



Washer – Flat, Steel

1 Introduction

1.1 Purpose. The purpose of this standard is to provide the dimensional, mechanical, and material requirements for the design of flat washers used in bolted joints.

1.2 Applicability. This standard applies to the design of steel flat washers. It is not applicable to washers pre-assembled to a bolt, screw, stud, or nut. This standard is not applicable to stainless steels or nonferrous metals.

1.3 Remarks. This standard references the content of a draft version of ISO 898-3. The status of ISO 898-3 shall be reviewed at the next revision of this standard.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

EN 10083-3	ISO 887	ISO 4759-3	ISO 6508-1
EN 10132-3	ISO 898-3	ISO 6507-1	

2.2 GM Standards/Specifications.

GMW3044	GMW3059	GMW3359	GMW4700
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3 Requirements

3.1 Test Reporting. Appendix A, Table A1 lists the minimum tests required to be performed and reported for Production Part Approval Process (PPAP), and also for each production lot. When requested, other requirements described in this standard shall be produced by the supplier. In the event of a conflict between the two (2) dimensional part drawing and this standard, the two (2) dimensional part drawing has precedence.

3.2 Dimensions.

3.2.1 Clearance Hole. Per ISO 887.

3.2.2 Outside Diameter. Per ISO 887.

3.2.3 Thickness. Per ISO 887.

3.2.4 Preferred Dimensions. Per ISO 887, Product Grade A.

3.3 Tolerances. Dimensional tolerances and tolerances of form and position per ISO 4759-3, Product Grade A. with the exceptions listed below.

Exceptions:

- Clearance hole (punched) ISO 4759-3, $h_1 = 0.1 h$ for $h \leq 4$ and $h > 4$. Tolerance requirements for d_1 is not changed.
- Thickness variation on the same part (ISO 4759-3) is not required.
- Flatness (ISO 4759-3), $t_2^a = 0.25$ for $1 < h \leq 2.5$. All other tolerance requirements are unchanged.

3.4 Material. Material selection by the manufacturer shall meet the mechanical properties defined in Table 2. The chemistry and minimum tempering temperature shall conform to the limits specified in Table 1.

Table 1: Chemical Composition of Steels

Material and Process			Chemical Composition Limits Cast Analysis, Percent (%) ^{Note 1}									Tempering Temperature
Material	Process	Carbon (C)		Manganese (Mn)		Silicon (Si)		Phosphorous (P)	Sulfur (S)	Chromium (Cr)	°C	
		Min	Max	Min	Max	Min	Max	Max	Max	Max	Min	
Carbon Steel	Quenched and Tempered	0.47	0.80	N/A	1.40	N/A	0.40	0.035	0.05	0.40	425	
Alloy Steel		0.17		See EN 10083-3, EN 10132-3 Lead (Pb) not permitted								

Note 1: For referee purposes, the actual production part shall be measured by X-ray fluorescence (XRF) or a similar method agreed upon by all parties.

Max = Maximum

Min = Minimum

N/A – Not applicable

3.5 Mechanical and Physical Properties.

Table 2: Mechanical and Physical Properties

		Quenched and Tempered ^{Note 1}
Vickers Hardness, (HV)	Minimum	360
	Maximum	430
Rockwell Hardness C, (HRC)	Minimum	37
	Maximum	43
Depth of partial decarburization, millimeters	Maximum	Note 2
Depth of complete decarburization Figure 2 (G), millimeters	Maximum	2% of t_{eff} or 0.2 mm Note 3
Carburization, HV 0.3	Maximum	Note 4
Reduction of hardness after re-tempering, HV 10	Maximum	20

Note 1: There shall be a sufficient hardenability to ensure a structure consisting of approximately 90% martensite in the core section in the as-hardened condition before tempering.

Note 2: For partial decarburization, hardness at 0.1 mm from the surface shall not be more than 30 Vickers points below the measured hardness on a transverse radial section through the washers in accordance per 3.6.2.

Note 3: The lowest value applies.

Note 4: For carburization, hardness at 0.1 mm from the surface shall not be > 30 Vickers points above the measured hardness on a transverse radial section through the washers in accordance per 3.6.3.

3.6 Test Methods.

3.6.1 Hardness Test.

3.6.1.1 General. The purpose of this test is to determine:

- The hardness of the washer is between the minimum and maximum values specified in Table 2.
- In addition for quenched and tempered washers, the material condition has been properly achieved during the heat treatment.

Washers shall be tested in the as-received condition.

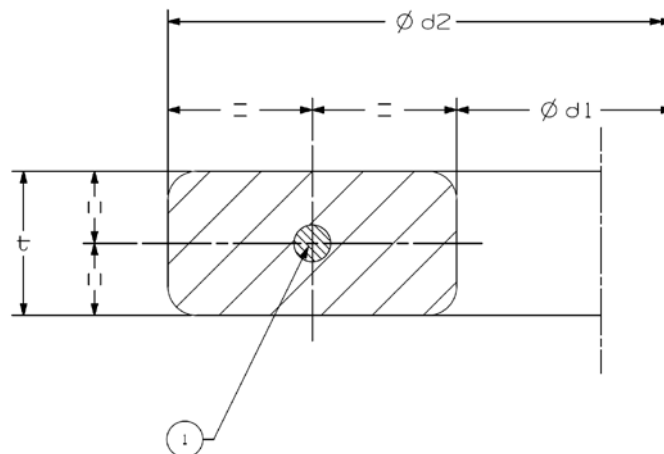
Hardness shall be determined using the Vickers Hardness (HV) test or the Rockwell Hardness (HR) test.

- The HV test shall be carried out in accordance with ISO 6507-1.
- The HR test shall be carried out in accordance with ISO 6508-1.

Hardness shall be determined either on a suitable surface by Vickers or on a transverse radial section through the washer by Vickers or Rockwell.

3.6.1.2 Test Procedure.

3.6.1.2.1 Hardness Determined on a Transverse Radial Section through the Washer. A radial section through the hole axis shall be taken, and the surface shall be suitably prepared. The test specimen shall be embedded in a plastic mount or, alternatively, in a clamp. After mounting, the surface shall be grounded and polished in accordance with good metallographic practice. Hardness readings shall be performed with HV in the middle of the section as specified in Figure 1.



1. Area for readings (radius of 0.25 t)

Figure 1: Area for Hardness Readings

3.6.1.2.2 Hardness Determined on the Washer Bearing Surface. The hardness shall be determined in the middle of the bearing surfaces after removal of any coating, decarburization, or carburization, and after suitable preparation of the test specimen.

3.6.1.2.3 Test Force for Hardness Determination.

3.6.1.2.3.1 Test force for HV test.

The choice of the test force for the HV for washers, depends on the washer material or manufacturing process and thickness.

- The HV test shall be carried out with a maximum test force of 294.2 N (HV30).
- In addition, the minimum test force should be selected in accordance with the formula $F = (t^2 \times HV) / 0.39$.