Designation: A 229/A 229M – 99 (Reapproved 2005)

Standard Specification for Steel Wire, Oil-Tempered for Mechanical Springs[1]

This standard is issued under the fixed designation A 229/A 229M; 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 Department of Defense.

1. Scope

1.1 This specification covers two classes of oil-tempered steel spring wire intended especially for the manufacture of mechanical springs and wire forms.

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.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products

A 510 Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel

A 510M Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel [Metric]

A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

A 941 Terminology Relating to Steel, Stainless Steel, Related Alloys and Ferroalloys

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E 1077 Test Methods for Estimating the Depth of Decarburization of Steel Specimens

2.2 *American National Standard:*

B 32.4M Preferred Metric Sizes for Round, Square, Rectangle, and Hexagon Metal Products[3]

2.3 *Military Standard:*

MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage[4]

2.4 *Federal Standard:*

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[4]

2.5 *AIAG Standard:*

AIAGB-5 02.00 Primary Metals Identification Tag Application Standard[5]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 For definition of terms used in this specification, refer to Terminology A 941.

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:

4.1.1 Quantity (mass or weight),

4.1.2 Name of material (oil-tempered steel mechanical spring wire) and class (Table 1 or Table 2),

4.1.3 Dimensions (Section 10),

4.1.4 Chemical composition (Table 3), if required,

4.1.5 Packaging (Section 16),

4.1.6 Cast or heat analysis report, if desired (see 7.2),

4.1.7 Certification or test report, or both, if specified (Section 15), and

4.1.8 ASTM designation and date of issue.

NOTE 1—A typical metric ordering description is as follows: 10 000 kg oil-tempered steel mechanical spring wire, Class I, 8.00 mm diameter, in 250-kg coils to ASTM A 229 M – xx, or for inch-pound units, 20 000 lb oil-tempered steel mechanical Spring Wire, Class I 0.315 in. diameter, in 500-lb coils to ASTM A 229 – xx.

5. General Requirements

5.1 Material furnished to this specification shall conform to the applicable requirements of either Specification A 510M or Specification A 510.

[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.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

[4] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

[5] Available from the Automotive Industry Action Group, 26200 Lahser, Suite 200, Southfield, MI 48034.

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TABLE 1 Tensile Requirements, SI Units[A]

Diameter,[B] mm	Class I		Class II	
	Tensile Strength, MPa		Tensile Strength, MPa	
	min	max	min	max
0.50	2050	2250	2230	2450
0.55	2020	2220	2220	2440
0.60	2000	2200	2210	2430
0.65	1950	2150	2190	2410
0.70	1950	2150	2170	2190
0.80	1900	2100	2140	2360
0.90	1850	2050	2100	2320
1.00	1800	2000	2060	2280
1.10	1780	1980	2030	2240
1.20	1750	1950	2000	2210
1.40	1700	1900	1950	2150
1.60	1650	1850	1900	2100
1.80	1620	1820	1860	2060
2.00	1600	1800	1820	2020
2.20	1580	1780	1790	1990
2.50	1550	1750	1750	1950
2.80	1520	1720	1710	1900
3.00	1500	1700	1690	1880
3.50	1450	1620	1640	1830
4.00	1400	1580	1600	1780
4.50	1380	1550	1560	1740
5.00	1350	1520	1520	1700
5.50	1320	1500	1500	1680
6.00	1300	1480	1480	1660
7.00	1280	1450	1450	1630
8.00	1250	1430	1430	1610
9.00	1220	1400	1410	1590
10.00	1200	1380	1400	1580
11.00	1180	1350	1380	1560
12.00	1150	1320	1360	1540
14.00	1120	1300	1340	1520
16.00	1120	1300	1320	1500

[A] Tensile strength values for intermediate diameters shall be interpolated.
[B] Preferred sizes. For a complete list, refer to ANSI B 32.4M , Preferred Metric Sizes for Round, Square, Rectangle, and Hexagon Metal Products.

TABLE 2 Tensile Requirements, Inch-Pound Units

Diameter,[A] in.	Class I		Class II	
	Tensile Strength, ksi†		Tensile Strength, ksi	
	min	max	min	max
0.020	293	323	324	354
0.023	289	319	320	350
0.026	286	316	317	347
0.029	283	313	314	344
0.032	280	310	311	341
0.035	274	304	305	335
0.041	266	296	297	327
0.048	259	289	290	320
0.054	253	283	284	314
0.062	247	277	278	308
0.072	241	271	272	302
0.080	235	265	266	296
0.092	230	260	261	291
0.106	225	255	256	286
0.120	220	250	251	281
0.135	215	240	241	266
0.148	210	235	236	261
0.162	205	230	231	256
0.177	200	225	226	251
0.192	195	220	221	246
0.207	190	215	216	241
0.225	188	213	214	239
0.244	187	212	213	238
0.250	185	210	211	236
0.312	183	208	209	234
0.375	180	205	206	231
0.438	175	200	201	226
0.500	170	195	196	221
0.562	165	190	191	216
0.625	165	190	191	216

[A] Tensile strength values for intermediate diameters shall be interpolated.

TABLE 3 Chemical Requirements

Element	Composition, %
Carbon	0.55–0.85
Manganese	0.30–1.20[A]
Phosphorus, max	0.040
Sulfur, max	0.050
Silicon	0.15–0.35

[A] Generally 0.80/1.20 % manganese for diameter 5.00 mm or 0.192 in. and larger; 0.30/0.90 % for diameters less than 5.00 mm or 0.192 in. The choice of composition shall be optional with the manufacturer unless the purchaser definitely specifies otherwise.

6. Materials and Manufacture

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

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

6.3 The wire shall be oil quenched and tempered to produce the desired mechanical properties.

7. Chemical Composition

7.1 The steel shall conform to the requirements for chemical composition prescribed in Table 3.

7.2 *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 3. 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 3.

7.3 *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 10 of Specification A 510 or A 510M.

7.4 For referee purposes, Test Methods, Practices, and Terminology A 751 shall be used.

8. Mechanical Properties

8.1 *Tension Test*:

8.1.1 *Requirements*—The material as represented by tension test specimens shall conform to the requirements prescribed in Table 1 or Table 2.

8.1.2 *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.

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

8.1.4 *Test Method*—The tension test shall be made in accordance with Test Methods and Definitions A 370.

8.2 *Wrap Test*:

8.2.1 *Requirements*—Wire 4.00 mm or 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 or 0.312 in. shall wind, without breakage, on a mandrel twice

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the wire diameter. Wrap test on wires over 8.00 mm or 0.312 in. diameter is not applicable.

8.2.2 *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.

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

8.2.4 *Test Method*—The wrap test shall be made in accordance with Test Methods and Definitions A 370, Supplement IV.

9. Metallurgical Requirements

9.1 *Surface Condition*—The surface of the wire as-received shall be free of rust, excessive scale die marks, pits and scratches detrimental to the end application. Seams shall not exceed 3.5 % of the wire diameter or 0.25 mm [0.010 in.], whichever is less.

9.1.1 *Location of Test*—Test specimens shall be taken from either or both ends of the coil.

9.2 *Microstructure*—A longitudinal section of the wire shall show a fine, homogeneous, tempered martensite structure.

9.3 *Decarburization*:

9.3.1 The maximum depth of decarburization (free ferrite plus partial decarburization) shall not exceed 2 % of the wire diameter or 0.15 mm [0.006 in.] whichever is less. The depth of complete decarburization (free ferrite shall not exceed 0.75 % of the wire diameter.

9.3.2 *Test Method*—Decarburization shall be determined by etching a suitably polished transverse section of wire with nital. The entire periphery to be examined should be in a single plane with no edge rounding.

9.3.3 The entire periphery shall be examined at a magnification of no less than 100× for depth of free ferrite and maximum affected depth. Smaller wire sizes may require higher magnification. Measure the worst area present excluding decarburization associated with seams or other surface imperfections. Complete decarburization exists when only free ferrite is present. Partial decarburization exists when ferrite is found mixed with pearlite or tempered martensite. Structures of 100 % martensite shall be defined as not decarburized.

10. Dimensions and Permissible Variations

10.1 The permissible variations in the diameter of the wire shall be as specified in Table 4 or Table 5.

11. Workmanship and Appearance

11.1 The wire shall be uniform in quality and temper and shall not be wavy or crooked.

TABLE 4 Permissible Variations in Wire Diameter, SI Units[A]

Diameter, mm	Permissible Variations, plus and minus, mm	Permissible Out-of Round, mm
To 0.70, incl	0.02	0.02
Over 0.70 to 2.00, incl	0.03	0.03
2.00 to 9.00, incl	0.05	0.05
Over 9.00	0.08	0.08

[A] For purposes of determining conformance with this specification, all specified limits are absolute as defined in Practice E 29.

TABLE 5 Permissible Variations in Wire Diameter, Inch-Pound Units[A]

Diameter, in.	Permissible Variations, plus and minus, in.	Permissible Out-of-Round, in.
0.020 to 0.028, incl	0.0008	0.0008
Over 0.028 to 0.075, incl	0.001	0.001
Over 0.075 to 0.375, incl	0.002	0.002
Over 0.375	0.003	0.003

[A] For purposes of determining conformance with this specification, all specified limits are absolute as defined in Practice E 29.

11.2 Each coil shall be one continuous length of wire, properly coiled and firmly tied. Welds made prior to cold drawing are permitted.

12. Retests

12.1 If any test specimen exhibits obvious defects or shows the presence of a weld, it may be discarded and another specimen substituted.

13. Inspection

13.1 Unless otherwise specified in the contract or purchase order, the manufacturer is responsible for the performance of all inspection and test requirements specified in this specification. Except as otherwise specified in the contract or purchase order, the manufacturer may use his own or any other suitable facilities for the performance of the inspection and test requirements unless disapproved by the purchaser at the time the order is placed. The purchaser shall have the right to perform any of the inspections and tests set forth in this specification when such inspections and tests are deemed necessary to assure that the material conforms to prescribed requirements.

14. Rejection and Rehearing

14.1 Unless otherwise specified, any rejection based on tests made in accordance with this specification shall be reported to the manufacturer as soon as possible so that an investigation may be initiated.

14.2 The material shall be adequately protected and correctly identified in order that the manufacturer may make a proper investigation.

15. Certification

15.1 When specified in the purchase order or contract, a manufacturer's or supplier's certification shall be furnished to the purchaser that the material was manufactured, sampled, tested, and inspected in accordance with this specification and has been found to meet the requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

15.2 The certification shall include the specification number, year date of issue, and revision letter, if any.

16. Packaging, Marking, and Loading for Shipment

16.1 The coil mass, dimensions, and the method of packaging shall be agreed upon between the manufacturer and purchaser.

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16.2 A tag shall be securely attached to each coil of wire with identifying information as agreed upon by the purchaser and manufacturer.

16.3 Unless otherwise specified in the purchaser's order, packaging, marking, and loading for shipments shall be in accordance with those procedures recommended by Practices A 700.

16.4 *For Government Procurement*—Packaging, packing, and marking of material for military procurement shall be in accordance with the requirements of MIL-STD-163, Level A, Level C, or commercial as specified in the contract or purchase order. Marking for shipment of material for civil agencies shall be in accordance with Fed. Std. No. 123.

16.5 *Bar Coding*—In addition to the previously-stated identification requirements, bar coding is acceptable as a supplementary identification method. Bar coding should be consistent with AIAG Standard 02.00, Primary Metals Identification Tag Application. The bar code may be applied to a substantially affixed tag.

17. Keywords

17.1 oil-tempered; springs; wire

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