

# SURFACE VEHICLE RECOMMENDED PRACTICE

**SAE** J933

REV.  
MAY1998

Issued 1965-07  
Revised 1998-05

Superseding J933 JUN79

Submitted for recognition as an American National Standard

## Mechanical and Quality Requirements for Tapping Screws

**Foreword**—This Document has also changed to comply with the new SAE Technical Standards Board Format. References were added as Section 2. All other section numbers have changed accordingly.

### 1. Scope

- 1.1** This SAE Recommended Practice covers the mechanical and quality requirements for steel tapping screws used in automotive and related industries. It does not apply to corrosion resistant (stainless) steel screws. (Dimensional requirements for most types of screws mentioned herein are covered in SAE J478.)
- 1.2** The primary objective of the specification is to insure that screws form or cut mating threads in materials of construction into which they are normally driven, without deforming their own thread and without breaking during assembly or service.

NOTE—Certain limitations on basic material and manufacturing processes have been incorporated because the size and configuration of the parts under consideration make them vulnerable to relatively small variations in chemistry, heat treatment, etc., and because experience has shown that in processing it is difficult to keep these variables consistently "in balance." Until improved performance tests are developed, these limitations will supplement the "performance" features of the specification.

### 2. References

- 2.1 Applicable Publication**—The following publication forms a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

**2.1.1 SAE PUBLICATION**—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J423—Methods of Measuring Case Depth  
SAE J478—Slotted and Recessed Head Screws

### 3. Performance Requirements

- 3.1 General**—In cases where screws are plated subsequent to delivery to the purchaser (or where plating of screws is otherwise under the control of the purchaser), the screw producer is not responsible for failures due to plating. In such cases, additional screws from the same lot shall be stripped of plating, baked, lubricated with machine oil, and retested in the plain finish condition.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-8512 FAX: (724) 776-0243  
TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790  
SAE WEB ADDRESS <http://www.sae.org>



**3.2 Drive Test for Types A, B, C, D, F, G, T, AB, and BP<sup>1</sup>**—Sample screws (coated or uncoated, as received) shall, without deforming their own thread, form a mating thread in test plate described as follows until a thread of full diameter is completely through the test plate.

The test plate shall be made of low-carbon cold-rolled steel, having hardness of Rockwell B70-85 or equivalent, and thickness as specified in Table 1A. Test holes shall be drilled or punched and redrilled, or reamed, to  $\pm 0.001$  in of nominal diameter specified in Table 1B for type and size screw being tested.

**TABLE 1A—STANDARD TEST PLATE THICKNESSES AND HOLES SIZES  
FOR DRIVE TEST INSPECTION OF TAPPING SCREWS<sup>(1)</sup>—THICKNESS**

| Nominal<br>Screw Size | Types<br>AB, A, B,<br>BP, and C<br>Gage | Types<br>AB, A, B,<br>BP, and C<br>Max | Types<br>AB, A, B,<br>BP, and C<br>Min | Types<br>D, F, G,<br>and T<br>Max | Types<br>D, F, G,<br>and T<br>Min |
|-----------------------|-----------------------------------------|----------------------------------------|----------------------------------------|-----------------------------------|-----------------------------------|
| 2                     | 18                                      | 0.0500                                 | 0.0460                                 | 0.0800                            | 0.0760                            |
| 3                     | 18                                      | 0.0500                                 | 0.0460                                 | 0.0960                            | 0.0920                            |
| 4                     | 18                                      | 0.0500                                 | 0.0460                                 | 0.1110                            | 0.1070                            |
| 5                     | 18                                      | 0.0500                                 | 0.0460                                 | 0.1110                            | 0.1070                            |
| 6                     | 14                                      | 0.0770                                 | 0.0730                                 | 0.1425                            | 0.1385                            |
| 7                     | 14                                      | 0.0770                                 | 0.0730                                 | —                                 | —                                 |
| 8                     | 14                                      | 0.0770                                 | 0.0730                                 | 0.1420                            | 0.1380                            |
| 10                    | 1/8                                     | 0.1270                                 | 0.1230                                 | 0.1905                            | 0.1845                            |
| 12                    | 1/8                                     | 0.1270                                 | 0.1230                                 | 0.1905                            | 0.1845                            |
| 14                    | 1/8                                     | 0.1270                                 | 0.1230                                 | —                                 | —                                 |
| 1/4                   | 3/16                                    | 0.1905                                 | 0.1845                                 | 0.2530                            | 0.2470                            |
| 16                    | 3/16                                    | 0.1905                                 | 0.1845                                 | —                                 | —                                 |
| 18                    | 3/16                                    | 0.1905                                 | 0.1845                                 | —                                 | —                                 |
| 5/16                  | 3/16                                    | 0.1905                                 | 0.1845                                 | 0.3155                            | 0.3095                            |
| 20                    | 3/16                                    | 0.1905                                 | 0.1845                                 | —                                 | —                                 |
| 24                    | 3/16                                    | 0.1905                                 | 0.1845                                 | —                                 | —                                 |
| 3/8                   | 3/16                                    | 0.1905                                 | 0.1845                                 | 0.3780                            | 0.3720                            |
| 7/16                  | 3/16                                    | 0.1905                                 | 0.1845                                 | —                                 | —                                 |
| 1/2                   | 3/16                                    | 0.1905                                 | 0.1845                                 | —                                 | —                                 |

1. Requirements shown in each column of Tables 1 and 2 are applicable also to screws which have thread-forming characteristics similar to the type(s) designated in the column heading.

1. This test does not apply to Types BF, BG, and BT screws.

**TABLE 1B—STANDARD TEST PLATE THICKNESSES AND HOLES SIZES FOR DRIVE TEST INSPECTION  
OF TAPPING SCREWS<sup>(1)</sup>—HOLE SIZE**

| Nominal<br>Screw<br>Size | Type A<br>Drill<br>Size | Type A<br>Hole<br>Dia | Types<br>AB, B,<br>and BP<br>Drill<br>Size | Types<br>AB, B,<br>and BP<br>Hole<br>Dia | Type C<br>Coarse<br>Thread<br>Drill<br>Size | Type C<br>Coarse<br>Thread<br>Hole<br>Dia | Type C<br>Fine<br>Thread<br>Drill<br>Size | Type C<br>Fine<br>Thread<br>Hole<br>Dia | Types D,<br>F, G,<br>and T<br>Coarse<br>Thread<br>Drill<br>Size | Types D,<br>F, G,<br>and T<br>Coarse<br>Thread<br>Hole<br>Dia | Types D,<br>F, G,<br>and T<br>Fine<br>Thread<br>Drill<br>Size | Types D,<br>F, G,<br>and T<br>Fine<br>Thread<br>Hole<br>Dia |
|--------------------------|-------------------------|-----------------------|--------------------------------------------|------------------------------------------|---------------------------------------------|-------------------------------------------|-------------------------------------------|-----------------------------------------|-----------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|-------------------------------------------------------------|
| 2                        | No. 48                  | 0.0760                | No. 48                                     | 0.0760                                   | No. 48                                      | 0.0760                                    | No. 48                                    | 0.0760                                  | No. 49                                                          | 0.0730                                                        | —                                                             | —                                                           |
| 3                        | No. 46                  | 0.0810                | No. 46                                     | 0.0810                                   | No. 44                                      | 0.0860                                    | No. 43                                    | 0.0890                                  | No. 46                                                          | 0.0810                                                        | —                                                             | —                                                           |
| 4                        | No. 44                  | 0.0860                | No. 44                                     | 0.0860                                   | No. 41                                      | 0.0960                                    | No. 40                                    | 0.0980                                  | No. 41                                                          | 0.0960                                                        | —                                                             | —                                                           |
| 5                        | No. 36                  | 0.1065                | No. 36                                     | 0.1065                                   | No. 35                                      | 0.1100                                    | No. 35                                    | 0.1100                                  | No. 37                                                          | 0.1040                                                        | —                                                             | —                                                           |
| 6                        | No. 32                  | 0.1160                | No. 32                                     | 0.1160                                   | No. 31                                      | 0.1200                                    | 1/8                                       | 0.1250                                  | No. 31                                                          | 0.1200                                                        | —                                                             | —                                                           |
| 7                        | No. 30                  | 0.1285                | No. 30                                     | 0.1285                                   | —                                           | —                                         | —                                         | —                                       | —                                                               | —                                                             | —                                                             | —                                                           |
| 8                        | No. 29                  | 0.1360                | No. 29                                     | 0.1360                                   | No. 27                                      | 0.1440                                    | No. 26                                    | 0.1470                                  | No. 26                                                          | 0.1470                                                        | —                                                             | —                                                           |
| 10                       | No. 21                  | 0.1590                | No. 21                                     | 0.1590                                   | No. 19                                      | 0.1660                                    | 11/64                                     | 0.1719                                  | No. 17                                                          | 0.1730                                                        | No. 16                                                        | 0.1770                                                      |
| 12                       | 3/16                    | 0.1875                | 3/16                                       | 0.1875                                   | No. 11                                      | 0.1910                                    | No. 10                                    | 0.1935                                  | No. 8                                                           | 0.1990                                                        | —                                                             | —                                                           |
| 14                       | 5.5 mm                  | 0.2165                | —                                          | —                                        | —                                           | —                                         | —                                         | —                                       | —                                                               | —                                                             | —                                                             | —                                                           |
| 1/4                      | —                       | —                     | 5.5 mm                                     | 0.2165                                   | 7/32                                        | 0.2188                                    | 1                                         | 0.2280                                  | 1                                                               | 0.2280                                                        | A                                                             | 0.2340                                                      |
| 16                       | B                       | 0.2380                | —                                          | —                                        | —                                           | —                                         | —                                         | —                                       | —                                                               | —                                                             | —                                                             | —                                                           |
| 18                       | G                       | 0.2610                | —                                          | —                                        | —                                           | —                                         | —                                         | —                                       | —                                                               | —                                                             | —                                                             | —                                                           |
| 5/16                     | —                       | —                     | 1                                          | 0.2720                                   | J                                           | 0.2770                                    | L                                         | 0.2900                                  | L                                                               | 0.2900                                                        | M                                                             | 0.2950                                                      |
| 20                       | L                       | 0.2900                | —                                          | —                                        | —                                           | —                                         | —                                         | —                                       | —                                                               | —                                                             | —                                                             | —                                                           |
| 24                       | 11/32                   | 0.3438                | —                                          | —                                        | —                                           | —                                         | —                                         | —                                       | —                                                               | —                                                             | —                                                             | —                                                           |
| 3/8                      | —                       | —                     | 21/64                                      | 0.3281                                   | R                                           | 0.3390                                    | 11/32                                     | 0.3438                                  | T                                                               | 0.3580                                                        | T                                                             | 0.3580                                                      |
| 7/16                     | —                       | —                     | 13/32                                      | 0.4062                                   | 10 mm                                       | 0.3937                                    | —                                         | —                                       | —                                                               | —                                                             | —                                                             | —                                                           |
| 1/2                      | —                       | —                     | 15/32                                      | 0.4688                                   | 29/64                                       | 0.4531                                    | —                                         | —                                       | —                                                               | —                                                             | —                                                             | —                                                           |

1. Requirements shown in each column of Tables 1 and 2 are applicable also to screws which have thread-forming characteristics similar to the type(s) designated in the column heading.

**3.3 Torsional Strength Test**—Shank of sample screw (coated or uncoated, as received) shall be securely clamped in a mating, split, blind-hole die (Figure 1) or other means, such that the clamped portion of the threads is not damaged and at least two full threads project above the clamping device and at least two full form threads exclusive of point, flute(s), or end slot are held within the clamping device. (A blind hole may be used in place of the clamping device, providing the hole depth is such as to insure that the breakage will occur beyond the point, or the full length of the flute(s) or end slot.) By means of a suitably calibrated torque measuring device, apply torque to the screw until failure occurs. The torque required to cause failure shall equal or exceed the minimum value shown in Table 2 for the type and size of screw being tested.

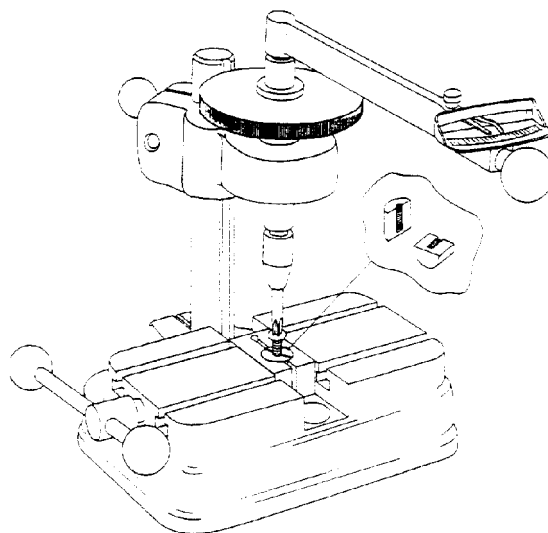


FIGURE 1—

**TABLE 2—TORSIONAL STRENGTH REQUIREMENTS FOR TAPPING SCREWS<sup>(1)</sup>**  
**(MINIMUM TORSIONAL STRENGTH, lb-in)**

| Nominal<br>Screw<br>Size | Type A | Types AB,<br>B, BF, BG,<br>BP, and BT | Type C<br>Coarse<br>Thread | Type C<br>Fine<br>Thread | Types D,<br>F, G, and T<br>Coarse<br>Thread | Types D,<br>F, G, and T<br>Fine<br>Thread |
|--------------------------|--------|---------------------------------------|----------------------------|--------------------------|---------------------------------------------|-------------------------------------------|
| 2                        | 4      | 4                                     | 5                          | 6                        | 5                                           | 6                                         |
| 3                        | 9      | 9                                     | 9                          | 10                       | 9                                           | 10                                        |
| 4                        | 12     | 13                                    | 13                         | 15                       | 13                                          | 15                                        |
| 5                        | 18     | 18                                    | 18                         | 20                       | 18                                          | 20                                        |
| 6                        | 24     | 24                                    | 23                         | 27                       | 23                                          | 27                                        |
| 7                        | 30     | 30                                    | —                          | —                        | —                                           | —                                         |
| 8                        | 39     | 39                                    | 42                         | 47                       | 42                                          | 47                                        |
| 10                       | 48     | 56                                    | 56                         | 74                       | 56                                          | 74                                        |
| 12                       | 83     | 88                                    | 93                         | 108                      | 93                                          | 108                                       |
| 14                       | 125    | —                                     | —                          | —                        | —                                           | —                                         |
| 1/4                      | —      | 142                                   | 140                        | 179                      | 140                                         | 179                                       |
| 16                       | 152    | —                                     | —                          | —                        | —                                           | —                                         |
| 18                       | 196    | —                                     | —                          | —                        | —                                           | —                                         |
| 5/16                     | —      | 290                                   | 306                        | 370                      | 306                                         | 370                                       |
| 20                       | 250    | —                                     | —                          | —                        | —                                           | —                                         |
| 24                       | 492    | —                                     | —                          | —                        | —                                           | —                                         |
| 3/8                      | —      | 590                                   | 560                        | 710                      | 560                                         | 710                                       |
| 7/16                     | —      | —                                     | —                          | —                        | —                                           | —                                         |
| 1/2                      | —      | —                                     | —                          | —                        | —                                           | —                                         |

1. Requirements shown in each column of Tables 1A, 1B, and 2 are applicable also to screws which have thread-forming characteristics similar to the type(s) designated in the column heading.

#### 4. Material and Processing Requirements

**4.1 Material**—Screws shall be made from cold heading quality, killed steel wire, conforming to the composition limits shown in Table 3:

**TABLE 3—**

| Tapping<br>Screw<br>Size (dia) | Analysis <sup>(1)</sup> | Chemical<br>Composition,<br>% by weight<br>Carbon | Chemical<br>Composition,<br>% by weight<br>Manganese |
|--------------------------------|-------------------------|---------------------------------------------------|------------------------------------------------------|
| No. 4 and smaller              | Ladle                   | 0.13–0.25                                         | 0.60–1.65                                            |
|                                | Check                   | 0.11–0.27                                         | 0.57–1.71                                            |
| No. 5 thru 1/2 in              | Ladle                   | 0.15–0.25                                         | 0.70–1.65                                            |
|                                | Check                   | 0.13–0.27                                         | 0.64–1.71                                            |

1. Ladle analyses are shown for informational purposes. Check analyses are mandatory and refer to individual determinations on uncarburized or core portion of screws.

- 4.2 Heat Treatment**—Shall be in carbonitriding or gas carburizing system. Screws shall be quenched in a liquid medium and then tempered by reheating to 650 °F min.

Cyaniding systems may be approved by a purchaser when the producer shows that a continuous flow (no batch) quenching process is employed which consistently produces uniform case and core.

- 4.3 Total Case Depth**—Shall conform to the tabulation as shown in Table 4, as measured at thread flank midpoint between the crest and root:

TABLE 4—

| Nominal<br>Screw<br>Size | Total Case<br>Depth (in)<br>Max. | Total Case<br>Depth (in)<br>Min |
|--------------------------|----------------------------------|---------------------------------|
| 4 and 6                  | 0.007                            | 0.002                           |
| 8 through 12             | 0.009                            | 0.004                           |
| 1/4 and larger           | 0.011                            | 0.005                           |

Case depth is to be checked in the hardened condition in accordance with SAE J423, 5.3.1, using a magnification of 100x. For referee purposes, the screws must meet all performance requirements as defined in Tables 1A, 1B, and 2, and the hardness at the maximum case depth shall not exceed 42 HRC when read with a microhardness instrument and a 500-g load converting the results to HRC. This is required to ensure that the total case does not exceed the maximum specified depth.

- 4.4 Surface Hardness After Tempering**—Screws shall have a surface hardness equivalent to 45 HRC minimum. For the purpose of routine testing or a quick check, the surface hardness may be checked by the use of HR15N, knoop, or pyramid indenter. The method selected shall be dependent on the size of the product and testable area. The readings may be taken on the surface with light surface preparation. In the event that a hardness lower than specification is obtained, the Referee Method described as follows will prevail.

The hardness readings shall be taken 0.002 in below the surface of the screw using a microhardness instrument with a knoop or pyramid indenter and a 500-g load. In cases where the total depth of the case is 0.004 in or less, the reading may be taken 0.001 in below the surface of the screw using 100-g load.

For the purposes of measuring surface hardness and case depth, the readings will be taken on specimens which have been sectioned in a tolerance zone from true center to above center in order to ensure adequate support in the mounting media. When measuring the apparent major diameter on the sectioned metallographic specimen, the apparent major diameter shall be no less than 95% of the minimum major diameter permitted for the size of fastener being tested.

- 4.5 Core Hardness After Tempering**—Shall be Rockwell C28-38<sup>1</sup>, as determined at mid-radius of a transverse section through the screw taken at a distance sufficiently behind the point of the screw to be through the full minor diameter.
- 4.6 Microstructure**—Shall show no band of free ferrite between case and core, as determined by metallographic examination.

1. Hardness shall not exceed maximum shown and preferably should be no higher than Rockwell C36 to insure against failure in assembly and service.

## 5. Testing Requirements

- 5.1** The requirements of this specification shall be met in continuous mass production for stock, and the producer shall make sample inspections to insure that the product is controlled within the specified limits. Additional tests of individual shipments are not ordinarily contemplated. Individual heats of steel are not identified in the finished product, and testing on a heat basis is not feasible.

When specified on purchase order or engineering drawing, the manufacturer shall furnish a report certified to be the latest set of test results for the following tests for each stock size in each shipment: Core Hardness, Torsional Strength Test, and Drive Test (in case of self-drilling screws, both Drill and Drive Tests).

Strength Test, and Drive Test.

Chemical and metallurgical tests (material analysis, surface hardness, case depth, metallographic examination of cross section) are not inspected frequently during normal processing, and consequently, such testing shall be considered as special and shall only be done by the manufacturer when specifically required in the original inquiry and purchase order.

- 5.2** When testing on a lot basis is specified, a lot shall consist of all screws of a single type, size, and length, manufactured under essentially the same conditions and submitted for inspection at one time. Unless otherwise agreed between purchaser and supplier the following number of tests shall be conducted to determine acceptance of each of the mechanical requirements (core hardness, torsional strength, and driving characteristics). (See Table 5.)

TABLE 5—

| Lot Size<br>(places) | No. of Tests | Lot Size<br>(places) | No. of Tests |
|----------------------|--------------|----------------------|--------------|
| 50 and less          | 2            | 501 to 35 000        | 5            |
| 51 to 500            | 3            | Over 35 000          | 8            |

- 5.3** If failure of a test specimen is due to improper preparation of the specimen or to incorrect testing technique, the specimen shall be discarded and another specimen substituted.

## 6. Notes

- 6.1 Marginal Indicia**—The change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

PREPARED BY THE SAE IRON AND STEEL TECHNICAL COMMITTEE

## SAE J933 Revised MAY1998

**Rationale**—The changes to this document are in 4.3 and 4.4 (old version 3.3. and 3.4). The document has also been reformatted to comply with the new SAE Technical Standards Board format. This includes adding References as Section 2. All other section numbers have changed. Old Section 2.4 was editorially removed.

**Relationship of SAE Standard to ISO Standard**—Not applicable.

**Application**—This SAE Recommended Practice covers the mechanical and quality requirements for steel tapping screws used in automotive and related industries. It does not apply to corrosion resistant (stainless) steel screws. (Dimensional requirements for most types of screws mentioned herein are covered in SAE J478.)

The primary objective of the specification is to insure that screws form or cut mating threads in materials of construction into which they are normally driven, without deforming their own thread and without breaking during assembly or service.

NOTE—Certain limitations on basic material and manufacturing processes have been incorporated because the size and configuration of the parts under consideration make them vulnerable to relatively small variations in chemistry, heat treatment, etc., and because experience has shown that in processing it is difficult to keep these variables consistently "in balance." Until improved performance tests are developed, these limitations will supplement the "performance" features of the specification.

### Reference Section

SAE J423—Methods of Measuring Case Depth

SAE J478—Slotted and Recessed Head Screws

**Developed by the SAE Iron and Steel Technical Committee**