



Standard Specification for Hardened Steel Washers [Metric]¹

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This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification covers the chemical, mechanical, and dimensional requirements for metric hardened steel washers for use with fasteners having nominal thread diameters M12 through M100. These washers are intended for general-purpose mechanical and structural use with bolts, nuts, studs, and other internally and externally threaded fasteners. These washers are suitable for use with fasteners covered in Specifications A 325M, A 490M, A 563M and with fasteners of Specification F 568 property classes 8.8 and higher.

1.2 The types of washers covered in this specification are:

1.2.1 *Type 1*—Washers made of carbon steel.

1.2.2 *Type 3*—Washers made of steel having atmospheric corrosion resistance and weathering characteristics comparable to that of steels covered in Specifications A 242/A 242M, A 588/A 588M, and A 709. The atmospheric corrosion resistance of these steels is substantially better than that of carbon steel with or without copper addition. See 5.1. When properly exposed to the atmosphere, these steels can be used bare (uncoated) for many applications.

1.3 The styles of washers covered in this specification are:

1.3.1 *Circular Washers*—Circular washers in nominal sizes 12 mm through 100 mm, are suitable for applications where sufficient space exists and angularity permits.

1.3.2 *Beveled Washers*—Beveled washers are square and rectangular, in nominal sizes 12 mm through 36 mm, with a beveled 1:6 surface for use with American Standard beams and channels.

1.3.3 *Clipped Washers*—Clipped washers are circular or beveled for use where space limitations necessitate that one side be clipped.

NOTE 1—This specification is the metric counterpart of Specification F 436.

2. Referenced Documents

2.1 ASTM Standards:

¹ This specification is under the jurisdiction of ASTM Committee F-16 on Fasteners and is the direct responsibility of Subcommittee F16.02 on Steel Bolts, Nuts, Rivets, and Washers.

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A 153 Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware²

A 242/A 242M Specification for High-Strength Low-Alloy Structural Steel³

A 325M Specification for High-Strength Bolts for Structural Steel Joints [Metric]⁴

A 490M Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints [Metric]⁴

A 563M Specification for Carbon and Alloy Steel Nuts [Metric]⁴

A 588/A 588M Specification for High-Strength Low-Alloy Structural Steel with 50 ksi [345 MPa] Minimum Yield Point to 4 in. [100 mm] Thick³

A 709 Specification for Structural Steel for Bridges³

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products⁵

B 695 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel⁶

D 3951 Practice for Commercial Packaging⁷

F 568 Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners⁴

F 606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets [Metric]⁴

G 101 Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels⁸

2.2 ANSI Standard:

B 18.23.2M Metric Beveled Washers⁹

3. Ordering Information

3.1 Orders for washers under this specification shall include the following:

3.1.1 Quantity,

² Annual Book of ASTM Standards, Vol 01.06.

³ Annual Book of ASTM Standards, Vol 01.04.

⁴ Annual Book of ASTM Standards, Vol 01.08.

⁵ Annual Book of ASTM Standards, Vols 01.01, 01.02, 01.03, 01.04, 01.05, and 03.05.

⁶ Annual Book of ASTM Standards, Vol 02.05.

⁷ Annual Book of ASTM Standards, Vol 15.09.

⁸ Annual Book of ASTM Standards, Vol 03.02.

⁹ Available from American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.

3.1.2 Name of product, (that is, circular washer, beveled washer, clipped circular washer, or clipped beveled washer),

3.1.3 Coating, if required (that is, hot-dip galvanized, mechanically galvanized, etc.),

3.1.3.1 When galvanized washers are specified, the type of galvanizing, such as hot-dip or mechanical (see 6.1 and 6.3),

3.1.3.1.1 When the type of galvanizing is not specified, the manufacturer, at his option, may furnish hot-dip or mechanically galvanized washers,

3.1.4 Dimensions, nominal size, and other dimensions, if modified from those covered in this specification,

3.1.5 Material type of washer (that is, Type 1 or Type 3),

3.1.5.1 When the type is not specified, either Type 1 or Type 3 washers may be supplied when permitted by the purchaser.

3.1.5.2 When atmospheric corrosion resistance is required, Type 3 washers shall be specified by the purchaser.

3.1.6 Surface roughness control (see S1),

3.1.7 ASTM designation and year of issue, and

3.1.8 Any special requirements.

NOTE 2—Two examples of ordering descriptions follow: (1) 1000 pieces, circular washers, hot-dip galvanized, 24 mm, Type 1 ASTM F 436M, dated _____. (2) 5000 pieces, beveled washers, 22 mm, Type 3, ASTM, F 436M, dated _____.

4. Materials and Manufacture

4.1 Steel used in the manufacture of washers shall be produced by the open-hearth, basic-oxygen, or electric-furnace process.

4.2 All washers in nominal sizes 12 through 36 mm, shall be through-quenched-and-tempered. Washers in nominal sizes larger than 36 mm may be either through-quenched-and-tempered or carburized, quenched-and-tempered at the manufacturer's option.

4.3 Hot-dip galvanized washers shall be hot-dip galvanized in accordance with the requirements for Class C of Specification A 153. Mechanically galvanized washers shall be mechanically zinc-coated, and the coating and coated washers shall conform to the requirements for Class 50 of Specification B 695.

4.4 If washers are heat treated by a subcontractor, they shall be returned to the manufacturer for testing prior to shipment to the purchaser.

5. Chemical Composition

5.1 Type 1 and Type 3 washers shall conform to the chemical composition requirements specified in Table 1. For Type 3 see Guide G 101 for methods of estimating corrosion resistance of low alloy steels.

5.2 Product analysis may be made by the purchaser from finished material representing each lot of washers. The chemical composition shall conform to the requirements of 4.1 and 5.1.

5.3 Individual heats of steel are not identified in the finished product.

5.4 Chemical analyses shall be performed in accordance with Test Methods, Practices, and Terminology A 751.

6. Mechanical Properties

6.1 Through-quenched-and-tempered washers shall have a

TABLE 1 Chemical Requirements

Element	Composition, %	
	Type 1	Type 3 ^A
Phosphorus, max		
Heat analysis	0.040	0.040
Product analysis	0.050	0.045
Sulfur, max		
Heat analysis	0.050	0.050
Product analysis	0.060	0.055
Silicon		
Heat analysis	...	0.15–0.35
Product analysis	...	0.13–0.37
Chromium		
Heat analysis	...	0.45–0.65
Product analysis	...	0.42–0.68
Nickel		
Heat analysis	...	0.25–0.45
Product analysis	...	0.22–0.48
Copper		
Heat analysis	...	0.25–0.45
Product analysis	...	0.22–0.48

^A Type 3 steel washers may also be manufactured from any of the steels listed in Table 2 of Specification F 568.

Rockwell hardness of 38 to 45 HRC, except when hot-dip galvanized, in which case they shall have a Rockwell hardness of 26 to 45 HRC.

6.2 Carburized, quenched-and-tempered washers shall be carburized to a minimum depth of 0.40 mm and shall have a Rockwell hardness of 69 to 73 HRA.

6.3 When mechanically galvanized, washers shall have the same hardness range as noncoated washers.

7. Dimensions and Tolerances

7.1 Circular and clipped circular washers shall conform to dimensions given in Table 2. All dimensions apply prior to plating or coating.

7.1.1 The axis of the inside hole shall be located at true position with respect to the axis of the washer circumference within a tolerance zone having a diameter of 0.6 mm for washers of nominal sizes 16 mm and smaller and 0.9 mm for washers of nominal sizes 20 mm and larger.

7.1.2 Washers shall be flat within 0.01 mm/mm outside diameter.

7.1.3 As a result of the punching process, the inside diameter of the washer generally consists of three distinct sections. On the punch entry side of the washer there is some drawing in of the material resulting in a rounded corner section, following which is a substantially parallel section, and finally at the exit side a tapered breakout may occur (see Fig. 1). The parallel sided section of the washer inside diameter shall be within the limits specified in Table 2, however, the specified maximum inside diameter may be exceeded at the washer face on the breakout side by a maximum taper allowance of 25 % of the specified maximum washer thickness for each size.

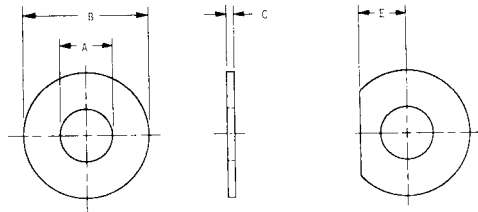
7.2 Beveled washers shall conform to dimensions in accordance with ANSI B18.23.2M.

7.3 Clipped beveled washers shall conform to dimensions for beveled washers in accordance with ANSI B18.23.2, except that one edge may be clipped off not closer than 0.0875 times the washer nominal size from the center of the hole.

8. Workmanship, Finish, and Appearance

8.1 Washers shall be free of excess mill scale, excess

TABLE 2 Dimensions of Circular Washers



Nominal Washer Size, mm ^A	Inside Diameter (A), mm		Outside Diameter (B), mm		Thickness (C), mm		Clipped Width (E), mm, min ^B
	max	min	max	min	max	min	
12	14.4	14.0	27.0	25.7	4.6	3.1	10.5
14	16.4	16.0	30.0	28.7	4.6	3.1	12.2
16	18.4	18.0	34.0	32.4	4.6	3.1	14.0
20	22.5	22.0	42.0	40.4	4.6	3.1	17.5
22	24.5	24.0	44.0	42.4	4.6	3.4	19.2
24	26.5	26.0	50.0	48.4	4.6	3.4	21.0
27	30.5	30.0	56.0	54.1	4.6	3.4	23.6
30	33.6	33.0	60.0	58.1	4.6	3.4	26.2
36	39.6	39.0	72.0	70.1	4.6	3.4	31.5
42	45.6	45.0	84.0	81.8	7.2	4.6	36.7
48	52.7	52.0	95.0	92.8	7.2	4.6	42.0
56	62.7	62.0	107.0	104.8	8.7	6.1	49.0
64	70.7	70.0	118.0	115.8	8.7	6.1	56.0
72	78.7	78.0	130.0	127.5	8.7	6.1	63.0
80	86.9	86.0	142.0	139.5	8.7	6.1	70.0
90	96.9	96.0	159.0	156.5	8.7	6.1	78.7
100	107.9	107.0	176.0	173.5	8.7	6.1	87.5

^A Nominal washer sizes are intended for use with fasteners of the same nominal thread diameter.

^B Washers may be clipped on one side not closer to the center of the washer than width E.

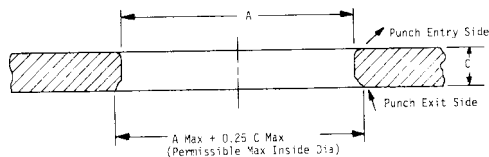


FIG. 1 Washer Inside Profile

coatings, and foreign material on bearing surfaces. Arc and gas cut washers shall be free of metal spatter.

9. Sampling and Number of Tests and Retests

9.1 The requirements of this specification shall be met in continuous mass production for stock, and the manufacturer shall make sample inspections to ensure that the product conforms to the specified requirements. Additional tests of in dividual shipments of material are not ordinarily necessary.

9.2 When specified in the purchase order, the manufacturer shall furnish a test report certified to be the last complete set of mechanical tests for each stock size in each shipment.

9.3 When the purchaser requires that additional tests be performed by the manufacturer to determine that the properties of products in an individual shipment are within specified limits, the purchaser shall specify the testing requirements, including the sampling plan and basis of acceptance, in the inquiry and purchase order.

9.3.1 When the purchaser does not specify the sampling plan and basis of acceptance the conditions in 9.3.1.1 through 9.3.1.3 shall apply:

9.3.1.1 The lot, for purposes of selecting samples, shall consist of all washers offered for inspection and testing, at one

time, that are the same type, style, nominal size, and surface finish.

9.3.1.2 From each lot, samples shall be selected at random and tested for each requirement, except as specified in 9.3.1.3, in accordance with Table 3.

9.3.1.3 When determining the weight of coating of plated and coated washers, the sampling plan defined in 9.3.1.2 shall apply, except that in no case shall the sample consist of less than three washers.

10. Test Methods

10.1 Hardness tests shall be performed in accordance with Test Methods F 606M.

11. Inspection

11.1 The inspector representing the purchaser shall have free entry to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer

TABLE 3 Sample Sizes and Acceptance Numbers for Mechanical Tests

Number of Pieces in Lot	Acceptance Criteria		
	Number of Tests	Acceptance Number	Rejection Number
800 and less	1	0	1
801 to 8000	2	0	1
8001 to 22 000	3	0	1
over 22 000	5	0	1

shall afford the inspector all reasonable facilities to satisfy that the material is being furnished in accordance with this specification. All tests and inspections required by the specification that are requested by the purchaser's representative shall be made prior to shipment, and shall be conducted as not to interfere unnecessarily with the operation of the works.

11.2 If other than the normal inspection for continuous mass production of parts as stipulated in 9.1 is required by the purchaser, it shall be specified in the inquiry and contract order.

12. Rejection

12.1 Unless otherwise specified, any rejection based on tests made in accordance with this specification shall be reported to the manufacturer within 30 working days from the receipt of samples by the purchaser.

13. Certification and Test Report

13.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the latest mechanical tests of each stock size in each shipment, shall be furnished at the time of shipment.

13.2 Data contained in the certified test report shall include material grade and hardness tests.

14. Responsibility

14.1 The party responsible for the fastener shall be the organization that supplies the fastener to the purchaser and certifies that the fastener was manufactured, sampled, tested and inspected in accordance with this specification and meets all of its requirements.

15. Product Marking

15.1 Washers shall be marked with a symbol, or other distinguishing marks, to identify the manufacturer or private label distributor, as appropriate.

15.2 Additionally, washers shall be marked to identify their

being metric size. Preferably, the metric marking shall be the symbol "M," but may be of other distinguishing design as determined by the manufacturer.

15.3 Additionally, Type 3 washers shall be identified with the symbol "3,"

15.4 Additional identification or distinguishing marks, or both, may be used by the manufacturer.

15.5 All marking symbols shall be depressed on one face of the washer.

15.6 Type and manufacturer's or private label distributor's identification shall be separate and distinct. The two identifications shall preferably be in different locations and, when on the same level, shall be separated by at least two spaces.

15.7 It is possible that during the clipping of circular washers, the marking symbols may be removed. This is acceptable provided the majority of washers in the lot still display the identification marks.

16. Packaging and Package Marking

16.1 *Packaging:*

16.1.1 Unless otherwise specified, packaging shall be in accordance with Practice D 3951.

16.1.2 When special packaging requirements are required, they shall be defined at the time of the inquiry and order.

16.2 *Package Marking:*

16.2.1 Each shipping unit shall include or be plainly marked with the following information:

16.2.1.1 ASTM designation,

16.2.1.2 Size,

16.2.1.3 Name and brand or trademark of the manufacturer,

16.2.1.4 Number of pieces,

16.2.1.5 Purchase order number, and

16.2.1.6 Country of origin.

17. Keywords

17.1 carbon steel; metric; steel; washers; weathering steel

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply only when specified by the purchaser in the contract or order. Details of these supplementary requirements shall be agreed upon in writing between the manufacturer and purchaser. Supplementary requirements shall in no way negate any requirement of the specification itself.

S1. Surface Roughness

S1.1 Washers shall have a multi-directional lay with a surface roughness not exceeding 19 μm in height including any flaws in or on the surface.

S1.2 Burrs shall not exceed 0.25 mm in height.

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