METRIC HEX FLANGE SCREWS

IFI 536 1982

IFI Note:

IFI-536 is an interim standard which will be withdrawn when a planned revision of ANSI B18.2.3.4 is published.

The first edition of B18.2.3.4 was released in 1979. Shortly before its publication it was submitted to ISO Technical Committee 2 for its consideration as the basis of an ISO standard. Several countries tested screws manufactured to its requirements and while experience was generally satisfactory some evidence was returned suggesting that wrenchability could be improved through modest changes in some of the head dimensions. At an ISO/TC2 meeting in early 1980 the design of hex flange screw heads was discussed and the Canadian delegation offered to accept responsibility for an analytical research study to search out the optimum relationship of wrenchability to material usage to manufacturing convenience. This offer was accepted and subsequently performed by Stelco, Inc.

Based on the findings of the Stelco research proposals were drafted and returned to AN Standards Committee B18. The two principal recommendations were that B18.2.3.4 be revised and that a new ANSI standard for a heavy hex flange screw be developed for use in heavy vehicle, machinery and equipment construction. Committee B18 endorsed these recommendations and authorized their submittal to ISO/TC2. At a TC2 task group meeting in May 1982 the USA/Canadian recommendations were accepted and proposed ISO standards for metric hex flange screws and metric heavy hex flange screws are now being drafted.

IFI-536 and IFI-538, page C—57, are in exact accord with the ISO decisions and with the expected revision of ANSI B18.2.3.4 and the new ANSI standard for heavy hex flange screws both of which are now under development. When the ANSI standards are published IFI will withdraw IFI-536 and IFI-538 and support the ANSI documents.

Copies of the ANSI standards, when published, may be obtained from the American Society of Mechanical Engineers, United Engineering Center, 345 E. 47th St., New York, NY 10017.

GENERAL DATA

1. Scope.

1.1 This standard covers the complete general and dimensional data for metric hex flange screws.

1.2 The inclusion of dimensional data in this standard is not intended to imply that all of the sizes in conjunction with the various options described herein are stock items. Consumers are requested to consult with manufacturers concerning lists of stock production hex flange screws.

2. Comparison With ISO Standards.

2.1 Hex flange screws as presented in this standard have been coordinated with a draft ISO proposed standard. The dimensional differences between this standard and the ISO proposal are few, relatively minor, and none will affect the functional interchangeability of screws manufactured to the requirements of either.

The following functional characteristics of screws are in agreement between this standard and the ISO proposal:

Diameters and thread pitches (see 29)
Body diameters
Widths across flats

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Bearing surface diameters
Flange diameters
Head heights
Thread lengths
Thread Dimensions
Nominal lengths

2.2 Letter symbols designating dimensional characteristics are in accord with those used in ISO standards, except capitals have been used for data processing convenience instead of lower case letters used in ISO standards.

3. **Dimensions.**

3.1 All dimensions in this standard are in millimeters, unless stated otherwise.

3.2 Symbols specifying geometric characteristics are in accord with American National Standard, Dimensioning and Tolerancing, ANSI Y14.5-1973.

4. **Top of Head.** The top of head shall be either full form or indented, at manufacturer's option. The top of head shall be chamfered or rounded. The diameter of the chamfer circle or the start of rounding shall be equal to the maximum width across flats within a tolerance of minus 15 percent.

5. **Head Height.** The head height is the distance, as measured parallel to the axis of the screw, from the top of the head to the plane of the bearing circle diameter.

6. **Hex Height.** The hex height is the distance, measured at a corner of the hex, from the junction of hex head with the flange to the top of the head.

7. **Wrenching Height.** The wrenching height is the distance at a corner of the hex, from the junction of hex head with the flange to the last plane of full formed hex, i.e., the plane closest to the top of head at which the width across corners of the hex is within its specified limits.

8. **Corner Fill.** The rounding due to lack of fill at the six corners of the head shall be reasonably uniform.

9. **Gaging of Hex Head.** The head shall be gaged using two plain ring gages, A and B, to demonstrate the coincidental acceptability of hex height, wrenching height, corner fill and width across corners. Gage A shall be placed over the head and shall seat on the flange. Gage B shall be placed on the top of head normal to the screw axis. The two gages shall not be in contact.

Note: The minimum inside diameter of Gage A equals the maximum width across corners of the hex head; the maximum inside diameter of Gage B equals the minimum width across corners of the hex head minus 0.01 mm. The maximum thickness of the Ta portion of Gage A equals the wrenching height, K_1. Gage dimensions are given in Table 1.

10. **True Position of Head.** The axis of the hex head shall be located at true position with respect to the axis of the screw (determined over a distance under the head equal to one screw diameter) within a tolerance zone of diameter specified in Table 4.

11. **Flange.** The top surface of the flange shall be conical or slightly rounded (convex) and the periphery shall be round within the specified maximum flange diameter and a tolerance of minus 5 percent. The contour of edge at flange periphery shall be optional provided the minimum flange thickness is maintained at the minimum bearing circle diameter.

12. **Gaging of Flange.** The flange shall be gaged using a stepped Gage A. The screw shall be seated on a flat surface and Gage A placed over the hex portion and seated on the flange (see Para. 9). Gage A shall not contact the flat surface.

13. **Bearing Surface.** The bearing surface shall be flat to concave to a maximum of 1.5

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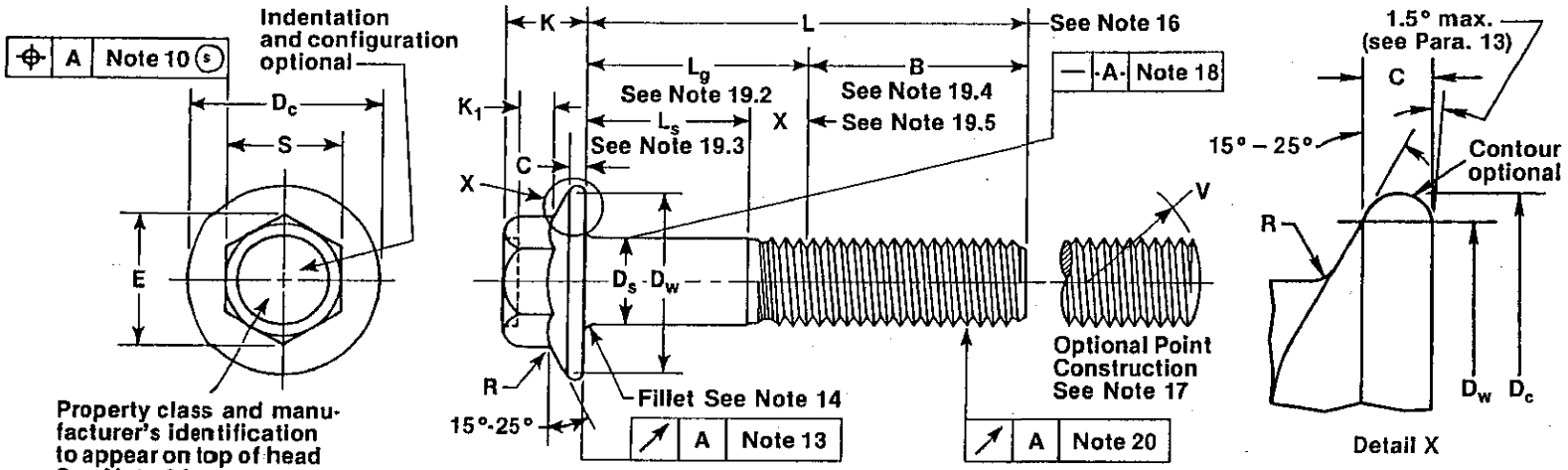
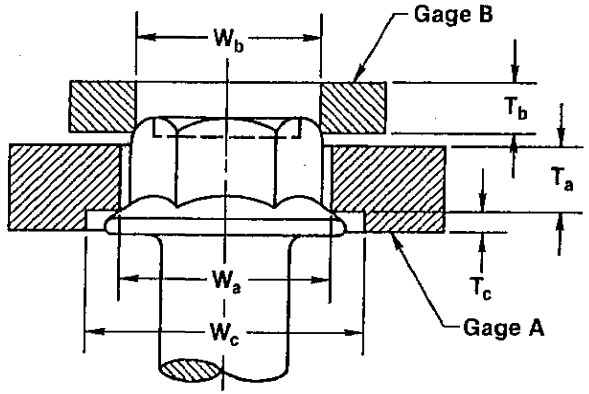


Table 1 Dimensions of Hex Flange Screws

Nom Screw Dia and Thread Pitch	D_s Body Diameter		S Width Across Flats		E Width Across Corners		D_c Flange Dia	D_w Bearing Circle Dia	Circular Runout of Bearing Circle FIM	C Flange Edge Thickness	K Head Height	K_1 Wrenching Height	R Flange Top Fillet Radius
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
M5 × 0.8	5.00	4.82	7.00	6.64	8.08	7.44	11.4	9.4	0.30	1.0	5.6	2.30	0.3
M6 × 1	6.00	5.82	8.00	7.64	9.24	8.56	13.6	11.6	0.33	1.1	6.8	2.90	0.4
M8 × 1.25	8.00	7.78	10.00	9.64	11.55	10.80	17.0	14.9	0.38	1.2	8.5	3.80	0.5
M10 × 1.5	10.00	9.78	13.00	12.57	15.01	14.08	20.8	18.7	0.43	1.5	9.7	4.30	0.6
M12 × 1.75	12.00	11.73	15.00	14.57	17.32	16.32	24.7	22.5	0.48	1.8	11.9	5.40	0.7
M14 × 2	14.00	13.73	18.00	17.57	20.78	19.68	28.6	26.4	0.54	2.1	12.9	5.60	0.8
M16 × 2	16.00	15.73	21.00	20.48	24.25	22.94	32.8	30.6	0.59	2.4	15.1	6.70	1.0
Refer to Para.	15				7, 8, 9		11	13	13	11	5	7, 9	

W_a		T_a		W_c		T_c		W_b		T_b
Gage A								Gage B		
Inside Dia		Thickness		Inside Dia		Thickness		Inside Dia		Thickness
Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Min
8.09	8.08	2.30	2.29	15.0	14.0	1.18	1.17	7.43	7.42	3.0
9.25	9.24	2.90	2.89	17.0	16.0	1.42	1.41	8.55	8.54	3.0
11.56	11.55	3.80	3.79	20.0	19.0	1.65	1.64	10.79	10.78	4.0
15.02	15.01	4.30	4.29	24.0	23.0	1.99	1.98	14.07	14.06	4.0
17.33	17.32	5.40	5.39	28.0	27.0	2.49	2.48	16.31	16.30	5.0
20.79	20.78	5.60	5.59	32.0	31.0	2.85	2.84	19.67	19.66	5.0
24.26	24.25	6.70	6.69	36.0	35.0	3.25	3.24	22.93	22.92	6.0
9, 12								9		



Gaging of Hex Flange Screws (See Paras. 9 and 12)

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Table 2 Maximum Grip Gaging Lengths And Minimum Body Lengths

Nom Dia and Thd Pitch	M5 x 0.8		M6 x 1		M8 x 1.25		M10 x 1.5		M12 x 1.75		M14 x 2		M16 x 2	
L Nominal Length	Lg Max	Ls Min	Lg Max	Ls Min	Lg Max	Ls Min	Lg Max	Ls Min	Lg Max	Ls Min	Lg Max	Ls Min	Lg Max	Ls Min
8														
10														
12														
14														
16														
20														
25	9.0	5.0												
30	14.0	10.0	12.0	7.0										
35	19.0	15.0	17.0	12.0	13.0	6.8								
40	24.0	20.0	22.0	17.0	18.0	11.8	14.0	6.5						
45	29.0	25.0	27.0	22.0	23.0	16.8	19.0	11.5	15.0	6.2				
50	34.0	30.0	32.0	27.0	28.0	21.8	24.0	16.5	20.0	11.2	16.0	6.0		
(55)			37.0	32.0	33.0	26.8	29.0	21.5	25.0	16.2	21.0	11.0	17.0	7.0
60			42.0	37.0	38.0	31.8	34.0	26.5	30.0	21.2	26.0	16.0	22.0	12.0
(65)					43.0	36.8	39.0	31.5	35.0	26.2	31.0	21.0	27.0	17.0
70					48.0	41.8	44.0	36.5	40.0	31.2	36.0	26.0	32.0	22.0
(75)					53.0	46.8	49.0	41.5	45.0	36.2	41.0	31.0	37.0	27.0
80					58.0	51.8	54.0	46.5	50.0	41.2	46.0	36.0	42.0	32.0
(85)							59.0	51.5	55.0	46.2	51.0	41.0	47.0	37.0
90							64.0	56.5	60.0	51.2	56.0	46.0	52.0	42.0
100							74.0	66.5	70.0	61.2	66.0	56.0	62.0	52.0
110									80.0	71.2	76.0	66.0	72.0	62.0
120									90.0	81.2	86.0	76.0	82.0	72.0
130											90.0	80.0	86.0	76.0
140											100.0	90.0	96.0	86.0
150													106.0	96.0

NOTES:
1. Lg is grip gaging length; Ls is body length.
2. Diameter-length combinations between the dashed lines are recommended. Lengths in parentheses are not recommended.
3. Screws with lengths above the heavy solid line are threaded full length.
4. For screws with lengths longer than the lower dashed lines, Lg and Ls values shall be computed from formulas as given in Note 19 of General Data.

deg from the plane formed by the bearing circle diameter. The plane formed by the bearing circle diameter shall be perpendicular to the axis of the body within 1 deg, and is expressed in terms of circular runout as specified in Table 1. The measurement of bearing face runout shall be made as close to the specified bearing circle diameter as possible while the screw is held in a collet or other gripping device at a distance equal to one screw diameter from the plane formed by the bearing circle diameter.

14. Fillet. The fillet configuration at the junction of the head and shank shall conform to either Style A, as shown in Fig. 1 and 2 with limits as specified in Table 5, or Style B, as shown in Fig. 3 and with limits as specified in Table 6, at the option of the manufacturer, unless the fillet style is specified by the purchaser. The fillet shall be a smooth and continuous curve fairing smoothly into the under head bearing surface and the shank within the limits specified. For Style A, no radius in the fillet contour shall be less than R minimum as specified in Table 5.

15. Body Diameter.

The diameter of the body on screws which are not threaded full length shall be within the limits specified in Table 1, unless

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Table 3 Thread Lengths

Nom Screw Dia and Thread Pitch	B (Ref) Thread Length Basic			X (Ref)	Lu				
				Transition Thread Length	Unthreaded Length Under Head				
	Screw Lengths ≤ 125	Screw Lengths > 125 and ≤ 200	Screw Lengths > 200	Max	Screw Lengths To and Incl.	Max	Screw Lengths Over	Screw Lengths To and Incl.	Max
M5 × 0.8	16	22	35	4.0	10	1.2	10	20	2.0
M6 × 1	18	24	37	5.0	12	1.5	12	25	2.5
M8 × 1.25	22	28	41	6.2	16	1.9	16	30	3.1
M10 × 1.5	26	32	45	7.5	20	2.2	20	35	3.8
M12 × 1.75	30	36	49	8.8	24	2.6	24	40	4.4
M14 × 2	34	40	53	10.0	28	3.0	28	45	5.0
M16 × 2	38	44	57	10.0	32	3.0	32	50	5.0

the purchaser specifies screws with "reduced diameter body." For screws threaded full length, the diameter of the unthreaded shank under the head shall not exceed the specified maximum body diameter nor be less than the minimum body diameter given in Table 4.

Screws may be obtained with "reduced diameter body" if so specified, however, screws with nominal lengths shorter than four times their nominal size are not recommended. Where "reduced diameter body" is specified, the body diameter shall be within the limits specified in Table 9. The screw shall have a shoulder under the head. The diameter and length of the shoulder shall be as specified in Table 9.

16. Length. The length of the screw shall be measured parallel to the axis of the screw from the plane formed by the under head bearing circle diameter to the extreme end of the shank. Tolerances for screw lengths are given in Table 7.

17. Points. The end of the screw shall be chamfered from a diameter equal to or slightly less than the thread root diameter to produce a length of chamfer or incomplete thread within the limits for Z specified in Table 8. The end of the screw shall be reasonably square with the axis of the screw, and where pointed blanks are used, the slight rim or cup resulting from roll threading shall be permissible. At the manufacturer's option, the end of the screw may have a rounded point of radius V as specified in Table 8.

18. Straightness. Shanks of screws shall be straight within a maximum camber of 0.006 mm/mm of screw length. The referee gage and gaging procedure for checking screw straightness is given in Appendix I of ANSI B18.2.3.1, page C—10.

19. Thread Length.

19.1 The length of thread on screws shall be controlled by the maximum grip gaging length (Lg) and the minimum body length (Ls) as set forth in 19.2 thru 19.5.

Table 4 Tolerance Zone

Nominal Screw Dia and Thread Pitch	Head True Position Tolerance Zone Diameter	Dsi Minimum Body Dia For Product Threaded to Head	Circular Runout of Shank to Thread
M5 × 0.8	0.35	4.36	0.48
M6 × 1	0.44	5.21	0.58
M8 × 1.25	0.56	7.04	0.58
M10 × 1.5	0.70	8.86	0.58
M12 × 1.75	0.84	10.68	0.70
M14 × 2	0.98	12.50	0.70
M16 × 2	1.12	14.50	0.70

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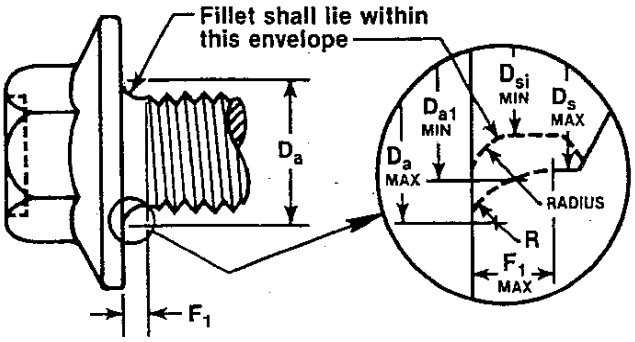

FIG. 1 STYLE 'A' FILLET DETAIL FOR SHORT SCREWS

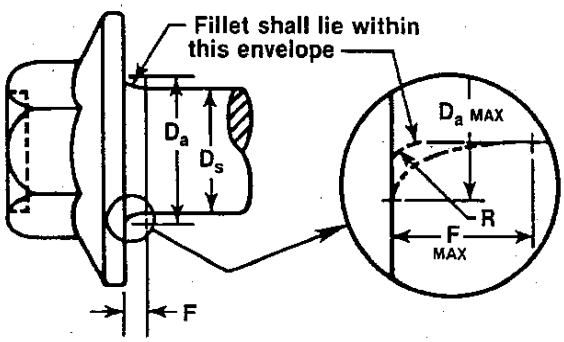

FIG. 2 STYLE 'A' FILLET DETAIL FOR LONG SCREWS

Table 5 Dimensions of Style 'A' Underhead Fillets

Nominal Screw Dia and Thread Pitch	D_{a1}	D_a	F	F_1	R
	Fillet Transition Diameter		Fillet Length		Fillet Radius
	For Short Screws	For Short and Long Screws	For Long Screws	For Short Screws	For Short and Long Screws
	Min	Max	Max	Max	Min
M5 x 0.8	5.1	5.7	1.2	0.7	0.2
M6 x 1	6.2	6.8	1.4	0.9	0.3
M8 x 1.25	8.3	9.2	2.0	1.1	0.4
M10 x 1.5	10.2	11.2	2.0	1.2	0.4
M12 x 1.75	12.2	13.7	3.0	1.3	0.6
M14 x 2	14.1	15.7	3.0	1.4	0.6
M16 x 2	16.5	17.7	3.0	1.6	0.6

Notes: 1. Short screws are screws which are threaded full length.
2. Values of D_{si} are given in Table 4.

19.2 Grip gaging length, Lg max, is the distance, measured parallel to the axis of the screw, from the plane formed by the bearing circle diameter to the face of a non-counterbored or non-countersunk standard GO thread ring gage assembled by hand as far as the thread will permit. For standard diameter-length combinations of screws the values for Lg max are specified in Table 2. For diameter-length combinations not listed in Table 2, the maximum grip gaging length, as calculated and rounded to one decimal place, shall be equal to the nominal screw length, L, minus the basic thread length, B, as specified in Table 3 (Lg max = L − B). Lg max shall be used as a criterion for inspection.

19.3 Body length, Ls min, is the distance, measured parallel to the axis of the screw, from the plane formed by the bearing circle diameter to the last scratch of thread or the top of the extrusion angle, whichever is closest to the head. For standard diameter-length combinations of screws the values of Ls min are specified in Table 2. For diameter-length combinations not listed in Table 2, the minimum body length, as calculated and rounded to one decimal place, shall be equal to the maximum grip gaging length (as computed) minus the maximum transition length as given in Table 3 (Ls min = Lg max − X max). Ls min shall be used as a criterion for inspection. Screws of nominal lengths which have a calculated Ls min value equal to or less than the length, Lu, as specified in Table 3 shall be threaded full length. For screws

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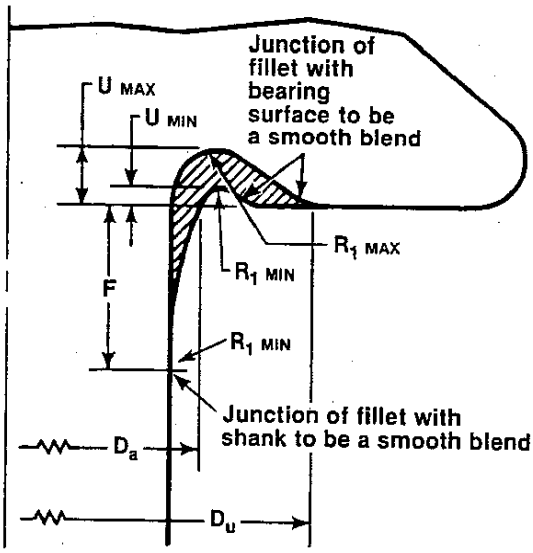
which are threaded full length, the distance from the plane formed by the bearing circle diameter to the face of a non-counterbored or non-countersunk standard GO thread ring gage assembled by hand as far as the thread will permit shall not exceed the length, Lu, as specified in Table 3.

19.4 Basic thread length, B, as specified in Table 3 is a reference dimension intended for calculation purposes only, and is the distance, measured parallel to the axis of the screw, from the extreme end of the screw to the last complete (full form) thread.



Note: The shaded area defines a boundary condition. In practice the actual radius of the fillet may be larger than R_1 max and should preferably be larger than R_1 min.

FIG. 3 STYLE 'B' FILLET DETAIL

19.5 Transition thread length, X max, as specified in Table 3 is a reference dimension intended for calculation purposes only. It includes the length of incomplete threads and tolerances on grip gaging length and body length. The transition from full thread to incomplete thread shall be smooth and uniform. The major diameter of the incomplete threads shall not exceed the actual major diameter of the complete (full form) threads. For screws of property class 10.9 and higher strength materials (tensile strength 1040 MPa and higher), the transition threads shall have a rounded root contour no radius of which shall be less than the specified minimum radius at the root of the full form thread.

20. Thread Runout. The runout of the thread with respect to the axis of the screw shank shall be within the limits specified in Table 4 when measured at a distance of one screw diameter from the last complete thread. The referee gage and gaging procedure for checking thread runout are given in Appendix I, (see Para. 18).

21. Threads.

21.1 Series. Threads shall be metric coarse thread series conforming to dimensions for general purpose external threads given in ANSI B1.13M, page A—8, unless otherwise specified by the purchaser. The class 6g tol-

Table 6 Dimensions of Style 'B' Underhead Fillets

Nom Screw Dia and Thread Pitch	Style B						
	D_u	D_a	U		F	R_1	
	Max	Max	Max	Min	Max	Max	Min
M5 × 0.8	6.1	5.5	0.15	0.05	1.4	0.25	0.10
M6 × 1	7.5	6.6	0.18	0.07	1.6	0.26	0.11
M8 × 1.25	10.1	8.8	0.24	0.11	2.1	0.36	0.16
M10 × 1.5	12.5	10.8	0.31	0.13	2.1	0.45	0.20
M12 × 1.75	15.7	12.8	0.37	0.16	2.1	0.54	0.24
M14 × 2	18.1	14.8	0.43	0.19	2.1	0.63	0.28
M16 × 2	20.5	17.2	0.51	0.23	3.2	0.72	0.32

Table 7 Length Tolerances

Nominal Length	Nom Screw Dia	
	M5 thru M8	M10 thru M16
to 10 mm	0.3	0.3
over 10 to 18 mm	0.4	0.4
over 18 to 30 mm	0.4	0.4
over 30 to 50 mm	0.5	0.8
over 50 to 80 mm	0.6	1.0
over 80 to 120 mm	0.7	1.1
over 120 to 180 mm	1.3	1.3
over 180 to 240 mm	2.3	2.3
over 240 mm	3.0	3.0

All tolerances are plus and minus.

erance shall apply to plain finish (unplated or uncoated) screws, and to plated or coated screws before plating or coating. For screws with additive finish, the 6g diameters may be exceeded by the amount of the allowance, i.e., the basic diameters shall apply to screws after plating or coating.

21.2 Acceptability. Unless otherwise specified by the purchaser, gaging for screw thread dimensional acceptability shall be in accordance with Gaging System 21 as specified in ANSI B1.3M, page A—35.

22. Material and Mechanical Properties. Unless otherwise specified, steel screws shall conform to the requirements for property class 9.8 or property class 10.9 as specified in ASTM F568, page B—1. Screws of other materials such as stainless steel, brass, bronze and aluminum alloys shall have properties as agreed upon by the manufacturer and the purchaser. Properties of screws of several grades of nonferrous materials are covered in ASTM F468M, page B—34, and of stainless steel in ASTM F738, page B—19.

23. Finish. Unless otherwise specified, screws shall be supplied with a natural (as processed) finish, unplated or uncoated.

24. Identification Symbols. Steel screws shall be marked with the property class symbol and with the manufacturer's identification symbol. Minimum height of property class symbols shall be 1.5 mm for M5 thru M8 screws, 2.3 mm for M10 and M12 screws, and 3.2 mm for M14 and M16 screws. Markings shall be located on the top of the head and may be raised or recessed unless otherwise ordered by the purchaser. When raised, markings shall project not less than 0.1 mm for M14 and smaller screws, and 0.3 mm for M16 screws above the surface of the head, and total head height (head plus markings) shall not exceed the specified maximum head height plus 0.1 mm for M5 and M6 screws, 0.2 mm for M8 and M10 screws, 0.3 mm for M12 and M14 screws, and 0.4 mm for M16 screws.

25. Options. Options, where specified, shall be at the discretion of the manufacturer unless otherwise agreed upon by the manufacturer and the purchaser.

26. Terminology. For definitions of terms relating to fasteners or component features thereof used in this standard, refer to American National Standard, Glossary of Terms for Mechanical Fasteners, ANSI B18.12, page J—5.

27. Workmanship. Screws shall not contain an excess of surface imperfections which might affect their serviceability, such as

Table 8 Dimensions of Points

Nominal Screw Dia and Thread Pitch	V	Z	
	Point Radius	Point Length	
	Approx	Max	Min
M5 x 0.8	7.0	1.20	0.40
M6 x 1	8.4	1.50	0.50
M8 x 1.25	11.2	1.88	0.62
M10 x 1.5	14.0	2.25	0.75
M12 x 1.75	16.8	2.62	0.88
M14 x 2	19.6	3.00	1.00
M16 x 2	22.4	3.00	1.00

V equals 1.4 times thread major diameter.
Z max equals 1.5 times thread pitch.
Z min equals 0.5 times thread pitch.

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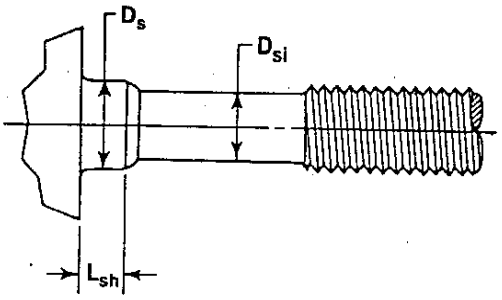

Table 9 Dimensions of Reduced Body Diameter

Nominal Screw Dia and Thread Pitch	D_s Shoulder Diameter		D_{si} Body Diameter		L_{sh} Shoulder Length	
	Max	Min	Max	Min	Max	Min
M5 × 0.8	5.00	4.82	4.46	4.36	3.5	2.5
M6 × 1	6.00	5.82	5.39	5.21	4.0	3.0
M8 × 1.25	8.00	7.78	7.26	7.04	5.0	4.0
M10 × 1.5	10.00	9.78	9.08	8.86	6.0	5.0
M12 × 1.75	12.00	11.73	10.95	10.68	7.0	6.0
M14 × 2	14.00	13.73	12.77	12.50	8.0	7.0
M16 × 2	16.00	15.73	14.77	14.50	9.0	8.0

Note: Shoulder is mandatory.

burrs, seams, laps, loose scale and other irregularities.

28. Clearance Holes. The recommended sizes of clearance holes in material to be assembled using hex flange screws are the normal series given in IFI-527, page J—21.

29. Designation. Hex flange screws shall be designated by the following data, preferably in the sequence shown: product name, nominal diameter and thread pitch, nominal length, steel property class or material identification, and protective coating, if required.

Note:
It is common practice in ISO standards to omit thread pitch from the product size designation when screw threads are the metric coarse thread series, e.g., M10 is M10 × 1.5.

Examples:

Hex flange screw, M10 × 1.5 × 50, class 9.8, zinc plated

Hex flange screw, M16 × 2 × 100, class 10.9

30. Inspection and Quality Assurance. Unless otherwise specified by the purchaser in the original inquiry and purchase order, acceptability shall be based on conformance with the requirements specified in ANSI B18.18.1, page J—23.

31. Reference Standards. Titles and source of availability of all documents referenced in this standard are given on page J—48.