

**DIMENSIONAL, MATERIAL REQUIREMENTS AND MECHANICAL PROPERTIES OF FLAT, TOOTHED, CONICAL, BOWED AND WAVY WASHERS****1. SCOPE**

This standard specifies the dimensional, material, heat treatment, hardness and performance requirements for flat and conical washers for general use and for use in bolt, screw, or nut and washer assemblies. Toothed, bowed, and wavy washers as well as hardness classes A, D, E, and F shall not be used for new design and were moved to WF900 Appendix A for reference purposes.

1.1 REFERENCES

ASTM E140	Hardness conversion tables for metals
ISO 7093	Plain Washers - Large Series - Part 1 and 2
ISO 7089	Plain Washers - Normal Series
ISO 4759	Tolerances for fasteners Part 3
ISO 6507	Metallic materials - Hardness test - Vickers test.

2. DIMENSIONS AND TOLERANCES**2.1 General**

Dimensions and tolerances shall be in accordance to ISO 4759-Part 3

2.2 FLAT WASHERS

The nominal inside diameter, outside diameter and thickness shall be as specified per ISO 4759 and ISO 7093 – Part 1 and 2 as appropriate.

2.3 TOOTHED, CONICAL, BOWED AND WAVY WASHERS

Dimensions and tolerances shall be as specified in (WF900 Appendix A).

2.4 ASSEMBLED

The inside diameter of washers for use in bolt, screw, or nut and washer assemblies shall be such as to permit rotation whilst disassembly is prevented.



3. MATERIAL, HEAT TREATMENT AND HARDNESS

Material, heat treatment and hardness requirements are specified below in Table 1. Alternative hardness testing methods may be used with values extracted from ASTM E 140 but Vickers Hardness test to ISO 6507 HV5 shall be the referee method.

Table 1 Material Heat Treatment and Hardness

Washer	Material, Heat Treat & Hardness Class	Material	Heat Treatment	Hardness
Flat Conical	B ¹⁾	Steel	Harden or Case Harden and Temper	300 - 390HV
Toothed Bowed Wavy	C	Steel	Harden and Temper	410 - 520HV
			Austemper	450 - 570HV
Flat	G	Steel	-	100 - 260HV

NOTE: The above requirements also apply to the washer component of bolt, screw, or nut and washer assemblies.

- 1) Washers used with case hardened and tempered screw and washer assemblies shall be copper flashed prior to heat treatment to avoid carbon pick up.

4. PERFORMANCE

4.1 RECOVERY FROM COMPRESSION (TOOTHED, CONICAL, BOWED AND WAVY)

Toothed, Conical, Bowed and Wavy - After compression between parallel surfaces for a minimum of 2 minutes with the load specified in (Table 11, WF900 Appendix A), the minimum height of the free washer shall be as shown for h2. When the same load is re-applied for the same period no further permanent set shall be acceptable. Mating countersunk holes and cones shall be used for countersunk toothed washers.

4.2 TWIST TEST ON TOOTHED WASHERS

The rim of the washer shall be cut or severed. Separation of the ends to 90° shall not result in fracture.