Standard Specification for Steel, Strip, High-Carbon, Cold-Rolled

This standard is issued under the fixed designation A684/A684M; 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.

1. Scope

1.1 This specification covers cold-rolled, high-carbon strip in coils or cut lengths. Strip is classified as product that is 0.3000 in. [7.6 mm] or less in thickness and over ½ to 23 ⅛ in. [12.5 to 600 mm] in width, inclusive. Strip tolerance products may be available in widths wider than 23 ⅛ in. (600 mm) by agreement between purchaser and supplier; however, such products are technically classified as cold-rolled sheet. The maximum of the specified carbon range is over 0.25 to 1.35 %, inclusive. It is furnished in the following types as specified:

1.1.1 Soft spheroidized annealed high-carbon steel is intended for applications requiring maximum cold forming. It is normally produced to give the lowest maximum Rockwell hardness for each grade.

1.1.2 Soft annealed high-carbon steel is intended for applications requiring moderate cold forming. It is produced to a maximum Rockwell hardness.

1.1.3 Intermediate hardness high-carbon steel is intended for applications where cold forming is slight or a stiff, springy product is needed, or both. It is produced to specified Rockwell hardness ranges, the maximum being higher than obtained for the annealed type.

1.1.4 Full hard high-carbon steel is intended for flat applications. It is produced to minimum Rockwell hardness requirements, which vary with grade, microstructure and gauge. Full hard can be produced with either a pearlitic or spheroidized microstructure or a mixture of both. The minimum hardness should be established between the consumer and the producer.

1.2 This specification is applicable for orders in either inch-pound units or SI units. However, unless the order specifies the applicable “M” specification designation (SI units), the material shall be furnished to inch-pound units. The metric portions of the tables 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.

2. Referenced Documents

2.1 ASTM Standards:

A109/A109M Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled
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
A700 Practices 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 Products, and Alloys

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.


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
2.2 Federal Standards:
Fed. Std. No. 123 Marking for Shipments (Civil Agencies)
Fed. Std. No. 183 Continuous Identification Marking of Iron
and Steel Products

2.3 Military Standard:
MIL-STD-129 Marking for Shipping and Storage

2.4 SAE Standard:
J 1086 Recommended Practice for Numbering Metals and
Alloys (UNS)

3. Terminology

3.1 Definitions of Terms Specific to This Standard:
3.1.1 burr—metal displaced beyond the plane of the surface
by slitting or shearing.

3.1.2 lot—quantity of material of the same type, size, and
finish produced at one time from the same cast or heat, and heat
treated in the same heat-treatment cycle.

3.1.3 spheroidizing—the heating and cooling of the strip in
controlled conditions (annealing) to produce a spheroidal or
globular form of carbide microconstituent.

3.1.4 stretcher strains—elongated markings that appear on
the surface of the strip when dead soft (fully annealed) material
is deformed beyond its yield point (see 5.2).

3.2 Refer to Terminology A941 for additional terms used in
this standard.

4. Ordering Information

4.1 Orders for material under this specification shall include
the following information:

4.1.1 ASTM designation and date of issue,
4.1.2 Name, type, and steel grade number,
4.1.3 Hardness (if intermediate or restricted hardness is
specified),
4.1.4 Decarburization (if required),
4.1.5 Application,
4.1.6 Dimensions,
4.1.7 Coil size requirements,
4.1.8 Edge (indicate No. 1 round, square, etc.),
4.1.9 Finish (indicate and specify),
4.1.10 Conditions (specify whether material is oiled or dry),
4.1.11 Package (bare coils, skid, etc.),
4.1.12 Cast or heat (formerly ladle) analysis report (if
required),
4.1.12.1 The additional chemical composition requirements
(heat analysis) for copper, nickel, chromium, and molybdenum
shall be specified as Limits L or Limits H. If no limits are
specified, Limits L will be provided.
4.1.12.2 Silicon requirement specified (Type 1, Type 2, or
other as agreed between purchaser and producer). If no
specification is supplied, then Type 1 (see
Table 1, Footnote B)
will be supplied.
4.1.13 Special requirements (if required).

4.2 Products covered by this specification are produced to
decimal thickness only, and decimal thickness tolerances apply.

NOTE 2—A typical ordering description is as follows: ASTM A684
dated ______ Cold Rolled, High-Carbon Soft, Strip, Spheroidized 1064,
0.042 in. by 6 in. by coil (16 in. ID by 40 in. OD max), No. 5 Edge, No.
2 Finish, Oiled, Bare Skid or “ASTM A684 dated ______ Cold Rolled,
High-Carbon, Soft, Strip. Spheroidized 1064, 0.6 mm by 200 mm by coil (400 mm ID by 7500 mm OD max), No. 3 Edge, No. 2 Finish, Oiled, Bare Skid."

5. Manufacture

5.1 Condition:
5.1.1 The strip shall be furnished cold rolled spheroidized annealed, soft annealed, intermediate hardness, or full hard, as specified.
5.1.2 Intermediate hardness may be obtained by either rolling the strip after final annealing or by varying the annealing treatment, or both.
5.2 Pinch Pass—Spheroidized annealed and annealed material may be pinch rolled after the final anneal to improve flatness, uniformly oil, modify surface, obtain proper mechanical properties and minimize stretcher strains if required by the purchaser.

6. Chemical Requirements

6.1 Limits:
6.1.1 When carbon steel strip is specified to chemical composition, the compositions are commonly prepared using the ranges and limits shown in Table 2. The elements comprising the desired chemical composition are specified in one of three ways:
6.1.1.1 By a maximum limit,
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 Steel grade numbers indicating chemical composition commonly produced to this specification are shown in Table 3 and may be used. Table 4 shows requirements for additional elements.
6.1.3 Additional elements may be present. Limits on such elements are by agreement between purchaser and supplier.
6.1.3.1 Any additional elements specified shall be included in the report of heat analysis.
6.2 Heat (Formerly Ladle) Analysis:
6.2.1 An analysis of each 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, heat analysis for elements listed or required shall be reported to the purchaser or to his representative. Each of the elements listed in Tables 3 and 4 and additional elements agreed upon by the purchaser and the supplier shall be included in the report of heat analysis. When

the amount of copper, nickel, chromium, or molybdenum is less than 0.02 %, the analysis may be reported as <0.02 %. When the amount of vanadium, columbium, or titanium is less than 0.008 %, the analysis may be reported as <0.008 %. The reported heat analysis shall conform to the chemical composition requirements of the appropriate grade in Table 3, if used, the additional elements in Table 4, and the limits of any other elements agreed upon by the purchaser and supplier.

6.3 Product Analysis—Product analysis is the chemical analysis of the semi-finished product form. The strip may be subjected to product analysis by the purchaser either for the purpose of verifying that the ordered chemical composition is within specified limits for each element as listed in Table 1 including applicable tolerance for product analysis, or to determine variations in compositions within a cast or heat. Table 5 lists additional chemical composition requirements. The results of analyses taken from different pieces within a heat may differ from each other and from the cast analysis. The
TABLE 5 Additional Chemical Composition Requirements—Heat Analysis

<table>
<thead>
<tr>
<th>Element</th>
<th>Composition—Weight %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>. . .</td>
</tr>
<tr>
<td>Vanadium</td>
<td>. . .</td>
</tr>
<tr>
<td>Chromium</td>
<td>. . .</td>
</tr>
<tr>
<td>Titanium</td>
<td>. . .</td>
</tr>
</tbody>
</table>

For appropriate scale testing requirements.

TABLE 2 for appropriate scale shall be used for referee purposes.

TABLE 6 Tolerances for Product Analysis

<table>
<thead>
<tr>
<th>Element</th>
<th>Limit or Max of Specification, %</th>
<th>Variations Over Max Limit or Under Min Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>over 0.25 to 0.40, incl.</td>
<td>0.03 0.04</td>
</tr>
<tr>
<td></td>
<td>over 0.40 to 0.80, incl.</td>
<td>0.03 0.05</td>
</tr>
<tr>
<td></td>
<td>over 0.80</td>
<td>0.03 0.06</td>
</tr>
<tr>
<td>Manganese</td>
<td>to 0.60, incl.</td>
<td>0.03 0.03</td>
</tr>
<tr>
<td></td>
<td>over 0.60 to 1.15, incl.</td>
<td>0.04 0.04</td>
</tr>
<tr>
<td></td>
<td>over 1.15 to 1.85, incl.</td>
<td>0.05 0.05</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>. . .</td>
<td>. . . 0.01</td>
</tr>
<tr>
<td>Sulfur</td>
<td>. . .</td>
<td>. . . 0.01</td>
</tr>
<tr>
<td>Silicon</td>
<td>to 0.30, incl.</td>
<td>0.02 0.03</td>
</tr>
<tr>
<td></td>
<td>over 0.30 to 0.60</td>
<td>0.05 0.05</td>
</tr>
</tbody>
</table>

Note: The sum of copper, nickel, chromium, and molybdenum shall not exceed 0.80 \% 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.

8. Mechanical Requirements

8.1 Unless otherwise specified in the applicable product specification, test specimens must be prepared in accordance with Test Methods and Definitions A370.

8.2 Mechanical tests shall be conducted in accordance with Test Methods and Definitions A370.

8.3 Hardness:

8.3.1 Spheroidized Annealed and Annealed Types—When furnished spheroidized annealed or annealed, the hardness of the strip shall not exceed the maximum values specified in Figs. 1 and 2 for the applicable carbon range and type.

8.3.2 Intermediate Hardness Type—When furnished as intermediate hardness, the hardness of the strip shall conform to the range specified on the purchase order. The maximum hardness limit and the corresponding minimum shall be specified by the purchaser. If the maximum temper is under Rockwell B 100 (15T93 or 30T82), that scale should be used exclusively. If the minimum temper is over Rockwell C 20 (15N69.5 or 30N41.5), that scale should be used exclusively.

For accuracy in testing, the hardness scales should not overlap. On either hardness scale, a range of ten points arithmetic difference is required. Refer to Table 2 for appropriate scale testing requirements.

8.3.3 Full hard is specified to a minimum hardness value. Refer to Table 2 for appropriate scale testing requirements.

8.3.4 At least one specimen shall be taken from each lot.

8.3.5 The sample shall be tested in accordance with Test Methods and Definitions A370.

8.4 Bend Test:

8.4.1 The steel strip produced as spheroidized, or the annealed type shall meet the cold bend requirement in Table 3. Any visible cracking on the tension side of the bend portion shall be cause for rejection.

8.4.2 At least one specimen shall be taken from each lot.

8.4.3 The specimen shall be the full thickness and shall be taken transverse to the rolling direction as described in Test Methods and Definitions A370. The edges of the bend test specimens shall be rounded and free of burrs; filing or machining is permissible.


9.1 The thickness, width, camber, and length tolerances shall conform to the requirements specified in Tables 5-10.

9.2 Flatness—It is not practical to formulate flatness tolerances for cold-rolled carbon spring steel strip to represent the range of widths and thicknesses in coils and cut lengths.

10. Finish and Edges

10.1 Surface—The strip shall be furnished with a No. 2 Regular Bright or No. 1 Matte (Dull) finish, as specified.
FIG. 1 Approximate Relationship Between Carbon Designations and the Maximum Hardness Limit of Soft Type Annealed Cold Rolled High Carbon Steel Strip

FIG. 2 Approximate Relationship Between Carbon Designations and the Maximum Hardness Limit of Spheroidized Annealed Cold Rolled High Carbon Steel Strip
10.2 Oilimg—The strip shall be furnished oiled or dry, as specified.

10.3 Edges—Cold-rolled carbon steel strip shall be supplied with one of the following edges as specified:

10.3.1 No. 1—A prepared edge of a specified contour (round or square) that is produced when a very accurate width is required or when an edge condition suitable for electroplating is required, or both.

10.3.2 No. 2—A natural mill edge carried through the cold rolling from the hot-rolled strip without additional processing of the edge.

10.3.3 No. 3—An approximately square edge produced by slitting on which the burr is not eliminated. This is produced when the edge condition is not a critical requirement for the finished part. Normal coiling or piling does not provide a definite positioning of the slitting burr.

10.3.4 No. 4—An approximately rounded edge. This edge is produced when the width tolerance and edge condition are not as exacting as for No. 1 edges.

10.3.5 No. 5—An approximately square edge produced from slit edge material on which the burr is eliminated.

10.3.6 No. 6—An approximately square edge. This edge is produced when the width tolerance and edge condition are not as exacting as for No. 1 edges.

10.3.7 Skived Edges—Custom-shaped edges produced by mechanical edge shaving with special tooling.

10.4 Finish—Cold-rolled carbon steel strip shall be supplied with the following finishes.
10.4.1 **Number 1 or Matte (Dull) Finish**—Finish without luster, produced by rolling on rolls roughened by mechanical or chemical means. This finish is especially suitable for lacquer or paint adhesion, and is beneficial in aiding drawing operations by reducing the contact friction between the die and the strip.

10.4.2 **Number 2 (Regular Bright) Finish**—Finish produced by rolling on rolls having a moderately smooth finish. It is less suitable than No. 1 (matte) finish for cold forming and may be applicable for certain types of plating.

### 11. Workmanship

11.1 The steel shall have a workmanlike appearance and shall not have defects of a nature or degree for the grade and quality ordered that will be detrimental to the fabrication of the finished part.

11.2 Coils may contain some abnormalities that render a portion of the coil unusable since the inspection of coils does not afford the same opportunity to remove portions containing imperfections as is the case with cut lengths.

### 12. Number of Tests and Retests

12.1 The difficulties in obtaining truly representative samples of strip without destroying the usefulness of the coil account for the generally accepted practice of allowing retests for mechanical properties and surface examination. Two additional samples are secured from each end of the coil from which the original sample was taken. A portion of the coil may...
be discarded prior to cutting the samples for retest. If any of the retests fail to comply with the requirements, the coil shall be rejected.

13. Rework and Retreatment

13.1 Lots rejected for failure to meet the specified requirements may be resubmitted for test provided the manufacturer has reworked the lots as necessary to correct the deficiency or has removed the nonconforming material.

14. Inspection

14.1 The manufacturer shall afford the purchaser’s inspector all reasonable facilities necessary to satisfy him that the material is being produced and furnished in accordance with this specification. Mill inspection by the purchaser shall not interfere unnecessarily with the manufacturer’s operations. Unless otherwise agreed to, all tests and inspections, except product analysis, shall be made at the place of production.

15. Rejection and Rehearing

15.1 Unless otherwise specified, any rejection based on tests made in accordance with this specification shall be reported to the purchaser within a reasonable time.

15.2 Material that shows injurious defects subsequent to its acceptance at the purchaser’s works shall be rejected and the manufacturer shall be notified. The material must be adequately protected and correctly identified in order that the manufacturer may make a proper investigation. In case of dissatisfaction with the results of the test, the manufacturer may make claims for a rehearing.

16. Certification and Reports

16.1 When test reports are required by the purchaser, the supplier shall report the results of all tests required by this specification and any additional tests required by the material specification or the purchase order, or both.

16.2 When certification is required by the purchase order, the supplier shall furnish a certification that the material has been manufactured and tested in accordance with the requirements of this specification and the applicable material specification.

16.3 A signature is not required on test reports. However, the document shall clearly identify the organization submitting the document. Notwithstanding the absence of a signature, the organization submitting the document is responsible for the content of the document.

16.4 When test reports are required, it is acceptable for the supplier to report test data from the original manufacturer, provided such data is not rendered invalid by the stripmaking process.

16.5 A Material Test Report, Certificate of Inspection, or similar document printed from or used in electronic form from an electronic data interchange (EDI) transmission shall be regarded as having the same validity as a counterpart printed in the certifier’s facility. The content of the EDI transmitted document must meet the requirements of the invoked ASTM standard(s) and conform to any existing EDI agreement between the purchaser and the supplier. Notwithstanding the absence of a signature, the organization submitting the EDI transmission is responsible for the context of the report.

Note 3—The industry definition as invoked here is: EDI is the computer to computer exchange of business information in an agreed upon standard format such as ANSI ASC X12.

17. Marking

17.1 Unless otherwise specified, the material shall be identified by having the manufacturer’s name or mark, ASTM designation, weight, purchase order number, and material identification legibly stenciled on top of each lift or shown on a tag attached to each coil or shipping unit.

17.2 When specified in the contract or order, and for direct procurement by or direct shipment to the Government, marking for shipment, in addition to requirements specified in the contract or order, shall be in accordance with MIL-STD-129 for military agencies and in accordance with Fed. Std. No. 123 for civil agencies.

17.3 For U.S. Government procurement by the Defense Supply Agency, strip material shall be continuously marked for identification in accordance with Fed. Std. No. 183.

17.4 Bar coding is acceptable as a supplementary identification method. Bar coding should be consistent with the Automotive Industry Action Group (AIAG) standard prepared by the primary metals subcommittee of the AIAG bar code project team.

18. Packaging

18.1 Unless otherwise specified, the strip shall be packaged and loaded in accordance with Practices A700.

18.2 When Level A is specified in the contract or order and for direct procurement by or direct shipment to the U.S. Government, preservation, packaging, and packing shall be in accordance with the Level A requirements of MIL-STD-163.

18.3 When coils are ordered it is customary to specify a minimum or range of inside diameter and maximum outside diameter and a maximum coil weight, if required. The ability of manufacturers to meet the maximum coil weights depends upon individual mill equipment. When required, minimum coil weights are subject to negotiation.

19. Keywords

19.1 cold rolled strip; high carbon; steel; strip
SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A684/A684M – 10a) that may impact the use of this standard. (Approved May 1, 2012.)

(1) Revised Table 1 to remove UNS Designations and added Steel Designation Number 1075.

(1) Added new section 4.1.12.1.

(2) Revised Table 5.

Committee A01 has identified the location of selected changes to this standard since the last issue (A684/A684M – 10) that may impact the use of this standard. (Approved Oct. 1, 2010.)

(1) Changed silicon from range to two types and option for other values for all grades in Table 1.

(2) Added 4.1.12.1 to indicate type (or other composition) that must be specified for silicon.

(2) Revised Table 5.

Committee A01 has identified the location of selected changes to this standard since the last issue (A684/A684M – 08) that may impact the use of this standard. (Approved May 1, 2010.)

(1) Added new section 4.1.12.1.

(2) Revised Table 5.

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