Designation: F 812/F812M – 97

# Standard Specification for Surface Discontinuities of Nuts, Inch and Metric Series[1]

This standard is issued under the fixed designation F 812/F812M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

## 1. Scope

1.1 This specification establishes allowable limits for the various types of surface discontinuities that may occur during the manufacture and processing of metric-series nuts with nominal diameters 5 mm and larger and inch-series nuts with nominal diameters ¼ in. and larger.

1.2 The values stated in either SI (metric) or inch-pound units are to be regarded separately as standard. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

1.3 When the engineering requirements of the application necessitate control of surface discontinuities on nuts, the purchaser shall specify conformance to this ASTM specification in the original inquiry and purchase order.

1.3.1 When the engineering requirements of the application necessitate that surface discontinuities on nuts be controlled within limits closer than those specified in this specification, the purchaser shall specify the applicable limits in the original inquiry and purchase order.

1.4 The allowable limits established in this specification for metric nuts, with nominal diameters 5 to 24 mm inclusive, are essentially identical with requirements given in ISO/DIS 6157/II. There are no ISO standards for surface discontinuities on metric-series nuts with nominal diameters larger than 24 mm or on any inch-series nuts.

1.5 The following precautionary caveat pertains only to the test method portion, Section 6, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*

F 606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets[2]

2.2 *ISO Standard:*

ISO/DIS 6157/II Fasteners, Surface Discontinuities on Nuts[3]

## 3. Ordering Information

3.1 Orders for nuts requiring surface discontinuity control shall include:

3.1.1 ASTM designation and date of issue of this specification.

3.1.2 Special requirements, for example, closer discontinuity limits (1.3.1) and inspection sampling plan (6.2).

## 4. Types of Surface Discontinuities

4.1 *Crack*—A clean (crystalline) fracture passing through or across the grain boundaries and may possibly follow inclusions of foreign elements. Cracks are normally caused by overstressing the metal during forging or other forming operations, or during heat treatment. Where parts are subjected to significant reheating, cracks usually are discolored by scale.

4.1.1 *Quench Cracks*— May occur due to excessively high thermal and transformation stresses during heat treatment. Quench cracks usually traverse an irregular and erratic course on the surface of the nut. Typical quench cracks are shown in Fig. 1; limits are specified in 5.2.

4.1.2 *Forging Cracks*— May occur during the cut-off or forging operations and are located on the top and bottom face of the nut and at the intersection of the face and flat. Typical forging cracks are shown in Fig. 2; limits are specified in 5.3.

4.1.3 *Inclusion Cracks*— Normally caused by nonmetallic inclusions or stringers inherent in the raw material. Typical inclusion cracks are shown in Fig. 2; limits are specified in 5.3.

4.1.4 *Locking-Element Cracks*—Occur due to application of pressure when forming the locking element of prevailing torque-type nuts. Such cracks are usually located in the vicinity of the locking element and may be either on the internal or external surface. Typical locking element cracks are shown in Fig. 3; limits are specified in 5.4.

4.1.5 *Washer-Retainer Cracks*—Openings in the lip or hub of metal used to retain a washer on a nut. Washer-retainer

[1] This specification is under the jurisdiction of ASTM Committee F-16 on Fasteners and is the direct responsibility of Subcommittee F16.02 on Steel Bolts, Nuts, Rivets, and Washers.

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[2] *Annual Book of ASTM Standards*, Vol 01.08.

[3] Available from American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.

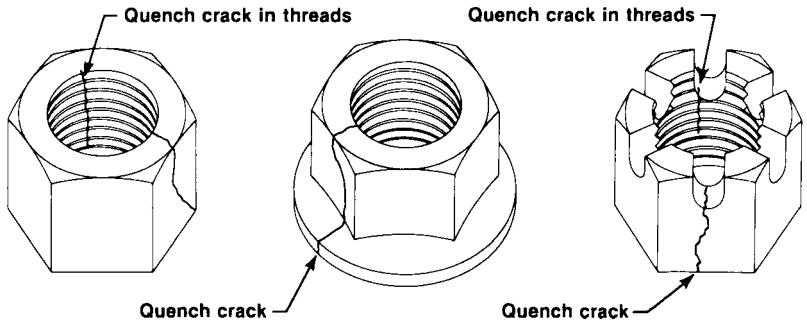


FIG. 1 Typical Quench Cracks in Nuts

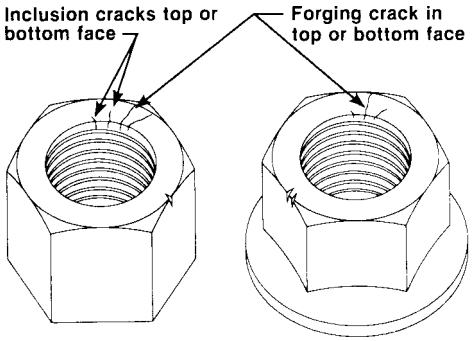


FIG. 2 Typical Forging and Inclusion Cracks in Nuts

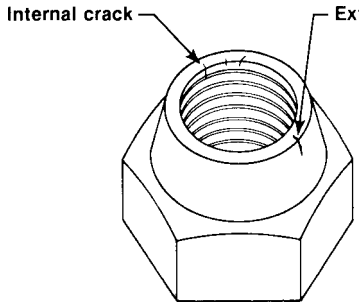


FIG. 3 Typical Locking Element Cracks in Prevailing-Torque Nuts

cracks may occur when pressure is applied to the lip or hub during assembly of the washer. Typical washer-retainer cracks are shown in Fig. 4; limits are specified in 5.5.

4.2 *Burst*—An open break in the metal. Bursts occur during the forging operation and are located on the flats or corners of nuts or at the periphery of the flange on flanged nuts. A typical burst is shown in Fig. 5; limits are specified in 5.6.

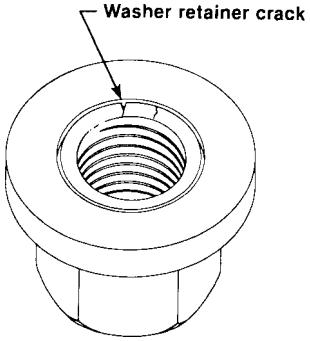


FIG. 4 Typical Washer Retainer Cracks in Nuts

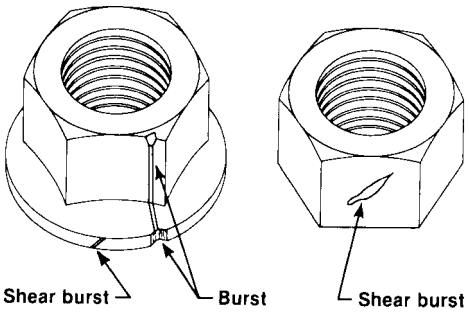


FIG. 5 Typical Bursts and Shear Bursts in Nuts

4.2.1 *Shear Burst*— An open break in the metal located at approximately a 45° angle to the nut axis. Shear bursts occur most frequently at the periphery of flanged nuts. A typical shear burst is shown in Fig. 5; limits are specified in 5.6.

4.3 *Seam*—Seams are generally inherent in the raw material from which the nut is made. Seams in nuts are usually straight or smooth-curved line discontinuities running generally parallel to the nut axis. Seams in raw material used for forged or formed nuts may lead to the formation of bursts. Typical seams are shown in Fig. 6; limits are specified in 5.7.

4.4 *Fold*—A doubling over of metal that occurs during the forging operation. Folds in nuts may occur at or near the intersection of diameter changes or on the top or bottom face of the nut. Typical folds are shown in Fig. 7; limits are specified in 5.8.

4.5 *Void*—A shallow pocket or hollow on the surface of a nut due to nonfilling of metal during forging. Voids are produced by marks or impressions of chips (shear burrs) or by rust formation on the raw material. They are not planished during forging. Typical voids are shown in Fig. 8; limits are specified in 5.9.

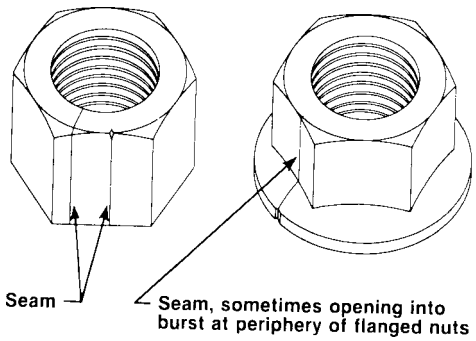


FIG. 6 Typical Seams in Nuts

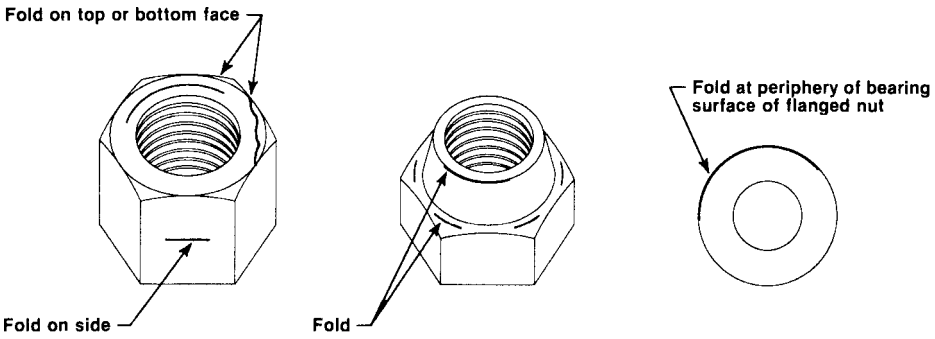


FIG. 7 Typical Folds on Surfaces of Nuts

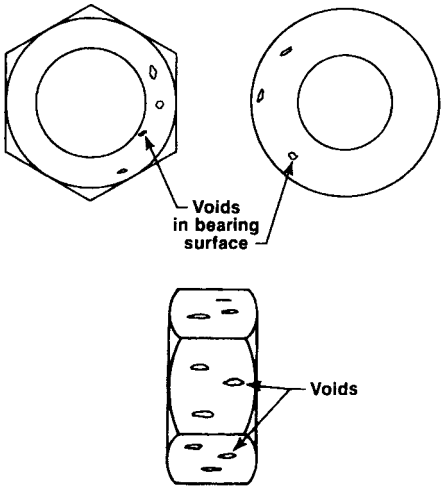


FIG. 8 Typical Voids in Nuts

4.6 *Tool Marks*—Longitudinal or circumferential grooves of shallow depth produced by the movement of manufacturing tools over the surface of the nut. Typical tool marks are shown in Fig. 9; limits are specified in 5.10.

4.7 *Nick or Gouge*— An indentation on the surface of a nut produced by forceful abrasion or the impact of product coming into contact with other product or manufacturing equipment during manufacture, handling, or transport. Limits are specified in 5.11.

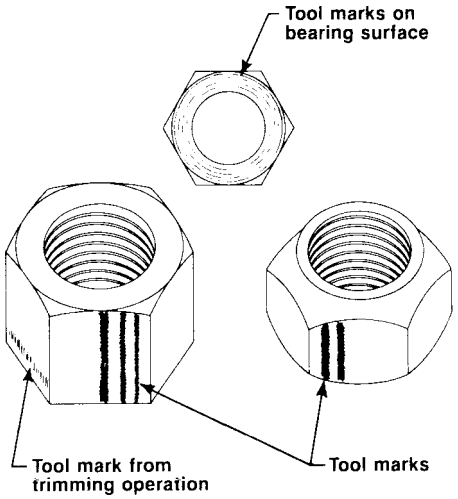


FIG. 9 Typical Tool Marks on Nut Surface

## 5. Allowable Limits

5.1 *Letter Definitions*—Throughout the following requirements, *D* designates the nominal nut size (basic major diameter of thread); *Dc* designates flange diameter (specified maximum) on flanged nuts; *S* designates nominal (specified maximum) width across flats. For metric-series nuts, *D*, *Dc*, and *S* are in millimetres; for inch series nuts, *D*, *Dc*, and *S* are in inches.

5.2 *Quench Cracks*— Quench cracks of any depth, any length, or in any location are not permitted.

5.3 *Forging Cracks and Inclusion Cracks*—Forging and inclusion cracks located in the top and bottom faces of nuts of all sizes are permitted provided that ( *a*) there are not more than two cracks that extend from the tapped hole across the full width of the face; (*b*) no crack extends into the tapped hole beyond the first full thread; (*c*) no crack in the threads exceeds a depth of 0.5 times the thread height; and (*d*) the width of any crack does not exceed 0.02 *D* or 0.30 mm or 0.012 in., whichever is greater.

5.3.1 Additionally, hex nuts with nominal diameters 5 to 36 mm inclusive and ¼ to 1½ in. inclusive, showing discontinuity indications, shall meet the requirements of the cone proof load test when sampled in accordance with 7.1, using samples selected in accordance with 7.5.2.

5.4 *Locking Element Cracks*:

5.4.1 Locking-element cracks (or seams) located on the external surface of the locking element of prevailing torque

nuts are permitted provided that the net meets all applicable torque requirements.

5.4.1.1 Additionally, hex nuts with nominal diameters 5 to 36 mm inclusive and ¼ to 1½ in. inclusive, showing discontinuity indications, shall meet the requirements of the cone proof load test when sampled in accordance with 7.1, using samples selected in accordance with 7.5.2.

5.4.2 Locking-element cracks located on the internal surface (threaded or unthreaded) of prevailing torque nuts are permitted provided that (*a*) no crack exceeds a length of two thread pitches; (*b*) no crack shall extend into the thread root; and (*c*) no crack shall have a width exceeding the following:

5.4.2.1 *Metric-Series Nuts*—0.18 mm for nuts with nominal diameters 5 to 10 mm inclusive, 0.25 mm for nuts with nominal diameters over 10 to 24 mm inclusive, and 0.40 mm for nuts with nominal diameters larger than 24 mm.

5.4.2.2 *Inch Series Nuts*— 0.007 in. for nuts with nominal diameters ¼ to 7⁄16 in. inclusive, 0.010 in. for nuts with nominal diameters over 7⁄16 to 1 in. inclusive, and 0.016 in. for nuts with nominal diameters larger than 1 in.

5.5 *Washer-Retainer Cracks*—Washer-retainer cracks are permitted if their location is limited to the contour of the lip or hub used for retaining purposes.

5.6 *Bursts and Shear Bursts*:

5.6.1 For hex nuts, bursts and shear bursts are permitted provided that (*a*) no burst or shear burst in the flats extends into the crown (chamfer) circle on the top of the nut or into the bearing circle on the bottom face; (*b*) no burst or shear burst located at the intersection of the top or bottom face with a wrenching flat has a width greater than 0.25 mm or 0.010 in. plus 0.02 *S*; and (*c*) no burst occurring at the intersection of two wrenching flats reduces the width across corners below its specified minimum.

5.6.2 For flanged nuts, bursts and shear bursts at the periphery of the flange are permitted provided that (*a*) not more than one of the bursts or shear bursts has a width greater than 0.04 *Dc* and (*b*) the width of the one burst or shear burst that exceeds a width of 0.04 *Dc* does not have a width greater than 0.08 *Dc*.

5.7 *Seams*—Seams are permitted provided that no seam has an open width at the surface greater than 0.013 *D* for nuts with nominal diameters 5 to 6 mm inclusive; 0.02 *D* for metric nuts with nominal diameters larger than 6 mm; and 0.02 *D* for all sizes of inch-series nuts.

5.7.1 Additionally, hex nuts with nominal diameters 5 to 36 mm inclusive and ¼ to 1½ in. inclusive, showing discontinuity indications, shall meet the requirements of the cone proof load test when sampled in accordance with 7.1 using samples selected in accordance with 7.5.2.

5.8 *Folds*—Folds located at the intersection of the flange periphery and bearing surface of flanged nuts shall not project below the bearing surface. All other folds on nuts are permitted.

5.9 *Voids*:

5.9.1 Voids on the surfaces of nuts are permitted provided that (*a*) depth of voids does not exceed 0.25 mm or 0.010 in. or 0.02 *D*, whichever is greater, and (*b*) the combined area of all voids on the bearing surface does not exceed 10% of the specified minimum-bearing surface area.

5.9.2 The method for determining the area of voids on the bearing surface shall be as agreed upon by purchaser and producer.

5.10 *Tool Marks*:

5.10.1 Tool marks on the bearing surface are permitted provided the surface roughness measurement does not exceed 3.2 µm or 125 µin., determined as the arithmetic average deviation from the mean surface.

5.10.2 Tool marks on other surfaces of the nut are permitted.

5.11 *Nicks and Gouges*— Nicks, gouges, dents, and scrapes are permitted provided that the functionality of the nut is not impaired.

## 6. Test Method

6.1 *Cone Proof Load Test*—The cone proof load test shall be conducted in accordance with the Cone Proof Load Test of Test Methods F 606.

6.2 The cone proof load shall be calculated as follows:
for metric-series nuts:

$$CPL = PL\,(1 - 0.012\,D) \quad (1)$$

where:
*CPL* = cone proof load, kn,
*PL* = specified axial proof load, kn, and
*D* = nominal thread diameter, mm.

for inch-series nuts:

$$CPL = PL\,(1 - 0.30\,D) \quad (2)$$

where:
*CPL* = cone proof load, lb,
*PL* = specified axial proof load, lb, and
*D* = nominal thread diameter, in.

## 7. Inspection and Evaluation

7.1 Nuts shall be inspected for surface discontinuities in accordance with the procedures in 7.2, 7.3, and 7.4.

7.2 The purchaser shall specify in the original inquiry and purchase order the inspection sampling requirements which the producer must satisfy to demonstrate the acceptability of nuts with respect to surface discontinuities.

7.3 In the absence of purchaser instructions (7.2), inspection and evaluation shall be in accordance with 7.5.

7.4 For referee purposes, unless other procedures have been specified by the purchaser (7.2), inspection and evaluation shall be in accordance with 7.5.

7.5 *Inspection Procedure*:

**TABLE 1 Sample Size for Visual Inspection (see 7.5.1)**

| Lot Size[A] | Sample Size |
|---|---|
| 2 to 15 | 2 |
| 16 to 25 | 3 |
| 26 to 90 | 5 |
| 91 to 151 | 8 |
| 151 to 500 | 13 |
| 501 to 1200 | 20 |
| 1201 to 10 000 | 32 |
| 10 001 to 35 000 | 50 |
| 35 001 to 150 000 | 80 |

[A] Lot size is the number of nuts of the same type, size, and property class submitted for inspection at one time.

7.5.1 *Visual Inspection*:

7.5.1.1 A random sample shall be taken from the lot in accordance with Table 1 and examined visually for the presence of quench cracks, forging cracks, inclusion cracks, locking-element cracks, washer retainer cracks, bursts, shear bursts, seams, folds, voids, tool marks, and nicks and gouges.

7.5.1.2 If during this inspection any nuts with quench cracks are found, the lot may be rejected by the purchaser.

7.5.1.3 If during this inspection any nuts are found with any other surface discontinuity, each discontinuity shall be measured and if any is found that exceeds the allowable dimensional limits for that discontinuity as specified in Section 5, the lot may be rejected by the purchaser.

7.5.1.4 *Measurement of Surface Discontinuities in Nuts*:

*(1)* For discontinuities originating from a flat: at the extremity of the discontinuity measure distance *D* perpendicular to the flat where the discontinuity originated (see Fig. 10).

*(2)* For discontinuities originating from a corner: at the extremity of the discontinuity measure distance *D* in a straight line to the corner where the discontinuity originated (see Fig. 10).

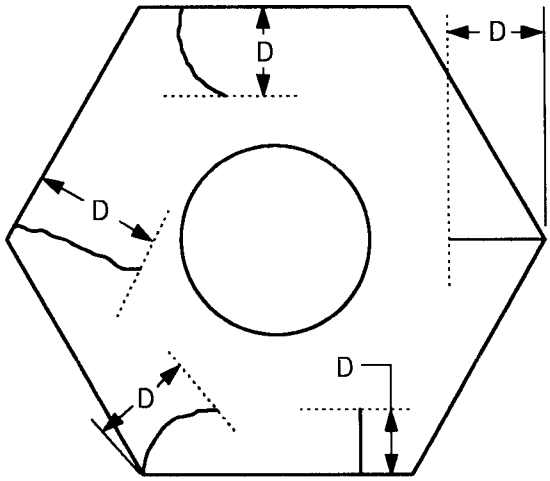


**FIG. 10 Measurement of Surface Discontinuities**

**TABLE 2 Sample Sizes for Cone Proof Load Testing (see 7.5.2)**

| Lot Size[A] | Sample Size |
|---|---|
| 1 | 1 |
| 2 to 8 | 2 |
| 9 to 15 | 3 |
| 16 to 25 | 5 |
| 26 to 50 | 8 |
| 51 to 80 | 13 |

[A] Lot size is the number of nuts set aside during the inspection specified in 7.5.2.

7.5.2 *Mechanical Testing*—During the visual inspection, all hex nuts with nominal diameters 5 to 36 mm inclusive and ¼ to 1½ in. inclusive, that have indications of forging cracks, inclusion cracks, locking-element cracks on external surfaces, or seams, shall be set aside. From this lot, a sample of size in accordance with Table 2 and consisting of those nuts indicating the most serious defects, shall be cone proof load tested as specified in 6.1. If any nut fails to meet the requirements of this test, the lot may be rejected by the purchaser.