Designation: ~~F436 – 11~~ F436/F436M – 16

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

This standard is issued under the fixed designation ~~F436;~~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 ~~A325,~~ A354~~,~~ ~~A449,~~ and ~~A490~~F3125.

1.2 The washers are designated by *type* denoting the ~~material and~~ material, by *style* denoting the ~~shape.~~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. ~~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 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 ~~1~~4½ 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~~ either inch-pound units for inch fasteners and SI units for metric fasteners and are to be regarded ~~as standard. No other units of measurement are included in this~~ 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.

~~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.*

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

~~A325 Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength (Withdrawn 2016)~~[3]

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 (Withdrawn 2016)~~[3]

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

~~D3951 Practice for Commercial Packaging~~

~~F436M Specification for Hardened Steel Washers (Metric) (Withdrawn 2016)~~[3]

~~F606~~F606/F606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, ~~and Rivets (Metric) F0606_F0606M~~ Direct Tension Indicators, and Rivets

~~F1136~~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.

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~~ 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).

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~~ 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/Aluminium~~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/Aluminium~~Zinc/Aluminum Corrosion Protective Coating, or no preference.

[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.

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

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 ~~A325~~A588/A588M and F3125.

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 3~~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 sided burnished depth 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.

7.4 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.~~Each lot shall be tested by the manufacturer prior to shipment in accordance with the lot control as described in 9.4.1 ~~Additional tests~~and 9.4.2 ~~of~~and Table 6~~individual shipments of material are not ordinarily contemplated.~~ .

9.1.1 When supplied by a source other than the manufacturer or processed by an outside supplier, the responsible party shall assure that all tests have been performed and the washers conform to this specification.

9.2 When specified in the purchase order, the manufacturer shall furnish a test report for the lot as defined in 9.4.1.

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

9.4 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:~~ 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 Same nominal size.~~

~~9.3.2 Same raw material heat number.~~

9.4.1 ~~Same nominal~~ 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, same raw material heat number, same nominal post treatment (heat ~~treatment or~~ treatment, coating or ~~both).~~ both) and surface finish.

9.4.2 Samples from each lot shall be selected at random and tested for each requirement in accordance with Table 8.

~~9.4 From each lot described in 9.3, the number of specimens tested for each required property shall be as follows:~~

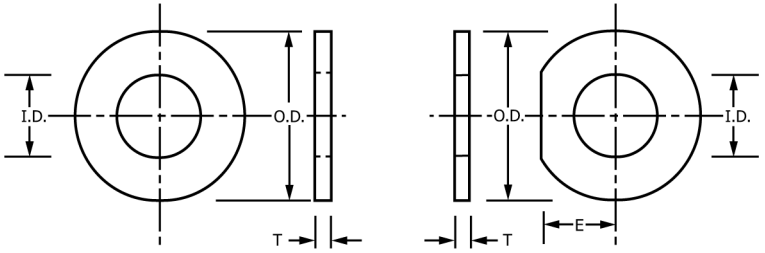
~~Number of Pieces in Lot~~	~~Number of Specimens~~
~~800 and under~~	~~1~~
~~801 to 8000~~	~~2~~
~~8001 to 22 000~~	~~3~~
~~Over 22 000~~	~~5~~

10. Test Methods

10.1 *Hardness:*

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

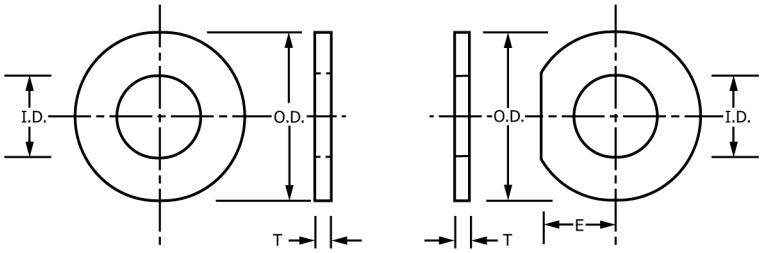
NOTE 1—Tolerances are as noted in table on washer dimension tolerances.



Circular and Extra Thick			Clipped Circular				
	Circular, Clipped *Circular,* and Extra Thick		Circular and Clipped		Extra Thick		Clipped
Nominal Size	Nominal Outside Diameter (OD), in.	Nominal Inside Diameter (ID), in.	Thickness (T), in. min	Thickness (T), in. max	Thickness (T), in. min	Thickness (T), in. max	Minimum Edge Distance *(E)*[A], in.
¼	0.625	0.281	0.051	0.080	...	...	0.219
5/16	0.688	0.344	0.051	0.080	...	...	0.281
⅜	0.813	0.406	0.051	0.080	...	...	0.344
7/16	0.922	0.469	0.051	0.080	...	...	0.406
½	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
⅝	1.313	0.688	0.122	0.177	0.305	0.375	0.563
¾	1.468	0.813	0.122	0.177	0.305	0.375	0.656
⅞	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
1⅛	2.250	1.188	0.136	0.177	0.305	0.375	1.000
1¼	2.500	1.375	0.136	0.177	0.305	0.375	1.094
1⅜	2.750	1.500	0.136	0.177	0.305	0.375	1.219
1½	3.000	1.625	0.136	0.177	0.305	0.375	1.313
1¾	3.375	1.875	0.178[B]	0.28[B]	0.305	0.375	1.531
2	3.750	2.125	0.178[B]	0.28[B]	0.305	0.375	1.750
2¼	4.000	2.375	0.24[C]	0.34[C]	0.305	0.375	2.000
2½	4.500	2.625	0.24[C]	0.34[C]	0.313	0.375	2.188
2¾	5.000	2.875	0.24[C]	0.34[C]	0.313	0.375	2.406
3	5.500	3.125	0.24[C]	0.34[C]	0.313	0.375	2.625
3¼	6.000	3.375	0.24[C]	0.34[C]	0.313	0.375	2.875
3½	6.500	3.625	0.24[C]	0.34[C]	0.313	0.375	3.063
3¾	7.000	3.875	0.24[C]	0.34[C]	0.313	0.375	3.313
4	7.500	4.125	0.24[C]	0.34[C]	0.313	0.375	3.500

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

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



Nominal Washer Size[D] 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.