D-17-19

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Military Coordinating Activity
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(Project 5306-0620)

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ERRATA

to

ANSI B18.2.3.5M-1979
METRIC HEX BOLTS

Page 3, Note 18, *change* B1.13 *to read* B1.13M

Page 5, in the standard shall be replaced with the second page of this errata

Page 10, MATERIAL AND FINISH CODE, *change to read:*

A – Steel w/Cadmium Plating per QQ-P-416, Type II, Class 3 (5.1μm Plating Thickness), Property Class 10.9.

B – Steel w/Zinc Plating per QQ-Z-325, Type II, Class 3 (5.1μm Plating Thickness), Property Class 10.9.

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D-17-19

AMERICAN NATIONAL STANDARD

Metric Hex Bolts

ANSI B18.2.3.5M - 1979

Government Key Words:
Bolt, Hex–Metric

SECRETARIAT

SOCIETY OF AUTOMOTIVE ENGINEERS
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ANSI B18.2.3.5M-79
26 APRIL 1979

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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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AMERICAN NATIONAL STANDARD

METRIC HEX BOLTS

GENERAL DATA

1. Scope

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

1.3 Hex 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 Hex bolts as presented in this standard have been coordinated, to the extent possible, with ISO 4016. The dimensional differences between this ANSI standard and ISO 4016 are few, relatively minor, and none will affect the functional interchangeability of bolts manufactured to the requirements of either.

The following functional characteristics of hex bolts in sizes M5 thru M36 are in agreement between this ANSI standard and ISO 4016:

Diameters and thread pitches (see 26)
Body diameters
Widths across flats (see 2.2)
Head heights
Thread lengths
Thread dimensions
Nominal lengths

2.2 At its meeting in Varna, May 1977, ISO/TC2 studied several technical reports analyzing design considerations influencing determination of the best series of width across flats for hexagon bolts, screws and nuts. A primary technical objective was to achieve a logical ratio between under head (nut) bearing surface area (which determines the magnitude of the compressive stress on the bolted members) and the tensile stress area of the screw thread (which governs the clamping force that can be developed by tightening the fastener.) Table 1 lists the sizes selected by ISO/TC2 to be ISO standard.

M10 bolts with 15 mm width across flats are currently being produced and used in U.S.A. and many other countries of the world. This size, however, is not an ISO standard. Unless M10 bolts with 15 mm width across flats are specifically ordered, M10 bolts with 16 mm width across flats shall be furnished.

2.3 Letter symbols designating dimensional characteristics are used 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. Availability. Hex bolts in sizes M5 thru M24 are standard only in lengths longer than 150 mm or 10D, whichever is shorter. When shorter lengths of these sizes are ordered, hex cap screws, in conformance with ANSI B18.2.3.1M, are normally supplied. Hex bolts in sizes M30 and larger are standard in all lengths, however, at manufacturer's option, hex cap screws may be substituted for any diameter-length combination.

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5. Surface Condition. Bolts need not be finished on any surface except the threads.

6. 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.

7. 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.

8. 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.

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

10. 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.

11. Bearing Surface. The bearing surface shall be reasonably flat. However, a die seam across the bearing face shall be permissible. Bearing surface shall be perpendicular to the axis of the body within a tolerance of 3 deg for sizes M24 and smaller, and 2 deg for sizes larger than M24. Angularity measurement shall be taken at a location to avoid interference from a die seam.

12. Bolt Diameter

12.1 Bolts shall be furnished with full diameter body within the limits specified in Table 1 or shall be threaded to the head unless the purchaser specifies bolts with "reduced diameter body" (12.3).

12.2 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:

0.50 mm for M5
0.65 mm for M6
0.75 mm for M8 thru M14
1.25 mm for M16
1.50 mm for M20 thru M30
2.30 mm for M36 thru M48
3.00 mm for M56 thru M72
4.80 mm for M80 thru M100

12.3 Bolts may be obtained with "reduced diameter body" if so specified, however, bolts with nominal lengths shorter than 4D are not recommended. Where "reduced diameter body" is specified, the body diameter shall be within limits specified in Table 2. A shoulder under the head may be supplied at option of the manufacturer. When a shoulder is supplied, its diameter and length shall be as specified in Table 2.

13. Fillet. The fillet at junction of head and shank shall be a smooth concave curve within an envelope of R minimum and a radius tangent to the shank and to the underside of the head at a point equal to one-half of Da maximum from the axis to the bolt.

14. Length. The length of the bolt shall be measured parallel to the axis of the bolt from the underside of head to the extreme end of the shank. Tolerances for bolt lengths are given in Table 3.

15. Point. Bolts need not be pointed.

16. 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 to 600 mm. The referee gage and gaging procedure for checking bolt straightness is given in Appendix I.

17. Thread Length

17.1 The length of thread on bolts shall be controlled by the grip gaging length Lg max as set forth in 17.2 thru 17.4.

17.2 Grip Gaging Length, Lg max, is the distance measured parallel to the axis of bolt, from the underside of the head 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.

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The maximum grip gaging length, as calculated and rounded to one decimal place, for any bolt length shall be equal to the nominal bolt length, L, minus the basic thread length, B, as specified in Table 1, (Lg max = L - B). It represents the minimum design grip length of the bolt and shall be used as the criterion for inspection and for determining thread availability when selecting bolt lengths even though usable threads may extend beyond this point.

All bolts of nominal lengths equal to or shorter than the sum of the basic thread length, B, plus a length of 2½ thread pitches for sizes up to and including M24, and B plus 3½ thread pitches for sizes larger than M24 shall be threaded full length. For bolts which are threaded full length, the distance from the bearing surface of the head 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 equivalent of 2½ thread pitches for sizes up to and including M24, and 3½ thread pitches for sizes larger than M24.

17.3 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.

17.4 Incomplete Thread Diameter. The major diameter of incomplete thread shall not exceed the actual major diameter of the full form thread.

18. Thread Series. Threads shall be metric coarse thread series conforming to dimensions for general purpose external threads given in ANSI B1.13, unless otherwise specified by the purchaser. The class 6g tolerance shall apply to plain finish (unplated or uncoated) bolts, and to plated or coated bolts before plating or coating. For bolts with additive finish, the 6g diameters may be exceeded by the amount of the allowance, i.e., the basic diameters shall apply to bolts after plating or coating.

19. Material and Mechanical Properties. Unless otherwise specified, steel bolts shall conform to the requirements specified in SAE J1199 or ASTM F568. Bolts of other materials such as stainless steel, brass, bronze and aluminum alloys shall have properties as agreed upon by the manufacturer and the purchaser.

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

21. Identification Symbols. Steel bolts 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 and M6 bolts, 2.3 mm for M8 and M10 bolts, 3.2 mm for M12 and M14 bolts, and 4.0 mm for M16 and larger bolts. 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 0.1mm for M14 and smaller bolts, and 0.3 mm for M16 and larger bolts 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 bolts, 0.2 mm for M8 and M10 bolts, 0.3 mm for M12 and M14 bolts, and 0.4 mm for M16 and larger bolts.

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

23. 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.

24. 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.

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

26. Designation

26.1 Hex 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 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 x 1.5.

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Examples:

Hex bolt, M20 x 2.5 x 160, class 4.6, zinc plated

Hex bolt, M36 x 4 x 80, silicon bronze

26.2 The government part numbering system for metric hex bolts is given in Appendix III.

27. 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.

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AMERICAN NATIONAL STANDARD
METRIC HEX BOLTS

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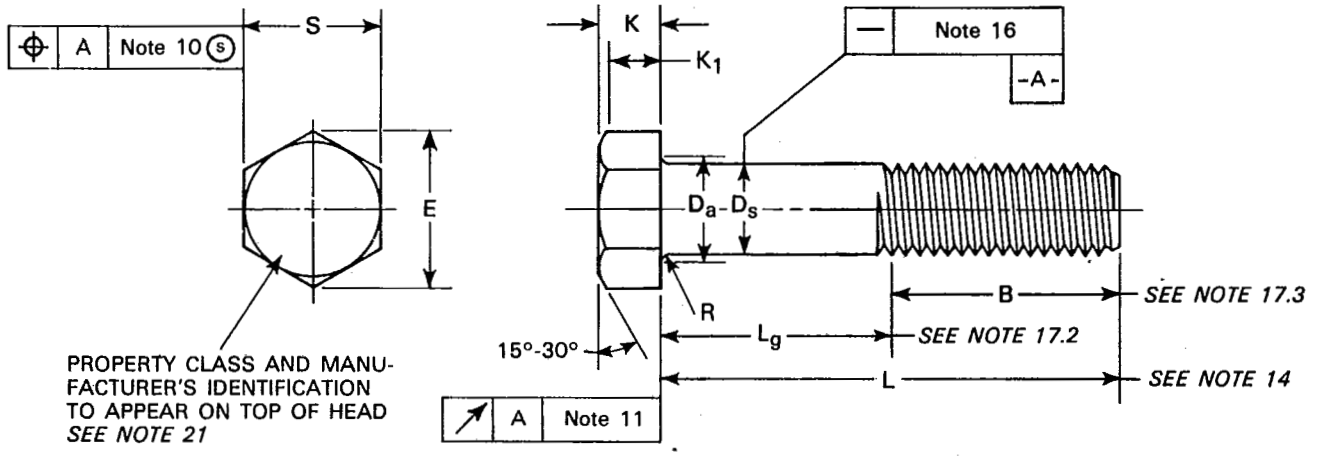

Table 1 Dimensions of Hex Bolts

D	Ds		S		E		K		K_1	Da	R	B (Ref)		
												Thread Length (Basic)		
Nominal Bolt Dia and Thread Pitch	Body Diameter		Width Across Flats		Width Across Corners		Head Height		Wrenching Height	Fillet Transition Dia	Radius of Fillet	Bolt Lengths ≤ 125	Bolt Lengths > 125 and ≤ 200	Bolt Lengths > 200
	Max	Min	Max	Min	Max	Min	Max	Min	Min	Max	Min			
M5 x 0.8	5.48	4.52	8.00	7.64	9.24	8.63	3.88	3.35	2.4	5.7	0.2	16	22	35
M6 x 1	6.19	5.52	10.00	9.64	11.55	10.89	4.38	3.85	2.8	6.8	0.3	18	24	37
M8 x 1.25	8.58	7.42	13.00	12.57	15.01	14.20	5.68	5.10	3.7	9.2	0.4	22	28	41
M10 x 1.5	10.58	9.42	16.00	15.57	18.48	17.59	6.85	6.17	4.5	11.2	0.4	26	32	45
M12 x 1.75	12.70	11.30	18.00	17.57	20.78	19.85	7.95	7.24	5.2	13.7	0.6	30	36	49
M14 x 2	14.70	13.30	21.00	20.16	24.25	22.78	9.25	8.51	6.2	15.7	0.6	34	40	53
M16 x 2	16.70	15.30	24.00	23.16	27.71	26.17	10.75	9.68	7.0	17.7	0.6	38	44	57
M20 x 2.5	20.84	19.16	30.00	29.16	34.64	32.95	13.40	12.12	8.8	22.4	0.8	46	52	65
M24 x 3	24.84	23.16	36.00	35.00	41.57	39.55	15.90	14.56	10.5	26.4	0.8	54	60	73
M30 x 3.5	30.84	29.16	46.00	45.00	53.12	50.55	19.75	17.92	13.1	33.4	1.0	66	72	85
M36 x 4	37.00	35.00	55.00	53.80	63.51	60.79	23.55	21.62	15.8	39.4	1.0	78	84	97
M42 x 4.5	43.00	41.00	65.00	62.90	75.06	71.71	27.05	25.03	18.2	45.4	1.2	90	96	109
M48 x 5	49.00	47.00	75.00	72.60	86.60	82.76	31.07	28.93	21.0	52.0	1.5	102	108	121
M56 x 5.5	57.20	54.80	85.00	82.20	98.15	93.71	36.20	33.80	24.5	62.0	2.0	—	124	137
M64 x 6	65.52	62.80	95.00	91.80	109.70	104.65	41.32	38.68	28.0	70.0	2.0	—	140	153
M72 x 6	73.84	70.80	105.00	101.40	121.24	115.60	46.45	43.55	31.5	78.0	2.0	—	156	169
M80 x 6	82.16	78.80	115.00	111.00	132.79	126.54	51.58	48.42	35.0	86.0	2.0	—	172	185
M90 x 6	92.48	88.60	130.00	125.50	150.11	143.07	57.74	54.26	39.2	96.0	2.0	—	192	205
M100 x 6	102.80	98.60	145.00	140.00	167.43	159.60	63.90	60.10	43.4	107.0	2.5	—	212	225
See Notes	12				6.9		7		8	13		17.3		
* M10 x 1.5	10.58	9.42	15.00	14.57	17.32	16.46	6.85	6.17	4.5	11.2	0.4	26	32	45

*See Note 2.2 of General Data.

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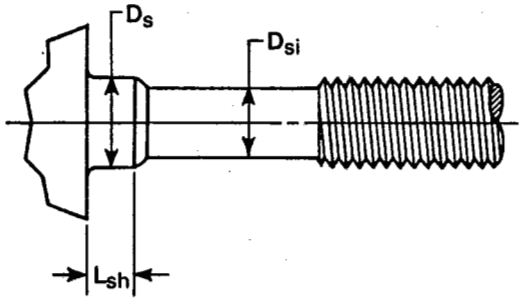

Table 2 Dimensions of Reduced Body Diameters

Nominal Bolt Dia and Thread Pitch	D_s Shoulder Diameter		D_{si} Body Diameter		L_{sh} Shoulder Length	
	Max	Min	Max	Min	Max	Min
M5 x 0.8	5.48	4.52	4.46	4.36	3.5	2.5
M6 x 1	6.48	5.52	5.39	5.21	4.0	3.0
M8 x 1.25	8.58	7.42	7.26	7.04	5.0	4.0
M10 x 1.5	10.58	9.42	9.08	8.86	6.0	5.0
M12 x 1.75	12.70	11.30	10.95	10.68	7.0	6.0
M14 x 2	14.70	13.30	12.77	12.50	8.0	7.0
M16 x 2	16.70	15.30	14.77	14.50	9.0	8.0
M20 x 2.5	20.84	19.16	18.49	18.16	11.0	10.0
M24 x 3	24.84	23.16	22.13	21.80	13.0	12.0

Note: Shoulder is optional.

Table 3 Length Tolerances

Nominal Length	Nominal Bolt Diameter				
	M5 thru M8	M10 thru M16	M20 and M24	M30 and M36	over M36
to 50 mm	0.8	1.3	2.0	3.0	—
over 50 to 80 mm	1.0	1.5	2.5	3.5	4.5
over 80 to 120 mm	1.1	1.8	3.0	4.0	6.0
over 120 to 180 mm	2.0	2.0	3.5	4.5	6.0
over 180 to 240 mm	4.0	4.0	4.0	6.0	6.0
over 240 mm	5.0	5.0	5.0	6.0	6.0

All tolerances are plus and minus

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APPENDIX I

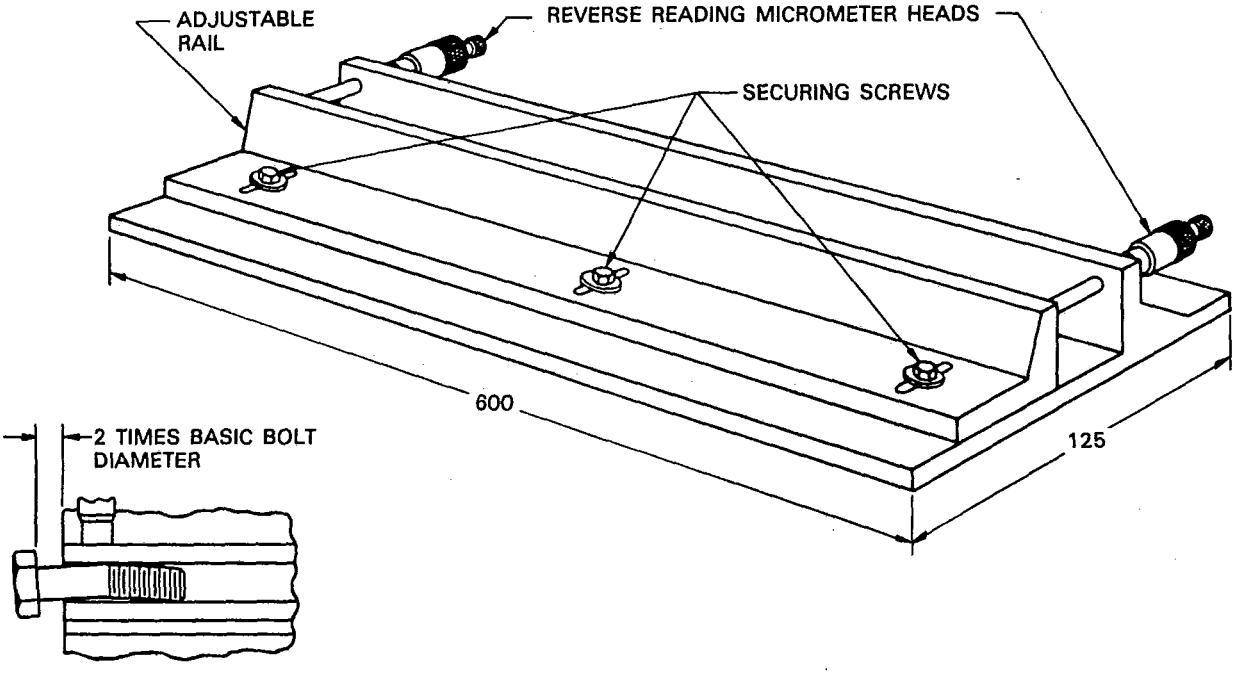
BOLT STRAIGHTNESS REFEREE GAGE AND GAGING PROCEDURE

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 occuring between the product and the gage which is sufficient to prevent rotation shall indicate excessive camber.

TYPICAL STRAIGHTNESS GAGE



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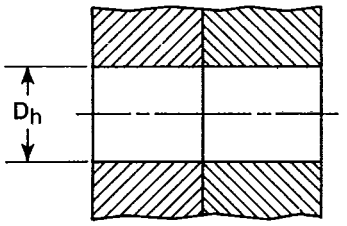
APPENDIX II

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
M5 x 0.8	5.3	5.5	5.8
M6 x 1	6.4	6.6	7.0
M8 x 1.25	8.4	9.0	10.0
M10 x 1.5	10.5	11.0	12.0
M12 x 1.75	13.0	13.5	14.5
M14 x 2	15.0	15.5	16.5
M16 x 2	17.0	17.5	18.5
M20 x 2.5	21.0	22.0	24.0
M24 x 3	25.0	26.0	28.0
M30 x 3.5	31.0	33.0	35.0
M36 x 4	37.0	39.0	42.0
M42 x 4.5	43.0	45.0	48.0
M48 x 5	50.0	52.0	56.0
M56 x 5.5	58.0	62.0	66.0
M64 x 6	66.0	70.0	74.0
M72 x 6	74.0	78.0	82.0
M80 x 6	82.0	86.0	91.0
M90 x 6	93.0	96.0	101.0
M100 x 6	104.0	107.0	112.0

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 bolt entry side to permit proper seating of the bolt 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 0.2 mm for bolt diameter M5; plus 0.3 mm for diameters M6 thru M16; plus 0.4 mm for bolt diameters M20 thru M24; plus 0.5 mm for bolt diameters M48 thru M72; and plus 0.6 mm for bolt diameters M80 thru M100.

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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. Diameter/Thread Pitch and Length Combinations—as specified in Table 4.

b. Material—Steel, Property Class 10.9.

c. Finish—Cadmium plating or zinc plating as coded in Part Numbering System.

d. Special Features—drilled head or self-locking, as specified.

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

e. Special Features

f. Special M10 Width Across Flats Size

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.

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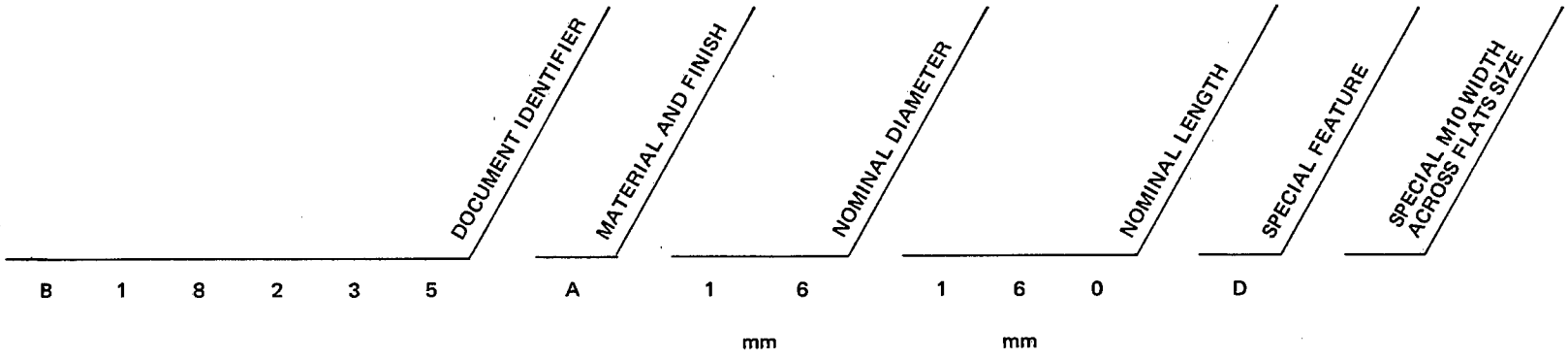
PART NUMBERING SYSTEM COVERING STANDARD ITEMS FOR GOVERNMENT USE

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



MATERIAL AND FINISH CODE

A — Steel w/Cadmium Pating per QQ-P-416, Type II, Class 3 (0.005 mm Plating Thickness), Property Class 10.9.

B — Steel w/Zinc Plating per QQ-Z-2, Type II, Class 3 (0.005mm Plating Thickness), Property Class 10.9.

SPECIAL FEATURE CODE

N — NONE

D — Drilled Head*

L — Self Locking*

C — Drilled Head and Self-Locking*

SPECIAL M10 WIDTH ACROSS FLATS SIZE CODE

F — 15mm Nominal

NOTE: The 16mm Hex Width Across Flats will be supplied unless Code F is designated.

EXAMPLE: B18235A16160D indicates a bolt, hex-metric, made of cadmium plated steel, property class 10.9, 16mm in diameter, 160mm in length, with drilled head.

*Details will be provided when available.

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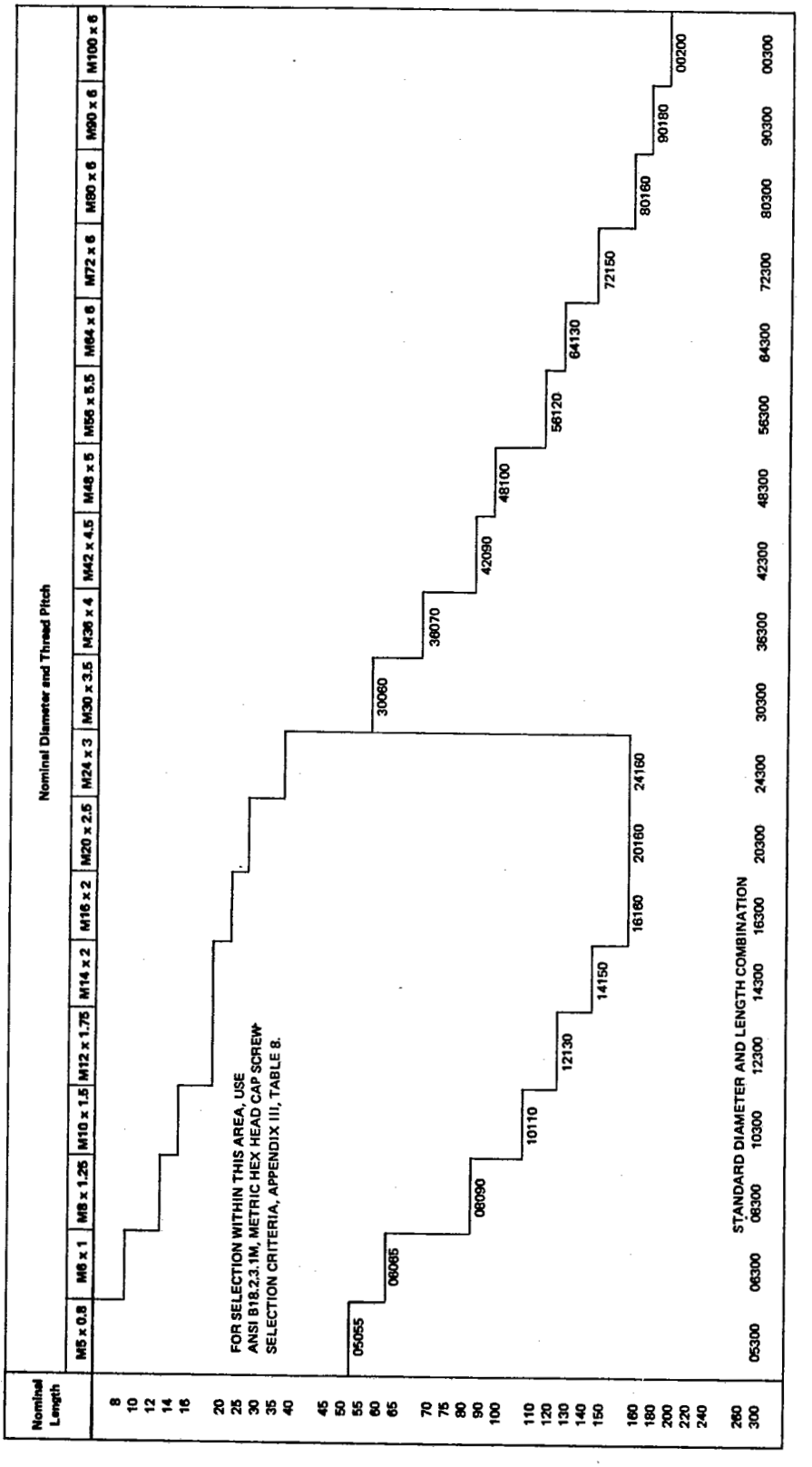
Table 4 Metric Hex Bolts—Standard Sizes for Government Use



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