226-7, -8, -9, -10 AND -13 DOUBLERS, POSITION -17, -18, -19, -20, -27, AND -28 DOUBLERS AND INSTALL ALL FASTENERS.
7. REMOVE ALL EXISTING UPPER SURFACE FASTENERS WITHIN THE OUTLINE OF THE -23, -25, -29 AND -31 DOUBLERS. AIRCRAFT WITH 42-22253-2, -4, -5, -6 DOUBLERS INSTALLED NEED NOT BE REWORKED UNLESS DAMAGED. IF DAMAGED INSTALL -23, -25, -29 AND -31.
8. POSITION -23, -25, -29 AND -31 DOUBLERS AND INSTALL ALL FASTENERS.
9. REINSTALL 159-33444 FITTING.
10. REPLACE THE FASTENERS REMOVED AT ANY OPEN HOLES.
11. REINSTALL WING TO FUSELAGE IN ACCORDANCE WITH T.O. 1T-28D-2, SECTION II, PAGE 2-25, PAR. 2-99.

NOTE

ONE FAIRING FASTENER HAS BEEN REPLACED WITH SP1561-832-9. SEE PLAN VIEW F-F.

Figure 2-5C. Front Spar Cap at Vertical Wing Sta. 26.86 Repair Procedures (Sheet 4 of 4)

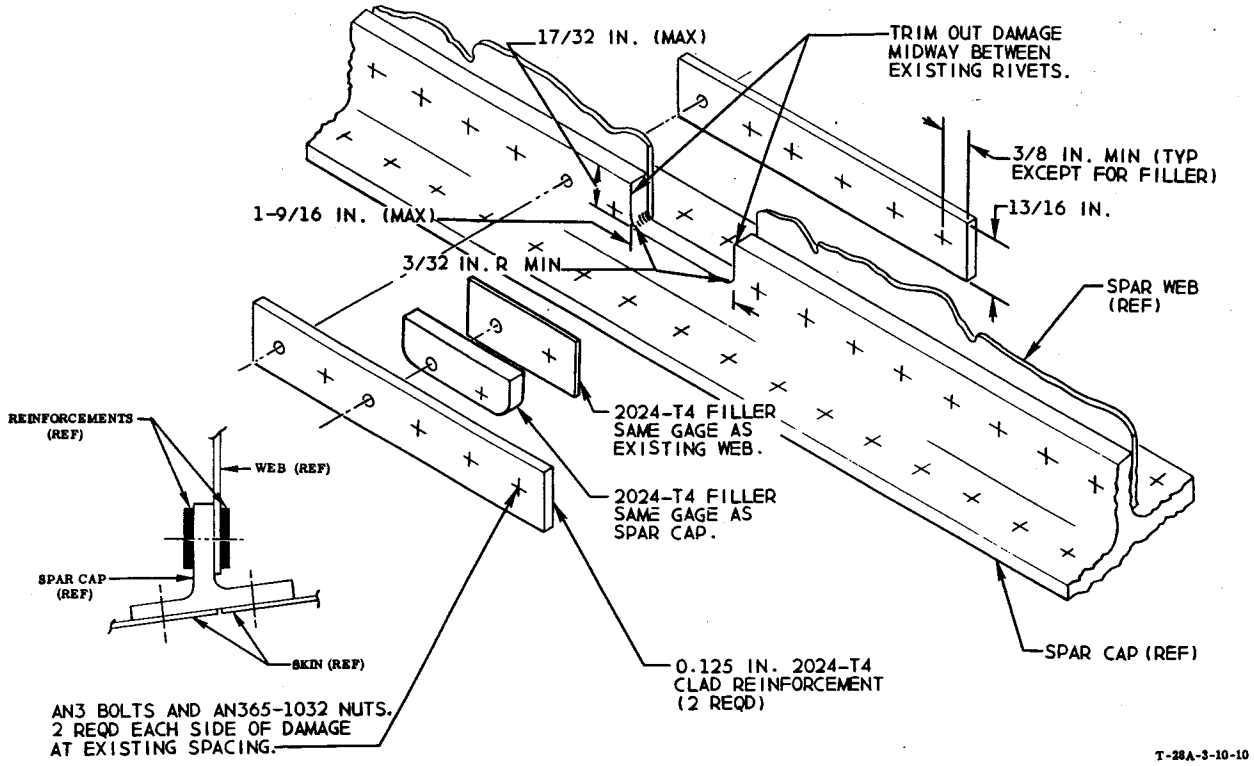


Figure 2-6. Rear Spar Lower Cap Repair - Station 32 to 66

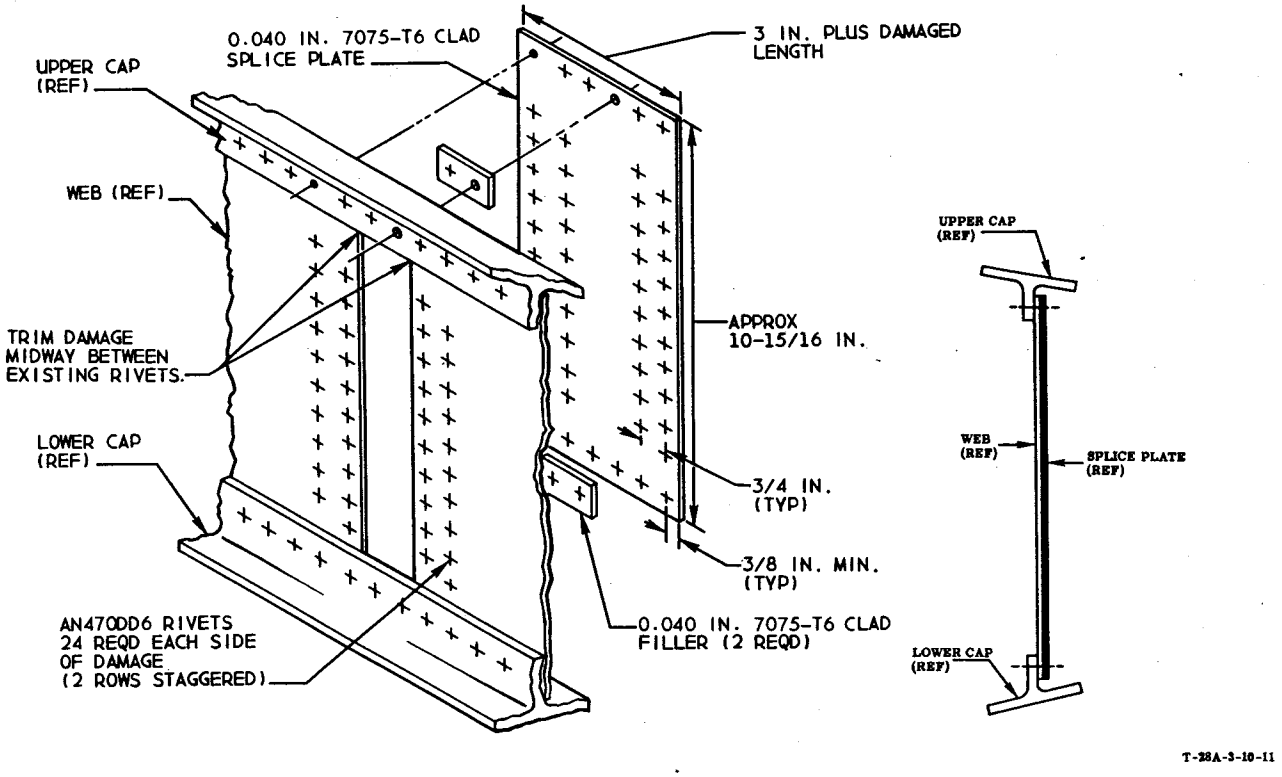


Figure 2-7. Front Spar Web Splice - Station 59 to 75

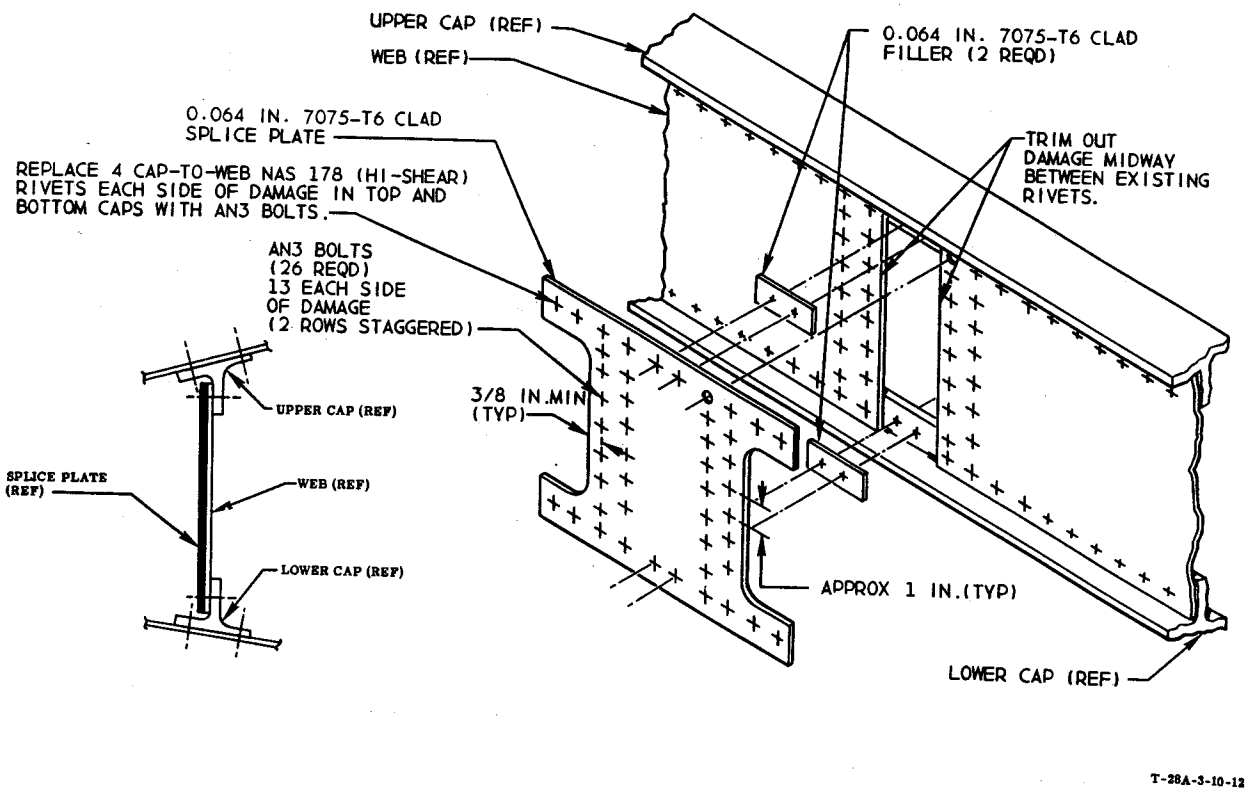


Figure 2-8. Rear Spar Web Splice - Station 31 to 66

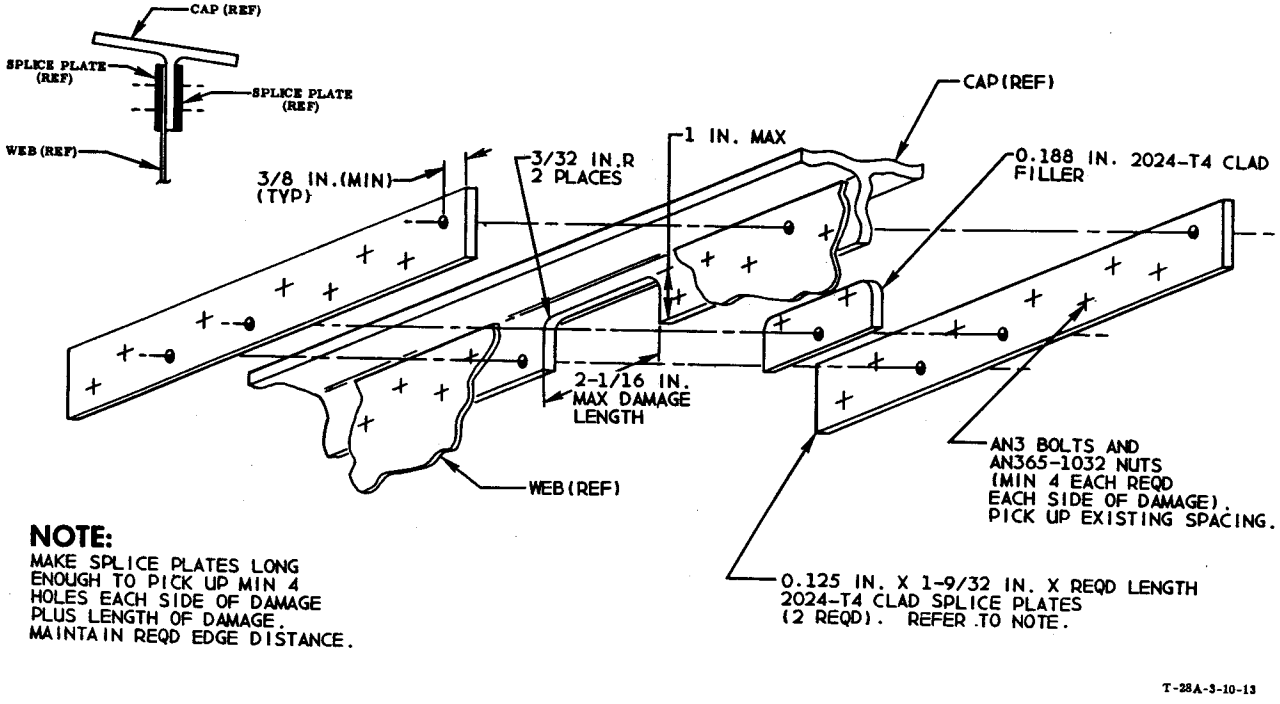


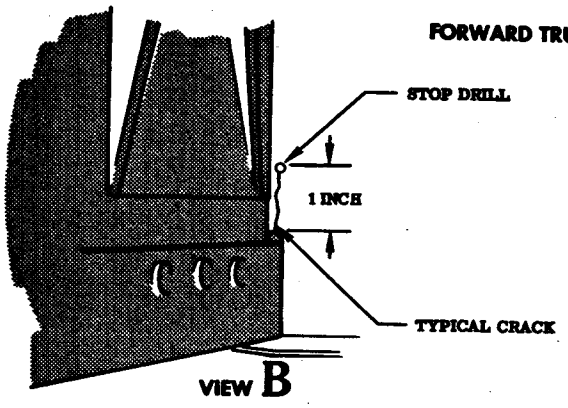
Figure 2-9. Main Landing Gear Beam Upper Cap Repair

1 Remove main landing gear wheel door. (Refer to main landing gear wheel door removal procedure in this section.)

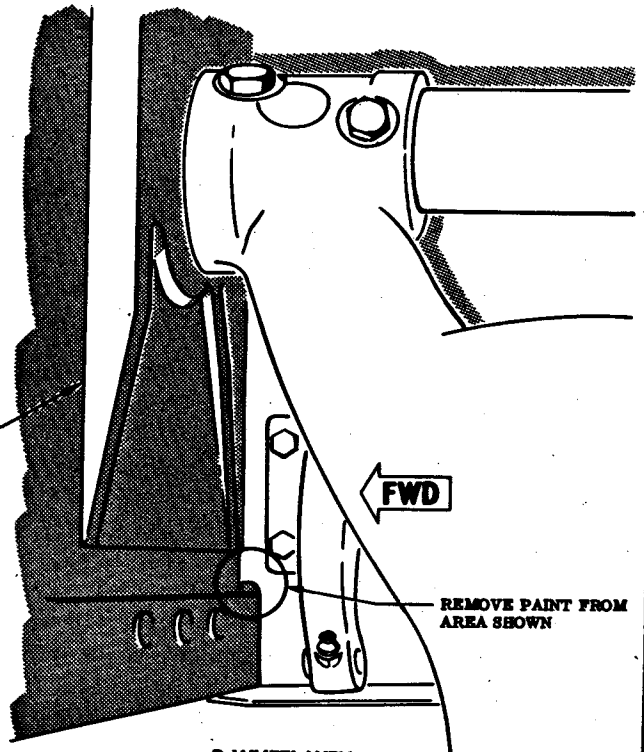
2 Thoroughly remove paint from area to be inspected. (See view A.)

3 Perform penetrant method of inspection. (Refer to applicable Technical Manual of Structural Repair.)

4 If inspection reveals a crack, check dimensions to see whether crack exceeds limits in View B.



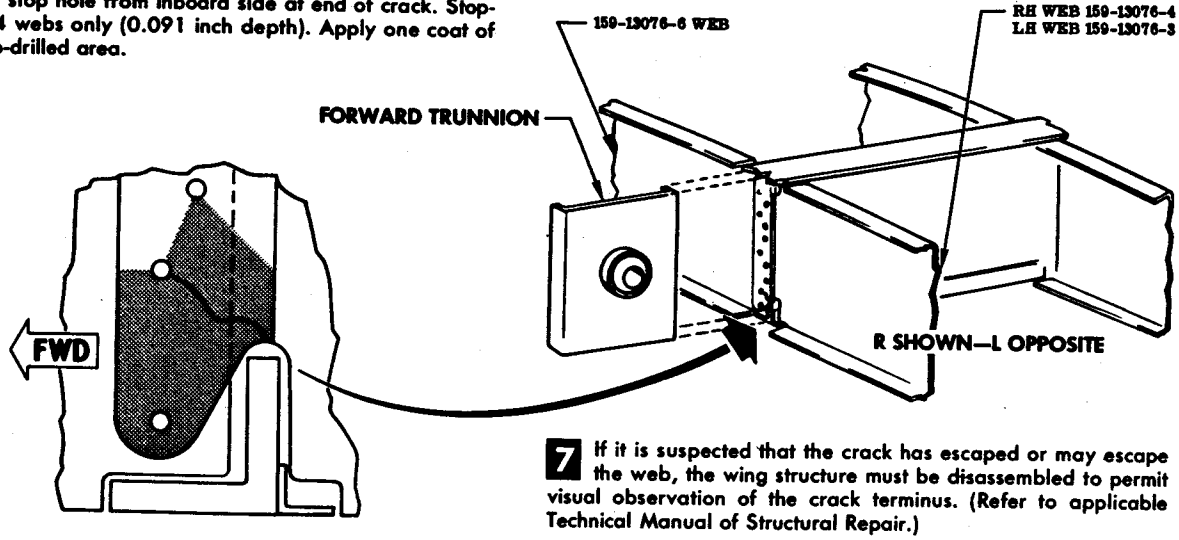
VIEW B



R WHEEL WELL

VIEW A

5 When crack terminus does not extend under landing gear trunnion plate and does not extend more than one inch toward upper wing surface from top of cutout, bottom-drill 1/8-inch diameter stop hole from inboard side at end of crack. Stop-drill -3 and -4 webs only (0.091 inch depth). Apply one coat of primer to stop-drilled area.



6 Cracked webs are acceptable if the crack turns forward under the trunnion plate and the forward web within a one-inch vertical distance of the referenced cutout. The extended crack must appear to be heading toward the -3 or -4 web area below the centerline of the second from the bottom 1/4-inch hole through the trunnion plate and the web.

7 If it is suspected that the crack has escaped or may escape the web, the wing structure must be disassembled to permit visual observation of the crack terminus. (Refer to applicable Technical Manual of Structural Repair.)

8 After area has been repaired or has been proved to be acceptable, prime area with zinc-chromate primer.

9 Replace main landing gear door. (Refer to main landing gear door installation procedure in this section.)

T-28A-2-33-8

Figure 2-9A. Repairing Rib Web Adjacent to Main Gear Forward Trunnion Plate

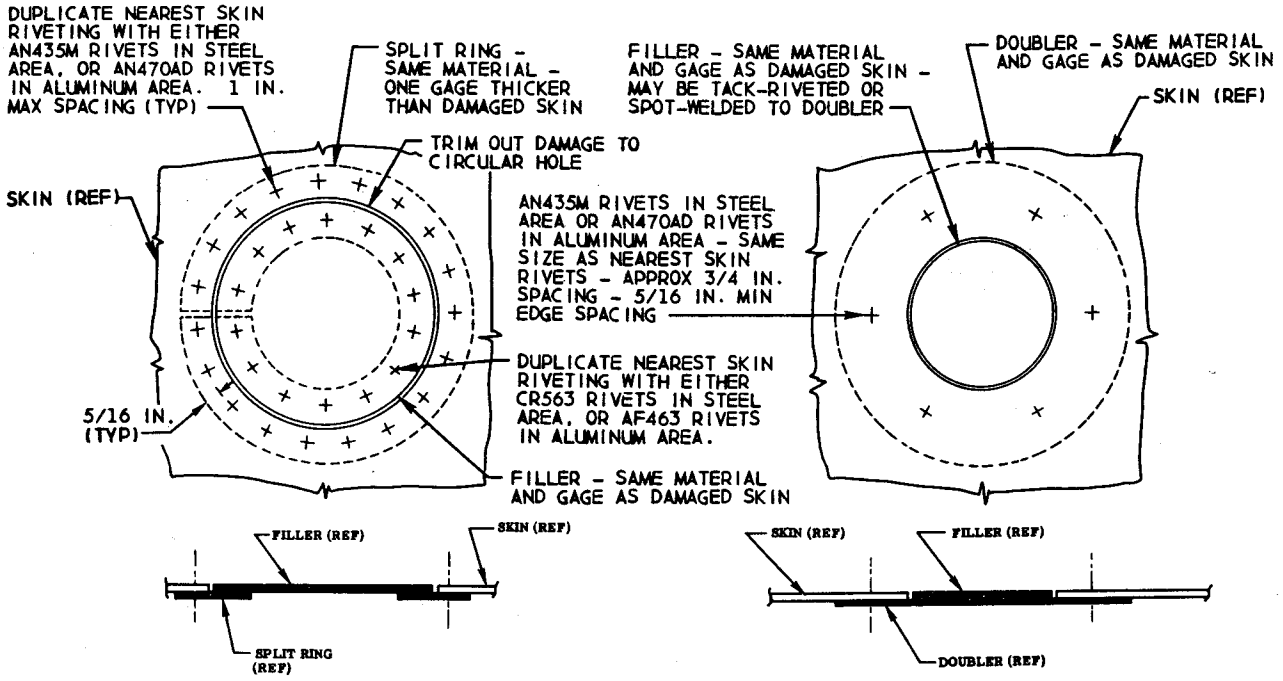


Figure 2-10. Wing Flap Leading Edge Skin Repair

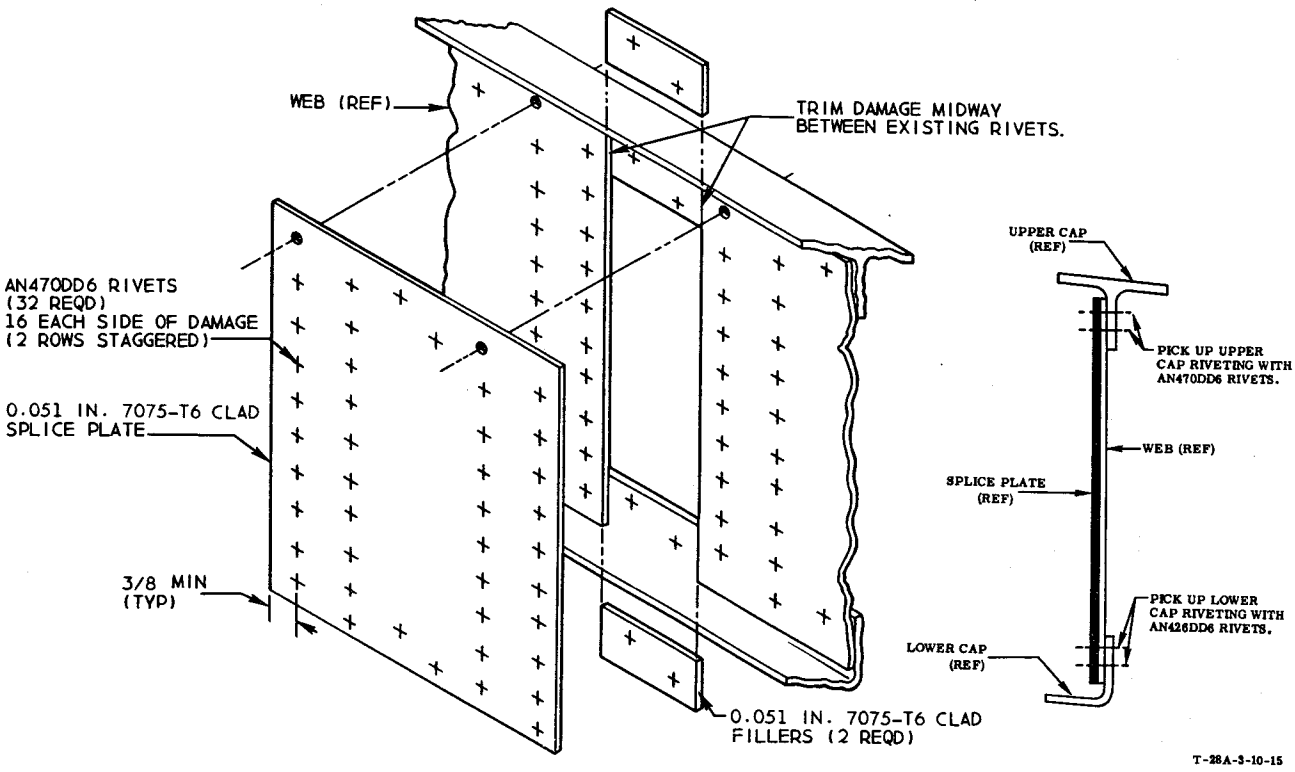


Figure 2-11. Main Landing Gear Beam Web Splice - Station 59 to 67.4

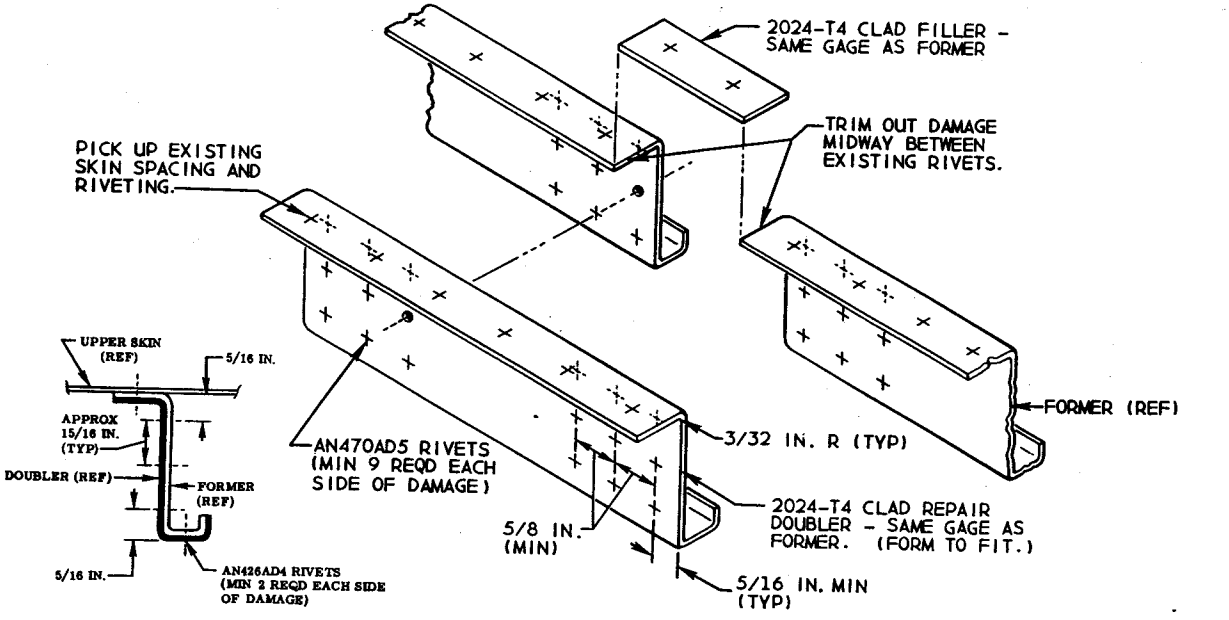


Figure 2-12. Former Repair

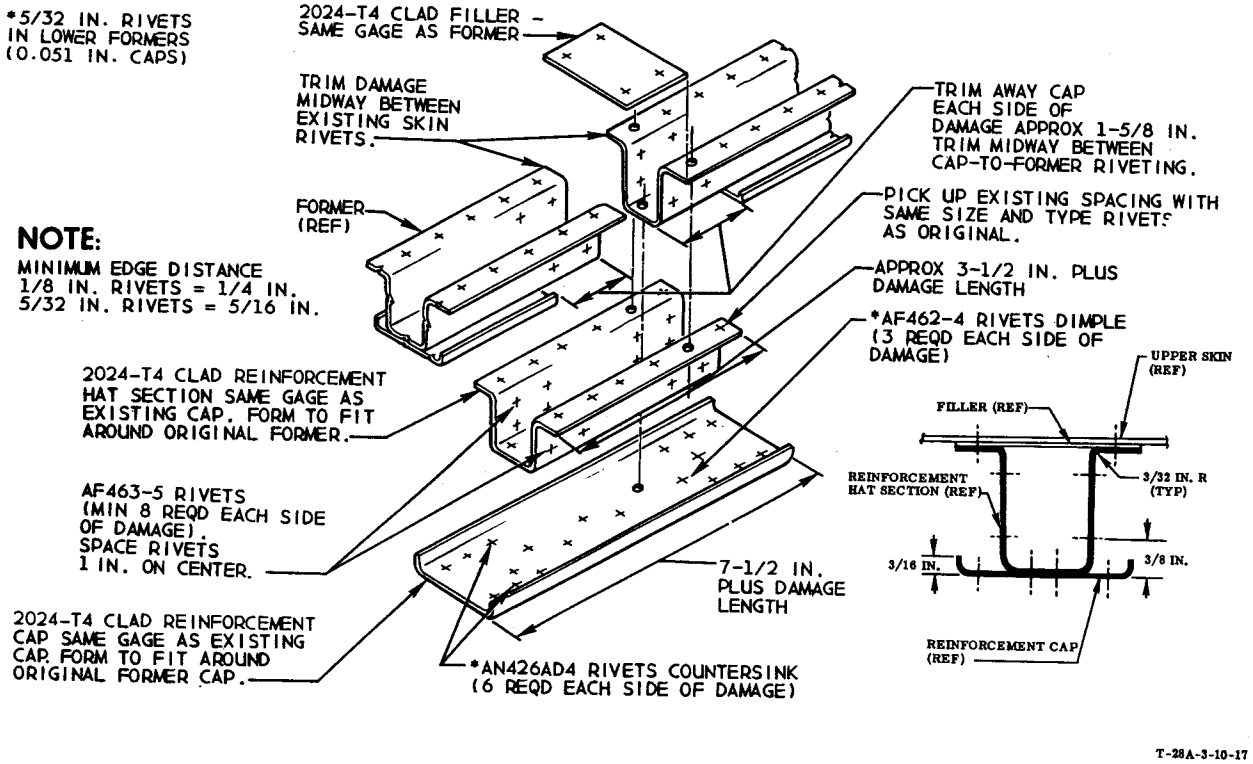


Figure 2-13. Tank Bay Former Repair

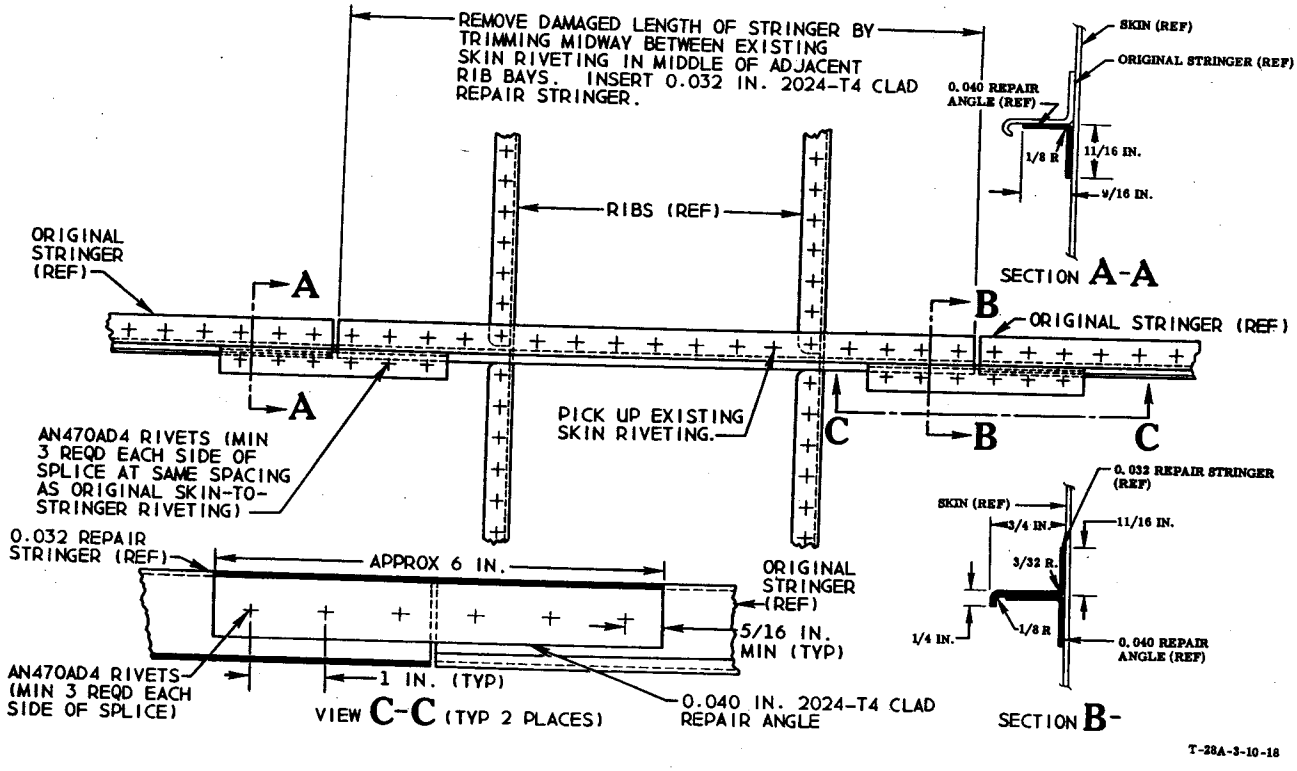
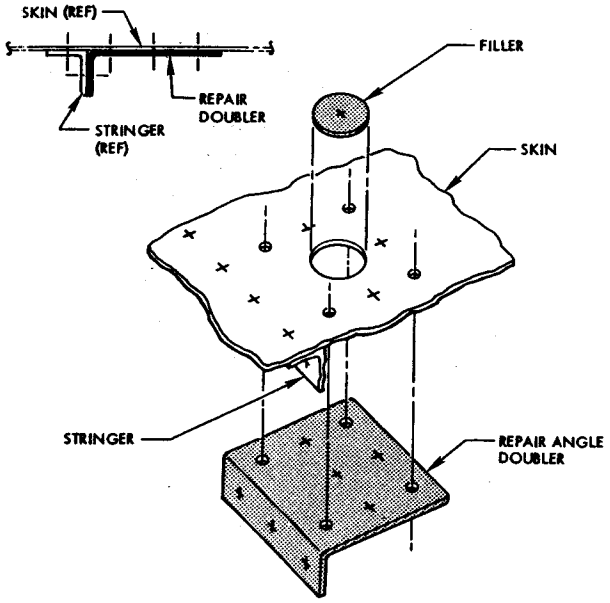
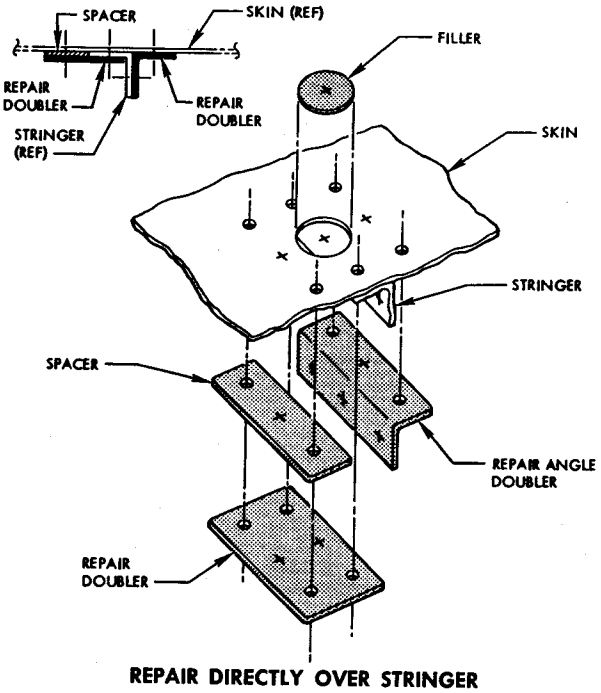


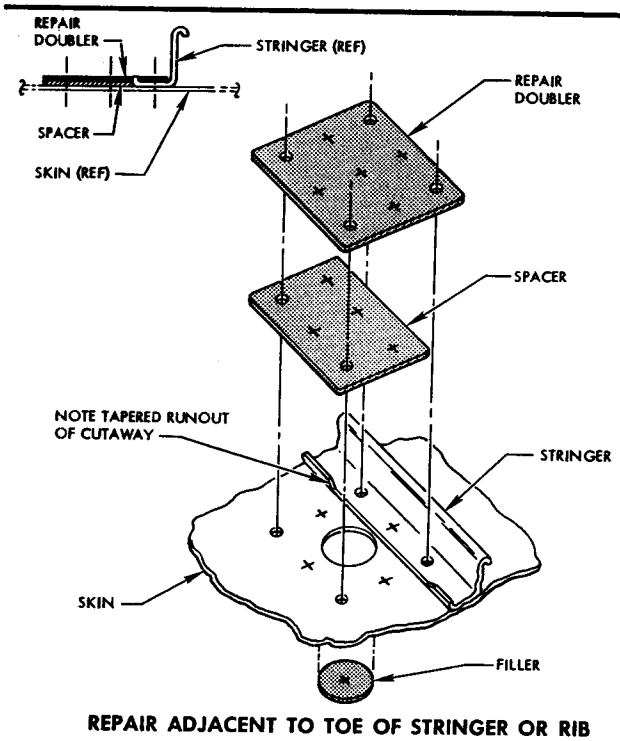
Figure 2-14. Flap Stringer Splice



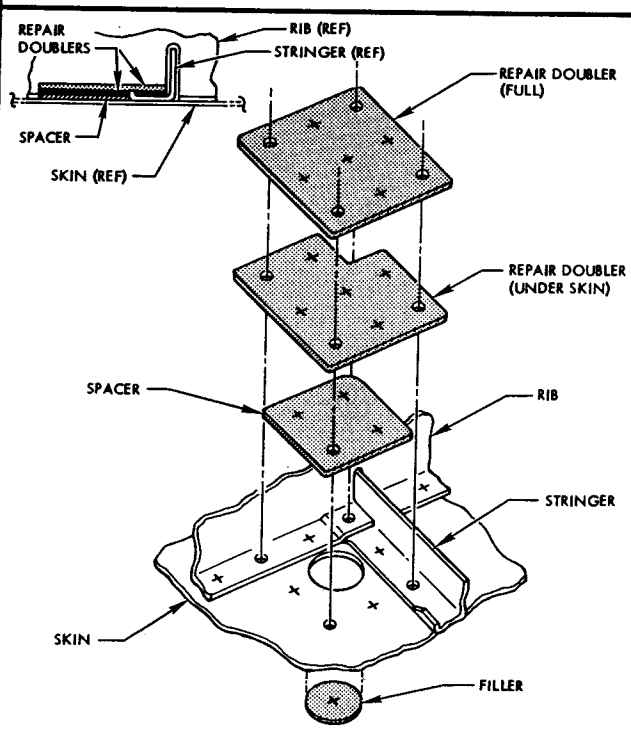
REPAIR ADJACENT TO HEEL OF STRINGER



REPAIR DIRECTLY OVER STRINGER



REPAIR ADJACENT TO TOE OF STRINGER OR RIB



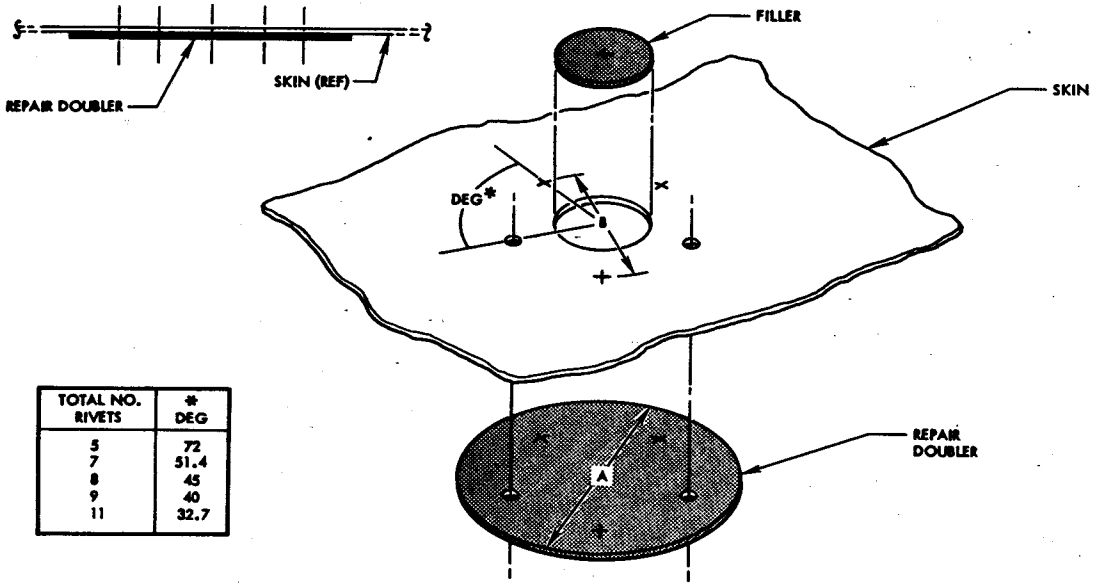
CORNER REPAIR

NOTE:

1. MAKE FILLERS AND FLAT DOUBLERS OF SAME GAGE AND MATERIAL AS DAMAGED SECTION. MAKE ANGLE DOUBLER FROM 2024-T4 MATERIAL—SAME GAGE AS STRINGER
2. MAXIMUM HOLE SIZE 1-1/2-INCH DIAMETER.
3. USE SAME SIZE RIVETS AND SAME SPACING AS IN THE ADJACENT STRINGER OR RIB.
4. FILLER MAY BE SPOT WELDED OR RIVETED TO DOUBLER.
5. DO NOT USE THESE PATCHES FORWARD OF THE FRONT SPAR.
6. MAINTAIN EDGE DISTANCE OF 2D.

T-28A-3-10-19

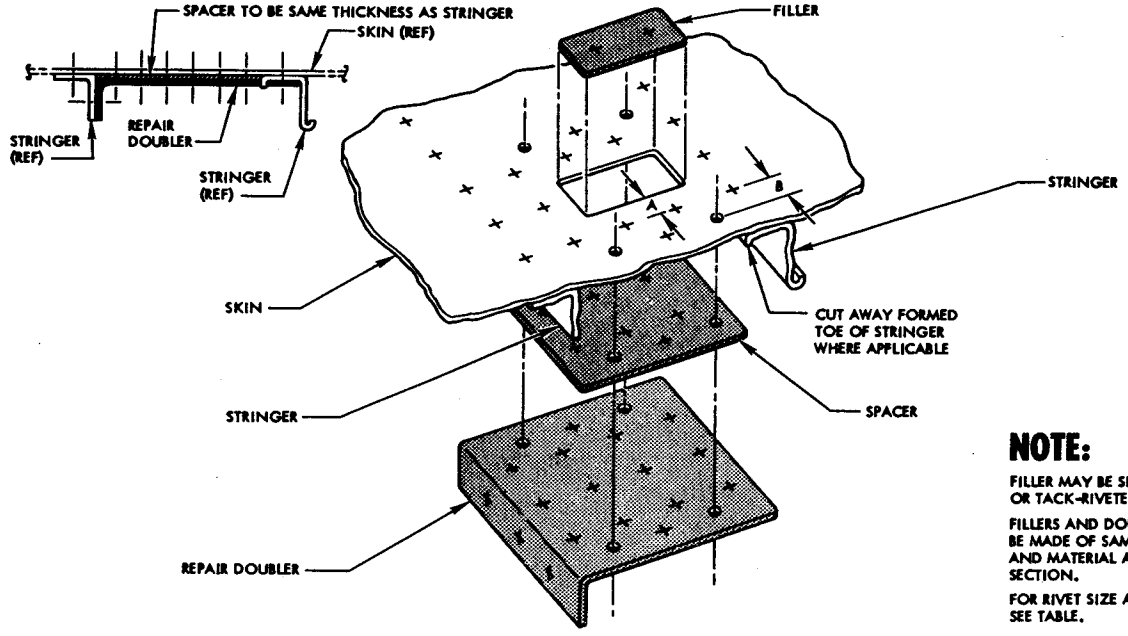
Figure 2-15. Wing Skin Repair Aft of Front Spar (Sheet 1 of 2)



TOTAL NO. RIVETS	* DEG
5	72
7	51.4
8	45
9	40
11	32.7

SKIN GAGE 2024-T4 CLAD	1/2 IN. DIA HOLE		RIVET SIZE	NO. REQD	3/4 IN. DIA HOLE		RIVET SIZE	NO. REQD	1 IN. DIA HOLE		RIVET SIZE	NO. REQD	RIVET TYPE
	A	B			A	B			A	B			
0.025 IN.	1-3/4 IN.	1-1/8 IN.	AD4	7	2 IN.	1-7/16 IN.	AD4	9	2-1/4 IN.	1-3/4 IN.	AD4	11	AN470
0.032 IN.	1-3/4 IN.	1-1/8 IN.	AD5	5	2-1/8 IN.	1-1/2 IN.	AD5	7	2-1/2 IN.	1-7/8 IN.	AD5	9	
0.040 IN.	1-3/4 IN.	1-1/8 IN.	AD5	5	2-1/8 IN.	1-1/2 IN.	AD5	7	2-1/2 IN.	1-7/8 IN.	AD5	9	

TYPICAL FOR HOLES UP TO 1 IN. DIAMETER



NOTE:

FILLER MAY BE SPOT-WELDED OR TACK-RIVETED TO DOUBLER.

FILLERS AND DOUBLERS TO BE MADE OF SAME GAGE AND MATERIAL AS DAMAGED SECTION.

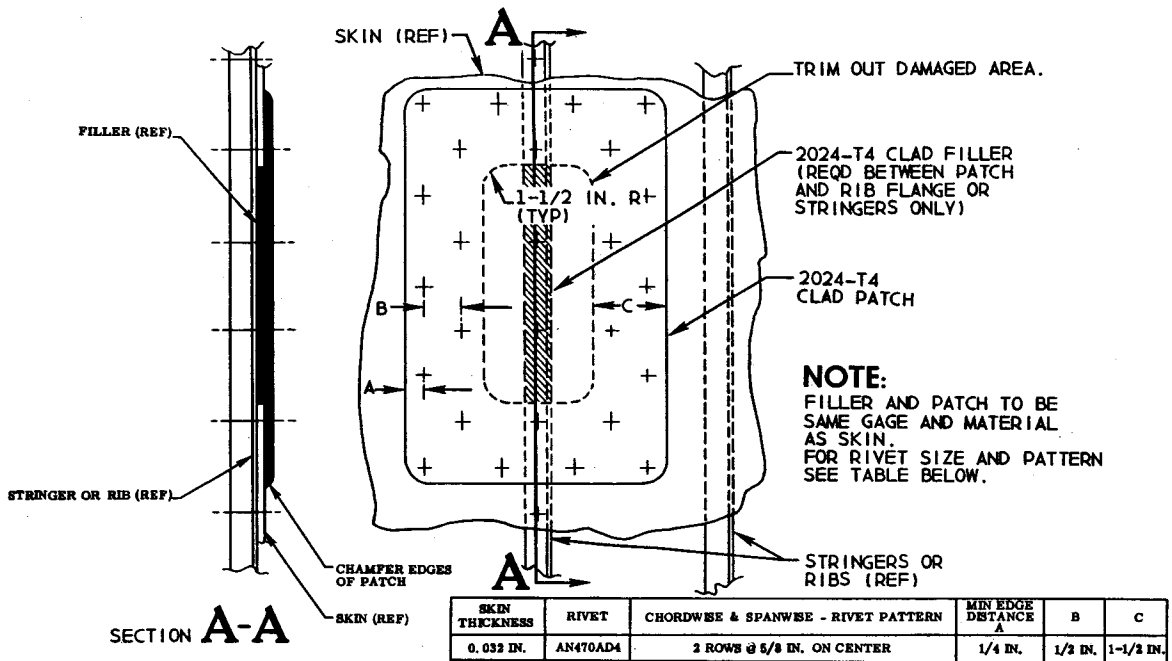
FOR RIVET SIZE AND SPACING, SEE TABLE.

SKIN GAGE	RIVET	CHORDWISE AND SPANWISE RIVET PATTERN	MIN EDGE DISTANCE A	B
0.025 IN.	AN470 AD4	2 ROWS @ 5/8 IN. ON CENTER	1/4 IN.	1/2 IN.
0.032 IN.	AN470 AD4	2 ROWS @ 5/8 IN. ON CENTER	1/4 IN.	1/2 IN.
0.040 IN.	AN470 AD5	2 ROWS @ 7/8 IN. ON CENTER	5/16 IN.	5/8 IN.

TYPICAL FOR HOLES OVER 1 IN. DIAMETER

T-28A-3-10-20

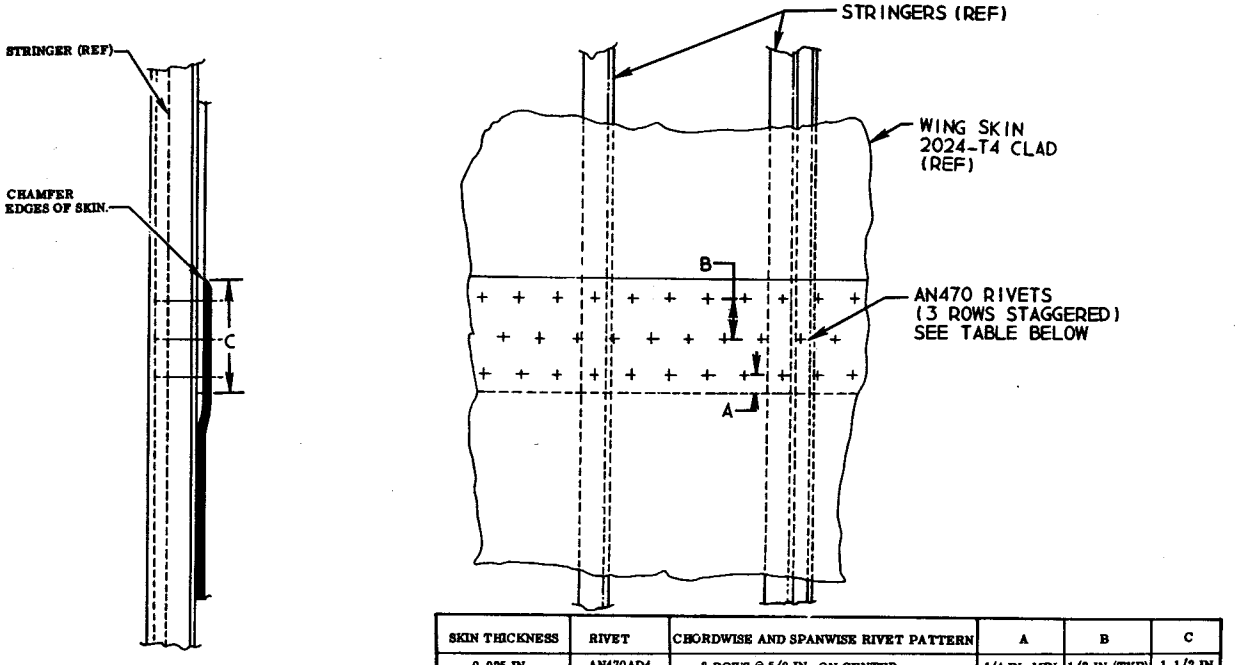
Figure 2-15. Wing Skin Repair Aft of Front Spar (Sheet 2 of 2)



SKIN THICKNESS	RIVET	CHORDWISE & SPANWISE - RIVET PATTERN	MIN EDGE DISTANCE A	B	C
0.032 IN.	AN470AD4	2 ROWS @ 5/8 IN. ON CENTER	1/4 IN.	1/2 IN.	1-1/2 IN.
0.040 IN.	AN470AD4	2 ROWS @ 5/8 IN. ON CENTER	1/4 IN.	1/2 IN.	1-1/2 IN.
0.025 IN.	AN470AD5	2 ROWS @ 7/8 IN. ON CENTER	5/16 IN.	5/8 IN.	1-7/8 IN.

T-28A-3-10-21

Figure 2-16. Nonflush Wing Skin Repair Aft of Front Spar



SKIN THICKNESS	RIVET	CHORDWISE AND SPANWISE RIVET PATTERN	A	B	C
0.025 IN.	AN470AD4	3 ROWS @ 5/8 IN. ON CENTER	1/4 IN. MIN	1/2 IN.(TYP)	1-1/2 IN.
0.032 IN.	AN470AD4	3 ROWS @ 5/8 IN. ON CENTER	1/4 IN. MIN	1/2 IN.(TYP)	1-1/2 IN.
0.040 IN.	AN470AD5	3 ROWS @ 7/8 IN. ON CENTER	5/16 IN. MIN	5/8 IN.(TYP)	1-7/8 IN.

T-28A-3-10-22

Figure 2-17. Large-area Skin Splice Aft of Front Spar

REPAIR: CRACKS IN FITTING PART NO. 159-14012 WILL BE CAUSE FOR REPLACING THE FITTING.

INSPECT: DEPAINT AND FLUORESCENT PENETRANT INSPECT FOR CRACKS ON EXPOSED SURFACE OF FITTING.

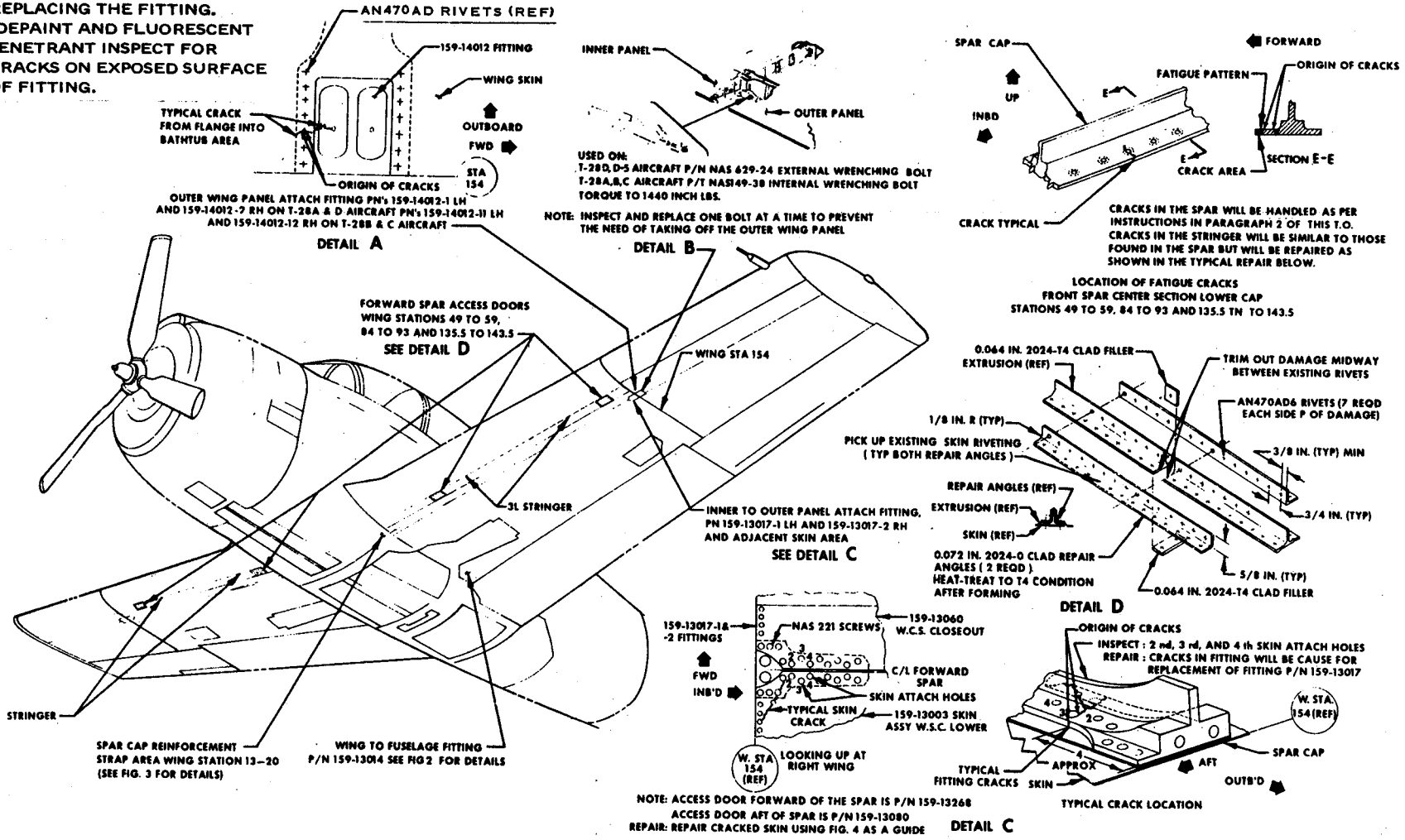
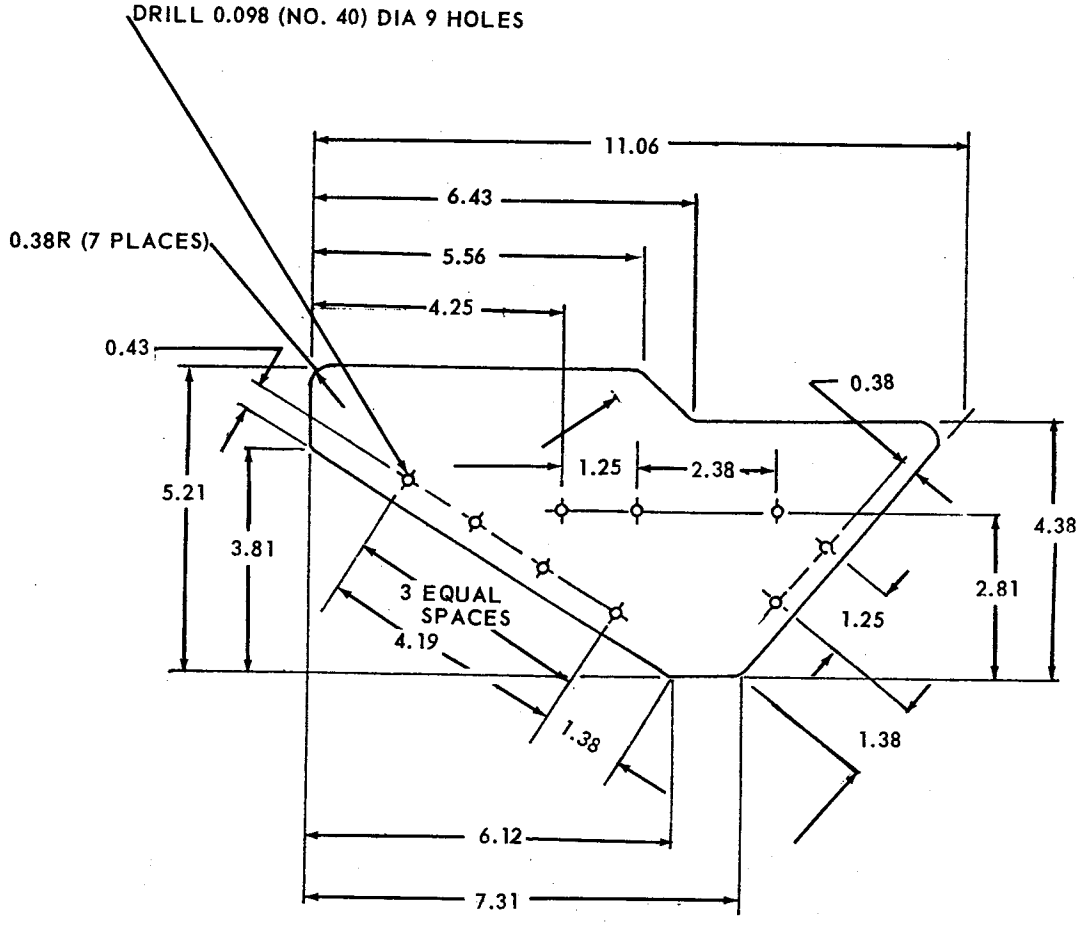


Figure 2-17A. Skin Repair for Fatigue Crack Locale of WS 154 Inboard Lower Forward Spar Cap Splice Fitting.

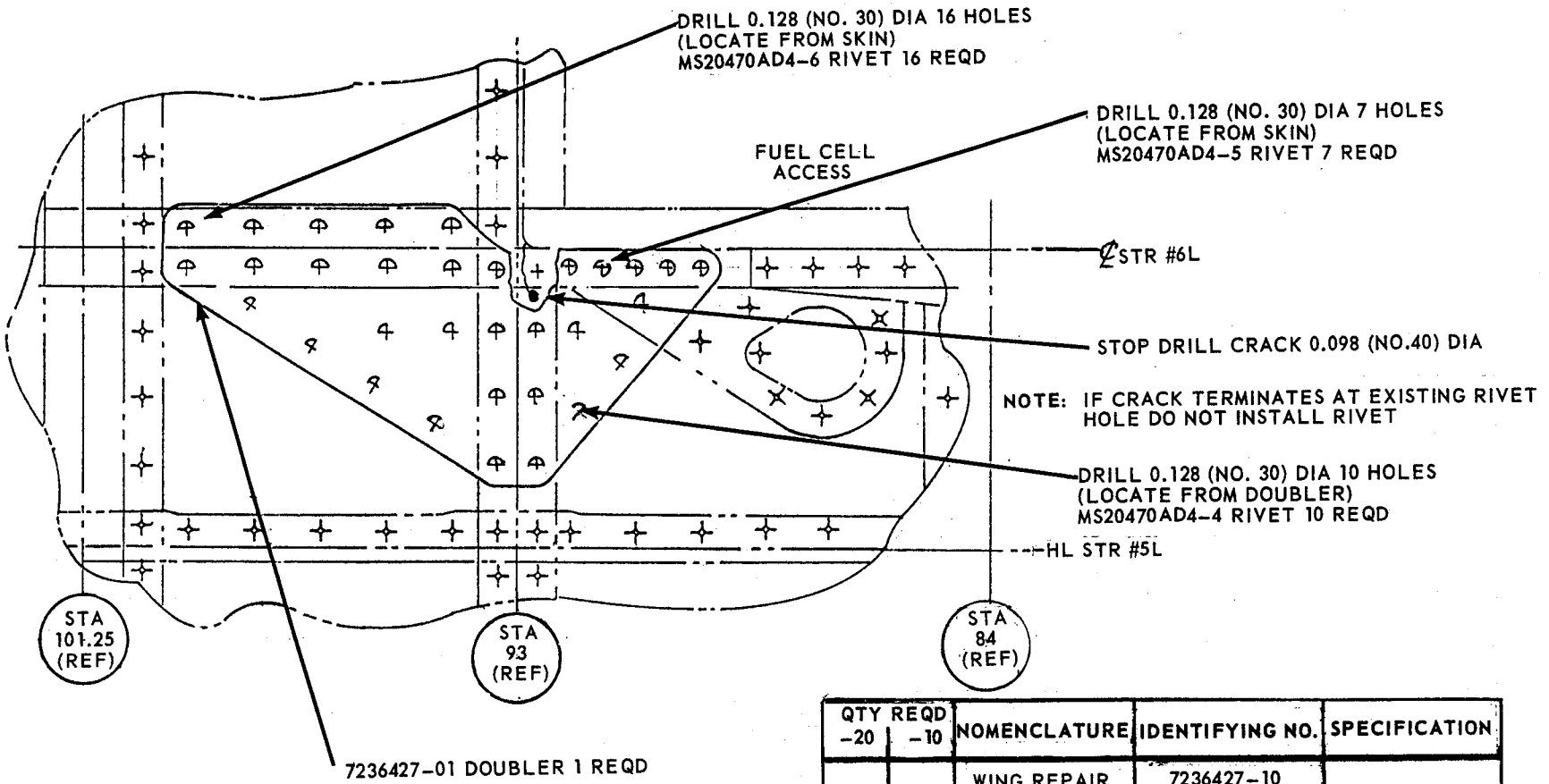
NOMENCLATURE	IDENTIFYING NO.	SPECIFICATION	MATERIAL
DOUBLER	7236426-01	TEMP T3 QQ-A-250/5	.040 x 5.25 x 11.06 AL ALY SH



NOTES:

1. BREAK ALL SHARP EDGES
2. FINISH PER MIL-STD-1516, CC 2206
3. PART NO. PER MIL-STD-130

Figure 2-17B. Lower Wing Skin Repair WS-93 (Sheet 1 of 2)



VIEW LOOKING UP AT WING LOWER SURFACE

7236427-10 SHOWN
7236427-20 OPPOSITE

QTY REQD -20	QTY REQD -10	NOMENCLATURE	IDENTIFYING NO.	SPECIFICATION
		WING REPAIR	7236427-10	
		WING REPAIR	7236427-20	
1	1	DOUBLER	7236426-01	
10	10	RIVET	MS20470AD4-4	
16	16	RIVET	MS20470AD4-5	
7	7	RIVET	MS20470AD4-6	
AR	AR	SEALER		MIL-S-8802 CLASS B-1/2

NOTE:

1. BREAK ALL SHARP EDGES
2. APPLY SEALER, MIL-S-8802, TO FAYING SURFACES
3. INSTALL RIVETS WET, USING PRIMER, MIL-P-23377
4. MS20600AD4W RIVETS MAY BE SUBSTITUTED AS NECESSARY, PROVIDED THAT AREA IS NOT READILY ACCESSIBLE DURING TIME OF REPAIR
5. STATIONS REFERENCED ARE WING STATIONS

Figure 2-17B. Lower Wing Skin Repair WS-93 (Sheet 2 of 2)

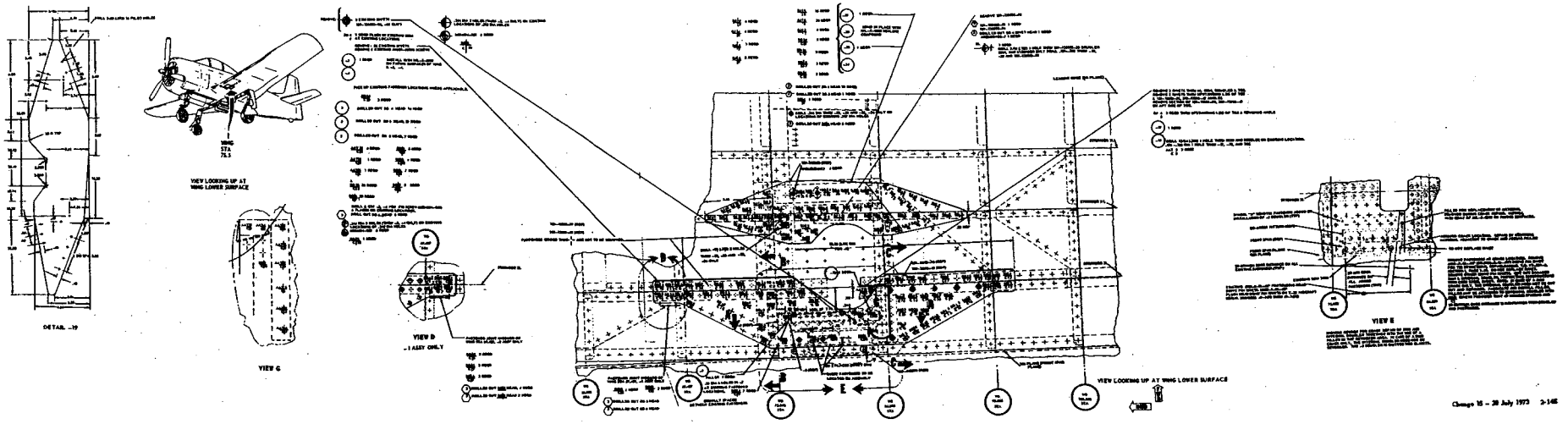


Figure 2-27C. Doubler Assembly Assen Chute (Modification) (Sheet 1 of 4)

Figure 3-17C. Doubler Assembly Aerial Crane (Modification) (Sheet 1 of 2)

AMMO CHUTE REINFORCEMENT PROCEDURES

1. REMOVE GUN PACKAGE IN ACCORDANCE WITH T.O. 1T-28D-2, SECTION IX, PAGE 9-15, PARAGRAPH 9-36.
2. REMOVE AND RETAIN 189-610112 GUN SUPPORT FITTING (REFERENCE T.O. 1T-28D-2, SECTION IX, PAGE 9-15, PARAGRAPH 9-36).
3. INSPECT STRUCTURE PER T.O. 1T-28A-36 PARAGRAPHS 4-276 THRU 4-294.

PROCEDURE FOR INSTALLING -19, -20 AND -23, -24 DOUBLERS

4. REMOVE AND RETAIN 189-130003-93, -94 CLIP (ZONE 35) AND TWO AN565D524H12 SETSCREWS FROM 189-610013 FITTING.
5. REMOVE EXISTING RIVETS COMMON TO -19 & -20 FASTENERS PATTERN. POSITION -19, -20 AND -23, -24 DOUBLERS. DRILL ALL RIVET HOLES AT NEW AND EXISTING LOCATIONS. DRILL TWO HOLES AT NUTPLATES. MARK CENTER OF TWO .312 DIA GUN SUPPORT FITTING HOLES (CODED ⊕)

CAUTION

FASTENERS CODED THUS $\frac{|}{|}$ ARE NOT TO BE REMOVED.

6. REMOVE -19, -20 AND -23, -24 DOUBLERS. DRILL TWO .344 DIA HOLES (ON LOCATIONS OF .312 DIA WING HOLES CODED ⊕) IN EACH DOUBLER. DIMPLE -19, -20 AND -23, -24 DOUBLERS AS CALLED ON DRAWING.
7. DRILL OVERSIZE HOLE THRU EXISTING SKIN, DOUBLER, AND STRINGER, ONE PLACE FOR 189-130003-93, -94 CLIP ATTACH RIVETS NAS1398D4-5.
8. INSTALL AN565D524H12 SETSCREWS AT 189-610112 FITTING ATTACH POINTS. COAT PROJECTING END OF SETSCREWS WITH PETROLATUM.
9. COAT INNER SURFACE OF -19, -20 AND -23, -24 DOUBLERS WITH MIL-S-8802 SEALING COMPOUND. INSTALL DIMPLE FILLERS AND POSITION DOUBLERS. POSITION 189-130003-93, -94 CLIP. INSTALL ALL FASTENERS.

NOTE

FABRICATE DRILLED OUT RIVET HEADS PER T.O. 1T-28A-3 PAGE 1-25 AND FIGURE 1-17, PAGE 1-32. INSTALL PER GENERAL NOTE 3.

10. REMOVE AN565D524H12 SETSCREWS AND CLEAN SEALANT FROM ATTACH HOLES. INSTALL SETSCREWS.

PROCEDURE FOR REMOVAL OF 189-130003-85, -86 GUN CHARGER LINE CLIPS (REPLACED BY -17, -18 CLIPS)

11. REMOVE 189-130003-85, -86 CLIPS REPLACE RIVETS FLUSH IN EXISTING HOLES.

PROCEDURE FOR INSTALLATION OF -17, -18 GUN CHARGER LINE CLIPS (VIEW E) .

12. REMOVE TWO RIVETS FROM AFT CAP OF TEE STRINGER 3L (159-13006-75, -76; 200-13006-43, -44) AT WING STATION 83 (IMMEDIATELY OUTBOARD OF THE AMMO CHUTE CUTOUT). REMOVE TWO RIVETS FROM UPSTANDING LEG OF TEE STRINGER AND ANGLES. REMOVE AFT ANGLE.
13. REPLACE RIVETS THRU UPSTANDING LEG AND REMAINING ANGLE.
14. POSITION -17, -18 CLIP ON WING AND DRILL TWO RIVET HOLES ON EXISTING LOCATIONS. REMOVE -17, -18 CLIP. ENLARGE HOLES IN WING STRUCTURE IN ACCORDANCE WITH DRAWING NOTES, VIEW E.
15. POSITION -17, -18 CLIP AND INSTALL RIVETS.

PROCEDURES FOR AMMUNITION CHUTE CUTOUT CRACK REPAIR.

NOTE

IF NO CRACKS ARE PRESENT, PROCEED WITH MODIFICATION STEP 18.

NOTE

IN CASE OF CRACKS IN THE SKIN ONLY, THE INTERNAL DOUBLER NEED NOT BE REWORKED UNLESS EXPEDIENT.

16. CRACKS LESS THAN .25 INCH LONG MAY BE REPAIRED BY REMOVING MATERIAL AND BLENDING, MAINTAINING A MINIMUM RADIUS OF .50 INCH. FINISH REWORKED SURFACE.

NOTE

REWORK OF FASTENER LOCATIONS WITH LESS THAN 2D EDGE DISTANCE CONSISTS OF REMOVING THE FASTENER AND TRIMMING AND BLENDING TO REMOVE THE FASTENER HOLE.

17. REPAIR CRACKS LESS THAN 1.25 INCHES LONG BY STOP DRILLING WITH A 3/16 DRILL.
18. REPAIR CRACKS LONGER THAN 1.25 INCHES BY EXTENDING THE CRACK TO THE AFT EDGE OF THE EXISTING SKIN AND DOUBLER (REFERENCE DETAIL E, ZONE 20B), REMOVING CRACKED MATERIAL AND BLENDING.

CAUTION

PROTECT SUBSTRUCTURE WITH CRES STEEL SHEET DURING REWORK.

NOTE

19. REPAIR OF CRACKS IN EXISTING SKIN AND DOUBLER MUST MAINTAIN 2D MINIMUM EDGE DISTANCE ON EXISTING AND ADDED FASTENERS. LOCATION OF ADDED FASTENERS MAY BE ADJUSTED TO MAINTAIN A MINIMUM OF 2D EDGE DISTANCE AND 4D SPACING.

NOTE

IF THE LOCATION OF THE CRACK OR CRACK REPAIR RESULTS IN LESS THAN 2D EDGE DISTANCE ON AN EXISTING 6951-S-06-4SP (OR 6950-S-06-4SP) DRIVE PIN RIVET AT THE FRONT SPAR (REF DETAIL E). THE RIVET MUST BE REMOVED IN ACCORDANCE WITH T.O. 1T-28A-3, SECTION 1, PAGE 1-39, AND NOT REPLACED. NO ADDITIONAL DRIVE PIN RIVETS ARE TO BE REMOVED.

Figure 2-17C. Doubler Assembly Ammo Chute (Modification) (Sheet 3 of 4)

20. FABRICATE A FILLER AND INSTALL WITH THE -3, -4 DOUBLER AND ASSOCIATED DETAILS (REF DETAIL E). THE FILLER IS INSTALLED WITH MIL-S-8802 SEALANT.

PROCEDURE FOR INSTALLING -3, -4 DOUBLER.

21. REMOVE EXISTING RIVETS AND SCREWS COMMON TO -3, -4 DOUBLER FASTENER PATTERN.

CAUTION

FASTENERS CODED THUS $\frac{|}{|}$ ARE NOT TO BE REMOVED.

22. POSITION -7 FILLER. DRILL .38 DIA. CLEARANCE HOLES IN -7 FILLER ON EXISTING FASTENER LOCATIONS.
23. POSITION -5, -6 ANGLE, -9 CLIP, AND -13 FILLER. DRILL FASTENER HOLES.
24. POSITION -3, -4 DOUBLER. MAINTAIN 2D MINIMUM EDGE DISTANCE ON EXISTING FASTENERS.
25. DRILL FASTENER HOLES IN -3, -4 DOUBLER ON EXISTING AND ADDED LOCATIONS.

CAUTION

USE CARE IN DRILLING THRU MOLD LINE STRUCTURE SINCE INTERNAL STRUCTURE EXISTS .44 FROM MOLD LINE.

26. PICK UP CENTER OF TWO .312 DIA GUN SUPPORT FITTING ATTACH HOLES CODED ⊕. REMOVE -3, -4 DOUBLER.
27. DRILL TWO .344 DIA HOLES IN -3, -4 DOUBLER ON LOCATIONS OF EXISTING .312 DIA GUN SUPPORT FITTING ATTACH HOLES CODED ⊕
28. DE-BURR ALL DRILLED HOLES IN -3, -4 DOUBLER, -5, -6 ANGLE, AND WING LEADING EDGE STRUCTURE.
29. INSTALL AN565D524H12 SETSCREWS AT 189-610011 FITTING. COAT PROJECTING END OF SETSCREWS WITH PETROLATUM.
30. COAT INNER SURFACE OF -3, -4 DOUBLER WITH MIL-S-8802 SEALANT.
31. INSTALL -3, -4 DOUBLER, -5, -6 ANGLE, -7 FILLER, -9 CLIP, -13 FILLER, AND FASTENERS. FILL EXISTING FASTENER DIMPLES WITH DRILLED OUT RIVET HEADS.

NOTE

FABRICATE DRILLED OUT RIVET HEADS PER T.O. 1T-28A-3, PAGE 1-25 AND FIGURE 1-17, PAGE 1-32. INSTALL PER GENERAL NOTE 3.

32. REMOVE AN565D524H12 SETSCREWS AND CLEAN SEALANT FROM ATTACH HOLES. INSTALL SETSCREWS.
33. INSTALL 189-610112 GUN SUPPORT FITTING IN ACCORDANCE WITH T.O. 1T-28D-2, SECTION IX, PAGE 9-15, PARAGRAPH 9-37.
34. INSTALL GUN PACKAGE IN ACCORDANCE WITH T.O. 1T-28D-2, SECTION II, PAGE 9-15, PARAGRAPH 9-37.

ODD DASH NUMBERS SHOWN
EVEN DASH NUMBERS OPPOSITE & NOTED

NOTES:

(3) 1. USE DRILLED OUT RIVET HEADS TO FILL DIMPLED RECESSES AT EXISTING FASTENER LOCATIONS.
(4) 2. RIVETS USED TO PRODUCE DRILLED HEADS FOR FILLING DIMPLES.
(5) 3. TO BE REUSED FOR REPAIR.
(6) 4. OBTAIN FROM DELETION LIST OF MATERIALS.
(7) 5. F04606-71-D-0023/0023.
(8) 6. MATERIAL FOR FILLER IF REQD TO REPAIR CRACKED AREA. FABRICATE FINISHED SIZE AS REQUIRED. ANY CLAD ALUMINUM ALLOY MAY BE SUBSTITUTED FOR FILLER MATERIAL.
7. ADD TAPERED FILLET OF MIL-S-8802 SEALENT AROUND ALL DOUBLERS. FILLET TO TAPER OUT APPROX 4 - 6 TIMES DOUBLER THICKNESS.
(9) 8. USE A .063 X .50 X 2.00 STRAP MADE FROM 2024-T4 CLADAL SHEET IN LIEU OF 189-13003-93 & -94 CLIP, WHEN CLIP IS NOT AVAILABLE.

PARTS LIST

QTY REQD -2	QTY REQD -1	CODE IDENT	PART NO.	NOMENCLATURE	MATERIAL	MATERIAL SIZE THKNS	MATERIAL SIZE OD/ID	MATERIAL SIZE LG	DRWG/SPEC.
(8) 1	1			FILLER	CLAD AL SH 2024-T3	.063	1.00	4.00	QQ-A-250/5
(8) 1	1			FILLER	CLAD AL SH 2024-T3	.032	1.00	4.00	QQ-A-250/5
5	5	96906	MS20426AD4-5	RIVET					
1	1		MS20426AD4-7						
4	4		MS20470AD4-8						
1	1		MS20470AD6-7						
2	2		MS20470AD6-8						
(4) 43	43		MS20426AD4-5						
(4) 34	32		MS20426AD5-5						
(4) 17	19	96906	MS20426AD6-5	RIVET					
(6) 4	4	88044	AN565D524H12	SETSCREW					
AR	AR			PETROLATUM					VV-P-236
	1		-3	DOUBLER	7075-T6CLAD AL SH	.071	6.06		30.06 QQ-A-250/13
1			-4	DOUBLER	7075-CLAD AL SH	.071	6.06		30.06 QQ-A-250/13
	1		-5	STIFFENER	1E100 EXTR 2024-T3511AL				8.81 QQ-A-200/3
1			-6	STIFFENER	1E100 EXTR 2024-T3511 AL				8.81 QQ-A-200/3
1	1		-7	FILLER	2024-T3 CLAD AL SH	.125	.94		6.62 QQ-A-250/5

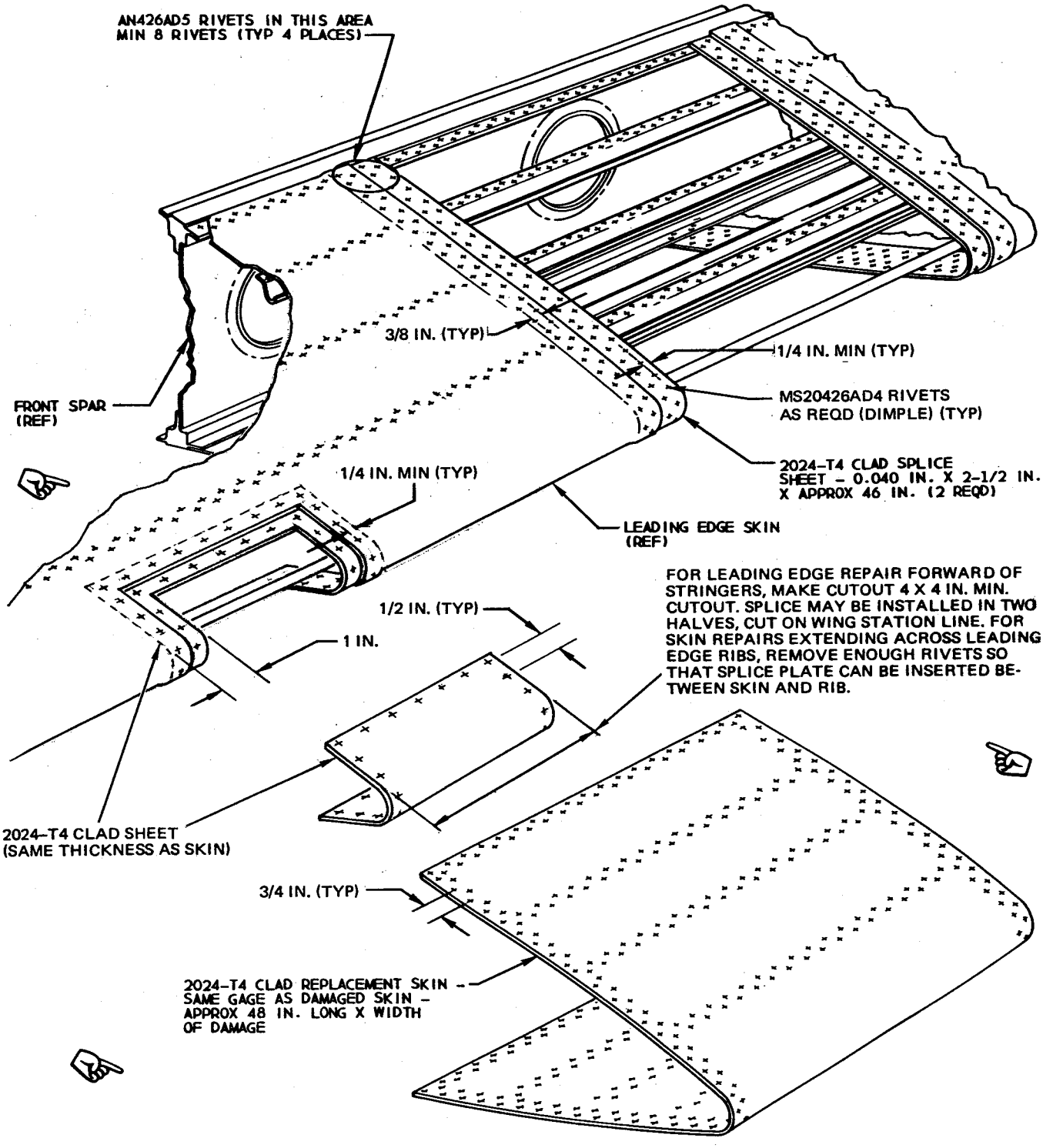
PARTS LIST (Cont)

QTY REQD -2	QTY REQD -1	CODE IDENT	PART NO.	NOMENCLATURE	MATERIAL	MATERIAL SIZE THKNS	MATERIAL SIZE OD/ID	MATERIAL SIZE LG	DRWG/SPEC
			189-130030	DOUBLER ASSY (Cont)					
1	1		-9	CLIP	2024-T3 CLAD AL SH	.050	.62	2.88	QQ-A-250/5
1	1		-13	FILLER	2024-T3 CLAD AL SH	.050	.75	.88	QQ-A-250/5
	1		-17	CLIP	2024-T3 CLAD AL SH	.032	1.38	1.62	QQ-A-250/5
1			-18	CLIP	2024-T3 CLAD AL SH	.032	1.38	1.62	QQ-A-250/5
	1		-19	DOUBLER	2024-T3 CLAD AL SH	.040	5.12	21.75	QQ-A-250/5
1			-20	DOUBLER	2024-T3 CLAD AL SH	.040	5.12	21.75	QQ-A-250/5
	1		-23		2024-T3 CLAD AL SH	.032	5.12	10.81	QQ-A-250/5
1			-24	DOUBLER	2024-T3 CLAD AL SH	.032	5.12	10.81	QQ-A-250/5
(9)(6) 1	1		189-130003-93	CLIP					
(9)(6) 1			189-130003-94	CLIP					
6	6	96906	MS20470AD4-5	RIVET					
15	15	96906	MS20470AD5-5	RIVET					
20	20	96906	MS20470AD5-6	RIVET					
35	33	96906	MS20426AD5-6	RIVET					
22	20		MS20426AD5-7						
7	7		MS20426AD5-8						
4	4		MS20426AD5-11						
3	1		MS20426AD6-7						
9	13		MS20426AD6-8						
2	2	96906	MS20470AD4-5	RIVET					
5	5	96906	MS20426AD4-8	RIVET					
2	2	96906	MS20426AD4-4	RIVET					
2	2	96906	MS21042L3	NUT					
2	2	96906	MS27039-1-09	SCREW					
AR	AR	81349	MIL-S-8802	SEALING COMPOUND					CLASS B
1	1	73197	HL18PB-6-5	PIN					
1	1	73197	HL18PB-8-3	PIN					
1	1	73197	HL70-6	COLLAR					
1	1	73197	HL70-8	COLLAR					
6	6	96906	MS24694-S53	SCREW					
2	2	80205	NAS1669-08-2	BLIND BOLT					
7	7	96906	MS20426AD4-9	RIVET					
1	1	80205	NAS1398D4-5						
2	2		NAS1739B5-3						
4	4		NAS1739B5-4						
1	1		NAS1739B5-6	RIVET					
2	2	80205	NAS1252-10H	WASHER					

QTY DELETION PARTS LIST

QTY -2	QTY -1	PART NO.	NOMEN
(5) 4	4	AN565D524H12	SETSCREW
(5) 1		189-130003-94	CLIP
(5)	1	189-130003-93	CLIP
1	1	MS21042L4	NUT
1	1	MS21042L3	NUT
6	6	AN509-10R10	SCREW
1	1	AN4-6A	BOLT
1	1	AN3-6A	BOLT
2	2	LD153-0011-0014	WASHER
2	2	LD153-0011-0012	WASHER
1		189-130003-86	CLIP
	1	189-130003-85	CLIP

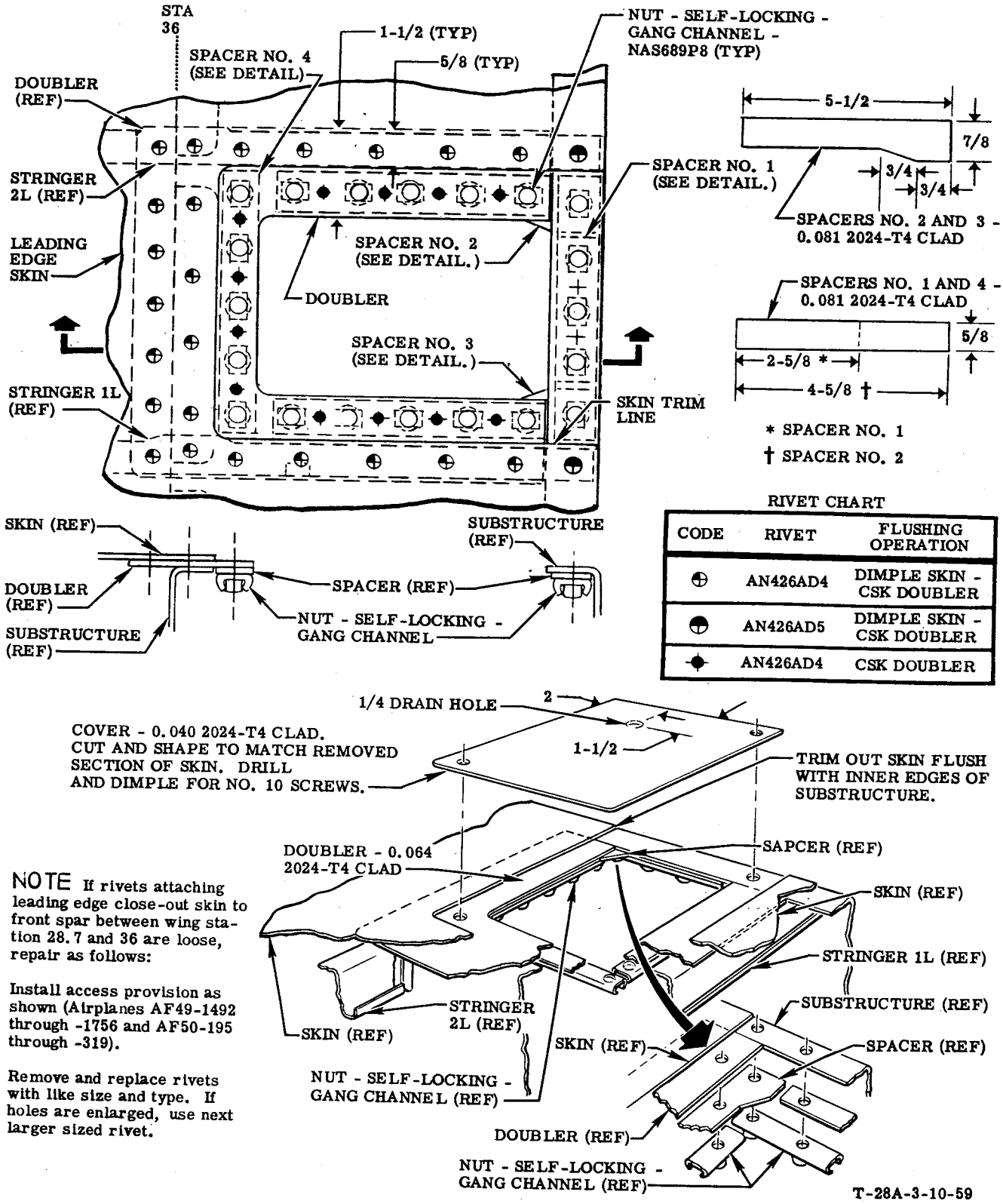
Figure 2-17C. Doubler Assembly Ammo Chute (Modification) (Sheet 4 of 4)



NOTE:

1. PICK UP EXISTING RIVETING AND SPACING THROUGH STRINGERS AND RIBS.
2. REMOVE ENOUGH RIVETS EACH SIDE OF DAMAGE SO THAT SPLICE SHEETS CAN BE INSERTED BETWEEN STRINGERS AND SKIN.
3. CAMBER EDGES OF SPLICE SHEETS.
4. ZINC CHROMATE ALL SURFACES.
5. ALL CORNER RADII.25 IN. MIN.
6. ANY REPAIR EXTENDING ACROSS MORE THAN TWO LEADING EDGE RIBS SHOULD CONSIST OF COMPLETE SKIN REPLACEMENT. INSERT FORWARD OF THE FORWARD SPAR.

Figure 2-18. Wing Leading Edge Skin Repair



RIVET CHART

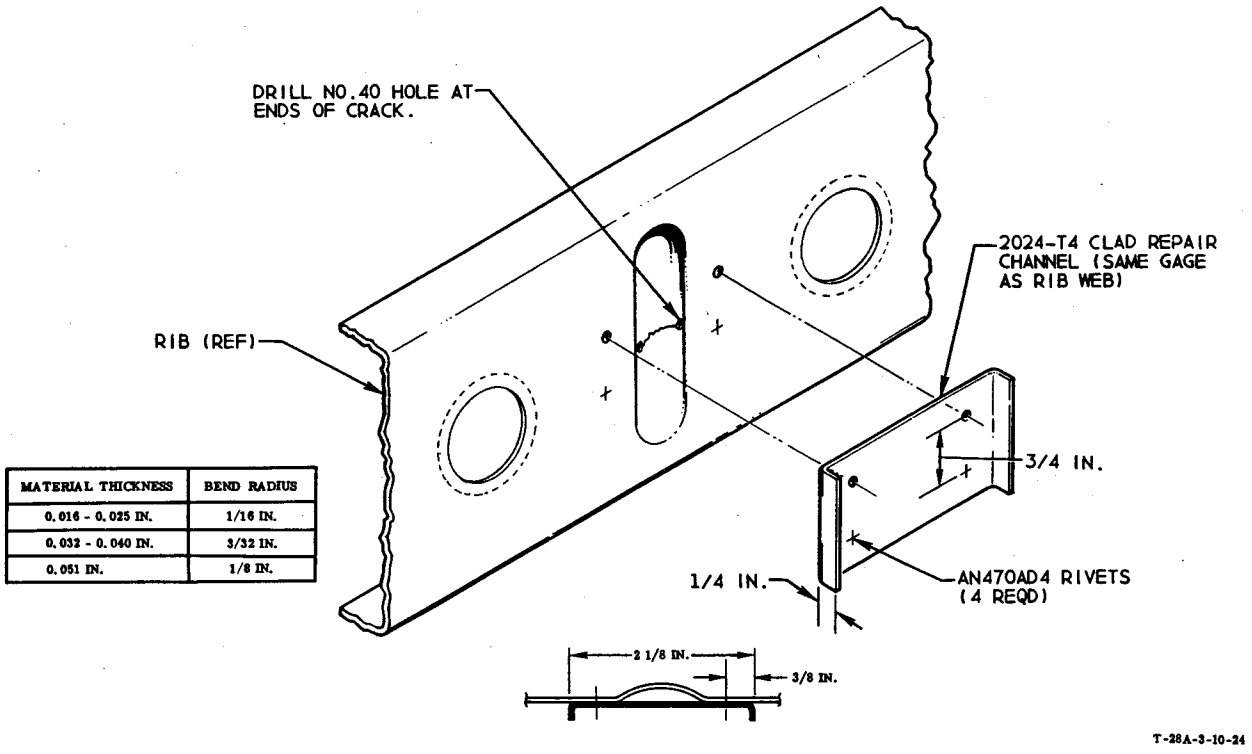
CODE	RIVET	FLUSHING OPERATION
⊕	AN426AD4	DIMPLE SKIN - CSK DOUBLER
⊕	AN426AD5	DIMPLE SKIN - CSK DOUBLER
✦	AN426AD4	CSK DOUBLER

NOTE If rivets attaching leading edge close-out skin to front spar between wing station 28.7 and 36 are loose, repair as follows:

Install access provision as shown (Airplanes AF49-1492 through -1756 and AF50-195 through -319).

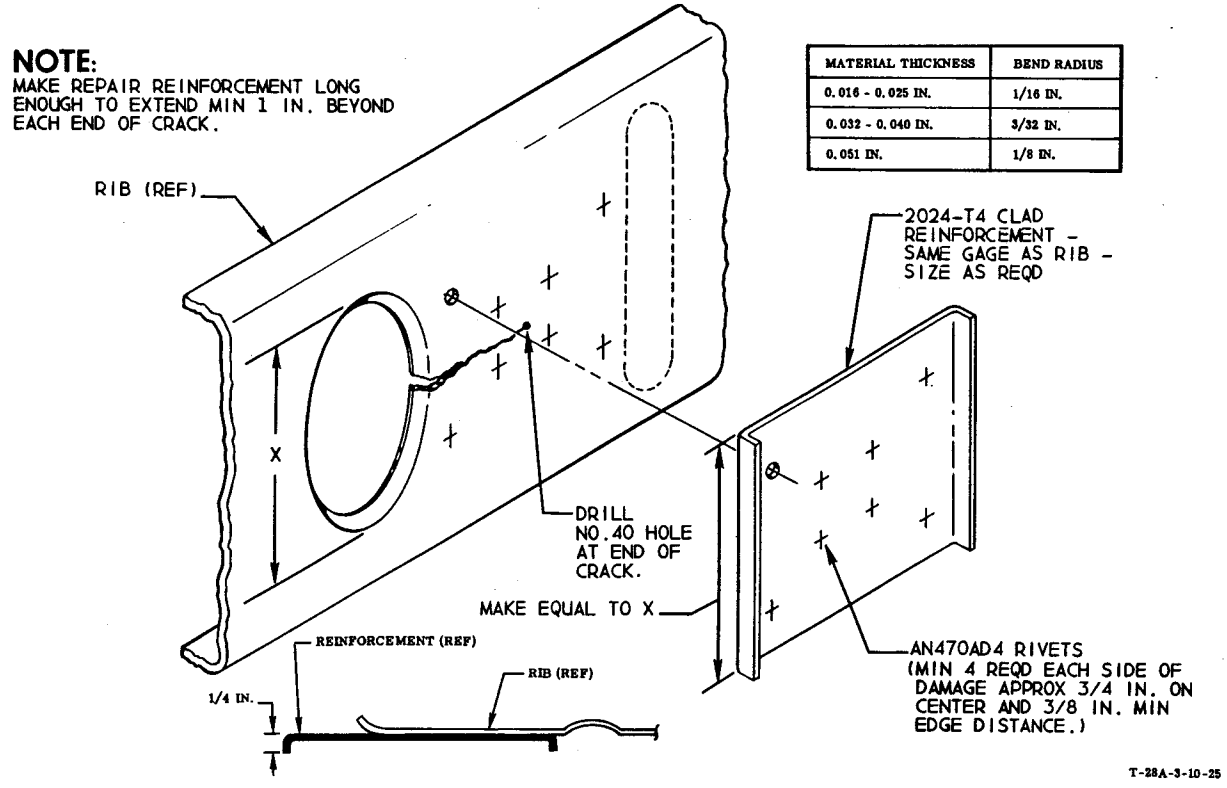
Remove and replace rivets with like size and type. If holes are enlarged, use next larger sized rivet.

Figure 2-19. Installation of Access Hole to Front Spar Close-out Skin Rivets — Station 32.5 — T-28A Airplanes



MATERIAL THICKNESS	BEND RADIUS
0.016 - 0.025 IN.	1/16 IN.
0.032 - 0.040 IN.	3/32 IN.
0.051 IN.	1/8 IN.

Figure 2-20. Cracked Rib Bead Repair



MATERIAL THICKNESS	BEND RADIUS
0.016 - 0.025 IN.	1/16 IN.
0.032 - 0.040 IN.	3/32 IN.
0.051 IN.	1/8 IN.

Figure 2-21. Lightening Hole Flange Crack Repair

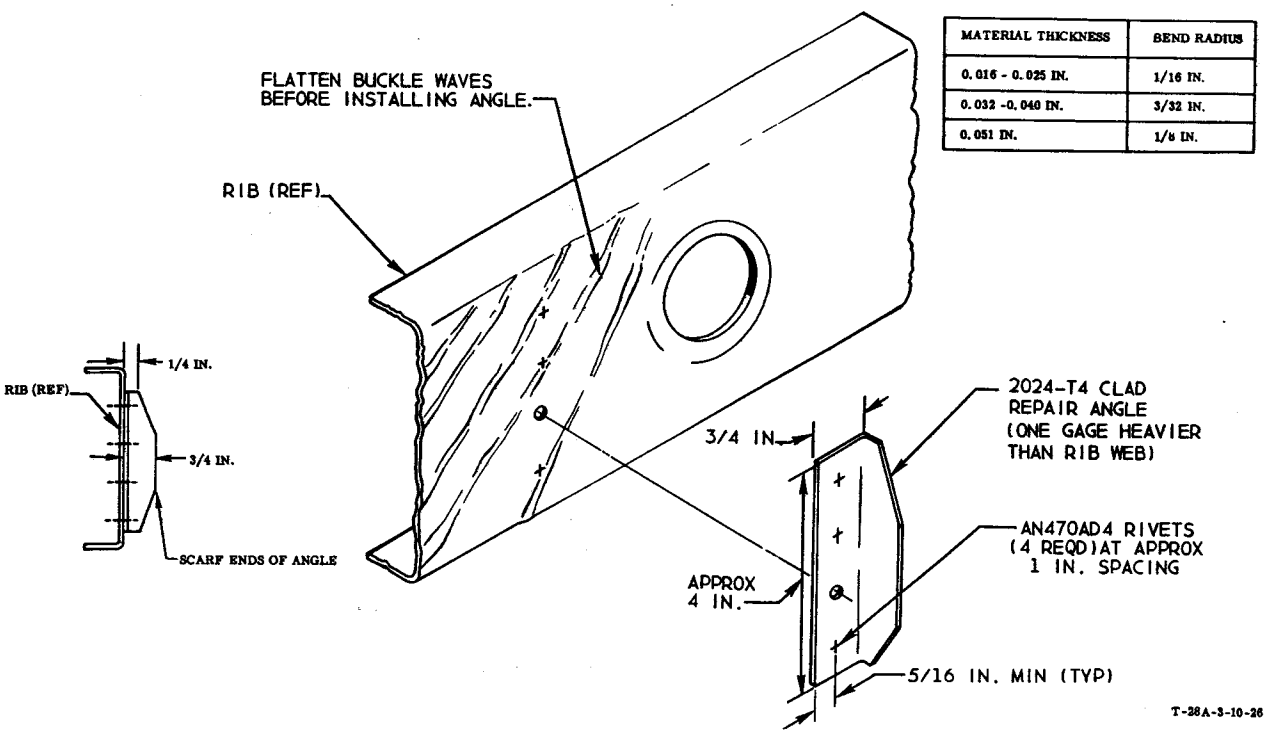


Figure 2-22. Buckled Rib Web Repair

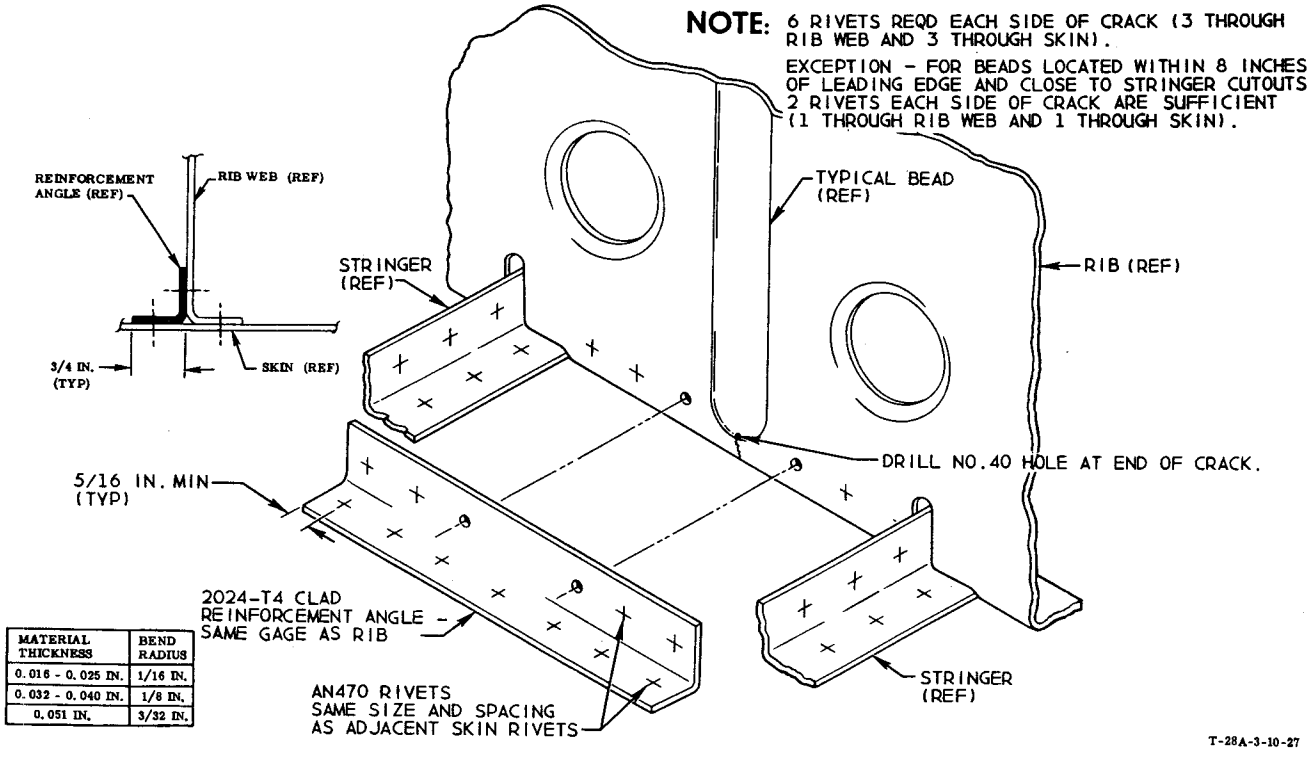


Figure 2-23. Rib Flange Repair

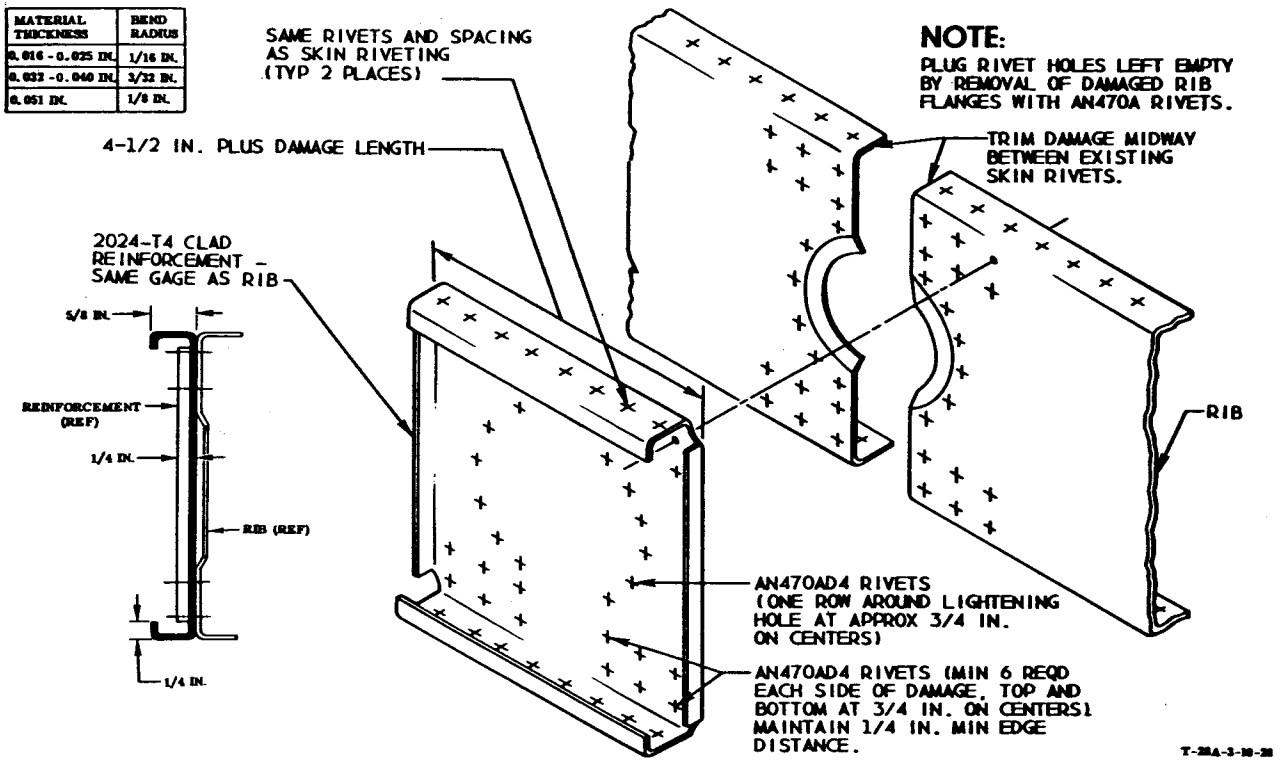


Figure 2-24. Wing Leading Edge Rib Splice

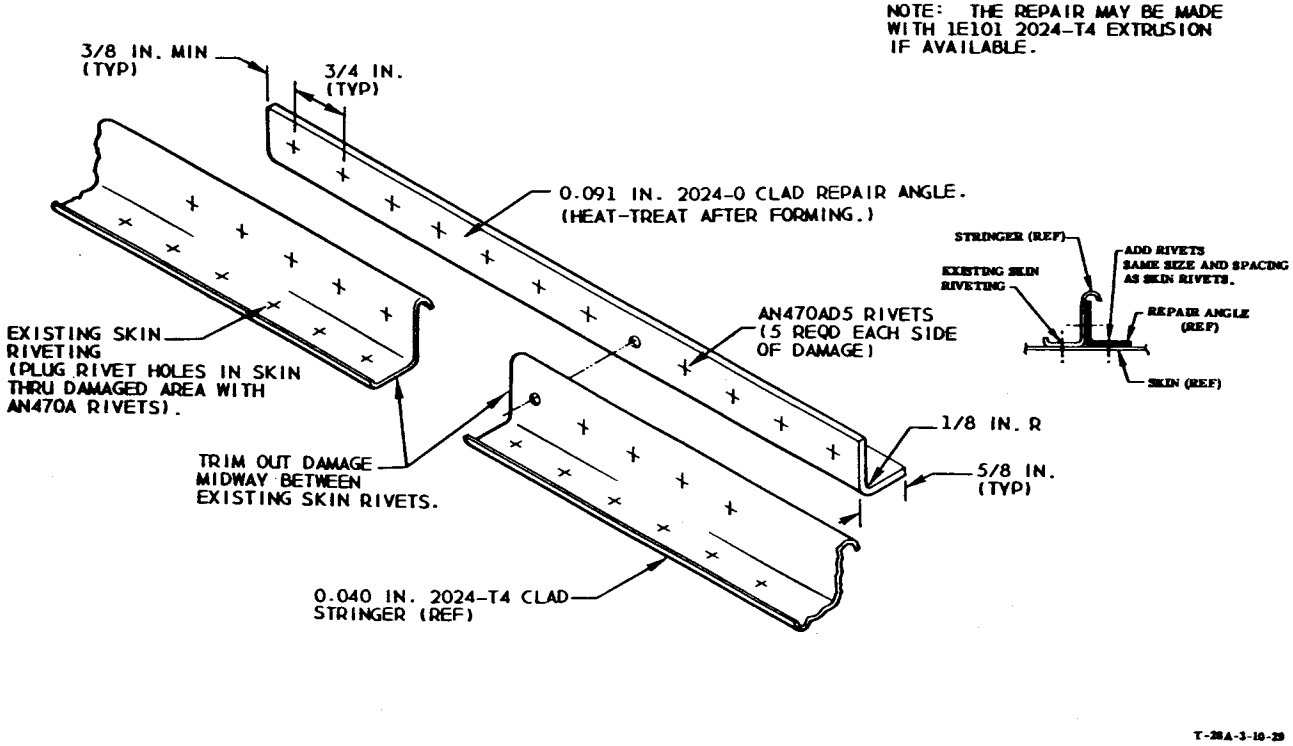
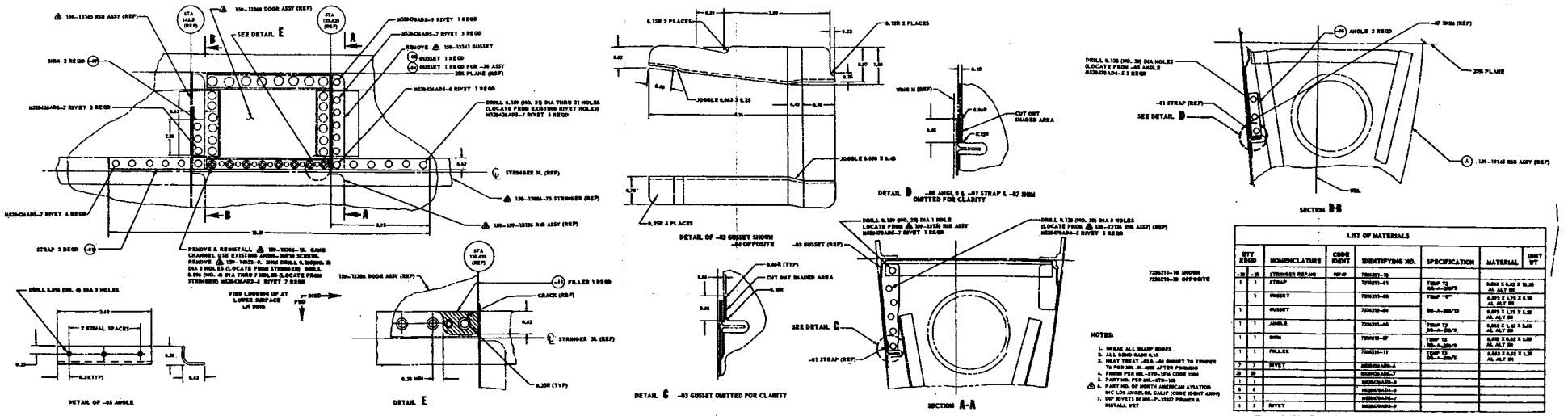


Figure 2-25. Formed Stringer Splice - NAA No. 1S40



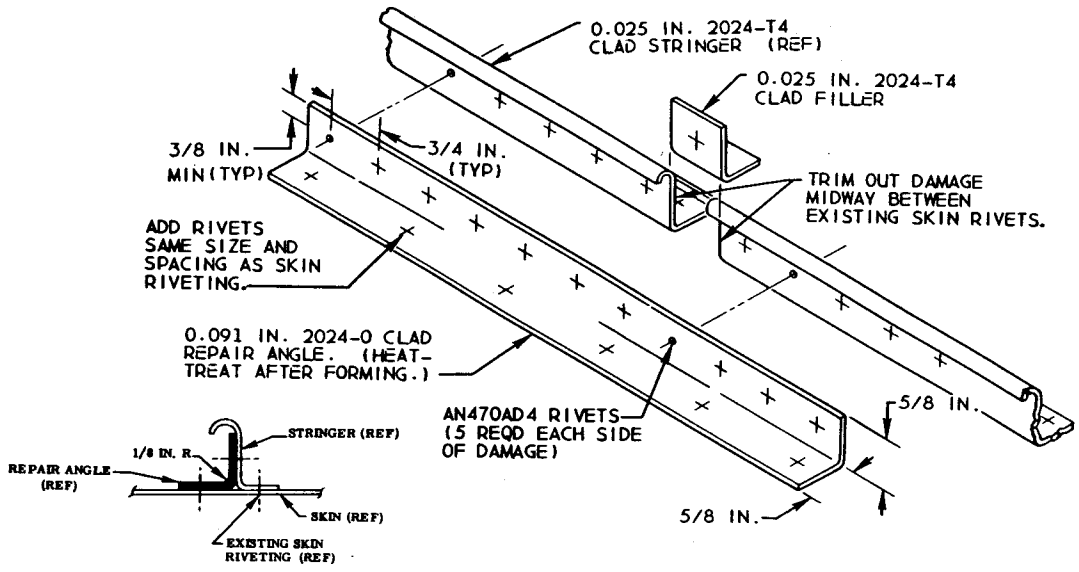
NOTES:

1. BREAK ALL SHARP EDGES
2. ALL BEND RADII 0.25
3. HEAT TREAT -83 & -84 GUSSET TO TEMPER T6 PER MIL-H-6088 AFTER FORMING
4. FINISH PER MIL-STD-maskedSTD-138
5. PART NO. PF MFR'R AMERICAN AVIATION INC LOS ANGELES, CALIF (CODE IDENT 49999)
6. DOF RIVETS IN MIL-P-25027 FINISH 8. INSTALL WET

LIST OF MATERIALS

SET REQD	NOMENCLATURE	CODE IDENT	IDENTIFYING NO.	SPECIFICATION	MATERIAL	UNIT WT
-39 / -40	STRINGER REF-ms	99049	7226211-39			
1 / 1	STRAP		7226211-81	TEMP T3 QQ-A-250/3	0.063 X 6.62 X 38.38 AL ALY SH	
1 / 1	GUSSET		7226211-83	TEMP "O"	0.072 T 1.75 X 6.25 AL ALY SH	
1	GUSSET		7226212-84	QQ-A-250/12	0.072 T 1.75 X 6.25 AL ALY SH	
1 / 1	ANGLE		7226211-85	TEMP T3 QQ-A-250/3	0.063 T 1.12 X 2.25 AL ALY SH	
1 / 1	SHIM		7226211-87	TEMP T3 QQ-A-250/3	0.032 T 0.62 X 1.50 AL ALY SH	
1 / 1	FILLER		7226211-11	TEMP T3 QQ-A-250/3	0.063 T 0.62 X 1.25 AL ALY SH	
7 / 7	RIVET		MS20426AD5-6			
28 / 28			MS20426AD6-7			
1 / 1			MS20426AD5-5			
4 / 4			MS20470AD4-5			
1 / 1			MS20470AD6-7			
1 / 1	RIVET		MS20426AD5-9			

Figure 2-25A. Repair Stringer 31, Between Wing Stations 135.6 and 142.5



NOTE:
THE REPAIR MAY BE MADE WITH 2024-T4 EXTRUSION OF THICKNESS EQUAL TO FORMED REPAIR ANGLE

Figure 2-26. Formed Stringer Splice - NAA No. 1S23

REPAIR FOR CRACK CONDITION 1 (see figure 2-26A).

1. The crack may extend from the ¼-inch bolt hole to the limit of the trailing edge and still be repairable.

2. Stop drill the crack with a 0.12 (No. 31) drill.

3. Install doubler in accordance with figures 2-26B and 2-26C.

REPAIR FOR CRACK CONDITION 2 (see figure 2-26A).

1. The crack may extend from the ¼-inch bolt hole to the radius of the skin attach flange but not into the flange.

2. Stop drill the crack with 0.12 (No. 31) drill.

3. Install a repair doubler in accordance with figures 2-26B and 2-26E.

REPAIR FOR CRACK CONDITION 3 (see figure 2-26A).

1. The cracks may extend to but not exceed 3 inches in length. No more than 3 condition 3 cracks total are allowed on an extrusion.

2. Remove the defect by trimming the flange to point midspace of the fasteners beyond the end of the crack. Install a filler of double primed 2024T3 material. Maintain a 0.120 radius at the corner.

3. Install a repair angle in accordance with figure 2-26B.

NOTE

Tapered 0.032-2024T3 shims will be necessary between the skin and the rib and/or stringer flanges to maintain the mold line. The minimum shim length is 5 inches. After repair and shim installation is complete, a 0.75 by 1.50-2024T3 shim must be installed on the rib and/or ribs at the bolt locations to fill the resultant gap. Secure with the area nut plate attach rivets, dimple to seat.

REPAIR FOR CRACK CONDITION 4 (see figure 2-26A).

1. The crack may extend to but not exceed 1.5 inches from the OD of the bolt hole. Cracking on both sides of the bolt hole are allowed but are not to exceed a total of 3 inches. Cracking is allowable at all 3 bolt hole areas on one extrusion.

2. Stop drill the crack with 0.120 (No. 31) drill.

3. Install condition 1 and 2 doublers in accordance with figures 2-26B, 2-26C and 2-26E.

REPAIR FOR CRACK CONDITION 5. (This repair applies to the upper magnesium alloy extrusion only (see figure 2-2F).

1. Install a condition 1 repair angle.

2. Machine and install the fitting, Part No. 159-14297, in accordance with figures 2-26D and 2-26F.

THE FOLLOWING SPECIFICATIONS APPLY TO ALL REPAIR CONDITIONS.

1. Repair angles will be fabricated from 0.063-7075T6 alclad sheet stock.

2. All repairs will use a corrosion barrier tape between the repair angles and the magnesium alloy extrusion. See appendix 1.

3. All joggles/bends will be sealed at the ends with a sealing compound. See appendix 1.

4. A minimum edge distance of 2 diameters will be maintained on all repairs.

5. MS20600W6 rivets or PP164 Jo-bolts will be used on all repairs.

6. A minimum of 4 rivets, staggered in two rows, are required beyond the ends of the cracks, with a minimum spacing of 4 diameters, or

7. Four Jo-bolts in a single row with a minimum of 6 diameter spacing on each side of the crack may be used.

If the repairs are made on the end of the extrusion, the fitting, Part No. 159-14297, will be mill cut 1.87 inches long and 0.063 inches deep to accept the angles installed by repair conditions 1, 2, and 5. For crack condition 4, the mill cut will be 1.87 inches long and 0.125 inches deep (see figure 2-27D).

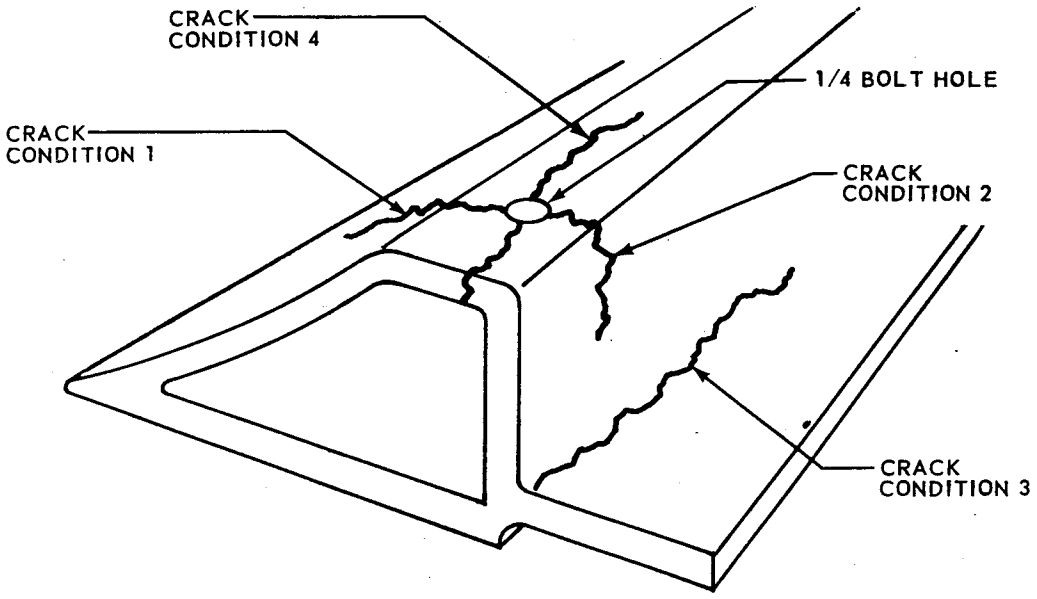


Figure 2-26A. Repairs for All Cracking Conditions Magnesium Alloy Extrusion

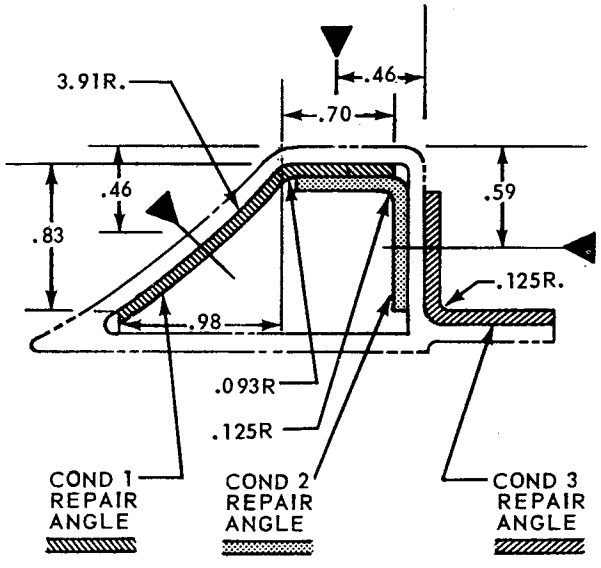


Figure 2-26B. Repairs for Cracking Conditions 1 and 2, Installation of Doublers

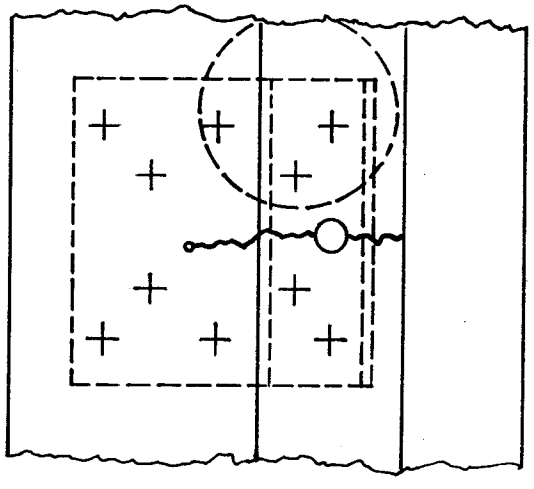


Figure 2-26C. Repair for Cracking Condition 1 and 2, Rivet Placement with Coupler

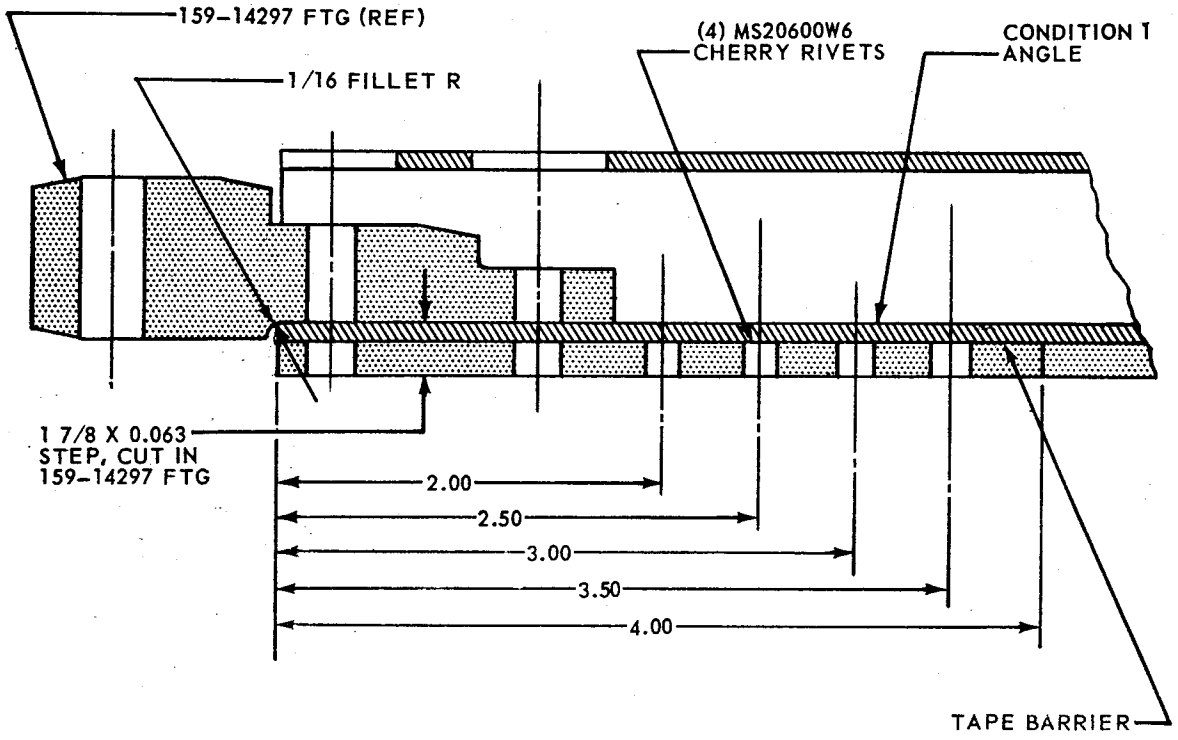


Figure 2-26D. Repair for Cracking Condition 5, Installation of Fitting 159-14297

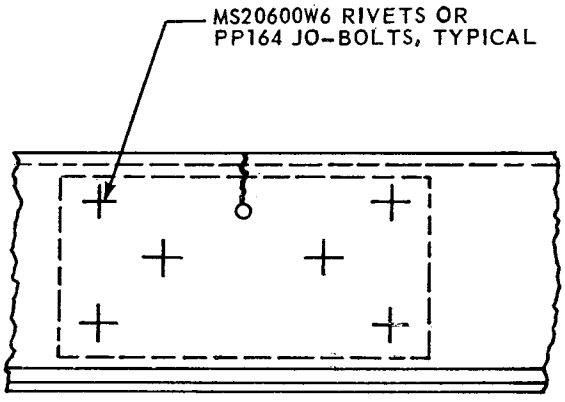


Figure 2-26E. Repair for Cracking Condition 2, Placement of Rivets

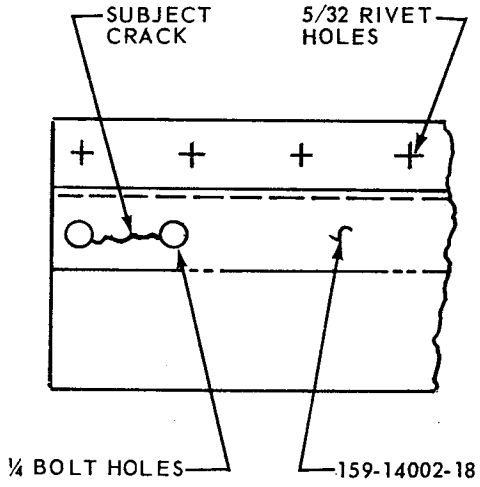
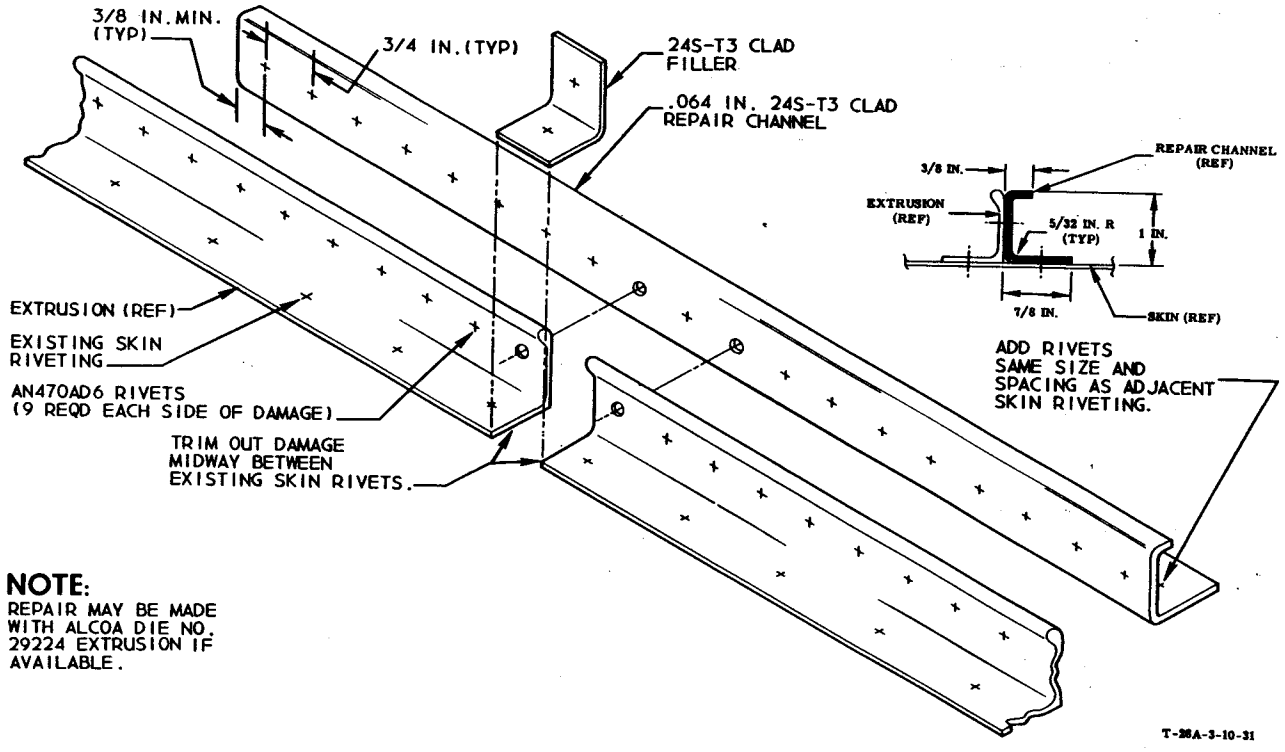


Figure 2-26F. Repair for Cracking Condition 5, Placement of Rivets



NOTE:
REPAIR MAY BE MADE WITH ALCOA DIE NO. 29224 EXTRUSION IF AVAILABLE.

Figure 2-27. Wing Extrusion Splice

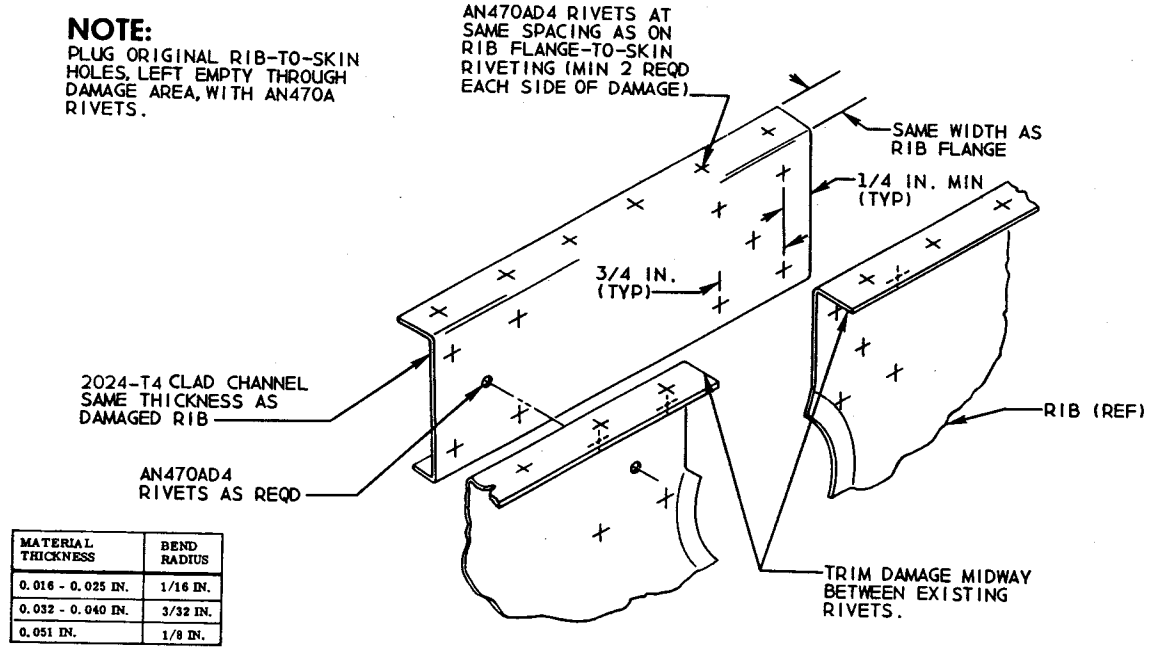


Figure 2-28. Flange and Lightening Hole Repair

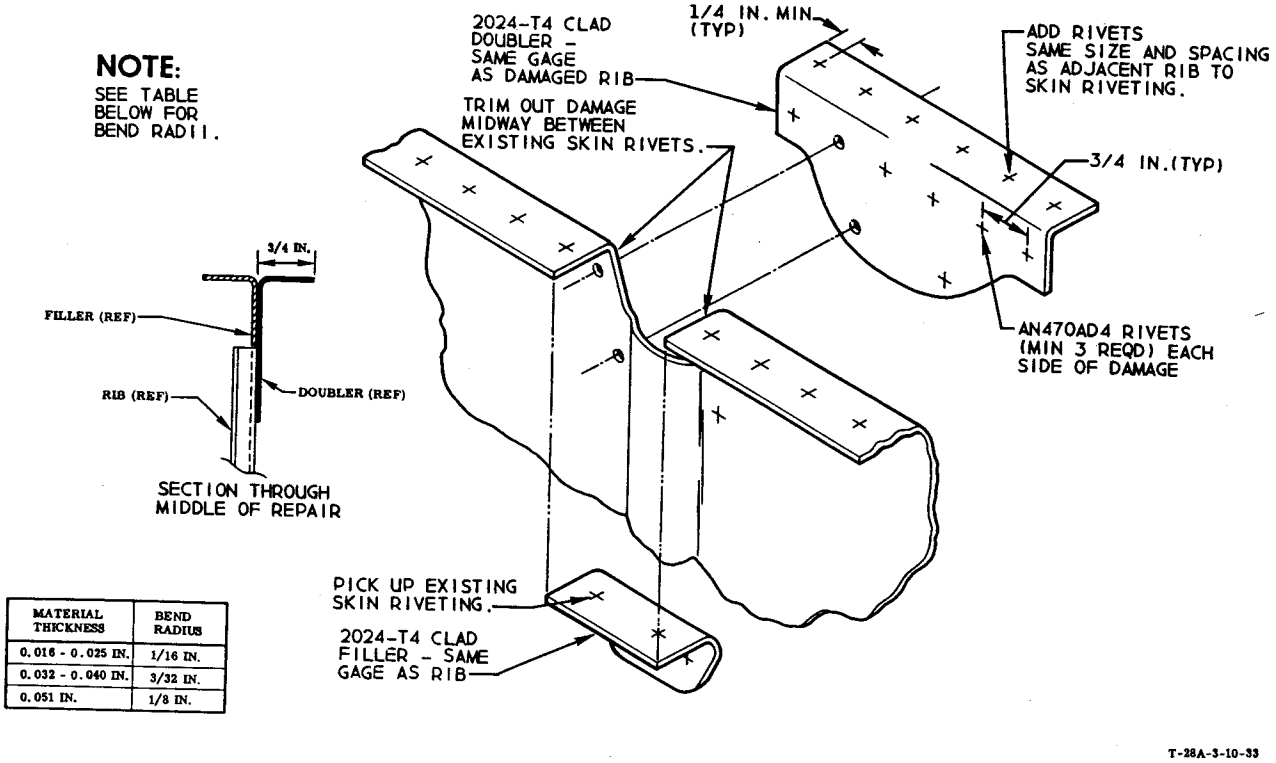


Figure 2-29. Flap Rib Flange and Web Repair

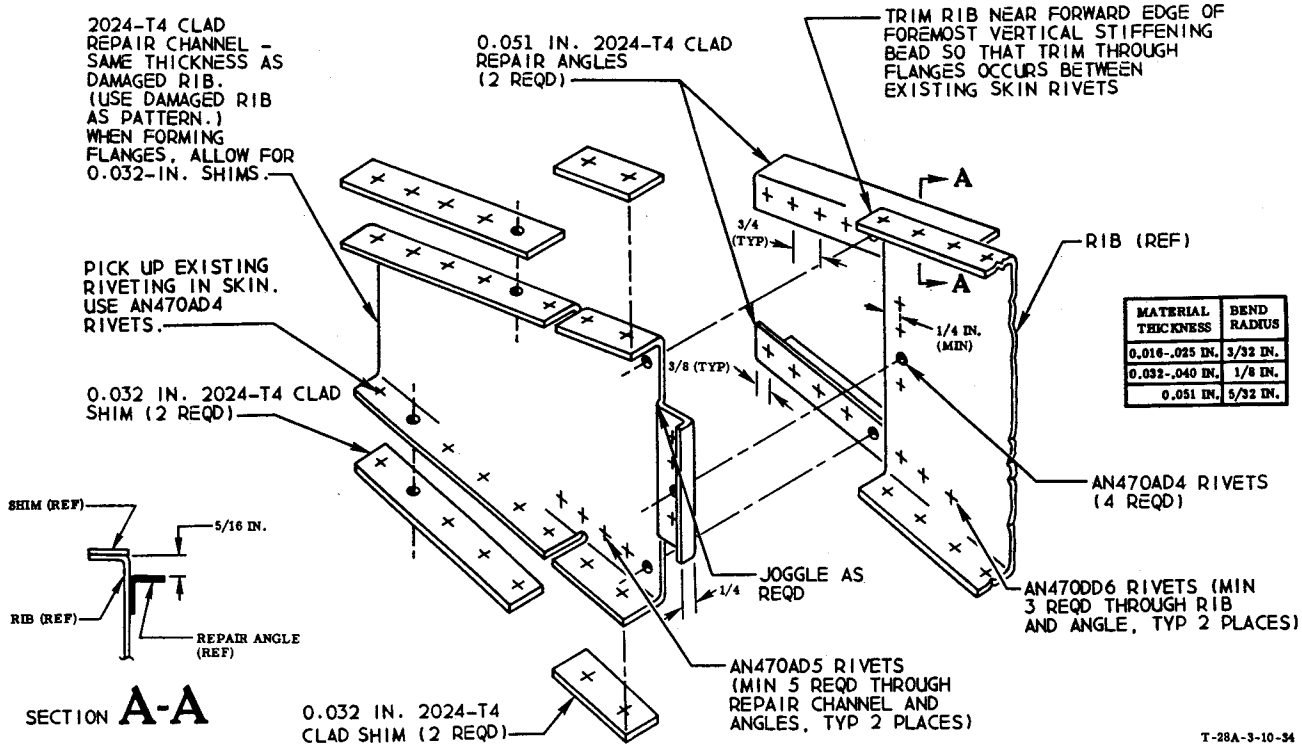


Figure 2-30. Aileron Rib Splice

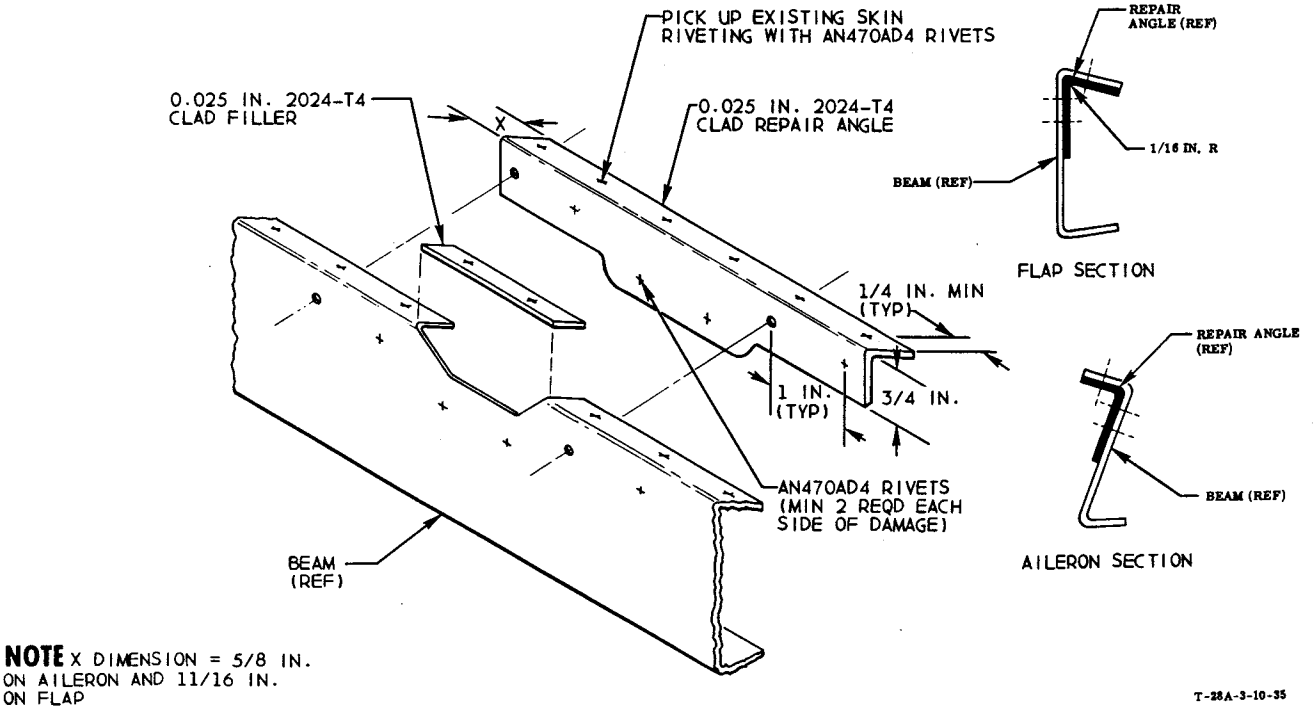


Figure 2-31. Aileron and Flap Rear Beam and Web Repair

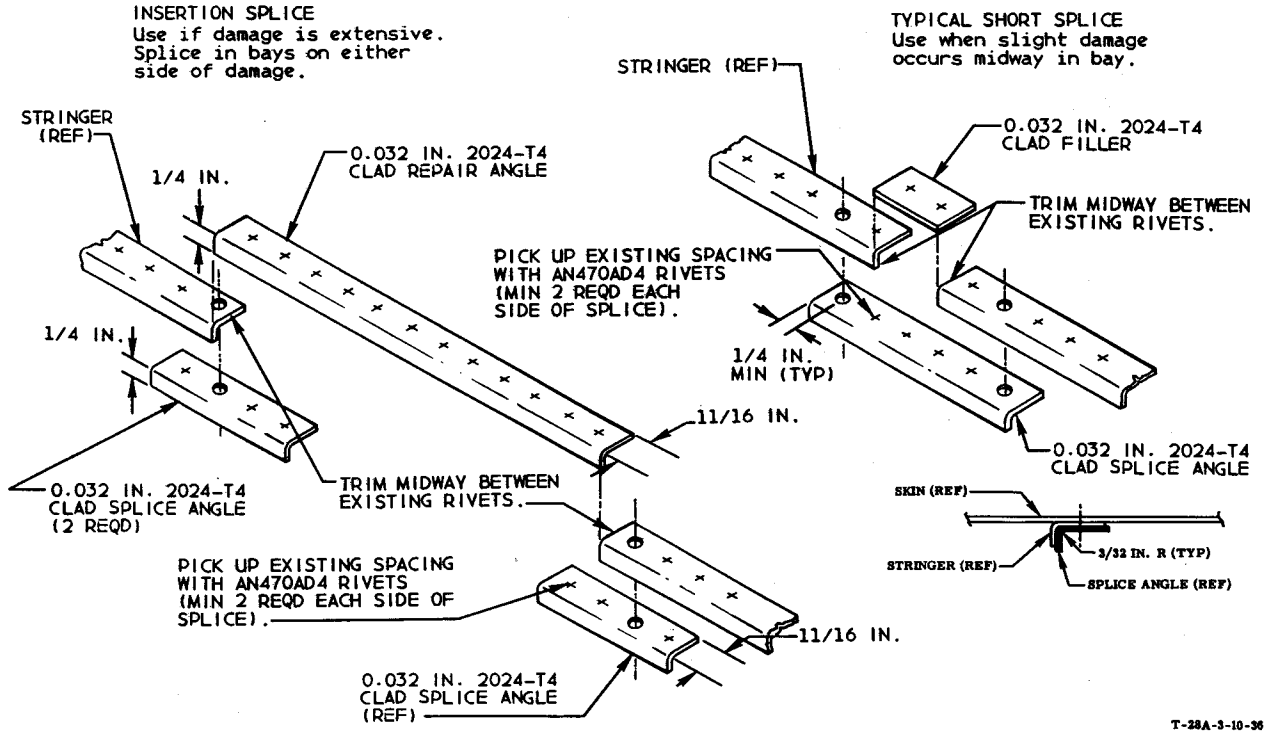


Figure 2-32. Aileron and Flap Stringer Splice

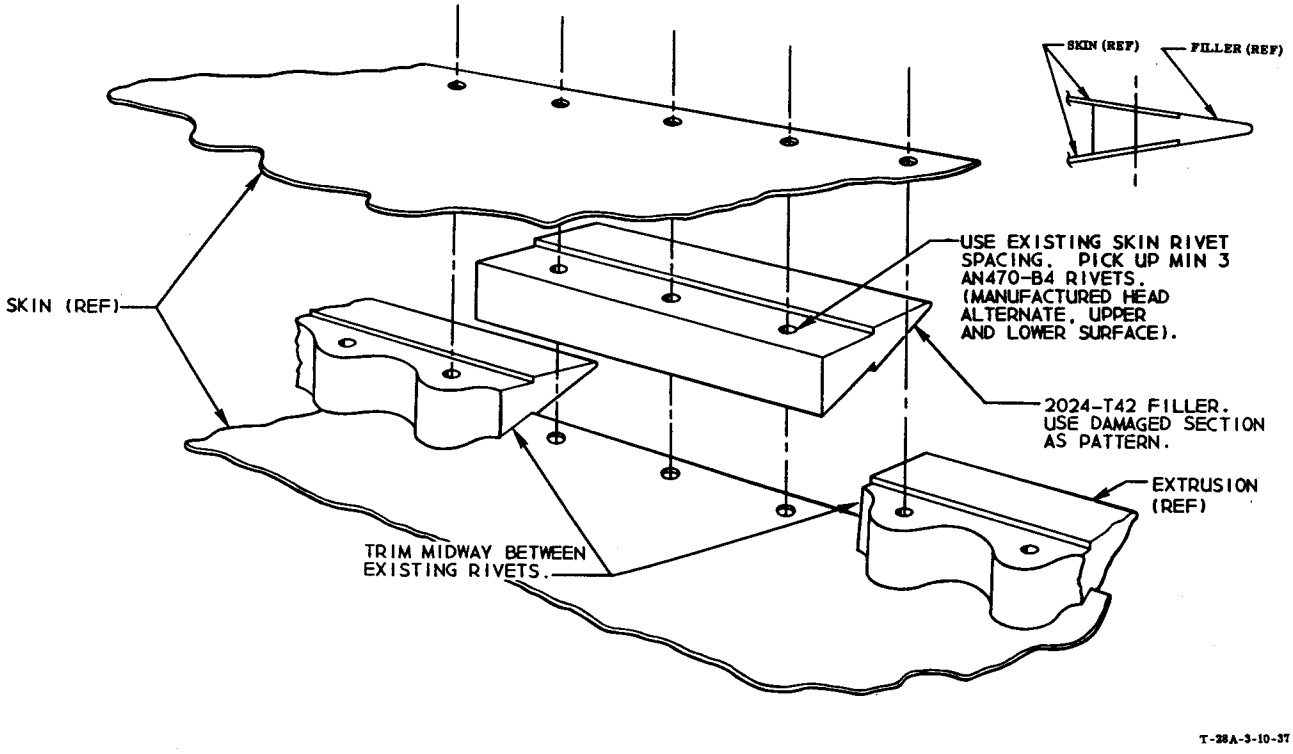


Figure 2-33. Trailing Edge Extrusion Repair

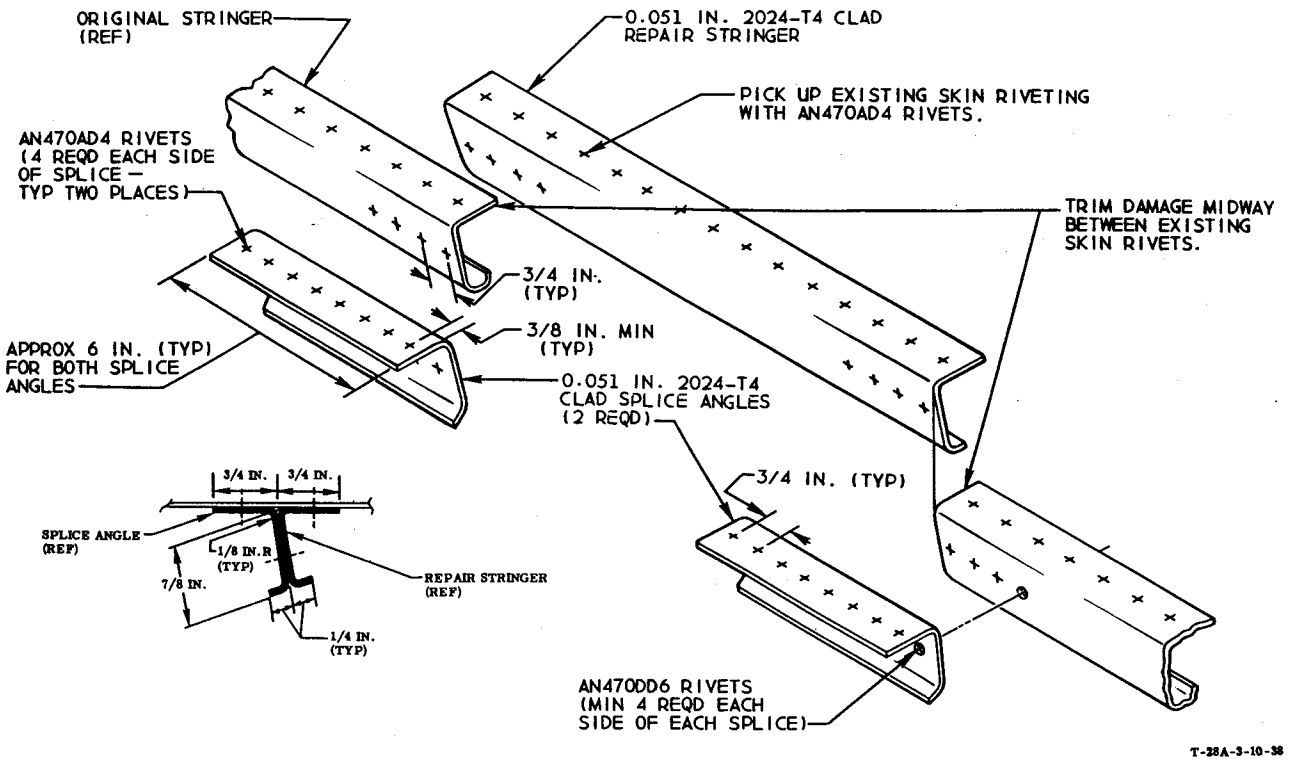
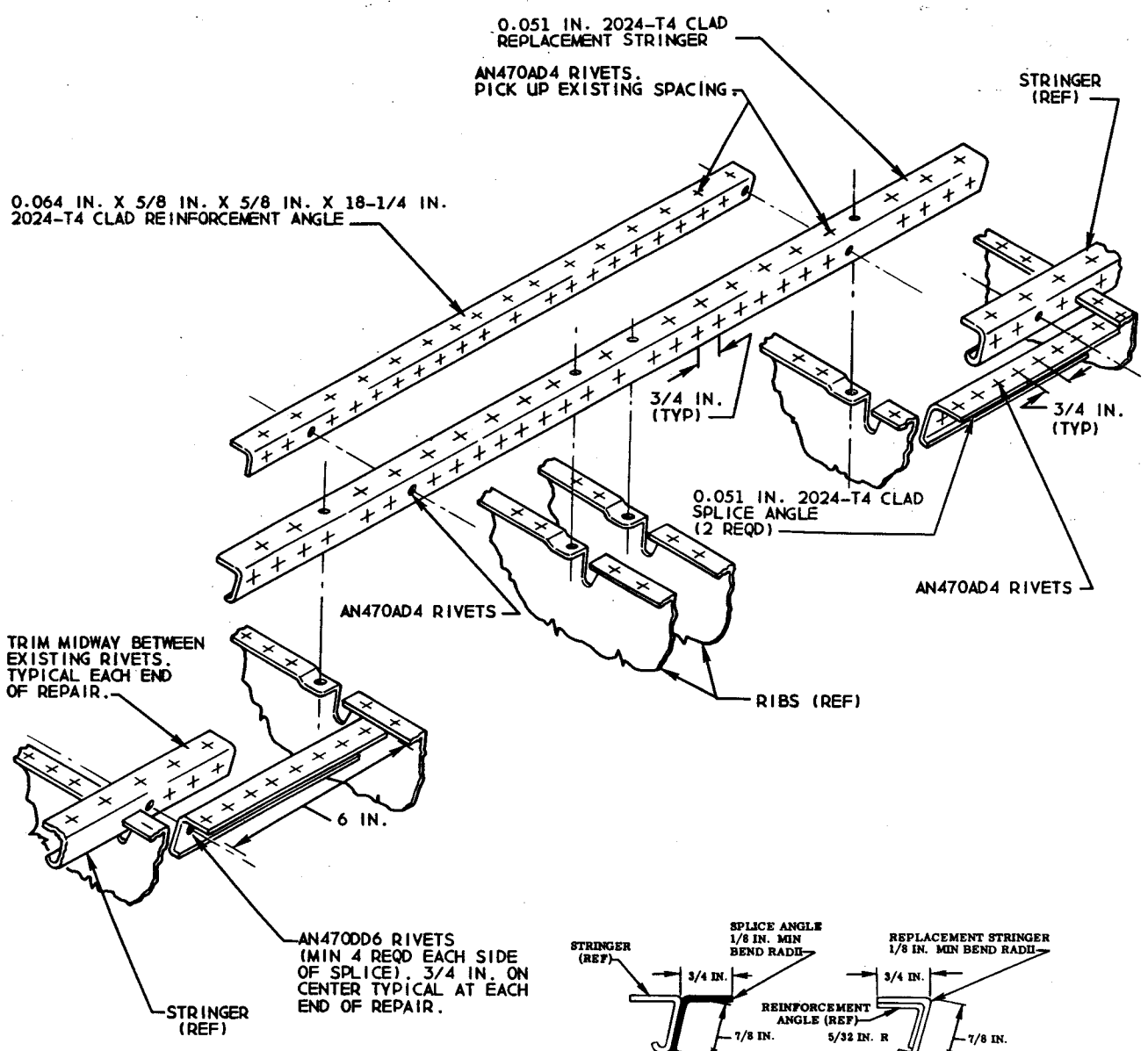


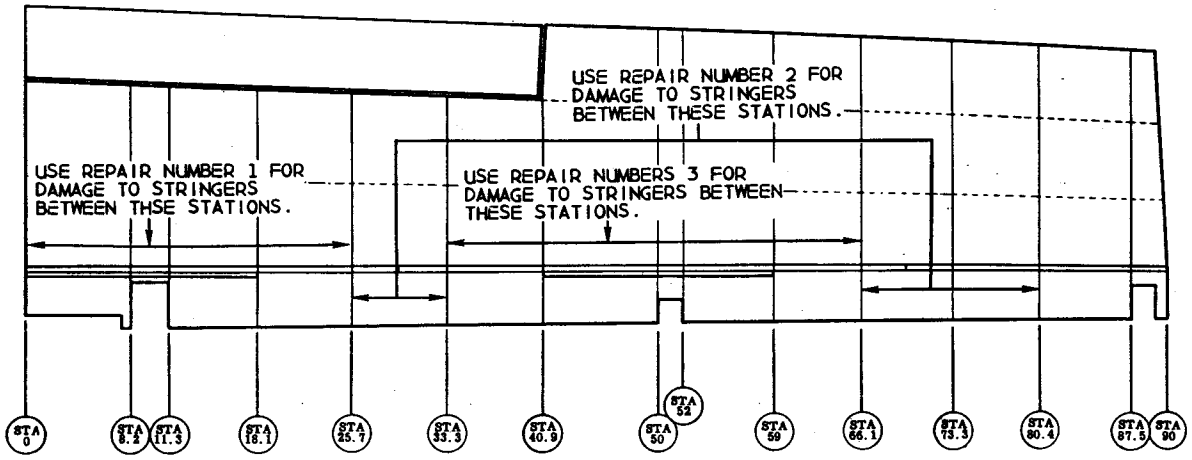
Figure 2-34. Flap Main Stringer Splice

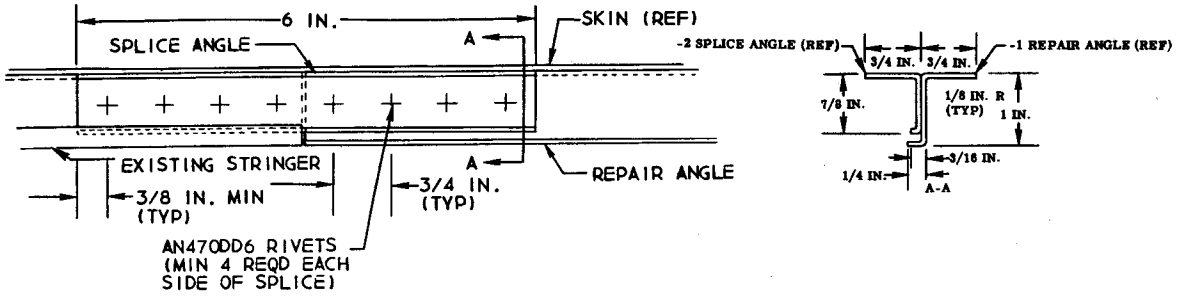


NOTE:
MAINTAIN 3/8 IN. MINIMUM EDGE DISTANCE.

T-28A-3-10-39

Figure 2-35. Flap Upper Stringer Repair Near Center Hinge





REPAIR NUMBER 1

1. TRIM STRINGER IN MIDDLE OF STATION 25.7-33.3 BAY AND REMOVE STRINGER TO STATION 0.
2. REPLACE REMOVED SECTION OF STRINGER WITH SECTION OF -1 REPAIR ANGLE.
3. REPLACE REINFORCING ANGLE BETWEEN STATIONS 0 AND 18.1.
4. SPLICE -1 REPAIR ANGLE TO STRINGER WITH -2 SPLICE ANGLE.
5. RIVET -2 SPLICE ANGLE TO SKIN WITH AN470AD4 RIVETS SPACED AT 3/4 IN.
6. PICK UP EXISTING SKIN RIVERING THROUGH -1 AN470AD4 RIVETS.
7. TRIM STRINGER RIB CUTOUTS AS NECESSARY.

REPAIR NUMBER 2

1. TRIM STRINGER IN MIDDLE OF BAYS ADJACENT TO DAMAGE.
2. INSERT -1 REPAIR ANGLE AND SPLICE TO STRINGER WITH -2 SPLICE ANGLES.
3. PICK UP EXISTING SKIN RIVETING THROUGH -1 REPAIR ANGLE WITH AN470AD4 RIVETS.
4. RIVET -2 SPLICE ANGLES TO SKIN WITH AN470AD4 RIVETS SPACED AT 3/4 IN.
5. TRIM STRINGER RIB CUTOUTS AS NECESSARY.

REPAIR NUMBER 3

1. TRIM STRINGER IN MIDDLE OF STATION 25.7 -33.3 AND STATION 66.1 -73.3 BAYS.
2. INSERT -1 REPAIR ANGLE AND SPLICE TO STRINGER WITH -2 SPLICE ANGLES.
3. REPLACE REINFORCING ANGLE BETWEEN STATIONS 40.9 AND 59.
4. PICK UP EXISTING SKIN RIVETING THROUGH -1 REPAIR ANGLE WITH AN470AD4 RIVETS.
5. RIVET -2 SPLICE ANGLES TO SKIN WITH AN470AD4 RIVETS SPACED AT 3/4 IN.
6. TRIM STRINGER RIB CUTOUTS AS NECESSARY.

T-28A-3-10-40

Figure 2-36. Aileron Stringer Repair

NOTE Length of repair angle = minimum of two rivet holes beyond end of crack.

- Height of repair angle = 3/4 inches beyond end of crack.
- Minimum rivet edge distance = 3/8 inches.

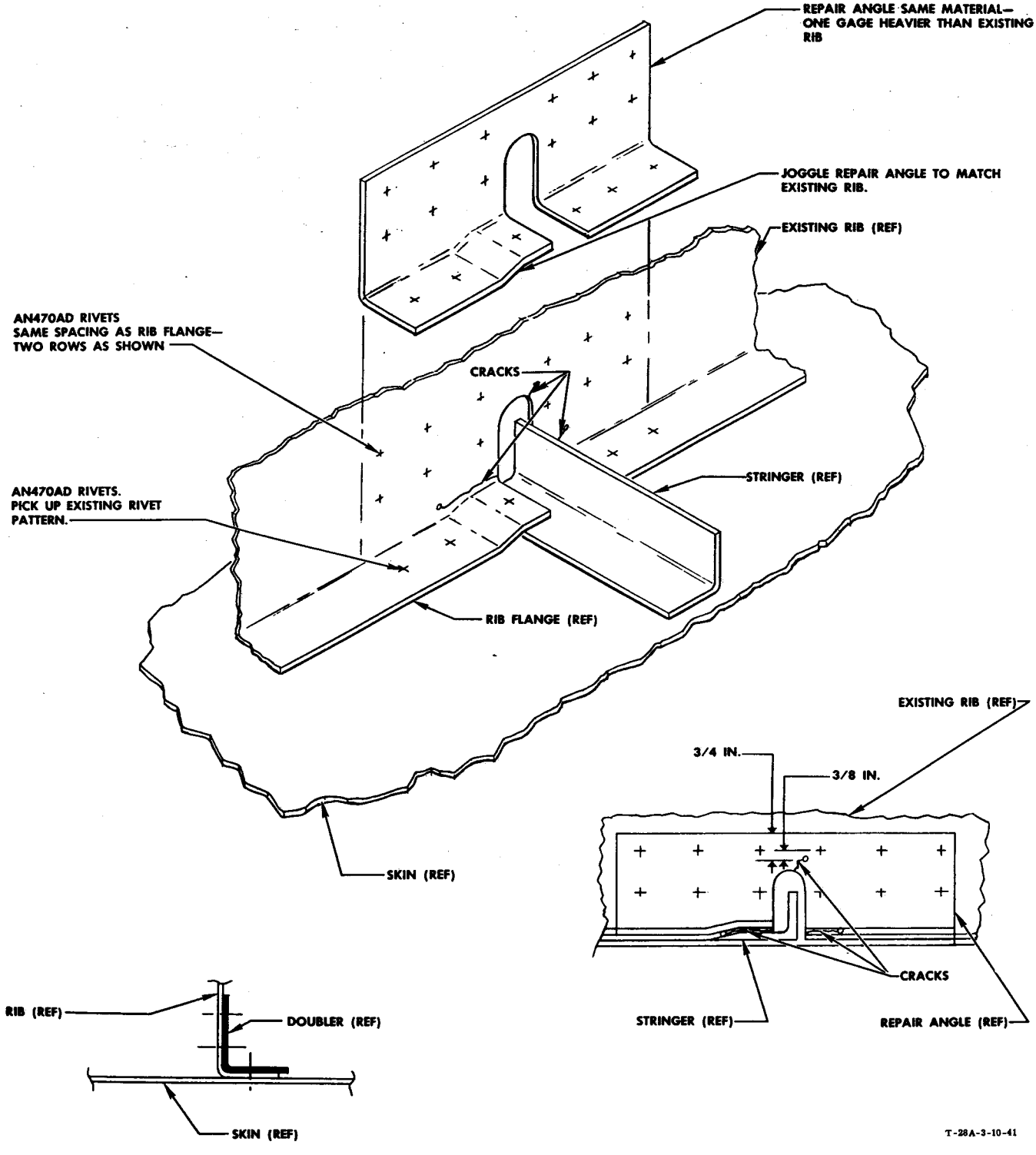


Figure 2-37. Flap Rib Repair at Stringer Cutout - Stations 66.2 and 73.2

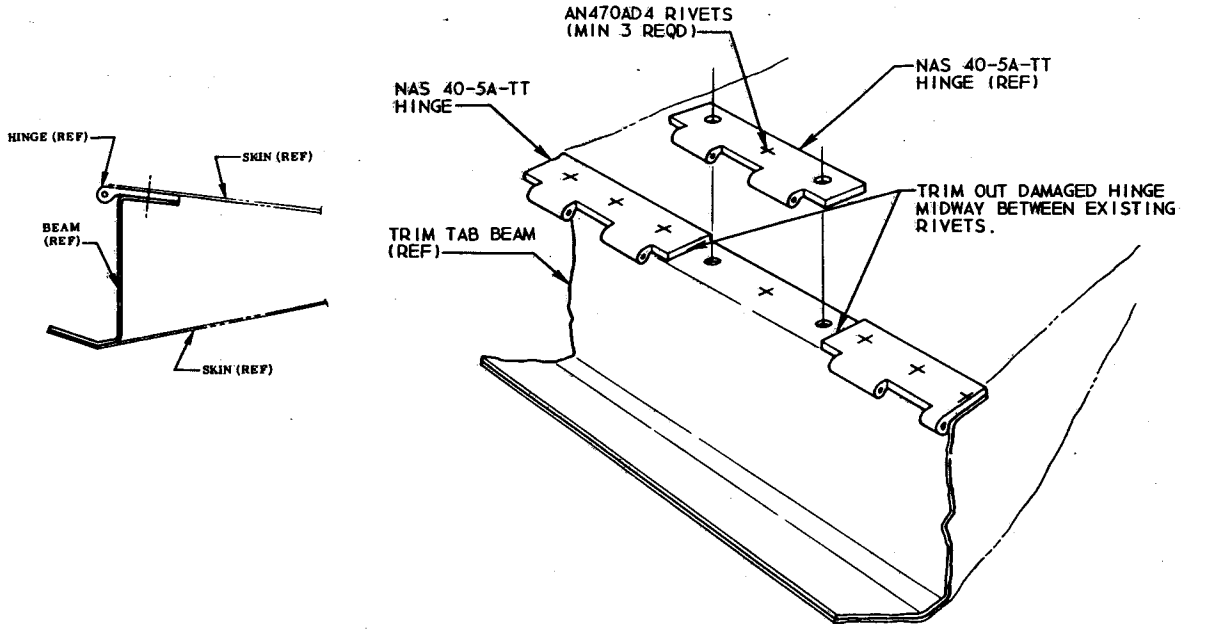


Figure 2-38. Aileron Trim Tab Hinge Repair

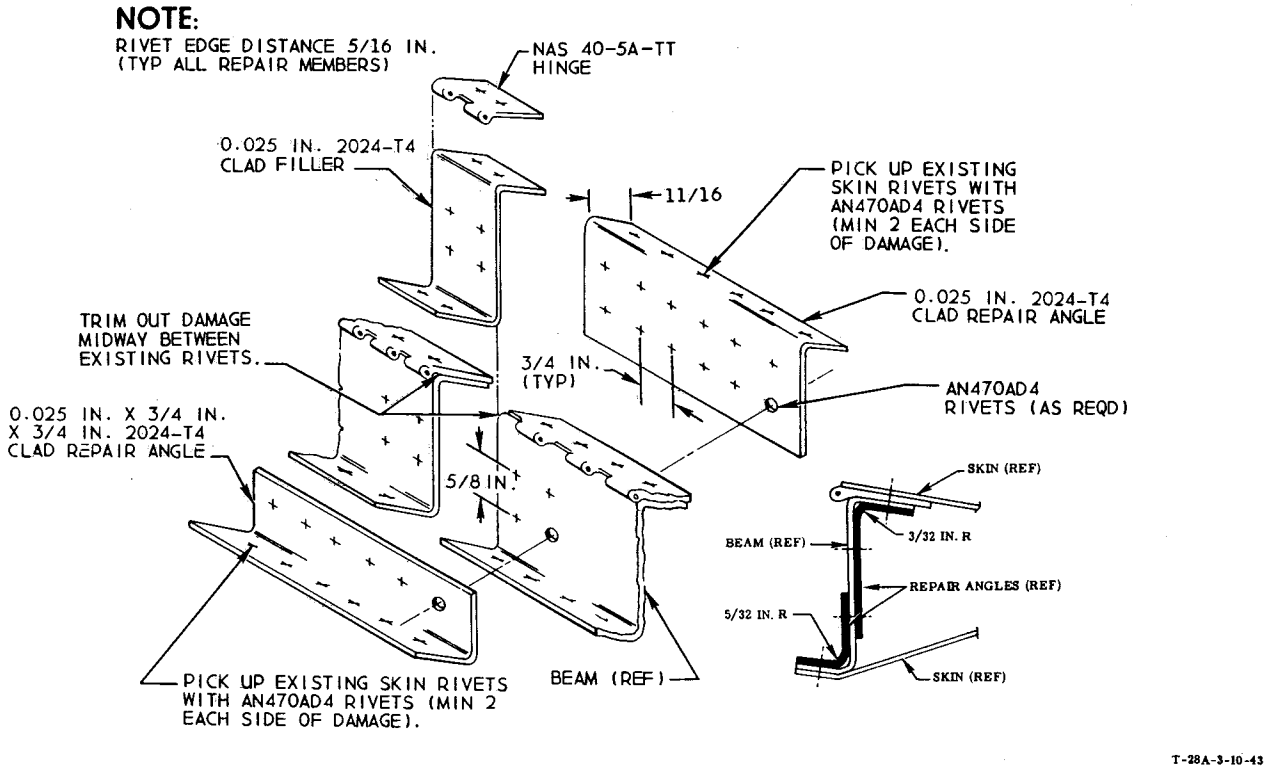


Figure 2-39. Aileron Trim Tab Front Beam Repair

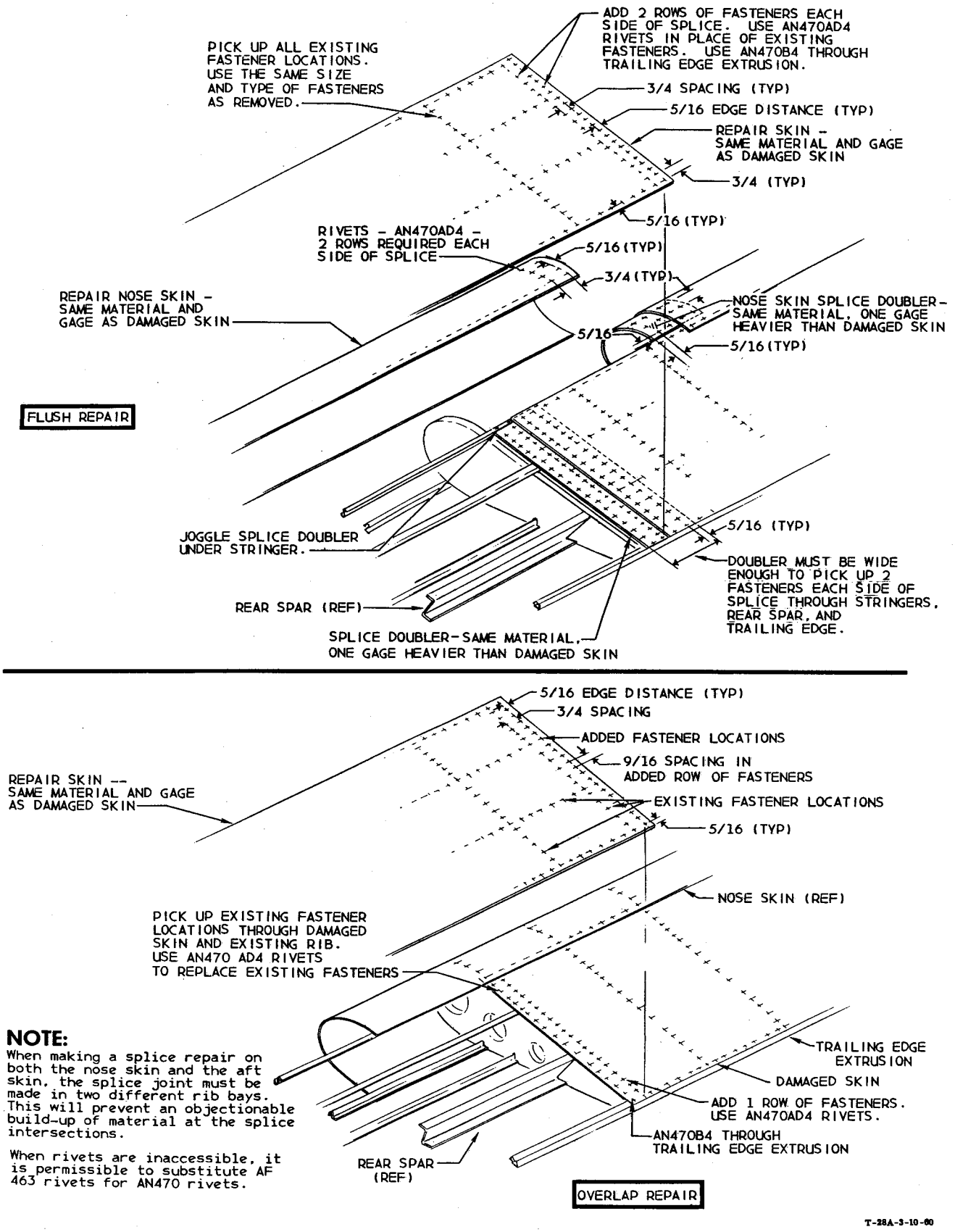


Figure 2-39A. Skin Splice - Aileron and Flap

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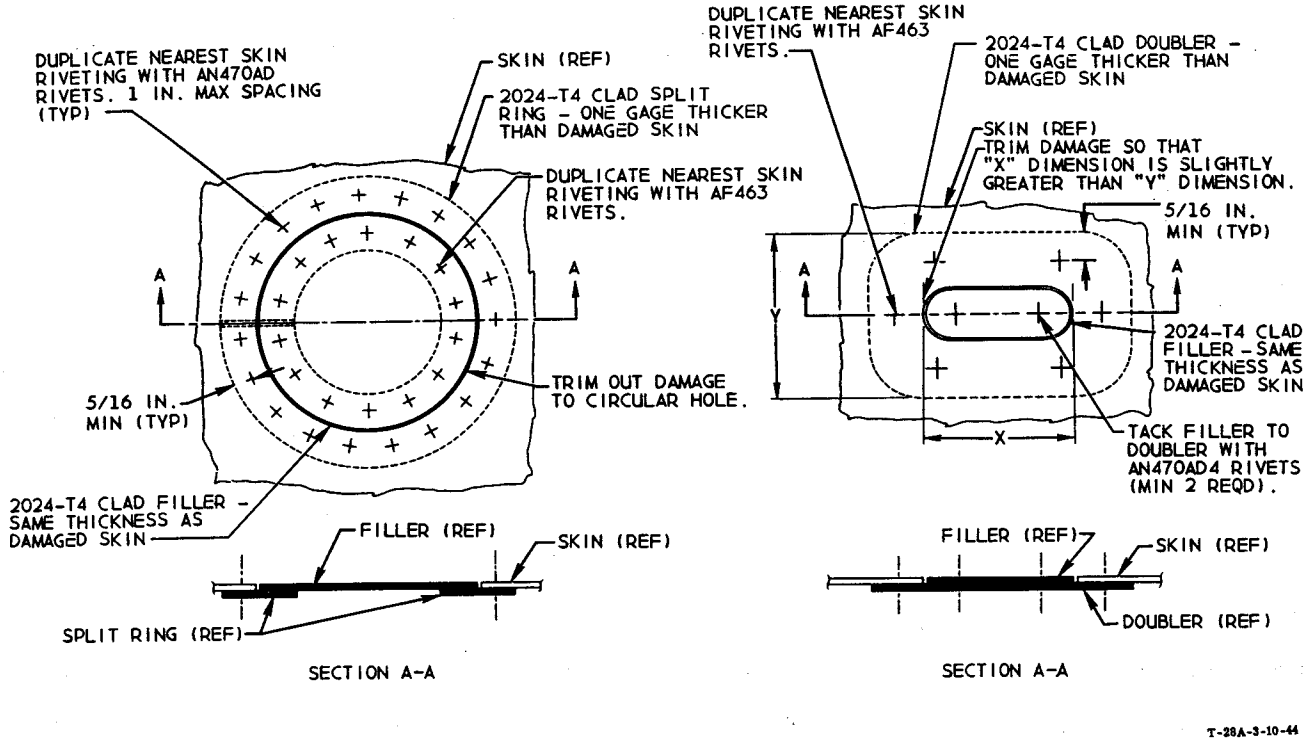


Figure 2-40. Flush Skin Repair - Aileron and Flap

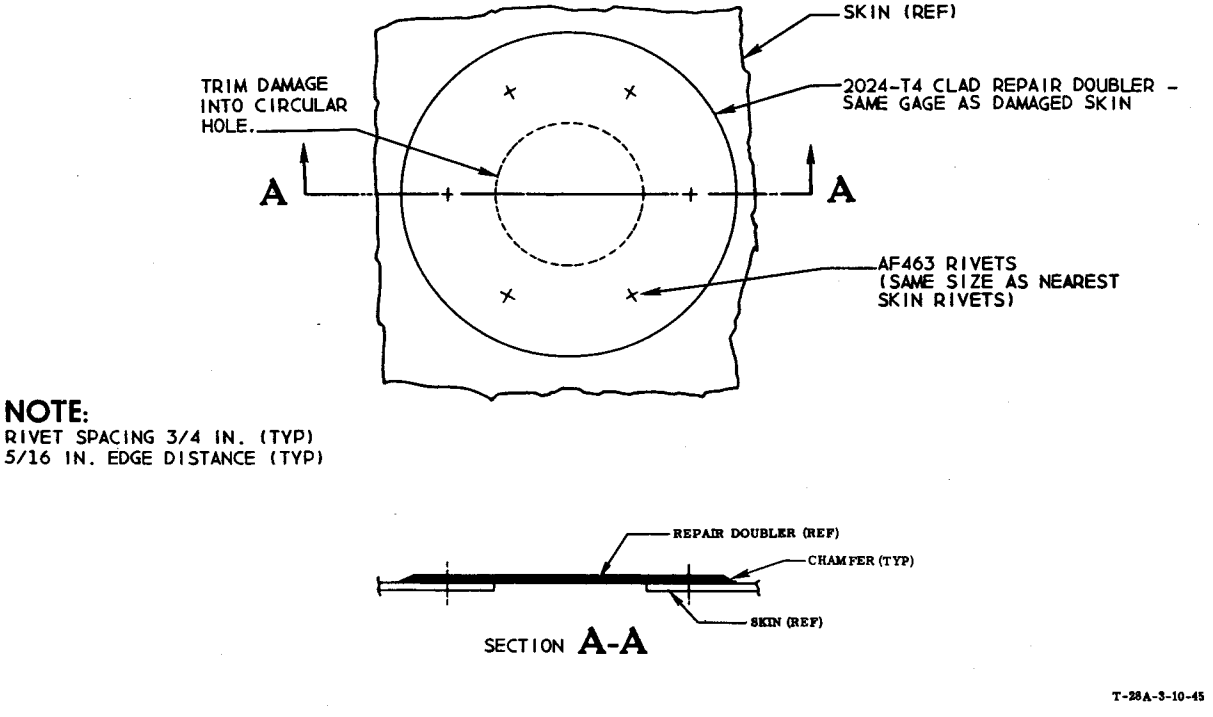


Figure 2-41. Nonflush Skin Repair - Aileron and Flap

NOTE The cracks in the 59-13303 doubler and in the gun camera opening which do not extend to the adjacent rib or stringer must be repaired as shown.

- Prime repair doubler on both sides before installation.

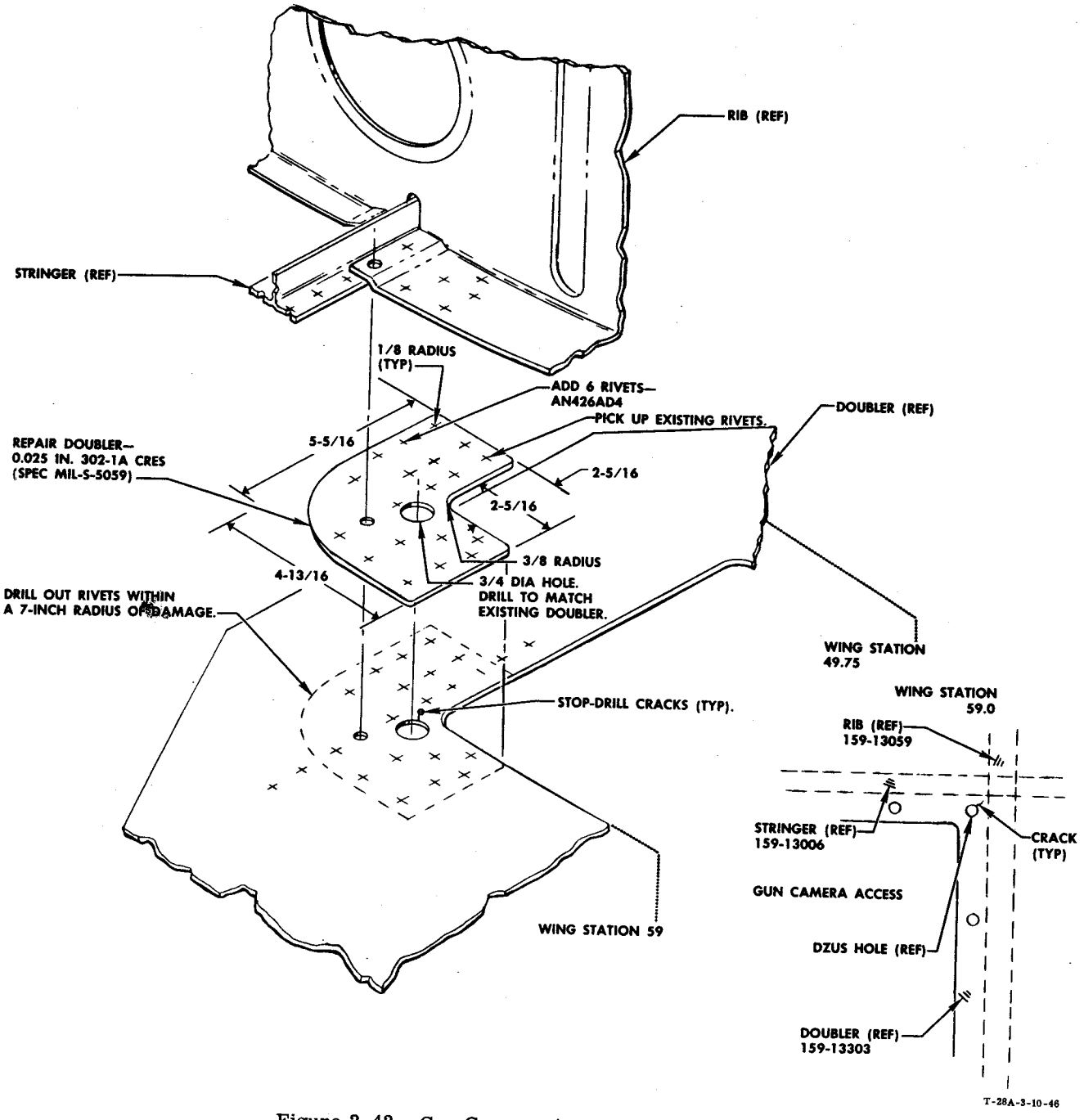


Figure 2-42. Gun Camera Access Doubler Repair

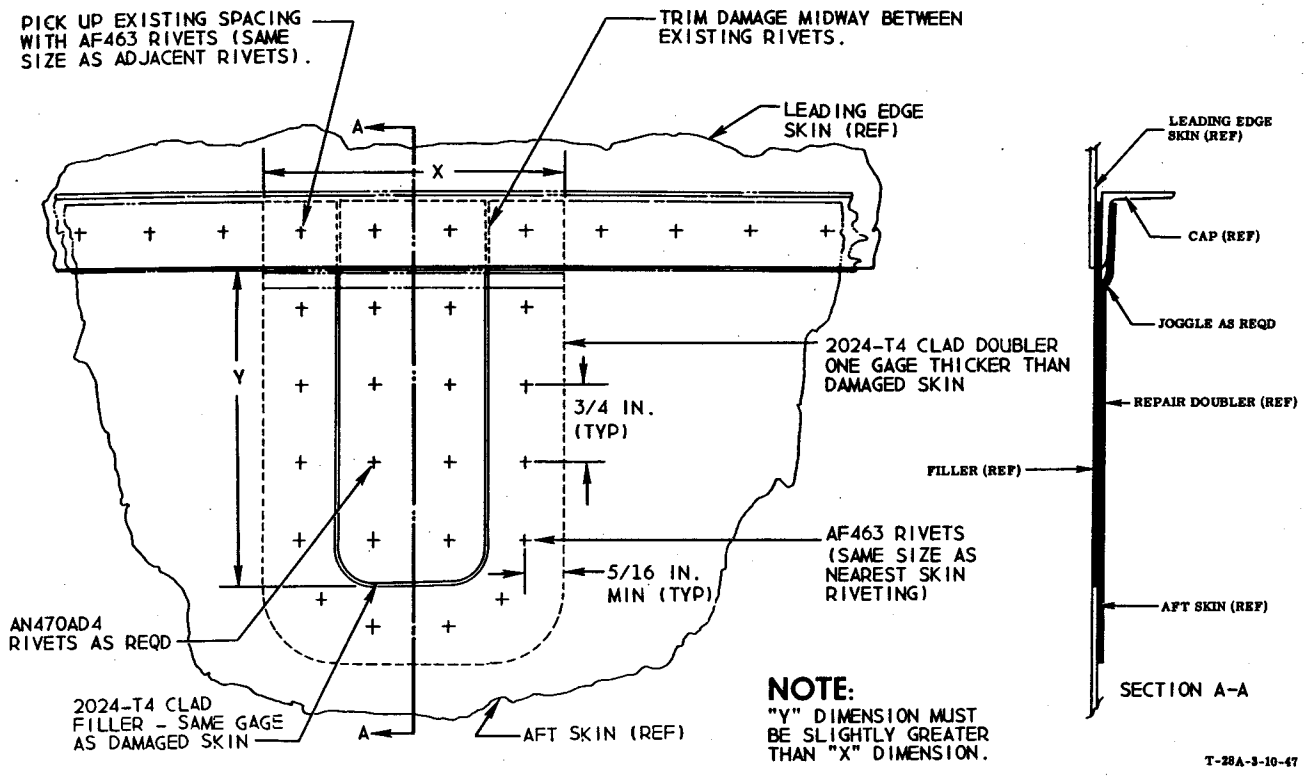


Figure 2-43. Flush Repair of Aft Skin Near Front Beam of Aileron and Flap

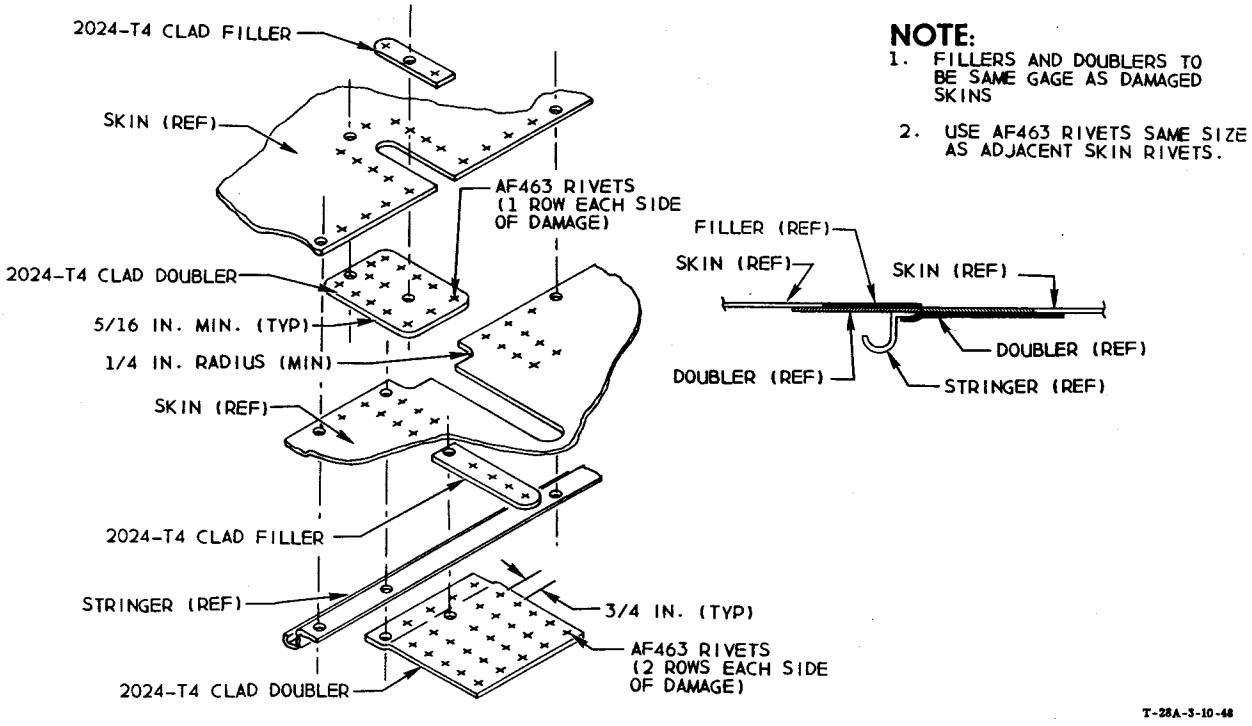


Figure 2-44. Flush Repair of Leading Edge Skin Near Front Beam of Aileron and Flap

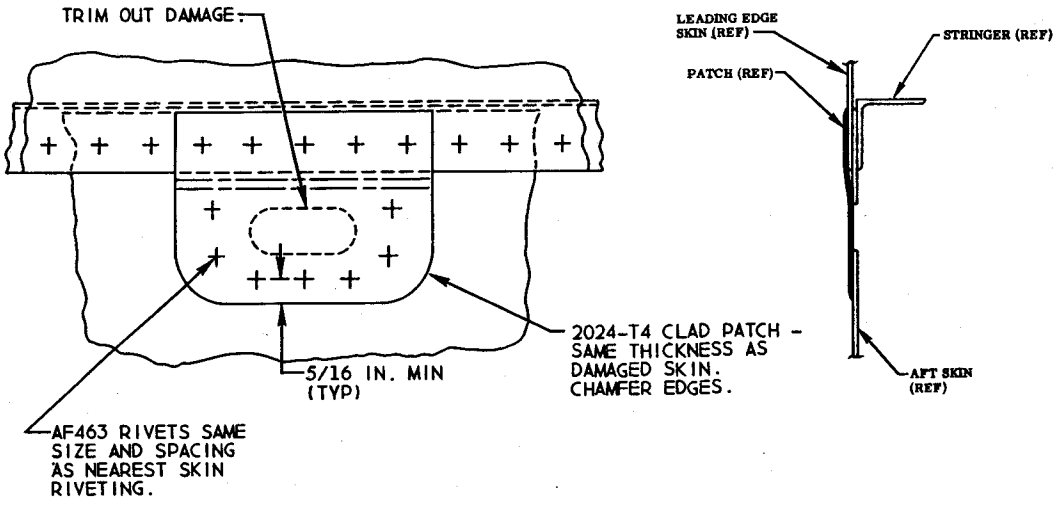


Figure 2-45. Nonflush Repair of Aft Skin Near Front Beam of Aileron and Flap

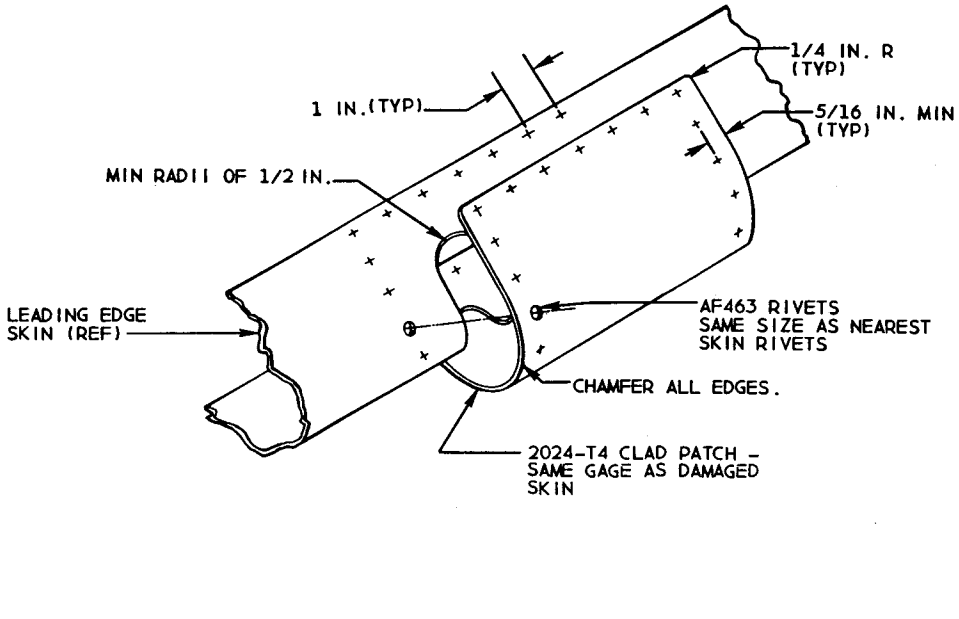


Figure 2-46. Nonflush Repair of Aileron Leading Edge Skin

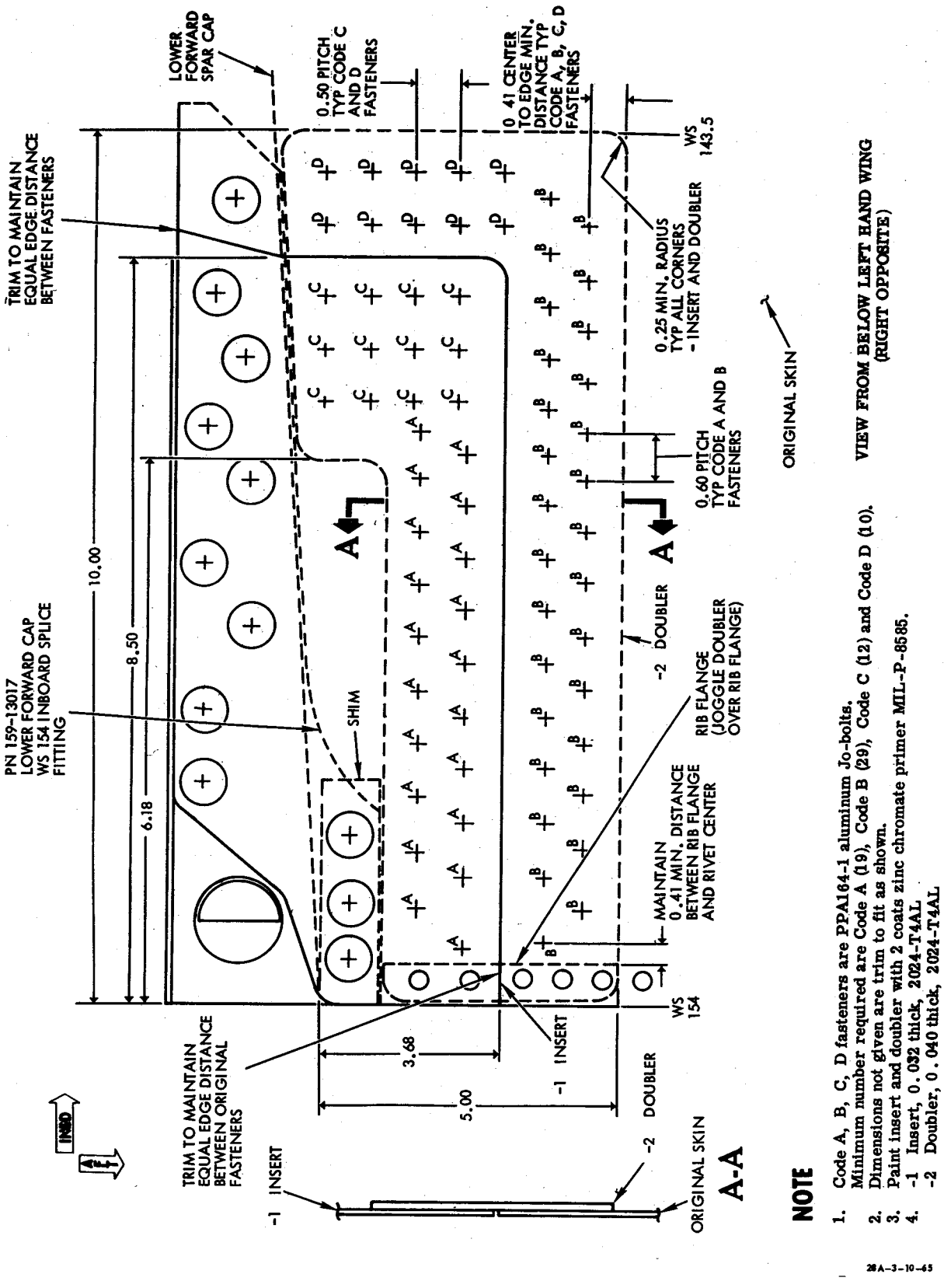
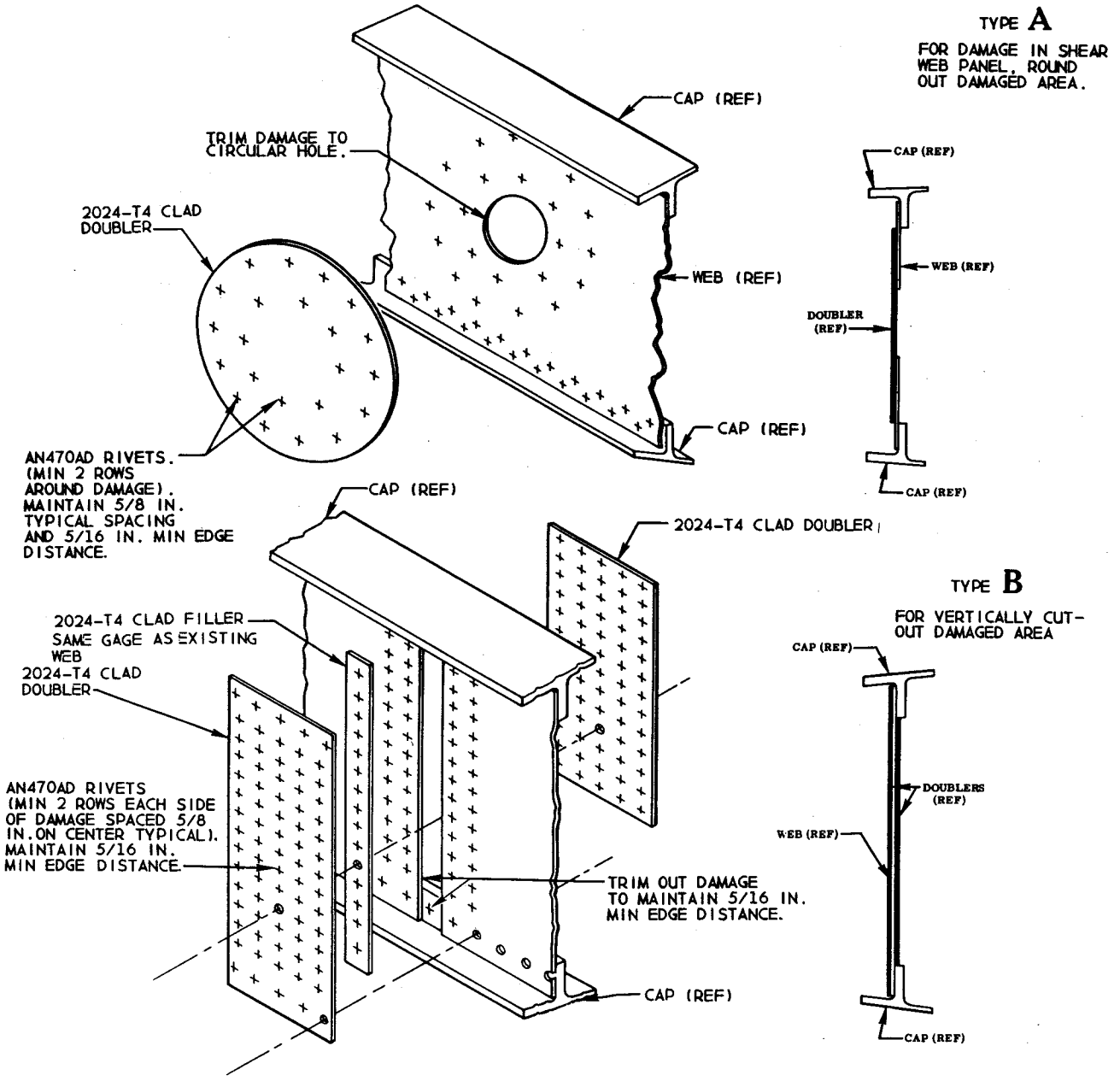


Figure 2-46A. Skin Repair for Fatigue Crack Locale – Station 154 Inboard Lower Forward Spar Cap Splice Fitting



WEB THICKNESS	TYPE A		TYPE B	
	DOUBLER THICKNESS	RIVETS	DOUBLER THICKNESS	RIVETS
0.025 IN.	0.032 IN.	AN470AD4	0.025 IN.	AN470AD4
0.032 IN.	0.040 IN.	AN470AD5	0.032 IN.	AN470AD5
0.040 IN.	0.051 IN.	AN470AD5	0.032 IN.	AN470AD6

T-28A-3-10-51

Figure 2-47. Spar and Rib Web Repair

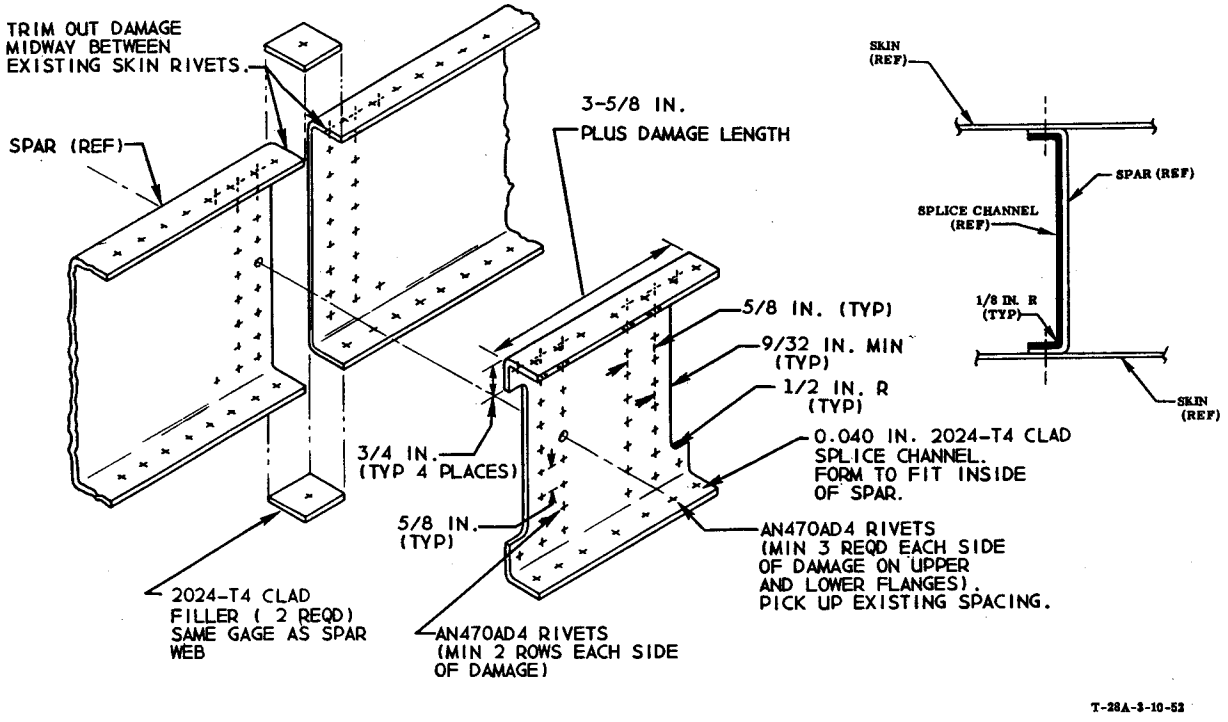


Figure 2-48. Outer Panel Rear Spar Repair

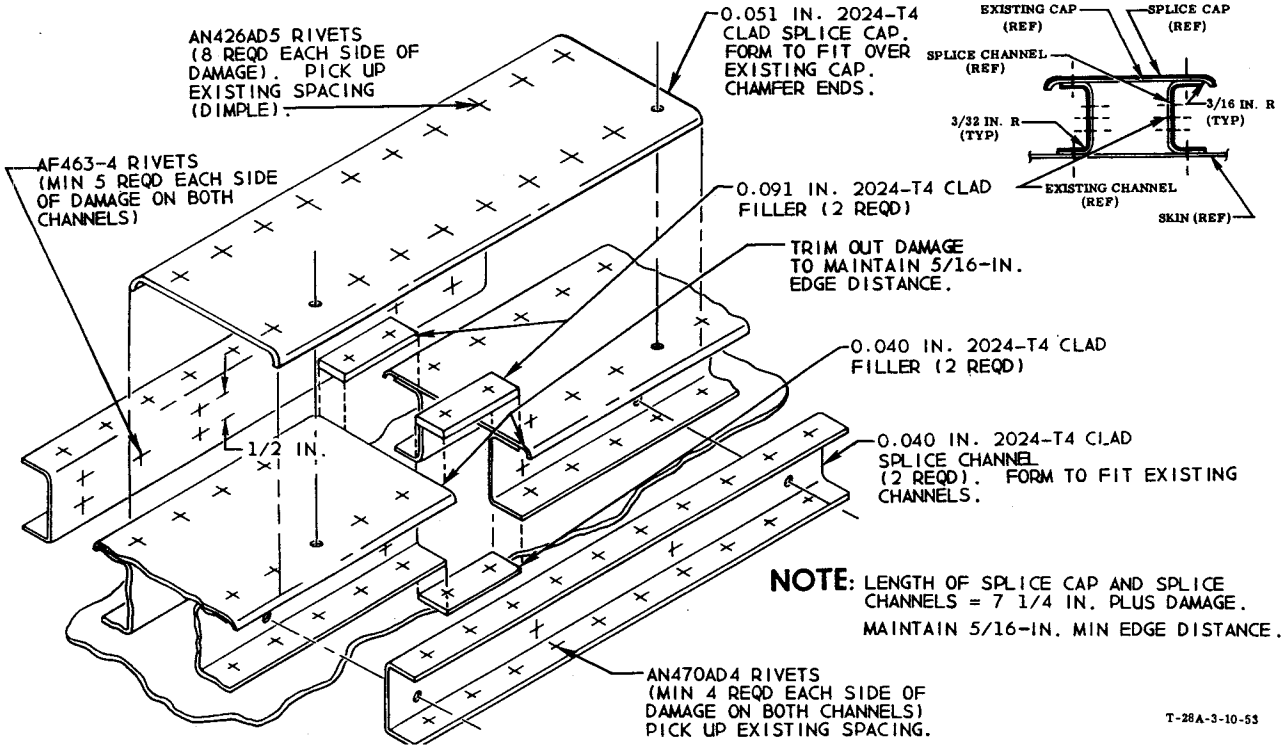
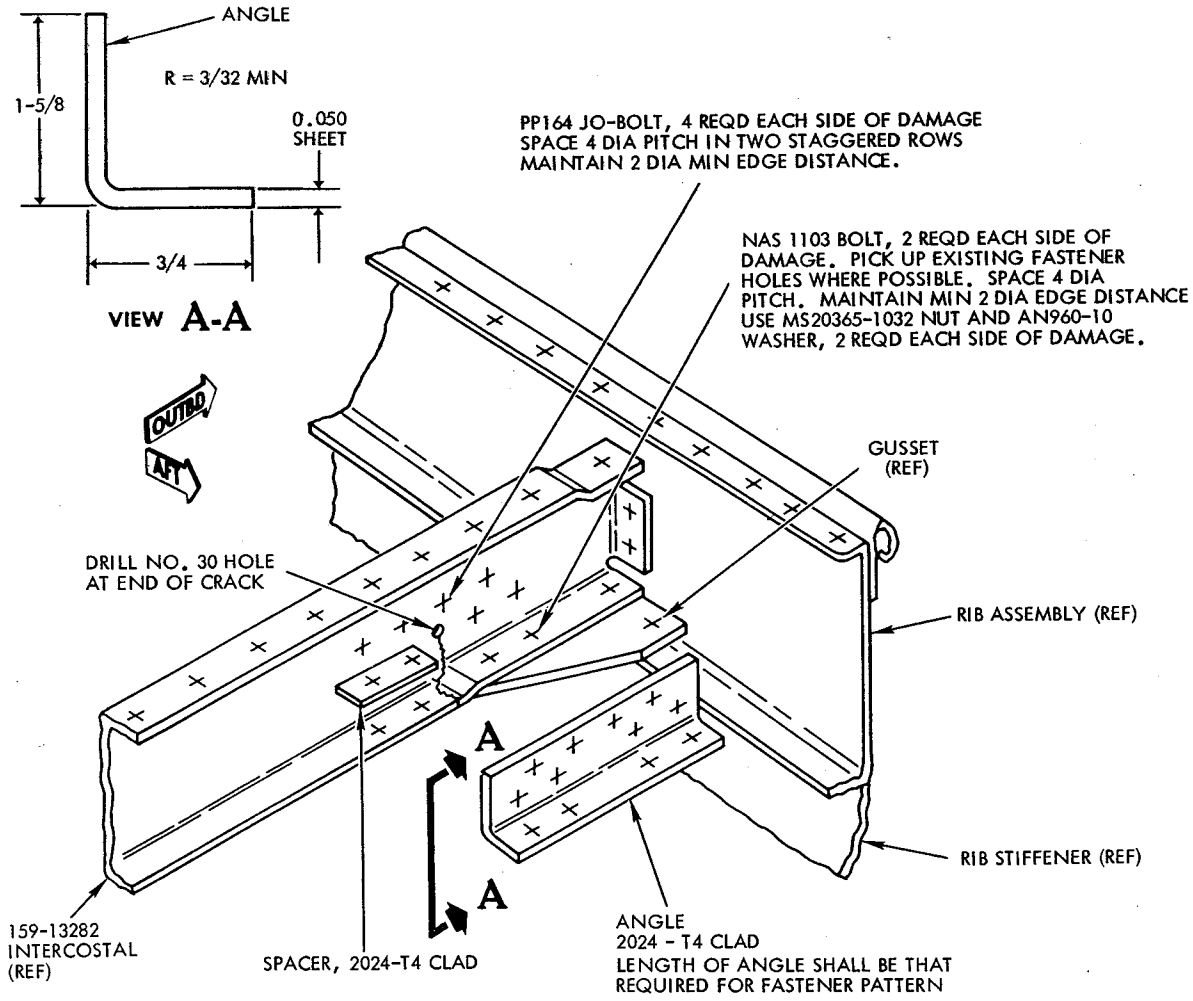


Figure 2-49. Former Repair - Station 101 and 110



NOTE

1. Smooth and straighten buckles and/or stop drill cracks with a No. 30 drill. Dye penetrant check for cracks after working and stop-drill any additional cracks.

2. Apply two coats of zinc chromate primer to all surfaces before installation of repair angle and spacer.

3. Locate and space fasteners with edge distances beginning at extreme edges of cracks or buckles.

4. Repair procedure is shown for upper intercostal lower flange, part No. 159-13282. This repair procedure may be used on lower intercostal upper flange, Part No. 159-13281, by applying an opposite installation and omitting the spacer. For T-28A model aircraft without gusset, apply the same installation procedure, except omit the spacer.

5. All buckles must be straightened prior to installation of the repair angle. If buckles cannot be straightened, the intercostal must be replaced. If damage requires the removal of the intercostal to replace or straighten it, replace the intercostal, see intercostal replacement illustration.

28A-3-10-64

Figure 2-49A. Intercostal Repair - Station 153.875

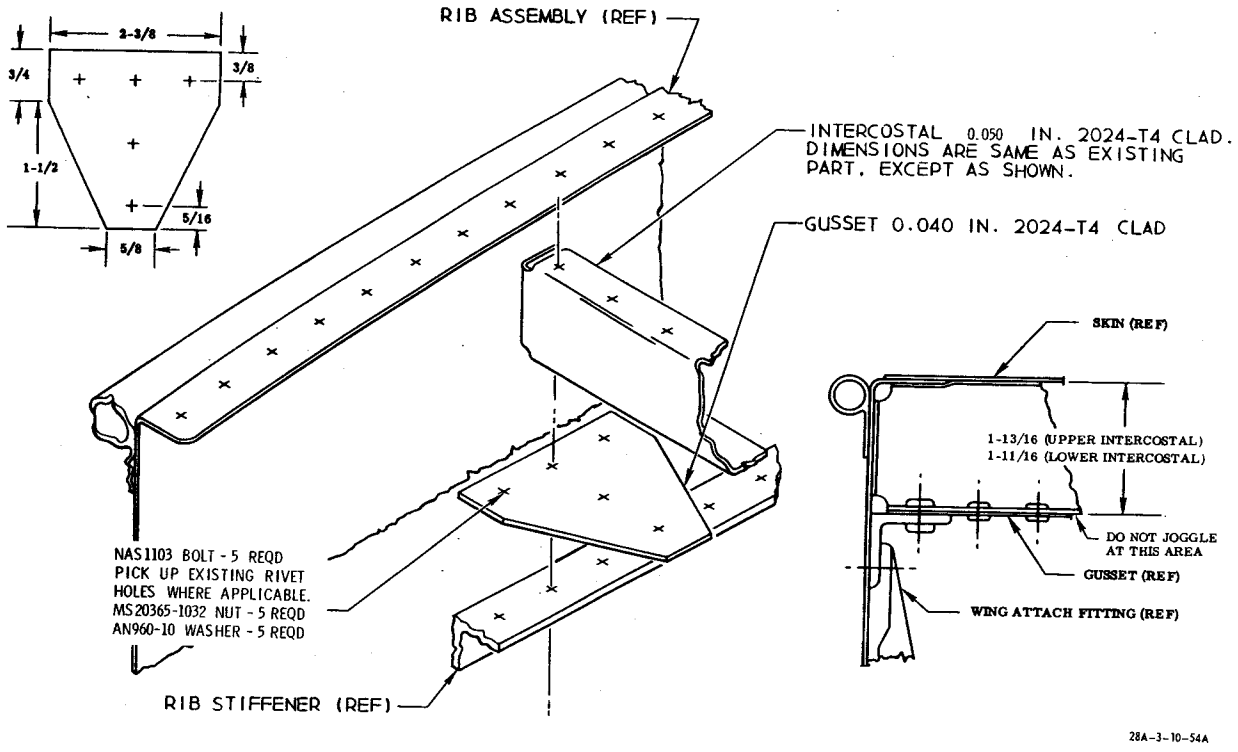


Figure 2-50. Intercostal Replacement – Station 153.875

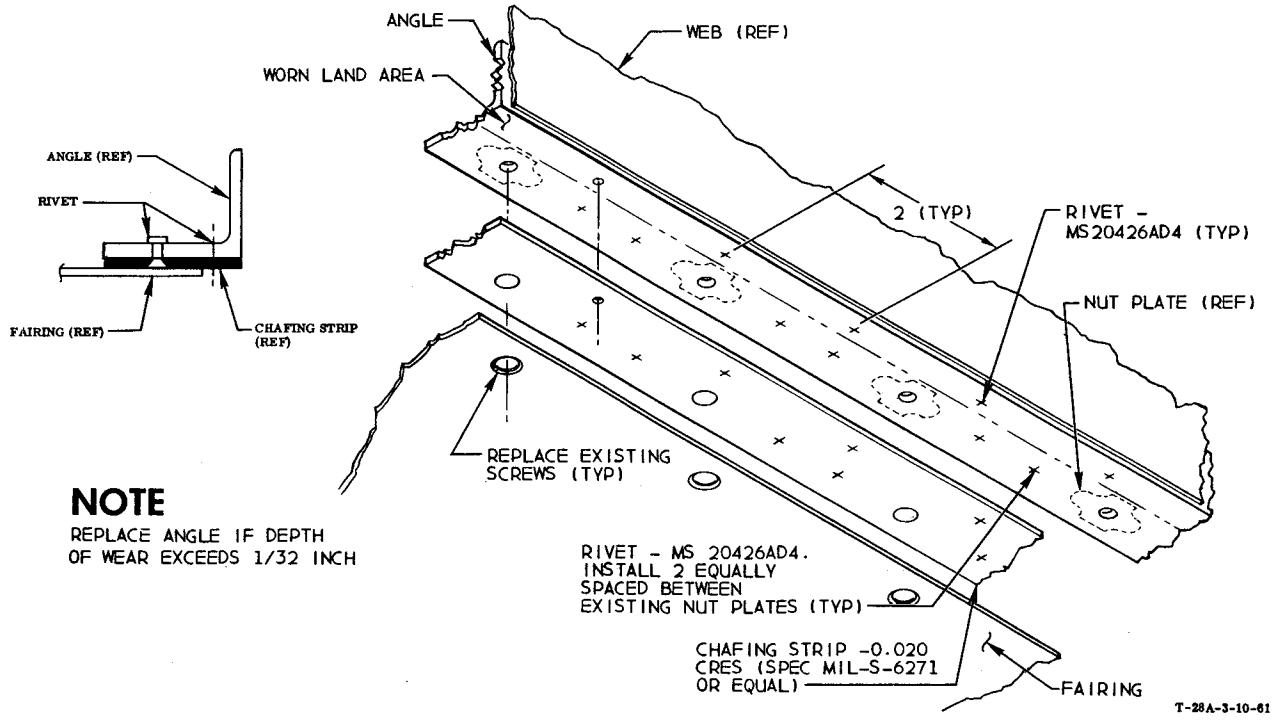


Figure 2-50A. Landing Assembly Typical Repair – Main Landing Gear Doors

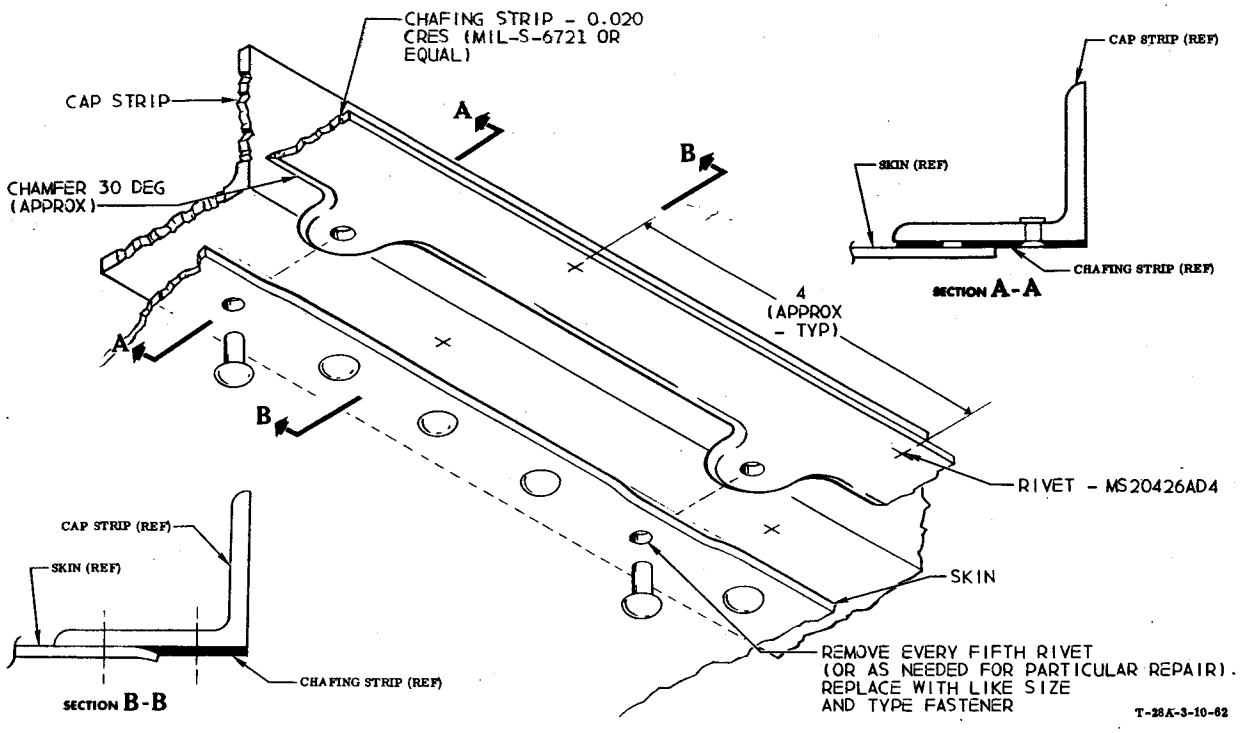


Figure 2-50B. Cap Strip Typical Repair - Auxiliary Main Landing Gear Beam

NOTE

REPLACE CAP STRIP (ANGLE) IF DEPTH OF WEAR EXCEEDS 1/32 INCH.

1 FABRICATE CHAFING STRIPS TO PICK UP EVERY FIFTH RIVET, OR TO SUIT INDIVIDUAL JOB.

2 REMOVE NECESSARY RIVETS THROUGH SKIN AND CAP STRIP.

3 INSTALL CHAFING STRIP, PICKING UP REMOVED RIVETS AND ADDING RIVETS IN CAP STRIP WHEN APPLICABLE.

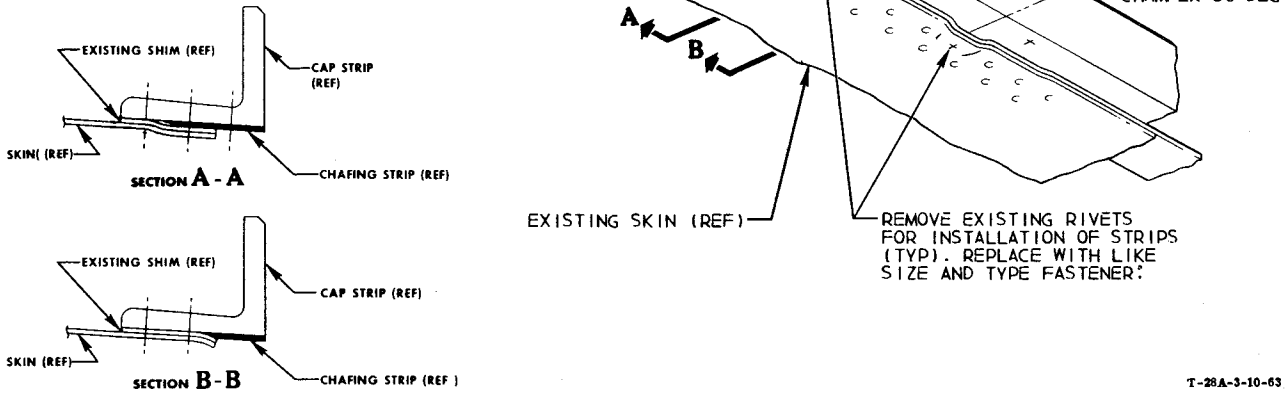


Figure 2-50C. Cap Strip Typical Repair - Main Landing Gear Beam

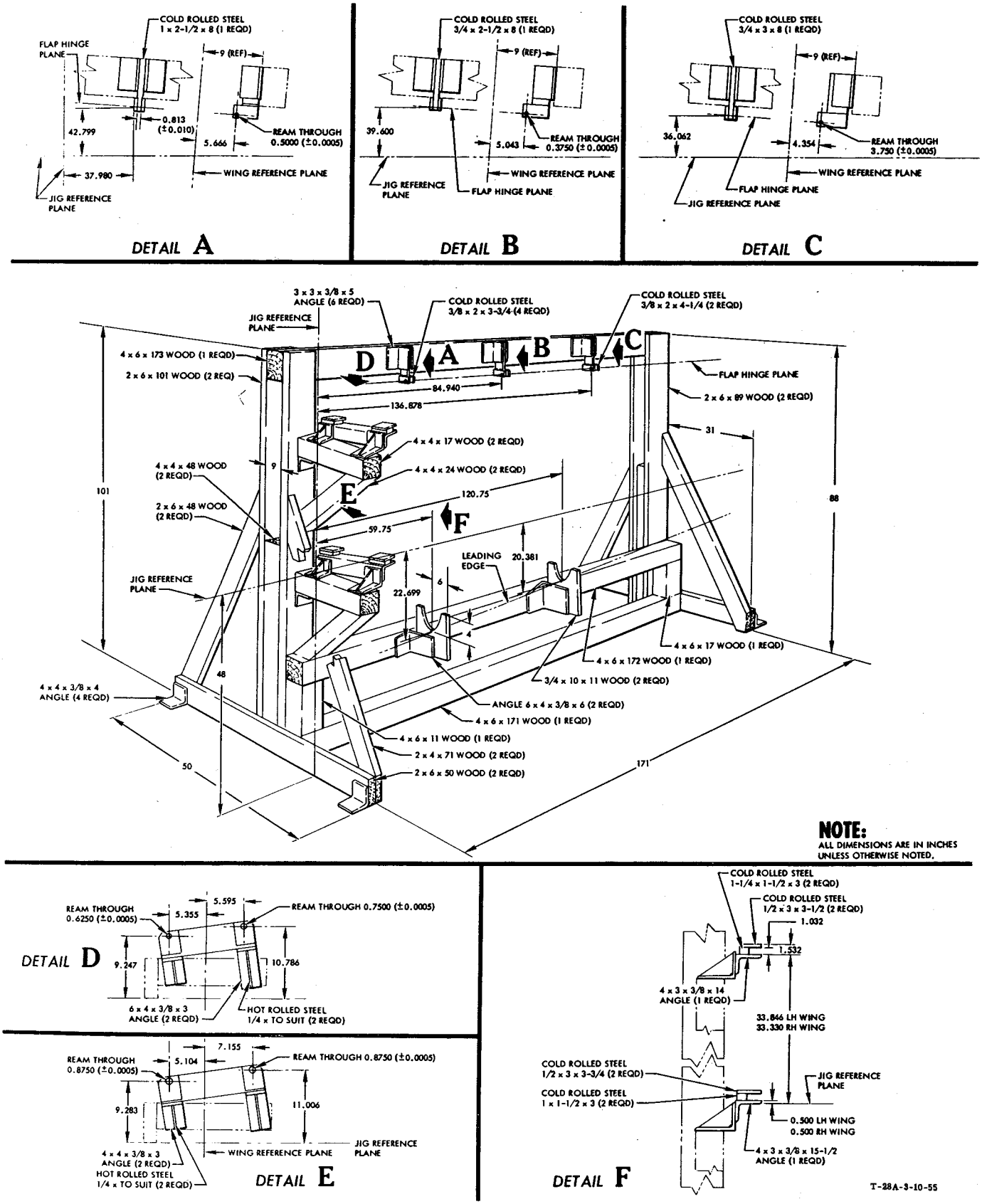


Figure 2-51. Wing Inner Panel Repair Jig

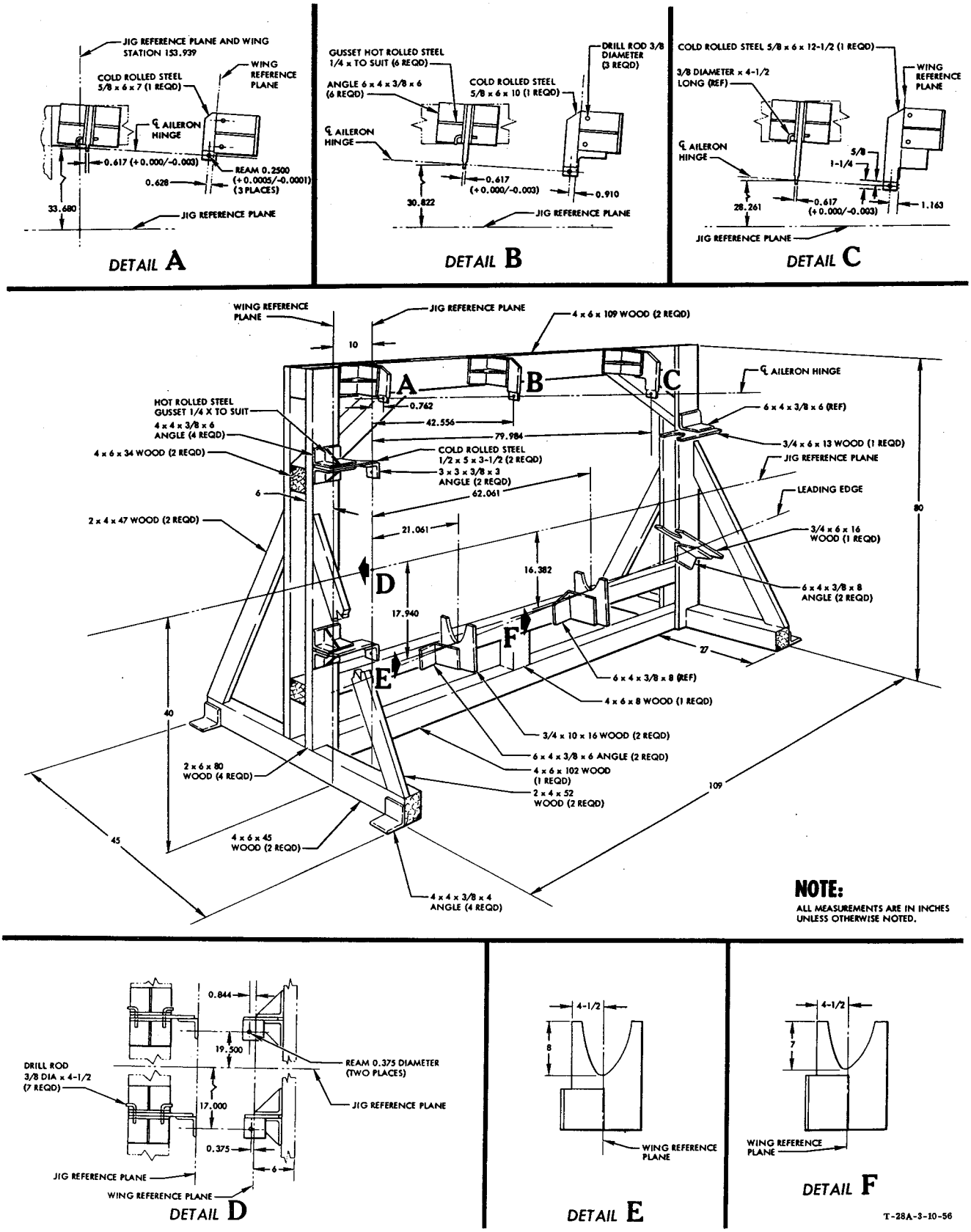


Figure 2-52. Wing Outer Panel Repair Jig

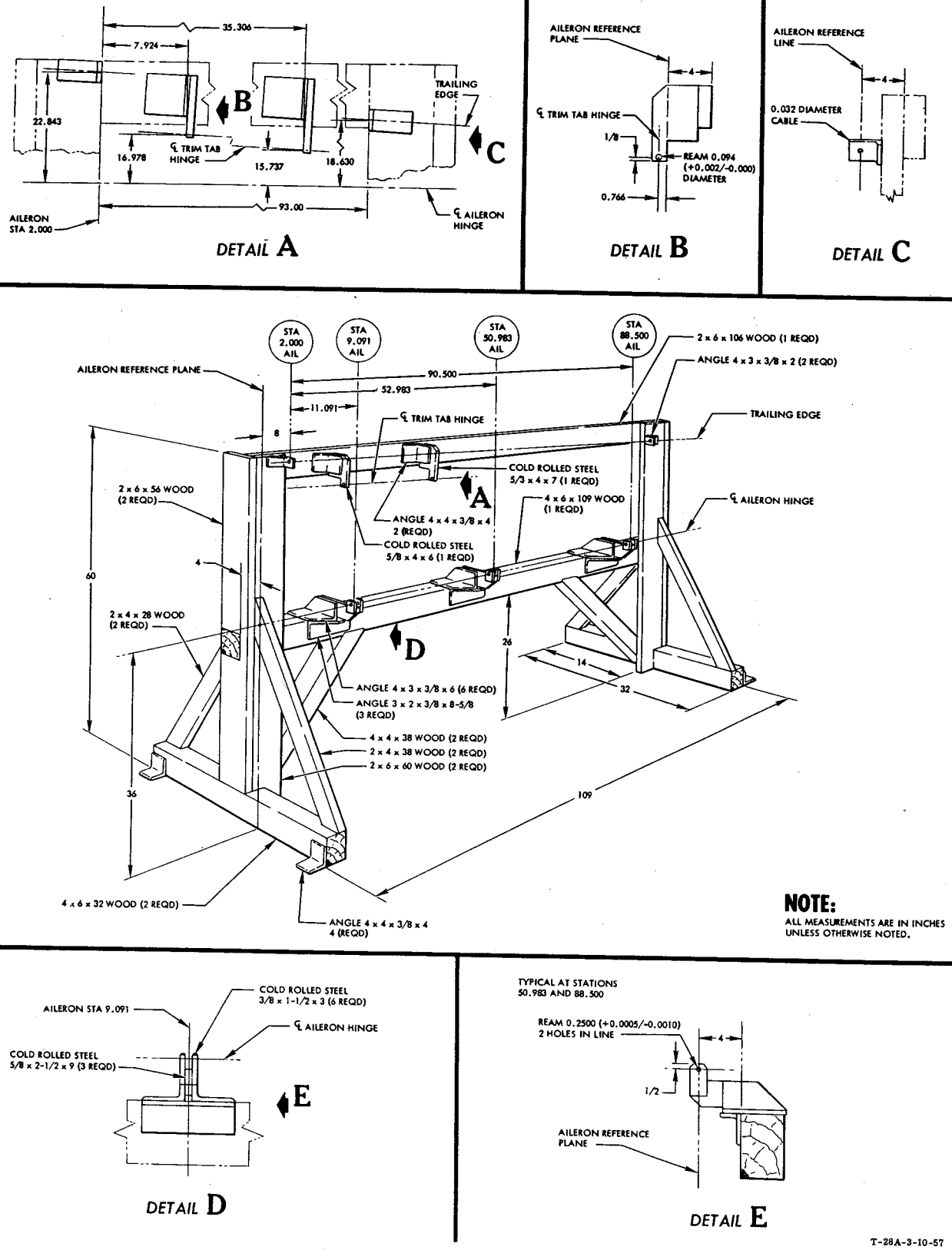


Figure 2-53. Aileron Repair Jig

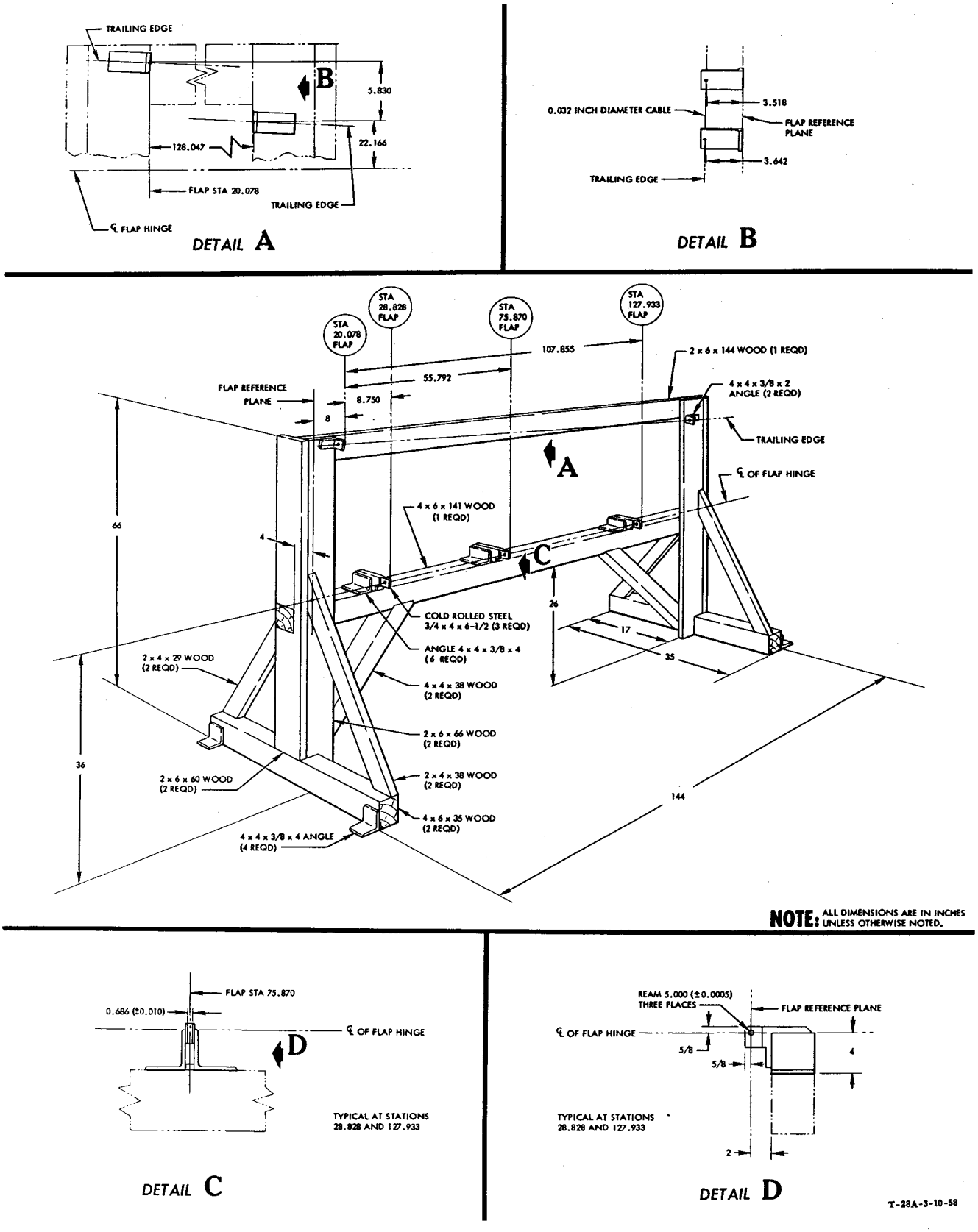


Figure 2-54. Flap Repair Jig

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SECTION III

TAIL GROUP

TAIL GROUP.

HORIZONTAL STABILIZER.

The horizontal stabilizer structure consists of two spanwise beams interconnected by closely spaced chordwise ribs supporting the skins. No spanwise stringers are used. Ribs and skins are made from 2024-T4 clad aluminum alloy sheet. All rivet attachments are either steel NAS 178 Hi-Shear or 2117-T4 aluminum alloy rivets. A channel formed from 2024-T4 clad sheet serves as the front beam. The rear beam is a built-up member with heavy caps machined from 7075-W aluminum alloy extrusion and a web made of 2024-T4 clad sheet stiffened by 2024-T4 clad sheet metal angles. A beam attachment fitting is machined integral with the end of each rear beam cap. The horizontal stabilizer is attached to the fuselage by three shear pins, one at the front beam and two at the rear beam. With this attachment, the rear beam must transfer all the surface bending moment, whereas both beams transfer the surface shear and torsion. Each horizontal stabilizer is equipped with a tip section consisting of a 2024-T4 clad aluminum alloy rib, rear beam, and skin, and a 5052-O aluminum alloy cap. All rivets used are 2117-T4.

ELEVATORS.

The elevators are single-cell structures using closely spaced chordwise ribs that support the skins. Ribs and skins are made from 2024-T4 clad aluminum alloy sheet. A spanwise 7075-T6 aluminum alloy extrusion, in both the upper and lower surface near the hinge line, reinforces the nose-to-aft-skin splices. The elevator is supported by three hinges; two are on the stabilizer, and one is on the fuselage. A universal joint provided on the inboard end of the elevator connects the elevator to the control horn in such a manner that shear and torque, but no bending, may be transferred to the fuselage. Each elevator is equipped with a trim tab built up from two 2024-T4 aluminum alloy clad sheets supported by ribs of the same material. The forward area of one of the skins is made to act as a beam, which is further stiffened by a spanwise continuous-type aluminum alloy hinge. The elevators and the elevator trim tabs are equipped with magnesium alloy trailing edge extrusion. Each elevator is equipped with a tip made from 5052-O aluminum alloy sheet. Rivet attachments of aluminum alloy members are made with 2024-T4 and 2117-T4 aluminum alloy rivets, and attachment of magnesium alloy trailing edge extrusion is made with 5056 aluminum alloy rivets. The horizontal stabilizer, elevator, and elevator trim tab assemblies used on either side of the airplane are identical and interchangeable from one side to the other.

VERTICAL STABILIZER.

The vertical stabilizer structure consists of two beams and closely spaced pressed-type ribs covered with skins. The ribs are made in two parts: a nose portion forward of the front beam, and an intermediate portion between the beams. Ribs and skins are made from 2024-T4 clad aluminum alloy sheet. The front beam is a built-up type beam with 2024-T4 aluminum alloy extruded caps and angles, and 2024-T4 clad aluminum alloy sheet web. The rear beam is a formed channel section made from 2024-T4 clad aluminum alloy sheet. Rivet attachments are either steel NAS 178 Hi-Shear rivets or 2117-T4 aluminum alloy rivets. The vertical stabilizer is attached to the fuselage with three shear pins. Two pins are provided on the front beam so that is transfers all the surface bending moment to the fuselage. Only one pin is on the rear beam. Thus, the surface shear and torque is transferred by both beams. The vertical stabilizer is equipped with a tip assembly that houses a radio antenna. The tip assembly consists of a rear beam, ribs, and intercostals (covered with 5052-O aluminum alloy sheet), and is supported off the stabilizer by a glass fabric strip. The rear beam is made of two parts; the top portion is made from 2024-T4 clad aluminum alloy sheet, and the bottom portion is made from glass fabric. Ribs and intercostals are made from 2024-T4 clad sheet. The metal parts of the assembly are completely insulated from the vertical stabilizer main structure by the glass fabric strip and the glass fabric portion of the rear beam. Rivet attachments are made with 2017-T4 and 2117-T4 rivets.

RUDDER.

The rudder and rudder trim tab structure is similar to that of the elevator and elevator trim tab. The rudder is equipped with a tip that consists of two ribs and an intercostal (which are made from resin-impregnated laminated plastic sheet) and a skin made of glass fabric. Rivet attachments are made with 2117-T4 rivets.

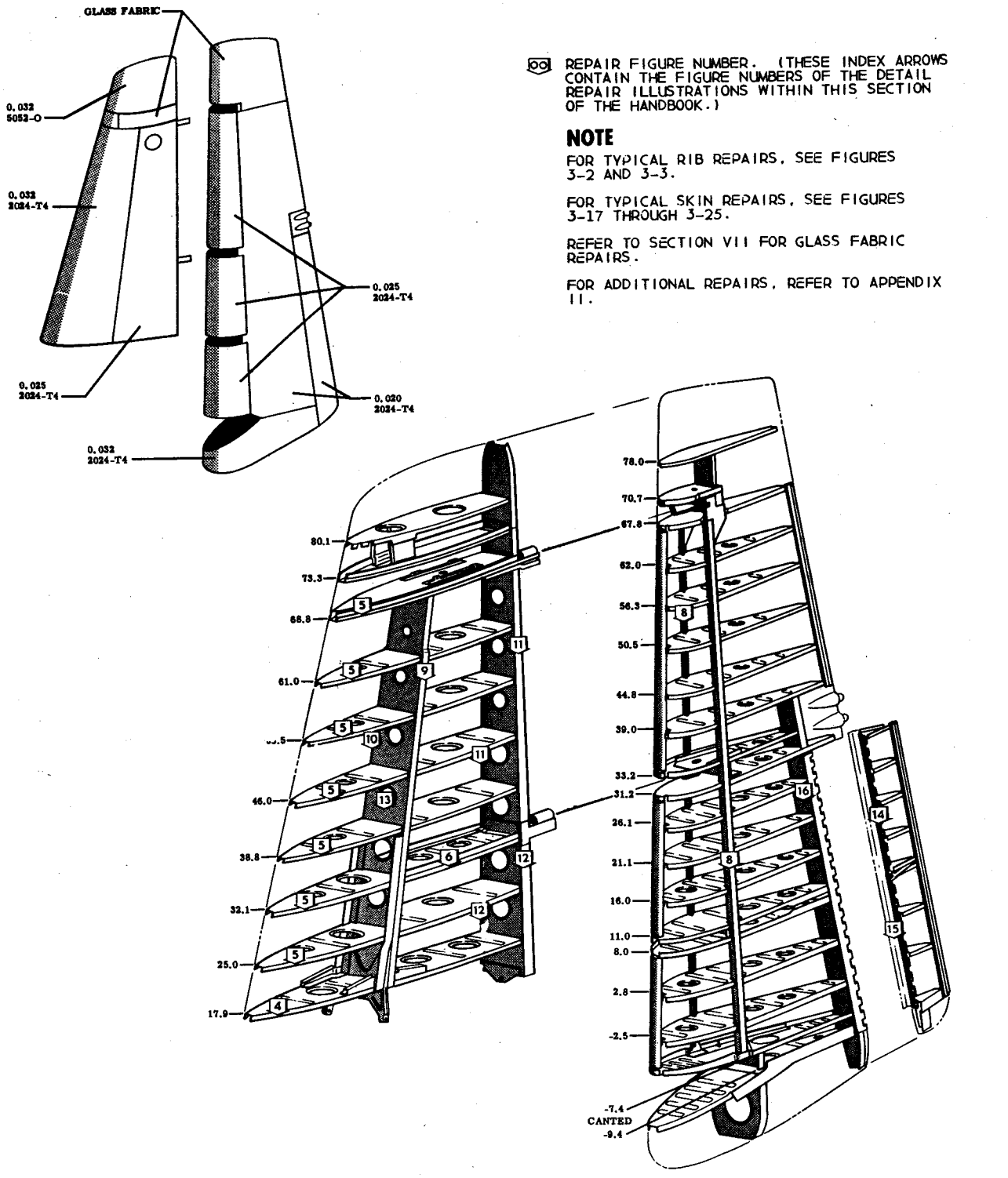


Figure 3-1. Tail Group Repair Index – T-28A and T-28D Airplanes (Sheet 1 of 2)

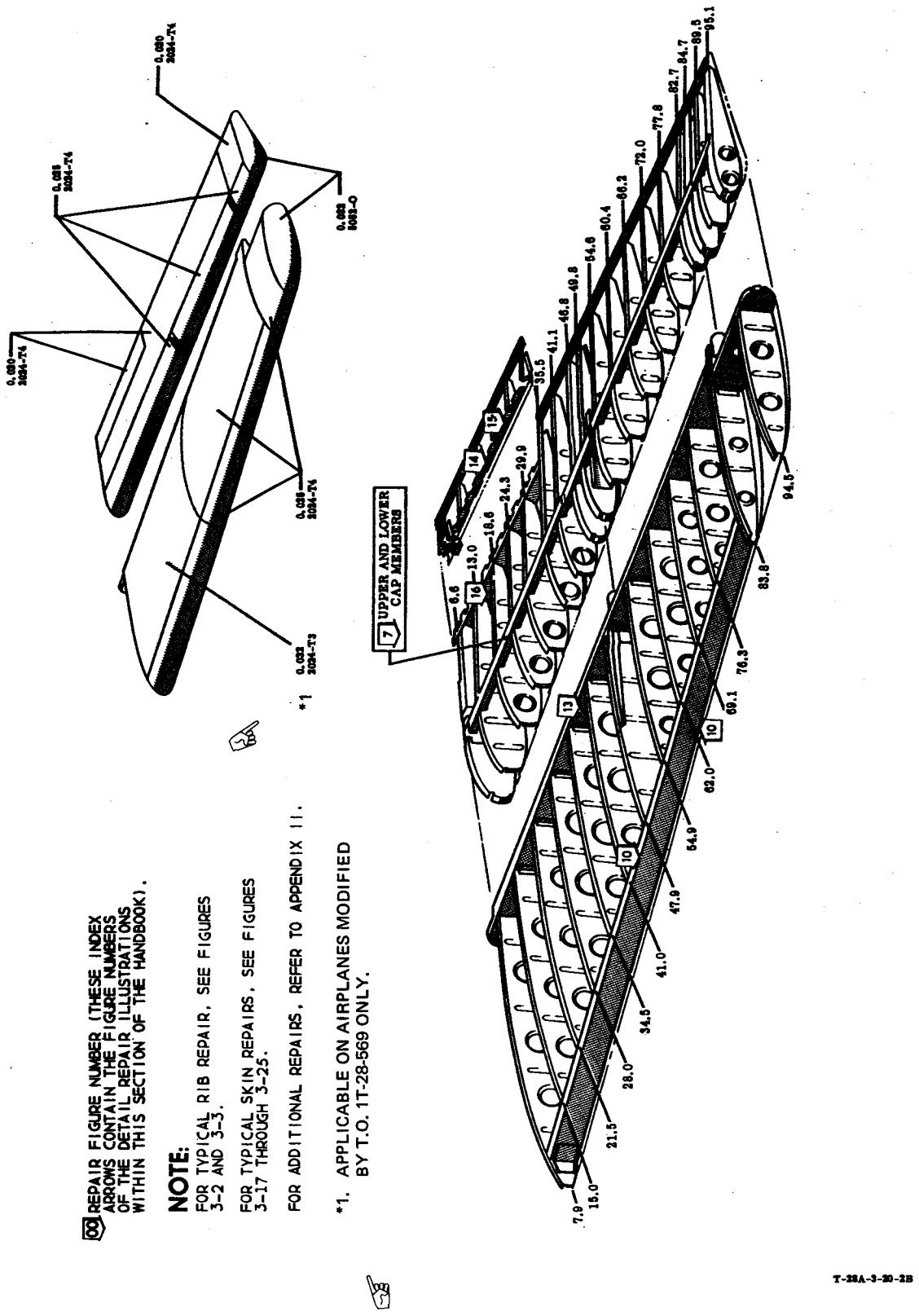


Figure 3-1. Tail Group Repair Index — T-28A and T-28D Airplanes (Sheet 2 of 2)

REPAIR FIGURE NUMBER. (THESE INDEX ARROWS CONTAIN THE FIGURE NUMBERS OF THE DETAIL REPAIR ILLUSTRATIONS WITHIN THIS SECTION OF THE HANDBOOK.)

NOTE

FOR TYPICAL RIB REPAIRS SEE FIGURES 3-2 AND 3-3.

FOR TYPICAL SKIN REPAIRS, SEE FIGURES 3-17 THROUGH 3-25.

FOR ADDITIONAL REPAIRS, REFER TO APPENDIX II.

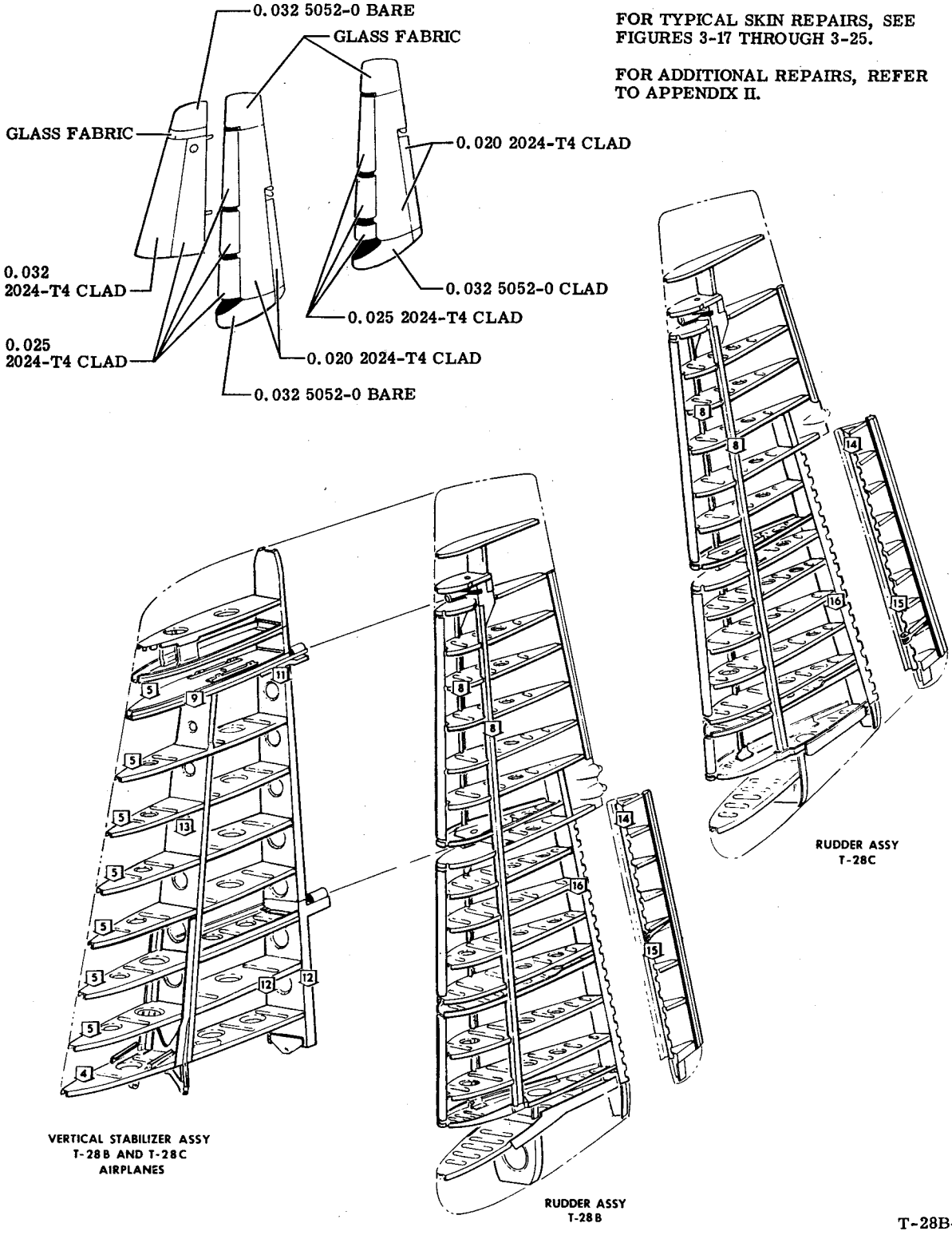


Figure 3-1A. Tail Group Repair Index — T-28B and T-28C Airplanes (Sheet 1 of 2)

00 REPAIR FIGURE NUMBER (THESE INDEX ARROWS CONTAIN THE FIGURE NUMBERS OF THE DETAIL REPAIR ILLUSTRATIONS WITHIN THIS SECTION OF THE HANDBOOK).

NOTE

FOR TYPICAL RIB REPAIR, SEE FIGURES 3-2 AND 3-3.

FOR TYPICAL SKIN REPAIRS, SEE FIGURES 3-17 THROUGH 3-25.

FOR ADDITIONAL REPAIRS, REFER TO APPENDIX II.

*1. APPLICABLE ON AIRPLANES MODIFIED BY T.O. 1T-28-569 ONLY.

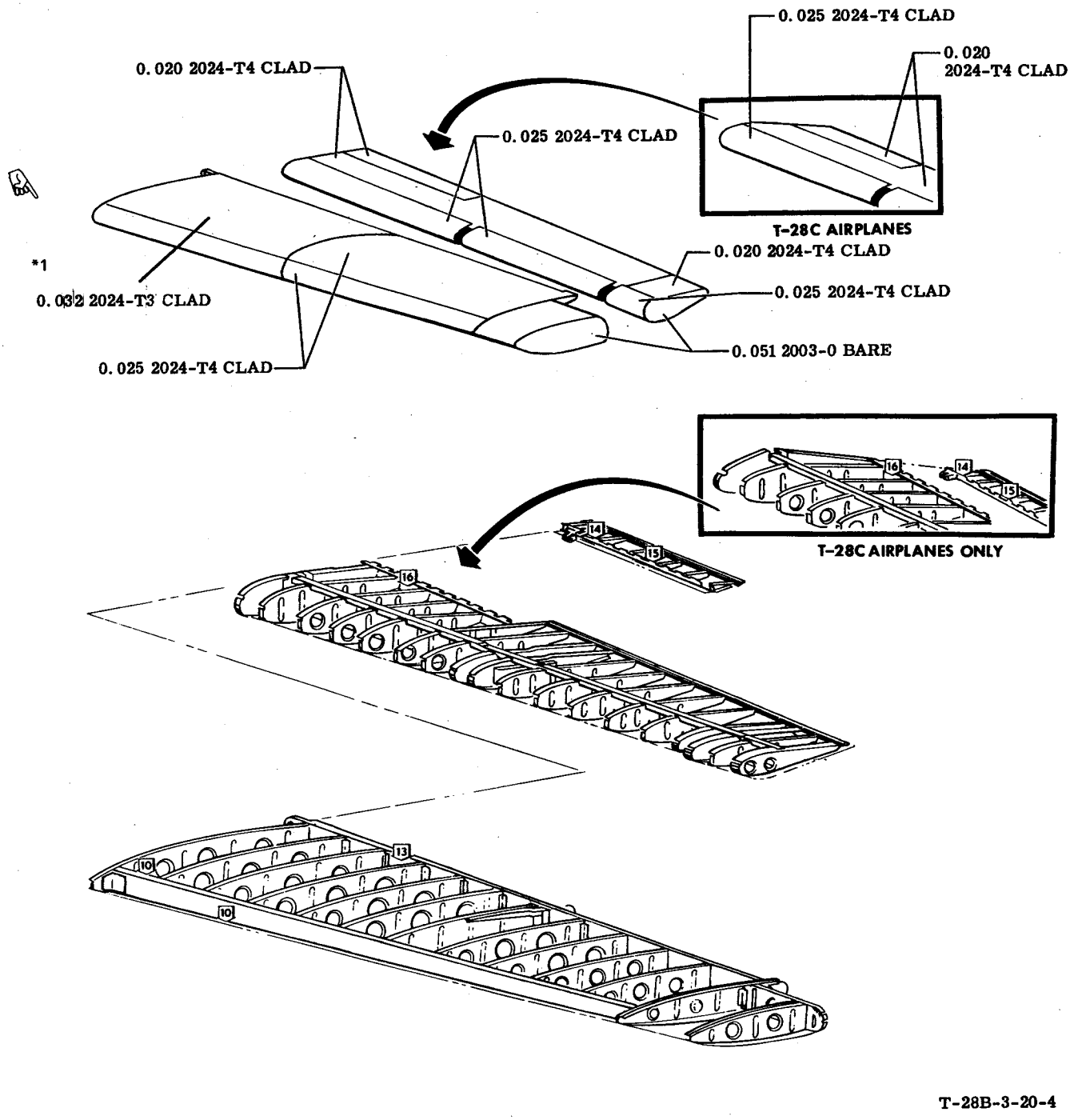
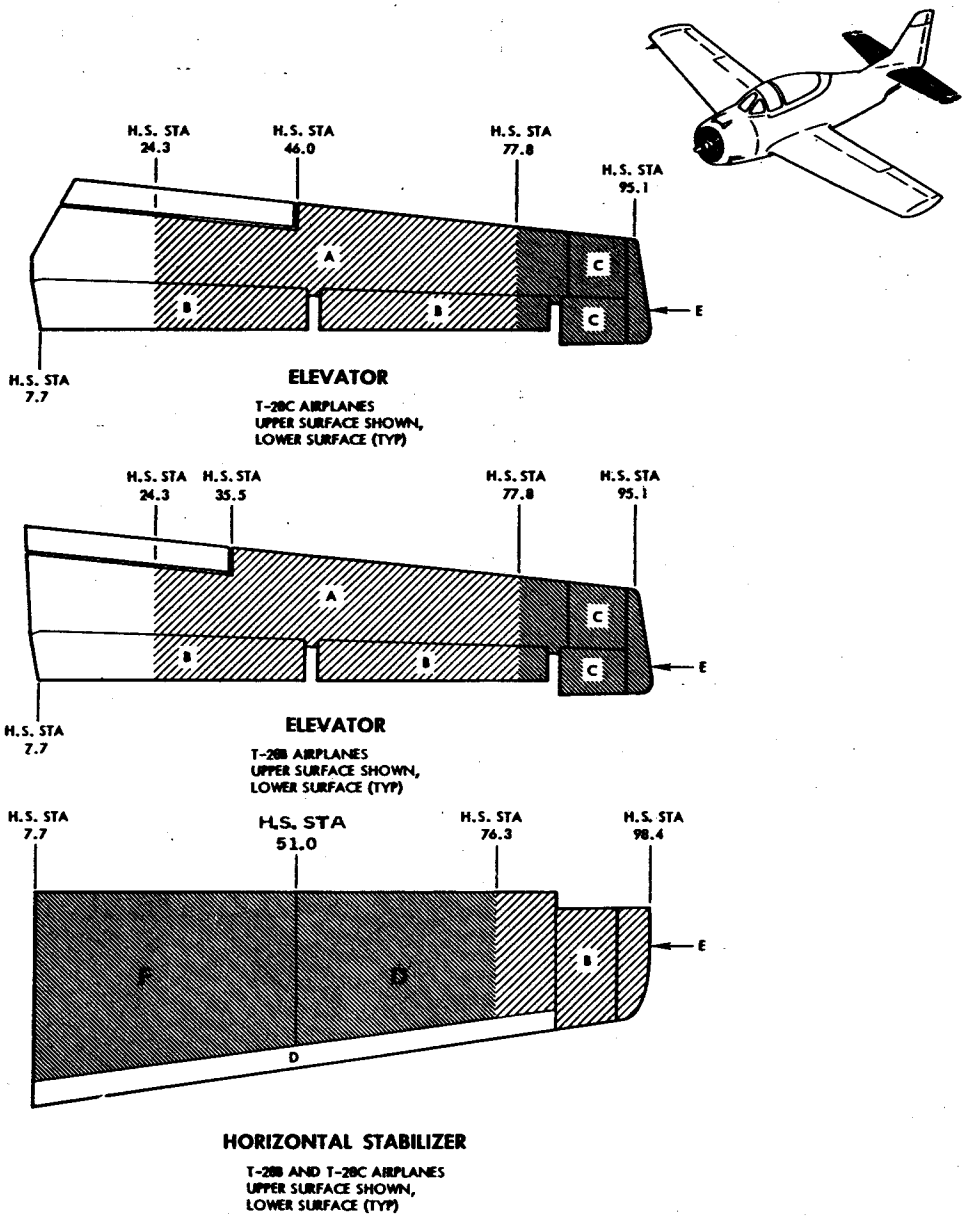


Figure 3-1A. Tail Group Repair Index — T-28B and T-28C Airplanes (Sheet 2 of 2)



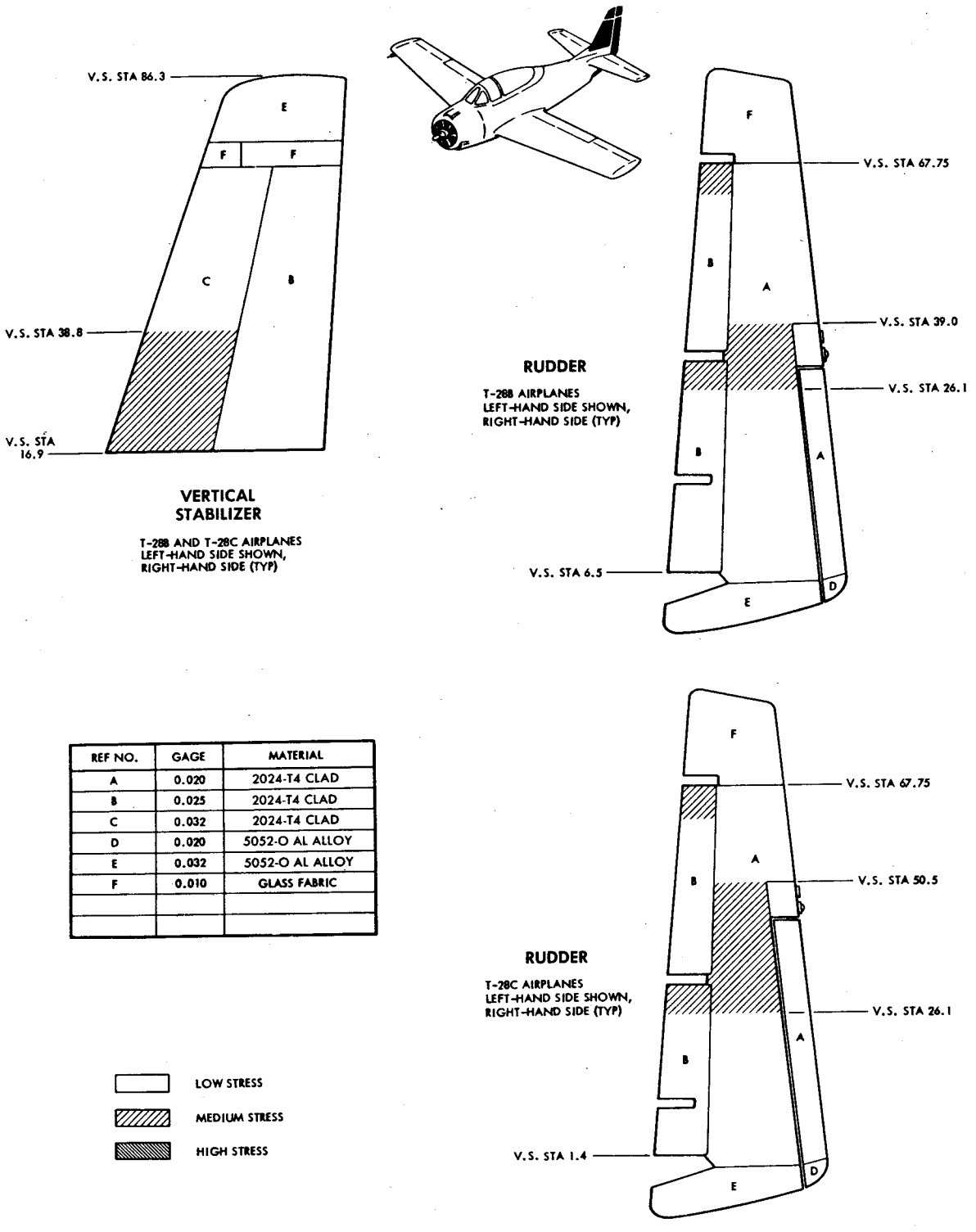
REF NO.	GAGE	MATERIAL	
A	0.020	2024-T4 CLAD	
B	0.025	2024-T4 CLAD	
C	0.020	2024-T4 CLAD	
D	0.025	2024-T4 CLAD	
E	0.051	3003-O AL ALLOY	
F	0.032	2024-T3 CLAD	*1

LOW STRESS
MEDIUM STRESS
HIGH STRESS

*1. APPLICABLE ON AIRPLANES MODIFIED BY T.O. 1T-28-569 ONLY.

T-28B-3-20-1

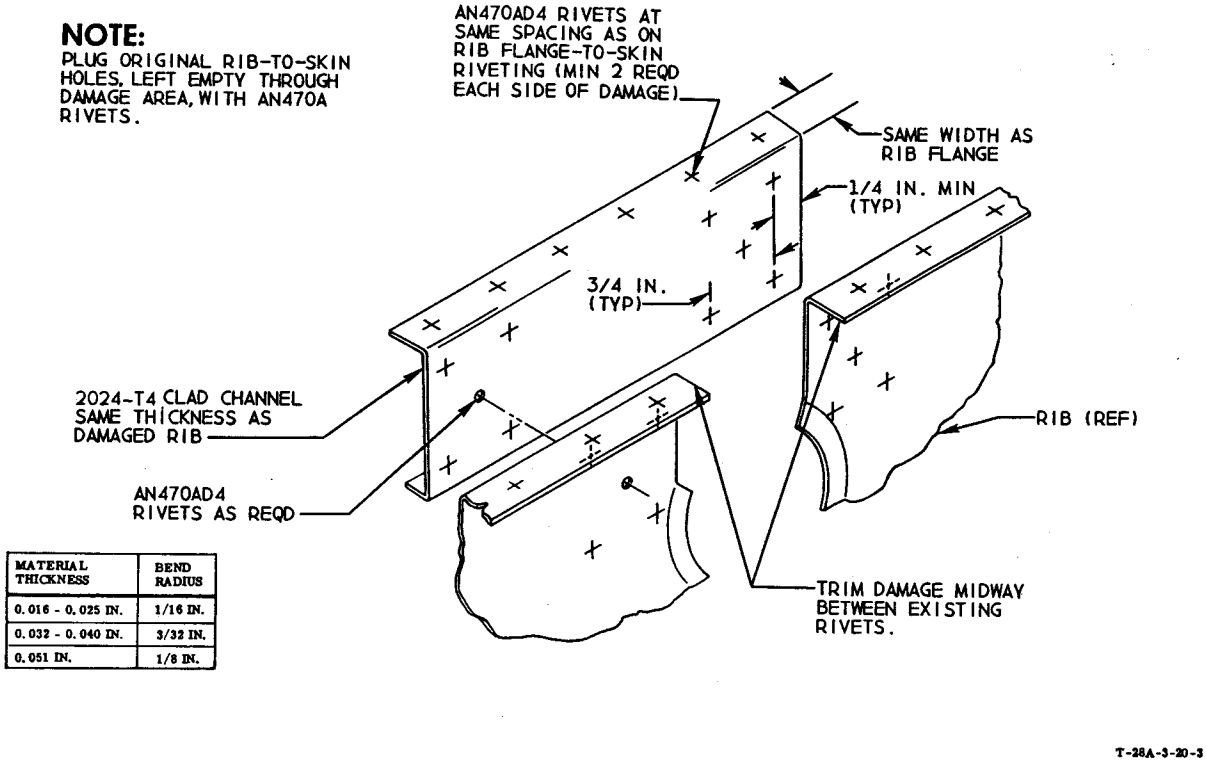
Figure 3-1B. Skin Stress Diagram — Horizontal Stabilizer and Elevator — T-28B and T-28C Airplanes



REF NO.	GAGE	MATERIAL
A	0.020	2024-T4 CLAD
B	0.025	2024-T4 CLAD
C	0.032	2024-T4 CLAD
D	0.020	5052-O AL ALLOY
E	0.032	5052-O AL ALLOY
F	0.010	GLASS FABRIC

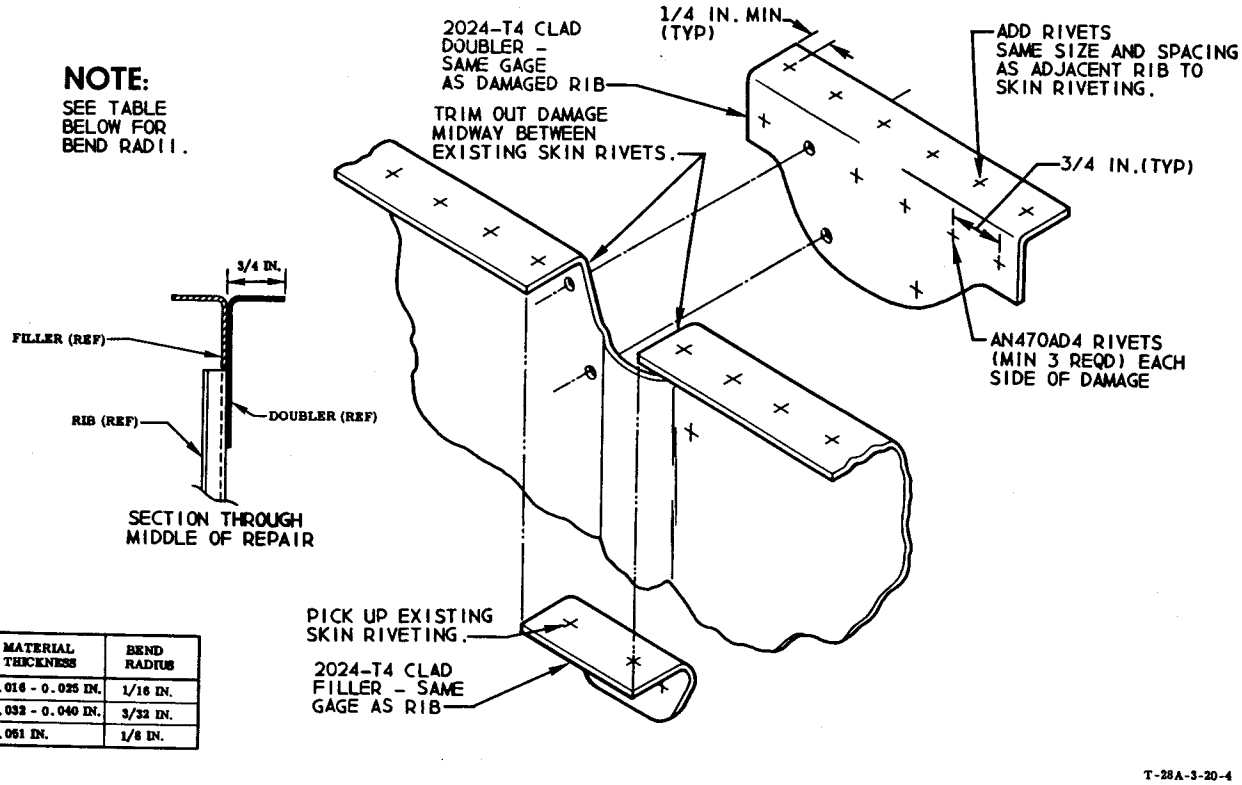
T-28B-3-20-2

Figure 3-1C. Skin Stress Duagram — Vertical Stabilizer and Rudder — T-28B and T-28C Airplanes



MATERIAL THICKNESS	BEND RADIUS
0.016 - 0.025 IN.	1/16 IN.
0.032 - 0.040 IN.	3/32 IN.
0.051 IN.	1/8 IN.

Figure 3-2. Rib Flange and Lightening Hole Repair



MATERIAL THICKNESS	BEND RADIUS
0.016 - 0.025 IN.	1/16 IN.
0.032 - 0.040 IN.	3/32 IN.
0.051 IN.	1/8 IN.

Figure 3-3. Rib Flange and Web Repair

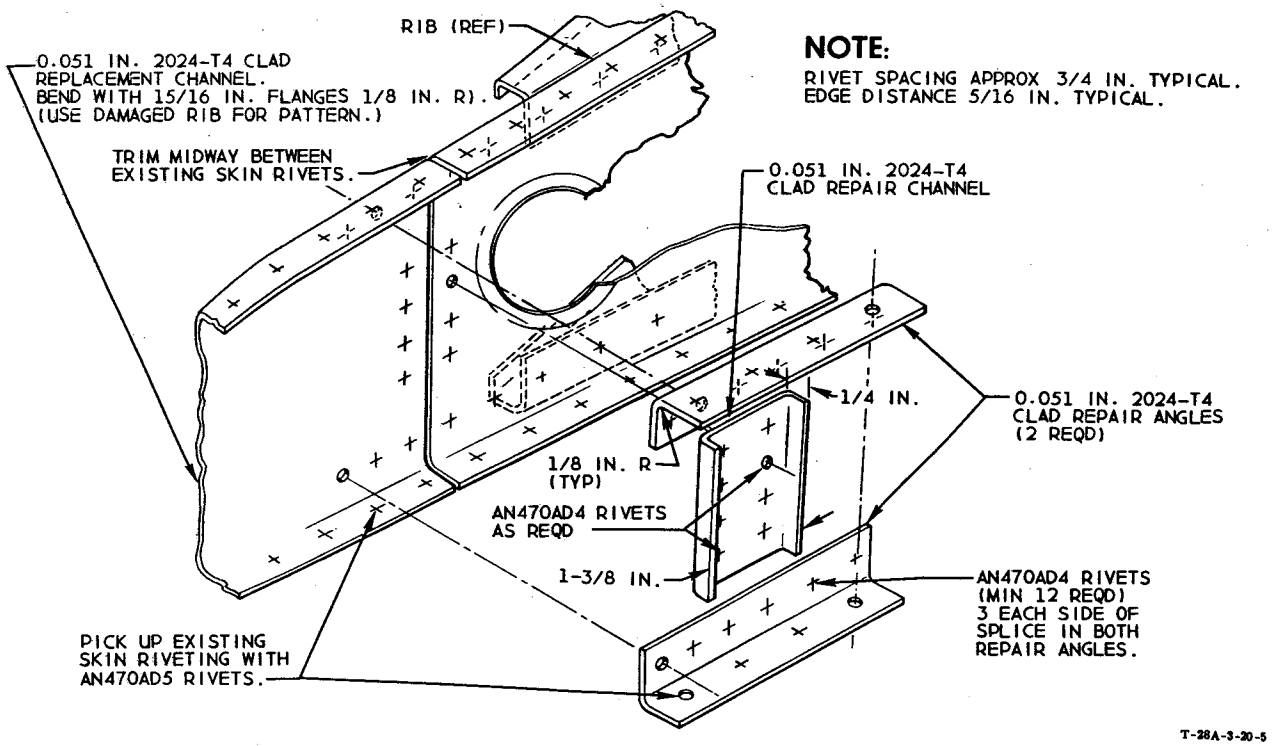


Figure 3-4. Vertical Stabilizer Nose Rib Splice - Station 17.9

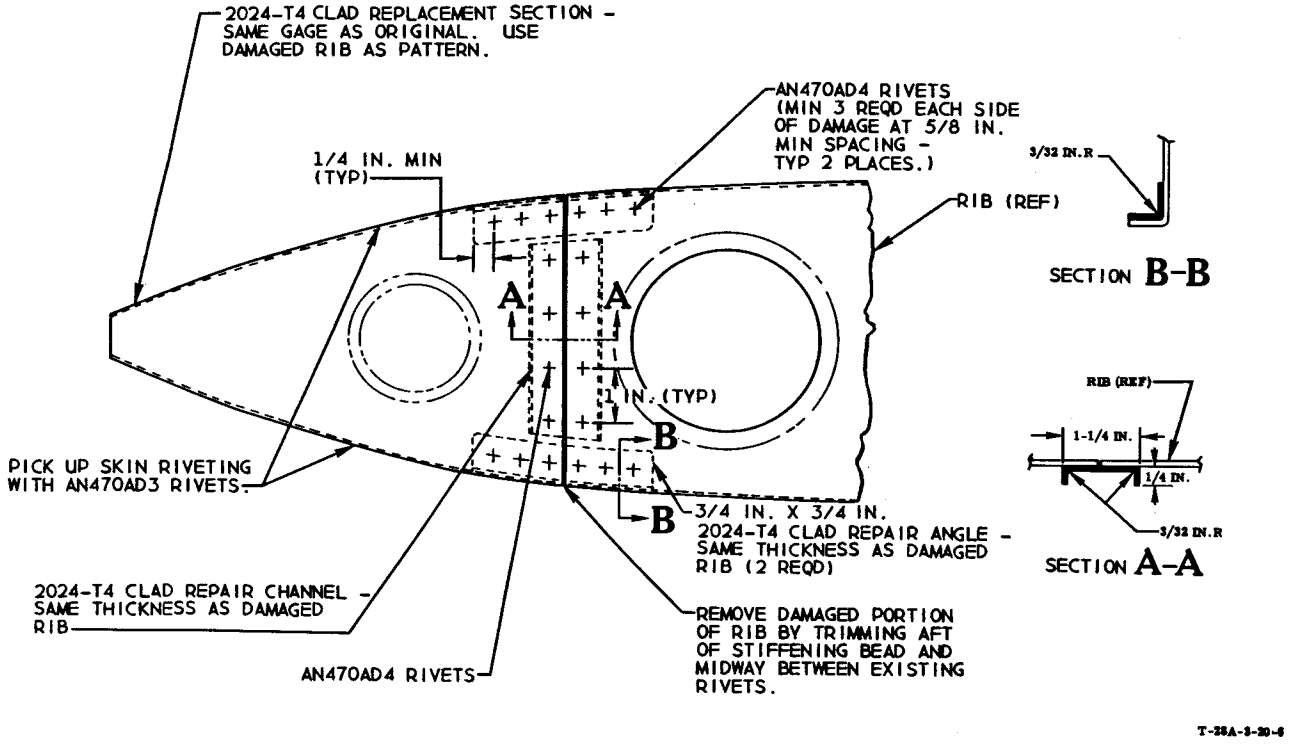


Figure 3-5. Vertical Stabilizer Nose Rib Splice

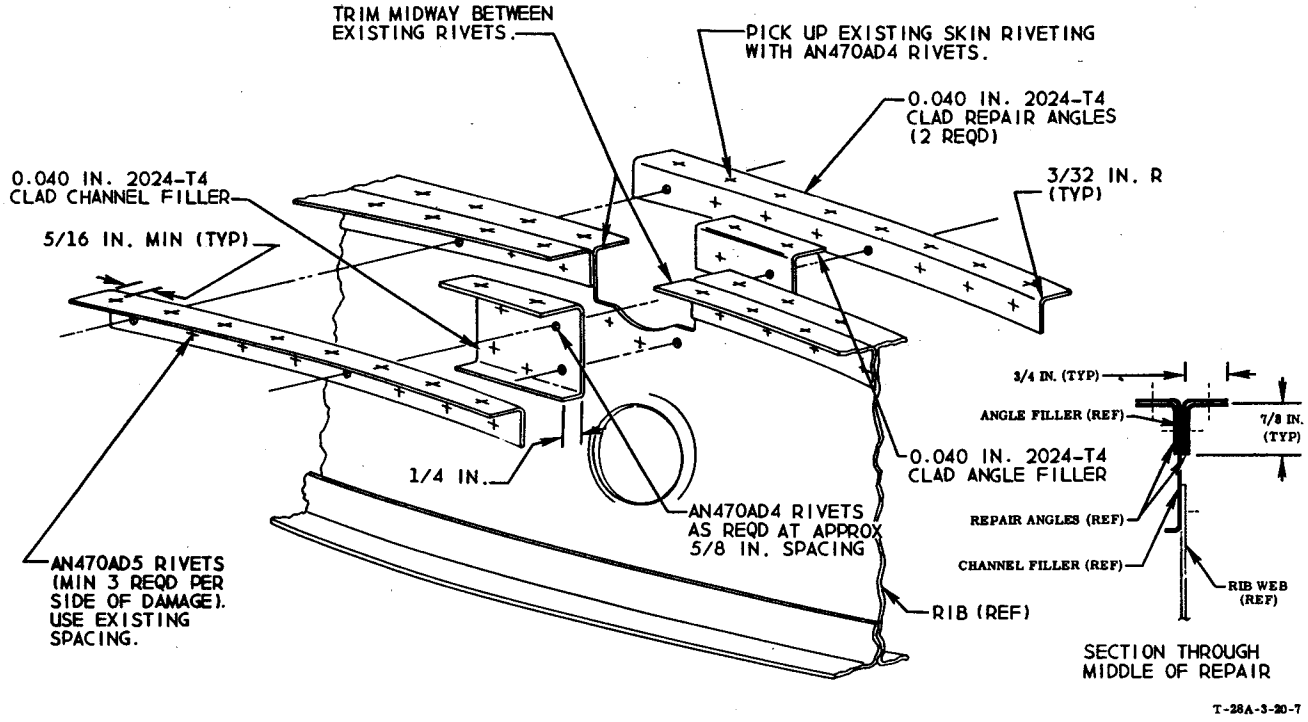


Figure 3-6. Rib Flange and Web Repair - Vertical Stabilizer Intermediate Rib - Station 32.1

NOTE:

1. SPLICE SHOWN TYPICAL BOTH ENDS OF REPAIR BETWEEN STATIONS 6.1 AND 41.1, ALSO BETWEEN STATIONS 54.6 AND 82.7.
2. REPLACE STRINGER IF DAMAGED BETWEEN STATIONS 41.1 AND 54.6
3. MAINTAIN MINIMUM EDGE DISTANCE OF 5/16 IN.

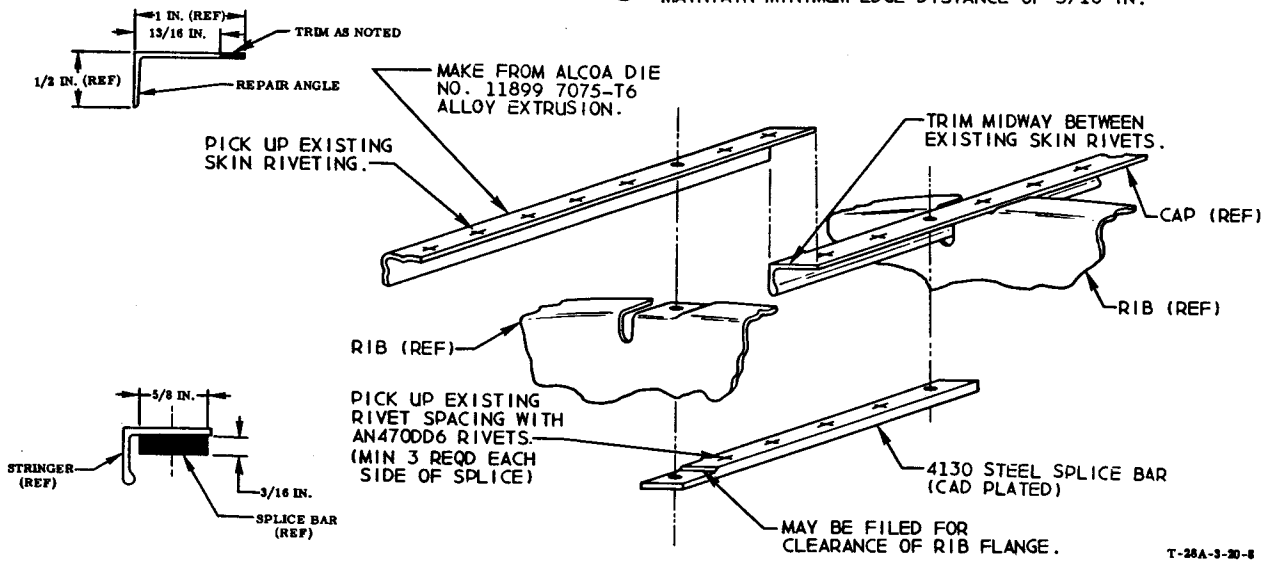


Figure 3-7. Elevator Cap Angle Repair

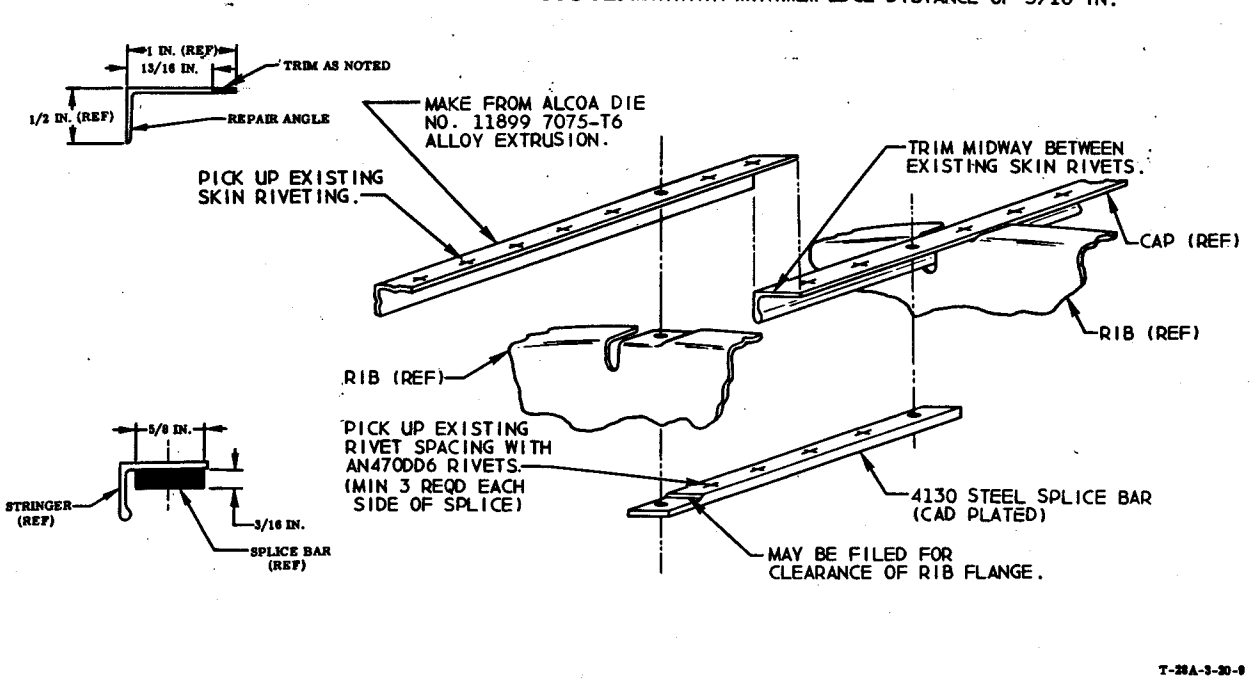
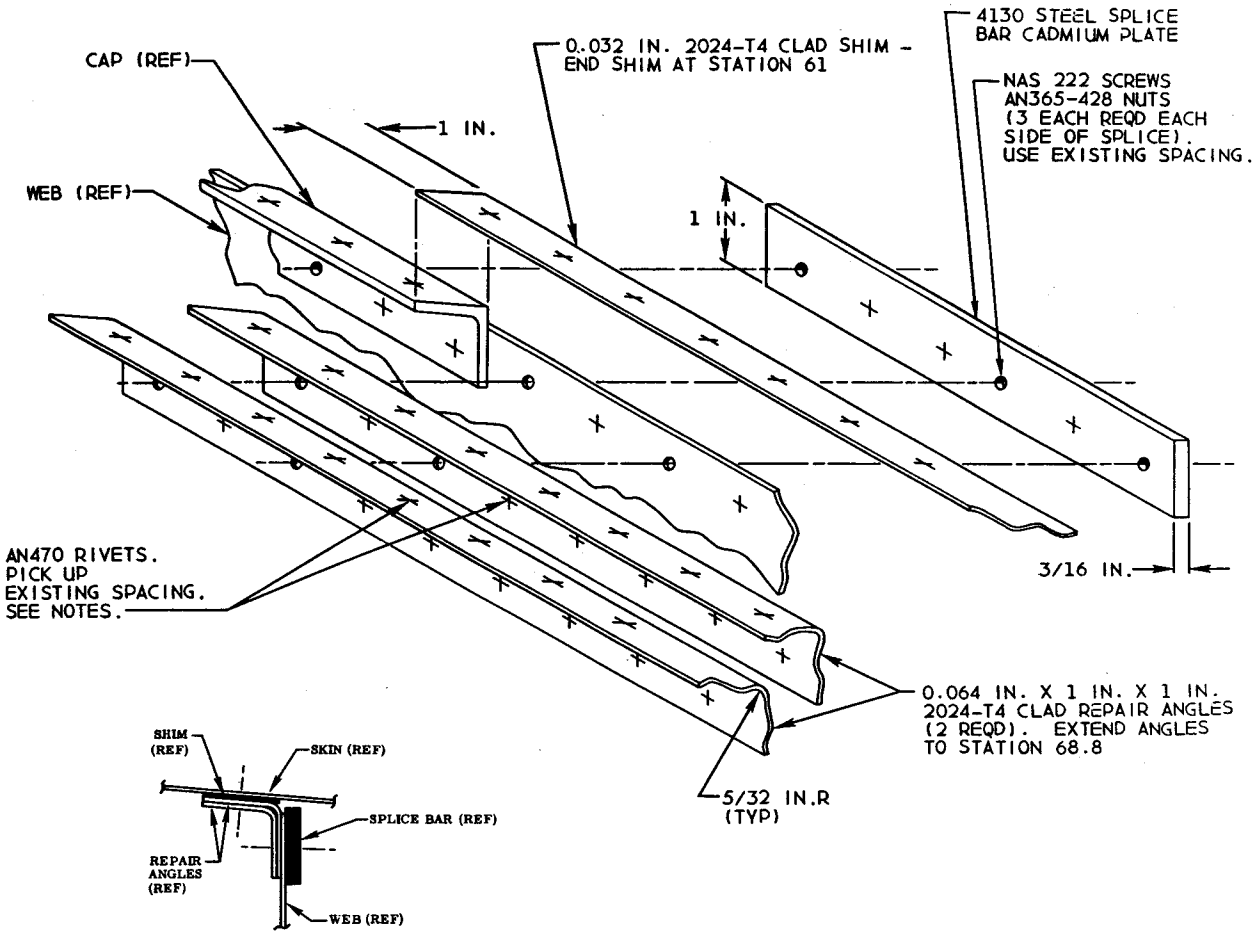


Figure 3-8. Rudder Cap Angle Repair



NOTE:

1. IF CAP IS DAMAGED INBOARD OF STATION 42.4, REPLACE IT.
2. MAINTAIN 5/16 IN. MIN EDGE DISTANCE ON RIVETS AND 1/2 IN. MIN EDGE DISTANCE ON SCREWS.
3. USE AN470AD5 RIVETS TO ATTACH ANGLES TO WEB FROM STATION 38.8 TO STATION 53.5; OUTBOARD OF STATION 53.5, USE AN470AD4 RIVETS.
4. USE AN470AD5 RIVETS TO ATTACH ANGLES TO SKIN OUT TO STATION 46; OUTBOARD OF STATION 46, USE AN470AD4 RIVETS.

T-28A-3-20-10

Figure 3-9. Vertical Stabilizer Front Beam Cap Splice

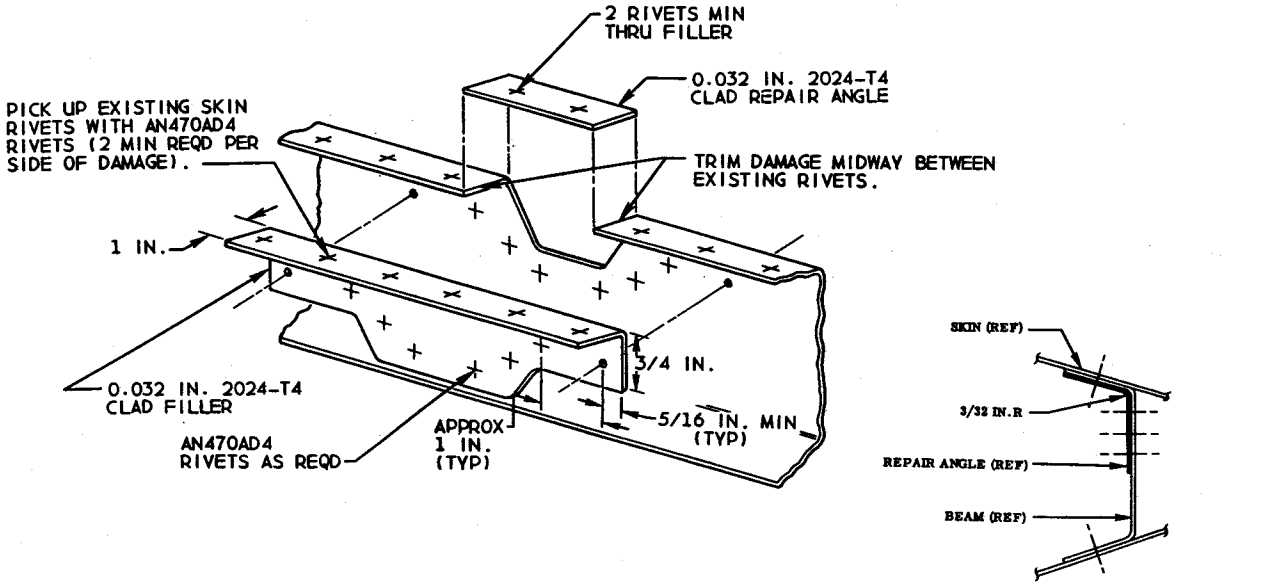


Figure 3-10. Horizontal Stabilizer Front Beam Flange and Web Repair

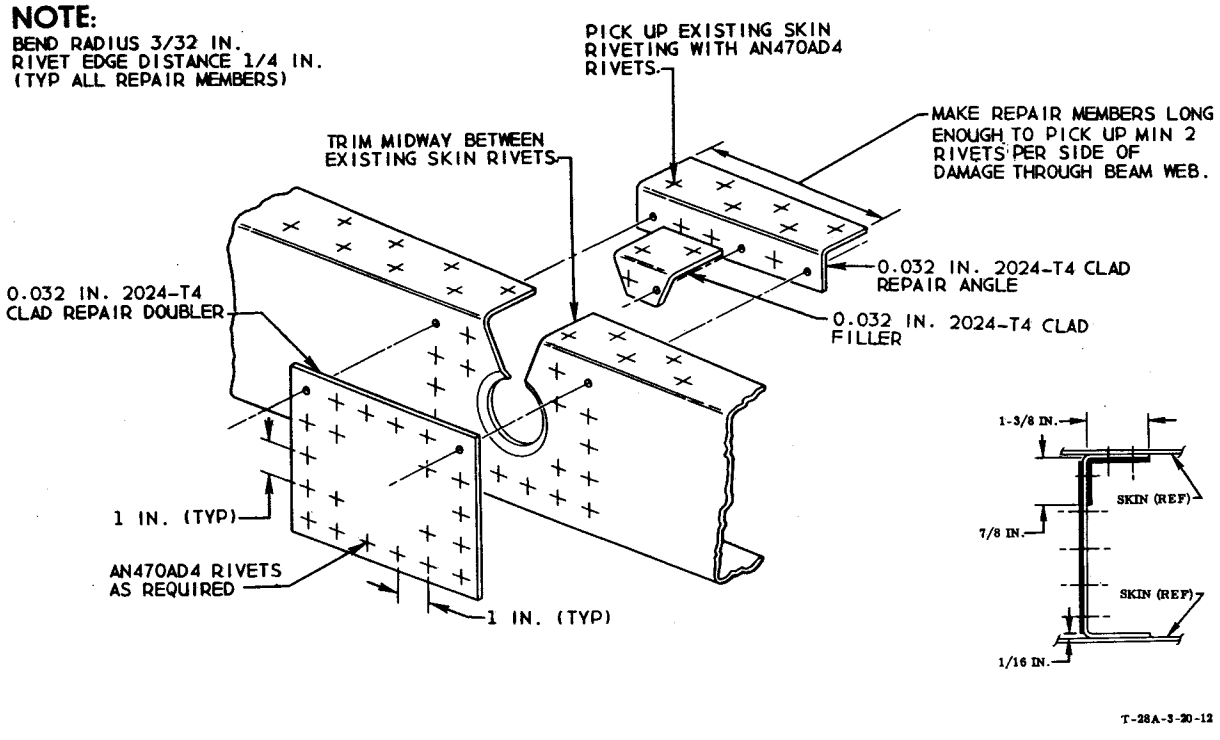


Figure 3-11. Vertical Stabilizer Rear Upper Beam Repair

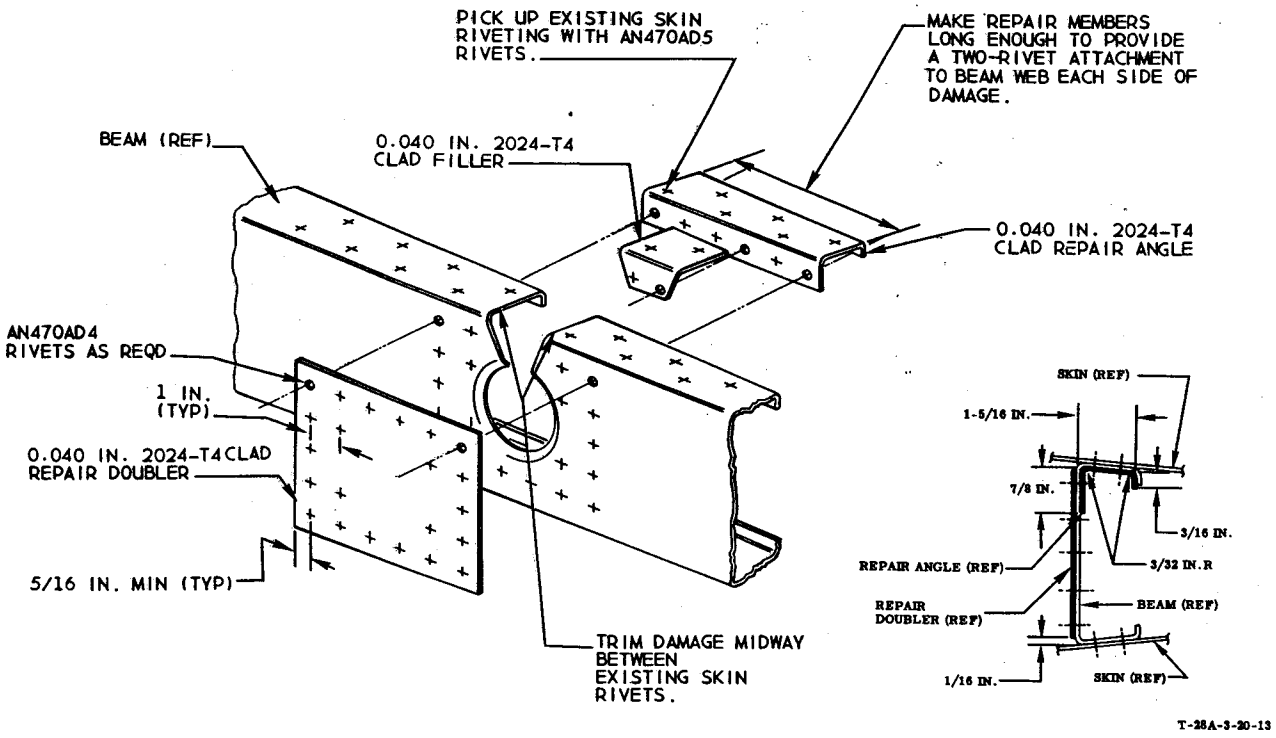


Figure 3-12. Vertical Stabilizer Rear Lower Beam Repair

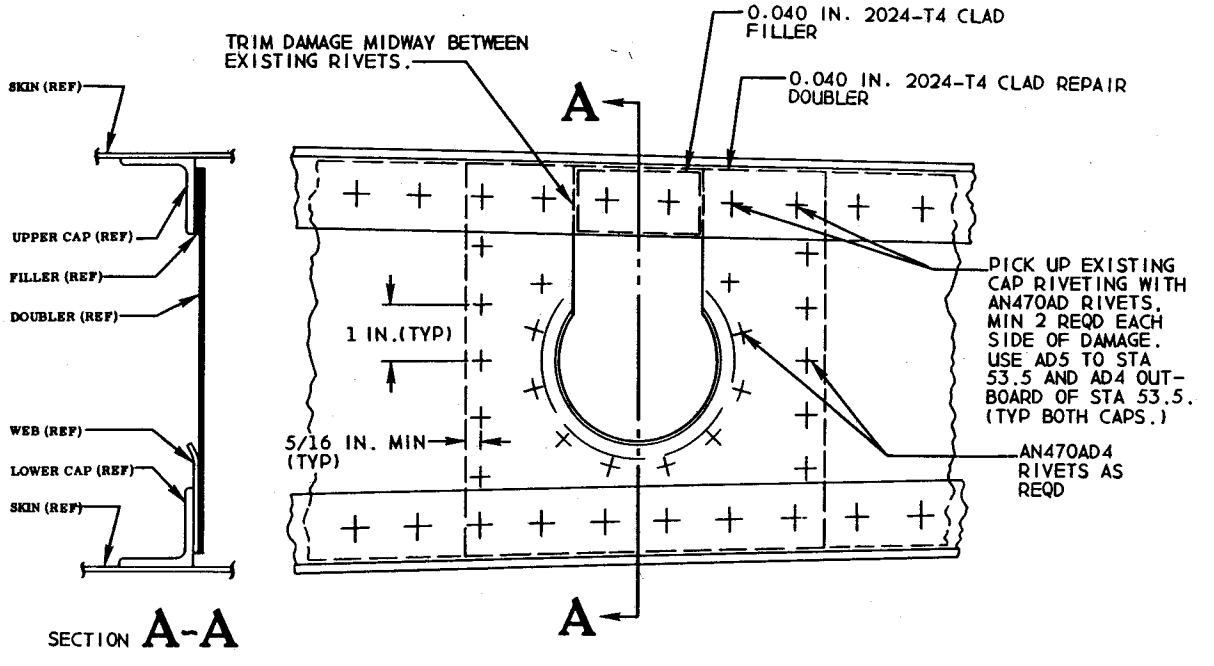
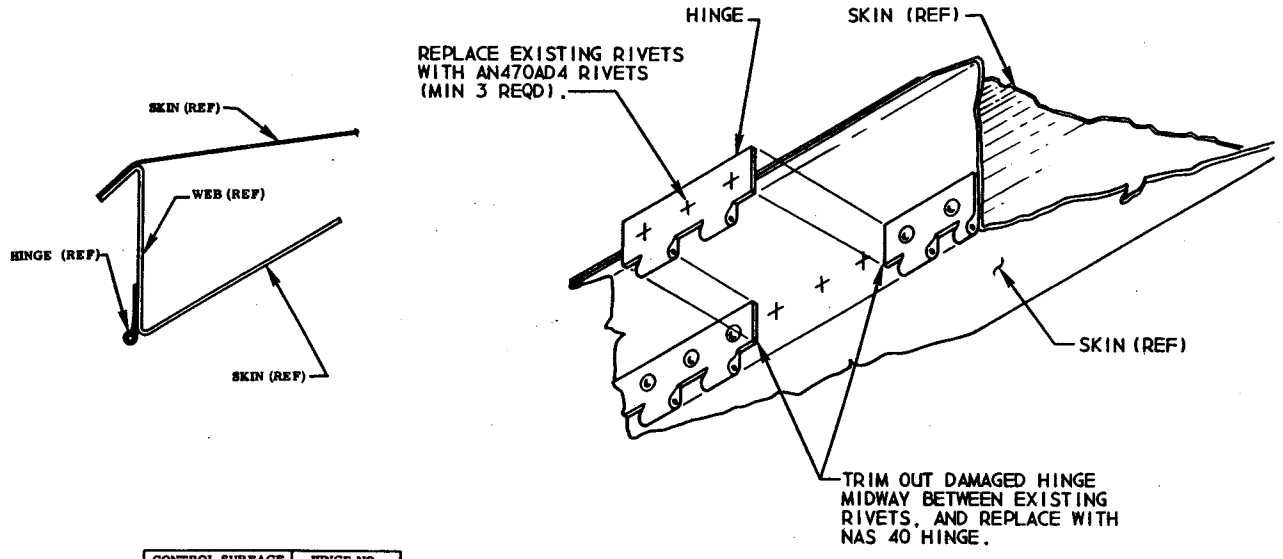


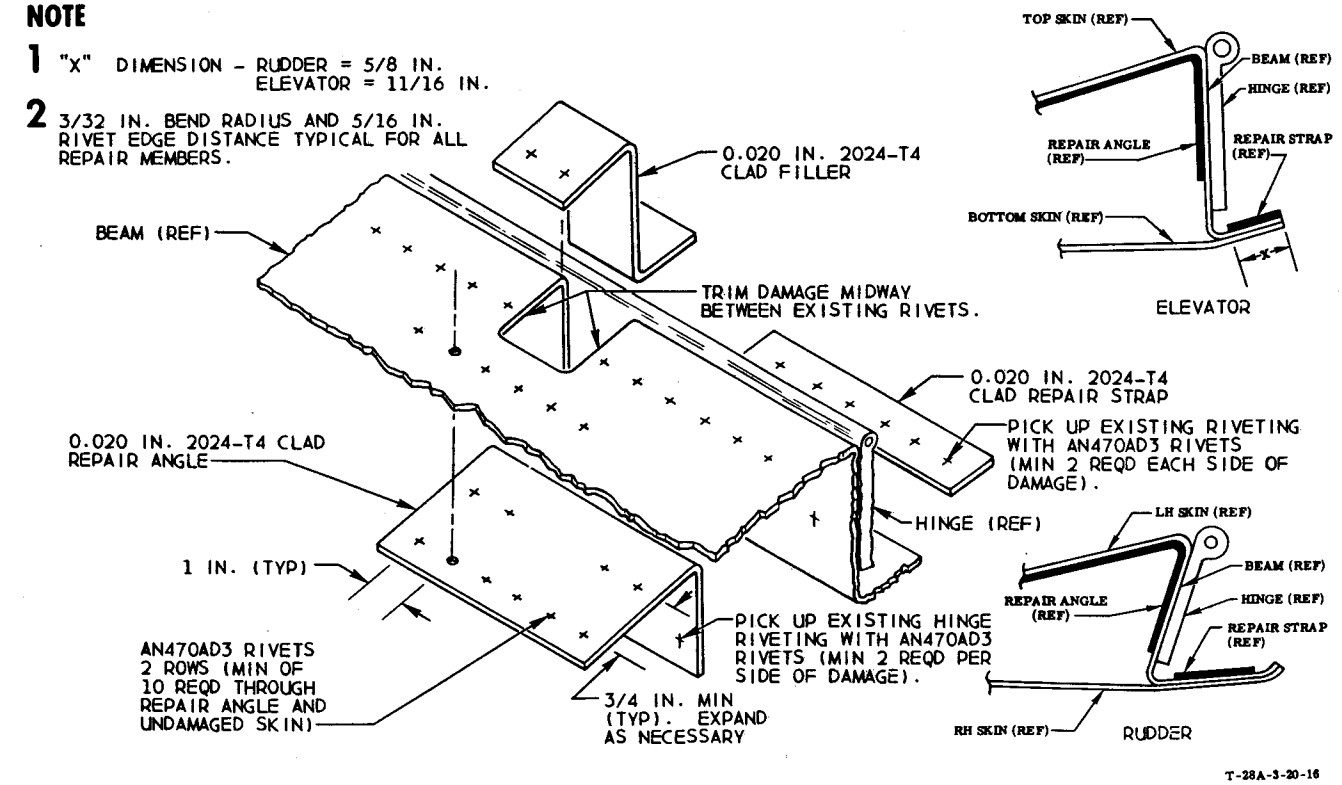
Figure 3-13. Vertical Stabilizer Front Beam and Horizontal Stabilizer Rear Beam Web Repair



CONTROL SURFACE	HINGE NO.
RUDDER	NAS 40-5A-TT
ELEVATOR	NAS 40-4A-TT

T-28A-3-20-15

Figure 3-14. Rudder and Elevator Trim Tab Hinge Repair



T-28A-3-20-16

Figure 3-15. Elevator and Rudder Trim Tab Beam Repair

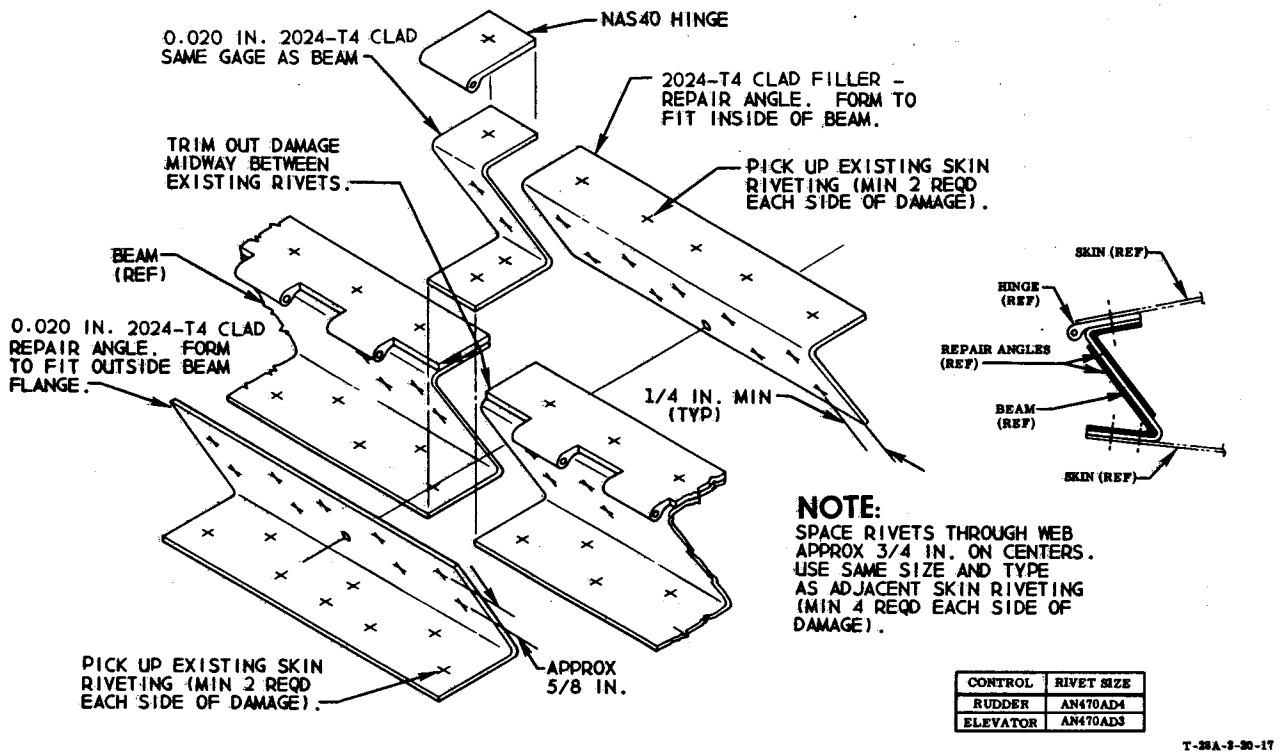


Figure 3-16. Elevator and Rudder Rear Beam Repair

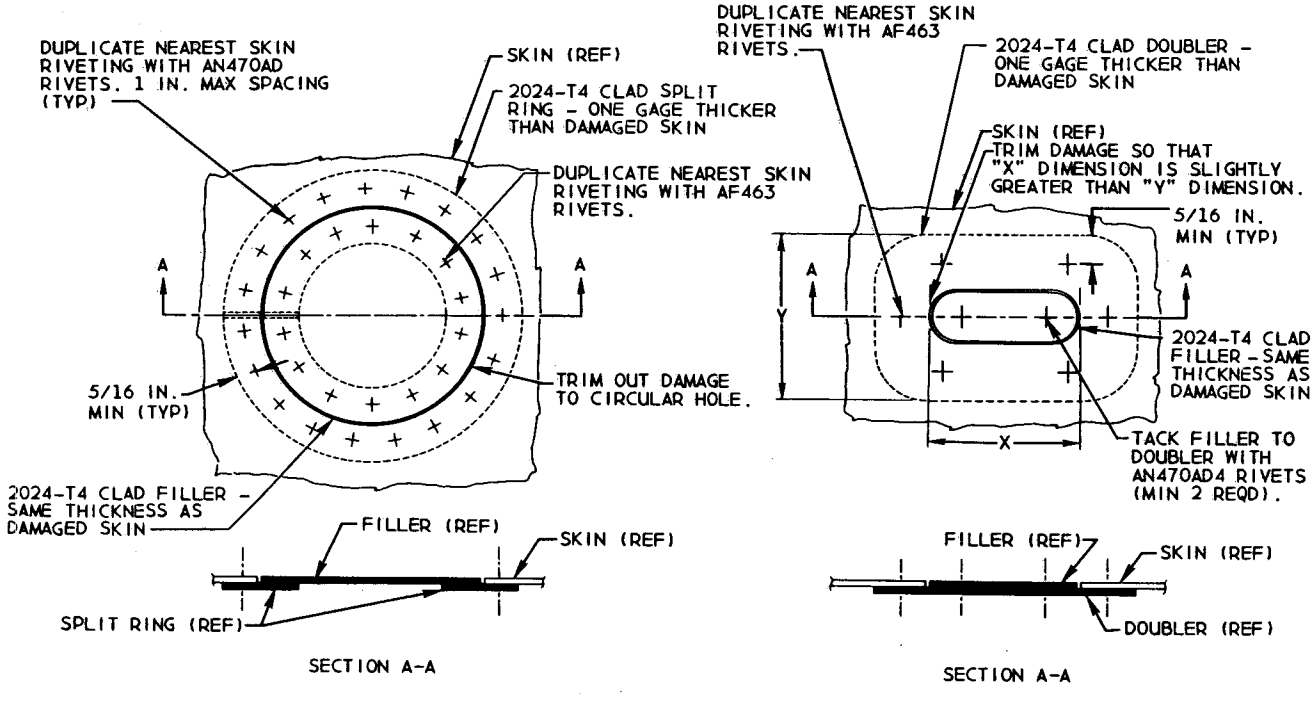


Figure 3-17. Flush Repair of Control Surface Skins

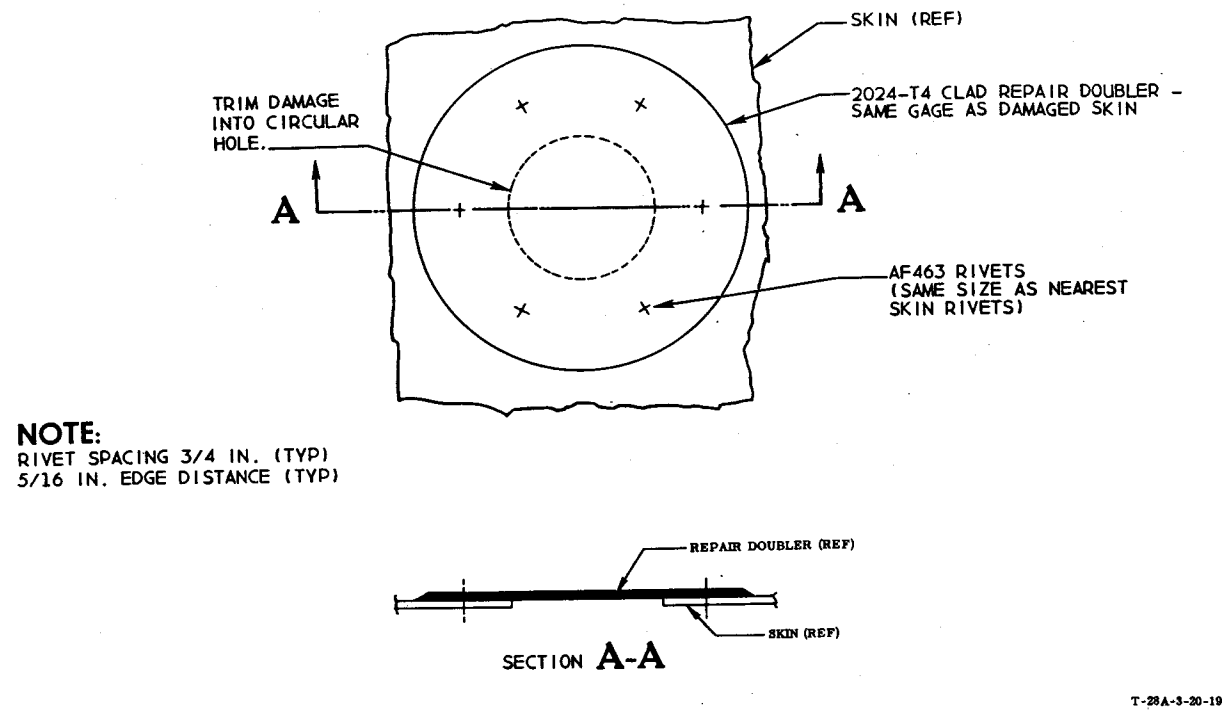


Figure 3-18. Nonflush Repair of Control Surface Skins

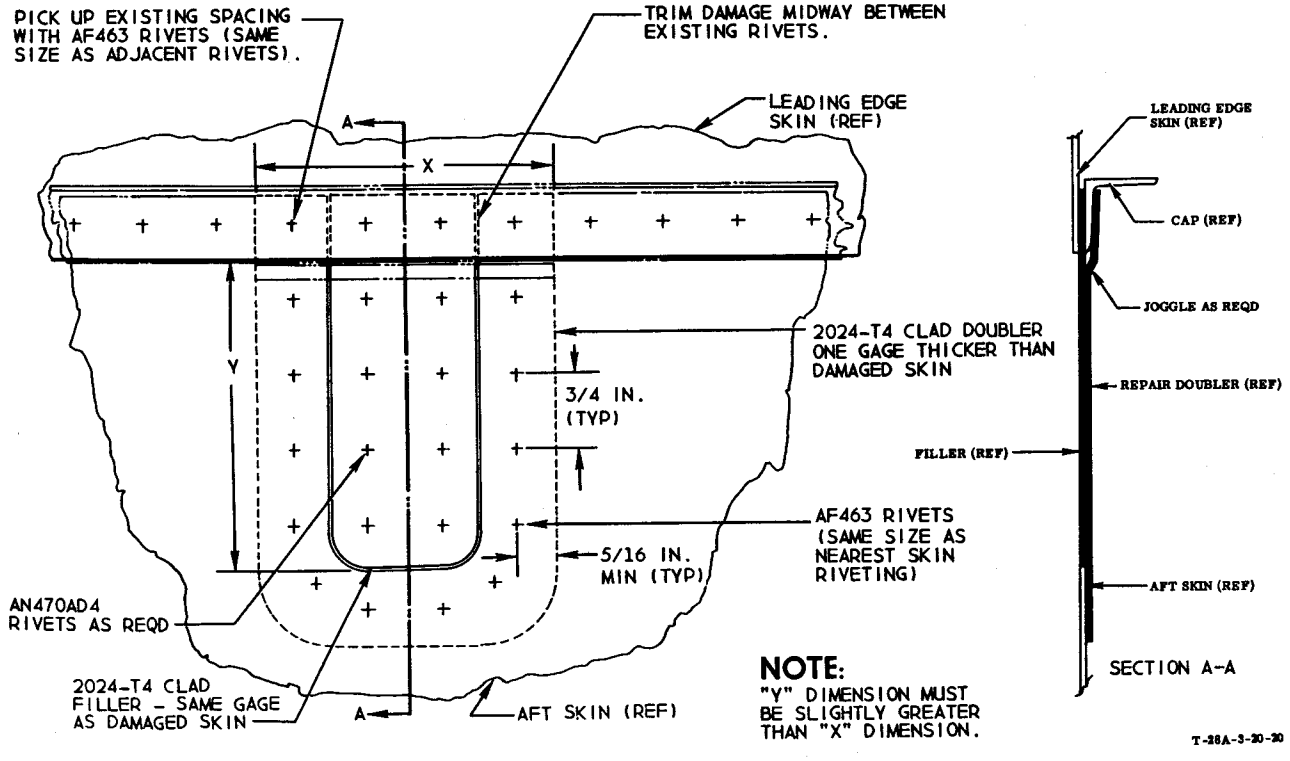


Figure 3-19. Flush Repair of Control Surface Aft Skins at Front Beams

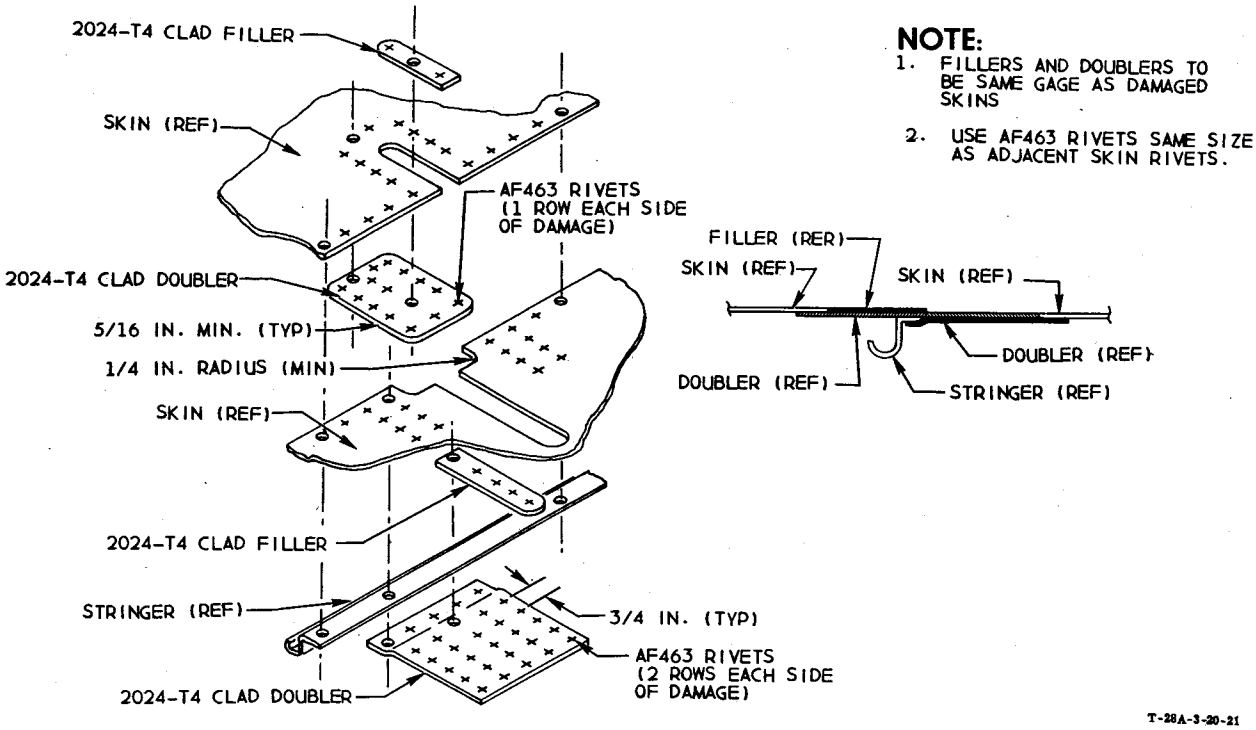


Figure 3-20. Flush Repair of Control Surface Leading Edge Skins at Front Beams

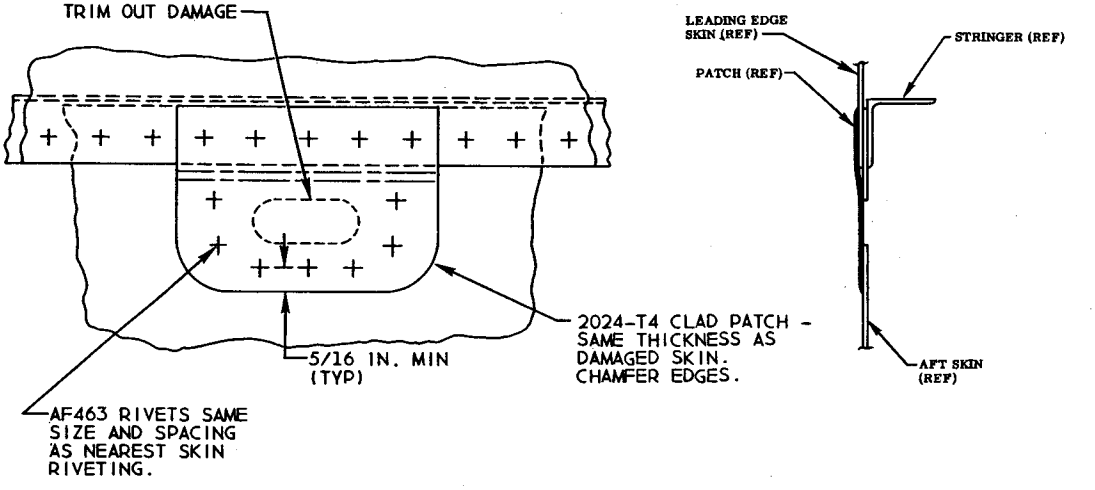


Figure 3-21. Nonflush Repair of Control Surface Aft Skins at Front Beams

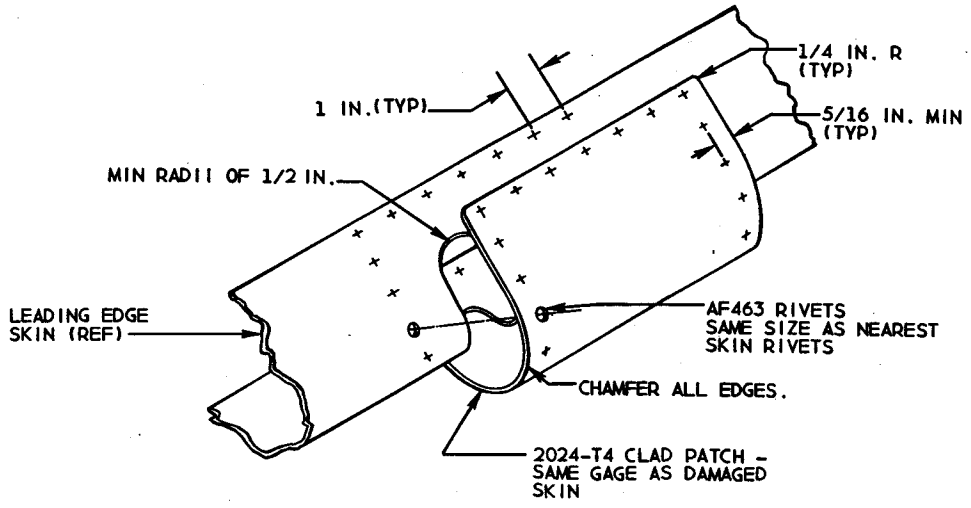
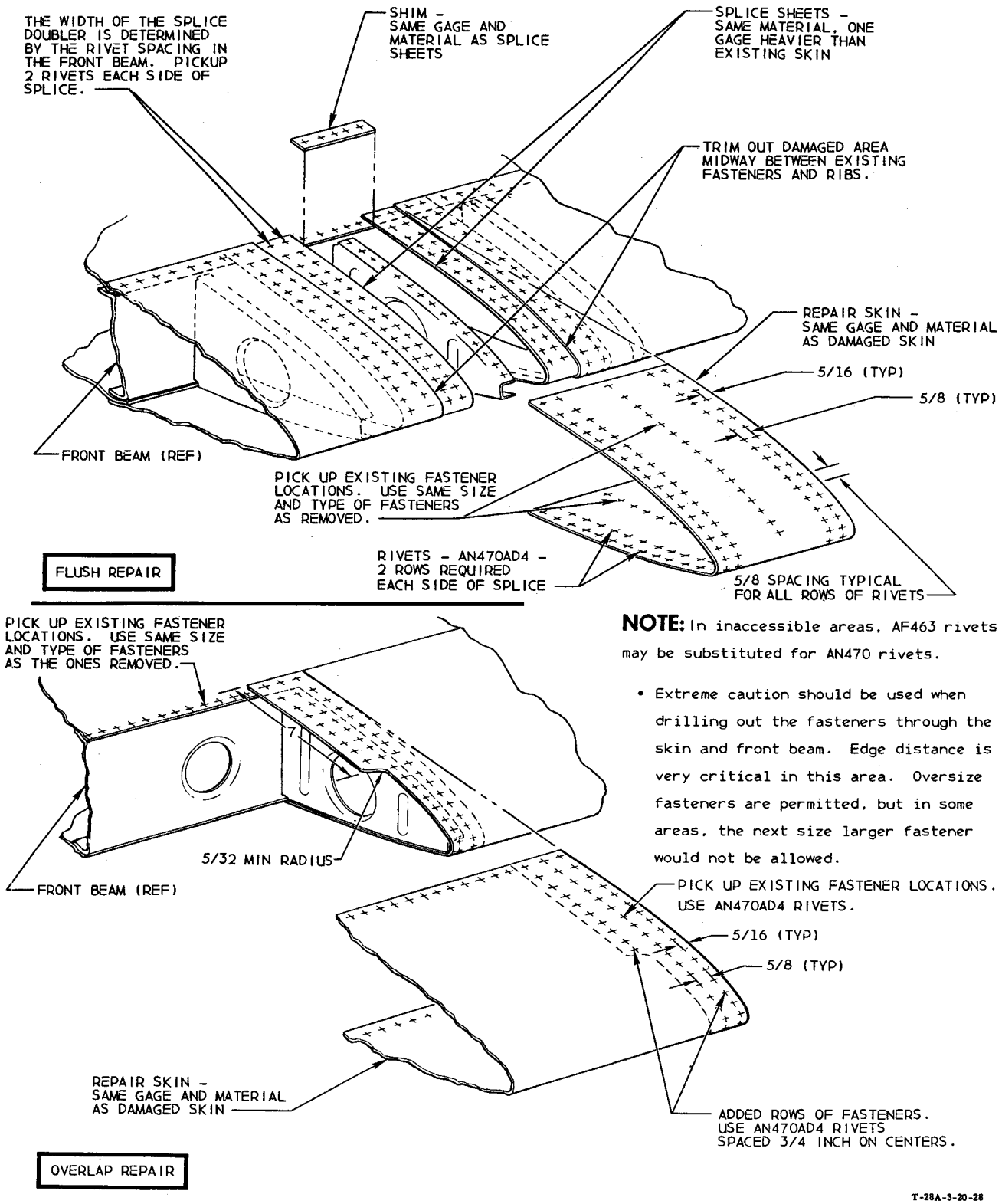


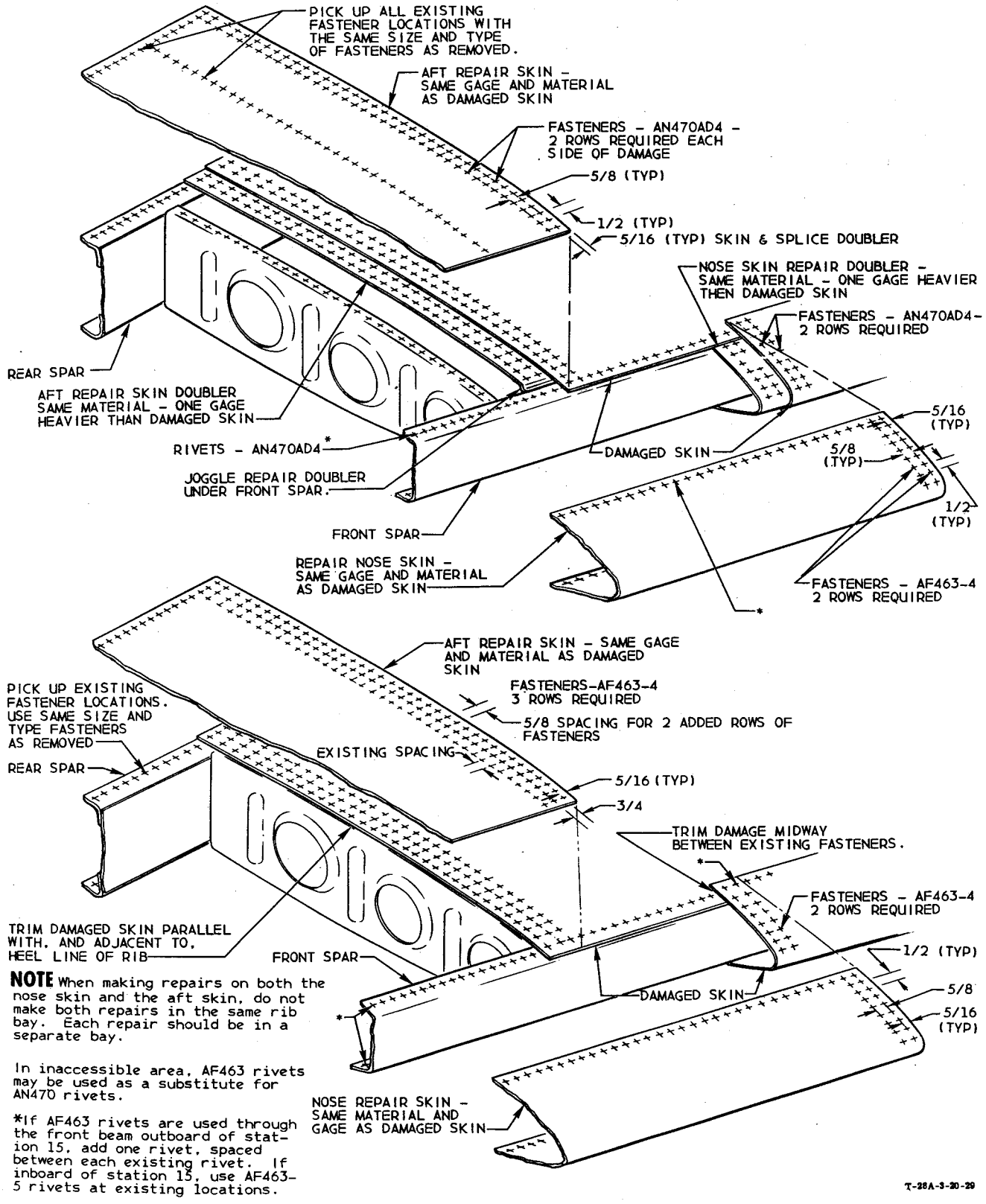
Figure 3-22. Nonflush Repair of Leading Edge Skins



NOTE: In inaccessible areas, AF463 rivets may be substituted for AN470 rivets.

- Extreme caution should be used when drilling out the fasteners through the skin and front beam. Edge distance is very critical in this area. Oversize fasteners are permitted, but in some areas, the next size larger fastener would not be allowed.

Figure 3-22A. Vertical Stabilizer Leading Edge Skin Splice



NOTE When making repairs on both the nose skin and the aft skin, do not make both repairs in the same rib bay. Each repair should be in a separate bay.

In inaccessible area, AF463 rivets may be used as a substitute for AN470 rivets.

*If AF463 rivets are used through the front beam outboard of station 15, add one rivet, spaced between each existing rivet. If inboard of station 15, use AF463-5 rivets at existing locations.

Figure 3-22B. Horizontal Stabilizer Skin Splice

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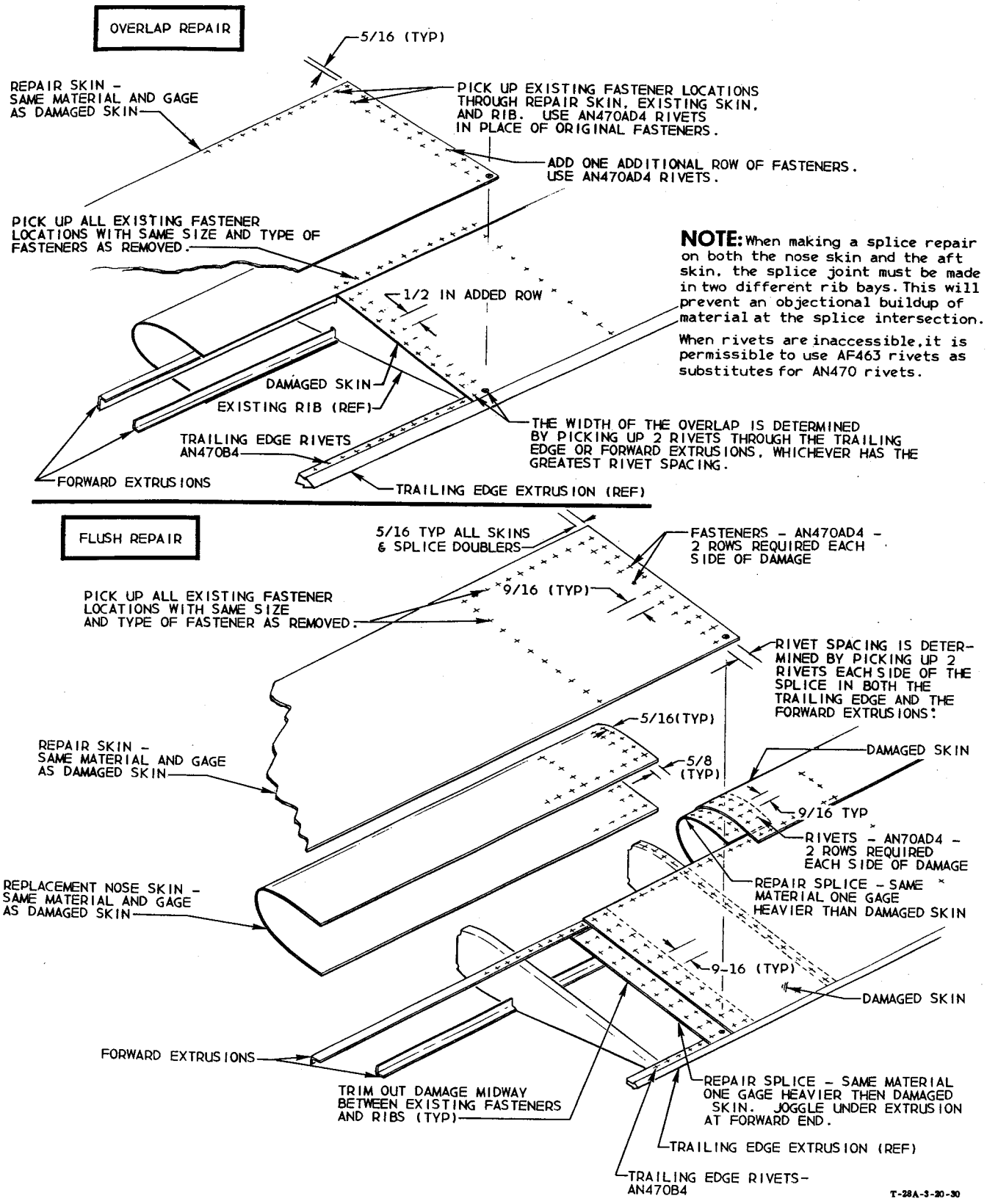

Figure 3-22C. Elevator Skin Splice

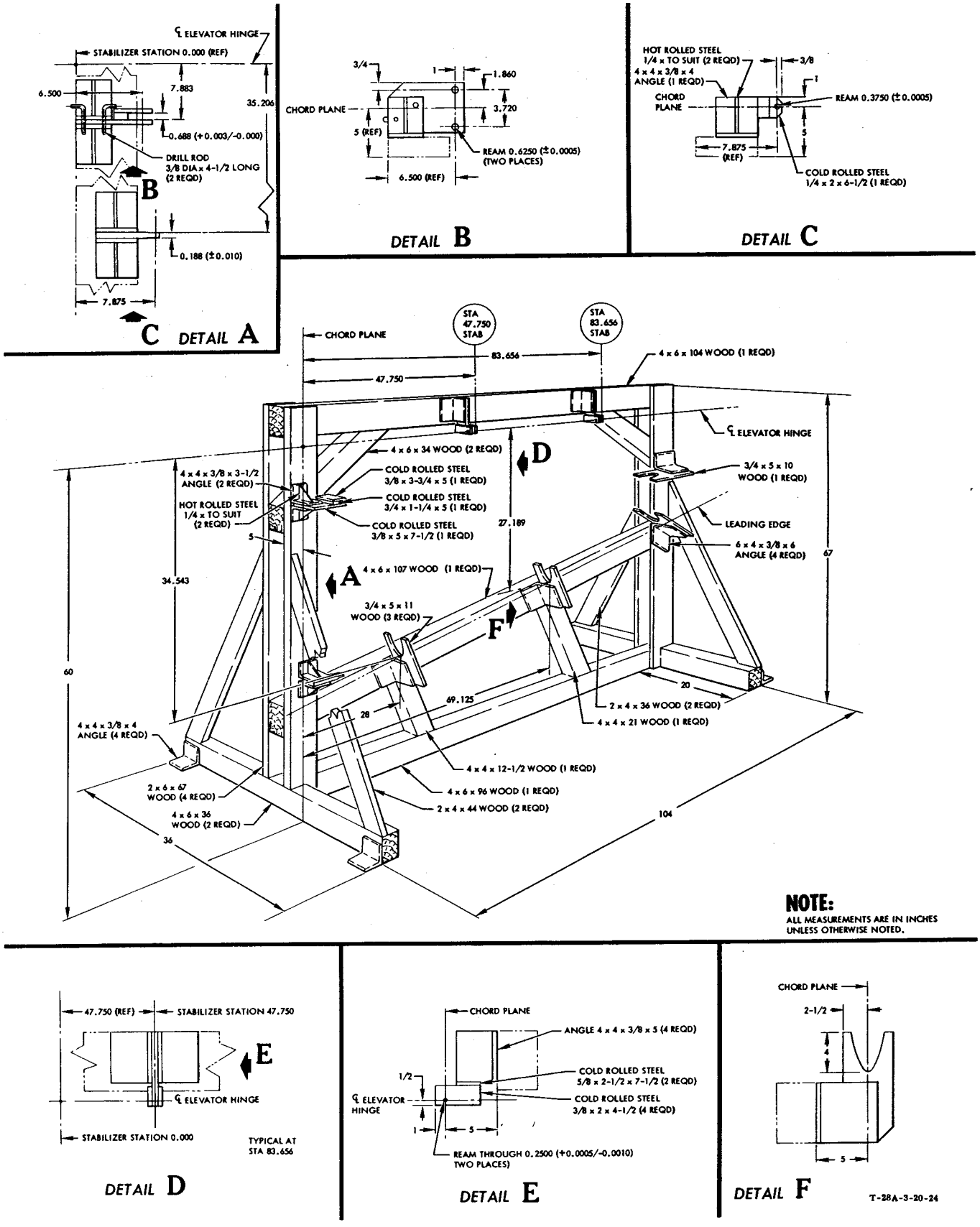

Figure 3-23. Horizontal Stabilizer Repair Jig

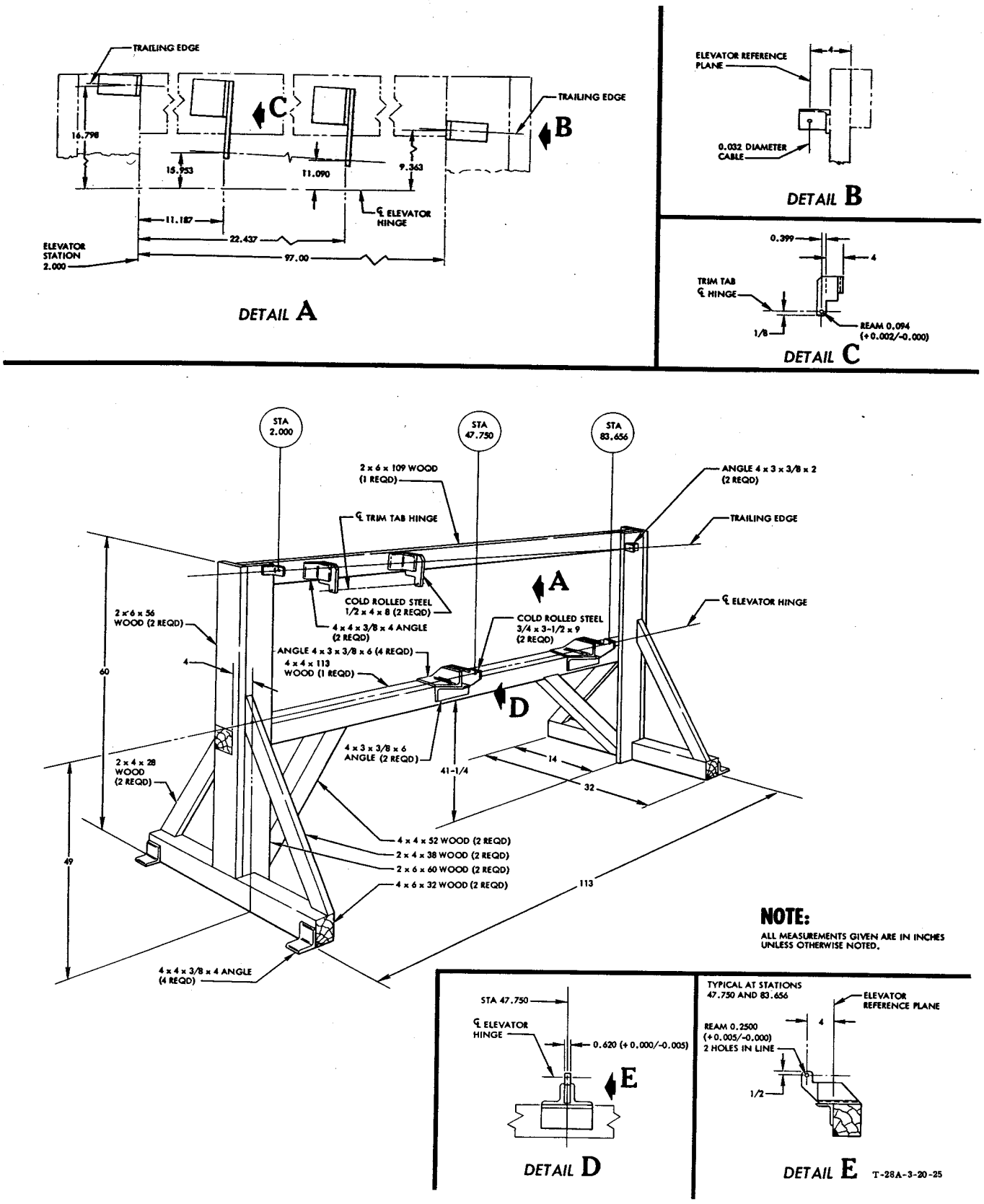

Figure 3-24. Elevator Repair Jig

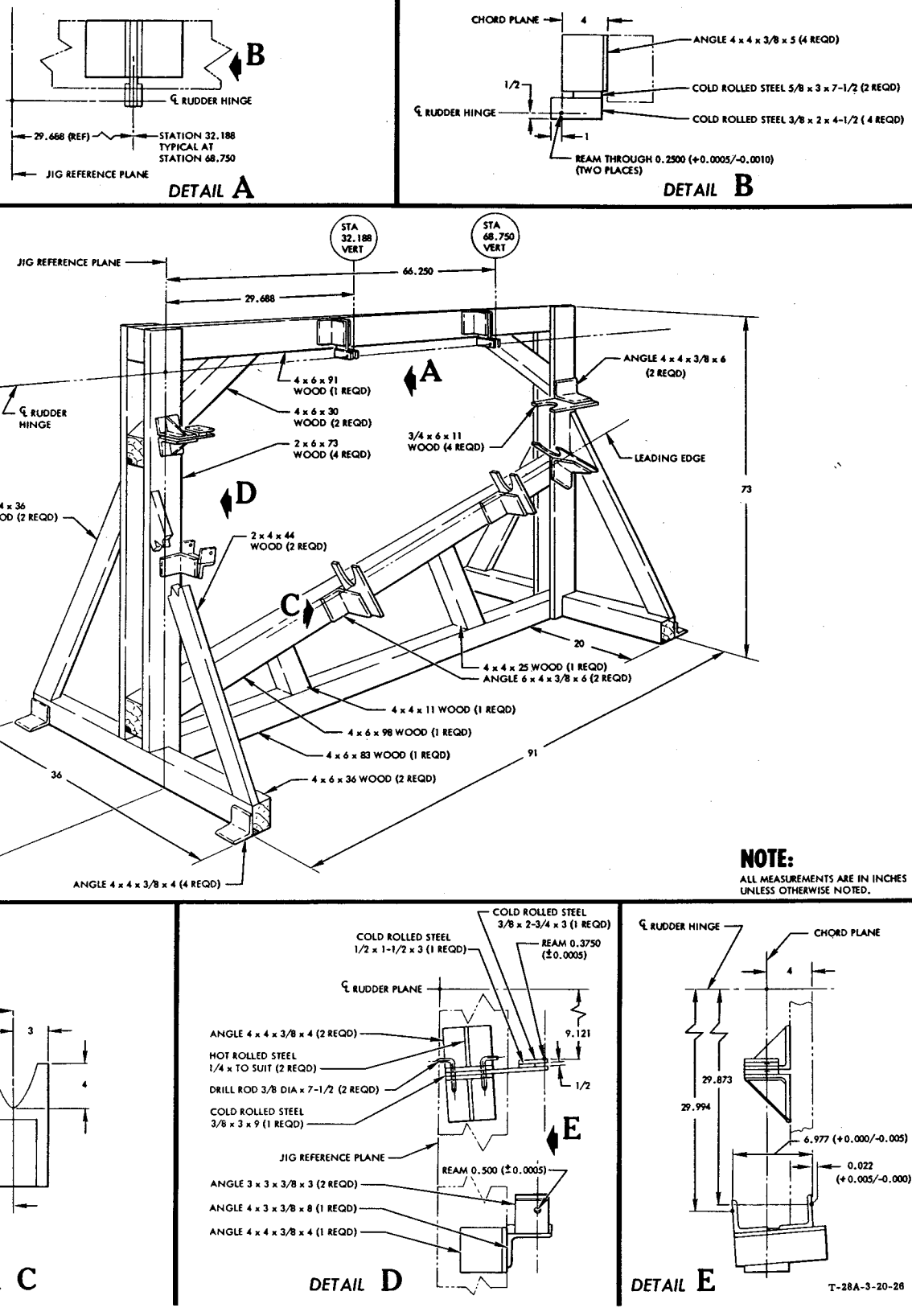

Figure 3-25. Vertical Stabilizer Repair Jig

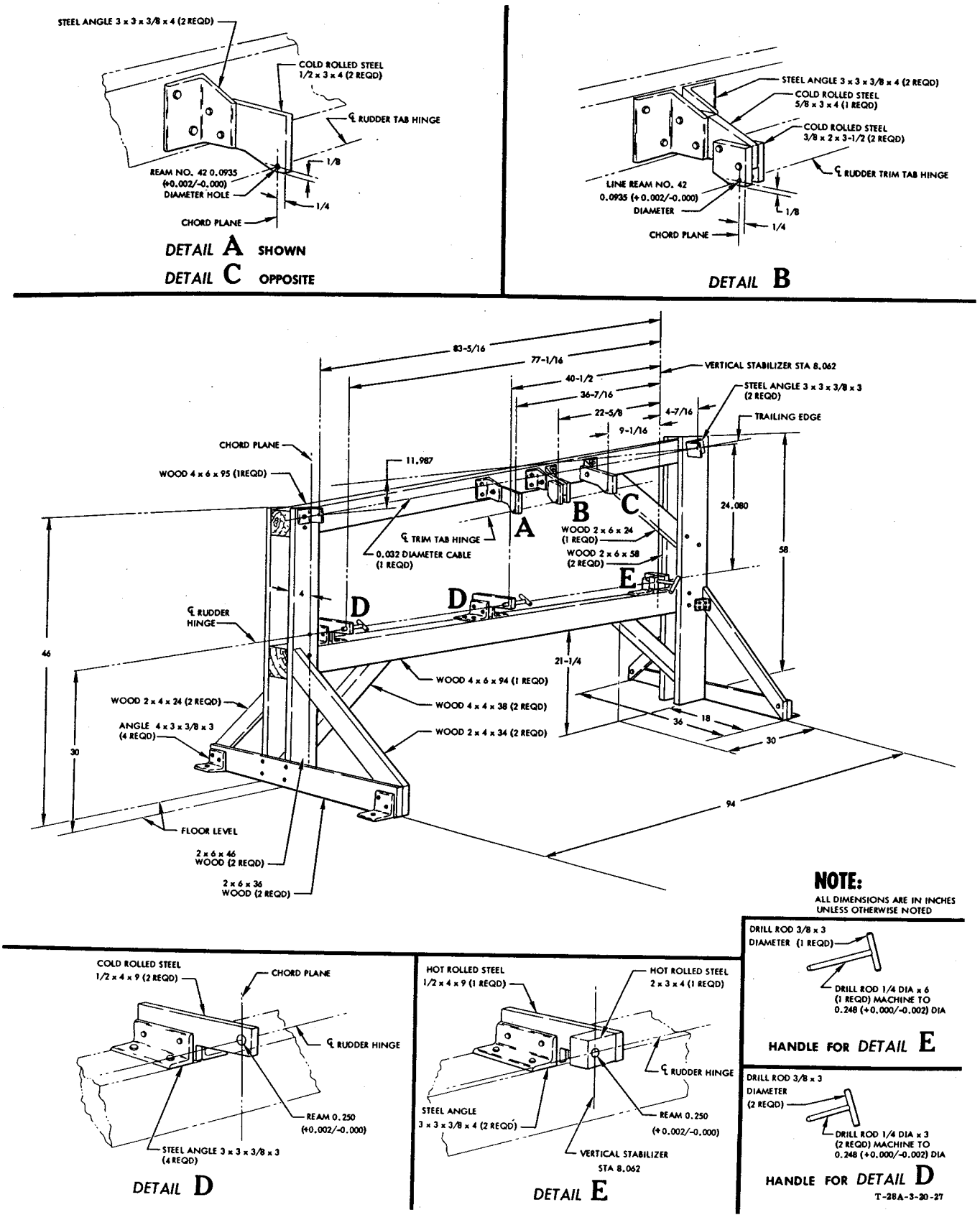

Figure 3-26. Rudder Repair Jig

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SECTION IV

FUSELAGE

FUSELAGE.

The fuselage is of semimonocoque construction. There are four main longerons, interconnected by transverse frames supporting the skins. The longerons are 7075-T6 aluminum alloy throughout, but the frames and skins are 2024-T4 and 7075-T6 clad aluminum alloy. All external rivets are the brazier head type with the exception of those in the upper longerons from fuselage station 78 to fuselage station 168. Rivets in the upper longerons are flushed to clear the canopy skirt. From the fire wall to the aft seat bulkhead, the fuselage is an open section. Side load is carried by the cockpit floor, and any torsional moment is resisted by differential bending of the side panels.

FUSELAGE FORWARD SECTION.

The fuselage forward section, from fuselage station 26 to fuselage station 238-7/8, includes the nose gear support beams and nose wheel well, windshield, canopy assembly, cockpits, and baggage compartment. The nose gear support beams are cantilevered forward from the fire wall and extend aft to the lower bulkhead at fuselage station 95-3/4. The nose gear drag brace is attached to the left beam only, just forward of the fire wall. The beam caps are 7075-T6 aluminum alloy extruded sections. The beam webs and the webs between the two beams forward of the fire wall, with the exception of the 2024-T4 aluminum alloy lower web along the fuselage mold line, are corrosion-resistant steel. Aft of the fire wall, the webs are 2024-T4 and 7075-T6 clad aluminum alloy. The wing is attached to the fuselage with four tension bolts at the front and rear wing spars and two adjustable links at the wing leading edge torque section. Front and rear spar loads are taken into the fuselage by double side frames, while the leading edge attachment is resisted by a single side frame only. All drag from the wing is taken by the front spar attachment because the rear spar attachment is drilled oversize to relieve stresses in the wing from fuselage deflections. The canopy assembly is made up of a forward and a rear canopy interconnected with steel cables and actuated by a single hydraulic strut. Each canopy moves on rollers in a steel "C" section track. For ease of maintenance, the windshield assembly is attached to the upper longerons and fire wall by bolts.

TAIL CONE SECTION.

The tail cone section is attached to the fuselage forward section with four tension bolts, one at each longeron. These bolts carry both fuselage shear loads and bending loads. The horizontal tail attaches to the tail cone section at the horizontal stabilizer front beam with two bolts that resist only shear, and at the horizontal stabilizer rear beam with four bolts to a fitting attached to the fuselage by two bolts that resist both stabilizer shear and bending moment. Rotational moment of the rear beam attachment fitting is resisted by two struts. One end of each strut is attached to the top of the attachment fitting; the other end, to the fuselage upper deck.

WINDSHIELD.

The windshield assembly consists of three panels. The center panel is made up of laminated glass (Specification MIL-G-7767, Type 1, Grade A). The windshield assembly side panels are made up of acrylic sheet 0.312 inch thick. Refer to Handbook of Maintenance Instructions, T.O. 1T-28A-2, for information on removal, replacement, and maintenance of the windshield.

WINDSHIELD REPAIR.

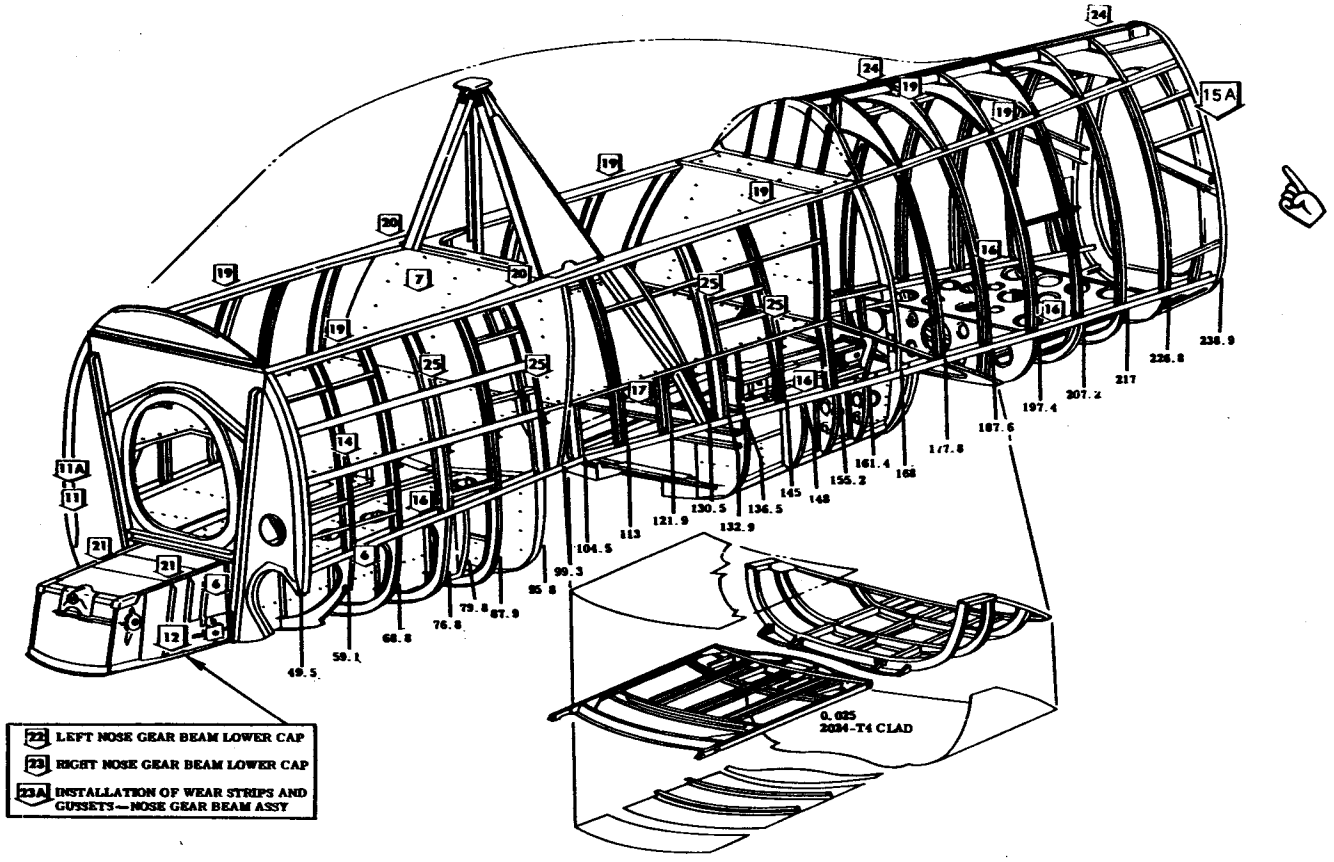
If a windshield is damaged, replacement of the windshield is determined by the severity of the cracks, scratches, etc. Prescribing the point at which a windshield should be replaced is a rather difficult type of information to present because of the many variable factors which must be considered. Therefore, it is the responsibility of personnel closely associated with the airplane to determine whether or not the windshield is to be replaced. Factors that must be considered when evaluating the damage are pilot's visibility and efficiency, and the effects of the damage on the structural strength of the windshield. Scratches have a tendency to develop into cracks, which become progressively larger and can result in possible structural failure. Therefore, damage that is considered negligible and is permitted to remain "as is" should be continually checked for enlargement.

CANOPY.

The canopy is a two-piece structure fabricated from acrylic plastic. The nominal thickness of the plastic is 0.250 inch; however, after working, the finished thickness is slightly less. The canopy is attached to the canopy frame with bolts through the glass thickness-fabric-reinforced edge. One paramount characteristic of acrylic plastic, which is similar to plate glass, is its optical quality. In addition, the use of acrylic plastic provides a relatively light weight versus strength characteristic, ease of fabrication, and relative safety. Refer to Handbook of Maintenance Instructions, T.O. 1T-28A-2, for information on operation, removal, replacement, and maintenance of the canopy.

CANOPY REPAIR.

Refer to Section VII.



00 REPAIR FIGURE NUMBER (THESE INDEX NUMBERS CONTAIN THE FIGURE NUMBERS OF THE DETAIL REPAIR ILLUSTRATIONS WITHIN THIS SECTION OF THE HAND BOOK).

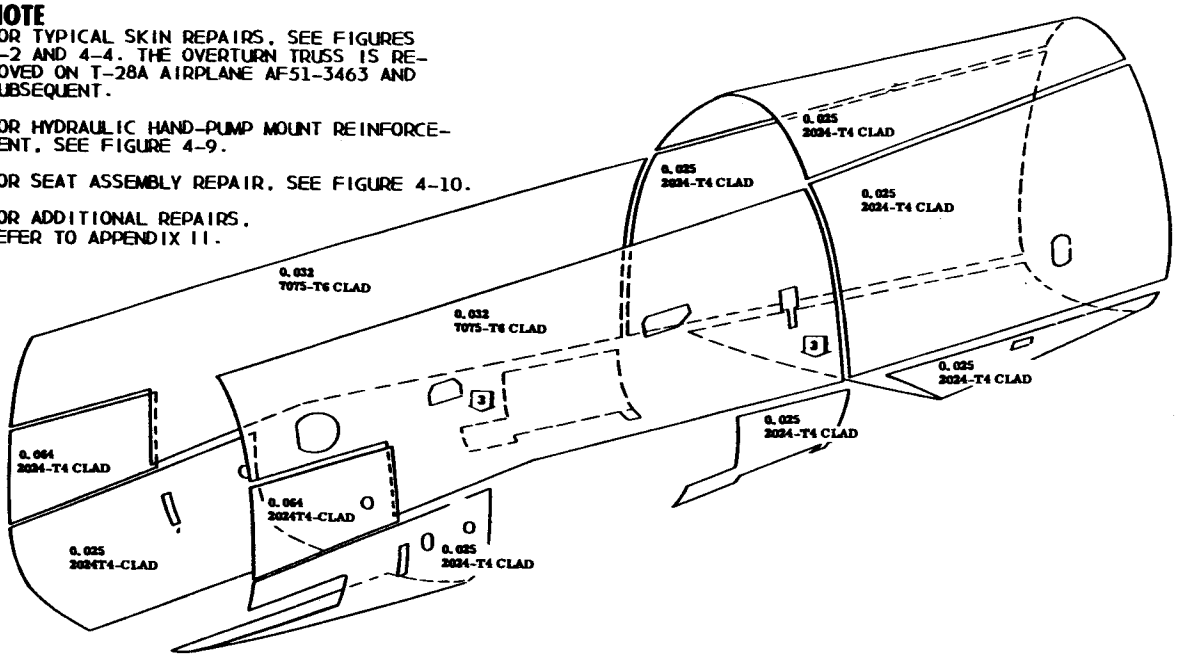
NOTE

FOR TYPICAL SKIN REPAIRS, SEE FIGURES 4-2 AND 4-4. THE OVERTURN TRUSS IS REMOVED ON T-28A AIRPLANE AF51-3463 AND SUBSEQUENT.

FOR HYDRAULIC HAND-PUMP MOUNT REINFORCEMENT, SEE FIGURE 4-9.

FOR SEAT ASSEMBLY REPAIR, SEE FIGURE 4-10.

FOR ADDITIONAL REPAIRS, REFER TO APPENDIX II.



T-28A-3-31-7C

Figure 4-1. Body Group Repair Index — T-28A, T-28B, and T-28D Airplanes (Sheet 1 of 2)

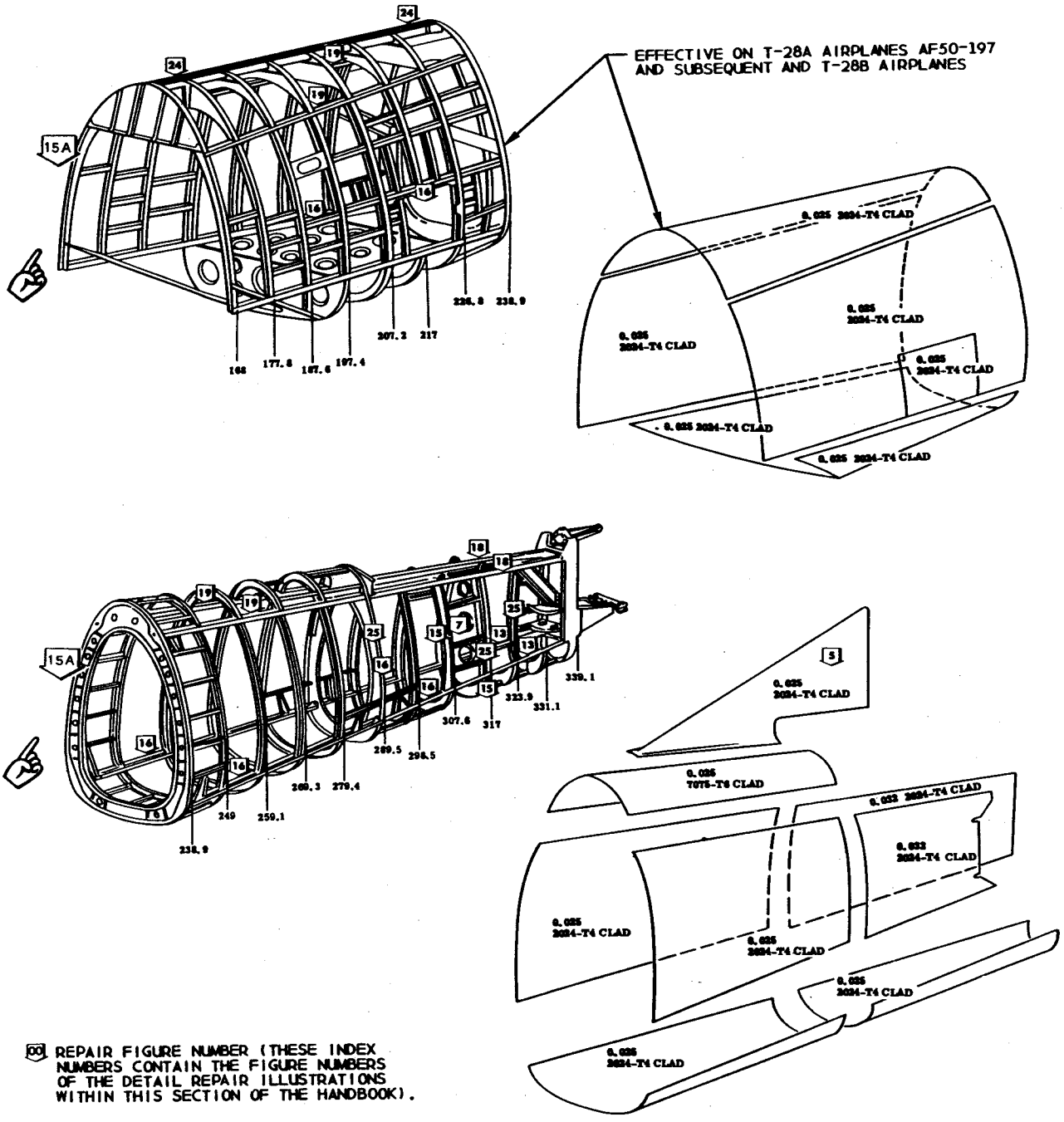


Figure 4-1. Body Group Repair Index — T-28A, T-28B, and T-28D Airplanes (Sheet 2 of 2)

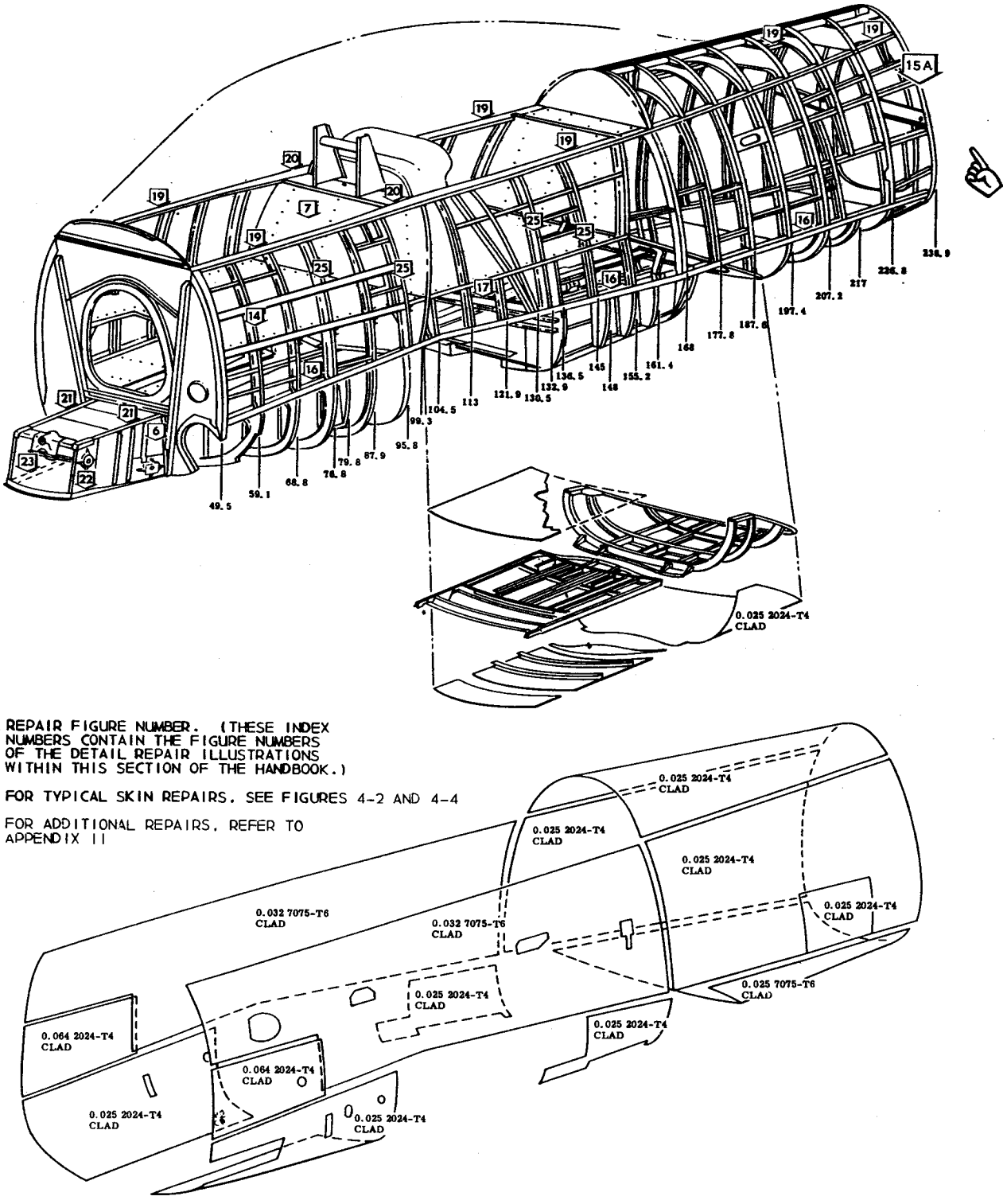


Figure 4-1A. Body Group Repair Index – T-28C Airplanes (Sheet 1 of 2)

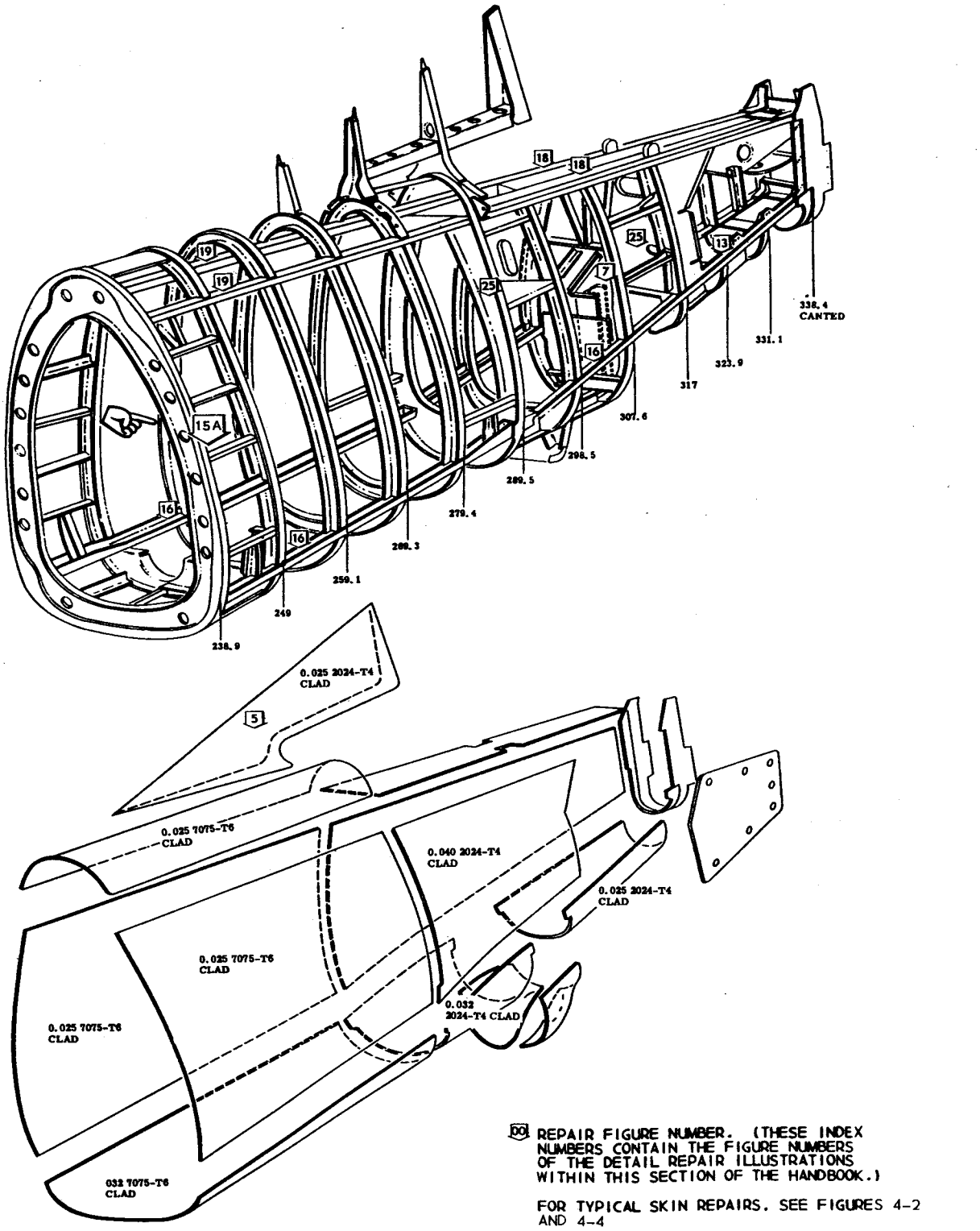
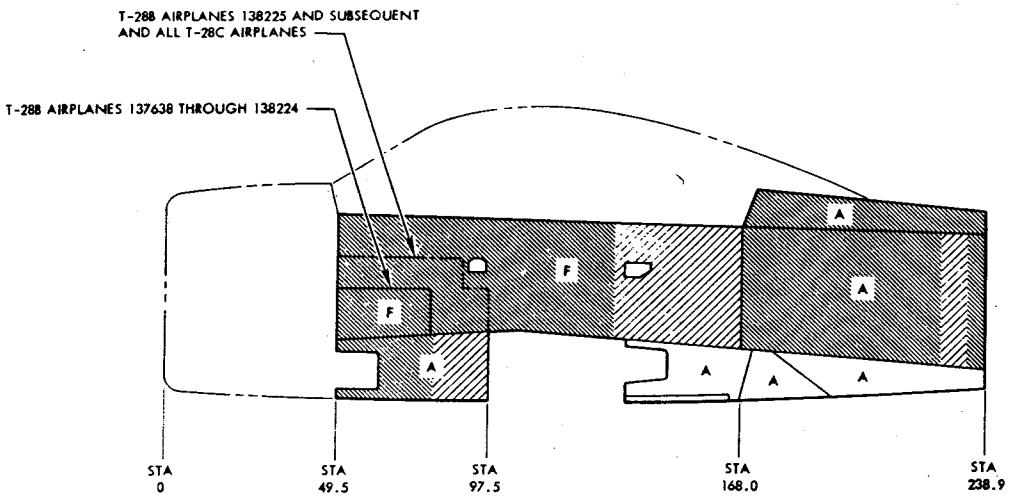
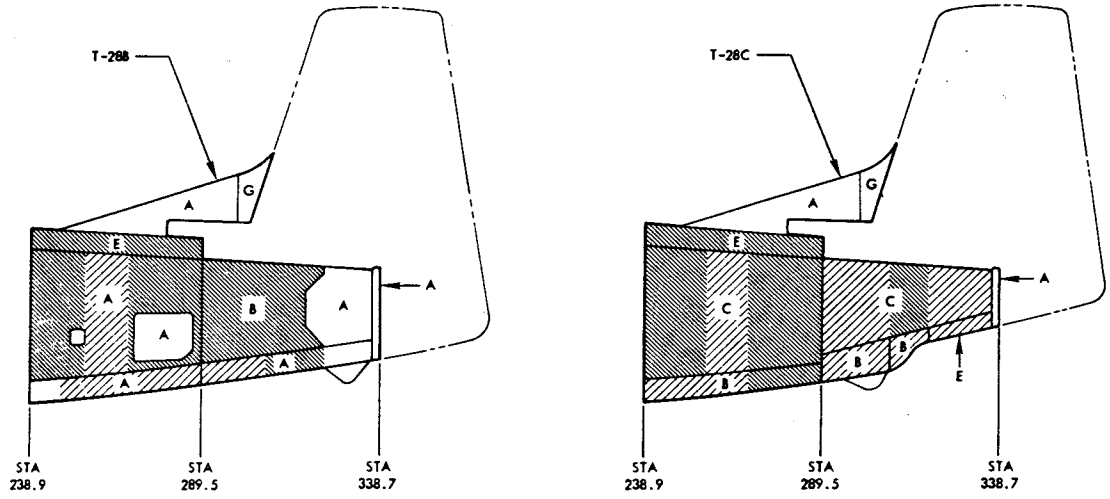


Figure 4-1A. Body Group Repair Index — T-28C Airplanes (Sheet 2 of 2)



FORWARD FUSELAGE SECTION

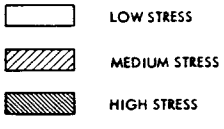
LEFT-HAND SIDE SHOWN
RIGHT-HAND SIDE (TYP)



AFT FUSELAGE SECTION

LEFT-HAND SIDE SHOWN
RIGHT-HAND SIDE (TYP)

REF NO.	GAGE	MATERIAL
A	0.025	2024-T4 CLAD
B	0.032	2024-T4 CLAD
C	0.040	2024-T4 CLAD
D	0.064	2024-T4 CLAD
E	0.025	7075-T6 CLAD
F	0.032	7075-T6 CLAD
G	0.025	5052-O AL ALLOY



T-28B-3-31-1

Figure 4-1B. Skin Stress Diagram — Fuselage — T-28B and T-28C Airplanes

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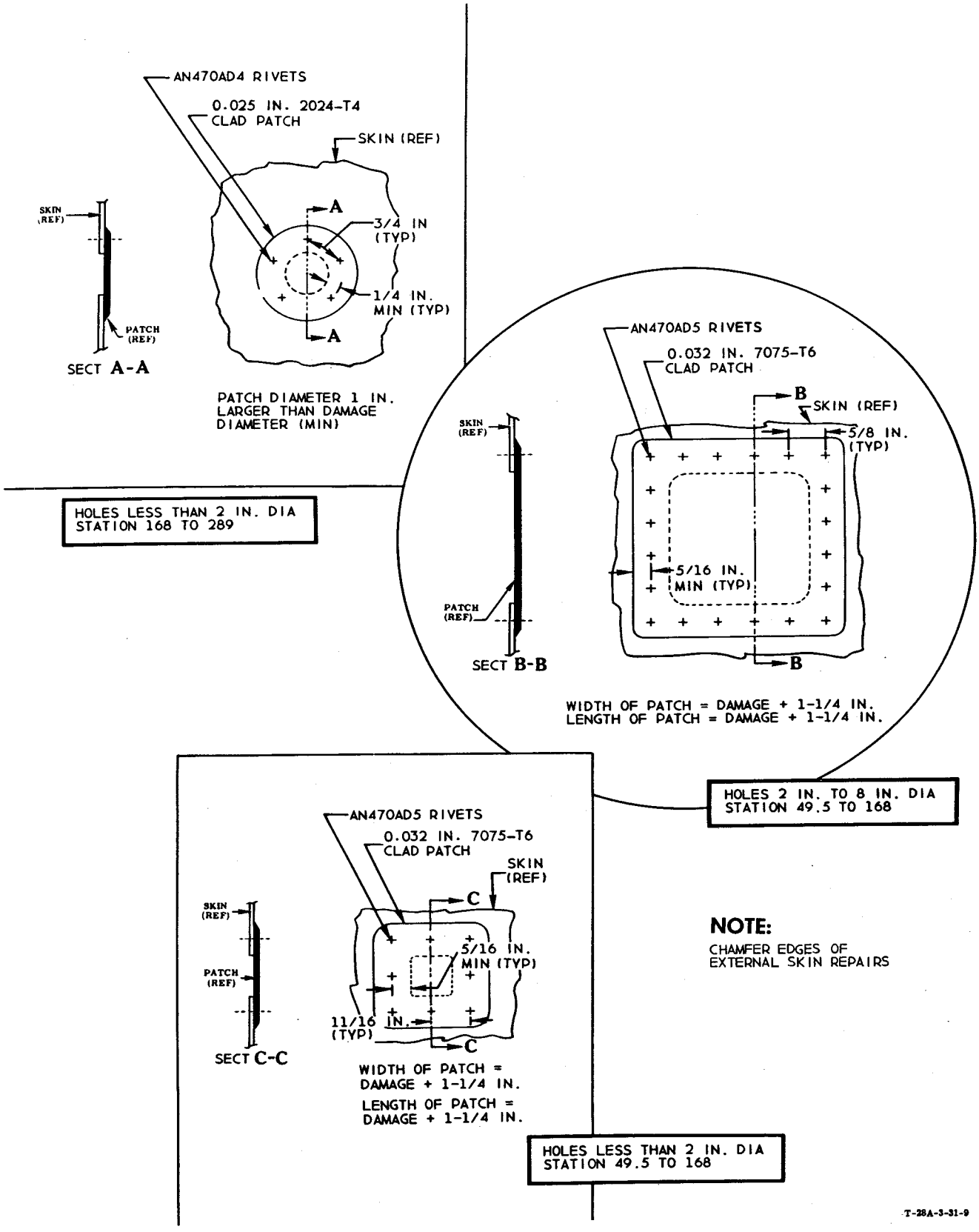


Figure 4-2. Nonflush Skin Repairs for Small Holes

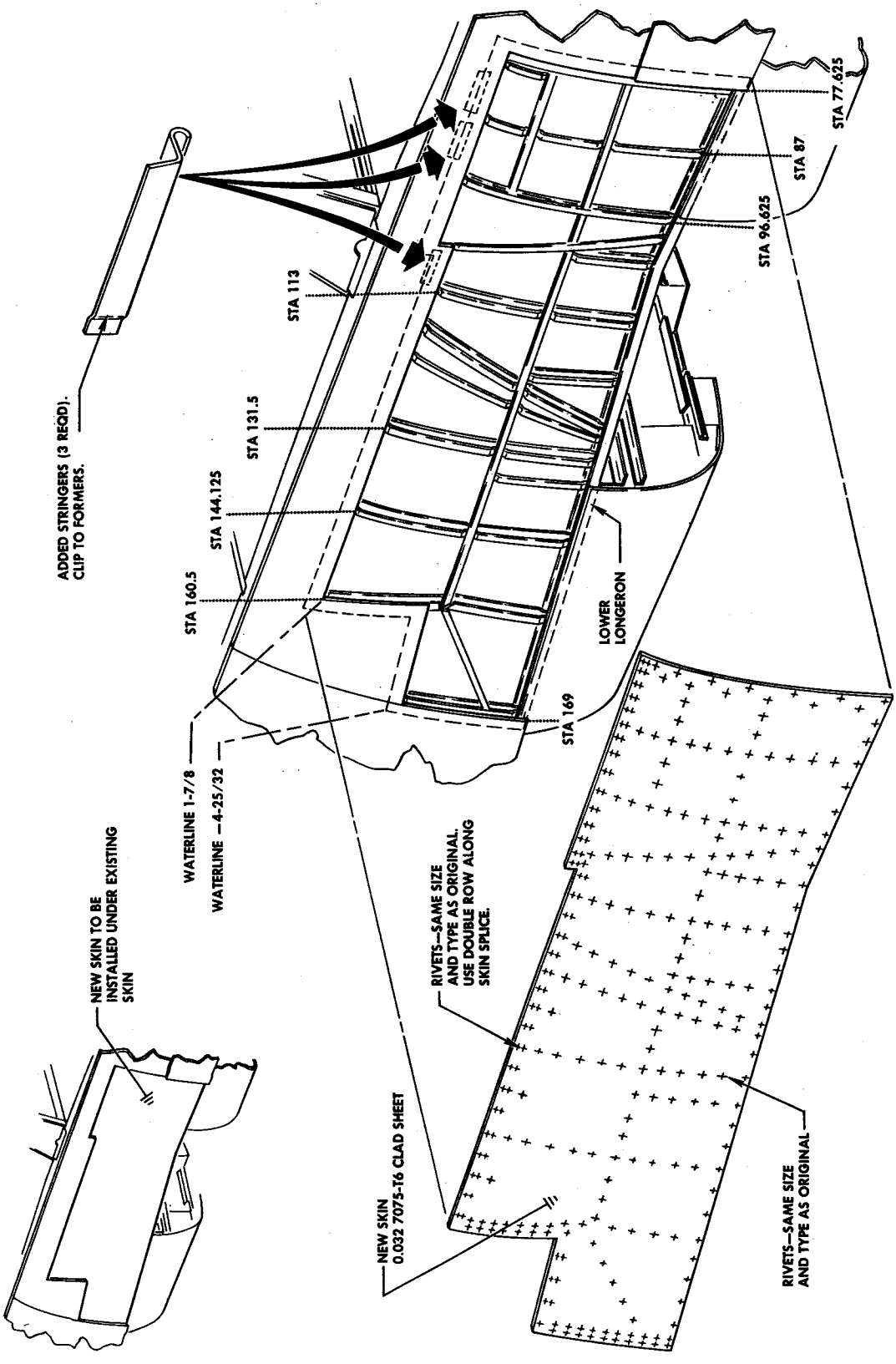
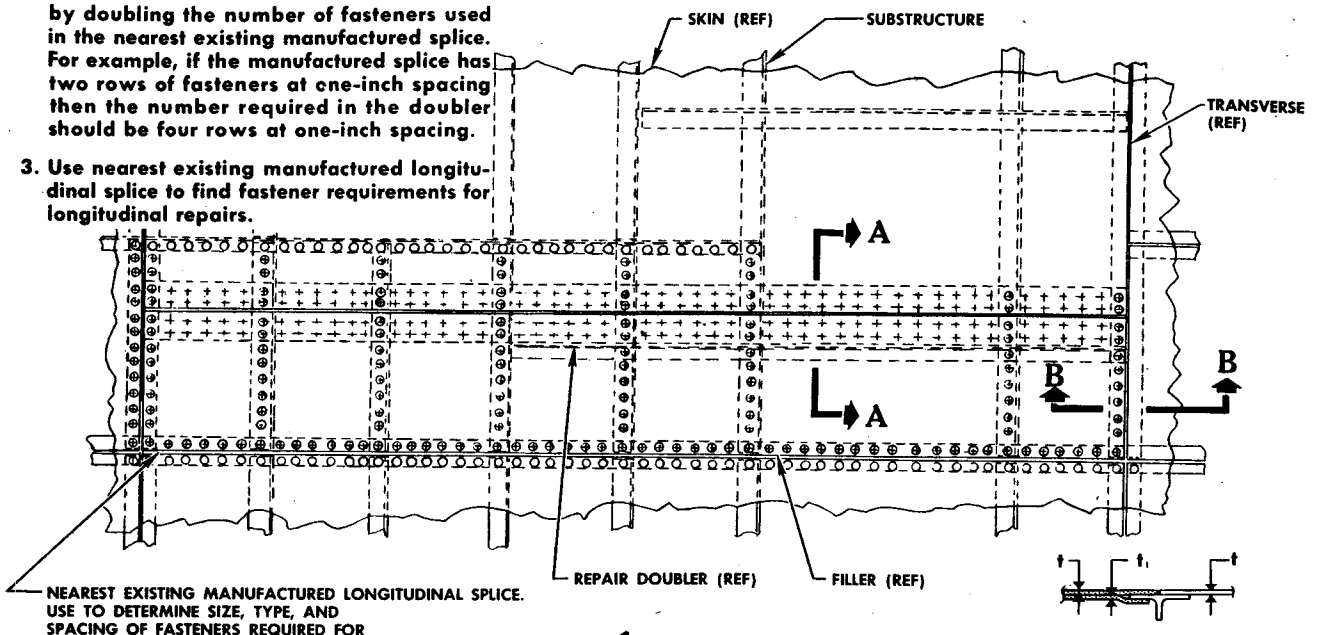
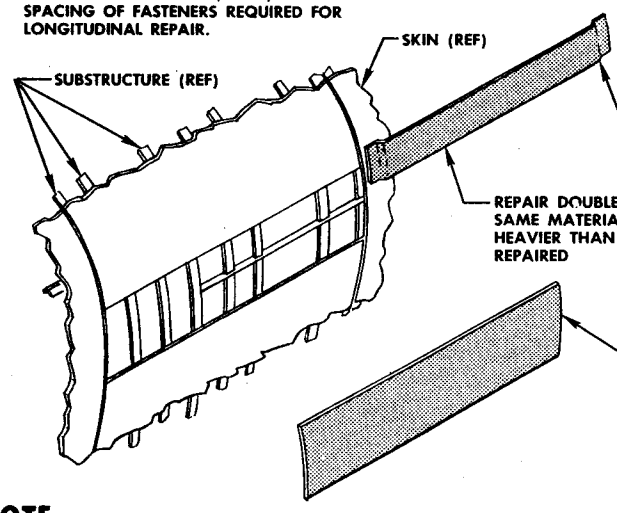
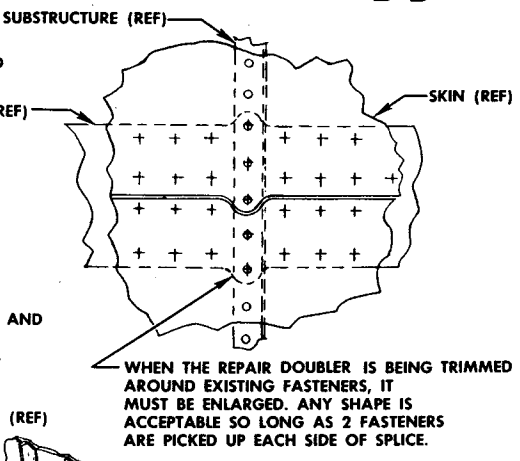


Figure 4-3. Skin Repair — Station 78 to 169 — T-28A and T-28D Airplanes

1. Trim out damage midway between existing fasteners.
2. Determine number of fasteners to be used by doubling the number of fasteners used in the nearest existing manufactured splice. For example, if the manufactured splice has two rows of fasteners at one-inch spacing then the number required in the doubler should be four rows at one-inch spacing.
3. Use nearest existing manufactured longitudinal splice to find fastener requirements for longitudinal repairs.







NOTE If drilled-out holes are not within tolerances, use next larger size fasteners.

- Pull-type blind fasteners of the same diameter may be substituted through skin and splice doubler for AD and DD rivets. Use Jo-bolts in place of Hi-shear rivets.
- This repair may be used to cover access holes.
- All edge distances are to be two times rivet diameter.

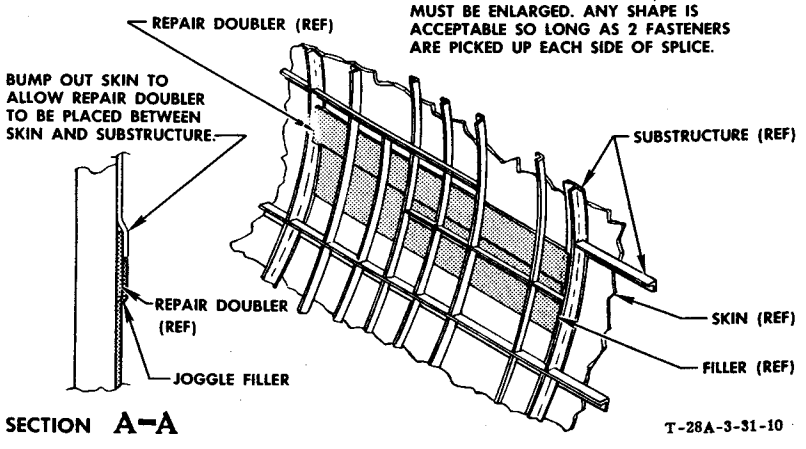
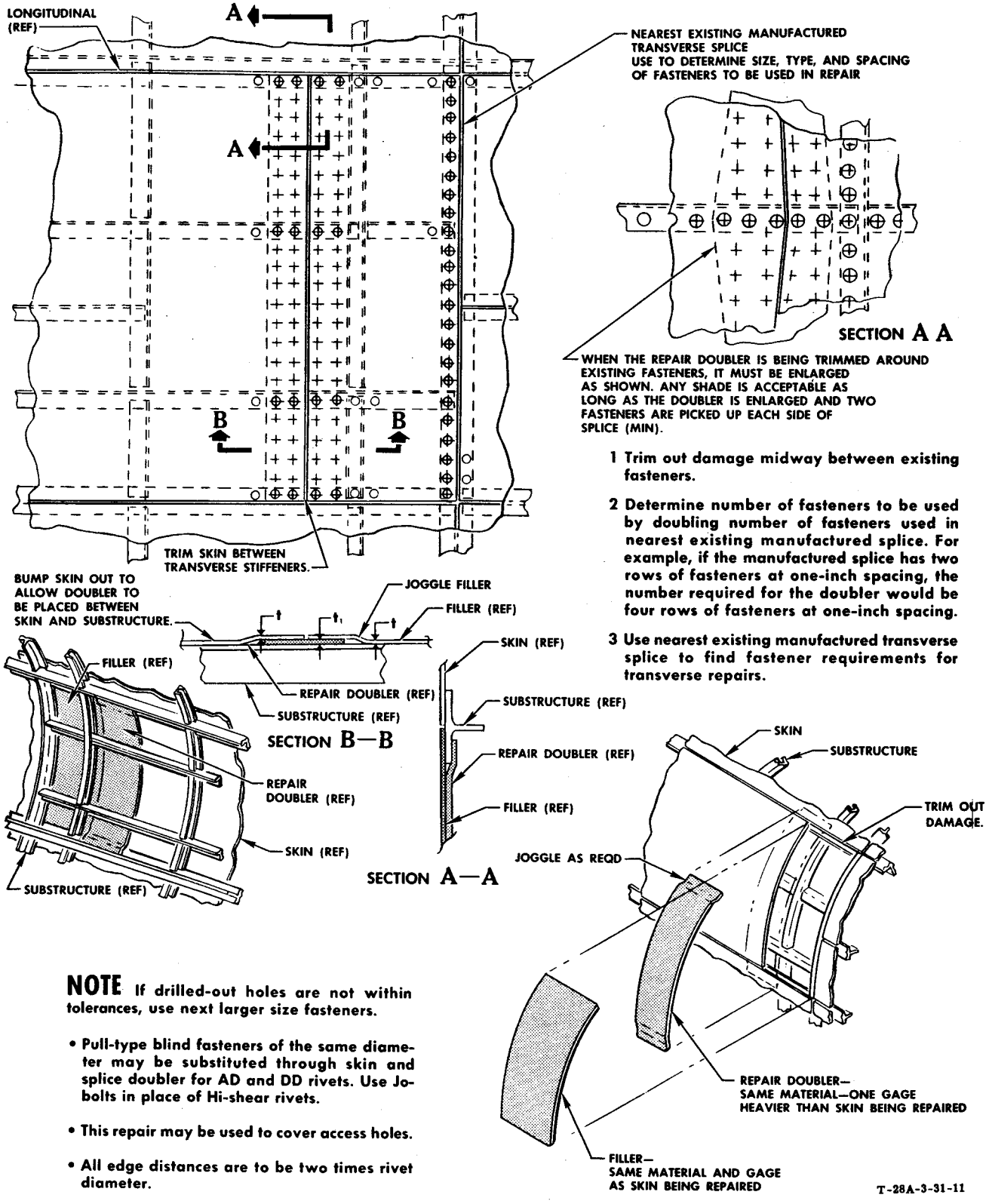


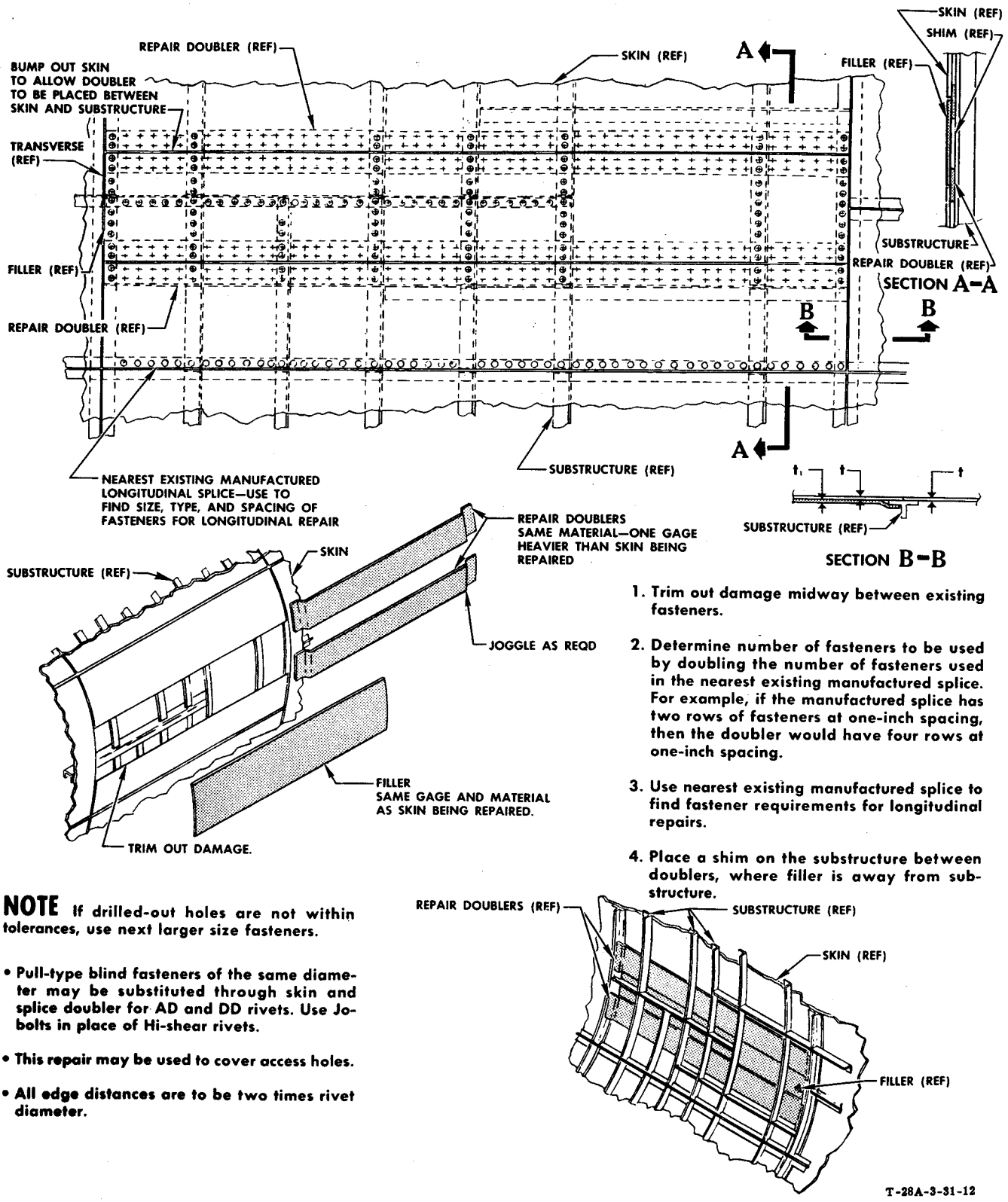
Figure 4-4. Skin Repairs - General (Sheet 1 of 8)



NOTE If drilled-out holes are not within tolerances, use next larger size fasteners.

- Pull-type blind fasteners of the same diameter may be substituted through skin and splice doubler for AD and DD rivets. Use Jo-bolts in place of Hi-shear rivets.
- This repair may be used to cover access holes.
- All edge distances are to be two times rivet diameter.

Figure 4-4. Skin Repairs - General (Sheet 2 of 8)

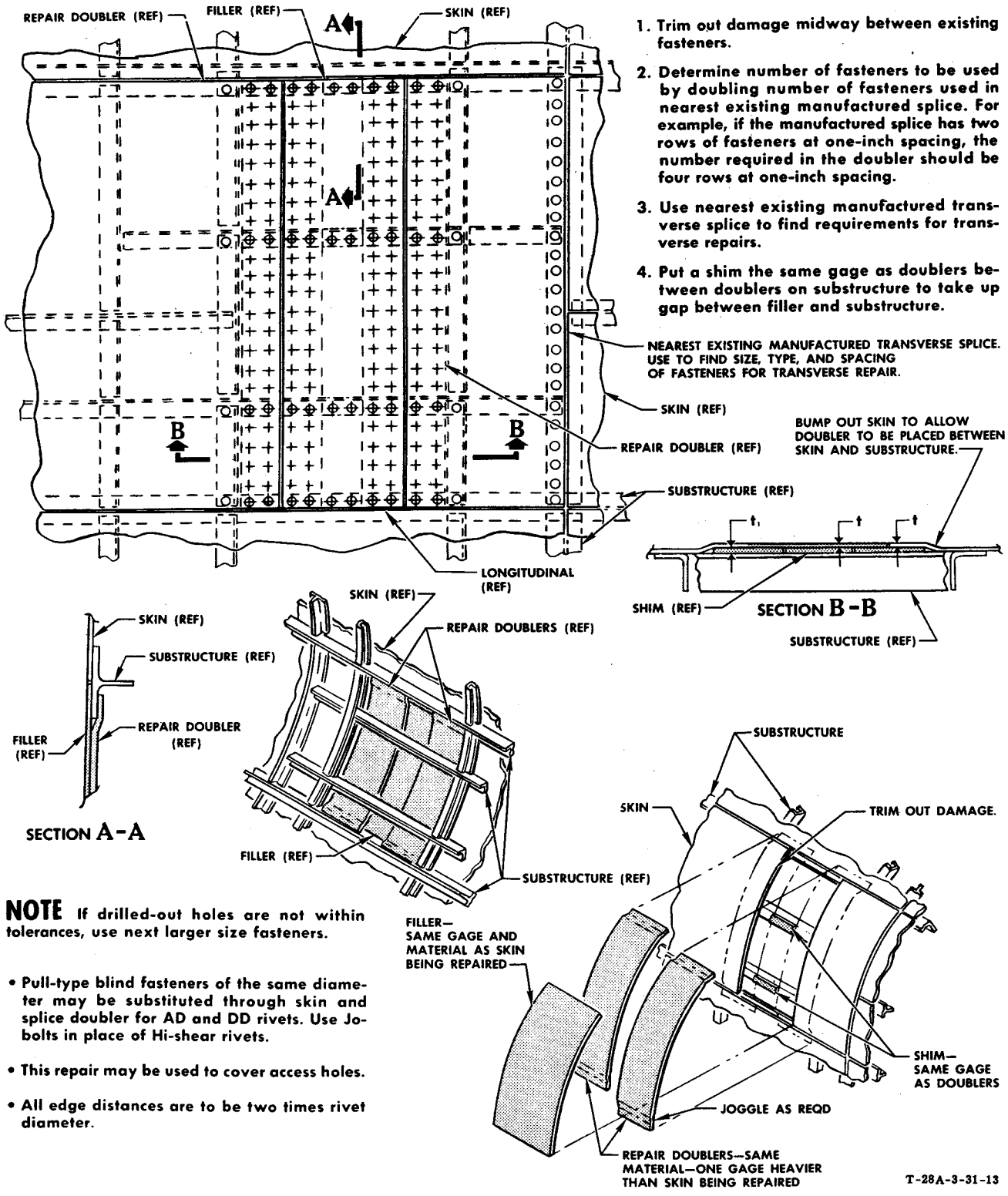


1. Trim out damage midway between existing fasteners.
2. Determine number of fasteners to be used by doubling the number of fasteners used in the nearest existing manufactured splice. For example, if the manufactured splice has two rows of fasteners at one-inch spacing, then the doubler would have four rows at one-inch spacing.
3. Use nearest existing manufactured splice to find fastener requirements for longitudinal repairs.
4. Place a shim on the substructure between doublers, where filler is away from substructure.

NOTE If drilled-out holes are not within tolerances, use next larger size fasteners.

- Pull-type blind fasteners of the same diameter may be substituted through skin and splice doubler for AD and DD rivets. Use Jo-bolts in place of Hi-shear rivets.
- This repair may be used to cover access holes.
- All edge distances are to be two times rivet diameter.

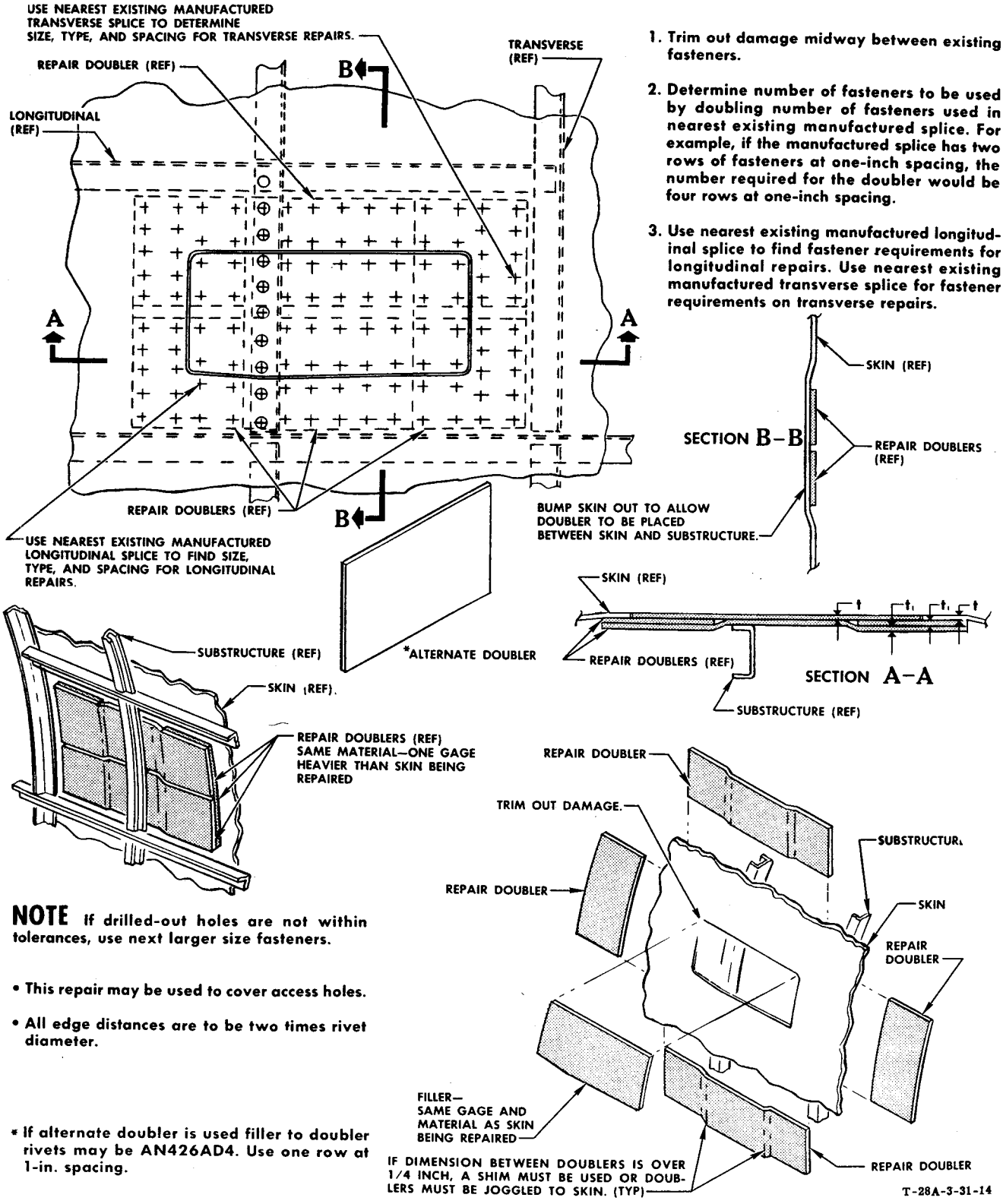
Figure 4-4. Skin Repairs - General (Sheet 3 of 8)



NOTE If drilled-out holes are not within tolerances, use next larger size fasteners.

- Pull-type blind fasteners of the same diameter may be substituted through skin and splice doubler for AD and DD rivets. Use Jo-bolts in place of Hi-shear rivets.
- This repair may be used to cover access holes.
- All edge distances are to be two times rivet diameter.

Figure 4-4. Skin Repairs - General (Sheet 4 of 8)



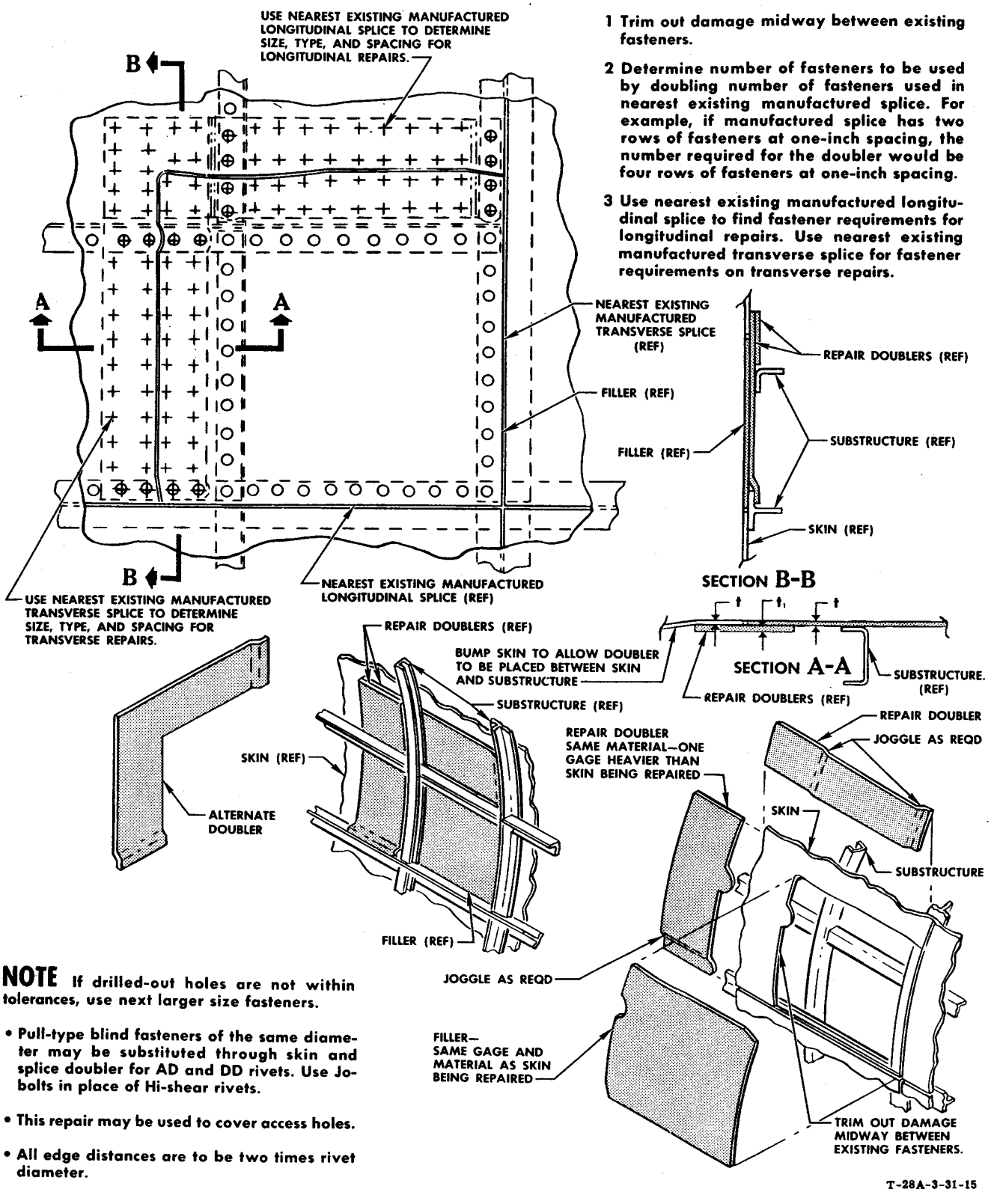
1. Trim out damage midway between existing fasteners.
2. Determine number of fasteners to be used by doubling number of fasteners used in nearest existing manufactured splice. For example, if the manufactured splice has two rows of fasteners at one-inch spacing, the number required for the doubler would be four rows at one-inch spacing.
3. Use nearest existing manufactured longitudinal splice to find fastener requirements for longitudinal repairs. Use nearest existing manufactured transverse splice for fastener requirements on transverse repairs.

NOTE If drilled-out holes are not within tolerances, use next larger size fasteners.

- This repair may be used to cover access holes.
- All edge distances are to be two times rivet diameter.

* If alternate doubler is used filler to doubler rivets may be AN426AD4. Use one row at 1-in. spacing.

Figure 4-4. Skin Repairs - General (Sheet 5 of 8)



NOTE If drilled-out holes are not within tolerances, use next larger size fasteners.

- Pull-type blind fasteners of the same diameter may be substituted through skin and splice doubler for AD and DD rivets. Use Jobolts in place of Hi-shear rivets.
- This repair may be used to cover access holes.
- All edge distances are to be two times rivet diameter.

Figure 4-4. Skin Repairs - General (Sheet 6 of 8)

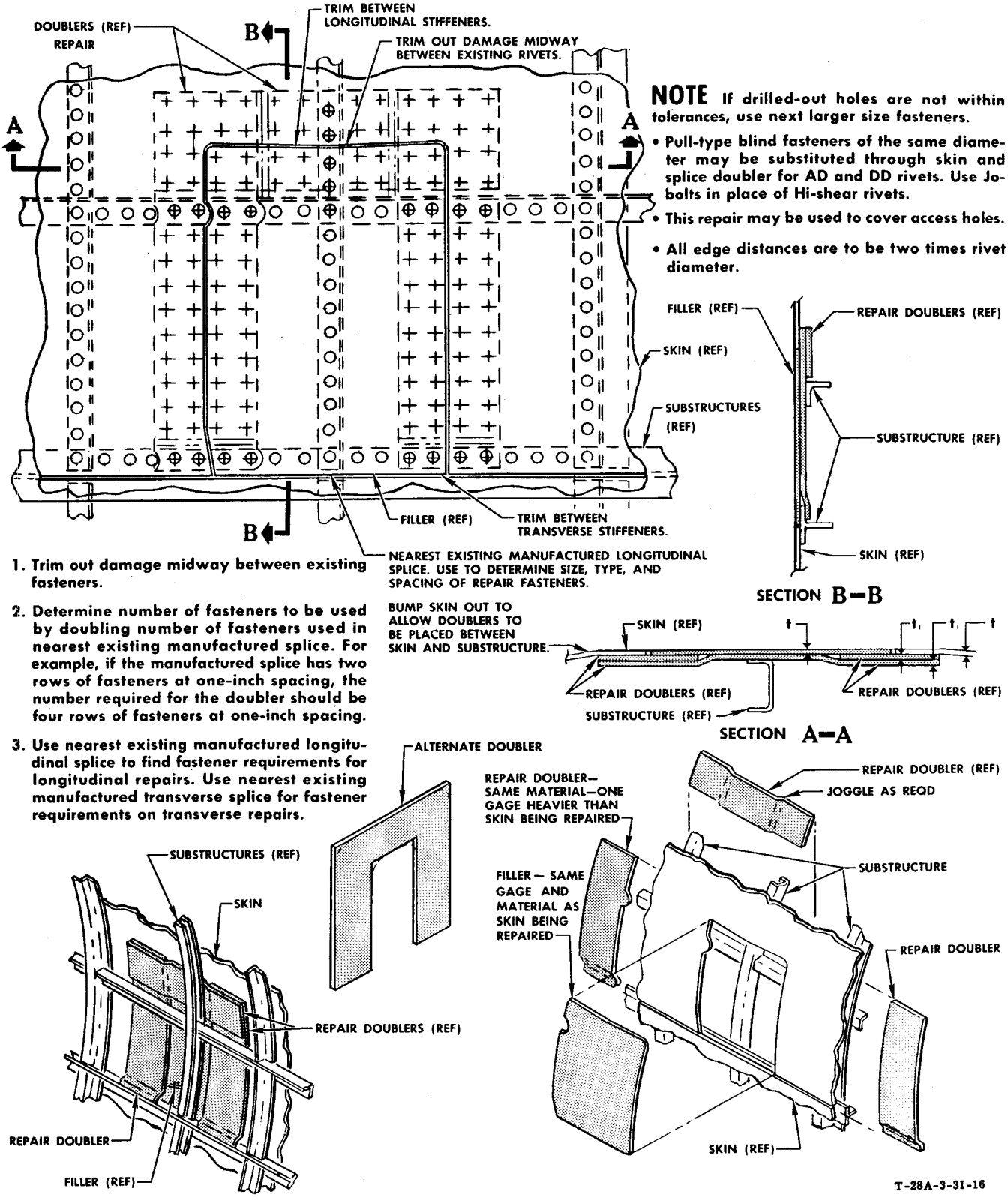
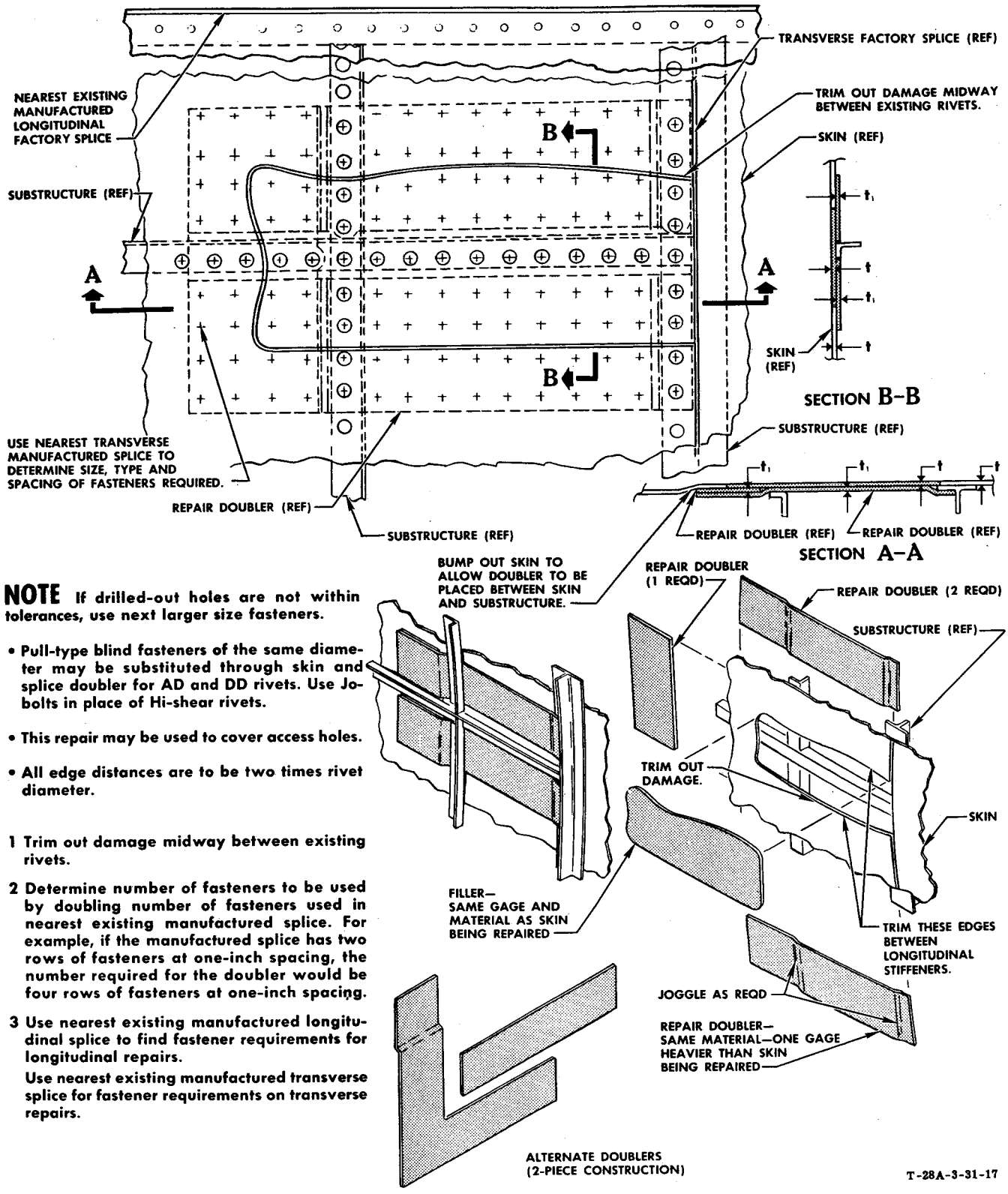


Figure 4-4. Skin Repairs - General (Sheet 7 of 8)



NOTE If drilled-out holes are not within tolerances, use next larger size fasteners.

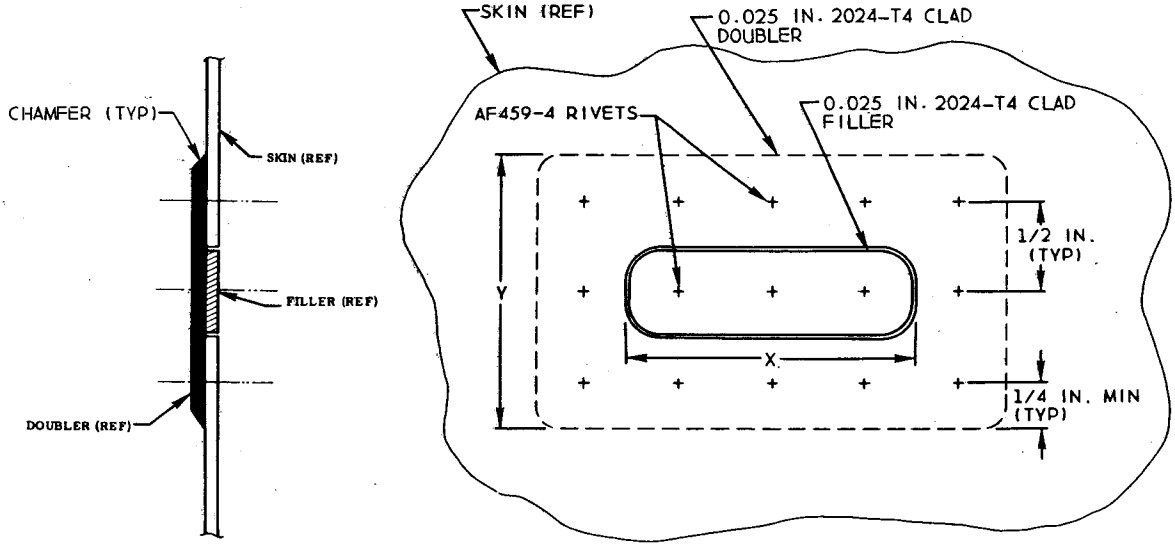
- Pull-type blind fasteners of the same diameter may be substituted through skin and splice doubler for AD and DD rivets. Use Jo-bolts in place of Hi-shear rivets.
- This repair may be used to cover access holes.
- All edge distances are to be two times rivet diameter.

1 Trim out damage midway between existing rivets.

2 Determine number of fasteners to be used by doubling number of fasteners used in nearest existing manufactured splice. For example, if the manufactured splice has two rows of fasteners at one-inch spacing, the number required for the doubler would be four rows of fasteners at one-inch spacing.

3 Use nearest existing manufactured longitudinal splice to find fastener requirements for longitudinal repairs.
Use nearest existing manufactured transverse splice for fastener requirements on transverse repairs.

Figure 4-4. Skin Repairs - General (Sheet 8 of 8)

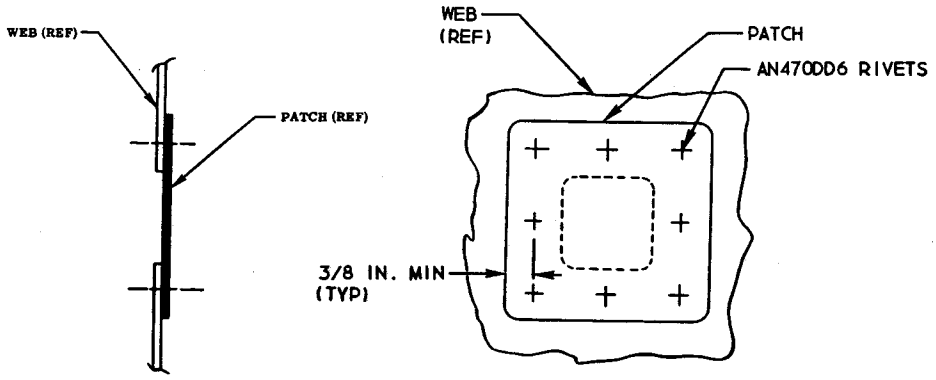


NOTE:

1. "X" DIMENSION MUST BE GREATER THAN "Y" DIMENSION TO INSTALL DOUBLER.
2. DOUBLER LENGTH = DAMAGE LENGTH PLUS 1 IN. MIN.
   DOUBLER WIDTH = DAMAGE WIDTH PLUS 1 IN. MIN.

T-28A-3-31-18

Figure 4-5. Dorsal Fin Skin Repair



NOTE:
WIDTH OF PATCH = 1-1/2 IN. PLUS DAMAGE WIDTH
LENGTH OF PATCH = 1-1/2 IN. PLUS DAMAGE LENGTH

STATION	WEB MATERIAL	PATCH MATERIAL	RIVET SPACING
26.5 TO 49	0.016 IN. STAINLESS STEEL 1/2 H	0.016 IN. STAINLESS STEEL 1/2 H	APPROX 1 IN.
49 TO 95	0.051 IN. 2024-T4 CLAD	0.051 IN. 2024-T4 CLAD	APPROX 3/4 IN.

T-28A-3-31-19A

Figure 4-6. Nose Gear Beam Web Repair

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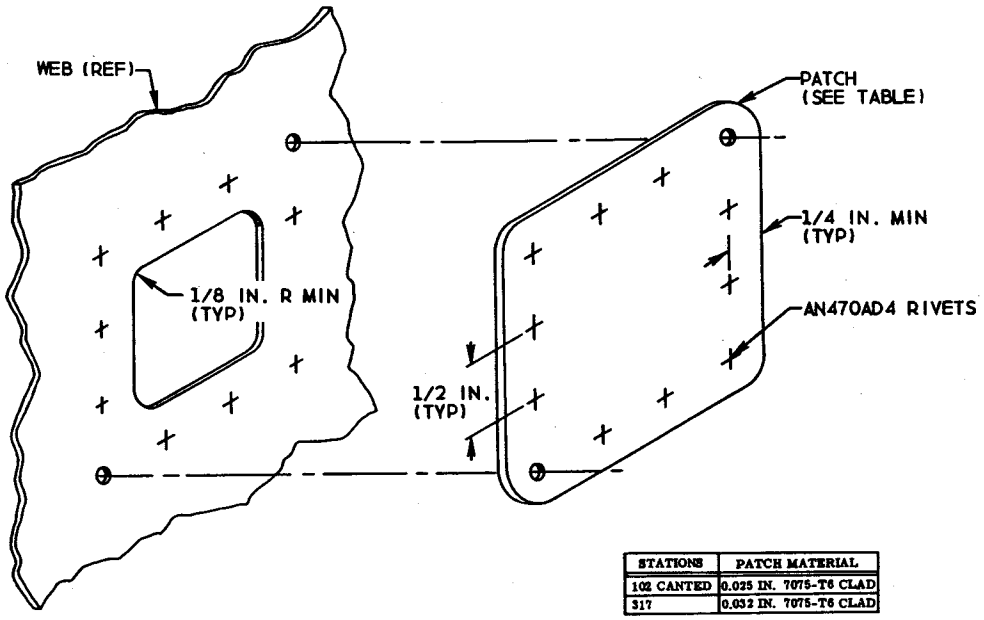
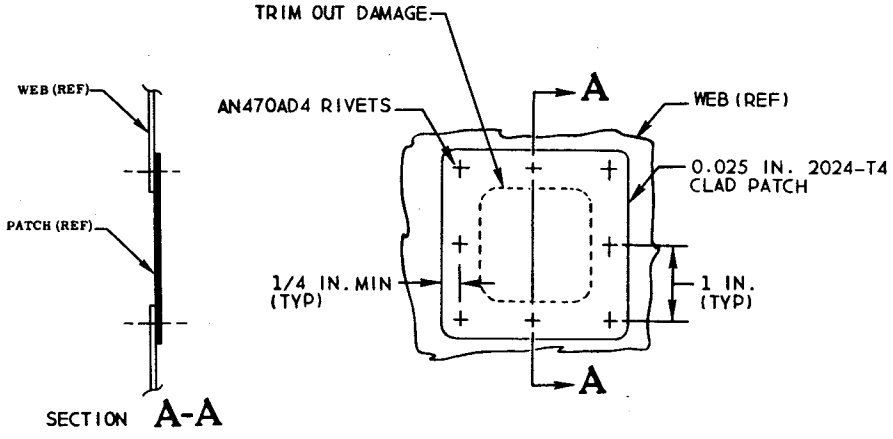


STATIONS	PATCH MATERIAL
102 CANTED	0.025 IN. 7075-T6 CLAD
317	0.032 IN. 7075-T6 CLAD

T-28A-3-31-20

Figure 4-7. Bulkhead Web Repair

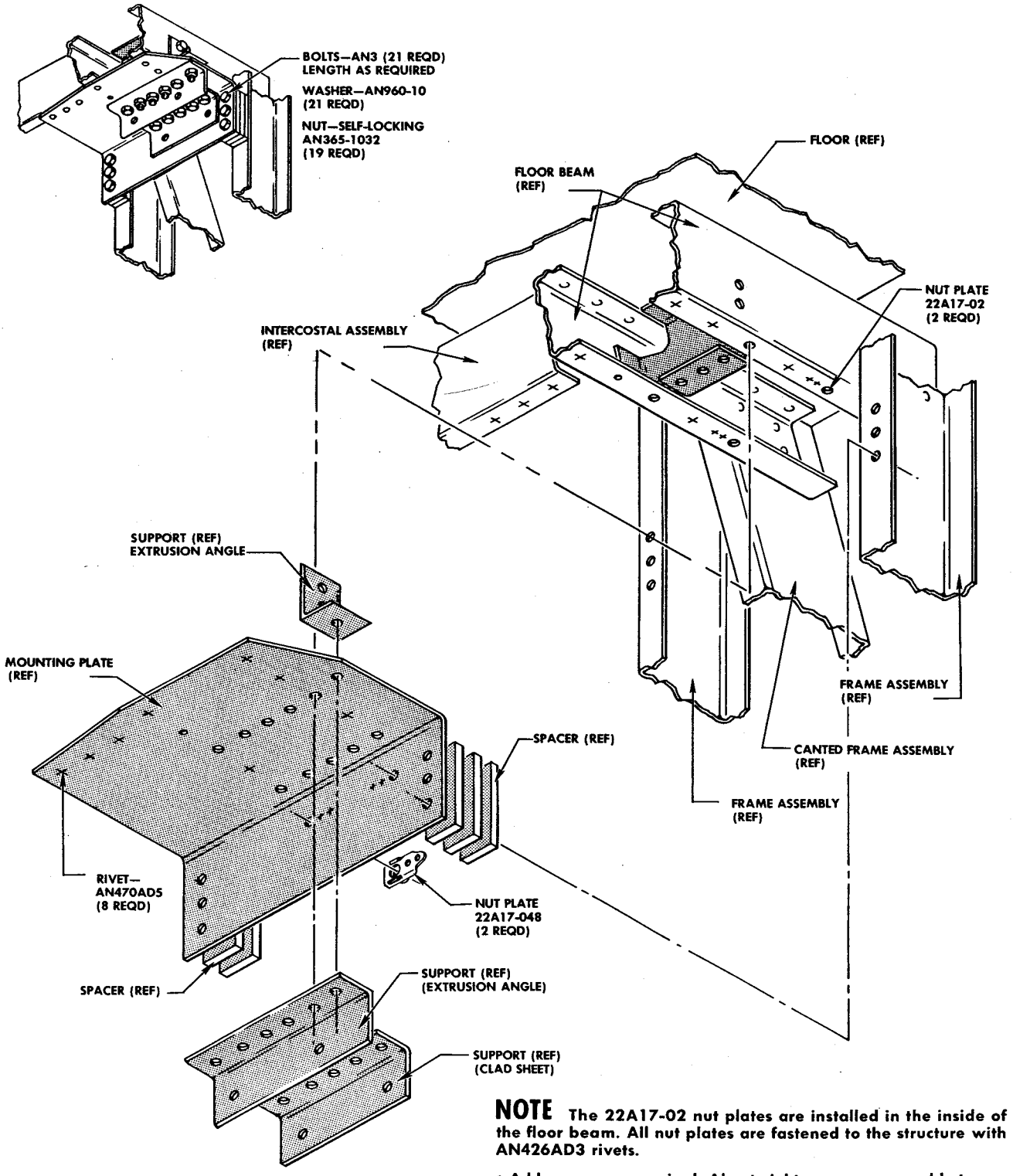


NOTE:

1. WIDTH OF PATCH = 1 IN. PLUS DAMAGE WIDTH.
   LENGTH OF PATCH = 1 IN. PLUS DAMAGE LENGTH.
2. AF459-4 RIVETS WITH 3/4 IN. SPACING MAY BE SUBSTITUTED FOR AN470AD4 RIVETS.

T-28A-3-31-21

Figure 4-8. Floor Web Repair

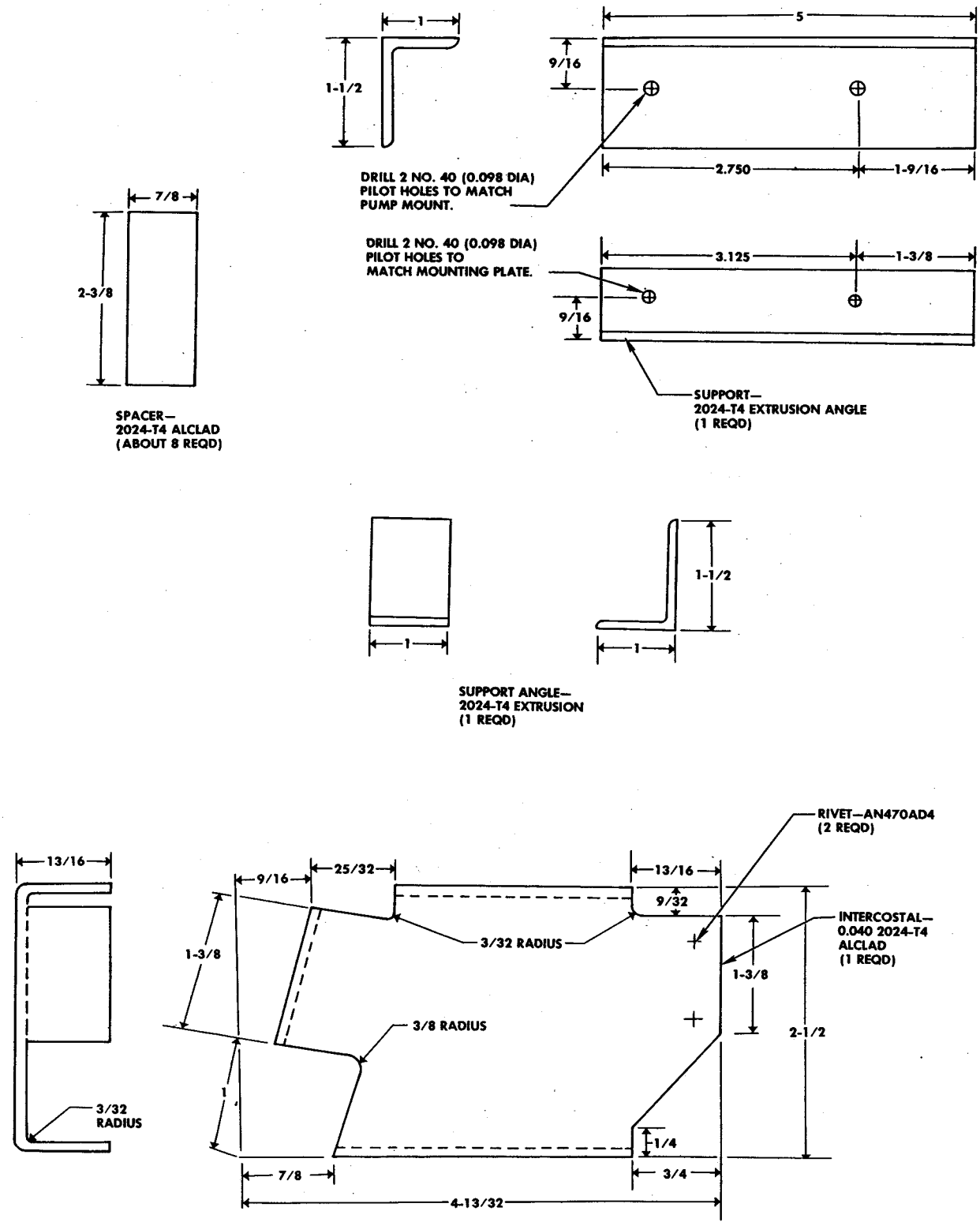


NOTE The 22A17-02 nut plates are installed in the inside of the floor beam. All nut plates are fastened to the structure with AN426AD3 rivets.

• Add spacers as required. About eight spacers are used between the flange of the mounting plate and the frame assembly. Since this space may vary between airplanes, the number and thickness of the spacers used must equal the total requirement.

T-28A-3-31-3

Figure 4-9. Hydraulic Hand-pump Mount Reinforcement — T-28A and T-28D Airplanes (Sheet 1 of 3)



T-28A-3-31-4

Figure 4-9. Hydraulic Hand-pump Mount Reinforcement — T-28A and T-28D Airplanes (Sheet 2 of 3)

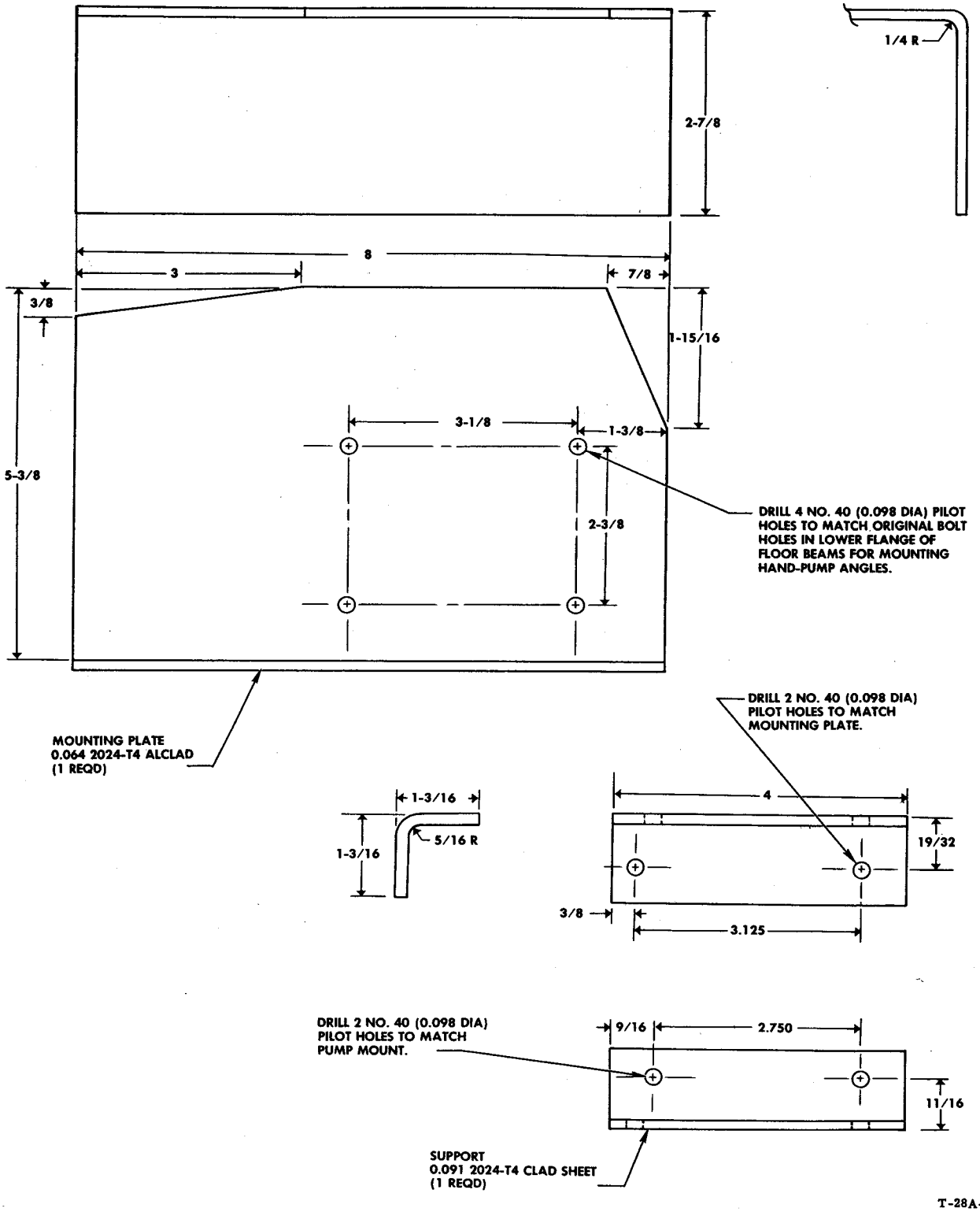
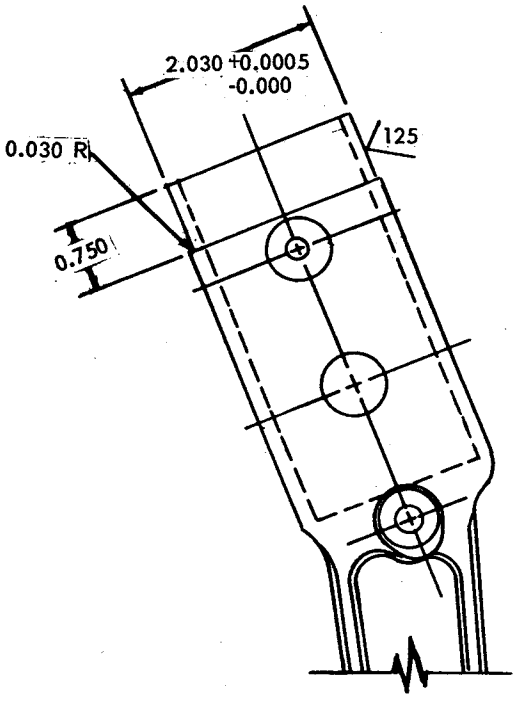
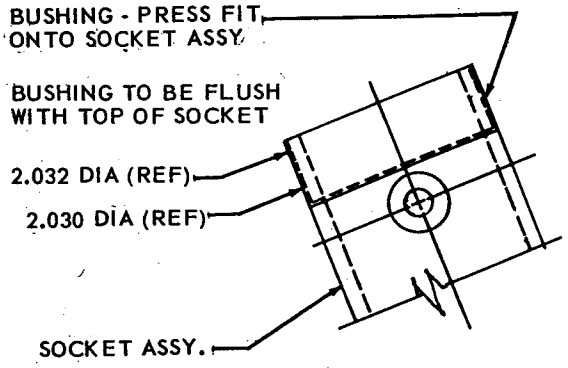


Figure 4-9. Hydraulic Hand-pump Mount Reinforcement — T-28A and T-28D Airplanes (Sheet 3 of 3)

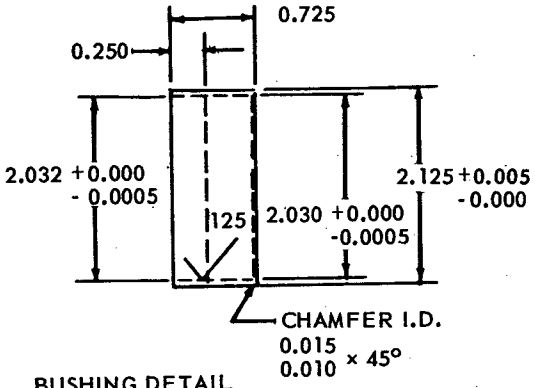


REWORK DETAIL
SOCKET ASSEMBLY

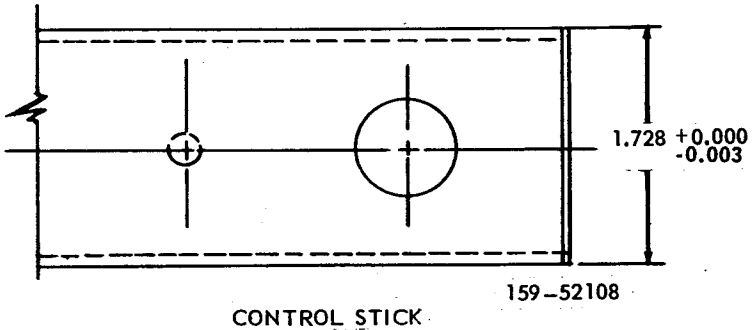


TYPICAL INSTALLATION

REASON FOR CHANGE IS TO INCREASE TOLERANCE BETWEEN CONTROL STICK AND SOCKET ASSY. TO PREVENT CRACK DAMAGE RESULTING FROM STRESS CORROSION.
CHANGE DIMENSION FROM 1.729+0.000 -0.001 TO 1.728+0.000 -0.003



BUSHING DETAIL
DIMENSIONS APPLY AFTER PLATING
MAKE FROM 4130ST., HT. TREAT TO 125–145KSI
CAD. PLATE PER SPEC QQ–P–416 TYPE CL3

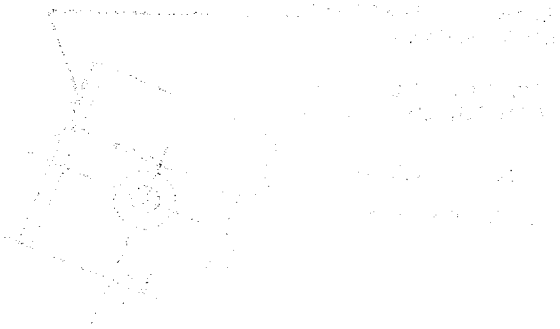


CONTROL STICK

NOTE

1. TREAT REWORKED AREA OF SOCKET ASSEMBLY PER MIL-C-5541 BEFORE INSTALLING BUSHING.
2. DEGREASE (WITH METHYLETHYL KETONE) BUSHING AND AREA ON THE STICK SOCKET MACHINED FOR THE BUSHING.
3. PRIME (WITH LOCKQUIC PRIMER, LOCKTITE CORP., NEWINGTON, CONN.) BUSHING AREA OF STICK SOCKET AND THE INNER PART OF BUSHING. ALLOW TWO HOUR DRYING PERIOD.
4. COAT (WITH LOCKTITE RETAINING COMPOUND, LOCKTITE CORP., NEWINGTON, CONN.) BUSHING AREA OF SOCKET AND THE INNER PART OF BUSHING.
5. PRESS-FIT BUSHING ONTO SOCKET ASSEMBLY.
6. THE 2.032-INCH INSIDE DIAMETER OF BUSHING MUST BE AT THE TOP OF STICK SOCKET. BUSHING MUST BE FLUSH WITH TOP OF SOCKET.
7. REMOVE EXCESS ADHESIVE AND ALLOW THE PART TO CURE FOR 24 HOURS AT ROOM TEMPERATURE (70°F OR ABOVE) BEFORE INSTALLING IN AIRCRAFT.

Figure 4-9A. Control Stick Socket Repair



BRACKET, SLIDE RH AND LH

1. The inside bore must not exceed 1.405 inch. Replace parts exceeding this dimension.
2. The lockpin hole must not exceed 0.265 inch. If it exceeds this dimension, it must be drilled out to 0.375 inch. A 4B1954-019 bushing (or equivalent) should then be installed by press fit (0.005-inch interference) and reamed to 0.057 inch.

TUBE, SEAT SUPPORT RH AND LH

1. The outside diameter of the tube must not exceed 1.365 inch. Replace parts exceeding this dimension.
2. The adjustment selection holes must not exceed 0.292 inch. Replace parts exceeding this dimension.

LOCKPIN, RH AND LH

1. The outside diameter must not be less than 0.242 inch. Replace parts if dimension is less than this minimum.

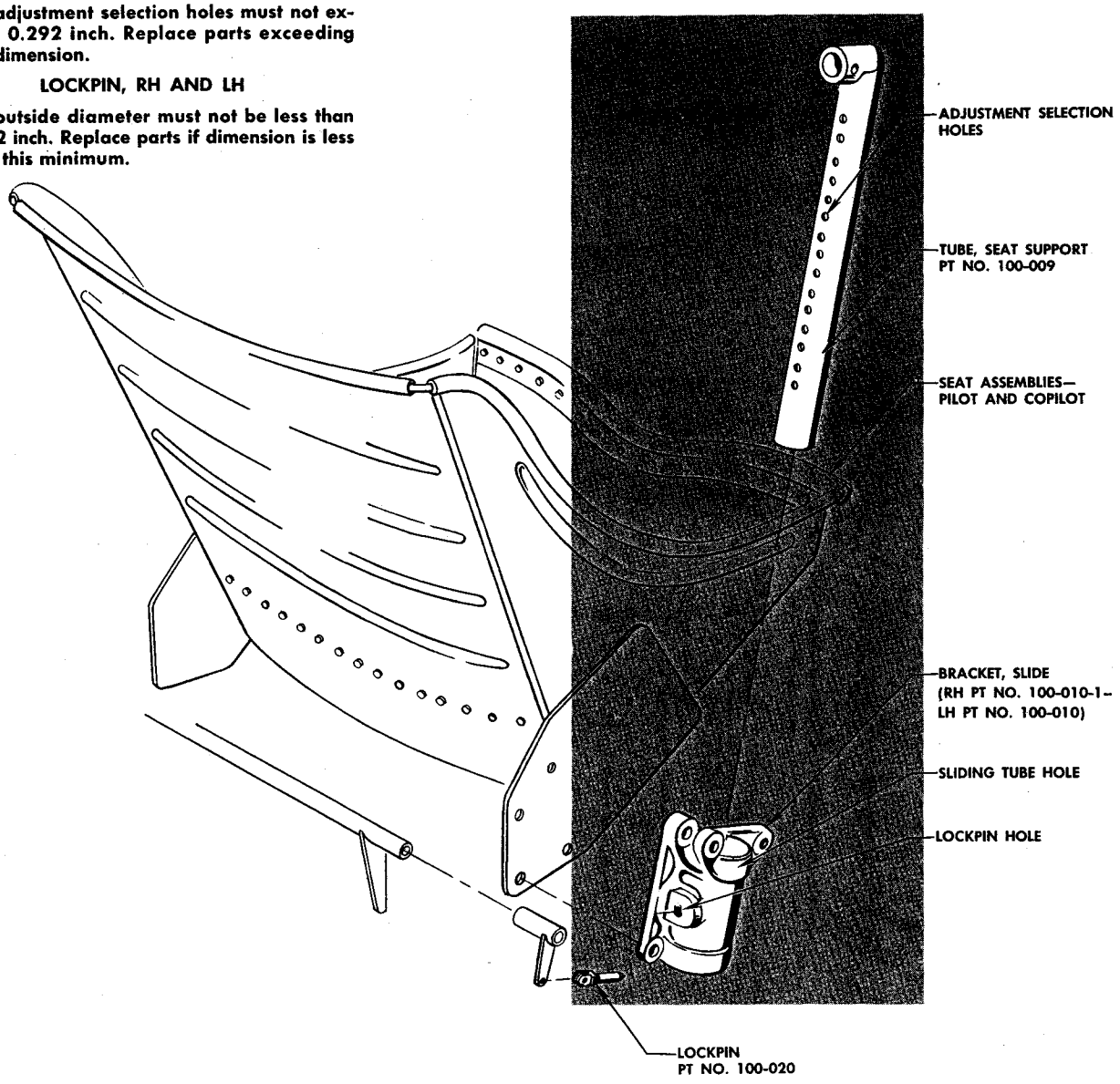


Figure 4-10. Seat Assembly Repair — T-28A and T-28D Airplanes

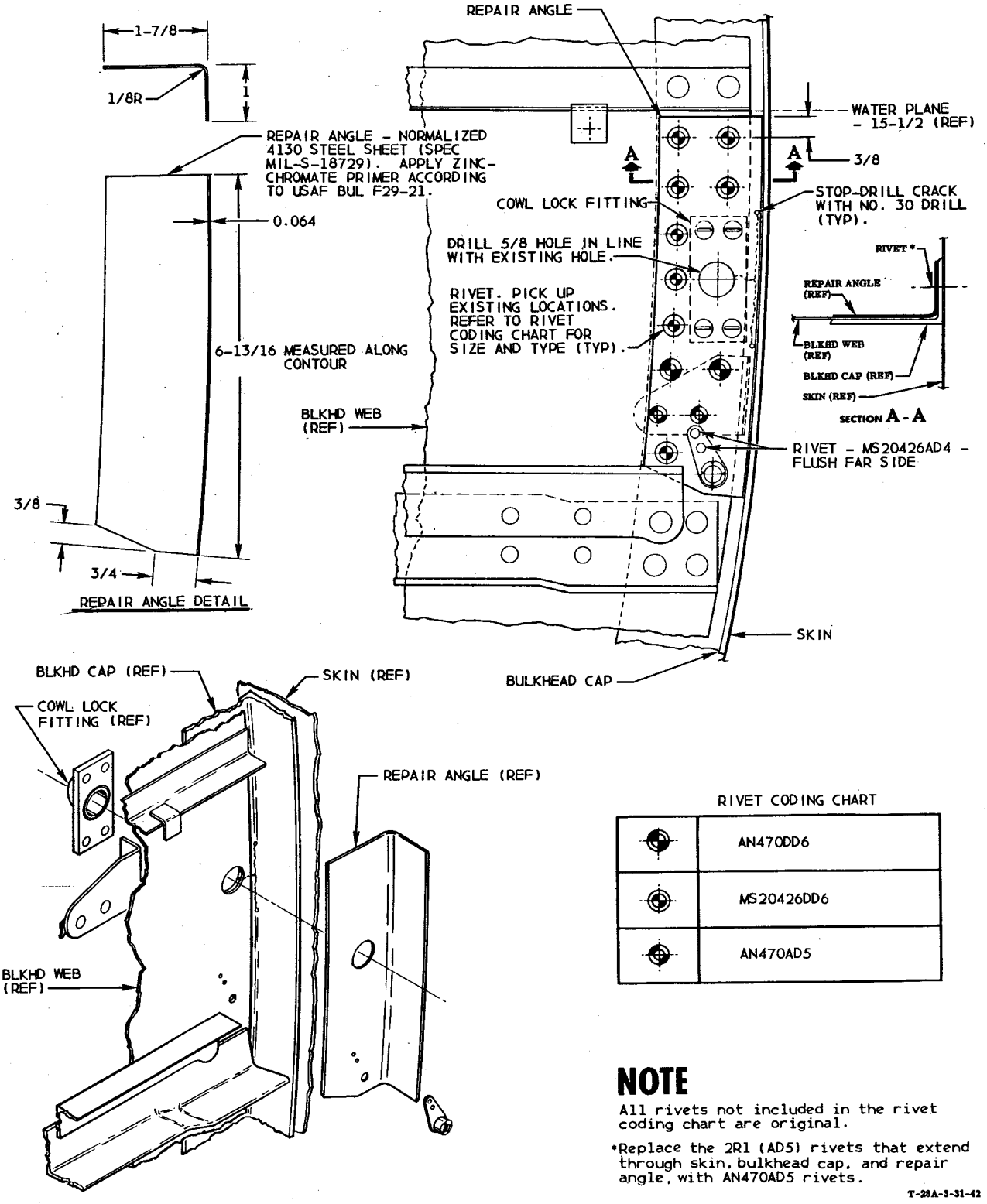


Figure 4-10A. Fire Wall Cap Angle Repair — Lower Right Cowl Lock Fitting — T-28A and T-28D Airplanes

1 Repair fire wall bulkhead cap damaged in area of cowl lock fitting 159-315408 by replacing end of angle with a section made from normalized 4130 steel.

2 Select location of cut so that nine existing fastener holes through cap and bulkhead web may be picked up in repair doubler on each side of splice. (Fasteners through the cowl lock fitting are not counted.)

3 Shape replacement cap to match removed section.

4 Shape repair doubler to fit inside bulkhead caps.

5 Cadmium-plate and prime new pieces, and install as shown.

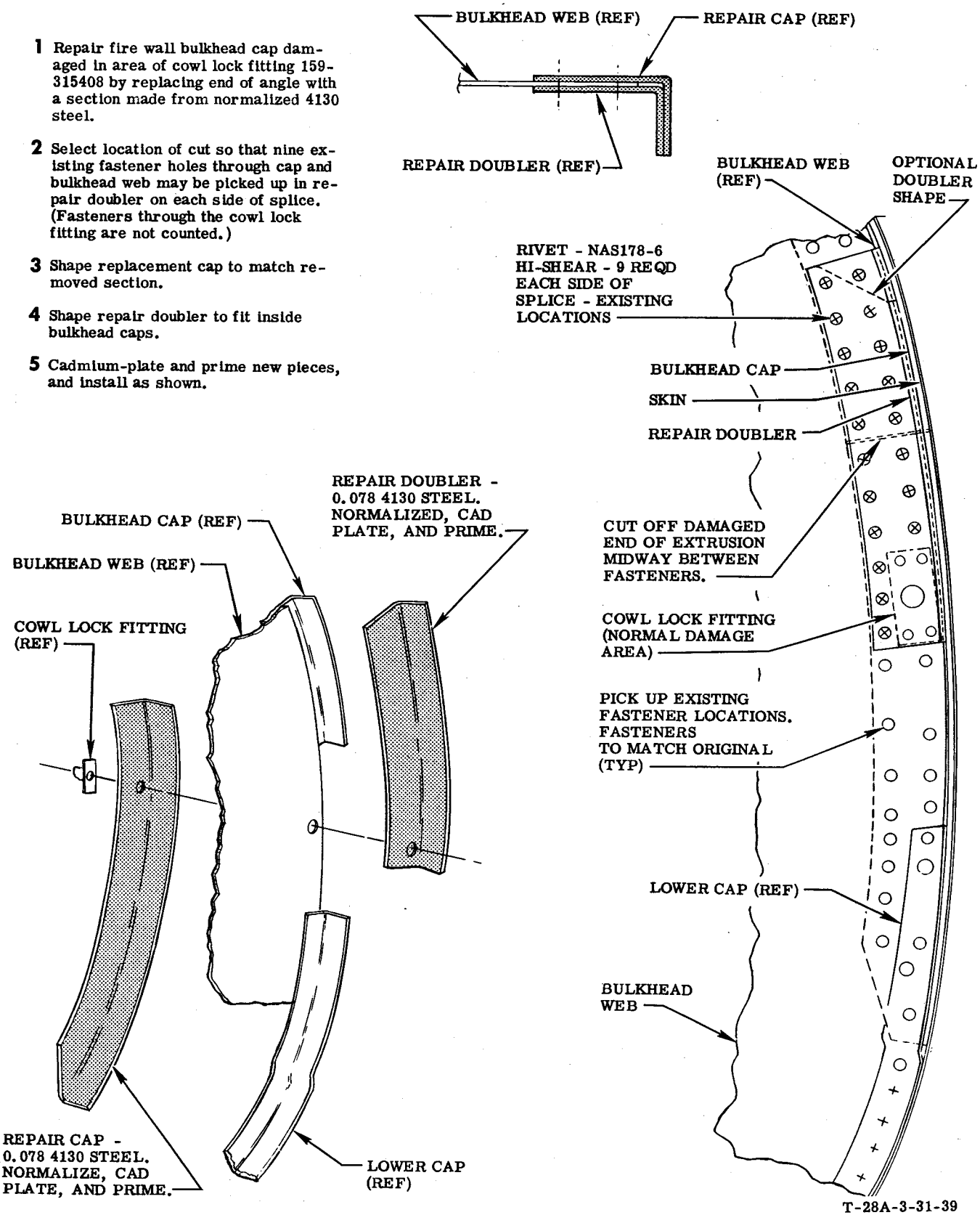


Figure 4-11. Fire Wall Cap Angle Splice – Lower Right Side – T-28A and T-28D Airplanes

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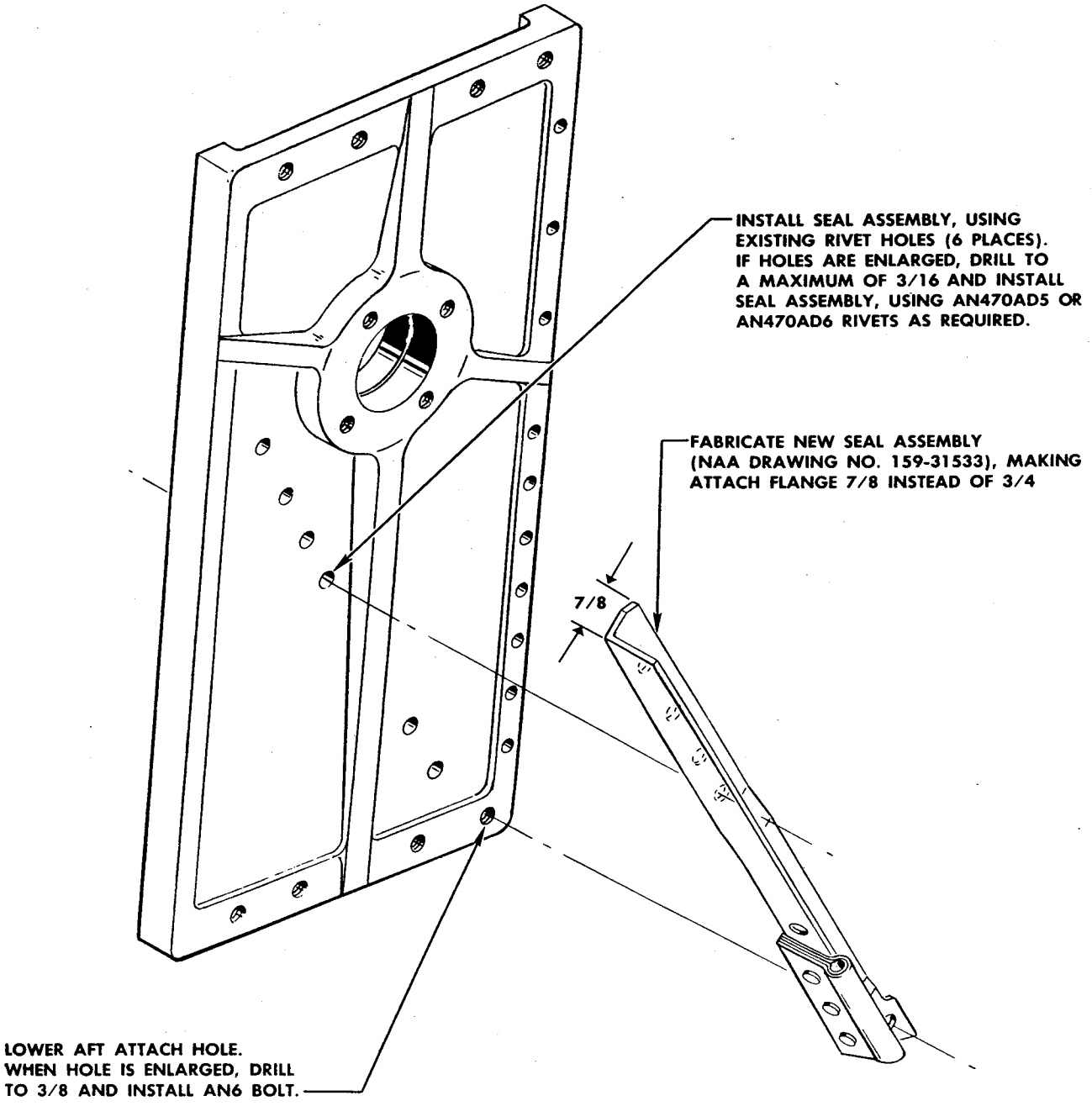


Figure 4-12. Engine Fixed Cowl Torque Box Seal Repair — T-28A and T-28D Airplanes

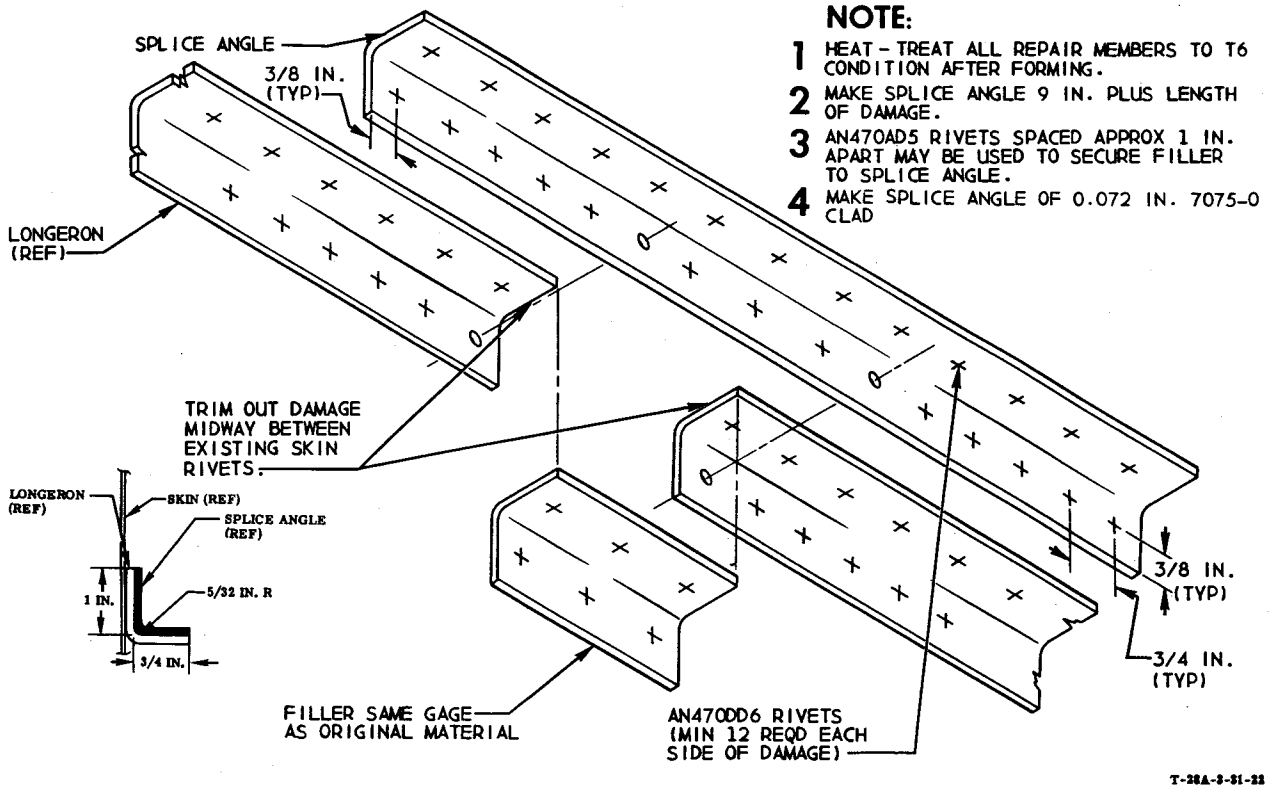


Figure 4-13. Lower Longeron Repair - Angle

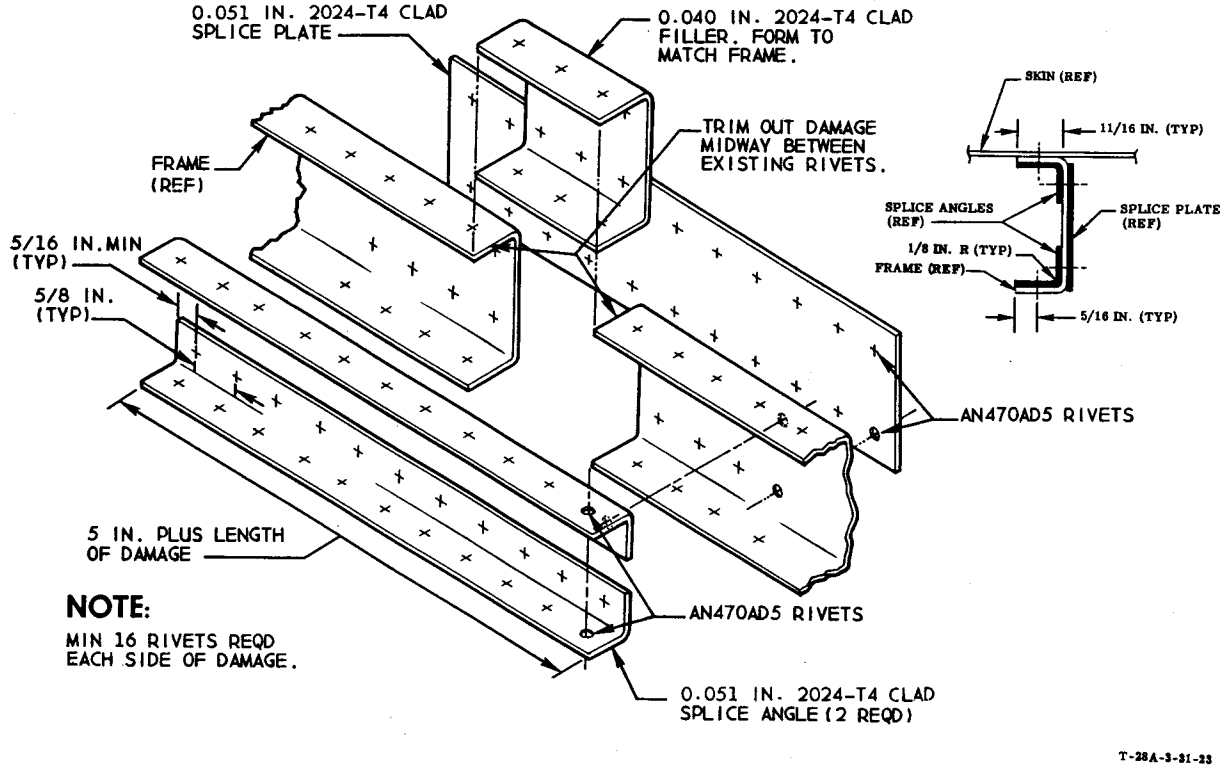
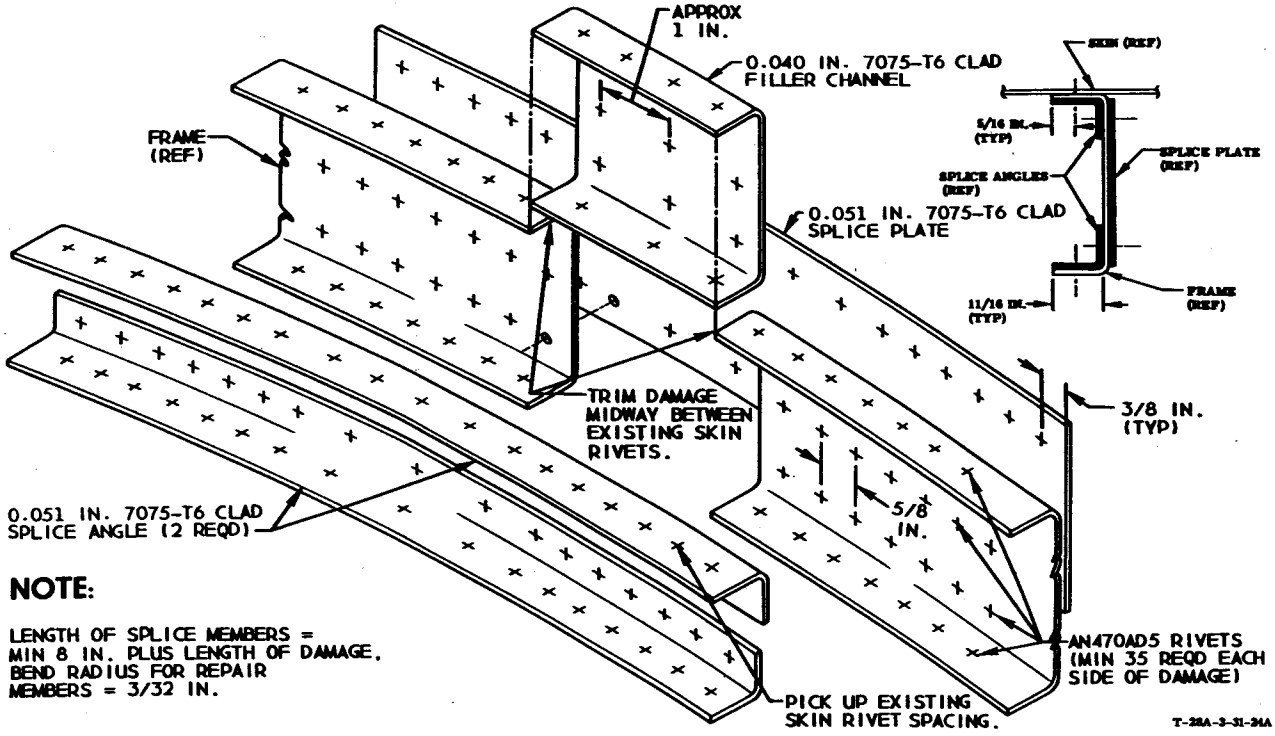


Figure 4-14. Frame Repair - Station 59.1



NOTE:

LENGTH OF SPLICE MEMBERS = MIN 8 IN. PLUS LENGTH OF DAMAGE. BEND RADIUS FOR REPAIR MEMBERS = 3/32 IN.

Figure 4-15. Lower Frame Repair — Station 317 — T-28A, T-28B, and T-28D Airplanes

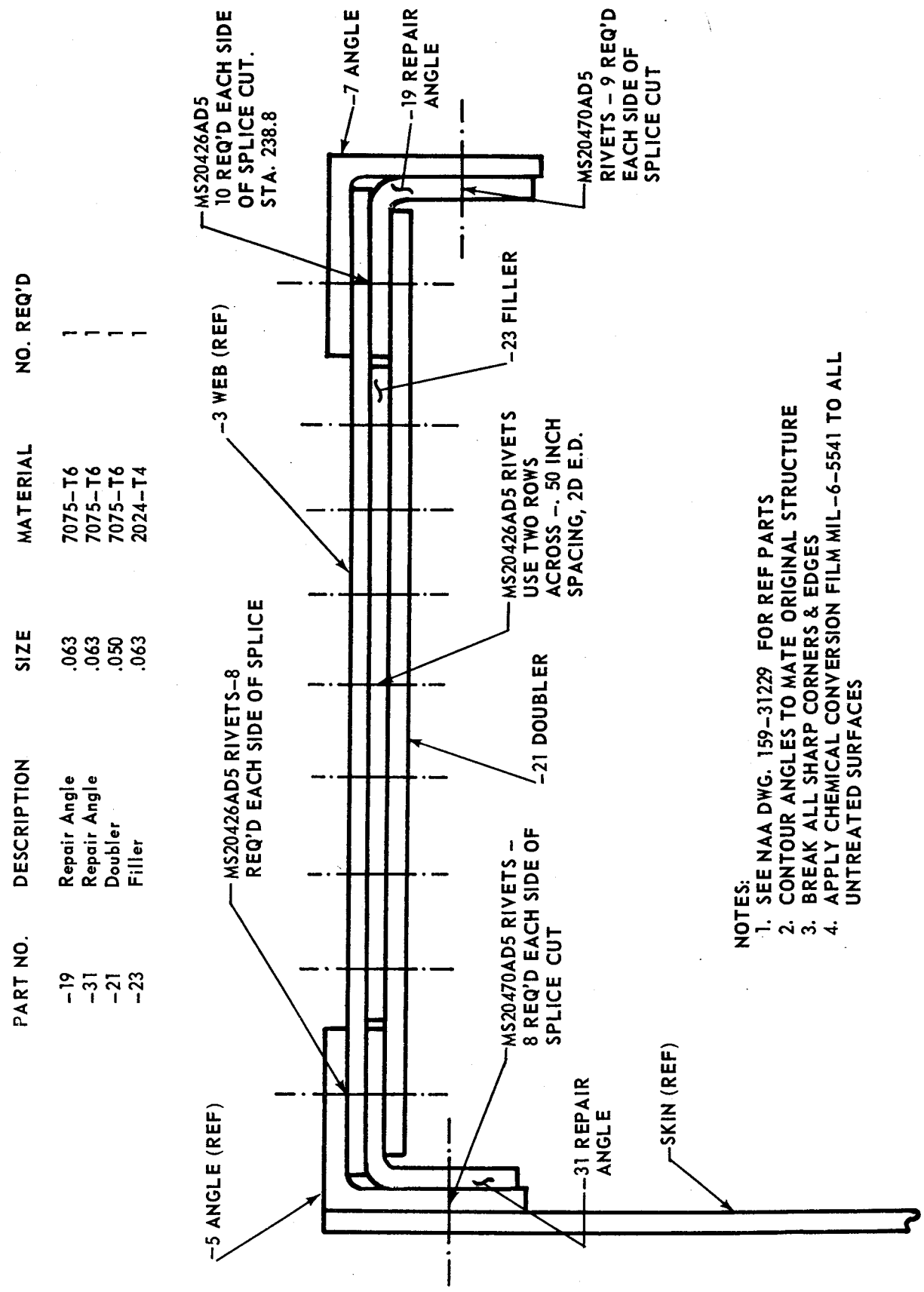
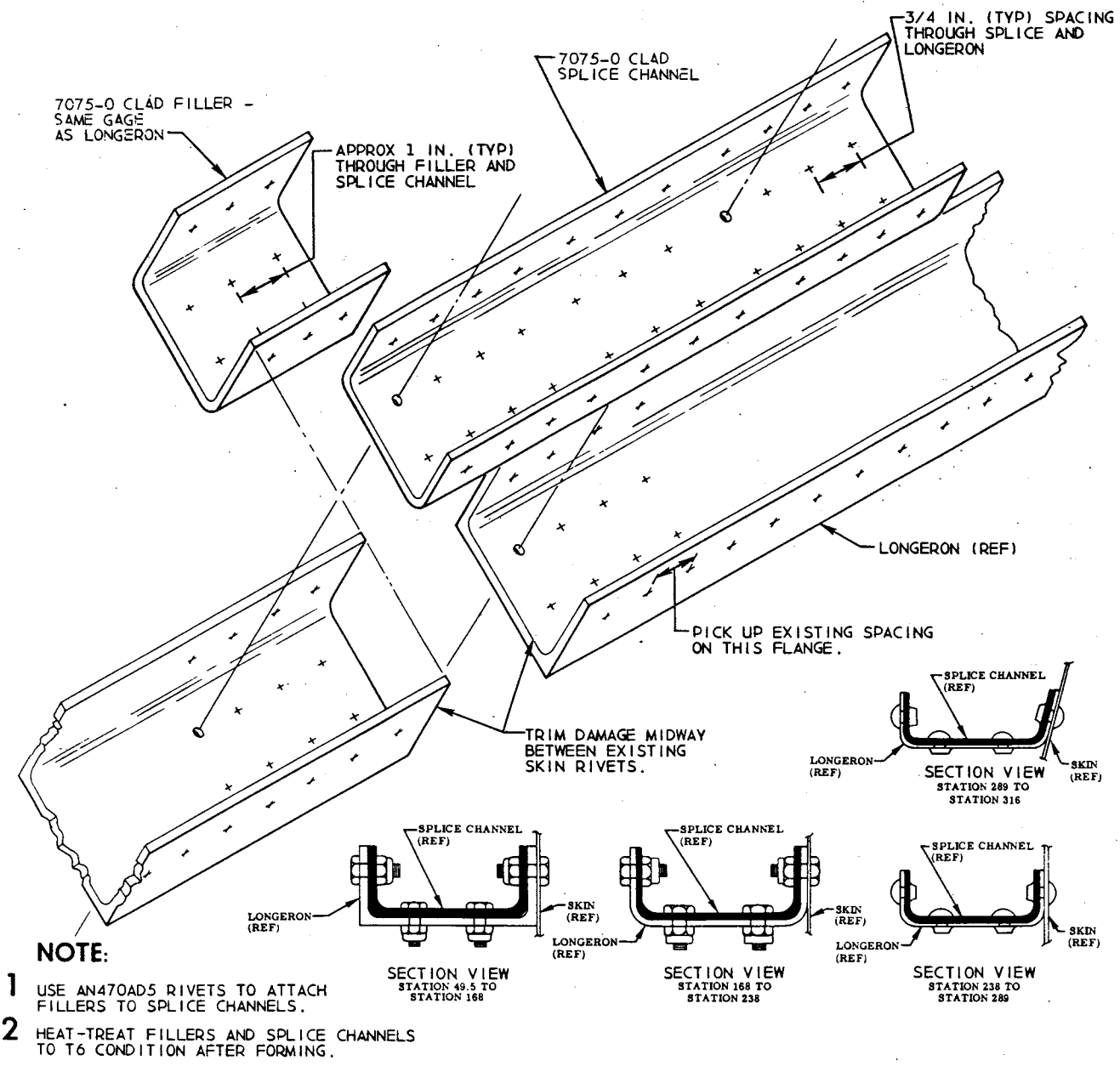


Figure 4-15A. Frame Splice and Repair



NOTE:

1 USE AN470AD5 RIVETS TO ATTACH FILLERS TO SPLICE CHANNELS.

2 HEAT-TREAT FILLERS AND SPLICE CHANNELS TO T6 CONDITION AFTER FORMING.

STATIONS	SPACING BETWEEN ROWS OF RIVETS AND BOLTS	MIN EDGE DISTANCE	FASTENERS THROUGH LONGERON AND SPLICE	NO. REQD EACH SIDE OF DAMAGE	GAUGE OF SPLICE CHANNEL	LENGTH OF SPLICE	BEND RADIUS
49.5 TO 168	1 IN.	3/8 IN.	AN3A BOLTS	16	0.125 IN.	6-1/2 IN. PLUS DAMAGE	11/32 IN.
168 TO 238	1-1/4 IN.	3/8 IN.	AN3A BOLTS	16	0.102 IN.	6-1/2 IN. PLUS DAMAGE	5/16 IN.
238 TO 289	1 IN.	3/8 IN.	AN470DD6 RIVETS	24	0.081 IN.	9 IN. PLUS DAMAGE	3/16 IN.
289 TO 316	1 IN.	3/8 IN.	AN470DD6 RIVETS	20	0.160 IN.	7 IN. PLUS DAMAGE	5/32 IN.

T-28A-3-31-25

Figure 4-16. Lower Longeron Repair - Channel

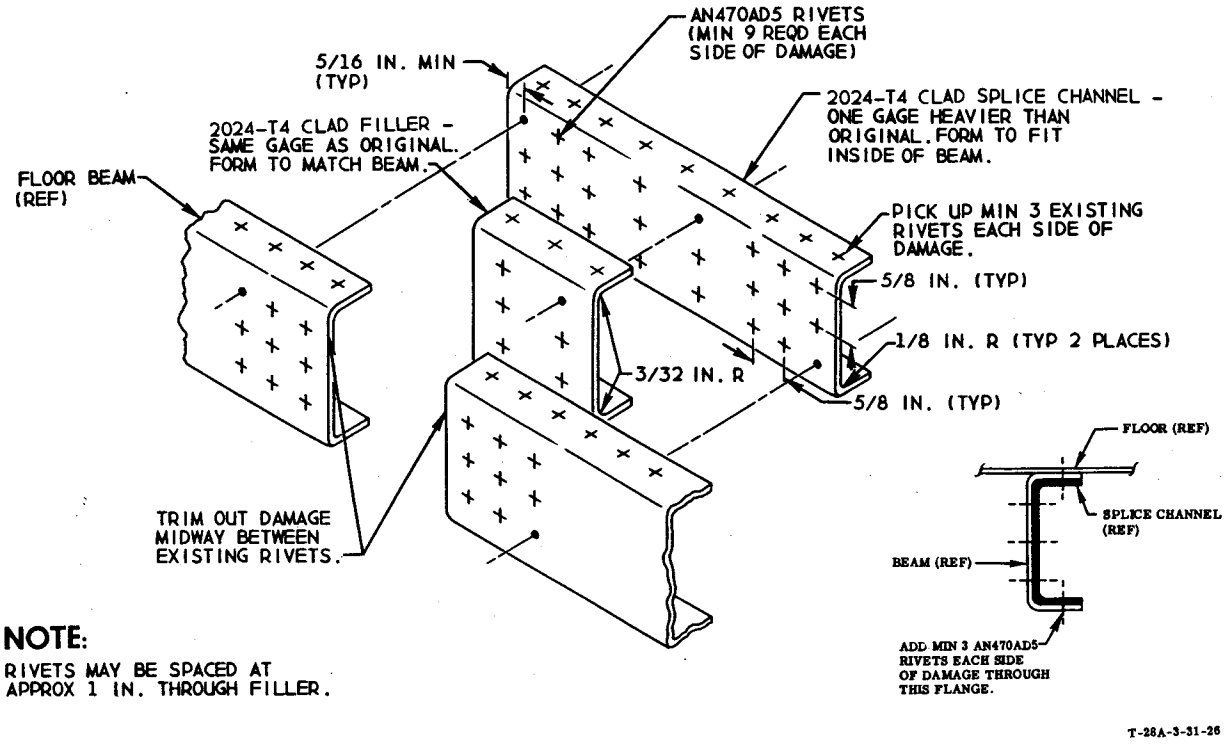


Figure 4-17. Floor Beam Repair

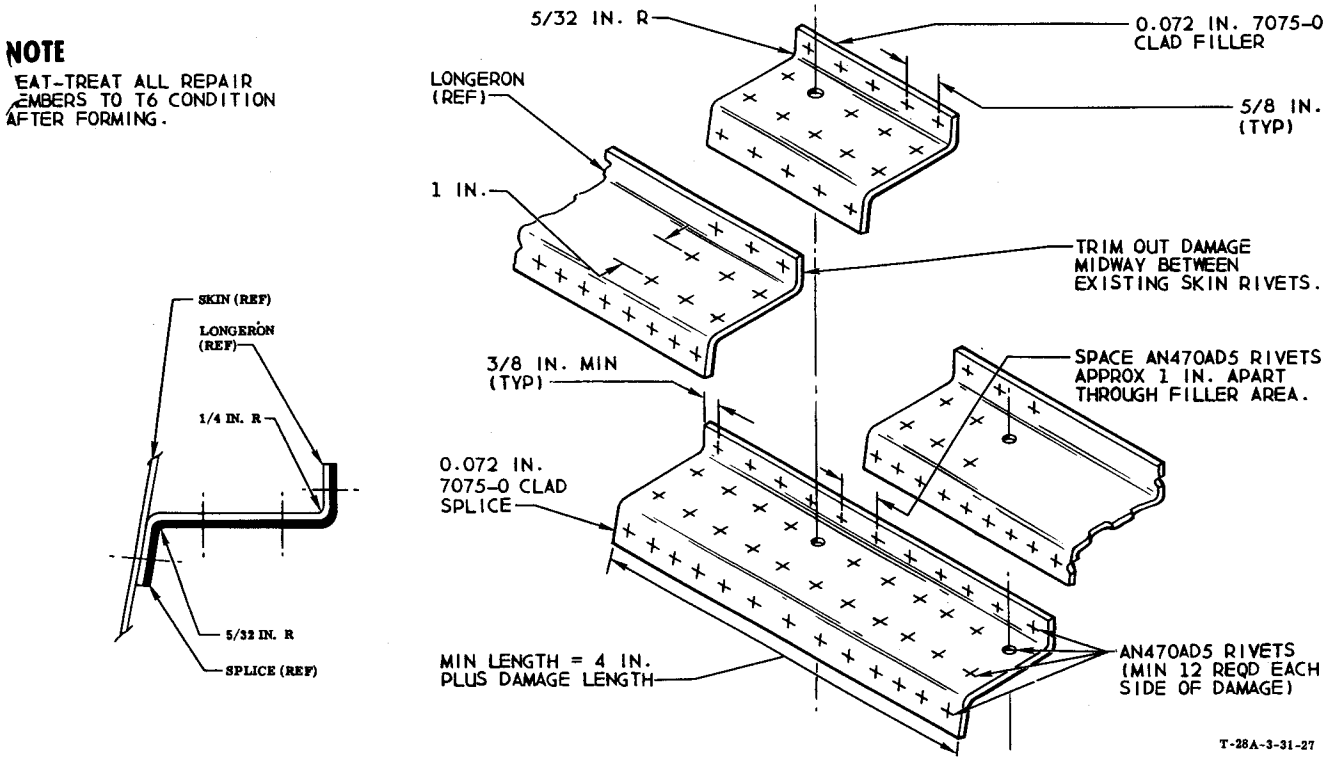
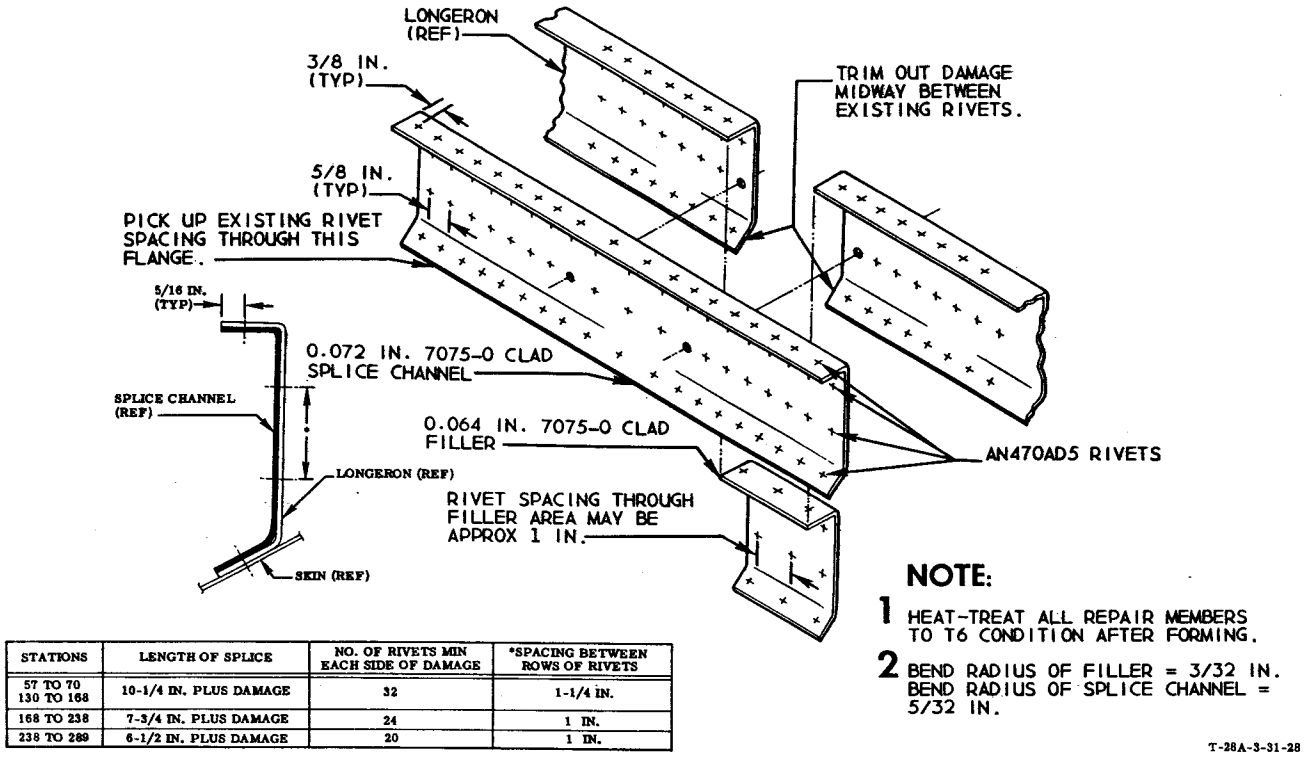


Figure 4-18. Upper Longeron Repair - Station 289 to 338



STATIONS	LENGTH OF SPLICE	NO. OF RIVETS MIN EACH SIDE OF DAMAGE	*SPACING BETWEEN ROWS OF RIVETS
57 TO 70 130 TO 168	10-1/4 IN. PLUS DAMAGE	32	1-1/4 IN.
168 TO 238	7-3/4 IN. PLUS DAMAGE	24	1 IN.
238 TO 289	6-1/2 IN. PLUS DAMAGE	20	1 IN.

Figure 4-19. Upper Longeron Repair - Station 138 to 289

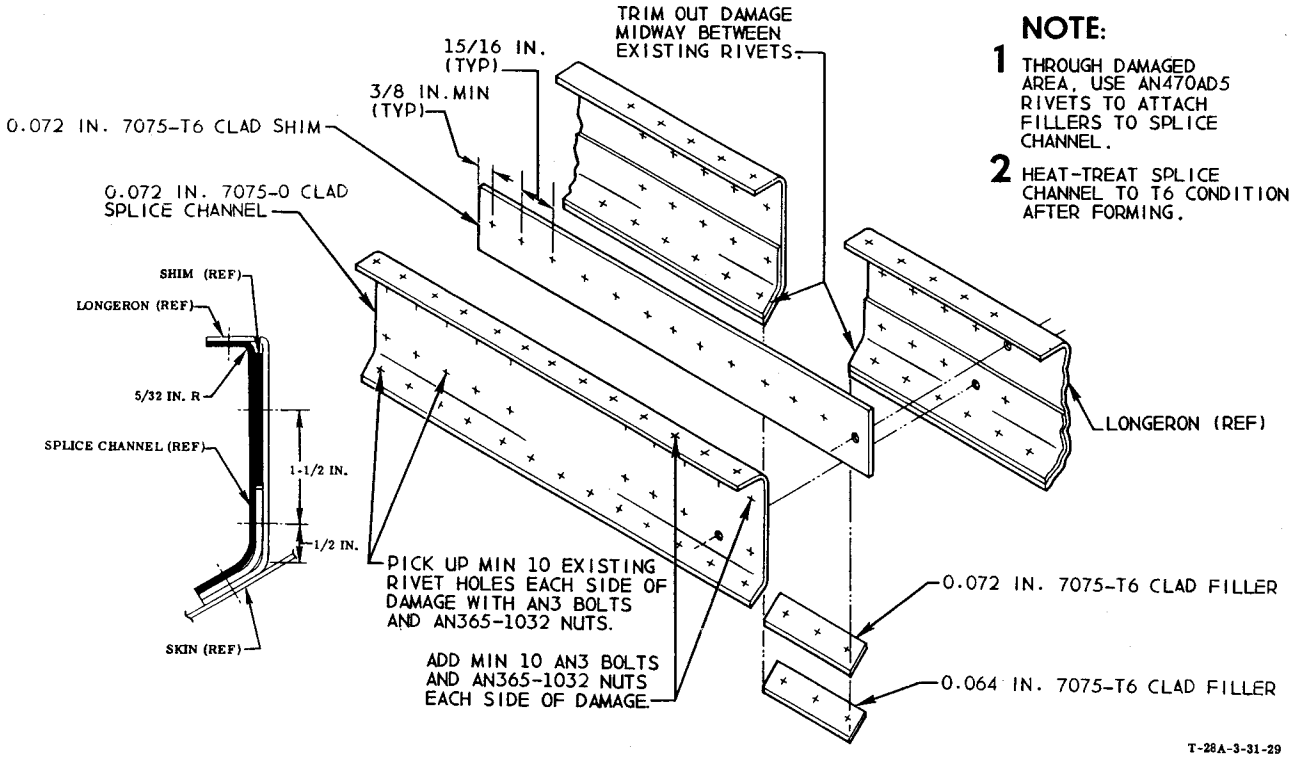
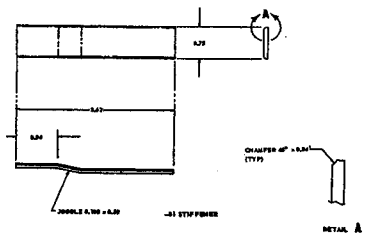
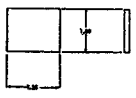
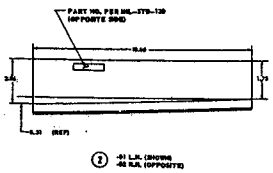


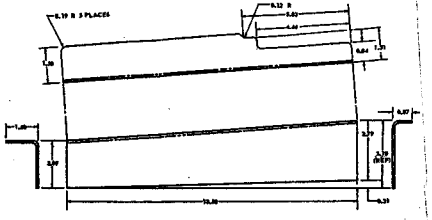
Figure 4-20. Upper Longeron Repair - Station 70 to 130



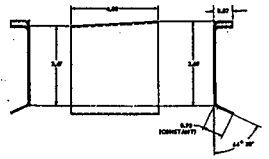




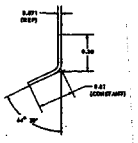
② -31 L.H. (SHOWN)
-32 R.H. (OPPOSITE)

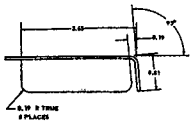


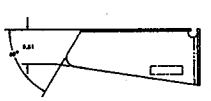
③ -31 ANGLE L.H. (SHOWN)
-32 ANGLE R.H. (OPPOSITE)

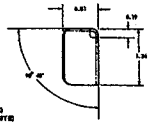


④ -31 FILLER L.H. (SHOWN)
-32 FILLER R.H. (OPPOSITE)

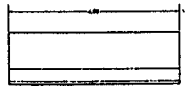




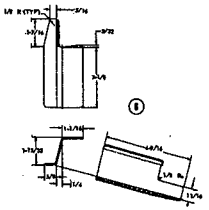




⑤ -31 CLIP L.H. (SHOWN)
-32 CLIP R.H. (OPPOSITE)



④



NOTES:

② BEND RADIUS 0.25.
HEAT TREAT TO T-6 COND AFTER FORMING
PER MIL-H-6088

③ BEND RADIUS 0.34
HEAT TREAT TO T-6 COND AFTER FORMING
PER MIL-H-6088

④ BEND RADII 0.19

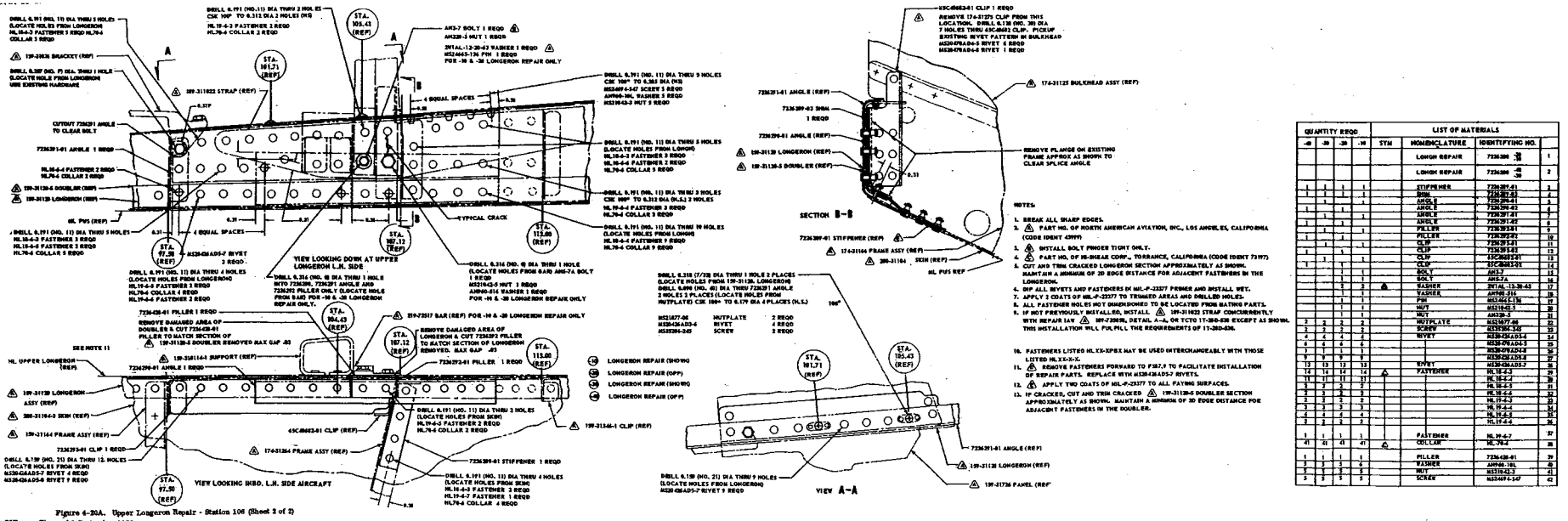
⑤ BEND RADII AND BEND RELIEF RADIUS 0.09
HEAT TREAT TO T-6 COND AFTER FORMING
PER MIL-H-6088

⑥ BEND RADII 3/32

LIST OF MATERIALS

		NOMENCLATURE	CODE IDENT	IDENTIFYING NO.	SPECIFICATION	MATERIAL	UNIT WT		
	1	STIFFENER		7236380-01		CRES 301 0.050 x 7.5 x 3.62			
		SHIM		7236389-03		AL. ALY. 2024 0.099 x 1.00 x 1.25			
②	2	ANGLE		7236390-01		AL. ALY. 2024 0.090 x 2.38 x 16.65			
				7236390-02					
③	3	ANGLE		7236391-01		AL. ALY. 2024 0.071 x 2.94 x 12.20			
				7236391-02					
④	4	FILLER		7236392-01		AL. ALY. 2024 0.063 x 4.00 x 5.64			
				7236393-02					
④	5	FILLER		7236438-01	2024 "T3" QQ-A-250/5	1.79 x 4.00 0.077 THK x			
⑤	6	CLIP		7236393-01		AL. ALY. 2024 0.063 x 2.12 x 4.12			
				7236293-02					
⑤	7	CLIP L.H.		65C40482	COND 0 QQ-A-250/12	AL. ALY. 2024 0.062 x 4 x 5			
		CLIP R.H.		65C40483-02	COND 0 QQ-A-250/12				

Figure 4-20A. Upper Longeron Repair - Station 106 (Sheet 1 of 2)



QUANTITY REQD					LIST OF MATERIALS		
-69	-39	-29	-19	SYM	NOMENCLATURE	IDENTIFYING NO.	
					LONGR REPAIR	7236388 -39 -19	1
					LONGR REPAIR	7236389 -69 -39	2
1	1	1	1		STIFFENER	7236287-01	3
1	1	1	1		SKIN	7236287-03	4
	1		1		ANGLE	7236294-01	5
1		1			ANGLE	7236299-03	6
			1		ANGLE	7236297-01	7
1		1			ANGLE	7236291-02	8
	1		1		FILLER	7236292-01	9
1		1			FILLER	7236292-02	10
			1		CLIP	7236293-01	11
1		1			CLIP	7236295-02	12
	1		1		CLIP	15C8682-01	13
1		1			CLIP	15C8682-02	14
		1	1		BOLT	AN3-7	15
		1	1		BOLT	AN3-7A	16
		1	2	▲	WASHER	2NTAL-12-20-43	17
		1	1		WASHER	AN960-516	18
		1	1		PIN	MS24665-153	19
		1	1		NUT	MS21042-3	20
		1	1		NUT	AN320-3	21
3	2	2	2		MUTPLATE	MS21077-08	22
2	2	2	2		SCREW	MS27286-24	23
4	4	4	4		RIVET	MS20426AD3-4	24
6	6	6	6			MS20426AD4-5	25
1	1	1	1			MS20426AD4-6	26
9	9	9	9			MS20426AD5-8	27
13	13	13	13		RIVET	MS20426AD5-7	28
14	14	14	14		FASTENER	HL 19-4-3	29
11	11	11	11			HL 19-4-4	30
3	2	2	2			HL 19-4-5	31
2	3	3	3			HL 19-4-6	32
3	3	3	2			HL 19-4-7	33
3	3	3	3			HL 19-4-8	34
4	4	4	4			HL 19-4-9	35
2	2	2	2			HL 19-4-4	36
1	1	1	1		FASTENER	HL 19-4-7	37
41	41	41	41	△	COLLAR	HL 70-4	38
1	1	1	1		FILLER	7236428-01	39
5	5	5	6		WASHER	AN960-516L	40
5	5	5	5		NUT	MS21042-3	41
5	5	5	5		SCREW	MS27697-S4P	42

Figure 4-26A. Upper Longeron Repair - Station 106 (Sheet 2 of 2)

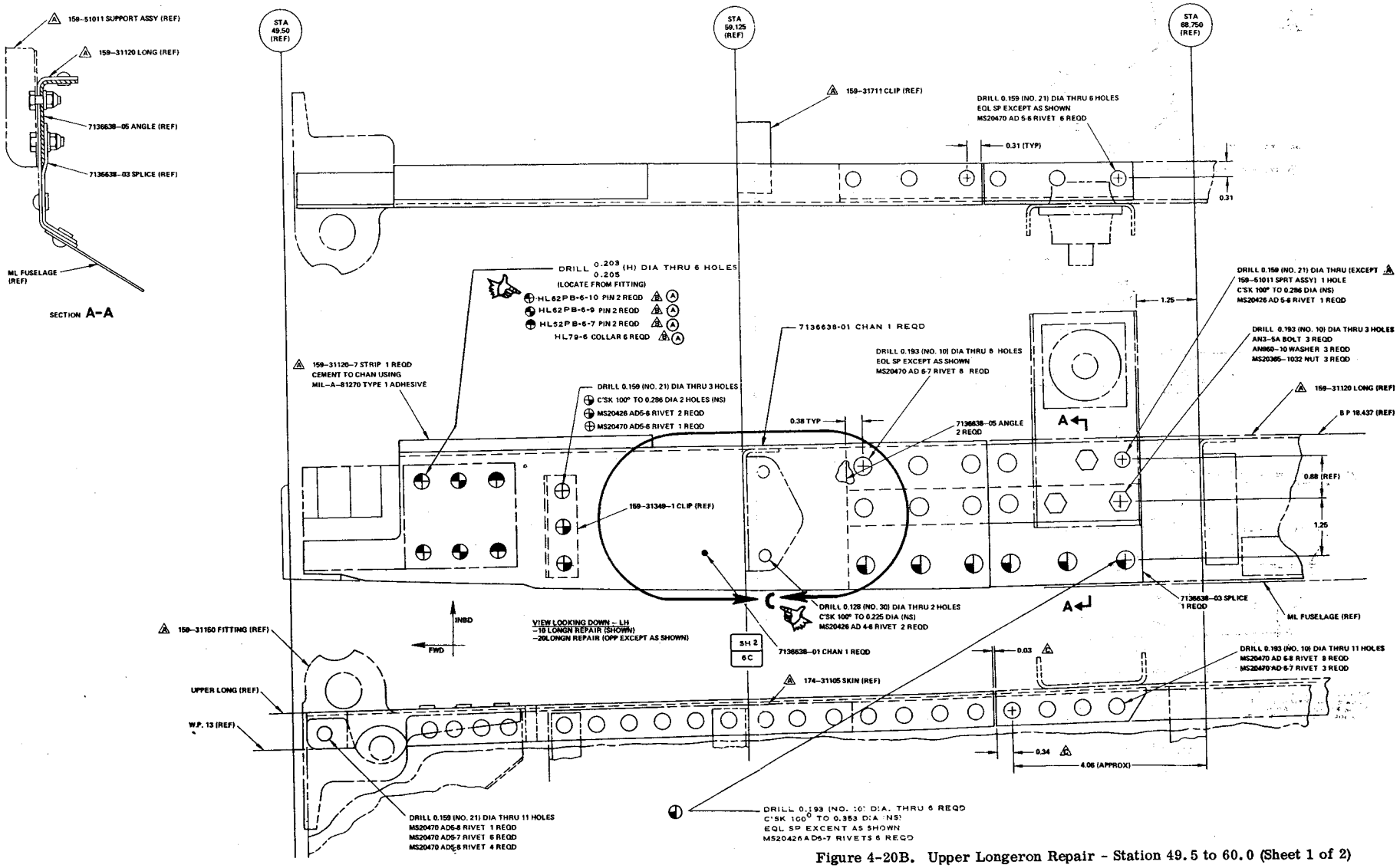
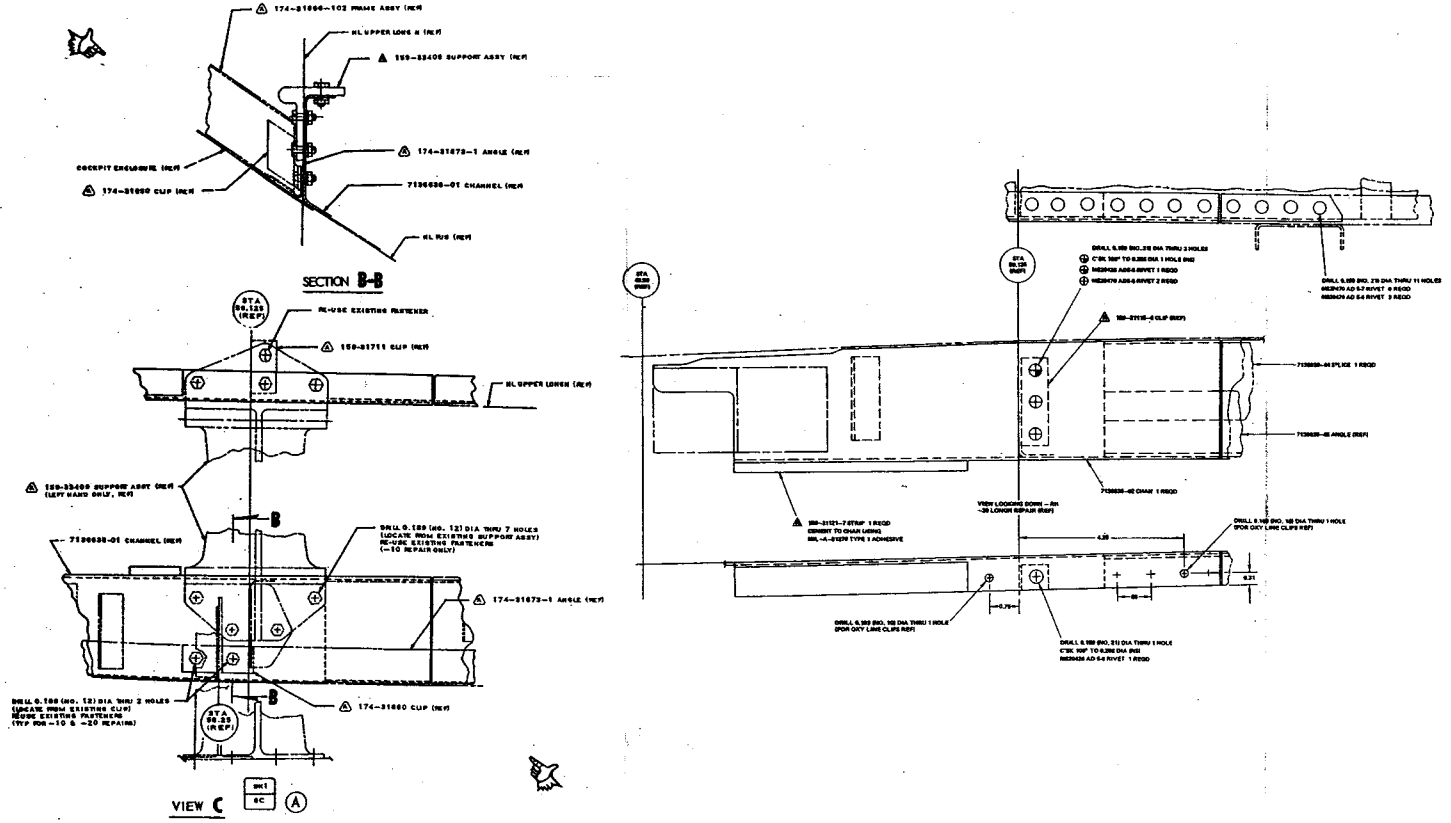


Figure 4-20B. Upper Longeron Repair - Station 49.5 to 60.0 (Sheet 1 of 2)



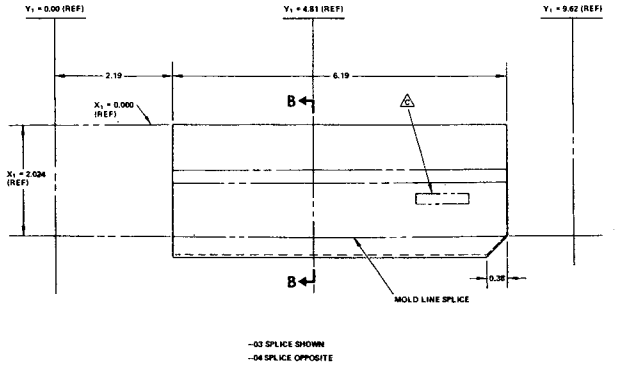
NOTE:

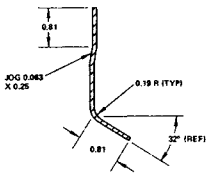
1. BREAK ALL SHARP EDGES.
2. ALL FASTENER HOLES NOT DIMENSIONED TO BE LOCATED FROM MATING PARTS.
3. PART NO. OF NORTH AMERICAN AVIATION INC., LOS ANGELES, CALIFORNIA, CODE IDENT NO. 43999.
4. COMPL PRODUCT MUST BE EQUAL TO AND INTERCHANGEABLE WITH NOTED PART NO'S DES LIS FOR MFR'S CODE IDENT NO'S.
5. TRIM STIFFENING LONGERON AND 7139035 CHANNEL AS INDICATED.
6. APPLY 2 COATS OF MIL-P-23377 TO TRIMMED AREAS AND DRILLED HOLES.
7. INSTALL FASTENERS WET USING MIL-P-4556 FOR BOLTS AND MIL-P-23377 FOR RIVETS.
8. HL82-6-7, -9 & -10 ▲ MAY BE USED IN LIEU OF LISTED PB RIVS

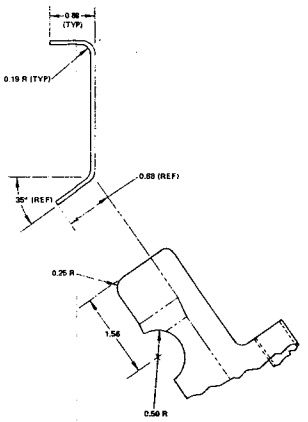
LIST OF MATERIALS

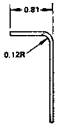
ITEM NO.	NOMENCLATURE	IDENT CODE	IDENTIFYING NO.	SPECIFICATION	MATERIAL	UNIT WT.	ZONE	SYM	QTY REQD -10	QTY REQD -20
1	LONGERON REPAIR	88240	-10						1	
2	LONGERON REPAIR		-20							1
3	CHANNEL		7139035-01						1	
4	CHANNEL		-02							1
5	SPLICE		-03						1	
6	SPLICE		-04							1
7	ANGLE	88240	7139035-05						1	1
8										
9										
10	STRAP	43999	180-31128-7	AMS 3267	SYNTH RUBBER 0.25 X 0.75 X 5.25				1	
11	STRAP	43999	180-31121-7	AMS 3267	SYNTH RUBBER 0.25 X 0.75 X 2.88					1
12										
13	PIN	73197	HL79-6	COMPL ▲▲					2	2
14	PIN		HL82PB-6-10						2	2
15	PIN		HL82PB-6-9						2	2
16	COLLAR	73197	HL82PB-6-7	COMPL ▲▲					6	6
17										
18	BOLT		AN3-6A						4	4
19	WASHER		AN960-10						4	4
20	NUT		MS21042-3						4	4
21	RIVET		MS20426AD4-6						2	
22	RIVET		MS20426AD5-6						3	5
23	RIVET		MS20470AD5-5						11	14
24	RIVET		MS20470AD5-7						6	
25	RIVET		MS20470AD5-8						1	1
26	RIVET		MS20470AD6-7						17	14
27	RIVET		MS20426AD4-6						6	
28										
29	ADHESIVE	81349	MIL-A-25463 TYPE 1						1 OZ	1 OZ

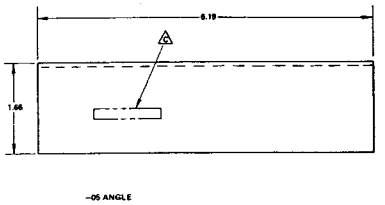
Figure 4-20B. Upper Longeron Repair - Station 49.5 to 60.0 (Sheet 2 of 2)



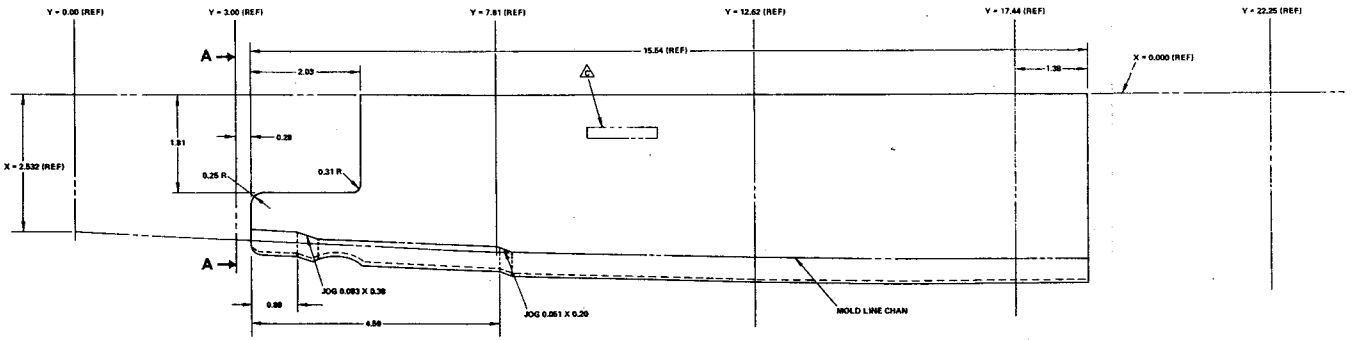








NOTE:
1. BREAK ALL SHARP EDGES.
2. ALL OFFSET DIMS ARE THEORETICAL. CONTOUR MOLD LINES MUST FAIR.
3. HEAT TREAT TO "T6" AFTER FORMING PER MIL-H-6088.
4. FINISH: APPLY TWO COATS OF MIL-P-23377 IN ACCORDANCE WITH MIL-F-7179 TYPE 1.
5. IDENTIFY WITH PART NO. PER MIL-STD-130 USING METAL STAMP.



OFFSET CONTOUR AND BEVEL CHART FOR -01

Y DIM	X DIM	BEVEL
0.00	2.532	35.5° OP
3.00	2.691	35° OP
7.81	2.882	34° OP
12.62	3.026	33° OP
17.44	3.072	32° OP
22.25	3.067	31.5° OP

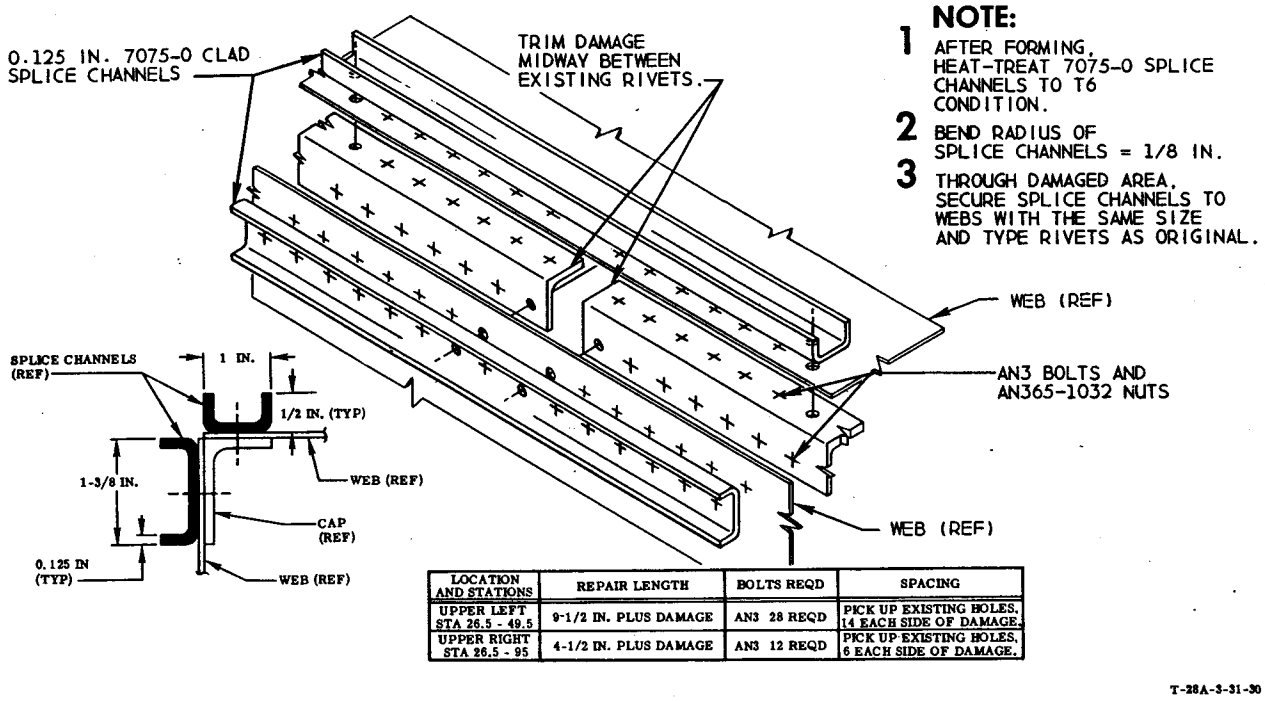
OFFSET CONTOUR AND BEVEL CHART FOR -03

Y_1 DIM	X_1 DIM	BEVEL
0.00	2.024	33° OP
4.81	2.068	32° OP
9.62	2.064	31.5° OP

LIST OF MATERIALS

FIND NO.	NOMENCLATURE	CODE IDENT	IDENTIFYING NO.	SPECIFICATION	MATERIAL	UNIT	ZONE
1	CHANNEL	98749	7136638				
2							
3	CHANNEL		7136638-01	QQ-A-250/13 7075 TEM W	0.071 X 5.00 X 16.00 AL ALY SH		
4	CHANNEL		-02				
5	SPLICE		-03	QQ-A-250/13 7075 TEM W	0.063 X 3.00 X 6.25 AL ALY SH		
6	SPLICE		-04				
7	ANGLE	98749	7136638-05	QQ-A-250/13 7075 TEM W	0.063 X 3.00 X 6.25 AL ALY SH		
8							
9							

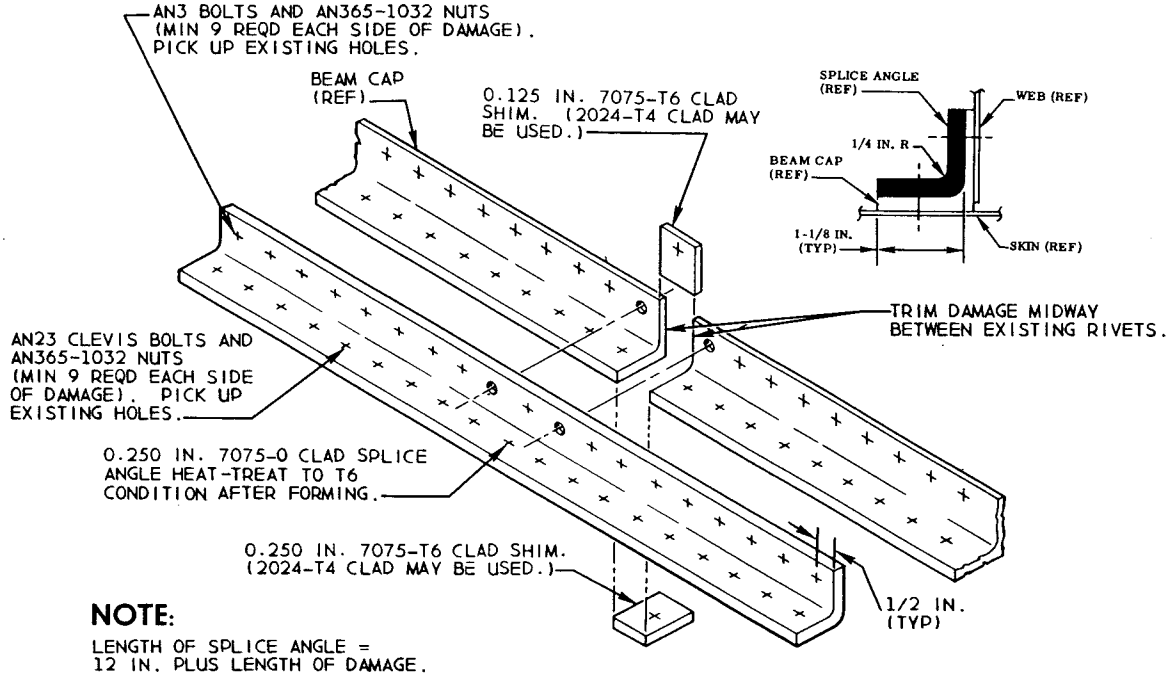
Figure 4-20C. Upper Longeron Repair - Station 49.5 to 60.0



LOCATION AND STATIONS	REPAIR LENGTH	BOLTS REQD	SPACING
UPPER LEFT STA 26.5 - 49.5	9-1/2 IN. PLUS DAMAGE	AN3 28 REQD	PICK UP EXISTING HOLES, 14 EACH SIDE OF DAMAGE.
UPPER RIGHT STA 26.5 - 95	4-1/2 IN. PLUS DAMAGE	AN3 12 REQD	PICK UP EXISTING HOLES, 6 EACH SIDE OF DAMAGE.

T-28A-3-31-30

Figure 4-21. Nose Gear Beam Repair - Upper Cap



T-28A-3-31-31

Figure 4-22. Nose Gear Beam Repair - Lower Left Cap

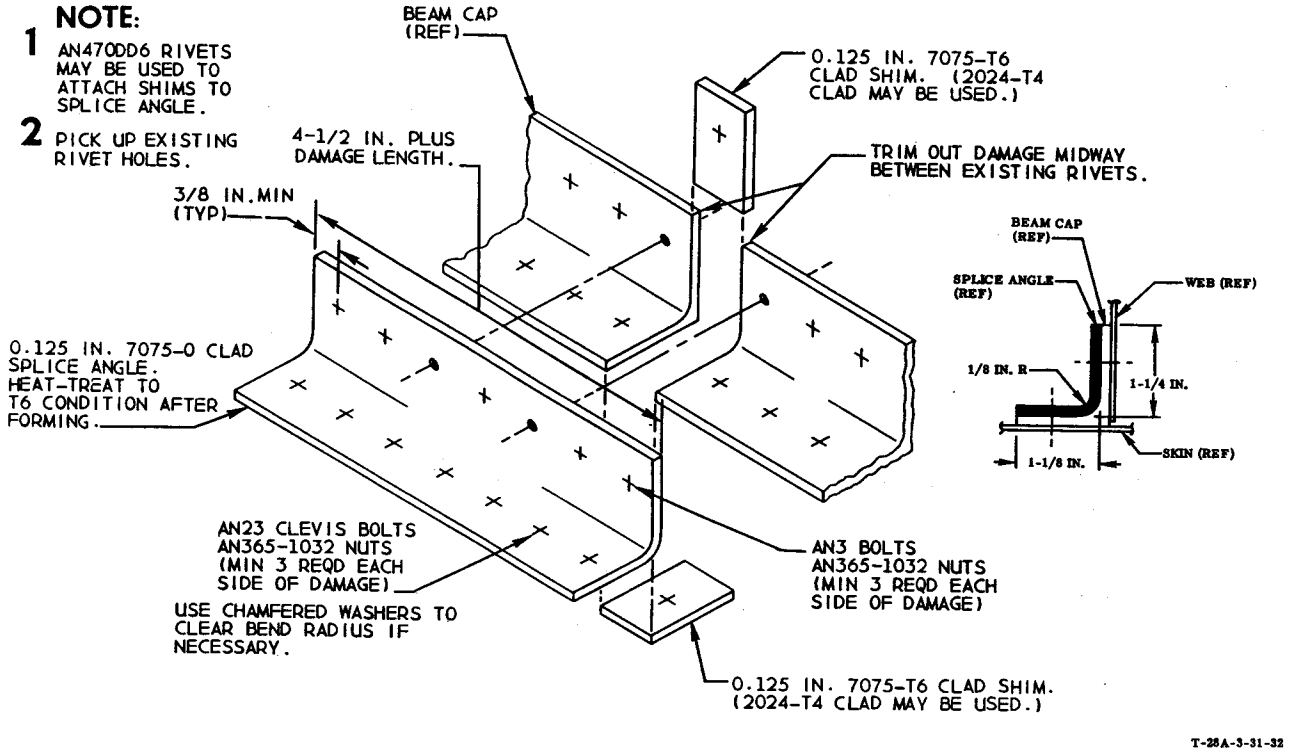
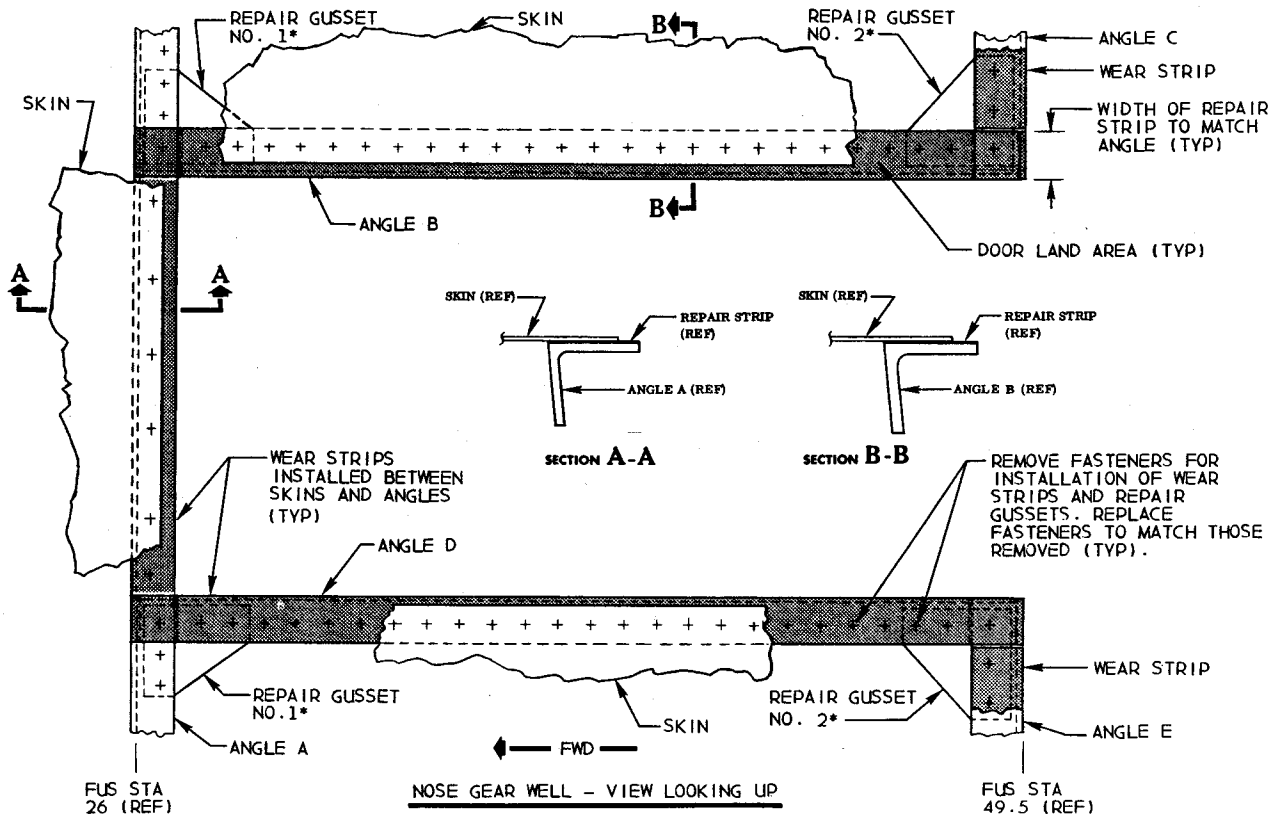
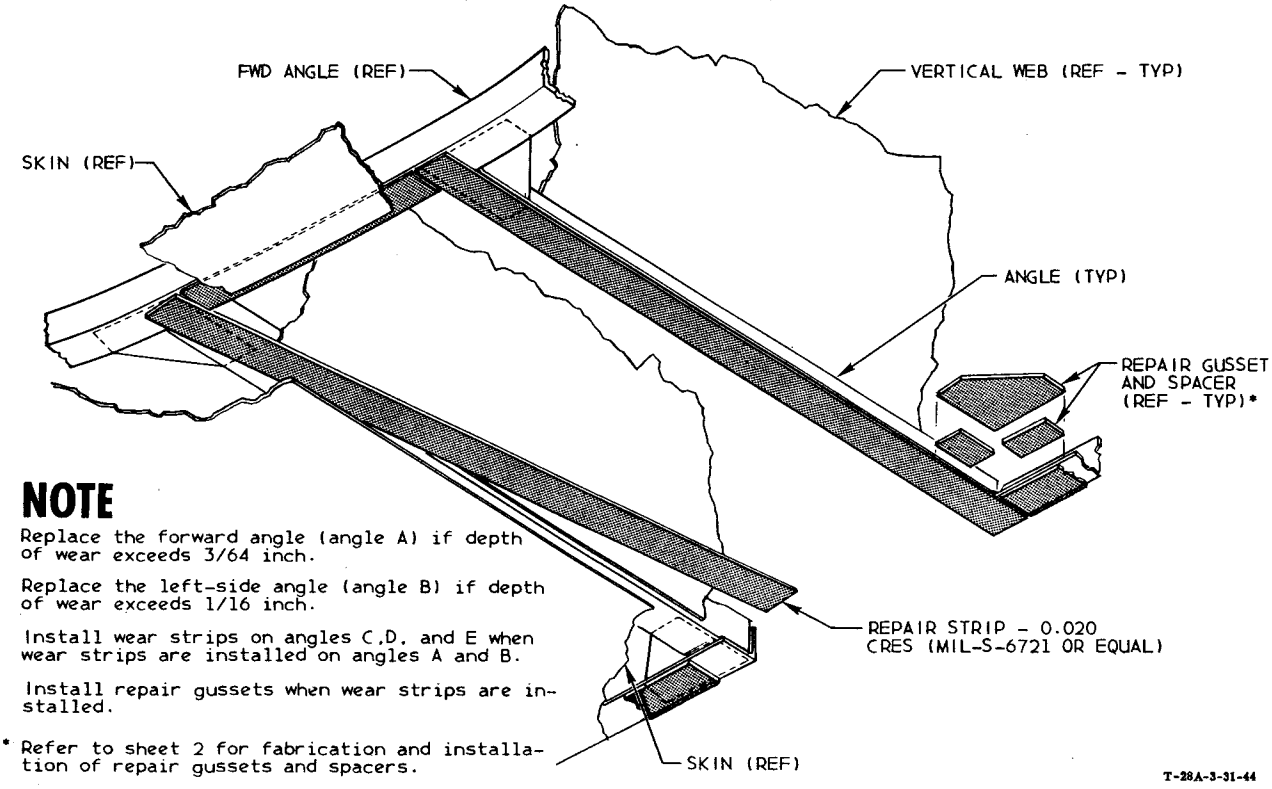


Figure 4-23. Nose Gear Beam Repair - Lower Right Cap





NOTE

Replace the forward angle (angle A) if depth of wear exceeds 3/64 inch.

Replace the left-side angle (angle B) if depth of wear exceeds 1/16 inch.

Install wear strips on angles C,D, and E when wear strips are installed on angles A and B.

Install repair gussets when wear strips are installed.

* Refer to sheet 2 for fabrication and installation of repair gussets and spacers.

Figure 4-23A. Installation of Wear Strips and Gussets - Nose Landing Gear Beams (Sheet 1 of 2)

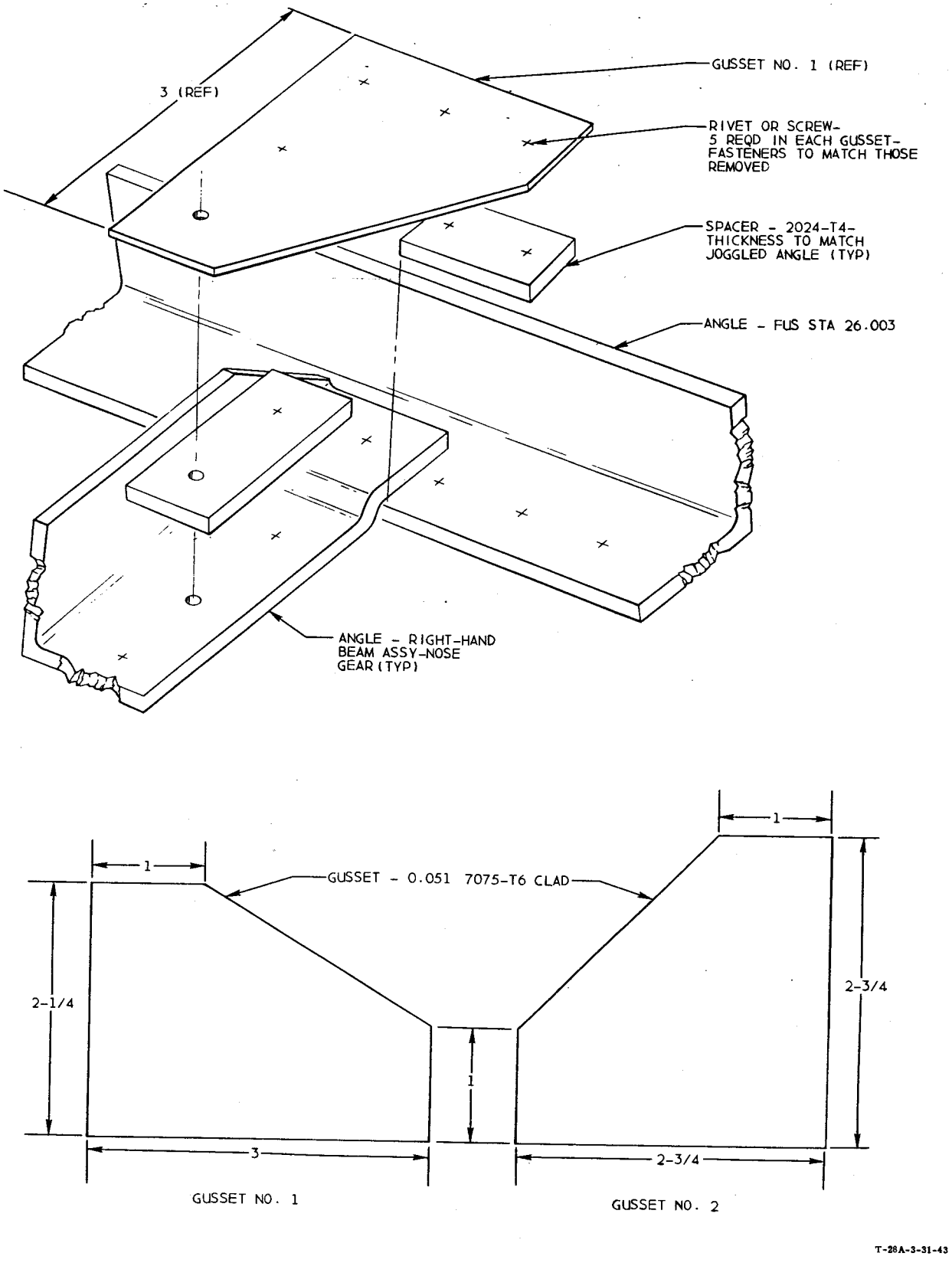


Figure 4-23A. Installation of Wear Strips and Gussets - Nose Landing Gear Beams (Sheet 2 of 2)

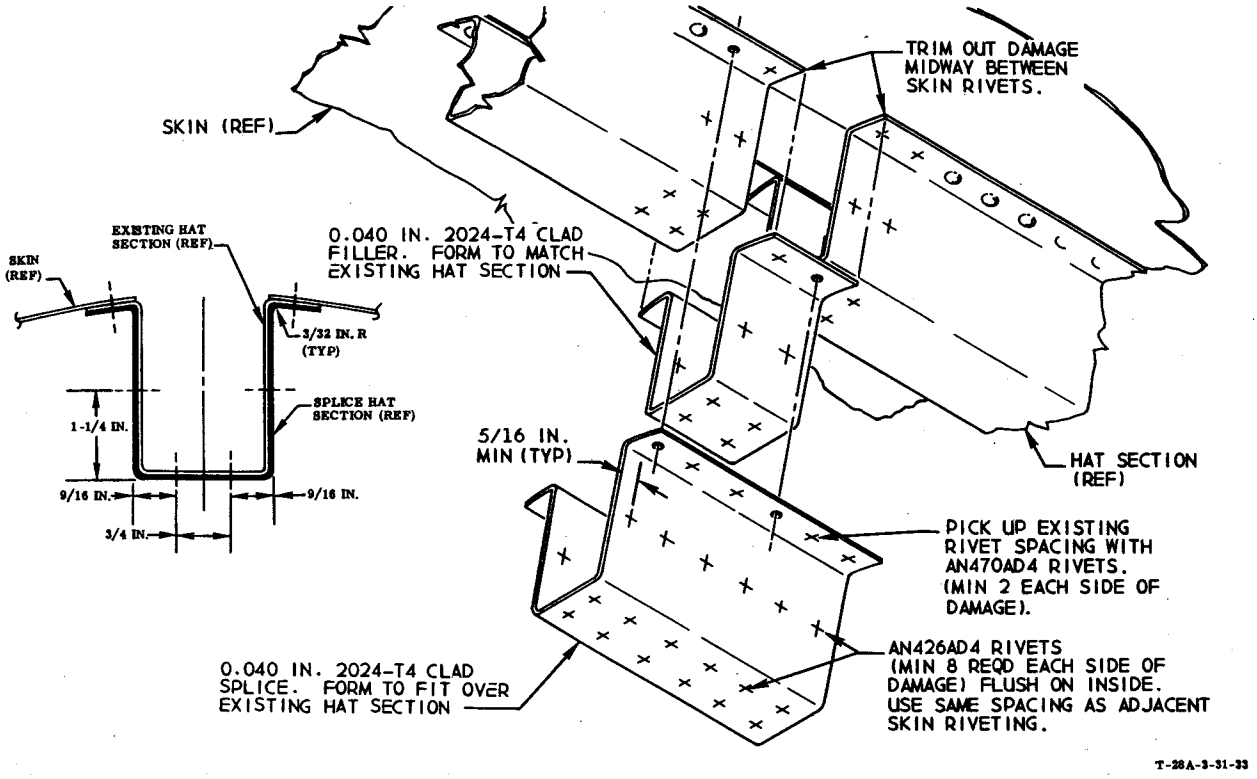
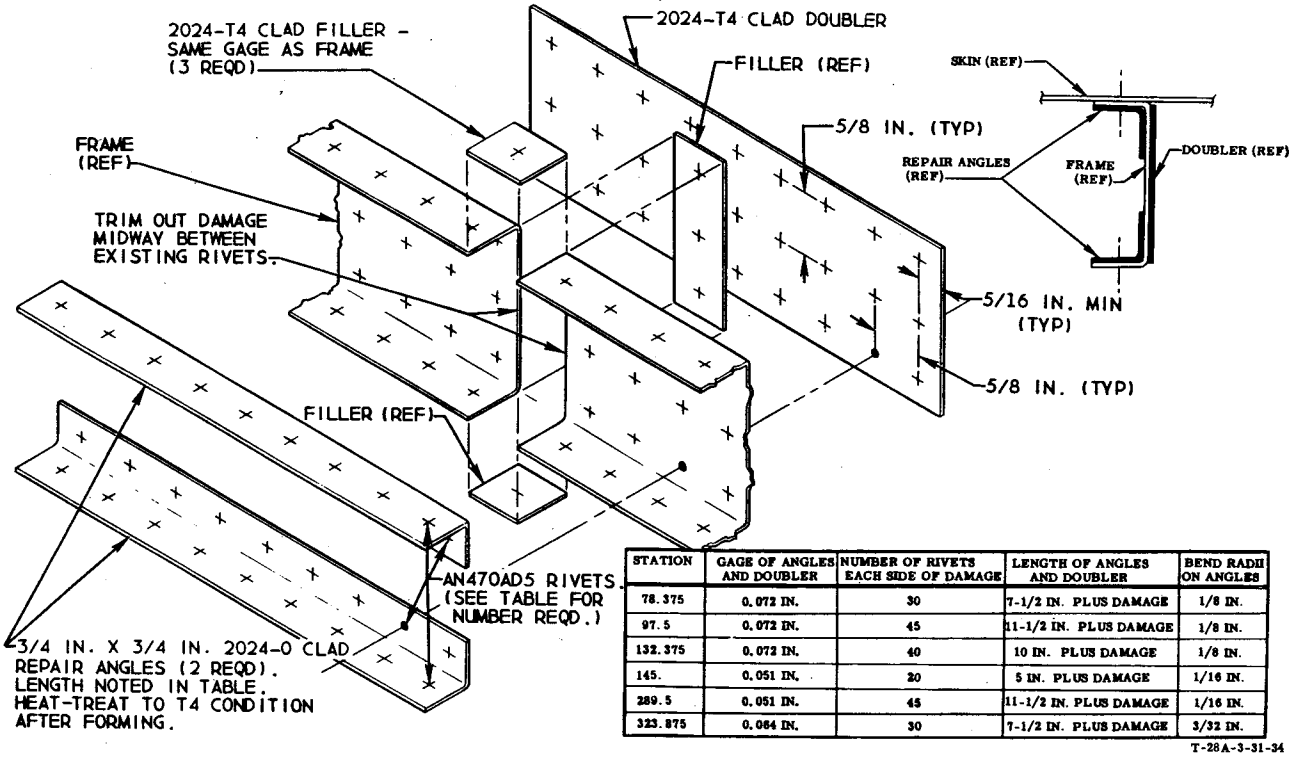
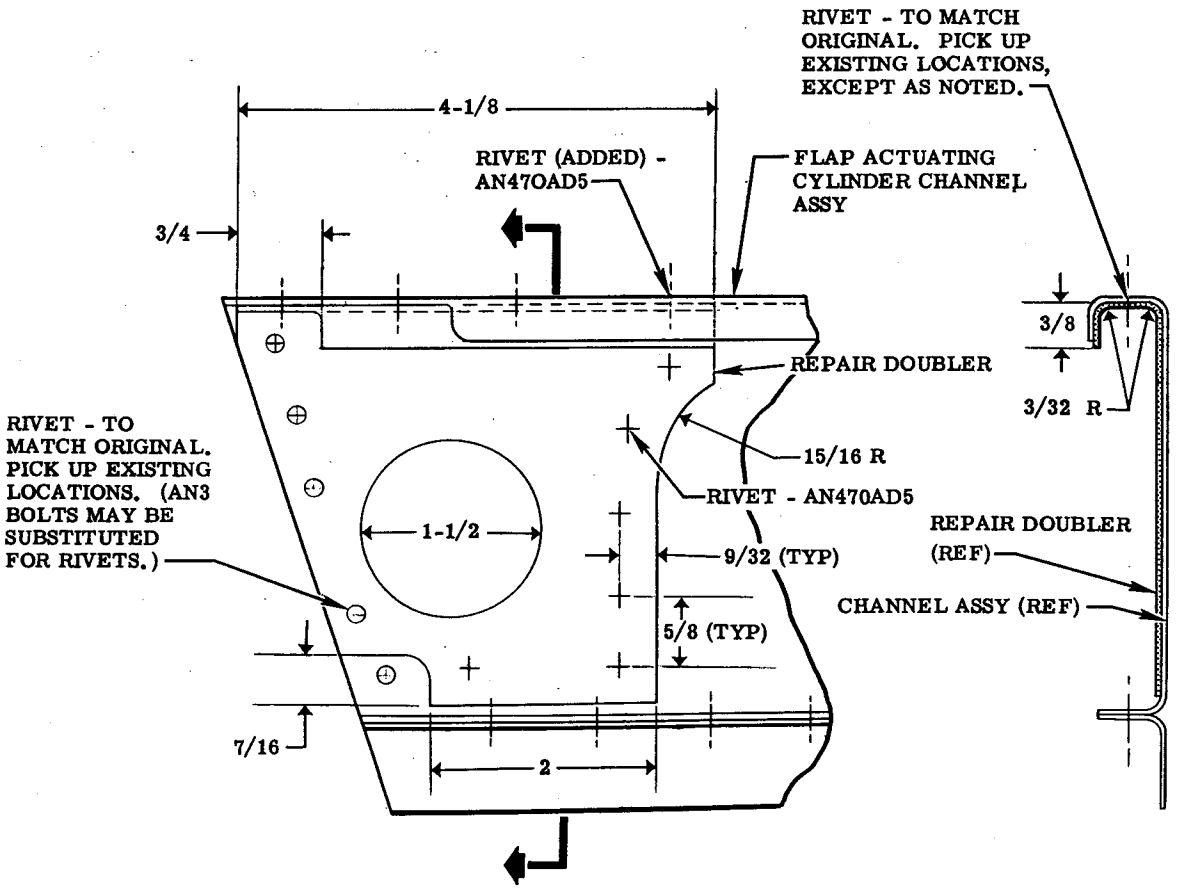


Figure 4-24. Canopy Track Support Channel Repair — T-28A and T-28D Airplanes

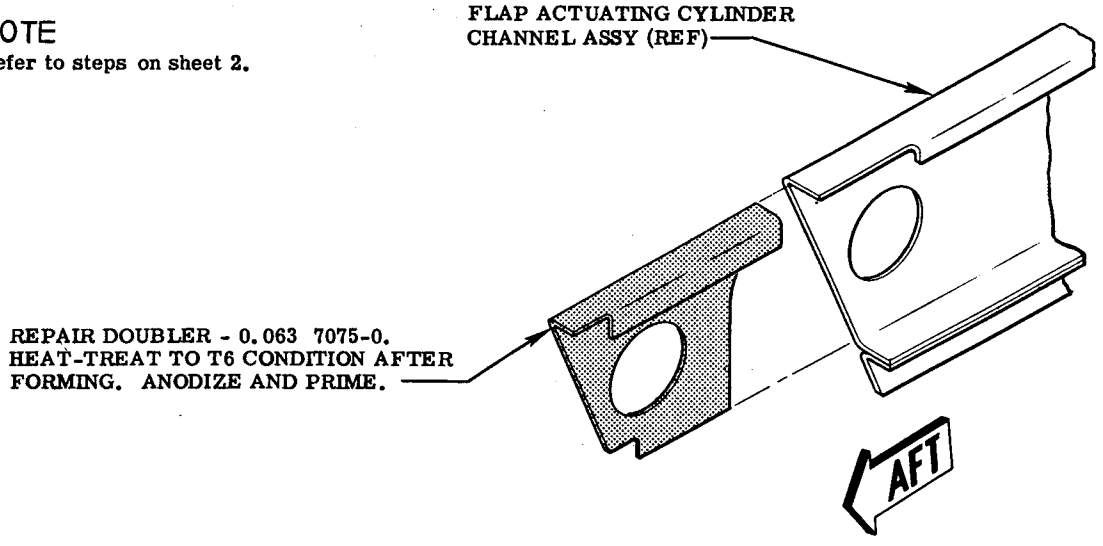


STATION	GAGE OF ANGLES AND DOUBLER	NUMBER OF RIVETS EACH SIDE OF DAMAGE	LENGTH OF ANGLES AND DOUBLER	BEND RADII ON ANGLES
78.375	0.072 IN.	30	7-1/2 IN. PLUS DAMAGE	1/8 IN.
97.5	0.072 IN.	45	11-1/2 IN. PLUS DAMAGE	1/8 IN.
132.375	0.072 IN.	40	10 IN. PLUS DAMAGE	1/8 IN.
145.	0.051 IN.	20	5 IN. PLUS DAMAGE	1/16 IN.
289.5	0.051 IN.	45	11-1/2 IN. PLUS DAMAGE	1/16 IN.
323.875	0.064 IN.	30	7-1/2 IN. PLUS DAMAGE	3/32 IN.

Figure 4-25. Frame Repair - General

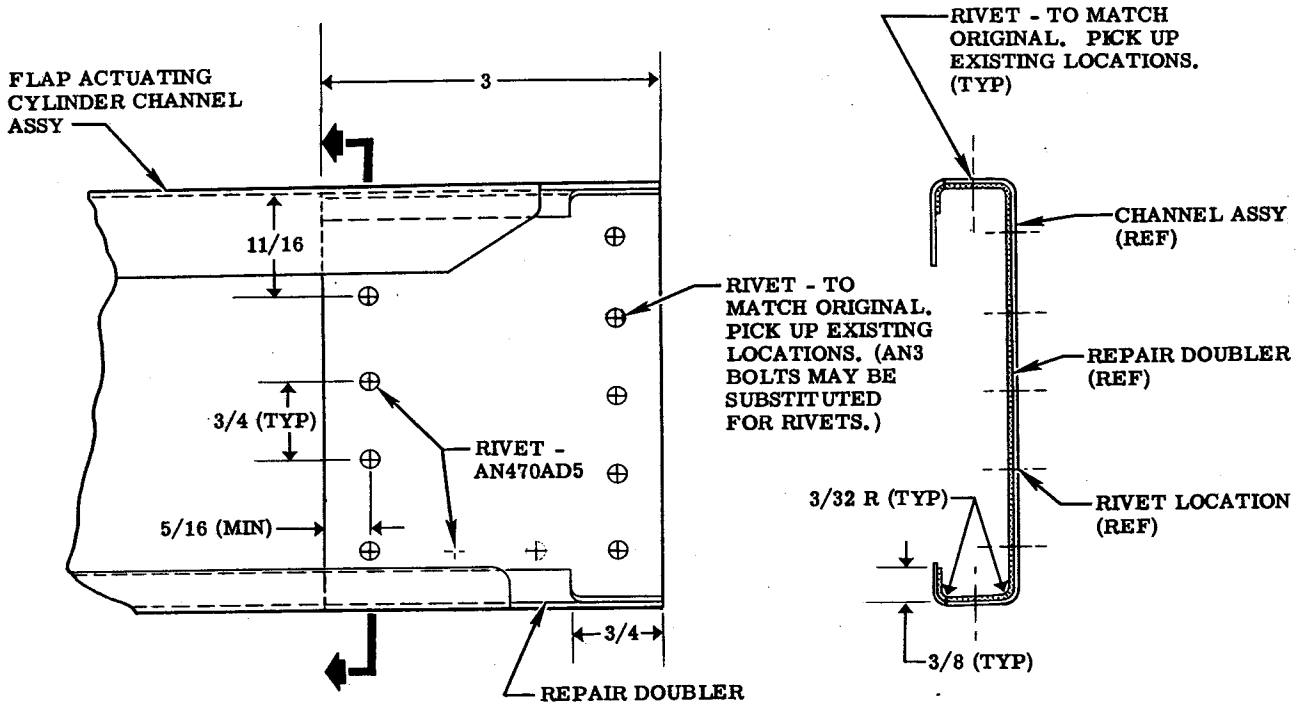


NOTE
Refer to steps on sheet 2.



T-28A-3-31-40

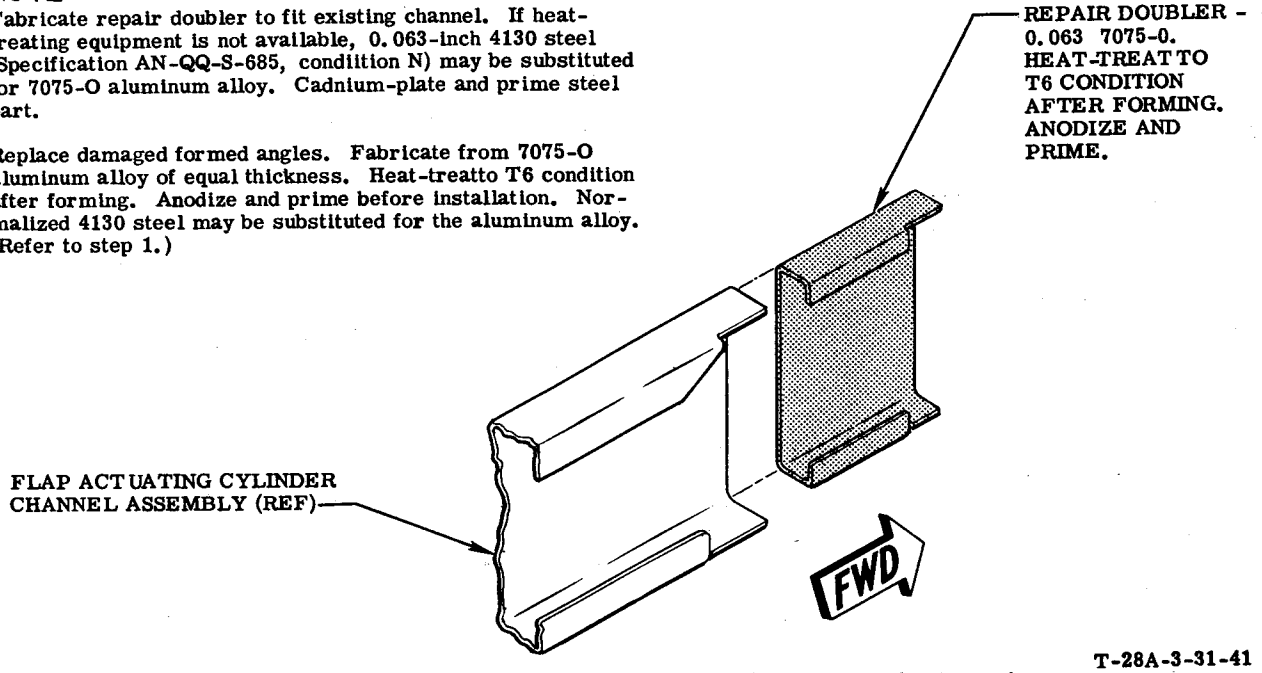
Figure 4-26. Channel Assembly Repair — Flap Actuating Cylinder — T-28A and T-28D Airplanes (Sheet 1 of 2)



NOTE

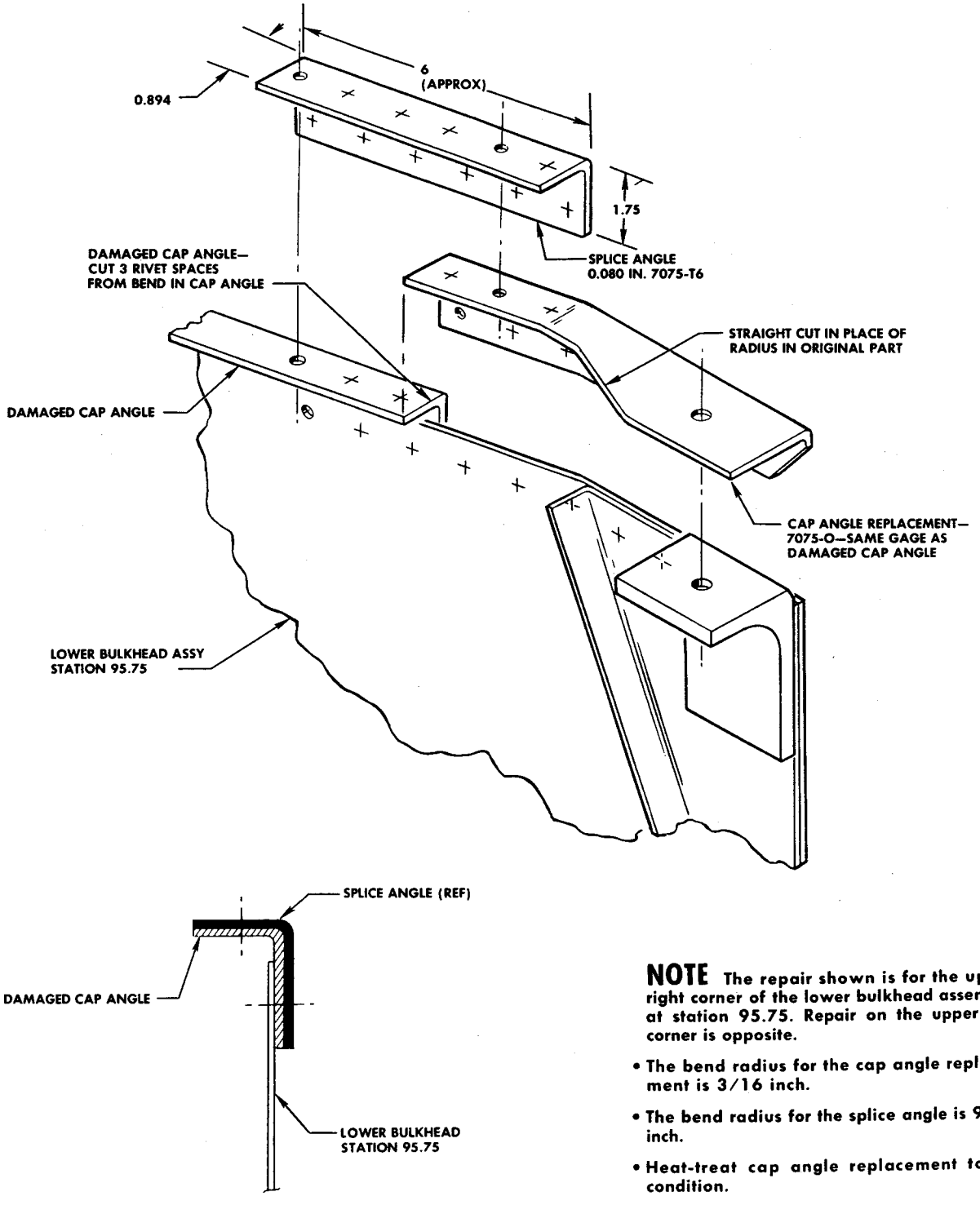
Fabricate repair doubler to fit existing channel. If heat-treating equipment is not available, 0.063-inch 4130 steel (Specification AN-QQ-S-685, condition N) may be substituted for 7075-O aluminum alloy. Cadnium-plate and prime steel part.

Replace damaged formed angles. Fabricate from 7075-O aluminum alloy of equal thickness. Heat-treatto T6 condition after forming. Anodize and prime before installation. Normalized 4130 steel may be substituted for the aluminum alloy. (Refer to step 1.)



T-28A-3-31-41

Figure 4-26. Channel Assembly Repair — Flap Actuating Cylinder — T-28A and T-28D Airplanes (Sheet 2 of 2)



NOTE The repair shown is for the upper right corner of the lower bulkhead assembly at station 95.75. Repair on the upper left corner is opposite.

- The bend radius for the cap angle replacement is 3/16 inch.
- The bend radius for the splice angle is 9/32 inch.
- Heat-treat cap angle replacement to T6 condition.
- Use AN470DD8 rivets to fasten splice angle in position.

T-28A-3-31-35

Figure 4-27. Bulkhead Cap Repair - Station 93. 75

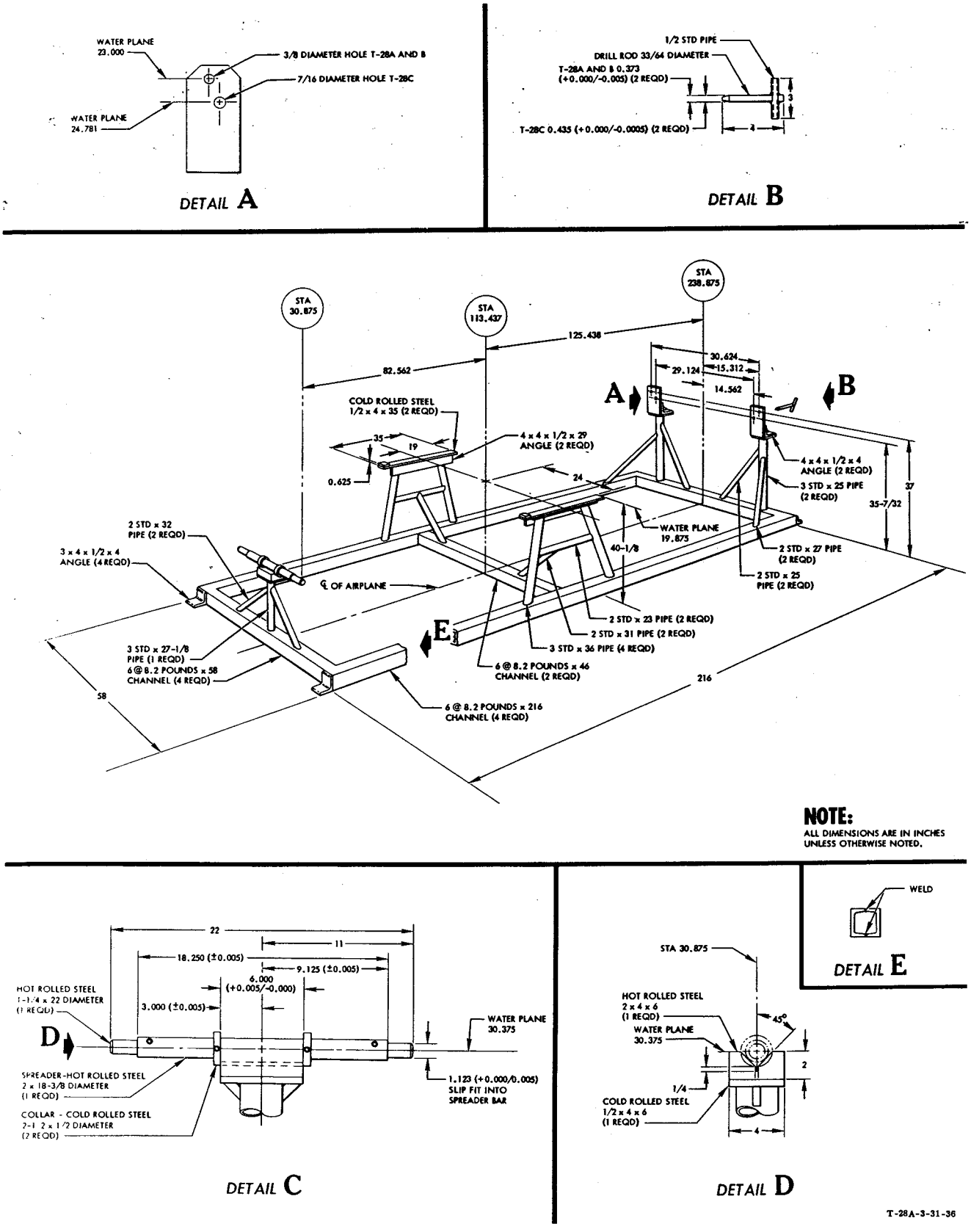


Figure 4-28. Fuselage Forward Section Repair Jig

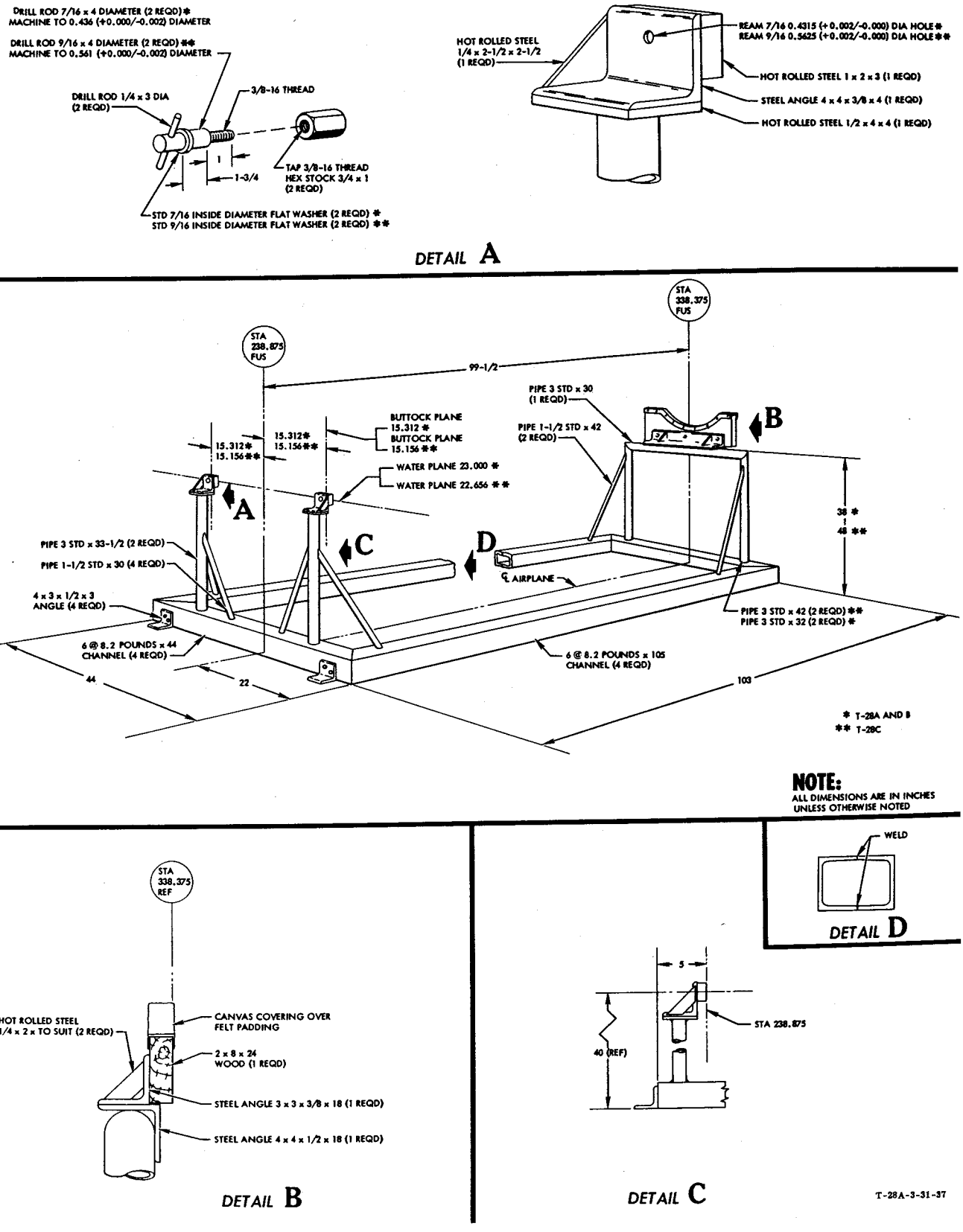
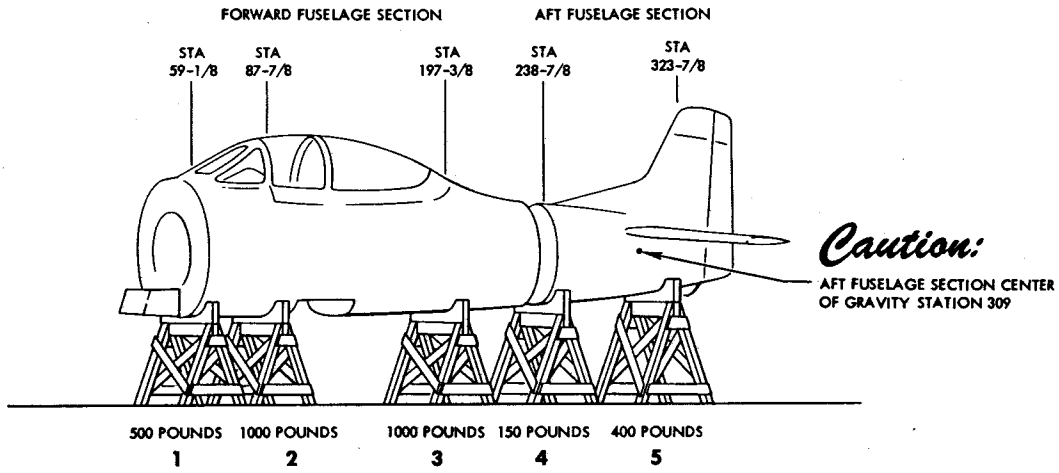
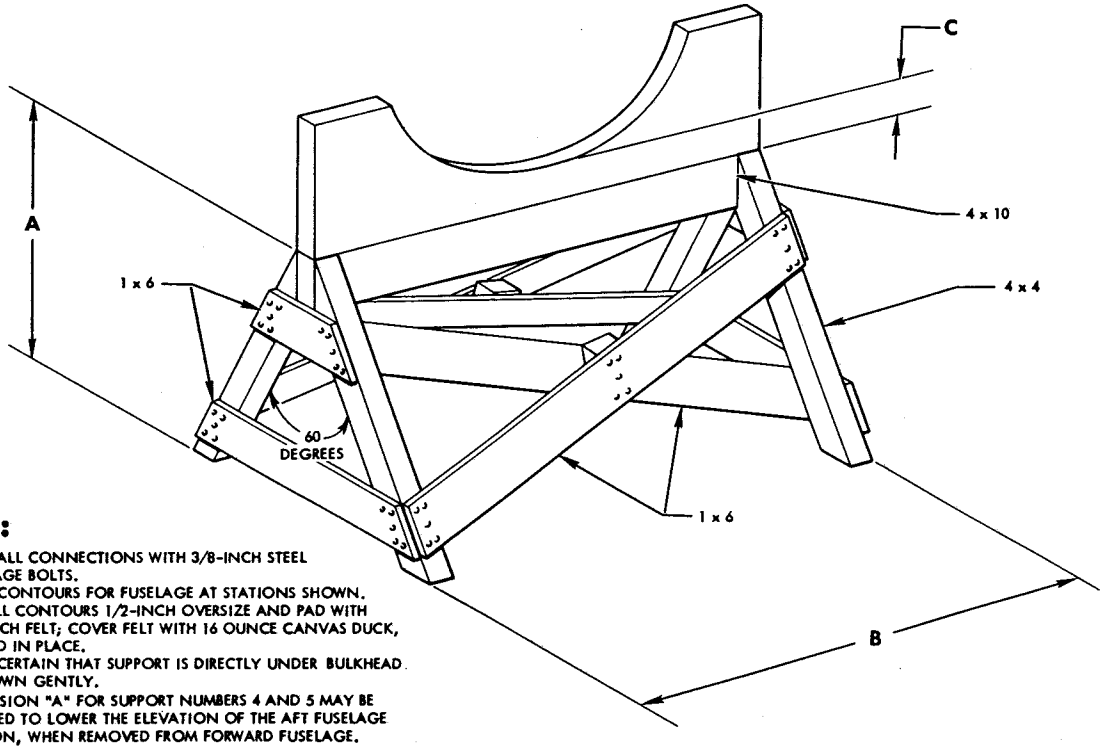


Figure 4-29. Fuselage Rear Section Repair Jig





NOTE:

1 MAKE ALL CONNECTIONS WITH 3/8-INCH STEEL CARRIAGE BOLTS.
2 MAKE CONTOURS FOR FUSELAGE AT STATIONS SHOWN.
3 CUT ALL CONTOURS 1/2-INCH OVERSIZE AND PAD WITH 1/2-INCH FELT; COVER FELT WITH 16 OUNCE CANVAS DUCK, TACKED IN PLACE.
4 MAKE CERTAIN THAT SUPPORT IS DIRECTLY UNDER BULKHEAD.
5 SET DOWN GENTLY.
6 DIMENSION "A" FOR SUPPORT NUMBERS 4 AND 5 MAY BE REDUCED TO LOWER THE ELEVATION OF THE AFT FUSELAGE SECTION, WHEN REMOVED FROM FORWARD FUSELAGE.

SUPPORT NUMBER	A	B	C	SUPPORT NUMBER	A	B	C
1	31-1/2 IN.	72 IN.	3 IN.	4	44 IN.	72 IN.	3 IN.
2	32 IN.	72 IN.	3 IN.	5*	53-3/4 IN.	48 IN.	3 IN.

T-28A-3-31-38

Figure 4-30. Fuselage Supports

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SECTION V

LANDING GEAR

MAIN LANDING GEAR.

Each main landing gear is a conventional single-strut, single-wheel, telescoping-cylinder type, utilizing an air and oil shock strut that incorporates an orifice and tapered metering pin which control the energy absorption. The piston and the cylinder of the shock strut are made from SAE 4140 alloy steel forgings and tube, and are interconnected by forged 2014-T6 aluminum alloy torsion links, which transmit the torsional loads from the piston to the cylinder. The end of the piston is equipped with a "stub" axle and mounts a tire, a wheel, and a brake assembly. Each gear is supported in the wing at two points. A forged 2014-T6 aluminum alloy trunnion head, at the top of the outer cylinder, attaches to fittings by pins that allow the gear to rotate inboard and outboard, and a knee-type side brace system prevents this rotation when the gear is down and locked. The side brace is attached by a pin to the strut, about 10 inches below the trunnion pivot axis on the trunnion head forward and inboard of the strut centerline, and is attached to the wing by a bolt through a shaft that lies parallel to the trunnion pivot axis and is inboard and above the strut attaching point. Together, these points resist vertical, side, drag, and torque loads in the strut.

NOSE GEAR.

The nose gear is of the conventional single-strut, single-wheel, steerable, telescoping-cylinder type, utilizing an air and oil shock strut with an orifice that controls the energy absorption. Support of the nose gear (and resistance to loads at its support points) is similar to that of the main gear. Torsional loads that are imposed on the gear are transferred from the fork to the knuckle fitting, and in turn to the inner cylinder, by means of a shimmy damper. This damper is attached to the fork through a lug on a splined collar fitting, and to the knuckle fitting through a bracket bolted to the right side of the knuckle fitting. The spline collar fitting also has a lug that transfers jacking torque loads directly into the knuckle fitting by means of a shear pin. Torsion is transferred from the inner cylinder to the outer cylinder by means of a pair of torsion links. The fork and axle assembly and the inner and outer cylinder are made from SAE 4140 alloy steel forgings and tube. The trunnion head, knuckle fitting, torsion links, and actuating arms are made from 2014-T6 aluminum alloy forgings.

INSPECTION FOR DAMAGE TO LANDING GEAR STRUCTURAL MEMBERS.

CRACKS.

The dye penetrant or oil and whiting inspection methods may be used for inspections for cracks. The dye penetrant inspection is explained in Section I. To perform the oil and whiting inspection, proceed as follows:

1. Remove paint and other foreign matter from areas to be inspected.

2. Soak areas throughly with kerosene.

3. Wipe dry with clean, dry rags.

4. Dust previously soaked areas with whiting (calcium carbonate, Specification JAN-C-293). If a crack is present, the oil which it retained will be drawn to the surface by the whiting.

LOOSE OR WORN BOLTS.

Examine all bolts for damage, wear, or looseness. If enlarged bolt holes are found, remove and replace affected parts when practicable. The use of oversize bolts must be limited to areas where sufficient edge distance and net section for load transfer remain after the enlarging of the original bolt hole. Replace all worn bolts and nuts with same material and type as original. Lock or safety all nuts.

NEGLIGIBLE DAMAGE TO LANDING GEAR ASSEMBLY.

The landing gear structural members are all highly stressed, and no damage should be considered negligible.

REPARABLE DAMAGE.

Reparable damage to landing gear structure consists mainly of sharp nicks caused by flying rocks, contact with ground handling equipment, etc. To alleviate stress concentration, smooth out all such damage with riffle file, emery paper, or a burnishing tool. After damage has been smoothed out, examine area for cracks. Paint all smoothed negligible damage with at least one coat of zinc-chromate primer (Specification MIL-P-6889).

DAMAGE NECESSITATING REPLACEMENT.

Because of the close tolerances and highly stressed condition of the landing gear members, the repair of any damage more serious than that outlined in "Reparable Damage" is impracticable. Any bent, broken, worn, or cracked components of the landing gear structure must be replaced.

LANDING GEAR FAIRING DOORS.

Each gear wheel well is completely enclosed by three doors which are fabricated from 2024-T4 clad aluminum alloy sheet. The web areas of the doors

are held rigid by depressions formed in the inner skins. Skins are fastened together with 2117-T4 rivets and with spot welds.

NEGLIGIBLE DAMAGE TO DOORS.

Negligible damage to the skin areas consists of cuts, dents, and scratches that do not exceed one inch in their greatest dimension.

REPAIR OF SKIN AREAS.

Holes and damages exceeding negligible limits can be repaired by an external-type skin patch. Typical skin repairs are shown in figure 5-1.

WHEELS, TIRES, AND TUBES.

For repair of damaged landing wheels, tires, and tubes, refer to the General Manual for Structural Repair, T.O. 1-1A-1.

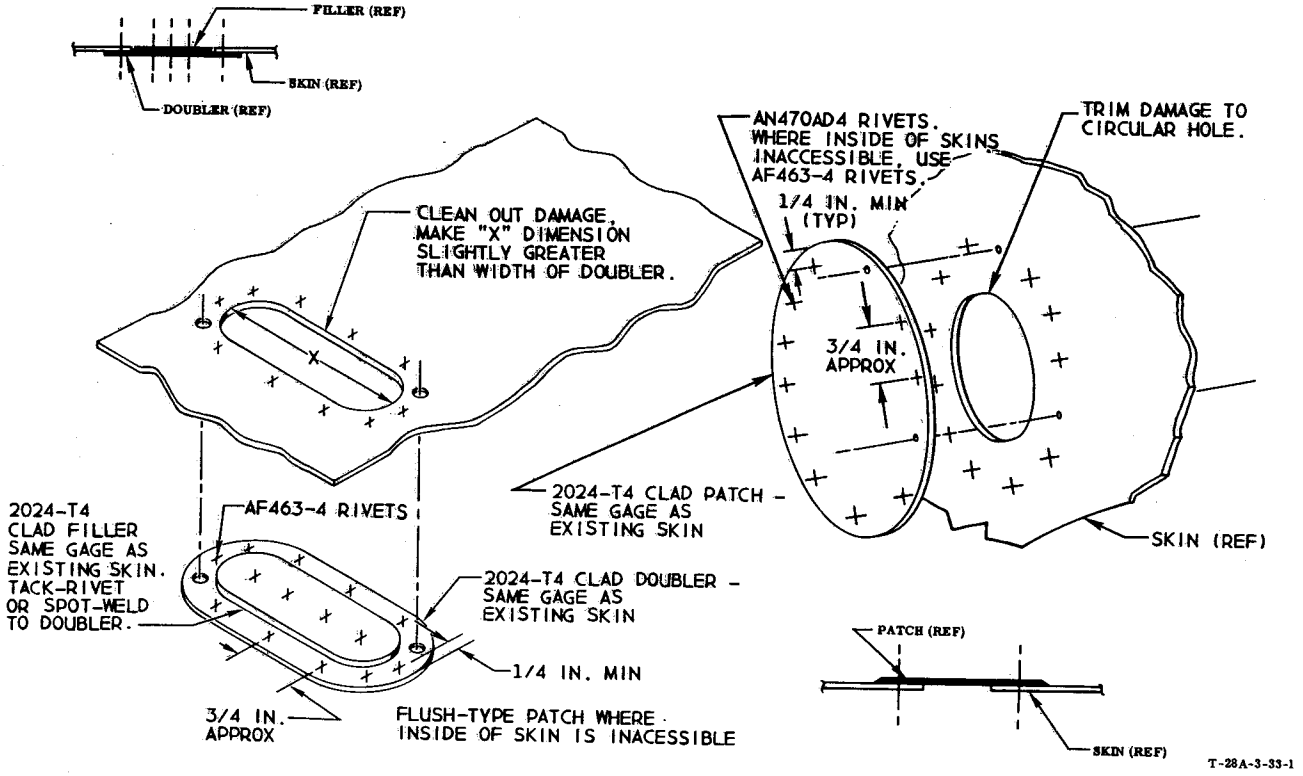
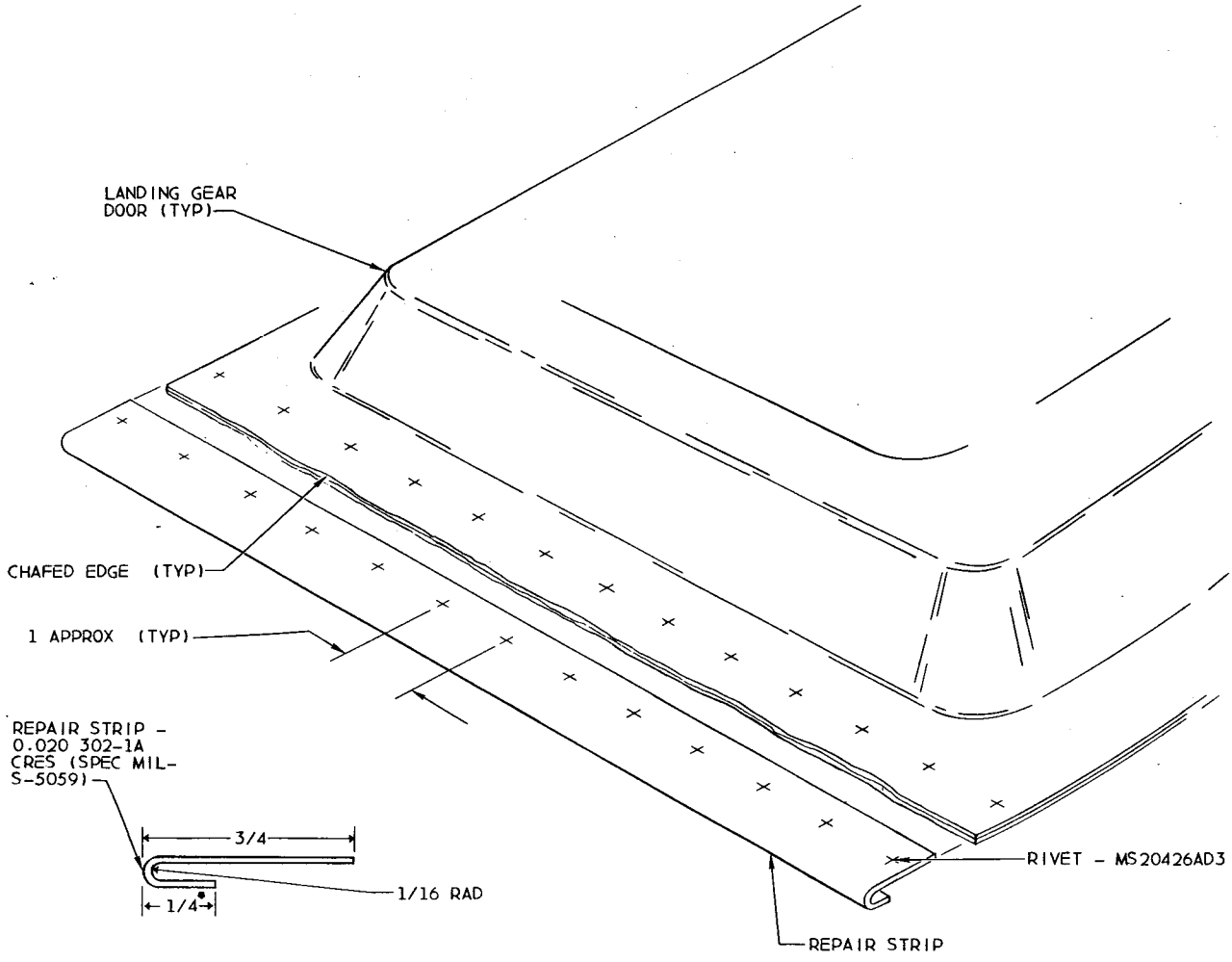


Figure 5-1. Landing Gear Door Repairs

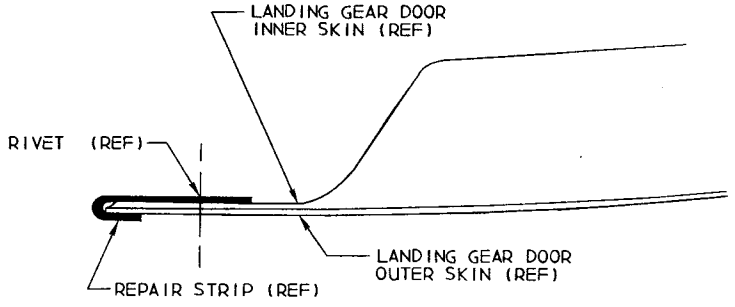


NOTE

This repair is applicable to areas where spotwelds or rivet edge distance has not been reduced below two diameters.

Repair strips must extend the entire length of the surface.

*Dimension may vary for contoured sections.



T-28A-3-33-2

Figure 5-2. Landing Gear Door Edge Repair

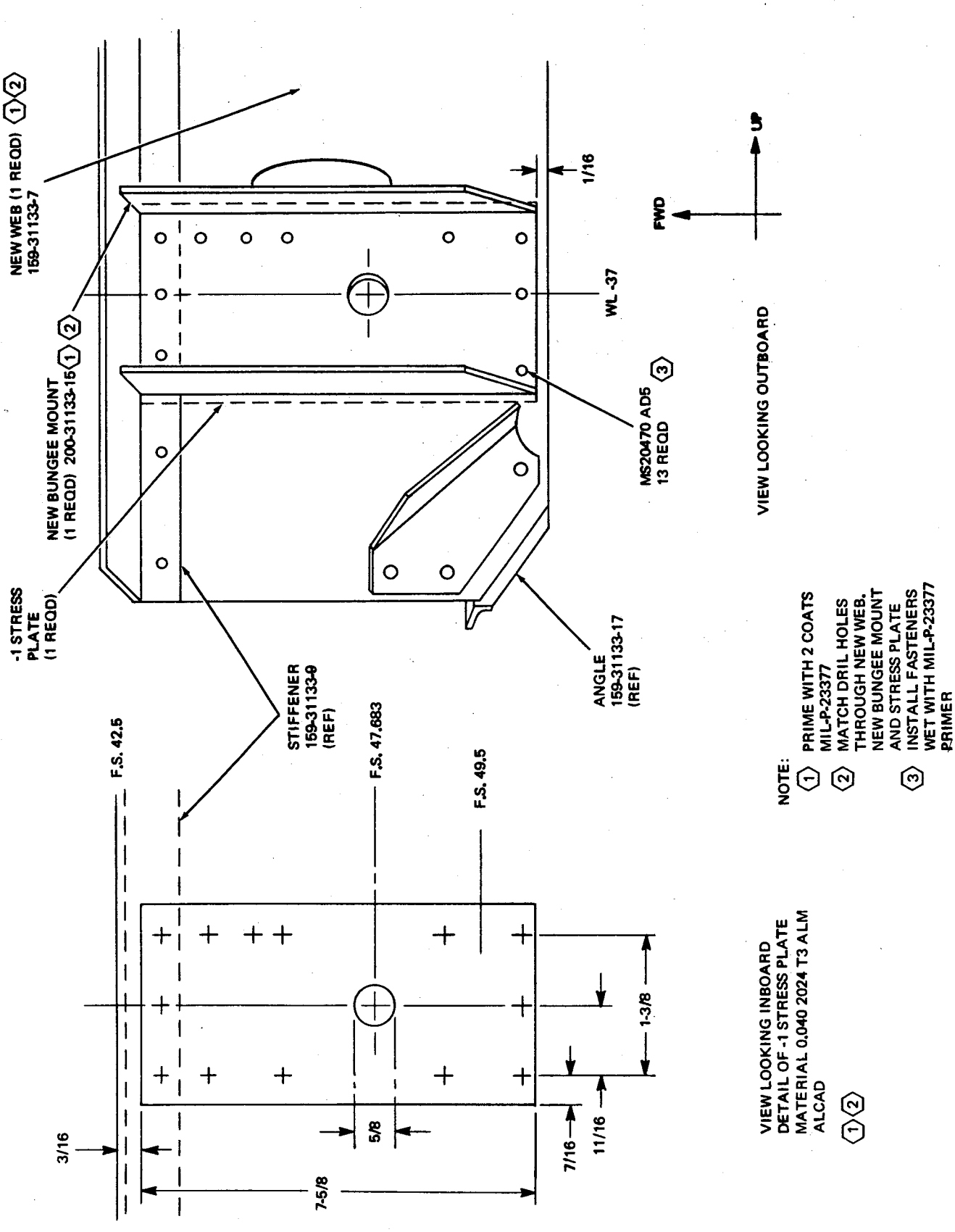
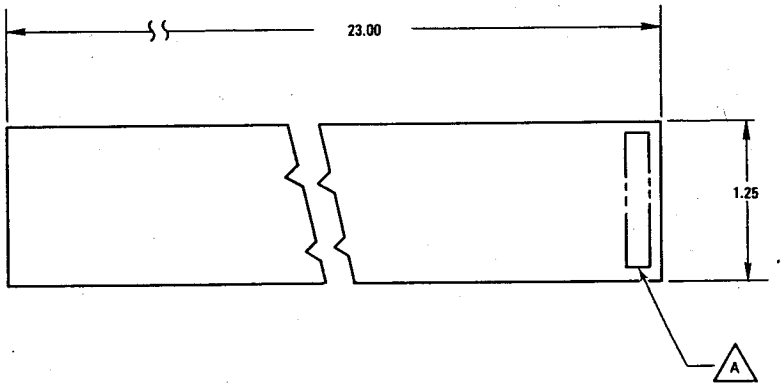


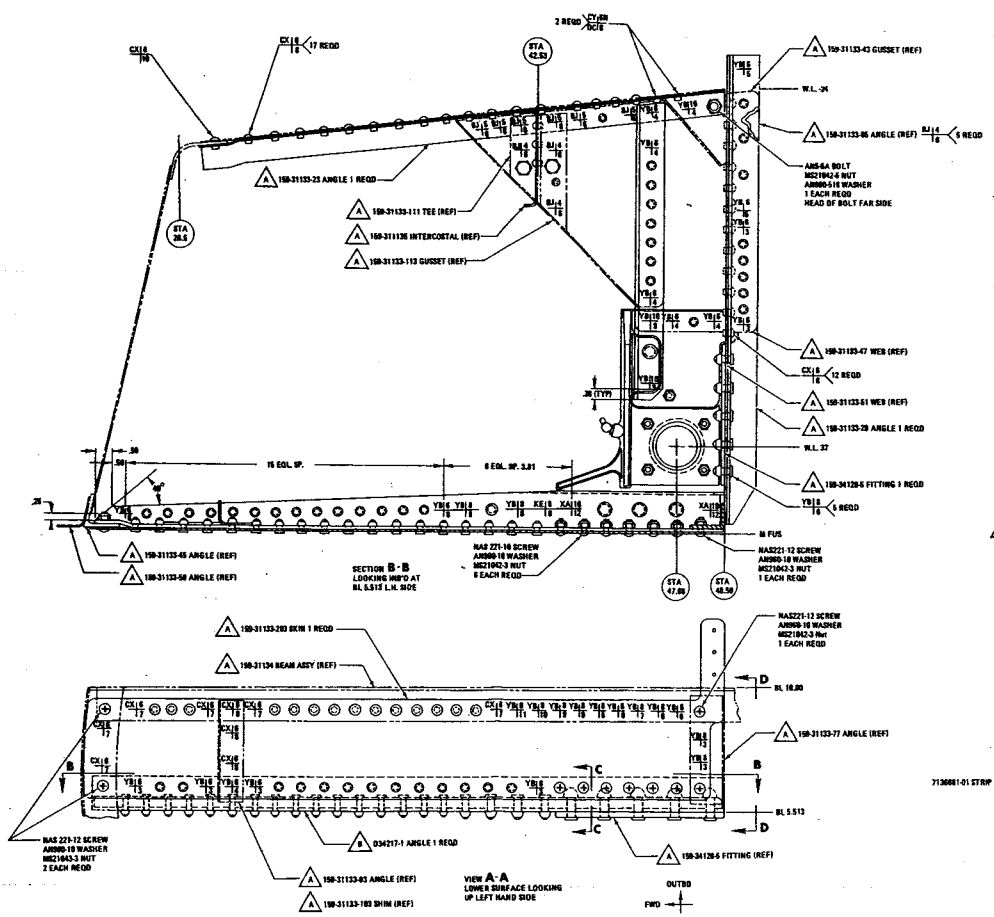
Figure 5-3. Nosegear Bungee-Mount-Bracket Repair

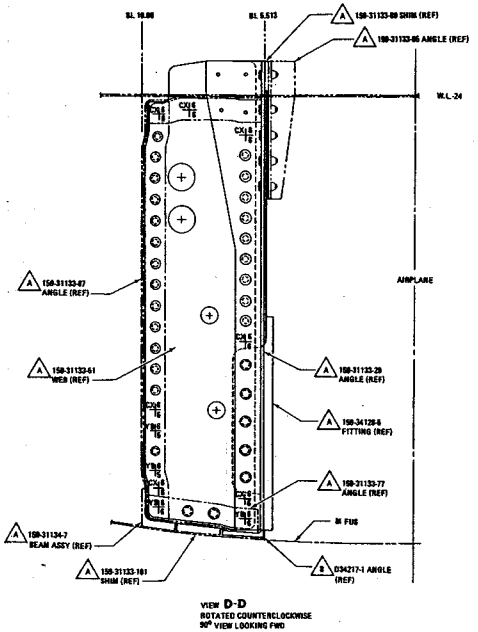


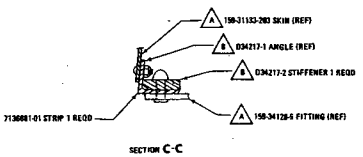
NOTES:
1. BREAK ALL SHARP EDGES.
2. APPLY PART NO PER MIL-STD-130 USING METAL STAMP.
3. APPLY 2 COATS MIL-P-23377 PER MIL-F-7179, CL E.

1. 159-31133-23 ANGLE, 159-31133-27 ANGLE, 159-31133-29 ANGLE, 159-31133-43 GUSSET, 159-31133-45 ANGLE, 159-31133-47 WEB, 159-31133-51 WEB,159-31133-59 ANGLE, 159-31133-77 ANGLE, 159-31133-85 ANGLE, 159-31133-113 GUSSET & 159-31135. INTERCOSTAL SHOULD BE REPLACED IF CRACKED OR HOLES ARE OVERSIZE SUCH THAT 2 DIA. FROM THE EDGE OR 4 DIA. BETWEEN THE HOLES IS NOT MAINTAINED.
2. 159-34128-5 FITTING SHOULD BE LOCATED WITH AID OF "LOCATING TOOL" SEE AF DRAWING 7136557-10.
3. PICK UP HOLE PATTERN FROM REPLACED PART. IF HOLES IN REPLACED PART ARE OVERSIZED, BE SURE TO MAINTAIN 2 DIA. FROM THE EDGE AND 4 DIA. BETWEEN FASTENERS.
4. THE HIGH SHEAR FASTENERS THROUGH THE FITTING & ANGLES MAY BE INSTALLED FROM EITHER SIDE.
5. INSTALL FASTENERS WET AFTER DIPPING IN PRIMER MIL-P-23377.
6. FINISH ALL PARTS PER MIL-F-7179 CLASS "F" USING MIL-P-23377 PRIMER EXCEPT EXTERIOR OF 159-31133-203 SKIN PER CLASS C, MIL-L-19538 TOP COAT, COLOR GREY (36440).
7. (A) PART NO. OF NORTH AMERICAN ROCKWELL CORP. LOS ANGELES DIV. LOS ANGELES, CALIF.
8. (B) PART NO. OF NAVAL AIR REWORK FACILITY NAVAL STATION, PENSACOLA, FLA.
9. (C) PART NO. OF HISHEAR CORP. TORRANCE, CALIF.

Figure 5-3. Nose Landing Gear Box Beam Repair (Sheet 1 of 2)







TYPE OF FASTENERS	DRILL SIZE	FINAL HOLE SIZE ± .0010	
HL 10-6	3/16 (.1875)	.1875	
HL 10-8	NO. C (.2420)	.2475	
HL 10-10	10/64 (.2960)	.3100	
HL 62-10	NO. 0 (.3160)	.3250	
MS 20470-4-	NO. 30 (.1285)	———	
MS 20470-5-	NO. 21 (.1660)	———	
MS 20470-6-	NO. 10 (.1935)	———	
NAS 221	NO. 10 (.1935)	———	
AN 5-	5/16 (.3125)	———	
HL 19-8	NO. C (.2420) CTSK .100 TO .081 DIA.	.2475	

BASIC CODE	DASH NO. FOR DIA. N = MFD HEAD NEAR SIDE F = MFD HEAD FAR SIDE
D = DIMPLE FIGURE = NO. OF SHEETS TO BE DIMPLED C = COUNTERSUNK	DASH NO. FOR LENGTH W = SPOT WELD OPTIONAL
BASIC CODES	
CX = MS20470DD BJ = MS20478AD CY = MS20426DD	XA = HL62PB7DW YB = HL10PB7DW KE = HL19PB7DW

Figure 5-3. Nose Landing Gear Box Beam Repair (Sheet 2 of 2)

SECTION VI

ENGINE SECTION

ENGINE MOUNT.

The radial engine is supported by a welded chrome-molybdenum steel tube mount which attaches to each upper fuselage longeron at the fire wall and to the forward end of the nose gear beam. Transverse tubes support the oil tank. Cracks at the clustered joints, or elsewhere in the engine mount tubing, may be located by the dye penetrant or the oil and whiting methods of inspection.

MAGNETIC INSPECTION. (Preferred Method). Refer to T.O. 1T-28A-36, Section VI and MIL-I-6868D.

DYE PENETRANT INSPECTION.

Refer to Section I.

OIL AND WHITING INSPECTION.

Areas to be inspected must be stripped of paint and free of all foreign matter. Soak suspected areas thoroughly with kerosene and wipe dry with clean rags. Dust previously soaked areas with whiting (calcium carbonate, Specification JAN-C-293). If a crack is present, the oil which it retained will be drawn to the surface by the whiting.

NEGLIGIBLE DAMAGE.

If tubes are not bent more than 1/32 inch, or if scratches are less than 1/32 inch in width or depth and less than 2 inches in length, round out with a fine file or emery cloth. Reprime area with two coats of zinc-chromate primer (Specification MIL-P-6889), and return to service.

REPARABLE DAMAGE.

See figure 6-1 for tube data. For tube repair procedure, refer to Section X of General Manual for Structural Repair, T.O. 1-1A-1. No repair should be attempted on cracks in the middle third of any tubular member, nor should more than two cracks in the same general area be repaired.

Tubes with drilled 1/8-inch diameter holes closer than 7/16 inch apart or more than two in number for any 7/16-inch circumferential band shall be considered reparable and welded in accordance with Section XV of General Manual for Structural Repair, T.O. 1-1A-1.

DAMAGE NECESSITATING REPLACEMENT.

Reject as unserviceable all tubing bent more than 1/16 inch, if crack or flaws are evident.

ENGINE COWLING ASSEMBLY.

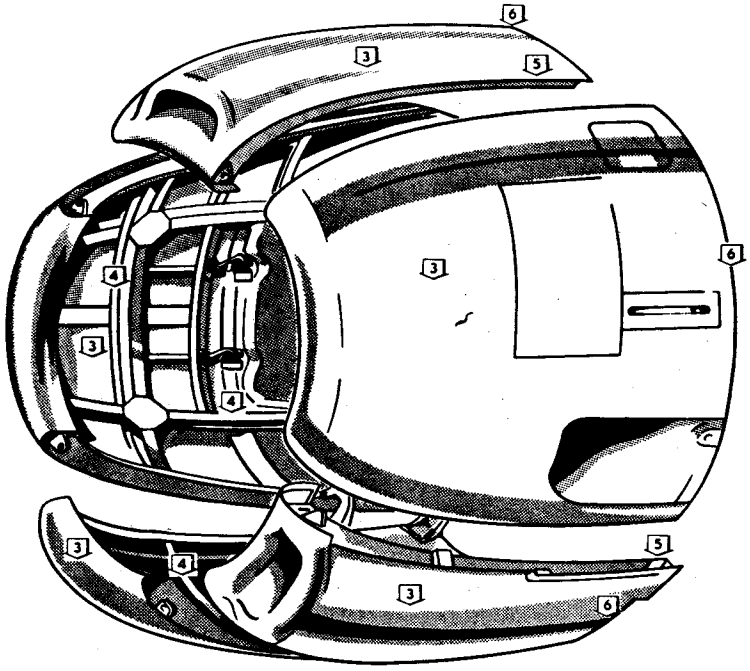
The cowling consists of five main panels and the "dishpan" that separates the engine and the engine accessory section. The top center panel, which contains the carburetor air duct, and the lower left panel, which contains the oil cooler duct, are fixed. The other three panels are independently hinged. The panels are made up of outer skins that are mainly stiffened by stretched and formed frames. Components of the cowl panels are constructed principally of 2024-T4 clad aluminum alloy sheet. The "dishpan" is constructed of corrosion-resistant steel.

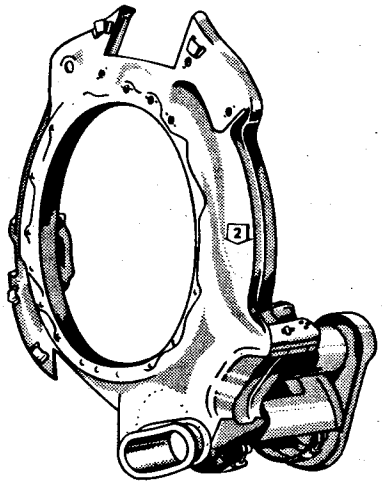
NEGLIGIBLE DAMAGE.

The engine cowl panels are highly stressed members, and no damage should be considered negligible.

COWLING REPAIRS.

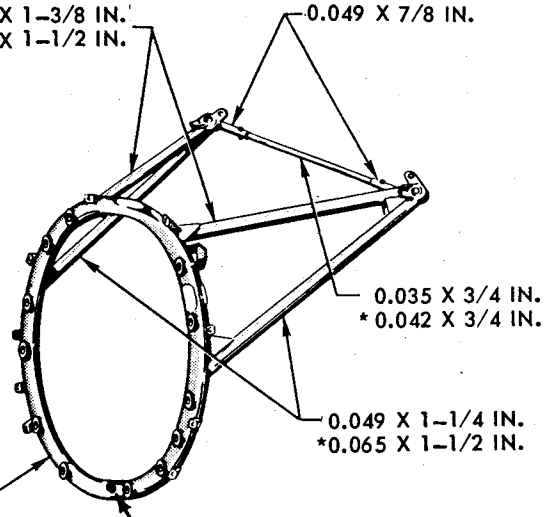
See figure 6-1.





00 REPAIR FIGURE NUMBERS, (THESE INDEX ARROWS CONTAIN THE FIGURE NUMBERS OF THE DETAIL REPAIR ILLUSTRATIONS WITHIN THIS SECTION OF THE HANDBOOK.)

NOTE FOR ADDITIONAL REPAIRS, REFER TO APPENDIX 11.

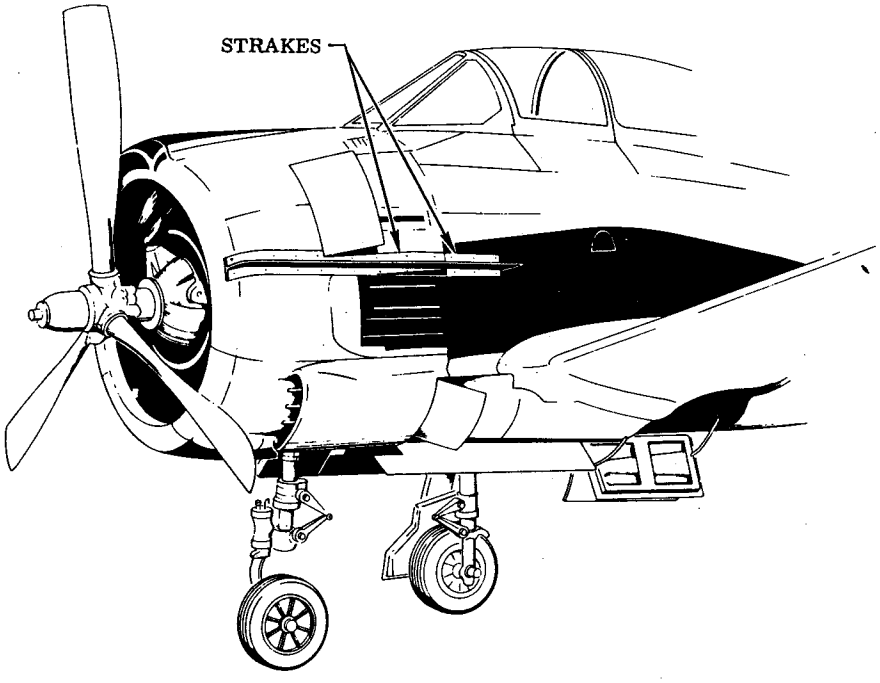


NOTE FOR CRACKS ON ENGINE LOWER AIRFRAME ATTACH POINT (FWD OR AFT SIDE), GRIND OUT CRACKS AND REWELD PER T.O. 1-1A-1. ALLOWABLE CRACK LIMIT IS 0.040 IN. DEEP AROUND A 360° CIRCUMFERENCE.

ALL ENGINE MOUNT TUBING IS 4130 STEEL (SPEC MIL-T-6736, COND "N").

*T-28B, T-28C, AND T-28D AIRPLANES.

Figure 6-1. Engine Repair Index

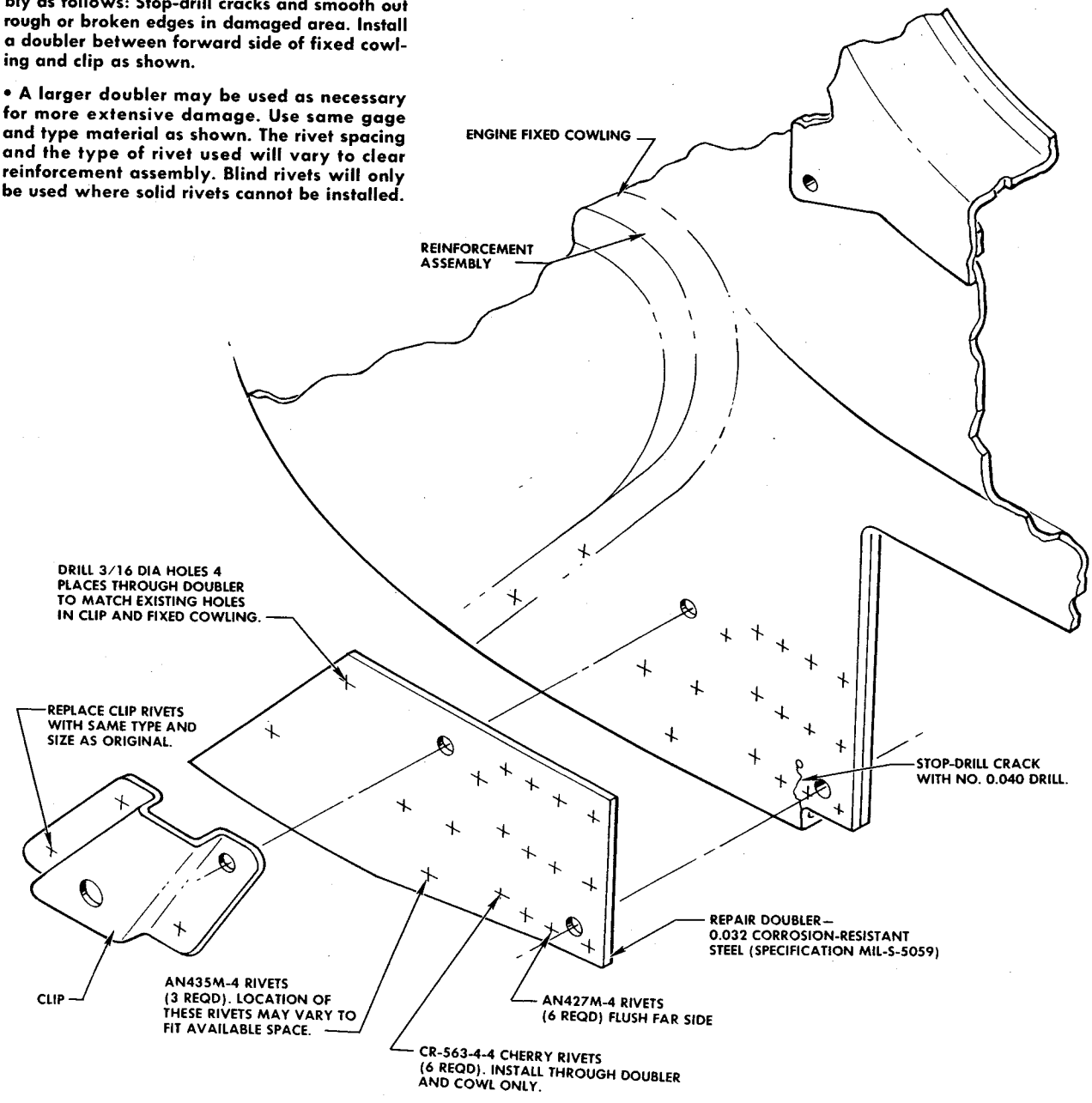


T-28B-3-40-1

Figure 6-1A. Strake Installation — Armament-modified T-28C Airplanes

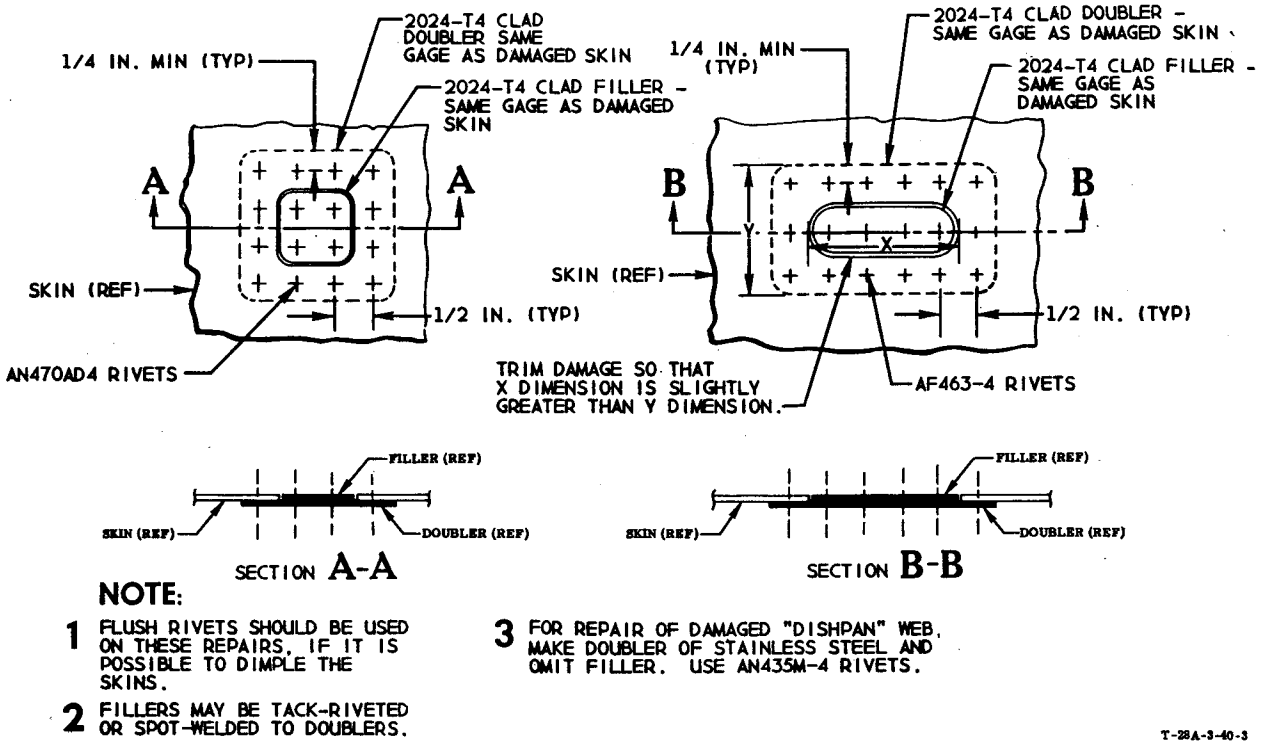
NOTE Repair engine fixed cowling found to be cracked at point of attachment to seal assembly as follows: Stop-drill cracks and smooth out rough or broken edges in damaged area. Install a doubler between forward side of fixed cowling and clip as shown.

• A larger doubler may be used as necessary for more extensive damage. Use same gage and type material as shown. The rivet spacing and the type of rivet used will vary to clear reinforcement assembly. Blind rivets will only be used where solid rivets cannot be installed.



T-28A-3-40-1

Figure 6-2. Engine Fixed Cowl Repairs — T-28A and T-28D Airplanes



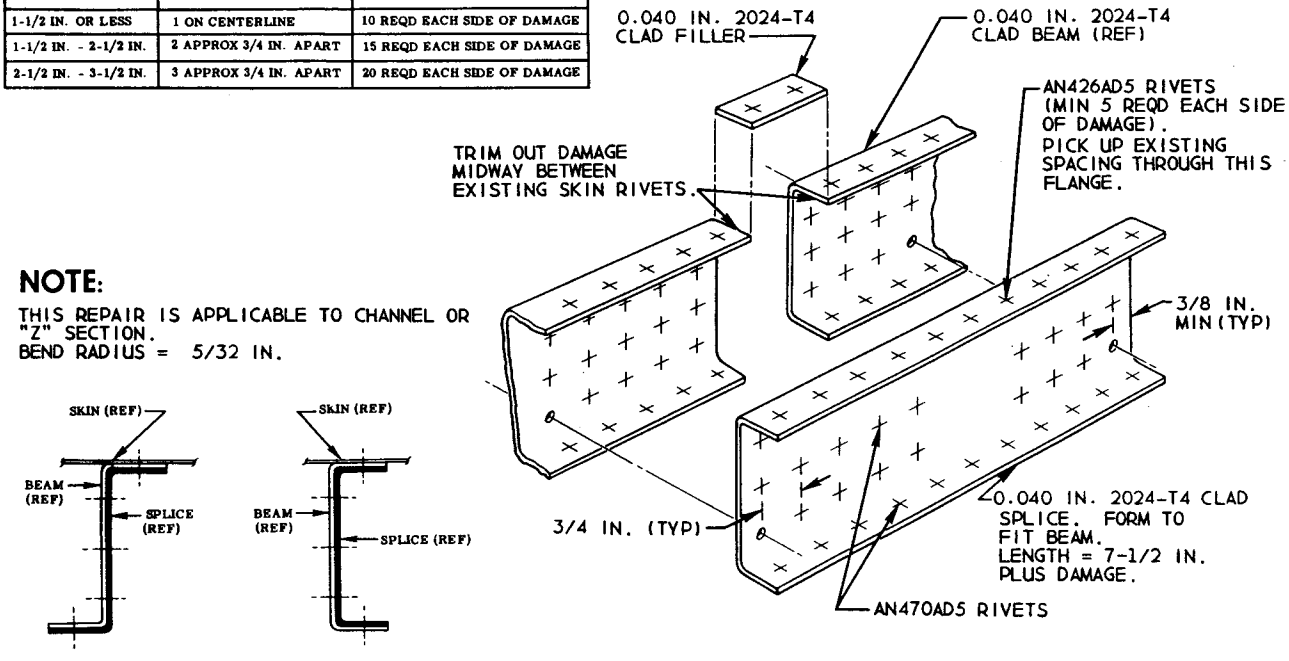
NOTE:

1. FLUSH RIVETS SHOULD BE USED ON THESE REPAIRS, IF IT IS POSSIBLE TO DIMPLE THE SKINS.
2. FILLERS MAY BE TACK-RIVETED OR SPOT-WELDED TO DOUBLERS.
3. FOR REPAIR OF DAMAGED "DISHPAN" WEB, MAKE DOUBLER OF STAINLESS STEEL AND OMIT FILLER. USE AN435M-4 RIVETS.

T-28A-3-40-3

Figure 6-3. Engine Cowl Skin Repairs

DEPTH OF BEAM OR FRAME	NO. OF ROWS THROUGH WEB	AN470AD5 RIVETS THROUGH WEB AND FLANGE
1-1/2 IN. OR LESS	1 ON CENTERLINE	10 REQD EACH SIDE OF DAMAGE
1-1/2 IN. - 2-1/2 IN.	2 APPROX 3/4 IN. APART	15 REQD EACH SIDE OF DAMAGE
2-1/2 IN. - 3-1/2 IN.	3 APPROX 3/4 IN. APART	20 REQD EACH SIDE OF DAMAGE

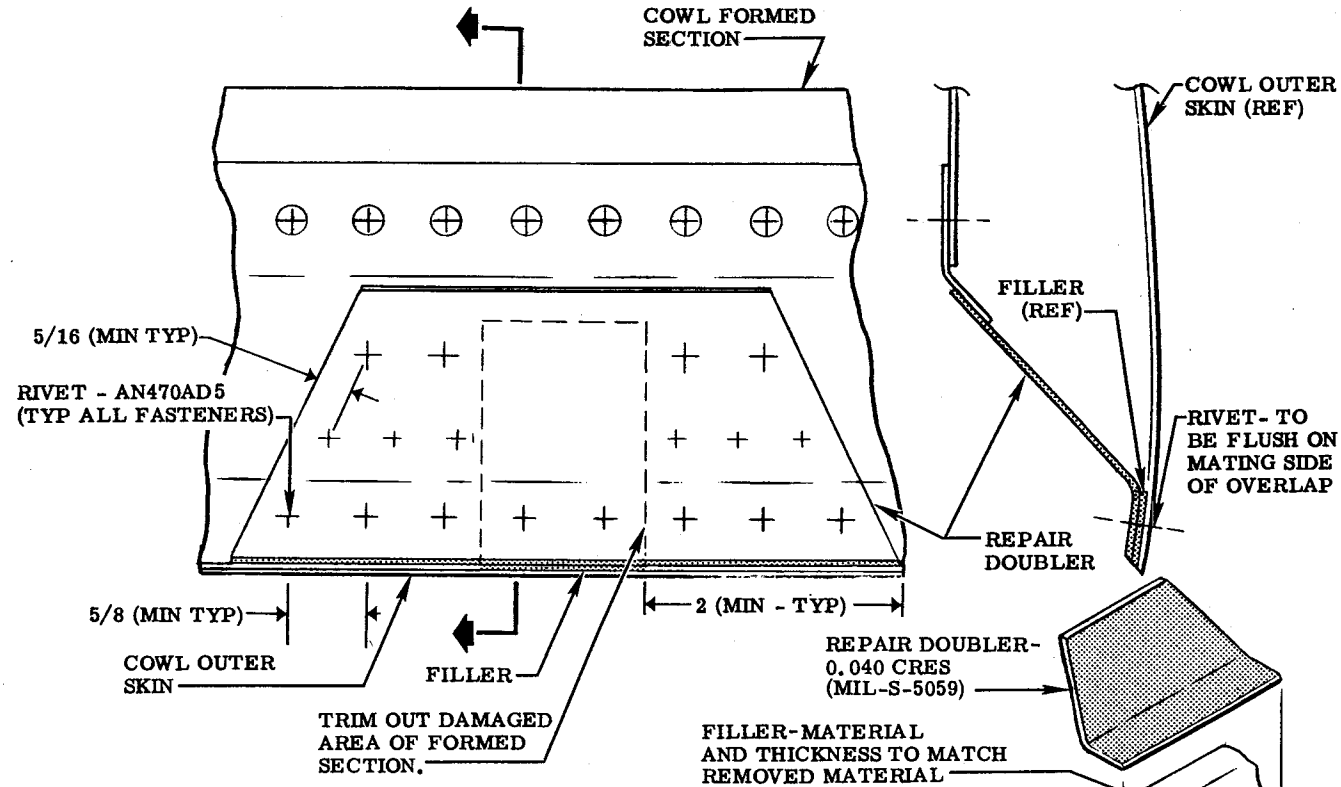


NOTE:

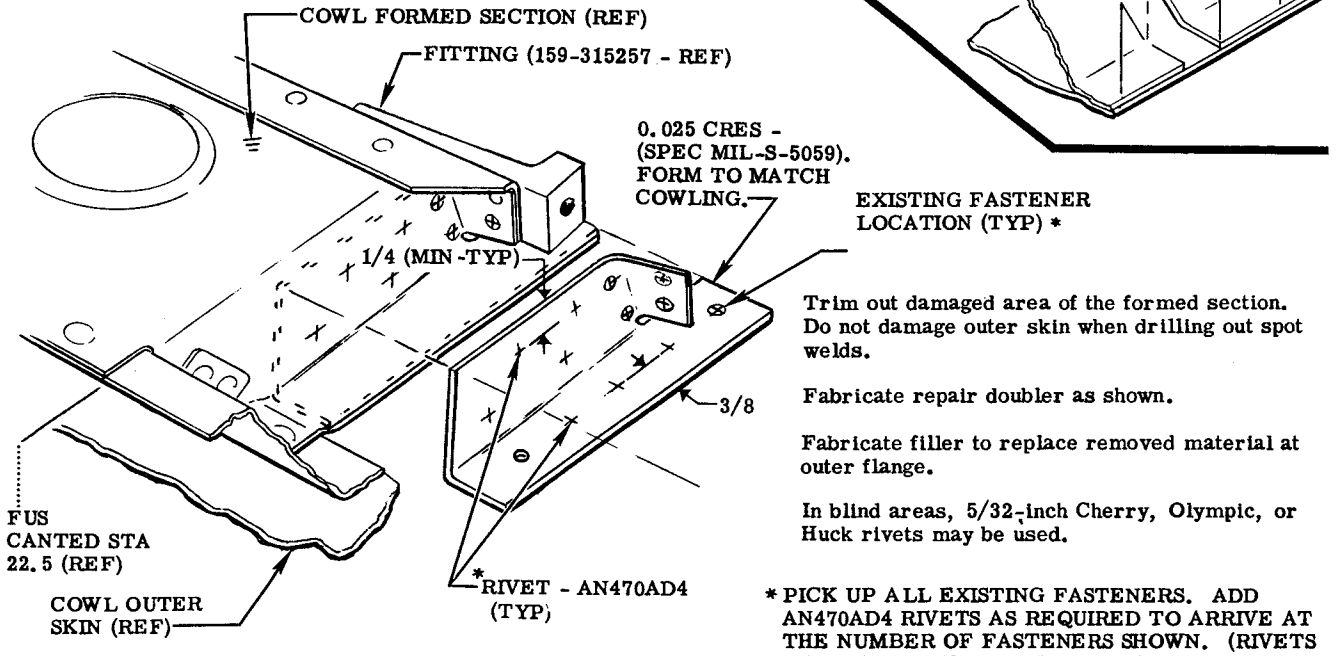
THIS REPAIR IS APPLICABLE TO CHANNEL OR "Z" SECTION.
BEND RADIUS = 5/32 IN.

T-28A-3-40-4

Figure 6-4. Engine Cowl Beam and Frame Repairs



TYPICAL REPAIR AT OVERLAP MATING AREAS



LOWER COWL FLANGE REPAIR - STA 22.5

Trim out damaged area of the formed section. Do not damage outer skin when drilling out spot welds.

Fabricate repair doubler as shown.

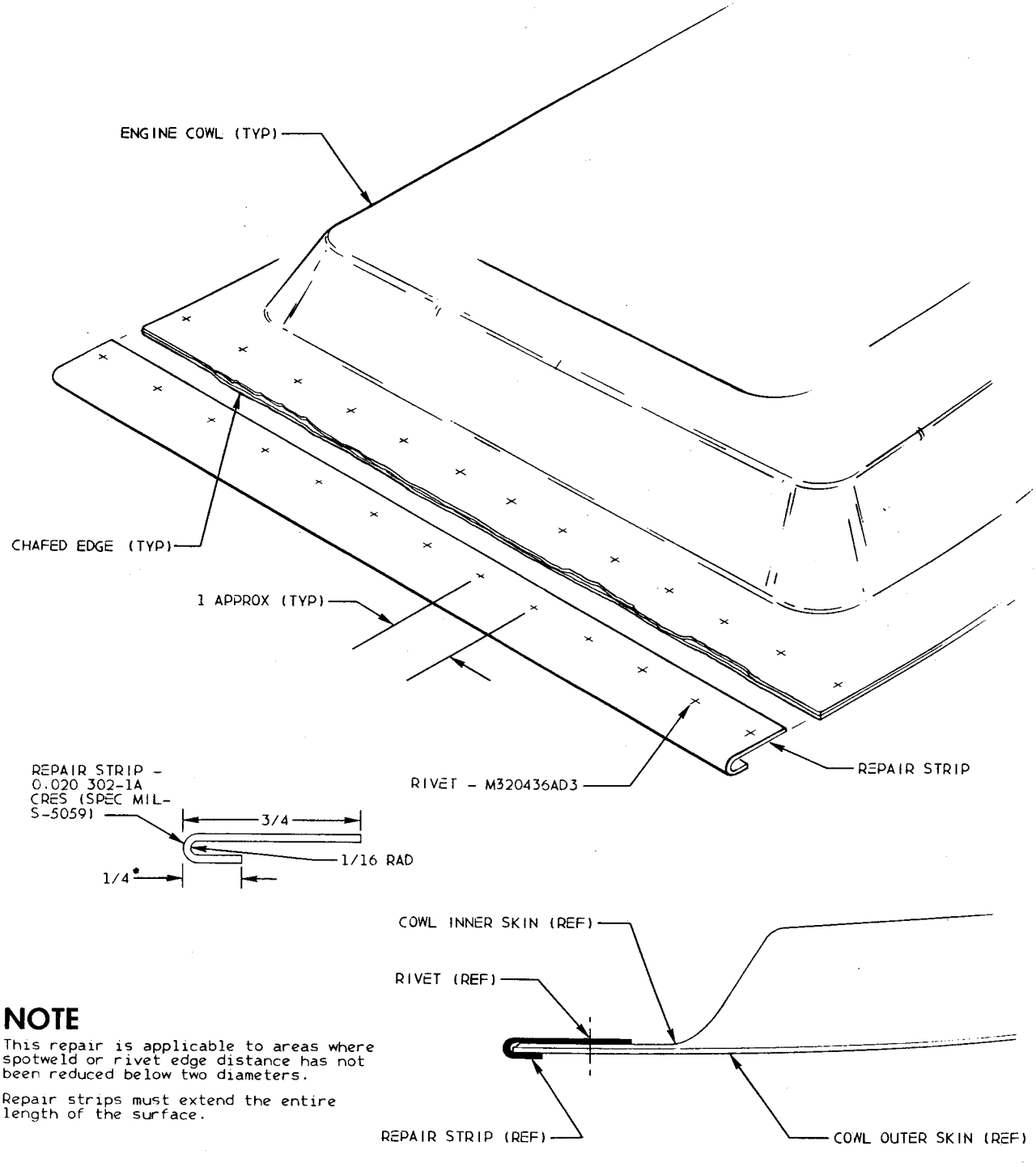
Fabricate filler to replace removed material at outer flange.

In blind areas, 5/32-inch Cherry, Olympic, or Huck rivets may be used.

* PICK UP ALL EXISTING FASTENERS. ADD AN470AD4 RIVETS AS REQUIRED TO ARRIVE AT THE NUMBER OF FASTENERS SHOWN. (RIVETS MAY HAVE BEEN PREVIOUSLY ADDED IN THE SPOT-WELDED AREA.)

T-28A-3-40-5

Figure 6-5. Engine Cowl Former Repairs



NOTE

This repair is applicable to areas where spotweld or rivet edge distance has not been reduced below two diameters.

Repair strips must extend the entire length of the surface.

*DIMENSION MAY VARY FOR CONTOURED SECTIONS

T-28A-3-40-6

Figure 6-6. Engine Cowling Edge Repair

SECTION VII

FABRIC REPAIR AND ATTACHMENT

GENERAL.

This section provides repair information for the repair of aileron aerodynamic seals, glass-fabric-reinforced plastic parts, and the acrylic plastic canopy in certain areas.

REPAIRING AILERON SEALS.

Rips, tears, and chafed areas may be repaired by using patches made of Rip Stop fabric (Specification MIL-C-7020, Type II) cemented to the seal with general-purpose rubber cement (Specification MIL-C-4003). Patches must be large enough to extend a minimum of 3/4 inch in all directions beyond damage.

1. Remove all dirt, grease, oil, talc, etc, from surfaces to be cemented, by wiping with a cloth dampened with dry-cleaning solvent (Federal Specification P-S-661).

2. Brush one even coat of cement on each of the surfaces to be joined. Allow cement to dry until it is tacky. A method of checking for the proper stage of tackiness is that of touching a knuckle to the drying cement. (Do not use the finger tip; it is likely to be oily or greasy.) When the cement appears to stick to the knuckle, but does not come away with it, the cement is in the proper condition for bonding.

NOTE

If the cement on areas to be bonded has dried tack-free before the bond has been made, apply a second coat of cement to one of the surfaces to be joined. If this is impractical, the first coat may be reactivated by moistening the cement surface with methyl ethyl ketone (Federal Specification TT-M-261).

3. Press or roll both surfaces together. This will eliminate any bubbles and ensure good adhesion. The bond should not be strained for 48 hours after assembly.

HANDLING OF CEMENT.

This cement is fast-drying and should not be allowed to stand in an open container. The solvents are flammable, and the cement must be used with all proper precautions in order to prevent fires. If the cement becomes too thick for easy application, it may be thinned with methyl ethyl ketone (Federal Specification TT-M-261). The cement should not be thinned beyond its original consistency.

CLEAN-UP AFTER CEMENTING.

Use a cloth dampened with methyl ethyl ketone (Federal Specification TT-M-261). Do not use an excess of this solvent.

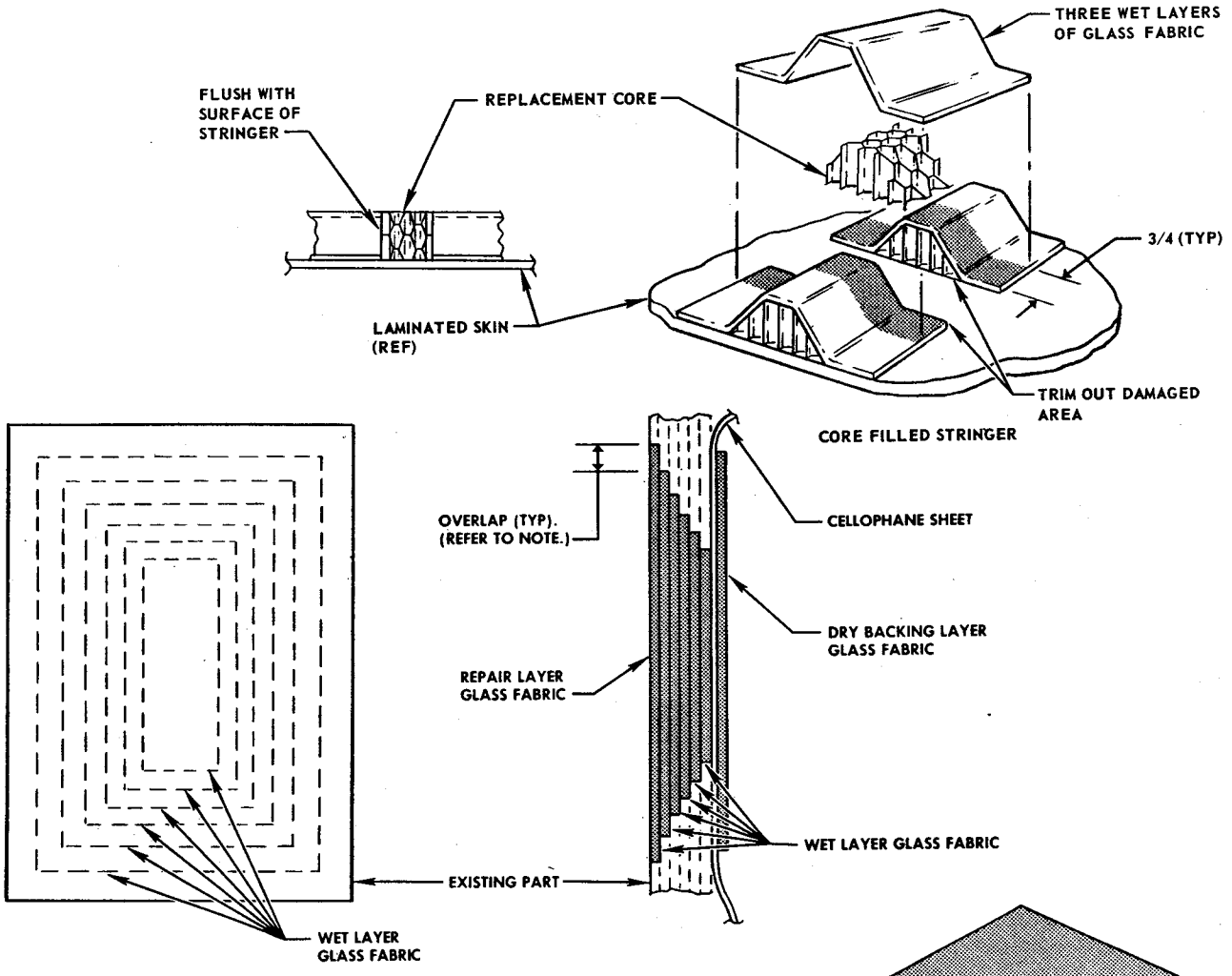
GLASS-FABRIC-REINFORCED PLASTIC.

Glass-fabric-reinforced plastic parts are made of layers of glass fabric which have been impregnated with chemical resins, molded to a particular contour, and cured to a hard consistency. Polyester resin, which is used in most cases, is a thermosetting (hardens when exposed to heat), low-pressure, laminating resin. When the resin is mixed with a catalyst according to the manufacturer's specification, and cured by heat or at room temperature, it gradually changes from thick sirupy liquid to a hard solid. The curing action is controlled by the type of catalyst used. The function of the glass fabric in glass-fabric-reinforced plastic is just as important as the function of the resin in providing good strength properties. When the glass fabric and resin are combined, a very strong, lightweight material is obtained which is resistant to water, weather, aging, and a variety of chemicals. This material also has desirable electrical properties so that it may be used for antenna covers, electrical shields, etc.

REPAIRING GLASS-FABRIC-REINFORCED PLASTIC.

Laminated glass-fabric-reinforced parts are strong and long-wearing; however, like any other aircraft material, they are subject to damage and abrasive wear. Glass-fabric-reinforced plastic may be damaged by sharp objects, flying stones, or other sharp blows much the same as metal parts. Damage usually consists of tears, bruised or delaminated areas, or both. The most common type of damage is skin fractures or tears. When cuts or tears extend through several layers of skin in locations where appearance is not important, the damage may be repaired by bonding a patch to the exterior surface of the part.

When damage occurs to the antenna covers in the area of radio transmission, repair personnel should be extra careful to maintain the exact design thickness of the original installation. A natural inclination to "beef up" the repair area with added layers of fabric should be resisted. The antenna cover is designed to admit a particular frequency of the electromagnetic spectrum at a particular angle of ray incidence; therefore, any changes in the thickness on the cover in this area may cause distortion of electronic waves.



NOTE

Holes not exceeding 2-1/2 by 4 inches require 1/2-inch overlap; holes exceeding 2-1/2 by 4 inches, but not exceeding 5 by 8 inches, require 3/4-inch overlap; holes exceeding 5 by 8 inches require one-inch overlap.

1 Trim out damaged area in "stair-step" fashion, as shown. Be careful not to cut into layer below the one being removed.

2 Mix resin and prepare layers. (Refer to text in this section.)

3 Install dry layer as shown.

4 Install wet layers.

5 Cover repair with polyvinyl alcohol sheet. Stretch it until it is as tight as possible, and tape it in place.

6 Cure, repair, and refinish area according to procedure in this section.

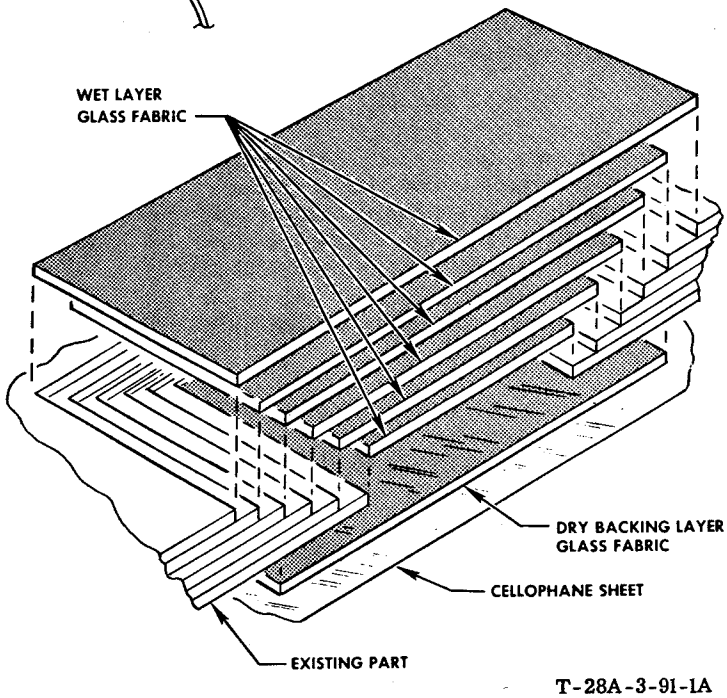


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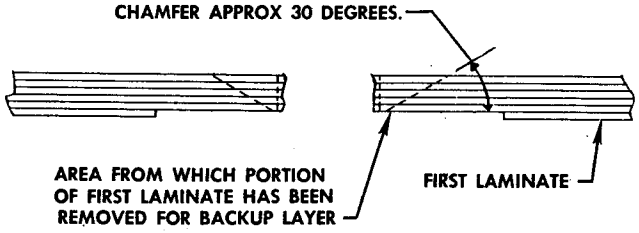
Figure 7-1. Glass-fabric Repair (Sheet 1 of 2)

TAPERED

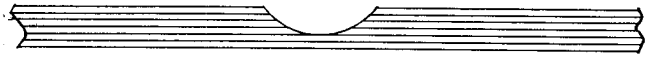
PARTIAL PENETRATION

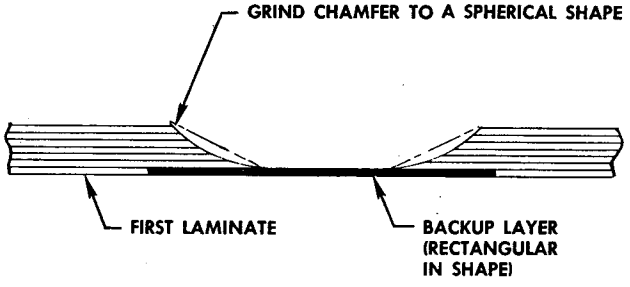
COMPLETE PENETRATION



1 Clean out damage to a rounded or circular-shaped opening.

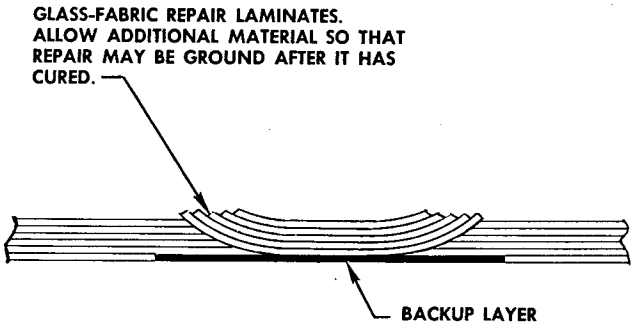
- Chamfer area around cleaned-up damage to approximately 30 degrees from first laminate.
- On the side opposite the chamfer, carefully remove a rectangular piece from the first laminate of glass cloth, the same length as the diameter of chamfered area.





2 Grind chamfered area to an approximately spherical shape. This will ensure that the glass-fabric repair laminates are in proper position.

- Replace removed portion of the first laminate with a backup layer of glass cloth saturated with laminating resin.
- Before attempting to install any of the repair laminates, allow backup layer to cure.



3 Restore damaged area to its original thickness by filling the spherical void with layers of glass-fabric repair laminates saturated with laminating resin.

- Allow repair to completely cure.
- Sand or grind completed repair to the same thickness as the existing laminations.

T-28D-3-91-3

Figure 7-1. Glass-fabric Repair (Sheet 2 of 2)

Laminated plastic parts may become bruised or delaminated beneath the surface if subjected to a sharp blow. Damage of this type which is not too extensive can often be repaired by injecting a small quantity of resin through the skin with a hypodermic syringe. If the damaged area is too large to be filled with a hypodermic syringe, a series of No. 60 holes, evenly spaced through the area of damage, may be drilled. A quantity of resin sufficient to ensure bonding of all separated surfaces is then injected through the holes. The entire area must be placed under enough pressure to remove excess resin. After curing, the area should be sanded and refinished. Delamination may be visible on the surface of the part as a bubble or blister. In some cases, however, subsurface delamination may not be visible. If delamination is suspected, but cannot be seen, the extent of damage may be determined by tapping the surface with a coin or small tool. Undamaged areas will respond with a sharp metallic ring, whereas delaminated areas will produce a hollow sound. The tapping procedure is not satisfactory for surfaces coated with rain erosion protective material because the coating dulls the sound of the coin or tool.

When cuts or tears extend through several layers of fabric, and when appearance or thickness is critical, the damage should be repaired by either the stepped method or the tapered method. (See figure 7-1.)

STEPPED METHOD.

When the stepped method is used, glass fabric layers are cut from the damaged area in rectangular strips which gradually decrease in size until the limit of damage is reached. Layers that are removed are saved to serve as templates. New strips of glass fabric are saturated with a resin mixture, accurately cut to match the size of the removed material, and then carefully fitted into the damaged area.

MATERIALS USED.

MATERIALS	SOURCE
Low-pressure laminating resin	Spec MIL-R-7575
Liquid catalyst (curing agent) methyl ethyl ketone peroxide (DDM)	Lucidol Div Novadel-Agene Corp Buffalo, N. Y.
Glass fabric, Type VIII	Spec MIL-F-9084
Rain-erosion-resistant coating material - primer (Bostik 1007)	B B Chemical Co Cambridge, Mass.
Top-coat base cement and accelerator	Spec MIL-C-7439
Cobalt naphthenate (6-percent)	Nuodex Corporation Elizabeth F, N. J.
Toluol	Fed. Spec. TT-T-548
Cellophane	Commercial
Polyvinyl alcohol sheet (0. 003- to 0. 005-inch)	Commercial
Felt sheet (0. 250-inch)	Commercial
Sandpaper (120-grit)	Commercial
Masking tape	Commercial
Scotch tape	Commercial

The following equipment is suggested to aid in making this repair. However, substitute equipment may be used as needed.

MATERIALS	SOURCE
Razor blades (single-edge)	Commercial
Infrared heat lamp (250-watt, 105- to 120-volt or equivalent)	Commercial
Small spatula	Commercial
Paint brush (1/2- or one-inch width)	Commercial
Rolling pin or equivalent	Commercial

REMOVING RAIN-EROSION-RESISTANT COATING.

If the area to be repaired is covered with a rain-erosion-resistant coating, the coating must be removed to a minimum of 3 inches around the damaged area. To remove coating, place a piece of 1/4-inch thick commercial felt over the area and fasten felt in place securely with masking tape. Saturate felt with toluol and keep it saturated for 30 to 45 minutes. At the end of this time, the coating should come loose from the glass fabric easily. Fair in edges of coating with a cloth soaked in toluol, or with commercial sandpaper, 120-grit.

PREPARATION OF DAMAGED AREA.

Clean out damage to a rectangular shape large enough to remove any areas that have delaminated. The rectangular shape makes it easier to fit the repair layers of glass cloth. A sharp knife or razor blade may be used to cut the material. After the hole has been sized, the correct amount of overlap for the top layer may be determined. (See figure 7-1.) Carefully trim and peel top layer of cloth from overlap area. Be careful not to cut into next layer of cloth, and do not let layers separate outside damage area. This would result in an area

which is structurally weaker than the surrounding area. Cut and peel each layer in stair-step fashion as shown in figure 7-1. A spatula is often helpful in lifting the layers and for separating the layers for removal.

MIXING LAMINATING RESIN.

The laminating resin must be mixed with the curing agent or catalyst according to the manufacturer's instructions before use. After adding curing agent to resin, mix thoroughly for several minutes. Laminating resin should be mixed in small amounts, to minimize waste, because the mixed resin has a pot life of only about 6 hours.

PREPARING "WET" LAYER.

Spread glass fabric on a sheet of cellophane on a flat surface. Saturate fabric with mixed resin, spreading it uniformly over surface with a spatula or other flat tool. Cover saturated fabric with another sheet of cellophane, and roll gently but firmly to force resin into fabric. This rolling acting forces the excess resin out to the edge of the fabric. This impregnated fabric between sheets of cellophane may then be cut to the required size. To avoid contamination, the cellophane should remain in contact with the "wet" fabric until the layer is to be used.

PREPARING "DRY" LAYER.

The "dry" or precured layer is used as a backing layer. This layer should be contoured to match the part being repaired as near as possible. The preparation is the same as for a "wet" layer, except that it is not cut to size until after it is cured. To cure "dry" layer, lay fabric smoothly over a contouring block and expose it to heat from an infrared heat lamp, or equivalent, for one hour. The lamp should be held about 12 to 15 inches from the surface of the layer. The surface temperature should be 150°F to 200°F for at least one hour. After the layer has cooled, it should be relatively hard, if it is completely cured. The cellophane sheets should not be removed.

REBUILDING DAMAGED AREAS.

When glass fabric has been damaged to the extent that all of the fabric laminates have been penetrated, it will be necessary to use a backup layer or plate to make the repair. If the area to be repaired is contoured, a dry backing layer should be made up to match the damaged part. If the damaged area is flat, a piece of sheet metal will work equally well as a prepared dry layer. The backup plate is used to support the repair layers as they are placed in position. Place a layer of cellophane between backup plate and damaged surface, and tape backup plate in place. The cellophane sheet should be large enough to prevent leakage of the laminating resin onto the adjacent areas of the panel. The cutout area to be rebuilt should be masked off with either cellophane or masking tape, covering an area at least 2 inches wide around the entire cutout. Masking saves considerable time and trouble in the cleanup process after the repair has cured. Peel cellophane from one side of first wet layer, and place in position with cellophane-covered side up. Rub cellophane gently, and work any excess resin and trapped air bubbles to edges. Remove remaining layers of cellophane, and repeat procedure for all layers until repaired area has same number of layers as original part.

When last layer is in place, remove outer cellophane from it and brush a thin coat of resin over outside layer. Cover repair area with a sheet of polyvinyl alcohol sheet. Stretch this sheet as tightly as possible, without wrinkles, and secure it with cellophane or masking tape. Rub repair area gently with a smooth tool to remove excess resin and to work any air bubbles out of layers and onto masking. Too much rubbing should be avoided because it may reduce the resin content of the fabric enough so that a poor bond results.

CURING LAY-UP.

Cure repair area with infrared heat lamp or equivalent. The lamp should be placed 12 to 15 inches from the surface to maintain a surface temperature of 150°F to 200°F. The curing time should be about one hour. If the repair is properly cured, the area should have a metallic ring when tapped with a coin. If a dull sound is produced, or if repair is soft to the touch, continue curing until repair is hard to the touch and produces a metallic ring. After repair is cured, remove polyvinyl sheet and masking around repair. The complete repair may be sanded lightly to obtain good fairing and a smooth surface.

If heating equipment is not available, the repair may be cold-cured. A special resin mix is required for a cold or room-temperature cure. This special mix is made by adding 6-percent cobalt naphthenate to unmixed resin according to the manufacturer's instructions. Mix thoroughly, add curing agent, and then mix again for several minutes.

CAUTION

The cobalt naphthenate must be mixed into the resin before the curing agent is added. Contact of the undiluted cobalt naphthenate with the curing agent produces an explosive mixture.

The pot life of the mixed resin for a cold cure is about 10 to 15 minutes at about 70°F. This time varies with the temperature of the air. The higher the temperature, the less time it takes the resin to

harden. At temperatures below about 60°F, the resin will not harden. For this reason, the room-temperature cure cannot be used below about 60°F. Curing time at about 70°F for this material is at least 2 hours or until the repair is hard to the touch and produces a metallic ring when tapped with a coin.

TAPERED METHOD.

When tapered method is used, grind damaged area out to an approximately spherical shape; then fill area with wet layers of glass fabric and cure in same manner as for stepped method. (See figure 7-1.)

REPAIRING CORE-FILLED STIFFENERS.

When an assembly with honeycomb-filled stiffeners is damaged, trim out damaged area (skin and stiffener), and repair and cure skin area; then repair stiffener. In addition to the other material listed, nylon phenolic formed honeycomb core (Specification MIL-C-8073, Type 1B) is required. After skin area is cured, trim replacement core section so that it is a tight fit and is flush with adjacent surface of stiffener. (See figure 7-1.) Do not remove fuzz from sawed edges of replacement core. These frayed surfaces are important aids in obtaining a strong bond. Brush a coat of mixed resin onto faces of replacement core and in core cavity.

Peel cellophane from one side of a precut "wet" layer of glass fabric. Position layer on core and rub layer gently with a smooth tool to remove excess resin and to secure layer in place. Repeat this procedure for all layers. When the last layer is in place, remove outer cellophane from it and brush a thin coat of resin over outside layer. Cover repair area with a sheet of polyvinyl alcohol sheet. Stretch this sheet as tightly as possible, without wrinkles, and secure it with cellophane or masking tape. Rub repair area gently with a smooth tool to remove excess resin and to work any air bubbles out of layers and onto masking. Too much rubbing should be avoided because it may reduce the resin content of the fabric enough so that a poor bond results. Cure in same manner as for stepped method.

REFINISHING RAIN-EROSION COATING.

Clean surface thoroughly with toluol, and let dry. Lightly sand surface to be refinished until surface appears dull and all foreign matter is removed. Apply a brush coat of Bostik 1007 primer cement at package consistency. Allow cement to dry for at least one hour. Mix top-coat material for use by mixing 8.3 parts by volume of accelerator (Specification MIL-C-7439) with 100 parts by volume of top-coat base cement (Specification MIL-C-7439). Brush this mixture on primed surface with a minimum of brush strokes. Keep brush well wet with mixture and a small amount of toluol. Avoid brushing over mixture that has started to dry. Immediately after area has been coated with cement mixture, dip brush in toluol and brush lightly over areas where air bubbles are seen. Continue this brushing until all air bubbles are removed. Use only enough toluol to dampen brush. Allow surface to air-dry for 30 minutes between coats. Repeat application of cement material until coating fairs in with old finish (0.010- to 0.014-inch thick). This usually requires six or seven coats. It is important to control the thickness of the coating, because a coating that is too thin does not provide good protection. The complete coating is cured after 72 hours of air drying. This curing time may be shortened by applying heat to the area. After the coating has been allowed to air-dry for a minimum of 6 hours, the surface may be heated to 130°F to 160°F for 3 to 4 hours to complete the cure.

GLASS-FABRIC REPAIR OF ACRYLIC PLASTIC CANOPY.

REPAIR MATERIALS.

MATERIAL	SOURCE
Methyl methacrylate monomer	Rohm and Hass, Philadelphia, Penna.
Caustic soda (commerical grade)	Federal Specification P-S-641
Anhydrous calcium chloride filter paper	Any local chemical supply house
Benzoin photocatalyst No. 302	Any local chemical supply house or Eastman Kodak Co, Rochester, New York
Paste catalyst (benzoyl peroxide) Luperco ATC	Any local chemical supply house or Lucidol Division of Novadel-Agene Corp, Buffalo, New York
Acrylic molding powder A-100	Any local thermo-plastic fabricator or Rohm and Hass, Philadelphia, Penna.
Cleaning compound	Specification MIL-C-18687 (Aer)
Naphtha	Federal Specification TT-N-95
Cellulose tape	Federal Specification UU-T-101

PREPARATION OF RESIN (CEMENT).

The cement used in the repair of the canopy is referred to as methyl methacrylate resin and must be prepared before application. To prepare this material, proceed as follows:

1. Remove inhibitor from methyl methacrylate monomer by adding one percent of caustic soda by weight and one percent of water by weight; agitate thoroughly. Decant monomer from caustic soda and repeat this process for a second time.

2. Filter monomer through two anhydrous calcium chloride filter papers.

3. Store purified monomer under a 40°F (±5°F) temperature until ready for use.

4. Before using purified monomer, warm to room temperature and add 0.5 percent of benzoin photocatalyst by weight, 2 percent of paste catalyst (heat) by weight, and thoroughly mix.

5. Stir catalyzed monomer rapidly and add an amount of acrylic molding powder which is equal to 30 percent of catalyzed monomer weight. Add powder slowly so that good dispersion can be obtained. Continue to mix until powder is in solution. Store resin at approximately 35°F.

REPAIR PROCEDURES.

If the canopy is cracked, broken, or crazed, it is recommended that it be replaced with a new part. The following repair procedures are recommended for use only under emergency conditions. Cracks in acrylic plastic may be repaired by laying up, cementing, and curing the glass-fabric laminates which have previously been bonded with an acrylic resin. Laying up is nothing more than placing a piece of glass fabric into the repair, applying a cement, and curing. After the curing is completed, this procedure is repeated until the damage area is completely filled with the fabric laminations. Since this type of repair is opaque, canopy damage which impairs vision will necessitate replacement rather than repair. These limitations are illustrated in figure 7-2. To repair canopy damage, proceed as follows:

CAUTION

Do not use this method of repair if crack is too near edges of canopy to permit a patch of dimensions given in figure 7-2.

1. Drill a 3/16-inch hole at end of crack to prevent further cracking during handling.

2. Using a portable grinder, or other suitable tool, grind down area surrounding crack. Grind down plastic to an approximate 1/8-inch thickness along edge of crack. The depression must taper gradually from the maximum depth to the edges. The edges of the depression must be at least 1-1/2 inches from the crack along the sides and at least 2 inches at the end.

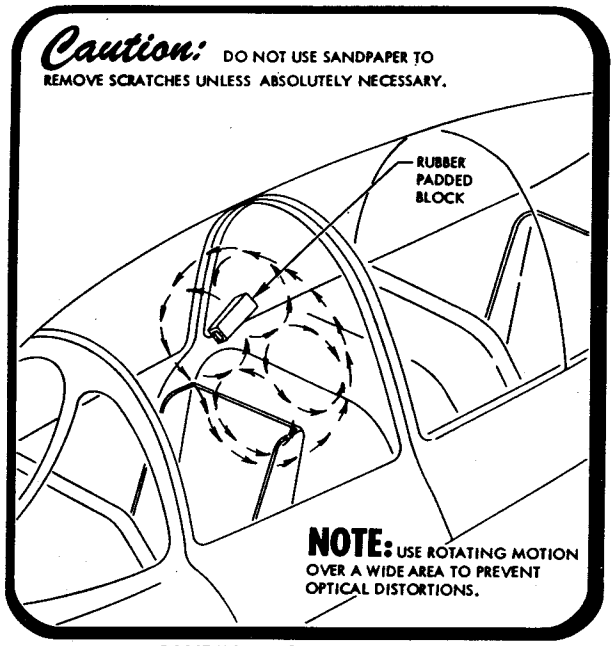
CAUTION

Care should be taken to prevent overheating the plastic while grinding.

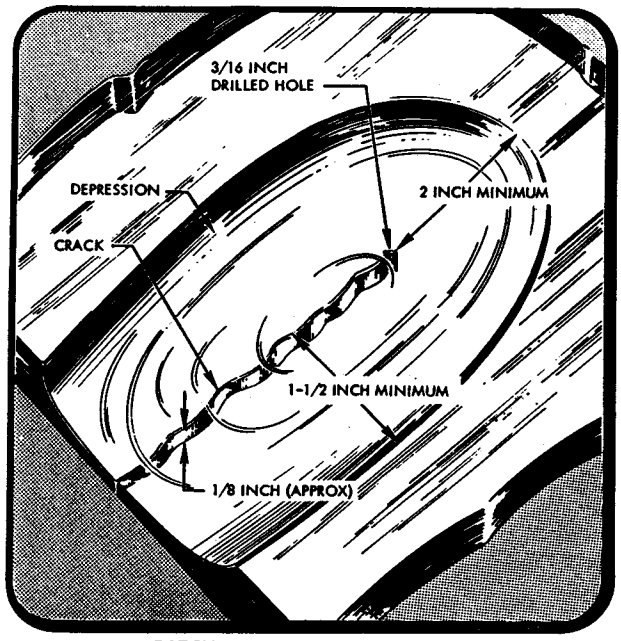
3. Using a scraper, smooth out depressions; finish smoothing by using fine sandpaper.

4. Clean depression with a clean, dry, soft cloth dampened with cleaning compound [Specification MIL-C-18687 (Aer)] or aliphatic naphtha (Federal Specification TT-N-95).

5. Mask all areas adjacent to depression with a clear cellulose tape (Federal Specification UU-T-101, Type II). The tape edge next to the depression must be free of wrinkles or bubbles that would permit cement to seep under the tape.

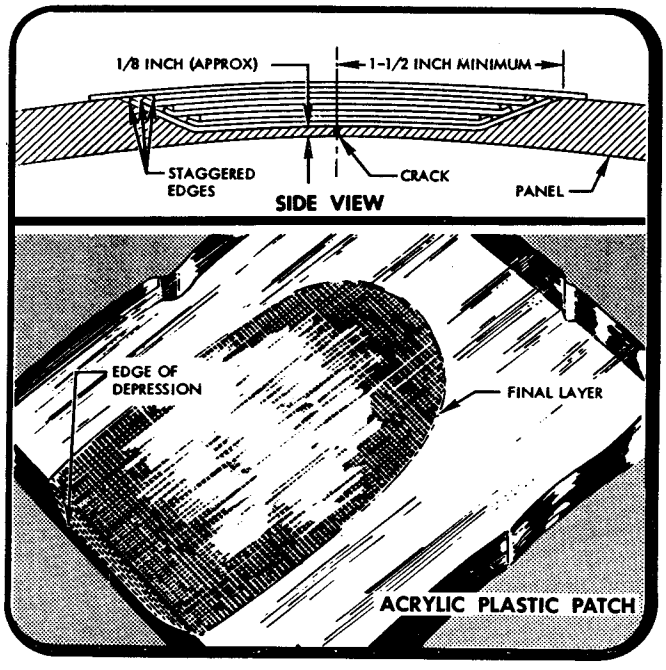


SANDING ACRYLIC PLASTICS



PATCHING AREA DIMENSIONS

METHOD OF LAYING-UP ACRYLIC PLASTIC PATCH



CANOPY VISION AREAS

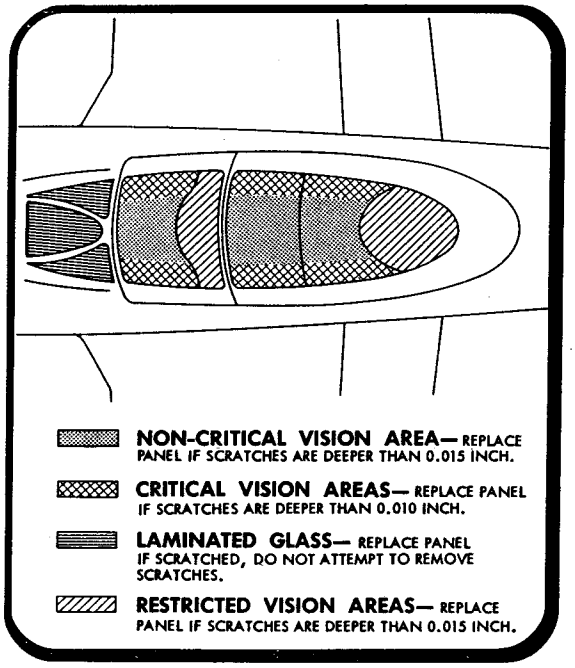


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Figure 7-2. Glass-fabric Repair of Acrylic Plastic Canopy

6. Place a piece of clear cellulose tape over drilled hole opposite side that has been ground out.

7. Cut a piece of glass fabric to proper size and exact shape to cover depression. Saturate this piece of glass fabric with methyl methacrylate resin (cement). To saturate glass fabric, spread a very heavy coating of cement on a large piece of cellophane and lay fabric out on cement. Press down on fabric to work cement up through weave. Then spread a heavy coating of cement on fabric and work in with a spatula. Smooth out and leave an ample excess of cement. An ideal fabric saturation contains 60 to 65 percent cement.

8. Coat entire depression and fill drilled hole with cement. Lay saturated fabric in place immediately.

CAUTION

This operation must be carried out within one minute of the saturation or it will be difficult to work out the bubbles.

9. Cover saturation with a piece of clear cellophane and work out all of bubbles, taking care not to work out cement. The small amount of cement that does seep out should be worked out onto the masking tape.

10. Leaving cellophane in place, irradiate saturated fabric for one hour with an ultraviolet lamp. The lamp, or lamps if necessary, should be 10 inches from the patch.

NOTE

It is possible to cure cement out-of-doors if ideal atmospheric conditions exist. It is recommended that the layers be exposed to direct, open sunlight on a clear day between 3 hours after sunup and 3 hours before sundown. Because of the variables present in sunlight curing, allow an additional 15 minutes for complete hardening. (Refer to step 11.) Air inhibits the curing of cement. If the cement will not harden by the prescribed irradiation process, it is because there is air under the cellophane. It is better to start over than to lengthen irradiation.

11. Strip away cellophane and cement another layer of glass cloth over first layer, using same procedure.

12. After the first two layers of fabric are cemented in place, continue to cement in additional layers until depression is filled. Use same cementing procedure as for the first two layers, with the exception that as many as four layers may be cemented in at one time. To fit patch to taper of edges of depression, stagger and overlap edges of fabric. (See figure 7-2.)

NOTE

Since excess cement collects around edges of patch, remove masking tape and scrape and sand edges following each set of four laminate plies. Remask before cementing additional layers.

CAUTION

Do not allow excess cement to change contour of patch.

13. Build patch up to point where surface is flush with canopy surface. Cut out one additional piece of fabric to cover and overlap depression by 1/4 to 1/2 inch. Using established procedure, cement this piece over patch.

14. If touch-up painting is required, mask off all plastic panels in area being worked.

CAUTION

A jet of air must be blown on the patch surface during this operation to keep the area cool. Excess heat causes bubbles to form.

15. Feel cement through cellophane to see whether it is cured. If it seems hard, test it further by probing through cellophane with a scribe or other sharp instrument. If cement is not completely hardened, irradiate for an additional 1/2 hour. If, after the additional 1/2 hour, cement is not hard, remove fabric and start over. Fully cured resin is essential to the strength of the repair.

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SECTION VIII

EXTRUSION CHART

EXTRUSION CHART.

With one exception, all repairs in this manual involving extrusions or rolled sections are made with bent-up sheet repair members; therefore, fabrication details for equivalent sections are contained as part of each detail repair figure. In the special instance where no substitution is possible, the Alcoa die number of the extrusion is shown in the detail repair figure.

SECTION IX
(Deleted)

(Pages 9-1 through 9-4, figures 9-1, 9-2 deleted)

APPENDIX I

REPAIR MATERIALS

REPAIR MATERIAL LIST

STOCK DESCRIPTION	GAGE	COMMERCIAL DESIGNATION	SPECIFICATION
		ALUMINUM	
Sheet	0.016	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Sheet	0.020	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Sheet	0.025	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Sheet	0.032	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Sheet	0.040	2024-T4 clad or 2024-T4 clad	Federal Spec QQ-A-362
Sheet	0.050	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Sheet	0.063	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Sheet	0.071	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Sheet	0.080	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Sheet	0.090	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Sheet	0.100	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Sheet	0.125	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Sheet	0.156	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Sheet	0.188	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Sheet	0.250	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Plate	0.375	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Plate	0.500	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Plate	0.625	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Plate	0.750	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Plate	1.000	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Plate	1.250	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Plate	1.500	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Plate	1.750	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Plate	2.000	2024-T4 clad or 2024-O clad	Federal Spec QQ-A-362
Sheet	0.016	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287

STOCK DESCRIPTION	GAGE	COMMERCIAL DESIGNATION	SPECIFICATION
Sheet	0.020	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
Sheet	0.025	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
Sheet	0.032	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
Sheet	0.040	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
Sheet	0.050	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
Sheet	0.063	7075-O clad or 7075-O clad	Federal Spec QQ-A-287
Sheet	0.071	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
Sheet	0.080	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
Sheet	0.090	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
Sheet	0.100	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
Sheet	0.125	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
Sheet	0.156	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
Sheet	0.188	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
Sheet	0.250	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
Plate	0.375	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
Plate	0.500	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
Plate	0.625	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
Plate	0.750	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
Plate	1.000	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
Plate	1.250	7075-T6 clad or 7075-T6 clad	Federal Spec QQ-A-287
Plate	1.500	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
Plate	1.750	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
Plate	2.000	7075-O clad or 7075-T6 clad	Federal Spec QQ-A-287
		MAGNESIUM ALLOY	
Magnesium alloy	0.020	Magnesium alloy	Federal Spec QQ-M-31
Magnesium alloy	0.025	Magnesium alloy	Federal Spec QQ-M-31
Magnesium alloy	0.032	Magnesium alloy	Federal Spec QQ-M-31
Magnesium alloy	0.040	Magnesium alloy	Federal Spec QQ-M-31
Magnesium alloy	0.050	Magnesium alloy	Federal Spec QQ-M-31
Magnesium alloy	0.063	Magnesium alloy	Federal Spec QQ-M-31
Magnesium alloy	0.071	Magnesium alloy	Federal Spec QQ-M-31
Magnesium alloy	0.080	Magnesium alloy	Federal Spec QQ-M-31
Magnesium alloy	0.090	Magnesium alloy	Federal Spec QQ-M-31
Magnesium alloy	0.100	Magnesium alloy	Federal Spec QQ-M-31
Magnesium alloy	0.125	Magnesium alloy	Federal Spec QQ-M-31
Magnesium alloy	0.190	Magnesium alloy	Federal Spec QQ-M-31
Magnesium alloy	0.250	Magnesium alloy	Federal Spec QQ-M-31

STOCK DESCRIPTION	GAGE	COMMERCIAL DESIGNATION	SPECIFICATION
		STEEL	
Sheet	0.010	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.012	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.016	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.018	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.020	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.024	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.025	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.030	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.032	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.035	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.036	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.040	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.045	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.050	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.063	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.080	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.090	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.125	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.160	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.190	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.250	1/2 hard (CRES)	Spec MIL-S-5059
Plate	0.312	1/2 hard (CRES)	Spec MIL-S-5059
Plate	0.375	1/2 hard (CRES)	Spec MIL-S-5059
Plate	0.500	1/2 hard (CRES)	Spec MIL-S-5059
Plate	0.625	1/2 hard (CRES)	Spec MIL-S-5059
Plate	0.750	1/2 hard (CRES)	Spec MIL-S-5059
Plate	1.000	1/2 hard (CRES)	Spec MIL-S-5059
Plate	1.250	1/2 hard (CRES)	Spec MIL-S-5059
Plate	1.500	1/2 hard (CRES)	Spec MIL-S-5059
Sheet	0.012	4130 (norm)	Spec MIL-S-18729
Sheet	0.016	4130 (norm)	Spec MIL-S-18729
Sheet	0.020	4130 (norm)	Spec MIL-S-18729
Sheet	0.025	4130 (norm)	Spec MIL-S-18729
Sheet	0.032	4130 (norm)	Spec MIL-S-18729
Sheet	0.036	4130 (norm)	Spec MIL-S-18729
Sheet	0.040	4130 (norm)	Spec MIL-S-18729
Sheet	0.045	4130 (norm)	Spec MIL-S-18729
Sheet	0.050	4130 (norm)	Spec MIL-S-18729
Sheet	0.063	4130 (norm)	Spec MIL-S-18729
Sheet	0.080	4130 (norm)	Spec MIL-S-18729
Sheet	0.090	4130 (norm)	Spec MIL-S-18729
Sheet	0.125	4130 (norm)	Spec MIL-S-18729
Sheet	0.160	4130 (norm)	Spec MIL-S-18729
Sheet	0.190	4130 (norm)	Spec MIL-S-18729
Sheet	0.250	4130 (norm)	Spec MIL-S-18729
Plate	0.312	4130 (norm)	Spec MIL-S-18729
Plate	0.375	4130 (norm)	Spec MIL-S-18729
Plate	0.500	4130 (norm)	Spec MIL-S-18729
Plate	0.625	4130 (norm)	Spec MIL-S-18729
Plate	0.750	4130 (norm)	Spec MIL-S-18729
Plate	1.000	4130 (norm)	Spec MIL-S-18729
Plate	1.250	4130 (norm)	Spec MIL-S-18729
Plate	1.500	4130 (norm)	Spec MIL-S-18729

REPAIR MATERIALS AND USES

MATERIAL	STOCK NO.	SPECIFICATION	REMARKS
		ADHESIVES	
Aerodynamic filler, PR-341 and PR-341A accelerator		Commercial	Used as a general aerodynamic smoothing compound.
Cement, EC-613B		Commercial	Used for liquidtight sealing in areas where temperature is between 400° F and 500° F.
Cement, transparent plastic	8040-266-0815	Commercial	Used in making repairs on transparent plastic.
Cement and accelerator top-coat base		Spec MIL-C-7439	Used in making repairs on glass fabric.
Cement. Also refer to resin.			
Methyl isobutyl ketone		Fed. Spec TT-M-268	Used as a thinner for abrasion-resistant coating.
Methylene chloride		Spec MIL-M-6998	Used as a substitute cement for transparent plastic.
Neoprene coating, Class I	8030-506-4030	Spec MIL-C-7439	Rain-resistant coating.
Neoprene coating, Class II	8030-NSL	Spec MIL-C-7439	Rain-resistant coating.
Resin, low-pressure		Spec MIL-R-7575	Used for making glass-fabric repairs.
Catalyst, methyl ethyl ketone peroxide (DDM)		Commercial	Curing agent for resin (Spec MIL-R-7575).
Sealant	8030-262-9041	Spec MIL-S-7124	Watertight seal.
Sealant		Spec MIL-S-7126	Fumetight seal.
Sealant		Spec MIL-S-7502, Class B-4	Fumetight sealant.
Sealing compound, PR-1221		Commercial	Used as a corrosion barrier.
Tape, cellulose		Fed. Spec UU-T-101	Masking around acrylic plastic repairs.
Tape		Fed. Spec PPP-T-60, Type II, Class I	With fumetight sealant.
Tape		Spec MIL-D-8634	Fumetight seal (substitute for Scotch-Cal tape).
Tape, Scotch-Cal No. 455		Commercial	Fumetight seal.

MATERIAL	STOCK NO.	SPECIFICATION	REMARKS
		CLEANERS AND SOLVENTS	
Acid, chromic		Fed. Spec O-C-303	Used in chemical identification of metals and for hand anodizing.
Acid, hydrochloric		Fed. Spec O-A-86	Used in chemical identification of metals.
Acid, nitric		Fed. Spec O-A-88	Used in chemical identification of metals.
Cleaner, phosphoric acid		Spec MIL-C-5410	Metal cleaner and brightener.
Cleaning compound, Deseal A		Commercial	Used as a cleaning agent.
Cleaning compound, LAR 1634		Commercial	Used as a cleaning agent.
Cleaning compound		Spec MIL-C-18687	Acrylic plastic cleaning.
Methyl ethyl ketone (MEK)	6810-281-2785	Fed. Spec TT-M-261	Used as a cleaning agent.
Naphtha		Fed. Spec TT-N-95	Used as a cleaning agent.
Polish and cleaner, transparent plastic		Spec MIL-C-18767	Used to clean and polish transparent plastics.
Sodium hydroxide		Spec MIL-S-11795	Used as a cladding check.
Solvent, Stoddard		Fed. Spec P-S-661	General-purpose cleaner.
Toluol	6810-231-2002	Fed. Spec TT-T-548	Used as a cleaning agent.
Thinner, wash		Fed. Spec P-S-661	Used as a paint remover.
Xylene, Grade B	6810-598-6600	Fed. Spec TT-X-916	Used as a spraying thinner or reducer.
		FINISHES	
Alodine 1200		Spec MIL-C-5541	Used as a corrosion preventive and also as a prepaint surface treatment of aluminum alloys.
Iridite 14		Spec MIL-C-5541	Identical to Alodine 1200.
Lacquer, aluminized		Spec MIL-L-7178	Exterior finish.
Lacquer, medium green		Spec MIL-L-6805	Interior finish.
Primer, rain-erosion-resistant coating meterial (Bostic 1007)		Commercial	Used as a protective coating for fiber-glass structure.
Primer, wash		MIL-C-8514	Used as a primer pretreatment coating on metal surfaces before painting.

MATERIAL	STOCK NO.	SPECIFICATION	REMARKS
Primer, zinc-chromate		Spec MIL-P-8585A	Primer coating used over wash primer or on clean metal surfaces of all types.
		MISCELLANEOUS	
Black light, Magnaflux ZB-26		Commercial	Used for locating and determining size of cracks in metal.
Butyl Cellosolve		Commercial	Used in corrosion- and abrasion-resistant coating.
Cadmium sulphate		Commercial	Used in chemical identification of metals.
Calcium carbonate		Spec JAN-C-293	Used to detect cracks in metal surfaces.
Catalyst, methyl ethyl ketone peroxide (DDM)		Commercial	Curing agent for glass-fabric resin.
Catalyst, paste, (benzoyl peroxide) Luperco ATC		Commercial	Curing agent for acrylic plastic resin.
Catalyst, benzoin Photocatalyst No. 302		Commercial	Curing agent for acrylic plastic resin.
Caustic soda		Fed. Spec P-S-641	Used in preparing acrylic plastic resin.
Cellophane sheet		Commercial	Used in glass-fabric repair.
Chamois skin	8330-257-2492	Fed. Spec KK-L-167	Used to clean transparent plastic.
Cloth, polishing		Fed. Spec CCC-F-466	General-purpose cleaning cloth.
Cobalt naphthenate (6 percent)		Commercial	Used in making glass-fabric repairs.
Core, nylon phenolic honeycomb		Spec MIL-C-8073, Type 1B	Used in repair of fixed gun enclosure.
Felt sheet 0.250-inch		Commercial	Used in making glass-fabric repairs.
Filter paper, anhydrous calcium chloride		Commercial	Used in preparing acrylic plastic resin.
Glass-fabric Type VIII		Spec MIL-F-9084	Used in making glass-fabric repairs.
Petrolatum		Fed. Spec VV-P-236	Used to prevent sealing compound from sticking to screws and removable fasteners.
Plastic, liquid acrylic, methyl methacrylate monomer		Commercial	Used to make repairs on transparent plastic canopies.
Plastic, powder, acrylic modling, A-100		Commercial	Used to make repairs on transparent plastic canopies.

MATERIAL	STOCK NO.	SPECIFICATION	REMARKS
Polyvinyl alcohol sheet, 0.003 to 0.005 inch		Commercial	Used in making glass-fabric repairs.
Silver nitrate crystals		Commercial	Used in chemical identification of metals.
Sodium chloride		Commercial	Used in chemical identification of metals.
Tape, general-purpose, pressure-sensitive, Type II, Grade III		Fed. Spec PPP-T-60	Used as backup, to prevent pressure from forcing sealants through openings in structure being sealed.
Tape, Vinyl No. 473		Commercial	Used as a corrosion barrier between magnesium and other metals.
Zyglo developer ZP-3		Commercial	Used to detect cracks in metal surfaces.
Zyglo penetrant		Commercial	Used to detect cracks in metal surfaces.

SOURCES OF COMMERCIAL PRODUCTS

PRODUCT	SOURCE
Acrylic molding powder F-100	Any local thermoplastic fabricator or Rohm and Hass, Philadelphia, Pa.
Anhydrous calcium chloride filter paper	Any local chemical supply house.
Benzoin Photocatalyst No. 302	Any local chemical supply house or Eastman Kodak Co, Rochester, N.Y.
Bolt, North American Aviation specification	Voi-Shan Manufacturing Co, Inc Culver City, Calif. Briles Manufacturing Co El Segundo, Calif.
Catalyst, DDM	Lucidol Division Novadel-Agene Corp Buffalo, N.Y.
Cement, EC-613B	Minnesota Mining and Mfg Co St. Paul, Minn.
Chemical film, Alodine 1200	American Chemical Paint Co Ambler, Pa.
Chemical film, Iridite 14	Allied Research Products, Inc Baltimore, Md.
Chuck, drill extension	Beaver Tool Company New York, N.Y.

PRODUCT	SOURCE
Cleaning compound, LAR 1634	Turco Products, Inc Los Angeles, Calif.
Cleaning compound, Deseal A	Kelite Products, Inc Los Angeles, Calif.
Coating compound, fuel- and oil-resistant, Stabond C-136	American Latex Products Corp Los Angeles, Calif.
Coating, Vulcabond V-36	American Latex Products Corp Los Angeles, Calif.
Coating, A56B	B. F. Goodrich Co Akron, Ohio
Coating, plastic, abrasion- & corrosion-resistant Everlube 1329, Everlube 1329A	Everlube Corp North Hollywood, Calif.
Detonator, friction, explosive rivet	Sheridan Products, Inc Inglewood 3, Calif.

PRODUCT	SOURCE
Developer, Zyglo (ZP-3)	Magnaflux Corp Chicago, Ill.
Drill extension, "Little Beaver"	Beaver Tool Co New York, N.Y.
Filler, aerodynamic skin filler PR-341	Products Research Corp Los Angeles, Calif.
Insert, threaded, Heli-Coil	Heli-Coil Corp Danbury, Conn.
Insert, threaded, Rosan	Rosan, Inc Newport Beach, Calif.
Jo-bolt	National Screw Manufacturing Co of Calif. Los Angeles, Calif.
Light, black, inspection, Magnaflux ZB-26	Magnaflux Corp Chicago, Ill.
Methyl methacrylate monomer	Rhom and Hass, Philadelphia, Pa.
Nut, EB series	Elastic Stop Nut Corp of America Union, N.J.
Penetrant, inspection, Zyglo	Magnaflux Corp Chciago, Ill.
Rivet, Cherry	Townsend Co, Cherry Rivet Div Santa Ana, Calif.
Rivet, Deutsch drive pin	Huck Manufacturing Co Detroit 7, Mich.
Rivet, explosive	E.I. Dupont De Nemours and Co (Inc) Explosives Department Wilmington 98, Del.
Rivet, Hi-Shear	Hi-Shear Rivet Tool Co Los Angeles 45, Calif.
Rivet, Huck	Huck Manufacturing Co Detroit 7, Mich.
Rivet, Olympic	Olympic Screw and Rivet Corp Downey, Calif.
Scotch-Cal No. 455 tape	Minnesota Mining and Manufacturing Co St. Paul, Minn.
Screw, Hi-Torque	Hi-Shear Rivet Tool Co Los Angeles 45, Calif.
Screw, Phillips head	American Phillips Recess American Screw Co Willimantic, Conn.

PRODUCT	SOURCE
Screw, Reed & Prince	Reed & Prince Mfg Co Worcester, Mass.
Screw, Torq-Set	American Screw Co Willimantic, Conn.
Sealant gun, disposal-cartridge	Pyles Industries, Inc Detroit 2, Mich.
Sealing compound, PR-341	Products Research Corp Los Angeles, Calif.
Sealing compound, high-temperature HT-23	American Latex Products Corp Hawthorne, Calif.
Sealing compound, high-temperature EC-1548	Minnesota Mining and Mfg Co St. Paul, Minn.
Sealing compound, general-purpose	Coast Pro-Seal & Mfg Co Los Angeles, Calif. Minnesota Mining and Mfg Co St. Paul, Minn. Products Research Corp Los Angeles, Calif.
Sealing compound, Pro-Seal 414	Coast Pro-Seal & Mfg Co Los Angeles, Calif.
Sealing compound, EC-612P	Minnesota Mining and Mfg Co St. Paul, Minn.
Sealing compound, Pro-Seal 714	Coast Pro-Seal & Mfg Co Los Angeles, Calif.
Sealing compound, Pro-Seal 714A	Coast Pro-Seal & Mfg Co Los Angeles, Calif.
Sealing tape, unfused Teflon 547	Minnesota Mining and Mfg Co St. Paul, Minn.
Tape, general-purpose, pressure-sensitive	Industrial Tape Corp New Brunswick, N. J.
Tape, general-purpose, pressure-sealing	Bauer & Black Division Kendall Co Chicago, Ill.
Tester, hardness, portable, Barcol	Barber-Colman Co Rockford, Ill.
Tester, hardness, portable, Ernst	Newage International, Inc New York 17, N. Y.
Tester, hardness, portable, Riehle	Riehle Testing Machine Div American Machine & Metals, Inc East Moline, Ill.
Tool, Jo-bolt driving	Lok-Fast, Inc Torrance, Calif.

APPENDIX II

TYPICAL REPAIRS

GENERAL.

Typical repairs are designed for the widest possible applications. The aim in designing repairs for areas considered to be primary structure is to rebuild the material. This is necessary because the typical repair has to be strong enough for the most heavily loaded part on which it may be used. Repairs for areas considered to be secondary structure are somewhat lighter, since the known loading in those areas is lighter. Repairs for secondary structure are skin repairs only. All substructure is to be considered as primary structure for repair purposes. Secondary structure repairs are noted as such in their titles. Nonstructural door repairs are also secondary structure repairs. All other repairs in this section are applicable to primary structures. Typical repair indexes show certain covers and doors as secondary structure. These covers and doors are nonstructural. However, the load-carrying ability of a structure must be continuous, so that, when a nonstructural door is installed, the load paths are transferred to the framework around the door and/or to the compartment which it covers.

TYPICAL REPAIR INDEX.

The typical repair index (figure 2A-1) contains the necessary information for selection of a typical repair. All outer skins are designated as primary or secondary structure. Primary structure skins are coded as to how they are loaded; that is, whether they are loaded in shear or tension, or in combined shear and tension. This repair index gives the type of repair required for each area only. It permits selection of the most suitable repair within the type.

The index applies to the skins only, not to the structures underneath them. For repair purposes, all formed and extruded shapes are considered to be tension-loaded. Use tension riveting tables when calculating rivet requirements. All internal webs are considered to be loaded in shear. Use shear riveting tables when calculating requirements for web repairs. Tension repairs used in this section are actually extra-strong shear repairs. The number of rivets required for "l" (cutout dimensions) is the same, regardless of the direction of tension. A 4-inch opening would have an equal number of rivets along each of its sides. This eliminates the need for determining the directions of the tension loads.

Typical repairs may be used whenever they meet the shape and material requirements, as long as they are applied to areas as previously specified. The following paragraphs discuss selecting the repair and fastener table, and also fastener distribution. Refer to "Developing a Typical Repair" for an itemized list of the various factors which must be considered when planning and working up a typical repair. It provides a convenient reference to the problems involved, and supplies the answers or refers to data which contains the answers.

SELECTING TYPICAL REPAIRS.

Typical repairs are selected by a combined use of the typical repair index (figure 2A-1) and the list of illustrations in the front of the book.

The repair titles are actually a brief description of the repair. For example: To repair a hole near a frame in a fuselage skin panel, find the damaged area on the fuselage view of the typical repair index. This diagram indicates that the damaged area is primary structure and that a shear-type repair is required. From the list of illustrations, select "Skin Repair Adjacent to Substructure, Shear and Tension." Each of the three sheets of this figure shows a different method of dealing with the problem. Select the method which best fits your needs. A brief study of the repair titles in the list of illustrations familiarizes the repairman with the many types of repairs he can make by using the information in this section.

SELECTING FASTENER TABLE.

Fastener tables, given in the list of illustrations, are titled according to the type of fastener and the shape of its head; the material or materials for which calculations were made; and how the repair is loaded (shear or tension).

The type of fastener chosen for a repair should be the one that best fits the need. In skin and web repairs, it is best to match the type and size of fastener that is in general use in the area. When it is necessary to use blind fasteners, they should be of the same size and head type as the original fasteners in the surrounding area.

Protruding-head fasteners must be used to repair extruded or formed shapes, except where external skins are picked up in the fastener pattern.

Because of the space available for overlap of repair parts, several calculations may be necessary to determine the suitable fastener. Minimum (or greater) fastener edge distance spacing must be observed to obtain the required strength in the repair.

FASTENER DISTRIBUTION PATTERNS.

The fastener distribution patterns (figure 2A-2) show how fastener patterns are developed for the more common types of repairs. Fastener layout determines the size and shape of the repair doubler.

The first three sheets of figure 2A-2 deal with problems in skin and web repairs; the fourth sheet deals with problems in repairing extruded and roll-formed shapes. In both cases, the problems are about the same. Whenever there is a break or gap in a piece of metal, it must be joined together with another piece of metal (a repair doubler). The repair doubler must be fastened to the broken material with a given number of fasteners. The required number, as found in the fastener tables, is the number that is required for each side of the break.

In skin and web repairs, the trimmed-out damage is usually rectangular or circular in shape. The rectangle has two directions of brake, at 90 degrees to each other. Each direction is treated separately, and the required fasteners are distributed on opposite sides of that particular direction of break.

The circle is considered to have but one break, its circumference. Fasteners are distributed evenly around the cutout.

A crack in sheet metal may have one or two directions, depending on the path the crack has taken. When it is a generally straight line, it is measured as a straight line and the required fasteners are distributed on each side of the break. When the path of the crack deviates from a generally straight line, it is considered to have two directions of break and is treated as a rectangular repair. The area of skin inside the rivet pattern actually becomes the "filler" material and may be tacked to the repair doubler with small structural rivets, as a filler would be.

The only skin and web repair that does not require the specified number of fasteners on each side of the break is the overlap splice. In this repair, the fasteners required for the break are distributed within the overlap area.

In extruded and roll-formed shape repairs, the length of the break may vary from a partial damage to one flange to a complete separation of the part. In all cases, fastener calculations are made for each surface of the shape affected by the break. Fasteners required for each surface are distributed in that surface on each side of the break. Fasteners may be added in any surface to obtain a uniform fastener pattern.

DEVELOPING A TYPICAL REPAIR.

The following items, listed in the left column as problems, are factors that must be considered when making a typical repair. The right column contains either the solution or reference to where the solution will be found.

PROBLEMS	SOLUTIONS
1. Identifying damaged material.	Refer to: Applicable group repair index. "Identification of Materials by Chemical Testing," in Section I.
2. Identifying material thickness ("t" on repair figure).	
3. Determining type of material to use in the repair.	Match the damaged material (2024-T3 may be used when 2024-T4 was used in the original part). The following material substitutions are allowed: One-half hard CRES may be substituted for aluminum alloys in skin repairs. Use half the thickness required for the aluminum alloy.
4. Determining whether primary or secondary structure repairs are required.	Refer to list of illustrations.
5. Determining whether a tension-type of shear-type repair is required.	Refer to list of illustrations.
6. Selecting appropriate repair.	Select the repair that best fits the need and satisfies conditions in problems 3 and 4.
7. Selecting appropriate fastener type.	Select fastener type on basis of material being repaired, ease of installation, blind area problems, and tools available. Protruding-head fasteners may be used temporarily if proper dimpling tools are not available. See figure 2A-19 for rivet hole sizes. NOTE Hole sizes for blind and nonexpanding fasteners are critical. Tolerances given must be maintained.

PROBLEMS	SOLUTIONS
8. Selecting appropriate fastener table.	Select table which satisfies conditions in problems 1 and 4.
9. Determining (from fastener tables) number of fasteners required.	The required number of fasteners for a given "l" dimension is found where the material thickness line crosses the selected rivet column, under the given "l" dimension. To compute for a dimension not shown, add requirements for smaller dimensions which are shown. Example. For an "l" of 7 inches, add requirements for 4-, 2-, and 1-inch dimensions.
10. Determining minimum fastener edge ("a" dimension on repair figures).	Minimum fastener edge distance = two times the fastener diameter, measured from center of fastener (unless otherwise noted).
11. Determining minimum and maximum fastener spacing ("b" dimension on repair figures).	Minimum fastener spacing = four times the fastener diameter. Maximum spacing = 1-1/2 inches. Spacing is measured from centers of fasteners.
12. Determining fastener distribution in skin and web repairs.	See figure 2A-2. (The referenced figure shows fastener distribution patterns in one-piece doubler repairs. Fastener distribution for split doublers and special situations are noted on the repair figure.)
13. Determining fastener distribution in extruded-and formed-shape repairs.	See figure 2A-2. (A roll-formed "Z" section is used in the fastener distribution examples. These examples, however, apply to all roll-formed and extruded shapes, for which repairs have been designed. Special fastener problems are noted on the repair figure.)

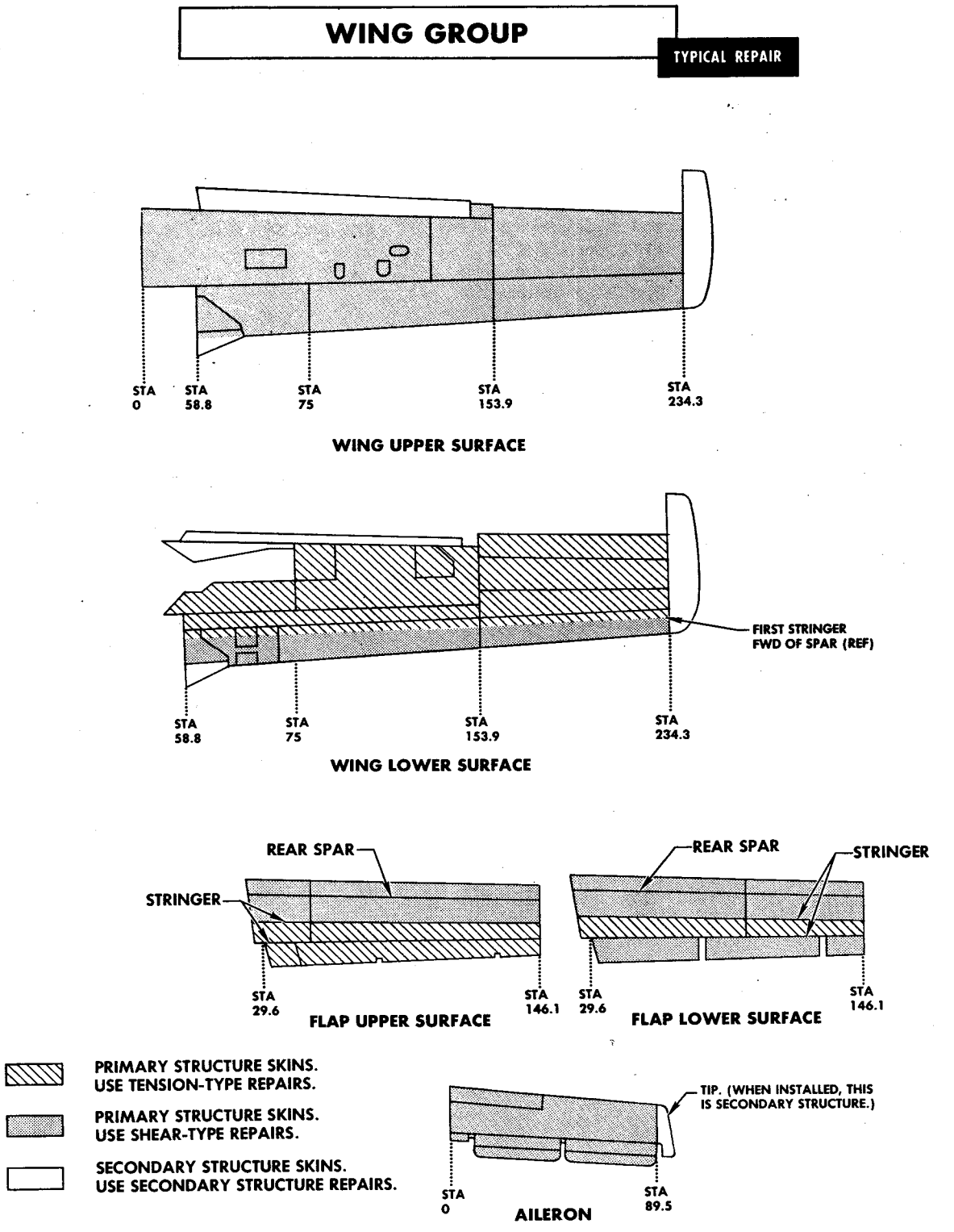


Figure 2A-1. Typical Repair Index (Sheet 1 of 3)

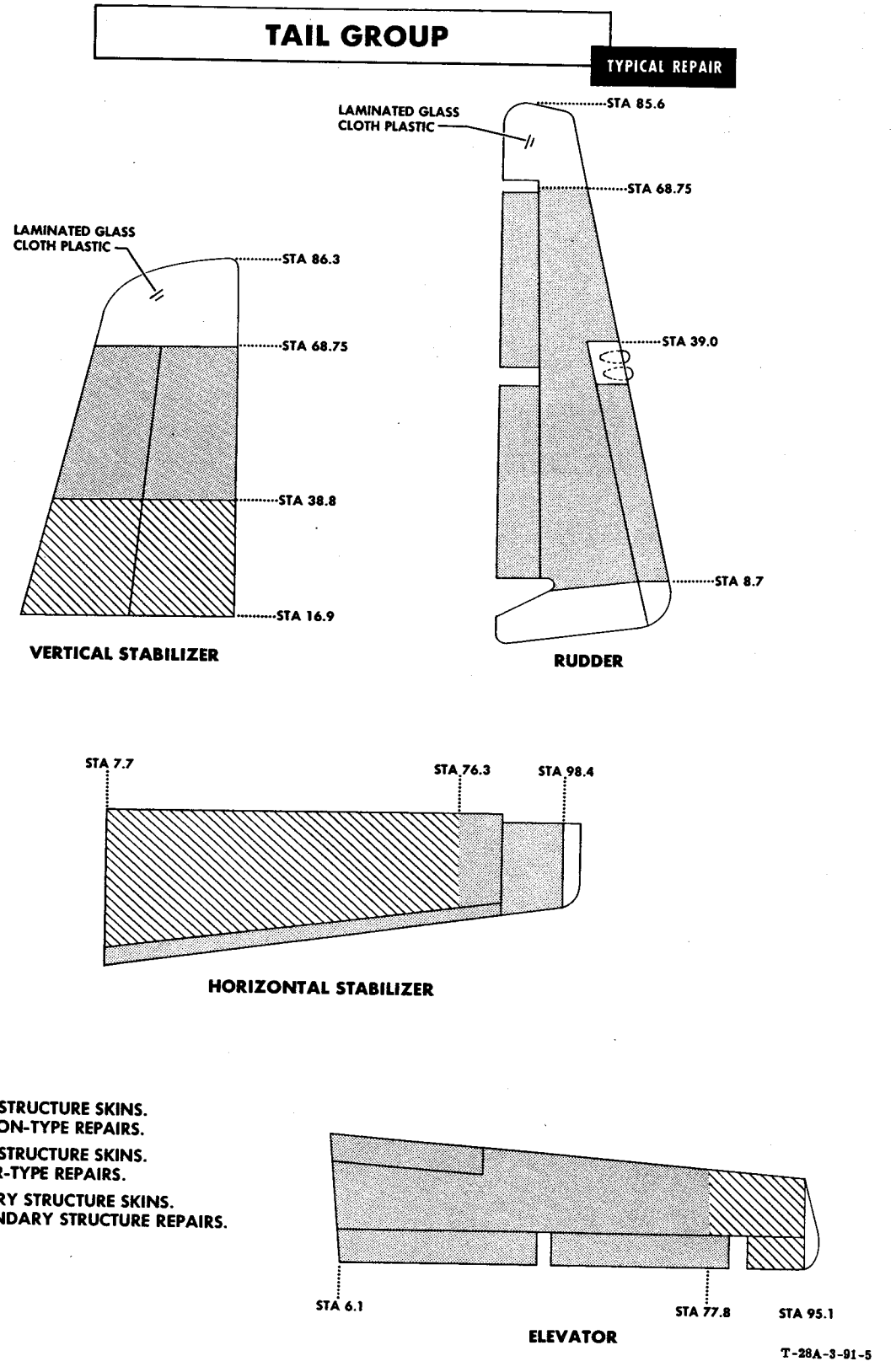


Figure 2A-1. Typical Repair Index (Sheet 2 of 3)

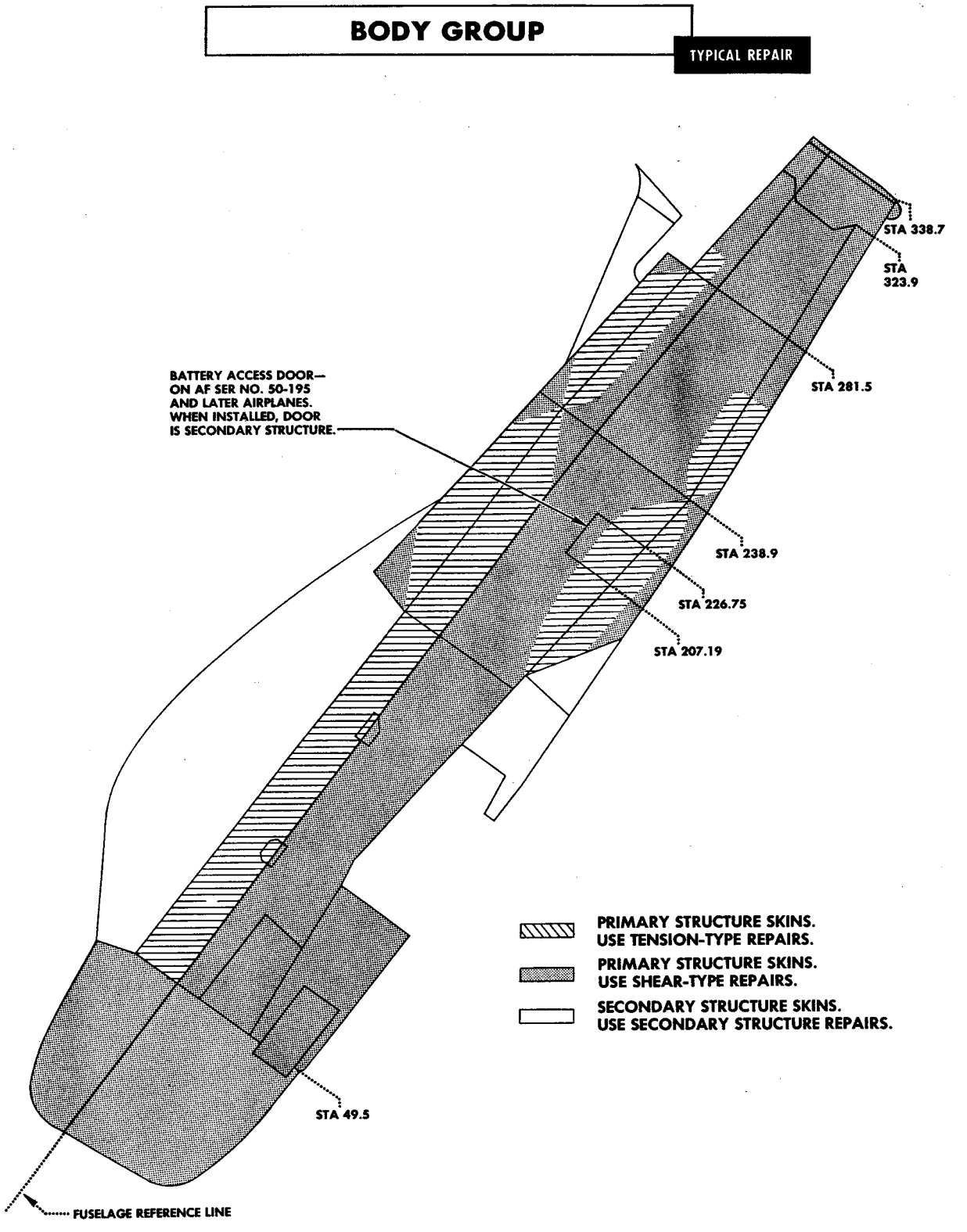
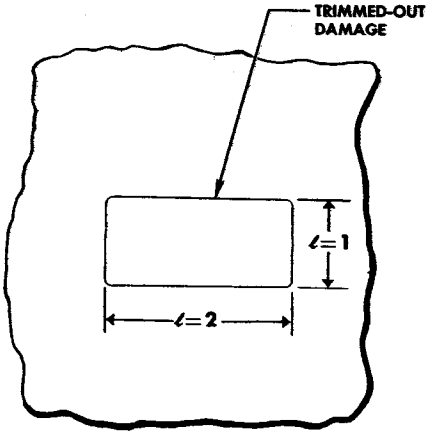


Figure 2A-1. Typical Repair Index (Sheet 3 of 3)

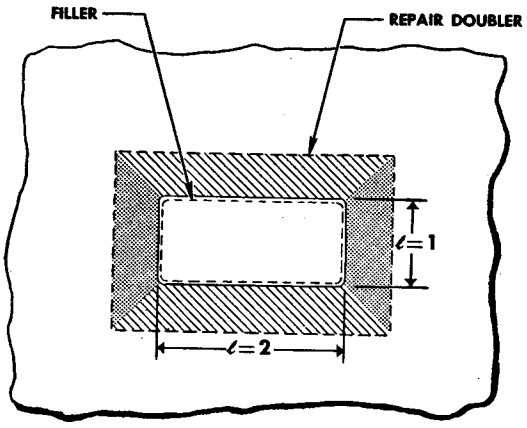
SKIN AND WEB

TYPICAL REPAIR



RECTANGULAR HOLE

A rectangular hole has two "ℓ" dimensions. If one-inch side shown requires five fasteners, use five fasteners on *each* side of one-inch opening. If two-inch side requires ten fasteners, use ten fasteners on *each* side of two-inch opening.



NORMAL FASTENER DISTRIBUTION

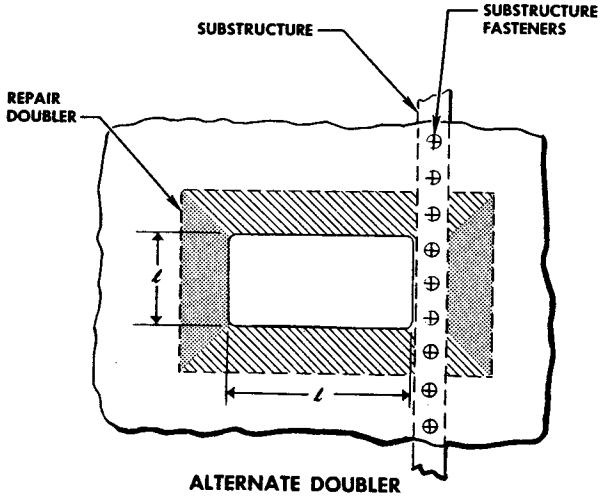
FASTENERS FOR 1 IN. SIDES.

FASTENERS FOR 2 IN. SIDES.

Divide area around hole as shown. Lay out fasteners in an approximately even pattern around hole. Watch minimum edge distance and minimum and maximum spacing.

The fastener pattern will determine size of repair doubler. Fasteners in filler may be the smallest structural-type rivet available.

See alternate fastener and doubler pattern.



ALTERNATE DOUBLER AND FASTENER PATTERN

This pattern is used when existing substructure fasteners are *not* counted in the number required for the repair.

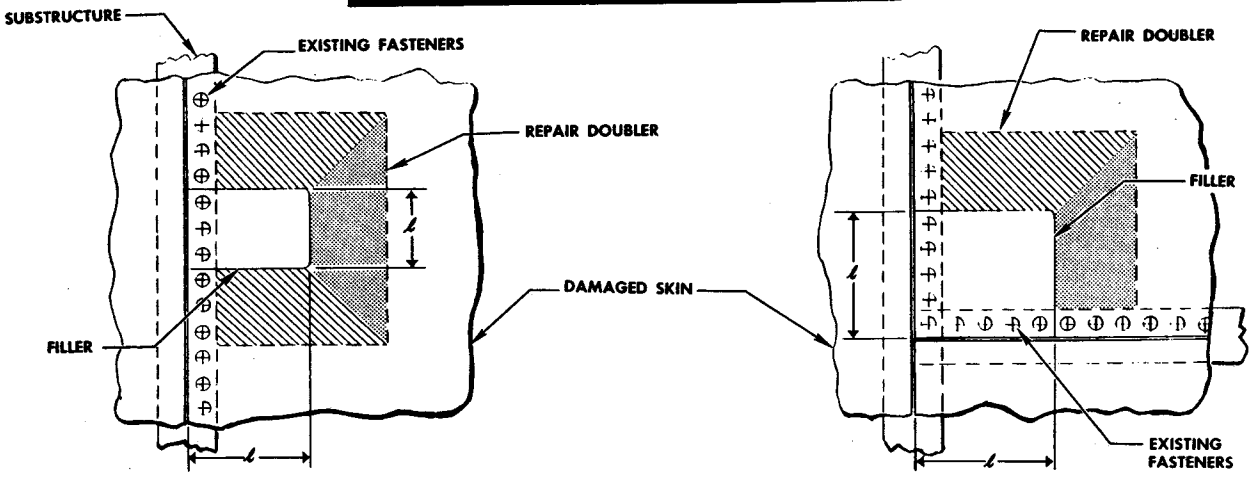
GEN-3-91-85A

Figure 2A-2. Fastener Distribution Patterns (Sheet 1 of 4)

SKIN AND WEB

TYPICAL REPAIR

VARIATIONS OF THE RECTANGULAR REPAIR

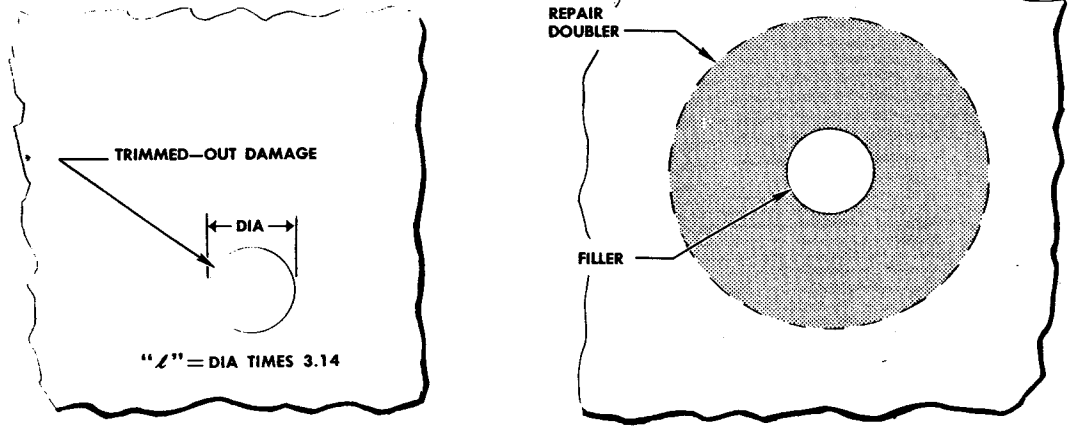


SKIN END REPAIR

SKIN END REPAIR—CORNER

Repairs to skin end are treated the same as rectangular repairs shown on sheet No. 1, except that skin attaching fasteners through the substructure are not counted in the fasteners required for the repair.

CIRCULAR REPAIR



A circular cutout has one "ℓ" dimension, which is the circumference of the hole. To find "ℓ," multiply the diameter by pi. (3.14)

Distribute fasteners required evenly around hole in shaded area (repair doubler).

Watch minimum edge distance and spacing. Fasteners in filler may be the smallest structural-type rivet available.

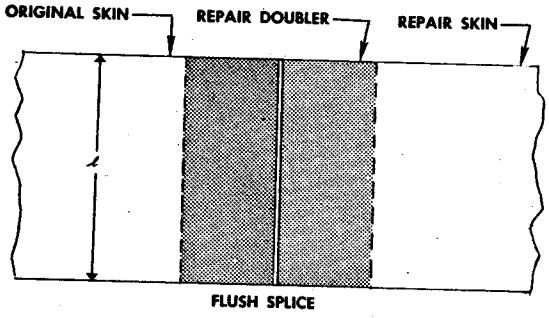
Gen-3-91-86

Figure 2A-2. Fastener Distribution Patterns (Sheet 2 of 4)

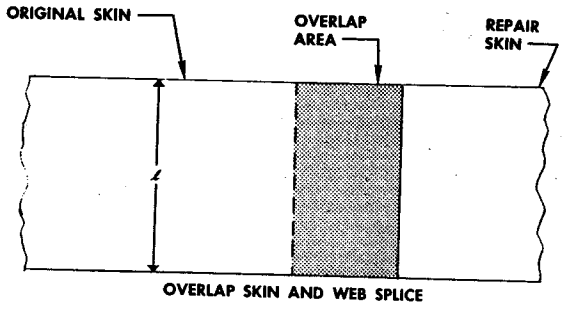
SKIN AND WEB

TYPICAL REPAIR

SPLICES

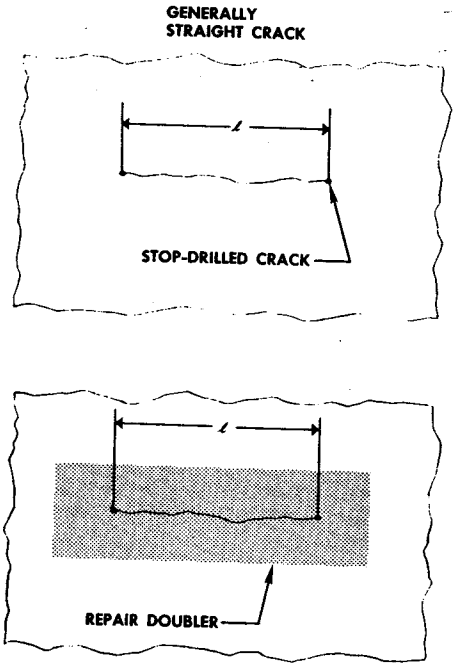


Distribute the number of fasteners required for "ℓ" evenly on each side of the splice. (If "ℓ" requires 24 fasteners, use 24 fasteners on each side of the splice.)



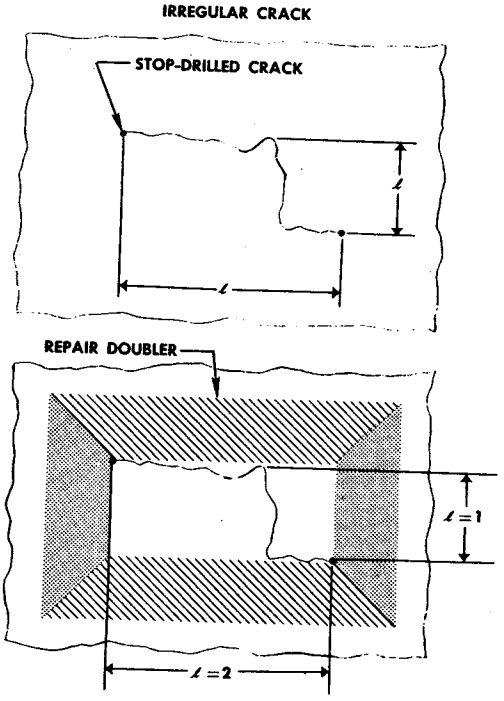
Required fasteners for "ℓ" are distributed evenly in the overlap area.

CRACKS



A crack which runs in a generally straight line can be considered to have one "ℓ" dimension.

If six rivets are required for "ℓ," distribute six rivets evenly through the doubler on each side of the crack.



A crack which deviates from a generally straight line should be treated as a rectangle with two "ℓ" dimensions.

Distribute rivets as shown and described for a rectangular repair.

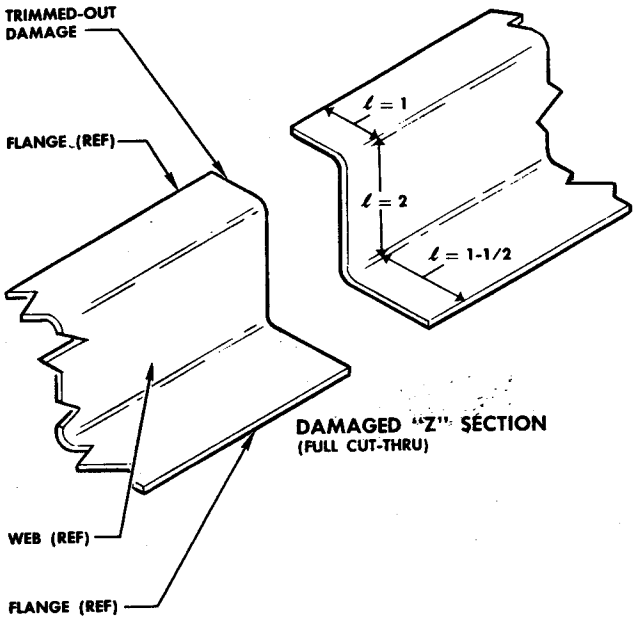
Use smallest structural-type rivets available to hold down irregular edges.

Gen-3-91-87

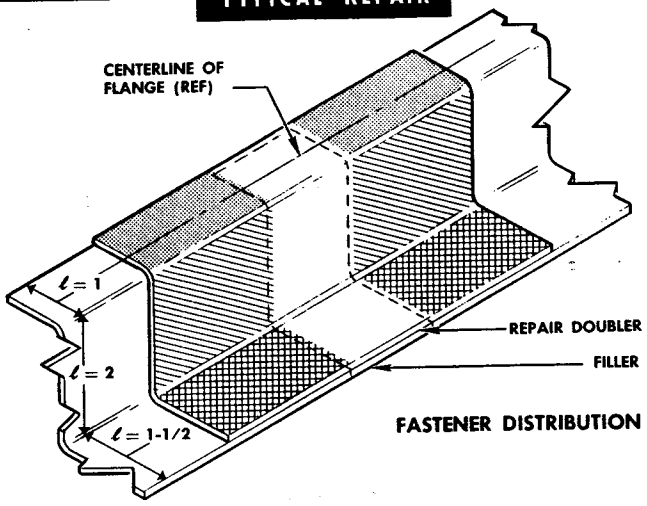
Figure 2A-2. Fastener Distribution Patterns (Sheet 3 of 4)

EXTRUDED AND FORMED SHAPES

TYPICAL REPAIR



DAMAGED "Z" SECTION
(FULL CUT-THRU)



FASTENER DISTRIBUTION

FASTENERS FOR 1-INCH FLANGE

FASTENER FOR 2-INCH WEB

FASTENERS FOR 1-1/2-INCH FLANGE

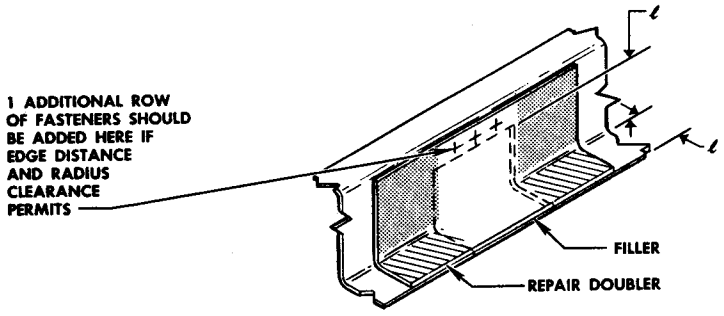
Each "ℓ" dimension shown is considered separately. If four fasteners are required for the one-inch flange, use four fasteners on each side of the one-inch opening. Repeat the calculations for the 2-inch web and the 1-1/2-inch flange. Distribute the fasteners as shown.

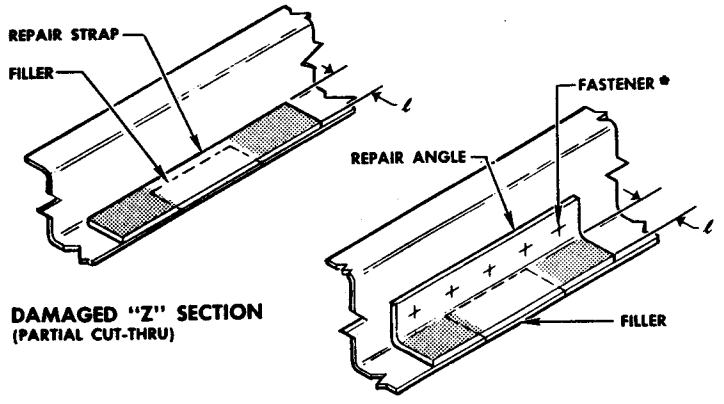
The fastener pattern should be similar on each side of the break.

When a flange has one row of fasteners, that row should be approximately on the centerline of the flange.

Observe minimum edge distance and minimum and maximum spacing.

Fasteners in the filler may be the smallest structural-type rivet available unless the filler is attached to a skin or web. In this case, fasteners should match those used in the repair.





DAMAGED "Z" SECTION
(PARTIAL CUT-THRU)

NOTE

The examples of fastener distribution shown apply to all other shapes for which typical repairs have been designed. Special fastener problems are noted on the repair figure.

*When an angle is used in repairing a partial flange damage, the fasteners attaching the repair angle to the undamaged portion of the shape are the same as those used in the remainder of the repair. The number required is determined by the length of the repair angle. Fastener spacing may be a maximum of 1-1/2 inches.

Gen-3-91-88

Figure 2A-2. Fastener Distribution Patterns (Sheet 4 of 4)

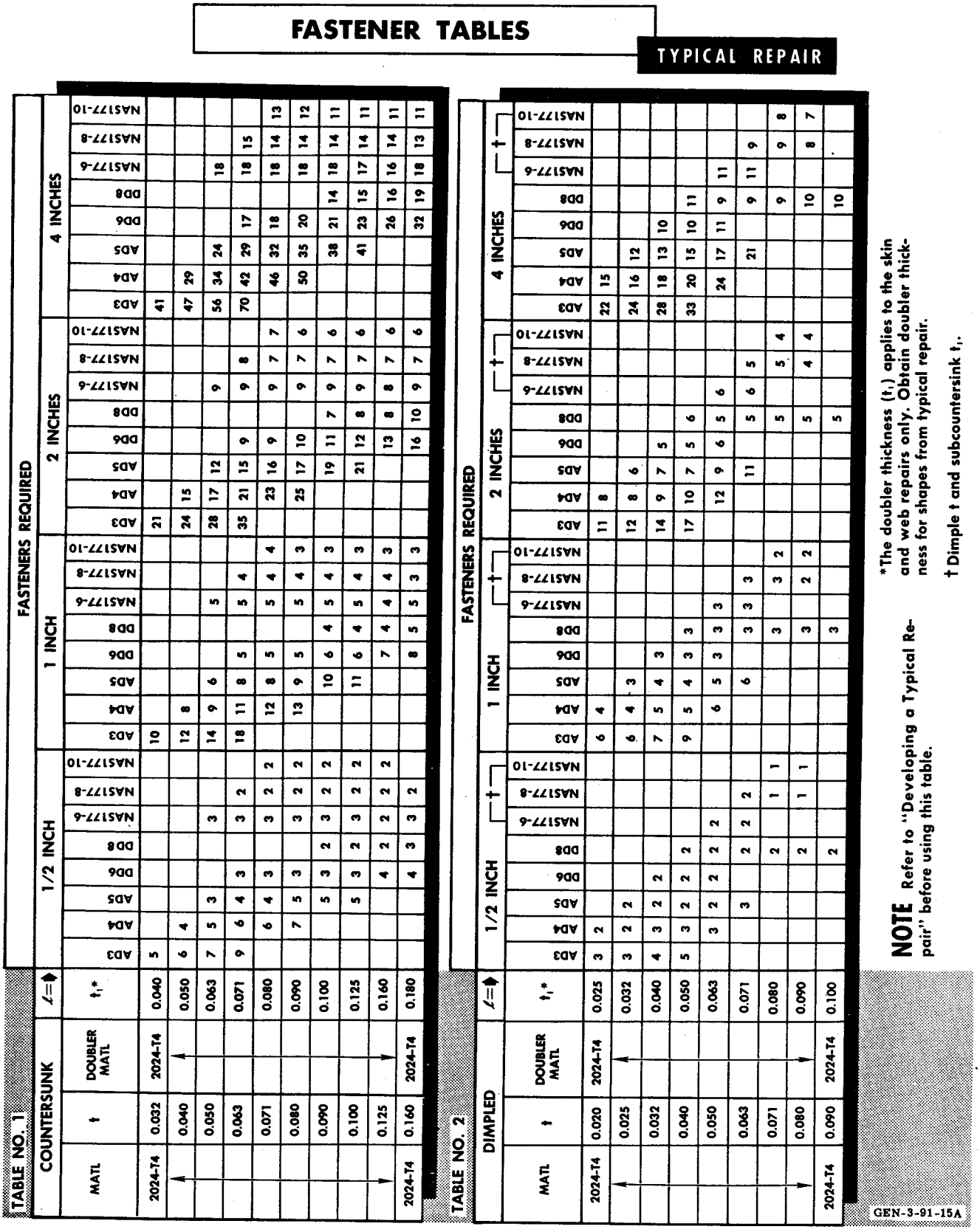


Figure 2A-3. Fastener Tables - Conventional and Hi-Shear, Flush, 2024-T4, Tension

FASTENER TABLES

TYPICAL REPAIR

TABLE NO. 1

MATL	t	DOUBLER MATL	∠=	t_1*	FASTENERS REQUIRED: 1/2 INCH											1 INCH											2 INCHES											4 INCHES										
					AD3	AD4	AD5	DD6	DD8	NAS177-6	NAS177-8	NAS177-10	AD3	AD4	AD5	DD6	DD8	NAS177-6	NAS177-8	NAS177-10	AD3	AD4	AD5	DD6	DD8	NAS177-6	NAS177-8	NAS177-10	AD3	AD4	AD5	DD6	DD8	NAS177-6	NAS177-8	NAS177-10	AD3	AD4	AD5	DD6	DD8	NAS177-6	NAS177-8	NAS177-10
2024-T4	0.032	2024-T4		0.040	4								7								13								25							
	0.040			0.050	4	3							7	5							15	9							29	18						
	0.050			0.063	5	3	2						9	6	4						17	11	8						34	21	15					
	0.063			0.071	6	4	3	2		2	2		11	7	5	3		3	3		22	13	9	6		6	5		43	26	18	11		11	9	
	0.071			0.080		4	3	2		2	2	1		7	5	3		3	3	2		14	10	6		6	5	4		28	20	11		11	9	8
	0.080			0.090		4	3	2		2	2	1		8	6	3		3	3	2		15	11	6		6	5	4		30	21	12		11	9	7
	0.090			0.100			3	2	2	2	1	1			6	4	3	3	2	2			12	7	5	6	4	4			23	13	9	11	8	7
	0.100			0.125			4	2	2	2	2	1			7	4	3	3	3	2			13	7	5	5	5	4			25	14	9	10	9	7
	0.125			0.160				2	2	2	1	1				4	3	3	2	2				8	5	5	4	4				16	10	10	8	7
2024-T4	0.160	2024-T4		0.190				3	2	2	1	1				5	3	3	2	2				10	6	6	4	4				19	12	11	8	7

TABLE NO. 2

MATL	t	DOUBLER MATL	∠=	t_1*	FASTENERS REQUIRED: 1/2 INCH											1 INCH											2 INCHES											4 INCHES										
					AD3	AD4	AD5	DD6	DD8	NAS177-6	NAS177-8	NAS177-10	AD3	AD4	AD5	DD6	DD8	NAS177-6	NAS177-8	NAS177-10	AD3	AD4	AD5	DD6	DD8	NAS177-6	NAS177-8	NAS177-10	AD3	AD4	AD5	DD6	DD8	NAS177-6	NAS177-8	NAS177-10	AD3	AD4	AD5	DD6	DD8	NAS177-6	NAS177-8	NAS177-10
2024-T4	0.020	2024-T4		0.025	2	2							4	3							7	5							13	10						
	0.025			0.032	2	2	1						4	3	2						8	5	4						15	10	8					
	0.032			0.040	3	2	1	1					5	3	2	2					9	6	4	3					17	11	8	6				
	0.040			0.050	3	2	2	1	1				5	3	3	2	2				10	6	5	3	4				20	12	9	6	7			
	0.050			0.063		2	2	1	1	1				4	3	2	2	2				8	5	4	3					15	10	7	6	7		
	0.063			0.071			2		1	1	1				4		2	2	2				7		3	4	3				13		6	7	6	
	0.071			0.080					1		1	1					2		2	2					3		3	3					6		6	5
	0.080			0.090					1		1	1					2		2	2					3		3	3					6		5	5
2024-T4	0.090	2024-T4		0.100					1								2								4								7			

NOTE Refer to "Developing a Typical Repair" before using this table.

*The doubler thickness (t_1) applies to the skin and web repairs only. Obtain doubler thickness for shapes from typical repair.

†Dimple t and subcountersink t_1.

GEN-3-91-16A

Figure 2A-4. Fastener Tables - Conventional and Hi-Shear, Flush, 2024-T4, Shear

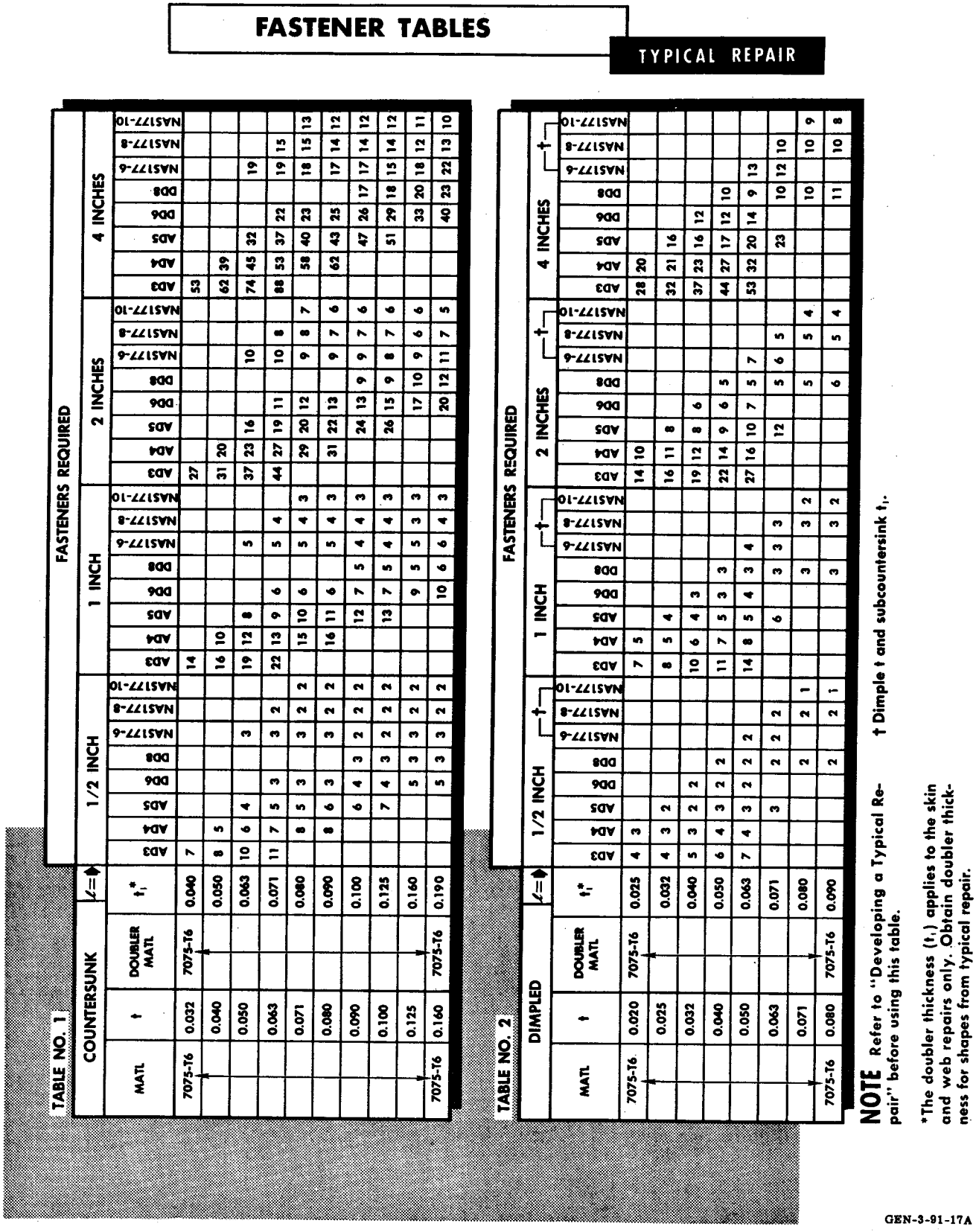


Figure 2A-5. Fastener Tables - Conventional and Hi-Shear, Flush, 7075-T6, Tension

FASTENER TABLES

TYPICAL REPAIR

TABLE NO. 1

COUNTERSUNK MATL	t	DOUBLER MATL	ℓ=	t_1*	FASTENERS REQUIRED: 1/2 INCH AD3	AD4	AD5	DD6	DD8	NAS177-6	NAS177-8	NAS177-10	1 INCH AD3	AD4	AD5	DD6	DD8	NAS177-6	NAS177-8	NAS177-10	2 INCHES AD3	AD4	AD5	DD6	DD8	NAS177-6	NAS177-8	NAS177-10	4 INCHES AD3	AD4	AD5	DD6	DD8	NAS177-6	NAS177-8	NAS177-10
7075-T6	0.032	7075-T6	0.040		4								8								16								32							
	0.040		0.050		5	3							10	6							19	12							37	23						
	0.050		0.063		6	4	3						11	7	5						22	14	10						44	27	19					
	0.063		0.071		7	4	3	2					13	8	6	4					27	16	11	7					53	31	22	13				
	0.071		0.080			5	3	2						9	6	4						17	12	7						34	24	14				
	0.080		0.090			5	4	2						10	7	4						19	13	8						37	26	15				
	0.090		0.100				4	2	2						7	4	3						14	8	6	5					28	16	11	10	9	7
	0.100		0.125				4	3	2	2					8	5	3	3	2	2			15	9	6	5	4	4			31	17	11	9	8	7
	0.125		0.160					3	2	2	1	1				5	3	3	2	2				10	6	6	4	4				20	12	11	7	7
	0.160	7075-T6	0.190					3	2	2	1	1				6	4	4	2	2				12	7	7	4	3				24	14	13	8	6

TABLE NO. 2

DIMPLED MATL	t	DOUBLER MATL	ℓ=	t_1*	FASTENERS REQUIRED: 1/2 INCH AD3	AD4	AD5	DD6	DD8	NAS177-6	NAS177-8	NAS177-10	1 INCH AD3	AD4	AD5	DD6	DD8	NAS177-6	NAS177-8	NAS177-10	2 INCHES AD3	AD4	AD5	DD6	DD8	NAS177-6	NAS177-8	NAS177-10	4 INCHES AD3	AD4	AD5	DD6	DD8	NAS177-6	NAS177-8	NAS177-10
7075-T6	0.020	7075-T6	0.025		3	2							5	3							9	6							17	12						
	0.025		0.032		3	2	2						5	4	3						10	7	5						19	13	10					
	0.032		0.040		3	2	2	1					6	4	3	2					11	7	5	4					22	14	10	8				
	0.040		0.050		4	2	2	1	1				7	4	3	2	2				13	8	6	4	3				26	16	11	8	6			
	0.050		0.063		4	3	2	1	1	1			8	5	3	2	2	2			16	10	6	4	3	4			32	19	12	8	6	8		
	0.063		0.071			2		1	1	1	1			4		2	2	2	2				7		3	4	3				14		6	7	6	
	0.071		0.080					1		1	1	1				2		2	2	2				3		3	3					6		6	6	5
7075-T6	0.160	7075-T6	0.090					1		1	1	1				2		2	2	2				4		3	3					7		6	5	

NOTE Refer to "Developing a Typical Repair" before using this table.

*The doubler thickness (t_1) applies to the skin and web repairs only. Obtain doubler thickness for shapes from typical repair.

† Dimple t and subcountersink t_1.

GEN-3-91-18A

Figure 2A-6. Fastener Tables - Conventional and Hi-Shear, Flush, 7075-T6, Shear

FASTENER TABLES

TYPICAL REPAIR

TABLE NO. 1

SINGLE SHEAR				FASTENERS REQUIRED																	
				1/2 INCH					1 INCH					2 INCHES					4 INCHES				
MATL	t	DOUBLER MATL	t_1*	AD3	AD4	AD5	DD6	DD8	AD3	AD4	AD5	DD6	DD8	AD3	AD4	AD5	DD6	DD8	AD3	AD4	AD5	DD6	DD8
2024-T4	0.020	2024-T4	0.025	4					7					14					27				
	0.025		0.032	4	3				7	5				14	10				27	20			
	0.032		0.040	5	3	2			9	5	4			17	10	8			33	20	16		
	0.040		0.050	6	3	2	2		11	6	4	4		21	12	8	7		42	24	16	14	
	0.050		0.063	7	4	3	2	2	14	8	5	4	3	27	15	10	7	5	53	30	20	14	10
	0.063		0.071		5	4	2	2		10	7	4	3		20	13	7	6		39	26	14	10
	0.071		0.080		6	4	2	2		11	8	4	3		22	15	8	6		44	29	15	10
	0.080		0.090			5	3	2			9	5	3			16	9	6			32	17	10
	0.090		0.100				3	2				5	3				10	6				19	11
2024-T4	0.100	2024-T4	0.125					2					3					6					12
DOUBLE SHEAR																							
2024-T4	0.032	2024-T4	0.025	4					7					14					27				
	0.040		0.032	4	3				7	5				14	10				27	20			
	0.050		0.040	4	3	2			7	5	4			14	10	8			28	20	16		
	0.063		0.050	5	3	3			9	6	5			18	11	9			35	21	17		
	0.071		0.063		3	3	2			6	5	4			12	9	7			23	17	14	
	0.080		0.071		4	3	2			7	5	4			13	9	7			25	17	14	
	0.090		0.080			3	2	2			5	4	3			10	7	6			19	14	10
	0.100		0.090			3	2	2			6	4	3			11	7	6			21	14	10
	0.125		0.100				2	2				4	3				7	6				14	10
2024-T4	0.160	2024-T4	0.125				2	2				4	3				8	6				16	10

TABLE NO. 2

SINGLE SHEAR				FASTENERS REQUIRED																	
				1/2 INCH					1 INCH					2 INCHES					4 INCHES				
MATL	t	DOUBLER MATL	t_1*	AD3	AD4	AD5	DD6	DD8	AD3	AD4	AD5	DD6	DD8	AD3	AD4	AD5	DD6	DD8	AD3	AD4	AD5	DD6	DD8
7075-T6	0.020	7075-T6	0.025	4					8					15					29				
	0.025		0.032	5	3				9	6				18	11				35	21			
	0.032		0.040	6	4	3			11	7	5			22	13	9			43	25	17		
	0.040		0.050	7	4	3	2		14	8	6	3		28	16	11	6		55	31	21	11	
	0.050		0.063	9	5	4	2	2	18	10	7	4	3	35	20	13	7	5	70	39	26	14	9
	0.063		0.071		7	4	2	2		13	8	4	3		25	16	8	5		49	32	16	10
	0.071		0.080		7	5	3	2		14	9	5	3		28	18	9	6		55	36	19	11
	0.080		0.090			6	3	2			10	6	3			21	11	6			41	21	12
	0.090		0.100					2					4					7					13
7075-T6	0.100	7075-T6	0.125					2					4					8					15
DOUBLE SHEAR																							
7075-T6	0.025	7075-T6	0.020	3	2				6	4				12	8				24	16			
	0.032		0.025	4	3	2			7	5	4			14	9	7			27	18	13		
	0.040		0.032	4	3	2			8	5	4			16	10	8			31	20	15		
	0.050		0.040	5	3	2	2		10	6	4	3		19	12	8	6		37	23	16	11	
	0.063		0.050	6	4	3	2		11	7	5	3		22	14	9	6		44	27	18	11	
	0.071		0.063		4	3	2	2		8	5	3	3		15	10	6	5		29	20	11	9
	0.080		0.071		4	3	2	2		8	6	3	3		16	11	6	5		31	22	12	9
	0.090		0.080		5	3	2	2		9	6	4	3		18	12	7	5		35	24	13	9
	0.100		0.090			4	2	2			7	4	3			13	7	5			26	14	9
	0.125		0.100			4	2	2			8	4	3			16	8	5			31	16	10
7075-T6	0.160	7075-T6	0.125					2					3					6					11

NOTE Refer to "Developing a Typical Repair" before using this table.

*The doubler thickness (t_1) applies to the skin and web repairs only. Obtain doubler thickness for shapes from typical repair.

GEN-3-91-19A

Figure 2A-7. Fastener Tables- Conventional, Protruding Head, 2024-T4 and 7075-T6, Tension

FASTENER TABLES

TYPICAL REPAIR

TABLE NO. 1

SINGLE SHEAR			ℓ=	FASTENERS REQUIRED																				
				1/2 INCH					1 INCH					2 INCHES					4 INCHES				
MATL	t	DOUBLER MATL	t_1*	AD3	AD4	AD5	DD6	DD8	AD3	AD4	AD5	DD6	DD8	AD3	AD4	AD5	DD6	DD8	AD3	AD4	AD5	DD6	DD8
2024-T4	0.020	2024-T4	0.025	2					4					8					16				
	0.025		0.032	3	2				5	3				9	6				17	12			
	0.032		0.040	3	2	2			5	3	3			10	6	5			20	12	10		
	0.040		0.050	4	2	2	2		7	4	3	3		13	7	5	5		26	14	10	8	
	0.050		0.063	4	3	2	2	1	8	5	3	3	2	16	9	6	5	3	32	18	12	8	6
	0.063		0.071		3	2	2	1		6	4	3	2		12	8	5	4		24	16	9	7
	0.071		0.080		4	3	2	1		7	5	3	2		14	9	5	4		27	18	9	7
	0.080		0.090			3	2	1			5	3	2			10	5	4			20	10	7
	0.090		0.100				2	1				3	2				6	4				12	7
2024-T4	0.100	2024-T4	0.125					1					2					4					7
DOUBLE SHEAR																							
2024-T4	0.032	2024-T4	0.025	2					4					8					16				
	0.040		0.032	2	2				4	3				8	6				16	12			
	0.050		0.040	3	2	2			5	3	3			9	6	5			17	12	10		
	0.063		0.050	3	2	2			6	4	3			11	7	5			22	13	10		
	0.071		0.063		2	2	2			4	3	3			7	5	5			14	10	9	
	0.080		0.071		2	2	2			4	3	3			8	6	5			15	11	9	
	0.090		0.080			2	2	1			3	3	2			6	5	4			12	9	7
	0.100		0.090			2	2	1			4	3	2			7	5	4			13	9	7
	0.125		0.100				2	1				3	2				5	4				9	7
2024-T4	0.160	2024-T4	0.125				2	1				3	2				5	4				10	7

TABLE NO. 2

SINGLE SHEAR			ℓ=	FASTENERS REQUIRED																				
				1/2 INCH					1 INCH					2 INCHES					4 INCHES				
MATL	t	DOUBLER MATL	t_1*	AD3	AD4	AD5	DD6	DD8	AD3	AD4	AD5	DD6	DD8	AD3	AD4	AD5	DD6	DD8	AD3	AD4	AD5	DD6	DD8
7075-T6	0.020	7075-T6	0.025	3					5					9					18				
	0.025		0.032	3	2				6	4				11	7				21	13			
	0.032		0.040	4	2	2			7	4	3			13	8	6			26	15	11		
	0.040		0.050	5	3	2	1		9	5	4	2		17	10	7	4		33	19	13	7	
	0.050		0.063	6	3	2	1	1	11	6	4	2	2	21	12	8	4	3	42	24	16	8	5
	0.063		0.071		4	3	2	1		8	5	3	2		15	10	5	3		29	19	10	6
	0.071		0.080		5	3	2	1		9	6	3	2		17	11	6	4		33	22	11	7
	0.080		0.090			3	2	1			6	4	2			12	7	4			24	13	7
	0.090		0.100					1					2					4					8
7075-T6	0.100	7075-T6	0.125					2					3					5					9
DOUBLE SHEAR																							
7075-T6	0.025	7075-T6	0.020	2	2				4	3				8	5				15	10			
	0.032		0.025	2	2	1			4	3	2			8	6	4			16	11	8		
	0.040		0.032	3	2	2			5	3	3			10	6	5			18	12	9		
	0.050		0.040	3	2	2	1		6	4	3	2		11	7	5	4		22	14	10	7	
	0.063		0.050	4	2	2	1		7	4	3	2		13	8	6	4		26	16	11	7	
	0.071		0.063		3	2	1	1		5	3	2	2		9	6	4	3		17	12	7	5
	0.080		0.071		3	2	1	1		5	4	2	2		10	7	4	3		19	13	7	5
	0.090		0.080		3	2	1	1		6	4	2	2		11	7	4	3		21	14	8	5
	0.100		0.090			2	1	1			4	2	2			8	4	3			15	8	5
	0.125		0.100			3	2	1			5	3	2			10	5	3			19	10	6
7075-T6	0.160	7075-T6	0.125					1					2					4					7

NOTE Refer to "Developing a Typical Repair" before using this table.

*The doubler thickness (t_1) applies to the skin and web repairs only. Obtain doubler thickness for shapes from typical repair.

GEN-3-91-20A

Figure 2A-8. Fastener Tables - Conventional, Protruding Head, 2024-T4 and 7075-T6, Shear

FASTENER TABLES

TYPICAL REPAIR

TABLE NO. 1

SINGLE SHEAR	ℓ=	1/2 INCH					1 INCH					2 INCHES					4 INCHES				
MATL	t	AD3	AD4	AD5	DD6	DD8	AD3	AD4	AD5	DD6	DD8	AD3	AD4	AD5	DD6	DD8	AD3	AD4	AD5	DD6	DD8
2024-T4	0.040	6	4	3	2		11	7	5	3		23	13	9	6		45	25	17	12	
	0.051	7	4	3	2	2	15	8	6	3	3	29	16	11	6	5	57	32	21	12	9
	0.062	9	5	4	2	2	18	10	7	4	3	35	20	13	7	5	69	39	25	13	9
	0.064		5	4	2	2		10	7	4	3		20	13	7	5		40	26	14	9
	0.078			4		2			8		3			16		5			32		9
	0.094					2					3					6					11
	0.100					2					3					6					12
2024-T4	0.125					2					4					8					15
DOUBLE SHEAR																					
2024-T4	0.040	4	3	2			7	5	4			13	9	7			25	17	14		
	0.051	4	3	2			8	5	4			15	10	7			30	19	14		
	0.062	5	3	2	2		9	6	4	3		18	11	8	6		35	21	15	12	
	0.064	5	3	2	2		9	6	4	3		18	11	8	6		36	22	15	12	
	0.078	6	4	3	2	2	11	7	5	3	3	22	13	9	6	5	44	25	17	12	9
	0.094		4	3	2	2		8	5	3	3		15	10	6	5		30	20	12	9
	0.100		4	3	2	2		8	6	3	3		16	11	6	5		31	21	12	9
	0.125		5	4	2	2		10	7	4	3		20	13	7	5		39	26	13	9
2024-T4	0.156			4	2	2			8	4	3			16	8	5			32	16	9

TABLE NO. 2

SINGLE SHEAR	ℓ=	1/2 INCH					1 INCH					2 INCHES					4 INCHES				
MATL	t	AD3	AD4	AD5	DD6	DD8	AD3	AD4	AD5	DD6	DD8	AD3	AD4	AD5	DD6	DD8	AD3	AD4	AD5	DD6	DD8
7075-T6	0.040		5	3	2			9	6	4			17	12	7			34	23	13	
	0.051		6	4	2	2		11	7	4	3		22	14	8	5		43	28	15	10
	0.062		7	5	3	2		13	9	5	3		26	17	9	5		52	34	17	10
	0.064		7	5	3	2		14	9	5	3		27	18	9	5		53	35	18	10
	0.078			6	3	2			11	6	3			21	11	6			42	22	12
	0.094					2					4					8					15
7075-T6	0.100					2					4					8					16
DOUBLE SHEAR																					
7075-T6	0.040	5	3	2	2		9	6	4	4		17	11	8	7		33	21	16	13	
	0.051	5	4	3	2	2	10	7	5	4	3	20	13	9	7	5	40	25	18	13	10
	0.062	6	4	3	2	2	12	7	5	4	3	23	14	10	7	5	46	28	20	13	10
	0.064	6	4	3	2	2	12	8	5	4	3	24	15	10	7	5	48	29	20	13	10
	0.078		5	3	2	2		9	6	4	3		17	12	7	5		33	23	13	10
	0.094		5	4	2	2		10	7	4	3		20	13	7	5		39	26	14	10
	0.100		6	4	2	2		11	7	4	3		21	14	8	5		42	28	15	10
	0.125			5	3	2			9	5	3			17	9	6			34	17	11
	0.156			6	3	2			11	6	3			21	11	6			42	22	12
7075-T6	0.188					2					4					8					15

NOTE Refer to "Developing a Typical Repair" before using this table.

GEN-3-91-21A

Figure 2A-9. Fastener Tables - Conventional, Protruding Head, Extrusions, Tension

FASTENER TABLES

TYPICAL REPAIR

TABLE NO. 1

SINGLE SHEAR—BRAZIER HEAD

1/2 HARD CRES				FASTENERS REQUIRED											
			ℓ=	1/2 IN.			1 IN.			2 IN.			4 IN.		
MATL	t	DOUBLER MATL	t_1*	AT4	AT5	AT6	AT4	AT5	AT6	AT4	AT5	AT6	AT4	AT5	AT6
CRES	0.010	CRES	0.016	4	3	3	7	6	5	14	11	9	27	22	18
↑	0.016	↑	0.020	4	3	3	7	6	5	14	11	9	27	22	18
	0.020		0.025	4	3	3	7	6	5	14	11	9	27	22	18
	0.025		0.032	4	3	3	7	6	5	14	11	9	27	22	18
	0.032		0.036	4	3	3	8	6	5	16	11	9	31	22	18
	0.036		0.040	5	3	3	9	6	5	17	12	9	34	23	18
	0.040		0.045	5	4	3	10	7	5	19	13	9	38	26	18
	0.045		0.050	6	4	3	11	7	5	21	14	10	42	28	20
	0.050		0.063	6	4	3	12	8	6	24	16	11	47	31	22
	0.063		0.071	8	5	4	15	10	7	30	19	14	59	38	27
↓	0.071	↓	0.080		6	4		11	8		22	15		43	30
CRES	0.080	CRES	0.090		6	5		13	9		25	17		49	34

TABLE NO. 3

SINGLE SHEAR—FLUSH HEAD (COUNTERSUNK)

1/2 HARD CRES				FASTENERS REQUIRED							
			ℓ=	1/2		1 IN.		2 IN.		4 IN.	
MATL	t	DOUBLER MATL	t_1*	BF6		BF6		BF6		BF6	
CRES	0.063	CRES	0.071	6		11		22		44	
↑	0.071	↑	0.080	6		12		23		46	
	0.080		0.090	7		13		25		49	
	0.090		0.100	7		14		27		53	
	0.100		0.125	8		15		29		57	
↓	0.125	↓	0.160	9		17		34		67	
CRES	0.160	CRES	0.190	10		20		40		80	

TABLE NO. 2

DOUBLE SHEAR—BRAZIER HEAD

1/2 HARD CRES				FASTENERS REQUIRED											
			ℓ=	1/2 IN.			1 IN.			2 IN.			4 IN.		
MATL	t	DOUBLER MATL	t_1*	AT4	AT5	AT6	AT4	AT5	AT6	AT4	AT5	AT6	AT4	AT5	AT6
CRES	0.020	CRES	0.025	4			7			13			25		
↑	0.025	↑	0.032	3	3		6	5		12	10		24	20	
	0.032		0.036	3	3	2	6	5	4	12	10	8	24	19	16
	0.036		0.040	3	3	2	6	5	4	12	10	8	24	19	16
	0.040		0.045	3	3	2	6	5	4	12	10	8	24	19	16
	0.045		0.050	4	3	2	7	5	4	13	10	8	25	19	16
	0.050		0.063	4	3	2	7	5	4	14	10	8	27	20	16
	0.063		0.071	4	3	3	8	6	5	16	11	9	31	22	17
	0.071		0.080	5	3	3	9	6	5	17	12	9	34	24	18
↓	0.080		0.090	5	4	3	10	7	5	19	13	10	38	26	19
CRES	0.090	CRES	0.100	6	4	3	11	7	6	21	14	11	42	28	21

TABLE NO. 4

SINGLE SHEAR—BRAZIER HEAD (BLIND MONEL RIVETS)

1/2 HARD CRES				FASTENERS REQUIRED											
			ℓ=	1/2 IN.			1 IN.			2 IN.			4 IN.		
MATL	t	DOUBLER MATL	t_1*	1/8	5/32	3/16	1/8	5/32	3/16	1/8	5/32	3/16	1/8	5/32	3/16
CRES	0.020	CRES	0.025	4			8			16			32		
↑	0.025	↑	0.032	5	4		9	7		17	14		33	27	
	0.032		0.040	5	4	3	9	7	6	18	14	11	36	27	22
	0.040		0.050	6	4	3	11	8	6	21	15	12	41	30	23
↓	0.050	↓	0.063	6	5	4	13	9	7	25	17	13	49	34	26
CRES	0.063	CRES	0.071		5	4		10	8		20	15		39	29

NOTE Refer to "Developing a Typical Repair" before using this table.

- "AT" designates NAS508M rivets;
- "BF" designates AN427M rivets.

*The doubler thickness (t_1) applies to the skin and web repairs only. Obtain doubler thickness for shapes from typical repair.

GEN-3-91-22A

Figure 2A-10. Fastener Tables - Flush, Protruding Head and Blind, 1/2 Hard CRES, Tension

FASTENER TABLES

TYPICAL REPAIR

TABLE NO. 1

COUNTERSUNK				RIVETS REQUIRED											
			∠=	1/2 INCH			1 INCH			2 INCHES			4 INCHES		
MATL	t	DOUBLER MATL	t_1*	AF462-4	AF462-5	AF462-6	AF462-4	AF462-5	AF462-6	AF462-4	AF462-5	AF462-6	AF462-4	AF462-5	AF462-6
2024-T4	0.032	2024-T4	0.040												
	0.040		0.050	7			13			25			50		
	0.050		0.063	6	6		12	11		24	21		48	42	
	0.063		0.071	6	5	11	12	10	21	24	19	42	48	38	
2024-T4	0.071	2024-T4	0.080	6	5	5	12	10	10	24	19	19	48	38	38
DIMPLED															
2024-T4	0.025	2024-T4	0.032	4	3		8	7		15	12		29	25	
	0.032		0.040	4	3	3	8	6	5	16	12	10	31	23	20
	0.040		0.050	5	3	3	9	6	5	17	12	10	34	23	19
	0.050		0.063	5	4	3	10	7	5	20	13	10	40	26	20
	0.063		0.071		4	3		8	6		16	12		32	24
	0.071		0.080			4			7			13			26
2024-T4	0.080	2024-T4	0.090			4			7			14			28

NOTE Refer to "Developing a Typical Repair" before using this table.

*The doubler thickness (t_1) applies to the skin and web repairs only. Obtain doubler thickness for shapes from typical repair.

TABLE NO. 2

COUNTERSUNK				RIVETS REQUIRED											
			∠=	1/2 INCH			1 INCH			2 INCHES			4 INCHES		
MATL	t	DOUBLER MATL	t_1*	AF462-4	AF462-5	AF462-6	AF462-4	AF462-5	AF462-6	AF462-4	AF462-5	AF462-6	AF462-4	AF462-5	AF462-6
7075-T6	0.032	7075-T6	0.040												
	0.040		0.050	9			17			33			66		
	0.050		0.063	8	7		15	14		30	28		60	55	
	0.063		0.071	8	6	13	15	12	26	30	24	52	59	48	
7075-T6	0.071	7075-T6	0.080	8	6	6	15	12	12	30	24	24	60	47	48
DIMPLED															
7075-T6	0.025	7075-T6	0.032	5	4		10	8		19	16		38	32	
	0.032		0.040	5	4	4	10	8	7	20	15	13	40	30	25
	0.040		0.050	6	4	4	12	8	7	23	16	13	45	31	25
	0.050		0.063	7	5	4	13	9	7	26	18	14	52	35	27
	0.063		0.071		5	4		10	8		20	15		40	30
	0.071		0.080			4			9			17			33
7075-T6	0.080	7075-T6	0.090			5			9			18			35

TABLE NO. 3

CR-562 MONEL RIVETS COUNTERSUNK				RIVETS REQUIRED											
			∠=	1/2 INCH			1 INCH			2 INCHES			4 INCHES		
MATL	t	DOUBLER MATL	t_1*	CR562-4	CR562-5	CR562-6	CR562-4	CR562-5	CR562-6	CR562-4	CR562-5	CR562-6	CR562-4	CR562-5	CR562-6
7075-T6	0.040	7075-T6	0.050	5			10			19			38		
	0.050		0.063	5	4		10	8		20	16		39	31	
	0.063		0.071	5	4	4	10	8	7	20	16	13	40	32	26
	0.071		0.080	6	4	4	11	8	7	21	16	13	42	32	26
	0.080		0.090	6	5	4	11	9	7	22	17	14	44	33	27
	0.090		0.100	6	5	4	12	9	7	24	17	14	47	34	27
	0.100		0.125	7	5	4	13	9	7	25	19	14	50	37	28
7075-T6	0.125	7075-T6	0.160	7	5	4	14	10	8	28	20	16	56	40	31

GEN-3-91-23A

Figure 2A-11. Fastener Tables - Cherry, Flush, 2024-T4 and 7075-T6, Tension

FASTENER TABLES

TYPICAL REPAIR

TABLE NO. 1

COUNTERSUNK				RIVETS REQUIRED											
			ℓ=	1/2 INCH			1 INCH			2 INCHES			4 INCHES		
MATL	t	DOUBLER MATL	t_1*	AF462-4	AF462-5	AF462-6	AF462-4	AF462-5	AF462-6	AF462-4	AF462-5	AF462-6	AF462-4	AF462-5	AF462-6
2024-T4	0.040	2024-T4	0.050	4			8			15			30		
↕	0.050	↕	0.063	4	4		7	7		14	13		28	25	
	0.063		0.071	4	3	7	8	6	13	15	12	26	29	23	51
2024-T4	0.071	2024-T4	0.080	4	3	3	8	6	6	15	12	12	29	23	23
DIMPLED															
2024-T4	0.025	2024-T4	0.032	3	2		5	4		9	8		18	15	
↕	0.032	↕	0.040	3	2	2	5	4	3	10	7	6	19	14	12
	0.040		0.050	3	2	2	6	4	3	11	7	6	21	14	12
	0.050		0.063	3	2	2	6	4	4	12	8	7	24	16	12
	0.063		0.071		3	2		5	4		10	8		20	15
	0.071		0.080			2			4			8			16
2024-T4	0.080	2024-T4	0.090			3			5			9			18

NOTE Refer to "Developing a Typical Repair" before using this table.

*The doubler thickness (t_1) applies to the skin and web repairs only. Obtain doubler thickness for shapes from typical repair.

TABLE NO. 2

COUNTERSUNK				RIVETS REQUIRED											
			ℓ=	1/2 INCH			1 INCH			2 INCHES			4 INCHES		
MATL	t	DOUBLER MATL	t_1*	AF462-4	AF462-5	AF462-6	AF462-4	AF462-5	AF462-6	AF462-4	AF462-5	AF462-6	AF462-4	AF462-5	AF462-6
7075-T6	0.032	7075-T6	0.040												
↕	0.040	↕	0.050	5			10			20			39		
	0.050		0.063	5	5		9	9		18	17		36	33	
	0.063		0.071	5	4	8	9	8	16	18	15	31	35	29	62
7075-T6	0.071	7075-T6	0.080	5	4	4	9	7	8	18	14	15	36	28	29
DIMPLED															
7075-T6	0.025	7075-T6	0.032	3	3		6	5		12	10		23	19	
↕	0.032	↕	0.040	3	3	2	6	5	4	12	9	8	24	18	15
	0.040		0.050	4	3	2	7	5	4	14	10	8	27	19	15
	0.050		0.063	4	3	2	8	6	4	16	11	8	31	21	16
	0.063		0.071		3	3		6	5		12	9		24	18
	0.071		0.080			3			5			10			20
7075-T6	0.080	7075-T6	0.090			3			6			11			21

TABLE NO. 3

COUNTERSUNK				RIVETS REQUIRED											
			ℓ=	1/2 INCH			1 INCH			2 INCHES			4 INCHES		
MATL	t	DOUBLER MATL	t_1*	CR562-4	CR562-5	CR562-6	CR562-4	CR562-5	CR562-6	CR562-4	CR562-5	CR562-6	CR562-4	CR562-5	CR562-6
7075-T6	0.040	7075-T6	0.050	3			6			12			22		
↕	0.050	↕	0.063	3	3		6	5		12	9		24	18	
	0.063		0.071	3	3	2	6	5	4	12	10	8	24	19	15
	0.071		0.080	4	3	2	7	5	4	13	10	8	25	19	16
	0.080		0.090	4	3	2	7	5	4	14	10	8	27	20	16
	0.090		0.100	4	3	3	7	6	5	14	11	9	28	21	16
	0.100		0.125	4	3	3	8	6	5	15	11	9	30	22	17
7075-T6	0.125	7075-T6	0.160	5	3	3	9	6	5	17	12	10	33	24	19

GEN-3-91-24A

Figure 2A-12. Fastener Tables - Cherry, Flush, 2024-T4 and 7075-T6, Shear

FASTENER TABLES

TYPICAL REPAIR

TABLE NO. 1

TENSION			ℓ=	FASTENERS REQUIRED - PROTRUDING HEAD															
				1/2 INCH				1 INCH				2 INCHES				4 INCHES			
MATL	t	DOUBLER MATL	t_1*	NAS178-6 AN3	NAS178-8 AN4	NAS178-10 AN5	NAS178-12 AN6	NAS178-6 AN3	NAS178-8 AN4	NAS178-10 AN5	NAS178-12 AN6	NAS178-6 AN3	NAS178-8	NAS178-10 AN5	NAS178-12 AN6	NAS178-6 AN3	NAS178-8 AN4	NAS178-10 AN5	NAS178-12 AN6
2024-T4	0.040	2024-T4	0.050	2				4				7				14			
	0.050		0.063	2	2			4	3			7	6			14	11		
	0.063		0.071	2	2	2		4	3	3		7	6	5		14	11	9	
	0.071		0.080	2	2	2	1	4	3	3	2	7	6	5	4	14	11	9	7
	0.080		0.090	2	2	2	1	4	3	3	2	7	6	5	4	14	11	9	7
	0.090		0.100	2	2	2	1	4	3	3	2	7	6	5	4	14	11	9	7
	0.100		0.112	2	2	2	1	4	3	3	2	7	6	5	4	14	11	9	7
	0.112		0.125	2	2	2	1	4	3	3	2	7	6	5	4	14	11	9	7
	0.125		0.140		2	2	1		3	3	2		6	5	4		11	9	7
	0.140		0.160			2	1			3	2			5	4			9	7
	0.160		0.180			2	1			3	2			5	4			9	7
2024-T4	0.180	2024-T4	0.190				1				2				4				7

TABLE NO. 2

SHEAR			ℓ=	FASTENERS REQUIRED - PROTRUDING HEAD															
				1/2 INCH				1 INCH				2 INCHES				4 INCHES			
MATL	t	DOUBLER MATL	t_1*	NAS178-6 AN3	NAS178-8 AN4	NAS178-10 AN5	NAS178-12 AN6	NAS178-6 AN3	NAS178-8 AN4	NAS178-10 AN5	NAS178-12 AN6	NAS178-6 AN3	NAS178-8 AN4	NAS178-10 AN5	NAS178-12 AN6	NAS178-6 AN3	NAS178-8 AN4	NAS178-10 AN5	NAS178-12 AN6
2024-T4	0.040	2024-T4	0.050	2				3				5				9			
	0.050		0.063	2	1			3	2			5	4			9	7		
	0.063		0.071	2	1	1		3	2	2		5	4	3		9	7	6	
	0.071		0.080	2	1	1	1	3	2	2	2	5	4	3	3	9	7	6	5
	0.080		0.090	2	1	1	1	3	2	2	2	5	4	3	3	9	7	6	5
	0.090		0.100	2	1	1	1	3	2	2	2	5	4	3	3	9	7	6	5
	0.100		0.112	2	1	1	1	3	2	2	2	5	4	3	3	9	7	6	5
	0.112		0.125	2	1	1	1	3	2	2	2	5	4	3	3	9	7	6	5
	0.125		0.140		1	1	1		2	2	2		4	3	3		7	6	5
	0.140		0.160			1	1			2	2			3	3			6	5
	0.160		0.180			1	1			2	2			3	3			6	5
2024-T4	0.180	2024-T4	0.190				1				2				3				5

NOTE Refer to "Developing a Typical Repair" before using this table.

*The doubler thickness (t_1) applies to the skin and web repairs only. Obtain doubler thickness for shapes from typical repair.

GEN-3-91-30A

Figure 2A-13. Fastener Tables - Hi-Shear and AN Bolts, Protruding Head, Shear and Tension (Sheet 1 of 2)

FASTENER TABLES

TYPICAL REPAIR

TABLE NO. 3

TENSION			ℓ⇒	FASTENERS REQUIRED — PROTRUDING HEAD															
				1/2 INCH				1 INCH				2 INCHES				4 INCHES			
MATL	t	DOUBLER MATL	t_1*	NAS178-6 AN3	NAS178-8 AN4	NAS178-10 AN5	NAS178-12 AN6	NAS178-6 AN3	NAS178-8 AN4	NAS178-10 AN5	NAS178-12 AN6	NAS178-6 AN3	NAS178-8 AN4	NAS178-10 AN5	NAS178-12 AN6	NAS178-6 AN3	NAS178-8 AN4	NAS178-10 AN5	NAS178-12 AN6
7075-T6	0.040	7075-T6	0.045	2				3				6				12			
↑	0.045	↑	0.050	2				3				6				12			
	0.050		0.056	2	2			3	3			6	5			12	9		
	0.056		0.063	2	2			3	3			6	5			12	9		
	0.063		0.071	2	2	1		3	3	2		6	5	4		12	9	7	
	0.071		0.080	2	2	1	1	3	3	2	2	6	5	4	3	12	9	7	6
	0.080		0.090		2	1	1		3	2	2		5	4	3		9	7	6
	0.090		0.100		2	1	1		3	2	2		5	4	3		9	7	6
	0.100		0.112		2	1	1		3	2	2		5	4	3		9	7	6
	0.112		0.125			1	1			2	2			4	3			7	6
↓	0.125	↓	0.140			1	1			2	2			4	3		.	7	6
7075-T6	0.140	7075-T6	0.160				1				2				3				6

TABLE NO. 4

SHEAR			ℓ⇒	FASTENERS REQUIRED — PROTRUDING HEAD															
				1/2 INCH				1 INCH				2 INCHES				4 INCHES			
MATL	t	DOUBLER MATL	t_1*	NAS178-6 AN3	NAS178-8 AN4	NAS178-10 AN5	NAS178-12 AN6	NAS178-6 AN3	NAS178-8 AN4	NAS178-10 AN5	NAS178-12 AN6	NAS178-6 AN3	NAS178-8 AN4	NAS178-10 AN5	NAS178-12 AN6	NAS178-6 AN3	NAS178-8 AN4	NAS178-10 AN5	NAS178-12 AN6
7075-T6	0.040	7075-T6	0.045	1				2				4				7			
↑	0.045	↑	0.050	1				2				4				7			
	0.050		0.056	1	1			2	2			4	3			7	5		
	0.056		0.063	1	1			2	2			4	3			7	5		
	0.063		0.071	1	1	1		2	2	1		4	3	2		7	5	4	
	0.071		0.080	1	1	1	1	2	2	1	1	4	3	2	2	7	5	4	4
	0.080		0.090		1	1	1		2	1	1		3	2	2		5	4	4
	0.090		0.100		1	1	1		2	1	1		3	2	2		5	4	4
	0.100		0.112		1	1	1		2	1	1		3	2	2		5	4	4
	0.112		0.125			1	1			1	1			2	2			4	4
↓	0.125	↓	0.140			1	1			1	1			2	2			4	4
7075-T6	0.140	7075-T6	0.160				1				1				2				4

NOTE Refer to "Developing a Typical Repair" before using this table.

*The doubler thickness (t_1) applies to the skin and web repairs only. Obtain doubler thickness for shapes from typical repair.

GEN-3-91-31A

Figure 2A-13. Fastener Tables - Hi-Shear and AN Bolts, Protruding Head, Shear and Tension (Sheet 2 of 2)

FASTENER TABLES

TYPICAL REPAIR

TABLE NO. 1

TENSION			ℓ=	FASTENERS REQUIRED—HUCK LOCK BOLTS															
				1/2 INCH				1 INCH				2 INCHES				4 INCHES			
MATL	t	DOUBLER MATL	t_1*	OS-8	OS-10	OS-12	BL-8	OS-8	OS-10	OS-12	BL-8	OS-8	OS-10	OS-12	BL-8	OS-8	OS-10	OS-12	BL-8
7075-T6	0.040	7075-T6	0.050	2				4				8				15			
↑	0.050	↑	0.063	2	2		2	3	3		3	6	5		5	12	10		9
	0.063		0.071	2	2	1	2	4	3	2	3	7	5	4	5	13	10	8	9
	0.071		0.080	2	2	1	2	4	3	2	3	7	5	4	5	13	10	8	9
	0.080		0.090	2	2	1	2	4	3	2	3	7	5	4	5	14	10	8	10
	0.090		0.100	2	2	1	2	4	3	2	3	8	6	4	5	15	11	8	10
	0.100		0.125		2	2	2		3	3	3		6	5	5		11	9	10
↓	0.125	↓	0.160			2	2			3	3			5	6			10	11
7075-T6	0.160	7075-T6	0.190				2				3				6				12

TABLE NO. 2

SHEAR			ℓ=	FASTENERS REQUIRED—HUCK LOCK BOLTS															
				1/2 INCH				1 INCH				2 INCHES				4 INCHES			
MATL	t	DOUBLER MATL	t_1*	OS-8	OS-10	OS-12	BL-8	OS-8	OS-10	OS-12	BL-8	OS-8	OS-10	OS-12	BL-8	OS-8	OS-10	OS-12	BL-8
7075-T6	0.040	7075-T6	0.050	2				3				5				9			
↑	0.050	↑	0.063	1	1		1	2	2		2	4	3		3	7	6		5
	0.063		0.071	1	1	1	1	2	2	2	2	4	3	3	3	8	6	5	6
	0.071		0.080	1	1	1	1	2	2	2	2	4	3	3	3	8	6	5	6
	0.080		0.090	2	1	1	1	3	2	2	2	5	3	3	3	9	6	5	6
	0.090		0.100	2	1	1	1	3	2	2	2	5	4	3	3	9	7	5	6
	0.100		0.125		1	1	1		2	2	2		4	3	3		7	5	6
↓	0.125	↓	0.160			1	1			2	2			3	4			6	7
7075-T6	0.160	7075-T6	0.190				1				2				4				7

NOTE Refer to "Developing a Typical Repair" before using this table.

*The doubler thickness (t_1) applies to the skin and web repairs only. Obtain doubler thickness for shapes from typical repair.

GEN-3-91-32A

Figure 2A-14. Fastener Tables - Huck Lock Bolt, 7075-T6, Shear and Tension

FASTENER TABLES

TYPICAL REPAIR

TABLE NO. 1

MATL	t	DOUBLER MATL	t_1*	FASTENERS REQUIRED																													
				PROTRUDING								COUNTERSUNK												DIMPLED									
				1/2		1		2		4		1/2		1		2		4		1/2		1		2		4		1/2		1		2		4	
				P164		P164		P164		P164		F164		F164		F164		F164		F164		F164		F164		F164		F312		F260		F200		F164	
2024-T4	0.025	2024-T4	0.032	3	5	9	18																										
	0.032		0.040	3	5	9	18																										
	0.040		0.050	3	5	9	18																										
	0.050		0.063	3	5	10	19	3								10		20		3	5	10	19										
	0.063		0.071	3	5	10	19	3	3					6	5		11	9		3	5	10	20										
	0.071		0.080	3	5	10	19	3	3					6	5		11	10		3	5	10	20										
	0.080		0.090	3	5	10	19	3	3					6	5		11	9															
	0.090		0.100	3	5	10	19	3	3	2				6	5	4	11	9	7		21	18	14										
	0.100		0.125	3	5	10	19	3	3	2	2			6	5	4	11	9	7	6	21	17	14	12									
	0.125		0.160	3	5	10	19	3	3	2	2			6	5	4	11	9	7	6	21	17	14	12									
	0.160		0.190	3	6	12	23	3	3	2	2			6	5	4	12	9	7	6	23	18	13	12									
	0.190		0.250	4	7	14	27	4	3	2	2			7	5	4	13	10	7	6	27	19	14	12									
	0.250		0.375						3	2	2				7	4	4		13	8	7		25	16	14								
2024-T4	0.375	2024-T4	0.500							3	3				6	5				11	9			21	17								

NOTE Refer to "Developing a Typical Repair" before using this table.

*The doubler thickness (t_1) applies to the skin and web repairs only. Obtain doubler thickness for shapes from typical repair.

GEN-3-91-33A

Figure 2A-15. Fastener Tables - Jo-bolt, Flush and Protruding Head, 2024-T4, Tension

FASTENER TABLES

TYPICAL REPAIR

TABLE NO. 1

MATL	t	DOUBLER MATL	t_1*	FASTENERS REQUIRED																																					
				PROTRUDING				COUNTERSUNK																				DIMPLED													
			∠= ◆	1/2	1	2	4	1/2 INCH				1 INCH				2 INCHES				4 INCHES								1/2	1	2	4										
				F164	F164	F164	F164	F164	F200	F260	F312	F164	F200	F260	F312	F164	F200	F260	F312	F164	F200	F260	F312					F164	F164	F164	F164										
2024-T4	0.025	2024-T4	0.032	2	3	6	11																					2	3	6	12										
◀	0.032	◀	0.040	2	3		11																					2	3	6	12										
	0.040		0.050	2	3	6	11																					2	3	6	12										
	0.050		0.063	2	3	6	11	2				3				6				12								2	3	6	12										
	0.063		0.071	2	3	6	12	2	2			4	3			7	6			13	11							2	4	7	13										
	0.071		0.080	2	3	6	12	2	2			4	3			7	6			13	12							2	4	7	13										
	0.080		0.090	2	3	6	12	2	2			4	3			7	6			13	11																				
	0.090		0.100	2	3	6	12	2	2	2		4	3	3		7	6	5		13	11	9																			
	0.100		0.125	2	3	6	12	2	2	2	1	4	3	3	2	7	6	5	4	13	11	9	8																		
	0.125		0.160	2	3	6	12	2	2	2	1	4	3	3	2	7	6	5	4	13	11	9	8																		
	0.160		0.190	2	4	7	14	2	2	1	1	4	3	2	2	7	6	4	4	14	11	8	8																		
	0.190		0.250	3	5	9	17	3	2	1	1	5	3	2	2	9	6	4	4	17	12	8	8																		
	0.250	▶	0.375						2	2	1		4	3	3		8	5	5		16	10	9																		
2024-T4	0.375	2024-T4	0.500							2	2			4	3			7	6			14	11																		

NOTE Refer to "Developing a Typical Repair" before using this table.

*The doubler thickness (t_1) applies to the skin and web repairs only. Obtain doubler thickness for shapes from typical repair.

GEN-3-91-34A

Figure 2A-16. Fastener Tables - Jo-bolt, Flush and Protruding Head, 2024-T4, Shear

FASTENER TABLES

TYPICAL REPAIR

TABLE NO. 1

TENSION			ℓ=	FASTENERS REQUIRED — PROTRUDING HEAD																	
				1/2 INCH				1 INCH				2 INCHES				4 INCHES					
MATL	t	DOUBLER MATL	t_1*	F164	F200	F260	F312	F164	F200	F260	F312	F164	F200	F260	F312	F164	F200	F260	F312		
7075-T6	0.025	7075-T6	0.032	2	2	2	2	4	4	3	3	8	7	5	5	16	13	10	9		
	0.032		0.040	2	2	2	2	4	4	3	3	8	7	5	5	16	13	10	9		
	0.040		0.050	2	2	2	2	4	4	3	3	8	7	5	5	16	13	10	9		
	0.050		0.063	2	2	2	2	4	4	3	3	8	7	5	5	16	13	10	9		
	0.063		0.071	2	2	2	2	4	4	3	3	8	7	5	5	16	13	10	9		
	0.071		0.080	2	2	2	2	4	4	3	3	8	7	5	5	16	13	10	9		
	0.080		0.090	2	2	2	2	4	4	3	3	8	7	5	5	16	13	10	9		
	0.090		0.100	3	2	2	2	5	4	3	3	9	7	5	5	17	13	10	9		
	0.100		0.125	3	2	2	2	5	4	3	2	9	7	5	4	18	13	10	8		
	0.125		0.160	3	2	2	2	6	4	3	3	11	8	5	5	22	15	10	9		
	0.160		0.190		3	2	2		5	3	3		10	6	5		19	12	9		
	0.190		0.250		3	2	2		6	4	3		11	7	5		22	14	10		
	0.250		0.375			3	2			5	3			9	6			17	12		
7075-T6	0.375	7075-T6	0.500			3	3			6	5			12	9			24	17		

TABLE NO. 2

TENSION			ℓ=	FASTENERS REQUIRED — COUNTERSUNK												FASTENERS REQUIRED — DIMPLED					
				1/2 INCH				1 INCH				2 INCHES				4 INCHES				1/2 INCH	
MATL	t	DOUBLER MATL	t_1*	F164	F200	F260	F312	F164	F200	F260	F312	F164	F200	F260	F312	F164	F200	F260	F312	F164	F200
7075-T6	0.025	7075-T6	0.032																	3	2
	0.032		0.040																	3	2
	0.040		0.050																	3	3
	0.050		0.063	3				6				12				24				3	3
	0.063		0.071	3	3			6	5			12	10			24	19			3	3
	0.071		0.080	3	3			6	5			12	10			24	19			4	
	0.080		0.090	3	3			6	5			12	10			24	19				
	0.090		0.100	3	3	2		6	5	4		12	10	8		24	19	15			
	0.100		0.125	3	3	2	2	6	5	4	4	12	10	8	7	24	19	15	13		
	0.125		0.160	3	3	2	2	6	5	4	4	12	10	8	7	24	19	15	13		
	0.160		0.190	4	3	2	2	8	5	4	4	15	10	8	7	29	20	15	13		
	0.190		0.250	5	3	2	2	9	6	4	4	17	12	8	7	34	23	15	13		
	0.250		0.375	6	4	3	2	11	8	5	4	22	15	9	7	33	29	18	13		
7075-T6	0.375	7075-T6	0.500	9	6	3	3	17	11	6	5	33	22	12	9	66	43	24	18		

FASTENERS REQUIRED — DIMPLED												
1 INCH				2 INCHES				4 INCHES				
F164	F200	F260	F312	F164	F200	F260	F312	F164	F200	F260	F312	
5	4	3	2	9	7	5	4	18	13	10	8	
5	4	3	2	10	8	5	4	20	15	10	8	
6	5	3	3	11	9	6	5	21	17	11	9	
6	5	4	3	12	9	7	5	23	18	13	10	
6	5	4	3	12	10	7	6	24	19	14	11	
7		4	3	13		7	6	25		14	11	
		4	3			8	6			15	12	
		4	3			8	6			15	12	

NOTE Refer to "Developing a Typical Repair" before using this table.

*The doubler thickness (t_1) applies to the skin and web repairs only. Obtain doubler thickness for shapes from typical repair.

Gen-3-91-35A

Figure 2A-17. Fastener Tables.- Jo-bolt, Flush and Protruding Head, 7075-T6, Tension

FASTENER TABLES

TYPICAL REPAIR

NOTE Refer to "Developing a Typical Repair" before using this table.

*The doubler thickness (t_1) applies to the skin and web repairs only. Obtain doubler thickness for shapes from typical repair.

TABLE NO. 1

SHEAR MATL	SHEAR t	DOUBLER MATL	∠=	t_1*	FASTENERS REQUIRED — PROTRUDING HEAD: 1/2 INCH P164	P200	P260	P312	1 INCH P164	P200	P260	P312	2 INCHES P164	P200	P260	P312	4 INCHES P164	P200	P260	P312
7075-T6	0.025	7075-T6		0.032	2	1	1		3	2	2		5	4	3		10	8	6	
	0.032			0.040	2	1	1	1	3	2	2	2	5	4	3	3	10	8	6	5
	0.040			0.050	2	1	1	1	3	2	2	2	5	4	3	3	10	8	6	5
	0.050			0.063	2	1	1	1	3	2	2	2	5	4	3	3	10	8	6	5
	0.063			0.071	2	1	1	1	3	2	2	2	5	4	3	3	10	8	6	5
	0.071			0.080	2	1	1	1	3	2	2	2	5	4	3	3	10	8	6	5
	0.080			0.090	2	1	1	1	3	2	2	2	5	4	3	3	10	8	6	5
	0.090			0.100	2	1	1	1	3	2	2	2	5	4	3	3	10	8	6	5
	0.100			0.125	2	1	1	1	3	2	2	2	6	4	3	3	11	8	6	5
	0.125			0.160	2	2	1	1	4	3	2	2	7	5	3	3	13	9	6	5
	0.160			0.190		2	1	1		3	2	2		6	4	3		12	7	5
	0.190			0.250		2	1	1		4	2	2		7	4	3		13	8	6
	0.250			0.375			2	1			3	2			5	4			10	8
7075-T6	0.375	7075-T6		0.500			2	2			4	3			8	5			15	10

TABLE NO. 2

SHEAR MATL	SHEAR t	DOUBLER MATL	∠=	t_1*	FASTENERS REQUIRED — COUNTERSUNK: 1/2 INCH F164	F200	F260	F312	1 INCH F164	F200	F260	F312	2 INCHES F164	F200	F260	F312	4 INCHES F164	F200	F260	F312
7075-T6	0.025	7075-T6		0.032																
	0.032			0.040																
	0.040			0.050																
	0.050			0.063	2				4				7				14			
	0.063			0.071	2	2			4	3			7	6			14	12		
	0.071			0.080	2	2			4	3			7	6			14	12		
	0.080			0.090	2	2			4	3			7	6			14	12		
	0.090			0.100	2	2	2		4	3	3		7	6	5		14	12	9	
	0.100			0.125	2	2	2	1	4	3	3	2	7	6	5	4	14	12	9	8
	0.125			0.160	2	2	2	1	4	3	3	2	7	6	5	4	14	12	9	8
	0.160			0.190	3	2	2	1	5	3	3	2	9	6	5	4	17	12	9	8
	0.190			0.250	3	2	2	1	5	4	3	2	10	7	5	4	20	14	9	8
	0.250			0.375		3	2	1		5	3	2		9	6	4		17	11	8
7075-T6	0.375	7075-T6		0.500			2	2			4	3			8	6			15	11

FASTENERS REQUIRED — DIMPLED

t_1*	1/2 INCH F164	F200	F260	F312	1 INCH F164	F200	F260	F312	2 INCHES F164	F200	F260	F312	4 INCHES F164	F200*	F260	F312
0.032	2	1	1	1	3	2	2	2	6	4	3	3	11	8	6	5
0.040	2	2	1	1	3	3	2	2	6	5	3	3	12	9	6	5
0.050	2	2	1	1	4	3	2	2	7	5	4	3	13	10	7	6
0.063	2	2	1	1	4	3	2	2	7	6	4	3	14	11	8	6
0.071	2	2	1	1	4	3	2	2	8	6	4	4	15	11	8	7
0.080	2		2	1	4		3	2	8		5	4	15		9	7
0.090			2	1			3	2			5	4			9	7
0.100			2	1			3	2			5	4			9	7
0.125																
0.160																
0.190																
0.250																
0.375																
0.500																

GEN-3-91-36A

Figure 2A-18. Fastener Tables - Jo-bolt, Flush and Protruding Head, 7075-T6, Shear

RIVET HOLE SIZES

TYPICAL REPAIR

HOLE SIZE												
	BLIND FASTENERS									DRIVE PIN RIVET (DEUTSCH)		
		FINAL HOLE SIZE										
			PULL			HUCK						
FASTENER SIZE	CONVENTIONAL RIVET*	EXPLOSIVE (DUPONT)	CHERRY & OLYMPIC			BL SERIES BLIND LOCK BOLT	OS & OSR SERIES RIVET	JO-BOLT		PILOT-DRILL BEFORE DIMPLING	FINAL HOLE SIZE	
			STANDARD RIVET	OVERSIZE RIVET								
3/32	0.097-0.100 (NO. 40)											
1/8	0.1290-0.1305 (NO. 30)	0.135-0.139 (NO. 29)	0.128-0.132 (NO. 30)	0.137-0.141 (NO. 29)						0.097-0.100 (NO. 40)	0.1255-0.1265	
5/32	0.160-0.162 (NO. 21)	0.172-0.176 (NO. 17)	0.160-0.164 (NO. 20)	0.177-0.181 (NO. 16)				0.164-0.166		0.128-0.132 (NO. 30)	0.1565-0.1575	
3/16	0.192-0.194 (NO. 11)	0.203-0.207 (NO. 6)	0.192-0.196 (NO. 10)	0.204-0.210 (NO. 5)				0.199-0.202		0.172-0.176 (NO. 17)	0.191-0.193	
1/4	0.256-0.261 (F)		0.256-0.261 (F)			0.260-0.265 (G)	0.271-0.276 (I)	0.260-0.263		0.227-0.231 (NO. 1)	0.259-0.262	
3/8								0.312-0.315		0.2802-0.2852 (9/32)	0.315-0.318	
								0.375-0.379			0.385-0.388	

*Holes after dimpling must not exceed the nominal drill size by more than 15 percent.

Holes to be dimpled for explosive and pull fasteners must be pilot-drilled using nominal drill size given for conventional rivets, dimpled, and redrilled to size.

If the hole size exceeds the limits given for the standard rivet but is within the limits given for the oversize rivet, use the oversize rivet.

GEN-3-91-12A

Figure 2A-19. Rivet Hole Sizes

CONVENTIONAL RIVET TYPES AND APPLICATIONS

TYPICAL REPAIR

	RIVET MATERIAL	AL ALLOY 2117-T4 (1)	AL ALLOY 2024-T4 (2)	AL ALLOY 5056-F (1)	AL 1100-F (1) (3)	MILD STEEL CAD-PLATED (1) (5)	MONEL (1)
IDENTIFICATION	HEAD MARKINGS	DIMPLE	RAISED DOUBLE DASH	RAISED CROSS	PLAIN	RECESSED TRIANGLE	DIMPLES / PLAIN
	UNIVERSAL HEAD	AN470AD	AN470DD	AN470B	AN470A		NAS508M
	ROUND HEAD					AN435	
	FLUSH HEAD	AN426AD	AN426DD	AN426B	AN426A	AN427	AN427M
	MAXIMUM TEMPERATURE	200°F	200°F	200°F		550°F	1000°F
	SIZES	3/32, 1/8, & 5/32 DIA	3/16 DIA & OVER			5/16 DIA MAX	3/16 DIA MAX
APPLICATION	AL ALLOY TO AL ALLOY	PREFERRED	PREFERRED	PERMISSIBLE BUT UNDESIRABLE	(3)	PROHIBITED	PROHIBITED
	AL ALLOY TO CAD PLATED STEEL	(4)	(4)	PROHIBITED	PROHIBITED	PREFERRED (5)	PERMISSIBLE BUT UNDESIRABLE
	AL ALLOY TO CRE STEEL						
	AL ALLOY TO TITANIUM						
	CAD PLATED STEEL TO CAD PLATED STEEL	PERMISSIBLE BUT UNDESIRABLE	PERMISSIBLE BUT UNDESIRABLE				
	CAD PLATED STEEL TO CRE STEEL						
	CAD PLATED STEEL TO TITANIUM						
	CRE STEEL TO CRE STEEL	PROHIBITED	PROHIBITED	PROHIBITED	PROHIBITED	PROHIBITED	PREFERRED
	CRE STEEL TO TITANIUM						
	TITANIUM TO TITANIUM						
	MAGNESIUM ALLOY TO AL ALLOY	PROHIBITED	PROHIBITED	PREFERRED	PROHIBITED	PROHIBITED	PROHIBITED
	MAGNESIUM ALLOY TO CAD PLATED STEEL						
	MAGNESIUM ALLOY TO MAGNESIUM ALLOY						
	SOFT MATERIAL	ACCEPTABLE	PROHIBITED	PERMISSIBLE BUT UNDESIRABLE	PREFERRED	PROHIBITED	PROHIBITED

(1) Use rivets in "as received" condition.

(2) Rivets should be reheat-treated and refrigerated before using, in accordance with Specification MIL-H-6088.

(3) May be used for welding, where extra softness is required, or for plugging holes.

(4) May be used for weight saving or strength.

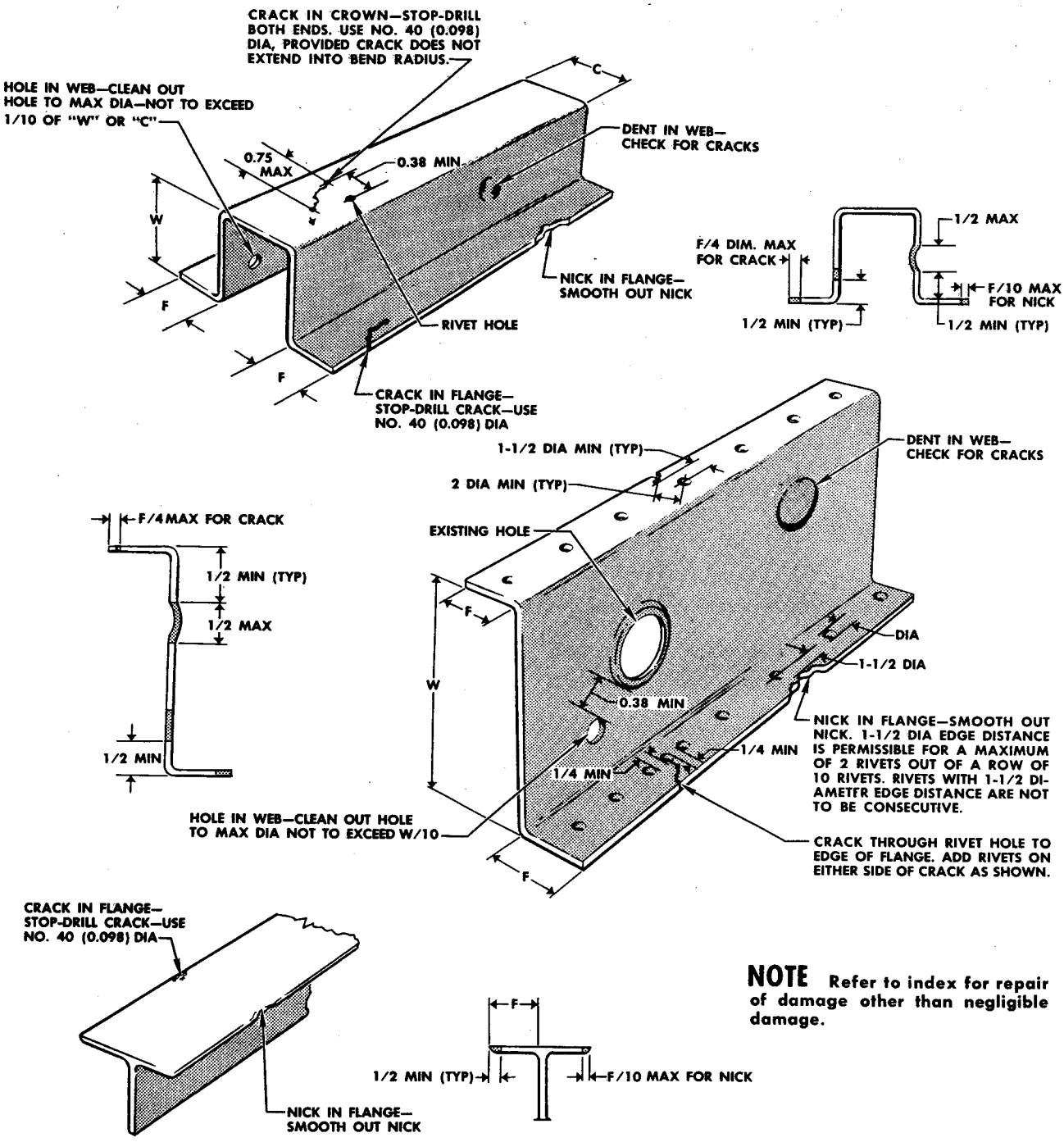
(5) Not recommended for structural applications.

GEN-3-91-13

Figure 2A-20. Conventional-type Rivets and Applications

NEGLIGIBLE DAMAGE SHAPES AND EXTRUSIONS

TYPICAL REPAIR



NOTE Refer to index for repair of damage other than negligible damage.

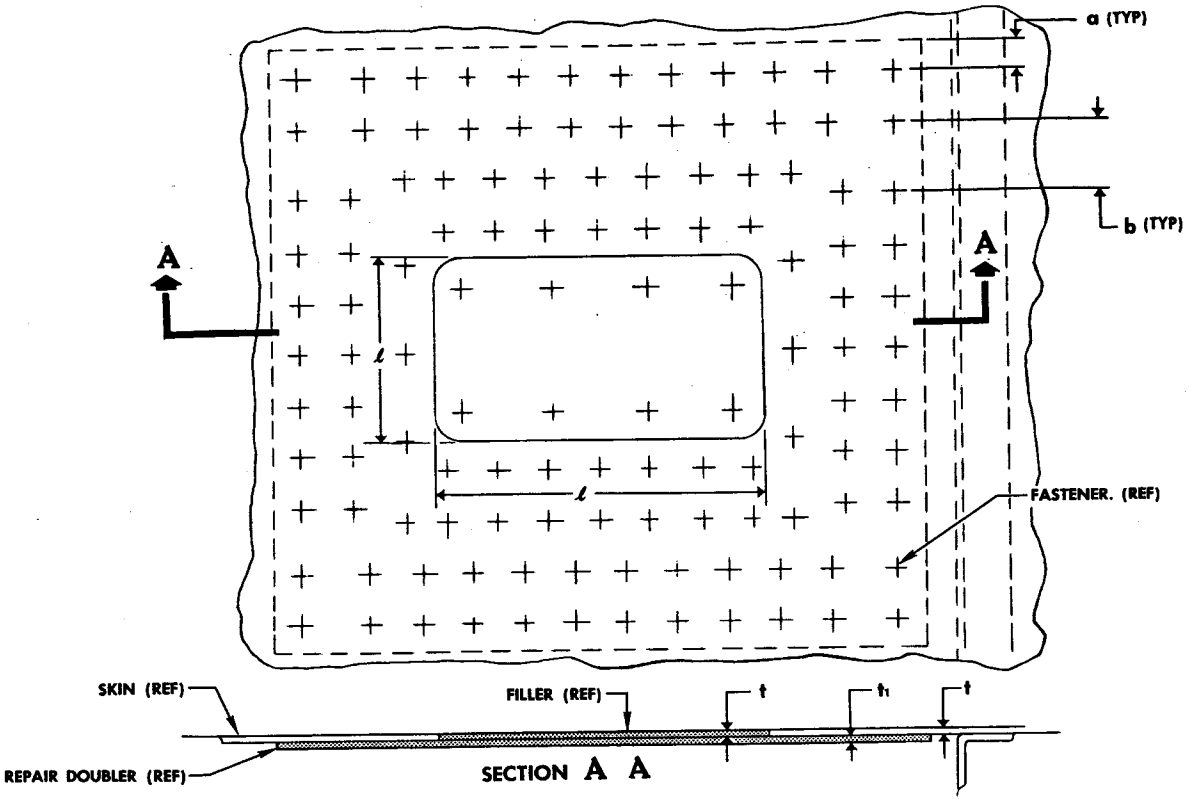
GEN-3-91-37

Figure 2A-21. Negligible Damage - Sheet Metal Shapes and Extrusions

SKIN REPAIR - SHEAR AND TENSION

TYPICAL REPAIR

1. Refer to "Developing a Typical Repair" before using this repair.



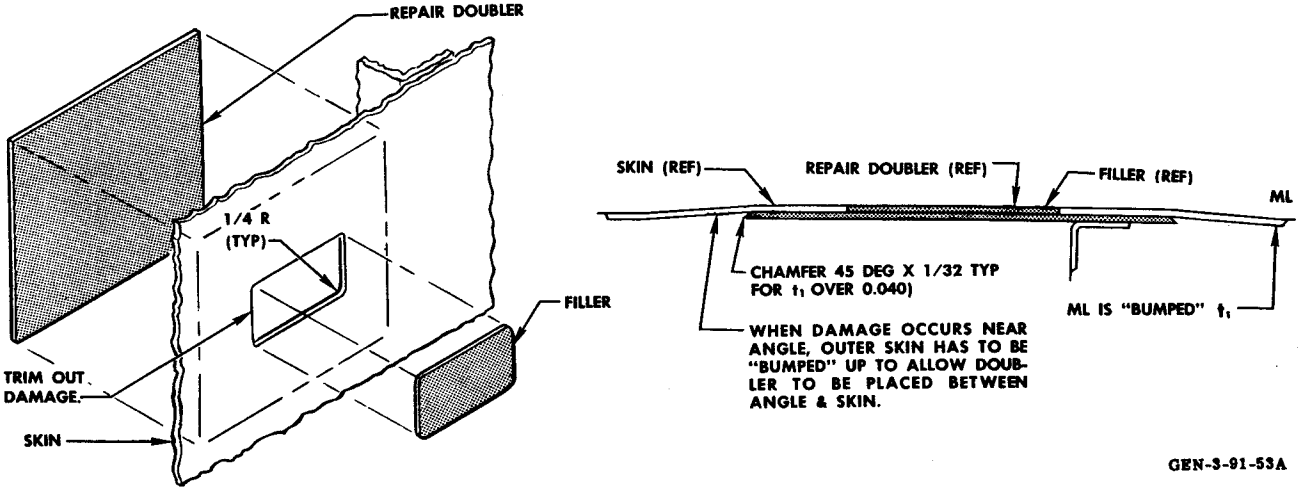
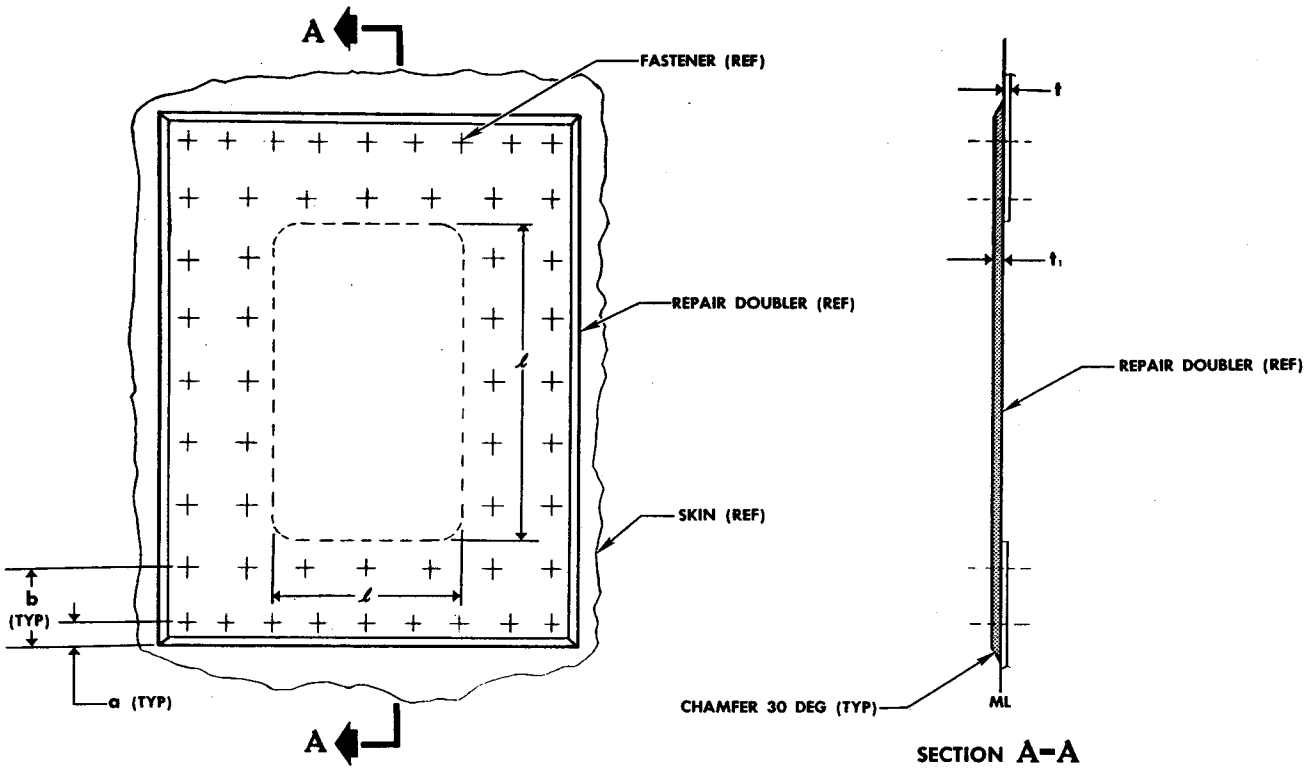


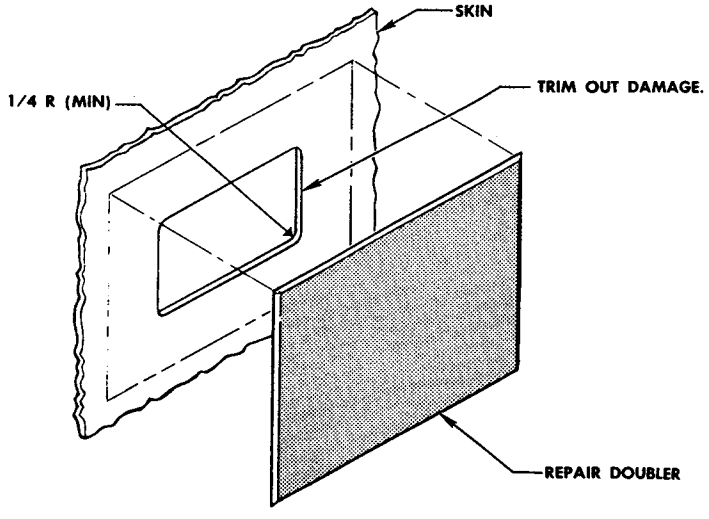
Figure 2A-22. Skin Repair - Shear and Tension

SKIN REPAIR—SHEAR AND TENSION

TYPICAL REPAIR

1. Refer to "Developing a Typical Repair" before using this repair.





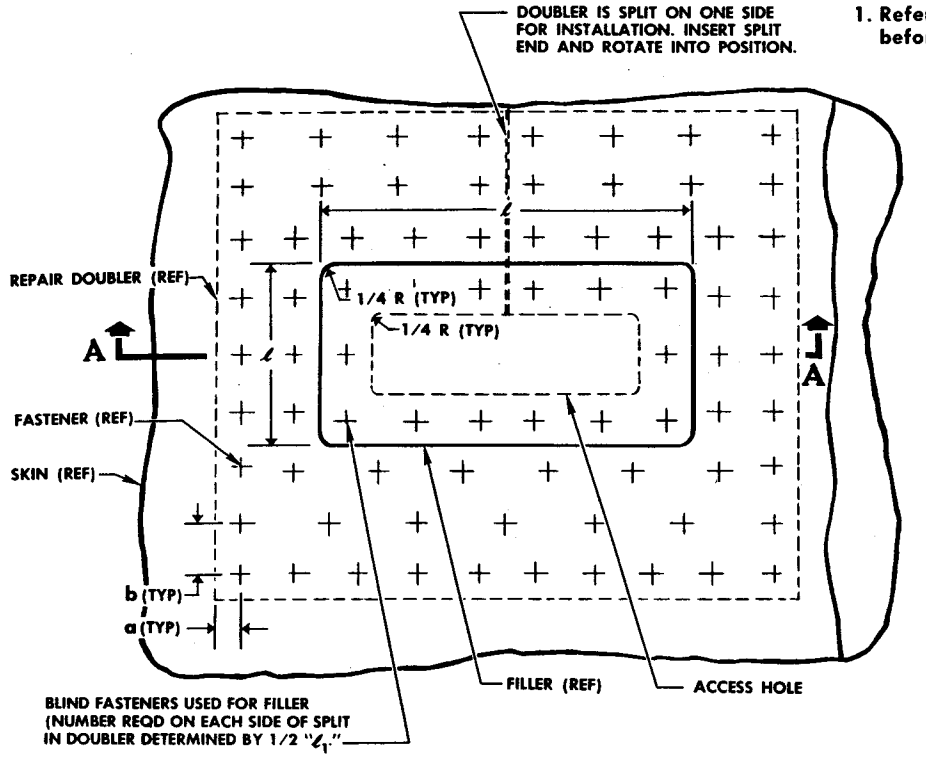
GEN-3-91-52A

Figure 2A-23. Skin Repair - Shear and Tension, Temporary

SKIN REPAIR - BLIND

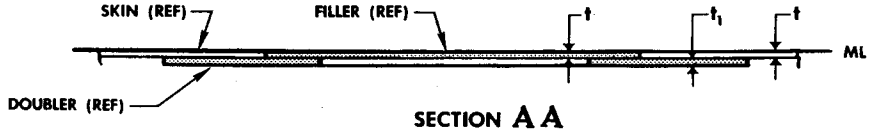
TYPICAL REPAIR

1. Refer to "Developing a Typical Repair" before using this repair.

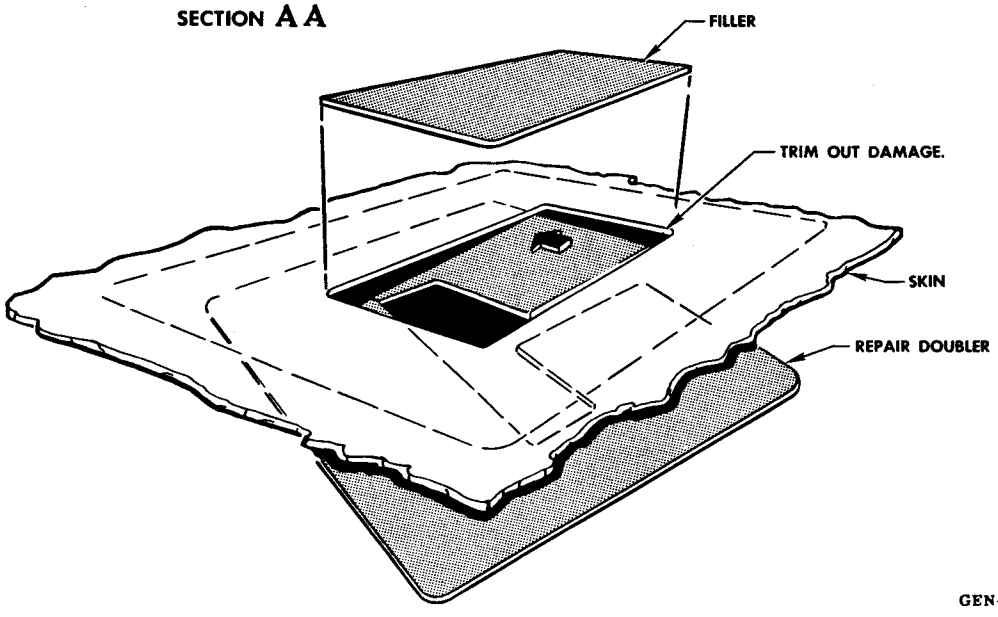


NOTE Use "ℓ" line in the fastener tables for "ℓ_1" values.

The fasteners required for "ℓ_1" are distributed through filler and doubler approximately as shown. (If the "ℓ_1" requirement is fourteen AF463-4 rivets, use seven AF463-4 rivets through filler and doubler on *each side* of the split in the doubler.)



SECTION A A

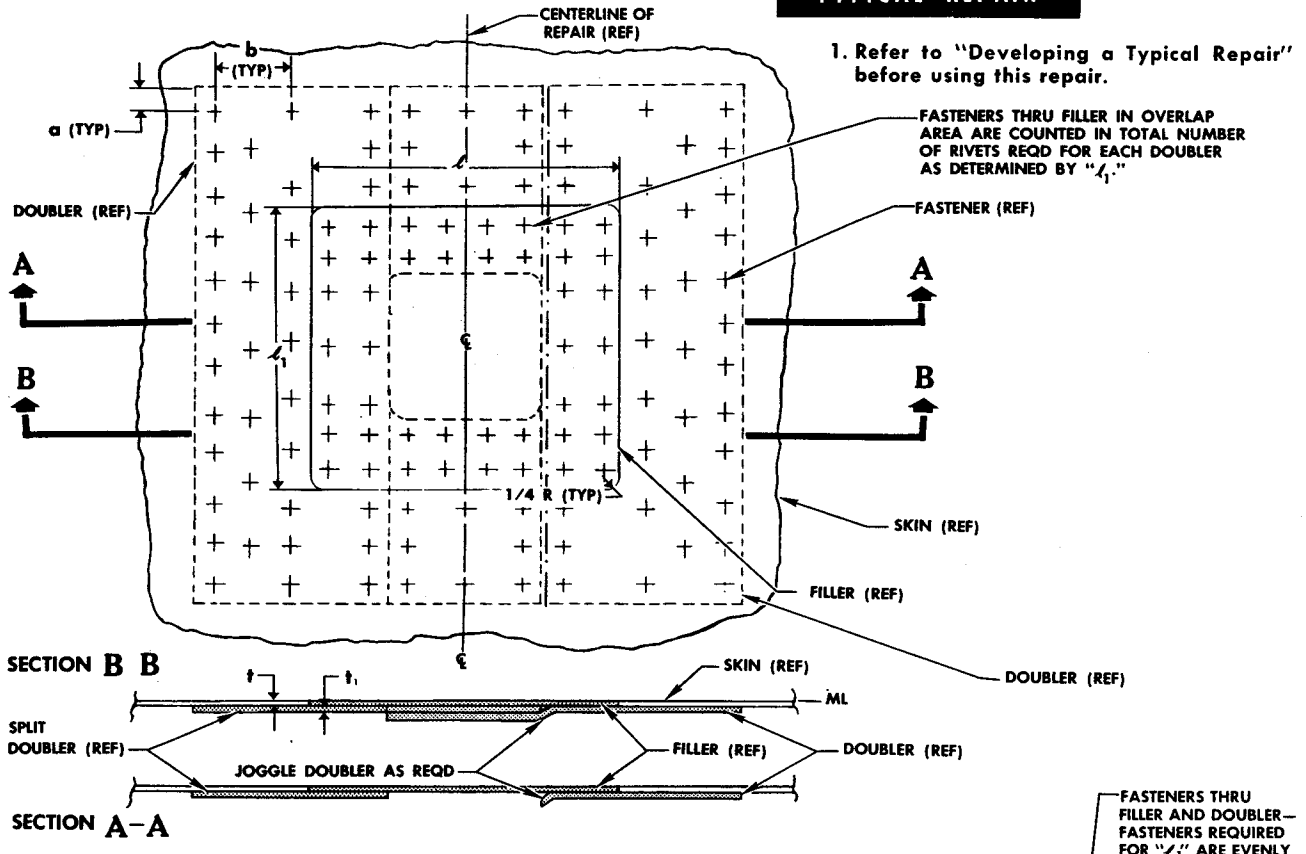


GEN-3-91-49A

Figure 2A-24. Skin Repair - Blind - Shear and Tension (Sheet 1 of 3)

SKIN REPAIR—BLIND

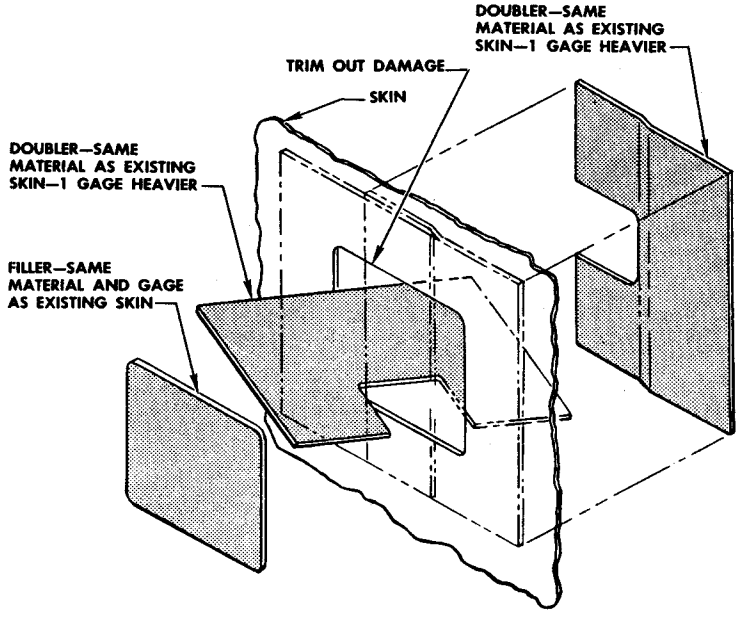
TYPICAL REPAIR

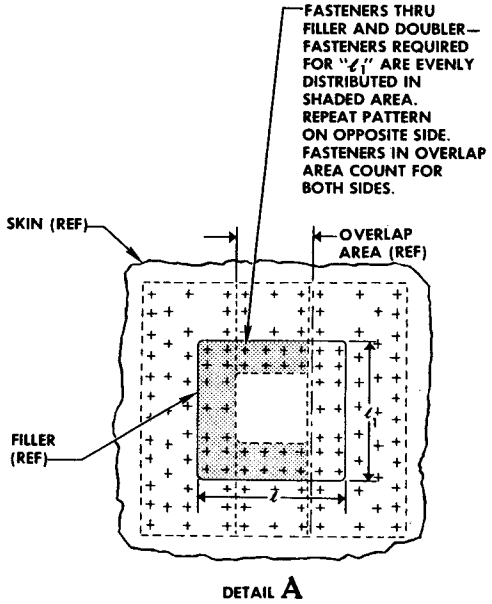


1. Refer to "Developing a Typical Repair" before using this repair.

SECTION B B

SECTION A–A





DETAIL A

NOTE Use "l" line in the fastener tables for "l_1" values.

The fastener distribution through the *skin* and doublers (around opening) is the same as when a one-piece doubler is used. (Refer to fastener distribution patterns.)

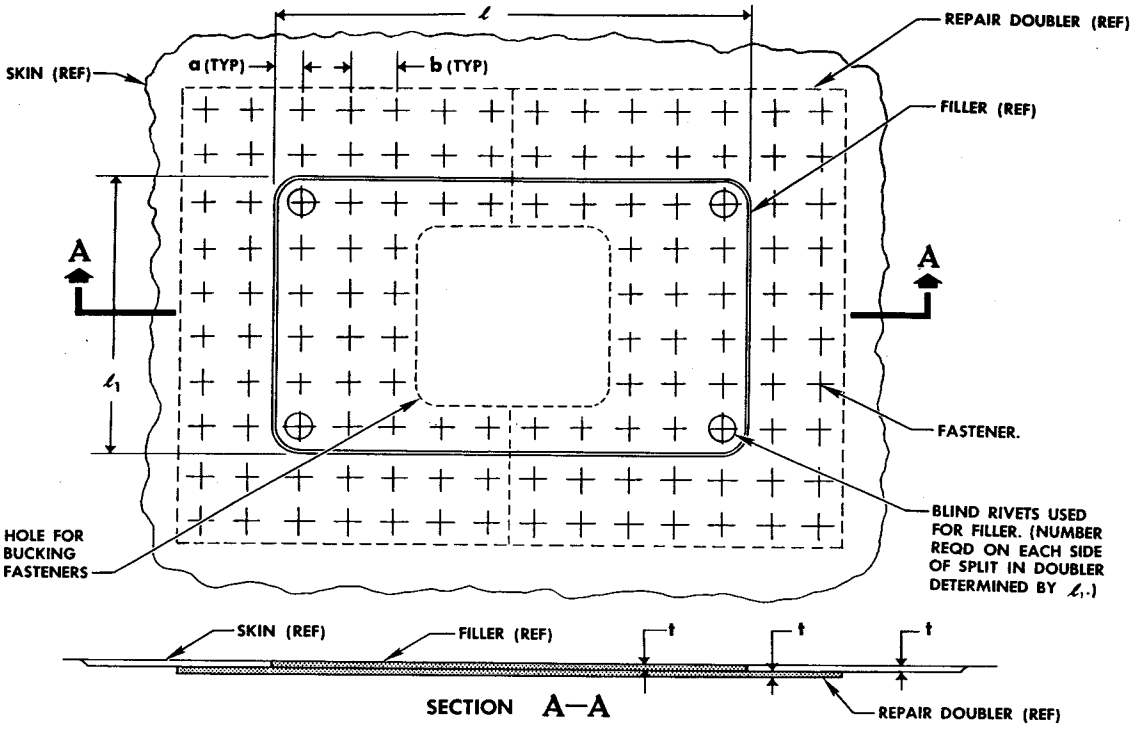
GEN-3-91-50A

Figure 2A-24. Skin Repair - Blind - Shear and Tension (Sheet 2 of 3)

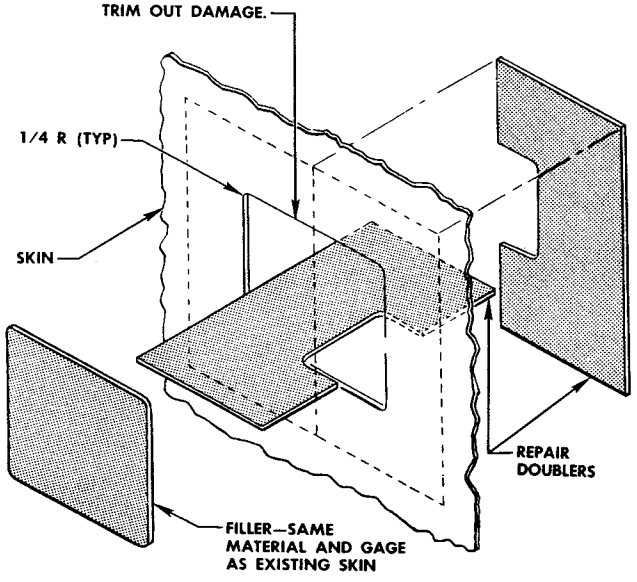
SKIN REPAIR - BLIND

TYPICAL REPAIR

1. Refer to "Developing a Typical Repair" before using this repair.



NOTE Use "ℓ" line in the fastener tables for "ℓ_1" values. The blind fasteners required for "ℓ_1" are distributed evenly through filler and doublers, approximately as shown. (If the "ℓ_1" requirement is twenty-two AF462-4 rivets, use twenty-two AF462-4 rivets through *each* doubler and filler.)



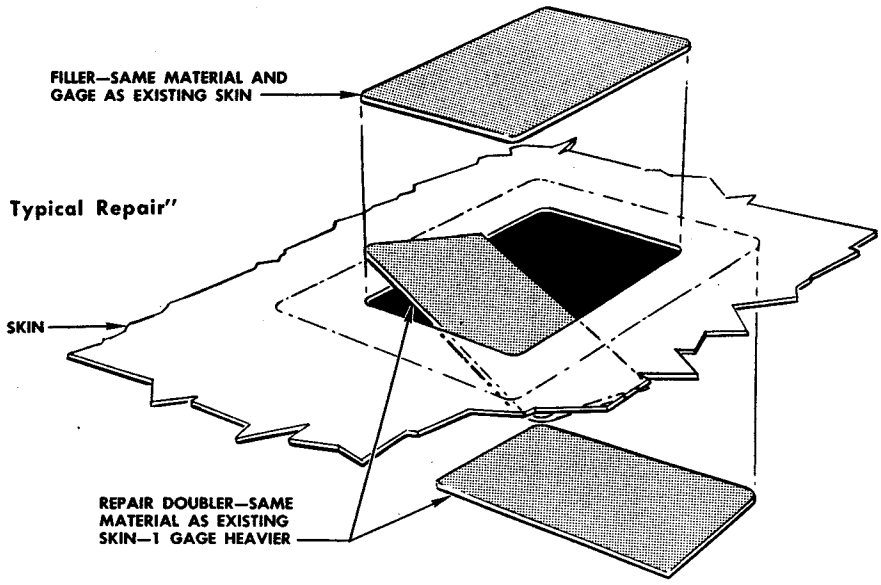
GEN-3-91-51A

Figure 2A-24. Skin Repair - Blind - Shear and Tension (Sheet 3 of 3)

SECONDARY STRUCTURE—BLIND

TYPICAL REPAIR

1. Refer to "Developing a Typical Repair" before using this repair.



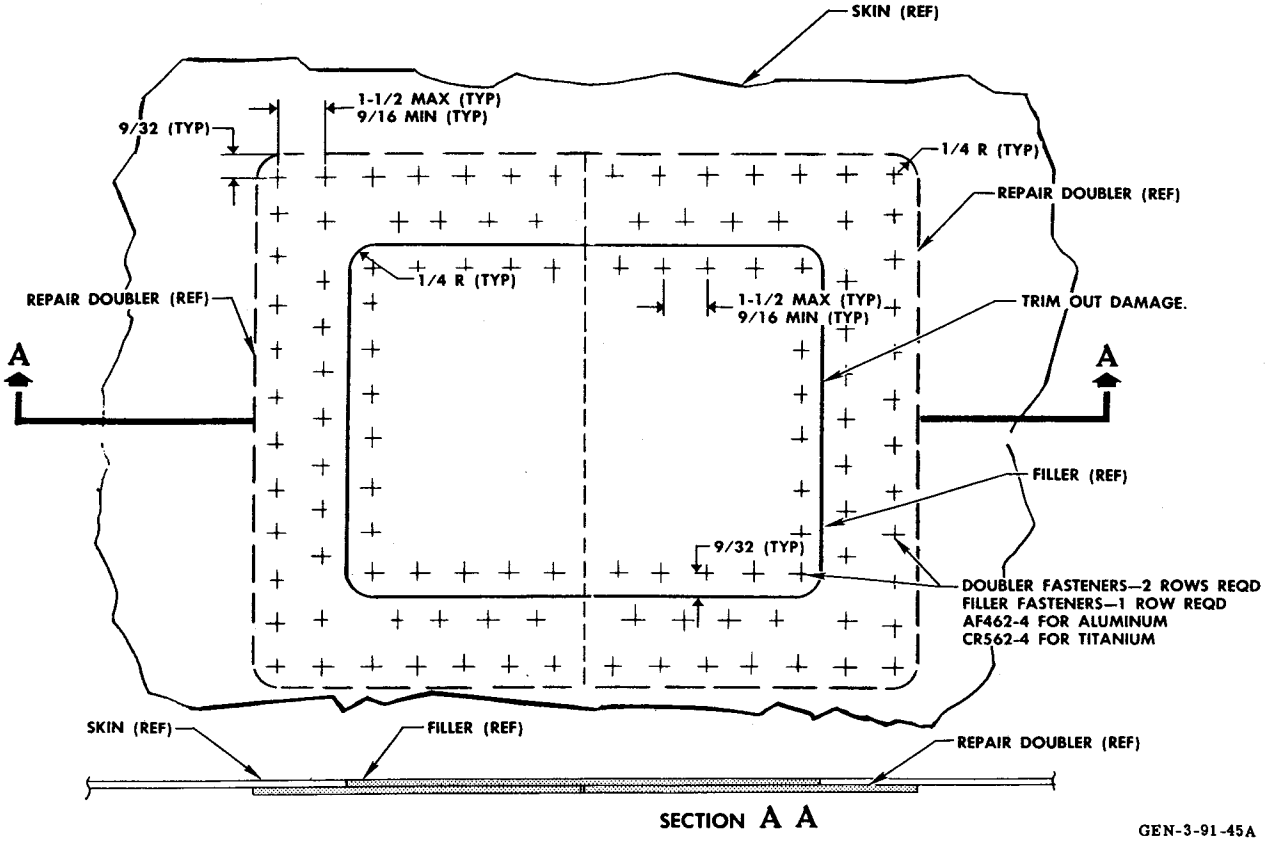
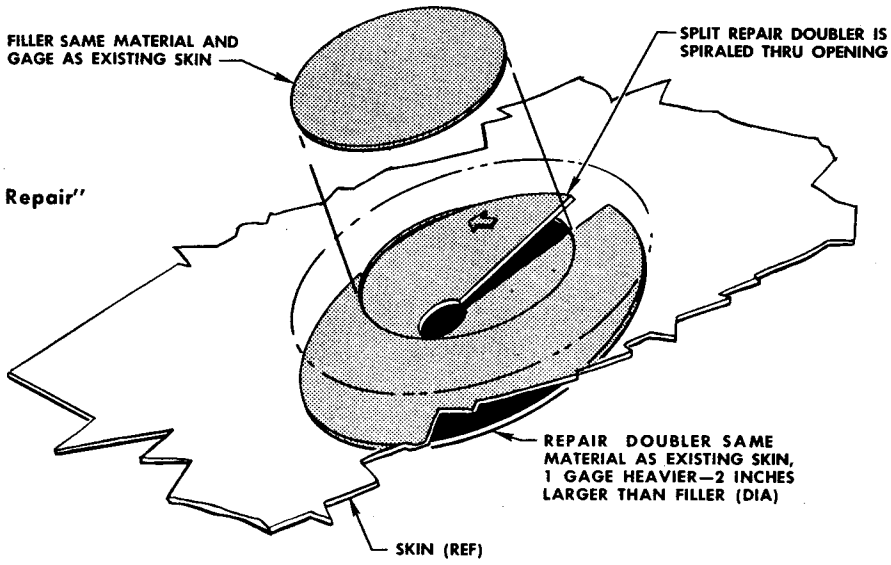


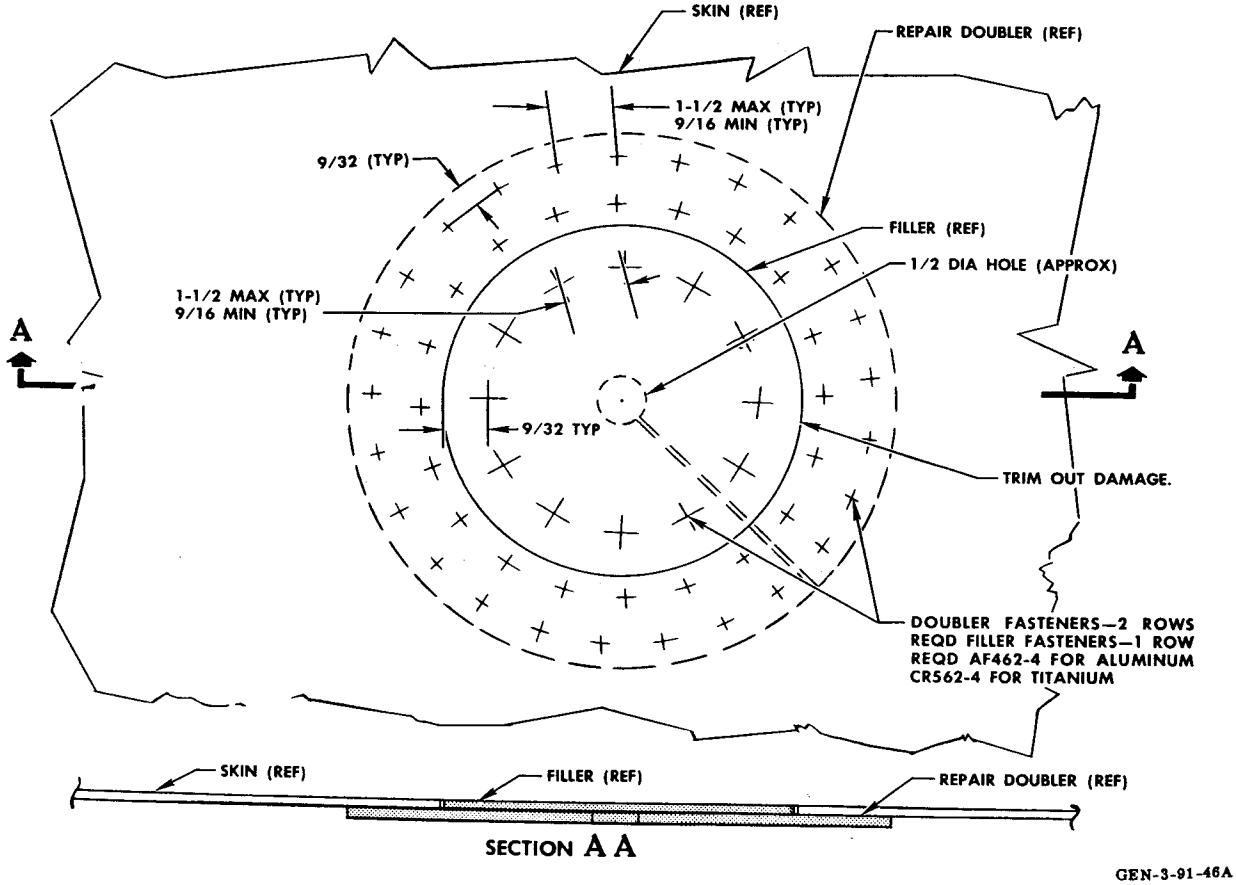
Figure 2A-25. Skin Repair - Blind, Secondary Structure (Sheet 1 of 4)

SECONDARY STRUCTURE—BLIND

TYPICAL REPAIR

1. Refer to "Developing a Typical Repair" before using this repair.





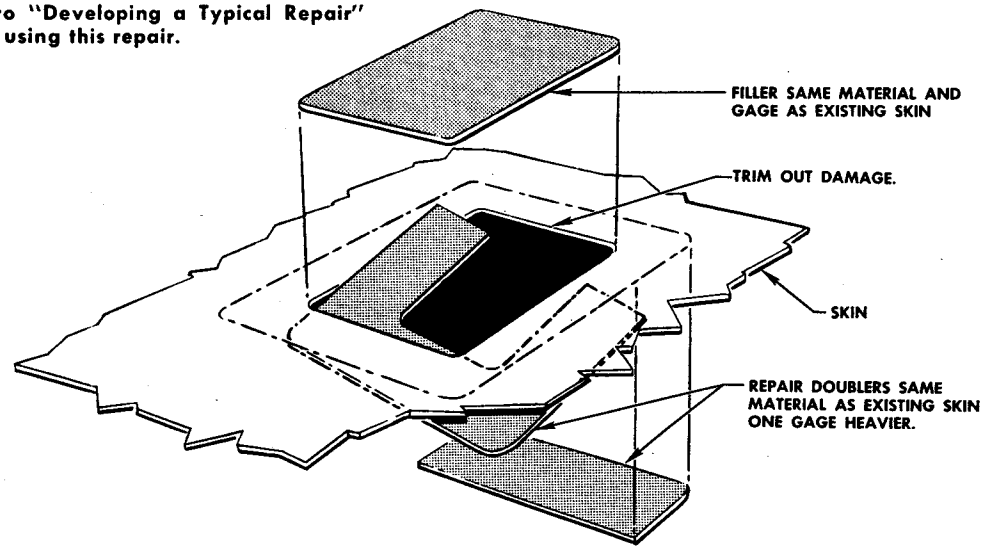
GEN-3-91-46A

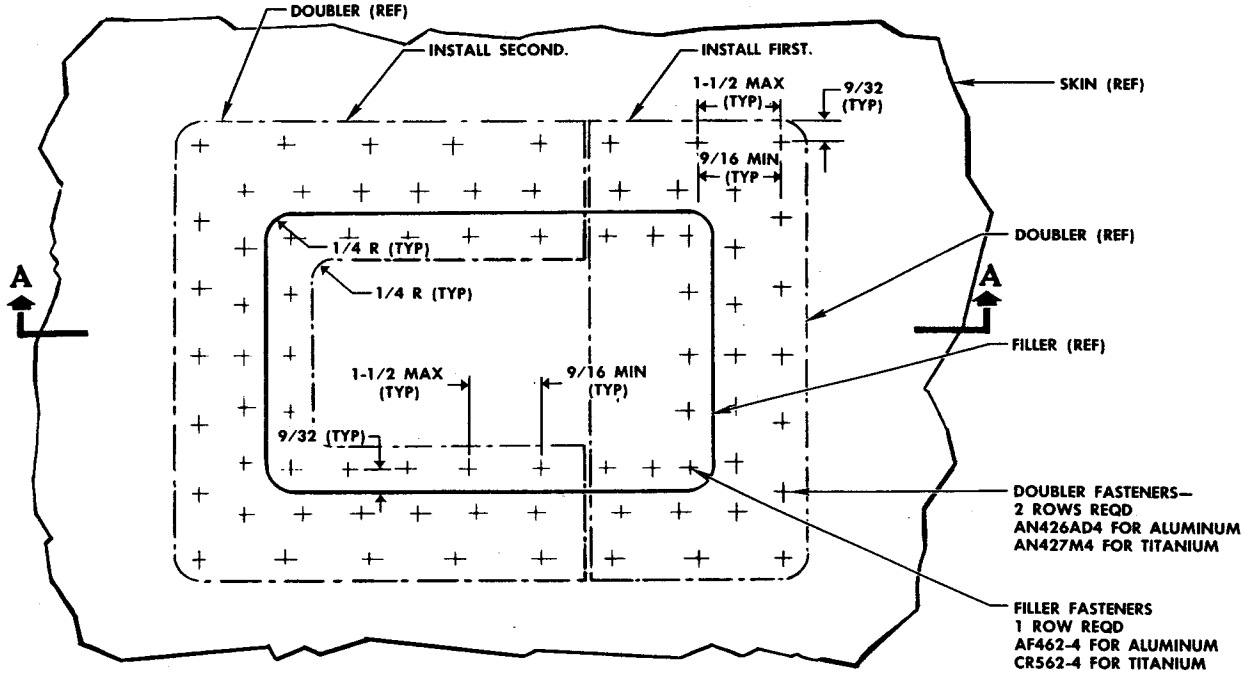
Figure 2A-25. Skin Repair - Blind, Secondary Structure (Sheet 2 of 4)

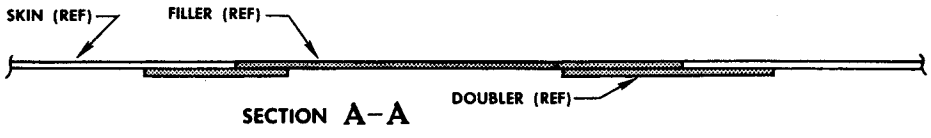
SECONDARY STRUCTURE - BLIND

TYPICAL REPAIR

1. Refer to "Developing a Typical Repair" before using this repair.







SECTION A-A

GEN-3-91-47A

Figure 2A-25. Skin Repair - Blind, Secondary Structure (Sheet 3 of 4)

SECONDARY STRUCTURE—BLIND

TYPICAL REPAIR

1. Refer to "Developing a Typical Repair" before using this repair.

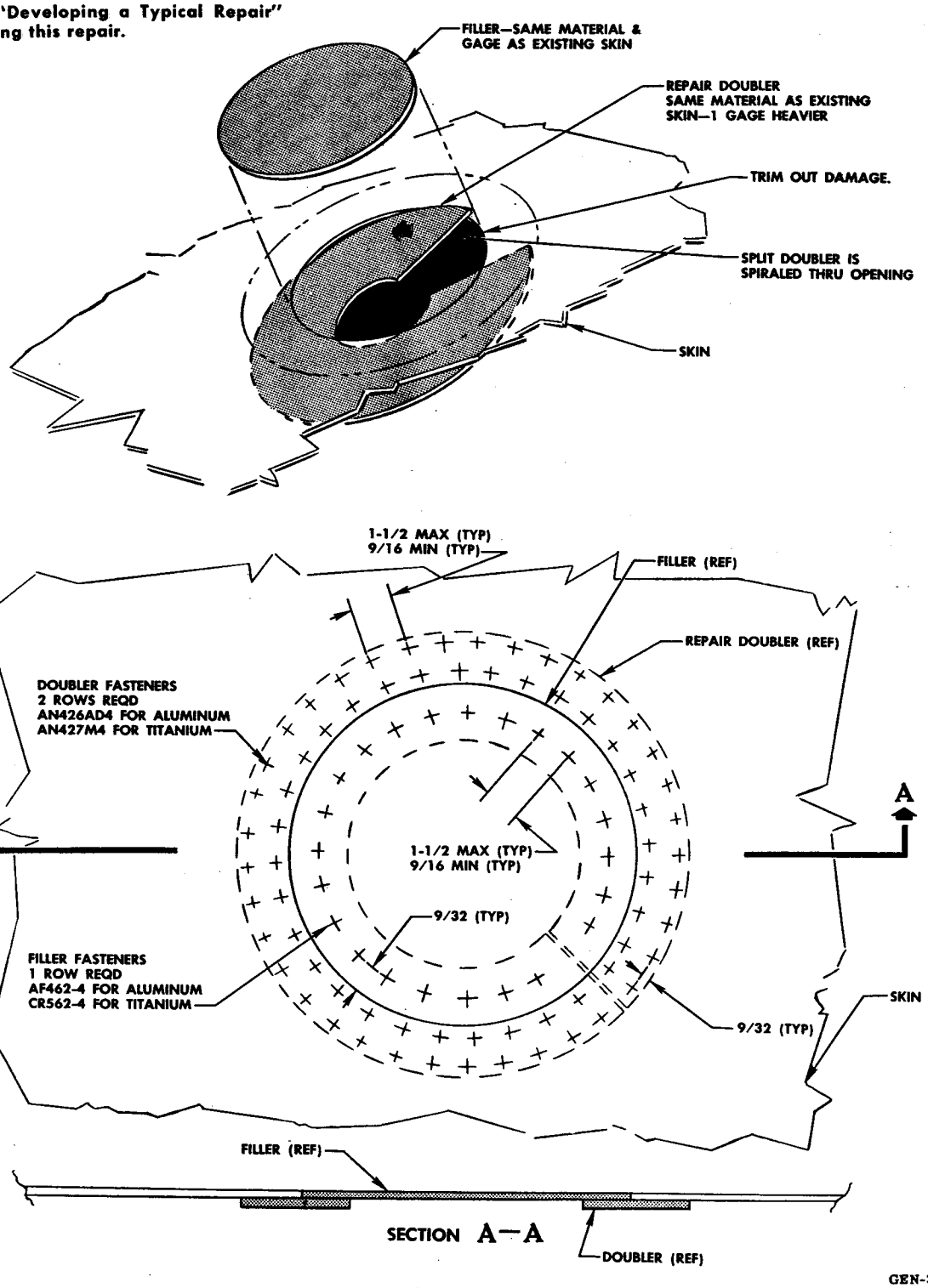


Figure 2A-25. Skin Repair - Blind, Secondary Structure (Sheet 4 of 4)

SKIN END REPAIR—SHEAR AND TENSION

TYPICAL REPAIR

1. Refer to "Developing a Typical Repair" before using this repair.

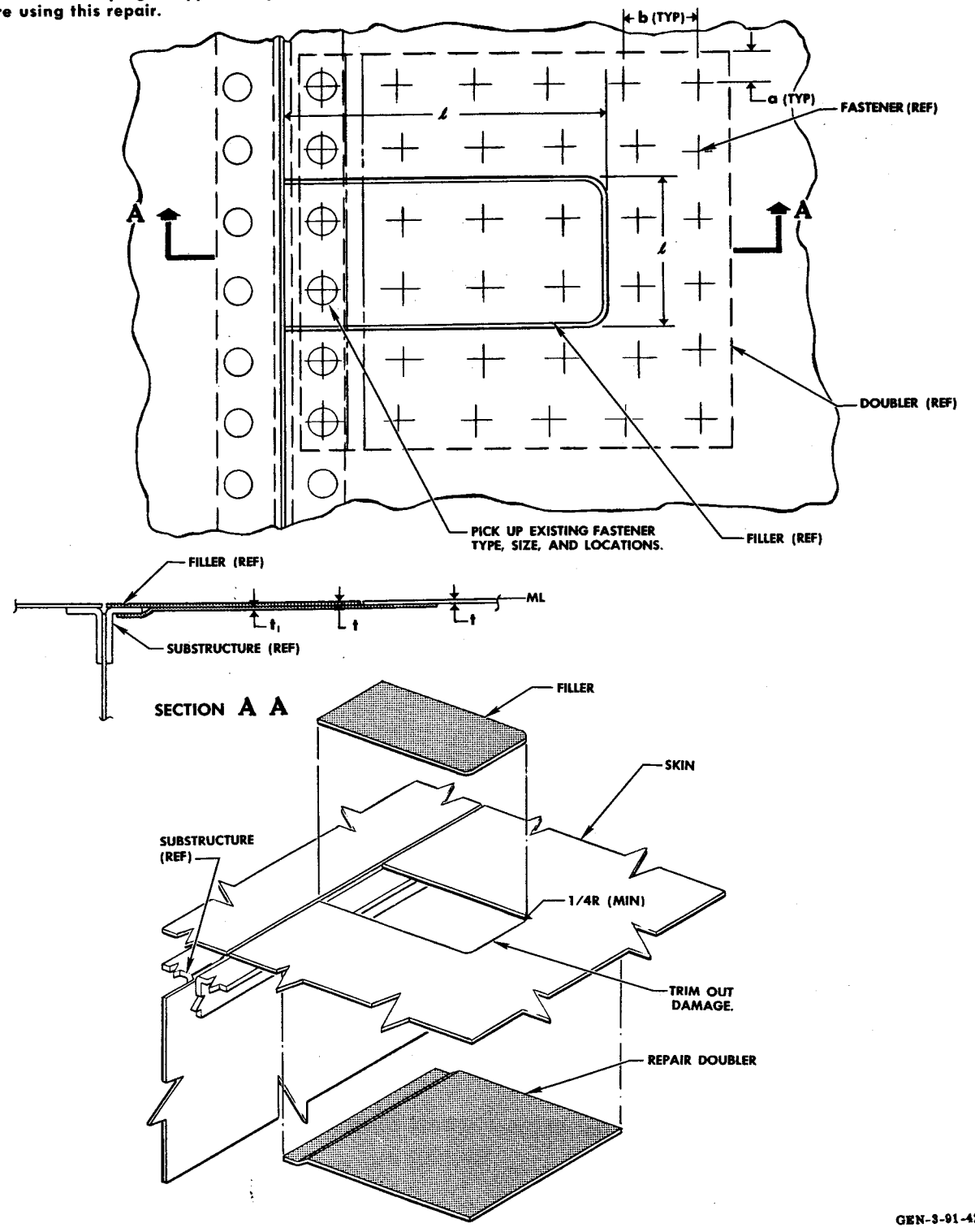
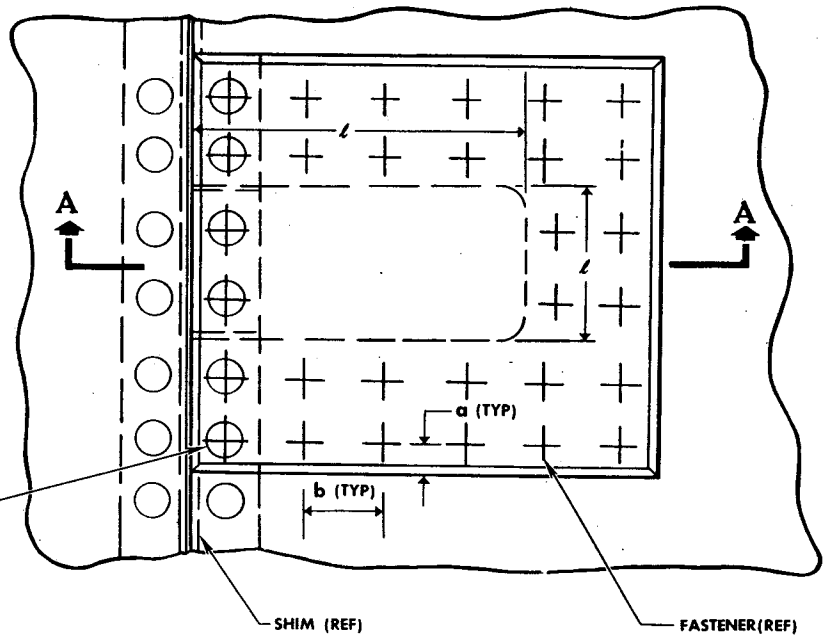


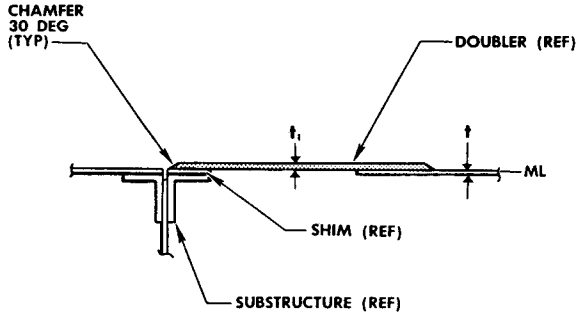
Figure 2A-26. Skin End Repair - Shear and Tension

SKIN END REPAIR—SHEAR AND TENSION

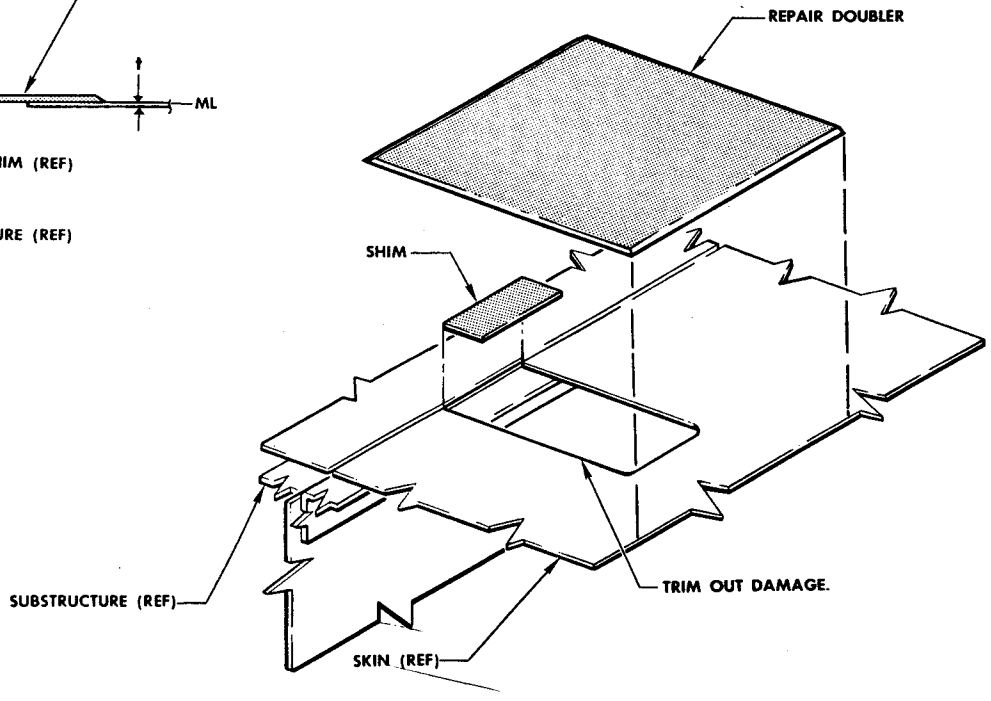
TYPICAL REPAIR

1. Refer to "Developing a Typical Repair" before using this repair.





SECTION A-A



GEN-3-91-41A

Figure 2A-27. Skin End Repair - Shear and Tension, Temporary

SKIN END REPAIR AND TENSION

TYPICAL REPAIR

1. Refer to "Developing a Typical Repair" before using this repair.

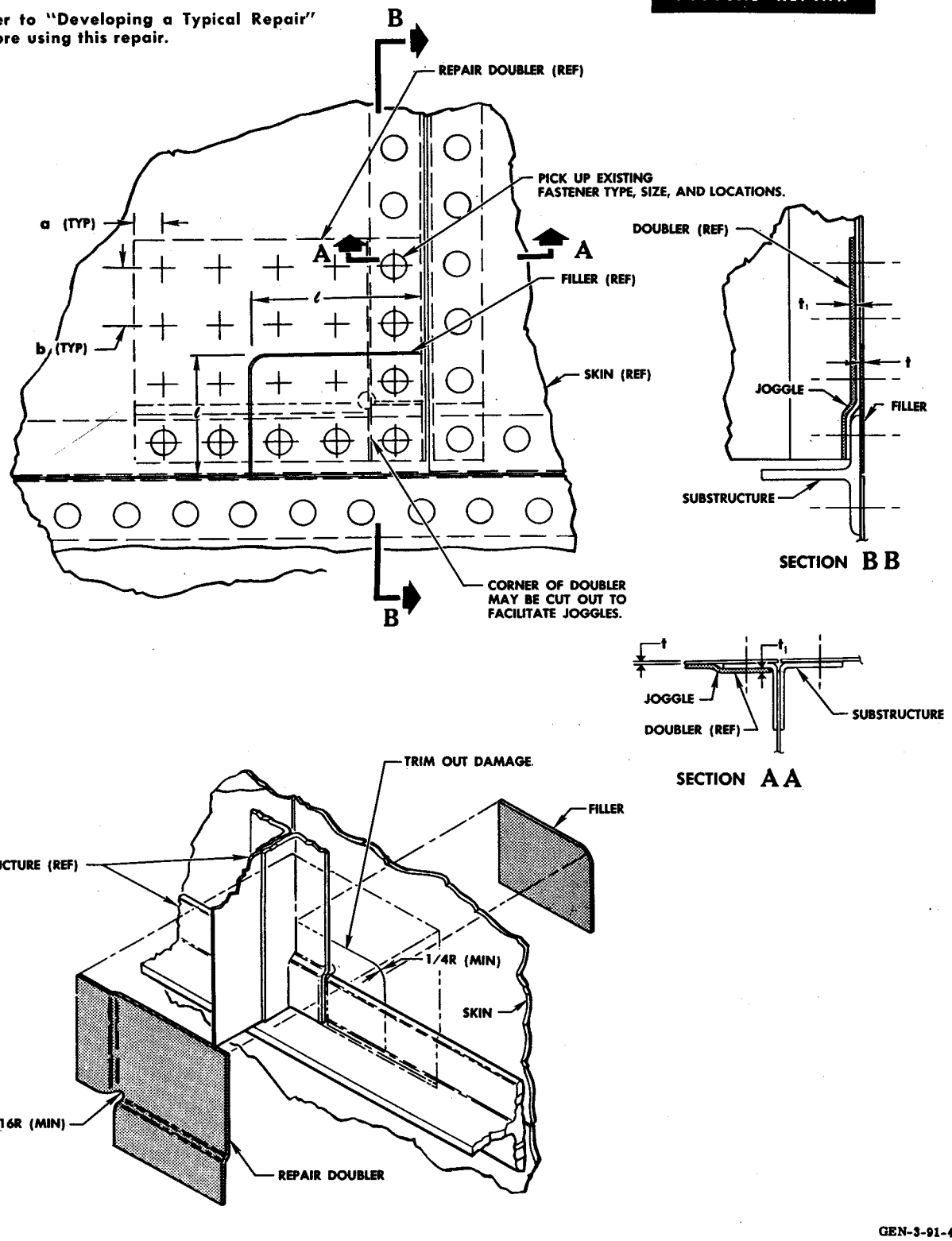
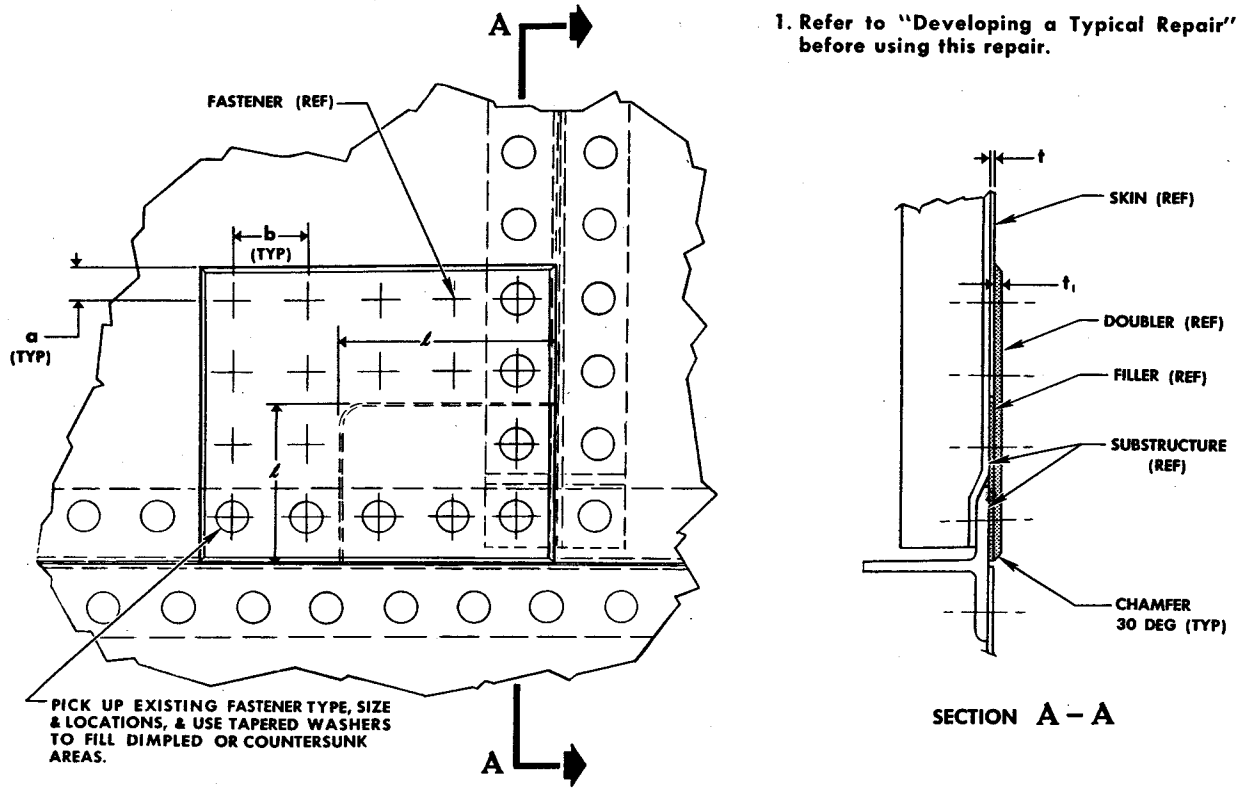
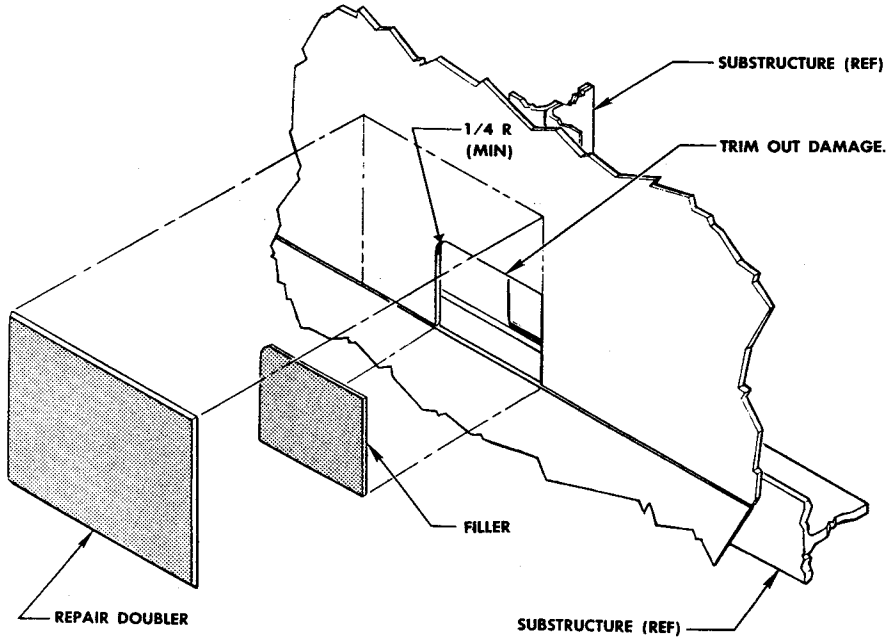


Figure 2A-28. Skin End Repair - Corner, Shear and Tension

SKIN END REPAIR—SHEAR

TYPICAL REPAIR





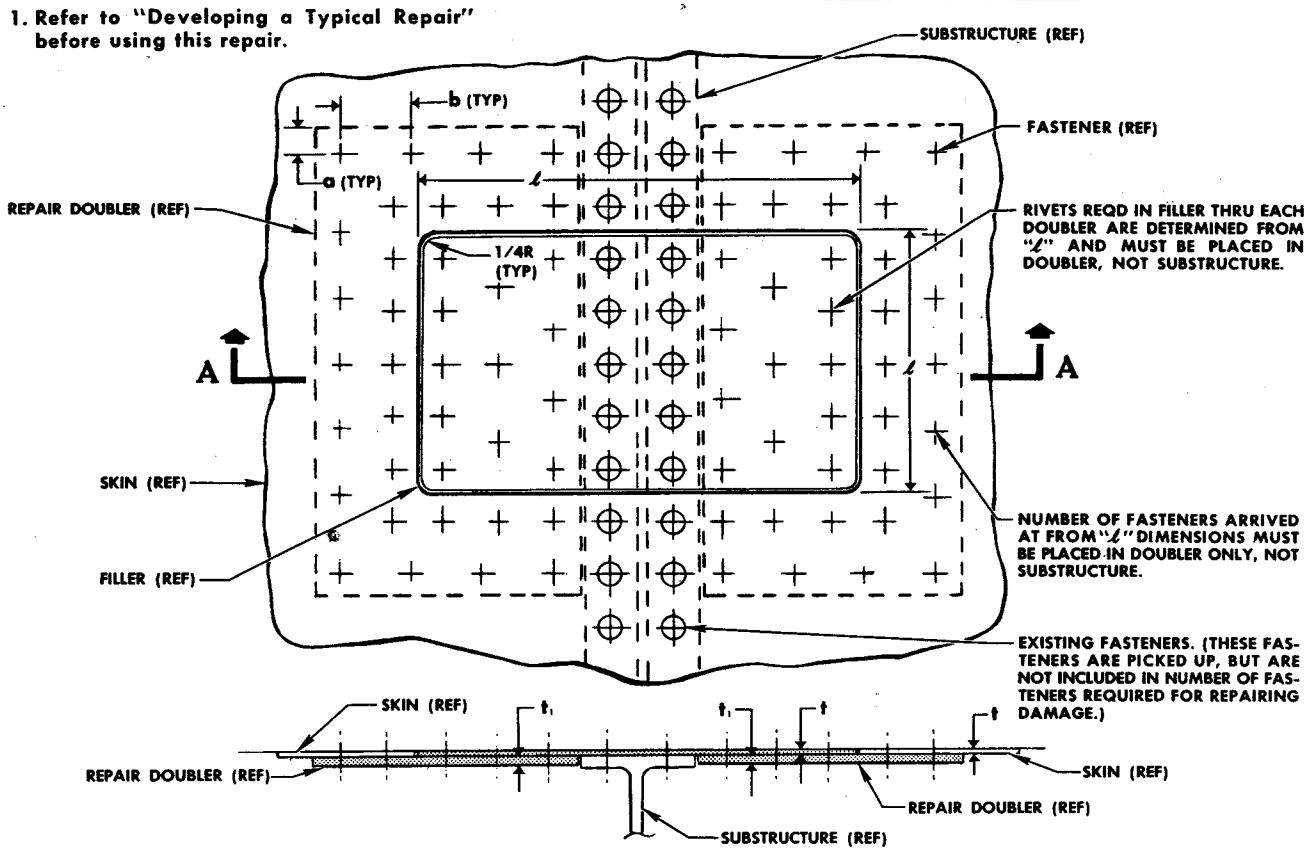
GEN-3-91-43A

Figure 2A-29. Skin End Repair - Corner, Shear and Tension, Temporary

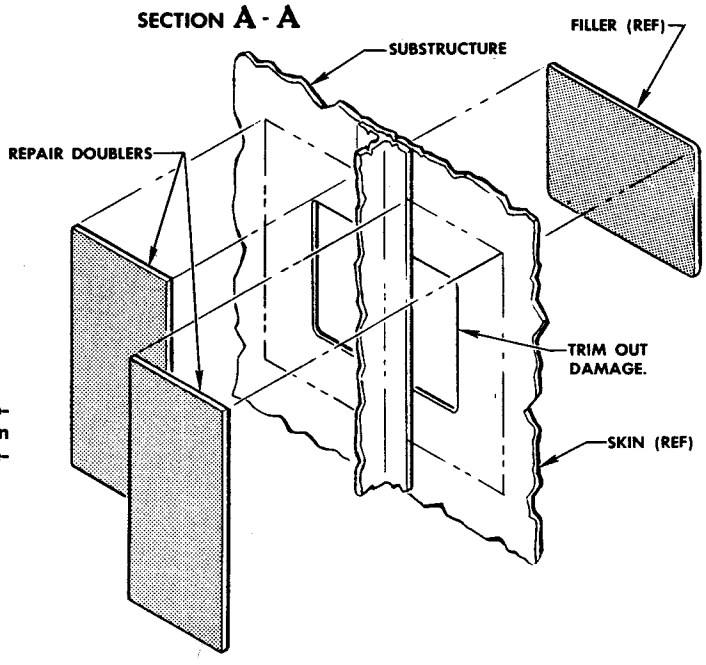
SKIN OVER SUBSTRUCTURE - SHEAR AND TENSION

TYPICAL REPAIR

1. Refer to "Developing a Typical Repair" before using this repair.



SECTION A - A



NOTE This repair loads the substructure and is to be used only on specific approval of the structural repair officer.

GEN-3-91-38A

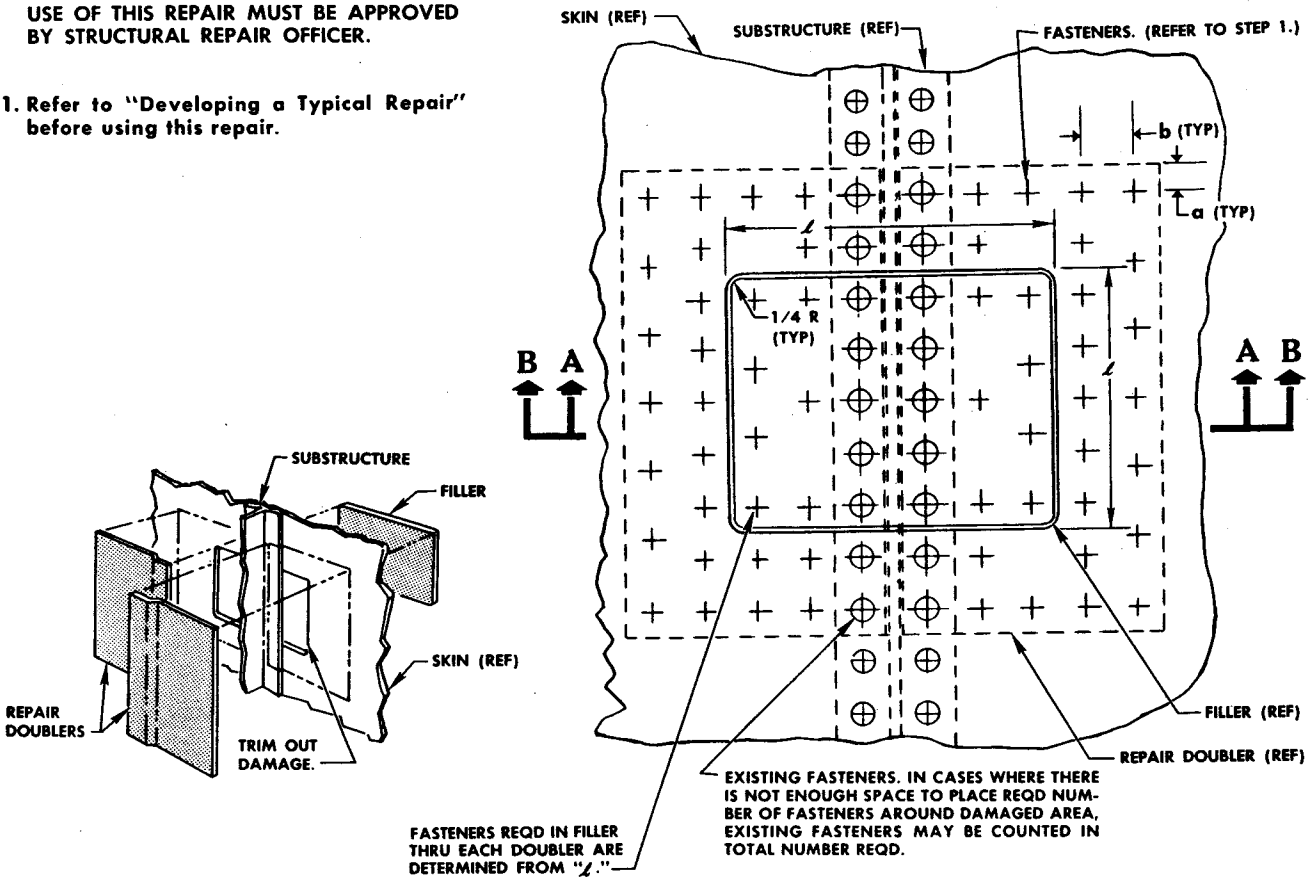
Figure 2A-30. Skin Over Substructure Repair - Shear and Tension (Sheet 1 of 3)

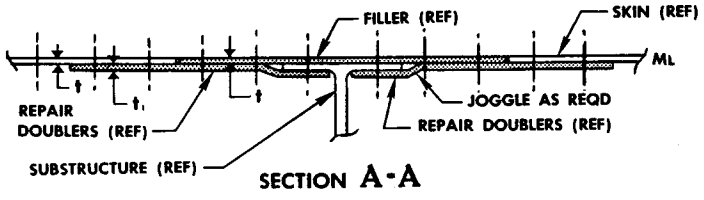
SKIN OVER SUBSTRUCTURE - SHEAR AND TENSION

TYPICAL REPAIR

USE OF THIS REPAIR MUST BE APPROVED BY STRUCTURAL REPAIR OFFICER.

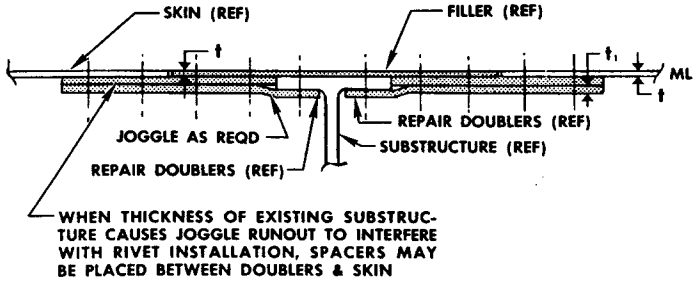
1. Refer to "Developing a Typical Repair" before using this repair.





SECTION A-A

SECTION B-B



GEN-3-91-39A

Figure 2A-30. Skin Over Substructure Repair - Shear and Tension (Sheet 2 of 3)

SKIN OVER SUBSTRUCTURE - SHEAR AND TENSION

TYPICAL REPAIR

1. Refer to "Developing a Typical Repair" before using this repair.

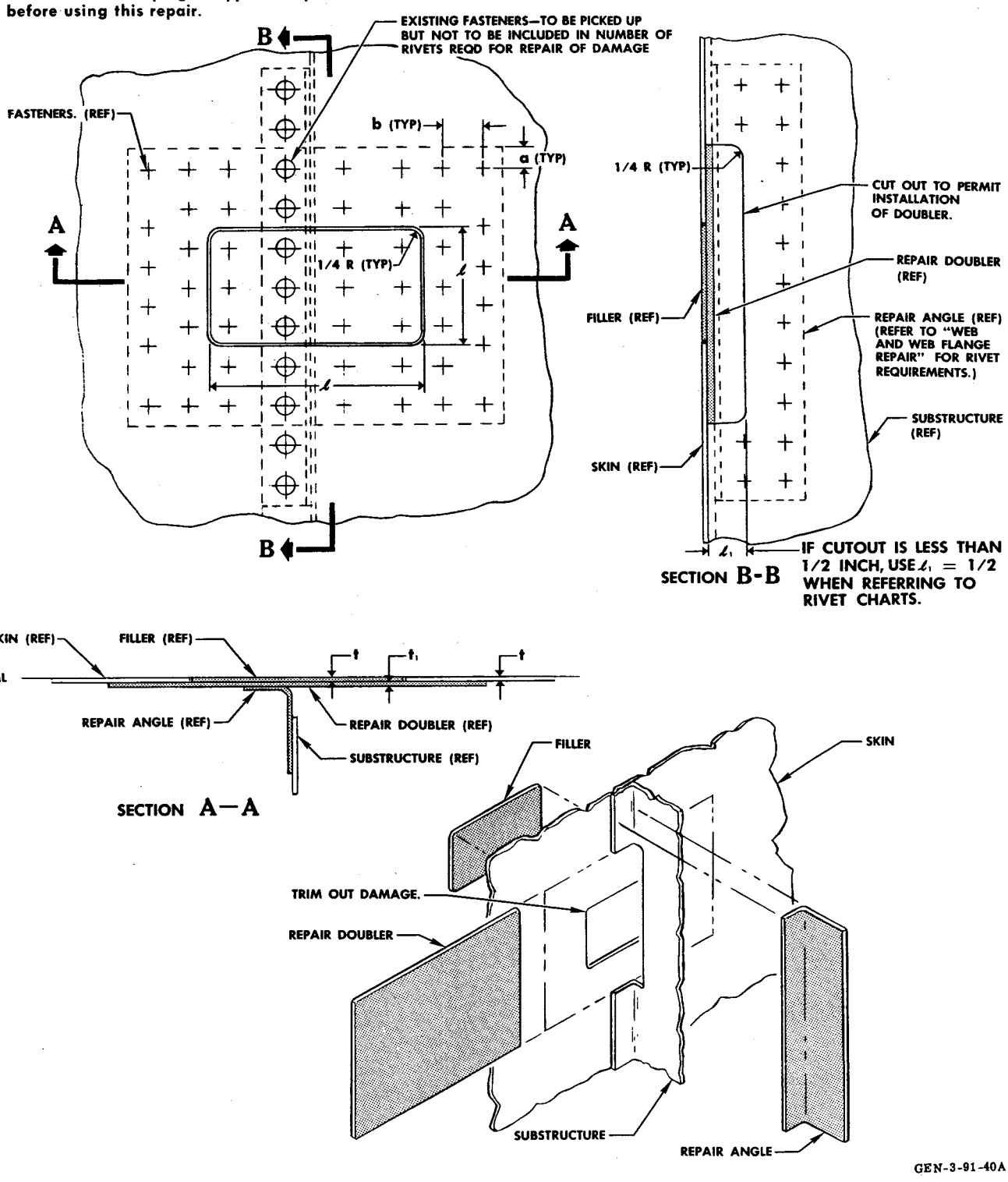


Figure 2A-30. Skin Over Substructure Repair - Shear and Tension (Sheet 3 of 3)

SKIN AT SUBSTRUCTURE - SHEAR AND TENSION

TYPICAL REPAIR

1. Refer to "Developing a Typical Repair" before using this repair.

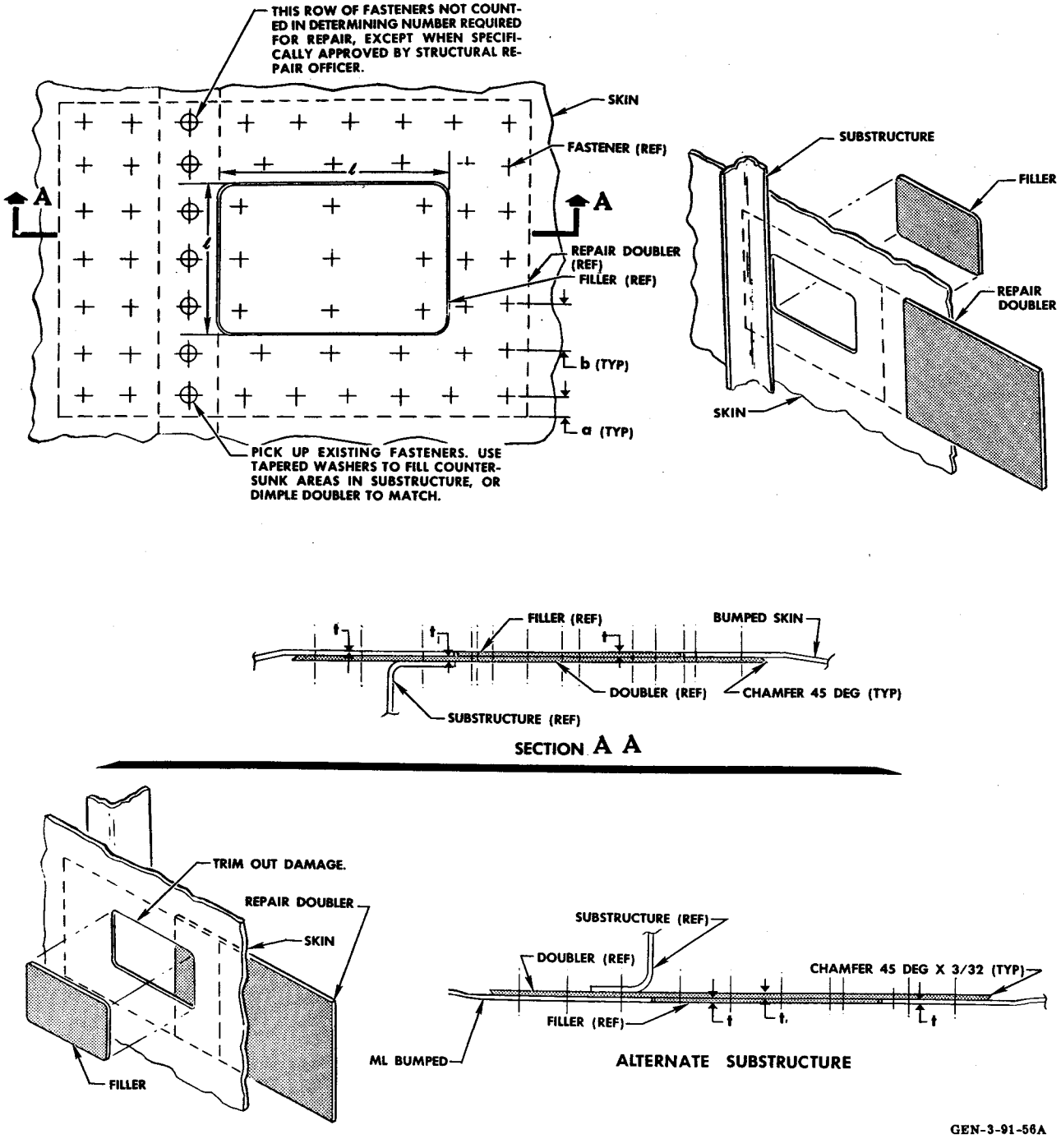


Figure 2A-31. Skin Repair Adjacent to Substructure - Shear and Tension (Sheet 1 of 3)

SKIN AT SUBSTRUCTURE - SHEAR AND TENSION

TYPICAL REPAIR

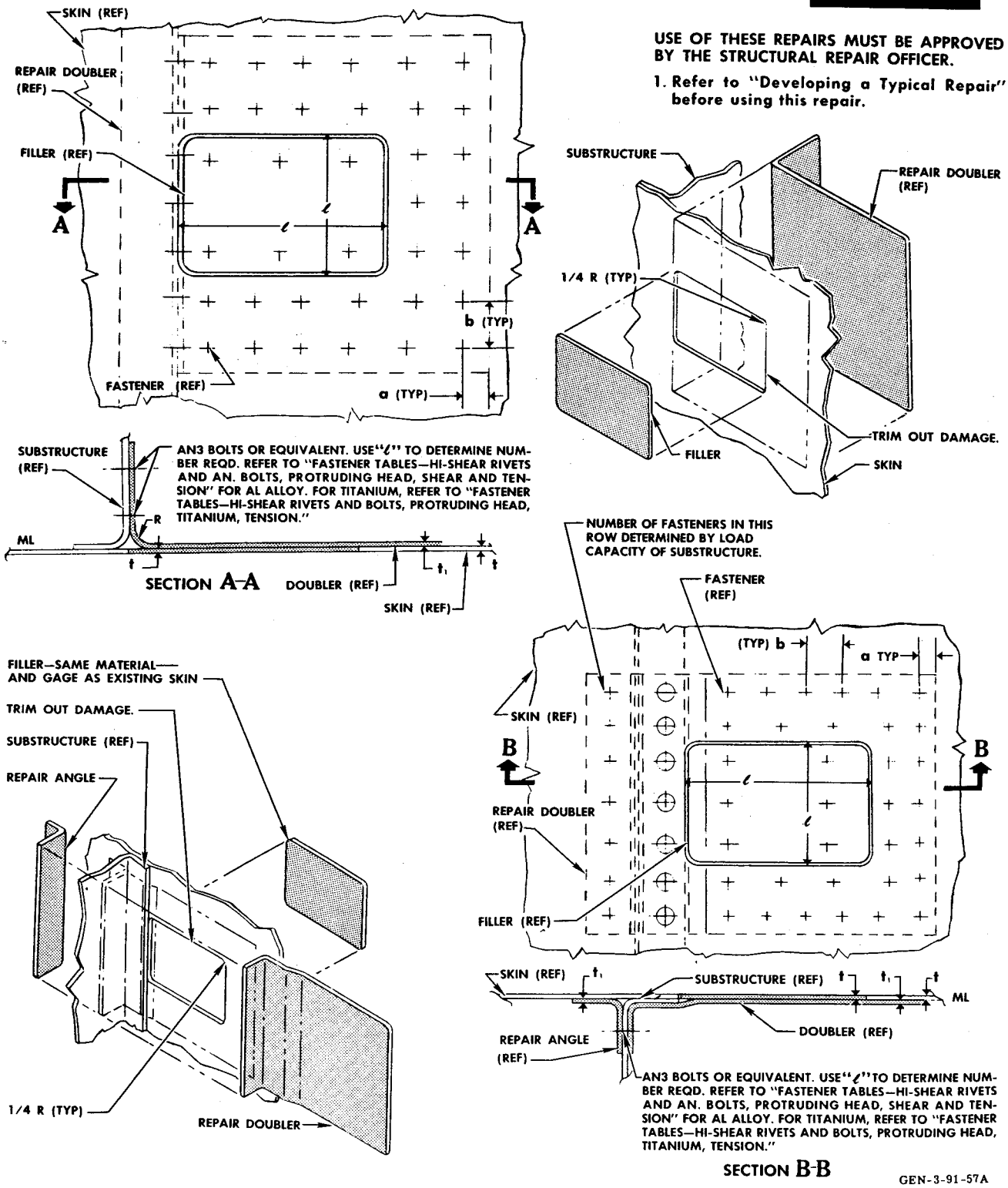


Figure 2A-31. Skin Repair Adjacent to Substructure - Shear and Tension (Sheet 2 of 3)

SKIN AT SUBSTRUCTURE—SHEAR AND TENSION

TYPICAL REPAIR

1. Refer to "Developing a Typical Repair" before using this repair.

USE OF THESE REPAIRS MUST BE APPROVED BY STRUCTURAL REPAIR OFFICER.

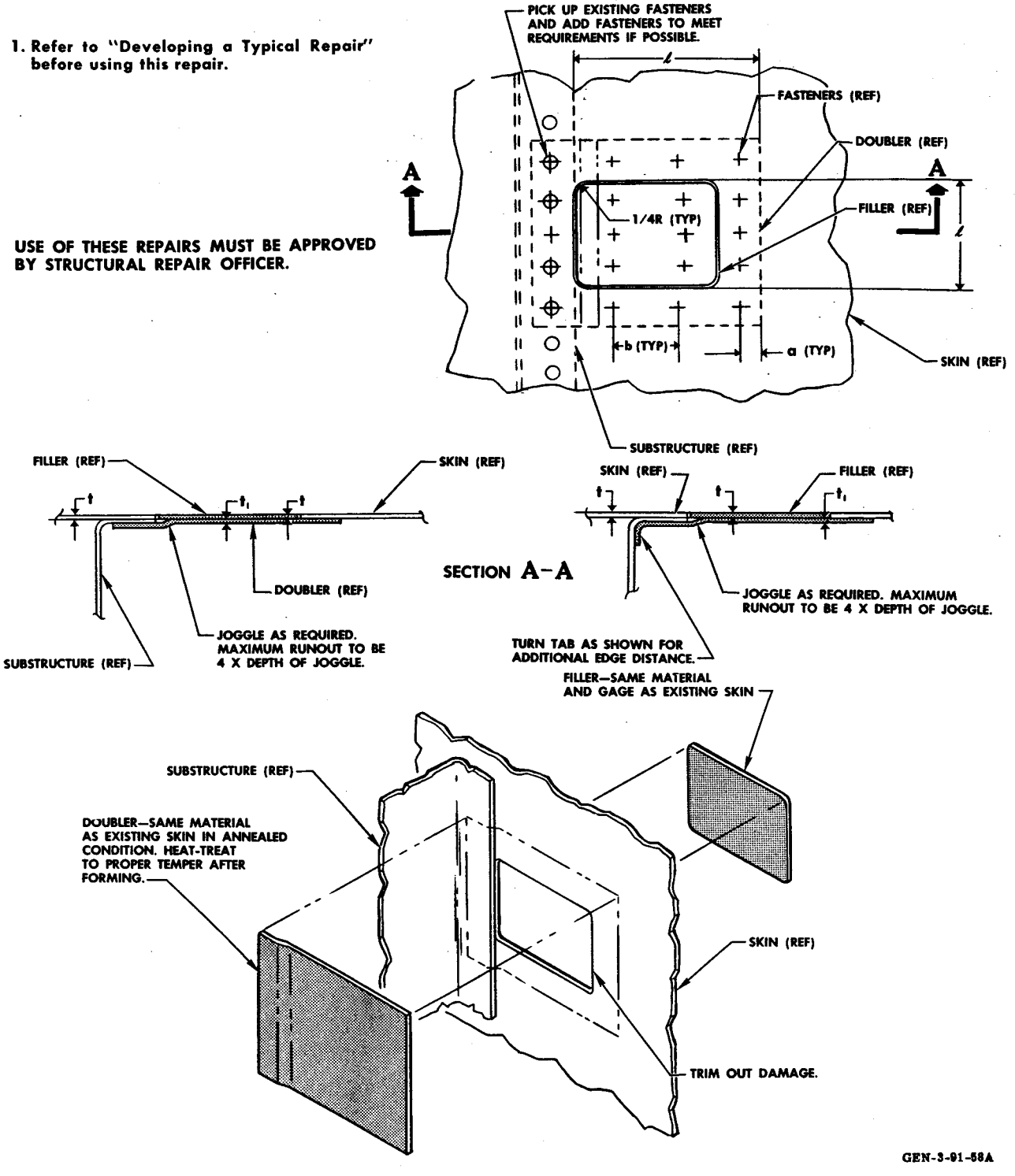
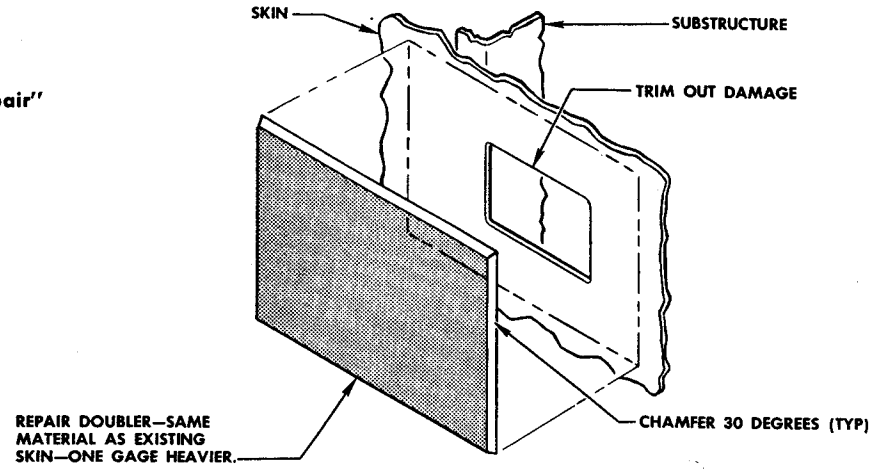


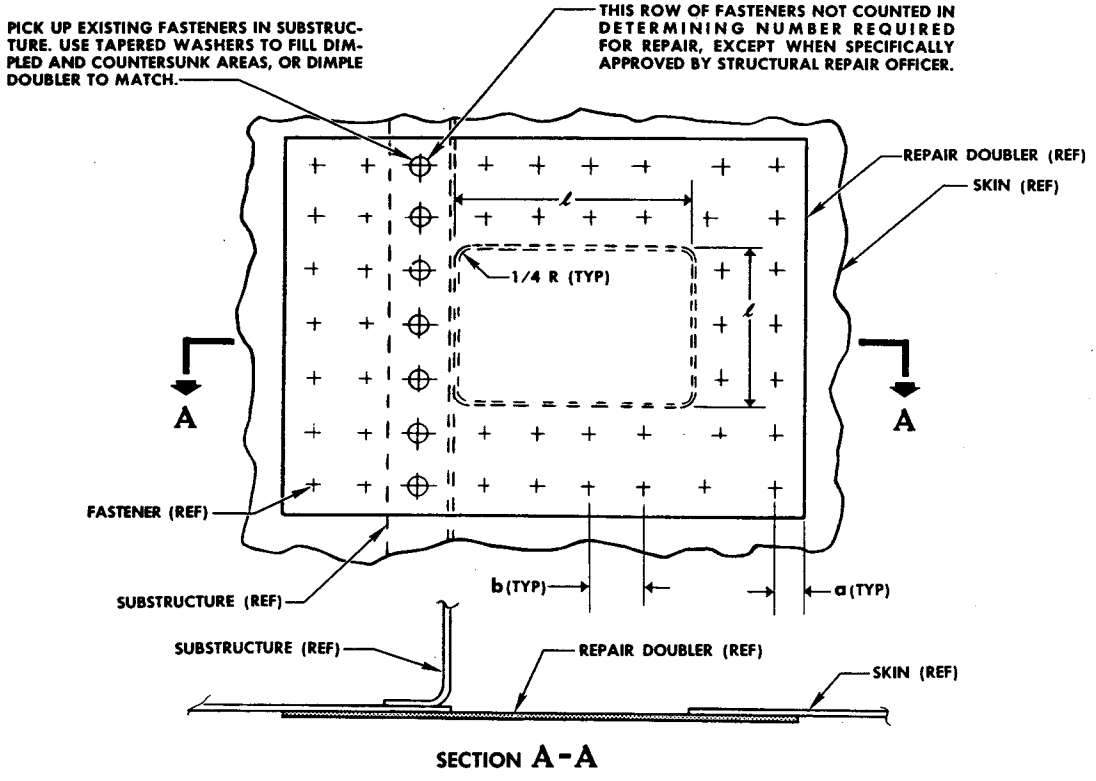
Figure 2A-31. Skin Repair Adjacent to Substructure - Shear and Tension (Sheet 3 of 3)

SKIN AND WEB - SHEAR AND TENSION

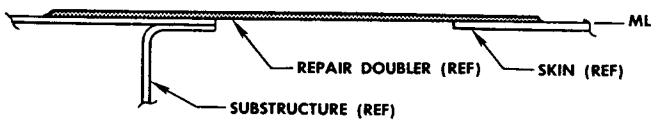
TYPICAL REPAIR

1. Refer to "Developing a Typical Repair" before using this repair.





SECTION A-A



ALTERNATE CONDITION

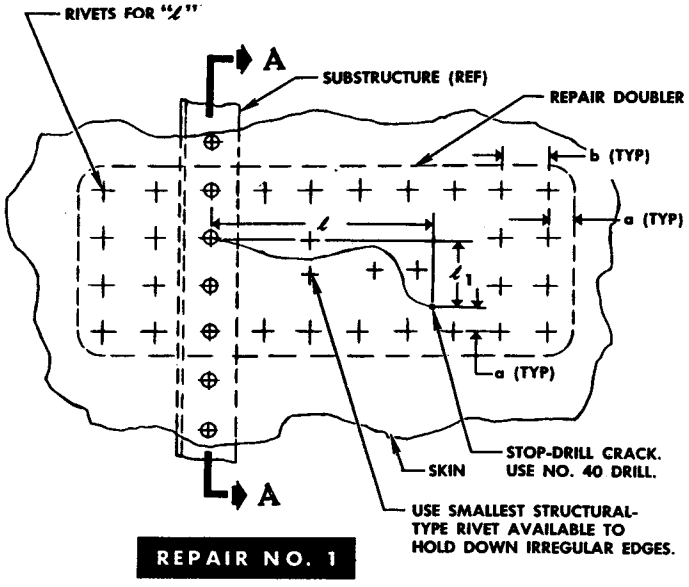
GEN-3-91-55A

Figure 2A-32. Skin Repair Adjacent to Substructure - Shear and Tension, Temporary

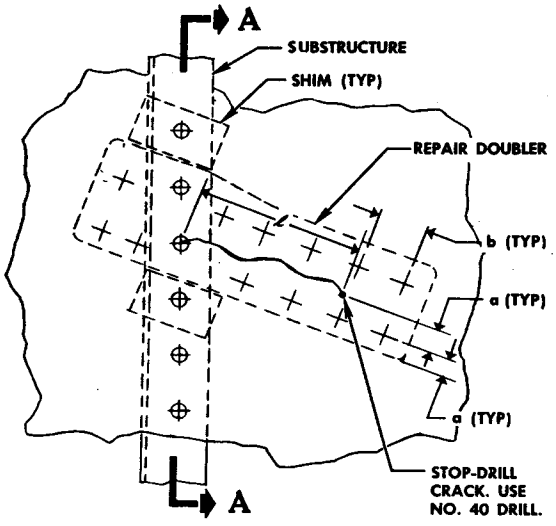
SKIN AND WEB

TYPICAL REPAIR

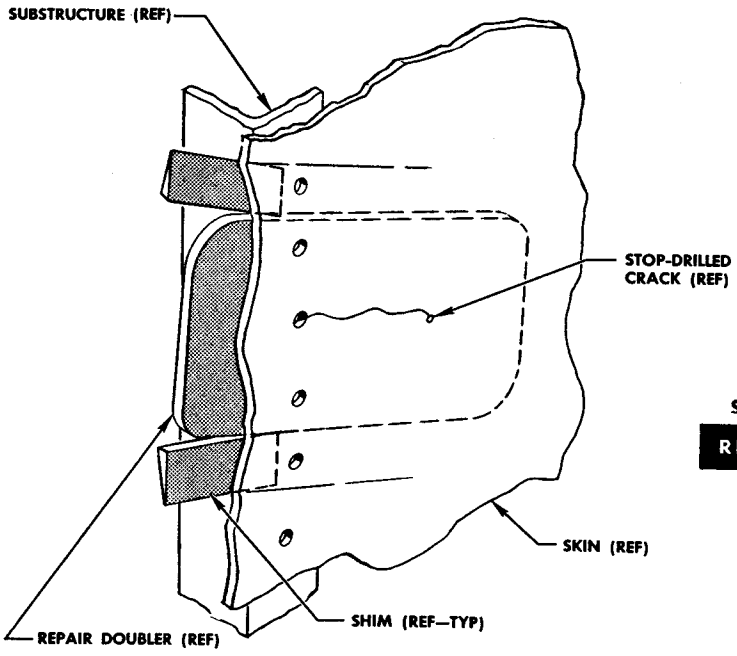
1. Refer to "Developing a Typical Repair" before using this repair.

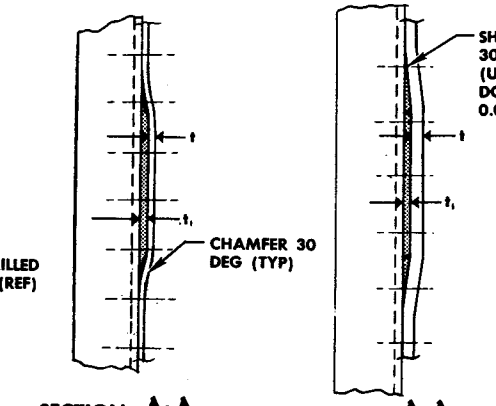


REPAIR NO. 1



REPAIR NO. 2





REPAIR NO. 1 REPAIR NO. 2

NOTE Distribute rivets approximately as shown. When the crack deviates from a generally straight line, it should be treated as a rectangle with two "ℓ" dimensions.

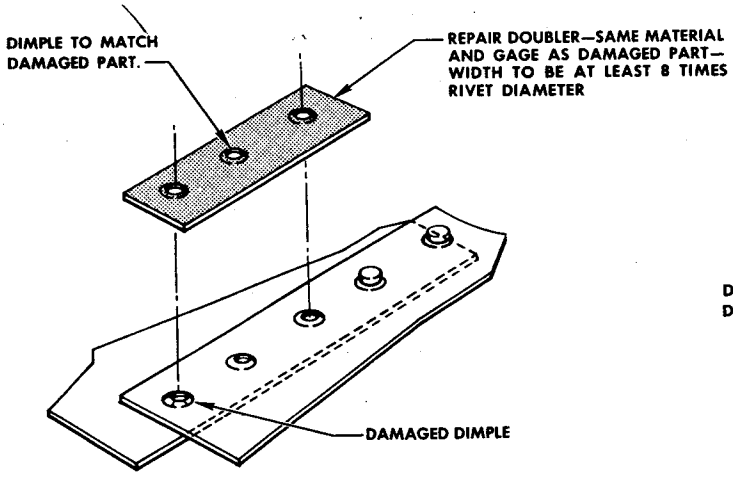
• When doubler material is 0.040 inch or less, chamfer edges as shown in repair No. 1. When the doubler material is over 0.040 inch, shims should be used, as shown in repair No. 2.

GEN-3-91-81A

Figure 2A-33. Cracked Skin and Web Repair

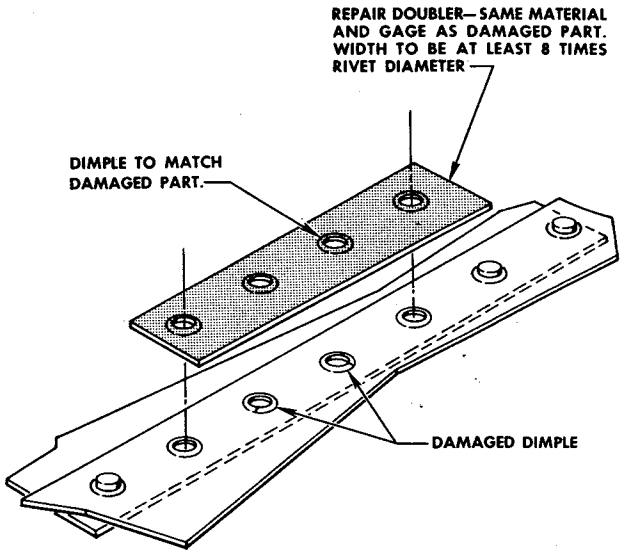
CRACKED DIMPLE

TYPICAL REPAIR

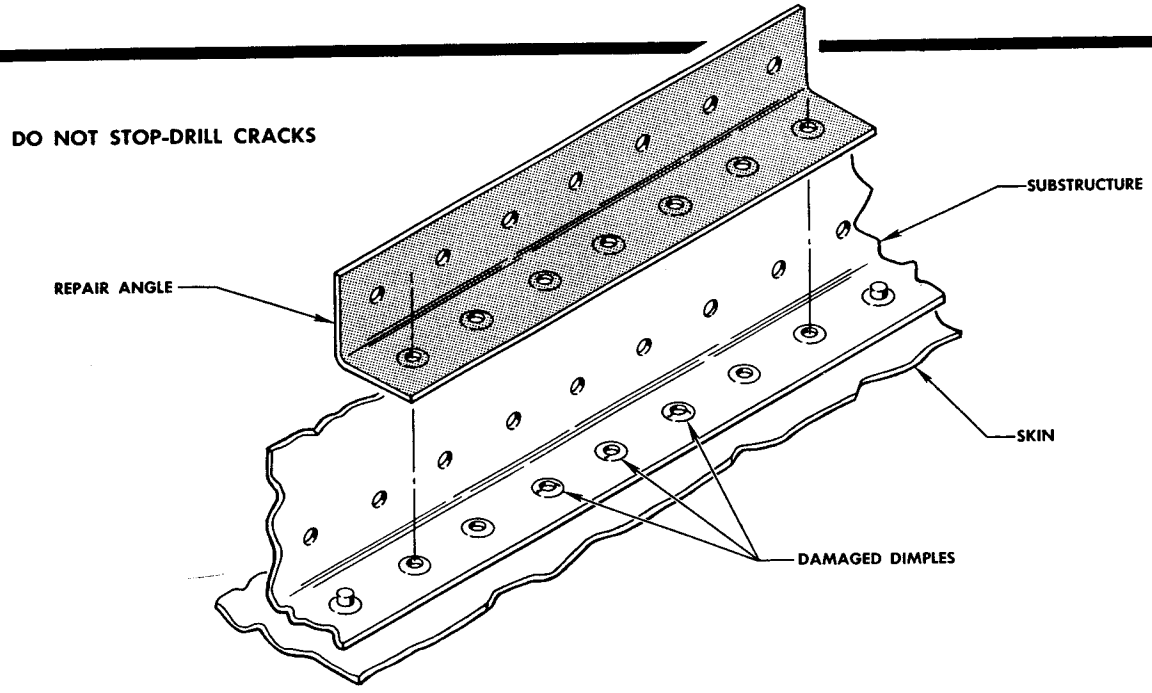


END DIMPLE REPAIR

DO NOT STOP-DRILL CRACKS



TWO DIMPLE REPAIR

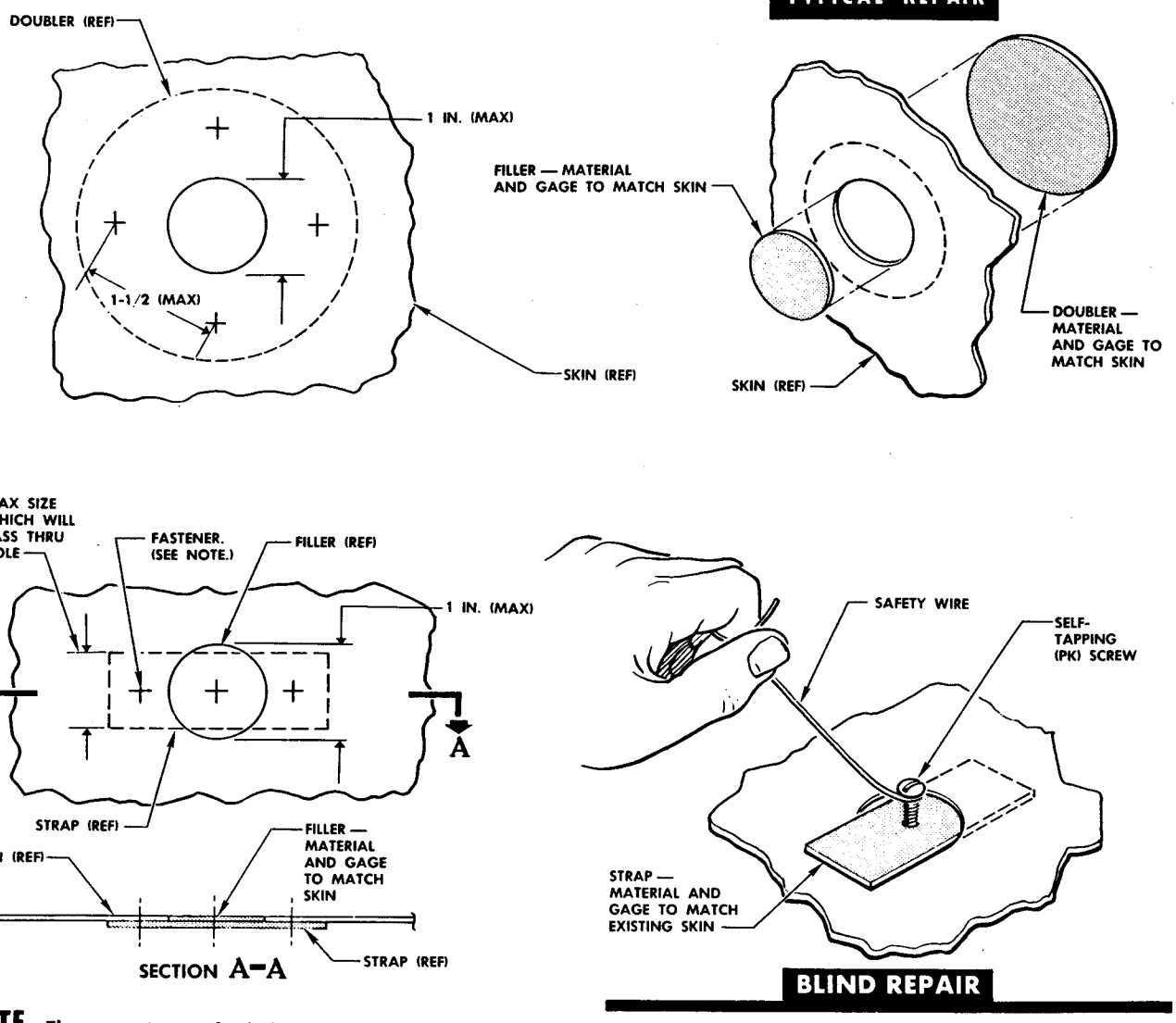


ADJACENT DIMPLE REPAIR

GEN-3-91-89

Figure 2A-34. Cracked Dimple Repair

MINOR HOLES



NOTE These repairs are for holes shown as *negligible*, on negligible damage illustrations.

- (The self-tapping screw and safety wire are suggested as means for holding the strap while it is being positioned, drilled, and riveted.)
- Use 3/32- or 1/8-inch flush rivets. (Refer to minimum countersink thickness table.) When 3/32-inch hollow Cherry rivets are used, the hole in the rivet must be plugged with aerodynamic skin filler. Use 3/32- or 1/8-inch universal head rivets in materials under 0.032 inch when material cannot be dimpled.
- Minor hole repairs in sealed areas must be sealed the same as the surrounding area.
- Aerodynamic sealer may be used around the edge of the filler to obtain a smooth outer surface.
- The circular repair doubler shown may be used on the outside of the skin as a temporary repair. Install with flush rivets and chamfer edges of the patch.

MINIMUM MATERIAL THICKNESS FOR COUNTERSINKING

RIVET			MATERIAL
DIA	AN426	CHERRY	
3 32	AD3	CR-116-3	0.032
1/8	AD4	AF462-4	0.040

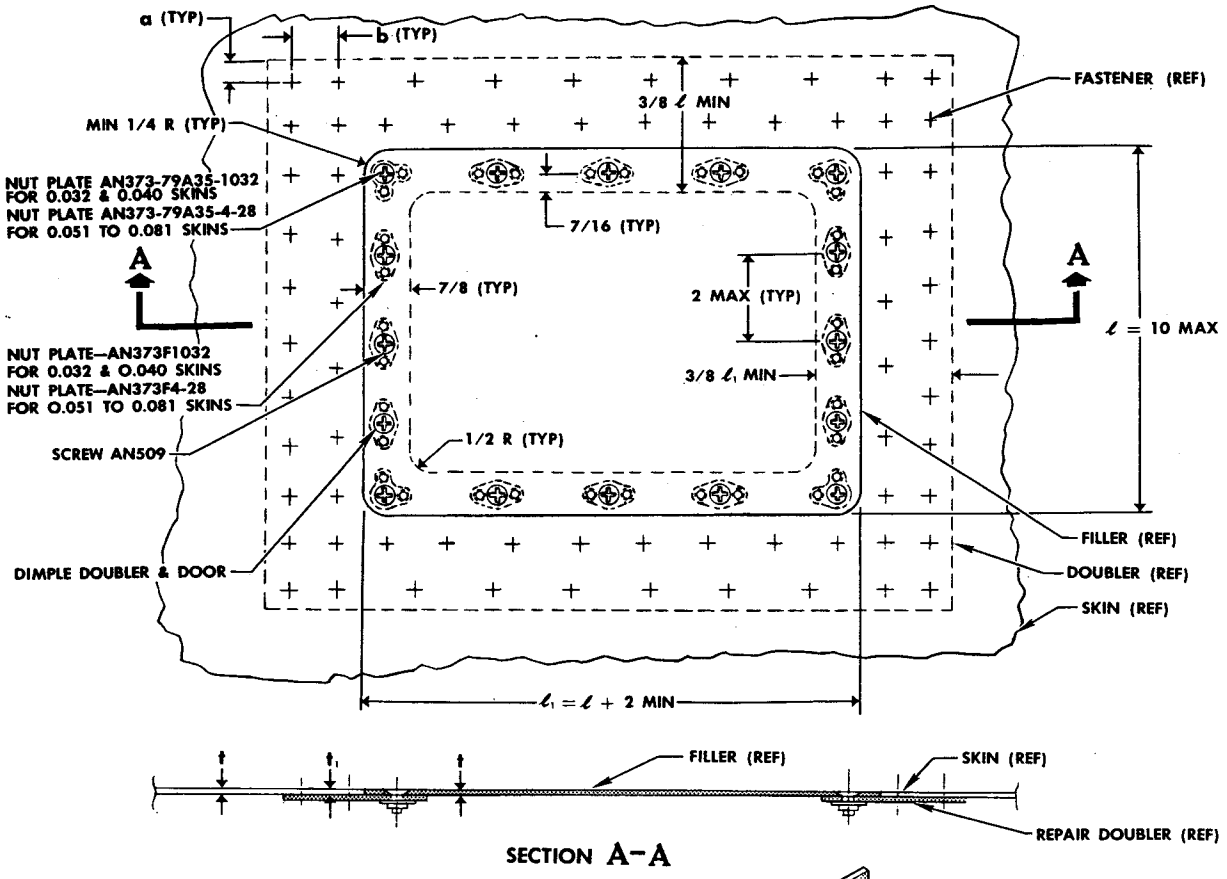
GEN-3-91-90

Figure 2A-35. Minor Hole Repairs

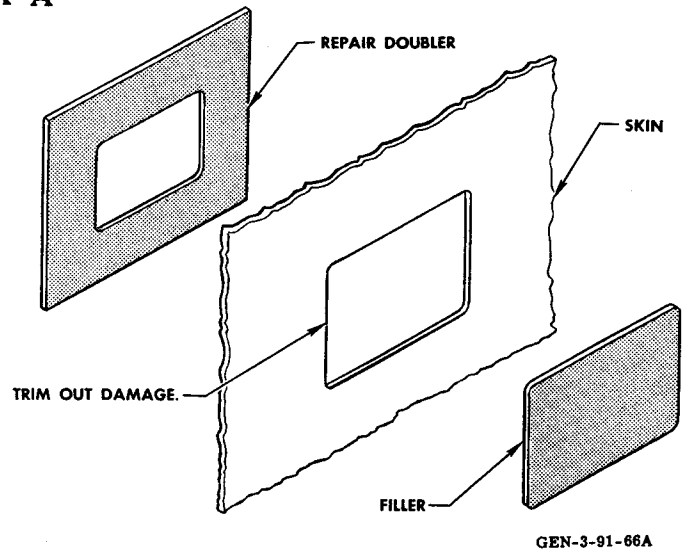
STRUCTURAL DOOR - SHEAR AND TENSION

TYPICAL REPAIR

1. Refer to "Developing a Typical Repair" before using this repair.



SECTION A-A



NOTE This repair applies to 0.032- through 0.081-inch skins.

• For both "ℓ" and "ℓ1" dimensions, refer to "ℓ" column in fastener tables.

Figure 2A-36. Access Door - Installation of - Shear and Tension

CRACKS—SHAPES AND EXTRUSIONS

TYPICAL REPAIR

1. Refer to "Developing a Typical Repair" before using this repair.

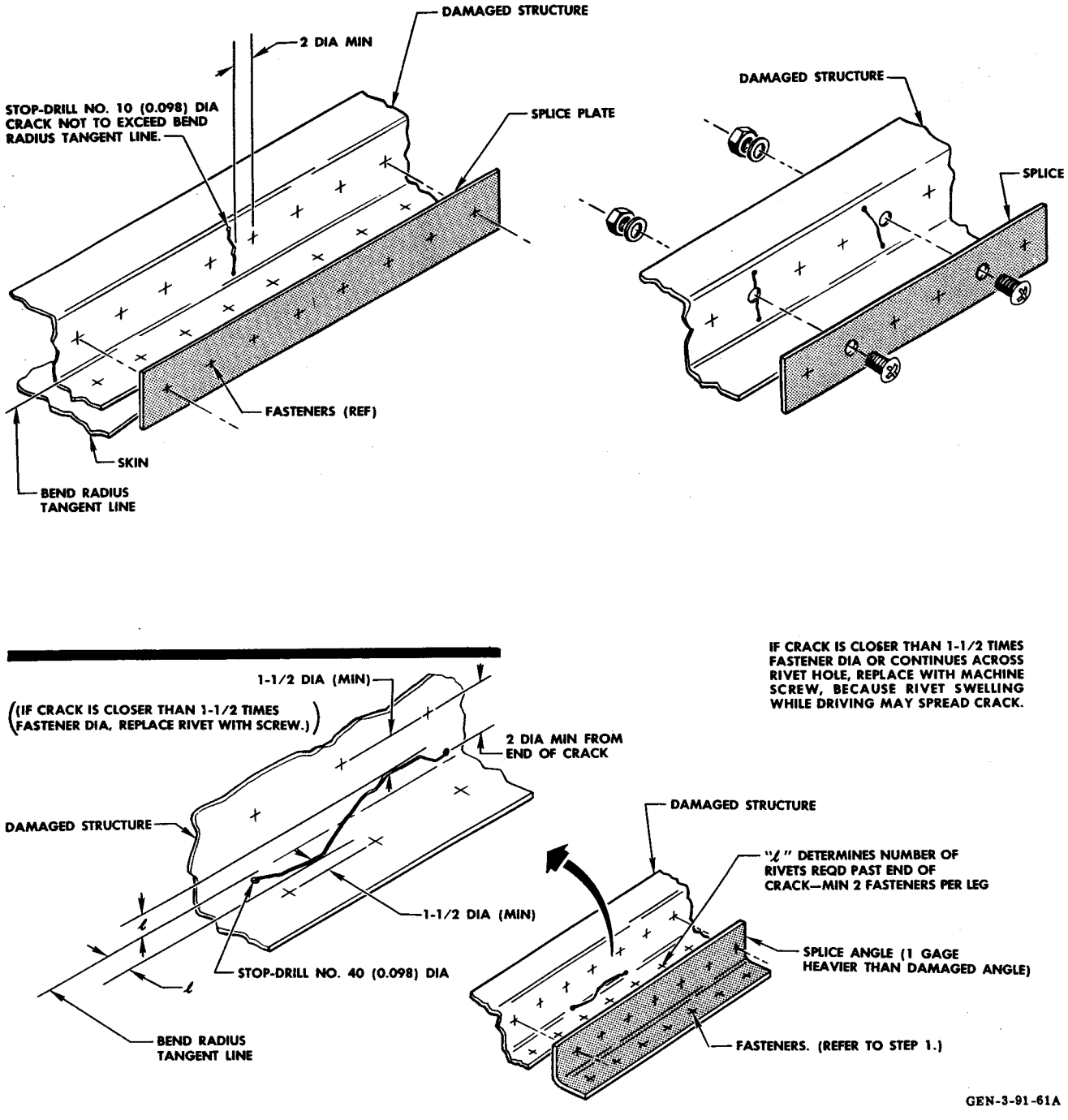


Figure 2A-37. Sheet-metal Shapes and Extrusions - Crack Repairs (Sheet 1 of 2)

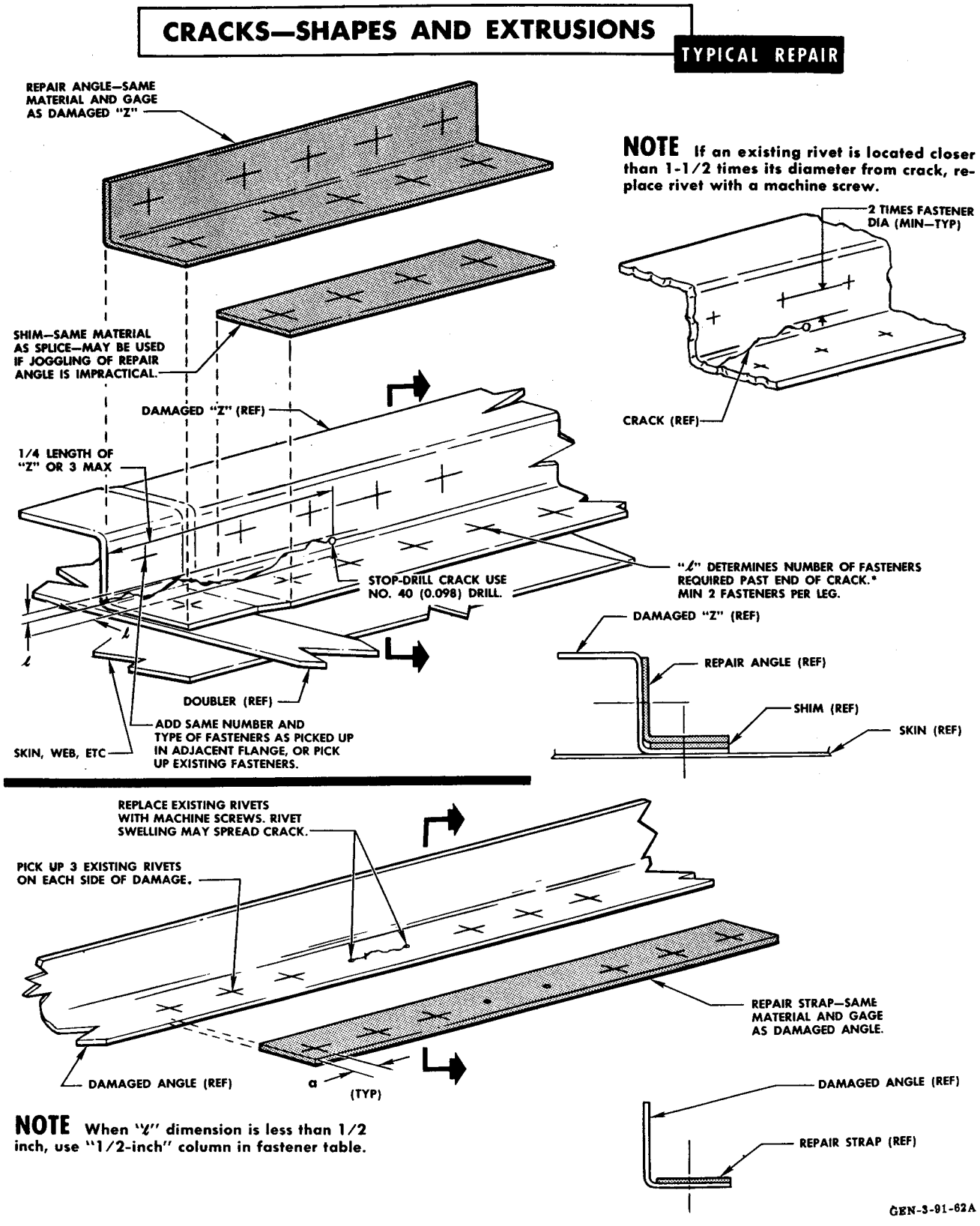
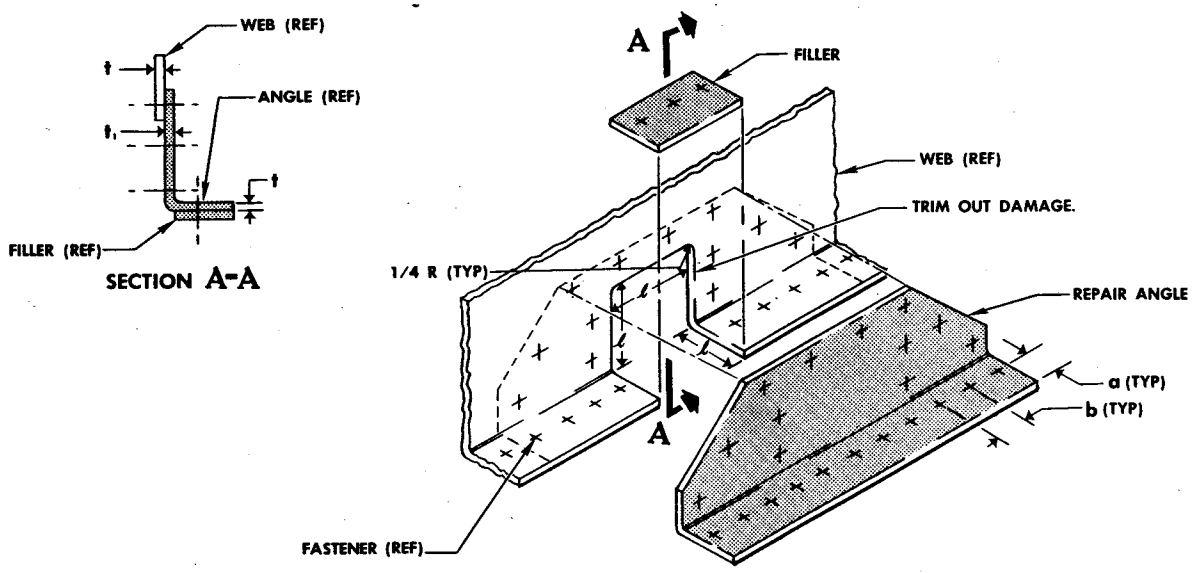


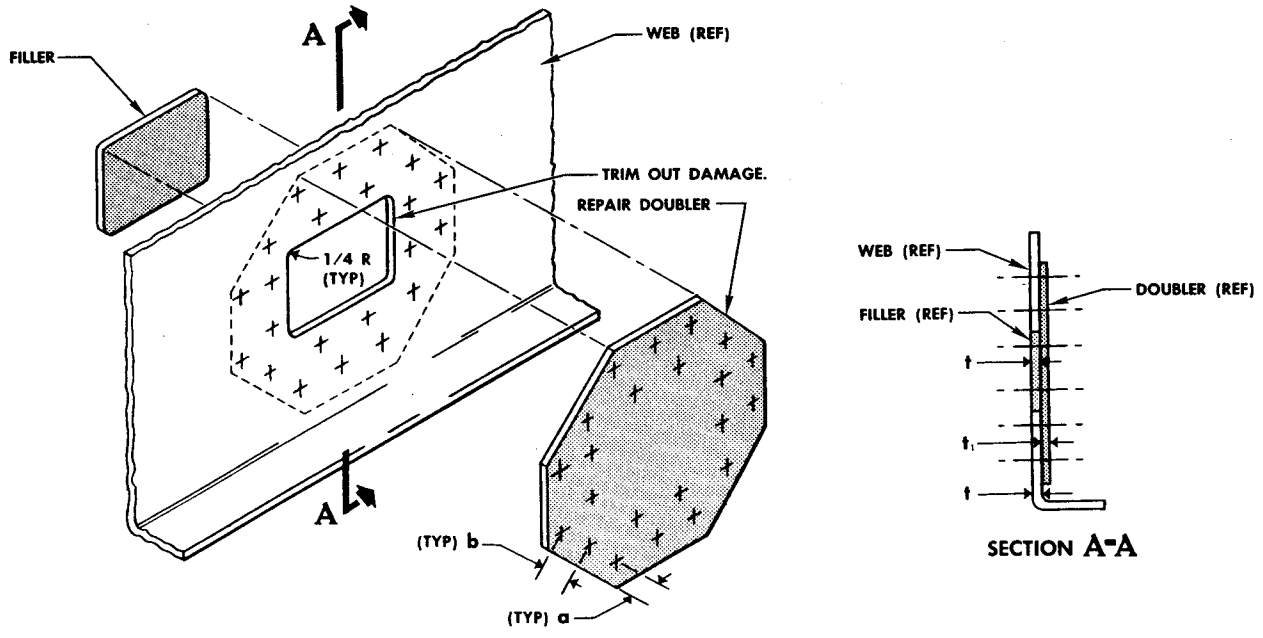
Figure 2A-37. Sheet-metal Shapes and Extrusions - Crack Repairs (Sheet 2 of 2)

WEB AND FLANGE

TYPICAL REPAIR

1. Refer to "Developing a Typical Repair" before using this repair.



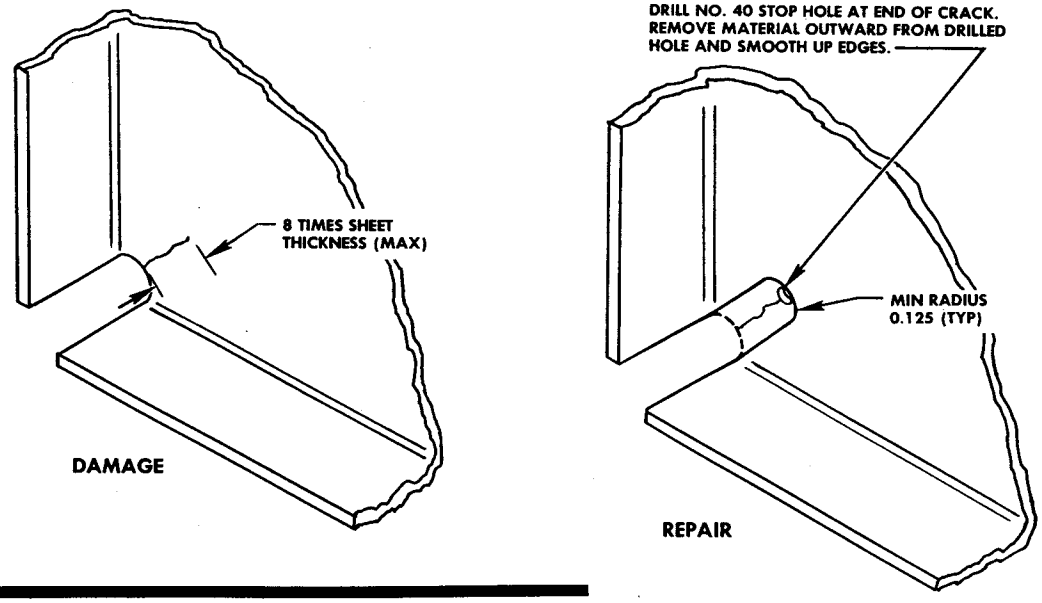


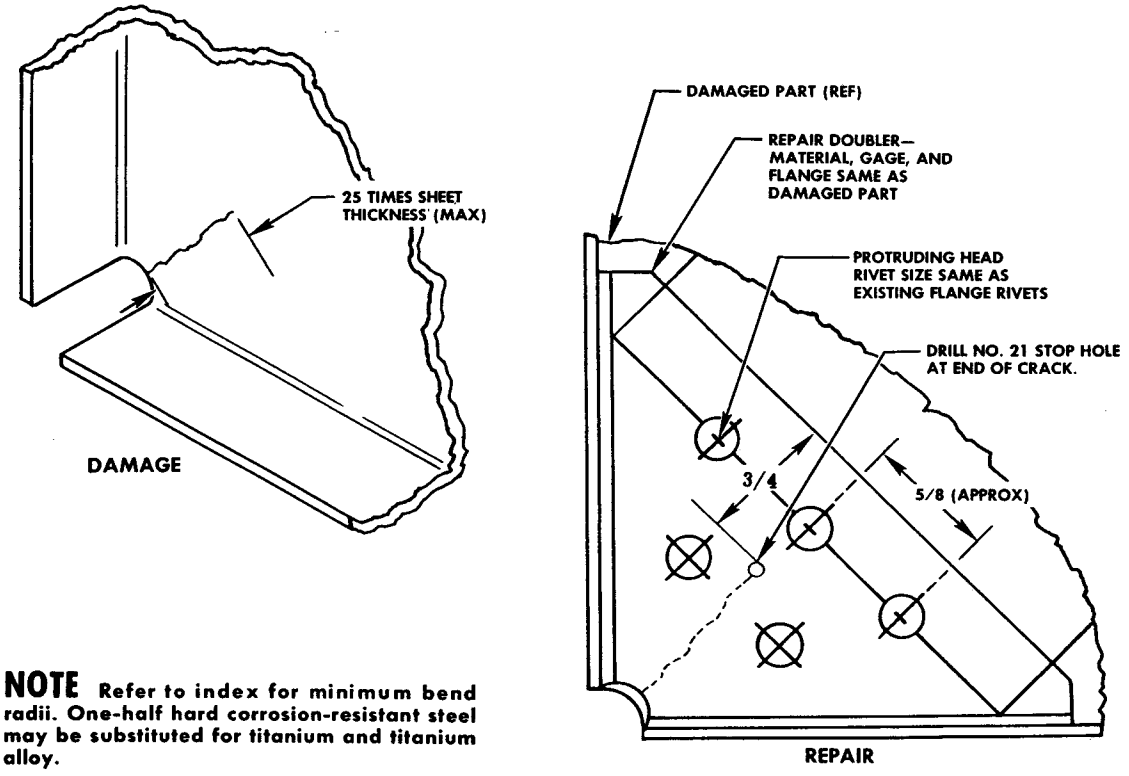
GEN-3-91-63A

Figure 2A-38. Web and Web Flange Repair

DOUBLE FORMED FLANGES

TYPICAL REPAIR





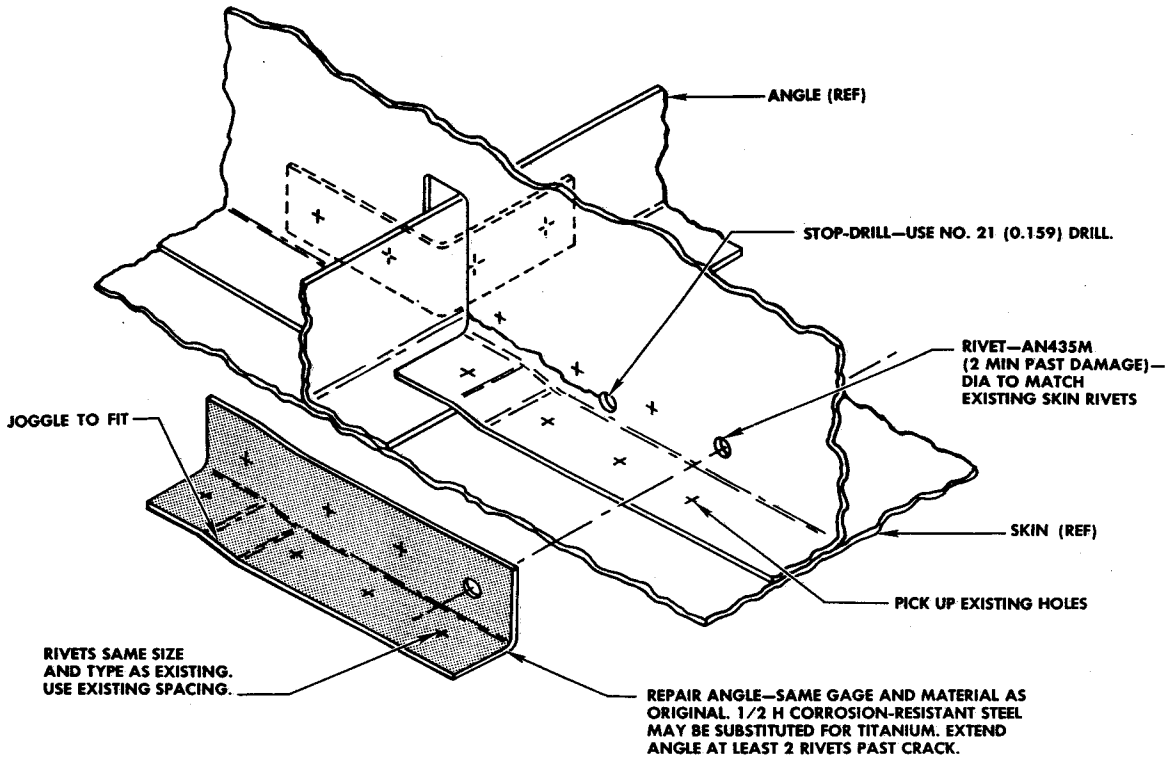
NOTE Refer to index for minimum bend radii. One-half hard corrosion-resistant steel may be substituted for titanium and titanium alloy.

GEN-3-91-69A

Figure 2A-39. Double Formed Flange Repairs

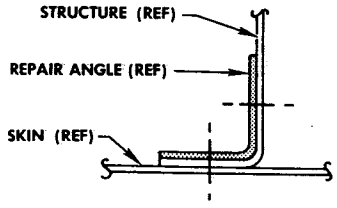
FORMED-FLANGE CRACKS

TYPICAL REPAIR



NOTE This repair is applicable to material of 0.063-inch maximum thickness.

- For minimum bend radii, refer to index.
- The minimum fastener edge distance is two times the fastener diameter.

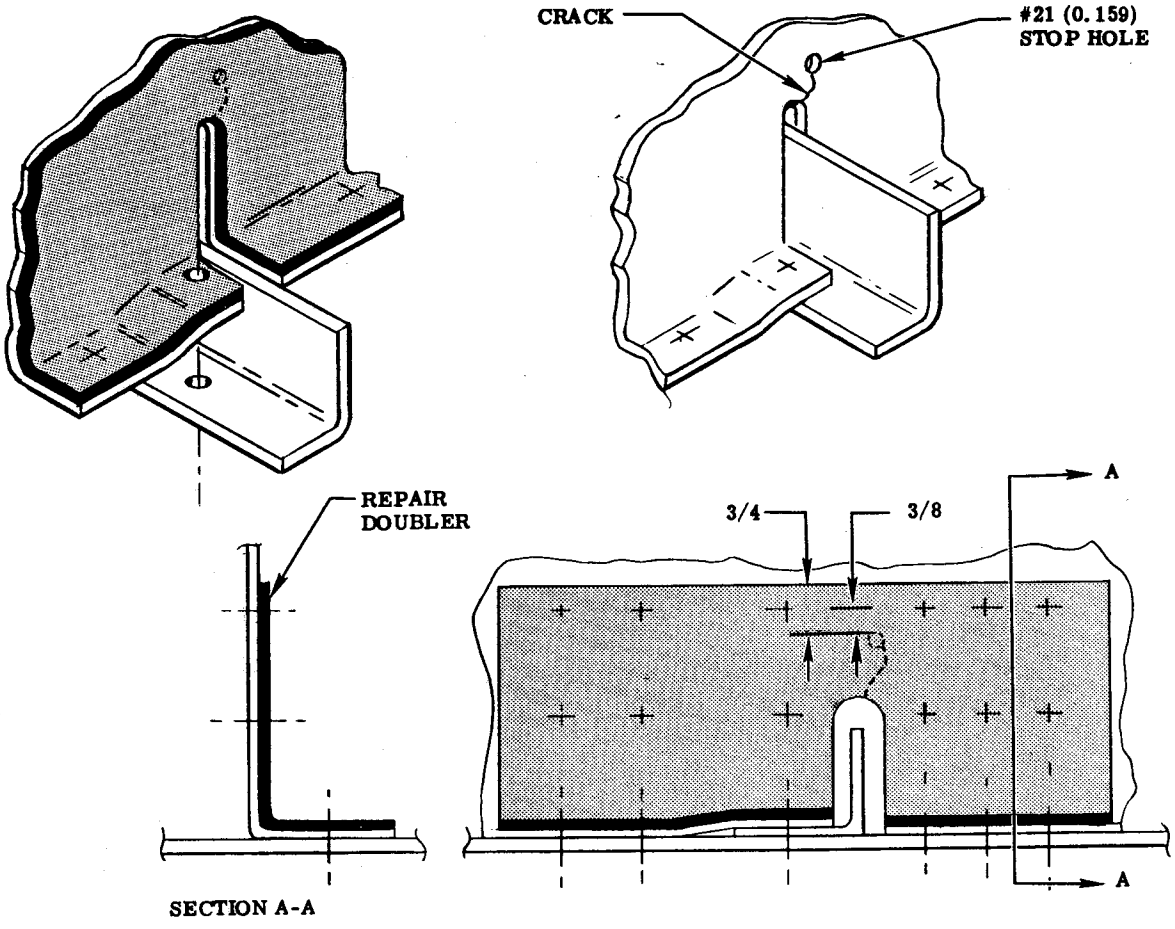


GEN-3-91-70A

Figure 2A-40. Formed Flange Crack Repairs

WEB CRACK

TYPICAL REPAIR



For repair of cracks in formed members at stringer cutouts in flanges: The length of crack is limited to 20 times the sheet thickness. The repair may be made by using a flanged doubler as shown in sketch.

1. Drill No. 21 (0.159) stop hole at end of crack.
2. Flanged doubler is to be one gage heavier than web thickness. Flange on doubler is to be same size as flange on damaged part.
3. Doubler-to-web rivets are to be in two rows at same spacing as existing flange rivets.
4. Doubler is to pick up a minimum of three flange rivets on either side of cutout.
5. Doubler-to-web rivets are to be same size as existing flange rivets.

GEN-3-91-71

Figure 2A-41. Stringer Cutout Repair

ALUMINUM ALLOY SHAPES

TYPICAL REPAIR

- The typical repair methods shown apply to 2024 and 7075 extruded and roll-formed shapes.
- Two types of repairs are shown: angle (preferred) repairs and strap (alternate) repairs. Angles should be used when the bend radius permits the minimum fastener edge distance, when the fastener head is clear of the radius, and when necessary tooling and time for proper forming are available.
- The repair materials and the heat-treatment must match the part being repaired.
- Repair angle thicknesses are shown in sheet No. 2. Repair strap thicknesses are shown in the chart on this page. Repair strap thicknesses over 0.090 inch may be built up of two straps of approximately equal gages; however, their combined net gage thickness must be at least one gage thicker than the minimum single strap required.
- Symbols used in the chart and on the drawing are as follows:
  t — thickness of damaged part
  t_1 — thickness of *outside* repair strap
  t_2 — thickness of *inside* repair strap
  l — length of cut across damaged angle
  f — width of flange
  g — length of cut parallel to edge of flange.
  d — fastener diameter.
- Flanges to be repaired by the strap method must have the following minimum widths:
  0.025 in. through 0.040 in. material = 5/8 in.
  Material thicker than 0.040 in. = 3/4 in.
- The minimum fastener edge distance for all parts is 1-1/2 times the fastener diameter.
- Use the following fastener tables with these repairs:
  "Fastener Tables—Conventional and Hi-Shear, Flush, 2024-T4, Tension"
  "Fastener Tables—Conventional and Hi-Shear, Flush, 7075-T6, Tension"
  "Fastener Tables—Conventional, Protruding-head, 2024-T4 and 7075-T6, Tension"
  "Fastener Tables—Conventional, Protruding-head, Extrusions, Tension"

REPAIR STRAP THICKNESS CHART

	2024-T4 CLAD SH		2024-T4 EXTR		7075-T6 CLAD SH		7075-T6 EXTR	
t	t_1	t_2	t_1	t_2	t_1	t_2	t_1	t_2
0.025	0.040	0.040	0.040	0.040	0.050	0.040	0.050	0.040
0.032	0.050	0.050	0.050	0.050	0.063	0.050	0.063	0.050
0.040	0.063	0.063	0.063	0.063	0.071	0.063	0.071	0.063
0.050	0.071	0.071	0.071	0.071	0.100	0.090	0.100	0.090
0.063	0.090	0.090	0.090	0.090	0.125	0.100	0.125	0.100
0.071	0.100	0.125	0.100	0.125	0.160	0.125	0.160	0.125
0.080	0.125	0.160	0.125	0.160	0.160	0.125	0.160	0.125
0.090	0.160	0.190	0.160	0.190	0.160	0.160	0.160	0.160
0.100	0.160	0.250	0.160	0.250	0.160	0.250	0.160	0.250
0.125	0.250	0.250	0.160	0.250	0.190	0.250	0.190	0.250
0.160			0.190*	0.250			0.190*	0.250
0.190			0.250	0.250			0.250	0.250

* If 0.190 gage is not available for strap, a strap built up from two sheets of 0.100-inch gage material may be used.

GEN-3-91-93A

Figure 2A-42. Angle Repairs (Sheet 1 of 3)

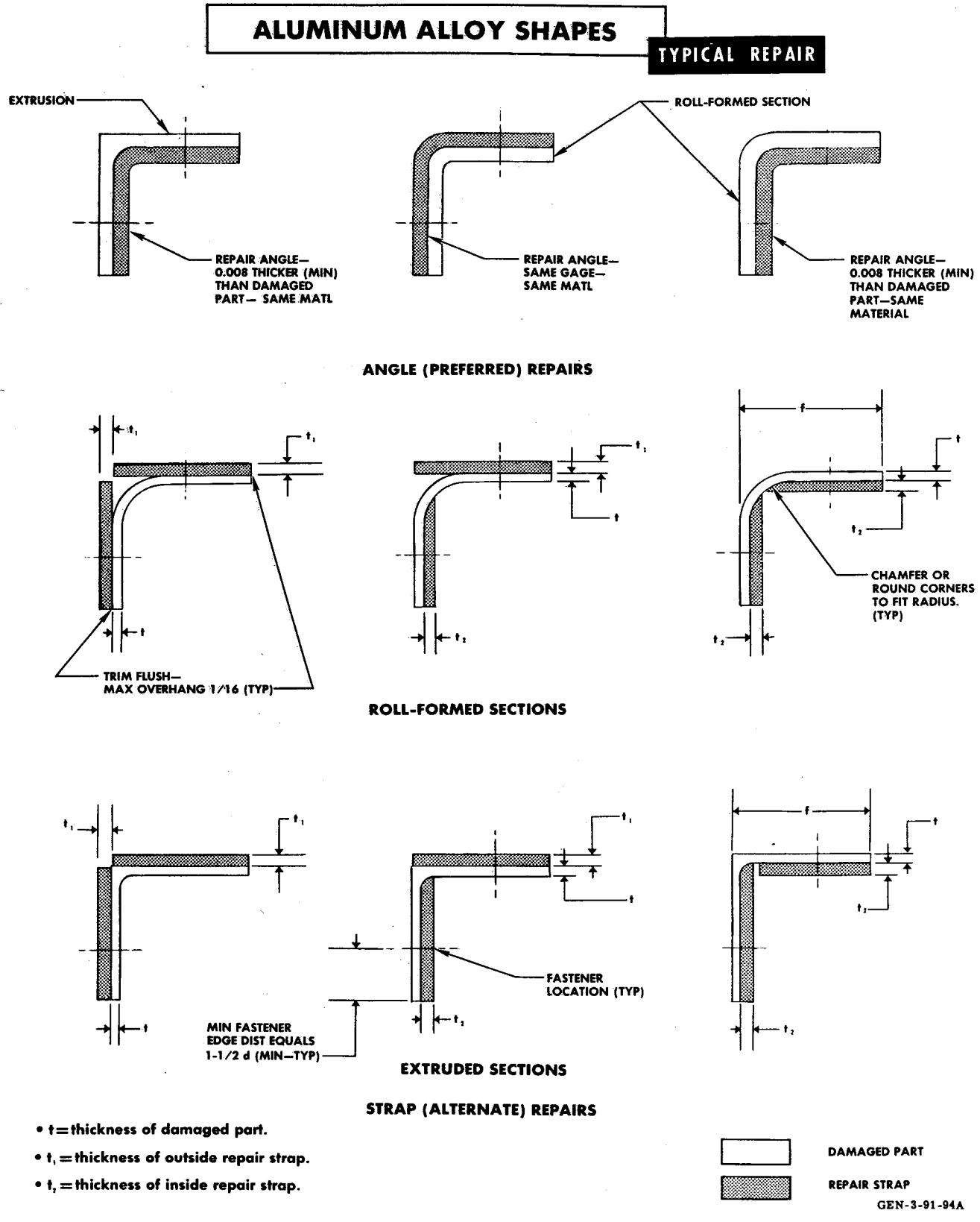
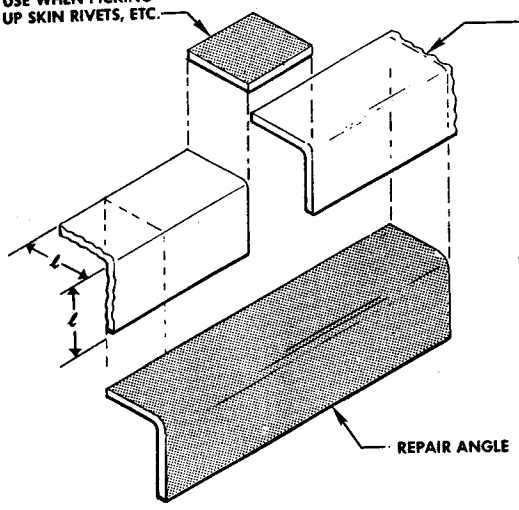


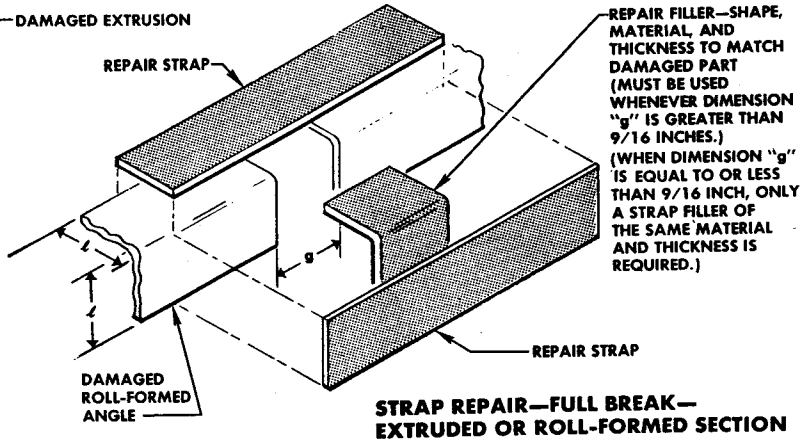
Figure 2A-42. Angle Repairs (Sheet 2 of 3)

ALUMINUM ALLOY SHAPES — TYPICAL REPAIR



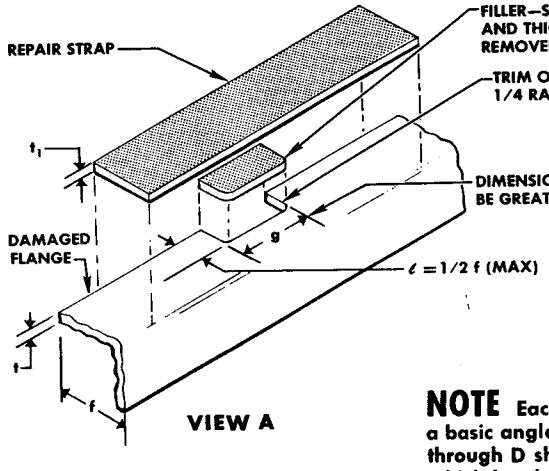
ANGLE (PREFERRED) REPAIR—FULL BREAK—EXTRUDED OR ROLL-FORMED SECTION

This repair should be used when (1) bend radius allows normal fastener installation and (2) when time and tooling are available for proper fabrication.

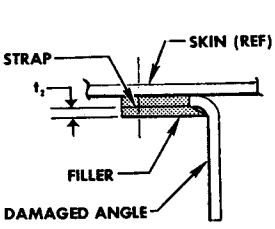


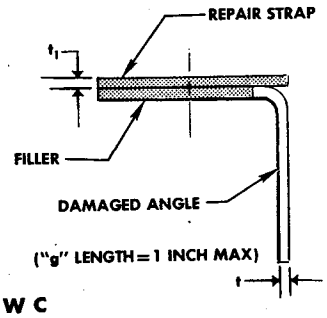
STRAP REPAIR—FULL BREAK—EXTRUDED OR ROLL-FORMED SECTION

Strap positions may be varied as shown in sheet No. 2
Repair straps may be used as splice straps at each end of an insert member.

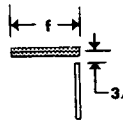


VIEW A

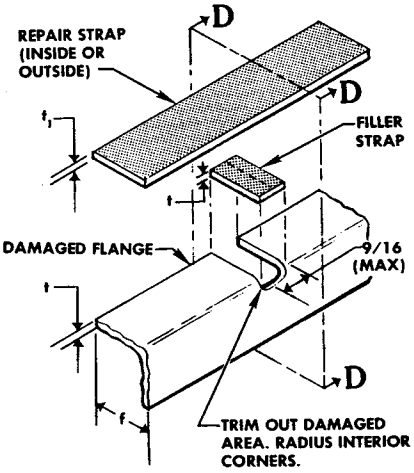




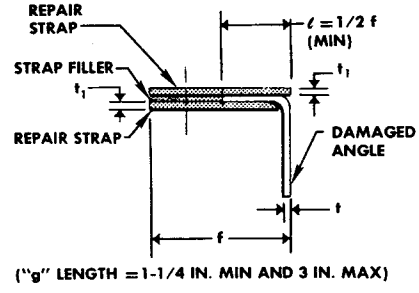
VIEW C



SECTION D–D



VIEW D



VIEW B

NOTE Each view shows a different repair for a basic angle with one leg damaged. Views A through D show different repairs for the angle which has been damaged along one leg only, the damage penetrating up to a depth of one half the length of the leg. View A is the repair for a maximum "g" length of 1-1/4 inches. View B is the repair for a minimum "g" length of 1-1/4 inches and a maximum "g" length of 3 inches. Views C and D show repairs for deeper leg damage. They differ in that the angle radius is not damaged in view C, while it is completely removed in view D. In view C, the maximum "g" length is one inch; in view D, the maximum "g" length is 9/16 inch. If both legs of an angle are damaged as shown in views C and D, and if this damage occurs in the same general area, cut out the damaged area and make repair as shown above (full break).

GEN-3-91-95A

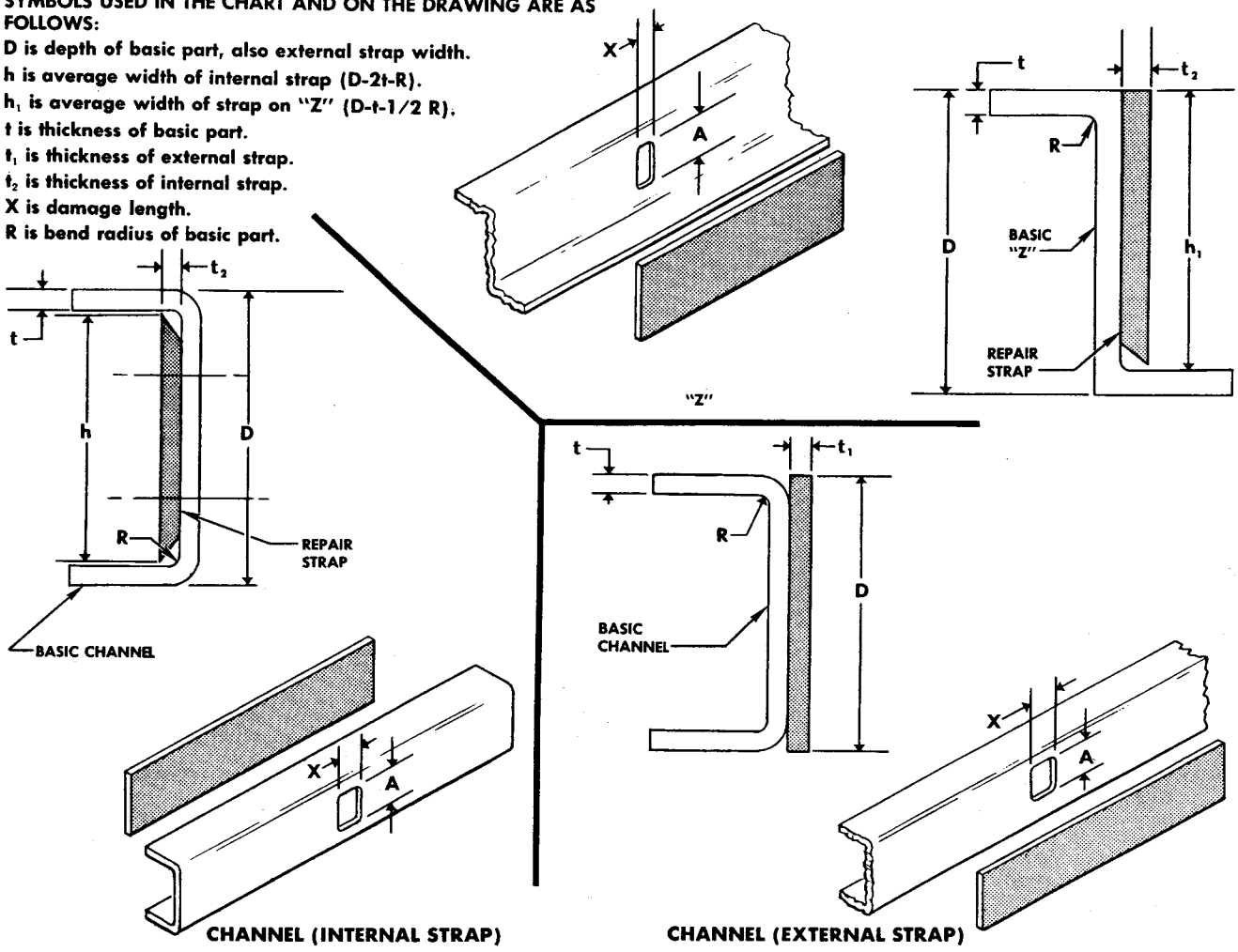
Figure 2A-42. Angle Repairs (Sheet 3 of 3)

ALUMINUM ALLOY SHAPES

TYPICAL

SYMBOLS USED IN THE CHART AND ON THE DRAWING ARE AS FOLLOWS:

D is depth of basic part, also external strap width.
h is average width of internal strap (D-2t-R).
h_1 is average width of strap on "Z" (D-t-1/2 R).
t is thickness of basic part.
t_1 is thickness of external strap.
t_2 is thickness of internal strap.
X is damage length.
R is bend radius of basic part.



CHANNEL (INTERNAL STRAP)

CHANNEL (EXTERNAL STRAP)

Use the following fastener tables from Section X with these repairs:

"Fastener Tables—Conventional and Hi-Shear, Flush, 2024-T4, Tension"

"Fastener Tables—Conventional and Hi-Shear, Flush, 7075-T6, Tension"

"Fastener Tables—Conventional, Protruding-head, 2024-T4 and 7075-T6, Tension"

"Fastener Tables—Conventional, Protruding-head, Extrusions, Tension"

If repair strap width is greater than one inch, use two or more rows of fasteners. The fasteners may be spaced either by staggering them or by placing them opposite one another, whichever is required, to maintain the correct number of fasteners with the proper edge distances.

When damage length (X) is less than 9/16 inch, use repair strap gages as shown in table. A filler is not required. When damage length (X) is more than 9/16 inch but less than 1-1/2 inches, use a repair strap 0.008 inch thicker than the gage required in the table. (The next standard gage may be used if it is thicker by 0.008 inch. A filler is not required.

When damage length (X) is greater than 1-1/2 inches, cut out the damaged area completely, and replace it with a new section. Fasten the new section in place with standard strap repairs. The new section is to have the same cross section, material, and gage as the original part.

REPAIR MATERIALS		
	2024-T4 or 7075-T6	
t	t_1	t_2
0.025	0.025	0.032
0.032	0.032	0.040
0.040	0.040	0.050
0.050	0.050	0.063
0.063	0.063	0.071
0.071	0.071	0.080
0.080	0.080	0.090
0.090	0.090	0.100
0.100	0.100	0.125
0.125	0.125	0.160
0.160	0.160	0.190
0.190	0.190	0.250

NOTE "A" equals the maximum damage width (D-2T-R), and the damage is not to extend into the fillet radius. If the damage extends into the fillet, repair as shown in sheet 2.

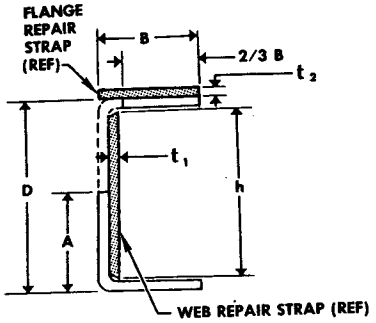
GEN 3-91-96

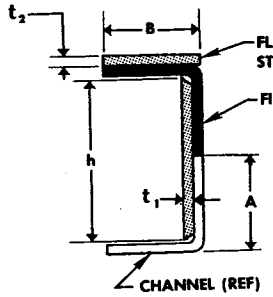
Figure 2A-43. Flanged Web Repairs (Sheet 1 of 2)

ALUMINUM ALLOY SHAPES

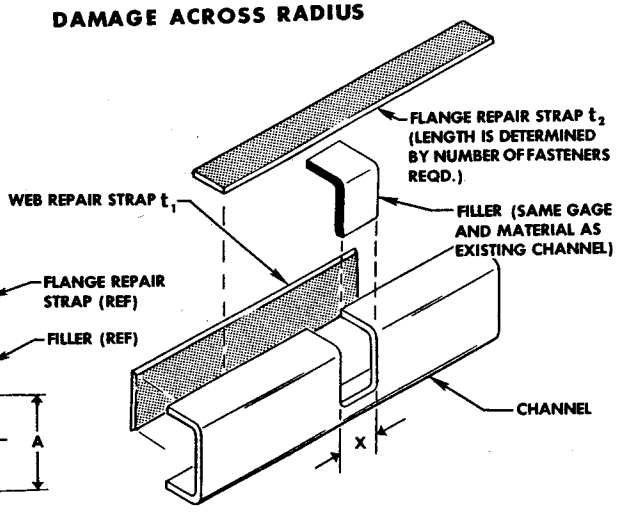
TYPICAL REPAIR

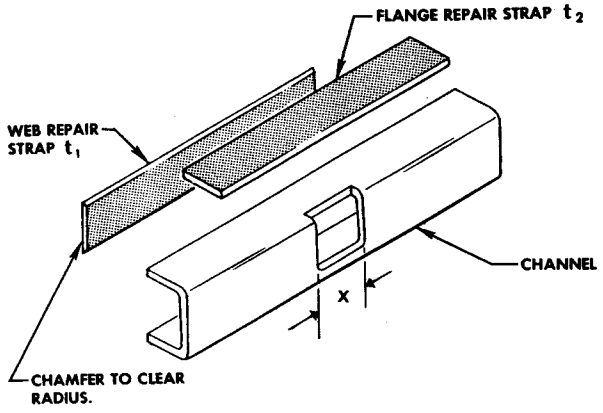
B is width of damaged flange, also width of external doubler.
h is average width of internal strap (D-2t-R).
t is gage of damaged part.
t_1 is gage of external straps.
t_2 is gage of internal straps.
D is depth of channel.
A=1/2 D min. If less than 1/2 D, cut out web and both flanges and repair as a full section.





DAMAGE ACROSS RADIUS





REPAIR MATERIALS		
	2024-T4 or 7075-T6	
0.025	0.025	0.032
0.032	0.032	0.040
0.040	0.040	0.050
0.050	0.050	0.063
0.063	0.063	0.071
0.071	0.071	0.080
0.080	0.080	0.090
0.090	0.090	0.100
0.100	0.100	0.125
0.125	0.125	0.160
0.160	0.160	0.190
0.190	0.190	0.250

Use the following fastener tables from Section X for these repairs:
"Fastener Tables—Conventional and Hi-Shear, Flush, 2024-T4, Tension"
"Fastener Tables—Conventional and Hi-Shear, Flush, 7075-T6, Tension"
"Fastener Tables—Conventional, Protruding-head, 2024-T4 and 7075-T6, Tension"
"Fastener Tables—Conventional, Protruding-head, Extrusions, Tension"

If the damage occurs across the radius and is less than 9/16 inch in length, and if the damage extends less than 1/3 of the flange width, the *flange repair* strap may be equal to t_1. The *web strap* must be of the same thickness as that shown in the table. If the damage extends across more than 1/3 of the flange width, use the strap gages directly from the table.

NOTE When strap thickness is built up of material of more than one gage, use a maximum of two separate gages of about equal thickness, but each must be at least equal to 2/3 of the thickness of the required strap. GEN 3-91-97

If the damage length (X) is more than 9/16 inch but less than 1-1/2 inches, and if the damage does not extend more than 1/3 of the distance across the flange, the flange repair strap is equal to t_1 and the web strap must be equal to t_2. A filler is not required. However, if the damage does extend more than 1/3 of the flange width, the damage must be cut out and a filler inserted. The tabulated strap repair gages must then be used on both the flange and the web.

If the damage length (X) is greater than 1-1/2 inches, cut out the damaged area completely, and replace with a suitable filler made to the same cross section as the original, and using the same material and gage as the original part. Fasten the new section in place using the standard strap repairs.

Figure 2A-43. Flanged Web Repairs (Sheet 2 of 2)

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APPENDIX III

BIBLIOGRAPHY

BIBLIOGRAPHY.

The publications listed in the following chart contain information which is general in nature. This bibliography is designed specifically for the repairman and provides information which will improve his knowledge and skills. It is recommended that some periods of spare time be devoted to learning where these reference publications are located and browsing through them to establish a general idea of their contents. This knowledge proves invaluable when a need for information of this nature arises.

PUBLICATION NUMBER	TITLE	DESCRIPTION OF CONTENTS
T.O. 1-1A-1	General Handbook of Structural Repair	Contains information which is general in nature. Items such as riveting, cable splicing, welding, and sheet-metal fabrication are covered in this publication.
T.O. 1-1A-8	Aircraft Structural Hardware	Describes specifically such items as rivets, bolts, screws, nuts, washers, turnbuckles, tie rods, and control rods, in addition to providing information on tubing, flexible hoses, electrical wiring, and safetying methods.
T.O. 1-1A-9	United States and British Commonwealth of Nations Aircraft Metals	Provides concise information relative to metals. This handbook will aid the repairman in the selection of alternative metals and in the preparation of these metals for repair purposes.
T.O. 1-1A-10	Corrosion Control for Aircraft	Describes the cause and types of corrosion and the preventive maintenance, protective requirements, and various protective processes used for aircraft surfaces. Also describes the corrosion control equipment which should be used.
T.O. 1-1A-12	Fabrication, Maintenance, and Repair of Transparent Plastics	Describes the different types of plastics, and the identification, fabrication, repair, maintenance, and installation of plastics.

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APPENDIX IV

GLOSSARY OF AIRPLANE AND AIRPLANE REPAIR TERMS

INTRODUCTION.

The definitions in this glossary correspond to the meanings of words and phrases as used in this manual. Nontechnical explanations are used whenever possible.

DEFINITIONS.

abrasion. Wearing away by friction, scratching.

abrasive. A substance used for grinding, polishing, etc, as emery paper.

acrylic plastic. Chemically, methylmethacryclate, a transparent plastic used for canopies. Trade name - Plexiglas.

aerodynamic. 1. Designed for favorable reaction when moved through the air. 2. The result from the reaction of the moving object to the forces in the surrounding air, as in aerodynamic drag or performance.

aft. Toward the rear or tail. —aft of. Behind.

airfoil. A surface or body designed to obtain a reaction from the air through which it moves.

airframe. The total airplane structure, including the framework (substructure) and skins.

air load. The aerodynamic load or force imposed upon a moving airfoil or other objects.

air-load rib. A rib which derives its principal loads from aerodynamic forces.

annealing. A process by which metals are stress-relieved and softened. This is done by carefully controlled heating and cooling (quenching).

anodize. An electrochemical treatment of bare aluminum alloys resulting in a corrosion-resistant surface. Anodized surfaces also offer an excellent bond for primer and paint.

axis. A straight line used as a reference for orienting a part, or about which a part could bend, twist, or rotate.

baffle. A plate or wall, as around an engine or in a tank, the purpose of which is to direct or retard the flow of a liquid or gas.

bead. 1. A pressed or rolled-in molding in sheet metal used for stiffening. 2. The fused area in fusion welding. 3. A narrow strip of sealant laid over or along a seam.

beam. The principal structural members running from root to tip in the stabilizers and rudder and from inboard to outboard in the ailerons and flaps. (Corresponding members in the wing are called spars.)

beam cap. The beam edge member to which the control surface skins are attached.

bend allowance. The flat pattern dimension that must be allowed for each bend in sheet-metal layout.

blind hole. A hole which does not pass through the material.

blind repair. A repair that can be made with access to but one side of the damage. Blind rivets or other fasteners that can be installed from one side are necessary for close-out.

blind rivet. A rivet that is installed from one side—pull rivet, drive-pin rivet, etc.

bolting angle. An angle provided for bolting one assembly to another.

bolting bar. A heavy bar-like member provided for bolting one assembly to another.

brake, n. A tool used for bending sheet metal. —v. to bend.

braze. To join metal with a hard solder, usually a copper alloy.

bulkhead. A solid or closed frame in the fuselage such as at each end of the pressurized compartment.

burring. The removal of sharp edges which result from cutting, drilling, and punching sheet metal.

cantilever. A beam or other member supported at one end only, as a wing.

centerline. A line running along the longitudinal center of an object. In the fuselage, it is the theoretical line dividing the left and right sides.

chamfer. The diagonal surface formed when a corner is removed. External patches are chamfered to blend the patch with the skin to reduce drag.

channel. a three-sided (generally U-shaped) member. It may be formed, machined, or extruded.

chord. A straight line between the leading and trailing edges of an airfoil section.

chordwise. In the direction of the chord of an airfoil. See chord.

clad. A general term applied to aluminum alloy sheet metal coated with pure aluminum.

close-out. Installation of the final panel, skin, or cover. This operation is often accomplished to some extent by the use of blind fasteners.

doubler. An added thickness of material, usually at the edge of a sheet. See repair doubler.

drag. The resistance produced by a body when moved through the air. An airplane is designed to produce the least possible drag. Any object added outside its mold line (skin) will increase the drag.

empennage. The group of fixed and movable control surfaces at the aft end of the airplane.

extrusion. A metal shape formed by forcing the material in a softened condition through a die.

fair. To streamline a part of an airplane, especially for reducing wind resistance or drag.

fairing. A nonstructural part of an airplane designed to blend with the surrounding structure to minimize drag.

fastener. A general term given to attaching hardware, such as bolts, screws, rivets, quick-acting fasteners, etc.

fatigue. The weakening of material caused by the repeated loading or bending movements applied to it.

faying surface. The surface area where one sheet of metal (or other material) overlaps another.

fillet. A concave area formed where two surfaces meet, or a member added to produce a concave area at a joint.

flutter. A vibrating movement of a wing or control surface caused by aerodynamic forces.

frame. Lateral members in the fuselage which support the skin and longitudinal members.

grid. A plate lightened by a pattern of holes, usually used for strength and/or stiffness inside the skin.

gusset. A corner brace, usually triangular in shape.

hat section. An extruded or formed shape, the cross section of which resembles that of a hat.

intercostal. A short, internal structural member connecting adjacent ribs or frames.

joggle. An offset or step in a sheet-metal part, usually used to fit against parts in different planes.

land. 1. The surface on, or against, which an object rests, as a door land. 2. In milled-skin construction, a thickened area where other members are attached, as a rib land, a spar land, etc.

longeron. A fore-and-aft member of the framing of an airplane fuselage, usually continuous across a number of points of support.

magnaflux. A patented method of inspecting steel parts for cracks or flaws. The part is first magnetized, then immersed in a solution of iron oxide and kerosene, thus making flaws visible to the naked eye.

manufactured splice. A skin splice made during the manufacture of the airplane.

mold line. The outside surface of an airplane. External patches are said to be "outside the mold line."

moment. The tendency for a force to produce rotation of an object about an axis. The magnitude is the product of the force and the perpendicular distance between the force and the axis. This distance is called the moment arm.

monocoque. A form of structure for whole components, consisting only of a stabilized or unstabilized shell. There are no internal members to carry direct loads.

nonstructural. A non-load-carrying member, but subjected to air loads when used as an external part.

panel (structural). A section of an airplane wing, especially a section manufactured separately as "a wing outer panel."

plane. A real or imaginary surface of infinite length and width, but having zero thickness.

prime. To apply the base or primer coats of finish in paints, lacquers, etc.

primer. A material used for the base coat (under the finish coat) of paint, lacquer, etc.

radial engine. An engine with cylinders arranged like the spokes in a wheel.

reciprocating engine. A piston-driven, internal combustion engine.

repair doubler. The added thickness of sheet or plate material that carries the loads across a hole or crack.

rib. A generally chordwise member of an airfoil which gives shape to the component. In addition, it usually carries structural loads.

semimonocoque. A form of structure for whole components, consisting of both an outer load-carrying shell and inner load-carrying stringers, beams, longerons, spars, etc.

spanwise. Across the ribs of an airfoil.

spar. A principal spanwise member of the structural framework of the wing.

spar cap. The upper and lower edge members of a spar. The skins are usually attached to this member.

specific gravity. The ratio of a weight or mass of a given volume to that of an equal volume of another substance. Water at 4°C is often used as a standard.

spotface. The removing of a small amount of the surface material around a hole providing a flat surface for a fastener head.

spring-back. The amount or degree that metal will return when the bending forces are released. Spring-back must be taken into consideration when making form blocks or making bends on a power brake.

static. At rest, without motion, influenced by no force other than its own weight.

statically balanced surface. A control surface that is in balance about its hinge axis when not subjected to aerodynamic forces.

strain. A condition in the material of a part expressed as the amount of dimensional distortion of the material (stretching, squeezing, etc) caused by the amount of stress being carried by the material. The higher the stress, the higher the strain.

stress. An internal condition of the material of a part, which is dependent upon the intensity of the load being carried by the part at that instant. Stress is always accompanied by strain. See strain.

stressed skin. A skin that works with the inner structure in carrying airframe loads.

stringer. Stiffening members usually running longitudinally in the fuselage and spanwise in the wing used to reinforce thin sheets and also to resist bending and shear loads.

substructure. A general term for any structure behind a skin or web.

tension. The effect of loads acting on a part that tend to pull it apart or lengthen the part.

torque, n. 1. A moment that tends to produce twisting deflections in a body. Parallel sections within the body tend to rotate about a common axis perpendicular to the moment. 2. The degree of tightening applied to a bolt. It is measured by multiplying the force applied by the moment arm. See moment.

torque, v. To apply a torque or torsional moment to a body, as in tightening a bolt.

transverse. Across or crosswise. Fuselage frames are transverse to the longerons.

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T.O. 1T-28A-4S-29

OPERATIONAL SUPPLEMENT

TECHNICAL MANUAL

ILLUSTRATED PARTS BREAKDOWN

USAF SERIES

T-28A

AIRCRAFT

THIS PUBLICATION SUPPLEMENTS T.O. 1T-28A-4, DATED 23 JUNE 1952. Reference to this supplement will be made on the title page of the basic manual by personnel responsible for maintaining the publication in current status.

COMMANDERS ARE RESPONSIBLE FOR BRINGING THIS SUPPLEMENT TO THE ATTENTION OF ALL AFFECTED AF PERSONNEL.

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE

20 OCTOBER 1973

1. PURPOSE.

To provide the necessary data required to establish the spar cap reinforcing strap as a logical spare part.

2. INSTRUCTIONS.

a. A new Figure 23A is hereby added to Section II as shown on page 2 of this supplement.

b. The following new part numbers and associated data in conjunction with new Figure 23A, are hereby added to Section II as follows:

Fig. & Index No.	Part No.	1 2 3 4 5 6 7 Nomenclature	Unit Per Assy	Useable On Code
23A-1	189-130012-1	. STRAP, LH	1	All
	189-130012-2	. STRAP, RH	1	
-2	NAS3003-8	. . BOLT, Shear, hex hd	6	
-3	NAS221-10	. . SCREW, Brazier hd Phillips recess, alloy steel, 10-32 thd	18	
-4	LD153-0002-1403	. . WASHER, Reduced O.D., alum., alloy	25	All

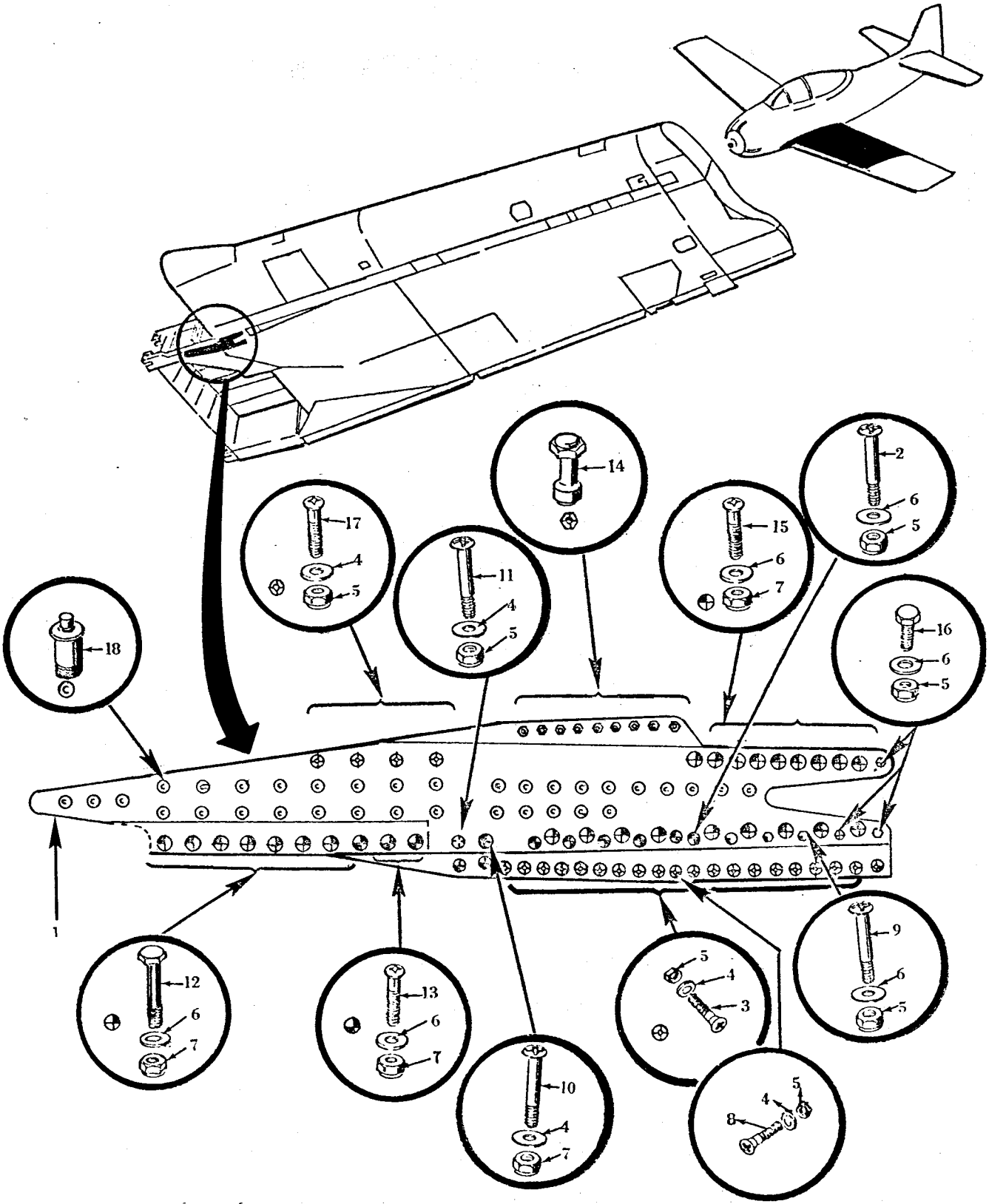

Figure 23A. Wing Center Section–Front Spar Lower Cap Reinforcing Strap at Wing Stations 14 to 36

Fig. & Index No.	Part No.	1 2 3 4 5 6 7 Nomenclature	Units Per Assy	Useable On Code
23A-5	MS21042L3	. . NUT, Self-locking	44	All
-6	LD153-0002-1404	. . WASHER, Reduced O.D. alum., alloy	19	
-7	MS21042L4	. . NUT, Self-locking	29	
-8	NAS221-11	. . SCREW, Phillips hd alloy steel, 10-32 thd	2	
-9	NAS3003-7	. . BOLT, Shear, hex hd	5	
-10	7S39-4A10	. . SCREW, 100 deg. Hi-shear hd, close tol.	1	
-11	7S15-10-19	. . SCREW, 100 deg. Hi-shear hd, close tol.	1	
-12	NAS222-16	. . SCREW, Phillips hd recess, steel alloy 1/4-28 thd	11	
-13	NAS222-17	. . SCREW, Phillips hd recess, steel alloy 1/4-28 thd	3	
-14	NAS1669-3-2	. . FASTENER BLIND, protruding head (HE111-0004-0302 may be used as sub).	9	
-15	NAS222-15	. . SCREW, Brazier hd, Phillips recess, steel alloy 1/4-28 thd	14	
-16	NAS3003-6	. . BOLT, Shear hex hd	3	
-17	NAS221-15	. . SCREW, Brazier hd Phillips recess. alloy steel, 10-32 thd	14	
-18	6951-S-08-8SP	. . DRIVE, pin	34	All

c. On page 511, the following changes are made:

(1) A new entry is added in part number numerical sequence to read:

Part No.	Fig. & Index No.	Qty Per Art	Source Code
LD153-0002-1403	23A-4	25	P1

(2) The following part numbers are hereby amended as follows:

LD153-0002-1404	23A-6	19	P1
MS1042L3	101-38C	2	P1
	23A-5	44	P1
MS20142L4	65-4	4	P1
	23A-7	29	P1

d. On page 512, the following changes are made:

(1) New entries are added in part number numerical sequence to read:

NAS1669-3-2	23A-14	9	P1
NAS221-15	23A-17	4	P1
NAS222-15	23A-15	14	P1
NAS3003-6	23A-16	3	P1
NAS3003-7	23A-9	5	P1
NAS3003-8	23A-2	6	P1

(2) The following part numbers are amended to read:

NAS221-10	10-51	310	P1
	23A-3	18	P1
NAS221-11	17-23	210	P1
	23A-8	2	P1

Part No.	Fig. & Index No.	Qty Per Art	Source Code
NAS222-16	46-13	43	P1
	23A-12	11	P1
NAS222-17	70-2	59	P1
	23A-13	3	P1

e. On page 556, new entries are added in part number numerical sequence to read:

189-130012-1	23A-1	1	P1
189-130012-2	23A	1	P1

f. On page 562B, new entries are added in part number numerical sequence to read:

6951-S-08-8SP	23A-18	34	P1
7S15-10-17	23A-11	1	P1
7S39-4A-10	23A-10	1	P1

THE END

T.O. 1T-28A-4S-28

OPERATIONAL SUPPLEMENT

TECHNICAL MANUAL

ILLUSTRATED PARTS BREAKDOWN

USAF SERIES
T-28A
AIRCRAFT

THIS PUBLICATION SUPPLEMENTS T.O. 1T-28A-4. Reference to this supplement will be made on the title page and opposite each affected paragraph in the basic manual by personnel responsible for maintaining the publication in current status.

COMMANDERS ARE RESPONSIBLE FOR BRINGING THIS SUPPLEMENT TO THE ATTENTION OF ALL AFFECTED AF PERSONNEL.

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE

24 SEPTEMBER 1973

1. PURPOSE.

To provide technical data to the basic manual on aircraft modified by T.O. 1T-28-588.

2. INSTRUCTIONS.

Add new figure Wing Center Section (Mod) Sheet 1 of 2 and 2 of 2 and also the Group Assembly Part List.

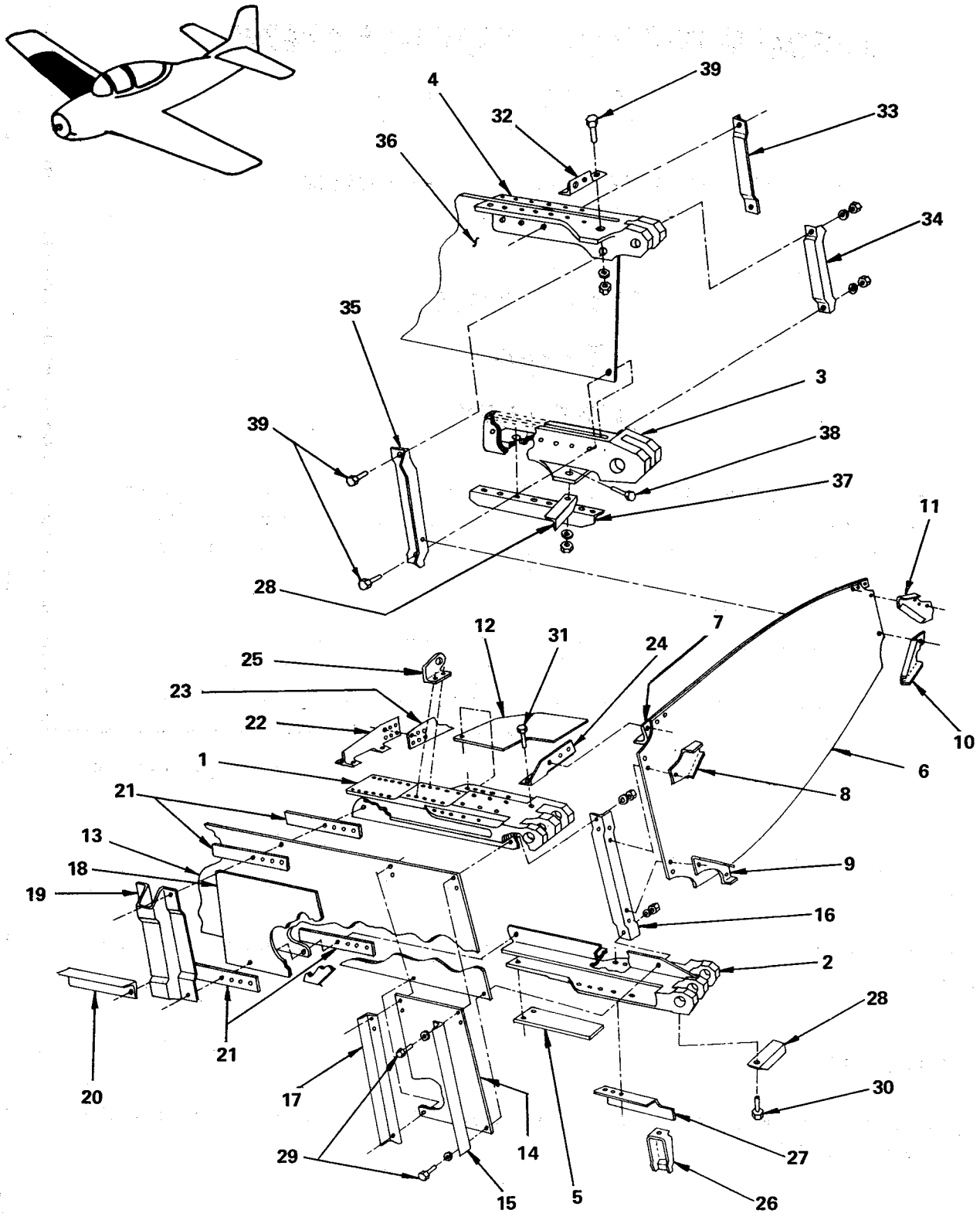

Figure 1. Wing Center Section (Mod) Sheet 1 of 2

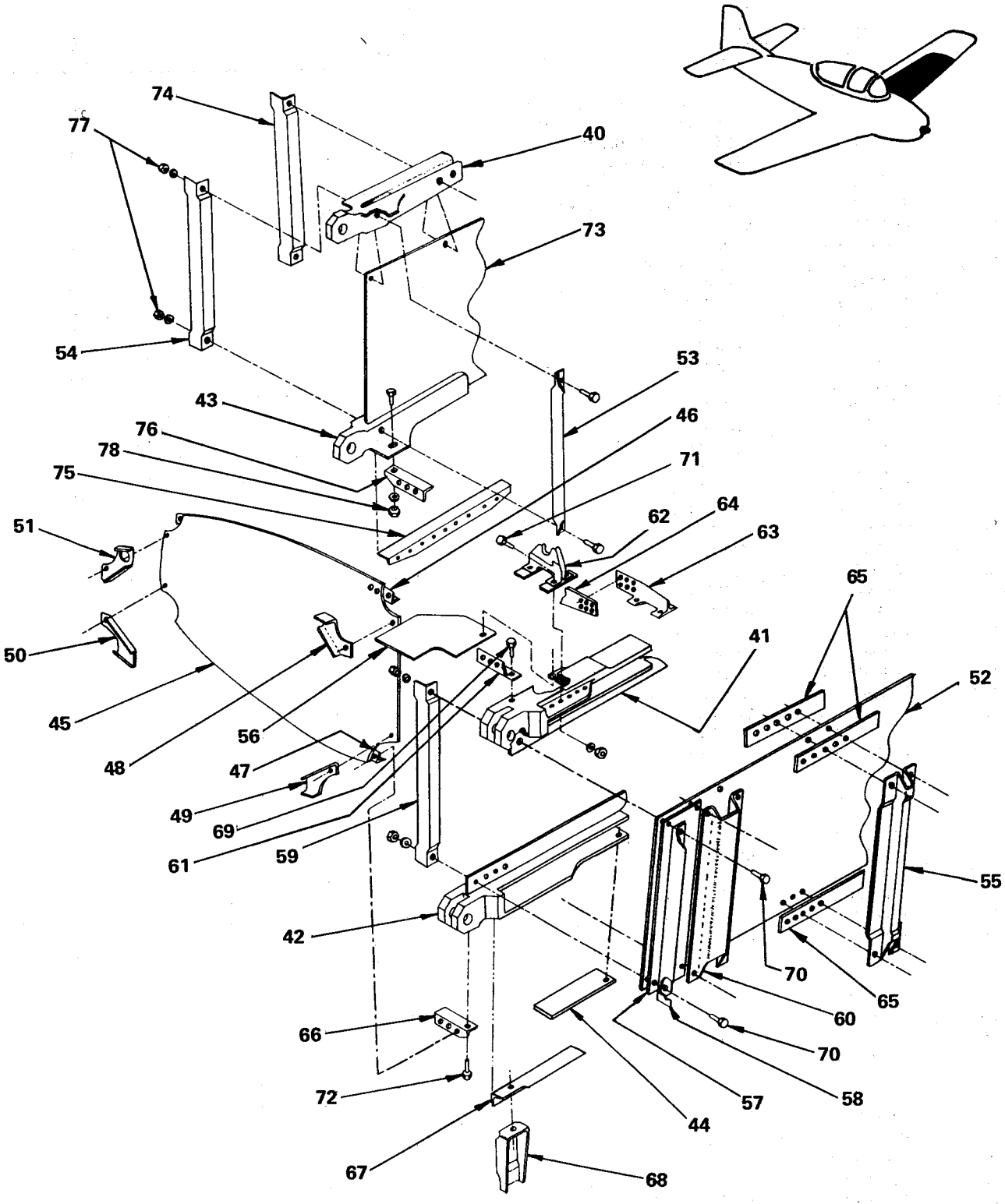

Figure 1. Wing Center Section (Mod) Sheet 2 of 2

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7	NOMENCLATURE	UNITS PER ASSY.	USEABLE ON CODE
	7335319-10		KIT INSTALLATION, Wing Spar Cap Lugs (Mod. by T.O. 1T-28-588)	Ref	
-1	7039859-01		FITTING, R.H. Forward Upper	1	
-2	7040023-03		FITTING, R.H. Forward Lower	1	
-3	7136056-01		FITTING, R.H. Aft Upper	1	
-4	7136057-01		FITTING, R.H. Aft Lower	1	
-5	7335357-01		STRAP	1	
-6	7136259-02		WEB	1	
-7	159-13201		RIB, Close-out	Ref	
-8	159-13208-3		GUSSET	Ref	
-9	159-13209-3		GUSSET	Ref	
-10	7136091-02		GUSSET	1	
-11	7136092-02		GUSSET	1	
-12	7040517-01		DOUBLER	1	
-13	7041164-01		WEB	1	
-14	7041165-01		DOUBLER	1	
-15	7041166-01		ANGLE	1	
-16	7041167-01		ANGLE	1	
-17	7041168-01		ANGLE	1	
-18	7040714-01		DOUBLER	1	
-19	7041238-01		STIFFENER	1	
-20	7039996-01		ANGLE	1	
-21	7039932-01		STRAP	4	
-22	7039931-01		TEE	1	
-23	159-33473		SUPPORT	Ref	
-24	7039930-01		ANGLE	1	
-25	7040516-01		BRACKET	1	
-26	7040437-01		GUSSET	1	
-27	7040436-02		ANGLE	1	
-28	7236443-02		ANGLE	1	
-29	AN174-7A		BOLT	Ref	
	AN960D416L		WASHER	Ref	
	AN960D416		WASHER	4	
	MS21042L4		NUT	2	
-30	AN3-24A		BOLT	1	
	AN960-10		WASHER	1	
	MS21042L3		NUT	1	
-31	AN3-23A		BOLT	1	
	AN960-10		WASHER	1	
	MS21042L3		NUT	1	
-32	7136143-10		ANGLE	1	
-33	7136098-01		ANGLE	1	
-34	7136142-01		ANGLE	1	
-35	7136143-01		ANGLE	1	
-36	200-13005-4		WEB	Ref	
-37	7136097-01		ANGLE	1	
-38	NAS1104-9		BOLT	2	
	AN960-416		WASHER	2	
	MS21042L4		NUT	2	
-39	NAS1104-13		BOLT	2	
	AN960-416		WASHER	2	
	MS21042L4		NUT	2	
-40	189-130180		FITTING	Ref	
-41	7039759-01		FITTING, L.H. Forward Upper	1	
-42	7040022-01		FITTING, L.H. Forward Lower	1	
-43	7136055-01		FITTING, L.H. Aft Lower	1	
-44	7335357-01		STRAP	1	
-45	7136259-01		WEB	1	
-46	159-13202		ANGLE	Ref	
-47	7335004-01		ANGLE	1	
-48	159-13208-3		GUSSET	Ref	
-49	159-13209-3		GUSSET	Ref	

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 NOMENCLATURE	UNITS PER ASSY.	USEABLE ON CODE
-50	7136091-01	GUSSET	1	
-51	7136092-01	GUSSET	1	
-52	7041245-01	WEB	1	
-53	7236207-01	ANGLE	1	
-54	7236208-01	ANGLE	1	
-55	7041248-01	STIFFENER	1	
-56	7040517-02	DOUBLER	1	
-57	7041246-01	DOUBLER	1	
-58	7041249-01	ANGLE	1	
-59	7041250-01	ANGLE	1	
-60	7041247-01	STIFFENER	1	
-61	7039930-02	ANGLE	1	
-62	7039993-10	BLOCK ASSY	1	
-63	7039931-02	TEE	1	
-64	159-33473	SUPPORT	Ref	
-65	7039932-01	STRAP	4	
-66	7236443-01	ANGLE	1	
-67	7040436-01	ANGLE	1	
-68	7040437-01	GUSSET	1	
-69	AN3-23A	BOLT	1	
	AN960-10	WASHER	1	
	MS21042L3	NUT	1	
-70	AN174-7A	BOLT	Ref	
	AN960D416L	WASHER	Ref	
	MS21042L4	NUT	2	
	AN960D416	WASHER	4	
-71	AN3-6A	BOLT	4	
	AN960-10	WASHER	4	
	MS21042L3	NUT	4	
-72	AN3-24A	BOLT	1	
	AN960-10	WASHER	1	
	MS21042L3	NUT	1	
-73		WEB	Ref	
-74	7136095-01	ANGLE	1	
-75	7136097-01	ANGLE	1	
-76		ANGLE	1	
-77	NAS1104-14	BOLT	1	
	AN960-416	WASHER	1	
	MS21042L4	NUT	1	
-78	NAS1104-9	BOLT	1	
	AN960-416	WASHER	1	
	MS21042L4	NUT	1	

T.O. 1T-28A-4S-27

OPERATIONAL SUPPLEMENT

TECHNICAL MANUAL

ILLUSTRATED PARTS BREAKDOWN

USAF SERIES

T-28A

AIRCRAFT

THIS PUBLICATION SUPPLEMENTS T.O. 1T-28A-4, DATED 23 JUNE 1952. Reference to this supplement will be made on the title page of the basic manual by personnel responsible for maintaining the publication in current status.

COMMANDERS ARE RESPONSIBLE FOR BRINGING THIS SUPPLEMENT TO THE ATTENTION OF ALL AFFECTED AF PERSONNEL.

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE

30 MARCH 1973

1. PURPOSE.

To provide technical data to the basic manual on changes to upper and lower front and rear spar cap lug bushings.

2. INSTRUCTIONS.

a. On page 37, Fig. & Index No. 16B-36 is hereby amended to change Part No. 4B19S12-030 to 4B19S12-031.

b. On page 42, Figure 19, upper LH corner, Index Nos. 33, 34 and 35 and detail of wing front spar lower cap lug are hereby deleted.

c. On page 42A, Index Nos. 33, 34 and 35 and their associated data are hereby deleted in their entirety.

d. A new Figure 19A and associated data are hereby added as shown on pages 3, 4 and 5 of this supplement.

e. On page 49, the following changes are made:

(1) Index -22 is hereby amended to delete Part No. 4B19S12-030 only (Bushing) and associated data.

(2) Index -23 is hereby amended to delete Part No. 4B19S10-030 only (Bushing) and associated data.

(3) Index -24 is hereby amended to delete Part No. 4B19S12-015 only (Bushing) and associated data.

(4) Index -25 is hereby amended to delete Part No. 4B19S10-015 only (Bushing) and associated data.

f. On page 559, NUMERICAL INDEX, the following changes are made:

(1) References of Part Nos. 4B19S10-030, 4B19S12-015, 4B19S12-030, 4B19S14-015, and 4B19S14-031 to Figures 16B, 19, and 22, are hereby deleted.

(2) New part numbers and Fig. & Index Nos. associated with new Figure 19A, as shown on page 5 of this supplement, will be added in proper part number numerical sequence.

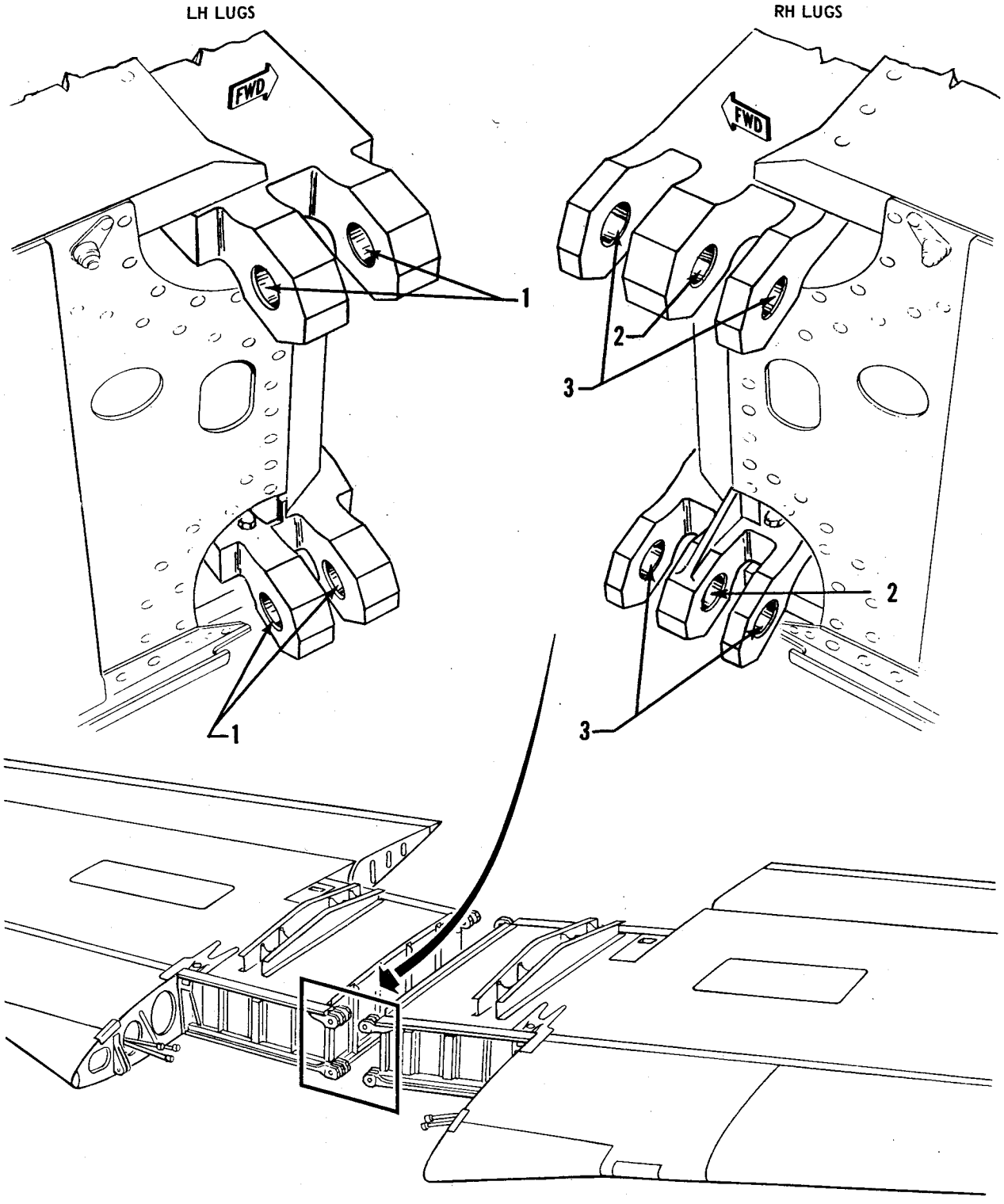

Figure 19A. Wing Center Section - Upper and Lower Front Spar Cap Lugs
(Sheet 1 of 2)

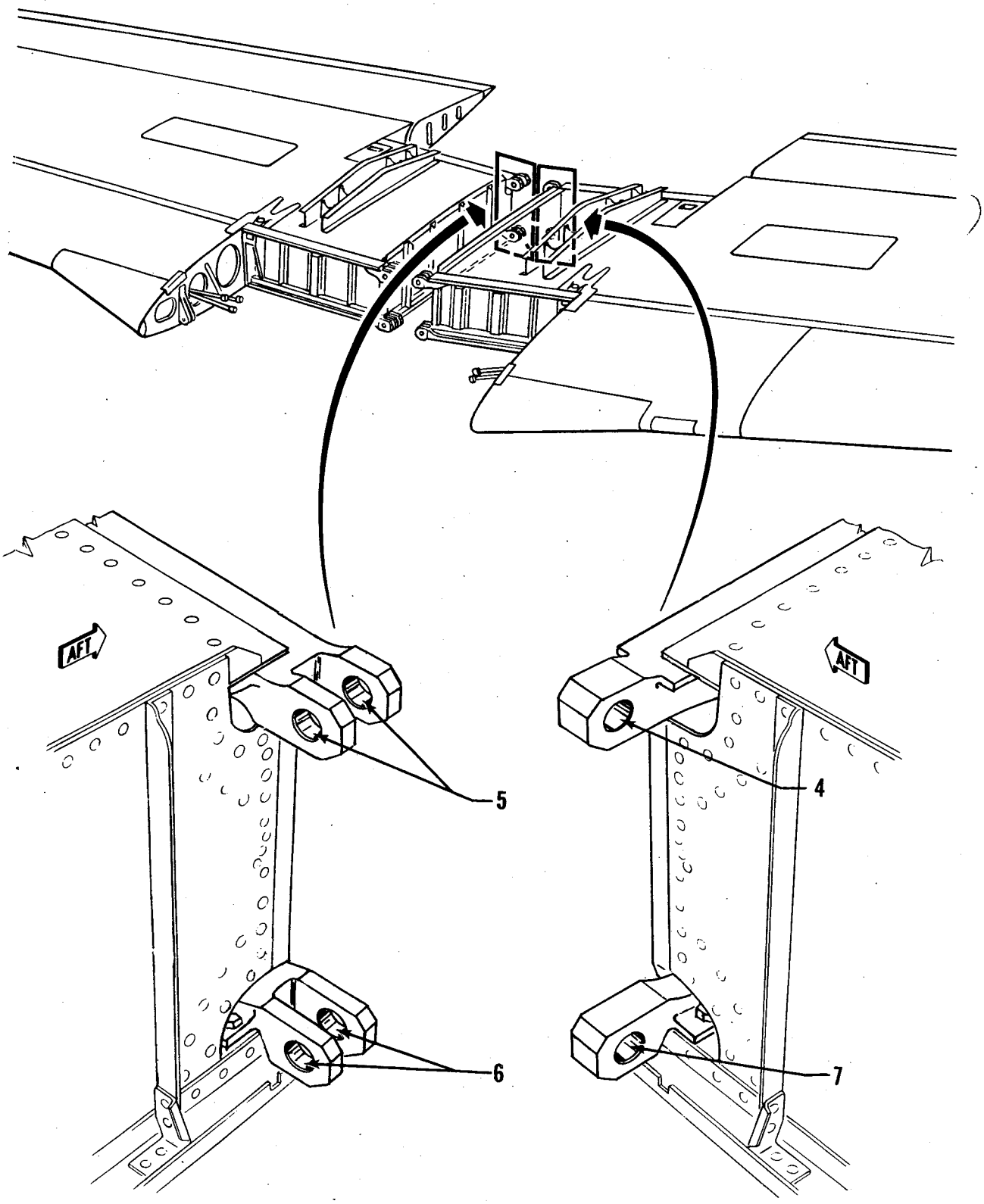

Figure 19A. Wing Center Section - Upper and Lower Rear Spar Cap Lugs
(Sheet 2 of 2)

FIGURE & INDEX NUMBER	PART NUMBER	NOMENCLATURE	UNITS PER ASSY	USABLE ON CODE
19A-1	4B19S14-031	BUSHING, Plain fit . . . . (North American)	2	
-2	4B19S14-031	BUSHING, Plain fit . . . . (North American)	1	
-3	4B19S14-015	BUSHING, Plain fit . . . . (North American)	2	
-4	4B19S12-031	BUSHING, Plain fit . . . . (North American)	1	4-393
-5	4B19S12-015	BUSHING, Plain fit . . . . (North American)	2	4-393
-6	4B19S10-015	BUSHING, Plain fit . . . . (North American)	2	4-393
-7	4B19S10-031	BUSHING, Plain fit . . . . (North American)	1	4-393

THE END

T.O. 1T-28A-4S-26

OPERATIONAL SUPPLEMENT

TECHNICAL MANUAL

ILLUSTRATED PARTS BREAKDOWN

USAF SERIES

T-28A

AIRCRAFT

THIS PUBLICATION SUPPLEMENTS T.O. 1T-28A-4. Reference to this supplement will be made on the title page of the basic manual by personnel responsible for maintaining the publication in current status.

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PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE

3 NOVEMBER 1972

1. PURPOSE.

To provide technical data to the basic manual on aircraft modified by T.O. 1T-28-568.

2. INSTRUCTIONS.

a. On page 2A, a new entry is hereby added in technical order numerical sequence to read:

T.O. NUMBER	SUBJECT
1T-28-568	Replacement of Engine Oil Magnetic Sump Plug. Part No. 2019D14, T-28 Aircraft

b. On page 438, Figure 252 is hereby amended as shown by Figure 1 (Sheet 1 of 2), this supplement.

c. On page 439, the following changes are made:

(1) Index-35 is hereby deleted in its entirety.

(2) Index -36 is hereby renumbered as Index-35.

(3) *2 shown at bottom of page, is hereby deleted.

d. A new Figure 252A is hereby added as shown in Figure 1 (Sheet 2 of 2), this supplement.

e. A new Figure and Index page 2-252A, is hereby added as shown on page 5 of this supplement.

f. Part numbers as shown with Figure and Index 2-252A, page 5 of this supplement, are hereby added in numerical sequence to Section III.

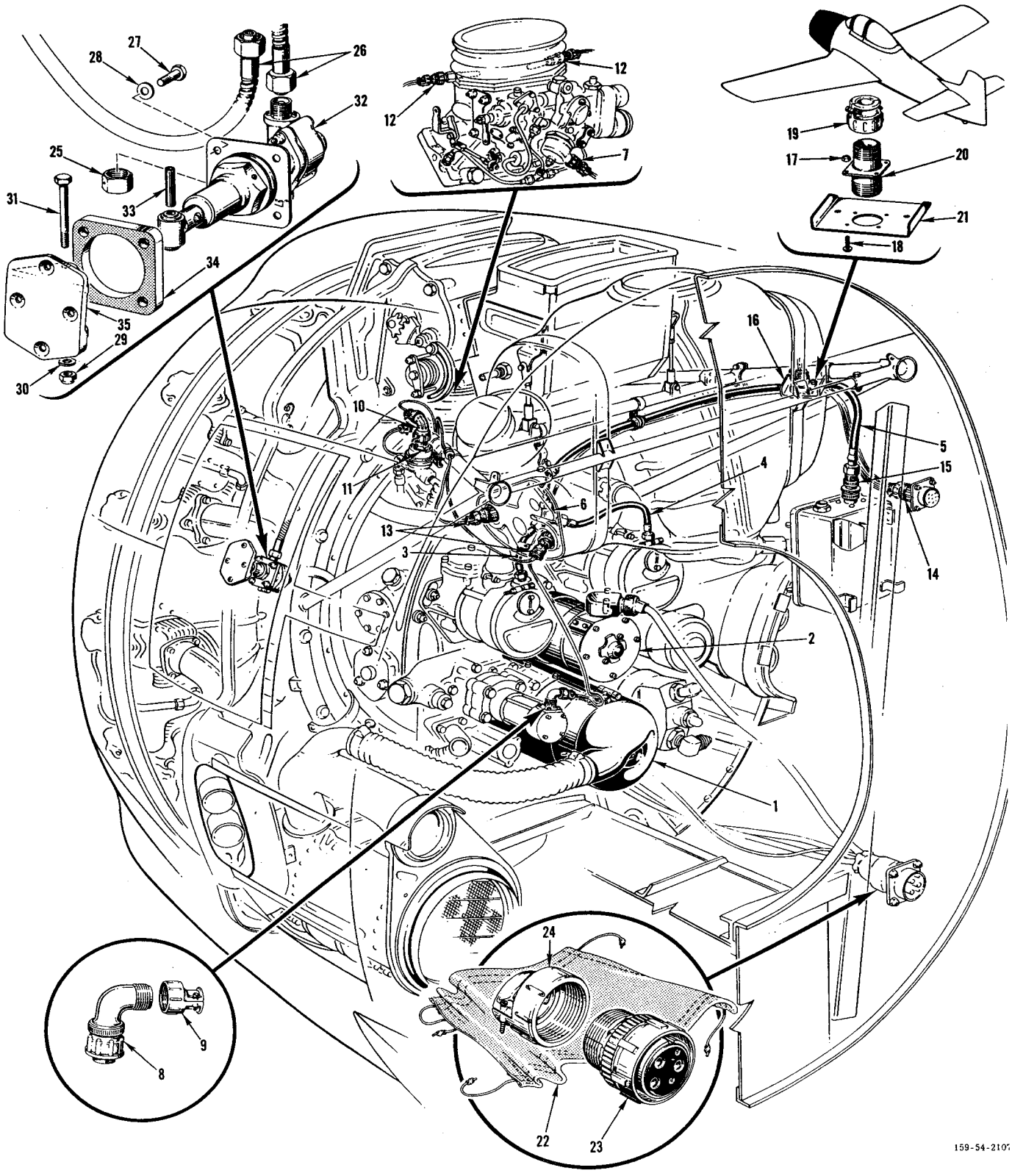

Figure 1. Engine Section Electrical Equipment (Sheet 1 of 2)

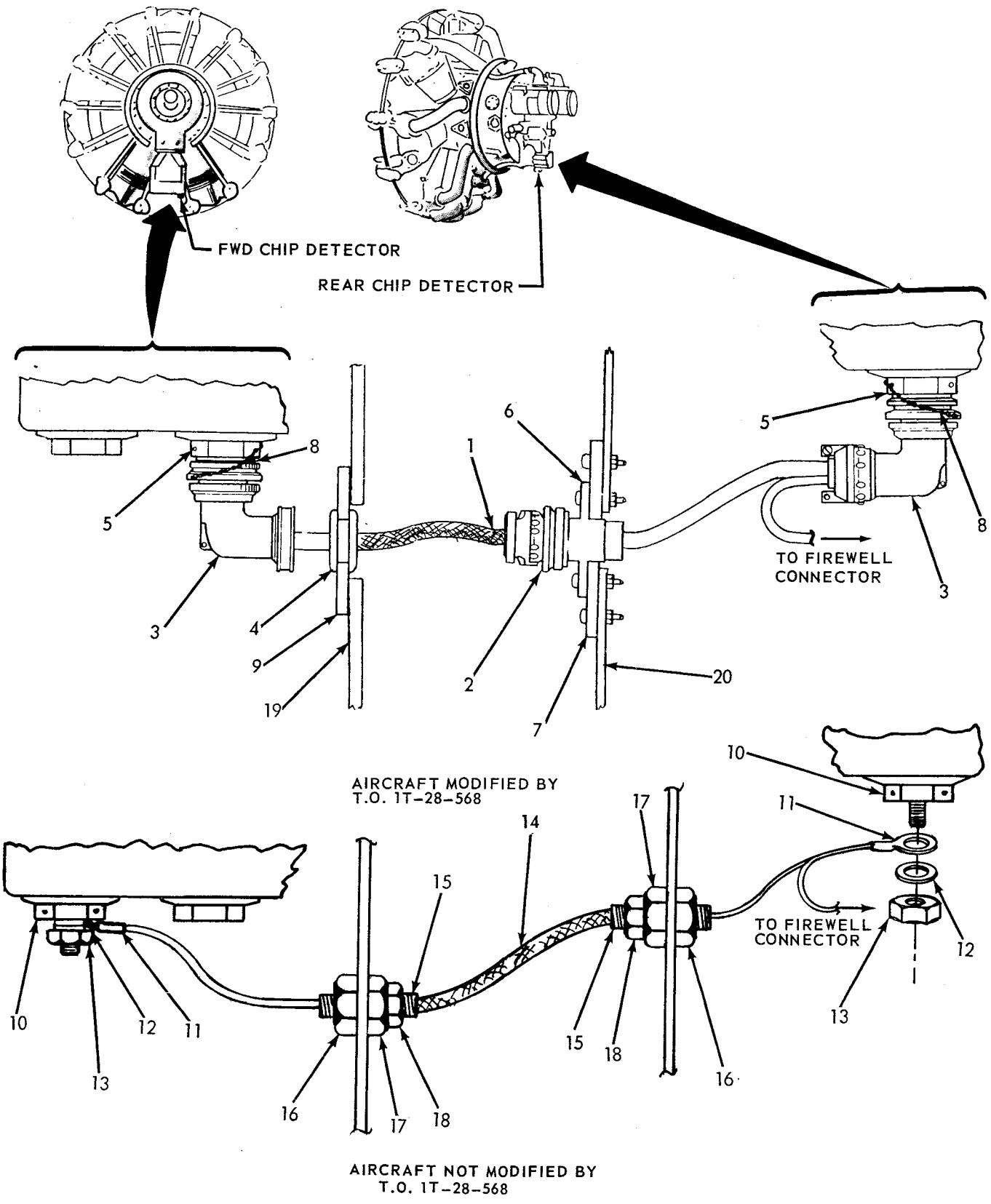

Figure 1. Engine Section Electrical Equipment (Sheet 2 of 2)

FIGURE & INDEX NUMBER	PART NUMBER		NOMENCLATURE	UNITS PER ASSY	USEABLE ON CODE
252A-	159-54040		ELECTRICAL EQUIPMENT INSTALLATION, ENGINE SECTION		
-1	7040668-10	*	. CABLE ASSEMBLY	Ref	
	MS25064-3	*	. . CONDUIT, Flexible (22 in.)	1	
	AN3050-3	*	. . FERRULE	2	
	AN3054-4	*	. . NUT, Coupling	2	
	MIL-I-3053	*	. . ASBESTOS, Braided (17 in.)	1	
-2	MS3106R10S-2P	*	. . CONNECTOR	1	
-3	MS3108R12S-4S	*	. . CONNECTOR	1	
-4	AN931-6-10	*	. . GROMMET	1	
-5	~~C~~D289	*	. DETECTOR	2	
-6	CA3100KE-10S-2S	*	. CONNECTOR	1	
			ATTACHING PARTS		
	MS35206-217	*	. . SCREW	4	
	AN960-4	*	. . WASHER	8	
	MS21042-04	*	. . NUT	4	
-7	7041032-01	*	. PLATE	1	
	AN3-6A	*	. . BOLT	2	
	MS210242-3	*	. . NUT	2	
	AN960-10	*	. . WASHER	4	
-8	QQW-461	*	. WIRE, Safety	AR	
-9	7041033-01	*	. PLATE	1	
	AN3-4A	*	. . BOLT	2	
	MS210242-3	*	. . NUT	2	
	AN960-10	*	. . WASHER	4	
-10	2019D14		. DETECTOR	2	
-11	MS25036-2		. . TERMINAL	2	
-12	AN960D8		. . WASHER	2	
-13	AN364-832		. . NUT	2	
-14	MS25064-6		. CONDUIT, Flexible (20 in.)	1	
-15	MS25065-6		. . FERRULE	2	
-16	AN3064-6		. . FITTING, Box	2	
-17	AN3066-6		. . NUT	2	
-18	MS25066-12		. . NUT	2	
-19	135861N1		. AIR DEFLECTOR	Ref	
-20	159-31547		. ENGINE FIXED COWLING	Ref	

* Used on aircraft modified by T.O. 1T-28-568.

THE END

T.O. 1T-28A-4S-25

OPERATIONAL SUPPLEMENT

TECHNICAL MANUAL

ILLUSTRATED PARTS BREAKDOWN

USAF SERIES

T-28A

AIRCRAFT

THIS PUBLICATION SUPPLEMENTS T.O. 1T-28A-4. Reference to this supplement will be made on the title page of the basic manual by personnel responsible for maintaining the publication in current status.

COMMANDERS ARE RESPONSIBLE FOR BRINGING THIS SUPPLEMENT TO THE ATTENTION OF ALL AFFECTED AF PERSONNEL.

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE

22 JUNE 1972

1. PURPOSE.

To provide technical data to the basic manual on changes generating from Material Improvement Program, SMNAC 72-3010.

2. INSTRUCTIONS.

a. On page 177, Fig & Index 96-2, Part No. AN6270-4-26 is hereby amended to read 601000-4-0260.

b. On page 506, Part No. AN6270-4-26 is hereby deleted in its entirety.

c. On page 562A, a new entry is hereby added in proper part number sequence to read:

PART NO.	FIGURE AND INDEX	QTY PER ART
601000-4-026	96-2	4

THE END

T.O. 1T-28A-4S-25

OPERATIONAL SUPPLEMENT

TECHNICAL MANUAL

ILLUSTRATED PARTS BREAKDOWN

USAF SERIES

T-28A

AIRCRAFT

THIS PUBLICATION SUPPLEMENTS T.O. 1T-28A-4.
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b. On page 506, Part No. AN6270-4-26 is hereby deleted in its entirety.

c. On page 562A, a new entry is hereby added in proper part number sequence to read:

PART NO.	FIGURE AND INDEX	QTY PER ART
601000-4-026	96-2	4

THE END

T.O. 1T-28A-3S-23

OPERATIONAL SUPPLEMENT

TECHNICAL MANUAL

STRUCTURAL REPAIR

USAF SERIES

T-28A, B, C & AT-28D

AIRCRAFT

THIS PUBLICATION SUPPLEMENTS T.O. 1T-28A-3. Reference to this supplement will be made on the title page of the basic manual by personnel responsible for maintaining the publication in current status.

COMMANDERS ARE RESPONSIBLE FOR BRINGING THIS SUPPLEMENT TO THE ATTENTION OF ALL AFFECTED AF PERSONNEL.

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE

20 SEPTEMBER 1973

1. PURPOSE.

To provide instructions to the basic manual in the Wing Section, for repair of loose wing leading edge to fuselage attach fittings (typical RH and LH wing fittings).

2. INSTRUCTIONS.

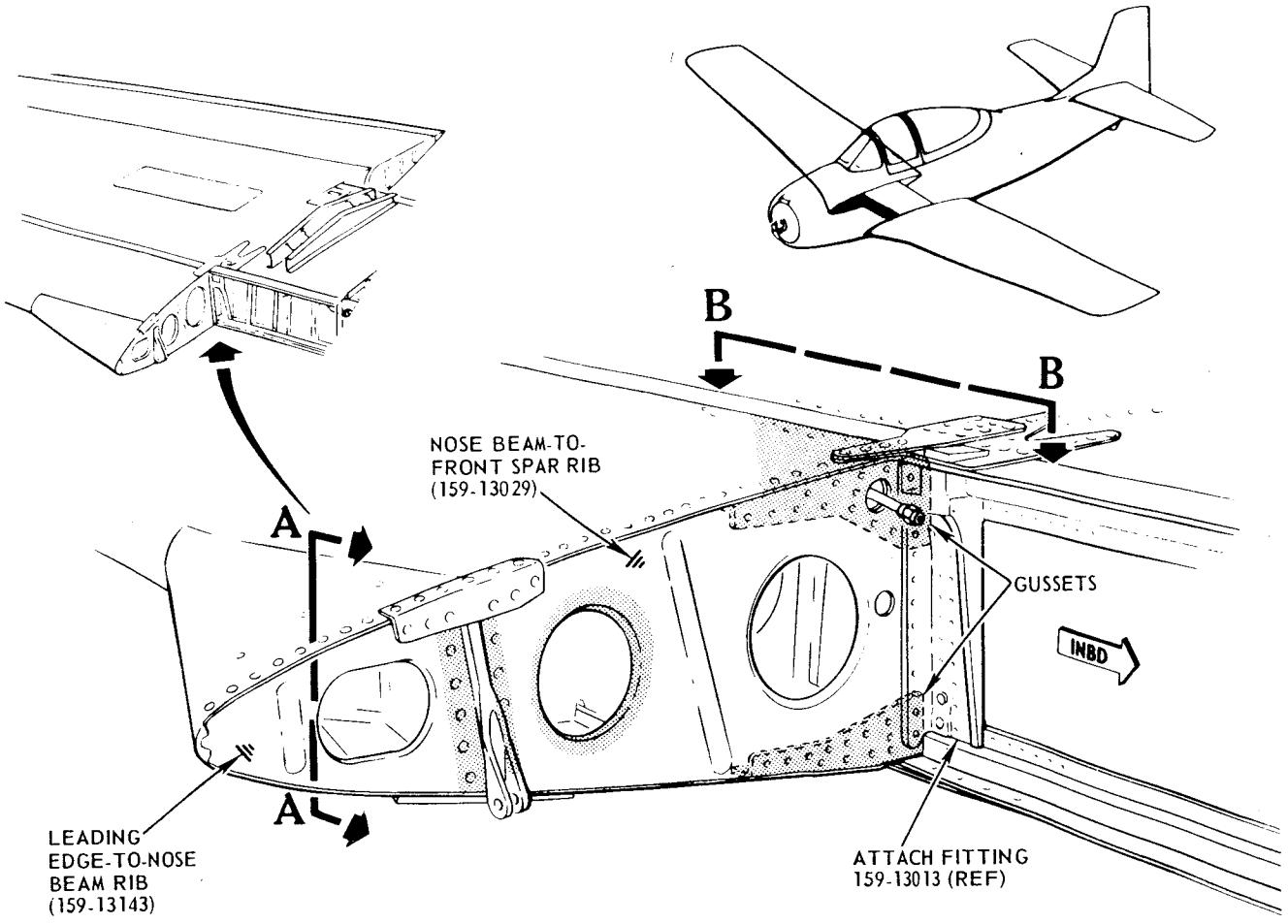
If sheared or loose fasteners are discovered at areas attaching fitting to both the leading edge-to-nose beam rib (P/N 159-13143) and the nose beam-to-front spar rib (P/N 159-13029), repair as follows:

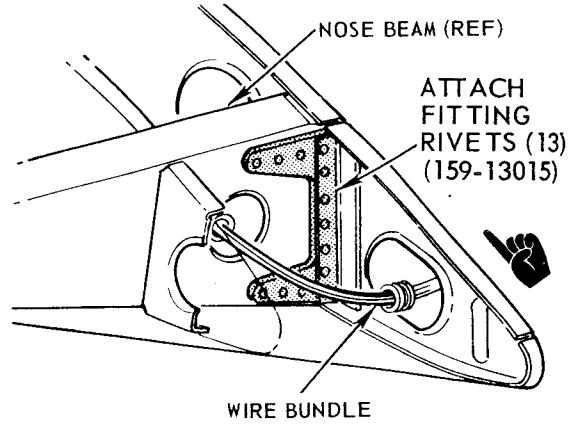
a. Remove a sufficient amount of skin from the leaking edge assy (P/N 159-13070) to gain access to the area, approximately W.S. 28.8 to W.S. 46.0. (see Figure 1, View A, of this supplement).

b. Replace any cracked rib with a new part.

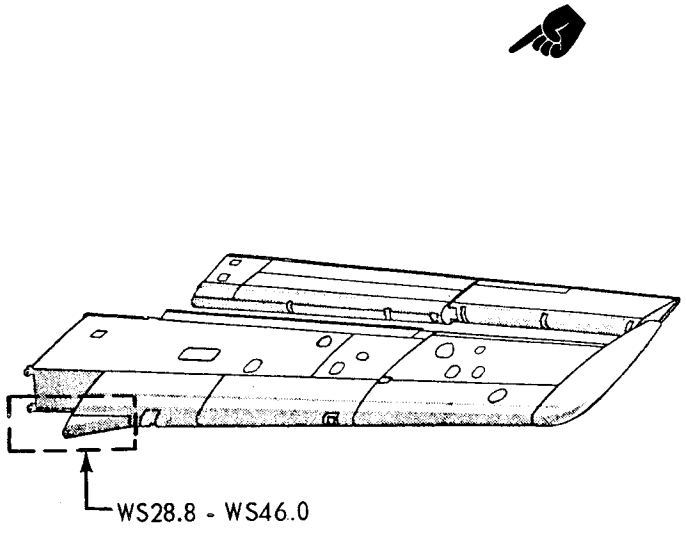
c. Remove all thirteen rivets which fasten the leading edge wing-to-fuselage attach fitting (P/N 159-13015), as shown in Figure 1, View A-A of this supplement.

d. Install NAS1103 bolt and AN365 nut in the upper inboard corner rivet hole in the attach fitting, P/N 159-13015.





VIEW A-A



VIEW A

28A-36-186

Figure 1. Wing Center Section - Leading Edge - to - Fuselage Attaching Structure

e. Drill and ream the remaining twelve rivet holes to 0.2500 (plus or minus 0.0005 inch) and replace existing rivets with NAS1104 or NAS464 bolts using AN365 nuts and AN960 washers.

f. Reinstall leading edge skin on leading edge skin assy, P/N 159-13070. Fasten skin using existing type rivets where possible and Huck or Olympic blind rivets as necessary.

THE END

T.O. 1T-28A-3S-22

OPERATIONAL SUPPLEMENT

TECHNICAL MANUAL

STRUCTURAL REPAIR

USAF SERIES

T-28A/B/C & AT-28D

AIRCRAFT

THIS PUBLICATION SUPPLEMENTS T.O. 1T-33A-3. Reference to this supplement will be made on the title page and opposite each affected paragraph of the basic manual by personnel responsible for maintaining the publication in current status.

COMMANDERS ARE RESPONSIBLE FOR BRINGING THIS SUPPLEMENT TO THE ATTENTION OF ALL AFFECTED AF PERSONNEL.

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NOTICE: Reproduction for non-military use of the information or illustrations contained in this publication is not permitted without specific approval of the issuing service.

14 SEPTEMBER 1973

1. PURPOSE.

To add additional maintenance requirements.

2. INSTRUCTIONS.

On page 1-18J/1-18K, new data is hereby added to read:

CORROSION TREATMENT FOR WING SPAR CAP REINFORCING STRAPS, STATION 12.875 TO 43.375.

1. Corrosion detected on spar cap reinforcing straps in the first 3.75 inches of the inboard area, or in the 0.060-thick or 0.100-thick skin land areas may be removed up to a maximum depth of 0.012 inches.

2. Straps that are corroded beyond the limits notes above shall be referred to SMAMA/MMAT for disposition.

3. Corrosion detected in the remaining area other than noted above may be removed up to a maximum depth of 0.031 inches.

THE END

T.O. 1T-28A-3S-21

OPERATIONAL SUPPLEMENT

TECHNICAL MANUAL

STRUCTURAL REPAIR

USAF SERIES

T-28A, T-28B, T-28C AND AT-28D

AIRCRAFT

THIS PUBLICATION SUPPLEMENTS T.O. 1T-28A-3 AND REPLACES OPERATIONAL SUPPLEMENT 1T-28A-3S-20, DATED 10 JANUARY 1973. Reference to this supplement will be made on the title page of the basic manual by personnel responsible for maintaining the publication in current status.

COMMANDERS ARE RESPONSIBLE FOR BRINGING THIS SUPPLEMENT TO THE ATTENTION OF ALL AFFECTED AF PERSONNEL.

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE

1 MAY 1973

1. PURPOSE.

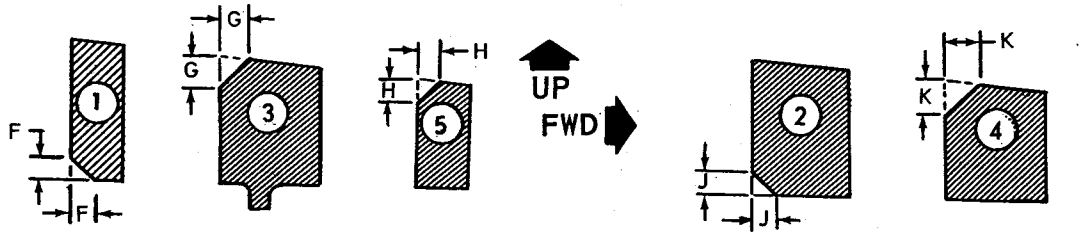
To provide technical data to the basic manual to clarify the technical content of operational supplement T.O. 1T-28A-3S-20.

2. INSTRUCTIONS.

New Figures 1 and 2 are hereby added to the basic manual to show the forward and rear wing spar lugs crack material removal limits and the recommended repair procedures.

CAP ASSY W.C.S. FRONT SPAR
UPPER R.H. P/N 159-13009
(SECTION 1.42 OUTBD OF W.S.O.O)

CAP ASSY W.C.S. FRONT SPAR
UPPER L.H. P/N 159-13011
(SECTION 1.42 OUTBD OF W.S.O.O)



R/H CROSS SECTIONAL VIEW LOOKING INBOARD

L/H CROSS SECTIONAL VIEW LOOKING OUTBOARD

LUG NO.	CHAMFER DIMENSION OF DAMAGE REMOVAL AREA	MAXIMUM DIMENSION
1	F	0.260
3	G	0.320
5	H	0.160
2	J	0.225
4	K	0.285

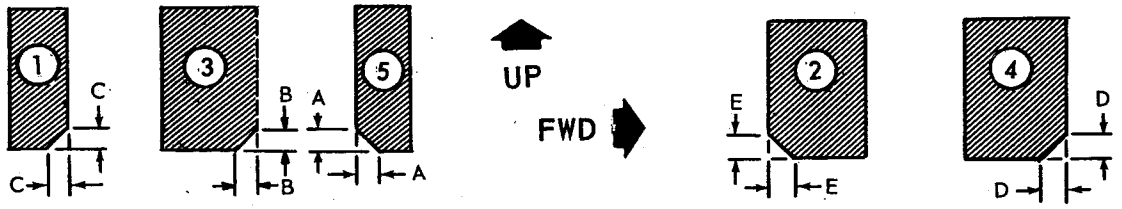
NOTES.

1. MATERIAL REMOVAL SHOWN IN MOST CRITICAL CORNER OF LUG.
2. THE MATERIAL MAY BE REMOVED TO THE EXTENT OF THE TABULATED MAXIMUM CHAMFERS ON ALL LUGS SIMULTANEOUSLY.
3. THE TABULATED DIMENSIONS APPLY TO A SINGLE CHAMFER PER LUG IF MORE THAN ONE CRACKED CORNER EXISTS ON A LUG, USE 2/3 OF TABULATED DIMENSIONS FOR TWO CRACKS AND 1/2 OF TABULATED DIMENSION FOR MORE THAN TWO FILLET CRACKS PER LUG.
4. THE SHAPE OF THE REMOVED MATERIAL NEED NOT BE AS SHOWN, BUT AREA REMOVED MAY NOT EXCEED THAT REPRESENTED BY A SINGLE CHAMFER WITH TABULATED DIMENSIONS.
5. MATERIAL REMOVAL AT EACH CRACK SHOULD BE LIMITED TO COMPLETE REMOVAL OF CRACK, HOWEVER SHOULD NOT EXCEED TABULATED DIMENSIONS WITHOUT SMAMA ENGINEERING APPROVAL.
6. CRACK SIZE AND MATERIAL REMOVAL DIMENSIONS MUST BE REPORTED TO SMAMA/MMAT IN ACCORDANCE WITH T.O. 1T-28A-36.

Figure 1. Front Spar Upper Cap Lugs at Wing Centerline Maximum Material Removal Limits for Cracks Occuring in Lug Fillets. (Sheet 1 of 4)

CAP ASSY – W.C.S. FRONT SPAR
LOWER R.H. P/N 159–13010
(SECTION 1.66 IN. OUTBD OF W.S.O.O.)

CAP ASSY – W.C.S. FRONT SPAR
LOWER L.H. P/N 159–13012
(SECTION 1.66 IN. OUTBD OF W.S.O.O.)



R/H CROSS SECTIONAL VIEW LOOKING INBOARD

L/H CROSS SECTIONAL VIEW LOOKING OUTBOARD

LUG NO.	CHAMFER DIMENSION OF DAMAGE REMOVAL AREA	PERMISSIBLE LUG TANG REWORK COMBINATIONS			
		I	II	III	IV
5	A	0.080	0	0	0.060
3	B	0	0.130	0	0.090
1	C	0.250	0.250	0.250	0.250
4	D	0.270	0.270	0.270	0.270
2	E	0.375	0.375	0.375	0.375

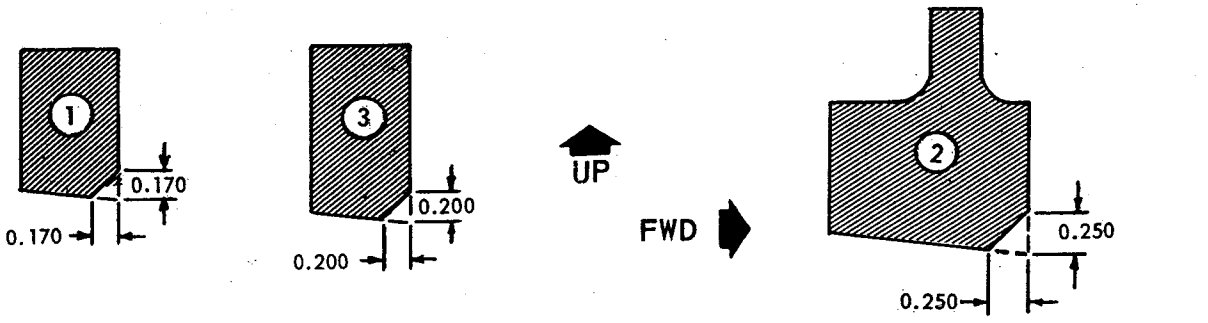
NOTES.

1. PERMISSIBLE LUG TANG REWORK COMBINATIONS I, II, III, IV, TABULATED ABOVE SHOW COMBINATIONS OF AREAS THAT CAN BE REWORKED SIMULTANEOUSLY.
2. THE ABOVE DIMENSIONS HAVE BEEN ROUNDED TO ACCOUNT FOR MEASUREMENT TOLERANCES. THEY SHOULD BE USED AS MAXIMUM, STRUCTURALLY PERMISSIBLE MATERIAL REMOVAL DIMENSIONS FOR A SINGLE FILLET CRACK PER LUG.
3. IF TWO FILLET CRACKS PER LUG EXIST, USE 2/3 OF TABULATED DIMENSIONS AS MAXIMUM. FOR MORE THAN TWO CRACKS PER LUG, USE 1/2 OF TABULATED DIMENSIONS.
4. LIMIT MATERIAL REMOVAL TO COMPLETE CLEANUP OF CRACK ONLY. HOWEVER, DO NOT EXCEED ABOVE LIMITS WITHOUT SMAMA ENGINEERING APPROVAL.
5. CRACK SIZE AND MATERIAL REMOVAL DIMENSIONS MUST BE REPORTED TO SMAMA/MMAT IN ACCORDANCE WITH 1T–28A–36.

Figure 1. Front Spar Lower Cap Lugs at Wing Centerline Maximum Material Removal Limits for Cracks Occurring in Lug Fillets. (Sheet 2 of 4)

CAP ASSY – W.C.S. REAR SPAR
LOWER R.H. – P/N 159–13025
(SECTION 1.375 IN. OUTBD OF W.S.O.O.)

CAP ASSY – W.C.S. REAR SPAR
LOWER L.H. – P/N 159–13019
(SECTION 1.625 IN. OUTBD OF W.S.O.O.)



R/H CROSS SECTIONAL VIEW LOOKING INBOARD

L/H CROSS SECTIONAL VIEW LOOKING OUTBOARD

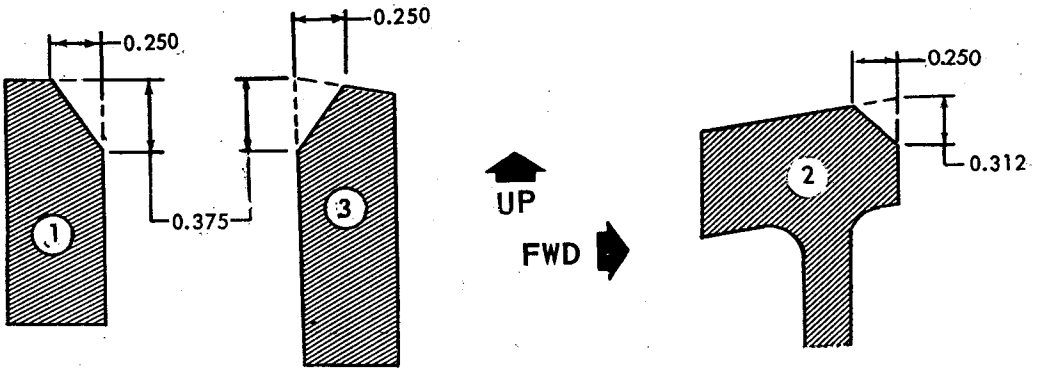
NOTES.

1. MATERIAL REMOVAL SHOWN AT MOST CRITICAL CORNER.
2. NOTED DIMENSIONS ARE MAXIMUM FOR SINGLE CRACK PER LUG. IF TWO OR MORE CRACKS EXIST ON A SINGLE LUG, USE 2/3 OF THE NOTED DIMENSIONS FOR EACH CRACK ON THAT LUG.
3. MATERIAL MAY BE REMOVED TO THE NOTED LIMITS ON ALL LUGS SIMULTANEOUSLY.
4. THE SHAPE OF THE AREA REMOVED NEED NOT BE AS SHOWN, BUT AREA REMOVED MAY NOT EXCEED THAT REPRESENTED BY ABOVE DIMENSIONS.
5. MATERIAL REMOVAL AT EACH CRACK SHOULD BE LIMITED TO MINIMUM REQUIRED FOR COMPLETE CRACK REMOVAL, AND SHOULD NOT EXCEED ABOVE DIMENSIONS WITHOUT SMAMA ENGINEERING APPROVAL.
6. CRACK SIZE AND MATERIAL REMOVAL DIMENSIONS MUST BE REPORTED TO SMAMA/MMAT IN ACCORDANCE WITH 1T–28A–36.

Figure 1. Rear Spar Lower Cap Lugs at Wing Centerline Maximum Material Removal Limits for Cracks Occurring in Lug Fillets. (Sheet 3 of 4)

CAP ASSY – W.C.S. REAR SPAR
UPPER R.H. – P/N 159–13024
(SECTION 1.0 IN. OUTBD OF W.S.O.O.)

CAP ASSY – W.C.S. REAR SPAR
UPPER L/H – P/N 159–13018
(SECTION 1.75 IN. OUTBD OF W.S.O.O.)



R/H CROSS SECTIONAL VIEW LOOKING INBOARD

L/H CROSS SECTIONAL VIEW LOOKING OUTBOARD

NOTES.

1. MATERIAL REMOVAL SHOWN AT MOST CRITICAL CORNER.
2. NOTED DIMENSIONS ARE MAXIMUM FOR SINGLE CRACK PER LUG. IF TWO OR MORE CRACKS EXIST ON A SINGLE LUG, USE 2/3 OF THE NOTED DIMENSIONS FOR EACH CRACK ON THAT LUG.
3. MATERIAL MAY BE REMOVED TO THE NOTED LIMITS ON ALL LUGS SIMULTANEOUSLY.
4. THE SHAPE OF THE AREA REMOVED NEED NOT BE AS SHOWN, BUT AREA REMOVED MAY NOT EXCEED THAT REPRESENTED BY ABOVE DIMENSIONS.
5. MATERIAL REMOVAL AT EACH CRACK SHOULD BE LIMITED TO MINIMUM REQUIRED FOR COMPLETE CRACK REMOVAL, AND SHOULD NOT EXCEED ABOVE DIMENSIONS WITHOUT SMAMA ENGINEERING APPROVAL.
6. CRACK SIZE AND MATERIAL REMOVAL DIMENSIONS MUST BE REPORTED TO SMAMA/MMAT IN ACCORDANCE WITH T.O. 1T–28A–36.

Figure 1. Rear Spar Lower Cap Lugs at Wing Centerline Maximum Material Removal Limits for Cracks Occurring in Lug Fillets. (Sheet 4 of 4)

PROCEDURE FOR CRACK REMOVAL, ETCH AND DYE-PENETRANT INSPECTION OF REWORK AREA

Since a positive method of insuring crack-free area is necessary after removal of cracks from the spar cap lug fillets, the following rework procedure is required:

1. Remove crack, using a -1/4 or -1/2 inch diameter cylindrical rotary file as required. Remove material gradually, using a low speed (less than 2000 RPM), to the typical configuration shown on pages 8 and 9 and within the dimensional limits specified on pages 2, 3, 4, and 5.

2. Blend reworked area, using sanding bullet with a rotary tool or hand blending with a crocus cloth. All tool marks must be blended smooth.

3. Clean reworked area with MEK, Trichlorethylene or equivalent.

4. Acid-etch the reworked area to check for any residual cracks. Operations performed in steps 1 and 2 tend to smear metal and conceal small cracks. Use following procedure for acid etch.

   a. Etch the crack area only with a Nitric Hydrofluoric solution (Nitric acid 15-20% by weight, Hydrofluoric acid 3 $\pm$ 1% by weight, balance water).

   b. Thoroughly rinse with water.

   c. When smutting occurs, remove by swabbing with Nitric acid (HNO_3) (Concentration to be of approximately 50% in water). Where applicable, step c.should follow step a.as soon as possible. If NO smutting occurs, step c.is not necessary.

   d. Thoroughly rinse with water.

   e. Thoroughly dry out area (use heat lamps to speed up operation).

CAUTION

Acid-etching of reworked area must be accomplished by or under the direction of qualified personnel.

- The use of eye and skin protection cannot be over-emphasized. Rubber gloves and safety goggles are a must. Also, etchants should be controlled so that the solutions will not damage any other materials or alloys which might be adjacent to crack area(s).

5. Penetrant-inspect rework area to check for residual cracks. Penetrant process, using solvent removable fluorescent dye, is recommended. Use magnifier to evaluate indications.

NOTE

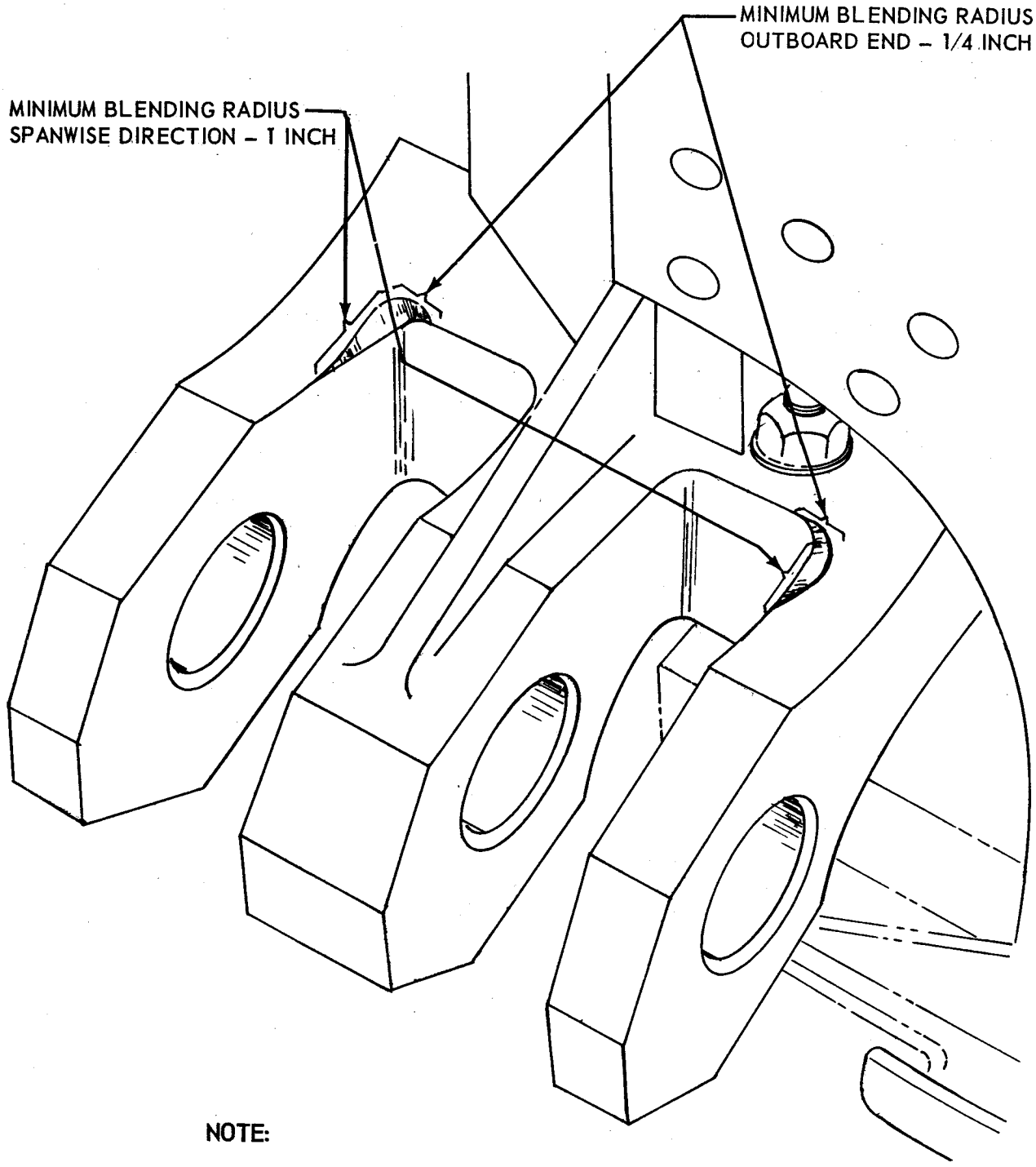
Residual acid from etching procedure will remove fluorescence from the penetrant. Therefore, a completely dry, acid-free area is required for penetrant check. If this cannot be assured, a visible dye inspection should be used.

6. After complete crack removal is assured, clean area of all inspection materials residue.

7. Coat reworked area with chem film in accordance with Specifications MIL-S-5002E and MIL-C-5541A.

8. Following list of equipment/material is recommended for performing the rework of the cracked area.

a. Drill motor - variable speed
b. Rotary files - cylindrical -1/4 and -1/2 in. dia. steel - hi-speed type
c. Sanding bullet or crocus cloth for blending
d. Metal etching kit containing:
   (1) Nitric hydrofluoric acid solution (Nitric acid 15 - 20% by weight, hydrofluoric acid 3 $\pm$ 1% by weight, balance water)
   (2) Nitric acid (HNO_3), 50% concentration in water
e. Penetrant kit - fluorescent or visible dye
f. Black light - portable
g. Magnifier - monocular type
h. Methyl Ethyl Ketone (Specification TT-M-261), or Trichlorethylene (Specification MIL-T-7703) or equivalent
i. Chem film (Specification MIL-C-5541A)

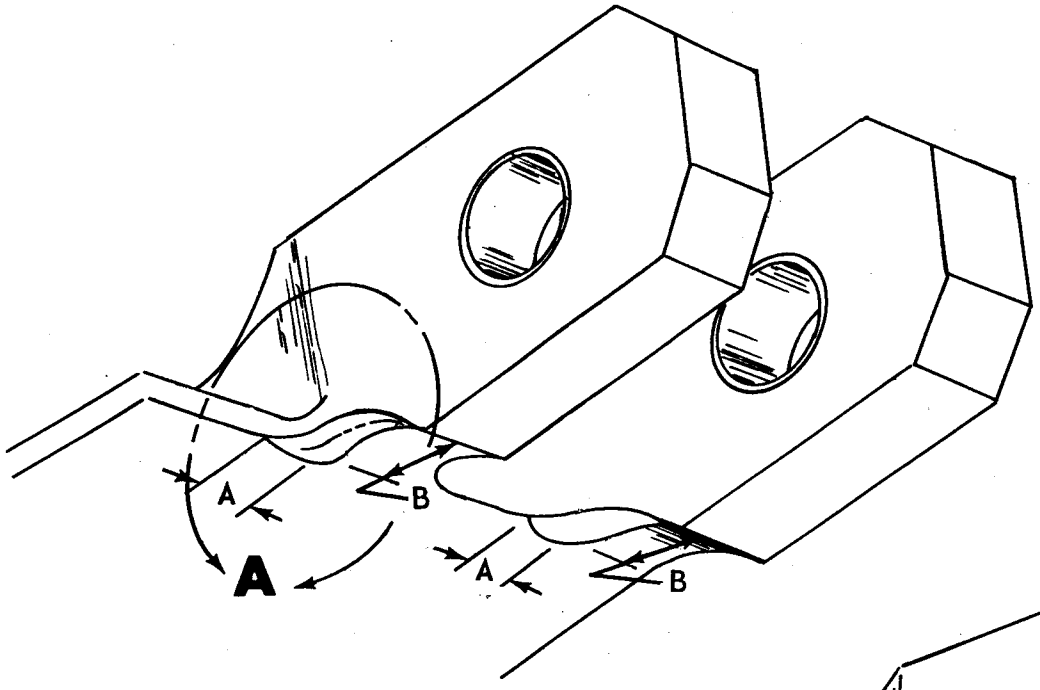


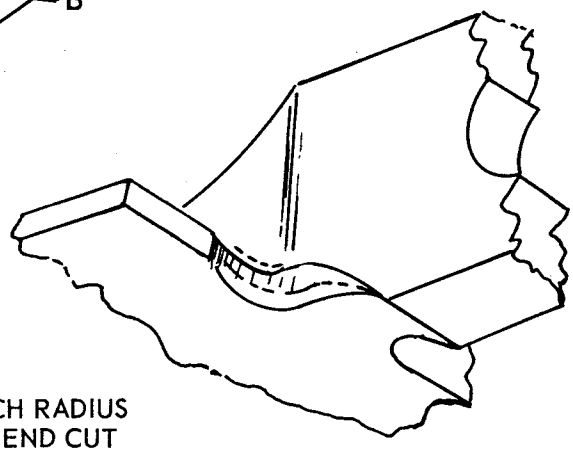
NOTE:

BLENDED AREAS SHOWN ARE TYPICAL FOR ALL FRONT SPAR UPPER AND LOWER CAP LUGS. MATERIAL REMOVAL LIMITS ARE SHOWN IN FIGURE 1 (SHEETS 1 AND 2) RH FRONT SPAR LOWER CAP LUGS SHOWN. ALL BLENDED AREAS ARE TO BE SMOOTH AND FREE FROM TOOL MARKS.

Figure 2. Front Spar Cap Lugs – Removal of Fillet Cracks Recommended Blending RADII (Sheet 1 of 2)

R/H LOWER CAP SHOWN,
TYPICAL FOR ALL REAR
SPAR CAP LUGS





DETAIL A

NOTES.

1. AFTER REMOVING CRACK WITH 1/4 INCH OR 1/2 INCH RADIUS CUTTER PER INSTRUCTIONS ON PAGES 6 AND 7, BLEND CUT OUT TO FOLLOWING DIMENSIONS:

   "A" (CHORDWISE) = 1/2" FROM ORIGINAL THEORETICAL CORNER

   "B" (SPANWISE), IF ON CURVED* SURFACE AS SHOWN, BLEND ALL THE WAY TO CORNER; IF ON FLAT SURFACE, B = 3/4" ** FROM ORIGINAL THEORETICAL CORNER.

2. AT FLANGES, IF CHAMFER IS MORE THAN 2/3 OF FLANGE THICKNESS, BLEND OUT OVER FULL FLANGE THICKNESS, SEE DETAIL "A".

* UPPER SURFACE OF UPPER LUGS AND LOWER SURFACE OF LOWER LUGS.

** LOWER SURFACE OF UPPER LUGS AND UPPER SURFACE OF LOWER LUGS.

Figure 2. Rear Spar Cap Lugs – Removal of Fillet Cracks Recommended Blending Dimensions (Sheet 2 of 2)

THE END