Designation: A 227/A 227M – 06

# Standard Specification for Steel Wire, Cold-Drawn for Mechanical Springs[1]

This standard is issued under the fixed designation A 227/A 227M; 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 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]

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 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

2.2 *American National Standard:*

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

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 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 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 A 227M 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 A 227 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.

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

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

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

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

**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 %.

## 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 10 of Specification A 510 or A 510M.

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 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 A 370.

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.



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**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 A 370, 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.

## 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.

**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 E 29.

**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 E 29.

## 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 A 700.

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 supplementary identification method. Bar coding should be



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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

## SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue, A 227/A 227M–99 (2005), that may impact the use of this standard. (Approved March 1, 2006.)

(*1*) Removed referenced document MIL-STD-163. This standard is obsolete and all references were removed.

(*2*) In 15.4, deleted the first sentence pertaining to MIL-STD-163 as that standard is obsolete.

(*3*) In Table 1, there was a mistake on the 4.00 mm wire size for Class 2. The correct numbers have been added.

(*4*) Added Summary of Changes.

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