

## SECTION 2

### CHAPTER 9

# WIRING: LOCK, SHEAR AND SEAL

## INTRODUCTION

1. Electric connectors, emergency devices, and other pieces of electrical equipment in aircraft are secured with wire when specified on engineering drawings or specified in the applicable aircraft maintenance handbook in order to prevent accidental loosening.

2. This chapter outlines the recommended procedures for wiring MS electric connectors and emergency devices such as switches, switch guards, and handles which operate ejection seats, emergency bomb releases, fire extinguishers, etc. General practices for safety wiring are specified in Military Standard Drawing MS33540 and wire identification is provided in Table 9-1.

## REFERENCE SPECIFICATIONS

3. The following specifications are applicable to Lock Wire, Shear Wire and Seal Wire:

SAE AS 50881	Wiring Aerospace Vehicle
NASM20995	Wire, Safety or Lock
NASM33540	Safety Wiring and Cotter Pinning, General Practices for

## DEFINITIONS

### Lock Wire

4. Lock wire is normally a single strand steel wire installed by twisting to double strand. It is used to secure parts against inadvertent opening or loosening in areas of high vibration such as the engine compartment. Electrical connectors are lockwired or safety wired in such high vibration areas. (Refer SAE AS 50881)

#### NOTE

Use 0.032 inch lockwire for general purpose lockwiring. 0.020 inch lockwire may be used on parts having a nominal hole diameter of less than 0.045 inch or on closely spaced screws and bolts of 0.250 inch (6.35mm) diameter or less.

#### NOTE

Connector plugs with self-locking coupling rings are designed for high vibration environments and do not have lock wire provisions.

### Shear Wire

5. Shear wire is used where it is necessary to purposely break or shear the wire to permit operation or actuation of emergency devices. Shear wire is a thin, single strand, easily breakable wire used to secure emergency devices.

#### NOTE

General purpose shear wire shall be 0.020 inch diameter.

### Seal Wire

6. Seal wire is the same as shear wire except that the ends of the wire are sealed with a lead seal. Seal wire is used to secure emergency devices such as fire extinguishers, oxygen regulators, etc., to prevent tampering with or use of these devices without indication.

### Metallic Seals

7. Metallic seals are not to be used on airborne components, equipment or systems. When anti-tampering seals are required for lock wire, a bright gloss paint system is to be used. The paint is to be applied in such a manner that will provide a visible indication that the lock wire has been tampered with.

## GENERAL PROCEDURES FOR LOCK, SHEAR AND SEAL WIRING

#### WARNING

Eye protection is required when using pliers that cut or trim and shall be worn while installing or removing safety wire. Keep fingers away from jaws and cutting edge.

**WARNING**

Lockwire ends must be bent under to prevent injury. Care should be taken not to confuse steel with aluminium wire.

**CAUTION**

Use only new wire when replacing wired electrical connectors or emergency devices.

**Length**

8. Use wire of the shortest length that will allow accomplishment of the procedures outlined in Paras 14 through 22. Double Twist Lock Wiring

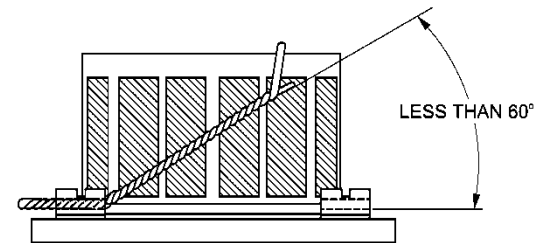
9. Use the double twist method of lock wiring as illustrated in Figure 9-1 for all equipment in areas of high vibration and for electrical connectors in areas which are inaccessible.

**Single Wire Method**

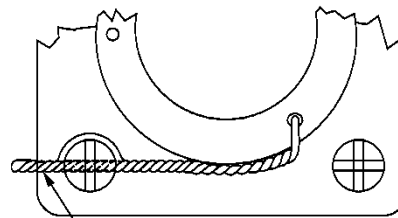
10. Use the single wire method shown in Figure 9-2 in all conditions specified for shear and seal wire as described in Paragraphs 5 and 6. In addition, the single wire method may be used with locking wire in areas hard to reach and small screws in a closely spaced or closed geometrical pattern such as triangles, squares, rectangles, circles, etc.

**NOTE**

All plugs and sockets that are required to be lock wired, as specified on an engineering drawing or in the applicable aircraft maintenance manual, are to be lock wired using the twisted wire method.



VERTICAL VIEW



HORIZONTAL VIEW

704500234

Figure 9-1 Double Twist Lock Wiring

Table 9-1 Safety Wire – Identification

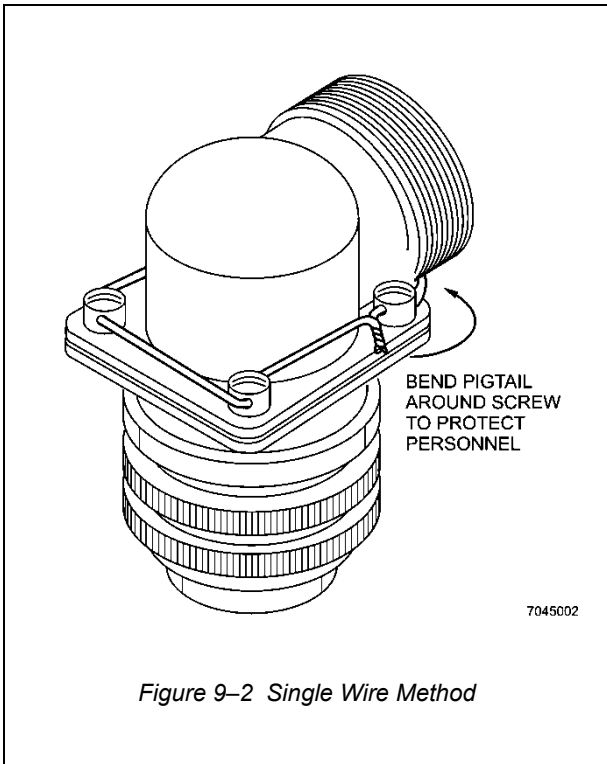
Wire Type	Material	Colour	Size	Identification
Lock Wire	Steel (Corrosion Resistant)	Silver	0.020 inch	MS20995C20 9505-00-221-2650
			0.032 inch	MS20995C32 9505-00-293-4208 or 9505-00-847-1663
Lock Wire (Above 370°C)	Inconel	Natural	0.020 inch	MS20995N20 9505-00-529-9195
			0.032 inch	MS20995N32 9505-00-529-0442
Shear or Seal Wire	Annealed Copper (Cadmium Plated)	Golden Yellow	0.015 inch	MS20995CY15 9525-01-082-1008
			0.020 inch	MS20995CY20 9525-01-047-6455
Lock, Shear or Seal Wire for Magnesium Parts	Aluminium Alloy (Anodized)	Blue	0.032 inch	MS20995AB32 9525-01-031-1086

**Twisting with Pliers**

11. When wire is twisted by hand, use pliers for the final twists to apply tension and to secure ends of wire. Cut off part of wire gripped by pliers to remove rough edges.

**NOTE**

Make sure wire does not become kinked or nicked during twisting operation. If wire is damaged, replace with new wire.



**Twisting With Special Tools**

12. Twist wire with a wire twister as follows (see Figure 9-3):

**WARNING**

Eye protection shall be worn while installing or removing safety wire. Keep fingers away from jaws and cutting edge.

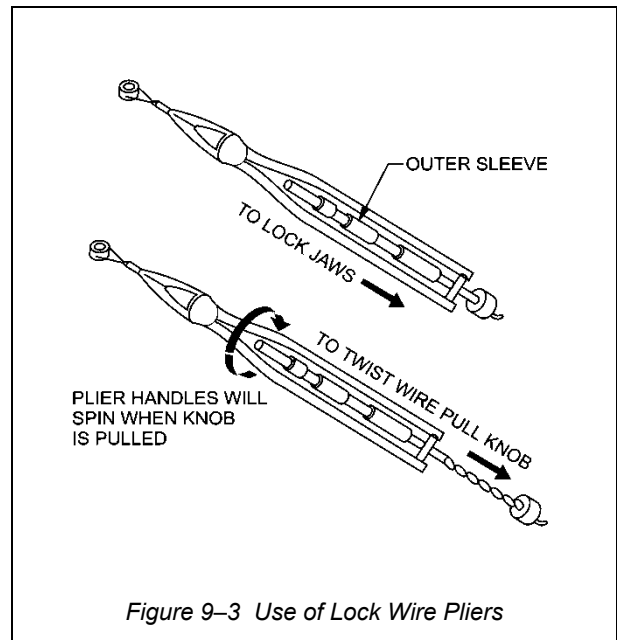
**WARNING**

When using wire twisters and wire extends 3 inches (75mm) beyond jaws of twisters, loosely wrap wire around pliers to prevent whipping and possible injury.

- a. Grip wire in jaws of wire twister and slide outer sleeve down with thumb to lock handles.
- b. Pull knob; spiral rod spins pliers and twists the wire.
- c. Squeeze handles together to release wire.

**Tightness of Wire**

13. Install wire so that the wire will be in tension if the part loosens. Twist wire together so that it is tight, but do not overstress wire as it may break under load or vibration.



**SPECIFIC PROCEDURES FOR LOCK, SHEAR AND SEAL WIRING**

**Lock Wiring Electrical Connectors and Backshells**

**NOTE**

Do not install lock wire under the head of a screw or bolt. Use predrilled fillister head screws or safety tabs.

14. Secure electrical connectors and back-shells with lock wire when specified on engineering drawings or specified in the applicable aircraft maintenance handbook. Electrical and RF connectors and backshells, unless of the self-locking type, shall be lock-wired in engine nacelles, areas of high vibration, locations not readily accessible for periodic maintenance and external electronic compartments. Connectors and backshells in these locations are identified by a painted/affixed red dot 0.50 inch (12.7mm) in diameter on adjacent aircraft structure.

15. Do not lock wire electric or RF connectors and backshells which have a mechanical lock, as lock wiring will act against the locking feature. Backshells on bayonet coupled connectors shall not be safety wired to connector coupling ring. Backshells with safety wire holes shall be safety wired to aircraft structure or to connector mounting flange when required (see Figure 9-9).

**Lock Wiring Connectors with Threaded Coupling Rings**

16. When specified on engineering drawings or specified in the applicable aircraft maintenance handbook, lock wire connectors as follows (see Figure 9-4):

- a. Thread lock wire through wire hole in coupling ring.

**CAUTION**

When installing new lock wire or replacing unserviceable existing lock wire, use MS20995, 0.020 inch lock wire only. Larger lock wire can break out the hole in the coupling ring.

**NOTE**

If connector plug to be lock wired does not have a wire hole, remove coupling nut and drill a #56 (0.046 inch) diameter hole diagonally through the edge of nut, as shown in Figure 9-6.

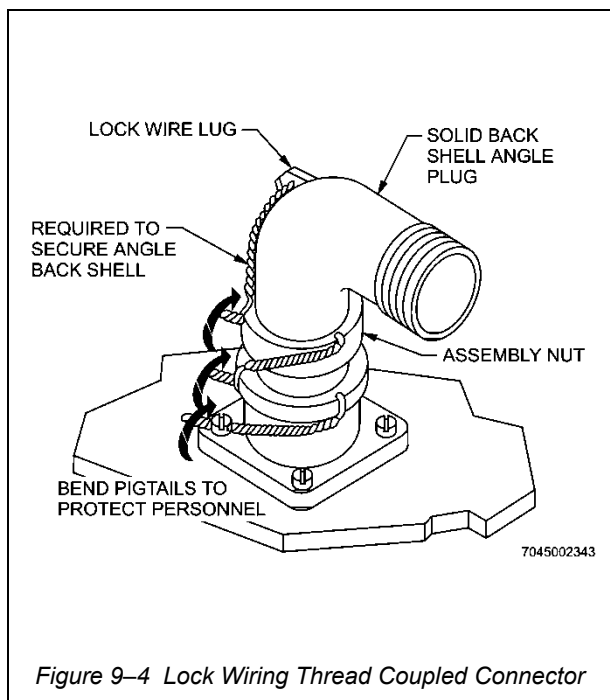


Figure 9-4 Lock Wiring Thread Coupled Connector

- b. Twist wire, under slight tension, approximately 9 to 11 turns per inch, (see Figure 9-5), by hand or by special tool, as described in Paras 11 and 12. Twist wire right handed so it will have a tightening effect. Twist to within approximately 0.125 inch (3mm) of each unit.

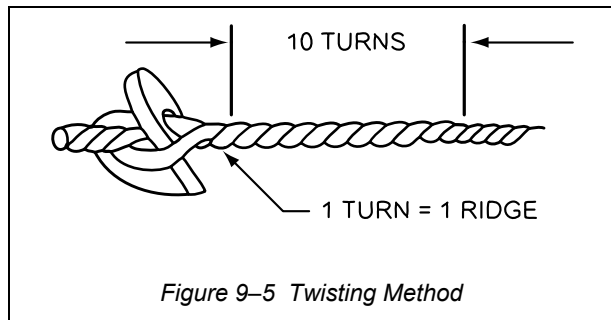


Figure 9-5 Twisting Method

- c. Pull one end of twisted wire through hole in drilled fillister head screw on mounting flange of connector. Use a fillister head screw so located as to allow a 60° or smaller angle of the wire, as shown in Figure 9-1.

**CAUTION**

Do not back off or over-torque mounting fillister head screws, in order to align holes for lock wiring.

- d. Form pigtail approximately 0.5 inch (12.7mm) or 3-7 turns.

**NOTE**

Individual sections of connectors may be lockwired with a continuous piece of lock wire if appropriate authorisation is obtained.

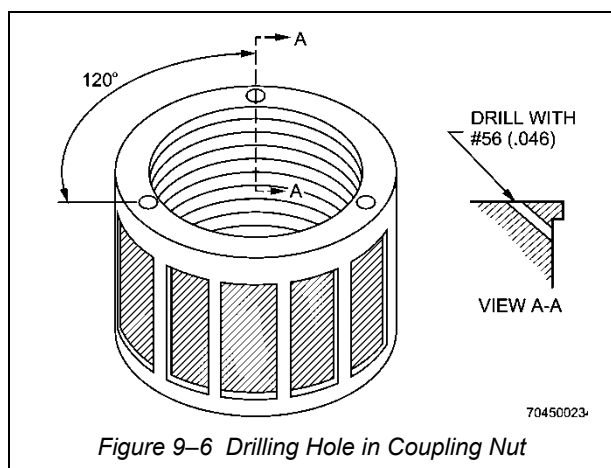


Figure 9-6 Drilling Hole in Coupling Nut

- e. Bend pigtail back towards body of connector to prevent it from injuring personnel.

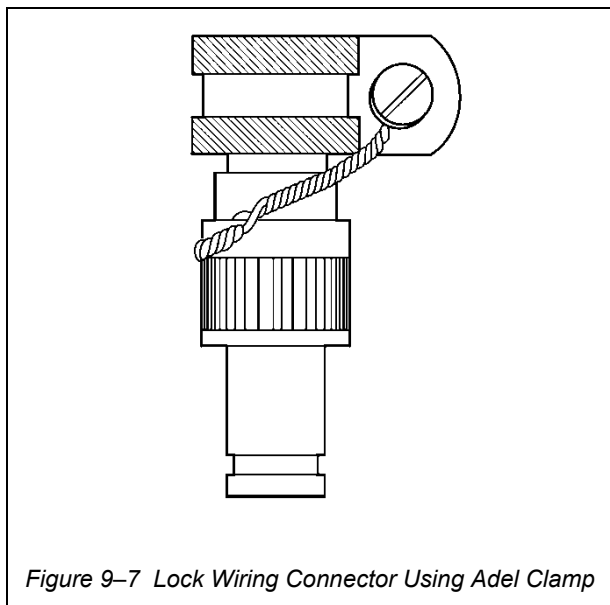
- f. Safety wire attached cable clamps/coupling ring to connector coupling ring if provisions exist. (See Figure 9-4.) If necessary, safety wire these parts to structure (see Figure 9-8) or to mounting flange (see Figure 9-9). Use same procedure as described in steps a through e.

**CAUTION**

Electrical connectors shall not be lockwired to any part of fuel, oil, hydraulic or oxygen systems (lines, tubes, elbows, flanges, jam nuts etc).

**NOTE**

Connectors should be lock wired to fillister head screws, through safety wire tabs or drilled holes in structure provided for that purpose. If no holes are provided, connectors may be lockwired to each other, however, the maximum number of connectors that can be lock-wired in series is three (3). In those applications where RF connectors require safety wiring and physical dimensions preclude drilling safety wire holes, a cable clamp can be attached to the connector for securing the safety wire. Attach the cable clamp as illustrated in Figure 9-7.



**Lock Wiring Connector to Structure**

17. If no fillister head screw or safety wire tab is available for attaching lock wire, secure wire to drilled hole in structure not more than 6 inches (15cm) from connector, as shown in Figure 9-8. Use same procedure as described in Para 14.

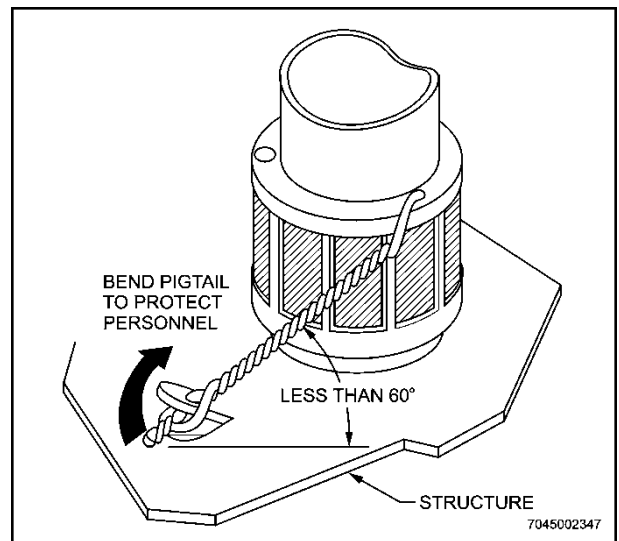
**Lock Wiring Split Shell Assemblies**

18. Split shell connectors are held together by two fillister head screws. Secure these screws as follows (see Figure 9-9):

- a. Draw wire through hole in one screw.
- b. Cross wire from left to right between screws, and draw through second screw.
- c. Twist wires together with pliers and bend back.

**Wiring Solid Shell Angle Plugs**

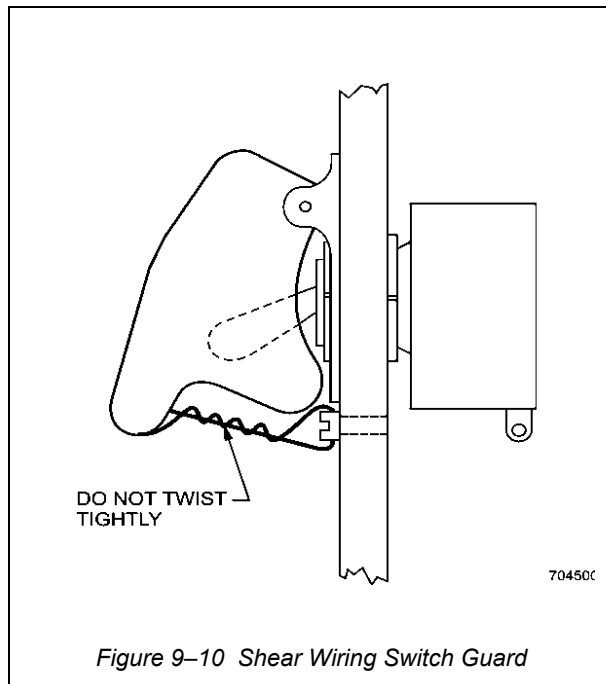
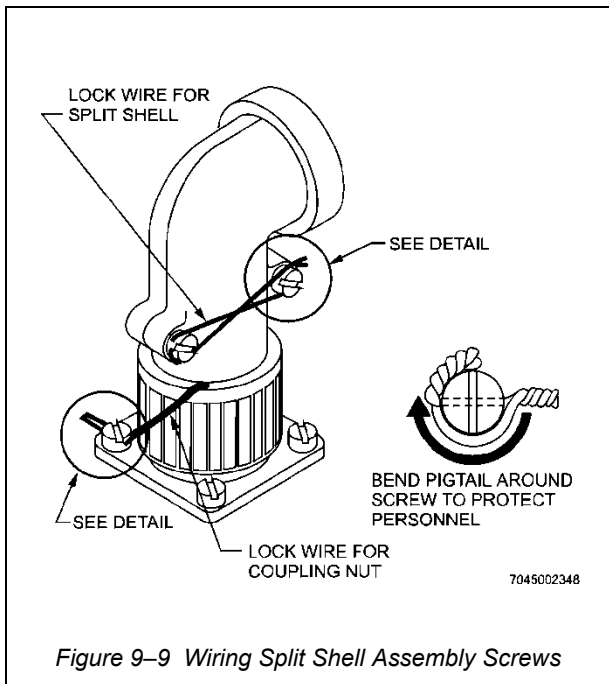
19. Angle plugs with solid black shells are in two parts, held together by four screws through mating flanges. Wire these screws with a single lock wire as shown in Figure 9-2. Solid shell angle plugs made by Bendix and Cannon have back shells held in place by assembly nuts. Install a double twisted lock wire between hole in assembly nut and lug on backshell as shown in Figure 9-4. If necessary to lock wire the plug itself install a second double twisted wire between the assembly nut and the coupling nut or between the coupling nut and one of the receptacle mounting screws, as shown in Figure 9-4.



*Figure 9-8 Lock Wiring Connector to Structure*

**Shear Wiring of Electrical Components**

20. The purpose of shear wiring is as follows:
- a. Prevent inadvertent operation of a switch, and
  - b. To highlight the selection or operation of a particular service or function.



**Shear Wiring Emergency Devices**

21. Use single wire method to secure emergency devices. (See Figure 9-10.) Make sure that wire is so installed that it can easily be broken when required in an emergency situation.

NOTE

Several sizes of shear wire may be used within aircraft, however, for applications such as shear wiring of electrical switches and switch covers Annealed Copper Wire PN MS20995CY20 (NSN 9525-01-047-6455) is to be used.