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Designation: ~~F436/F436M – 16~~ F436/F436M – 18

Standard Specification for Hardened Steel Washers Inch and Metric Dimensions[1]

This standard is issued under the fixed designation F436/F436M; 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 (ε) indicates an editorial change since the last revision or reapproval.

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

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. and 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 A354, A449, A563, A563M, F959/F959M, and F3125.

1.2 The washers are designated by *type* denoting the material, by *style* denoting the shape, and by inch or metric dimensions.

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.

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 ¼ through 4 in. and M12 through M100 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., M12 through M16, 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.

1.2.2.4 *Extra Thick*—Extra thick washers are circular washers in nominal sizes ½ through 4 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 either inch-pound units for inch fasteners and SI units for metric fasteners and are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

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

A563 Specification for Carbon and Alloy Steel Nuts

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[1] 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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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at 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**

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A563M Specification for Carbon and Alloy Steel Nuts (Metric)
A588/A588M Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance
A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
B695 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
F606/F606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets
F959/F959M Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners, Inch and Metric Series
F1136/F1136M 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
F3125 Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions
G101 Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels

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),
3.1.3.1 Material type of washer (that is, Type 1 or Type 3),
3.1.3.2 When the type is not specified, either Type 1 or Type 3 washers may be ~~supplied when permitted by the purchaser.~~supplied.
3.1.4 When galvanized or zinc/aluminum washers are specified, specify, the type of galvanizing, such as hot-dip or mechanical (see 4.3),
3.1.4.1 When the type of galvanizing is not specified, the manufacturer, at his option, may furnish hot-dip or mechanically galvanized washers.
3.1.4.2 When atmospheric corrosion resistance is required, Type 3 washers shall be specified by the purchaser.
3.1.5 Dimensions, nominal size, and other dimensions, if modified from those covered in this specification,
3.1.5.1 Standard thickness shall be supplied unless extra thick is specified.
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.
3.1.9 ~~Surface roughness control (See S1).~~Any supplementary requirements.

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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. for inch fasteners and M36 for metric fasteners, shall be through hardened. Washers over 1½ in. for inch fasteners and M36 for metric fasteners, may be either through hardened or carburized at the option of the manufacturer.

4.3 *Zinc Coatings, Hot-Dip and Mechanically Deposited, Zinc/Aluminum 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/Aluminum 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/Aluminum Corrosion Protective Coating is specified, the washers shall be coated in accordance with the requirements of Grade 3 of Specification F1136/F1136M.
4.3.5 When no preference is specified, the supplier may furnish either a hot-dip zinc coating in accordance with Specification F2329, or a mechanically deposited zinc coating in accordance with Specification B695, Class 55, or a Zinc/Aluminum Corrosion Protective Coating in accordance with Specification F1136/F1136M, 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.

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. (inch series) or 0.38 mm (metric series) 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 4 (inch washers) and Table 5 and Table 7(metric washers).

7.2 All square beveled and clipped square beveled washers shall conform to the dimensions shown in Table 3 and Table 4 (inch washers) and Table 6 and Table 7 (metric washers). In addition, rectangular beveled and clipped rectangular beveled washers shall conform to the dimensions shown in the appropriate Table 3 and Table 4 (inch washers) or Table 6 and Table 7 (metric washers) except that one side may be longer than shown for the "A" dimension.

7.3 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 a burnished depth section, and finally at the exit side a tapered breakout may occur (see Fig. 1). The parallel

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TABLE 1 Chemical Requirements[A]

Element	Composition, %	
	Type 1	Type 3[B]
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

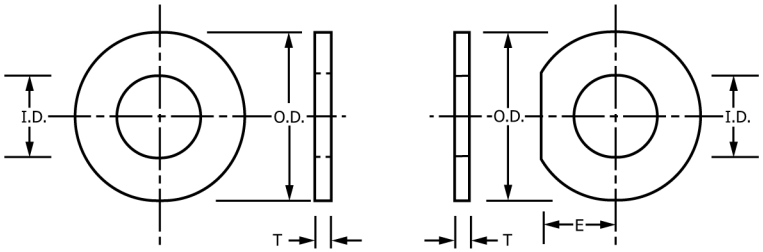
[A] When providing Weathering Steels to a calculated corrosion index use the Legault-Leckie formula from Guide G101. Link to online calculator: http://www.astm.org/COMMIT/G01_G101Calcultr1100.xls

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

[B] Weathering steel washers may also be manufactured from any of the steels listed in Table 2 of Specification A588/A588M and F3125.

TABLE 2 Hardened Circular, Clipped Circular, and Extra (Inch Washers)

NOTE 1—Other tolerances are as noted in Table 4.



Nominal Washer[D] Size Inch	Clipped Circular				Circular and Extra Thick				
	Inside Diameter *(I.D)* Inch		Outside Diameter *(O.D.)* Inch		Thickness Standard *(T)* Inch		Thickness Extra Thick *(T)* Inch		Clipped
	min	max	min	max	min	max	min	max	Minimum Edge Distance *(E)*[A]
¼	0.281	0.313	0.593	0.657	0.051	0.080	. . .	. . .	0.219
5⁄16	0.344	0.376	0.656	0.720	0.051	0.080	. . .	. . .	0.281
⅜	0.406	0.438	0.781	0.845	0.051	0.080	. . .	. . .	0.344
7⁄16	0.469	0.501	0.890	0.954	0.051	0.080	. . .	. . .	0.406
½	0.531	0.563	1.031	1.095	0.097	0.177	0.305	0.375	0.438
9⁄16	0.625	0.657	1.156	1.220	0.110	0.177	0.305	0.375	0.500
⅝	0.688	0.720	1.281	1.345	0.122	0.177	0.305	0.375	0.563
¾	0.813	0.845	1.436	1.500	0.122	0.177	0.305	0.375	0.656
⅞	0.938	0.970	1.718	1.782	0.136	0.177	0.305	0.375	0.781
1	1.063	1.126	1.937	2.063	0.136	0.177	0.305	0.375	0.875
1⅛	1.188	1.251	2.187	2.313	0.136	0.177	0.305	0.375	1.000
1¼	1.375	1.438	2.437	2.563	0.136	0.177	0.305	0.375	1.094
1⅜	1.500	1.563	2.687	2.813	0.136	0.177	0.305	0.375	1.219
1½	1.625	1.688	2.937	3.063	0.136	0.177	0.305	0.375	1.313
1¾	1.875	1.938	3.312	3.438	0.178[B]	0.28[B]	0.305	0.375	1.531
2	2.125	2.188	3.687	3.813	0.178[B]	0.28[B]	0.305	0.375	1.750
2¼	2.375	2.438	3.937	4.063	0.24[C]	0.34[C]	0.305	0.375	2.000
2½	2.625	2.688	4.437	4.563	0.24[C]	0.34[C]	0.313	0.375	2.188
2¾	2.875	2.938	4.937	5.063	0.24[C]	0.34[C]	0.313	0.375	2.406
3	3.125	3.188	5.437	5.563	0.24[C]	0.34[C]	0.313	0.375	2.625
3¼	3.375	3.500	5.875	6.125	0.24[C]	0.34[C]	0.313	0.375	2.875
3½	3.625	3.750	6.375	6.625	0.24[C]	0.34[C]	0.313	0.375	3.063
3¾	3.875	4.000	6.875	7.125	0.24[C]	0.34[C]	0.313	0.375	3.313
4	4.125	4.250	7.375	7.625	0.24[C]	0.34[C]	0.313	0.375	3.500

[A] Clipped edge *E* shall be not closer than ⅞ of the bolt diameter from the center of the washer.
[B] 3⁄16 in. nominal.
[C] ¼ in. nominal.
[D] Nominal washer sizes are intended for use with fasteners of the same nominal thread size.

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