Surface Discontinuities on General Application Bolts, Screws, and Studs—SAE J1061a

SAE Recommended Practice
Approved September 1973
Metric Products Added July 1975

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LAND SEA AIR SPACE

PREPRINT

SURFACE DISCONTINUITIES ON GENERAL APPLICATION BOLTS, SCREWS, AND STUDS—SAE J1061a

SAE Recommended Practice

Report of Iron and Steel Technical Committee approved September 1973. Editorial change; metric products added July 1975.

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

2.1 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.

2.1.1 Quench Cracks—Quench cracks may occur during heat treatment due to excessively high thermal and transformation stresses. They usually traverse an irregular and erratic course on the surface of the fastener. Typical quench cracks are shown in Fig. 1.

2.1.2 Forging Cracks—Forging cracks may occur during the cutoff or forging operations and are located on the top of the heads of screws and bolts. Typical forging cracks are shown in Fig. 2.

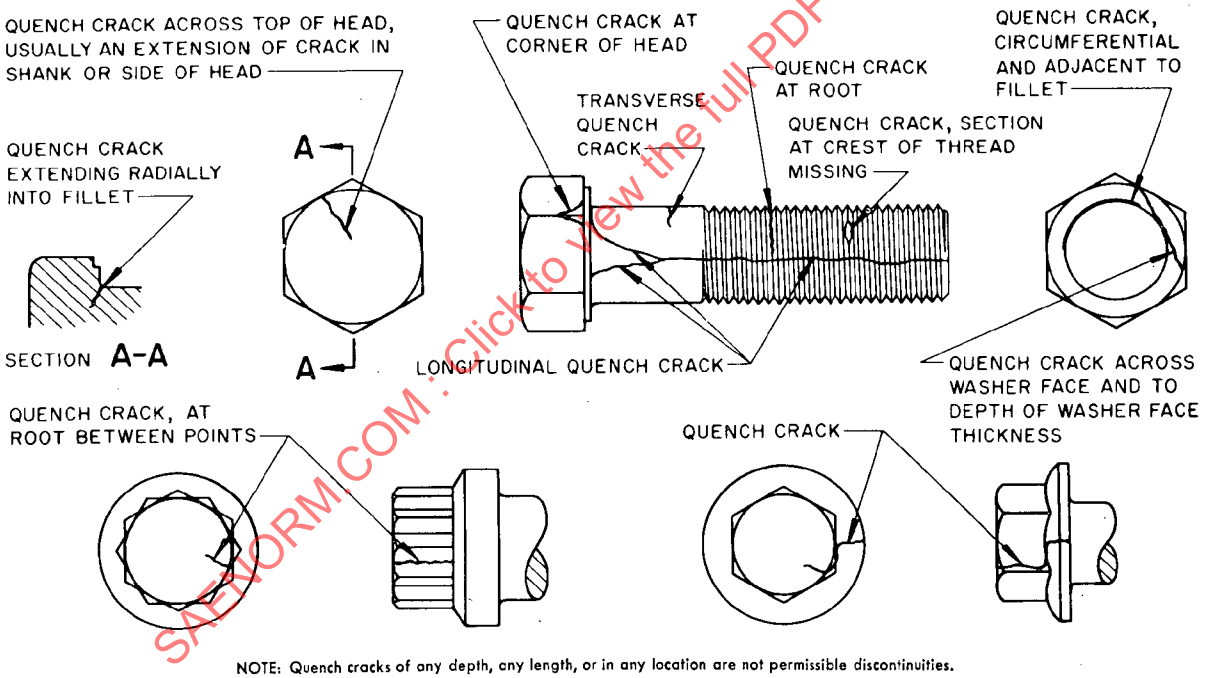
2.2 Seam—Seams are generally inherent in the raw material from which fasteners are manufactured. They are narrow, generally straight or smooth-curved line discontinuities, running longitudinally, on the shank and/or thread. Seams may extend onto the tops of the heads of circular head products as well as being present at the periphery of the head. Seams may also extend into the chamfer circle, washer face, and wrenching flats of hex head products. Typical seams are shown in Fig. 3.

2.3 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 Fig. 4.

2.4 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 deg to the product axis. Shear bursts may also occur on the sides of hex head products. Typical discontinuities of this type are shown in Fig. 4.

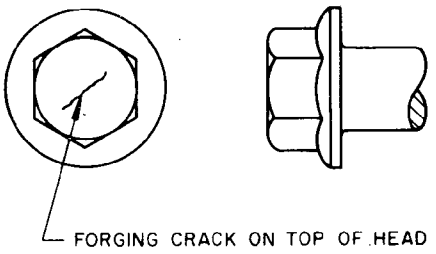
2.5 Void—A void is a shallow pocket or hollow on the surface of the bolt or screw due to nonfilling of metal during forging or upsetting. Typical voids are shown in Fig. 5.

2.6 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



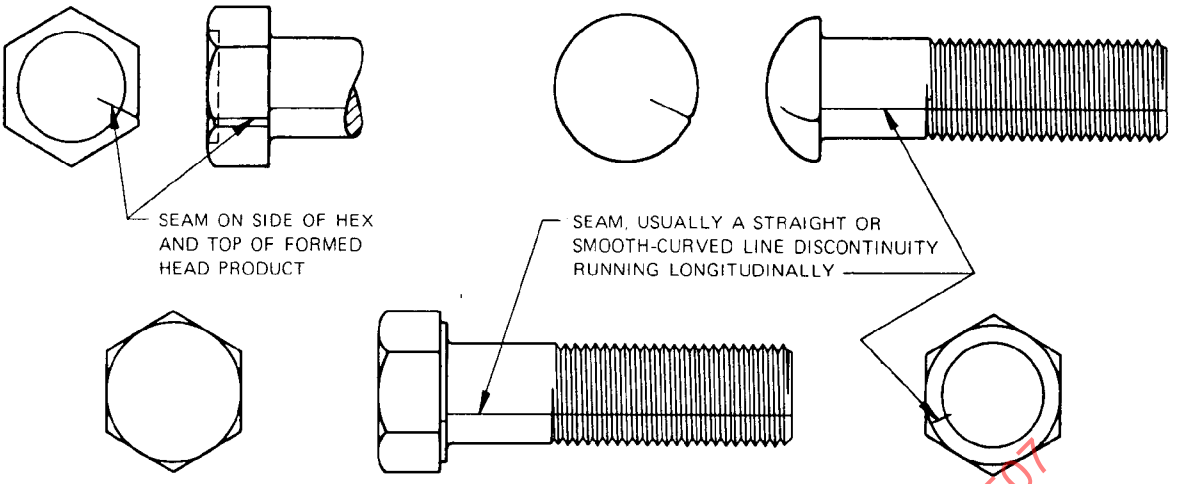
NOTE: Quench cracks of any depth, any length, or in any location are not permissible discontinuities.

FIG. 1—TYPICAL QUENCH CRACKS



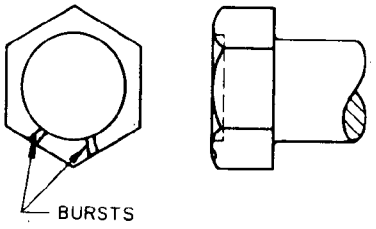
NOTE: Forging cracks are permissible discontinuities if with the limits specified in paragraph 3.4.

FIG. 2—TYPICAL FORGING CRACKS

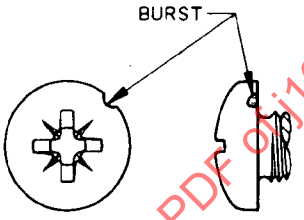


NOTE: Seams are permissible discontinuities if within the limits specified in paragraph 3.5.

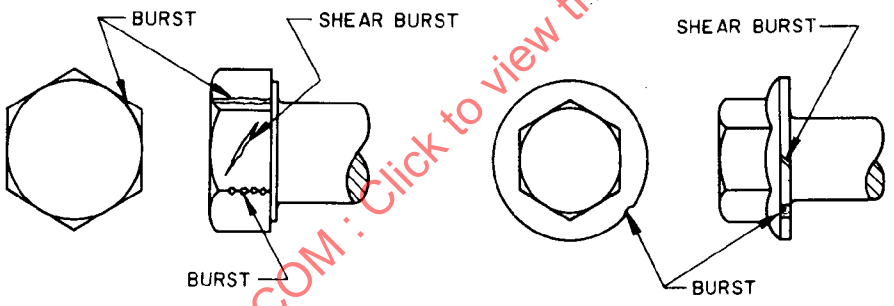
FIG. 3—TYPICAL SEAMS



NOTE: Bursts in raised periphery of indented head bolts and screws are permissible discontinuities if within the limits specified in paragraph 3.6.3.

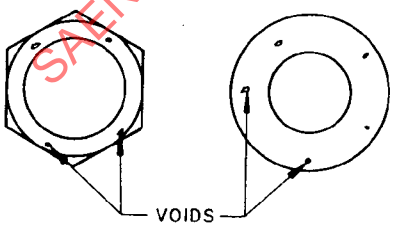


NOTE: Bursts in circular head products, with or without recess, are permissible discontinuities if within the limits specified in paragraph 3.6.2.



NOTE: Bursts and shear bursts are permissible discontinuities if within the limits specified in paragraph 3.6.

FIG. 4—TYPICAL BURSTS AND SHEAR BURSTS



NOTE: Voids are permissible discontinuities if within the limits specified in paragraph 3.7.

FIG. 5—TYPICAL VOIDS ON BEARING SURFACE

changes, and are especially prevalent with noncircular necks, shoulders, and heads. Typical folds are shown in Fig. 6.

2.7 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 Fig. 7.

2.8 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.

3. Limits for Surface Discontinuities

3.1 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.

3.2 Quench Cracks—Quench cracks of any depth, any length, or in any location, are not permitted. (See paragraph 2.1.1 and Fig. 1.)

3.3 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 paragraph 2.6 and Fig. 6.)

3.4 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.

3.5 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 paragraph 2.2 and Fig. 3.)

3.6 Bursts and Shear Bursts

3.6.1 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.

3.6.2 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.

3.6.3 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 paragraph 2.3 and Fig. 4.)

3.7 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 paragraph 2.5 and Fig. 5.)

3.8 Tool Marks—Tool marks on the bearing surface shall not exceed surface roughness measurement of 2.8 μm (110 μ in.) determined as the arithmetic average deviation from the mean surface. (See paragraph 2.7 and Fig. 7.)

3.9 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.

4. 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 paragraphs 4.1 and 4.2.

4.1 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.

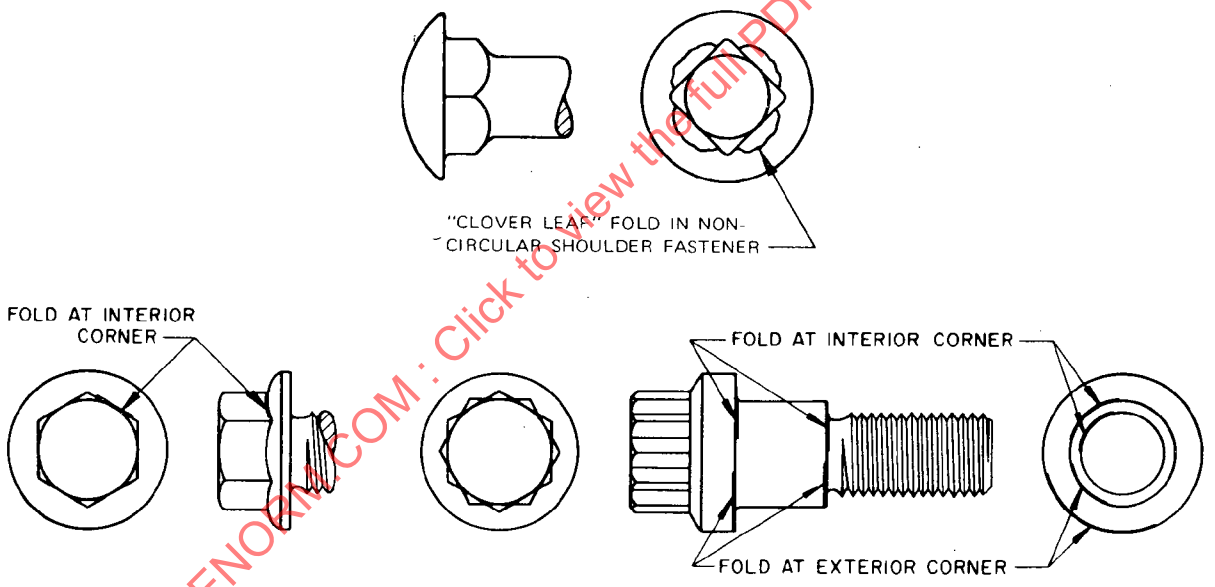
4.1.1 If any part is found with quench cracks or with folds at internal corners at or below the bearing surface, the lot shall be subject to rejection.

4.1.2 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 paragraph 3, the lot shall be subject to rejection.

4.2 Seam Inspection—A representative sample with a size as given in Table 1 (if acceptable by visual inspection) shall then be examined for seams by deep (surface) acid etch or magnetic inspection techniques (Magna-glo, Magna-flux, eddy current, etc.). (NOTE: Other examining procedures may be used providing they have an ability to detect discontinuities of the size specified in paragraph 3.5.)

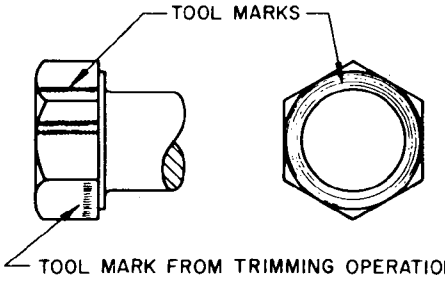
(NOTE: During this inspection, attention should also be given to examining the product for indications showing transverse quench cracks or folds in internal corners as these discontinuities are sometimes not readily seen in visual examination.)

4.2.1 All parts showing indications which could be interpreted as seams shall be set aside. From this group, a secondary sample with a size as given in Table 2 shall be picked at random and each part in this sample sectioned through the shank perpendicular to the axis and etched for microscopic examination. The section should be through the unthreaded body adjacent to the thread runout. For bolts and screws which are threaded to the head, the section should be taken where the seam indication intersects the root of the thread at a distance of approximately 1 D from the underside of the head, where D is nominal size of bolt or screw. (A recommended procedure is outlined in ASTM E 3, Methods of Preparing Metallographic Specimens.) If during the microscopic examination any part is found having a seam with a depth in excess of the limit specified in paragraph 3.5, the lot shall be subject to rejection.



NOTE: Folds in interior corners at or below the bearing surface are not permissible discontinuities. Folds at exterior corners are permissible discontinuities if within the limits specified in paragraph 3.3

FIG. 6—TYPICAL FOLDS



NOTE: Tool marks are permissible discontinuities if within the limits specified in paragraph 3.8.

FIG. 7—TYPICAL TOOL MARKS

TABLE 1—SAMPLE SIZE FOR VISUAL AND SEAM INSPECTION

Lot Size	Sample Size Visual and Nondestructive Techniques	Sample Size 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