Designation: ~~A805/A805M – 09~~ A805/A805M – 09 (Reapproved 2016)

Standard Specification for Steel, Flat Wire, Carbon, Cold-Rolled[1]

This standard is issued under the fixed designation A805/A805M; 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 carbon steel flat wire in coils or cut lengths. Flat wire is classified as a cold-rolled section, rectangular in shape, 0.500 in. [12.7 mm] or less in width and under 0.250 in. [6.35 mm] in thickness.

1.2 Low-carbon steel flat wire is produced from steel compositions with a maximum carbon content of 0.25 % by cast or heat analysis.

1.3 Carbon spring steel flat wire is produced to a carbon range in which the specified or required maximum is over 0.25 % by cast or heat analysis.

1.3.1 Two types of carbon spring steel flat wire are produced:

1.3.1.1 Untempered cold-rolled carbon spring steel flat wire, produced to several desirable combinations of properties and

1.3.1.2 Hardened and tempered carbon spring steel wire.

1.4 Definite application flat wire is a product developed for a specific application and may be specified only by size and descriptive name.

1.5 The values stated in either inch-pound units or SI units are to be regarded as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in non-conformance with this specification.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A510 Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel

A510M Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel (Metric) (Withdrawn 2011)[3]

A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

E45 Test Methods for Determining the Inclusion Content of Steel

E112 Test Methods for Determining Average Grain Size

E140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness

2.2 *Military Standard:*[4]

MIL-STD-129 Marking for Shipment and Storage

2.3 *Federal Standard:*[4]

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

2.4 *SAE Standard:*[5]

Recommended Practice SAE J 419 Methods of Measuring Decarburization

---

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloysand is the direct responsibility of Subcommittee A01.19 on Steel Sheet and Strip.

Current edition approved ~~May 1, 2009~~May 1, 2016. Published ~~June 2009~~May 2016. Originally approved in 1982. Last previous edition approved in ~~2008~~2009 as ~~A805 – 08.~~A805/A805M – 09. DOI: ~~10.1520/A0805_A0805M-09.~~10.1520/A0805_A0805M-09R16.

[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] The last approved version of this historical standard is referenced on www.astm.org.

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

[5] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

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

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *annealing*—the process of heating to and holding at a suitable temperature and then cooling at a suitable rate, for such purposes as reducing hardness, facilitating cold working, producing a desired microstructure, or obtaining desired mechanical, physical, or other properties.

3.1.2 *batch annealing*—annealing that is generally performed in large cylindrical bell type or large rectangular box or car-type furnaces. The product is protected from scaling and decarburization by the use of a controlled atmosphere that envelops the charge in an inner chamber sealed to prevent the influx of air or products of combustion. The coils or bundles are heated to a temperature in the vicinity of the lower critical temperature for the grade of steel, and held at that temperature for a definite length of time; after which the steel is allowed to cool slowly to room temperature. The time of holding at the annealing temperature varies with the grade of the steel and the desired degree of softness.

3.1.3 *continuous or strand annealing*—annealing that consists of passing a number of individual strands of flat wire continuously through either a muffle furnace or a bath of molten lead or salt, thus heating the flat wire to the desired temperature for a definite time. The hardness obtained by this type of annealing, as measured by Rockwell hardness number, is normally somewhat higher than is secured by batch-type annealing. Other characteristics peculiar to strand–annealed steel require this type of annealing for some flat wire products.

3.1.4 *salt annealing*—annealing that is accomplished by immersing bundles or coils of flat wire in a molten salt bath at a desired temperature for a definite time. Following the annealing, the coils are permitted to cool slowly, after which they are immersed in hot water to remove any adhering salts.

3.1.5 *spheroidize annealing*—an operation consisting of prolonged heating and prolonged cooling cycles to produce a globular or spheroidal condition of the carbide for maximum softness.

3.1.6 *cold reduction*—the process of reducing the thickness of the strip at room temperature. The amount of reduction is greater than that used in skin-rolling.

3.1.7 *finish*—the degree of smoothness or lustre of the flat wire. The production of specific finishes requires special preparation and control of the roll surfaces employed.

3.1.8 *hardening and tempering*—a heat treatment for steel over 0.25 % carbon by cast or heat analysis involving continuous strand heating at finish size to an appropriate temperature above the critical temperature range, followed by quenching in oil and finally passing the strands through a tempering bath. This heat treatment is used in the production of such commodities as oil-tempered spring wire for use in certain types of mechanical springs that are not subjected to a final heat treatment after forming. Oil-tempered wire is intended primarily for the manufacture of products that are required to withstand high stresses. The mechanical properties and resiliency of oil-tempered wire provide resistance to permanent set under repeated and continuous stress applications.

3.1.9 *patenting*—a thermal treatment usually confined to steel over 0.25 % carbon. In this process individual strands of rods or wire are heated well above the upper critical temperature followed by comparatively rapid cooling in air, molten salt, or molten lead. This treatment is generally employed to prepare the material for subsequent processing.

3.1.10 *skin-rolled*—a term denoting a relatively light cold-rolling operation following annealing. It serves to reduce the tendency of the steel to flute or stretcher strain during fabrication. It is also used to impart surface finish, or affect hardness or other mechanical properties.

3.1.11 *temper*—a designation by number to indicate the hardness as a minimum, as a maximum, or as a range. The tempers are obtained by the selection and control of chemical composition, by amounts of cold reduction, and by thermal treatment.

4. Ordering Information

4.1 Orders for material to this specification shall include the following information, as necessary, to describe adequately the desired product:

4.1.1 Quantity,
4.1.2 Name of material (flat wire identified by type),
4.1.3 Analysis or grade, if required (Section 6),
4.1.4 Temper of low carbon or type of spring steel (Sections 9, 10, and 11),
4.1.5 Edge (Section 7),
4.1.6 Finish or coating (Sections 14 and 12),
4.1.7 Dimensions,
4.1.8 Coil type and size requirements (Section 17),
4.1.9 Packaging (17.1),
4.1.10 Condition (oiled or not oiled) (14.4),
4.1.11 ASTM designation and date of issue,
4.1.12 Copper-bearing steel, if required,

4.1.13 Application (part identification or description),
4.1.14 Case or heat analysis (request, if desired), and
4.1.15 Exceptions to the specification, if required.

NOTE 1—A typical ordering description is as follows: 18 000 lb [8000 kg] Low-Carbon Cold-Rolled Carbon Steel Flat Wire, Temper 4, Edge 4, Finish 2, 0.125 by 0.450-in. [3.18 by 11.4 mm] vibrated coils, 2000 lb [900 kg] max, coil weight, 16 to 20 in. [410 to 510 mm] ID, 36 in. [915 mm] max OD, Face dimension 6 to 10 in. [150 to 250 mm], ASTM A805/A805M – 09, for Stove Frames.

5. Materials and Manufacture

5.1 Low-carbon steel flat wire is normally produced from rimmed, capped, or semi-killed steel. When required, killed steel may be specified, with silicon or aluminum as the deoxidizer.

5.2 Untempered-carbon spring steel flat wire is commonly produced from killed steel, although semi-killed steel is sometimes used.

5.3 Hardened and tempered carbon spring steel flat wire customarily has a carbon content over 0.60 %.

5.4 Flat wire is generally produced from hot-rolled rods or round wire, by one or more cold-rolling operations, primarily for the purpose of obtaining the size and section desired and for improving surface finish, dimensional accuracy, and varying mechanical properties. Flat wire can also be produced from slitting hot- or cold-rolled flat steel to the desired width. The hot-rolled slit flat steel is subsequently cold reduced. The width to thickness ratio and the specified type of edge generally determine the process that is necessary to produce a specific flat-wire item.

5.5 The production of good surface quality flat wire is dependent upon scale-free and clean wire, rod, or hot-rolled steel prior to cold-rolling. Scale removal can be accomplished by chemical or mechanical cleaning.

5.6 Edge rolls, machined with contour grooves, may be used in conjunction with flat-rolling passes to produce the desired edge shape.

5.7 Straightness in flat wire may be controlled by the use of roll straighteners alone or in conjunction with cold-rolling passes.

5.8 Edges of flat wire produced by slitting wider flat-rolled steel can be dressed, depending upon requirements by:
5.8.1 *Deburring*—A process by which burrs are removed by rolling or filing to obtain an approximate square edge;
5.8.2 *Rolling*—A process by which the slit edge is dressed by edge rolling to the desired contour; and
5.8.3 *Filing*—A process by which the slit edge is filed to a specific contour and dimension by passing one or more times against a series of files mounted at various angles.

6. Chemical Composition

6.1 *Limits:*
6.1.1 When carbon steel flat wire is specified to chemical composition, the compositions are commonly prepared using the ranges and limits shown in Table 1. The elements comprising the desired chemical composition are specified in one of three ways:
6.1.1.1 By a maximum limit, Tables 2-5
6.1.1.2 By a minimum limit, or
6.1.1.3 By minimum and maximum limits, termed the "range." By common usage, the range is the arithmetical difference between the two limits (for example, 0.60 to 0.71 is 0.11 range).
6.1.2 When carbon steel flat wire is produced from round rods or wire it may be designated by grade number. In such cases the chemical ranges and limits of Table 6, Table 7, Table 8, and Table 9 of Specification A510 shall apply.

6.2 *Cast or Heat Analysis:*
6.2.1 An analysis of each cast or heat of steel shall be made by the manufacturer to determine the percentage of elements specified or restricted by the applicable specification.
6.2.2 When requested, cast or heat analysis for elements listed or required shall be reported to the purchaser or his representative.

6.3 *Product Analysis* may be made by the purchaser on the finished material.
6.3.1 Capped or rimmed steels are not technologically suited to product analysis due to the nonuniform character of their chemical composition and, therefore, the tolerances in Table 2 do not apply. Product analysis is appropriate on these types of steel only when misapplication is apparent, or for copper when copper steel is specified.
6.3.2 For steels other than rimmed or capped, when product analysis is made by the purchaser, the chemical analysis shall not vary from the limits specified by more than the amounts in Table 2. The several determinations of any element shall not vary both above and below the specified range.
6.3.3 When flat wire is produced from round rods or wire, and when a grade number is used to specify the chemical composition, the values obtained on a product analysis shall not vary from the limits specified by more than the amounts in Table 7 of Specification A510 or A510M.

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

TABLE 1 Cast or Heat Analysis

Element	Standard Chemical Ranges and Limits, %	
	When Maximum of Specified Element is	Range
Carbon[A]		
	to 0.15 incl	0.05
	over 0.15 to 0.30 incl	0.06
	over 0.30 to 0.40 incl	0.07
	over 0.40 to 0.60 incl	0.08
	over 0.60 to 0.80 incl	0.11
	over 0.80 to 1.35 incl	0.14
Manganese		
	to 0.50 incl	0.20
	over 0.50 to 1.15 incl	0.30
	over 1.15 to 1.65 incl	0.35
Phosphorus[B]		
	to 0.08 incl	0.03
	over 0.08 to 0.15 incl	0.05
Sulfur[B]		
	to 0.08 incl	0.03
	over 0.08 to 0.15 incl	0.05
	over 0.15 to 0.23 incl	0.07
	over 0.23 to 0.33 incl	0.10
Silicon[C]		
	to 0.15 incl	0.08
	over 0.15 to 0.30 incl	0.15
	over 0.30 to 0.60 incl	0.30
Copper		
	When copper is required 0.20 minimum is commonly specified.	. . .

[A] *Carbon*—The carbon ranges shown in the column headed "Range" apply when the specified maximum limit for manganese does not exceed 1.00 %. When the maximum manganese limit exceeds 1.00 %, add 0.01 to the carbon ranges shown above.
[B] *Phosphorus and Sulfur*—The standard lowest maximum limits for phosphorus and sulfur are 0.030 % and 0.035 % respectively. Certain qualities, descriptions, or specifications are furnished to lower standard maximum limits.
[C] *Silicon*—The standard lowest maximum for silicon is 0.10 %.

TABLE 2 Tolerances for Product Analysis[A]

Element	Limit, or Maximum of Specified Element, %	Tolerance, %	
		Under Minimum Limit	Over Maximum Limit
Carbon	to 0.15 incl	0.02	0.03
	over 0.15 to 0.40 incl	0.03	0.04
	over 0.40 to 0.80 incl	0.03	0.05
	over 0.80	0.03	0.06
Manganese	to 0.60 incl	0.03	0.03
	over 0.60 to 1.15 incl	0.04	0.04
	over 1.15 to 1.65 incl	0.05	0.05
Phosphorus	. . .	. . .	0.01
Sulfur	. . .	. . .	0.01
Silicon	to 0.30 incl	0.02	0.03
	over 0.30 to 0.60 incl	0.05	0.05
Copper	. . .	0.02	. . .

[A] When produced from round wire or rod the producer may use the tolerances for product analysis that appear in Specification A510 or A510M (see 6.3.3).

7. Edge

7.1 The desired edge shall be specified as follows:

7.1.1 *Number 1 Edge* is a prepared edge of a specified contour (round or square) which is produced when a very accurate width is required or when the finish of the edge suitable for electroplating is required, or both.

7.1.2 *Number 2 Edge* is not applicable to flat wire products.

7.1.3 *Number 3 Edge* is an approximately square edge produced by slitting.

7.1.4 *Number 4 Edge* is a rounded edge produced either by edge rolling or resulting from the flat rolling of a round section. Width tolerance and edge condition are not as exacting as for a No. 1 Edge.

TABLE 3 Thickness Tolerances

Specified Thickness in. [mm]	Tolerances for Specified Thickness, Plus and Minus, in. [mm]
0.005 [0.13] to 0.010 [0.25], excl	0.0005 [0.013]
0.010 [0.25] to 0.029 [0.74], excl	0.001 [0.03]
0.029 [0.74] to 0.0625 [1.59], excl	0.0015 [0.04]
0.0625 [1.59] to 0.250 [6.35], excl	0.002 [0.05]

7.1.5 *Number 5 Edge* is an approximately square edge produced from slit–edge material on which the burr is eliminated by rolling or filing.

7.1.6 *Number 6 Edge* is a square edge produced by edge rolling when the width tolerance and edge condition are not as exacting as for No. 1 Edge.

8. Dimensional Tolerances

8.1 The dimensional tolerances shall be in accordance with the following:

Tolerances	Table Number
Thickness	3
Width	4
Length	5

8.2 If restricted tolerances closer than those shown in Table 3, Table 4, and Table 5 are required, the degree of restriction should be established between the purchaser and manufacturer.

8.3 Tolerances for camber should be established between the purchaser and manufacturer. Camber is the greatest deviation of a side edge from a straight line, the measurement being taken on the concave side with a straight edge.

9. Temper and Bend Test Requirement for Low-Carbon Steel Flat Wire

9.1 Low-carbon steel flat wire specified to temper numbers shall approximate the hardness or tensile strength values shown in Table 6.

9.2 Bend test specimens shall stand being bent at room temperatures as required in Table 7.

9.3 All mechanical tests are to be conducted in accordance with Test Methods and Definitions A370.

10. Types of Untempered-Carbon Spring Steel Flat Wire

10.1 The following types are produced:

10.1.1 *Hard-Type Carbon Spring Steel Flat Wire* is a very stiff, springy product intended for flat work not requiring ability to withstand cold forming. It is cold reduced with or without preparatory treatment to a minimum Rockwell value of B 98.

10.1.2 *Soft-Type Spring Steel Flat Wire* is intended for application where varying degrees of cold forming are encountered, that necessitates control of both carbon content and hardness. Maximum values for carbon vary from 0.25 to 1.35 %, inclusive. This type also involves one of the following hardness restrictions; a maximum only designated as "soft-type annealed" or a range only designated as "soft-type intermediate hardness."

10.1.2.1 *Soft-Type Annealed Carbon Spring Steel Flat Wire,* intended for moderately severe cold forming, is produced to a specific maximum hardness value. The final anneal is at the finish thickness. Lowest maximum expected hardness values or tensile strength for specific carbon maximums for steel to 0.90 % maximum manganese are shown in Table 8.

10.1.2.2 *Soft-Type Intermediate Carbon Spring Steel Flat Wire* is produced to a specified hardness range, somewhat higher than the category covered in 10.1.2.1. The product is produced by rolling after annealing or by varying the annealing treatment, or both.

10.1.2.3 The Rockwell hardness range which can be produced varies with the carbon content, the required hardness, and the thickness of the material. In Table 9, Table 10, and Table 11 are shown the applicable hardness ranges for various carbon contents and several thickness ranges. If hardness values other than those shown in the tables are required, the applicable ranges should be agreed upon between the purchaser and the manufacturer. Rockwell hardness range is the arithmetical difference between two limits (for example B 82 to B 90 is an eight–point range).

10.1.3 *Spheroidize-Type Carbon Spring Steel Flat Wire* is best suited for the severest cold-forming application, where heat treatment after forming is employed. Spheroidize annealing treatment is employed in its production. Lowest maximum expected hardness values by carbon maximums for steel to 0.90 % maximum manganese are shown in Table 12. For thicknesses under 0.025 in. [0.64 mm] the values for the "Soft-Type Annealed" as contained in Table 8 shall apply.

11. Hardness and Tensile Properties of Hardened and Tempered Carbon Spring Steel Flat Wire

11.1 This product is commonly produced to meet a range of Rockwell hardness as shown in Table 13.

TABLE 4 Tolerances (Plus and Minus) for Specified Width

Edge Number	Specified Width, in. [mm]	Specified Thickness, in. [mm]		
		Under 0.0625 [1.60]	0.0625 [1.59] to 0.126 [3.20] excl	0.126 [3.20] to 0.250 [6.35] excl
1	Under 0.0625 [1.60]	0.003 [0.08]	. . .	. . .
	0.0625 [1.60] to 0.126 [3.20] excl	0.004 [0.10]	0.004 [0.10]	. . .
	0.126 [3.20] to 0.500 [12.70] incl	0.005 [0.13]	0.005 [0.13]	0.005 [0.13]
4 and 6	Under 0.0625 [1.60]	0.006 [0.15]	. . .	. . .
	0.0625 [1.60] to 0.126 [3.20] excl	0.008 [0.20]	0.008 [0.20]	. . .
	0.126 [3.20] to 0.500 [12.70] incl	0.010 [0.25]	0.010 [0.25]	0.010 [0.25]
3 and 5	0.125 [3.18] to 0.500 [12.70] incl	0.005 [0.13]	0.008 [0.02]	. . .

TABLE 5 Length Tolerances

Specified Length, in. [mm]	Tolerances Over the Specified Length in. [mm]—No Tolerance Under
24 [600] to 60 [1500], incl	¼ [6.4]
Over 60 [1500] to 120 [3000], incl	½ [12.7]
Over 120 [3000] to 240 [6100], incl	¾ [19.1]

11.2 The hardness scale appropriate to each thickness range is shown in Table 14. Although conversion tables for hardness numbers are available, the recommended practice is to specify the same scale as that to be used in testing. A Rockwell hardness range is the arithmetic difference between two limits (for example C 42 to C 46 is a four-point range). Below a thickness of 0.008 in. [0.20 mm] the Rockwell 15N test becomes inaccurate, and the use of the tensile test is recommended. The values of ultimate tensile strength cited in Fig. 1 apply only to thicknesses less than 0.008 in. [0.20 mm]. When necessary to specify tensile properties for thicknesses of 0.008 in. [0.20 mm] and greater, the manufacturer should be consulted.

11.3 Shown in Fig. 1 is the relationship of thickness and carbon content with Rockwell hardness or tensile strength for hardened and tempered spring steel flat wire appropriate for spring applications. When mechanical properties are specified, they should be compatible with the application.

12. Coatings

12.1 Low-carbon steel flat wire can be produced with various coatings, such as liquor finish, white-liquor finish, lacquer, paint, copper, zinc (galvanized), cadmium, chromium, nickel, and tin. Metallic coatings can be applied by the hot-dip method or by electrodeposition. The flat steel can be coated prior to slitting to wire widths. In this case the slit edges will not be coated.

12.1.1 Copper or liquor coatings consist of thin deposits of either copper or bronze produced by immersion of the material in an acid solution of metallic salts. Because of the nature of liquor coatings no appreciable corrosion protection is afforded by them.

12.1.2 Hot-dipped coatings are produced by passing strands of cleaned flat wire continuously through a molten bath of metal or alloy. Zinc and tin are commonly applied in this manner.

12.1.3 Electrodeposited coatings are produced by passing strands of cleaned flat wire through an electroplating tank containing a solution of a metallic salt, wherein the metal is deposited on the flat wire. Zinc, tin, nickel, cadmium, and copper are applied in this manner.

12.2 Coatings applicable to untempered-carbon spring steel flat wire are the same as those covered in 14.1.

12.3 Metallic coatings are seldom applied to hardened and tempered carbon steel flat wire. If they are required the manufacturer should be consulted.

13. Workmanship

13.1 Cut lengths shall have a workmanlike appearance and shall not have defects of a nature or degree for the product, the grade, and the quality ordered that will be detrimental to the fabrication of the finished part.

13.2 Coils may contain more frequent imperfections that render a portion of the coil unusable since the inspection of coils does not afford the manufacturer the same opportunity to remove portions containing imperfections as in the case with cut lengths.

14. Finish and Condition

14.1 The finish of low-carbon steel flat wire normally specified is one of the following:

14.1.1 *Number 2 or Regular Bright Finish* is produced by rolling on rolls having a moderately smooth finish. It is not generally applicable to plating.