Designation: ~~A231/A231M – 15~~ A231/A231M – 18

Standard Specification for Chromium-Vanadium Alloy Steel Spring Wire[1]

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.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

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
A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys
E8/E8M Test Methods for Tension Testing of Metallic Materials
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this specification, see Terminology A941.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *equivalent round diameter, n*—diameter of a round wire having equivalent cross sectional area to a given shaped wire.

3.2.2 *round wire, n*—wire having a circular cross section.

3.2.3 *shape factor, n*—this value is used to obtain cross sectional area for shaped wires when multiplied by measured width and thickness.

3.2.4 *shaped wire, n*—wire having a non-circular cross section.

4. Ordering Information

4.1 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:

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[1] 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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[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.

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

4.1.1 Quantity (mass),
4.1.2 Name of material (chromium-vanadium alloy steel wire),
4.1.3 Wire diameter (Table 1 and Section 9), and
4.1.4 ASTM designation and date of issue.

4.2 ~~It~~ The purchaser 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:~~have the option to specify additional requirements, including but not limited to:

~~3.1.1 Quantity (mass),~~
~~3.1.2 Name of material (chromium-vanadium alloy steel wire),~~
4.2.1 ~~Wire diameter~~ Requirements for certifications, heat analysis or test reports (~~Table 1~~6.2 and Section ~~8~~14),
~~3.1.4 Packaging (Section 14),~~
~~3.1.5 Heat analysis report (if requested) (5.2),~~
4.2.2 ~~Certification or test report, or both, if specified~~ Special packing, marking, and loading requirements (Section ~~13~~15), and
4.2.3 ~~ASTM designation and date of~~ Other special requirements, if any.
~~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_____.~~

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_____.

5. Materials and Manufacture

5.1 The steel may be made by any commercially accepted steel–making process. The steel may be either ingot cast or strand cast.

5.2 The finished wire shall be free from detrimental pipe and undue segregation.

6. Chemical Composition

6.1 The steel shall conform to the requirements of Grade 6150 for chemical composition specified in Table 2.

6.2 *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.

6.3 *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.

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

7. Mechanical Properties

7.1 *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.

7.2 *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~~ area 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.~~

7.2.1 *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.

7.2.2 *Location of Tests*—~~Test specimens~~ It shall be ~~taken~~ permissible to take test specimens from either end of the coil.

7.2.3 *Test Method*—The tension test shall be made in accordance with Test Methods and Definitions A370. For shaped wires, cross sectional area shall be calculated either by using the procedure in Test Methods E8/E8M for uniform but nonsymmetrical cross-sections, or by measuring width and thickness and multiplying by a shape factor. Reduction of area for shaped wires shall be calculated by using this shape factor. Measure the maximum and minimum dimension on the necked down section and multiply by the shape factor to estimate the cross sectional area for use in the standard reduction of area calculation.

TABLE 1 Tensile Requirements[A]

SI Units

Diameter,[B] mm	~~SI Units~~MPa, min	MPa, max	Reduction of Areas, min, %[C,D]
	~~MPa, min~~	~~MPa, max~~	
~~0.50~~	~~2060~~	~~2260~~	~~C~~
0.50	2060	2260	. . .
~~0.55~~	~~2050~~	~~2240~~	~~C~~
0.55	2050	2240	. . .
~~0.60~~	~~2030~~	~~2220~~	~~C~~
0.60	2030	2220	. . .
~~0.65~~	~~2010~~	~~2200~~	~~C~~
0.65	2010	2200	. . .
~~0.70~~	~~2000~~	~~2160~~	~~C~~
0.70	2000	2160	. . .
~~0.80~~	~~1980~~	~~2140~~	~~C~~
0.80	1980	2140	. . .
~~0.90~~	~~1960~~	~~2120~~	~~C~~
0.90	1960	2120	. . .
~~1.00~~	~~1940~~	~~2100~~	~~C~~
1.00	1940	2100	. . .
~~1.10~~	~~1920~~	~~2080~~	~~C~~
1.10	1920	2080	. . .
~~1.20~~	~~1900~~	~~2060~~	~~C~~
1.20	1900	2060	. . .
~~1.40~~	~~1860~~	~~2020~~	~~C~~
1.40	1860	2020	. . .
~~1.60~~	~~1820~~	~~1980~~	~~C~~
1.60	1820	1980	. . .
~~1.80~~	~~1800~~	~~1960~~	~~C~~
1.80	1800	1960	. . .
~~2.00~~	~~1780~~	~~1930~~	~~C~~
2.00	1780	1930	. . .
~~2.20~~	~~1750~~	~~1900~~	~~C~~
2.20	1750	1900	. . .
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

Inch-Pound Units

~~Diameter,[B] in.~~	~~Inch-Pound Units~~	~~Reduction of Area, min %~~	Reduction of Area, min %[C,D]
Diameter,[B] in.	ksi, min.	ksi, max	
~~ksi, min.~~	~~ksi, max~~		
~~0.020~~	~~300~~	~~325~~	~~C~~
0.020	300	325	. . .
~~0.032~~	~~290~~	~~315~~	~~C~~
0.032	290	315	. . .
~~0.041~~	~~280~~	~~305~~	~~C~~
0.041	280	305	. . .
~~0.054~~	~~270~~	~~295~~	~~C~~
0.054	270	295	. . .
~~0.062~~	~~265~~	~~290~~	~~C~~
0.062	265	290	. . .
~~0.080~~	~~255~~	~~275~~	~~C~~
0.080	255	275	. . .
0.105	245	265	45
0.135	235	255	45
0.162	225	245	40
0.192	220	240	40