Process Specification for Installation of Threaded and Collared Fasteners
Engineering Directorate

Structural Engineering Division

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Process Specification for Installation of Threaded and Collared Fasteners

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ES4

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ES4

<table>
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<th>VERSION</th>
<th>CHANGES</th>
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<td>7/13/00</td>
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<tr>
<td>A</td>
<td>Changed Division name. Revised Section 3.1 (Work Instructions) and moved to Section 6.1, renumbered Section 6, and revised Section 9.0 (Training).</td>
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<td>Updated document number for JPR 8500.4 in Section 4.0 (References)</td>
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Verify correct version before use.
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1.0 **SCOPE**

This process specification establishes the engineering requirements for the installation of threaded and collared fasteners, including conventional threaded fasteners, and Hi-Lok fasteners.

2.0 **APPLICABILITY**

This specification shall be applicable whenever the installation of threaded or collared fasteners is invoked per section 3.0, “Usage”.

3.0 **USAGE**

Manufactured heads are on the forward or near side relative to the engineering drawing, unless otherwise noted. The quantity of washers and their location (under head or nut) shall be specified.

Fastener size and hole size shall be specified on the engineering drawing. When countersink washers are not used under fastener heads, an appropriate radius or chamfer shall be specified on the fastener hole to accommodate the fastener fillet radius.

The included angle of a countersunk fastener or dimple shall correspond to that of the flush fastener being installed. The diameter and depth of the countersink or dimple shall be specified on the engineering drawing so that the fasteners will meet the standard flushness requirement of 0.010 inch above the surface and 0.002 below. Alternate flushness tolerances shall be specified on the drawing.

This process specification shall be called out on the engineering drawing with a drawing note. For example:

**INSTALL FASTENERS PER NASA/JSC PRC-9007. TORQUE 190-210 IN-LBS ABOVE LOCKING TORQUE. LOCKING TORQUE SHALL BE 6.5-60 IN-LBS.**

For conventional threaded fasteners, the net torque and locking torque shall be specified by the engineering drawing. These torques may be included in the process specification callout (as above), or they may be located in the field of the drawing near the appropriate joint for clarity, or an assembly specification referenced by the engineering drawing.

The locking torque will be measured by the installation technician and added to the net torque on the engineering drawing to determine the installation torque for each fastener.
The locking torque shall be called out on the engineering drawing. Normally, the range specified is obtained from the procurement specification for the locking element, such as MIL-DTL-25027, MIL-DTL-18240, MIL-I-45914, MIL-I-45932, and NASM8846.

Wet installation of fasteners with corrosion preventative primer is standard. An example callout is:

**SEAL FASTENER PER NASA/JSC PRC-4004 USING XXXXX SEALANT.**

This callout should immediately follow the installation specification. In some design cases, sealant may not be necessary, but the decision to not use sealant should be reviewed in advance with Materials and Processes Branch (ES4) personnel.

Fastener joints should be designed so that proper grip or fastener length will be achieved during installation. However, the grip/length of bolts/screws and the number of washers used will be changed during assembly if necessary to achieve proper grip/length and locking feature engagement unless specifically prohibited by the drawing note, such as:

**NO GRIP SUBSTITUTIONS OR WASHER CHANGES ALLOWED.**

Details of allowable grip/length substitutions and washer number changes for bolt/screw installation are found in section 6.2 and 6.3.

### 4.0 REFERENCES

All documents listed are assumed to be the current revision unless a specific revision is listed.

- **SOP-007.1** *Preparation and Revision of Process Specifications*
- **JPR 8500.4** *Engineering Drawing System Manual*
- **NASA/JSC PRC-4004** *Sealing of Joints and Faying Surfaces, PRC for the*
- **MIL-DTL-25027** *Nut, Self-Locking, 250°F, 450°F, and 800°F*
- **MIL-DTL-18240** *Fastener Element, Self-Locking, Threaded Fastener, 250°F Maximum*
- **MIL-I-45914** *Insert, Screw Thread - Locked In, Key Locked*
- **MIL-I-45932** *Insert, Screw Thread, Thin Wall, Locked In*

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5.0 MATERIAL REQUIREMENTS

None identified.

6.0 PROCESS REQUIREMENTS

6.1 WORK INSTRUCTIONS

All work shall be performed to written procedures. The work instructions shall contain sufficient detail to ensure that the manufacturing process produces consistent, repeatable products that comply with this specification.

For work performed at JSC facilities, these work procedures consist of Detailed Process Instructions (DPI’s).

For contracted work, the contractor shall be responsible for preparing and maintaining, and certifying written work procedures that meet the requirements of this specification.

6.2 GENERAL REQUIREMENTS

Holes shall be verified as deburred before fasteners are installed.

No lubricant or sealant shall be applied to fasteners or threads unless it is specifically called out on the engineering drawing.

Locking torque shall be measured during installation and verified to be within the minimum-maximum range. Fasteners with locking torques found outside the range shall be replaced using the appropriate materials review board activity.

Fasteners removed shall be reinstalled to the same procedures as for new fasteners. Fasteners shall be examined for wear or deformation before being reinstalled.

6.3 SPECIAL REQUIREMENTS FOR SHANKED THREADED FASTENERS

The proper grip shall be verified during assembly of the joint. Proper grip is that range where there are no threads within the members being joined, nor does the nut bottom on the shank of the fastener.
Bolt/screw shall protrude one full thread length, including the chamfer, beyond the end of the nut or insert. When the locking feature is located on the bolt/screw, the locking feature, or at least a portion of the locking feature equal to one thread diameter, shall be engaged in the internal thread.

Unless disallowed by the engineering drawing, changes to the bolt/screw grip or to the number of washers can be made during the assembly process to achieve proper grip and ensure engagement of the locking feature. Bolts/screws one grip increment longer or shorter may be substituted. One or two additional washers may be added, or one less washer may be used than specified, as long as there was at least one washer specified at that location. No less than one washer may be left where only one was specified. Grip substitutions and washer changes are not permitted for bolts/screws used with threaded inserts or barrel nuts.

Substitute bolts/screws shall be identical to those called out on the drawing except for the grip difference. Extra washers shall be identical to the original washer specified.

6.4 SPECIAL REQUIREMENTS FOR FULL THREADED FASTENERS

The proper length shall be verified during assembly of the joint. Proper length is that range where the bolt/screw shall protrude a minimum of one full thread length, including chamfer, beyond the end of the nut or insert. When the locking feature is located on the bolt/screw, the entire locking feature, or at least a portion of the locking feature equal to one thread diameter, shall be engaged in the internal thread.

Unless disallowed by the engineering drawing, changes to the bolt/screw length or to the number of washers can be made during the assembly process to ensure engagement of the locking feature. Bolts/screws one length increment number longer or shorter may be substituted. One or two additional washers may be added, or one less washer may be used than specified, as long as there was at least one washer specified at that location. A washer cannot be omitted where only one was specified. Bolt/screw length substitutions and washer changes are not permitted for full threaded bolts/screws used with threaded inserts or barrel nuts.

Substitute bolts/screws shall be identical to those called out on the drawing except for the length difference. Extra washers shall be identical to the original washer specified.

6.5 SPECIAL REQUIREMENTS FOR COLLARED FASTENERS

Proper hand or pneumatic equipment shall be used to install Hi-Lok fasteners.
Perpendicularity of hole axis to surface shall be $\pm \frac{1}{2}$ degree. Maximum tilt or gap under protruding or flush head pins shall be 0.002 inch, one side only. No gap is permitted between the faying surface at the fastener shank. Collars shall not engage the first imperfect thread adjacent to the pip grip. Nuts shall not be loose, cracked or split nor exhibit abnormal shear fracture. Nuts shall not be removed and reinstalled. Pins shall not have sheared threads. The threaded pin end shall not be fractured. Manufactured heads shall not have cracks or dimple.

The pin shall extend beyond the surface of the material attached as shown in Table 1. Any length pin may be used to comply with this requirement as long as it is otherwise identical with the pin specified on the engineering drawing.

<table>
<thead>
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<th>Fastener Dash No.</th>
<th>Size</th>
<th>Minimum Extension</th>
<th>Maximum Extension</th>
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<tr>
<td>-05</td>
<td>(0.164)</td>
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<tr>
<td>-16</td>
<td>(0.500)</td>
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Locking torque is not verified during installation of Hi-Loks.

6.6 TORQUE WRENCH SELECTION

All torque wrenches shall be verified to be in calibration before they are used.

Torque wrenches shall only be used between 20 and 80 percent of their torquing capability (middle 60 percent of full scale). Extensions do not apply.

6.7 TORQUE APPLICATION

Fasteners shall be tightened to the installation torque specified by the engineering drawing. The installation torque shall be established for each bolt/screw by measuring the actual locking torque, and adding it to the net torque. Fasteners shall be tightened from the nut side whenever possible. Fasteners tightened from the head side should be torqued to the high side of the specified torque range.

7.0 PROCESS QUALIFICATION

None required.

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8.0 PROCESS VERIFICATION

Joints requiring secondary verification of assembly torque and the recording of torque values shall have this indicated on the engineering drawing or in the assembly procedure referenced by the engineering drawing.

Assembled joints shall be visually inspected to verify the requirements of Section 6.0 that can be determined visually.

Torque audits made at a later time to verify torque shall only be conducted under appropriate materials review board (MRB) activity. When they are conducted, torque audits shall be measured in the tightening direction.

9.0 TRAINING AND CERTIFICATION OF PERSONNEL

This process shall be performed by personnel qualified through training or experience and certified by their supervision to conduct the process.

10.0 DEFINITIONS

Locking Torque Torque required to turn the bolt/screw through the locking feature of the nut while in motion in either the installation or removal direction, without preload on the fastener. Also known as “running torque”.

Net Torque Installation torque minus the locking torque