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## Standard Specification for Steel Wire, Chromium-Silicon Alloy, Chrome-Silicon- Vanadium Alloy Valve Spring Quality<sup>1</sup>

This standard is issued under the fixed designation A877/A877M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope\*

1.1 This specification covers the highest quality of round and shaped chromium-silicon alloy steel valve spring wire, uniform in quality and temper, intended for the manufacture of valve springs and other springs requiring high-fatigue properties when used at moderately elevated temperatures. ~~It is similar to the grade VD (referenced in EN 10270-2) intended for high fatigue levels.~~ This wire shall be either in the annealed and cold-drawn or ~~oil-tempered-quenched and tempered~~ condition as specified by purchaser.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. ~~Within the text, the inch-pound units are shown in brackets.~~ The values stated in each system ~~are~~ may not be exact equivalents; therefore, each system ~~must~~ shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment

A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E45 Test Methods for Determining the Inclusion Content of Steel

#### 2.2 Federal Standard: European Standard:

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

#### 2.3 Military Standard:<sup>3</sup>

MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage

#### 2.4 AIAG Standard:

AIAG B-502.00 Primary Metals Identification Tag Application Standard EN 10270-2 Steel Wire for Mechanical Springs Part 2: Oil-Hardened and Tempered Springsteel Wire of Unalloyed and Alloyed Steels.<sup>3</sup>

### 3. Ordering Information

~~3.1 Orders for material under this specification shall include the following information for each ordered item:~~

3.1 It shall be the responsibility of the purchaser to specify all requirements that are necessary for material under this specification. Such requirements are permitted to include, but are not limited to the following:

3.1.1 Quantity (mass),

3.1.2 Name of material (chromium-silicon alloy steel valve spring quality wire),

3.1.3 Dimensions (Table 1 and Section 8),

3.1.4 Condition (Section 6),

3.1.5 Packaging (Section 14),

3.1.6 Heat analysis report, if requested (5.2),

3.1.7 Certification or test report, or both, if specified (Section 13), and

3.1.8 ASTM designation and year of issue.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.03 on Steel Rod and Wire.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098

<sup>3</sup> Available from European Committee for Standardization, rue di Stassart 36, B-1050 Brussels, Belgium.

\*A Summary of Changes section appears at the end of this standard.

**TABLE 1 Permissible Variations in Wire Diameter<sup>A</sup>**

SI Units		
Diameter, mm	Permissible Variations, ±mm	Permissible Out-of-Round, mm
0.5 to 2.0, incl	0.02	0.02
Over 2.0 to 4.0, incl	0.03	0.03
Over 4.0 to 9.5, incl	0.04	0.04
Inch-Pound Units		
Diameter, in.	Permissible Variations, ± in.	Permissible Out-of-Round, in.
0.020 to 0.075, incl	0.0008	0.0008
Over 0.075 to 0.148, incl	0.001	0.001
Over 0.148 to 0.375, incl	0.0015	0.0015

<sup>A</sup> For purposes of determining conformance with this specification, all specified limits are absolute as defined in Recommended Practice E29.

NOTE 1—A typical ordering description is as follows: ~~20 000-kg oil-tempered-20 000-kg quenched and tempered chromium-silicon alloy steel valve spring quality wire, size 6.00 mm in 150-kg coils to ASTM A877/A877M dated \_\_\_\_\_, or for inch-pound units, 40 000-lb oil-tempered-40 000-lb quenched and tempered chromium-silicon alloy steel valve spring quality wire, size 0.250 in. in 350-lb coils to ASTM A877/A877M dated \_\_\_\_\_.~~

#### 4. Materials and Manufacture

- 4.1 ~~The~~4.1 The steel may be made by any commercially accepted steel making process. The steel shall be continuously cast.
- 4.2 The finished wire shall be free from detrimental pipe and undue segregation.

#### 5. Chemical Composition

5.1 The steel shall conform to the requirements for chemical composition specified in Table 2.

5.2 *Heat Analysis*—Each heat of steel shall be analyzed by the manufacturer to determine the percentage of elements prescribed in Table 2. This analysis shall be made from a test specimen preferably taken during the pouring of the heat. When requested, this shall be reported to the purchaser and shall conform to the requirements of Table 2.

5.3 *Product Analysis*—An analysis may be made by the purchaser from finished wire representing each heat of steel. The average of all the separate determinations made shall be within the limits specified in the analysis column. Individual determinations may vary to the extent shown in the product analysis tolerance column, except that the several determinations of a single element in any one heat shall not vary both above and below the specified range.

5.4 For referee purposes, Test Methods, Practices, and Terminology A751 shall be used.

#### 6. Mechanical Properties

6.1 *Annealed and Cold Drawn*—When purchased in the annealed and cold-drawn condition, the wire shall have been given a sufficient amount of cold working to meet the purchaser’s coiling requirements and shall be in a suitable condition to respond properly to heat treatment. In special cases the hardness, if desired, shall be stated in the purchase order.

**TABLE 2 Chemical Requirements**

	Analysis, %	
	Grade A Chromium-Silicon	Grade B Chromium-Silicon- Vanadium
Carbon	0.51–0.59	±0.02
Carbon	0.51–0.59	0.55–0.70
Manganese	0.50–0.80	±0.03
Manganese	0.50–0.80	0.50–0.80
Phosphorus	0.025 max	±0.005
Phosphorus	0.025 max	0.025 max
Sulfur	0.025 max	±0.005
Sulfur	0.025 max	0.025 max
Silicon	1.20–1.60	±0.05
Silicon	1.20–1.60	1.20–1.65
Chromium	0.60–0.80	±0.03–0.80
Chromium	0.60–0.80	0.50–0.80
Vanadium	<sup>A</sup>	0.08–0.25

<sup>A</sup> Not required.

6.2 Oil-Quenched and Tempered—When purchased in the oil-tempered, quenched and tempered condition, the tensile strength and % R.A. shall conform to the requirements prescribed in Table 3 and Table 4.

6.2.1 Tensile Strength of Shaped and Flat Rolled Wire—Tensile strength of shaped and flat rolled wires shall conform to these tables based on the conversion to equivalent round dimensions. Percent reduction of area is not applicable to shaped and flat rolled wires.

NOTE 2—Equivalent round definition: The cross sectional area of non-round wires converted to the round wire diameter.

6.2.2 Tensile Strength Variation—In addition, the maximum tensile variation in a coil shall be 70 MPa [10.15 ksi].

6.2.3 Number of Tests—One test specimen shall be taken for each five coils, or fraction thereof, in a lot. Each heat in a given lot shall be tested.

6.2.2

NOTE 3—Any specimen breaking in the tensile grips shall be discarded and a new specimen tested if the specified mechanical properties are not achieved. If breakage in the tensile grips prevents conformance to percent reduction in area requirements, conformance to the wrap test (see 6.3) shall suffice.

6.2.4 Location of Tests—Test specimens shall be taken from either end of the coil.

6.2.3

6.2.5 Test Method—The tension test shall be made in accordance with Test Methods and Definitions A370.

6.3 Wrap Test:

6.3.1 Oil-tempered or cold-drawn wire 4.00 mm [0.162 in.] and smaller in diameter shall wind on itself as an arbor without breakage. Larger diameter wire up to and including 8.00 mm [0.312 in.] in diameter shall wrap without breakage on a mandrel twice the wire diameter. The wrap test is not applicable to wire over 8.00 mm [0.312 in.] in diameter.

6.3.2

6.3.1 Round quenched and tempered or cold drawn wire 4.00 mm [0.157 in.] or smaller in diameter shall wrap on itself as an arbor without breakage. Larger diameter wire up to and including 8.00 mm [0.315 in.] in diameter shall wrap without breakage on a mandrel twice the wire diameter. The wrap test is not applicable to wire over 8.00 mm [0.315 in.] in diameter or to shaped and flat rolled wires.

6.3.2 The high tensile chrome silicon vanadium grade of quenched and tempered wire 4.00 mm [0.1575 in.] or smaller in diameter shall wrap on a mandrel twice the diameter without breakage. Larger diameter wire up to and including 8.00 mm [0.315 in.] shall wrap without breakage on a mandrel three times the wire diameter. The wrap test is not applicable to wire over 8.00 mm

**TABLE 3 Tensile and %RA Requirements<sup>A</sup>**

(Chrome Silicon)			
SI Units			
Diameter, mm	MPa, min	MPa, max	Min % R.A. <sup>B</sup>
0.5	2100	2280	β
1.0	2070	2240	β
1.5	2030	2210	β
2.0	2000	2140	45
3.0	1930	2070	45
3.75	1900	2030	40
4.5	1830	1970	40
5.0	1810	1950	40
5.7	1800	1930	40
6.3	1760	1900	40
7.9	1730	1860	40
9.5	1690	1830	40
Inch-Pound Units			
Diameter, in.	ksi, min	ksi, max	Min % R.A. <sup>B</sup>
0.020	305	330	β
0.040	300	325	β
0.060	295	320	β
0.080	290	310	45
0.120	280	300	45
0.148	275	295	40
0.177	265	285	40
0.200	263	283	40
0.225	260	280	40
0.250	255	275	40
0.312	250	270	40
0.375	245	265	40

<sup>A</sup> Tensile strength values for intermediate diameters may be interpolated.

<sup>B</sup> β % R.A. is not applicable to wire diameters under 2.0 mm [0.080 in.].