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AMERICAN NATIONAL STANDARD

Metric Heavy Hex Structural Bolts

ANSI B18.2.3.7M - 1979

REAFFIRMED 1995

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SECRETARIAT

SOCIETY OF AUTOMOTIVE ENGINEERS
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United Engineering Center 345 East 47th Street New York, N.Y. 10017

ACCEPTANCE NOTICE

This non-Government document was adopted on 26 April 1979 and is approved for use by the DoD and Federal Agencies. Metric heavy hex structural bolts shall conform to this document and Appendix III, which establishes standard items for Government application. Appendix III, Table 5 shall be used for item selection in accordance with the part numbering system and size information contained therein. The indicated industry group has furnished the clearances required by existing regulations. Copies of the document are stocked by DoD Single Stock Point, Naval Publications and Forms Center, Philadelphia, PA, 19120, for issue to DoD activities and Federal Agencies only. Contractors and industry groups must obtain copies directly from:

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FSC 5306

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ERRATA

to

ANSI B18.2.3.7M-1979
METRIC HEAVY HEX STRUCTURAL BOLTS

Page 3, Note 16, *change* B.13 *to read* B1.13 M

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
345 East 47 Street, New York, N.Y. 10017

April 1981

FOREWORD

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 American 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.

At its meeting on December 4, 1974, Committee B18 authorized preparation of a series of standards for metric fasteners. Subcommittee 2 was assigned responsibility for developing standards for metric hex bolts, screws and nuts.

At a meeting on September 22, 1976, Subcommittee 2 organized the contents of a standard covering eight different hex head screw and bolt products. Actual drafting was postponed until ISO/TC2 could reach final decisions relating to basic dimensions and characteristics of hex bolts, screws and nuts. At ISO/TC2 meetings held in April 1977, final actions were taken. Committee B18 affirmed the TC2 decisions at a meeting on June 29, 1977 and drafting of this standard was started.

In February 1978, Committee B18 established a cooperative program with the Department of Defense to draft American National Standards for metric fasteners in such a way that they could be used directly by the Government for procurement purposes. The Department of Defense requested that each of the eight products be covered in separate standards, and Subcommittee 2 accepted this approach at its meeting on June 27, 1978.

This standard was approved by letter ballot of Committee B18 on September 15, 1978, and was subsequently approved by the secretariat and submitted to the American National Standards Institute for designation as an American National Standard. This was granted on April 26, 1979.

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CONTENTS

AMERICAN NATIONAL STANDARD

METRIC HEAVY HEX STRUCTURAL BOLTS

GENERAL DATA

1. Scope

1.1 This standard covers the complete general and dimensional data for metric heavy hex structural bolts recognized as "American National Standard."

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 production items. Consumers are requested to consult with manufacturers concerning lists of stock production heavy hex structural bolts.

1.3 Heavy hex structural bolts purchased for Government use shall conform to this standard, and additionally to the requirements of Appendix III.

2. Comparison With ISO Standards

2.1 Heavy hex structural bolts as presented in this standard have been coordinated, to the extent possible, with a draft ISO proposed standard. The dimensional differences between this ANSI standard and the ISO proposal are few, relatively minor, and none will affect the functional interchangeability of bolts manufactured to the requirements of either.

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

Diameters and thread pitches (see 24)
Body diameters
Widths across flats
Bearing surface diameters
Head heights
Thread lengths (see 2.3)
Thread dimensions
Nominal lengths

2.2 There will be two ISO standards for heavy hex structural bolts, with the only difference between them being length of thread. This ANSI standard is essentially identical to the proposed ISO standard for bolts with the shorter thread lengths.

2.3 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 full form and 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 bolt, from the top of the head to the under head bearing surface.

6. Wrenching Height. The wrenching height is the distance, measured at a corner of the hex, from the plane of the bearing surface 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.

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

8. True Position of Head. The axis of the hex head shall be located at true position with respect to the axis of the bolt (determined over a distance under the head equal to one bolt diameter) within a tolerance zone of diameter equal to 6 percent of the specified maximum width across flats.

9. Bearing Surface. The bearing surface shall be flat and washer faced. However, a die seam across the bearing face shall be permissible. Diameter of bearing surface shall not exceed the width across flats nor be less than the specified minimum washer face diameter. For referee purposes, measurement of bearing surface diameter shall be taken at mid thickness of the washer face. The plane of the bearing surface shall be perpendicular to the axis of the body within the total runout specified in Table 1. The measurement of bearing face runout shall be made as close to the periphery of the washer face as possible while the bolt is held in a collet or other gripping device at a distance equal to one bolt diameter from the underside of the head. Angularity measurement shall be taken at a location to avoid interference from a die seam.

10. Body Diameter

10.1 Bolts shall be furnished with a full diameter body within the limits specified in Table 1.

10.2 There may be a reasonable swell, fin, or die seam on the body adjacent to the underside of head not to exceed the nominal bolt diameter by the following:

1.25 mm for M16
1.50 mm for M20 thru M30
2.30 mm for M36

11. Fillet. The fillet at junction of head and shank shall be a smooth concave curve within an envelope of R minimum, and a smooth multiradius curve tangent to the underside of head at a point no greater than one-half of Da maximum from the axis of the bolt and tangent to the shank of the bolt at a distance no greater than F maximum from the underside of head.

12. Length. Recommended lengths of bolts are given in Table 2. The length of the bolt shall be measured parallel to the axis of the bolt from the under head bearing surface to the extreme end of the shank. Length tolerances shall be as specified in Table 3.

13. Points. The end of the bolt 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 4. The end of the bolt shall be reasonably square with the axis of bolt, 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 bolt may have a rounded point of radius V as specified in Table 4.

14. Straightness. Shanks of bolts shall be straight within a maximum camber of 0.006 mm/mm of bolt length for bolts having nominal lengths of 300 mm or shorter; and within 0.008 mm/mm of bolt length for bolts having nominal lengths over 300 mm. The referee gage and gaging procedure for checking bolt straightness are given in Appendix I.

15. Thread Length

15.1 The length of thread on bolts shall be controlled by the maximum grip gaging length (Lg) and the minimum body length (Ls) as set forth in 15.2 thru 15.5.

15.2 Grip gaging length, Lg max, is the distance measured parallel to the axis of the bolt, from the under head bearing surface 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 bolts 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 bolt length, L, minus the basic thread length, B, as specified in Table 1 (Lg max = L - B). Lg max shall be used as a criterion for inspection.

15.3 Body length, Ls min, is the distance, measured parallel to the axis of the bolt, from the under head bearing surface 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 bolts the values of Ls min are given in Table 2. For diameter-length combinations not listed in Table 2, the minimum body length, as calculated and rounded to one decimal place, is equal to the maximum grip gaging length (as computed) minus the maximum transition thread length as given in Table 1 (Ls min =

Lg max - X max). Ls min shall be used as a criterion for inspection. Bolts of nominal lengths which have a calculated Ls min value equal to or less than the length of 2.5 times the thread pitch shall be threaded full length. Bolts which are threaded full length shall have a minimum body length under the head equal to F as specified in Table 1.

15.4 Basic thread length, B, as specified in Table 1 is a reference dimension intended for calculation purposes only, and is the distance, measured parallel to the axis of the bolt, from the extreme end of the bolt to the last complete (full form) thread.

15.5 Transition thread length, X max, as specified in Table 1 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.

16. Thread Series. Threads shall be metric coarse thread series conforming to dimensions for general purpose external threads given in ANSI B1.13. The class 6g tolerance shall apply to plain finish (unplated or uncoated) bolts, and to plated or coated bolts before plating or coating.

17. Material and Mechanical Properties. Chemical composition and mechanical requirements of steel bolts shall conform to ASTM A325M or ASTM A490M.

Note

These two ASTM standards are under development. Mechanical properties of A325M bolts are essentially the same as SAE J1199 property class 8.8, and those of A490M essentially the same as SAE J1199 property class 10.9.

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

19. Identification Symbols. Steel bolts shall be marked with the grade identification symbols and with the manufacturer's identification symbol. Minimum height of property class symbols shall be 4.0 mm. 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 0.3 mm above the surface of the head, and total head height (head plus markings) shall not exceed the specified maximum head height plus 0.4 mm.

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

21. Terminology. For definition 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.

22. Workmanship. Bolts shall not contain an excess of surface imperfections which might affect their serviceability, such as burrs, seams, laps, loose scale and other irregularities.

23. Clearance Holes. The recommended sizes of clearance holes in material to be assembled using heavy hex structural bolts are the normal series given in Appendix II.

24. Designation

24.1 Heavy hex structural bolts shall be designated by the following data preferably in the sequence shown: product name, nominal diameter and thread pitch, nominal length, steel property class, 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., M20 is M20 x 2.5.

Examples:

Heavy hex structural bolt, M22 x 2.5 x 160, ASTM A325M, zinc galvanized

Heavy hex structural bolt, M24 x 3 x 80, ASTM A490M.

24.2 The Government part numbering system for metric heavy hex structural bolts is given in Appendix III.

25. Referenced Standards

Copies of referenced ASTM standards may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

Copies of referenced SAE standards may be obtained from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pennsylvania 15096.

Copies of referenced ISO standards may be obtained from the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

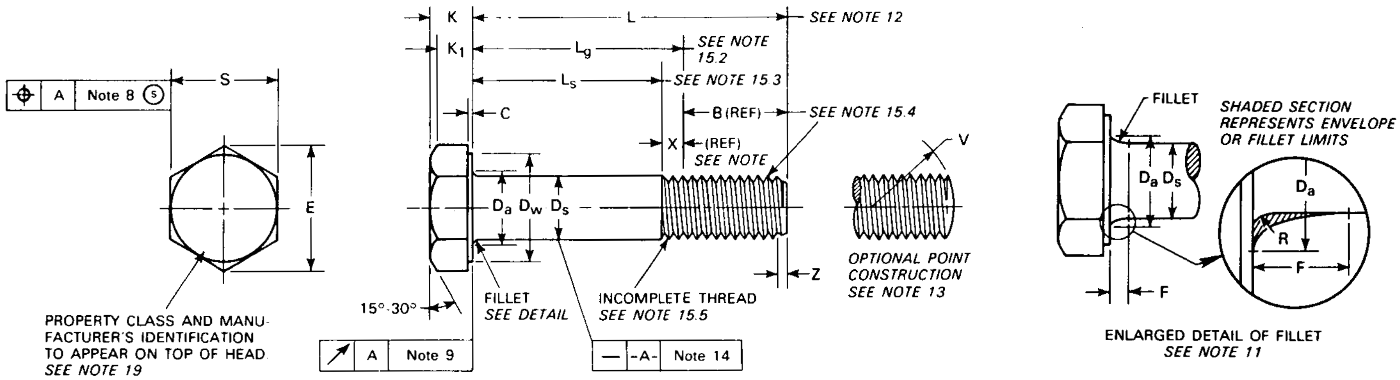


Table 1 Dimensions of Heavy Hex Structural Bolts

D	Ds		S		E		K		K1	Dw		C		Da	F	R	B (Ref)		X (Ref)
Nominal Bolt Dia and Thread Pitch	Body Diameter		Width Across Flats		Width Across Corners		Head Height		Wrench-ing Height	Washer Face Dia	Runout of Bearing Surface FIM	Washer Face Thickness		Fillet Trans-ition Dia	Fillet Length	Fillet Radius	Thread Length		Trans-ition Thread Length
																	Bolt Lengths ≤ 100	Bolt Lengths > 100	
	Max	Min	Max	Min	Max	Min	Max	Min	Min	Min	Max	Max	Min	Max	Max	Min	Basic		Max
M16 x 2	16.70	15.30	27.00	26.16	31.18	29.56	10.75	9.25	6.5	24.9	0.48	0.8	0.4	18.2	3.0	0.6	31	38	6.0
M20 x 2.5	20.84	19.16	34.00	33.00	39.26	37.29	13.40	11.60	8.1	31.4	0.59	0.8	0.4	22.4	4.0	0.8	36	43	7.5
M22 x 2.5	22.84	21.16	36.00	35.00	41.57	39.55	14.90	13.10	9.2	33.3	0.63	0.8	0.4	24.4	4.0	0.8	38	45	7.5
M24 x 3	24.84	23.16	41.00	40.00	47.34	45.20	15.90	14.10	9.9	38.0	0.70	0.8	0.4	26.4	4.0	1.0	41	48	9.0
M27 x 3	27.84	26.16	46.00	45.00	53.12	50.85	17.90	16.10	11.3	42.8	0.77	0.8	0.4	30.4	5.0	1.2	44	51	9.0
M30 x 3.5	30.84	29.16	50.00	49.00	57.74	55.37	19.75	17.65	12.4	46.5	0.85	0.8	0.4	33.4	6.0	1.2	49	56	10.5
M36 x 4	37.00	35.00	60.00	58.80	69.28	66.44	23.55	21.45	15.0	55.9	1.01	0.8	0.4	39.4	6.0	1.5	56	63	12.0
See Notes	10				6.7		5		6	9	9	9			11				

Table 2 Maximum Grip Gaging Length and Minimum Body Lengths for Heavy Hex Structural Bolts

Nom Bolt Dia and Thd Pitch	M16 x 2		M20 x 2.5		M22 x 2.5		M24 x 3		M27 x 3		M30 x 3.5		M36 x 4	
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
45	14	8												
50	19	13	14	6.5										
55	24	18	19	11.5	17	9.5								
60	29	23	24	16.5	22	14.5	19	10						
65	34	28	29	21.5	27	19.5	24	15	21	12				
70	39	33	34	26.5	32	24.5	29	20	26	17	21	10.5		
75	44	38	39	31.5	37	29.5	34	25	31	22	26	15.5		
80	49	43	44	36.5	42	34.5	39	30	36	27	31	20.5	24	12
85	54	48	49	41.5	47	39.5	44	35	41	32	36	25.5	29	17
90	59	53	54	46.5	52	44.5	49	40	46	37	41	30.5	34	22
95	64	58	59	51.5	57	49.5	54	45	51	42	46	35.5	39	27
100	69	63	64	56.5	62	54.5	59	50	56	47	51	40.5	44	32
110	72	66	67	59.5	65	57.5	62	53	59	50	54	43.5	47	35
120	82	76	77	69.5	75	67.5	72	63	69	60	64	53.5	57	45
130	92	86	87	79.5	85	77.5	82	73	79	70	74	63.5	67	55
140	102	96	97	89.5	95	87.5	92	83	89	80	84	73.5	77	65
150	112	106	107	99.5	105	97.5	102	93	99	90	94	83.5	87	75
160	122	116	117	109.5	115	107.5	112	103	109	100	104	93.5	97	85
170	132	126	127	119.5	125	117.5	122	113	119	110	114	103.5	107	95
180	142	136	137	129.5	135	127.5	132	123	129	120	124	113.5	117	105
190	152	146	147	139.5	145	137.5	142	133	139	130	134	123.5	127	115
200	162	156	157	149.5	155	147.5	152	143	149	140	144	133.5	137	125
210	172	166	167	159.5	165	157.5	162	153	159	150	154	143.5	147	135
220	182	176	177	169.5	175	167.5	172	163	169	160	164	153.5	157	145
230	192	186	187	179.5	185	177.5	182	173	179	170	174	163.5	167	155
240	202	196	197	189.5	195	187.5	192	183	189	180	184	173.5	177	165
250	212	206	207	199.5	205	197.5	202	193	199	190	194	183.5	187	175
260	222	216	217	209.5	215	207.5	212	203	209	200	204	193.5	197	185
270	232	226	227	219.5	225	217.5	222	213	219	210	214	203.5	207	195
280	242	236	237	229.5	235	227.5	232	223	229	220	224	213.5	217	205
290	252	246	247	239.5	245	237.5	242	233	239	230	234	223.5	227	215
300	262	256	257	249.5	255	247.5	252	243	249	240	244	233.5	237	225

Notes:

1. Lg is grip gaging length; Ls is body length.
2. Bolts with lengths above the heavy solid line are threaded full length.
3. For bolts with longer lengths, Lg and Ls values shall be computed from formulas as given in Note 15 of General Data.

Table 3 Length Tolerances

Nominal Length	Nominal Bolt Dia
	M16 thru M36
to 50 mm	± 1.2
over 50 to 80 mm	± 1.5
over 80 to 120 mm	± 1.8
over 120 to 150 mm	± 2.0
over 150 mm	± 4.0

Table 4 Dimensions of Points

Nom Bolt Dia and Thread Pitch	V	Z	
	Point Radius	Point Length	
	Approx	Max	Min
M16 x 2	22.4	3.00	1.00
M20 x 2.5	28.0	3.75	1.25
M22 x 2.5	30.8	3.75	1.25
M24 x 3	33.6	4.50	1.50
M27 x 3	37.8	4.50	1.50
M30 x 3.5	42.0	5.25	1.75
M36 x 4	50.4	6.00	2.00

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

APPENDIX I

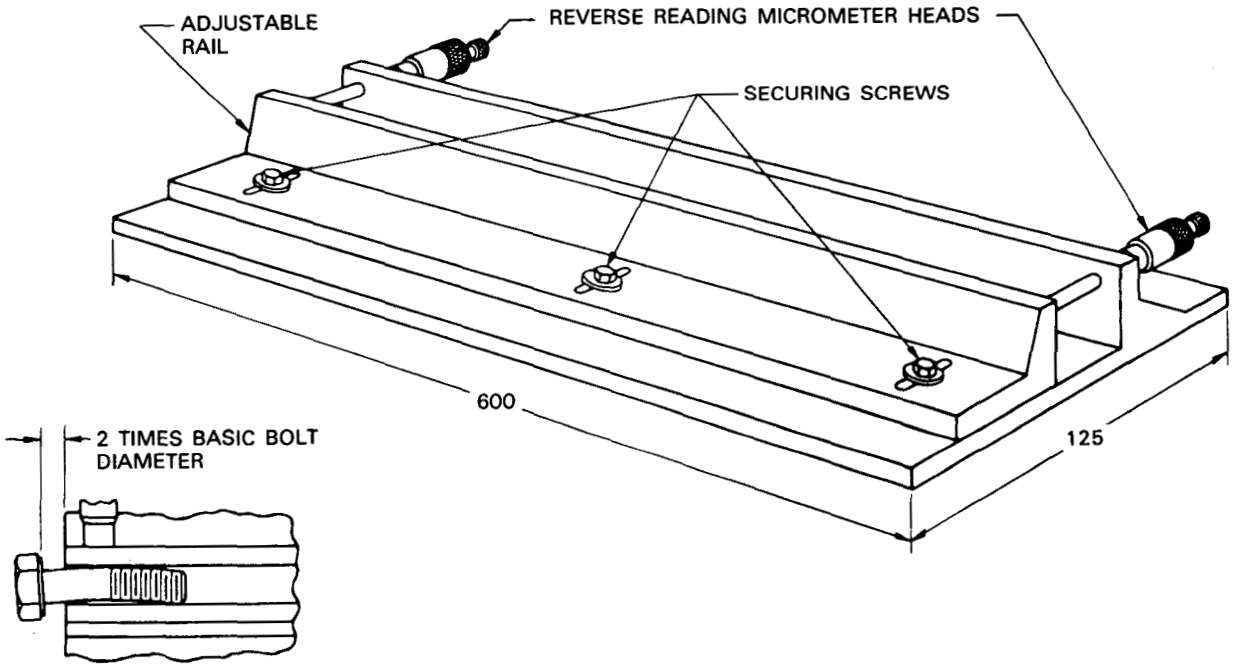
BOLT STRAIGHTNESS
REFEREE GAGE AND GAGING PROCEDURE

The conformance of bolts to shank straightness or camber limitations set forth in the respective product standards shall be checked by using the gage illustrated below in accordance with the following procedure:

Allowable total camber on the product to be inspected shall be calculated by multiplying the specified permissible camber per mm of length by the product length expressed as a one place decimal. 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.

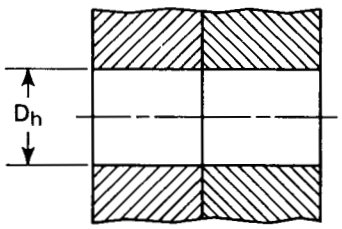
The product shall then be inserted between rails, excluding from the gage any permissible length of swell or fillet under the head. The product shall be rotated by hand through full 360 deg. Any interference occurring between the product and the gage which is sufficient to prevent rotation shall indicate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

TYPICAL STRAIGHTNESS GAGE



APPENDIX II

RECOMMENDED CLEARANCE HOLES FOR BOLTS



Clearance Holes for Bolts

Nom Bolt Dia and Thread Pitch	Dh—Clearance Hole Diameter, Basic		
	Close Clearance	Normal Clearance (Preferred)	Loose Clearance
M16 x 2	17.0	17.5	18.5
M20 x 2.5	21.0	22.0	24.0
M22 x 2.5	23.0	24.0	26.0
M24 x 3	25.0	26.0	28.0
M27 x 3	28.0	30.0	32.0
M30 x 3.5	31.0	33.0	35.0
M36 x 4	37.0	39.0	42.0

Notes:

1. **Normal Clearance.** Normal clearance hole sizes are preferred for general purpose applications, and should be specified unless special design considerations dictate the need for either a close or loose clearance hole.

2. **Close Clearance.** Close clearance hole sizes should be specified only where conditions such as critical alignment of assembled parts, wall thickness or other limitations necessitate use of a minimal hole. When close clearance holes are specified, special provision (e.g., countersinking) must be provided at the screw entry side to permit proper seating of the screw head.

3. **Loose Clearance.** Loose clearance hole sizes should be specified only for applications where maximum adjustment capability between components being assembled is necessary.

4. **Recommended Tolerances.** The clearance hole diameters given in the table are minimum sizes. Recommended tolerances are plus 0.3 mm for bolt diameter M16; and plus 0.4 mm for bolt diameters M20 thru M36.

APPENDIX III

Government Standard Items and Part Numbering System

Note

The Government encourages the general use of this appendix to achieve maximum parts standardization.

This appendix establishes the standard items for Government application selected from the possible variations of items within the scope of the standard and provides a part numbering system for identification and application in engineering documents.

The following variations are standard:

a. Size and Length Combinations–as specified in Table 5.

b. Material–Steel

c. Finish–Plain finish or zinc galvanized as coded in Part Numbering System.

The part number shall consist of the following element codes in the order shown:

a. Document Identifier – ANSI Standard Number less decimal points.

b. Material and Finish

c. Nominal Diameter

d. Nominal Length

Note

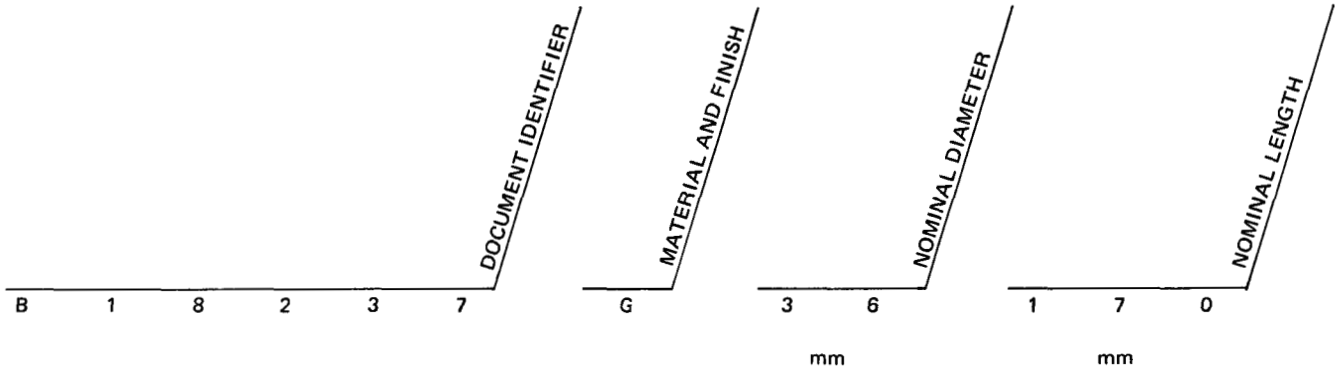
The Part Numbering System may also be used for non-standard diameter and length combinations.

Quality Assurance Provisions: Quality assurance provisions shall be in accordance with FF-S-85 Screw, Cap, Slotted and Hexagon Head.

Packaging: Packaging shall be in accordance with PPP-H-1581, Hardware (Fasteners and Related Items), Packaging and Packing for Shipment and Storage of.

PART NUMBERING SYSTEM COVERING STANDARD ITEMS FOR GOVERNMENT USE

NOTE: THE GOVERNMENT ENCOURAGES THE GENERAL USE OF THIS SYSTEM TO ACHIEVE MAXIMUM PARTS STANDARDIZATION.



MATERIAL AND FINISH CODE
M – Steel, per ASTM A325M, plain finish.
G – Steel, per ASTM A325M, zinc galvanized.

EXAMPLE: B18237G36170 indicates a bolt, structural, heavy hex-metric, made of zinc galvanized steel, per ASTM A325M, 36 mm in diameter and 170 mm in length.

Table 5 Metric Heavy Hex Structural Bolts—Standard Size for Government Use

Nominal Length	Nominal Diameter and Thread Pitch						
	M16 x 2	M20 x 2.5	M22 x 2.5	M24 x 3	M27 x 3	M30 x 3.5	M36 x 4
45	16045						
50		20050					
55			22055				
60				24060			
65					27065		
70						30070	
75							
80							36080
85							
90	STANDARD						
95							
100		DIAMETER AND					
110							
120				LENGTH			
130							
140					COMBINATION		
150							
160							
170							
180							
190							
200							
210							
220							
230							
240							
250							
260							
270							
280							
290							
300	16300	20300	22300	24300	27300	30300	36300