



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

This standard is issued under the fixed designation F436; 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 1/4 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 [A325](#), [A354](#), [A449](#), and [A490](#).

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 [A588/A588M](#) and [A709/A709M](#). 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.

1.2.1.3 This specification provides for furnishing Type 3 to chemical composition or a Corrosion Index (CRI) of 6 or higher at the suppliers option.

1.2.2 The styles of washers covered are:

1.2.2.1 *Circular*—Circular washers in nominal bolt sizes 1/2 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 1/2 through 1 1/2 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.

<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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1.2.2.4 *Extra Thick*—Extra thick washers are circular washers in nominal sizes 1/2 through 1 1/2 in., with a nominal thickness of 5/16 in. suitable for structural applications with oversized holes.

1.3 Terms used in this specification are defined in Terminology [F1789](#) unless otherwise defined herein.

1.4 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

NOTE 1—A complete metric companion to Specification [F436M](#) has been developed—Specification [F436M](#); therefore no metric equivalents are presented in this specification.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

[A325](#) Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

[A354](#) Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners

[A449](#) Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use

[A490](#) Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength

[A588/A588M](#) Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance

[A709/A709M](#) Specification for Structural Steel for Bridges

[A751](#) Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

[B695](#) Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

\*A Summary of Changes section appears at the end of this standard.

- D3951 Practice for Commercial Packaging
- F436M Specification for Hardened Steel Washers (Metric)
- F606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets
- F1136 Specification for Zinc/Aluminum Corrosion Protective Coatings for Fasteners
- F1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection
- F1789 Terminology for F16 Mechanical Fasteners
- F2329 Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
- G101 Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels

Specification F2329, or a mechanically deposited zinc coating in accordance with Specification B695, Class 55, or a Zinc/Aluminium Corrosion Protective Coating in accordance with Specification F1136, Grade 3. 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 washers shall conform to the chemical composition specified in Table 1.

5.2 Type 3 washers shall conform to the heat analysis specified in Table 1. Alternatively, at the suppliers option, Type 3 washers having a Copper minimum Heat Analysis of 0.25%, Phosphorous and Sulfur conforming to Table 1 and a Corrosion Index of 6 or higher as calculated from the Heat Analysis as described in Guide G101 Predictive method based on the data of Larabee and Coburn shall be accepted.

5.3 For Type 1 and 3 furnished to the Chemical Compositions in Table 1, Product Analysis may be made by the purchaser on finished washers representing each lot. The Chemical Composition shall conform to the requirements in Table 1, Product Analysis.

5.4 Product Analysis are not applicable to Type 3 washers furnished to a CRI of 6 or higher calculated from the Heat Analysis.

5.5 Chemical analyses shall be performed in accordance with Test Methods, Practices, and Terminology A751.

**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, Zinc/Aluminium Corrosion Protective Coating, or no preference (see 4.3),
- 3.1.5 Dimensions, nominal size, and other dimensions, if 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, Zinc/Aluminium Corrosion Protective Coating:

4.3.1 When zinc-coated washers are required, the purchaser shall specify the zinc coating process, for example, hot-dip, mechanically deposited, Zinc/Aluminium Corrosion Protective Coating, 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 Specification F2329.

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 55 of Specification B695.

4.3.4 When Zinc/Aluminium Corrosion Protective Coating is specified, the washers shall be coated in accordance with the requirements of Grade 3 of Specification F1136.

4.3.5 When no preference is specified, the supplier may furnish either a hot-dip zinc coating in accordance with

**TABLE 1 Chemical Requirements<sup>A</sup>**

Element	Composition, %	
	Type 1	Type 3 <sup>B</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	0.055
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

<sup>A</sup> When providing Weathering Steels to a calculated corrosion index use the Legault-Leckie formula from Guide G101. Link to online calculator: [http://www.astm.org/COMMIT/G01\\_G101Calculr1100.xls](http://www.astm.org/COMMIT/G01_G101Calculr1100.xls)

$$I = 26.01 (\% Cu) + 3.88 (\% Ni) + 1.20 (\% Cr) + 1.49 (\% Si) + 17.28 (\% P) - 7.29 (\% Cu) (\% Ni) - 9.10 (\% Ni) (\% P) - 33.39 (\% Cu)^2$$

<sup>B</sup> Weathering steel washers may also be manufactured from any of the steels listed in Table 2 of Specification A325.

## 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.

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 weathering steels are furnished to Corrosion Resistance Index, the CRI number shall be calculated for each heat.

9.3 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:

9.3.1 Same nominal size.

9.3.2 Same raw material heat number.

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

9.4 From each lot described in [9.3](#), the number of specimens tested for each required property shall be as follows:

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 [F606](#).

10.3 *Corrosion Resistance Index:*

10.3.1 The corrosion Resistance Index shall be calculated from the Heat Analysis in accordance with [G101](#) Prediction Method based on the data of Larabee and Coburn.

## 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 Disposition of nonconforming washers shall be in accordance with Guide [F1470](#) section titled “Disposition of Nonconforming Lots.”

## 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, hardness tests, and calculated Corrosion Resistance Index when type 3 is furnished to a Corrosion Resistance Index.

## 14. Responsibility

14.1 The party responsible for the fastener shall be the organization that supplies the fastener to the purchaser.

## 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.

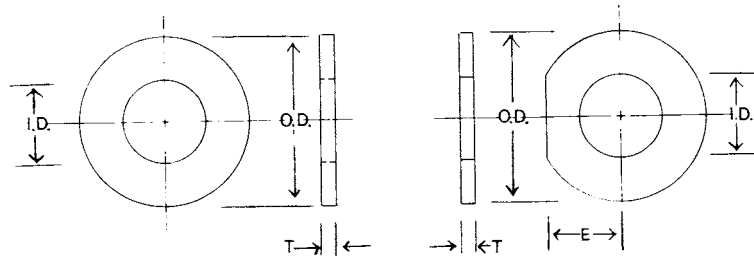
15.2 Additionally, Type 3 weathering steel washers shall be identified with the symbol “3”.

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.

**TABLE 2 Hardened Circular, Clipped Circular, and Extra-Thick Washers**

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



Nominal Size	Circular and Extra Thick		Clipped Circular				
	Circular, Clipped Circular, and Extra Thick		Circular and Clipped		Extra Thick		Clipped
	Nominal Outside Diameter (OD), in.	Nominal Inside Diameter (ID), in.	Thickness (T), in.				Minimum Edge Distance (E) <sup>A</sup> , in.
min			max	min	max		
1/4	0.625	0.281	0.051	0.080	...	...	0.219
5/16	0.688	0.344	0.051	0.080	...	...	0.281
3/8	0.813	0.406	0.051	0.080	...	...	0.344
7/16	0.922	0.469	0.051	0.080	...	...	0.406
1/2	1.063	0.531	0.097	0.177	0.305	0.375	0.438
9/16	1.188	0.625	0.110	0.177	0.305	0.375	0.500
5/8	1.313	0.688	0.122	0.177	0.305	0.375	0.563
3/4	1.468	0.813	0.122	0.177	0.305	0.375	0.656
7/8	1.750	0.938	0.136	0.177	0.305	0.375	0.781
1	2.000	1.063	0.136	0.177	0.305	0.375	0.875
1 1/8	2.250	1.188	0.136	0.177	0.305	0.375	1.000
1 1/4	2.500	1.375	0.136	0.177	0.305	0.375	1.094
1 3/8	2.750	1.500	0.136	0.177	0.305	0.375	1.219
1 1/2	3.000	1.625	0.136	0.177	0.305	0.375	1.313
1 3/4	3.375	1.875	0.178 <sup>B</sup>	0.28 <sup>B</sup>	0.305	0.375	1.531
2	3.750	2.125	0.178 <sup>B</sup>	0.28 <sup>B</sup>	0.305	0.375	1.750
2 1/4	4.000	2.375	0.24 <sup>C</sup>	0.34 <sup>C</sup>	0.305	0.375	2.000
2 1/2	4.500	2.625	0.24 <sup>C</sup>	0.34 <sup>C</sup>	0.313	0.375	2.188
2 3/4	5.000	2.875	0.24 <sup>C</sup>	0.34 <sup>C</sup>	0.313	0.375	2.406
3	5.500	3.125	0.24 <sup>C</sup>	0.34 <sup>C</sup>	0.313	0.375	2.625
3 1/4	6.000	3.375	0.24 <sup>C</sup>	0.34 <sup>C</sup>	0.313	0.375	2.875
3 1/2	6.500	3.625	0.24 <sup>C</sup>	0.34 <sup>C</sup>	0.313	0.375	3.063
3 3/4	7.000	3.875	0.24 <sup>C</sup>	0.34 <sup>C</sup>	0.313	0.375	3.313
4	7.500	4.125	0.24 <sup>C</sup>	0.34 <sup>C</sup>	0.313	0.375	3.500

<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.

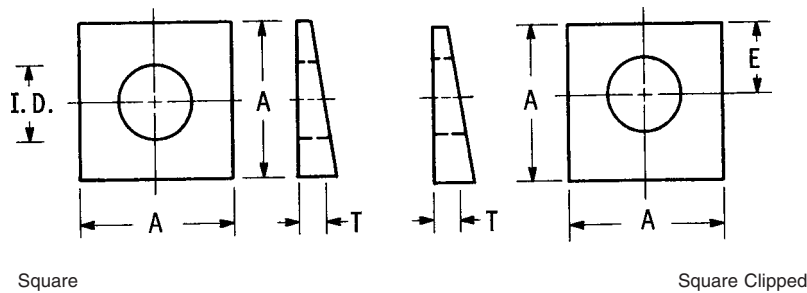
**TABLE 3 Washer Dimensional Tolerances**

Dimensional Characteristics	<1 in. Nominal Size	1 through 1½ in. Nominal Size	>1½ through 3 in. Nominal Size	>3 in. Nominal Size
Nominal diameter of hole, in.	-0, +0.032	-0, +0.063	-0, +0.063	-0, +0.125
Nominal outside diameter, in.	±0.032	±0.063	±0.063	±0.125
Flatness: max deviation from straightedge placed on cut side shall not exceed (in.)	0.010	0.015	0.020	0.032
Concentricity, in.: center of hole to outside diameter	0.030 FIR <sup>A</sup>	0.060 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	0.020	0.025

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

**TABLE 4 Hardened Beveled Washers**

NOTE 1—Tolerances are as noted in Table 3.



Bolt Size, in.	Square Beveled and Clipped Square Beveled <sup>A</sup>				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.
½	1¾	17/32	5/16	1:6	7/16
5/8	1¾	11/16	5/16	1:6	9/16
¾	1¾	13/16	5/16	1:6	21/32
7/8	1¾	15/16	5/16	1:6	25/32
1	1¾	1 1/8	5/16	1:6	7/8
1 1/8	2¼	1 ¼	5/16	1:6	1
1 ¼	2¼	1 3/8	5/16	1:6	1 1/32
1 3/8	2¼	1 ½	5/16	1:6	1 7/32
1 ½	2¼	1 5/8	5/16	1:6	1 15/16

<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.

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 D3951.

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**

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

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

## SUMMARY OF CHANGES

Committee F16 has identified the location of selected changes to this standard since the last issue (F436–10) that may impact the use of this standard. (Approved May 15, 2011.)

- (1) **Table 1** was revised. (3) **9.3.2** was revised.  
(2) **5.5** was removed and subsequent sections renumbered.

Committee F16 has identified the location of selected changes to this standard since the last issue (F436–09) that may impact the use of this standard. (Approved May 1, 2010.)

- (1) In **5.2-5.4, 9.2, 10.3.1** and **13.2** provided for furnishing Type 3 to a corrosion Resistance Index of 6 or higher. (2) Revised **12** Rejection and Rehearing to invoke Guide **F1470**.

Committee F16 has identified the location of selected changes to this standard since the last issue (F436–07) that may impact the use of this standard. (Approved Jan. 1, 2009.)

- (1) Revised **4.3** to add provision of specifying Zinc/Aluminum Corrosion Protective Coating conforming to Specification **F1136**, Grade 3.

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