Designation: ~~A230/A230M – 05 (Reapproved 2011)$^{\varepsilon 1}$~~ A230/A230M – 19

Standard Specification for Steel Wire, ~~Oil-Tempered~~ Carbon Valve Spring Quality[1]

This standard is issued under the fixed designation A230/A230M; 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.

~~ε[1] NOTE—Changes were made editorially throughout in July 2011.~~

1. Scope*

1.1 This specification covers the highest quality of round and shaped carbon steel spring wire, uniform in quality and temper, intended especially for the manufacture of valve springs and other springs requiring high-fatigue properties. 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 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. 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.

1.3 *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~~A510/A510M Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon ~~Steel (Metric) A0510_A0510M~~ Steel, and Alloy Steel

~~A510M Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel (Metric) (Withdrawn 2011)[3]~~

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

E45 Test Methods for Determining the Inclusion Content of Steel

~~2.2 *ANSI Standard:*[4]~~

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

~~2.3 *Military Standard:*[5]~~

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

2.2 *Federal Standard:*[3]

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

2.3 ~~*AIAG*~~ *European Standard:*[4]

~~AIAG B-5~~EN 10270-2 ~~02.00 Primary Metals Identification Tag Application Standard~~Steel Wire for Mechanical Springs Part 2: Oil-Hardened and Tempered Spring Steel Wire of Unalloyed and Alloyed Steels

[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.

Current edition approved ~~July 1, 2011~~Sept. 1, 2019. Published ~~July 2011~~September 2019. Originally approved in 1939. Last previous edition approved in ~~2005~~2011 as ~~A230/A230M – 05.~~A230/A230M – 05 (2011)$^{\varepsilon 1}$. DOI: ~~10.1520/A0230_A0230M-05R11E01.~~10.1520/A0230_A0230M-19.

[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.

[3] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.

[4] Available from ~~Automotive Industry Action Group (AIAG), 26200 Lahser Rd., Suite 200, Southfield, MI 48034.~~European Committee for Standardization, CEN-CENELEC Management Centre Avenue Marnix 17-B-1000 Brussels, Belgium.

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

3. Terminology

3.1 *Definitions:*

3.1.1 Refer to Terminology A941 for additional definitions of terms used in this standard.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *billet, n*—an as-cast or forged section, typically available for transport, inspection, and conditioning, that is used as raw material for wire rod manufacture.

3.2.2 *bloom, n*—an as-cast or forged section used as raw material for billet manufacture.

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

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

3.2.5 *shape factor, n*—a value used to obtain cross sectional area for shaped wires when multiplied by measured width and measured thickness

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

4. Ordering Information

~~3.1 Material furnished under this specification shall conform to the applicable requirements of the current edition of either Specification A510 or Specification A510M.~~

4.1 Orders for material under this specification should include the following information for each ordered item:

4.1.1 Quantity (mass or weight),

4.1.2 Name of material ~~(oil-tempered carbon~~ (carbon steel valve spring quality wire),

4.1.3 Dimensions (Section ~~8~~9),

4.1.4 Chemical composition (Table 1), if required,

4.1.5 ~~Packaging~~Condition (Section ~~14~~5), and

~~3.2.6 Cast or heat analysis report, if desired (see 5.2),~~

~~3.2.7 Certification or test report, or both, if specified (Section 13), and~~

4.1.6 ASTM designation and ~~date~~year of issue.

~~NOTE 1—A typical metric ordering description is as follows: For inch-pound units, 40 000 lb oil-tempered carbon steel valve spring quality wire, 0.250 in. diameter in 350-lb coils to ASTM A230 dated _____, or for SI units 20 000 kg oil-tempered carbon steel valve spring quality wire, 6.00 mm diameter in 125-kg coils to ASTM A230M dated _____.~~

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

4.2.1 Requirements for certifications, heat analysis or test reports (6.2 and Section 14)

4.2.2 Special packing, marking, and loading requirements (Section 15), and

4.2.3 Other special requirements, if any.

NOTE 1—A typical ordering description is as follows: 20 000 kg quenched and tempered carbon steel valve spring quality wire, 6.00 mm diameter in 125-kg coils to ASTM A230M dated _____. For inch-pound units, 40 000 lb quenched and tempered carbon steel valve spring quality wire, 0.250 in. diameter in 350-lb coils to ASTM A230 dated _____.

TABLE 1 Chemical Requirements

~~Element~~	~~Composition, %~~
~~Carbon~~	~~0.60–0.75[A]~~
~~Manganese~~	~~0.60–0.90[A]~~
~~Phosphorus, max~~	~~0.025~~
~~Sulfur, max~~	~~0.030~~
~~Silicon~~	~~0.15–0.35~~

TABLE 1 Chemical Requirements

Element	Composition, %
Carbon	0.60–0.75[A]
Manganese	0.60–0.90[A]
Phosphorus, max	0.025
Sulfur, max	0.030
Silicon	0.15–0.35

[A] ~~Carbon and~~ For quenched and tempered wires, carbon and manganese may be varied by the manufacturer at his discretion, provided the mechanical properties specified are maintained and provided the purchaser does not specifically stipulate otherwise.

5. Materials and Manufacture

5.1 The steel ~~may~~shall be made by ~~any commercially accepted steel-making process. The steel shall be continuously cast.~~ a steel making process combined with secondary ladle refining that is capable of satisfying the inclusion content requirements of this specification.

5.2 The steel shall be continuously cast into blooms and rolled into billets.

5.3 Billet conditioning shall precede wire rod manufacture. The resulting wire rods shall be of sufficient surface quality that when combined with a surface removal operation performed prior to or during the wire manufacturing operation the resulting wire shall satisfy the surface condition and decarburization requirements of this specification.

5.4 The finished wire shall be free of detrimental pipe and undue segregation.

5.5 ~~The~~ Unless ordered in the annealed and cold-drawn condition, the wire shall be ~~hardened~~quenched and tempered to produce the desired mechanical properties.

5.6 Alternate manufacturing processes may be used upon agreement between purchaser and supplier.

6. Chemical Composition

6.1 The steel shall conform to the requirements for chemical composition prescribed in Table 1.

6.2 ~~*Cast or Heat Analysis*~~—Each ~~cast or~~ heat of steel shall be analyzed ~~by the manufacturer~~ to determine the percentage of elements prescribed in Table 1. 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 1.

6.3 *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 ~~1~~03 of Specification ~~A510~~A510/A510M ~~or Specification A510M~~.

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

7. Mechanical Properties

7.1 *Tension Test:*

7.1.1 *Requirements for Annealed and Cold-Drawn Wires*—Tension test requirements, if any, shall be stated in the purchase order.

7.1.2 ~~*Requirements—*~~*Requirements for Quenched and Tempered Wires*—The material as represented by tension test specimens shall conform to the requirements ~~prescribed~~ in Table 2 ~~or~~ . Variation in tensile strength within a coil shall not exceed 70 Mpa [10.15 ksi]. Tensile strength of shaped wires shall conform to Table ~~3~~2.

~~TABLE 2 Tensile Requirements, SI Units~~

~~Diameter, mm~~	~~Tensile Strength, MPa~~		~~Reduction of Areas, min, %[A]~~
	~~min~~	~~max~~	
~~Less than 1.50~~	~~1700~~	~~1850~~	~~. . .~~
~~1.50 to 2.50, incl~~	~~1650~~	~~1800~~	~~. . .~~
~~Over 2.50 to 3.50, incl~~	~~1600~~	~~1750~~	~~40~~
~~Over 3.50 to 4.00, incl~~	~~1580~~	~~1720~~	~~40~~
~~Over 4.00 to 4.80, incl~~	~~1550~~	~~1700~~	~~40~~
~~Over 4.80 to 5.50, incl~~	~~1520~~	~~1680~~	~~40~~
~~Over 5.50 to 6.50, incl~~	~~1500~~	~~1650~~	~~40~~
~~Over 6.50~~	~~1450~~	~~1600~~	~~40~~

~~[A] The reduction of area test is not applicable to wire diameters under 2.34 mm.~~

~~TABLE 3 Tensile Requirements, Inch-Pound Units~~ TABLE 2 Tensile and % Reduction of Area Requirements

~~Diameter, in.~~	~~Tensile Strength, ksi~~		~~Reduction of Area, min, %[A]~~
	~~min~~	~~max~~	
	SI Units		
Diameter, mm	Tensile Strength, MPa		Reduction of Areas, min, %[A]
	min	max	
Less than 1.50	1700	1850	. . .
1.50 to 2.35, incl	1650	1800	. . .
Over 2.35 to 3.25, incl	1620	1770	40
Over 3.25 to 4.00, incl	1580	1720	40
Over 4.00 to 4.90, incl	1550	1700	40
Over 4.90 to 5.70, incl	1520	1680	40
Over 5.70 to 6.35, incl	1480	1630	40
Over 6.35	1450	1600	40
	Inch-Pound Units		
Diameter, in.	Tensile Strength, ksi		Reduction of Area, min, %[A]
	min	max	
~~Less than 0.062~~	~~245~~	~~265~~	~~. . .~~
Less than 0.062	245	265	. . .
~~0.062 to 0.092, incl~~	~~240~~	~~260~~	~~. . .~~
0.062 to 0.092, incl	240	260	. . .[B]
Over 0.092 to 0.128, incl	235	255	40
~~Over 0.128 to 0.162, incl~~	~~230~~	~~250~~	~~40~~
Over 0.128 to 0.157, incl	230	250	40
~~Over 0.162 to 0.192, incl~~	~~225~~	~~245~~	~~40~~
Over 0.157 to 0.192, incl	225	245	40
Over 0.192 to 0.225, incl	220	240	40
Over 0.225 to 0.250, incl	215	235	40
Over 0.250	210	230	40

[A] ~~The~~ The reduction of area test is not applicable to wire diameters under ~~0.092 in.~~2.34 mm [0.092 in.].

[B] The minimum reduction of area requirement for a 0.092 in. wire is 40 %.

". . ." Indicates that there is no requirement.

based on the conversion to equivalent round diameter.

7.1.3 *Number of Tests*—~~One~~ For quenched and tempered wires, each coil in a lot shall be tested. When specified for annealed and cold-drawn wires, one test specimen shall be taken for each five coils, or fraction thereof, in a lot. Each ~~cast or~~ heat in a given lot shall be tested.

7.1.4 *Location of Tests*—~~Test~~ For quenched and tempered wires, test specimens shall be taken from both ends of the coil. For annealed and cold-drawn wires, it shall be permissible for test specimens to be taken from either end of the coil.

7.1.5 *Test Method*—The tension test shall be made in accordance with Test Methods and Definitions A370. Any tensile test specimen breaking in the tensile grips shall be discarded and a new specimen tested if the specified mechanical properties are not achieved. For shaped wires, cross sectional area shall be calculated using either the procedure in Test Methods E8/E8M for uniform but nonsymmetrical cross-sections, or 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.

7.1.5.1 Upon agreement between purchaser and supplier, the shape factor for the design provided by the wire mill shall be permissible to be adopted for use. In other situations if the shape factor is not available from the wire mill, the shape factor shall be calculated by measuring the cross sectional area in accordance with Test Methods E8/E8M and dividing by the width and thickness.

7.2 *Wrap Test:*