Designation: ~~A109/A109M – 16 (Reapproved 2018)~~ A109/A109M – 24

Standard Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled[1]

This standard is issued under the fixed designation A109/A109M; 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 cold-rolled carbon steel strip in cut lengths or coils, furnished to closer tolerances than cold-rolled carbon steel sheet, with specific temper, with specific edge or specific finish, and in sizes as follows:

Width, in.	Thickness, in.
~~Over ½ to 23 15/16~~	~~0.300 and under~~
Over ½ to 23 15/16	0.300 and under
Over 12.5 to 600 mm	7.6 mm and under

1.2 Cold-rolled strip is produced with a maximum specified carbon not exceeding 0.25 percent.

1.3 Strip tolerance products may be available in widths wider than ~~23~~23 15/16 in. [600 mm] by agreement between purchaser and supplier. However, such products are technically classified as cold rolled sheet. The tolerances, finishes, tempers, edges, and available widths and thicknesses differentiate cold rolled strip from the product known as cold rolled sheet which is defined by Specification A568/A568M and from cold rolled high carbon strip which is defined by Specification A682/A682M.

1.4 For the purpose of determining conformance with this specification, values shall be rounded to the nearest unit in the right hand place of figures used in expressing the limiting values in accordance with the rounding method of Practice E29.

1.5 The SI portions of the tables contained herein list permissible variations in dimensions and mass (see Note 1) in SI (metric) units. The values listed are not exact conversions of the values listed in the inch-pound tables, but instead are rounded or rationalized values. Conformance to SI tolerances is mandatory when the "M" specification is used.

NOTE 1—The term *weight* is used when inch-pound units are the standard. However, under SI the preferred term is *mass*.

1.6 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.

1.7 This specification is expressed in both inch-pound units and SI units. However, unless the order specifies the applicable "M" specification designation (SI units), the material shall be furnished to inch-pound units.

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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 A01.19 on Steel Sheet and Strip.

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

1.8 *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]

A370 Test Methods and Definitions for Mechanical Testing of Steel Products
A568/A568M Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
A682/A682M Specification for Steel, Strip, High-Carbon, Cold-Rolled, General Requirements For (Withdrawn 2009)[3]
A700 Guide for Packaging, Marking, and Loading Methods for Steel Products for Shipment
A751 Test Methods and Practices for Chemical Analysis of Steel Products
A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys
A1073/A1073M Practice for Using Hand Micrometers to Measure the Thickness of Uncoated Steel Sheet and Nonmetallic and Metallic-Coated Steel Sheet
E18 Test Methods for Rockwell Hardness of Metallic Materials
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
E92 Test Methods for Vickers Hardness and Knoop Hardness of Metallic Materials
E430 Test Methods for Measurement of Gloss of High-Gloss Surfaces by Abridged Goniophotometry

2.2 *Military Standard:*

MIL-STD-129 Marking for Shipment and Storage[4]

2.3 *Federal Standard:*

123 Marking for Shipments (Civil Agencies)[4]
183 Continuous Identification Marking of Iron and Steel Products[4]

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.

3.1.1.1 *box annealing*—involves annealing in a sealed container under conditions that minimize oxidation. The strip is usually heated slowly to a temperature below the transformation range, but sometimes above or within it, and is then cooled slowly.

3.1.1.2 *continuous annealing*—involves heating the strip in continuous strands through a furnace having a controlled atmosphere followed by a controlled cooling.

3.1.2 *carbon steel*—the designation for steel when no minimum content is specified or required for aluminum, chromium, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium, zirconium or any other element added to obtain a desired alloying effect; when the specified minimum for copper does not exceed 0.40 % or when the maximum content specified for any of the following elements does not exceed the percentage noted: manganese 1.65, silicon 0.60, or copper 0.60.

3.1.2.1 *Discussion*—

In all carbon steels small quantities of certain residual elements unavoidably retained from raw materials are sometimes found which are not specified or required, such as copper, nickel, molybdenum, chromium, and so forth. These elements are considered as incidental and are not normally reported.

3.1.3 *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 3.1.7).

3.1.4 *dead soft*—the temper of strip produced without definite control of stretcher straining or fluting. It is intended for deep drawing applications where such surface disturbances are not objectionable.

[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://quicksearch.dla.mil.

3.1.5 *finish*—the degree of smoothness or luster of the strip. The production of specific finishes requires special preparation and control of the roll surfaces employed.

3.1.6 *normalizing*—heating to a suitable temperature above the transformation range and then cooling in air to a temperature substantially below the transformation range. In bright normalizing the furnace atmosphere is controlled to prevent oxidizing of the strip surface.

3.1.7 *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, or to improve flatness.

3.1.8 *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, by thermal treatment, and by skin-rolling.

3.2 Refer to Terminology A941 for additional definitions of terms used in this Specification.

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 (cold-rolled carbon steel strip),

4.1.3 Condition (oiled or not oiled),

4.1.4 Temper (Section 7),

4.1.5 Edge (Section 8),

4.1.6 Dimensions (Section 9),

4.1.7 Workmanship, Finish, and Appearance (Section 10),

4.1.8 Coil size requirements (15.2),

4.1.9 ASTM designation and year of issue,

4.1.10 Copper-bearing steel, if required,

4.1.11 Application (part identification or description),

4.1.12 Cast or heat analysis (request, if required), and

4.1.13 Special requirements, if required.

NOTE 2—A typical ordering description is as follows: 20 000 lb Cold-Rolled Strip, Oiled, Temper 4, Edge 3, Finish 3, 0.035 by 9 in. by coil, 5000 lb max, 16-in. ID ASTM A 109-XX, for Toaster Shells.

5. Materials and Manufacture

5.1 The steel shall be made by the open-hearth, basic-oxygen, or electric-furnace process.

5.2 Cold-rolled carbon steel strip is normally manufactured from continuously cast steel with aluminum used as the deoxidizer. However, some applications are specified as silicon killed. Ingot cast rimmed, capped and semi-killed steels are subject to limited availability.

5.3 Cold-rolled carbon steel strip is manufactured from hot-rolled descaled coils by cold reducing to the desired thickness on a single stand mill or on a tandem mill consisting of several single stands in series. Sometimes an anneal is used at some intermediate thickness to facilitate further cold reduction or to obtain desired temper and mechanical properties in the finished strip. An anneal and skin pass is typically used as the final step for Temper 4 and 5.

6. Chemical Composition

6.1 *Heat Analysis*—An analysis for each heat of steel shall be made by the manufacturer to determine the percentage of elements shown in Table 1. This analysis shall conform to the requirements shown in Table 1. When requested, heat analysis shall be reported to purchaser or his representative.

6.2 *Product, Check, or Verification Analysis* may be made by the purchaser on the finished material.

6.2.1 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.

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

TABLE 1 Heat Analysis [A]

Element	~~Composition, Wt~~ Composition, Wt %	
	Temper No. 1, 2, 3	Temper No. 4, 5
Carbon, max	0.25	0.15
Manganese, max	0.90	0.60
Phosphorous, max	0.025	0.025
Sulfur, max	0.025	0.025
Silicon[A]	. . .	. . .
Aluminum[A,B]	. . .	. . .
Copper[C]	0.20	0.20
Nickel, max[D]	0.20	0.20
Chromium, max[D, E]	0.15	0.15
Molybdenum, max[D]	0.06	0.06
Vanadium[F]	. . .	. . .
Columbium[F]	. . .	. . .
Titanium[F]	. . .	. . .

[A] Where an ellipsis (. . .) appears in this table, there is no requirement, but the analysis shall be reported unless otherwise specified in this specification.
[B] The analysis shall be reported. When killed steel is specified and aluminum is the deoxidizing element, the minimum is 0.02, and the analysis shall be reported.
[C] When copper steel is specified, the copper limit specified is a minimum requirement. When copper steel is not specified, the copper limit is a maximum requirement.
[D] The sum of copper, nickel, chromium, and molybdenum shall not exceed 0.50 % on heat analysis. When one or more of these elements is specified, the sum does not apply; in which case, only the individual limits on the remaining elements will apply.
[E] Chromium is permitted, at the producer's option, to 0.25 % maximum when the carbon is less than or equal to 0.05 %. In such case, the limit on the sum of the four elements in Footnote D does not apply.
[F] Reporting shall be required when the level for any of these elements exceeds 0.008 wt%.

TABLE 2 Tolerances for Product Analysis

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 0.25, incl	0.03	0.04
Manganese	to 0.60, incl	0.03	0.03
Phosphorus		. . .	0.01
Sulfur		. . .	0.01
Copper		0.02	. . .

6.4 For applications where cold-rolled strip is to be welded, care must be exercised in selection of chemical composition, as well as mechanical properties, for compatibility with the welding process and its effect on altering the properties.

7. Temper and Bend Test Requirement

7.1 Cold-rolled carbon strip specified to temper numbers shall conform to the ~~Rockwell~~ hardness requirements shown in Table 3.

7.1.1 When a temper number is not specified, ~~Rockwell~~ hardness requirements are established by agreement.

7.1.2 When Vickers testing is not available, Rockwell HR15TS values obtained with the use of a steel ball and a spot anvil may be used by agreement. The alternate test for thin metals is not advised for critical applications where properties must be in a tight range.

7.2 It is recommended that hardness values be specified in the same scale as that which will be used in testing the strip.

7.3 Bend tests shall be conducted at room temperature and test specimens shall be capable of being bent to the requirements shown in Table 4.

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

8. Edge

8.1 The desired edge number shall be specified as follows:

8.1.1 *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 an edge condition suitable for electroplating is required, or both.

8.1.2 *Number 2 Edge* is a natural mill edge carried through the cold rolling from the hot-rolled strip without additional processing of the edge.

8.1.3 *Number 3 Edge* is an approximately square edge, produced by slitting, on which the burr is not eliminated. Normal coiling or piling does not necessarily provide a definite positioning of the slitting burr.

8.1.4 *Number 4 Edge* is a rounded edge produced by edge rolling either the natural edge of hot-rolled strip or slit-edge strip. This edge is produced when the width tolerance and edge condition are not as exacting as for No. 1 edge.

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

8.1.6 *Number 6 Edge* is a square edge produced by edge rolling the natural edge of hot-rolled strip or slit-edge strip. This edge is produced when the width tolerance and edge condition are not as exacting as for No. 1 edge.

8.1.7 *Skived Edges* are custom shaped edges produced by mechanical edge shaving with special tooling.

TABLE 3 Hardness Requirements

INCH-POUND UNITS

Temper	Thickness, in.		Rockwell Hardness[C]		Vickers Hardness[D]	
	Under	Through	Minimum	Maximum (approx.)	Minimum	Maximum (approx.)
No. 1 (hard)	0.010	...	...	...	185	...
~~No. 1 (hard)~~	~~0.025~~	~~...~~	~~15T90~~	~~...~~		
	0.025	0.010	HR15TW90	...	...	...
	~~0.040~~	~~0.025~~	~~30T76~~	~~...~~		
	0.040	0.025	HR30TW76	...	...	...
	~~0.070~~	~~0.040~~	~~B90.0~~	~~...~~		
	0.070	0.040	HRBW90.0	...	...	...
	~~0.300~~	~~0.070~~	~~B84.0~~	~~...~~		
	0.300	0.070	HRBW84.0	...	...	...
~~No. 2[A] (half-hard)~~	~~0.025~~	~~...~~	~~15T83.5~~	~~15T88.5~~		
No. 2[A] (half-hard)	0.010	...	...	...	125	165
	0.025	0.010	HR15TW83.5	HR15TW88.5	...	...
	~~0.040~~	~~0.025~~	~~30T63.5~~	~~30T73.5~~		
	0.040	0.025	HR30TW63.5	HR30TW73.5	...	...
	~~0.300~~	~~0.040~~	~~B70.0~~	~~B85~~		
	0.300	0.040	HRBW70.0	HRBW85	...	...
~~No. 3[A] (quarter-hard)~~	~~0.025~~	~~...~~	~~15T80~~	~~15T85~~		
No. 3[A] (quarter-hard)	0.010	...	...	...	107	137
	0.025	0.010	HR15TW80	HR15TW85	...	...
	~~0.040~~	~~0.025~~	~~30T56.5~~	~~30T67~~		
	0.040	0.025	HR30TW56.5	HR30TW67	...	...
	~~0.300~~	~~0.040~~	~~B60~~	~~B75~~		
	0.300	0.040	HRBW60	HRBW75	...	...
~~No. 4[A,B] (skin-rolled)~~	~~0.025~~	~~...~~	~~...~~	~~15T82~~		
No. 4[A,B] (skin-rolled)	0.010	...	...	...	...	115
	0.025	0.010	...	HR15TW82	...	...
	~~0.040~~	~~0.025~~	~~...~~	~~30T60~~		
	0.040	0.025	...	HR30TW60	...	...
	~~0.300~~	~~0.040~~	~~...~~	~~B65~~		
	0.300	0.040	...	HRBW65	...	...
~~No. 5[A,B] (dead-soft)~~	~~0.025~~	~~...~~	~~....~~	~~15T78.5~~		
No. 5[A,B] (dead-soft)	0.010	...	...	...	...	100
	0.025	0.010	....	HR15TW78.5	...	...
	~~0.040~~	~~0.025~~	~~...~~	~~30T53~~		
	0.040	0.025	...	HR30TW53	...	...
—	~~0.300~~	~~0.040~~	~~...~~	~~B55~~		
	0.300	0.040	...	HRBW55	...	...

SI UNITS

Temper	Thickness, mm		Rockwell Hardness[C]		Vickers Hardness[D]	
	Under	Through	Minimum	Maximun (approx.)	Minimum	Maximum (approx.)
No. 1 (hard)	0.25	...	...	...	185	...
~~No. 1 (hard)~~	~~0.6~~	~~...~~	~~15T90~~	~~...~~		
	0.6	0.25	HR15TW90	...	...	...
	~~1.0~~	~~0.6~~	~~30T76~~	~~...~~		
	1.0	0.6	HR30TW76	...	...	...
	~~1.8~~	~~1.0~~	~~B90.0~~	~~...~~		
	1.8	1.0	HRBW90.0	...	...	...
	~~7.6~~	~~1.8~~	~~B84.0~~	~~...~~		
	7.6	1.8	HRBW84.0	...	...	...
~~No. 2[A] (half-hard)~~	~~0.6~~	~~...~~	~~15T83.5~~	~~15T88.5~~		
No. 2[A] (half-hard)	0.25	...	...	...	125	165
	0.6	0.25	HR15TW83.5	HR15TW88.5	...	...
	~~1.0~~	~~0.6~~	~~30T63.5~~	~~30T73.5~~		
	1.0	0.6	HR30TW63.5	HR30TW73.5	...	...
	~~7.6~~	~~1.0~~	~~B70.0~~	~~B85~~		
	7.6	1.0	HRBW70.0	HRBW85	...	...
~~No. 3[A] (quarter-hard)~~	~~0.6~~	~~...~~	~~15T80~~	~~15T85~~		
No. 3[A] (quarter-hard)	0.25	...	...	...	107	137
	0.6	0.25	HR15TW80	HR15TW85	...	...
	~~1.0~~	~~0.6~~	~~30T56~~	~~30T67~~		
	1.0	0.6	HR30TW56	HR30TW67	...	...
	~~7.6~~	~~1.0~~	~~B60~~	~~B75~~		
	7.6	1.0	HRBW60	HRBW75	...	...
~~No. 4[A,B] (skin-rolled)~~	~~0.6~~	~~...~~	~~...~~	~~15T82~~		