



~~Designation: A231/A231M-04~~ Designation: A231/A231M - 10

## Standard Specification for Chromium-Vanadium Alloy Steel Spring Wire<sup>1</sup>

This standard is issued under the fixed designation A231/A231M; 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.

*This standard has been approved for use by agencies of the Department of Defense.*

### 1. Scope\*

1.1 This specification covers round and shaped chromium-vanadium alloy steel spring wire having properties and quality intended for the manufacture of springs used at moderately elevated temperatures. This wire shall be either in the annealed and cold-drawn or oil-tempered condition as specified by the purchaser.

1.2 The values stated in either SI (~~metric~~) units or inch-pound units are to be regarded separately as standard. 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.

1.2.1 Within the text, the inch-pound units are shown in brackets.

### 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

A752 Specification for General Requirements for Wire Rods and Coarse Round Wire, Alloy Steel

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

#### 2.2 ANSI Standard:

B 32.4M Preferred Metric Sizes for Round, Square, Rectangle, and Hexagon Metal Products

#### 2.3 Military Standard:

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

#### 2.4 Federal Standard:

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)<sup>4</sup>

#### 2.5 AIAG Standard:

AIAGB-502.00 Primary Metals Identification Tag Application Standard

### 3. Ordering Information

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

3.1.1 Quantity (mass),

3.1.2 Name of material (chromium-vanadium alloy steel wire),

3.1.3 Wire diameter (Table 1 ~~and Table 2~~ and Section 8),

3.1.4 Packaging (Section 14),

~~3.1.5 Cast or heat analysis report (if requested) (~~

3.1.5 Heat analysis report (if requested) (5.2),

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

3.1.7 ASTM designation and date of issue.

NOTE 1—A typical ordering description is as follows: 20 000 kg oil-tempered chromium-vanadium alloy steel wire, size 6.00 mm in 150-kg coils to

<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.

Current edition approved Sept. 1, 2004; 2010. Published September 2004; June 2010. Originally approved in 1939. Last previous edition approved in 2002; 2004 as A231/A231M-96(2002); A231/A231M-04. DOI: 10.1520/A0231\_A0231M-104.

<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.

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

**TABLE 1 Tensile Requirements, SI Units<sup>A</sup>**

Diameter, <sup>B</sup> mm	Tensile Strength, MPas		Reduction of Areas, min, %
	MPa, min	MPa, max	
0.50	2060	2260	C
0.55	2050	2240	C
0.60	2030	2220	C
0.65	2010	2200	C
0.70	2000	2160	C
0.80	1980	2140	C
0.90	1960	2120	C
1.00	1940	2100	C
1.10	1920	2080	C
1.20	1900	2060	C
1.40	1860	2020	C
1.60	1820	1980	C
1.80	1800	1960	C
2.00	1780	1930	C
2.20	1750	1900	C
2.50	1720	1860	45
2.80	1680	1830	45
3.00	1660	1800	45
3.50	1620	1760	45
4.00	1580	1720	40
4.50	1560	1680	40
5.00	1520	1640	40
5.50	1480	1620	40
6.00	1460	1600	40
6.50	1440	1580	40
7.00	1420	1560	40
8.00	1400	1540	40
9.00	1380	1520	40
10.00	1360	1500	40
11.00	1340	1480	40
12.00	1320	1460	40

  

Diameter, <sup>B</sup> in.	Inch-Pound Units		Reduction of Area, min %
	ksi, min.	ksi, max	
0.020	300	325	C
0.032	290	315	C
0.041	280	305	C
0.054	270	295	C
0.062	265	290	C
0.080	255	275	C
0.105	245	265	45
0.135	235	255	45
0.162	225	245	40
0.192	220	240	40
0.244	210	230	40
0.283	205	225	40
0.312	203	223	40
0.375	200	220	40
0.438	195	215	40
0.500	190	210	40

<sup>A</sup> Tensile strength values for intermediate diameters may be interpolated.  
<sup>B</sup> Preferred sizes. For a complete list, refer to ANSI B 32.4M, Preferred Metric Sizes for Round, Square, Rectangle, and Hexagon Metal Products.  
<sup>C</sup> The reduction of area test is not applicable to wire diameters under 2.34 mm [0.092 in.] in diameter.

ASTM A231/A231M dated \_\_\_\_\_, or for inch-pound units, 40 000 lb oil-tempered chromium-vanadium alloy steel spring wire, size 0.250 in. in 350-lb coils to ASTM A231/A231M dated \_\_\_\_\_.

**4. Materials and Manufacture**

- 4.1 The steel may be made by any commercially accepted steel-making process. The steel may be either ingot cast or strand 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 as to of Grade 6150 for chemical composition specified in Table 32.
- 5.2 ~~Cast or Heat Analysis~~—Each ~~cast or~~ heat of steel shall be analyzed by the manufacturer to determine the percentage of

**TABLE 2 — Chemical Requirements, Inch-Pound Units<sup>A</sup>**

Diameter, <sup>B</sup> in.	min	max	
	Element	Analysis, %	
0.020	300	325C	
	Carbon	0.48–0.53	
0.032	290	315	ε
	Manganese	315	ε <sup>0.70–0.90</sup>
0.044	280	305C	
	Phosphorus	0.035 max	
0.054	270	295	ε
	Sulfur	295	ε <sup>0.040 max</sup>
0.062	265	290C	
	Silicon	0.15–0.35	
0.080	255	275	ε
	Chromium	275	ε <sup>0.80–1.10</sup>
0.105	245	265	45
	Vanadium	265	45
0.135 <sup>235</sup>	255	45	
0.152 <sup>35</sup>	255	45	
0.162	225	245	40
0.192	220	240	40
0.244	210	230	40
0.283	205	225	40
0.312	203	223	40
0.375	200	220	40
0.438	195	215	40
0.500	190	210	40
0.500	190	210	40 min

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

<sup>B</sup>Preferred sizes. For a complete list, refer to ANSI B 32.4M, Preferred Metric Sizes for Round, Square, Rectangle, and Hexagon Metal Products.

<sup>C</sup>The reduction of area test is not applicable to wire diameters under 0.092 in.

elements prescribed in Table 32. This analysis shall be made from a test specimen preferably taken during the pouring of the cast or heat. When requested, this shall be reported to the purchaser and shall conform to the requirements of Table 32.

5.3 *Product Analysis*—An analysis may be made by the purchaser from finished wire representing each cast or heat of steel. The chemical composition thus determined, as to elements required or restricted, shall conform to the product analysis requirements specified in Table 54 of Specification A752.

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, or tensile strength, if desired, shall be stated in the purchase order.

6.2 *Oil Tempered*—When purchased in the oil-tempered condition, the tensile strength and minimum percent reduction of area, sizes 2.50 mm or 0.105 in. [0.105 in.] and coarser, of the wire shall conform to the requirements as shown in Table 1 or Table 2. Tensile strength of shaped and flat rolled wires shall conform to this table 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.

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

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

6.2.3 *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 or 0.162 in. [0.157 in.] and smaller in diameter shall wind on itself as an arbor without breakage. Larger diameter wire up to and including 8.00 mm or 0.312 in. [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 0.312 in. in diameter, to shaped or flat rolled wires.

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

6.3.3 *Location of Test*—Test specimens shall be taken from either end of the coil.

6.3.4 *Test Method*—The wrap test shall be made in accordance with Supplement FVA4.7 of Test Methods and Definitions A370.

## 7. Metallurgical Properties

### 7.1 *Surface Condition:*