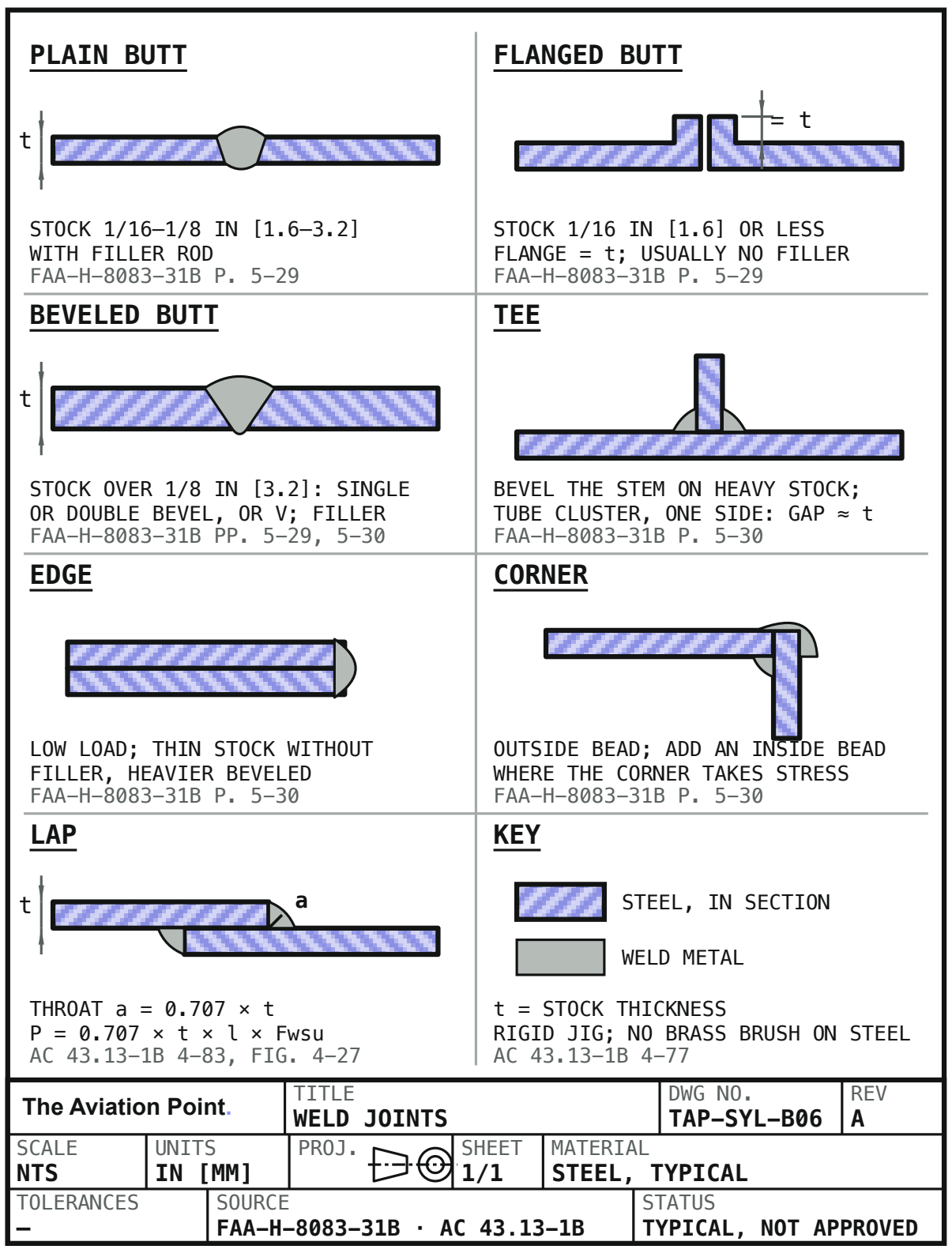
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Welding and Brazing: Processes, Weld Inspection and Steel-Tube Repairs

Process by metal · never weld · inspect the bead · tube repairs

1 Identification



Joints and preparation after FAA-H-8083-31B pp. 5-29 to 5-31 and AC 43.13-1B 4-77, 4-83 (Fig. 4-27).

Which metal may be welded, and how

Metal or part	Status	Why, and the conditions
4130 chrome-moly tube and sheet	**Allowed**	Readily weldable (SAE 4100 series). Over 3/16 in (4.8 mm): preheat 300 to 400 °F (150 to 205 °C). TIG on wall under 0.120 in (3.0 mm): no preheat, post-weld stress relief recommended. 4130
Plain carbon (1000), nickel (2300), chrome-nickel (3100), low Ni-Cr-Mo (8600) steels	**Allowed**	Listed as readily weldable
Members that depend on heat treatment	**Only with approval**	The more an alloy steel responds to heat treatment, the less weldable it is. Weld with a rod that gives heat-treated values, then heat treat to the manufacturer's specification; a heat-treated tubular spar needs the whole assembly reheat treated
Heat-treated alloy steel parts: bolts, turnbuckle ends, axle stubs	**Not allowed**	Heat treated to improve their properties; damaged axle stubs are replaced
Parts strengthened by cold work: streamline wire, cables	**Not allowed**	Their strength comes from cold working
Brazed or soldered parts	**Not allowed**	The braze or solder penetrates and weakens the hot steel. Never weld a joint that was brazed
Austenitic stainless (300 series)	**Check**	All weldable except 303 and 303Se. Structural stainless is cold worked and loses strength when heated: by gas, only non-structural stainless welds satisfactorily (slightly carburizing flame, 1/16 in (1.6 mm) feather, tip one or two sizes smaller than for steel)
Aluminum 2024 and 7075	**Not allowed**	The heat of welding causes severe cracking
Aluminum 1100, 3003, 4043, 5052	**Allowed**	Gas welding usually 0.031 to 0.125 in (0.8 to 3.2 mm) thick, tip one size larger than for steel. TIG on AC, argon preferred, no flux
Aluminum 6053, 6061, 6151	**Only with approval**	Used heat treated: weld only if the part can be reheat treated
Magnesium	**Check**	High expansion: rigid fixtures, no joints that trap flux, butt and edge welds preferred. Never weld aluminum to magnesium. TIG current: the two documents differ. AC 43.13-1B fig. 4-30 sets AC; FAA-H-8083-31B p. 5-23 names DC either polarity or AC with high frequency, DC reverse polarity preferred by hand. The welding procedure of the repair data governs

Educational reference only, not approved data. Always consult the applicable SRM, AMM, or AC 43.13-1B and your certifying authority.

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Metal or part	Status	Why, and the conditions
Titanium	**Check**	DC straight polarity; clean area free of drafts; puddle, trailing and back side shielded until the weld is below 800 °F (427 °C)

2 Allowable damage

Inspecting a finished weld

Look at	Accept	Source
Seam	Smooth, ripples evenly spaced, uniform thickness	AC 43.13-1B 4-78(a); FAA-H-8083-31B p. 5-15
Contour	Built up slightly convex; tapered smoothly into the base metal; no undercut at the toe	AC 43.13-1B 4-78(a), (b); FAA-H-8083-31B p. 5-15
Oxide	None on the base metal more than 1/2 in (12.7 mm) from the weld	AC 43.13-1B 4-78(c)
Porosity	No blowholes, porosity or projecting globules; numeric limits only where the specification on the drawing gives them (military specifications, ASTM codes)	AC 43.13-1B 4-78(d)
Base metal	No pitting, burning, cracking or distortion	AC 43.13-1B 4-78(e)
Penetration	Base metal and filler fused through the joint; underside checked	AC 43.13-1B 4-78(f), (g)
Scale and slag	Removed by wire brush or sandblasting; no roll-over, cold lap or unfused weld metal	AC 43.13-1B 4-78(g)
Titanium color	Bright silver. Straw: slight contamination, unlikely to affect properties. Dark blue or white powdery oxide: remove the whole weld and reweld	FAA-H-8083-31B p. 5-24
Brazed joint	Filler drawn through the joint by capillarity, uniform bead. — : no other acceptance criteria in these documents; the drawing's or the process specification's	FAA-H-8083-31B p. 5-19

3 Repair

Steel-tube repairs: the dimensions

Repair	Key dimensions	Source
Finger patch at a cluster	Plate of the material and thickness of the heaviest damaged tube; fingers ≥ 1.5 D over each tube; gap to the joint ≤ 1/16 in (1.6 mm); tack, then weld all edges	AC 43.13-1B 4-91c, fig. 4-34; FAA-H-8083-31B p. 5-31
Welded split sleeve	ID about equal to the tube OD; same material, wall at least the original; 30° cut on both ends; near end ≥ 1-1/2 D from the dent or crack; weld both sides and both ends	AC 43.13-1B 4-92, fig. 4-35
Welded patch	Same material, one gauge thicker; limits in the damage table	AC 43.13-1B 4-94, fig. 4-36
Inner-sleeve splice	Diagonal cut; replacement tube same material and diameter, wall at least the original; 1/8 in (3.2 mm) gap at each end; sleeve OD = tube ID, diameter difference ≤ 1/16 in (1.6 mm); sleeve ends ≥ 1-1/2 D from the nearest end of the cut; rosette tacks, weld through the gap	AC 43.13-1B 4-95, fig. 4-37; FAA-H-8083-31B p. 5-32
Outer-sleeve splice	90° cut; replacement bears on the stubs within 1/32 in (0.8 mm) total; sleeve clearance ≤ 1/16 in (1.6 mm); sleeve ends ≥ 1-1/2 D from the cut; fishmouth where possible; weld one sleeve, let it cool, then the other. Most welding of all: only when the others do not suit	AC 43.13-1B 4-96, figs. 4-38, 4-39
Larger-diameter replacement tube	Square cut; short stub ≥ 2-1/2 D, long stub ≥ 4-1/2 D; diameter difference ≤ 1/16 in (1.6 mm); ends ≥ 1-1/2 D from the cut; fishmouth where possible. Not close to cluster joints or where brackets need the original diameter	AC 43.13-1B 4-97, fig. 4-40
Engine mount member	Larger-diameter tube telescoped over the stub with fishmouth and rosette welds; 30° scarf acceptable. Alignment kept with a fixture or by bolting to engine or airframe; cracked welds ground out; re-stress relieve if the maker did	AC 43.13-1B 4-99; FAA-H-8083-31B p. 5-35

1. Data and qualified welder.
2. Identify metal, heat treat, process.
3. Find all damage; remove cracks.
4. Clean, jig, fit to the repair.
5. Weld; stress relieve if called for.
6. Inspect both sides; record.

Key points

- **Equal to the original weld** (AC 4-74).
- **Never weld** 2024, 7075, heat-treated bolts, brazed joints.
- **Oxide ≤ 1/2 in** from the weld; no grinding, no filling.
- **Primary structure:** major repair, approved data.

MAIN SOURCES · FAA AC 43.13-1B CHG 1, Acceptable Methods, Techniques, and Practices: Aircraft Inspection and Repair · FAA-H-8083-31B, Aviation Maintenance Technician Handbook: Airframe · 14 CFR part 43 · MIL-STD-1595A, Qualification of Aircraft, Missile and Aerospace Fusion Welders · AWS D17.1, Specification for Fusion Welding for Aerospace Applications · Regulation No 748/2012, Annex I

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