



Designation: A 232/A 232M – 99

Standard Specification for Chromium-Vanadium Alloy Steel Valve Spring Quality Wire¹

This standard is issued under the fixed designation A 232/A 232M; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification covers the highest quality of round chromium-vanadium alloy steel valve spring wire, uniform in quality and temper, intended for the manufacture of valve springs and other springs requiring high-fatigue properties when used at moderately elevated temperatures. This wire shall be either in the annealed and cold-drawn or oil-tempered condition as specified by the purchaser.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. Within the text, the inch-pound units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independent of the other.

2. Referenced Documents

2.1 ASTM Standards:

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products²

A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment³

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products²

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications⁴

2.2 ANSI Standard:

B 32.4 Preferred Metric Sizes for Round, Square, Rectangle, and Hexagon Metal Products⁵

2.3 Federal Standard:

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)⁶

2.4 Military Standard:

MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage⁶

2.5 AIAG Standard:

AIAG B-5 02.00 Primary Metals Identification Tag Application Standard⁷

3. Ordering Information

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

3.1.1 Quantity (mass),

3.1.2 Name of material (chromium-vanadium alloy steel valve spring quality wire),

3.1.3 Dimensions (Table 1 and Section 8),

3.1.4 Condition (Section 6),

3.1.5 Packaging (Section 14),

3.1.6 Heat analysis report, if requested (5.2),

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

3.1.8 ASTM designation and year of issue.

NOTE 1—A typical ordering description is as follows: 20 000 kg oil-tempered chromium-vanadium alloy steel valve spring quality wire, size 6.00 mm in 150 kg coils to ASTM A 232/A 232M dated __, or for inch-pound units, 40 000 lb oil-tempered chromium-vanadium alloy steel valve spring quality wire, size 0.250 in. in 350-lb coils to ASTM A 232/A 232M dated __.

4. Materials and Manufacture

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

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

5. Chemical Composition

5.1 The steel shall conform to the requirements for chemical composition specified in Table 2.

5.2 *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, this shall be reported to the purchaser and shall conform to the requirements of Table 2.

¹ This specification is under the jurisdiction of ASTM Committee A-1 on Steel, Stainless Steel, and Related Alloys and is the direct responsibility of Subcommittee A1.03 on Steel Rod and Wire.

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² *Annual Book of ASTM Standards*, Vol 01.03.

³ *Annual Book of ASTM Standards*, Vol 01.05.

⁴ *Annual Book of ASTM Standards*, Vol 14.02.

⁵ Available from the American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.

⁶ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

⁷ Available from the Automotive Industry Action Group, 26200 Lahser, Suite 200, Southfield, MI 48034.

TABLE 1 Tensile Requirements^A

| SI Units | | | |
|---------------------------|----------|----------|---------------------------|
| Diameter, ^B mm | MPa, min | MPa, max | Reduction of Area, min, % |
| 0.50 | 2060 | 2260 | C |
| 0.55 | 2050 | 2240 | C |
| 0.60 | 2030 | 2220 | C |
| 0.65 | 2010 | 2200 | C |
| 0.70 | 2000 | 2160 | C |
| 0.80 | 1980 | 2140 | C |
| 0.90 | 1960 | 2120 | C |
| 1.00 | 1940 | 2100 | C |
| 1.10 | 1920 | 2080 | C |
| 1.20 | 1900 | 2060 | C |
| 1.40 | 1860 | 2020 | C |
| 1.60 | 1820 | 1980 | C |
| 1.80 | 1800 | 1960 | C |
| 2.00 | 1780 | 1930 | C |
| 2.20 | 1750 | 1900 | C |
| 2.50 | 1720 | 1860 | 45 |
| 2.80 | 1680 | 1830 | 45 |
| 3.00 | 1660 | 1800 | 45 |
| 3.50 | 1620 | 1760 | 45 |
| 4.00 | 1580 | 1720 | 40 |
| 4.50 | 1560 | 1680 | 40 |
| 5.00 | 1520 | 1640 | 40 |
| 5.50 | 1480 | 1600 | 40 |
| 6.00 | 1460 | 1600 | 40 |
| 6.50 | 1440 | 1580 | 40 |
| 7.00 | 1420 | 1560 | 40 |
| 8.00 | 1400 | 1540 | 40 |
| 9.00 | 1380 | 1520 | 40 |
| 10.00 | 1360 | 1500 | 40 |
| 11.00 | 1340 | 1480 | 40 |
| 12.00 | 1320 | 1460 | 40 |

| Inch-Pound Units | | | |
|------------------|----------|----------|---------------------------|
| Diameter, in. | ksi, min | ksi, max | Reduction of Area, min, % |
| 0.020 | 300 | 325 | C |
| 0.032 | 290 | 315 | C |
| 0.041 | 280 | 305 | C |
| 0.054 | 270 | 295 | C |
| 0.062 | 265 | 290 | C |
| 0.080 | 255 | 275 | C |
| 0.105 | 245 | 265 | 45 |
| 0.135 | 235 | 255 | 45 |
| 0.162 | 225 | 245 | 40 |
| 0.192 | 220 | 240 | 40 |
| 0.244 | 210 | 230 | 40 |
| 0.283 | 205 | 225 | 40 |
| 0.312 | 203 | 223 | 40 |
| 0.375 | 200 | 220 | 40 |
| 0.438 | 195 | 215 | 40 |
| 0.500 | 190 | 210 | 40 |

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

^B Preferred sizes. For a complete list, refer to ANSI B32.4.

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

5.3 *Product Analysis*—An analysis may be made by the purchaser from finished wire representing each heat of steel. The average of all the separate determinations made shall be within the limits specified in the analysis column. Individual determinations may vary to the extent shown in the product analysis tolerance column, except that the several determinations of a single element in any one heat shall not vary both above and below the specified range.

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

TABLE 2 Chemical Requirements

| | Analysis, % | Product Analysis Tolerance, % |
|------------|-------------|-------------------------------|
| Carbon | 0.48–0.53 | ±0.02 |
| Manganese | 0.70–0.90 | ±0.03 |
| Phosphorus | 0.020 max | +0.005 |
| Sulfur | 0.035 max | +0.005 |
| Silicon | 0.15–0.35 | ±0.02 |
| Chromium | 0.80–1.10 | ±0.05 |
| Vanadium | 0.15 min | –0.01 |

6. Mechanical Properties

6.1 *Annealed and Cold-Drawn*—When purchased in the annealed and cold-drawn condition, the wire shall have been given a sufficient amount of cold working to meet the purchaser's coiling requirements and shall be in a suitable condition to respond properly to heat treatment. In special cases the hardness, if desired, shall be stated in the purchase order.

6.2 *Oil Tempered*—When purchased in the oil-tempered condition, the tensile strength and minimum percent reduction of area, sizes 2.50 mm [0.105 in.] and coarser, of the wire shall conform to the requirements prescribed in Table 1.

6.2.1 *Number of Tests*—One test specimen shall be taken for each five coils, or fraction thereof, in a lot. Each heat in a given lot shall be tested.

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

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

6.3 Wrap Test:

6.3.1 Oil-tempered or cold-drawn wire 4.00 mm [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 [0.312 in.] in diameter shall wrap without breakage on a mandrel twice the wire diameter. The wrap test is not applicable to wire over 8.00 mm in diameter.

6.3.2 *Number of Tests*—One test specimen shall be taken for each five coils, or fraction thereof, in a lot. Each heat in a given lot shall be tested.

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

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

6.4 *Special Surface Inspection*—When specified, the entire length of every coil used by engine valve spring manufacturers shall be inspected for surface imperfections with a magnetic and/or eddy current defect analyzer or equivalent.

7. Metallurgical Requirements

7.1 Surface Condition:

7.1.1 The surface of the wire as received shall be free of imperfections such as pits, die marks, scratches, seams, and other defects tending to impair the fatigue value of the springs.

7.1.2 *Number of Tests*—One test specimen shall be taken from each end of every coil.

7.1.3 *Test Method*—The surface shall be examined after etching in a solution of equal parts of hydrochloric acid and water that has been heated to approximately 80°C for a