SURFACE VEHICLE STANDARD

J78™ JUL2021

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Superseding J78 APR2013

(R) Steel Self-Drilling Tapping Screws

RATIONALE

SAE J78 is being revised to update some of the testing procedures and add requirements for point Styles 2, 3, 4, and 5, which are in common use.

1. SCOPE

1.1 General

This SAE Standard covers the dimensional and general specifications, including performance requirements, for carbon steel self-drilling tapping screws suitable for use in general applications having point Styles 2, 3, 4, and 5.

It is the objective of this document to ensure that carbon steel self-drilling tapping screws, by meeting the mechanical and performance requirements specified, shall drill a hole and form or cut mating threads in materials into which they are driven without deforming their own thread and without breaking during assembly.

1.2 Screw Types and Application

The two types of self-drilling tapping screws covered by this document are designated and described as follows:

1.2.1 Type BSD

Type BSD screws shall have spaced threads with drill points of varying configuration, designated Style 2, Style 3, Style 4, and Style 5 designed to accommodate different panel thickness conditions as delineated in Section 6.

1.2.2 Type CSD

Type CSD screws shall have threads of machine screw diameter-pitch combinations approximating unified form with drill points of varying configuration, designated Style 2, Style 3, Style 4, and Style 5 designed to accommodate different panel thickness conditions as delineated in Section 6. Type CSD screws are not subject to thread gaging but shall meet dimensions specified in this document. They are intended for application where the use of a machine screw pitch thread is preferred over the spaced thread.

1.3 Head and Drive Types

The head types and drive types applicable to self-drilling tapping screws covered by this document shall include those specified in ASME B18.6.3, except for slotted head and hex (non-washer) head designs which are not recommended for self-drilling screws.

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2. REFERENCES

2.1 Applicable Documents

The following publications form 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 International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J423 Methods of Measuring Case Depth

2.1.2 ASME Publications

Available from ASME, P.O. Box 2900, 22 Law Drive, Fairfield, NJ 07007-2900, Tel: 800-843-2763 (U.S./Canada), 001-800-843-2763 (Mexico), 973-882-1170 (outside North America), www.asme.org.

ASME B18.6.3 Machine Screws, Tapping Screws, and Metallic Drive Screws

ASME B18.21.1 Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers

2.1.3 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM F1941/F1941M Electrodeposited Coatings on Mechanical Fasteners

3. DIMENSIONAL REQUIREMENTS

3.1 General Dimensions

Dimensions and general specifications applicable to heads, body, and screw length for Type BSD and Type CSD screws shall conform to those specified for Type B and Type C tapping screws, respectively, as specified in ASME B18.6.3, except as specified in 3.2 to 3.4.

3.2 Heads

The underside on all non-countersunk styles of heads on milled point self-drilling screws may be chamfered at the periphery of head in accordance with the dimensions specified in Figure 1 and Table 1 and/or may be undercut into the bearing surface of the head as shown in Figure 2 at the discretion of the manufacturer to facilitate threading close to the head.

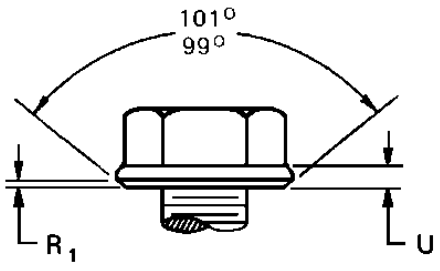

FIGURE 1A—HEX WASHER HEAD

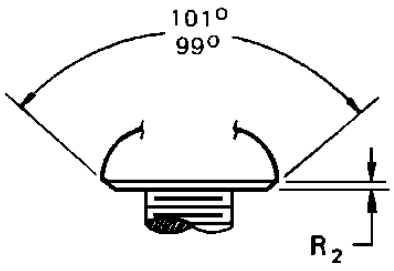

FIGURE 1B—RECESSED HEADS

Figure 1 - Head chamfers on milled point screws

Figure 2 - Optional undercut in bearing surface

Table 1 - Head chamfer dimensions for milled point self-drilling tapping screws in figure 1

Nominal Screw Size	U Washer Thickness Max	U Washer Thickness Min	R_1 Chamfer Height Hex Washer Heads Ref	R_2 Chamfer Height Recessed Heads Ref
4	0.030	0.020	0.015	0.015
6	0.040	0.025	0.015	0.015
8	0.050	0.035	0.020	0.015
10	0.050	0.035	0.020	0.020
12	0.050	0.035	0.020	0.020
1/4	0.060	0.040	0.025	0.020

3.3 Eccentricity

Eccentricity is defined as one-half of the full or total indicator reading.

3.3.1 Eccentricity of Hex and Hex Washer Heads

Hex and hex washer heads shall not be eccentric with the axis of screw by an amount equal to more than 4% of the basic screw diameter.

3.3.2 Eccentricity of Recess

The recess in recessed head screws shall not be eccentric with the axis of screw by an amount equal to more than 4% of the basic screw diameter.

3.3.3 Recess Wobble

A firm fit between the driver bit and recess is critical for the proper driving of self-drilling screws. All recessed screws made to this standard shall conform to the wobble requirements specified in ASME B18.6.3.

3.4 Length of Thread

3.4.1 Type BSD Screws

For screws of nominal lengths equal to or shorter than 1.50 inches, the full form threads shall extend close to the head such that the specified minor diameter limits are maintained to within one pitch (thread), or closer if practicable, of the underside of the head. There shall be no threading into the underhead fillet. See Figure 3. For screws of nominal lengths longer than 1.50 inches, the length of full form thread shall be as specified by the purchaser.

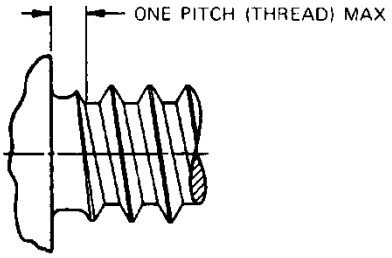

Figure 3 - Type BSD thread form

3.4.2 Type CSD Screws

For screws of nominal lengths equal to or shorter than 1.50 inches, the full form threads shall extend close to the head such that the specified major diameter limits are maintained to within two pitches (threads), or closer if practicable, of the underside of the head. There shall be no threading into the underhead fillet. See Figure 4. For screws of nominal lengths longer than 1.50 inches, the length of full form thread shall be as specified by the purchaser.

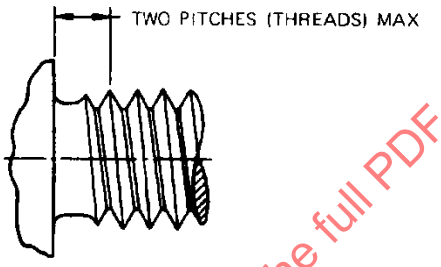

Figure 4 - Type CSD thread form

3.5 Threads and Points

The threads and points applicable to screws covered by this document are generally described under 1.2. They shall conform to the dimensions specified in Tables 2A and 2B.

Table 2A - Dimensions of threads and points for types BSD and CSD self-drilling tapping screws Styles 2 and 3 (Figure 5)[1]

Nominal Size [2] or Basic Screw Diameter		Type BSD Threads Per Inch	Type BSD D Major Diameter Max	Type BSD D Major Diameter Min	Type BSD d Minor Diameter Max	Type BSD d Minor Diameter Min	Type BSD Z[3] Protrusion Allowance (Ref) Style 2 Point	Type BSD Z[3] Protrusion Allowance (Ref) Style 3 Point	Type CSD Threads Per Inch	Type CSD D Major Diameter Max	Type CSD D Major Diameter Min	Type CSD Z[3] Protrusion Allowance (Ref) Style 2 Point	Type CSD Z[3] Protrusion Allowance (Ref) Style 3 Point
4	0.1120	24	0.114	0.110	0.086	0.082	0.163	—	40	0.1120	0.1072	0.130	—
6	0.1380	20	0.139	0.135	0.104	0.099	0.190	0.220	32	0.1380	0.1326	0.152	0.172
8	0.1640	18	0.166	0.161	0.122	0.116	0.211	0.251	32	0.1640	0.1586	0.162	0.202
10	0.1900	16	0.189	0.183	0.141	0.135	0.235	0.300	24	0.1900	0.1834	0.193	0.258
12	0.2160	14	0.215	0.209	0.164	0.157	0.283	0.353	24	0.2160	0.2094	0.223	0.293
1/4	0.2500	14	0.246	0.240	0.192	0.185	0.318	0.393	20	0.2500	0.2428	0.275	0.350

(1) Drill portion of points may be milled and/or cold formed and details of point taper and flute design shall be optional with the manufacturer, provided the screws meet the performance requirements specified in this document and are capable of drilling the maximum panel thicknesses shown in Table 9 prior to thread pickup.

(2) Where specifying nominal size in decimals, zeros preceding decimal and in fourth decimal place shall be omitted.

(3) Protrusion allowance Z is the distance, measured parallel to the axis of screw, from the extreme end of the point to the first full form thread beyond the point and encompasses the length of drill point and the tapered incomplete threads. It is intended for use in calculating the maximum effective design grip length Y on the screw in accordance with the following: Y = L min – z.

Table 2B - Dimensions of threads and points for types BSD and CSD self-drilling tapping screws Styles 4 and 5 (Figure 5)[1]

Nominal Size [2] or Basic Screw Diameter		Type BSD Threads Per Inch	Type BSD D Major Diameter Max	Type BSD D Major Diameter Min	Type BSD d Minor Diameter Max	Type BSD d Minor Diameter Min	Type BSD Z[3] Protrusion Allowance (Ref) Style 4 Point	Type BSD Z[3] Protrusion Allowance (Ref) Style 5 Point	Type CSD Threads Per Inch	Type CSD D Major Diameter Max	Type CSD D Major Diameter Min	Type CSD Z[3] Protrusion Allowance (Ref) Style 4 Point	Type CSD Z[3] Protrusion Allowance (Ref) Style 5 Point
12	0.2160	14	0.215	0.209	0.164	0.157	0.500	0.730	24	0.2160	0.2078	0.500	0.650
1/4	0.2500	14	0.246	0.237	0.192	0.185	0.500	NA	20	0.2500	0.2428	0.515	0.650

(1) Drill portion of points may be milled and/or cold formed and details of point taper and flute design shall be optional with the manufacturer, provided the screws meet the performance requirements specified in this document and are capable of drilling the maximum panel thicknesses shown in Table 9 prior to thread pickup.

(2) Where specifying nominal size in decimals, zeros preceding decimal and in fourth decimal place shall be omitted.

(3) Protrusion allowance Z is the distance, measured parallel to the axis of screw, from the extreme end of the point to the first full form thread beyond the point and encompasses the length of drill point and the tapered incomplete threads. It is intended for use in calculating the maximum effective design grip length Y on the screw in accordance with the following: Y = L min – z.

Table 2A - Dimensions of threads and points for types BSD and CSD self-drilling tapping screws Styles 2 and 3 (Figure 5)[1] (continued)

Nominal Size[2] or Basic Screw Diameter		Types BSD and CSD L Minimum Practical Nominal Screw Lengths (Ref) Style 2 Points Formed 90 Deg Heads	Types BSD and CSD L Minimum Practical Nominal Screw Lengths (Ref) Style 2 Points Formed Csk Heads	Types BSD and CSD L Minimum Practical Nominal Screw Lengths (Ref) Style 2 Points Milled 90 Deg Heads	Types BSD and CSD L Minimum Practical Nominal Screw Lengths (Ref) Style 2 Points Milled Csk Heads	Types BSD and CSD L Minimum Practical Nominal Screw Lengths (Ref) Style 3 Points Formed 90 Deg Heads	Types BSD and CSD L Minimum Practical Nominal Screw Lengths (Ref) Style 3 Points Milled Csk Heads	Types BSD and CSD L Minimum Practical Nominal Screw Lengths (Ref) Style 3 Points Formed 90 Deg Heads	Types BSD and CSD L Minimum Practical Nominal Screw Lengths (Ref) Style 3 Points Milled Csk Heads
4	0.1120	5/16	3/8	3/8	7/16	—	—	—	—
6	0.1380	5/16	3/8	3/8	7/16	3/8	7/16	7/16	1/2
8	0.1640	3/8	7/16	7/16	1/2	7/16	1/2	1/2	9/16
10	0.1900	7/16	1/2	15/32	19/32	1/2	9/16	9/16	21/32
12	0.2160	1/2	5/8	17/32	21/32	1/2	5/8	21/32	25/32
1/4	0.2500	1/2	5/8	17/32	11/16	1/2	5/8	11/16	27/32

(1) Drill portion of points may be milled and/or cold formed and details of point taper and flute design shall be optional with the manufacturer, provided the screws meet the performance requirements specified in this document and are capable of drilling the maximum panel thicknesses shown in Table 9 prior to thread pickup.
(2) Where specifying nominal size in decimals, zeros preceding decimal and in fourth decimal place shall be omitted.

Table 2B - Dimensions of threads and points for types BSD and CSD self-drilling tapping screws Styles 4 and 5 (Figure 5)[1] (continued)

Nominal Size[2] or Basic Screw Diameter		Types BSD and CSD L Minimum Practical Nominal Screw Lengths (Ref) Style 4 Points Formed 90 Deg Heads	Types BSD and CSD L Minimum Practical Nominal Screw Lengths (Ref) Style 4 Points Formed Csk Heads	Types BSD and CSD L Minimum Practical Nominal Screw Lengths (Ref) Style 4 Points Milled 90 Deg Heads	Types BSD and CSD L Minimum Practical Nominal Screw Lengths (Ref) Style 4 Points Milled Csk Heads	Types BSD and CSD L Minimum Practical Nominal Screw Lengths (Ref) Style 5 Points Formed 90 Deg Heads	Types BSD and CSD L Minimum Practical Nominal Screw Lengths (Ref) Style 5 Points Milled Csk Heads	Types BSD and CSD L Minimum Practical Nominal Screw Lengths (Ref) Style 5 Points Formed 90 Deg Heads	Types BSD and CSD L Minimum Practical Nominal Screw Lengths (Ref) Style 5 Points Milled Csk Heads
12	0.2160	7/8	1	7/8	1	1 1/4	1 3/8	1 1/4	1 3/8
1/4	0.2500	1	1 3/16	1	1 3/16	1 1/2	1 3/4	1 1/2	1 3/4

(1) Drill portion of points may be milled and/or cold formed and details of point taper and flute design shall be optional with the manufacturer, provided the screws meet the performance requirements specified in this document and are capable of drilling the maximum panel thicknesses shown in Table 9 prior to thread pickup.
(2) Where specifying nominal size in decimals, zeros preceding decimal and in fourth decimal place shall be omitted.

4. MATERIAL AND PROCESS REQUIREMENTS

4.1 Material and Chemistry

Screws shall be made from cold heading quality, killed steel wire conforming to the chemical composition in Table 3:

Table 3 - Chemical composition - composition limits, % by weight

Analysis	Carbon Max	Carbon Min	Manganese Max	Manganese Min
Check	0.27	0.13	1.71	0.64

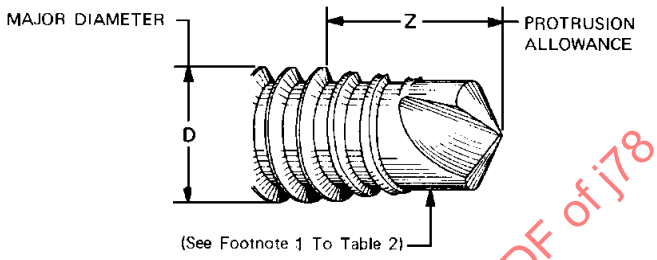

Figure 5 - Typical self-drilling tapping screw point

4.2 Heat Treatment

Screws shall be heat treated in a carbonitriding or gas-carburizing system. Cyaniding systems may be approved by the purchaser when it is shown that a continuous flow (no batch) quenching process which consistently produces uniform case and core hardnesses is employed.

4.2.1 Tempering Temperature

Minimum tempering temperature shall be 330 °C (625 °F).

4.2.2 Total Case Depth

Screws shall have a total case depth conforming to the tabulation in Table 4:

Table 4 - Total case depth

Nominal Screw Size	Total Case Depth, Inch Max	Total Case Depth, Inch Min
4 and 6	0.007	0.002
8 through 12	0.009	0.004
1/4 and larger	0.011	0.005

Total case depth shall be measured at a midpoint between crest and root on the thread flank. The recommended technique for measuring case depth is given in Appendix A. Total case depth is the distance measured perpendicularly from the surface of a hardened case to a point where differences in chemical or physical properties of the case and core can no longer be distinguished (refer to SAE J423) or when the microhardness converted to HRC is 42.

4.2.3 Surface Hardness

Screws shall have a surface hardness equivalent to 50 to 56 HRC. For the purpose of the 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 reading shall be taken 0.002 inch 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 case depth is 0.004 inch or less, the reading may be taken 0.001 inch below the surface of the screw using 100-g load used.

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.

4.2.4 Core Hardness

Screws shall have a core hardness equivalent to Rockwell C32-38 when measured 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.

4.3 Ductility

Heads of screws shall not separate completely from the shank when a permanent deformation is induced between the plane of the under head bearing surface and a plane normal to the axis of the screw, when tested in accordance with 4.3.1.

4.3.1 Ductility Test

The ductility test shall be conducted in accordance with ASME B18.6.3.

4.4 Finish

Unless otherwise specified, screws shall be supplied with a natural (as processed) finish, unplated or uncoated. When electroplated finishes are specified by the purchaser the requirements of ASTM F1941/F1941M shall be applied.

4.4.1 Hydrogen Embrittlement Test

The hydrogen embrittlement test specified in ASME B18.6.3 shall be performed on all plated or coated screws. When necessary, the hole sizes in the test plates may be enlarged enough for the points to pass freely through the test plates before the threading begins.

4.4.2 In cases where screws are plated or coated following delivery to the purchaser (or where plating or coating of screws is otherwise under the control of the purchaser), the screw producer shall not be responsible for failures of screws to meet mechanical or performance requirements due to plating or coating. In such cases, additional screws from the same lot shall be stripped of plating or coating, baked, lubricated with machine oil, and retested in the natural finish.

5. PERFORMANCE REQUIREMENTS AND TESTS

5.1 Torsional Strength

Screws shall not fail with the application of a torque less than the torsional strength torque specified in Table 5, when tested in accordance with 5.1.1.

Table 5 - Mechanical and performance requirements for types BSD and CSD self-drilling tapping screws

Nominal Screw Size	Minimum Torsional Strength lb-in Type BSD	Minimum Torsional Strength lb-in Type CSD
4	14	14
6	24	24
8	42	48
10	61	65
12	92	100
1/4	150	156

5.1.1 Torsional Strength Test

The torsional strength test shall be performed in accordance with the procedure in ASME B18.6.3, except when the point diameter prohibits adequate clamping on the threads, the points may be removed at the intersection of the point and thread.

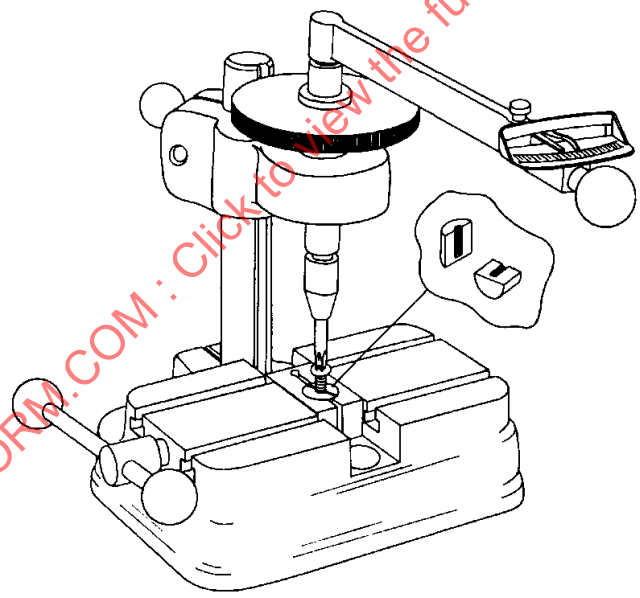

Figure 6 - Typical torsional strength test fixture

5.2 Drill-Drive Test

Sample screws shall be selected at random from the lot and shall be used to drill holes and form or cut mating threads in a test plate. The time in seconds for the screw to drill and thread a hole completely through the test plate shall be recorded. The test plate material and thickness, and load applied against the screw during drilling and threading, and the other test conditions are specified in Table 6. Each screw shall be used to drill and thread only one hole. A typical drill drive test fixture is depicted in Figure 7.

Table 6 - Drill-drive test conditions and requirements for types BSD and CSD self-drilling tapping screws

Nominal Screw Size	Test Plate Thickness,(1) Inch Max	Test Plate Thickness,(1) Inch Min	Axial Loading,(2) Pounds A Max	Axial Loading,(2) Pounds B Max	Axial Loading,(2) Pounds C Max	Time to Drill and Form Thread,(3) Seconds Max
4	0.068	0.055	25	30	40	2.0
6	0.068	0.055	30	35	45	2.5
8	0.068	0.055	30	35	45	3.0
10	0.068	0.055	35	40	50	3.5
12	0.068	0.055	45	50	60	4.0
1/4	0.068	0.055	45	50	60	5.0

(1) Test plates shall be low carbon, cold rolled steel having a hardness of Rockwell B60-85.
(2) Axial loads are varied to offset the detrimental effects on drilling capability created by finishes applied to screws in accordance with the following:
Column A—Axial loads tabulated shall apply to plain, oiled, and commercial phosphate coating and cadmium and zinc platings up to 0.0003 inch thickness.
Column B—Axial loads tabulated shall apply special electroplated finishes exceeding 0.0003 inch thickness and to special coatings, such asthread sealing hot melts, etc.
Column C—Axial loads tabulated shall apply to chromium finish.
(3) Tool speed shall be 2500 rpm for screw sizes No. 4 through No. 10. Tool speed of 1800 rpm is recommended for screw sizes No. 12 and 1/4; however, 2500 rpm may be used provided care is exercised to minimize influence of high heat buildup due to surface speed.

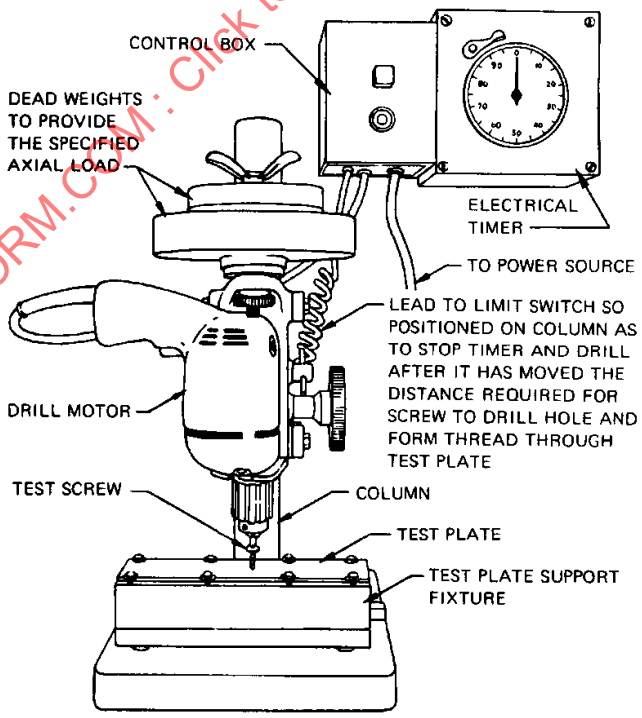

Figure 7 - Typical drill-drive test fixture

The drill-drive test shall be conducted in accordance with the sampling plan in Table 7:

Table 7 - Sampling plan

Lot Size[1]	Sample Size
Up to 5000	6
5001 to 15000	12
15001 to 50000	18
50001 and over	25

[1] Lot size is defined as a quantity submitted for inspection.

If the actual time for each of the sample screws to drill and thread a hole does not exceed the maximum time specified in Table 6, the lot shall be acceptable. If one or more of the test times exceed the maximum specified in Table 6, a retest shall be made using twice the original sample size. The lot shall then be acceptable in accordance with Table 8:

Table 8 - Lot acceptance limits

Sample Size	Slow Drive[1]	Excessive Drive[2]
12	1	0
24	1	0
36	2	1
50	3	1

[1] A “slow drive” is defined as a screw having a drilling and threading time in excess of, but less than, twice the specified maximum.
[2] An “excessive drive” is defined as a screw having a drilling and threading time twice the specified maximum or greater.

5.3 Drilling Performance Test - Optional

When requested by the purchaser, any style may be tested into the maximum panel/plate thickness specified in Table 9. The point of the screw shall pass completely through the test panel/plate without point or thread distortion. The test panel/plate (see Figures 9A and 9D) shall be cold rolled steel (Rockwell B60-85). Other test parameters (i.e., axial load, RPMs, and drill time) shall be as agreed upon between supplier and purchaser.

5.4 Drill Hole Size

When required by the purchaser on the quote and purchasing documents to determine that the drill point does not drill an oversize hole that would cause a loss of thread engagement and result in premature stripping of the mating thread, a drill hole size test may be conducted in accordance with 5.4.1. The diameter of the hole drilled by the screw shall not exceed the point diameter of the test screw by more than 0.005 inch.

5.4.1 Drill Hole Size Test

The sample screw shall be inserted through a sleeve or collar (Figure 8) having an inside diameter of approximately 0.010 inch greater than the major diameter of the screw. The length of sleeve or collar should be such that sufficient unthreaded point length extends through the sleeve or collar to drill a hole through the minimum thickness material specified in Table 6 without thread pickup. After the hole is drilled in the test plate, the screw shall be removed and the diameter of the drilled hole gaged.

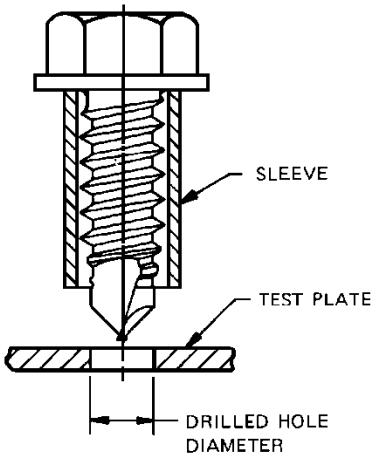

Figure 8 - Drill hole size test

6. SCREW SELECTION AND INSTALLATION CONSIDERATIONS

Screw point style selection should be made on the basis of the recommended panel thicknesses specified in Table 9. For multi-panel applications which exceed the thickness tabulated, clearance holes should be provided in the uppermost panel or panels to reduce the thickness to be drilled by the screw.

Driving tools which operate between 1800 and 3000 rpm are commonly used for self-drilling tapping screw applications.

Table 9 - Self-drilling tapping screw selection chart

Screw Type	Point Style	Nominal Screw Size	P(1) Recommended Panel Thickness, Inch
BSD and CSD	2	4	0.080 max
		6	0.090 max
		8	0.100 max
		10	0.110 max
		12	0.140 max
		1/4	0.175 max
	3	6	0.110 max
		8	0.140 max
		10	0.175 max
		12	0.210 max
		1/4	0.210 max
	4	12	0.125-0.250
		1/4	0.125-0.250
	5	12	0.125-0.500
		1/4	0.125-0.500

(1) If the panel to be drilled is comprised of two or more layers (see Figures 9B and 9C), the gap between the layers (which might consist of a sealing strip, airspace caused by warpage, etc., or just the separation caused by the pressure exerted by the driver) must be considered in determining the point style for the particular fastener. Using a self-drilling tapping screw as covered in this document in a multilayer application with an excessive gap could result in point breakage since the tapping in one layer begins before completion of the drilling of the other layers and since the advancement of the screw in the tapping operation is much faster than in the drilling operation.