IFI
533
1982

SURFACE DISCONTINUITIES ON METRIC NUTS

MATERIALS

IFI Note:

IFI-533 was originally written in 1977. Since that time it has been used as the basis for an ISO standard which when approved will be designated ISO 6157/II. IFI-533 has also been used as the basis of an ASTM standard which should be finalized and issued in 1983. When this ASTM standard is published, IFI will withdraw IFI-533 and support the ASTM document.

The contents and requirements of this IFI-533 are in essential agreement with both ISO 6157/II and the ASTM standard now under development.

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 nuts with nominal thread diameters M5 and larger.

1.2 The requirements covered in this specification are not referenced in other standards covering dimensional, mechanical and performance properties of nuts. When the engineering requirements of the application necessitate control of surface discontinuities on nuts, the purchaser shall specify conformance to this IFI specification in the original inquiry and purchase order.

1.2.1 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.

1.3 The allowable limits established in this specification for nuts with nominal thread diameters M5 to M24 inclusive are essentially identical with requirements given in ISO/DIS 6157/II. There are no ISO standards for surface discontinuities on metric nuts with nominal thread diameters larger than M24.

2. Types of Surface Discontinuities.

2.1 Cracks. A crack is 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.

2.1.1 Quench Cracks. Quench cracks may occur during heat treatment due to excessively high thermal and transformation stresses.

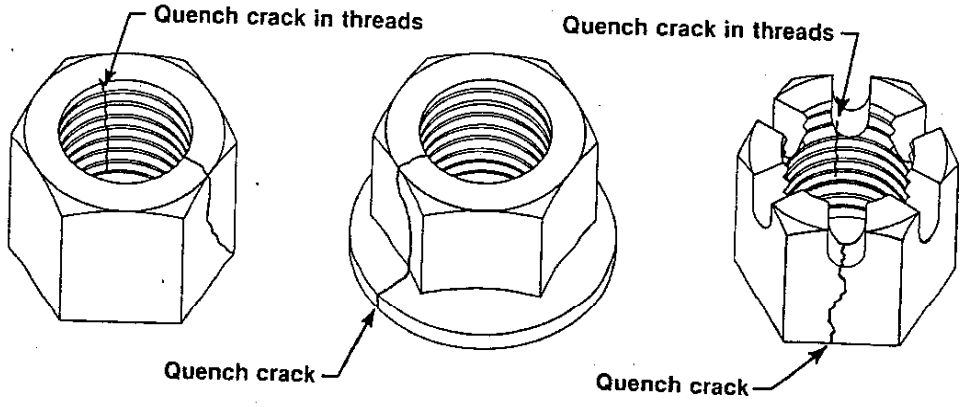

FIG. 1 TYPICAL QUENCH CRACKS IN NUTS

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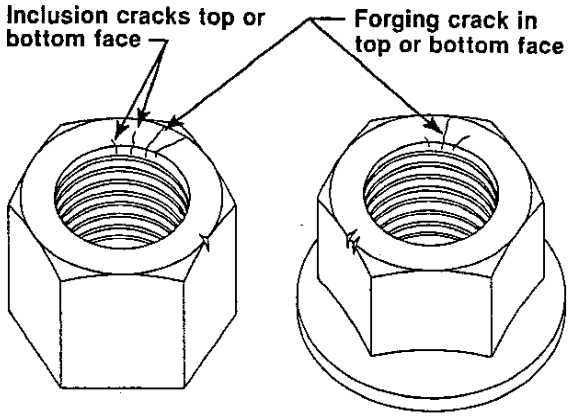

FIG. 2 TYPICAL FORGING AND INCLUSION CRACKS IN NUTS

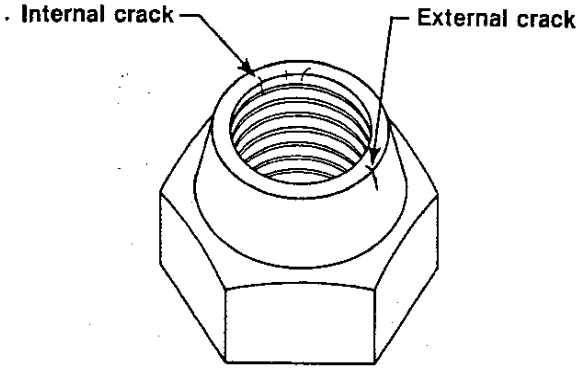

FIG. 3 TYPICAL LOCKING ELEMENT CRACKS IN PREVAILING-TORQUE NUTS

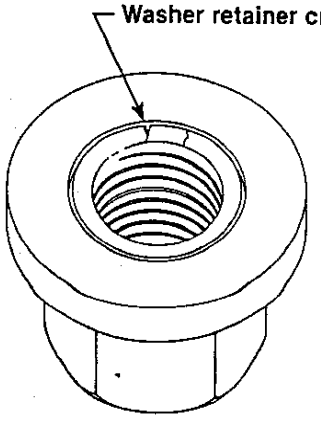

FIG. 4 TYPICAL WASHER RETAINER CRACKS IN NUTS

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 3.2.

2.1.2 Forging Cracks. 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 3.3.

2.1.3 Inclusion Cracks. Inclusion cracks are normally caused by non-metallic inclusions or stringers inherent in the raw material. Typical inclusion cracks are shown in Fig. 2; limits are specified in 3.3.

2.1.4 Locking Element Cracks. 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 3.4.

2.1.5 Washer Retainer Cracks. Washer retainer cracks are openings in the lip or hub of metal used for captivating a washer on a nut. Washer retainer 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 3.5.

2.2 Burst. A burst is 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 3.6.

2.2.1 Shear Burst. A shear burst is an open break in the metal located at approximately a 45 degree 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 3.6.

2.3 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

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used for forged or formed nuts may lead to the formation of bursts. Typical seams are shown in Fig. 6; limits are specified in 3.7.

2.4 Fold. A fold is a doubling over of metal which 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 3.8.

2.5 Void. A void is a shallow pocket or hollow on the surface of a nut due to non-filling 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 3.9.

2.6 Tool Marks. Tool marks are 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 3.10.

2.7 Nick or Gouge. A nick or gouge is 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 3.11.

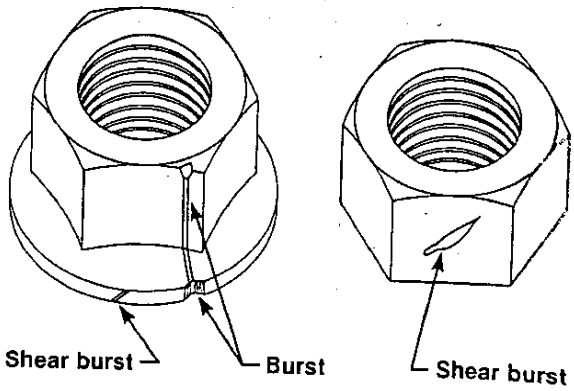

FIG. 5 TYPICAL BURSTS AND SHEAR BURSTS IN NUTS

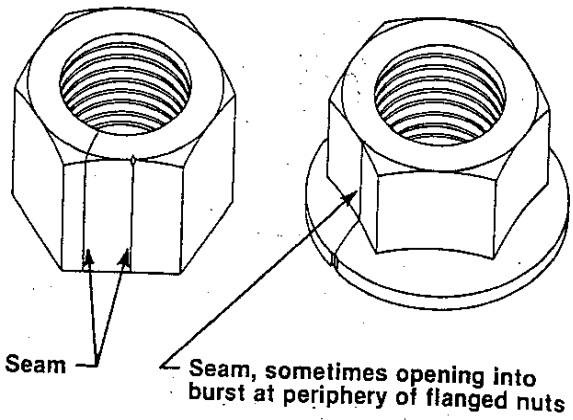

FIG. 6 TYPICAL SEAMS IN NUTS

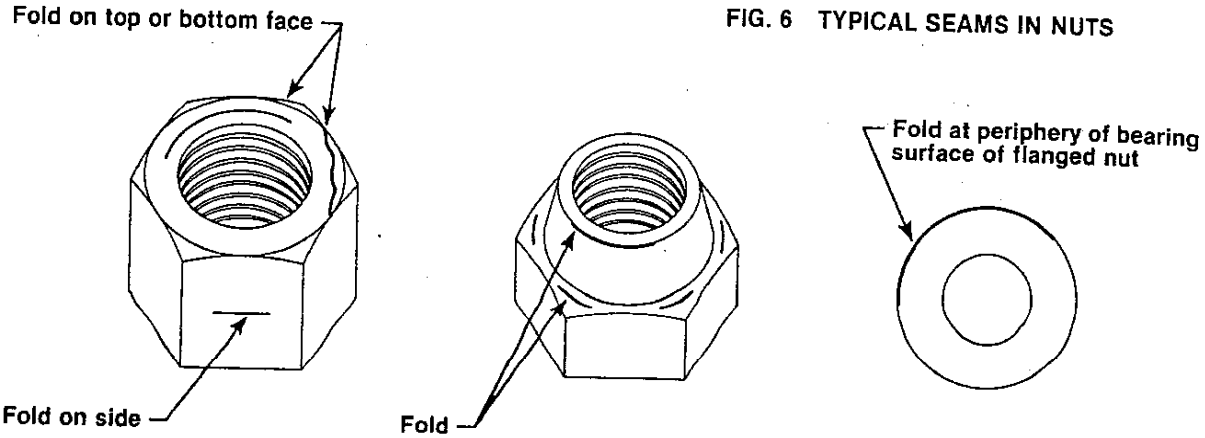

FIG. 7 TYPICAL FOLDS ON SURFACES OF NUTS

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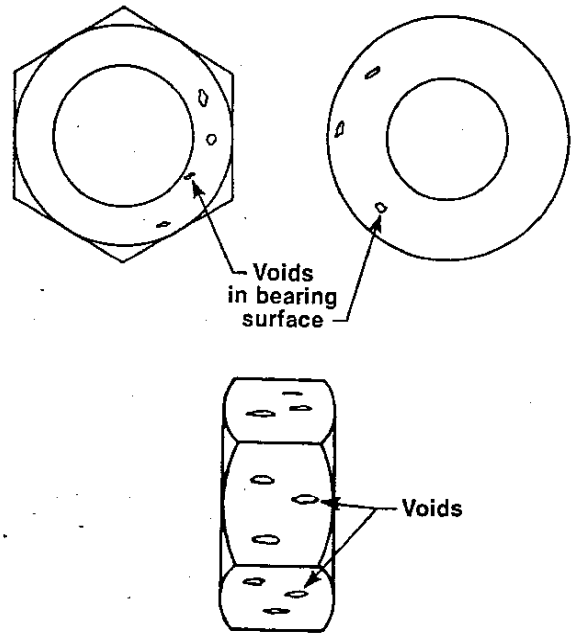

FIG. 8 TYPICAL VOIDS IN NUTS

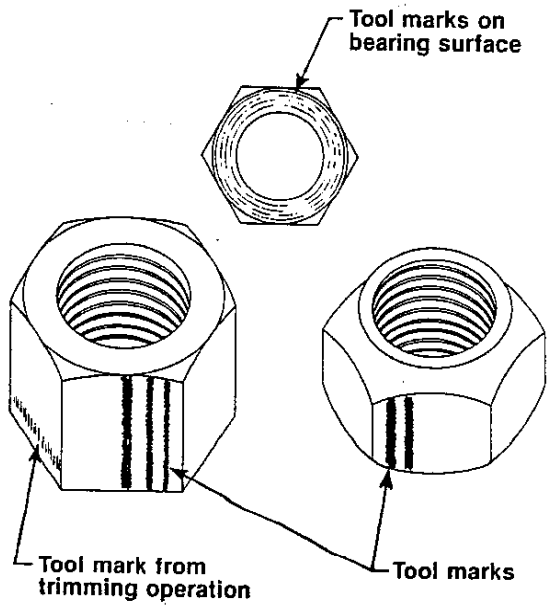

FIG. 9 TYPICAL TOOL MARKS ON NUT SURFACE

3. Allowable Limits.

3.1 Letter Definitions.

3.1.1 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.

3.2 Quench Cracks.

3.2.1 Quench cracks of any depth, any length, or in any location are not permitted.

3.3 Forging Cracks and Inclusion Cracks.

3.3.1 Forging cracks and inclusion cracks are permitted provided that the requirements of 3.3.2 and 3.3.3 are met.

3.3.2 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 which extend from the tapped hole across the full width of the face, and (*b*) no crack extends into the tapped hole beyond the first full thread, and (*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 0.30mm, whichever is greater.

3.3.3 Additionally, nuts with nominal thread diameters M5 to M36 inclusive shall meet the requirements of the cone proof load test when tested in accordance with 5.1.

3.4 Locking Element Cracks.

3.4.1 Locking element cracks (or seams) located on the external surface of the locking element of prevailing torque nuts are permitted provided that the nut meets all applicable torque requirements and the requirements of the cone proof load test when tested in accordance with 5.1.

3.4.2 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, and (*b*) no crack shall extend into the thread root, and (*c*) no crack shall have a width exceeding 0.18 mm for nuts with nominal thread diameters M5 to M10 inclusive,

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0.25 mm for nuts with nominal thread diameters M12 to M24 inclusive, and 0.40 mm for nuts with nominal thread diameters larger than M24.

3.5 Washer Retainer Cracks.

3.5.1 Washer retainer cracks are permitted if their location is limited to the contour of the lip or hub used for retaining purposes.

3.6 Bursts and Shear Bursts.

3.6.1 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, and (*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 0.2 mm 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.

3.6.2 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 which exceeds a width of 0.04 *Dc* does not have a width greater than 0.08 *Dc*.

3.7 Seams.

3.7.1 Seams are permitted provided that (*a*) no seam has an open width at the surface greater than 0.13 *D* for nuts with nominal thread diameters M5 and M6; 0.02 *D* for nuts with nominal thread diameters larger than M6; and (*b*) nuts with nominal thread diameters M5 to M36 inclusive shall meet the requirements of the cone proof load test when tested in accordance with 5.1.

3.8 Folds.

3.8.1 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.

3.9 Voids.

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

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

3.10 Tool Marks.

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

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

3.11 Nicks and Gouges.

3.11.1 Nicks, gouges, dents and scrapes are permitted provided that the functionability of the nut is not impaired.

4. Inspection and Evaluation.

4.1 Nuts shall be inspected for surface discontinuities in accordance with the procedures outlined in 4.2, 4.3, and 4.4.

4.2 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.

4.3 In the absence of purchaser instructions (4.2), inspection and evaluation shall be in accordance with 4.5.

4.4 For referee purposes, unless other procedures have been specified by the purchaser (4.2), inspection and evaluation shall be in accordance with 4.5.

4.5 Inspection Procedure.

4.5.1 Visual Inspection.

4.5.1.1 A random sample shall be taken from

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Table 1 Sample Size for Visual Inspection (4.5.1) and for Seam and Crack Inspection (4.5.2)

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 1,200	20
1,201 to 10,000	32
10,001 to 35,000	50
35,001 to 150,000	80

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

Table 2 Sample Sizes for Mechanical Testing (4.5.2)

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 products showing seam and crack indication(s) during the seam and crack inspection specified in 4.5.2.1.

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.

4.5.1.2 If, during this inspection, any nuts with quench cracks are found, the lot shall be subject to rejection.

4.5.1.3 If, during this inspection, any nuts are found with any other surface discontinuity exceeding the allowable dimensional limits for that discontinuity as specified in Section 3, the lot shall be subject to rejection.

4.5.2 Mechanical Testing.

4.5.2.1 During the visual inspection, all nuts with 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 5.1. If any nut fails to meet the requirements of this test, the lot shall be subject to rejection.

5. Test Method.

5.1 Cone Proof Load Test.

5.2 The cone proof load test shall be conducted as described in 4.3 of F606, page B—67.

5.2.1 The cone proof load shall be calculated as follows:

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

where:

CPL = cone proof load, kn
PL = specified axial proof load, kn
D = nominal thread diameter, mm