

ASME B18.2.6M-2012
[Revision, redesignation, and consolidation of
ASME B18.2.3.7M-1979 (R2006) and ASME B18.2.4.6M-2010]

Metric Fasteners for Use in Structural Applications

AN AMERICAN NATIONAL STANDARD



**The American Society of
Mechanical Engineers**

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**The American Society of
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Three Park Avenue • New York, NY • 10016 USA

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FOREWORD

In the spring of 2010, the B18 Committee decided that a metric version of ASME B18.2.6, Fasteners for Use in Structural Applications, should be created for fastener guidance on metric structural fasteners used in North America. This Standard, ASME B18.2.6M, is the result of that effort. It was decided that since there were not yet any ASTM material and testing standards for twist-off bolts, their dimensions should not be included in this initial edition of this Standard. This Standard does include the dimensions for metric structural bolts, metric heavy hex nuts, metric structural washers, and metric compressible-washer-type direct tension indicators.

Suggestions for improvement of this Standard are welcome. They should be addressed to the Secretary, ASME B18 Standards Committee, Three Park Avenue, New York, NY 10016-5990.

This Standard was approved as an American National Standard on February 9, 2012.

ASME B18 COMMITTEE

Standardization of Bolts, Nuts, Rivets, Screws, Washers, and Similar Fasteners

(The following is the roster of the Committee at the time of approval of this Standard.)

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Secretary, B18 Standards Committee
The American Society of Mechanical Engineers
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Proposing Revisions. Revisions are made periodically to the Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

Proposing a Case. Cases may be issued for the purpose of providing alternative rules when justified, to permit early implementation of an approved revision when the need is urgent, or to provide rules not covered by existing provisions. Cases are effective immediately upon ASME approval and shall be posted on the ASME Committee Web page.

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Interpretations. Upon request, the B18 Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the B18 Standards Committee.

The request for interpretation should be clear and unambiguous. It is further recommended that the inquirer submit his/her request in the following format:

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

Requests that are not in this format may be rewritten in the appropriate format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME Committee or Subcommittee. ASME does not “approve,” “certify,” “rate,” or “endorse” any item, construction, proprietary device, or activity.

Attending Committee Meetings. The B18 Standards Committee regularly holds meetings that are open to the public. Persons wishing to attend any meeting should contact the Secretary of the B18 Standards Committee.

METRIC FASTENERS FOR USE IN STRUCTURAL APPLICATIONS

1 INTRODUCTION

1.1 Scope

1.1.1 This Standard covers the complete general and dimensional data for products in the metric series recognized as American National Standard for sizes M12 through M36. These four metric structural products include

- (a) metric heavy hex structural bolts: ASTM A325M and ASTM A490M
- (b) metric heavy hex nuts: ASTM A563M
- (c) metric hardened steel washers; circular, circular clipped, and beveled: ASTM F436M
- (d) metric compressible washer-type direct tension indicators: ASTM F959M

1.1.2 The inclusion of dimensional data in this Standard is not intended to imply that all products described herein are stock production sizes. Consumers should consult with suppliers concerning lists of available stock production sizes.

1.2 Dimensions

All dimensions in this Standard are in millimeters, unless stated otherwise, and apply to unplated or uncoated product. When plating or coating is specified, the finished product dimensions shall be as agreed upon between supplier and purchaser. Symbols specifying geometric characteristics are in accordance with ASME Y14.5.

1.3 Options

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

1.4 Terminology

For definitions of terms relating to fastener dimensional or component features used in this Standard, refer to ASME B18.12.

1.5 Comparison to ISO and CEN Standards

ISO 4775 is similar to the nut in this Standard.

ISO 7415 is similar to the structural washer in this Standard.

There are no comparable ISO standards for compressible indicating washers.

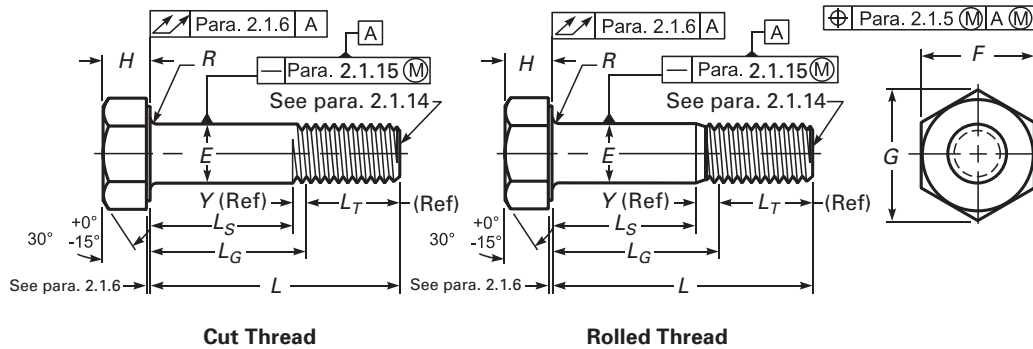
CEN 14399 is a similar standard for structural fasteners including hex bolts, heavy hex nuts, structural washers, and compressible indicating washers.

1.6 Referenced Standards

Unless otherwise specified, the referenced standard shall be the most recent issue.

- ASME B1.3, Screw Thread Gaging Systems for Acceptability — Inch and Metric Screw Threads (UN, UNR, UNJ, M, and MJ)
 - ASME B1.13M, Metric Screw Threads — M Profile
 - ASME B1.16M, Gages and Gaging for Metric M Screw Threads
 - ASME B18.2.4.6M, Metric Heavy Hex Nuts
 - ASME B18.2.9, Straightness Gage and Gaging for Bolts and Screws
 - ASME B18.12, Glossary of Terms for Mechanical Fasteners
 - ASME B18.18, Quality Assurance for Fasteners
 - ASME B18.24, Part Identifying Number (PIN) Code System for B18 Fastener Products
 - ASME Y14.5-2009, Dimensioning and Tolerancing
- Publisher: The American Society of Mechanical Engineers (ASME), Three Park Avenue, New York, NY 10016-5990; Order Department: 22 Law Drive, P.O. Box 2900, Fairfield, NJ 07007-2900 (www.asme.org)

- ASTM A325M, Structural Bolts, Steel, Heat Treated 830 MPa Minimum Tensile Strength (Metric)
 - ASTM A490M, High Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Joints (Metric)
 - ASTM A563M, Carbons and Alloy Steel Nuts (Metric)
 - ASTM B695, Coatings of Zinc Mechanically Deposited on Iron and Steel
 - ASTM F436M, Hardened Steel Washers (Metric)
 - ASTM F788/F788M, Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series
 - ASTM F812/F812M, Surface Discontinuities of Nuts, Inch and Metric Series
 - ASTM F959M, Compressible Washer Type Direct Tension Indicators for Use With Structural Fasteners (Metric)
 - ASTM F2674, Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners (Metric)
- Publisher: American Society for Testing and Materials (ASTM International), 100 Barr Harbor Drive, P.O. Box

Table 1 Dimensions of Metric Heavy Hex Structural Bolts

Pitch	Body Diameter, E		AF, F		AC, G		Head Height, H		Minimum Fillet Radius, R	Thread Length, L _T , Ref.	Maximum Transition Thread Length, Y, Ref.	Maximum Runout of Bearing Surface FIM
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.				
M12 × 1.75	12.70	11.30	21.00	20.16	24.25	22.78	7.95	7.05	0.60	25	5.2	0.4
M16 × 2	16.70	15.30	27.00	26.16	31.18	29.56	10.75	9.25	0.60	31	6.0	0.5
M20 × 2.5	20.84	19.16	34.00	33.00	39.26	37.29	13.40	11.60	0.80	36	7.5	0.6
M22 × 2.5	22.84	21.16	36.00	35.00	41.57	39.55	14.90	13.10	0.80	38	7.5	0.6
M24 × 3	24.84	23.16	41.00	40.00	47.34	45.20	15.90	14.10	1.00	41	9.0	0.7
M27 × 3	27.84	26.16	46.00	45.00	53.12	50.85	17.90	16.10	1.20	44	9.0	0.8
M30 × 3.5	30.84	29.16	50.00	49.00	57.74	55.37	19.75	17.65	1.20	49	10.5	0.9
M36 × 4	37.00	35.00	60.00	58.80	69.28	66.44	23.55	21.45	1.50	56	12.0	1.0

GENERAL NOTE: See Table 2 for L_G and L_S dimensions.

C700, West Conshohocken, PA 19428-2959 (www.astm.org)

2 METRIC HEAVY HEX STRUCTURAL BOLTS: ASTM A325M AND ASTM A490M

2.1 Metric Heavy Hex Structural Bolt Dimensions

Bolts shall conform to the dimensions given in Table 1.

2.1.1 Top of Head. The top of the head shall be full form and chamfered or rounded with the diameter of the chamfer circle, or start of rounding being equal to the maximum width across flats within a tolerance of -15% of the maximum across flats dimension.

2.1.2 Width Across Flats. The width across flats of heads shall be the distance measured perpendicular to the axis of product, overall between two opposite sides of the head.

2.1.3 Head Taper. The maximum width across flats shall not be exceeded. No transverse section through the head between 25% and 75% of actual head height, as measured from the bearing surface, shall be less than the minimum width across flats.

2.1.4 Head Height. The head height shall be that overall distance measured parallel to the axis of the product from the top of the head to the bearing surface and shall include the thickness of the washer face. The

raised grade and the manufacturer's identification are excluded from the head height.

2.1.5 Position of Head. The runout of the flats of the head shall be no greater than 6% of the maximum width across flats. For referee purposes, the evaluation shall be made by indicating on the flats while holding the body one bolt diameter from under the head and rotating the part.

2.1.6 Bearing Surface. Bearing surface shall be flat and washer faced. However, a die seam across the bearing face shall be permissible. The diameter of the washer face shall be equal to the maximum width across the flats with a minus tolerance of 10%. The thickness of the washer face shall be not less than 0.04 mm nor greater than 0.08 mm. The plane of the bearing surface shall be perpendicular to the axis of the body within the FIM limits specified for total runout. The measurement of FIM shall extend as close to the periphery of the bearing surface as possible while the bolt is being held in a collet or other gripping device at a distance of one bolt diameter from the underside of the head. The angularity measurement shall be taken at a location to avoid interference from a die seam.

2.1.7 Body Diameter. The body diameter limits are shown in Table 1. Any swell or fin under the head or any die seam on the body shall not exceed the basic bolt diameter by the following:

- (a) 1.25 mm for M12 and M16
- (b) 1.5 mm for M20 through M30
- (c) 2.30 mm for M36

2.1.8 Bolt Length. The bolt length shall be the distance measured parallel to the axis of the product from the bearing surface of the head to the extreme end of the bolt including point. Bolts are normally furnished in 5 mm length increments through 100 mm and 10 mm increments over 100 mm.

2.1.9 Length Tolerance. Bolt length tolerances shall be as tabulated below.

Size	M12	M16	M20	M22	M24	M27	M30	M36
Length ≤ 150 mm	-3.0	-3.0	-4.0	-4.0	-4.0	-6.0	-6.0	-6.0
Length > 150 mm	-4.0	-6.0	-6.0	-6.0	-6.0	-6.0	-6.0	-6.0

2.1.10 Threads. Threads shall be cut or rolled in accordance with ASME B1.13M coarse, Class 6g. Structural bolts shall not be undersized.

2.1.11 Thread Acceptability. Unless otherwise specified by the purchaser, gaging for screw thread dimensional acceptability shall be in accordance with Gaging System 21 as specified in ASME B1.3.

2.1.12 Thread Length. The length of thread on bolts shall be controlled by the grip gaging length, L_G max., and the body length, L_S min.

Grip gaging length, L_G max., is the distance measured parallel to the axis of the bolt, from the under head bearing surface to the face of a noncounterbored 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 L_G 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, L_T , as specified in Table 1 (L_G max. = $L - L_T$). L_G max. shall be used as a criterion for inspection.

Thread length, L_T , is a reference dimension, intended for calculation purposes only, which represents the distance from the extreme end of the bolt to the last complete (full form) thread.

Body length, L_S 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 L_S 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 (L_S min. = L_G max. - Y max.). L_S min. shall be used as a criterion for inspection. Bolts of nominal lengths that have a calculated L_S min. value

equal to or less than the length of 2.5 times the thread pitch shall be threaded full length.

Transition thread length, Y , is a reference dimension, intended for calculation purposes only, which represents the length of incomplete threads and tolerance on grip gaging length.

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

2.1.14 Point. Point shall be chamfered or rounded at the manufacturer's option from major diameter to slightly below the minor diameter of the thread. The first full formed thread at major diameter is located a distance no greater than 2 times the pitch measured from the end of the bolt. This distance is to be determined by measuring how far the point enters into a cylindrical NOT GO major diameter ring gage (reference gage, ASME B1.16M).

2.1.15 Straightness. Shanks of bolts shall be straight within the following limits at maximum material condition (MMC). Bolts with nominal lengths to and including 300 mm, shall have a maximum camber of 0.006 mm/mm (0.006L) of bolt length. Bolts with nominal lengths over 300 mm to and including 600 mm shall have a maximum camber of 0.008 mm/mm (0.008L) of length. A suggested gage and gaging procedure for checking bolt straightness is given in ASME B18.2.9.

2.2 Bolt Materials and Processing

Chemical and mechanical properties of steel bolts shall conform to ASTM A325M or ASTM A490M as applicable.

2.3 Bolt Finish

Structural fasteners shall be plain finish unless otherwise specified by the purchaser. Finishes shall be limited to those approved in the specified ASTM A325M and A490M material standards as applicable.

2.4 Bolt Designation

(a) Metric heavy hex structural bolts shall be designated by the following data in the sequence shown: product name, specification, nominal size (fractional or decimal equivalent), thread pitch, product length (fractional or two-decimal-place equivalent), material (including specification and type where necessary), and protective finish (if required).

EXAMPLE: Metric Heavy Hex Structural Bolt, ASME B18.2.6M, M20 \times 2.5 \times 100, ASTM A325M Type 1, Hot-Dip Zinc Coated per ASTM F2674

(b) For a part-identifying number (PIN), refer to ASME B18.24.

2.5 Identification Symbols

Identification marking symbols on the tops of heads may be indented or raised. If raised, they shall project

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

Nominal Length, L	Nominal Bolt Diameter and Thread Pitch															
	M12 \times 1.75		M16 \times 2		M20 \times 2.5		M22 \times 2.5		M24 \times 3		M27 \times 3		M30 \times 3.5		M36 \times 4	
	L_G , Max.	L_S , Min.	L_G , Max.	L_S , Min.	L_G , Max.	L_S , Min.	L_G , Max.	L_S , Min.	L_G , Max.	L_S , Min.	L_G , Max.	L_S , Min.	L_G , Max.	L_S , Min.	L_G , Max.	L_S , Min.
40	15	9.8	...	...	...	...	...	...	...	...	...	...	...	...	...	...
45	20	14.8	14	8	...	...	...	...	...	...	...	...	...	...	...	...
50	25	19.8	19	13	14	6.5	...	...	...	...	...	...	...	...	...	...
55	30	24.8	24	18	19	11.5	17	9.5	...	...	...	...	...	...	...	...
60	35	29.8	29	23	24	16.5	22	14.5	19	10	...	...	...	...	...	...
65	40	34.8	34	28	29	21.5	27	19.5	24	15	21	12	...	...	...	...
70	45	39.8	39	33	34	26.5	32	24.5	29	20	26	17	21	10.5	...	...
75	50	44.8	44	38	39	31.5	37	29.5	34	25	31	22	26	15.5	...	...
80	55	49.8	49	43	44	36.5	42	34.5	39	30	36	27	31	20.5	19	7
85	60	54.8	54	48	49	41.5	47	39.5	44	35	41	32	36	25.5	24	12
90	65	59.8	59	53	54	46.5	52	44.5	49	40	46	37	41	30.5	29	17
95	70	64.8	64	58	59	51.5	57	49.5	54	45	51	42	46	35.5	34	22
100	75	69.8	69	63	64	56.5	62	54.5	59	50	56	47	51	40.5	39	27
110	...	...	79	73	74	66.5	72	64.5	69	60	66	57	61	50.5	44	32
120	...	...	89	83	84	76.5	82	74.5	79	70	76	67	71	60.5	54	42
130	...	...	99	93	94	86.5	92	84.5	89	80	86	77	81	70.5	64	52
140	...	...	109	103	104	96.5	102	94.5	99	90	96	87	91	80.5	74	62
150	...	...	119	113	114	106.5	112	104.5	109	100	106	97	101	90.5	84	72
160	...	...	129	123	124	116.5	122	114.5	119	110	116	107	111	100.5	94	82
170	...	...	139	133	134	126.5	132	124.5	129	120	126	117	121	110.5	104	92
180	...	...	149	143	144	136.5	142	134.5	139	130	136	127	131	120.5	114	102
190	...	...	159	153	154	146.5	152	144.5	149	140	146	137	141	130.5	124	112
200	...	...	169	163	164	156.5	162	154.5	159	150	156	147	151	140.5	134	122
210	...	...	179	173	174	166.5	172	164.5	169	160	166	157	161	150.5	144	132
220	...	...	189	183	184	176.5	182	174.5	179	170	176	167	171	160.5	154	142
230	...	...	199	193	194	186.5	192	184.5	189	180	186	177	181	170.5	164	152
240	...	...	209	203	204	196.5	202	194.5	199	190	196	187	191	180.5	174	162
250	...	...	219	213	214	206.5	212	204.5	209	200	206	197	201	190.5	184	172
260	...	...	229	223	224	216.5	222	214.5	219	210	216	207	211	200.5	194	182
270	...	...	239	233	234	226.5	232	224.5	229	220	226	217	221	210.5	204	192
280	...	...	249	243	244	236.5	242	234.5	239	230	236	227	231	220.5	214	202
290	...	...	259	253	254	246.5	252	244.5	249	240	246	237	241	230.5	224	212
300	...	...	269	263	264	256.5	262	254.5	259	250	256	247	251	240.5	234	222

not less than 0.3 mm above the surface of the top of the head nor more than 0.4 mm over the specified maximum head height. The size of the marking characters or symbol shall not be less than 0.4 mm.

2.5.1 Grade Symbols. Each bolt shall be marked in accordance with the requirements of the applicable specification, ASTM A325M or ASTM A490M.

2.5.2 Identification Symbols. Identification marking symbols on products included in this Standard shall be raised or indented at the manufacturer's option unless otherwise specified. Markings shall be legible to the unaided eye with the exception of corrective lenses. When raised, the height of the marking may not exceed 0.4 mm over the specified maximum head height for bolts M16 and smaller. For bolts larger than M16, the marking may not project more than 0.8 mm over the specified maximum head height. When indented, the depth of the marking shall not reduce the load-carrying capacity of the fastener.

2.6 Bolt Workmanship

The allowable limits, inspection, and evaluation of the surface discontinuities, quench cracks, forging cracks, head bursts, shear bursts, seams, folds, thread laps, voids, tool marks, nicks, and gouges shall be in accordance with ASTM F788/F788M.

2.7 Quality Assurance

Unless otherwise specified, products shall be furnished in accordance with ASME B18.18.

3 METRIC HEAVY HEX NUTS: ASTM A563M

3.1 Metric Nut Dimensions

Nuts shall conform to the dimensions given in Table 3. Metric heavy hex nut formulas for thickness, width across flats, and width across corners are given in Mandatory Appendix II of ASME B18.2.4.6M.

3.1.1 Width Across Flats. The width across flats of heavy hex nuts shall be the overall distance measured, perpendicular to the axis of the nut, and between two opposite sides of the nut in accordance with Table 3.

Maximum width across flats shall not be exceeded (except as stated in the previous paragraph). No transverse section through the nut between 25% and 75% of the actual nut thickness, as measured from the bearing surface, shall be less than the minimum width across flats.

3.1.2 Nut Thickness. The nut thickness shall be the overall distance measured parallel to the axis of the nut, from the top of the nut to the bearing surface, and shall include the thickness of the washer face where provided.

3.1.3 Tops and Bearing Surfaces. Nuts may be double chamfered or have a washer faced bearing surface and chamfered top.

The diameter of chamfer circle on double chamfered nuts and the diameter of washer face shall be within the limits of the maximum width across flats and 95% of the minimum width across flats.

The tops of washer faced nuts shall be flat, and the diameter of the chamfer circle shall be equal to the maximum width across flats with a minus tolerance of 15%. The length of chamfer at hex corners shall be 5% to 15% of the basic thread diameter. The surface of chamfer may be slightly convex or rounded.

Bearing surfaces shall be flat and, unless otherwise specified, shall be perpendicular to the axis of the threaded hole within the total runout (FIM) tabulated for the respective nut size, type, and strength level.

3.1.4 Corner Fill. A rounding or lack of fill at junction of hex corners with chamfer shall be permissible, provided the width across corners is within specified limits at and beyond a distance equal to 17.5% of the basic thread diameter from the chamfered faces.

3.1.5 Position of Hexagon to Tapped Hole. At maximum material condition, the nut body shall be located at true position with respect to the thread pitch diameter within a tolerance zone having a diameter equivalent to 4% of the maximum width across the flats.

3.1.6 Countersink. The tapped hole shall be countersunk on the bearing face or faces. The maximum countersink diameter shall be 1.08 times the thread basic (nominal) major diameter. No part of the threaded portion shall project beyond the bearing surface.

3.1.7 Threads. Threads shall be Class 6H in accordance with ASME B1.13M except when overtapping is required according to para. 3.1.7.2.

3.1.7.1 Thread Gaging. Unless otherwise specified by the purchaser, gaging for screw thread dimensional acceptability shall be in accordance with Gaging System 21 as specified in ASME B1.3.

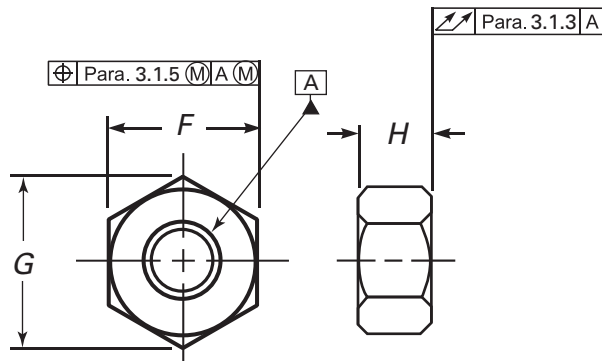
3.1.7.2 Overtapping. When nuts are zinc coated, either hot dip or mechanical, they shall be overtapped in accordance with the requirements in ASTM A563M.

3.2 Nut Materials

Chemical and mechanical properties of heavy hex nuts shall conform to ASTM A563M property classes.

3.3 Nut Finish

Unless otherwise specified, nuts shall be supplied with a plain (as-processed) finish, unplated or uncoated. If a finish is required, it shall conform with the applicable finish standard listed in ASTM A563M. The finish on nuts shall be the same type as that designated on and approved for the mating bolts.

Table 3 Dimensions of Metric Heavy Hex Nuts for Use With Structural Bolts

Pitch	Width Across Flats, F		Width Across Corners, G		Thickness, H		Maximum Total Runout of Bearing Surface FIM
	Max.	Min.	Max.	Min.	Max.	Min.	
M12 × 1.75	21.00	20.16	24.25	22.78	12.3	11.9	0.38
M16 × 2.00	27.00	26.16	31.18	29.56	17.1	16.4	0.47
M20 × 2.50	34.00	33.00	39.26	37.29	20.7	19.4	0.58
M22 × 2.50	36.00	35.00	41.57	39.55	23.6	22.3	0.63
M24 × 3.00	41.00	40.00	47.34	45.20	24.2	22.9	0.72
M27 × 3.00	46.00	45.00	53.12	50.85	27.6	26.3	0.80
M30 × 3.50	50.00	49.00	57.74	55.37	30.7	29.1	0.87
M36 × 4.00	60.00	58.80	69.28	66.44	36.6	35.0	1.05

3.4 Nut Designation

(a) Nuts shall be designated by the following data in the sequence shown: product name, specification, nominal diameter and thread pitch, material (including specification where necessary), and protective finish (if required).

EXAMPLE: Metric Heavy Hex Nut ASME B18.2.6M, M24 × 3, ASTM A563M Property Class 10, Plain Finish

(b) For a part-identifying number (PIN), refer to ASME B18.24.

3.5 Identification Symbols

3.5.1 Property Class Symbols. Each nut shall be marked in accordance with the applicable requirements of ASTM A563M.

3.5.2 Source Symbols. Each nut shall be marked to identify the source (manufacturer or private label distributor) accepting the responsibility for conformance to this and other applicable specifications.

3.6 Nut Workmanship

Surface discontinuity limits shall be in accordance with ASTM F812/F812M.

3.7 Nut Quality Assurance

Unless otherwise specified, products shall be furnished in accordance with ASME B18.18.

4 METRIC HARDENED STEEL WASHERS: ASTM F436M

4.1 Circular and Circular Clipped Washers

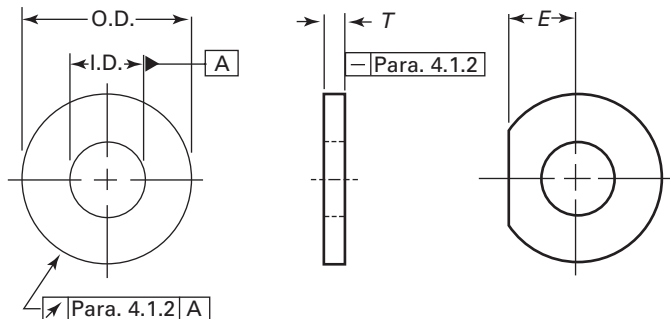
4.1.1 Circular and Circular Clipped Washer Dimensions. All circular and circular clipped washers shall conform to the dimensions given in Table 4.

4.1.2 Tolerances. The washer inside diameter, outside diameter, thickness, and edge distance shall be in accordance with Table 4. The deviation from flatness shall not exceed 0.01 mm/mm of outside diameter as the maximum deviation from a straight edge placed on the cut side. The circular runout of the outside diameter with respect to the hole shall not exceed 0.75 mm FIM. Burrs shall not project above the immediately adjacent washer surface by more than 0.25 mm.

4.1.3 Thickness. There are two thicknesses of structural washers: standard and extra thick. Unless otherwise specified by the buyer on the order, the standard thickness shall be supplied.

4.1.4 Washer Finish. Unless otherwise specified, washers shall be supplied with a plain (as-processed) finish. If a finish is required, it shall conform with the applicable finish standard listed in ASTM F436M.

4.1.5 Washer Materials and Mechanical Properties. Materials and properties shall conform to the requirements specified in ASTM F436M.

Table 4 Dimensions of Metric Hardened Steel Circular and Circular Clipped Washers

Nominal Size [Note (1)]	I.D.		O.D.		T				Clipped Width, E, Min. [Note (2)]
					Standard		Extra Thick		
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	
12	14.4	14.0	27.0	25.7	4.6	3.1	10.0	8.0	10.5
16	18.4	18.0	34.0	32.4	4.6	3.1	10.0	8.0	14.0
20	22.5	22.0	42.0	40.4	4.6	3.1	10.0	8.0	17.5
22	24.5	24.0	44.0	42.4	4.6	3.4	10.0	8.0	19.2
24	26.5	26.0	50.0	48.4	4.6	3.4	10.0	8.0	21.0
27	30.5	30.0	56.0	54.1	4.6	3.4	10.0	8.0	23.6
30	33.6	33.0	60.0	58.1	4.6	3.4	10.0	8.0	26.2
36	39.6	39.0	72.0	70.1	4.6	3.4	10.0	8.0	31.5
42	45.6	45.0	84.0	81.8	7.2	4.6	10.0	8.0	36.7
48	52.7	52.0	95.0	92.8	7.2	4.6	10.0	8.0	42.0
56	62.7	62.0	107.0	104.8	8.7	6.1	10.0	8.0	49.0
64	70.7	70.0	118.0	115.8	8.7	6.1	10.0	8.0	56.0
72	78.7	78.0	130.0	127.5	8.7	6.1	10.0	8.0	63.0
80	86.9	86.0	142.0	139.5	8.7	6.1	10.0	8.0	70.0
90	96.9	96.0	159.0	156.5	8.7	6.1	10.0	8.0	78.7
100	107.9	107.0	176.0	173.5	8.7	6.1	10.0	8.0	87.5

NOTES:

- (1) Nominal washer sizes are intended for use with comparable nominal bolt diameters.
(2) Clipped edge, E, shall not be closer than 0.875 times the nominal bolt diameter from the center of the washer.

4.1.6 Washer Workmanship. Washers shall be free of excess mill scale, excess coatings, and foreign material on bearing surfaces; arc and gas cut washers shall be free of metal splatter.

4.1.7 Washer Designation

(a) Washers shall be designated by the following data in the sequence shown: product name, specification, nominal diameter, material specification, and protective finish (if required).

EXAMPLE: Metric Hardened Steel Circular Washer, ASME B18.2.6M, M30, ASTM F436M, Mechanical Zinc, ASTM B695 Class 55, Type I.

(b) For a part-identifying number (PIN), refer to ASME B18.24.

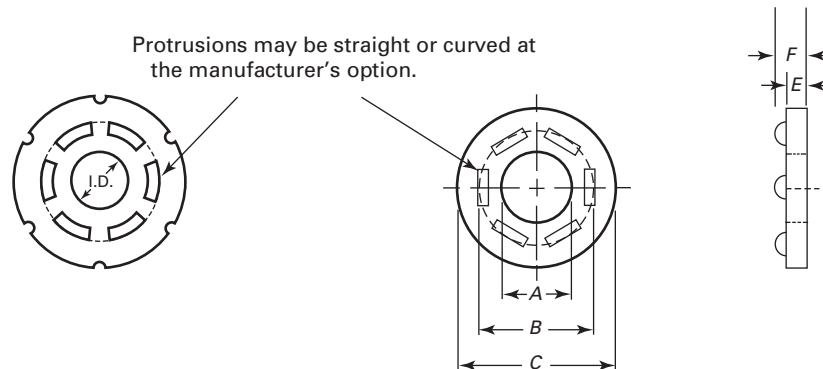
4.1.8 Washer Identification Symbols. Grade and source marking and symbols shall conform to the requirements of ASTM F436M. The source marking is

intended to identify the source accepting the responsibility for the conformance to this and other applicable specifications.

4.1.9 Washer Quality Assurance. Unless otherwise specified, products shall be furnished in accordance with ASME B18.18.

5 METRIC COMPRESSIBLE WASHER-TYPE DIRECT TENSION INDICATORS: ASTM F959M**5.1 Direct Tension Indicator Dimensions**

All washer-type direct tension indicators, Type 325M and Type 490M, shall conform to the dimensions given in Table 5. Additional characteristics to accommodate the necessary features for silicone-emitting type indicator washers are permissible.

Table 5 Dimensions for Metric Compressible Washer-Type Direct Tension Indicators

Size [Note (2)]	Type 8.8 [Note (1)]					Type 10.9 [Note (1)]					All Types		
	C		Number of Protrusions (Equally Spaced)	E, Min.	F, Max.	C		Number of Protrusions (Equally Spaced)	E, Min.	F, Max.	A		B
	Min.	Max.				Min.	Max.				Min.	Max.	
M12	...	...	...	...	...	...	...	...	...	...	...	...	...
M16	35.2	36.8	4	3.2	5.5	35.2	36.8	4	3.6	6.0	16.75	16.85	25.0
M20	44.0	46.0	5	3.6	6.0	44.0	46.0	6	3.6	6.0	20.95	21.05	29.0
M22	48.4	50.6	5	3.6	6.0	48.4	50.6	6	4.0	7.0	23.05	23.15	33.0
M24	52.8	55.2	6	4.0	7.0	52.8	55.2	7	4.0	7.0	25.15	25.25	38.0
M27	59.4	62.1	6	4.0	7.0	59.4	62.1	7	4.0	7.0	28.3	28.4	43.0
M30	66.0	69.0	7	4.0	7.0	66.0	69.0	8	4.8	7.5	31.45	31.55	46.5
M36	79.2	82.8	8	4.8	7.5	79.2	82.8	9	4.8	7.5	37.75	37.85	56.0

GENERAL NOTE: Additional requirements are in section 5.

NOTES:

- (1) Type 8.8 and Type 10.9 are intended for use on ASTM A325M and ASTM A490M bolts, respectively.
 (2) Nominal direct tension indicator sizes are intended for use with fasteners of the same nominal diameter.

5.2 DTI Finish

Unless otherwise specified, direct tension indicators shall be supplied with a plain (as-processed) finish, unplated, or uncoated. If a finish is required, it shall conform with the applicable finish standard listed in ASTM F959M.

5.3 DTI Materials and Properties

Direct tension indicators shall conform to the requirements of ASTM F959M. Silicone-emitting type indicator washers shall meet all of the performance requirements of ASTM F959M and the dimensional requirement in this Standard.

5.4 DTI Workmanship

The workmanship shall be smooth and free of burrs, laps, seams, excess mill scale, and foreign material on bearing surfaces or in protrusions, or other defects that would make them unsuitable for intended application.

5.5 DTI Designation

(a) Compressible washer-type direct tension indicators shall be designated by the following data in the sequence shown: product name, specification, nominal size, Type (8.8 or 10.9), and finish (plain, zinc, or epoxy).

EXAMPLE: DTI, ASME B18.2.6M, M16, Type 8.8 per ASTM F959M, Plain Finish

(b) For a part-identifying number (PIN), refer to ASME B18.24.

5.6 Identification Symbols or Markings

Grade, lot number, and source marking symbols shall conform to the requirements of ASTM F959M.

5.7 DTI Quality Assurance

Unless otherwise specified, products shall be furnished in accordance with ASME B18.18.

B18 AMERICAN NATIONAL STANDARDS FOR BOLTS, NUTS, RIVETS, SCREWS, WASHERS, AND SIMILAR FASTENERS

Small Solid Rivets	B18.1.1-1972 (R2011)
Large Rivets	B18.1.2-1972 (R2011)
Metric Small Solid Rivets	B18.1.3M-1983 (R2011)
Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)	B18.2.1-2010
Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)	B18.2.2-2010
Metric Hex Cap Screws	B18.2.3.1M-1999 (R2011)
Metric Formed Hex Screws	B18.2.3.2M-2005
Metric Heavy Hex Screws	B18.2.3.3M-1979 (R2001)
Metric Hex Flange Screws	B18.2.3.4M-2001 (R2011)
Metric Hex Bolts	B18.2.3.5M-1979 (R2011)
Metric Heavy Hex Bolts	B18.2.3.6M-1979 (R2006)
Metric Heavy Hex Flange Screws	B18.2.3.9M-2001 (R2006)
Metric Slotted Hex Nuts	B18.2.4.3M-1979 (R2012)
Metric Flanged 12-Point Head Screws	B18.2.5M-2009
Metric Fasteners for Use in Structural Applications	B18.2.6M-2012
Metric 12-Spline Flange Screws	B18.2.7.1M-2002 (R2007)
Clearance Holes for Bolt, Screws, and Studs	B18.2.8-1999 (R2010)
Straightness Gage and Gaging for Bolts and Screws	B18.2.9-2010
Socket Cap, Shoulder, and Set Screws, Hex and Spline Keys (Inch Series)	B18.3-2003 (R2008)
Socket Head Cap Screws (Metric Series)	B18.3.1M-1986 (R2008)
Metric Series Hexagon Keys and Bits	B18.3.2M-1979 (R2008)
Hexagon Socket Head Shoulder Screws (Metric Series)	B18.3.3M-1986 (R2008)
Hexagon Socket Button Head Cap Screws (Metric Series)	B18.3.4M-1986 (R2008)
Hexagon Socket Flat Countersunk Head Cap Screws (Metric Series)	B18.3.5M-1986 (R2008)
Metric Series Socket Set Screws	B18.3.6M-1986 (R2008)
Round Head Bolts (Inch Series)	B18.5-1990 (R2003)
Metric Round Head Short Square Neck Bolts	B18.5.2.1M-2006 (R2011)
Metric Round Head Square Neck Bolts	B18.5.2.2M-1982 (R2010)
Wood Screws (Inch Series)	B18.6.1-1981 (R2008)
Slotted Head Cap Screws, Square Head Set Screws, and Slotted Headless Set Screws (Inch Series)	B18.6.2-1998 (R2010)
Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series)	B18.6.3-2010
Thread Forming and Thread Cutting Tapping Screws and Metallic Drive Screws (Inch Series)	B18.6.4-1998
Metric Thread-Forming and Thread-Cutting Tapping Screws	B18.6.5M-2000 (R2010)
Metric Machine Screws	B18.6.7M-1999 (R2010)
Thumb Screws and Wing Screws (Inch Series)	B18.6.8-2010
Wing Nuts (Inch Series)	B18.6.9-2010
General Purpose Semi-Tubular Rivets, Full Tubular Rivets, Split Rivets and Rivet Caps	B18.7-2007
Metric General Purpose Semi-Tubular Rivets	B18.7.1M-2007
Clevis Pins and Cotter Pins (Inch Series)	B18.8.1-1994 (R2010)
Taper Pins, Dowel Pins, Straight Pins, Grooved Pins, and Spring Pins (Inch Series)	B18.8.2-2000 (R2010)
Spring Pins: Coiled Type, Spring Pins: Slotted, Machine Dowel Pins: Hardened Ground, and Grooved Pins (Metric Series)	B18.8.100M-2000 (R2010)
Cotter Pins, Headless Clevis Pins, and Headed Clevis Pins (Metric Series)	B18.8.200M-2000 (R2010)
Plow Bolts	B18.9-2007
Track Bolts and Nuts	B18.10-2006 (R2011)
Miniature Screws	B18.11-1961 (R2010)
Glossary of Terms for Mechanical Fasteners	B18.12-2012
Screw and Washer Assemblies — Sems (Inch Series)	B18.13-1996 (R2008)
Screw and Washer Assemblies: SEMS (Metric Series)	B18.13.1M-2011
Forged Eyebolts	B18.15-1985 (R2008)
Prevailing-Torque Type Steel Metric Hex Nuts and Hex Flange Nuts	B18.16M-2004 (R2009)
Serrated Hex Flange Locknuts 90,000 psi (Inch Series)	B18.16.4-2008
Nylon Insert Locknuts (Inch Series)	B18.16.6-2008
Quality Assurance for Fasteners	B18.18-2011

Inspection and Quality Assurance for General Purpose Fasteners	B18.18.1-2007
Inspection and Quality Assurance for High-Volume Machine Assembly Fasteners	B18.18.2-2009
Inspection and Quality Assurance for Special Purpose Fasteners	B18.18.3M-1987 (R2005)
Inspection and Quality Assurance for Fasteners for Highly Specialized Engineered Applications	B18.18.4M-1987 (R2005)
Inspection and Quality Assurance Plan Requiring In-Process Inspection and Controls	B18.18.5M-1998 (R2009)
Quality Assurance Plan for Fasteners Produced in a Third Party Accreditation System	B18.18.6M-1998 (R2009)
Quality Assurance Plan for Fasteners Produced in a Customer Approved Control Plan	B18.18.7M-1998 (R2009)
Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)	B18.21.1-2009
Lock Washers (Metric Series)	B18.21.2M-1999 (R2005)
Double Coil Helical Spring Lock Washers for Wood Structures	B18.21.3-2008
Metric Plain Washers	B18.22M-1981 (R2010)
Part Identifying Number (PIN) Code System for B18 Fastener Products	B18.24-2004
Square and Rectangular Keys and Keyways	B18.25.1M-1996 (R2008)
Woodruff Keys and Keyways	B18.25.2M-1996 (R2008)
Square and Rectangular Keys and Keyways: Width Tolerances and Deviations Greater Than Basic Size	B18.25.3M-1998 (R2008)
Tapered and Reduced Cross Section Retaining Rings (Inch Series)	B18.27-1998 (R2011)
Helical Coil Screw Thread Inserts — Free Running and Screw Locking (Inch Series)	B18.29.1-2010
Helical Coil Screw Thread Inserts: Free Running and Screw Locking (Metric Series)	B18.29.2M-2005 (R2010)
Open-End Blind Rivets With Break Mandrels (Metric Series)	B18.30.1M-2000 (R2010)
Metric Continuous and Double-End Studs	B18.31.1M-2008
Continuous and Double-End Studs	B18.31.2-2008
Threaded Rods (Inch Series)	B18.31.3-2009
Threaded Rod (Metric Series)	B18.31.4M-2009
Bent Bolts (Inch Series)	B18.31.5-2011

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