

SURFACE VEHICLE RECOMMENDED PRACTICE

Submitted for recognition as an American National Standard

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SURFACE DISCONTINUITIES ON GENERAL APPLICATION BOLTS, SCREWS, AND STUDS

Foreword—This reaffirmed document has been changed only to reflect the new SAE Technical Standards Board format.

1. Scope—This SAE Recommended Practice defines, illustrates, and specifies allowable limits for various types of surface discontinuities that may occur during the manufacture and processing of bolts, screws, and studs in sizes through 24 mm or 1 in diameter inclusive with lengths to 150 mm or 6 in inclusive, having specified minimum tensile strengths of 900 MPa or 120 000 psi and greater, which are primarily intended for use in automotive assemblies.

1.1 The basic recommended practice does not include inspection sampling requirements. It is intended that 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 bolts and screws with respect to surface discontinuities.

2. References

2.1 Applicable Documents—The following publications form a part of this specification to the extent specified herein.

2.1.1 ASTM PUBLICATIONS—Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM E 3—Methods of Preparing Metallographic Specimens

3. Types of Surface Discontinuities—For the purpose of this document, surface discontinuities on bolts, screws, and studs are divided into nine "types", defined as follows:

3.1 Crack—A crack is a clean (crystalline) fracture passing through or across the grain boundaries without inclusion of foreign elements. Cracks are normally caused by overstressing the metal during forging or other forming operation, or during heat treatment. Where parts are subjected to significant reheating, cracks usually are discolored by scale.

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QUENCH CRACK ACROSS TOP OF HEAD, USUALLY AN EXTENSION OF CRACK IN SHANK OR SIDE OF HEAD

QUENCH CRACK EXTENDING RADIALLY INTO FILLET

SECTION A-A

QUENCH CRACK, AT ROOT BETWEEN POINTS

QUENCH CRACK ACROSS TOP OF HEAD, USUALLY AN EXTENSION OF CRACK IN SHANK OR SIDE OF HEAD

QUENCH CRACK AT CORNER OF HEAD

TRANSVERSE QUENCH CRACK

LONGITUDINAL QUENCH CRACK

QUENCH CRACK AT ROOT

QUENCH CRACK, SECTION AT CREST OF THREAD MISSING

QUENCH CRACK, CIRCUMFERENTIAL AND ADJACENT TO FILLET

QUENCH CRACK ACROSS WASHER FACE AND TO DEPTH OF WASHER FACE THICKNESS

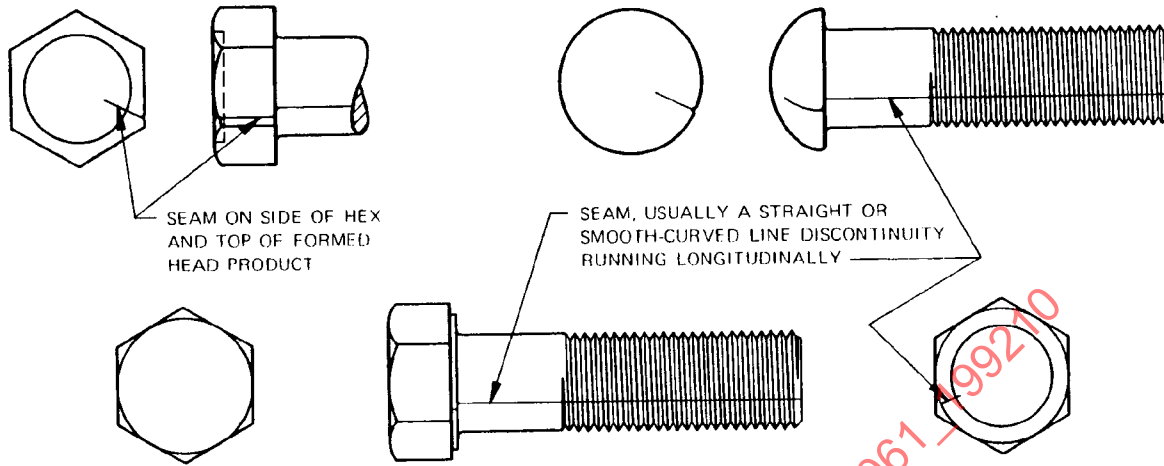
QUENCH CRACK

FIGURE 1—TYPICAL QUENCH CRACKS

FORGING CRACK ON TOP OF HEAD

FIGURE 2—TYPICAL FORGING CRACKS

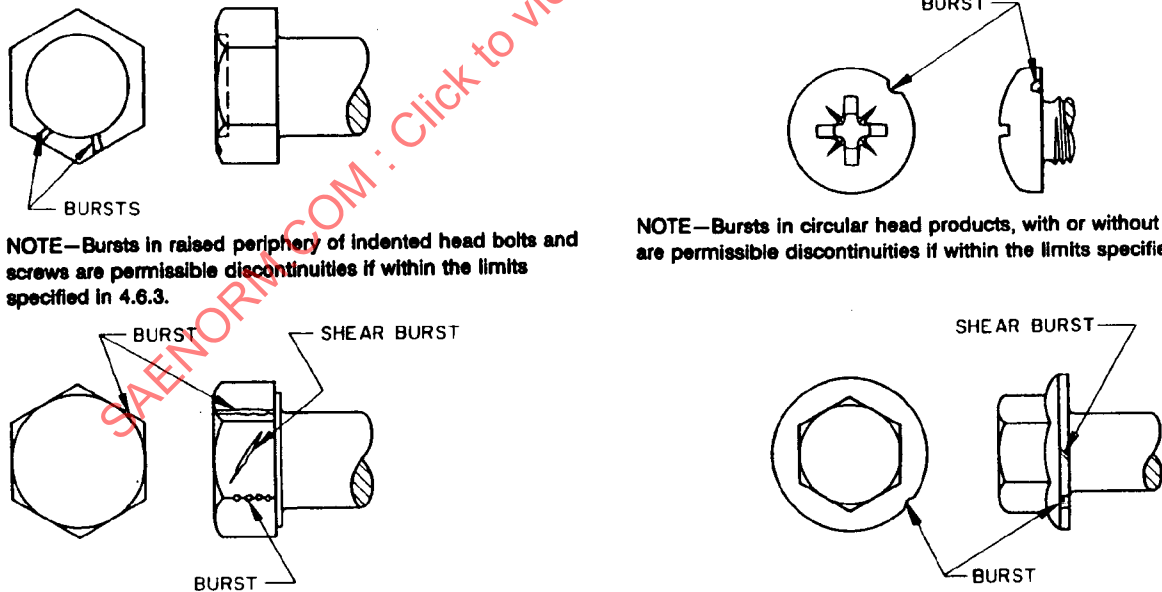
- 2 -



NOTE—Seams are permissible discontinuities if within the limits specified in 4.5.

FIGURE 3—TYPICAL SEAMS

3.3 Burst—A burst is an open break in the metal (material). Bursts may occur on the flats or corners of the heads of bolts and screws, at the periphery of flanged or circular head products, or on the raised periphery of indented head bolts and screws. Typical bursts are shown in Figure 4.



NOTE—Bursts in raised periphery of indented head bolts and screws are permissible discontinuities if within the limits specified in 4.6.3.

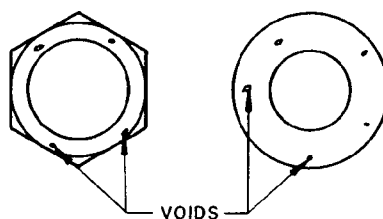
NOTE—Bursts in circular head products, with or without recess, are permissible discontinuities if within the limits specified in 4.6.2.

NOTE—Bursts and shear bursts are permissible discontinuities if within the limits specified in 4.6.

FIGURE 4—TYPICAL BURSTS AND SHEAR BURSTS

3.4 Shear Burst—A shear burst is an open break in the metal, occurring most frequently at the periphery of products having circular or flanged heads and are generally located at approximately 45 degrees to the product axis. Shear bursts may also occur on the sides of hex head products. Typical discontinuities of this type are shown in Figure 4.

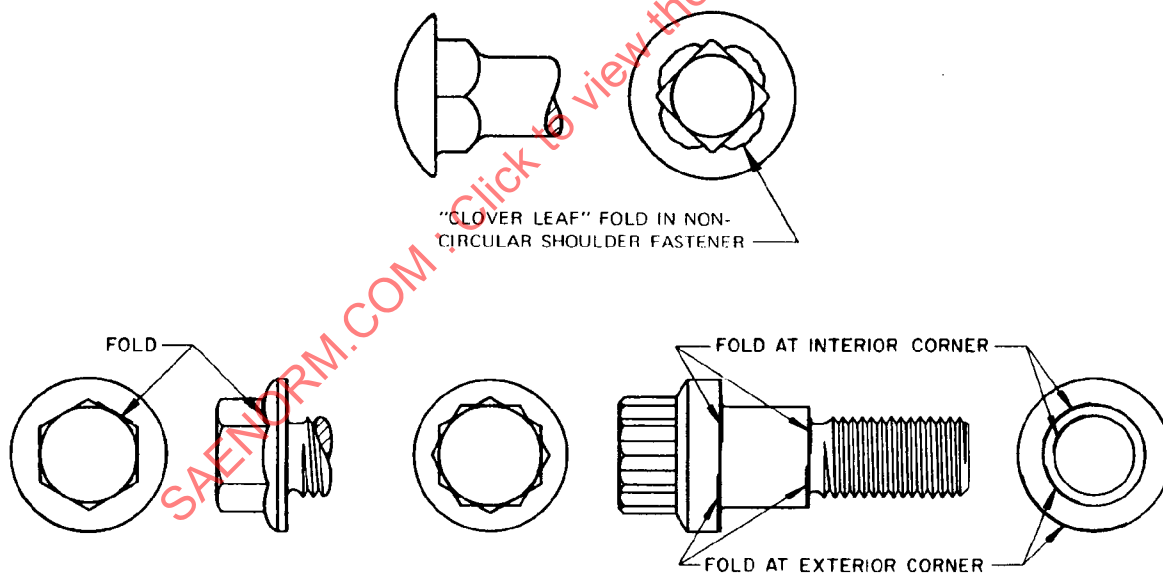
3.5 Void—A void is a shallow pocket or hollow on the surface of the bolt or screw due to nonfilling of metal during forging or upsetting. Typical voids are shown in Figure 5.



NOTE—Voids are permissible discontinuities if within the limits specified in 4.7.

FIGURE 5—TYPICAL VOIDS ON BEARING SURFACE

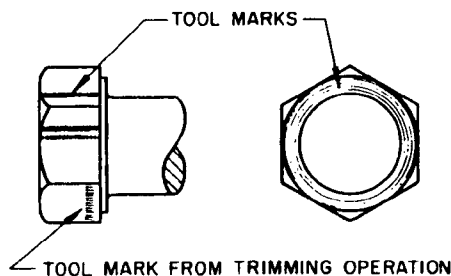
3.6 Fold—A fold is a doubling over of metal which may occur during the forging operation. Folds may occur at or near the intersection of diameter changes, and are especially prevalent with noncircular necks, shoulders, and heads. Typical folds are shown in Figure 6.



NOTE—Folds in interior corners at or below the bearing surface are non-permissible discontinuities. Folds at exterior corners are permissible discontinuities if within the limits specified in 4.3.

FIGURE 6—TYPICAL FOLDS

3.7 Tool Marks—Tool marks are longitudinal or circumferential grooves of shallow depth produced by the movement of manufacturing tools over the surface of the fastener. Typical tool marks are shown in Figure 7.



NOTE—Tool marks are permissible discontinuities if within the limits specified in 4.8.

FIGURE 7—TYPICAL TOOL MARKS

3.8 Nick or Gouge—A nick or gouge is an indentation on the surface of the fastener, produced by forceful abrasion or the impact of product coming into contact with other product or manufacturing equipment during manufacture.

4. Limits for Surface Discontinuities

4.1 Letter Definitions—Throughout the following requirements D designates the nominal size (basic major diameter of thread) of bolts, screws, and studs, except for bolts and screws with shoulders, in which case D designates the largest shoulder diameter. F designates the nominal flange diameter or head diameter of products having circular heads. For metric-series products, use millimeter; for inch-series products use inch.

4.2 Quench Cracks—Quench cracks of any depth, any length, or in any location, are not permitted. (See 3.1.1 and Figure 1.)

4.3 Folds—Folds located in internal corners at or below the bearing surface, for example, in the fillet at the junction of head and shank, are not permitted. (See 3.6 and Figure 6.)

4.4 Forging Cracks—Forging cracks on the top of heads of bolts and screws shall not exceed a length of 1 D or a width or depth of 0.040 D or 0.25 mm (0.010 in), whichever is greater.

4.5 Seams—Seams in the shanks of bolts, screws, and studs shall not exceed a depth of 0.030 D or 0.20 mm (0.008 in), whichever is greater. Seams extending into the heads and flanges of fasteners which do not open beyond the limits specified for bursts are acceptable. (See 3.2 and Figure 3.)

4.6 Bursts and Shear Bursts

4.6.1 No burst in the flats of hex bolts and screws shall extend into the top crown of head surface (chamfer circle) or the under head bearing surface. In addition, bursts occurring at the intersection of two wrenching flats shall not reduce the width across corners below the specified minimum.

4.6.2 Flanges of bolts and screws and peripheries of circular head products may have two or more bursts or shear bursts, providing that only one has a width greater than 0.040 F; in addition, this one burst shall not have a width exceeding 0.080 F.

- 4.6.3 Bursts in the raised periphery of indented head bolts and screws shall not exceed a width of 0.060 D or 0.40 mm (0.015 in), whichever is greater, or have a depth extending into the indented portion. (See 3.3 and Figure 4.)
- 4.7 **Voids on Bearing Surface**—Voids on the bearing surface of bolts and screws shall not exceed a depth of 0.25 mm (0.010 in), and the combined area of all voids shall not exceed 10% of the specified minimum area of the bearing surface. The method for determining area of voids shall be as agreed upon by purchaser and producer. (See 3.5 and Figure 5.)
- 4.8 **Tool Marks**—Tool marks on the bearing surface shall not exceed surface roughness measurement of $2.8 \mu\text{m}$ (110 μin) determined as the arithmetic average deviation from the mean surface. (See 3.7 and Figure 7.)
- 4.9 **Nicks and Gouges**—Nicks and gouges located in the threaded length shall not be of size and number which will interfere with assembly of the proper GO thread gage on the thread with the application of not more than 0.05 times DN·m (12 times D in-lb) of torque, where D is the nominal bolt, screw, or stud size in inches. The manufacturer shall exercise due care during the manufacture and handling of parts to minimize the number and magnitude of nicks and gouges.
5. **Inspection Procedure**—Bolts, screws, and studs shall be inspected. For referee purposes, unless otherwise specified by purchaser, inspection shall be in accordance with the procedures outlined in 5.1 and 5.2.
- 5.1 **Visual Inspection**—A representative sample with a size as given in Table 1 shall be picked at random from the lot. The sample shall be examined visually for quench cracks, bursts, shear bursts, forging cracks, folds, tool marks, seams, voids on the bearing surface, and nicks and gouges.

TABLE 1—SAMPLE SIZE FOR VISUAL AND SEAM INSPECTION

Lot Size	Sample Size	
	Visual and Nondestructive Techniques	Destructive Techniques
Up to 1 500, incl	15	2
1 501 to 5 000	25	3
5 001 to 15 000	50	5
15 001 to 50 000	75	8
50 001 and over	100	10

- 5.1.1 If any part is found with quench cracks or with folds at internal corners at or below the bearing surface, the lot shall be subject to rejection.
- 5.1.2 If any part is found with seams, bursts, shear bursts, forging cracks, tool marks, voids, or nicks and gouges which exceed the allowable limits as specified for the applicable type of discontinuity under Section 4, the lot shall be subject to rejection.