

OIL-TEMPERED CARBON-STEEL VALVE SPRING QUALITY WIRE AND SPRINGS

1. **Scope**—This SAE Recommended Practice covers the physical and chemical requirements of oil-tempered carbon-steel valve spring quality wire used for the manufacture of engine valve springs and other springs requiring high-fatigue properties. This document also covers the basic processing requirements of springs fabricated from this wire.
2. **References**
 - 2.1 **Applicable Publications**—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.
 - 2.1.1 **SAE PUBLICATION**—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.
HS 84—Manual on Shot Peening
 - 2.1.2 **ASTM PUBLICATIONS**—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.
ASTM A 230—Specification for Steel Wire, Oil-Tempered Carbon Valve Spring Quality
ASTM A 230M—Specification for Steel Wire, Oil-Tempered Carbon Valve Spring Quality (Metric)
ASTM A 510—Specification for General Requirements for Wire Rods and Coarse Round Wire Carbon Steel
ASTM A 510M—Specification for General Requirements for Wire Rods and Coarse Round Wire Carbon Steel (Metric)
 3. **Wire**
 - 3.1 The wire shall conform to ASTM A 230/A 230M and ASTM A 510/A 510M.
 - 3.2 **Microstructure**—A longitudinal section shall show a fine homogeneous tempered martensitic structure. Decarburization shall be determined by etching a polished transverse section of the tempered wire in nital and examining the entire periphery at 100X magnification measuring the worst area present. Inspection at 100X magnification shall show no completely decarburized (carbon free) areas and partial decarburization shall not exceed a depth of 0.025 mm (0.001 in) on wire 4.90 mm (0.192 in) and smaller or 0.038 mm (0.0015 in) on wire larger than 4.90 mm (0.192 in).

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3.3 Twist Test—A 250 mm (10 in) specimen of wire slowly twisted four revolutions in one direction and then twisted in the opposite direction until failure shall show a square break normal to the axis of the wire without splits or cracks.

3.4 Special Surface Inspection—When specified, the entire length of every coil used by engine valve spring manufacturers shall be inspected for surface imperfections with a magnetic and/or eddy current defect analyzer or equivalent.

4. Springs

4.1 Heat Treatment—Springs coiled from this wire shall be stress relieved for a minimum of 30 min at heat. Normally the temperature used will be the maximum which will leave the original hardness of the wire essentially unchanged. Typical temperatures are 340 to 400 °C (650 to 750 °F).

4.2 Hardness—Hardness of springs shall be measured on suitably ground flats. Hardness values shall conform to Table 1A or 1B.

TABLE 1A—HARDNESS⁽¹⁾, SI UNITS

	Wire Diameter, mm	Min	Max
R45N	1.60 to 2.20 incl	52	57
	Over 2.20 to 3.25 incl	51	56
RC	Over 3.25 to 4.00 incl	46	51
	Over 4.00 to 4.90 incl	45	50
	Over 4.90 to 5.50 incl	44	49
	Over 5.50 to 6.35 incl	44	49

1. Hardness ranges indicated apply to finished springs and are subject to normal variations found in standard hardness testing procedures.

TABLE 1B—HARDNESS⁽¹⁾, INCH-POUND UNITS

	Wire Diameter, in	Min	Max
R45N	0.062 to 0.092 incl	52	57
	Over 0.092 to 0.128 incl	51	56
RC	Over 0.128 to 0.162 incl	46	51
	Over 0.162 to 0.192 incl	45	50
	Over 0.192 to 0.225 incl	44	49
	Over 0.225 to 0.250 incl	44	49

1. Hardness ranges indicated apply to finished springs and are subject to normal variations found in standard hardness testing procedures.

4.3 Surface Condition—Engine valve springs shall be shot peened to a minimum of 90% coverage on the ID of the spring (see HS 84). After shot peening, the springs shall be stress relieved at 200 to 230 °C (400 to 450 °F). Springs containing surface defects 0.05 mm (0.002 in) deep and greater must be rejected.

PREPARED BY THE SAE IRON AND STEEL TECHNICAL COMMITTEE DIVISION 17—SPRING WIRE