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Standard Specification for Steel Wire, Music Spring Quality¹

This standard is issued under the fixed designation A 228/A 228M; 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 a high quality, round, cold-drawn steel music spring quality wire, uniform in mechanical properties, intended especially for the manufacture of springs subject to high stresses or requiring good fatigue properties.

1.2 The values stated in either SI (metric) units or inch-pound units are to be regarded separately as standard. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other.

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 938 ~~Standard Test~~ Test Method for Torsion Testing of Wire

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 *Military Standard:*

MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage³

2.3 *Federal Standard:*

Fed. Std. No. 123, Marking for Shipment (Civil Agencies)³

2.4 ~~American National Standard:~~ *American National Standard:*⁴

B32.4 Preferred Metric Sizes for Round, Square, Rectangle, and Hexagon Metal Products

2.5 *AIAG Standard:*⁵

AIAG B-5 02.00 Primary Metals Identification Tag Application Standard

3. Terminology

3.1 *Definitions*— For definitions 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 information:

4.1.1 Quantity (mass),

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² Annual Book of ASTM Standards, Vol 01.03.

³ 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.

⁴ Annual Book of ASTM Standards, Vol 01.01.

⁵ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://www.dodssp.daps.mil>.

⁶ Annual Book of ASTM Standards, Vol 01.01.

⁷ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁸ Annual Book of ASTM Standards, Vol 14.02.

⁹ Available from Automotive Industry Action Group (AIAG), 26200 Lahser Rd., Suite 200, Southfield, MI 48033, <http://www.aiag.org>.

- 4.1.2 Name of material (music steel spring wire),
- 4.1.3 Dimensions (Table 1 and Section 9),
- 4.1.4 Finish (see 10.2),
- 4.1.5 Packaging (Section 15),
- 4.1.6 Heat analysis report, if requested (see 6.2),
- 4.1.7 Certification or test report, or both, if specified (Section 14), and
- 4.1.8 ASTM designation and year of issue.

NOTE 1—A typical metric ordering description is as follows: 2500 kg Music Spring Wire, 1.40 mm diameter, phosphate coated in 25 kg coils to ASTM A 288M dated _____, or for inch-pound units, 5000 lb Music Spring Wire, 0.055 in. diameter, phosphate coated in 50 lb coils to ASTM A 288 dated _____.

TABLE 1 Tensile Requirements

SI Units					
Diameter, mm ^{A,B}	Tensile Strength, MPa		Diameter, mm ^{A,B}	Tensile Strength, MPa	
	min	max		min	max
0.10	3000	3300	0.90	2200	2450
0.11	2950	3250	1.00	2150	2400
0.12	2900	3200	1.1	2120	2380
0.14	2850	3150	1.2	2100	2350
0.16	2800	3100	1.4	2050	2300
0.18	2750	3050	1.6	2000	2250
0.20	2700	3000	1.8	1980	2220
0.22	2680	2980	2.0	1950	2200
0.25	2650	2950	2.2	1900	2150
0.28	2620	2920	2.5	1850	2100
0.30	2600	2900	2.8	1820	2050
0.35	2550	2820	3.0	1800	2000
0.40	2500	2750	3.2	1780	1980
0.45	2450	2700	3.5	1750	1950
0.50	2400	2650	3.8	1720	1920
0.55	2380	2620	4.0	1700	1900
0.60	2350	2600	4.5	1680	1880
0.65	2320	2580	5.0	1650	1850
0.70	2300	2550	5.5	1620	1820
0.80	2250	2500	6.0	1600	1800

Inch-Pound Units					
Diameter, in. ^A	Tensile Strength, ksi		Diameter, in. ^A	Tensile Strength, ksi	
	min	max		min	max
0.004	439	485	0.055	300	331
0.005	426	471	0.059	296	327
0.006	415	459	0.063	293	324
0.007	407	449	0.067	290	321
0.008	399	441	0.072	287	317
0.009	393	434	0.076	284	314
0.010	387	428	0.080	282	312
0.011	382	422	0.085	279	308
0.012	377	417	0.090	276	305
0.013	373	412	0.095	274	303
0.014	369	408	0.100	271	300
0.015	365	404	0.102	270	299
0.016	362	400	0.107	268	296
0.018	356	393	0.110	267	295
0.020	350	387	0.112	266	294
0.022	345	382	0.121	263	290
0.024	341	377	0.125	261	288
0.026	337	373	0.130	259	286
0.028	333	368	0.135	258	285
0.030	330	365	0.140	256	283
0.032	327	361	0.145	254	281
0.034	324	358	0.150	253	279
0.036	321	355	0.156	251	277
0.038	318	352	0.162	249	275
0.040	315	349	0.177	245	270
0.042	313	346	0.192	241	267
0.045	309	342	0.207	238	264
0.048	306	339	0.225	235	260
0.051	303	335	0.250	230	255

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

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

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. The rod to be used in the manufacture of wire furnished to this specification shall be in accordance with Specification A 510 or A 510M.

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

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 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 in the purchase order, the heat analysis shall be reported to the purchaser.

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 7 of Specification A 510M or A 510.

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

7. Mechanical Properties

7.1 *Tension Test:*

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

7.1.2 *Number of Tests*—One test specimen shall be taken from each end of every coil or from the top or outside end of each reel or spool.

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

7.1.4 For wire diameters over 6.0 mm [0.250 in.], mechanical properties and chemical composition shall be negotiated between purchaser and supplier and shall be included on the order information.

7.2 *Wrap Test:*

7.2.1 *Requirements*—The wrap test shall be applied only to sizes smaller than 0.70 mm [0.028 in.] in diameter.

7.2.2 *Number of Tests*—One test specimen shall be taken from the top or outside end of each coil, reel or spool and shall be tested for conformance.

7.2.3 *Test Method*—Each test specimen shall be closed wound on an arbor of its own diameter for a minimum of four full wraps. Wire so tested shall not show any splits or fractures.

7.3 *Torsion Test:*

7.3.1 *Requirements*—The torsion test shall be applied to wire sizes 0.70 mm [0.028 in.] and larger in diameter. For wire sizes smaller in diameter than 0.70 mm [0.028 in.], the torsion test may be substituted for the wrap test (7.2). In this case, the minimum number of torsions to failure will be equivalent to 25 in a test length of 100*d*.

7.3.2 *Number of tests*—One test specimen shall be taken from the top or outside end of each coil, reel, or spool and shall be tested for conformance.

7.3.3 *Test Method*—Test specimens shall be prepared and tested as shown in A 938 with the following exception. The minimum number of torsions (twists) to failure in a test length of 100*d* (where *d* = the wire diameter being tested) are shown in Table 3.

7.3.4 Following completion of the torsion test, the torsion fracture shall be perpendicular to the longitudinal axis of the test specimen and the surface of the test specimen shall not be split. Secondary (recoil) fractures shall be ignored.

7.3.5 Test lengths other than 100*d* may be utilized. In this case, the minimum number of torsions to failure shall be adjusted in direct proportion to the change in test length as determined by the following formula:

$$T_x = \frac{T_d \times L_x}{L_d} \quad (1)$$

TABLE 2 Chemical Requirements

Element	Composition, %
Carbon	0.70–1.00
Manganese	0.20–0.60
Manganese	0.20–0.70
Phosphorus, max	0.025
Sulfur, max	0.030
Silicon	0.10–0.30