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Standard Specification for Steel, Flat Wire, Carbon, Cold-Rolled¹

This standard is issued under the fixed designation A 805; 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 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 inch-pound units are to be regarded as standard. The values given in parentheses are for information only.

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

E 45 ~~Practice~~ Test Methods for Determining the Inclusion Content of Steel

E 112 ~~Test Methods for Determining Average Grain Size~~³

E 140 ~~Hardness Conversion Tables for Metals~~³ Test Methods for Determining Average Grain Size

E 140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, and Scleroscope Hardness

2.2 ~~Military Standards:~~ *Military Standard:*³

~~MIL-STD-129 Marking for Shipment and Storage~~

~~MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage~~⁴ MIL-STD-129 Marking for Shipment and Storage

2.3 *Federal Standard:*³

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

2.4 *SAE Standard:*⁴

Recommended Practice SAE J 419 Methods of Measuring Decarburization

3. Terminology

3.1 ~~Definitions of Terms Specific to This Standard:~~ Descriptions of Terms Specific to This Standard:

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 A01.19 on Sheet-Steel Sheet and Strip.

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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*, Vol 01-03, volume information, refer to the standard's Document Summary page on the ASTM website.

³ Annual Book of ASTM Standards, Vol 03.01.

³ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://www.dodssp.daps.mil>.

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

⁴ 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.

3.1.1 *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* (see section 3.3). *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 Low-Carbon Cold-Rolled Carbon Steel Flat Wire, Temper 4, Edge 4, Finish 2, 0.125

by 0.450-in. vibrated coils, 2000 lb max, coil weight, 16 to 20 in. ID, 36 in. max OD, Face dimension 6 to 10 in., ASTM A 805 dated ~~—~~ XX, 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 A 510 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 10 of Specification A 510.

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

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 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 A 510 (see 6.3.3).

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:

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]

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	1/4 [6.4]
Over 60 [1500] to 120 [3000], incl	1/2 [12.7]
Over 120 [3000] to 240 [6100], incl	3/4 [19.1]

TABLE 6 Temper, Hardness and Tensile Strength Requirement for Low-Carbon Steel Flat Wire

Temper	Thickness, in. [mm]	Rockwell Hardness		Approximate Tensile Strength, ksi [MPa]	
		min	max (approximate)	min	max
No. 1 (hard)	Under 0.010 [0.25]			85 [586]	...
	0.010 [0.25] to 0.025 [0.64] excl	15T90	...		
	0.025 [0.64] to 0.040 [1.02] excl	30T76	...		
	0.040 [1.02] to 0.070 [1.78] excl	B90	...		
No. 2 (half-hard)	0.070 [1.78] and over	B84	...		
	Under 0.010 [0.25]			65 [448]	90 [621]
	0.010 [0.25] to 0.025 [0.64] excl	15T83.5	15T88		
	0.025 [0.64] to 0.040 [1.02] excl	30T63.5	30T74		
No. 3 (quarter-hard)	0.040 [1.02] and over	B70	B85		
	Under 0.010 [0.25]			55 [379]	80 [552]
	0.010 [0.25] to 0.025 [0.64] excl	15T80	15T85		
	0.025 [0.64] to 0.040 [1.02] excl	30T56.5	30T67		
No. 4 (skin-rolled)	0.040 [1.02] and over	B60	B75		
	Under 0.010 [0.25]			...	65 [448]
	0.010 [0.25] to 0.025 [0.64] excl	...	15T82		
	0.025 [0.64] to 0.040 [1.02] excl	...	30T60		
No. 5 (dead-soft)	0.040 [1.02] and over	...	B65		
	Under 0.010 [0.25]			...	60 [414]
	0.010 [0.25] to 0.025 [0.64] excl	...	15T78.5		
	0.025 [0.64] to 0.040 [1.02] excl	...	30T53		
	0.040 [1.02] and over	...	B55		

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.

TABLE 7 Temper and Bend Test Requirement for Low-Carbon Steel Flat Wire

Temper	Bend Test Requirement
No. 1 (hard)	Not required to make bends in any direction.
No. 2 (half-hard)	Bend 90° across ^A the direction of rolling around a radius equal to that of the thickness.
No. 3 (quarter-hard)	Bend 180° across ^A the direction of rolling over one thickness of the wire.
No. 4 (skin-rolled)	Bend flat upon itself in any direction.
No. 5 (dead-soft)	Bend flat upon itself in any direction.

^A To bend “across the direction of rolling” means that the bend axis (crease of the bend) shall be at a right angle to the length of the wire.

TABLE 8 Soft-Type Annealed Carbon Spring Steel Flat Wire Lowest Expected Maximum Rockwell Hardness or Tensile Strength

Maximum of Carbon Range, %	Flat Wire Thickness, in. [mm]			
	Under 0.010 [0.25]	0.010 [0.25] to 0.025 [0.64] excl	0.025 [0.64] to 0.040 [1.02] excl	0.040 [1.02] and Over
	Tensile Strength ksi [MPa]	Rockwell Hardness, 15T Scale	Rockwell Hardness, 30T Scale	Rockwell Hardness, B Scale
0.30	66 [455]	84	67	74
0.35	68 [469]	84	68	76
0.40	70 [483]	85	70	78
0.45	72 [496]	85	71	80
0.50	74 [510]	86	72	82
0.55	76 [524]	87	73	84
0.60	78 [538]	87	74	85
0.65	80 [552]	88	75	87
0.70	82 [565]	88	76	88
0.75	83 [572]	88	76	89
0.80	85 [586]	89	77	90
0.85	87 [600]	89	77	91
0.90	88 [607]	89	78	92
0.95 and over	90 [621]	90	78	92

TABLE 9 Rockwell Hardness Ranges for Soft-Type Intermediate Hardness Carbon Spring Steel Flat Wire Thickness Under 0.025 in. [0.64 mm]

Maximum of Carbon Range, %	For Maximum of Specified Rockwell Hardness Range, 15T Scale													
	83.5	84.5	85	85.5	86	86.5	87	87.5	88	88.5	89	89.5	90/92	Over 92 ^A
0.26–0.30 ^B	...	5	5	5	5	5	4	4	4	4	4	4	3	...
0.31–0.35 ^B	5	5	5	5	4	4	4	4	4	4	3	...
0.36–0.40 ^B	5	5	5	4	4	4	4	4	4	3	...
0.41–0.45 ^B	5	5	4	4	4	4	4	4	3	...
0.46–0.50 ^B	5	4	4	4	4	4	4	3	3
0.51–0.55 ^B	4	4	4	4	4	4	3	3
0.56–0.60 ^B	4	4	4	4	4	3	3
0.61–0.65 ^B	4	4	4	4	3	3
0.66–0.70 ^B	4	4	4	3	3
0.71–0.75 ^B	4	4	4	3	3
0.76–0.80 ^B	4	4	3	3
0.81–0.90 ^B	4	3	3
0.91–1.35	3	3

^A Rockwell 15T Scale is not recommended for values over 15T93.

^B Indicates soft-type annealed cold-rolled carbon spring steel flat wire which is furnished to a maximum (hardness) shown in Table 8.

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 A 370.

10. Types of Untempered-Carbon Spring Steel Flat Wire

10.1 The following types are produced: