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AVIATION MAINTENANCE TECHNICIAN CERTIFICATION SERIES

MATERIALS AND HARDWARE

6

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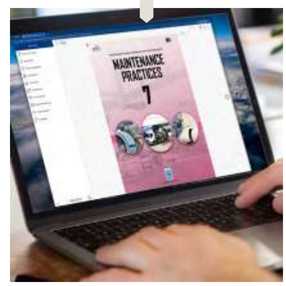

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VERSION	EFFECTIVE DATE	DESCRIPTION OF REVISION(S)
001	2013.01	Module creation and release.
002	2014.07	Format Updates
003	2018.07	Modified Submodule sequence in accordance to Appendix A. Added content in the following areas: 6.3 – Thixotropic agents;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

MATERIALS AND HARDWARE

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

NOTES:

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

Figure 1-5. Heat treatment procedures for steels.

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

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

EFFECT OF ALLOYING ELEMENT

- 1000 series: Made of 99 percent aluminum or higher, excellent for its corrosion resistance, high thermal and electrical conductivity, low mechanical properties, and excellent workability. Iron and silicon are major impurities.
- 2000 series: Copper is the principal alloying element. Solution heat treatment, optimum properties equal to mild steel, poor corrosion resistance unclad. It is usually clad with 6000 or high purity alloy. Its best known alloy is 2024.
- 3000 series—Manganese is the principal alloying element of this group which is generally non-heat treatable. The percentage of manganese which will be alloy effective is 1.5 percent. The most popular is 3003, which is of moderate strength and has good working characteristics.
- 4000 series—Silicon is the principal alloying element of this group, and lowers melting temperature. Its primary use is in welding and brazing. When used in welding heat treatable alloys, this group will respond to a limited amount of heat treatment.
- 5000 series—Magnesium is the principal alloying element. It has good welding and corrosion resistant characteristics. High temperatures (over 65°C) or excessive cold working will increase susceptibility to corrosion.
- 6000 series: Silicon and magnesium form magnesium silicide which makes alloys heat treatable. It is of medium strength, good forming qualities, and has corrosion resistant characteristics. The most popular alloy of the series is 6061. When coupled with magnesium, it results in heat treatable alloys of very high strength. It usually has copper and chromium added.
- 7000 series: Zinc is the principal alloying element. The principal alloy of this group is 7075.

HARDNESS IDENTIFICATION

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

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

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

MAGNESIUM

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

Percentage of Alloying Elements
(aluminum and normal impurities constitute remainder)

Alloy	Copper	Silicon	Manganese	Magnesium	Zinc	Nickel	Chromium	Lead	Bismuth
1100	—	—	—	—	—	—	—	—	—
3003	—	—	1.2	—	—	—	—	—	—
2011	5.5	—	—	—	—	—	—	0.5	0.5
2014	4.4	0.8	0.8	0.4	—	—	—	—	—
2017	4.0	—	0.5	0.5	—	—	—	—	—
2117	2.5	—	—	0.3	—	—	—	—	—
2018	4.0	—	—	0.5	—	2.0	—	—	—
2024	4.5	—	0.6	1.5	—	—	—	—	—
2025	4.5	0.8	0.8	—	—	—	—	—	—
4032	0.9	12.5	—	1.0	—	0.9	—	—	—
6151	—	1.0	—	0.6	—	—	0.25	—	—
5052	—	—	—	2.5	—	—	0.25	—	—
6053	—	0.7	—	1.3	—	—	0.25	—	—
6061	0.25	0.6	—	1.0	—	—	0.25	—	—
7075	1.6	—	—	2.5	5.6	—	0.3	—	—

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

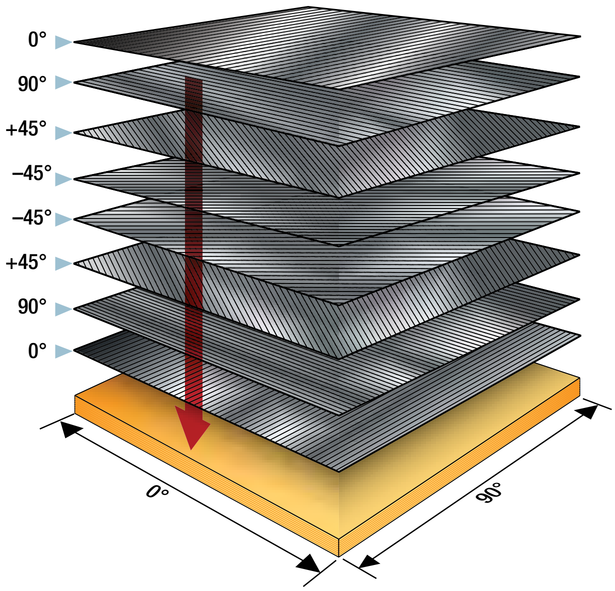

Figure 3-3. Quasi-isotropic material layup.

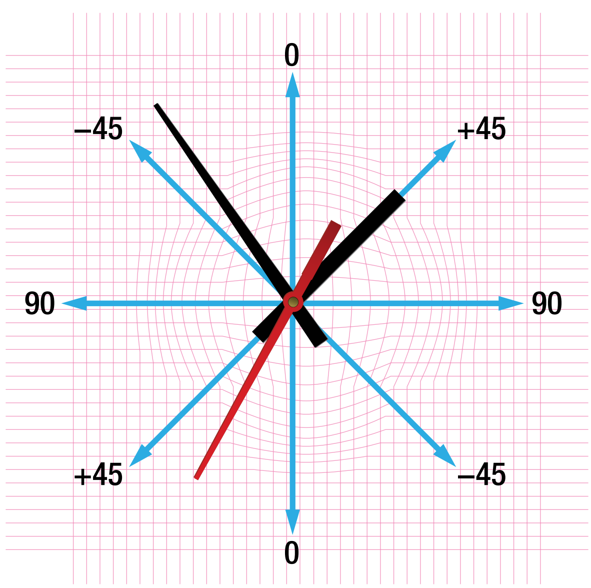

Figure 3-4. A warp clock.

FIBER FORMS

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

ROVING

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

UNIDIRECTIONAL (TAPE)

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

BIDIRECTIONAL FABRIC

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

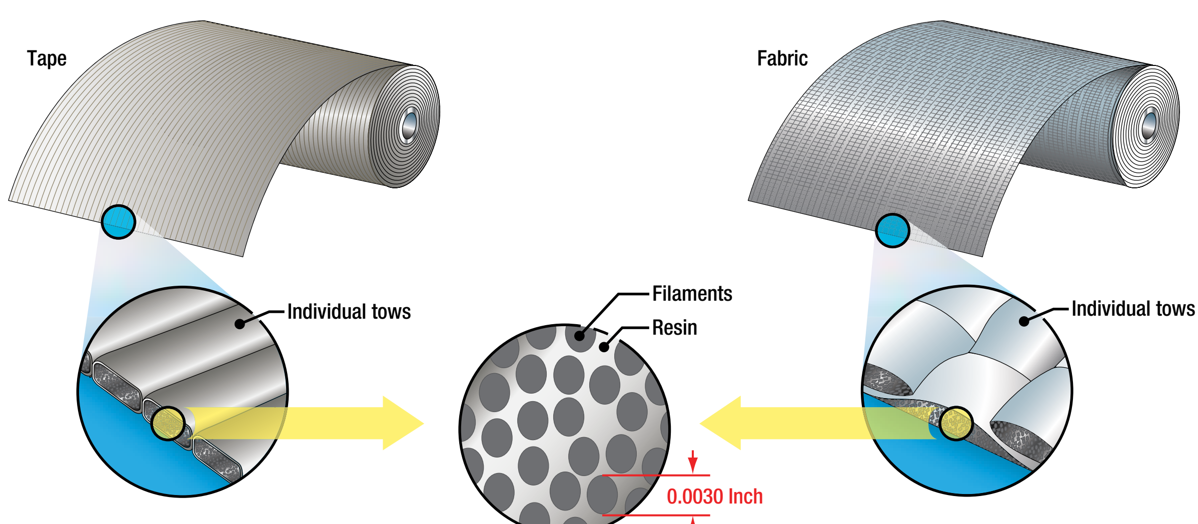

Figure 3-5. Tape and fabric products.

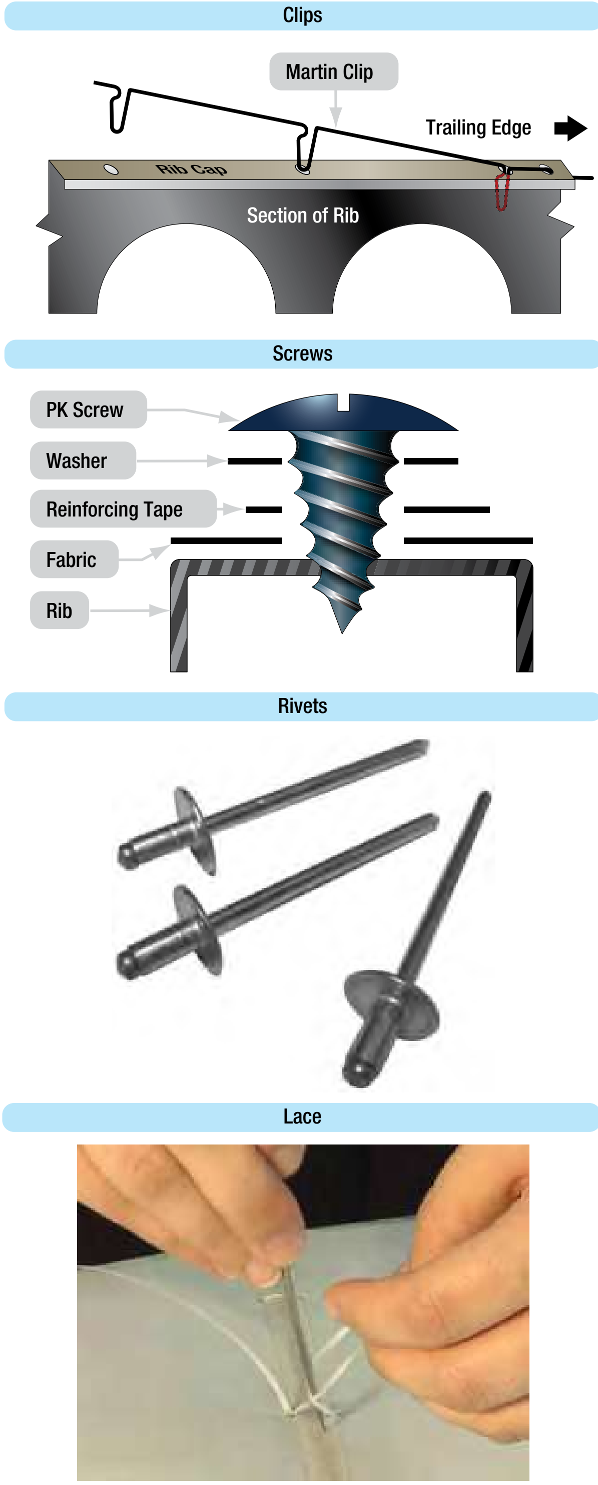

Figure 3-120. Clips, screws, rivets, or lace are used to attach the fabric to wing and empennage ribs.

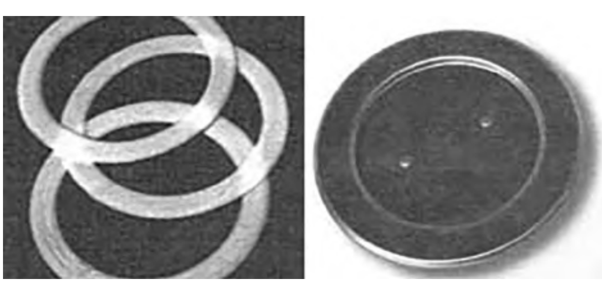
Figure 3-121. Inspection rings and an inspection cover.

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

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

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

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

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

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

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

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

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

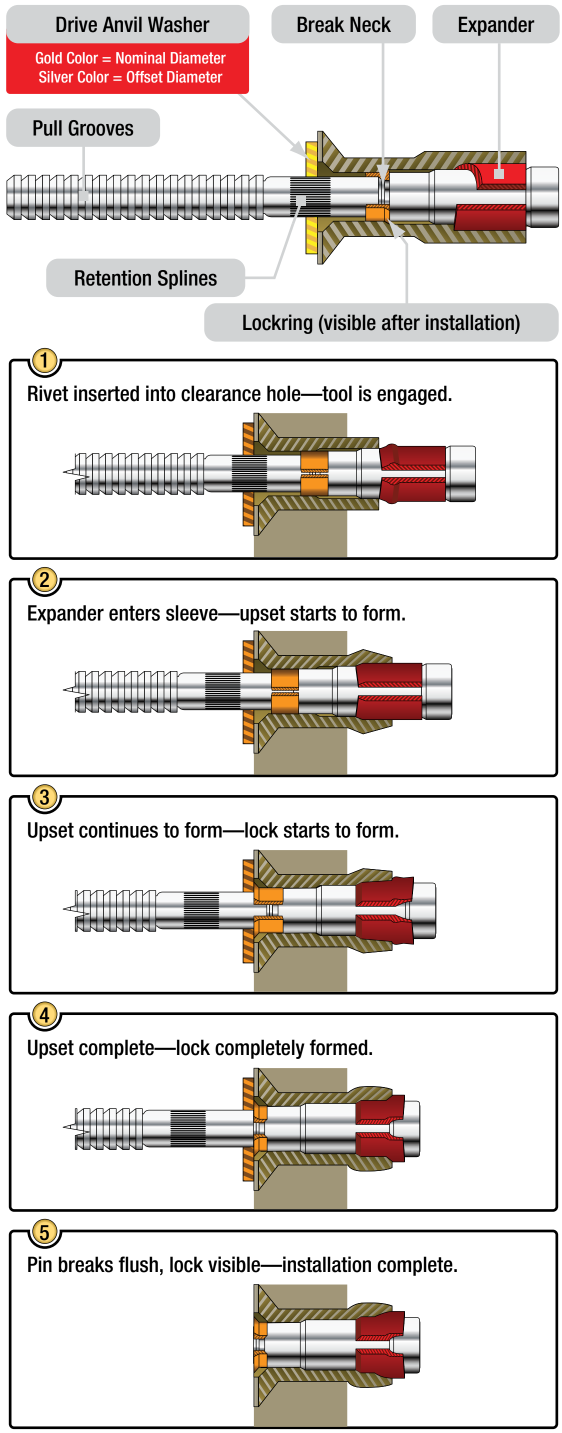

Figure 5-61. Huck Blind Bolt system.

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

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

INSTALLATION PROCEDURE

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

TAPERED SHANK BOLT

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

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

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