Designation: ~~A510/A510M – 13~~ A510/A510M – 18

Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel[1]

This standard is issued under the fixed designation A510/A510M; 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 general requirements for carbon and alloy steel wire rods and uncoated coarse round wire in coils or straightened and cut lengths.

1.2 In case of conflict, the requirements in the purchase order, on the drawing, in the individual specification, and in this general specification shall prevail in the sequence named.

1.3 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.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

~~A5 Specification for High-Carbon Steel Joint Bars; Replaced by A 3 (Withdrawn 1979)[3]~~

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

~~A510M Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel (Metric) (Withdrawn 2011)[3]~~

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

A1040 Guide for Specifying Harmonized Standard Grade Compositions for Wrought Carbon, Low-Alloy, and Alloy Steels

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

~~E30 Test Methods for Chemical Analysis of Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron (Withdrawn 1995)[3]~~

E112 Test Methods for Determining Average Grain Size

E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

~~2.2 *SAE Standard:*[4]~~

~~J 1086 Numbering Metals and Alloy~~

~~2.3 *AIAG Standard:*[5]~~

~~AIAGB-5 02.00 Primary Metals Identification Tag Application Standard~~

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

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[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.

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

3.1.1 *coarse round ~~wire~~—wire, n—from ~~0.035 to 0.999 in. [0.90 to 25 mm]~~0.90 to 25 mm [0.035 to 0.999 in.] in diameter, inclusive*, wire that is produced from hot-rolled wire rods or hot-rolled coiled bars by one or more cold reductions primarily for the purpose of obtaining a desired size with dimensional accuracy, surface finish, and mechanical properties. By varying the amount of cold reduction and other wire mill practices, including thermal treatment, a wide diversity of mechanical properties and finishes are made available.

3.1.1.1 *Discussion—*

Coarse round wire is designated by Steel Wire Gauge numbers, common fractions, or decimal parts of an inch, or metric equivalents. The Steel Wire Gauge system ~~(US)~~ is shown in Table 1 ~~(English Units) and~~ . ~~Table 1 (M) (SI Units).~~ Since the many gauge systems in use may cause confusion, the purchaser is encouraged to specify wire diameters in inches, decimal parts, or metric equivalents.

3.1.2 *straightened and cut ~~wire~~—wire, n—*wire that is produced from coils of wire by means of special machinery which straightens the wire and cuts it to a specified length.

TABLE 1 Steel Wire Gauge[A] ~~(English Units)~~

~~Gauge No.~~	~~Decimal Equivalent, in.~~	~~Gauge No.~~	~~Decimal Equivalent, in.~~
~~7/0~~			
~~6/0~~	~~0.462*~~	~~9½~~	~~0.142~~
~~5/0~~	~~0.430*~~	~~10~~	~~0.135~~
~~4/0~~	~~0.394*~~	~~10½~~	~~0.128~~
~~3/0~~	~~0.362*~~	~~11~~	~~0.120*~~
~~2/0~~	~~0.331~~	~~11½~~	~~0.113~~
~~1/0~~	~~0.306~~	~~12~~	~~0.106*~~
~~1~~	~~0.283~~	~~12½~~	~~0.099~~
~~1½~~	~~0.272~~	~~13~~	~~0.092*~~
~~2~~	~~0.262*~~	~~13½~~	~~0.086~~
~~2½~~	~~0.253~~	~~14~~	~~0.080~~
~~3~~	~~0.244*~~	~~14½~~	~~0.076~~
~~3½~~	~~0.234~~	~~15~~	~~0.072~~
~~4~~	~~0.225*~~	~~15½~~	~~0.067~~
~~4½~~	~~0.216~~	~~16~~	~~0.062*~~
~~5~~	~~0.207~~	~~16½~~	~~0.058~~
~~5½~~	~~0.200~~	~~17~~	~~0.054~~
~~6~~	~~0.192~~	~~17½~~	~~0.051~~
~~6½~~	~~0.184~~	~~18~~	~~0.048*~~
~~7~~	~~0.177~~	~~18½~~	~~0.044~~
~~7½~~	~~0.170~~	~~19~~	~~0.041~~
~~8~~	~~0.162~~	~~19½~~	~~0.038~~
~~8½~~	~~0.155~~	~~20~~	~~0.035*~~

Inch-Pound Units			
Gauge No.	Decimal Equivalent, in.	Gauge No.	Decimal Equivalent, in.
7/0	0.490	9	0.148*
~~0.490~~ 6/0	0.462*	9½	0.142
5/0	0.430*	10	0.135
4/0	0.394*	10½	0.128
3/0	0.362*	11	0.120*
2/0	0.331	11½	0.113
1/0	0.306	12	0.106*
1	0.283	12½	0.099
1½	0.272	13	0.092*
2	0.262*	13½	0.086
2½	0.253	14	0.080
3	0.244*	14½	0.076
3½	0.234	15	0.072
4	0.225*	15½	0.067
4½	0.216	16	0.062*
5	0.207	16½	0.058
5½	0.200	17	0.054
6	0.192	17½	0.051
6½	0.184	18	0.048*
7	0.177	18½	0.044
7½	0.170	19	0.041
8	0.162	19½	0.038
8½	0.155	20	0.035*

[A] The steel wire gauge outlined in this table has been taken from the original Washburn and Moen Gauge chart. In 20 gauge and coarser, sizes originally quoted to 4 decimal equivalent places have been rounded to 3 decimal places in accordance with rounding procedures of Practice E29. All rounded U.S. customary values are indicated by an asterisk.

TABLE 1 Steel Wire Gauge[A]

SI Units
Diameter, mm
0.90
1.00
1.10
1.20
1.30
1.40
1.60
1.80
2.0
2.1
2.2
2.4
2.5
2.6
2.8
3.0
3.2
3.5
3.8
4.0
4.2
4.5
4.8
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
19.0
20.0
21.0
22.0
23.0
24.0
25.0
–

~~TABLE 1 (M) Steel Wire Gauge[A] (SI Units, mm)~~

~~0.90~~
~~1.00~~
~~1.10~~
~~1.20~~
~~1.30~~
~~1.40~~
~~1.60~~
~~1.80~~
~~2.0~~
~~2.1~~
~~2.2~~
~~2.4~~
~~2.5~~
~~2.6~~
~~2.8~~
~~3.0~~
~~3.2~~
~~3.5~~
~~3.8~~
~~4.0~~
~~4.2~~
~~4.5~~
~~4.8~~
~~6.0~~
~~6.5~~
~~7.0~~
~~7.5~~
~~8.0~~
~~8.5~~
~~9.0~~
~~9.5~~
~~10.0~~
~~11.0~~
~~12.0~~
~~13.0~~
~~14.0~~
~~15.0~~
~~16.0~~
~~17.0~~
~~18.0~~
~~19.0~~
~~20.0~~
~~21.0~~
~~22.0~~
~~23.0~~
~~24.0~~

~~5.0~~	~~25.0~~
~~5.5~~	

3.1.2.1 *Discussion—*

The straightening operation may alter the mechanical properties of the wire, especially the tensile strength. The straightening operation may also induce changes in the diameter of the wire. The extent of the changes in the properties of the wire after cold straightening depends upon the kind of wire and also on the normal variations in the adjustments of the straightening equipment. It is therefore not possible to forecast the properties of straightened and cut wire and each kind of wire needs individual consideration. In most cases, the end use of straightened and cut wire is not seriously influenced by these changes.

3.1.3 *wire ~~rods—~~rods, n—*rods that are hot rolled from billets to an approximate round cross section into coils of one continuous length. Rods are not comparable to hot-rolled bars in accuracy of cross section or surface finish and as a semifinished product are intended primarily for the manufacture of wire.

3.1.3.1 *Discussion—*

Rod sizes from 5.5 to 18.6 mm [7⁄32 to 47⁄64 ~~in. [5.5 to 18.6 mm]~~in.] in diameter, inclusive, are designated ~~by fractions or decimal parts of an inch or metric equivalents as shown~~ in Table 2 ~~(English Units) and~~ . ~~Table 2(M) (SI Units).~~

3.1.4 *direct-drawn wire, n—*wire that is produced from hot-rolled wire rods or hot-rolled coiled bars to finished wire through one or more cold reductions without annealing or patenting heat treatment.

4. Ordering Information

4.1 Orders for hot-rolled wire rods under this specification should include the following information:

4.1.1 Quantity ~~(lbs [kg~~ (mass or ~~Mg]),~~weight),

4.1.2 Name of material (wire rods),

4.1.3 Diameter (Table 2),

4.1.4 Chemical composition grade no. ~~(Guide~~(see ~~A1040~~Section 6),

4.1.5 Packaging,

4.1.6 ASTM designation and date of issue, and

4.1.7 ~~Special requirements, if any.~~ The purchaser shall have the option to specify additional requirements, including but not limited to:

4.1.7.1 Requirements for certifications, heat analysis, or test reports (see Sections 6 and 14),

4.1.7.2 Mechanical property requirements (see Sections 6 & 8),

4.1.7.3 Freedom from welds (see Section 10),

4.1.7.4 Special packing, marking, and loading requirements (see Section 15),

4.1.7.5 Other special requirements, if any.

NOTE 1—A typical ordering description is as follows: ~~100 000 lb Wire Rods,~~ 50 000 ~~7⁄32 in., Grade 1010 in approximately 1000 lb Coils to 50 000~~ kg steel wire rods, 5.5 mm, Grade G10100 in approximately 600 kg for metric orders to ASTM ~~A510~~A510/A510M dated _______, or 100 000 lb Wire Rods, 7⁄32 in., Grade 1010 in approximately 1000 lb Coils to ASTM A510/A510M dated _______.

4.2 Orders for coarse round wire under this specification should include the following information:

4.2.1 Quantity ~~(lbs or pieces [kg or pieces]),~~ (mass or weight]),

4.2.2 Name of material (uncoated carbon steel wire or alloy steel wire),

4.2.3 Diameter (see 3.1.1),

4.2.4 Length (straightened and cut only),

4.2.5 Chemical composition ~~(Guide~~(see ~~A1040~~Section 6),

4.2.6 Packaging,

4.2.7 ASTM designation and date of issue, and

4.2.8 ~~Special requirements, if any.~~ The purchaser shall have the option to specify additional requirements, including but not limited to:

~~NOTE 2—A typical ordering description is as follows: 40 000 lb Uncoated Carbon or Alloy Steel Wire, 0.148 in. (9 ga.) diameter, Grade 1008 in 500 lb Coils on Tubular Carriers to ASTM A150/A150M-XX, or~~

~~2500 Pieces, Carbon or Alloy Steel Wire, 0.375 in. diameter, Straightened and Cut 29½ in., Grade 1015, in 25 Piece Bundles on Pallets to ASTM A150/A150M-XX.~~

~~For metric, a typical ordering description is as follows: 15 000 kg uncoated carbon or alloy steel wire 3.8 mm diameter, Grade G10080 in 1000 Kg coils on tubular carriers to ASTM A150/A150M-XX, or 2500 pieces carbon or alloy steel wire, 9.5 mm diameter, straightened and cut, 0.76 m, Grade G10500, in 25-piece bundles on pallets to ASTM A150/A150M-XX.~~

4.2.8.1 Requirements for certifications, heat analysis, or test reports (see Sections 6 and 14),

4.2.8.2 Mechanical property requirements (see Sections 6 & 8),

4.2.8.3 Freedom from welds made prior to or during wire drawing, or marking of welds (see Section 10),

TABLE 2 Sizes of Wire Rods[A] ~~(English Units)~~

~~Inch Fraction~~	~~Decimal Equivalent, in.~~	~~Inch Fraction~~	~~Decimal Equivalent, in.~~
~~7⁄32~~	~~0.219~~	~~31⁄64~~	~~0.484~~
~~15⁄64~~	~~0.234~~	~~1⁄2~~	~~0.500~~
~~7⁄32~~	~~0.250~~	~~31⁄64~~	~~0.516~~
~~1⁄4~~	~~0.266~~	~~33⁄64~~	~~0.531~~
~~9⁄32~~	~~0.281~~	~~35⁄64~~	~~0.547~~
~~17⁄64~~	~~0.297~~	~~17⁄32~~	~~0.562~~
~~19⁄64~~	~~0.312~~	~~9⁄16~~	~~0.578~~
~~21⁄64~~	~~0.328~~	~~19⁄32~~	~~0.594~~
~~5⁄16~~	~~0.344~~	~~37⁄64~~	~~0.609~~
~~11⁄32~~	~~0.359~~	~~39⁄64~~	~~0.625~~
~~3⁄8~~	~~0.375~~	~~41⁄64~~	~~0.641~~
~~23⁄64~~	~~0.391~~	~~5⁄8~~	~~0.656~~
~~25⁄64~~	~~0.406~~	~~21⁄32~~	~~0.672~~
~~27⁄64~~	~~0.422~~	~~11⁄16~~	~~0.688~~
~~13⁄32~~	~~0.438~~	~~43⁄64~~	~~0.703~~
~~7⁄16~~	~~0.453~~	~~45⁄64~~	~~0.719~~
~~15⁄32~~	~~0.469~~	~~47⁄64~~	~~0.734~~

TABLE 2 Sizes of Wire Rods[A]

SI Units	
Diameter, mm	
5.5	12.5
6	13
6.5	13.5
7	14
7.5	14.5
8	15
8.5	15.5
9	16
9.5	16.5
10	17
10.5	17.5
11	18
11.5	18.5
12	19

Inch-Pound Units			
Inch Fraction	Decimal Equivalent, in.	Inch Fraction	Decimal Equivalent, in.
7⁄32	0.219	31⁄64	0.484
15⁄64	0.234	1⁄2	0.500
1⁄4	0.250	33⁄64	0.516
17⁄64	0.266	17⁄32	0.531
9⁄32	0.281	35⁄64	0.547
19⁄64	0.297	9⁄16	0.562
5⁄16	0.312	37⁄64	0.578
21⁄64	0.328	19⁄32	0.594
11⁄32	0.344	39⁄64	0.609
23⁄64	0.359	5⁄8	0.625
3⁄8	0.375	41⁄64	0.641
25⁄64	0.391	21⁄32	0.656
13⁄32	0.406	43⁄64	0.672
27⁄64	0.422	11⁄16	0.688
7⁄16	0.438	45⁄64	0.703
29⁄64	0.453	23⁄32	0.719
15⁄32	0.469	47⁄64	0.734

[A] Rounded off to 3 decimal places in decimal equivalents in accordance with procedures outlined in Practice E29.

~~TABLE 2 (M) Sizes of Wire Rods (SI Units, mm)~~

~~5.5~~	~~12.5~~
~~6~~	~~13~~
~~6.5~~	~~13.5~~
~~7~~	~~14~~

~~7.5~~	~~14.5~~
~~8~~	~~15~~
~~8.5~~	~~15.5~~
~~9~~	~~16~~
~~9.5~~	~~16.5~~
~~10~~	~~17~~
~~10.5~~	~~17.5~~
~~11~~	~~18~~
~~11.5~~	~~18.5~~
~~12~~	~~19~~

4.2.8.4 Special packing, marking, and loading requirements (see Section 15),

4.2.8.5 Other special requirements, if any.

NOTE 2—A typical ordering description is as follows: 15 000 kg uncoated carbon or alloy steel wire 3.8 mm in diameter, Grade G10080 in 1000 kg coils on tubular carriers to ASTM A510/A510M-XX, or 2500 pieces carbon or alloy steel wire, 9.5 mm diameter, straightened and cut, 0.76 m, Grade G10500, in 25-piece bundles on pallets to ASTM A510/A510M dated _____.

For inch-pound units, a typical ordering description is as follows: 40 000 lb Uncoated Carbon or Alloy Steel Wire, 0.148 in. (9 ga.) diameter, Grade 10080 in 500 lb Coils on Tubuliar carriers to ASTM A510/A510M dated _____, or

2500 Pieces, Carbon or Alloy Steel Wire, 0.375 in. diameter, Straightened and Cut 29½ in., Grade 1015, in 25 Piece Bundles on Pallets to ASTM A510/A510M dated _____.

5. Manufacture

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

6. Chemical Composition

6.1 The chemical composition for steel under this specification shall conform to the requirements set forth in the purchase order. Chemical compositions are specified by ranges or limits for carbon and other elements. The grades commonly specified for carbon and alloy steel wire rods and coarse round wire are designated in Guide A1040. Other grades not designated in Guide A1040 may be specified.

6.1.1 For wire rods intended for direct-drawn wire, it is common practice to specify a range of tensile strength. If chemistry ranges are also specified, due consideration should be taken to ensure that the producer can achieve the required strengths within the allowable carbon range. The Mn, P, and S limits for carbon steel wire rods are normally specified according to Guide A1040.

6.2 *Boron Additions to Control Strain Ageing Behavior*—Intentional additions of boron to low carbon steels for the purpose of controlling strain ageing behavior during wire drawing is permissible only with the agreement of the purchaser. In such cases, the boron content shall be reported in either a material test report or certification.

6.2.1 For steels that do not have intentional boron additions for hardenability or for control of strain ageing behavior, the boron content will not normally exceed 0.0008 %.

6.3 ~~*Cast or*~~ *Heat Analysis* (*Formerly Ladle Analysis*)—An analysis of each cast or heat shall be made by the producer to determine the percentage of the elements specified. The analysis shall be made from a test sample, preferably taken during the pouring of the ~~cast or~~ heat. The chemical composition thus determined shall be reported, if required, to the purchaser, or his representative. Reporting of significant figures and rounding shall be in accordance with Test Methods, Practices, and Terminology A751.

6.4 *Product Analysis* (*Formerly Check Analysis*)—A product analysis may be made by the purchaser. The ~~analysis is not used for a duplicate analysis to confirm a previous result. The~~ purpose of the product analysis is to verify that the chemical composition is within specified limits for each element, including applicable permissible variations in product analysis. The results of analyses taken from different pieces of a heat may differ within permissible limits from each other and from the heat ~~or cast~~ analysis. Table 3 shows the permissible variations for product analysis of carbon steel. Table 4 shows the permissible variations for product analysis of alloy steel. The results of the product analysis obtained, except lead, shall not vary both above and below the permissible limits.

6.4.1 Rimmed or capped steels are characterized by a lack of uniformity in their chemical composition, especially for the elements carbon, phosphorus, and sulfur, and for this reason product analysis is not technologically appropriate for these elements unless misapplication is clearly indicated.

6.4.2 Because of the degree to which phosphorus and sulfur segregate, product analysis for these elements is not technologically appropriate for rephosphorized or resulfurized steels, or both, unless misapplication is clearly indicated.

6.4.3 The location at which chips for product analysis are obtained from the sample is important because of segregation. For rods and wire, chips are taken by milling or machining the full cross section of the sample.

6.4.3.1 Steel subjected to certain thermal treatment operations by the purchaser may not give chemical analysis results that properly represent its original composition. Therefore, purchasers should analyze chips taken from the steel in the condition in which it is received from the producer.

TABLE 3 Permissible Variations for Product Analysis of Carbon Steel

~~Element~~	~~Limit, or Max of Specified Range, %~~	~~Over Max Limit, %~~	~~Under Min Limit, %~~
~~Carbon~~	~~0.25 and under~~	~~0.02~~	~~0.02~~
	~~over 0.25 to 0.55, incl~~	~~0.03~~	~~0.03~~
	~~over 0.55~~	~~0.04~~	~~0.04~~
~~Manganese~~	~~0.90 and under~~	~~0.03~~	~~0.03~~
	~~over 0.90 to 1.65, incl~~	~~0.06~~	~~0.06~~
~~Phosphorus~~	~~to 0.040, incl~~	~~0.008~~	~~. . .~~
~~Sulfur~~	~~to 0.060, incl~~	~~0.008~~	~~. . .~~
~~Silicon~~	~~0.35 and under~~	~~0.02~~	~~0.02~~
	~~over 0.35 to 0.60, incl~~	~~0.05~~	~~0.05~~
~~Copper[A]~~	~~under minimum only~~	~~. . .~~	~~0.02~~
~~Lead[B]~~	~~0.15 to 0.35, incl~~	~~0.03~~	~~0.03~~

TABLE 3 Permissible Variations for Product Analysis of Carbon Steel

Element	Limit, or Max of Specified Range, %	Over Max Limit, %	Under Min Limit, %
Carbon	0.25 and under	0.02	0.02
	over 0.25 to 0.55, incl	0.03	0.03
	over 0.55	0.04	0.04
Manganese	0.90 and under	0.03	0.03
	over 0.90 to 1.65, incl	0.06	0.06
Phosphorus	to 0.040, incl	0.008	. . .
Sulfur	to 0.060, incl	0.008	. . .
Silicon	0.35 and under	0.02	0.02
	over 0.35 to 0.60, incl	0.05	0.05
Copper[A]	under minimum only	. . .	0.02
Lead[B]	0.15 to 0.35, incl	0.03	0.03

[A] Product analysis permissible variations for copper apply only when the amount of copper is specified or required. Copper bearing steels typically specify 0.20 % min copper.

[B] Product analysis permissible variations for lead apply only when the amount of lead is specified or required. A range from 0.15 to 0.35 % lead is normally specified for leaded steels.

6.4.3.2 When samples are returned to the producer for product analysis, the samples should consist of pieces of the full cross section.

6.4.4 For referee purposes, Test Methods ~~E30~~A751 shall be used.

7. Metallurgical Structure

7.1 Grain size, when specified, shall be determined in accordance with the requirements of Test Methods E112.

7.2 Wire rods of the steel grades listed in Table 3, when supplied in the "as-rolled'' condition, shall not contain injurious microconstituents such as untempered martensite.

8. Mechanical Requirements

8.1 Mechanical properties shall conform to requirements set forth in the purchase order. The properties enumerated in the purchase order and individual specifications shall be determined in accordance with Test Methods and Definitions A370.

8.2 Because of the great variety in the kinds of wire and the extensive diversity of end uses, a number of formal mechanical test procedures have been developed. These tests are used as control tests by producers during the intermediate stages of wire processing, as well as for final testing of the finished product, and apply particularly to specification wire and wires for specified end uses. A number of these tests are further described in ~~Supplement IV,~~Annex A4, Round Wire Products, of Test Methods and Definitions A370.