

Issued 1967-11  
Cancelled 1998-06

Superseding J316 JUN94

## Oil-Tempered Carbon-Steel Spring Wire and Springs

1. **Scope**—This SAE Recommended Practice covers the mechanical, chemical, and dimensional requirements of oil-tempered carbon-steel spring wire used in the automotive and related industries. It is especially intended for the manufacture of mechanical springs and wire forms which are not subjected to a large number of high stress cycles. Class I wire is intended for moderate stress and Class II for higher stress level applications. This document also covers the processing requirements for 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.
    - 2.1.1 **ANSI PUBLICATION**—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ANSI B32.4M—Preferred Metric Sizes for Round, Square, Rectangle, and Hexagon Metal Products
    - 2.1.2 **ASTM PUBLICATIONS**—Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM A 229—Specification for Steel Wire, Oil-Tempered for Mechanical Springs  
ASTM A 229M—Specification for Steel Wire, Oil-Tempered for Mechanical Springs (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 Steel (Metric)
3. **Wire**
  - 3.1 The wire shall conform to ASTM A 229/A 229M and ASTM A 510 or A 510M.
    - 3.1.1 Orders shall include the class (I or II) to be supplied.

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**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 wire in nital and examining the entire periphery at 100X magnification, measuring the worst area present, but not measuring decarburization which is directly associated with a seam or other surface defect. Carbon-free depth of decarburization shall not exceed 0.5% of the wire diameter. Combined depth of carbon free and partial decarburization shall not exceed 2% of the wire diameter on sizes less than 6.0 mm (0.250 in) or 0.1 mm (0.005 in) on sizes 6.0 mm (0.250 in) or larger.

**3.3 Seams**—Unless otherwise specified by the purchaser, seams shall not exceed 3.5% of the wire diameter or 0.25 mm (0.010 in), whichever is the smaller as measured on a transverse section.

#### **4. Springs**

**4.1 Heat Treatment**—Springs coiled from this wire shall be stress relieved for a minimum of 30 min at temperature. Normally, the temperature used will be the maximum which will leave the original hardness of the wire essentially unchanged. Typical temperatures are:

- a. 230 °C (450 °F)—small diameter (0.5 to 1.4 mm) (0.20 to 0.054 in)
- b. 290 °C (550 °F)—medium diameter (over 1.4 to 3.0 mm) (over 0.054 to 0.120 in)
- c. 340 °C (650 °F)—large diameter (over 3.0 mm) (over 0.120 in)

It should be recognized that in certain applications, such as extension springs with initial tension requirements, lower than the typical stress-relieving temperature may be used. This is also true for thin flexible spring designs to minimize distortion. Springs requiring maximum resistance to relaxation at moderately elevated temperatures may be stress relieved at higher than the typical temperatures with some loss of hardness.

**4.2 Hardness**—Hardness of springs shall be measured on suitable ground flats on wire sizes of 1.6 mm (0.062 in) and larger, or on ground-mounted sections for wire sizes of less than 1.6 mm (0.062 in). Hardness values shall conform to Table 1A or 1B.

**4.3 Surface Condition**—The surface condition of the finished parts shall be as described for the wire except in certain instances where shot peening might be used. In addition, there shall be no excessive coiling marks, nicks, or gouges which would impair the serviceability of the parts.

TABLE 1A—HARDNESS<sup>(1)</sup>, SI UNITS

	Diameter <sup>(2)</sup> mm	Class I min	Class I max	Class II min	Class II max
R 15N	0.50	88.0	90.0	90.0	92.0
	0.55	88.0	90.0	90.0	92.0
	0.60	88.0	90.0	90.0	92.0
	0.65	88.0	90.0	89.0	91.0
	0.70	87.5	89.5	89.0	91.0
	0.80	87.5	89.5	88.5	90.5
	0.90	87.0	89.0	88.0	90.0
	1.00	86.5	88.5	87.5	89.5
	1.10	86.0	88.0	87.0	89.0
	1.20	86.0	88.0	87.0	89.0
	1.40	86.0	88.0	87.0	89.0
R 45N	1.60	55.0	60.0	58.0	63.0
	1.80	54.0	59.0	57.0	62.0
	2.00	53.0	58.0	56.0	61.0
	2.20	52.0	57.0	55.5	60.5
	2.50	51.5	56.5	55.0	60.0
	2.80	51.0	56.0	54.5	59.5
	3.00	50.5	55.5	54.5	59.5
RC	3.50	45	50	50	55
	4.00	43	48	48	53
	4.50	42	48	48	53
	5.00	41	47	47	52
	5.50	40	46	46	51
	6.00	40	45	45	50
	7.00	40	45	45	50
	8.00	39	44	44	49
	9.00	37	43	43	48
	10.00	37	43	43	48
	11.00	36	42	42	47
	12.00	36	42	42	47
14.00	35	41	41	46	
	16.00	35	41	41	46

Values for intermediate sizes may be interpolated.

1. Hardness ranges indicated apply to finished springs and are subject to normal variations found in standard hardness testing procedures.
2. Preferred sizes. For a complete list, refer to ANSI B32.4M.

TABLE 1B—HARDNESS<sup>(1)</sup>, INCH-POUND UNITS

	Decimal Size in	Class I Wire min	Class I Wire max	Class II Wire min	Class II Wire max
R 15N	0.020	88.0	90.0	90.0	92.0
	0.023	88.0	90.0	90.0	92.0
	0.026	88.0	90.0	89.0	91.0
	0.029	87.5	89.5	89.0	91.0
	0.032	87.5	89.5	88.5	90.5
	0.035	87.0	89.0	88.0	90.0
	0.041	86.5	88.5	87.5	89.5
	0.048	86.0	88.0	87.0	89.0
	0.054	86.0	88.0	87.0	89.0
R 45N	0.062	55.0	60.0	58.0	63.0
	0.072	54.0	59.0	57.0	62.0
	0.080	53.0	58.0	56.0	61.0
	0.092	52.0	57.0	55.5	60.5
	0.106	51.5	56.5	55.0	60.0
	0.120	50.5	55.5	54.5	59.5
RC	0.135	45	50	50	55
	0.148	44	49	49	54
	0.162	43	48	48	53
	0.177	42	48	48	53
	0.192	41	47	47	52
	0.207	40	46	46	51
	0.225	40	45	45	50
	0.244	40	45	45	50
	0.250	40	45	45	50
	0.312	39	44	44	49
	0.375	39	44	44	49
	0.438	37	43	43	48
	0.500	36	42	42	47
	0.562	35	41	41	46
0.625	35	41	41	46	

Values for intermediate sizes may be interpolated.

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

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