SAE International™ SURFACE VEHICLE STANDARD

SAE J2655

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Fastener Part Standard—Washers and Lockwashers (Inch Dimensioned)

1. ***Scope***—This SAE Part Standard covers selected inch dimensioned washers and lock washers manufactured in accordance with American Society for Mechanical Engineers dimensional standards. This SAE standard covers material most often used in ship systems and equipment but its use may be applied wherever washers of the covered materials are used. This standard permits the washers to be identified and ordered by a part or identifying number (PIN) as defined in this standard.

1.1 Purpose—The purpose of this document is to assist the designer and other personnel in providing requirements and part or identifying numbers for the most commonly used washers and lock washers. A part or identification number (PIN) is normally required for all military applications and provides a useful means of communicating washer and lock washer requirements to suppliers and manufacturers in a very succinct manner.

1.2 Washer and Lock Washer Part Numbers—This document provides PINs that can be used to identify washers and lock washers covered by this standard. The PIN identifies the configuration (shape), nominal diameters, special features (plating and coatings), and material.

2. References

2.1 Applicable Publications—The following documents form a part of this standard to the extent specified herein. The latest issue of the documents shall be used except in those cases where an invitation for bid or procurement contract specifically identifies the issues in effect on a particular date.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Web site: www.sae.org, Tel. (724)-776-4970.

SAE AMS 2412—Silver Plating, Copper Strike, Low Bake
SAE AMS 2485—Black Oxide Coating
SAE AMS 2487—Anodic Treatment of Titanium and Titanium Alloys—Solution pH 12.4 maximum
SAE AMS 2488—Anodic Treatment, Titanium and Titanium Alloys—Solution pH 13 or Higher
SAE J2280—Ship Systems and Equipment—Fasteners—Selection and Identification Requirements

TO PLACE A DOCUMENT ORDER:
Tel: 877-606-7323 (inside USA and Canada)
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: custsvc@sae.org
SAE WEB ADDRESS: http://www.sae.org

2.1.2 ASME PUBLICATIONS—Available from the American Society of Mechanical Engineers, 22 Law Drive, Box 2900, Fairfield, NJ 07007-2900, Web site: www.asme.org, Tel. (800)-843-2763

ASME B18.2.6—Fasteners for Use In Structural Applications
ASME B18.18.2—Inspection and Quality Assurance for High-Volume Machine Assembly Fasteners
ASME B18.21.1—Lock Washers (Inch Series)
ASME B18.22.1—Plain Washers

2.1.3 ASTM PUBLICATIONS—Available from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, Web site: www.astm.org, Tel. (610)-832-4585

ASTM A 342/A 342M—Standard Test Methods for Permeability of Feebly Magnetic Materials
ASTM A 380—Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM B 580—Standard Specification for Anodic Oxide Coatings on Aluminum
ASTM B 695—Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM F 436—Hardened Steel Washers
ASTM F 1136—Chromium/Zinc Corrosion Protective Coatings for Fasteners
ASTM F 1137—Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners
ASTM F 1470—Fastener Sampling for Specified Mechanical Properties and Performance Inspection
ASTM F 1941—Electrodeposited Coatings on Threaded Fasteners (Unified Inch Screw Threads (UN/UNR))
ASTM D 4066—Standard Classification System for Nylon Injection and Extrusion Materials

2.1.4 DEPARTMENT OF DEFENSE PUBLICATIONS—Available from the DoD Single Stock Point - DoDSSP Building 4 / Section D, 700 Robbins Avenue, Philadelphia, PA 19111-5098, Web site: http://assist.daps.mil or http://assist2.daps.dla.mil/quicksearch, Tel. (215) 697-2179

MIL-DTL-16232—Phosphate Coating, Heavy, Manganese or Zinc Base
QQ-N-286—Nickel-Copper-Aluminum Alloy, Wrought (UNS N05500)

2.1.5 NATIONAL AEROSPACE STANDARDS—Available from the Aerospace Industries Association of America, Inc., 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3901, Web site: www.aia-aerospace.org, Tel. 703-358-1000

3. Requirements

3.1 SAE Washer Standards—This washer standard utilizes ASME dimensional standards for flat washers, helical spring lock washers and tooth type lock washers.

3.2 Part or Identifying Numbers (PINs) for Selected Washers and Lock Washers—PINs are provided herein for selected washers and lock washers for the purpose of common logistics parts identification between designers, fastener manufacturers, construction and repair activities and equipment operators. Part numbers are provided for only those fastener configurations and materials most likely to be needed for ship systems and equipment. Figure 1 provides a part or identifying number (PIN) for selected washers and lock washers. The PIN consists of a number of fields in order as identified in Figure 1. (There are no blank spaces in the PIN.) The next to last field in the PIN, Field 4, designates the washer material and the last field, Field 5, if applicable designates the finish. Dimensions for various configuration washers are provided in Tables 1 through 4 as identified below:

Table 1 - Nominal Dimensions for Round Flat Washers
Table 2 - Nominal Dimensions for Helical Spring Lock Washers
Table 3 - Nominal Dimensions for Tooth-Lock Washers
Table 4 - Nominal Dimensions for Internal/External Tooth Lock Washers
Tables 5 and 6 list the material designators for Field 4 of the PIN along with the UNS alloy number and hardness requirements. Tables 5 and 6 also list recommended finishes for Field 5 of the PIN.

3.3 Dimensional Requirements

3.3.1 THICKNESS OF WASHERS—The thickness of standard washers shall be in accordance with the applicable standard as identified in Figure 1. For non-standard washers the thickness shall be specified per Appendix A and shall be within the tolerances of Appendix A.

3.3.2 DIAMETERS—For standard washers, the internal and outside diameters shall be restricted to those identified in the applicable dimensional standards as identified in Figure 1. For non-standard washers, dimensions shall be as identified in Appendix A.

3.3.2.1 *Inside Diameter Profile*—The inside diameter of a flat washer usually has three distinct profiles as a result of the punch press process. As the punch enters, there is some pushing in of the material; that results in a rounded corner section (A). As the punch advances, it creates an essentially parallel section until it approaches the exit point and a tapered breakout occurs (B). Dimensions given for inside diameters, and their accepted tolerances, apply to the parallel sections. At the break out side of the washer, the specified maximum inside diameter may be exceeded by a maximum of 25% of the specified thickness (See Figure 2). For information on selecting the inside diameter see 4.5.3.

3.3.3 PLATING THICKNESS—Dimensions apply before plating or coating. Plating thickness is additive. See 3.5.4.

3.4 Finish Requirements—Finishes (coatings and platings) shall be limited to those identified herein. Finishes are recommended for the medium carbon steels for corrosion protection. The applicable finishes shall be designated in the part identification number as indicated in Figure 1. Recommended finishes for the various materials are identified in Table 5 for plain washers & Table 6 for lock washers. Other finishes may be specified if needed. While not normally recommended, the black oxide coating can be specified for materials other than carbon steels where a shiny natural appearance must be avoided.

3.4.1 REQUIRED TREATMENTS/COATINGS FOR ALUMINUM, STAINLESS STEEL AND TITANIUM WASHERS—The following treatments are required for all washers of the indicated material and are not identified in Field 5 of the PIN since the treatment is mandatory.

3.4.1.1 *Aluminum*—All aluminum washers shall be anodized in accordance with ASTM B 580.

3.4.1.2 *Stainless Steel*—All corrosion-resistant steel washers shall be passivated in accordance with ASTM A 380. Additional coatings are not usually required for protection of corrosion resistant steel washers

3.4.1.3 *Titanium*—Washers of titanium alloy shall be anodized in accordance with SAE AMS 2487 or AMS 2488 Type 2 (except testing requirements may be negotiated between manufacturer and coating supplier).

3.4.2 ALUMINUM COATINGS—Aluminum coatings shall have a conversion or other top coat and shall be subjected to a 400 hour salt spray test and meet the coating requirements of ASTM F 1137 except for appearance.

3.4.3 BLACK OXIDE COATINGS—Black oxide coatings shall be in accordance with SAE AMS 2485. See SAE J2280 for possible restrictions on use of black oxide finishes on brass and other materials for Navy ships.

3.4.4 ELECTRO-DEPOSITED COATINGS—Electro-deposited coatings of cadmium, zinc, and zinc-nickel shall be in general accordance with ASTM F 1941 for inch-dimensioned washers except that equivalent plating standards are permitted. The minimum coating thickness shall be 0.0002 inches. Additional corrosion protection shall be provided by a chromate or other finish that provides corrosion protection equivalent to designation D for cadmium, zinc and zinc-nickel coatings as defined in ASTM F 1941.

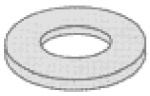
NOTE— Cadmium plated washers are not recommended and are prohibited in many Navy applications. See SAE J2280 for additional information. Some activities also restrict the use of chromate finishes.

J2655 FAN 1250 G1 Z

Field 5 Finish (Platings and Coatings) (See below)
Field 4 Material (See Table 5 or 6 as applicable)
Field 3 Nominal Fastener Size (See Tables 1, 2, 3, & 4)
Field 2 Type/Configuration/Dimensional Std (See below)
Field 1 SAE Standard – J2655

Field 1 - SAE J2655 Washer Part Standard

Field 2 – Type Product/Configuration/Dimensional Standard



Field 2 Designator	Dimensional Standard	Size Range
FAN – Washer, Round, Flat	ASME B18.22.1 Type A Narrow	0.138 (No. 6) to 3.00
FAW – Washer, Round, Flat	ASME B18.22.1 Type A Wide	0.250 to 1.500
FBN – Washer, Round, Flat	ASME B18.22.1 Type B Narrow	0.060 (No. 0) to 3.00
FBR – Washer, Round, Flat	ASME B18.22.1 Type B Regular	0.060 (No. 0) to 3.00
FBW – Washer, Round, Flat	ASME B18.22.1 Type B Wide	0.060 (No. 0) to 3.00
FCR – Washer, Circular	ASTM F 436* Hardened Steel	1/4 to 4 inch
FCC – Washer, Circular, Clipped	ASTM F 436* Hardened Steel	1/4 to 4 inch
BSB -- Washer, Square, Beveled	ASTM F 436* Hardened Steel	1/2 to 1-1/2
BSC – Washer, Square, Beveled & Clipped	ASTM F 436* Hardened Steel	1/2 to 1-1/2

* - See 4.5.4 for information about similar B18.2.6 washers

LHR – Lock Washer, Helical Spring, Regular	ASME B18.21.1	No. 2 (.086) to 3.000
LHH – Lock Washer, Helical Spring, Heavy	ASME B18.21.1	No. 2 (.086) to 3.000
LHE – Lock Washer, Helical Spring, Extra Duty	ASME B18.21.1	No. 2 (.086) to 3.000
LHC – Lock Washer, Helical Spring, High Collar	ASME B18.21.1	No. 4 (.112) to 3.000

LTR – Lock Washer, Internal Tooth	ASME B18.21.1	No. 2 (.086) to 1.250
LTH – Lock Washer, Internal Tooth, Heavy	ASME B18.21.1	0.250 to 0.875
LET – Lock Washer, External Tooth	ASME B18.21.1	No. 3 (.099) to 1.000
LEC – Lock Washer, External Tooth, Countersunk	ASME B18.21.1	No. 4 (.112) to 0.500

FIGURE 1—Part or Identifying Numbers (PINs) for Washers and Lockwashers

LCA – Lock Washer, Internal/External Tooth (Narrow)* B18.21.1 No. 10 (.190) to 0.625
LCB – Lock Washer, Internal/External Tooth (Regular)* B18.21.1 No. 4 (.112) to 0.625
LCC – Lock Washer, Internal/External Tooth (Wide)* B18.21.1 No. 4 (.112) to 0.625
LCD – Lock Washer, Internal/External Tooth (Extra-wide)* B18.21.1 No. 4 (.112) to 0.625
* Narrow, Regular, Wide and Extra-wide designations not used in ASME B18.21.1

Field 3 – Nominal Fastener Size The nominal fastener size is the nominal diameter (expressed in thousandths of an inch) of the externally threaded fastener with which the washer is intended to be used. See Table 1 (Round Flat Washers), Table 2 (Helical Spring Lock Washers), Table 3 (Tooth Lock Washers), and Table 4 (Internal/External Tooth Lockwashers) for applicable product to find the diameter in thousandths of an inch.

Examples: A washer for a No. 8 size screw with a nominal I.D. of 0.164 inches would have a Field 3 identification of 0164 while a washer for a ½ inch nominal diameter fastener would have a Field 3 identification of 0500. The identification is the nominal size of the externally threaded fastener and not the actual I.D. of the washer.

Field 4- Material - See Table 5 (Plain Washers) and Table 6 (Lock Washers) for the two character Field 4 designators

Field 5 – Finish (Coatings and platings) – If no coating is required, leave Field 5 blank; otherwise designate the selected coating (as permitted by Table 5 or 6 as applicable) from the following list

A = Aluminum (see 3.4.2)
B = Black oxide (see 3.4.3)
C = Cadmium electroplate (see 3.4.4)
G = Zinc Coating - Mechanically deposited (For ASTM F 436 Type 1 hardened steel washers, see ASTM F 436 for finish requirements. Either mechanically deposited or hot dip zinc finish may be supplied unless a particular finish is specified in the order.)
M4= Manganese Phosphate Coating with chemically converted Class 4 supplementary treatment (See 3.4.6)
S = Silver plating (see 3.4.7)
Z = Zinc Electroplate (see 3.4.4) or Mechanically Deposited Zinc (see 3.4.5)
Z1 = Zinc Phosphate with supplementary protective oil type compound (See 3.4.6)
Z2 = Zinc Phosphate Coating with supplementary zinc rich epoxy resin coating (See 3.4.6)
Z3 = Zinc/Aluminum Inorganic Coating (see 3.4.8)
Z4 = Zinc-Nickel Electro-deposited (see 3.4.4)

FIGURE 1—Part or Identifying Numbers (PINs) for Washers and Lockwashers (Continued)

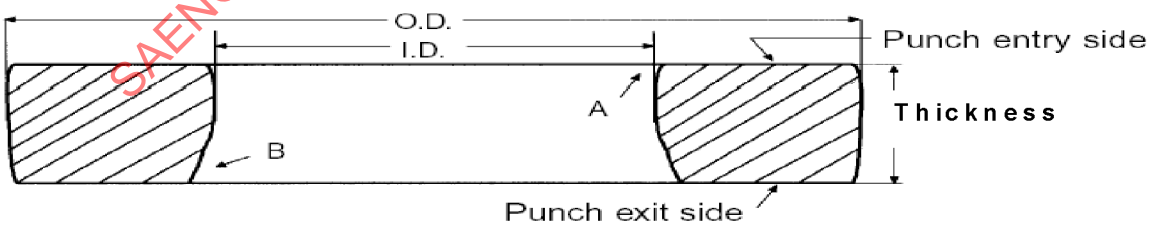


FIGURE 2—Washer Profile (Exaggerated for Clarity)

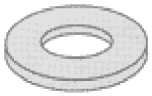


TABLE 1—NOMINAL DIMENSIONS FOR ROUND FLAT WASHERS

Nominal Washer Size[1]/Diam		Field 3	Type A Wide (Dimensions)[2] FAW		Type A Narrow and Type B (Dimensions)[2]				
					Type A Narrow FAN	All	Type B Narrow FBN	Type B Regular FBR	Type B Wide FBW
			ID	OD/Thk	OD/Thk	ID	OD/Thk	OD/Thk	OD/Thk
No. 0	0.060	**0060**				0.068	0.125/0.025	0.188/0.025	0.250/0.025
No. 1	0.073	**0073**				0.084	0.156/0.025	0.219/0.025	0.281/0.032
No. 2	0.086	**0086**				0.094	0.188/0.025	0.250/0.032	0.344/0.032
No. 3	0.099	**0099**				0.109	0.219/0.025	0.312/0.032	0.406/0.040
No. 4	0.112	**0112**				0.125	0.250/0.032	0.375/0.040	0.438/0.040
No. 5	0.125	**0125**				0.141	0.281/0.032	0.406/0.040	0.500/0.040
No. 6	0.138	**0138**			0.375/0.049	0.156	0.312/0.032	0.438/0.040	0.562/0.040
No. 8	0.164	**0164**			0.438/0.049	0.188	0.375/0.040	0.500/0.040	0.625/0.063
No. 10	0.190	**0190**			0.500/0.049	0.203[3]	0.406/0.040	0.562/0.040	0.734/0.063
No. 12	0.216	**0216**			0.562/0.065	0.234[4]	0.438/0.040	0.625/0.063	0.875/0.063
1/4	0.250	**0250**	0.312	0.734/0.065	0.625/0.065	0.281	0.500/0.063	0.734/0.063	1.000/0.063
5/16	0.312	**0312**	0.375	0.875/0.083	0.688/0.065	0.344	0.625/0.063	0.875/0.063	1.125/0.063
3/8	0.375	**0375**	0.438	1.000/0.083	0.812/0.065	0.406	0.734/0.063	1.000/0.063	1.250/0.100
7/16	0.438	**0438**	0.500	1.250/0.083	0.922/0.065	0.469	0.875/0.063	1.125/0.063	1.469/0.100
1/2	0.500	**0500**	0.562	1.375/0.109	1.062/0.095	0.531	1.000/0.063	1.250/0.100	1.750/0.100
9/16	0.562	**0562**	0.625	1.469/0.109	1.156/0.095	0.594	1.125/0.063	1.469/0.100	2.000/0.100
5/8	0.625	**0625**	0.688	1.750/0.134	1.312/0.095	0.656	1.250/0.100	1.750/0.100	2.250/0.160
3/4	0.750	**0750**	0.812	2.000/0.148	1.469/0.134	0.812	1.375/0.100	2.000/0.100	2.500/0.160
7/8	0.875	**0875**	0.938	2.250/0.165	1.750/0.134	0.938	1.469/0.100	2.250/0.160	2.750/0.160
1	1.000	**1000**	1.062	2.500/0.165	2.000/0.134	1.062	1.750/0.100	2.500/0.160	3.000/0.160
1-1/8	1.125	**1125**	1.250	2.750/0.165	2.250/0.134	1.188	2.000/0.100	2.750/0.160	3.250/0.160
1-1/4	1.250	**1250**	1.375	3.000/0.165	2.500/0.165	1.312	2.250/0.160	3.000/0.160	3.500/0.250
1-3/8	1.375	**1375**	1.500	3.250/0.180	2.750/0.165	1.438	2.500/0.160	3.250/0.160	3.750/0.250
1-1/2	1.500	**1500**	1.625	3.500/0.180	3.000/0.165	1.562	2.750/0.160	3.500/0.250	4.000/0.250
1-5/8	1.625	**1625**	1.750	3.750/0.180		1.750	3.000/0.160	3.750/0.250	4.250/0.250
1-3/4	1.750	**1750**	1.875	4.000/0.180		1.875	3.250/0.160	4.000/0.250	4.500/0.250
1-7/8	1.875	**1875**	2.000	4.250/0.180		2.000	3.500/0.250	4.250/0.250	4.750/0.250
2	2.000	**2000**	2.125	4.500/0.180		2.125	3.750/0.250	4.500/0.250	5.000/0.250
2-1/4	2.250	**2250**	2.375	4.750/0.220		2.375	4.000/0.250	5.000/0.250	5.500/0.375
2-1/2	2.500	**2500**	2.625	5.000/0.238		2.625	4.500/0.250	5.500/0.375	6.000/0.375
2-3/4	2.750	**2750**	2.875	5.250/0.259		2.875	5.000/0.250	6.000/0.375	6.500/0.375
3	3.000	**3000**	3.125	5.500/0.284		3.125	5.500/0.375	6.500/0.375	7.000/0.375

1. Use only sizes in **bold** type for new design.
2. See ASME B18.22.1 for complete dimensions. ASME B18.22.1 uses the Narrow and Wide designations only for sizes ¼ through 1-1/2 nominal diameters. Note: As indicated by the heavy dividing line, the I.D. dimensions for Type A Wide washers also apply to the Type A Narrow washers for nominal sizes 1-1/8 to 1-1/2.
3. The ID for Type A Narrow is 0.219 inches.
4. The ID for Type A Narrow is 0.250 inches.

TABLE 2—NOMINAL DIMENSIONS FOR HELICAL SPRING LOCK WASHERS

Nominal Washer Size[1]/Diam		Field 3	Maximum Outside Diameter/Minimum Thickness (Inches)[2]			
			Regular LHR	Heavy LHH	Extra Duty LHE	High Collar LHC
No. 2	0.086	**0086**	0.172/0.020	0.182/0.025	0.208/0.027	
No. 3	0.099	**0099**	0.195/0.025	0.209/0.031	0.239/0.034	
No. 4	0.112	**0112**	0.209/0.025	0.223/0.031	0.253/0.034	0.173/0.022
No. 5	0.125	**0125**	0.236/0.031	0.252/0.040	0.300/0.045	0.202/0.030
No. 6	0.138	**0138**	0.250/0.031	0.266/0.040	0.314/0.045	0.216/0.030
No. 8	0.164	**0164**	0.293/0.040	0.307/0.047	0.375/0.057	0.267/0.047
No. 10	0.190	**0190**	0.334/0.047	0.350/0.056	0.434/0.068	0.294/0.047
No. 12	0.216	**0216**	0.377/0.056	0.391/0.063	0.497/0.080	
1/4	0.250	**0250**	0.487/0.062	0.489/0.077	0.583/0.084	0.363/0.078
5/16	0.312	**0312**	0.583/0.078	0.593/0.097	0.619/0.108	0.457/0.093
3/8	0.375	**0375**	0.680/0.094	0.688/0.115	0.738/0.123	0.550/0.125
7/16	0.438	**0438**	0.776/0.109	0.784/0.133	0.836/0.143	0.644/0.140
1/2	0.500	**0500**	0.869/0.125	0.879/0.151	0.935/0.162	0.733/0.172
9/16	0.562	**0562**	0.965/0.141	0.975/0.170	1.035/0.182	
5/8	0.625	**0625**	1.073/0.156	1.087/0.189	1.151/0.202	0.917/0.203
3/4	0.750	**0750**	1.265/0.188	1.285/0.226	1.355/0.241	1.105/0.218
7/8	0.875	**0875**	1.459/0.219	1.489/0.266	1.571/0.285	1.291/0.234
1	1.000	**1000**	1.656/0.250	1.700/0.306	1.794/0.330	1.478/0.250
1-1/8	1.125	**1125**	1.847/0.281	1.903/0.345	2.013/0.375	1.663/0.313
1-1/4	1.250	**1250**	2.036/0.312	2.104/0.384	2.222/0.417	1.790/0.313
1-3/8	1.375	**1375**	2.219/0.344	2.301/0.422	2.429/0.458	2.031/0.375
1-1/2	1.500	**1500**	2.419/0.375	2.491/0.458	2.627/0.496	2.159/0.375
1-5/8	1.625	**1625**	2.553/0.389	2.694/0.458	2.784/0.496	
1-3/4	1.750	**1750**	2.679/0.389	2.820/0.458	2.902/0.526	2.596/0.469
1-7/8	1.875	**1875**	2.811/0.422	2.945/0.458	3.027/0.526	
2	2.000	**2000**	2.936/0.422	3.144/0.496	3.156/0.526	2.846/0.469
2-1/4	2.250	**2250**	3.221/0.440	3.398/0.496		3.345/0.508
2-1/2	2.500	**2500**	3.471/0.440	3.648/0.496		3.595/0.508
2-3/4	2.750	**2750**	3.824/0.458	3.910/0.526		4.095/0.633
3	3.000	**3000**	4.074/0.458	4.160/0.526		4.345/0.633

1. Use only sizes in **bold** type for new design.
2. For complete dimensions see ASME B18.21.1.

TABLE 3—NOMINAL DIMENSIONS FOR TOOTH-LOCK WASHERS

Nominal Washer Size[1]/Diam.		Field 3	Maximum Outside Diameter/Maximum Thickness (Inches)[2]			
			Internal Tooth LTR	Heavy Internal Tooth LTH	External Tooth LET	Countersunk 82° External Tooth LEC
No. 2	0.086	**0086**	0.200/0.016			
No.3	0.099	**0099**	0.232/0.016		0.235/0.016	
No. 4	0.112	**0112**	0.270/0.018		0.260/0.018	0.213/0.019
No. 5	0.125	**0125**	0.280/0.020		0.285/0.020	
No. 6	0.138	**0138**	0.295/0.022		0.320/0.022	0.289/0.021
No. 8	0.164	**0164**	0.340/0.023		0.381/0.023	0.322/0.021
No. 10	0.190	**0190**	0.381/0.024		0.410/0.024	0.354/0.025
No. 12	0.216	**0216**	0.410/0.027		0.475/0.027	0.421/0.025
1/4	0.250	**0250**	0.478/0.028	0.536/0.045	0.510/0.028	0.454/0.025
5/16	0.312	**0312**	0.610/0.034	0.607/0.050	0.610/0.034	0.599/0.028
3/8	0.375	**0375**	0.692/0.040	0.748/0.050	0.694/0.040	0.765/0.034
7/16	0.438	**0438**	0.789/0.040	0.858/0.067	0.760/0.040	0.867/0.045
1/2	0.500	**0500**	0.900/0.045	0.924/0.067	0.900/0.045	0.976/0.045
9/16	0.562	**0562**	0.985/0.045	1.034/0.067	0.985/0.045	
5/8	0.625	**0625**	1.071/0.050	1.135/0.067	1.070/0.050	
3/4	0.750	**0750**	1.245/0.055	1.265/0.084	1.260/0.055	
7/8	0.875	**0875**	1.410/0.060	1.447/0.084	1.410/0.060	
1	1.000	**1000**	1.637/0.067		1.620/0.067	
1-1/8	1.125	**1125**	1.830/0.067			
1-1/4	1.250	**1250**	1.975/0.067			

1. Use only sizes in **bold** type for new design
2. For complete dimensions see ASME B18.21.1.

TABLE 4—NOMINAL DIMENSIONS FOR INTERNAL/EXTERNAL TOOTH LOCK WASHERS

Nominal Size[1]/Diam.		Field 3	Maximum Outside Diameter/Maximum Thickness (Inches)[2]			
			LCA	LCB	LCC	LCD
No. 4	0.112	**0112**		0.475/0.021	0.510/0.021	0.610/0.021
No. 5	0.125	**0138**		0.510/0.028	0.610/0.028	0.690/0/028
No. 6	0.138	**0164**		0.610/0.034	0.690/0.034	0.760/0.034
No. 8	0.164	**0190**	0.610/0.034	0.690/0.040	0.760/0.040	0.900/0.040
No. 10	0.190	**0216**	0.690/0.040	0.760/0.040	0.900/0.040	0.985/0.045
No. 12	0.216	**0250**	0.760/0.040	0.900/0.040	0.985/0.045	1.070/0.045
1/4	0.250	**0312**	0.900/0.040	0.985/0.045	1.070/0.050	1.155/0.050
5/16	0.312	**0375**	0.985/0.045	1.070/0.050	1.155/0.050	1.260/0.050
3/8	0.375	**0438**	1.070/0.050	1.155/0.050	1.260/0.055	1.315/0.055
7/16	0.438	**0500**	1.260/0.055	1.315/0.055	1.410/0.060	1.620/0/067
1/2	0.500	**0562**	1.315/0.055	1.430/0.060	1.620/0.067	1.830/0.067
9/16	0.562	**0625**	1.410/0/0.060	1.620/0.067	1.830/0.067	1.975/0.067

1. Use only sizes in **bold** type for new design.
2. For complete dimensions see ASME B18.21.1.

TABLE 5—MATERIALS FOR PLAIN WASHERS

Field 4 Designator	UNS Number	Material/Alloy	Hardness	Recommended Configurations (See Figure 1)	(Field 5 Designator) Recommended Finishes
G1	G10080 – G10200	Carbon Steel	≤ .069 Thk 90 HRB min. ≥.070 Thk 84 HRB min.	All	B, C, G, M4, Z
G4	G40370	Alloy Steel	38 - 46 HRC	All	B, C, G, M4, Z
F1	F436 Ty 1	Carbon Steel	See Note 2	FCR, FCC, BSB, & BSC	G
F3	F436 Ty 3	Weathering Steel	See Note 2	FCR, FCC, BSB, & BSC	N
S1	S30200 S30400 S30403 S30500 S31600 S31603	Stainless Steel Alloy 302. Alloy 304 Alloy 304L Alloy 305 Alloy 316 Alloy 316L	80-92 HRB 80-92 HRB 80-92 HRB 80-88 HRB 80-95 HRB 80-95 HRB	All	P
S2	S31600 S31603	Alloys 316 & 316L	80-95 HRB	All	P
C2	C28000	Brass (Cu –Zn Alloy)	74 HRB min	**FAN** **FAW**	N, B
N2	N10276	Ni-Mo-Cr Alloy C-276	80 HRB min.	All, **FAW**	N
N4	N04400	NI-Cu Alloy 400	60 HRB min.	All, **FAW**	N
N5	N05500	Ni-Cu-Al	70 HRB min.	All	N
N6	N06686	Ni-Cr-Mo-W Alloy 686	80 HRB min.	All	N
P1	PA111 per ASTM D 4066	Plastic Polyamide (Nylon)	188 HRR min.	**FAW**	N
A5	A95052	Alloy 5052 H32 or H34		All, **FAW**	A
A6	A96061	Aluminum 6061-T6	40 HRB min.	All, **FAW**	A
T2	R50400	Titanium Grade 2	80 HRB min.	All	A
T3	R55111	Titanium Alloy 5111	24 HRC min.	All, **FAW**	A

A = Anodize, **B** = Black Oxide, **C** = Cadmium, **G** = Zinc (hot dipped or mechanically deposited), **4** = Manganese Phosphate, **N** = None, **NR** = Not Recommended, **P** = Passivate, **Z** = Zinc (see Field 5 for options)

Notes:(1) For those configurations listed as NR, the material may not be readily available or better material choices may be available. A particular configuration listed in **bold** is an indication that parts are more readily available in this configuration.
(2) See ASTM F 436 for material, hardness and other requirements.

TABLE 6—MATERIALS FOR LOCK WASHERS

Field 4 Designator	UNS Number	Material/ Alloy	Helical Spring Lock Washer		Tooth Lock Washers		Finishes (Field 5 Designator)
			Hardness	Config.	Hardness	Config.	
G5	G10500 – G10650	Carbon Steel		NR	40 – 50 HRC	All	B, C, G, Z
G6	G10550 - G10650	Carbon Steel-	38 – 46 HRC	All		NR	B, C, G, Z
G4	G40370	Alloy Steel	38 - 46 HRC	All		NR	B, C, G, Z
S1	S30200 S30400 S30403 S30500 S31600 S31603	Stainless Steel Alloy 302, Alloy 304 Alloy 304L Alloy 305 Alloy 316 Alloy 316L	5/8 & < 35 – 43 HRC 3/4 & > 32 – 43 HRC	All	40 - 50 HRC	All	P
S2	S31600 S31603	Alloys 316 & 316L	See above	All	See above	All, **LET**	P
S4	S41000	Martensitic Alloy 410		NR	40 - 50 HRC	ALL, **LET**	P
C4	C42500	Tin Brass Alloy 425		NR	Temper H06 min.	All. **LET**	
C5	C51000	Phosphor Bronze 510	90 HRB min.		All	All, **LET**	
C6	C65100 or C65500	Silicon Bronze Alloy 651 or 655	90 HRB min.	All, **LHR**		NR	
N5	N05500	Ni-Cu-Al QQ-N-286	33-40 HRC	All, **LHR**		NR	N
A7	A97075	Alloy 7075-T73	75 – 97 HRB	All		NR	A

A = Anodize, **B** = Black Oxide, **C** = Cadmium, **G** = Zinc (hot dipped or mechanically deposited), **N** = None, **NR** = Not Recommended, **P** = Passivate, **Z** = Zinc (see Field 5 for options)

Notes:(1) For those configurations listed as NR, the material may not be readily available or better material choices may be available. A particular configuration listed in **bold** is an indication that parts are more readily available in this configuration.

3.4.5 MECHANICALLY-DEPOSITED ZINC—Mechanically deposited zinc coatings shall be in accordance with ASTM B 695. Minimum coating thickness shall be 0.0002 inches for washers of nominal diameters of ½ inch and less and 0.0003 inches for nominal diameters greater than ½ inch. Additional corrosion protection shall be provided by a chromate or other finish that provides corrosion protection equivalent to designation D for cadmium, zinc and zinc-nickel coatings as defined in ASTM F 1941.

NOTE— Mechanically deposited zinc is not recommended for tooth washers, see 4.5.3.1

3.4.6 PHOSPHATE COATINGS—Manganese Phosphate coatings should not be exposed to temperature in excess of 121 °C (250 °F). Zinc Phosphate coatings should not be used if contact with alkaline materials or exposure to temperatures above 93 °C (200 °F) is expected. A supplementary coating shall be provided for improved corrosion resistance. The designated Field 5 phosphate coatings shall be as indicated below:

M4 = Manganese Phosphate with chemically converted supplemental treatment in accordance with MIL-DTL-16232, Type M, Class 4
Z1 = Zinc Phosphate with supplementary protective oil type compound (Coating shall be in accordance with MIL-DTL-16232 or ASTM F 1137 and shall meet 72 hour salt spray test.)
Z2 = Zinc Phosphate Coating with supplementary zinc rich epoxy resin coating. (Coating shall be in accordance with ASTM F 1137 Grade II or Grade III and shall meet 240 hour salt spray test.)

3.4.7 SILVER PLATING—Silver plating shall be in accordance with SAE AMS 2412,

3.4.8 ZINC/ALUMINUM OR CHROMIUM ZINC INORGANIC COATING—This coating shall meet the requirements of Grade 3 in accordance with ASTM F1136 except that a pigmented topcoat is permitted. (If a particular pigmented topcoat color is required it must be specifically identified on the ordering documentation.)

3.5 Quality Assurance—The ordering document must address quality assurance requirements. SAE J2280 Appendix A identifies additional test/inspection requirements that are to be applied when SAE J2280 Appendix A is contractually invoked, such as for most military procurements. If the ordering document does not address quality control requirements, the following inspections shall apply:

3.5.1 WORKMANSHIP, FINISH, AND APPEARANCE—Washers shall be free of excess mill scale, excess coatings and foreign material (including metal spatter) on bearing surfaces.

3.5.2 DIMENSIONS—Dimensional inspections shall be in accordance with the referenced product standard. If the number of samples is not addressed in the product standard, the requirements of ASME B18.18.2 shall apply except Sample Size A of ASTM F 1470 may be applied for lots of 5000 pieces or less.

3.5.3 HARDNESS TESTS—These tests and inspections shall be in accordance with the referenced product standard. If the number of samples is not addressed in the product standard, the number of samples for hardness shall be in accordance with ASTM F 1470.

3.5.4 COATING THICKNESS—For coated washers, the coating thickness shall be verified by one of the methods identified in ASTM F 1941. The number of samples shall be as specified in ASTM F 1941.

4. ***Notes—***This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.

4.1 Intended Use—This standard establishes requirements and PINs for washers of selected materials. While this standard was developed specifically for ship systems and equipment, its use is not restricted to these applications.

4.2 Identification of Part Numbering System on Drawings—On drawings where a column exists for identifying the manufacturer or his Commercial and Government Entity (CAGE) Code, indicate the CAGE Code “81343/J2655” or “SAE J2655” as required by the drawing standard. If no column exists or there is space only for the 5-digit CAGE Code, then a note must indicate that the part numbers are defined in SAE J2655.

4.3 Magnetic Permeability—For certain applications, low magnetic permeability may be required. Most non-ferrous fasteners have a relative magnetic permeability in air of 2.0 maximum when determined in accordance with ASTM A 342/A 342M on the finished fastener. However Nickel-Copper Alloy 400 and 405 washers should not be used when a magnetic permeability of 2.0 maximum is required as the magnetic permeability changes significantly at a transition temperature that is within the temperature range of normal usage. For CRES fasteners, alloy 316/316L should be specified when low magnetic permeability is required. For washers where low permeability is essential, Nickel alloys UNS N05500 and UNS N06686 should be considered. If compliance with magnetic permeability requirements is necessary, the requirements must be identified in addition to the part number for the washer.

4.3.1 Nickel-Copper alloys such as Alloy 400 can often be identified by their magnetic properties. The Curie point will be between -5 °C and 100 °C depending upon the alloy. This means the material will be magnetic when placed in a freezer and the magnetic properties will disappear when it is placed in hot water above the Curie point.

4.4 Use of Coatings—Not all coatings are suitable for use with all materials. In addition to the recommendations in Tables 5 and 6, the Appendix of J2280 identifies further restrictions regarding coating for use on Navy ships.

4.4.1 USE OF SILVER PLATING—Silver plating should only be specified for washers of materials that are more noble than silver, such as nickel-copper and nickel base alloys and some stainless steel. Silver shall not be applied to titanium washers.

4.5 Washer Application and Selection Guidance—Brief application and selection guidance is provided for the types of washers and lock washers covered in this standard.

Flat Washers–Washers prevent embedment of fasteners in the clamped material by spreading the load over a larger area, aid in tightening and increase the effective bolt length thereby increasing the amount of stretch the bolt can withstand under shock. Selection of the configuration to use for particular size is based upon the amount of fastener preload, clearance in the fastener hole, amount of space available for the washer outer diameter, and strengths of the members in the joint.

Helical Spring Lockwashers–These washers provide protection against looseness resulting from vibration, provide a hardened bearing surface resulting in more uniform torque control and increase the effective bolt length significantly more than plain washers. The regular configuration is suitable for most applications; the heavy and extra heavy configurations are used in applications with higher torques. The high collar configuration is for use in confined areas and for use with socket head cap screws.

Tooth Lockwashers–The twist in the "tooth" is shaped to provide resistance to loosening and when compressed acts as a spring to provide additional spring load to the fastener. External tooth lockwashers with the teeth on the OD provide greater resistance to lo loosening than internal tooth lockwashers. Internal tooth washers are primarily used for small head fasteners and where the appearance of the teeth is detrimental for appearance or scratch/snag potential. Internal/External tooth washers are used where large bearing area is desired, for large or elongated holes, and for electrical connections. Countersunk lockwashers are for use with countersunk screws. It is important that the head/washer surface of the fastener cover the entire diameter of the external teeth on a lock washer.

4.5.1 AVAILABLE SIZES—Not all washer sizes or materials listed in this standard are available off the shelf. It is recommended that manufacturer and distributor catalogs and web sites be consulted to determine availability of products. For small orders, off-the-shelf products should be selected whenever feasible. There are many washer standards that cover configurations, materials and coatings not covered in this standard. Many military washer standards have been converted to NAS standards or made inactive for new design. For a listing of these standards and comparison to configurations and coatings in J2655 see the following Tables in Appendix B:

Table B1. Flat Washers - Active Standards, Sizes, Materials and Finishes
Table B2. Flat Washers - Inactive Standards, Sizes, Materials and Finishes
Table B3. Helical Lock Washers - Standards, Sizes, Materials and Finishes
Table B4. Tooth Lock Washers - Standards, Sizes, Materials and Finishes

4.5.2 PART NUMBERS FOR NON-STANDARD FLAT WASHERS—Users should select standard washers from this standard or one of the active washer standards listed in Table B1. If neither of these options can provide the required washer, a part number can be developed in accordance with Appendix A to cover almost any flat washer that is required.

4.5.3 CAUTION ON SELECTION AND INSTALLATION OF WASHERS—Some washers have a relatively small clearance on the inside diameter that can result in interference with the fillet radius at the junction of the head and shank of screws and bolts. This interference can cause embedment that results in loss of preload and stress concentrations at the junction of the head and shank leading to possible failure. If a washer is to be installed directly under the head of a screw or bolt, a dimensional analysis should be made to ensure that an interference will not result under adverse tolerances. Countersunk washers are available to alleviate this condition. (See Table B1.) The clearance tends to be less with Military and NAS washers. This condition is further aggravated when the breakout (punch exit) side of punched washers is not installed directly under the head of a screw or bolt. (See 3.3.2.1 and Figure 2.) The clearance is usually the greatest on the ASME B18.22.1 Type A Wide configuration washers and this configuration is recommended for use directly under heads when available in the required size.

4.5.3.1 *Coating Limitations*—While mechanically deposited zinc and electroplated zinc are listed as being interchangeable, experience has shown that mechanically deposited zinc is more suitable for flat and helical spring washers whereas good coverage of mechanically deposited zinc is difficult to obtain on tooth washers.

4.5.4 ASME B18.2.6 HARDENED STEEL STRUCTURAL WASHERS—Hardened steel washers to ASME B18.2.6 are considered equivalent to the ASTM F 436 washers except that ASTM F 436 covers larger diameter circular washers. Quality Assurance requirements may differ slightly. In event of a dispute for washers to this SAE standard, the ASTM F 436 requirements apply.

5. Notes

5.1 **Key Words**—Helical spring lock washer, round flat washers, tooth lock washer, countersunk washer, internal/external tooth lock washer

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APPENDIX A

PART NUMBERS FOR NON-STANDARD FLAT WASHERS

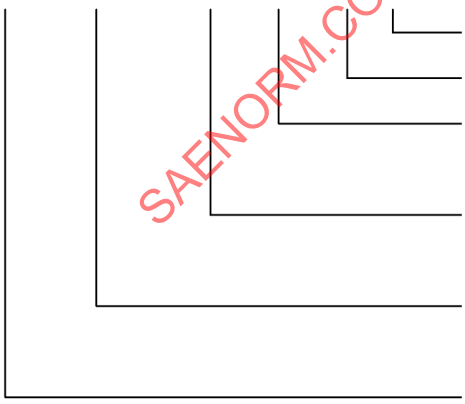
A.1 Purpose—The purpose of this Appendix is to provide a means of establishing Part Identification Number (PINs) for non-standard flat washers that are not covered in J2655. Users are encouraged to select washers of standard configurations wherever possible. However, this Appendix permits the establishment of PINs for washers with a nominal diameter greater than 3 inches and other washers of a different thickness or dimensions including other configurations listed in ASME B18.22.1.

A.2 Recommended Dimensions

A.2.1 Diameters—It is recommended that the ID for 3 inch and smaller nominal diameter washers be based on the values in Table 1 for Type A Wide (FAW) or Type A Narrow (FAN) as tooling for manufacturing these diameters is more likely to be available. See Table A1 for recommended tolerances on diameters for non-standard washers. Many washers are manufactured by punching. When a hole is punched it does not have a constant radius through the entire thickness of the part. The result is that the diameter increases (or tapers) as a function of the die clearance between the punch diameter and the diameter. The die clearance is usually about 10% of the material thickness.

A.2.2 Thickness—A liberal tolerance for thickness is needed because of the manner in which washers are manufactured. They are usually stamped from sheet, strip or plate. While sheet can be rolled to relatively close tolerances, it is preferable to select a thickness based on standard mill products. With sheet products the thickness varies, being thicker in the center and thinner at the edges. On very thin sheets this variation can be as much as plus or minus 10% of the sheet thickness. While a plus or minus tolerance is permitted for sheet material, the tolerance will normally be on the minus side. Another factor is that Standard Gage Nos. for thickness result in different dimensions depending upon whether the metal is Ferrous (and CRES) or Non-ferrous (Aluminum and others). When selecting materials it is important that standard mill thickness be specified whenever practical, particularly if the quantity of washers ordered is small so that readily available material may be used. Table A2 lists standard gage thickness for carbon steel and CRES along with thickness tolerances for non standard washers. Where possible it is recommended that the values for nominal standard thickness be used.

J2655 Ahhh Bhhh Tttt G1 Z



Field 6 – Finish (From J2655 Figure 1, Field 5)

Field 5 – Material (From J2655 Table 5)

Field 4 – Thickness T)
(ttt = Thousandths of an inch)

Field 3 – Outside Diameter (B)
(hhh = Hundredths of an inch)

Field 2 – Inside Diameter (A)
(hhh = Hundredths of an inch)

Field 1 – SAE Number (J2655)

Example: **J2655A420B900T375G1Z** is the part number for a 4 inch nominal diameter washer which has an ID (A) of 4.20 inches, an OD (B) of 9.00 inches, and a thickness (T) of 0.375 inches; it is manufactured of carbon steel (G1) with a zinc (Z) coating.

FIGURE A1—Part or Identifying Numbers (PINs) for Non Standard Flat Washers

TABLE A1—DIAMETERS FOR NON-STANDARD WASHERS

Outside Diameter	Recommended ID & OD Tolerances		
	Basic ID	Plus	Minus
0.500 and less	See FAW or FAN in Table 1	0.008	0.005
0.501 to 1.000	See above	0.015	0.005
1.001 to 3.000	See above	0.030	0.007
3.001 to 5.000	See above	0.045	0.010
5.001 to 7.000	See above	0.065	0.010
> 7.001 inches	Fastener Nominal Diam. + 0.19	0.075	0.015

TABLE A2—THICKNESS TOLERANCES FOR NON-STANDARD FLAT WASHERS

Tolerances for Standard Thickness Washers					Tolerances for Non-Standard Thickness Washers		
Standard Nominal Thickness	Steel Gauge No./ Thickness		Washer Thickness		Specified Thickness	Tolerance	
			Max.	Min.		Max.	Min
.020	25	0.0209	0.024	.017	.020 - .039	.005	.005
.025	23	0.0269	0.030	.020			
.032	22	0.0299	0.036	.028	.041 - .049	.006	.006
.040	19	0.0418	0.045	.036			
.050			0.057	.043	.051 - .062	.007	.008
.063	15	0.0673	0.070	.060			
.075			0.085	.065	.064 - .074	.011	.011
.090	13	0.0897	0.100	.080			
.105	12	0.1046	0.113	.095	.076 - .104	.012	.012
.125			0.135	.110			
.134	10	0.1345	0.143	.125	.106 - .133	.013	.013
.160	8	0.1644	0.173	.150			
.250	1/4	0.250	0.285	.230	.135 - .159	.014	.014
.312	5/16	0.312	0.345	0.290			
.375	3/8	0.375	0.410	0.350	.161 - .311	.016	.016
.500	1/2	0.500	0.535	0.480			
					> .313	.030	.030