



Designation: A231/A231M – 15

Standard Specification for Chromium-Vanadium Alloy Steel Spring Wire¹

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 (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. 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 units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system 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*:²

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A510/A510M Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel

A700 Guide 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

3. Ordering Information

3.1 It shall be the responsibility of the purchaser to specify all requirements that are necessary for material under this

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² 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.

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 **Section 8**),

3.1.4 Packaging (**Section 14**),

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 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 of Grade 6150 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 chemical composition thus determined, as to elements required or restricted, shall conform to the product analysis requirements specified in **Table 4** of Specification **A510/A510M**.

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

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

TABLE 1 Tensile Requirements^A

Diameter, ^B mm	SI Units		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, ^B 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

^A Tensile strength values for intermediate diameters may be interpolated.

^B Preferred sizes. For a complete list, refer to ANSI B 32.4M.

^C The reduction of area test is not applicable to wire diameters under 2.34 mm [0.092 in.] in diameter.

TABLE 2 Chemical Requirements

Element	Analysis, %
Carbon	0.48–0.53
Manganese	0.70–0.90
Phosphorus	0.035 max
Sulfur	0.040 max
Silicon	0.15–0.35
Chromium	0.80–1.10
Vanadium	0.15 min

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 [0.105 in.] and coarser, of the wire shall conform to the requirements as shown in Table 1. 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 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 [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 [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 or flat rolled wires.