



LOCKING OF THREADED COMPONENTS

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Issue N°	Date (Mmm DD, YYYY)	Changes
1	Jun 25, 2004	Creation of PCS-7610.
2	Feb 27, 2006	Correction: PS1011-1 is partially superseded by PCS-7610. §7A(2)(h): Encapsulation of the wire locked nut or head and the wire tail is only requested if specified on the drawing. Associated documents not listed in the PCS suppressed. PCS-7500 called instead of DSS-5604.
3	Jul 09, 2009	Introduction of safety cables.
4	Dec 16, 2019	Clarification of cup washer indentation and additional split pin alternative method. References to PCS-7500 removed.
5	Jun 12, 2024	Elongated ferrule alternative clarified

Changes denoted by a change bar in the left margin.

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1 SCOPE

- A. This specification describes the procedures for locking of threaded components with the following locking devices:
 - Split Pins (Cotter Pins),
 - Locking Wire or Safety Cable
 - Tab Washers,
 - Cup Washers.

- B. This specification supersedes PS1011-1 partially, PS1011-16, NCT60-300-03MD partially, NCT60-300-04MD partially and NCT60-300-01MD partially.

2 ASSOCIATED DOCUMENTS

- A. SAFRANLS specifications

DSS-5104: Warranty seals.

3 DEFINITIONS

- A. Competent Authority: Person (or group of persons) within SAFRAN LS authorised to take decisions for granting exceptions to the present standard. This (these) person(s) is (are) defined as follows:

« When there is a request for any deviation from the requirements of this specification, the request shall be processed via the Quality Department responsible of the area/site of manufacture. All queries relating to any technical aspect of the component must be addressed to the Engineering department responsible for the design of the part within SAFRAN LS.

Decisions on parts where the component design, base material, its processing, or treatments are concerned will be provided via this route.

When the query addressees issues which will not affect the life or function of the part, e.g. « cosmetic » variations, the decision will be given by the responsible Quality Department (Please note that surface finish, protective treatment variances and profile variations must not be interpreted as « cosmetic »).

- B. CMM Component Maintenance Manual

4 HEALTH AND SAFETY

- A. It is the Department Manager's responsibility to develop safe working practices and to adequately train operators in accordance with local legislation requirements.

5 LOCKING BY DEFORMING THE LOCKING DEVICE

A. Tab washer, fishtail type / Key washer

- (1) Place the tab washer over structure edge or into the drilled hole as relevant.
- (2) Torque tighten the fastener in accordance with the drawing or CMM requirements.
- (3) The hexagon headed bolt or nut is locked by bending up each side of the 'fish tail' locking tab against the adjacent hexagon flat or flats, as shown in Figure 1.
- (4) To avoid accidental unlocking, injury and damage to clothing and mating parts, check that the 'fish tail' tabs do not stand proud of the hexagon.
- (5) The tab washer must never be used more than once.

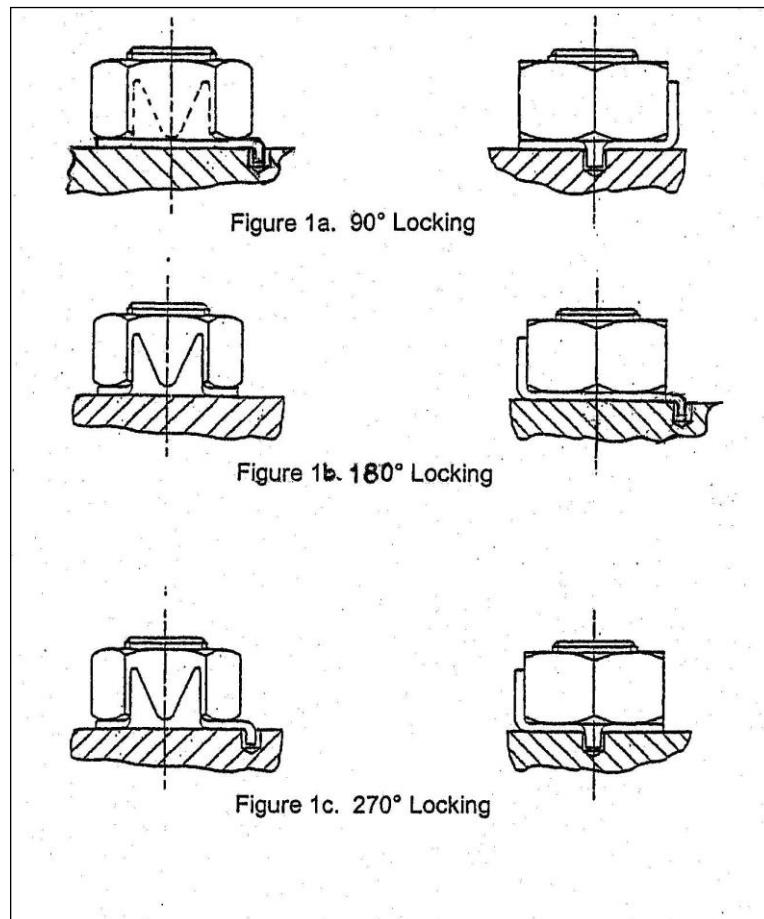


Figure 1

B. Tab washers, Internal Tab

- (1) The tab washer is assembled concentric with the threaded hole and the internal tab is deformed to provide the 'key', by bending it sufficiently to be inserted totally in to the slot on the end of the pin. The bolt type fastener is subsequently threaded in to the end of the pin and torque tightened in accordance with the drawing instructions.
- (2) The pin and fastener assembly is locked relative to each other by bending or deforming the outer edge of the tab washer either on to the face of the torque tightening hexagon or in to the torque tightening slot (see Figure 2).
- (3) To avoid accidental unlocking, injury and damage to clothing and mating parts, the deformed edge of the tab washer shall not stand proud of the head of the fastener. Apply procedures given in paragraph 5.A.(3).
- (4) The tab washer must never be used more than once.

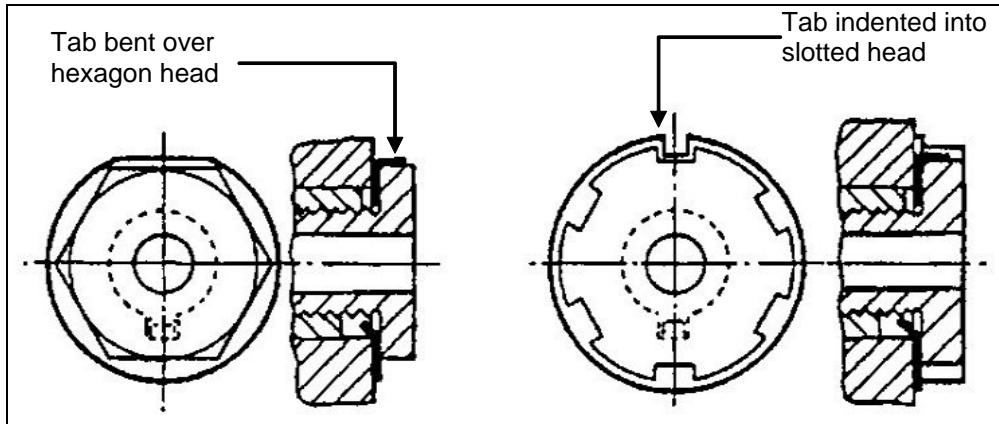


Figure 2

C. Cup Washer

- (1) The Cup Washer is assembled over the threaded hole or shaft with the keying dowels or 'dog' tooth / teeth fitted in to the mating holes or slots. The fastener or shaft is subsequently threaded in to the housing and torque tightened in accordance with the drawing instructions.
- (2) The assembly is locked by indenting the lip of the Cup Washer in to two opposing slots in the fastener or shaft, in such a manner that it cannot be moved. Each indented portion of the cup washer should be in contact with both corners of the opposing slot and at an appropriate depth as shown by examples of acceptable and unacceptable practice in Figure 4.

Cup Washers may be used up to four times dependent upon their condition being satisfactory. When re-using a Cup Washer, it must not be indented again at the position of any previous indentation. If it is not possible to indent in a previously unused position, the Cup Washer must be scrapped and replaced.

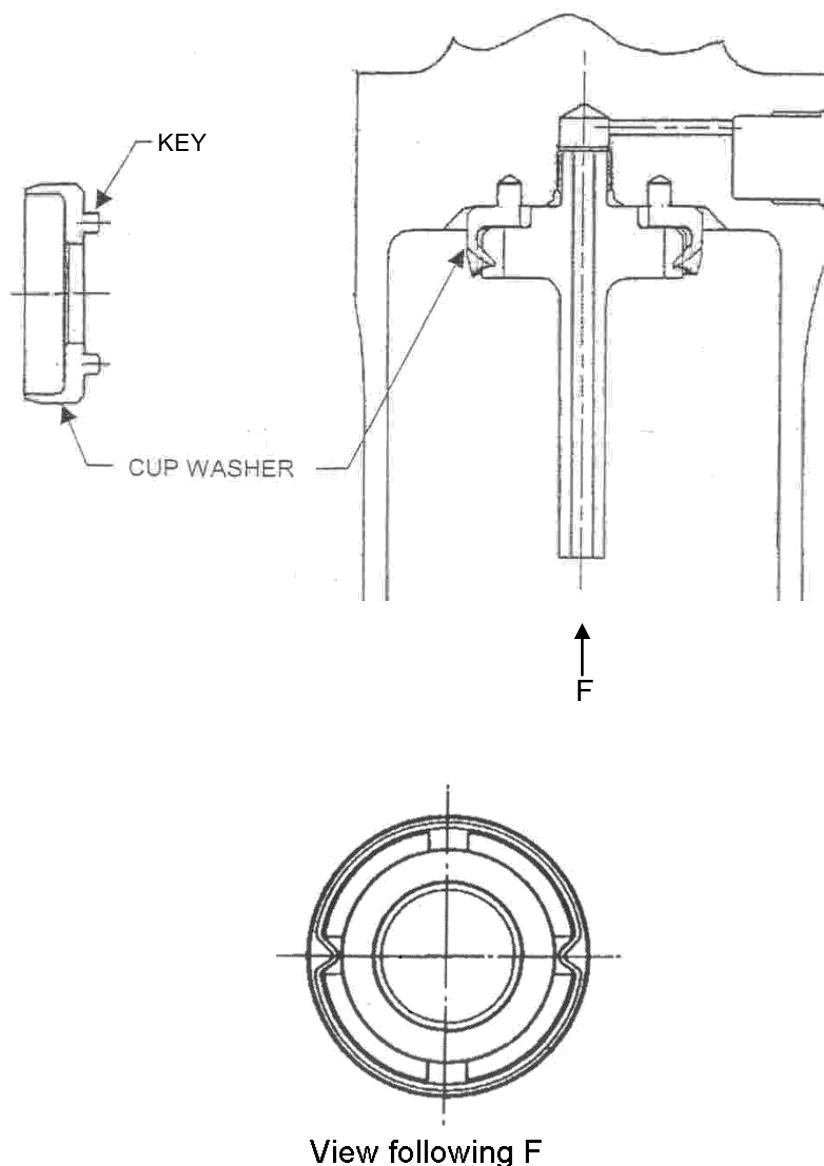


Figure 3



Unacceptable

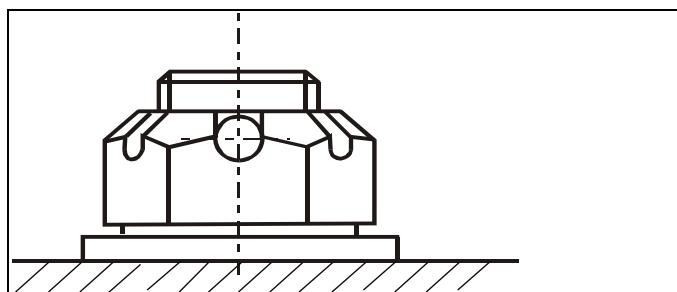


Acceptable

Figure 4

6 SPLIT PIN (COTTER PIN) LOCKING

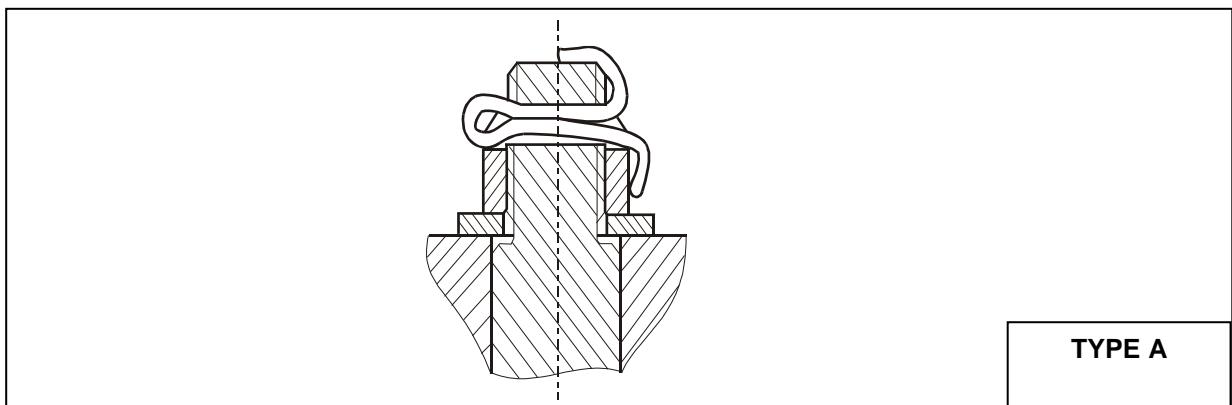
- Check that adequate deburring of holes receiving split pin had been performed.
- Torque tighten the nut in accordance with the drawing or CMM requirements. It is not normally possible to insert the locking pin when the nut has been tightened to the required torque. In order to be able to do this, use the tolerances on the tightening torque to position the notch with respect to the hole (see Figure 5).

**Figure 5**

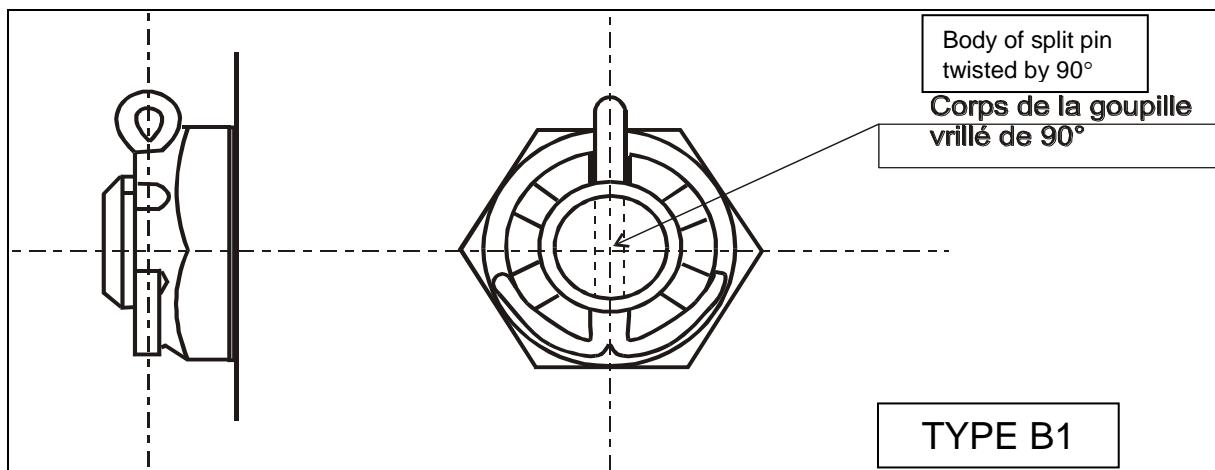
Check:

- The diameter of the split pin;
- That the head is correctly formed.

- If the split pin is not fitted immediately after the tightening of the nut, make sure before pinning that the tightening torque is correct. Insert the split pin through the castellation and hole, so that the pin 'loop' is hard against the male threaded part.
- After pinning, apply sufficient pressure to the head to ensure that it is appropriately embedded in the notch (never use a hammer, which could cause distortion to the head of the split pin and damage the nut and the pin).
- Shorten the legs of the split pin if necessary with wire cutters before bending them back. Cutting of the legs of the split pin after pinning is strictly forbidden on the inside of a mechanical assembly, where recovery of the cut ends cannot be assured.
- Bending of the split legs:
 - Unless otherwise stated on the drawing, the bending of the split legs must be performed in accordance with Type A (see Figure 6).

**Figure 6 : PREFERRED**

- (2) The following bending types may be used if shown on the drawing or in the CMM (see Figure 7 and Figure 8):

**Figure 7 : 'ALTERNATIVE METHOD' Type B1**

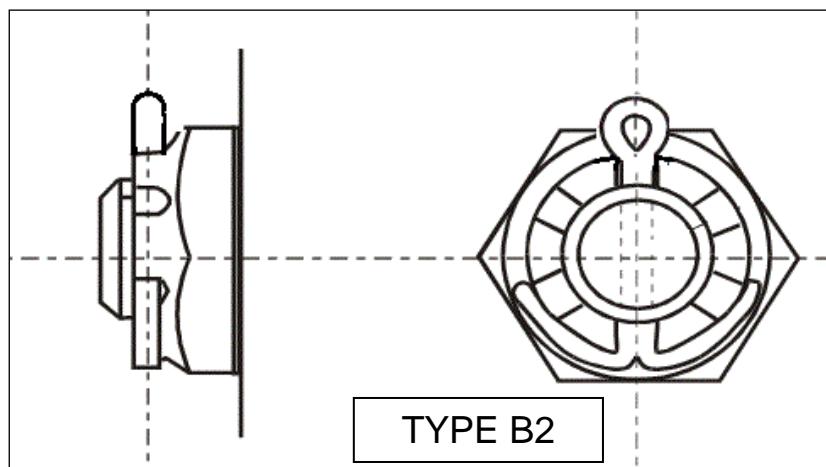


Figure 8 : 'ALTERNATIVE METHOD' Type B2

- G. Check after pinning and locking that the split pin is correctly fitted which does not exclude that it may be allowed to rotate slightly in its housing.
- H. A split pin must be used once only.

7 LOCKING WIRE AND APPLICATION OF WARRANTY SEALS

A. Locking of screws and nuts

(1) Preliminary operations

Check that adequate deburring of holes receiving locking wire had been performed.

The holes in parts must be thoroughly deburred prior to protective treatment.

Where possible and where a light alloy part is being locked, isolate the contact surface between the wire and the part with a spot of paint.

(2) General rules

(a) The wire linking the items to be locked must be fitted such that any tendency to unscrew is resisted by an increase in the tension in the wire.

Note the reversed direction of the winding of the twisted wires C compared to twisted wires A. Movement of the loop B is possible only in a direction which increases the twist of the wires A and C (see Figure 9).

(b) After it has been passed through the hole provided, the wire must be twisted around itself 8 to 12 times over a length of 25 mm (1.00 in.) until the wire is just short of the second fastener. This will ensure that the loop around the fastener does not lift and become loose. The wire must be kept taut during operation.

(c) Whenever possible, excessive lengths of twisted wire should be avoided.

(d) The length of untwisted wire in the vicinity of each hole must not exceed 3 mm (.118 in.) (See Figure 9).

(e) After the last hole, the wire must be twisted for 10 to 15 mm (.500 to .625 in.), and then formed into a loop so that it is not dangerous.

(f) Bend the tail in half in an anticlockwise direction, towards the item to be locked so as to prevent it becoming a snag. The bent tail should protrude beyond the locked item no more than approximately 6 to 9 mm (.250 to .350 in.) (See Figure 9).

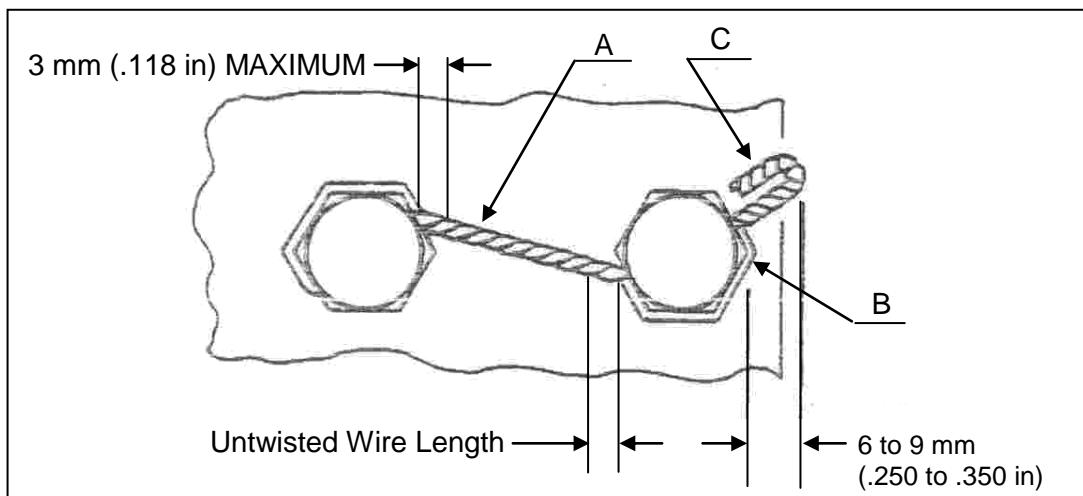
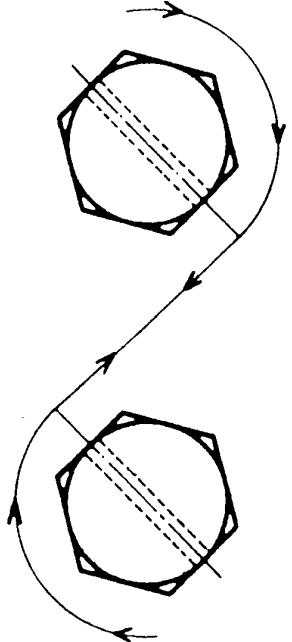
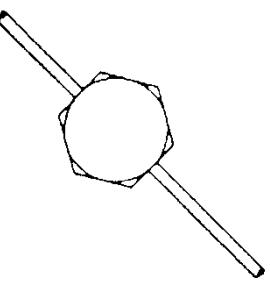
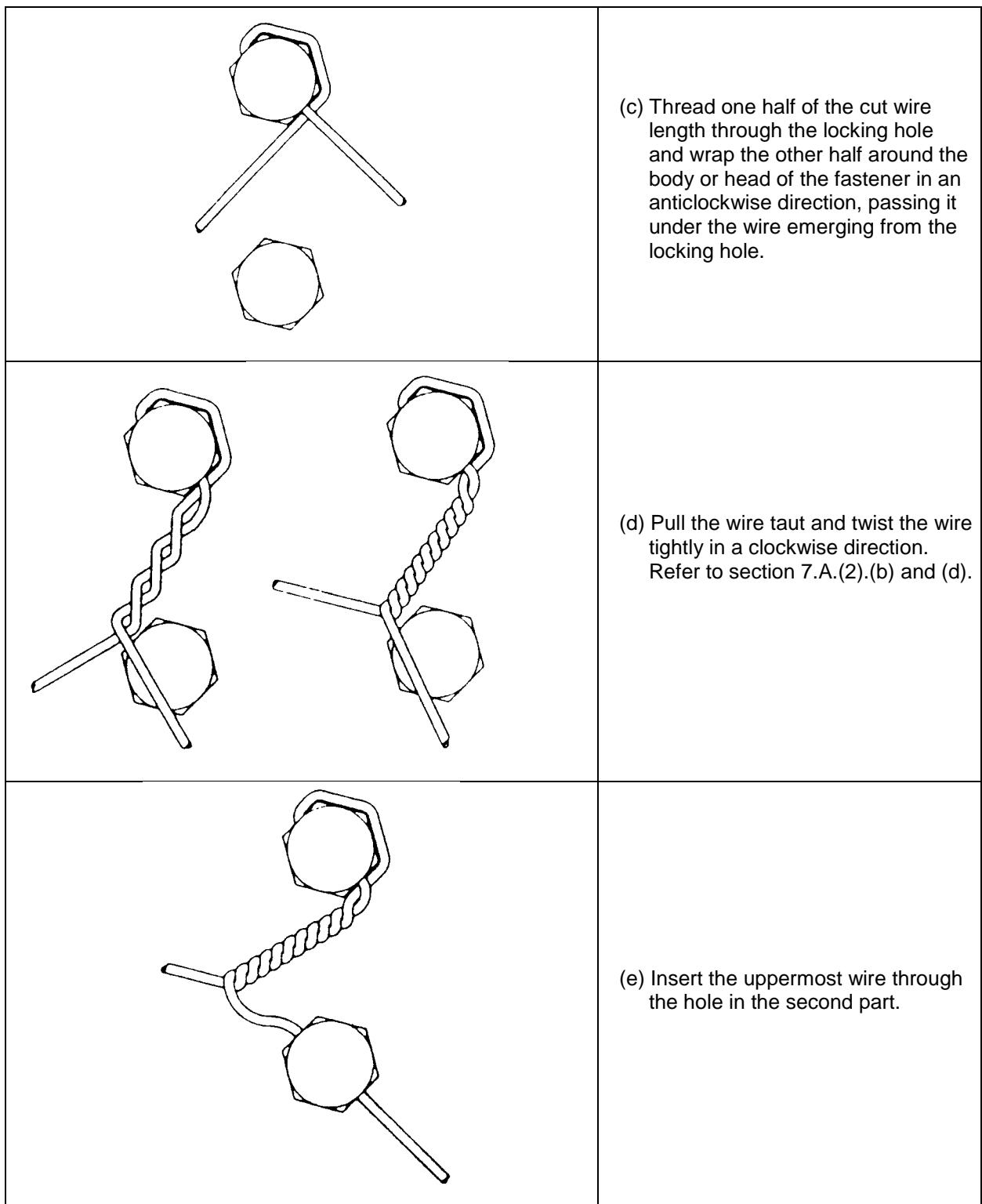
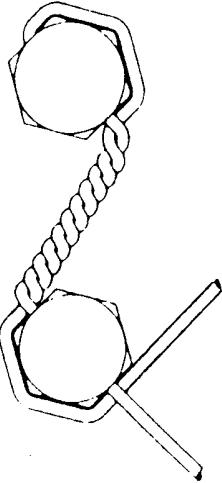
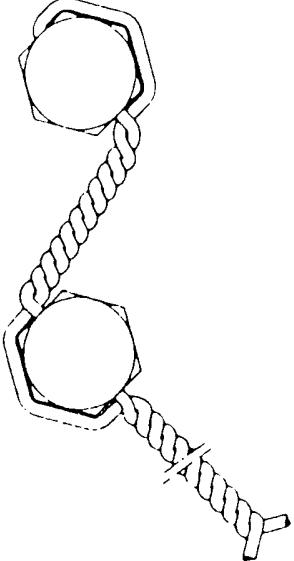
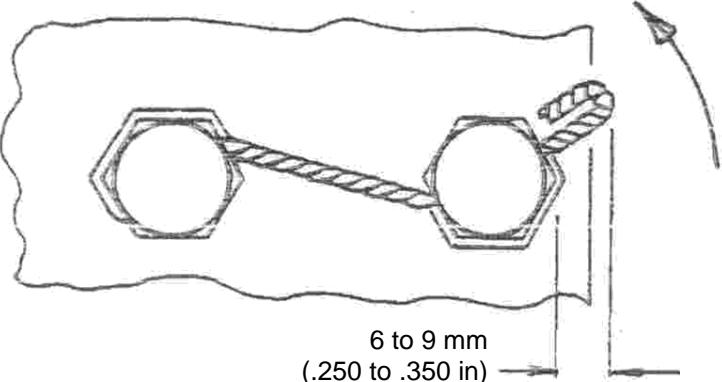


Figure 9

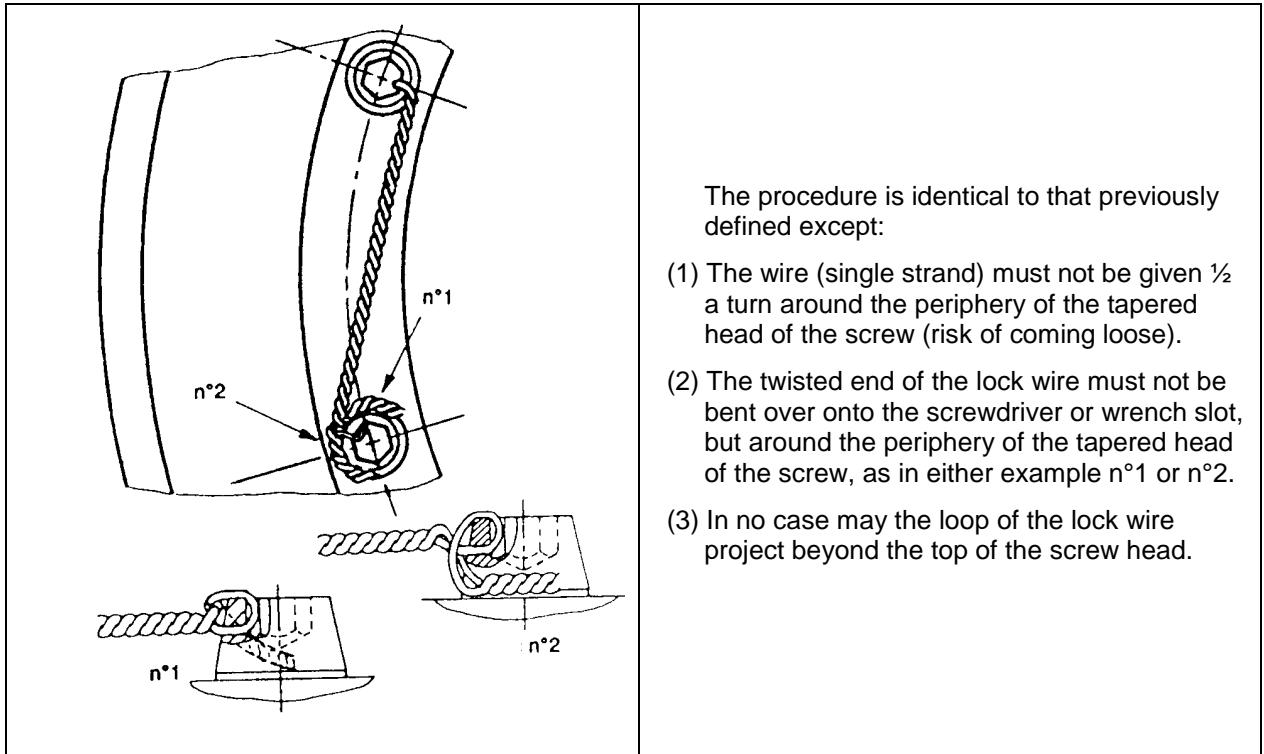
- (g) The wire must be fitted such that it does not suffer any wear due to chafing (pressing against a sharp edge) or excessive tension caused by a random pressure.
 - (h) On all locked fasteners, the wire locked nut or head and the wire tail should be encapsulated with sealant where specified on the drawing.
 - (i) A locking wire must be used once only.
- (3) Locking wire process (Example of two screw heads)
- The following procedure applies to right handed threads. The direction of winding must be reversed for applications with a left-handed thread.

	<p>(a) Ensure that all fasteners are torque tightened to the drawing requirements before locking.</p> <p>Remark: if the positions of the holes are beyond those permitted, do not tighten or slacken. Select a screw where the permissible positions can be maintained</p> <p>When locking adjacent parts, the line of approach of the locking wire should be as near tangential as possible, to the part being locked.</p>
	<p>(b) Thread the locking wire through the hole at the anchor point, where applicable, otherwise through a suitable locking hole in the part to be locked (i.e. where fasteners are locked to each other.)</p>



	<p>(f) Bring the other end of the wire around the flats on the second fastener, in the anticlockwise direction, and pass it under the wire emerging from the hole. Twist it by hand, as in operation (d), but in the opposite direction.</p>
	<p>(g) After wiring the last item, continue twisting the wire to form a tail (refer to 7.A.(2).(e)).</p>
 <p style="text-align: center;">6 to 9 mm (.250 to .350 in)</p>	<p>(h) Bend the tail in half in an anticlockwise direction, towards the item to be locked so as to prevent it becoming a snag (refer to 7.A.(2).(f)).</p> <p>Check that the locking is tight, if slack the wire must be cut and discarded. The procedure should then be repeated.</p>

B. Locking of tapered screw heads (2x2)

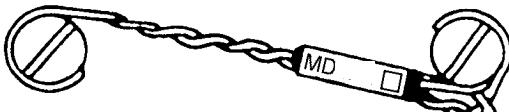


C. Application of warranty seals

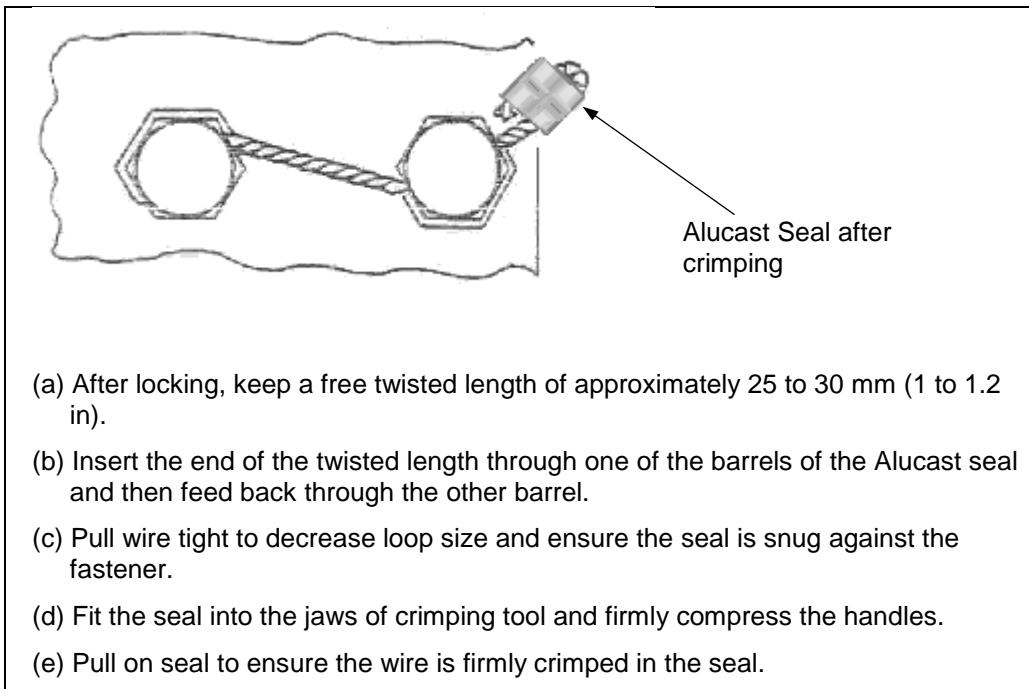
(1) Technical definition

The dimensions, inscriptions, material, etc are defined by DSS-5104.

(2) Fitment of the heat-shrunk sleeve

When the distance between the two points to be locked is sufficient	When the distance between the two points to be locked is not sufficient
 <ul style="list-style-type: none"> (a) Before locking the second point, insert the wire into the sleeve. (b) Link up the second point and keep a free twisted length of approximately 20 mm (.8 inch.). (c) Bend back the free end and slide the sleeve over the two twisted wires. (d) Heat the sleeve to shrink it. 	 <ul style="list-style-type: none"> (a) After locking, keep a free twisted length of approximately 25 to 30 mm (1 to 1.2 inch.). (b) Bend over the free end at a length of approximately 10 mm (.4 inch.). (c) Slide the sleeve along so that it covers the ends of the wire. (d) Heat the sleeve to shrink it.

(3) Installing #67 Alucast Seals





8 SAFETY CABLE AND WARRANTY SEALS

The term "safety cable" is used to apply to any cable system complying with AS4536. It includes "Safety Cable™" by Bergen Cable Technologies (cage code 70958) and "Safe-T-Cable®" by Daniels Manufacturing Corporation (cage code 11851).

A. Substitution

When drawing defines a locking with lock wire, safety cable may be used as an alternative to locking wire, provided that all the following conditions are met:

- That there is sufficient space to allow the crimping tooling to be used and ensure that the cable tension could be correctly applied.
- That the safety cable conforms to AS3510 and is replacing corrosion resistant steel lock wire to MS20995C20, MS20995C32, AS44725-1 or AS44725-2 only.
- That the safety cable nominal diameter corresponds with the lock wire nominal diameter.
- That adequate clearance is maintained between the safety cable / ferrule and all adjacent parts, including those which might pass close by during functioning movement, maintenance or assembly.
- That no more than two bolts are secured together with a single safety cable, unless approved by the Competent Authority, or unless shown as more than two bolts and defined as safety cable on the drawing.

If safety cable is specified on the drawing (alone, or as an alternative to lock wire), then the drawing shall take precedence.

If the drawing defines a locking with lock wire, and safety cable is used in lieu, then lock wire may still be re-substituted for the safety cable at a later date.

If the drawing defines a locking with safety cable (only) then lock wire may not be substituted.

B. Installation of Safety Cable

When using safety cables, the following rules shall be respected (accordingly to AS4536).

(1) Preliminary operations and checks

- (a) Check that adequate deburring of holes receiving locking wire had been performed. The holes in parts must be thoroughly deburred prior to protective treatment.
- (b) When safety cable is being substituted for lock wire in an existing installation, the safety cable shall be of equivalent diameter to the lock wire.
- (c) Any cable defect (nick, fray, kink, or any other mutilation of the safety cable) found prior to, during, or subsequent to installation, at or between termination points, is not acceptable.
- (d) Safety cable and ferrule shall be new upon each application. Reuse is not acceptable.

(2) General rules

- (a) The safety cable must follow the routing shown on the drawing. If safety cable is substituted in place of lock wire then the same general routing shall be followed as for lock wire, but some variation at termination (e.g. at the head of a fastener) may be made in order to achieve a proper installation
- (b) Safety cable shall be installed in such a manner that any tendency for a fastener to loosen will be counteracted by an additional tension on the cable. The recommended practice for installation is to limit exit bends to 135 degrees or less as the cable is threaded through the fasteners.

This will prevent the safety cable from slipping over the head of the fastener and becoming excessively loose.

(c) Hole alignment:

Undertorquing or overtorquing to obtain proper alignment of the holes is not permitted. Apply recommended torque values to parts to be secured, and alignment of holes shall be evaluated before attempting to proceed with safety cable installation.

- (d) The span of the safety cable will be as defined on the drawing, either specifically as safety cable, or as shown for the wire locking that is to be substituted by safety cable.
- (e) Where possible, the cable termination and ferrule should be positioned within the outline profile of the part, to minimise the risk of snagging.
- (f) Various examples of safety cable installation are shown on Figure 10. Not all possible combinations and applications are shown.

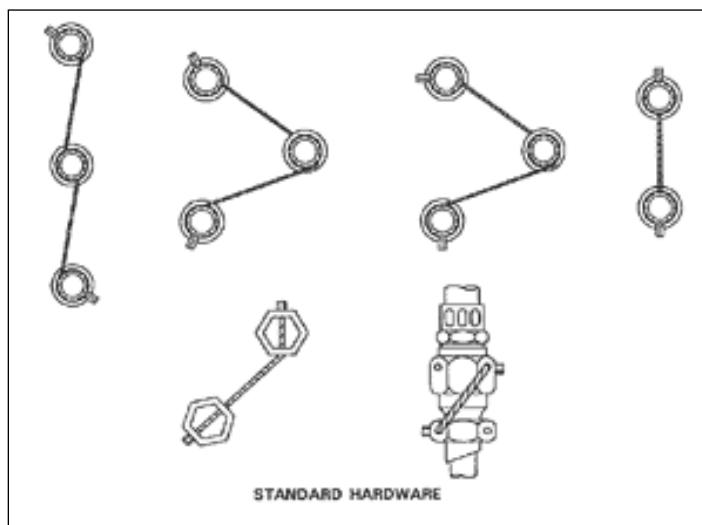


Figure 10 : Examples of Safety Cable

Note that the 'three bolt assembly' configuration is prohibited unless approved by the Competent Authority, or shown defined on the drawing for safety cable application.

In the event of the drawing not showing a lockwire or safety cable routing, routing of the cable shall be as direct as possible.

- (g) Crimp requirements (see Table 1):

To install safety cable the recommended tool shall have a repeatable mechanism which applies tension to the cable, crimps the ferrule, and cuts the cable. The crimping tool shall then be calibrated in accordance with crimp specifications provided in Table 1 and periodically checked to validate lockings (frequency to be defined by the applicable quality department).

Nominal Cable Diameter mm (inch)	Safety Cable Construction	Minimum Pull-Off Load N (lbf)
0.51 (0.02)	1 x 7	133.4 (30)
0.81 (0.032)	3 x 7	311.4 (70)

Table 1: Minimum Crimp Requirements

It is important to hold the tool as steady and perpendicular to the fastener as possible during the crimp/cut cycle in order to maintain consistent tensioning of the cable after the tool is removed.

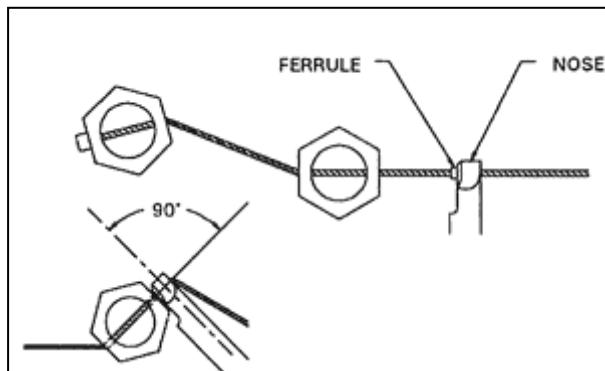


Figure 11 : Correct application of safety cable

(h) After installing safety cable excess cable from the crimped ferrule shall be cut by the installation tool. The maximum allowable length of cable extending beyond the ferrule shall be .031 inch (0.8mm).

(i) **Cable Tension**

After installing safety cable, light finger pressure shall be applied on the cable to check cable tension (for a three bolt assembly check tension between the first and the second bolts and then between the second and the third ones).

(j) **Cable flex limits**

After installing the maximum cable flex limits between termination points shall be no greater than the specified values in **Table 2**:

A inch (mm)	B inch (mm)	C inch (mm)
0.5 (12.7)	0.125 (3.2)	0.062 (1.6)
1.0 (25.4)	0.250 (6.4)	0.125 (3.2)
2.0 (50.8)	0.375 (9.5)	0.188 (4.8)
3.0 (76.2)	0.375 (9.5)	0.188 (4.8)
4.0 (101.6)	0.500 (12.7)	0.250 (6.4)
5.0 (127.0)	0.500 (12.7)	0.250 (6.4)
6.0 (152.4)	0.625 (15.9)	0.312 (7.9)

Table 2 : Maximum Flex limits

(3) Ferrule Choice

Ferrule of extra length, according to AS3618, having a radius at one end and a straight surface at the other end, may be used in applications which restrict the clearance for the installation tool nose to be placed in correct alignment with the fastener (such as low profile fastener heads, recess locations, or obstructions by structures or installed components).

Fasteners that have limited clearance between the safety wire hole (less than .100 inch), and the surface of the component to which the fastener is attached, can present a challenge to the installation of safety cable. This is due to the clearance required by the application tool nose, adjacent to the fastener. The radius allows the ferrule to be installed at an angle without loss of tension on the cable when the ferrule returns to the straight position.

Always install elongated ferrules with the radius end toward the fastener, and the straight end in the tool crimp cavity (see Figure 12).

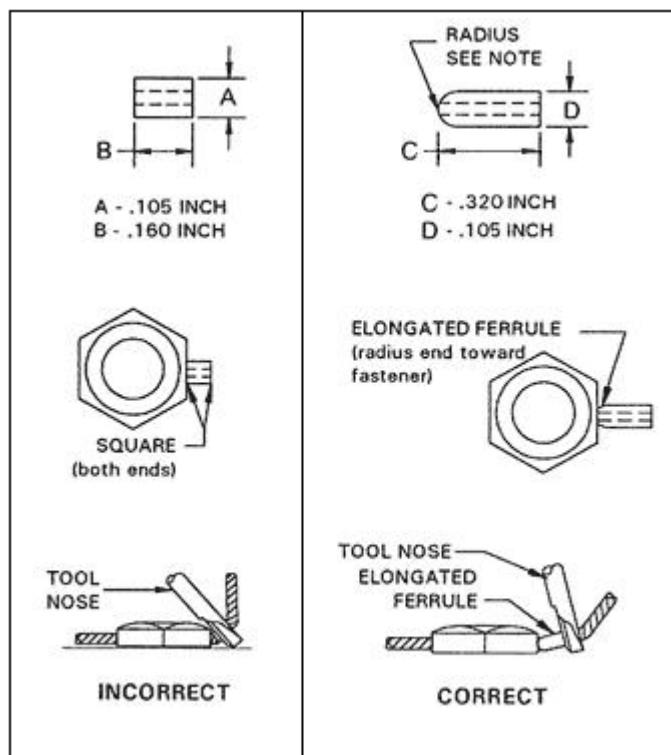


Figure 12 : Use of elongated ferule

When the definition calls a safety cable as per AS3510, an elongated ferrule as per AS3618 may be used as an alternative. This substitution is not considered as a change to design definition. However, the elongated ferrule shall not cause a foul to adjacent components. Please find below some examples of part numbers equivalence :

Definition (short ferrule)		Equivalence (elongated ferrule)			
Part Numbers	Type	Part Numbers		Type	
AS3510-0209K	Kit	AS3618-02-09K		Kit	
AS3510-0209K	Kit	AS3510-0209C	AS3618-02F	Cable + Ferrule	Cable + Ferrule
AS3510-0209C	AS3510-02F	Cable + Ferrule	AS3510-0209C	AS3618-02F	Cable + Ferrule

Table 3 : Ferrule equivalence examples



C. Warranty

Where a logo or ID is required to be a permanent part of the safety cable installation (for warranty or traceability), a stamp may be applied to one or more surfaces of the square end fitting of the cable. Only impression stamping is permitted, no paint, ink, or labels are acceptable (see Figure 13).

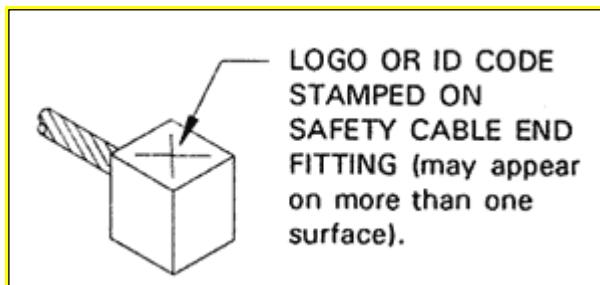


Figure 13 : Stamp