



# Standard Specification for Hardened Steel Washers<sup>1</sup>

This standard is issued under the fixed designation F 436; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification covers the chemical, mechanical, and dimensional requirements for hardened steel washers for use with fasteners having nominal thread diameters of ¼ through 4 in. 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 325, A 354, A 449, A 490, and A 687.

1.2 The washers are designated by *type* denoting the material and by *style* denoting the shape.

1.2.1 The types of washers covered are:

1.2.1.1 *Type 1*—Carbon steel.

1.2.1.2 *Type 3*—Weathering steel. Atmospheric corrosion resistance and weathering characteristics are comparable to that of steels covered in Specifications A 588/A 588M and A 709/A 709M. 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.

1.2.2 The styles of washers covered are:

1.2.2.1 *Circular*—Circular washers in nominal hole sizes ¼ through 4 in. suitable for applications where sufficient space exists and angularity permits.

1.2.2.2 *Beveled*—Beveled washers are square or rectangular, in nominal sizes ½ through 1½ in., with a beveled 1 to 6 ratio surface for use with American standard beams and channels.

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

NOTE 1—A complete metric companion to Specification F 436 has been developed—Specification F 436M; therefore no metric equivalents are presented in this specification.

## 2. Referenced Documents

### 2.1 ASTM Standards:

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee F16 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 Hardware<sup>2</sup>

A 325 Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength<sup>3</sup>

A 354 Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners<sup>3</sup>

A 449 Specification for Quenched and Tempered Steel Bolts and Studs<sup>3</sup>

A 490 Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength<sup>3</sup>

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] Thick<sup>4</sup>

A 687 Specification for High-Strength Nonheaded Steel Bolts and Studs<sup>3</sup>

A 709/A 709M Specification for Structural Steel for Bridges<sup>4</sup>

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products<sup>5</sup>

B 695 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel<sup>6</sup>

D 3951 Practice for Commercial Packaging<sup>7</sup>

F 606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets<sup>3</sup>

G 101 Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels<sup>8</sup>

## 3. Ordering Information

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

3.1.1 ASTM designation and year of issue,

3.1.2 Quantity (number of pieces by size),

3.1.3 Type and Style (see 1.2.1 and 1.2.2),

3.1.4 *Zinc Coating*—Specify the zinc coating process required, for example, hot-dip, mechanically deposited, or no preference (see 4.3),

3.1.5 Dimensions, nominal size, and other dimensions, if

<sup>2</sup> Annual Book of ASTM Standards, Vol 01.06.

<sup>3</sup> Annual Book of ASTM Standards, Vol 01.08.

<sup>4</sup> Annual Book of ASTM Standards, Vol 01.04.

<sup>5</sup> Annual Book of ASTM Standards, Vol 01.03.

<sup>6</sup> Annual Book of ASTM Standards, Vol 02.05.

<sup>7</sup> Annual Book of ASTM Standards, Vol. 15.09.

<sup>8</sup> Annual Book of ASTM Standards, Vol 03.02.

modified from those covered in this specification,

3.1.6 Specify if inspection at point of manufacture is required,

3.1.7 Specify if manufacturer's certification or test reports, or both, are required, and

3.1.8 Special requirements.

**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 Washers up to and including 1½ in. in bolt size shall be through hardened. Washers over 1½ in. may be either through hardened or carburized at the option of the manufacturer.

**4.3 Zinc Coatings, Hot-Dip and Mechanically Deposited:**

4.3.1 When zinc-coated washers are required, the purchaser shall specify the zinc coating process, for example, hot-dip, mechanically deposited, or no preference.

4.3.2 When hot-dip is specified the washers shall be zinc coated by the hot-dip process in accordance with the requirements of Class C of Specification A 153.

4.3.3 When mechanically deposited is specified the washers shall be zinc coated by the mechanical-deposition process in accordance with the requirements of Class 50 of Specification B 695.

4.3.4 When no preference is specified, the supplier may furnish either a hot-dip zinc coating in accordance with Specification A 153, Class C, or a mechanically deposited zinc coating in accordance with Specification B 695, Class 50. Threaded components (bolt and nuts) shall be coated by the same zinc-coating process and the supplier's option is limited to one process per item with no mixed processes in a lot.

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 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 hardened washers shall have a hardness of 38 to 45 HRC, except when zinc-coated by the hot-dip process, in which case they shall have a hardness of 26 to 45 HRC.

6.2 Carburized washers shall be carburized to a minimum depth of 0.015 in. and shall have a surface hardness of 69 to 73 HRA or 79 to 83 HR15N, except when zinc-coated by the hot-dip process, in which case they shall have a hardness of 63 to 73 HRA or 73 to 83 HR15N.

**TABLE 1 Chemical Requirements**

Element	Composition, %	
	Type 1	Type 3 <sup>A</sup>
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	0.05
Silicon		
Heat analysis	...	0.15-0.35
Product analysis	...	0.3-0.37
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

<sup>A</sup> Weathering steel washers may also be manufactured from any of the steels listed in Table 2 of Specification A 325.

6.3 Carburized and hardened washers shall have a minimum core hardness of 30 HRC or 65 HRA.

**7. Dimensions and Tolerances**

7.1 All circular and clipped circular washers shall conform to the dimensions shown in Table 2 and Table 3.

7.2 All square beveled and clipped square beveled washers shall conform to the dimensions shown in Table 3 and Table 4. In addition, rectangular beveled and clipped rectangular beveled washers shall conform to the dimensions shown in Table 3 and Table 4, except that one side may be longer than shown for the "A" dimension.

7.3 Unless otherwise stated in the inquiry or purchase order, plain (uncoated) hardened steel circular washers shall be furnished. Where corrosion-preventive treatment is required, washers shall be coated as agreed upon between the manufacturer and the purchaser.

**8. Workmanship, Finish, and Appearance**

8.1 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 spatter.

**9. Sampling and Number of Tests**

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 individual shipments of material are not ordinarily contemplated.

9.2 When additional tests are specified in the inquiry or purchase order, a lot, for purposes of selecting test samples, shall consist of all material offered for inspection at one time that has the following common characteristics:

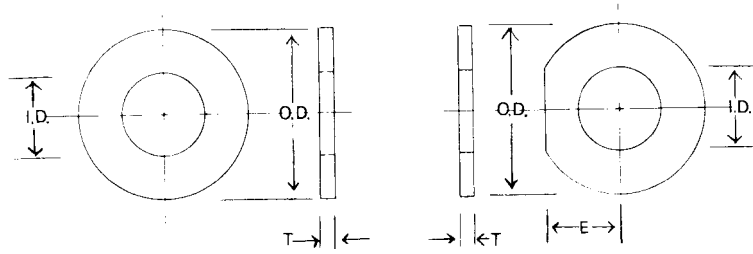
9.2.1 Same nominal size.

9.2.2 Same material grade.

9.2.3 Same nominal post treatment (heat treatment or coating or both).

TABLE 2 Hardened Circular and Clipped Circular Washers

NOTE 1—Tolerances are as noted in table on washer dimension tolerances.



Bolt Size	Circular and Clipped Circular		Thickness (T), in.		Clipped Minimum Edge Distance (E) <sup>A</sup> , in.
	Nominal Outside Diameter (OD), in.	Nominal Inside Diameter (ID), in.	Thickness (T), in.		
			min	ma.	
1/4	5/8	9/32	0.051	0.130	7/32
5/16	11/16	11/32	0.051	0.080	9/32
3/8	13/16	13/32	0.051	0.080	11/32
7/16	59/64	15/32	0.051	0.080	13/32
1/2	11/16	17/32	0.097	0.177	7/16
5/8	15/16	11/16	0.122	0.177	9/16
3/4	119/32	13/16	0.122	0.177	21/32
7/8	13/4	15/16	0.136	0.177	25/32
1	2	11/8	0.136	0.177	7/8
1 1/8	2 1/4	1 1/4	0.136	0.177	1
1 1/4	2 1/2	1 3/8	0.136	0.177	1 3/32
1 3/8	2 3/4	1 1/2	0.136	0.177	1 7/32
1 1/2	3	1 5/8	0.136	0.177	1 5/16
1 3/4	3 3/8	1 7/8	0.178 <sup>B</sup>	0.28 <sup>B</sup>	1 17/32
2	3 3/4	2 1/8	0.178 <sup>B</sup>	0.28 <sup>B</sup>	1 3/4
2 1/4	4	2 3/8	0.24 <sup>C</sup>	0.34 <sup>C</sup>	2
2 1/2	4 1/2	2 5/8	0.24 <sup>C</sup>	0.34 <sup>C</sup>	2 3/16
2 3/4	5	2 7/8	0.24 <sup>C</sup>	0.34 <sup>C</sup>	2 13/32
3	5 1/2	3	0.24 <sup>C</sup>	0.34 <sup>C</sup>	2 5/8
3 1/4	6	3 3/8	0.24 <sup>C</sup>	0.34 <sup>C</sup>	2 7/8
3 1/2	6 1/2	3 5/8	0.24 <sup>C</sup>	0.34 <sup>C</sup>	3 1/16
3 3/4	7	3 7/8	0.24 <sup>C</sup>	0.34 <sup>C</sup>	3 5/16
4	7 1/2	4 1/8	0.24 <sup>C</sup>	0.34 <sup>C</sup>	3 1/2

<sup>A</sup> Clipped edge E shall be not closer than 7/8 of the bolt diameter from the center of the washer.

<sup>B</sup> 3/16 in. nominal.

<sup>C</sup> 1/4 in. nominal.

TABLE 3 Washer Dimension Tolerances

	To 1 1/2 in. Nominal Bolt Size, incl	Over 1 1/2 in. Nominal Bolt Size, incl	Over 3 to 4 in. Nominal Bolt Size, incl
Nominal diameter of hole, in.	-0, +1/32	-0, +1/16	-0, +1/8
Nominal outside diameter, in.	± 1/32	± 1/16	± 1/8
Flatness: max deviation from straightedge placed on cut side shall not exceed (in.)	0.010	0.015	0.032
Concentricity, in.: center of hole to outside diameter	0.030 FIR <sup>A</sup>	0.090 FIR <sup>A</sup>	0.250 FIR <sup>A</sup>
Burr shall not project above immediately adjacent washer surface more than (in.)	0.010	0.015	0.025

<sup>A</sup> Full indicator runoff.

Number of Pieces in Lot

Number of Specimens

800 and under	1
801 to 8000	2
8001 to 22 000	3
Over 22 000	5

## 10. Test Methods

### 10.1 Hardness:

10.1.1 *Non-carburized Washers*—A minimum of two readings shall be taken 180° apart on at least one face at a minimum depth of 0.015 in.

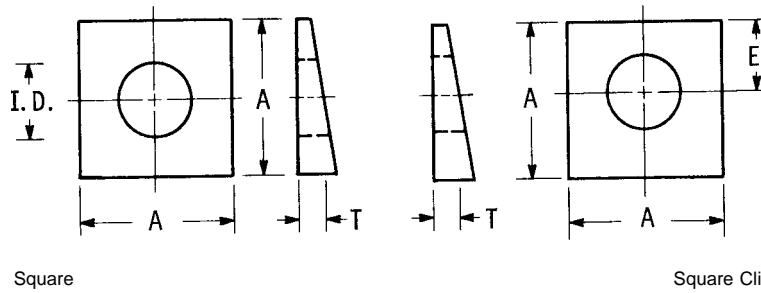
10.1.2 *Carburized Washers*—A minimum of two readings shall be taken 180° apart on at least one face.

10.2 Hardness tests shall be performed in accordance with the Rockwell test method specified in Test Methods F 606.

9.3 From each lot described in 9.2, the number of specimens tested for each required property shall be as follows:

TABLE 4 Hardened Beveled Washers

NOTE 1—Tolerances are as noted in Table 3.



Bolt Size, in.	Square		Square Beveled and Clipped Square Beveled <sup>A</sup>			Square Clipped
	Minimum Side Dimension (A), in.	Nominal Inside Diameter (I.D.), in.	Mean Thickness (T), in.	Slope or Taper in Thickness	Nominal Edge Distance (E), <sup>B</sup> in.	
1/2	1 3/4	17/32	5/16	1:6	7/16	
5/8	1 3/4	1 1/16	5/16	1:6	9/16	
3/4	1 3/4	1 3/16	5/16	1:6	2 1/32	
7/8	1 3/4	1 5/16	5/16	1:6	2 5/32	
1	1 3/4	1 1/8	5/16	1:6	7/8	
1 1/8	2 1/4	1 1/4	5/16	1:6	1	
1 1/4	2 1/4	1 3/8	5/16	1:6	1 3/32	
1 3/8	2 1/4	1 1/2	5/16	1:6	1 7/32	
1 1/2	2 1/4	1 5/8	5/16	1:6	1 5/16	

<sup>A</sup> Rectangular beveled washers shall conform to the dimensions shown above, except that one side may be longer than that shown for the A dimension.

<sup>B</sup> Clipped edge E shall not be closer than 7/8 of the bolt diameter from the center of the washer.

**11. Inspection**

11.1 The manufacturer shall afford the purchaser's inspector all reasonable facilities necessary to satisfy him that the material is being produced and furnished in accordance with this specification. Mill inspection by the purchaser shall not interfere unnecessarily with the manufacturer's operations. All tests and inspections shall be made at the place of manufacture, unless otherwise agreed to.

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 and Rehearing**

12.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer or supplier may make claim for a rehearing.

**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, Type 3 weathering steel washers shall be identified with the symbol "3".

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

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

15.5 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.

15.6 It is possible that during the clipping of circular washers the marking symbols may be removed. This is acceptable provided that 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 and type,

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; steel; washers; weathering steel

**SUPPLEMENTARY REQUIREMENTS****S1. Surface Roughness**

S1.1 Washers shall have a multidirectional lay with a surface roughness not exceeding 750  $\mu\text{in.}$  in height including any flaws in or on the surface.

S1.2 Burrs shall not exceed 0.01 in. in height.

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