Erratum
to
ASME B18.2.1-1996
Square and Hex Bolts and Screws (Inch Series)

On page 13, Table 4, the fourteenth entry under "Basic" in Column *H* is revised. Revision appears on the overleaf.

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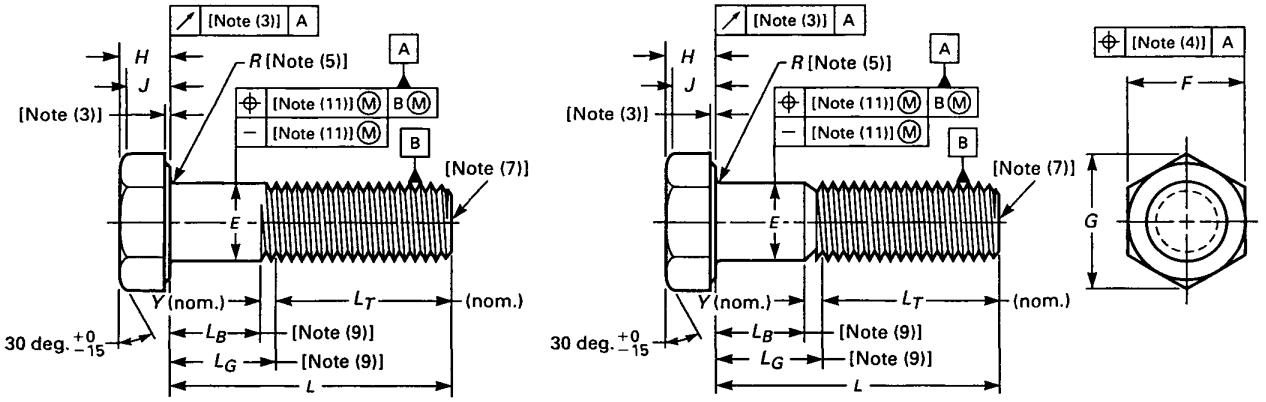
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Cut Thread Rolled Thread

TABLE 4 DIMENSIONS OF HEX CAP SCREWS

Nominal Size or Basic Product Diameter [Note (15)]		E		F			G		H			J	L_T		Y	Circular Runout of Bearing Surface FIM [Note (3)]
		Body Diameter [Note (6)]		Width Across Flats			Width Across Corners [Note (2)]		Head Height			Wrenching Height [Note (2)]	Thread Length for Screw Lengths [Note (9)]		Transition Thread Length [Notes (9), (10)]	
		Max.	Min.	Basic	Max.	Min.	Max.	Min.	Basic	Max.	Min.	Min.	6 in. and Shorter Nom.	Over 6 in. Nom.	Max.	Max.
1/4	0.2500	0.2500	0.2450	7/16	0.438	0.428	0.505	0.488	5/32	0.163	0.150	0.106	0.750	1.000	0.250	0.010
5/16	0.3125	0.3125	0.3065	1/2	0.500	0.489	0.577	0.557	13/64	0.211	0.195	0.140	0.875	1.125	0.278	0.011
3/8	0.3750	0.3750	0.3690	9/16	0.562	0.551	0.650	0.628	15/64	0.243	0.226	0.160	1.000	1.250	0.312	0.012
7/16	0.4375	0.4375	0.4305	5/8	0.625	0.612	0.722	0.698	9/32	0.291	0.272	0.195	1.125	1.375	0.357	0.013
1/2	0.5000	0.5000	0.4930	3/4	0.750	0.736	0.866	0.840	5/16	0.323	0.302	0.215	1.250	1.500	0.385	0.014
9/16	0.5625	0.5625	0.5545	13/16	0.812	0.798	0.938	0.910	23/64	0.371	0.348	0.250	1.375	1.625	0.417	0.015
5/8	0.6250	0.6250	0.6170	15/16	0.938	0.922	1.083	1.051	25/64	0.403	0.378	0.269	1.500	1.750	0.455	0.017
3/4	0.7500	0.7500	0.7410	1 1/8	1.125	1.100	1.299	1.254	15/32	0.483	0.455	0.324	1.750	2.000	0.500	0.020
7/8	0.8750	0.8750	0.8660	1 5/16	1.312	1.285	1.516	1.465	35/64	0.563	0.531	0.378	2.000	2.250	0.556	0.023
1	1.0000	1.0000	0.9900	1 1/2	1.500	1.469	1.732	1.675	39/64	0.627	0.591	0.416	2.250	2.500	0.625	0.026
1 1/8	1.1250	1.1250	1.1140	1 11/16	1.688	1.631	1.949	1.859	11/16	0.718	0.658	0.461	2.500	2.750	0.714	0.029
1 1/4	1.2500	1.2500	1.2390	1 7/8	1.875	1.812	2.165	2.066	25/32	0.813	0.749	0.530	2.750	3.000	0.714	0.033
1 3/8	1.3750	1.3750	1.3630	2 1/16	2.062	1.994	2.382	2.273	27/32	0.878	0.810	0.569	3.000	3.250	0.833	0.036
1 1/2	1.5000	1.5000	1.4880	2 1/4	2.250	2.175	2.598	2.480	15/16	0.974	0.902	0.640	3.250	3.500	0.833	0.039
1 3/4	1.7500	1.7500	1.7380	2 5/8	2.625	2.538	3.031	2.893	1 3/32	1.134	1.054	0.748	3.750	4.000	1.000	0.046
2	2.0000	2.0000	1.9880	3	3.000	2.900	3.464	3.306	1 7/32	1.263	1.175	0.825	4.250	4.500	1.111	0.052
2 1/4	2.2500	2.2500	2.2380	3 3/8	3.375	3.262	3.897	3.719	1 3/8	1.423	1.327	0.933	...	5.000	1.111	0.059
2 1/2	2.5000	2.5000	2.4880	3 3/4	3.750	3.625	4.330	4.133	1 17/32	1.583	1.479	1.042	...	5.500	1.250	0.065
2 3/4	2.7500	2.7500	2.7380	4 1/8	4.125	3.988	4.763	4.546	1 11/16	1.744	1.632	1.151	...	6.000	1.250	0.072
3	3.0000	3.0000	2.9880	4 1/2	4.500	4.350	5.196	4.959	1 7/8	1.935	1.815	1.290	...	6.500	1.250	0.079

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ADDENDA

to

ASME B18.2.1-1996
SQUARE AND HEX BOLTS AND SCREWS (INCH SERIES)

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ASME B18.2.1a-1999

Following approval by the ASME B18 Committee and ASME, and after public review, ASME B18.2.1a-1999 was approved by the American National Standards Institute on April 9, 1999.

Addenda to the 1996 edition of ASME B18.2.1 are issued in the form of replacement pages. Revisions, additions, and deletions are incorporated directly into the affected pages. It is advisable, however, that this page, the Addenda title and copyright pages, and all replaced pages be retained for reference.

SUMMARY OF CHANGES

This is the first Addenda to be published to ASME B18.2.1-1996.

Replace or insert the pages listed. Changes given below are identified on the pages by a margin note, **(a)**, placed next to the affected area. The pages not listed are the reverse sides of the listed pages and contain no changes.

Page	*Location*	*Change*
vi.1	Correspondence With B18 Committee	Added
ix	Contents	Updated to reflect Addenda
10	Table 3	In fifth column, second entry corrected by errata to read $1\frac{1}{16}$
16–18	Table 4, Note (5)	Four equations deleted by errata
	Fig. 2	Four equations added by errata
	Table 4, Note (11)	Revised
23, 24	Fig. 5	Four equations added by errata
	Table 6, Note (7)	Four equations deleted by errata
	Table 6, Note (11)	Revised
33	Appendix I	Deleted
35	Appendix II	Revised in its entirety

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Subject:	Cite the applicable paragraph number(s) and the topic of the inquiry.
Edition:	Cite the applicable edition of the Standard for which the interpretation is being requested.
Question:	Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. The inquirer may also include any plans or drawings which are necessary to explain the question; however, they should not contain proprietary names or information.

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manufacturer's option unless otherwise specified. The marking shall be in accordance with the requirements of para. 2.8. Markings shall be legible to the unaided eye with the exception of corrective lenses. When raised, the height of the marking may not exceed 0.015 in. over the specified maximum head height for bolts 5/8 in. and smaller. For bolts larger than 5/8 in., the marking may not project more than 0.030 in. over the specified maximum head height. When indented, the depth of the marking shall not reduce the load-carrying capability of the fastener.

(15) **Material.** Unless otherwise specified, chemical and mechanical properties of steel bolts shall conform to ASTM A 307, Grade A. Other materials and grades shall be as agreed upon by manufacturer and purchaser.

(16) **Nominal Size.** Where specifying nominal size in decimals, zeros preceding the decimal and in the fourth decimal place shall be omitted.

(17) **Dimensional Conformance.** Unless otherwise specified, hex bolts shall have the following characteristics inspected to ASME B18.18.2M to the inspection levels shown:

Characteristic	Inspection Level
Threads	C
Width across corners	C
Head height	C
Grip length	C
Visual	C

If verifiable in-process inspection is used, see para. 2.10.

(18) **Additional Requirements.** For additional requirements, see Section 1, Introductory Notes, and Section 2, General Data.

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TABLE 3 DIMENSIONS OF HEAVY HEX BOLTS

Nominal Size or Basic Product Diameter [Note (16)]		E		F		G		H			R		L_T	
		Full Size Body Diameter [Notes (6), (7)]		Width Across Flats [Note (3)]		Width Across Corners [Note (3)]		Head Height			Radius of Fillet		Thread Length for Bolt Lengths [Note (11)]	
		Max.	Min.	Basic	Max.	Min.	Max.	Min.	Basic	Max.	Min.	Max.	Min.	6 in. and Shorter	Over 6 in.
														Nom.	Nom.
½	0.5000	0.515	0.482	⅞	0.875	0.850	1.010	0.969	11/32	0.364	0.302	0.03	0.01	1.250	1.500
⅝	0.6250	0.642	0.605	1 1/16	1.062	1.031	1.227	1.175	27/64	0.444	0.378	0.06	0.02	1.500	1.750
¾	0.7500	0.768	0.729	1 ¼	1.250	1.212	1.443	1.383	½	0.524	0.455	0.06	0.02	1.750	2.000
⅞	0.8750	0.895	0.852	1 7/16	1.438	1.394	1.660	1.589	37/64	0.604	0.531	0.06	0.02	2.000	2.250
1	1.0000	1.022	0.976	1⅝	1.625	1.575	1.876	1.796	43/64	0.700	0.591	0.09	0.03	2.250	2.500
1 ⅛	1.1250	1.149	1.098	1 13/16	1.812	1.756	2.093	2.002	¾	0.780	0.658	0.09	0.03	2.500	2.750
1 ¼	1.2500	1.277	1.223	2	2.000	1.938	2.309	2.209	27/32	0.876	0.749	0.09	0.03	2.750	3.000
1⅜	1.3750	1.404	1.345	2 3/16	2.188	2.119	2.526	2.416	29/32	0.940	0.810	0.09	0.03	3.000	3.250
1½	1.5000	1.531	1.470	2⅜	2.375	2.300	2.742	2.622	1	1.036	0.902	0.09	0.03	3.250	3.500
1¾	1.7500	1.785	1.716	2¾	2.750	2.662	3.175	3.035	1 5/32	1.196	1.054	0.12	0.04	3.750	4.000
2	2.0000	2.039	1.964	3⅛	3.125	3.025	3.608	3.449	1 1/32	1.388	1.175	0.12	0.04	4.250	4.500
2¼	2.2500	2.305	2.214	3½	3.500	3.388	4.041	3.862	1½	1.548	1.327	0.19	0.06	4.750	5.000
2½	2.5000	2.559	2.461	3⅞	3.875	3.750	4.474	4.275	1 21/32	1.708	1.479	0.19	0.06	5.250	5.500
2¾	2.7500	2.827	2.711	4¼	4.250	4.112	4.907	4.688	1 13/16	1.869	1.632	0.19	0.06	5.750	6.000
3	3.0000	3.081	2.961	4⅝	4.625	4.475	5.340	5.102	2	2.060	1.815	0.19	0.06	6.250	6.500

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TABLE 4B L_G, MAXIMUM AND L_B, MINIMUM LIMITATIONS FOR SHORT SCREWS THREADED FULL LENGTH

Nominal Size of Basic Product Diameter	For Nominal Product Lengths [Note (1)]	L_G, Max. [Note (2)]	For Nominal Product Lengths		L_G, Max. [Note (3)]			L_B, Min. [Note (4)]
	Less Than or Equal to	All Thread Series	Greater Than	Less Than or Equal to [Note (5)]	Coarse (UNC) Thread	Fine (UNF) Thread	8 (UN) Thread	All Thread Series
1/4	0.500	0.075	0.500	1.125	0.125	0.089	...	0.043
5/16	0.625	0.083	0.625	1.250	0.139	0.104	...	0.045
3/8	0.750	0.094	0.750	1.375	0.156	0.104	...	0.048
7/16	0.875	0.107	0.875	1.625	0.179	0.125	...	0.052
1/2	1.000	0.115	1.000	1.750	0.192	0.125	...	0.053
9/16	1.125	0.125	1.125	2.000	0.208	0.139	...	0.075
5/8	1.250	0.136	1.250	2.125	0.227	0.139	...	0.078
3/4	1.500	0.150	1.500	2.500	0.250	0.156	...	0.081
7/8	...	...	...	2.750	0.278	0.179	...	0.105
1	...	...	...	3.000	0.312	0.208	...	0.140
1 1/8	...	...	...	3.500	0.357	0.208	0.312	0.146
1 1/4	...	...	...	3.750	0.357	0.208	0.312	0.146
1 3/8	...	...	...	4.250	0.417	0.208	0.312	0.154
1 1/2	...	...	...	4.500	0.417	0.208	0.312	0.154
1 3/4	...	...	...	5.125	0.500	...	0.312	0.166
2	...	...	...	5.750	0.556	...	0.312	0.173
2 1/4	...	...	...	6.500	0.556	...	0.312	0.173
2 1/2	...	...	...	7.125	0.625	...	0.312	0.183
2 3/4	...	...	...	7.625	0.625	...	0.312	0.183
3	...	...	...	8.125	0.625	...	0.312	0.183

NOTES:
(1) Tabulated values are equal to 2 times the basic product diameter.
(2) Tabulated values are equal to 1.5 times the coarse thread (UNC) pitch.
(3) Tabulated values are equal to 2.5 times the thread pitch.
(4) L_B, min. equals fillet length, L_f, max., as given in Table 4A.
(5) Longest screw threaded full length.

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Notes to Table 4:

(1) **Top of Head.** Top of head shall be full form and chamfered, with the diameter of chamfer circle being equal to the maximum width across flats within a tolerance of minus 15%.

(2) **Wrenching Height, *J*.** Wrenching height is a distance measured from the bearing surface up the side of the head at the corners. The width across corners shall be within specified limits for the full wrenching height.

(3) **Bearing Surface.** Bearing surface shall be flat and washer faced. Diameter of washer face shall be equal to the maximum width across flats within a tolerance of minus 10%.

Thickness of the washer face shall be not less than 0.015 in. nor greater than 0.025 in. for screw sizes ¾ in. and smaller, and not less than 0.015 in. nor greater than 0.035 in. for sizes larger than ¾ in. Measurement of washer face diameter shall be taken at a height of 0.004 in. above the bearing surface.

Circular runout of the bearing surface, with respect to the axis of the body, shall be within the FIM limits specified. Measurement of FIM shall be made as close to the periphery of the bearing surface as possible while the screw is held in a collet or other gripping device at a distance of one screw diameter from the underside of the head.

(4) **True Position of Head.** The axis of the head shall be located at true position with respect to the axis of the body (determined over a distance under the head equal to one diameter) within a tolerance zone whose diameter is equivalent to 6% of the maximum width across flats, regardless of feature size.

(a) (5) **Fillet.** Two styles of head-to-shank fillets are provided for long screws in lengths longer than the maximum lengths specified in Table 4B. Style 1 will be supplied unless Style 2 is specified by the purchaser.

Style 1 is a continuous radius in accordance with the maximum–minimum limits for R shown in Table 4A.

Style 2 has an elliptical shape defined as a smooth, multiradius, concave curve tangent to the underhead bearing surface at a point no greater than one-half of E_a, max. or less than one-half of E_a, min. from the axis of the screw; and tangent to the shank at a distance from the underhead bearing surface within the limits specified for L_a. No radius in the fillet shall be less than R, min. (see Fig. 1 and Table 4A).

For short screws threaded full length (Table 4B), the fillet shall be a smooth, concave curve lying within the envelope established by either:

(*a*) a continuous radius tangent to the underhead bearing surface and min./max. shank diameter E_1, min. (min. pitch diameter) to E, max., whose value shall be no less than R, min. as specified in Table 4A; or

(*b*) a continuous or multiradius curve tangent to the underhead bearing surface at a point no greater than one-half E_a, max. from the axis of screw, and tangent to the maximum shank diameter, E, max., at a distance not exceeding L_f, max. from the bearing surface.

No radius in the multiradius curve shall be less than R, min. specified in Table 4A (see Fig. 2).

(6) **Body Diameter.** The diameter of body, except for a length equal to L_a, max. under the head, shall conform to the limits for E given in Table 4. The diameter of the unthreaded length on short screws which are threaded for full length shall not be less than the minimum pitch diameter of the thread nor greater than the maximum body diameter, E, max., specified in Table 4 (see Fig. 2).

(7) **Point.** Point shall be chamfered or rounded at manufacturer's option from approximately 0.016 in. below the minor diameter of the thread. The first full formed thread at major diameter is located at a distance no greater than 2 times the pitch measured from the end of the screw. This distance is to be determined by measuring how far the point enters into a cylindrical NOT GO major diameter ring gage (reference Gage 3.1, ASME B1.2).

(8) **Length Tolerances.** Screw length tolerances are given in Table 10. Tolerances for pointed products shall apply.

(9) **Thread Length.** The length of thread on screws shall be controlled by the grip gaging length, L_G, max., and body length, L_B, min.

Long screws not threaded full length of diameters through 1¼ in. and lengths through 10 in. are specified in Table 5. For short screws threaded full length, L_G, max. and L_B, min. are given in Table 4B (see Fig. 3).

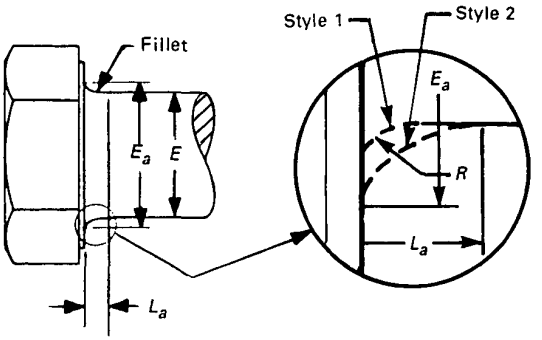
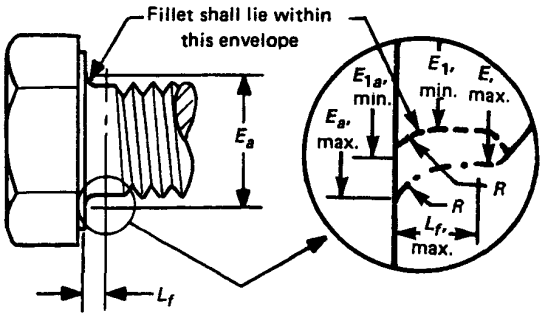


FIG. 1 UNDERHEAD FILLET FOR LONG SCREWS

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$$L_f, \text{ max.} = \frac{E_a, \text{ max.} - E_1, \text{ min.}}{2}$$

E_1, min. = minimum specified pitch diameter of coarse thread (UNC-2A)

E_a, max. = maximum fillet transition diameter (see Table 4A)

E_{1a}, min. = E_a, max. – 0.5 (E_a, max. – E_1, min.)

FIG. 2 UNDERHEAD FILLET FOR SHORT SCREWS THREADED FULL LENGTH

For diameter-length combinations not included in Table 4B or Table 5, the maximum grip gaging length, L_G, max., for long screws which are not threaded full length, as calculated and rounded to two decimal places, shall be equal to the nominal screw length minus the nominal thread length (L_G, max. = L, nom. − L_T). It shall be used as the criterion for inspection.

Nominal thread length, L_T, is a reference dimension intended for calculation purposes only, which represents the distance from the extreme end of the screw to the last complete (full form) thread. Nominal thread length equals twice the basic thread diameter plus 0.25 in. for nominal screw length up to and including 6 in., and twice the basic thread diameter plus 0.50 in. for nominal lengths over 6 in.

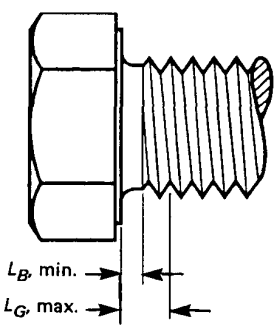


FIG. 3 L_G, MAXIMUM AND L_B, MINIMUM FOR SHORT SCREWS THREADED FULL LENGTH

Body length, L_B, min., is the distance measured parallel to the axis of screw from the underhead bearing surface to the last scratch of thread or to the top of the extrusion angle. For diameter length combinations not included in Table 4B or Table 5, the minimum body length, L_B, min., as calculated and rounded to two decimal places, shall be equal to the maximum grip gaging length minus the maximum transition thread length (L_B, min. = L_G, max. − Y, max.). It shall be a criterion for inspection.

Transition thread length, Y, max., is a reference dimension equal to five coarse (UNC) pitches and intended for calculation purposes only. It includes the length of incomplete threads, the extrusion angle on rolled threads, and tolerances on grip length.

(10) **Incomplete Thread Diameter.** The major diameter of incomplete thread shall not exceed the actual major diameter of the full form thread.

(11) **Straightness.** Shanks of screws shall be straight within the following limits at MMC. For screws with nominal lengths up to and including 12 in., the maximum camber shall be 0.006 in. per inch (0.006L) of screw length. For screws with nominal lengths over 12 in. up to and including 24 in., the maximum camber shall be 0.008 in. per inch (0.008L) of screw length. A typical gage and gaging procedure for checking screw straightness is given in Appendix II. (a)

(12) **Threads.** Threads, when rolled, shall be Unified Inch coarse, fine, or 8 thread series (UNRC, UNRF, or 8 UNR Series), Class 2A. Threads produced by other methods shall preferably be UNRC, UNRF, or 8 UNR, but at manufacturer's option, may be Unified Inch coarse, fine, or 8 thread series (UNC, UNF, or 8 UN Series), Class 2A. Acceptability of screw threads shall be determined based on System 21 ASME B1.3M, Screw Thread Gaging Systems for Dimensional Acceptability—Inch and Metric Screw Threads (UN, UNR, UNJ, M, and MJ).

(13) **Identification Symbols.** Identification marking symbols on screw heads shall be raised or indented at the manufacturer's option unless otherwise specified. The marking shall be in accordance with the requirements of para. 2.8. Markings shall be legible to the unaided eye with the exception of corrective lenses. When raised, the height of the marking may not exceed 0.015 in. over the specified maximum head height for screws 5/8 in. and smaller. For screws larger than 5/8 in., the marking may not project more than 0.030 in. over the specified maxi-

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mum head height. When indented, the depth of the marking shall not reduce the load carrying capability of the fastener.

(14) **Material.** Unless otherwise specified, chemical and mechanical properties of steel screws shall conform to ASTM A 307, ASTM A 449, ASTM A 354 Grade BD, or SAE J429. Other materials and grades shall be as agreed upon by manufacturer and purchaser.

(15) **Nominal Size.** Where specifying nominal size in decimals, zeros preceding the decimal and in the fourth decimal place shall be omitted.

(16) **Dimensional Conformance.** Unless otherwise specified, hex cap screws shall have the following characteristics inspected to ASME B18.18.2M to the inspection levels shown:

Characteristic	Inspection Level
Threads	C
Width across corners	C
Grip length	C
Screw length	C
Visual	C

If verifiable in-process inspection is used, see para. 2.10.

(17) **Additional Requirements.** For additional requirements, see Section 1, Introductory Notes, and Section 2, General Data.

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Notes to Table 6:

(1) **Top of Head.** Top of head shall be full form and chamfered with the diameter of chamfer circle being equal to the maximum width across flats, within a tolerance of minus 15%.

(2) **Wrenching Height, *J*.** Wrenching height is a distance measured from the bearing surface up the side of the head at the corners. The width across corners shall be within the specified limits for minimum wrenching height.

(3) **Bearing Surface.** Bearing surface shall be flat and washer faced. Diameter of washer face shall be equal to the maximum width across flats within a tolerance of minus 10%.

Thickness of the washer face shall be not less than 0.015 in. nor greater than 0.025 in. for screw sizes ¾ in. and smaller, and not less than 0.015 in. nor greater than 0.035 in. for sizes larger than ¾ in. Measurement of washer face diameter shall be taken at a height of 0.004 in. above the bearing surface.

Circular runout of the bearing surface with respect to the axis of the body shall be within the FIM limits specified. Measurement of FIM shall be made as close to the periphery of the bearing surface as possible while the screw is being held in a collet or other gripping device at a distance of one screw diameter from the underside of the head.

(4) **True Position of Head.** The axis of the head shall be located at true position with respect to the axis of the body (determined over a distance under the head equal to one diameter) within a tolerance zone having a diameter equivalent to 6% of the maximum width across flats, regardless of feature size.

(5) **Fillet.** Two styles of head-to-shank fillets are provided for long screws in lengths longer than the maximum length specified in Table 6B. Style 1 will be supplied unless Style 2 is specified by the purchaser.

Style 1 is a continuous radius in accordance with the maximum-minimum limits for R shown in Table 6A.

Style 2 has an elliptical shape defined as a smooth, multiradius, concave curve tangent to the underhead bearing surface at a point no greater than one-half of E_a, max. nor less than one-half of E_a, min. from the axis of the screw and tangent to the shank at a distance from the underhead bearing surface within the limits specified for L_a. No radius in the fillet shall be less than R, min. (see Fig. 4 and Table 6A).

For short screws threaded full length (Table 6B), the fillet shall be a smooth, concave curve lying within the envelope established by either:

(*a*) a continuous radius tangent to the underhead bearing surface and min./max. shank diameter, E_1 (min. pitch diameter) to E, max., whose value shall be no less than R, min. as specified in Table 6A; or

(*b*) a continuous or multiradius curve tangent to the underhead bearing surface at a point no greater than one half E_a, max. from the axis of screw and tangent to the maximum shank diameter, E, max., at a distance not exceeding L_f, min. from the bearing surface. No radius in the curve shall be less than R, min., as specified in Table 6A (see Fig. 5).

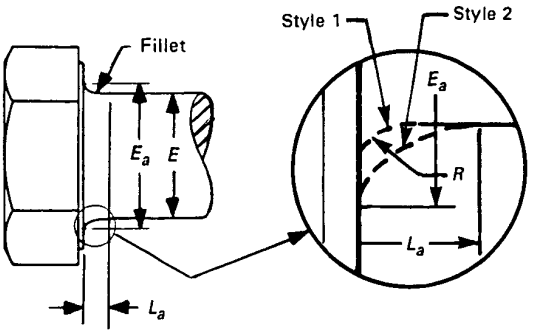
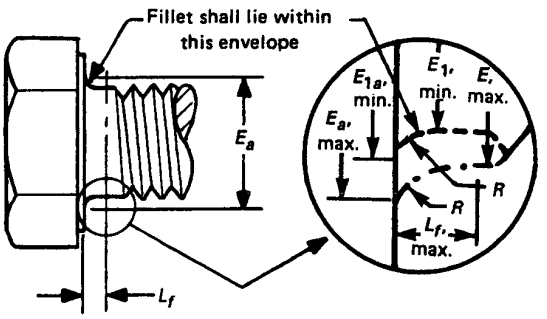


FIG. 4 UNDERHEAD FILLET FOR LONG SCREWS



$$L_f, \text{ max.} = \frac{E_a, \text{ max.} - E_1, \text{ min.}}{2}$$

E_1, min. = minimum specified pitch diameter of coarse thread (UNC)

E_a, max. = maximum fillet transition diameter (see Table 6A)

E_{1a}, min. = E_a, max. – 0.5 (E_a, max. – E_1, min.)

FIG. 5 UNDERHEAD FILLET FOR SHORT SCREWS THREADED FULL LENGTH (a)

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(6) **Body Diameter.** The diameter of body, except for a length equal to L_a, max. under the head, shall conform to the limits for E given in Table 6. The diameter of the unthreaded length on short screws which are threaded for full length shall not be less than the minimum pitch diameter of the thread nor greater than the maximum body diameter, E, max., specified in Table 6. Hot forged screws may have a reasonable swell under the head provided the straightness requirement, Note (11), is met.

(a) (7) **Point.** Point shall be chamfered or rounded at manufacturer's option from approximately 0.016 in. below the minor diameter of the thread. The first full formed thread at major diameter is located at a distance no greater than 2 times the pitch measured from the end of the screw. This distance is determined by measuring how far the point enters into a cylindrical NOT GO major diameter ring gage (ref. Gage 3.1 ASME B1.2).

(8) **Length Tolerances.** Screw length tolerances are given in Table 10. Tolerances for pointed products shall apply.

(9) **Thread Length.** The length of thread on screws shall be controlled by the grip gaging length, L_G, max., and body length, L_B, min. For long screws threaded full length of diameters through 1¼ in. and lengths through 10 in., the values for L_G, max. and L_B, min. are specified in Table 5. For short screws threaded full length, L_G, max. and L_B, min. are given in Table 6B (see Fig. 3).

For diameter-length combinations not included in Table 6B or Table 5, the maximum grip gaging length, L_G, max., for long screws which are not threaded full length, as calculated and rounded to two decimal places, shall be equal to the nominal screw length minus the nominal thread length (L_G, max. = L, nom. − L_T). It shall be used as the criterion for inspection.

Nominal thread length, L_T, is a reference dimension intended for calculation purposes only. It represents the distance from the extreme end of the screw to the last complete (full form) thread. Nominal thread length equals twice the basic thread diameter plus 0.25 in. for nominal bolt lengths up to and including 6 in., and twice the basic thread diameter plus 0.50 in. for nominal lengths over 6 in.

Transition thread length, Y, max., is a reference dimension equal to five coarse (UNC) pitches and is intended for calculation purposes only. It includes the length of incomplete threads, the extrusion angle on rolled threads, and the tolerances on grip length.

For diameter-length combinations not included in Table 5 or Table 6B, the minimum body length, as calculated and rounded to two decimal places, shall be equal to the maximum grip gaging length minus the maximum transition thread length (L_B, min. = L_G, max. − Y, max.). It shall be used as the criterion for inspection.

(10) **Incomplete Thread Diameter.** The major diameter of incomplete thread shall not exceed the actual major diameter of the full form thread.

(11) **Straightness.** Shanks of screws shall be straight within the following limits at MMC. For screws with nominal lengths up to and including 12 in., the maximum camber shall be 0.006 in. per inch (0.006L) of screw length. For screws with nominal lengths over 12 in. up to and including 24 in., the maximum camber shall be 0.008 in. per inch (0.008L) of screw length. A typical gage and gaging procedure for checking screw straightness is given in Appendix II. (a)

(12) **Threads.** Threads, when rolled, shall be Unified Inch coarse, fine, or 8 thread series (UNRC, UNRF, or 8 UNR Series), Class 2A in accordance with ASME B1.1. Threads produced by other methods shall preferably be UNRC, UNRF, or 8 UNR, but at manufacturer's option, may be Unified Inch coarse, fine, or 8 thread series (UNC, UNF, or UN Series), Class 2A. Acceptability of screw threads shall be determined based on System 21 of ASME B1.3M, Screw Thread Gaging Systems for Dimensional Acceptability.

(13) **Identification Symbols.** Identification marking symbols on screw heads shall be raised or indented at the manufacturer's option unless otherwise specified. The marking shall be in accordance with the requirements of para. 2.8. Markings shall be legible to the unaided eye with the exception of corrective lenses. When raised, the height of the marking may not exceed 0.015 in. over the specified maximum head height for screws ⅝ in. and smaller. For screws larger than ⅝ in., the marking may not project more than 0.030 in. over the specified maximum head height. When indented, the depth of the marking shall not reduce the load carrying capability of the fastener.

(14) **Material.** Unless otherwise specified, chemical and mechanical properties of steel screws shall conform to ASTM A 307, ASTM A 449, ASTM A 354 Grade BD, or SAE J429. Other materials and grades shall be as agreed upon by manufacturer and purchaser.

(15) **Nominal Size.** Where specifying nominal size in decimals, zeros preceding the decimal and in the fourth decimal place shall be omitted.

(16) **Dimensional Conformance.** Unless otherwise specified, heavy hex screws shall have the following characteristics inspected to ASME B18.18.2M to the inspection levels shown:

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APPENDIX I (a)

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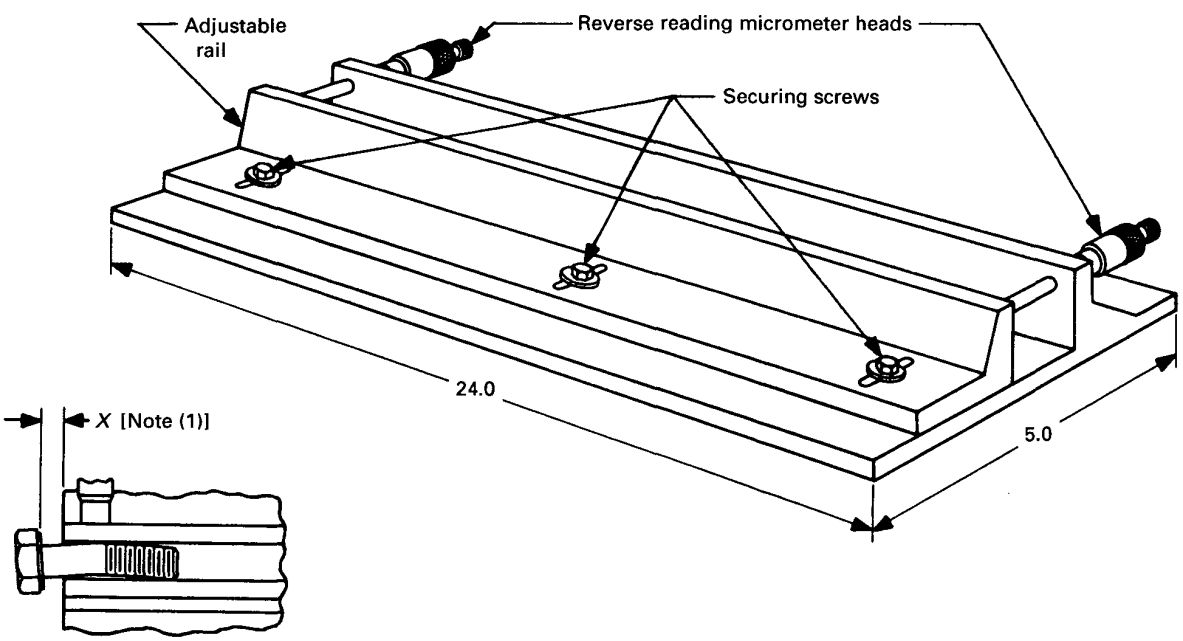
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APPENDIX II (a)
STRAIGHTNESS GAGE AND GAGING

(This Appendix is an integral part of ASME B18.2.1-1996 and is placed after the main text for convenience.)

Allowable total camber on the product to be inspected shall be calculated by multiplying the specified permissible camber per inch or per millimeter of length by the product length expressed as a two-place decimal in inches or a one-place decimal in millimeters. The total camber thus derived shall be added to the specified maximum body diameter exclusive of allowance for swell or fin under head, and the adjustable rail of gage shall be adjusted to provide a parallel space between the rails equal to this distance by obtaining common readings on both micrometer heads. The adjustable rail shall then be locked in place by tightening securing screws.

The product shall then be inserted between rails, excluding from the gage any permissible length of swell or fillet under the head. The product shall be rotated by hand through full 360 deg. Any interference occurring between the product and the gage which is sufficient to prevent rotation indicates excessive camber.



NOTE:
(1) Excluded length X equals 2 times basic bolt diameter.

TYPICAL STRAIGHTNESS GAGE

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Date of Issuance: July 29, 1997

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FOREWORD

(This Foreword is not part of ASME B18.2.1-1996.)

American National Standards Committee B18 for the standardization of bolts, screws, nuts, rivets, and similar fasteners was organized in March 1922, as Sectional Committee B18, under the aegis of the American Engineering Standards Committee (later the American Standards Association, then the United States of America Standards Institute and, as of October 6, 1969, the American National Standards Institute, Inc.), with the Society of Automotive Engineers and the American Society of Mechanical Engineers as joint sponsors. Subcommittee 2 was subsequently established and charged with the responsibility for technical content of standards covering wrench head bolts and nuts.

Subcommittee 2, after appraisal of the requirements of industry, developed a proposed standard series of bolt head and nut dimensions. This proposal was finally approved and designated a Tentative American Standard in February 1927.

A first revision of the document was designated as an American Standard in March 1933, and was followed by a second revision which was granted approval as an American Standard in January 1941.

Following reorganization of the B18 Committee in 1947, Subcommittee 2 was asked to expand the standard on head proportions into a complete product standard. A proposal covering square and hexagon head bolts, and nuts, hexagon head cap screws, and automotive hexagon head bolts was prepared and submitted to the B18 Committee in April 1950. While this draft was under consideration, the B18 Committee received a proposal from the British Standards Institution for unification of dimensions on products incorporating Unified screw threads. The Committee welcomed the opportunity of discussing the proposals and an American-British-Canadian Conference was held in New York, June 1–2, 1950.

It was agreed in the Conference that the essentials of unification could be accomplished by selection of mutually satisfactory across-the-flats dimensions, since this would permit the use of the same wrenches and because other features would rarely affect interchangeability. After due consideration, suitable existing across-the-flats dimensions were selected for the hexagon products affected.

In its meeting of October 13, 1950, Subcommittee 2 agreed to incorporate in the proposed standard the conference recommendations on 1/4 in. hexagon head bolts, 5/8 in. hexagon head cap screws and automotive hexagon head bolts, 5/16 and 3/8 in. regular hexagon and square nuts, and 7/16 in. light and regular hexagon and square nuts. At a subsequent meeting of Subcommittee 2, further changes were adopted in order to combine the light and regular series of nuts and to combine the automotive hexagon head bolt, hexagon head cap screw, and regular hexagon head close tolerance bolt.

In view of the progress made in the United States and the urgency of standardization for mutual defense, the British Standards Institution sponsored a second Conference in London in April 1951, to complete the unification of certain hexagon bolts and nuts.

At a meeting on June 8, 1951, Subcommittee 2 reaffirmed its acceptance of the unified dimensions, which corresponded with those in the March 1951 draft, but attempted to select bet-

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ter nomenclature for the unified products. A final draft incorporating the nomenclature *Finished Hexagon Bolts and Nuts* and containing numerous editorial changes was submitted for letter ballot in September 1951. Following approval by the B18 Committee and the sponsors, the proposal was presented to the American Standards Association for approval and designation as an American Standard. This was granted on March 24, 1952.

Recognizing the standard was in need of additional refinements, Subcommittee 2 began immediately to revise it, removing inconsistencies with respect to fillets, improving the length tolerances on heavy hexagon bolts, and incorporating numerous other corrections and clarifications. The most noteworthy editorial change was a decision to combine the coverage for hexagon cap screws and square head set screws from the B18.2 standard with the coverage for slotted head cap screws and slotted headless set screws from the B18.6 standard and publish them in a separate document. The requirements for the unified hexagon cap screws and finished hexagon bolts being identical in the overlapping sizes, this data would now be available in two publications. Following approvals by the B18 Committee and sponsor organizations, the proposal was submitted to the American Standards Association and declared an American Standard on February 2, 1955.

A revision of this document comprised of numerous editorial corrections and inclusion of an appendix for grade markings was duly approved and designated an American Standard on April 18, 1960.

At a meeting in February 1960, Subcommittee 2 approved a recommendation to reduce the head heights for heavy, heavy semi-finished, and heavy finished hexagon bolts which was subsequently approved by letter ballot of the B18 Committee on August 16, 1960. A proposed standard for heavy hexagon structural bolts submitted and accepted by Subcommittee 2 at its October 17, 1960 meeting was approved by letter ballot of the B18 Committee on May 9, 1961. To meet the urgent needs of the steel construction industry, it was considered necessary to publish the standard for the structural bolts immediately. Consequently, Appendix IV to ASA B18.2-1960 containing coverage for the revised heavy hexagon bolts and the new heavy hexagon structural bolts was released in 1962.

In October of 1961, Subcommittee 2 appointed a subgroup to review all product standards for square and hexagon bolts, screws, and nuts, and to recommend simplifications which would be compatible with technical, production, and distribution advances that had occurred over the prior several years. The subgroup presented its recommendations at a meeting of Subcommittee 2 in October of 1962. It was agreed that the internally and externally threaded products should be published in separate documents as suggested, and draft proposals for each were completed.

The proposed revision for square and hex bolts and screws incorporated the following subgroup recommendations: consolidation of hexagon head cap screws and finished hexagon bolts into a single product; consolidation of heavy semifinished hexagon bolts and heavy finished hexagon bolts into a single product; elimination of regular semifinished hexagon bolts; a new length tolerancing pattern for all bolts and screws; documentation of a positive identification procedure for determining whether an externally threaded product should properly be designated a bolt or a screw; and an abbreviated and purified set of product nomenclature reflecting application of the identification procedure. Letter ballot of this proposal to the B18 Committee in March, 1964 resulted in several comments which were resolved to the satisfaction of the Committee in June of 1964. Following acceptance by the sponsor organizations, the revision was submitted to the American Standards Association and was designated American Standard ASA B18.2.1 on September 8, 1965.

Subcommittee 2 continued to further develop refinements initiated by the simplification subgroup and revisions reflecting changes in manufacturing practices and consumer requirements. This work culminated in Subcommittee acceptance of a 1970 proposal incorporating, in addition to numerous editorial changes, revisions in the following significant areas: addition of coverage for askew head bolts and hex head lag screws; addition of straightness requirements to applicable products; addition of minimum fillet to square and hex bolts and lag screws; appli-

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