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Standard Specification for Steel Wire, Cold-Drawn for Mechanical Springs¹

This standard is issued under the fixed designation A227/A227M; 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 two classes of round cold-drawn steel spring wire having properties and quality for the manufacture of mechanical springs that are not subject to high stress or requiring high fatigue properties 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

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

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

2.2 American National Standard:

B 32.4M Preferred Metric Sizes for Round, Square, Rectangle, and Hexagon Metal Products³

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.

2.3 Federal Standard:

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

2.4 AIAG Standard:

AIAG B-5 02.00 Primary Metals Identification Tag Application Standard⁵

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 A941.

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 requirement may include, but are not limited to, the following:

4.1.1 Quantity (mass),

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

4.1.3 Wire diameter (Table 1 or Table 2),

4.1.4 Packaging (Section 15),

4.1.5 Cast or heat analysis report, if requested (Section 6),

4.1.6 Certification or test report, or both, if specified (Section 14), and

4.1.7 ASTM designation and date of issue.

NOTE 1—A typical ordering description is as follows: 15 000 kg Cold-Drawn Mechanical Spring Wire, Class I, Size 5.00 mm in 700-kg coils to ASTM A227M dated_____, or for non-SI units, 30 000 lb Cold-Drawn Mechanical Spring Wire, Class I, Size 0.207 in. diameter in 500-lb coils to ASTM A227 dated_____.

5. 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 of detrimental pipe and undue segregation.

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

⁵ Available from Automotive Industry Action Group (AIAG), 26200 Lahser Rd., Suite 200, Southfield, MI 48034.

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	1960	2240	2240	2520
0.55	1940	2220	2220	2500
0.60	1920	2200	2200	2480
0.65	1900	2180	2180	2460
0.70	1870	2140	2140	2410
0.80	1830	2100	2100	2370
0.90	1800	2070	2070	2340
1.00	1770	2040	2040	2310
1.10	1740	2000	2000	2260
1.20	1720	1980	1980	2240
1.40	1670	1930	1930	2180
1.60	1640	1880	1880	2120
1.80	1600	1840	1840	2080
2.00	1580	1810	1810	2040
2.20	1550	1780	1780	2010
2.50	1510	1730	1730	1960
2.80	1480	1700	1700	1920
3.00	1460	1680	1680	1900
3.50	1420	1630	1630	1840
4.00	1380	1590	1590	1800
4.50	1350	1550	1550	1750
5.00	1320	1510	1510	1700
5.50	1300	1490	1490	1670
6.00	1280	1470	1470	1650
6.50	1250	1440	1440	1630
7.00	1220	1410	1410	1600
7.50	1200	1390	1390	1580
8.00	1190	1370	1370	1550
9.00	1160	1340	...	...
10.00	1130	1310	...	...
11.00	1110	1280	...	...
12.00	1090	1260	...	...
14.00	1050	1210	...	...
16.00	1010	1170	...	...

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

^B Preferred sizes. For a complete list, refer to ANSI B32.4M, Preferred Metric Sizes for Round, Square, Rectangle, and Hexagon Metal Products.

5.3 The wire shall be cold drawn to produce the desired mechanical properties.

6. Chemical Composition

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

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 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**.

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 3 of Specification **A510/A510M**.

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

7. Mechanical Properties

7.1 Tension Test:

TABLE 2 Tensile Requirements, Inch-Pound Units^A

Diameter, in.	Class I		Class II	
	Tensile Strength, ksi		Tensile Strength, ksi	
	min	max	min	max
0.020	283	323	324	364
0.023	279	319	320	360
0.026	275	315	316	356
0.029	271	311	312	352
0.032	266	306	307	347
0.035	261	301	302	342
0.041	255	293	294	332
0.048	248	286	287	325
0.054	243	279	280	316
0.062	237	272	273	308
0.072	232	266	267	301
0.080	227	261	262	296
0.092	220	253	254	287
0.106	216	248	249	281
0.120	210	241	242	273
0.135	206	237	238	269
0.148	203	234	235	266
0.162	200	230	231	261
0.177	195	225	226	256
0.192	192	221	222	251
0.207	190	218	219	247
0.225	186	214	215	243
0.250	182	210	211	239
0.312	174	200	201	227
0.375	167	193	194	220
0.438	165	190	191	216
0.500	156	180	181	205
0.562	152	176	177	201
0.625	147	170	171	294

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

TABLE 3 Chemical Requirements

Element	Composition, %
Carbon	0.45–0.85 ^A
Manganese	0.30–1.30 ^B
Phosphorus, max	0.040
Sulfur, max	0.050
Silicon	0.15–0.35

^A Carbon in any one lot shall not vary more than 0.13 %.

^B Manganese in any one lot shall not vary more than 0.30 %.

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

7.1.2 *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.

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

7.1.4 *Test Method*—The tension test shall be made in accordance with Test Methods and Definitions **A370**.

7.2 Wrap Test:

7.2.1 *Requirements*—The material as represented by the wrap test specimens shall conform to the requirements specified in **Table 4** or **Table 5**. Wrap test on wires over 8.5 mm or 0.312 in. in diameter is not applicable. Since the conventional methods will not accommodate over 8.5 mm or 0.312 in., an alternative test procedure shall be agreed upon between purchaser and producer.

**TABLE 4 Wrap Test Requirements, SI Units**

Diameter, mm	Mandrel Size	
	Class I	Class II
0.50 to 4.0, incl	1X ^A	2X
Over 4.0 to 8.0, incl	2X	4X

^A For 1X mandrel, wire shall be wrapped on itself.

TABLE 5 Wrap Test Requirements, Inch-Pound Units

Diameter, in.	Mandrel Size	
	Class I	Class II
0.020 to 0.162, incl	1X ^A	2X
Over 0.162 to 0.312, incl	2X	4X

^A For 1X mandrel, wire shall be wound on itself.

7.2.2 *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.

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

7.2.4 *Test Method*—The wrap test shall be made in accordance with Test Methods and Definitions A370, Supplement IV.

8. Metallurgical Requirements

8.1 Surface Condition:

8.1.1 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.

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

9. Dimensions and Permissible Variations

9.1 The permissible variations in the diameter of the wire shall be as specified in Table 6 or Table 7.

10. Workmanship and Appearance

10.1 *Workmanship*—The wire shall not be kinked or improperly cast. To test for cast, a few convolutions of wire shall be cut from the coil and placed on a flat surface. The wire shall lie flat on itself and not spring up excessively nor show a wavy condition.

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

TABLE 6 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
Over 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 E29.

TABLE 7 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 to 0.625, incl	0.003	0.003

^A For purposes of determining conformance with this specification, all specified limits are absolute as defined in Practice E29.

11. Retests

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

12. Inspection

12.1 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.

13. Rejection and Rehearing

13.1 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.

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

14. Certification

14.1 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.

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

15. Packaging, Marking, and Loading for Shipment

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

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

15.3 Unless otherwise specified in the purchaser's order, packaging, marking, and loading for shipments shall be in accordance with those procedures recommended by Practices **A700**.

15.4 *For Government Procurement*—Marking for shipment of material for civil agencies shall be in accordance with Fed. Std. No. 123.

15.5 *Bar Coding*—In addition to the previously stated identification requirements, bar coding is acceptable as a supple-

mentary 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.

16. Keywords

16.1 cold-drawn; springs; wire

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