

IFI
538
1982

METRIC HEAVY HEX FLANGE SCREWS

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IFI Note:

IFI-538 is an interim standard which will be withdrawn when a proposed ANSI standard for metric heavy hex flange screws is published. Copies of the ANSI standard, following its publication, may be obtained from the American Society of Mechanical Engineers, United Engineering Center, 345 E. 47th St., New York, NY 10017.

For an explanation of IFI-538, why it was introduced and how it relates to proposed ISO and ANSI standards, refer to the IFI Note leading into IFI-536, page C-48.

GENERAL DATA

1. Scope.

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

2. Comparison With ISO Standards.

2.1 Heavy 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
- 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



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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 0.01mm. The maximum thickness of the Ta portion of Gage A equals the wrenching height, K₁. 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 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 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

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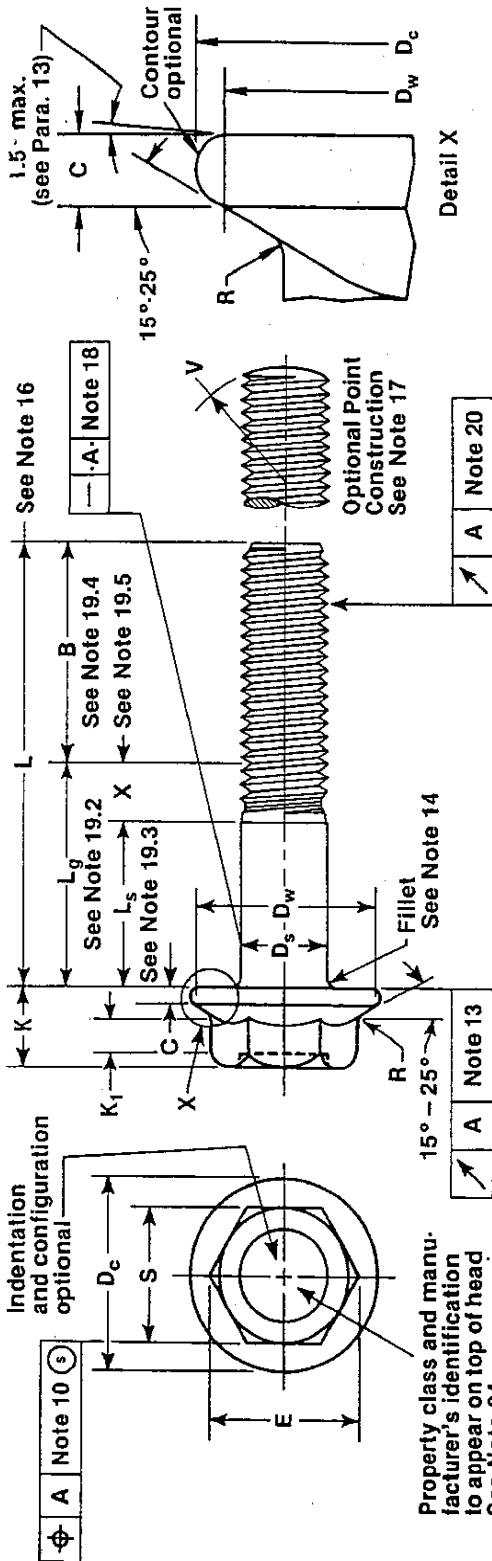
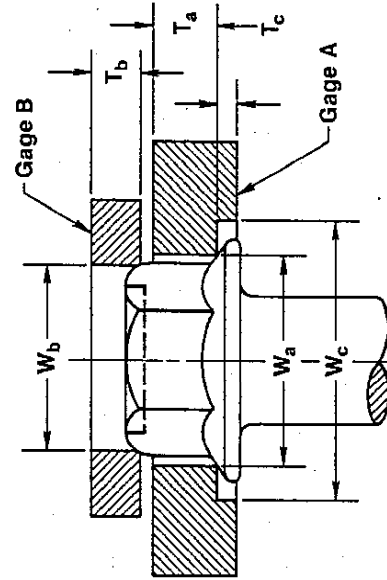


Table 1 Dimensions of Heavy Hex Flange Screws

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	C Circular Runout of Bearing Circle FIM		K Head Height	K ₁ Wrenching Height	R Flange Top Fillet Radius
	Max	Min	Max	Min	Max	Min			Max	Min			
M10 x 1.5	10.00	9.78	15.00	14.57	17.32	16.32	22.3	19.6	0.43	0.6	8.6	3.70	0.6
M12 x 1.75	12.00	11.73	18.00	17.57	20.78	19.68	26.6	23.8	0.50	0.7	10.4	4.60	0.7
M14 x 2	14.00	13.73	21.00	20.48	24.25	22.94	30.5	27.6	0.55	0.9	12.4	5.50	0.9
M16 x 2	16.00	15.73	24.00	23.16	27.71	25.94	35.0	31.9	0.61	1.0	14.1	6.20	1.0
M20 x 2.5	20.00	19.67	30.00	29.16	34.64	32.66	43.0	39.9	0.76	1.2	17.7	7.90	1.2
Refer to Para.	15		7, 8, 9		11		13	13	13	5	7, 9		



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

W _a	T _a	W _c	T _c	W _b	T _b	Gage A				Gage B			
						Thickness		Inside Dia		Thickness		Inside Dia	
Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
17.33	17.32	3.70	3.69	25.0	24.0	1.81	1.80	16.31	16.30	5.0	5.0		
20.79	20.78	4.60	4.59	30.0	29.0	2.20	2.19	19.67	19.66	5.0	5.0		
24.26	24.25	5.50	5.49	34.0	33.0	2.55	2.54	22.93	22.92	6.0	6.0		
27.72	27.71	6.20	6.19	38.0	37.0	2.96	2.95	25.93	25.92	6.0	6.0		
34.65	34.64	7.90	7.89	46.0	45.0	3.70	3.69	32.65	32.64	6.0	6.0		
9, 12												9	



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Table 2 Maximum Grip Gaging Lengths
And Minimum Body Lengths

Nom Dia and Thd Pitch	M10 x 1.5		M12 x 1.75		M14 x 2		M16 x 2		M20 x 2.5	
	Lg Max	Ls Min	Lg Max	Ls Min	Lg Max	Ls Min	Lg Max	Ls Min	Lg Max	Ls Min
14 16			-----	-----	-----	-----				
20 25 30 35							-----	-----	-----	-----
40 45 50	14.0 19.0 24.0	6.5 11.5 16.5	15.0 20.0	6.2 11.2			16.0 6.0			
(55) 60 (65)	29.0 34.0 39.0	21.5 26.5 31.5	25.0 30.0 35.0	16.2 21.2 26.2	21.0 26.0 31.0	11.0 16.0 21.0	17.0 22.0 27.0	7.0 12.0 17.0		
70 (75) 80	44.0 49.0 54.0	36.5 41.5 46.5	40.0 45.0 50.0	31.2 36.2 41.2	36.0 41.0 46.0	26.0 31.0 36.0	32.0 37.0 42.0	22.0 27.0 32.0	24.0 29.0 34.0	11.5 16.5 21.5
(85) 90 100	59.0 64.0 74.0	51.5 56.5 66.5	55.0 60.0 70.0	46.2 51.2 61.2	51.0 56.0 66.0	41.0 46.0 56.0	47.0 52.0 62.0	37.0 42.0 52.0	39.0 44.0 54.0	26.5 31.5 41.5
110 120 130			80.0 90.0	71.2 81.2	76.0 86.0 90.0	66.0 76.0 80.0	72.0 82.0 86.0	62.0 72.0 76.0	64.0 74.0 78.0	51.5 61.5 65.5
140 150					100.0 90.0	90.0	96.0 106.0	86.0 96.0	88.0 98.0	75.5 85.5

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.

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



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Table 3 Thread Lengths

Nom Screw Dia and Thread Pitch	B (Ref)			X (Ref)	Lu				
	Thread Length Basic			Transi- tion Thread Length	Unthreaded Length Under Head				
	Screw Lengths ≤ 125	Screw Lengths > 125 and ≤ 200	Screw Lengths > 200		Screw Lengths To and Incl.	Max	Screw Lengths		Max
				Over			To and Incl.		
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
M20 × 2.5	46	52	65	12.5	40	3.8	40	60	6.2

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.

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-counter-bored 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 ($Lg \text{ max} = L - B$). 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

Table 4 Tolerance Zone

Nominal Screw Dia and Thread Pitch	Head True Position Tolerance Zone Diameter	Dsi	Circular Runout of Shank to Thread
		Minimum Body Dia For Product Threaded to Head	
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
M20 × 2.5	1.40	18.16	0.84



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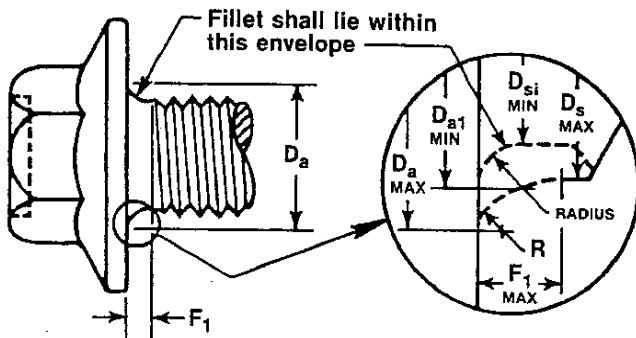


FIG. 1 STYLE 'A' FILLET DETAIL FOR SHORT SCREWS

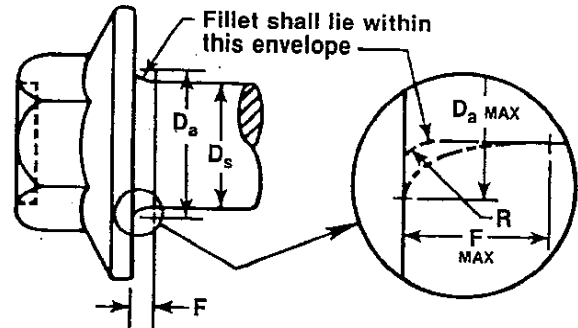


FIG. 2 STYLE 'A' FILLET DETAIL FOR LONG SCREWS

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
M10 × 1.5	10.2	11.2	2.0	1.2	0.4
M12 × 1.75	12.2	13.7	3.0	1.3	0.6
M14 × 2	14.1	15.7	3.0	1.4	0.6
M16 × 2	16.5	17.7	3.0	1.6	0.6
M20 × 2.5	20.7	22.4	4.0	2.1	0.8

Notes: 1. Short screws are screws which are threaded full length.
2. Values of D_{s1} are given in Table 4.

to the maximum grip gaging length (as computed) minus the maximum transition length as given in Table 3 ($L_s \text{ min} = L_g \text{ max} - X \text{ max}$). $L_s \text{ min}$ shall be used as a criterion for inspection. Screws of nominal lengths which have a calculated $L_s \text{ min}$ value equal to or less than the length, L_u , as specified in Table 3 shall be threaded full length. For screws 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, L_u , 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.

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



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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 check-

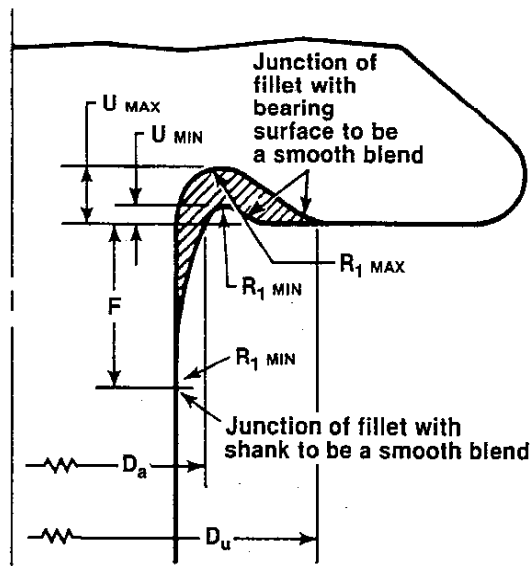
ing thread runout are given in Appendix I, (see Para. 18).

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 tolerance 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.



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

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
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
M20 × 2.5	26.1	21.6	0.65	0.29	4.2	0.90	0.40



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Table 7 Length Tolerances

Nominal Length	Nom Screw Dia	
	M10 thru M16	M20
over 10 to 18 mm	0.4	—
over 18 to 30 mm	0.4	0.7
over 30 to 50 mm	0.8	1.3
over 50 to 80 mm	1.0	1.5
over 80 to 120 mm	1.1	1.8
over 120 to 180 mm	1.3	2.0
over 180 to 240 mm	2.3	2.3
over 240 mm	3.0	3.0

All tolerances are plus and minus.

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 2.3 mm for M10 and M12 screws, 3.2 mm for M14 and M16 screws, and 4.0 mm for M20 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 and M20 screws above the surface of the head, and total head height (head plus markings) shall not exceed the specified maximum

head height plus 0.2 mm for M10 screws, 0.3 mm for M12 and M14 screws, and 0.4 mm for M16 and M20 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 burrs, seams, laps, loose scale and other irregularities.

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

29. Designation. Heavy hex flange screws shall be designated by the following data, preferably in the sequence shown: product

Table 8 Dimensions of Points

Nominal Screw Dia and Thread Pitch	V	Z	
	Point Radius	Point Length	
	Approx	Max	Min
M10 × 1.5	14.0	2.25	0.75
M12 × 1.75	16.8	2.62	0.88
M14 × 2	19.6	3.00	1.00
M16 × 2	22.4	3.00	1.00
M20 × 2.5	28.0	3.75	1.25

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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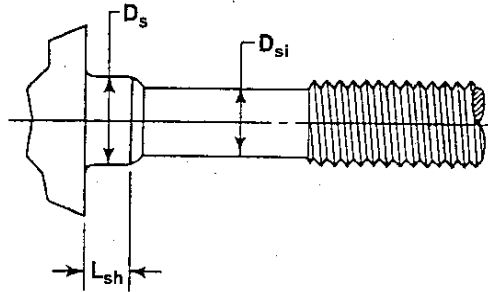


Table 9 Dimensions of Reduced Body Diameter

Nominal Screw Dia and Thread Pitch	D_s		D_{si}		L_{sh}	
	Shoulder Diameter		Body Diameter		Shoulder Length	
	Max	Min	Max	Min	Max	Min
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
M20 × 2.5	20.00	19.67	18.49	18.16	11.0	10.0

Note: Shoulder is mandatory.

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:

Heavy hex flange screw, M10 × 1.5 × 50, class 9.8, zinc plated

Heavy 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.

