



Designation: A 635/A 635M – 04^{ε1}

Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for¹

This standard is issued under the fixed designation A 635/A 635M; 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.

^{ε1} NOTE—Section 4.1 was editorially corrected in April 2004.

1. Scope*

1.1 This specification covers the general requirements for hot-rolled, heavy-thickness sheet and strip in coils.

1.2 It applies to Specification A 1018/A 1018.

1.3 This material is available only in coils described as follows:

Product	Size Limits, Coils Only	
	Width, in. [mm]	Thickness, in. [mm]
Strip	over 8 to 12, incl [over 200 through 300]	0.230 to 1.000, incl [from 6.0 through 25]
Sheet	over 12 to 48, incl [over 300 through 1200]	0.230 to 1.000, incl [from 6.0 through 25]
Sheet	over 48 [over 1200]	0.180 to 1.000, incl [from 4.5 through 25]

1.4 In case of any conflict in requirements, the requirements of the individual material specification shall prevail over those of this general specification.

1.5 Annex A1 lists 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 Annex A1 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 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 nonconformance with this specification.

1.7 This specification and the applicable material specifications are 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.

2. Referenced Documents

2.1 ASTM Standards:²

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products

A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment

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

A 1018/A 1018M Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability

E 11 Specification for Wire Cloth and Sieves for Testing Purposes

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E 59 Practice for Sampling Steel and Iron for Determination of Chemical Composition³

2.2 Federal Standards:

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)⁴

Fed. Std. No. 183 Continuous Identification Marking of Iron and Steel Products⁴

2.3 Military Standards:

MIL-STD-129 Marking for Shipment and Storage⁴

MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage⁴

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 Withdrawn.

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

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.

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 Steel Types:

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 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 percentages 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, etc. These elements are considered as incidental and are not normally determined or reported.

3.1.3 *high-strength, low-alloy steel*—a specific group of steels in which higher strength, and in some cases additional resistance to atmospheric corrosion or improved formability, are obtained by moderate amounts of one or more alloying elements.

3.2 Product Types:

3.3 *hot-rolled sheet and strip*—manufactured by hot rolling slabs in a continuous mill to the required thickness; however, the product classification of sheet and strip is based on a combination of thickness and width (see Specification A 1018/A 1018M.)

4. Index of Tables, Dimensions, and Allowances

4.1 See the following table.

Index of Tables for Dimensions, Tolerances, and Allowances		
Dimensions	Table No.	
	Inch-Pound Units†	SI Units
Camber		
Sheet	6	A1.5
Strip	11	A1.10
Crown		
Strip	9	A1.8
Thickness		
Sheet	2, 3	A1.1, A1.2
Strip	7, 8	A1.6, A1.7
Width		
Sheet	4, 5	A1.3, A1.4
Strip	10	A1.9

† Table numbers in this column were corrected editorially.

5. Materials and Manufacture

5.1 *Melting Practice*—Hot-rolled heavy thickness sheet and strip coils are normally produced from rimmed, capped, or semi-killed steel. If either coarse or fine-grain practice is specified, special soundness steel will be furnished.

5.2 Steel may be produced as ingot-cast or strand-cast. When different grades of strand-cast steel are sequentially cast, identification and separation of the transition material is required.

5.3 The steel shall be in the hot-rolled condition.

6. Chemical Composition

6.1 *Cast or Heat (Formerly Ladle) Analysis*—An analysis of each heat or cast shall be made by the manufacturer to

determine the conformance with the appropriate requirement. The analysis shall be from a test sample preferably taken during the pouring of the heat or cast.

6.1.1 Where the material is used for fabrication by welding, care must be exercised in selection of chemical composition or mechanical properties to assure compatibility with the welding process and its effect on altering the properties.

6.2 Product, Check, or Verification Analysis:

6.2.1 Non-killed steels such as 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 1 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 non-killed (capped or rimmed), product analysis may be made by the purchaser. The chemical analysis shall not vary from the limits specified by more than the amounts in Table 1. The several determinations of any element in a cast shall not vary both above and below the specified range.

6.2.3 Sampling for Product Analysis:

6.2.3.1 To indicate adequately the representative composition of a cast by product analysis, it is general practice to select samples to represent the steel, as fairly as possible, from a minimum number of pieces as follows: three pieces for lots up to 15 tons included, and six pieces for lots over 15 tons (see Practice E 59).

6.2.3.2 When the steel is subject to tension test requirements, samples for product analysis may be taken either by drilling entirely through the used tension test specimens themselves, or as covered in 6.2.3.3.

6.2.3.3 When the steel is not subject to tension test requirements, the samples for analysis must be taken by milling or drilling entirely through the sheet in a sufficient number of places so that the samples are representative of the entire sheet or strip. The sampling may be facilitated by folding the sheet both ways, so that several samples may be taken at one drilling. Steel subjected to certain heating operations by the purchaser may not give chemical analysis results that properly represent its original composition. Therefore, users must analyze chips taken from the steel in the condition in which it is received from the steel manufacturer.

TABLE 1 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
	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	...

6.3 *Specimen Preparation*—Drillings or chips must be taken without the application of water, oil, or other lubricant, and must be free of scale, grease, dirt, or other foreign substances. They must not be overheated during cutting to the extent of causing decarburization. Chips must be well mixed and those too coarse to pass a No. 10 sieve or too fine to remain on a No. 30 sieve are not suitable for proper analysis. Sieve size numbers are in accordance with Specification E 11.

6.4 *Test Methods*—In case a referee analysis is required and agreed upon to resolve a dispute concerning the results of a chemical analysis, the procedure for performing the referee analysis must be in accordance with the latest issue of Test Methods, Practices, and Terminology A 751, unless otherwise agreed upon between the manufacturer and the purchaser.

7. Mechanical Properties

7.1 The mechanical property requirements, number of specimens, and test locations and specimen orientation shall be in accordance with the applicable product specification.

7.2 Unless otherwise specified in the applicable product specification, test specimens must be prepared in accordance with Test Methods and Definitions A 370.

7.3 Mechanical tests shall be conducted in accordance with Test Methods and Definitions A 370.

7.4 To determine conformance with the product specification, a calculated value shall be rounded to the nearest 1 ksi tensile strength and yield point or yield strength, and to the nearest unit in the right hand place of figures used in expressing the limiting value for other values in accordance with the rounding off method given in Practice E 29.

8. Dimensions and Tolerances

8.1 The permissible tolerances for dimensions shall not exceed the applicable limits specified in Tables 2-6 for hot-rolled and hot-rolled, pickled-sheet coils and Tables 7-11 for hot-rolled and hot-rolled, pickled-strip coils (Annex A1, Tables A1.1-A1.10).

9. Workmanship, Finish, and Appearance

9.1 The steel shall have a workmanlike appearance and shall not have defects of a nature or degree that will be detrimental to the stamping or fabrication of finished parts.

9.2 Coils are subject to some abnormal imperfections that render a portion of the coil unusable since the inspection of coils does not afford opportunity to remove portions containing imperfections.

9.3 *Surface Finish:*

9.3.1 Unless otherwise specified, the material shall be furnished without removing the hot-rolled oxide or scale.

9.3.2 When required, it is permissible to specify the material to be pickled or blast-cleaned.

9.4 *Oiling:*

9.4.1 Unless otherwise specified, hot-rolled, as-rolled material shall be furnished not oiled, and hot-rolled, pickled, or blast-cleaned material shall be furnished oiled.

9.4.2 When required, it is permissible to specify as-rolled material be furnished oiled, or that pickled or blast-cleaned material be furnished not oiled.

9.5 *Edges:*

9.5.1 As-rolled material has mill edges. Pickled or blast-cleaned material has cut edges; if mill-edge material is required, it must be specified.

9.5.2 When required, it is permissible to specify as-rolled material to have cut edges.

10. Inspection

10.1 When the purchaser’s order stipulates that inspection and chemical tests (except product analyses) for acceptance of the steel be made prior to shipment from the mill, the manufacturer shall afford the purchaser’s inspector all reasonable facilities to determine that the steel is being furnished in accordance with this specification. Steel sheet and strip products subject to the purchaser’s inspection and sampling are customarily inspected and sampled in conjunction with the manufacturer’s inspection and sampling operations.

TABLE 2 Standard Thickness Tolerances for Heavy-Thickness Hot-Rolled Sheet (Carbon and High-Strength Low-Alloy Steel)—¹/₈-in. (Cut Edge) and ³/₄-in. (Mill Edge) Minimum Edge Distance (Coils Only)

NOTE 1—Thickness is measured at any point across the width not less than ³/₈ in. from a cut edge and not less than ³/₄ in. from a mill edge. This table does not apply to the uncropped ends of mill edge coils.

NOTE 2—The specified thickness range captions also apply when sheet is specified to a nominal thickness, and the tolerances are divided equally, over and under.

NOTE 3—Micrometers used for measurement of thickness shall be constructed with anvils and spindles having minimum diameters of 0.188 in. [4.80 mm]. The tip of the spindle shall be flat, and the tip of the anvil shall be flat or rounded with a minimum radius of curvature of 0.10 in. [2.55 mm]. Micrometers with pointed tips are not suitable for thickness measurements.

Specified Width, in.	Thickness Tolerances Over, in., No Tolerance Under					
	Specified Minimum Thickness, in.					
	0.180 to 0.229, incl	0.230 to 0.313, incl	Over 0.313 to 0.375, incl	Over 0.375 to 0.500, incl	Over 0.500 to 0.625, incl	Over 0.625 to 1.000, incl
Over 12 to 20, incl	^A	0.020	0.024	0.028	0.030	0.032
Over 20 to 40, incl	^A	0.022	0.024	0.028	0.030	0.032
Over 40 to 48, incl	^A	0.024	0.026	0.028	0.030	0.032
Over 48 to 60, incl	0.020	0.024	0.028	0.030	0.032	0.034
Over 60 to 72, incl	0.022	0.026	0.030	0.032	0.036	0.038
Over 72	0.024	0.030	0.032	0.036	0.038	0.040

^A Product not available in this size range.

TABLE 3 Restricted Thickness Tolerances for Heavy-Thickness Hot-Rolled Sheet (Carbon and High-Strength Low-Alloy Steel)— $\frac{5}{8}$ -in. (Cut Edge) and 1-in. (Mill Edge) Minimum Edge Distance (Coils Only)

NOTE 1—Thickness is measured at any point across the width not less than $\frac{5}{8}$ in. from a cut edge and not less than 1 in. from a mill edge. This table does not apply to the uncropped ends of mill edge coils.

NOTE 2—The specified thickness range captions also apply when sheet is specified to a nominal thickness, and the tolerances are divided equally, over and under.

NOTE 3—Micrometers used for measurement of thickness shall be constructed with anvils and spindles having minimum diameters of 0.188 in. [4.80 mm]. The tip of the spindle shall be flat, and the tip of the anvil shall be flat or rounded with a minimum radius of curvature of 0.10 in. [2.55 mm]. Micrometers with pointed tips are not suitable for thickness measurements.

NOTE 4—This table was constructed by multiplying the values in the standard table by 0.75 and rounding to 3 decimal places using standard ASTM practice.

Specified Width, in.	Thickness Tolerances Over, in., No Tolerance Under					
	Specified Minimum Thickness, in.					
	0.180 to 0.229, incl	0.230 to 0.313, incl	Over 0.313 to 0.375, incl	Over 0.375 to 0.500, incl	Over 0.500 to 0.625, incl	Over 0.625 to 1.000, incl
Over 12 to 20, incl	^A	0.015	0.018	0.021	0.022	0.024
Over 20 to 40, incl	^A	0.016	0.018	0.021	0.022	0.024
Over 40 to 48, incl	^A	0.018	0.020	0.021	0.022	0.024
Over 48 to 60, incl	0.015	0.018	0.021	0.022	0.024	0.026
Over 60 to 72, incl	0.016	0.020	0.022	0.024	0.027	0.028
Over 72	0.018	0.022	0.024	0.027	0.028	0.030

^A Product is not available in this size range.

TABLE 4 Width Tolerances for Heavy-Thickness Mill Edge Sheet (Coils Only)

NOTE 1—This table does not apply to the uncropped end of mill-edge coils.

Specified Width, in.	Tolerance Over Specified Width, in. (No Tolerance Under)
Over 12 to 14, incl	$\frac{7}{16}$
Over 14 to 17, incl	$\frac{1}{2}$
Over 17 to 19, incl	$\frac{9}{16}$
Over 19 to 21, incl	$\frac{5}{8}$
Over 21 to 24, incl	$1\frac{1}{16}$
Over 24 to 26, incl	$1\frac{3}{16}$
Over 26 to 28, incl	$1\frac{5}{16}$
Over 28 to 35, incl	$1\frac{1}{8}$
Over 35 to 50, incl	$1\frac{1}{4}$
Over 50 to 60, incl	$1\frac{1}{2}$
Over 60 to 65, incl	$1\frac{3}{8}$
Over 65 to 70, incl	$1\frac{3}{4}$
Over 70 to 80, incl	$1\frac{7}{8}$
Over 80	2

TABLE 5 Width Tolerances for Heavy-Thickness Cut-Edge Sheet (Coils Only)

NOTE 1—Heavy-thickness edge cutting results in a bevelled edge. The width shall be measured on the wide surface of the cut-edge coil. Depending upon the angle of the bevelled edge cut, the width of the narrow surface of the cut-edge coil may be less than the minimum ordered width. The manufacturer must be consulted regarding the capability to control level angle.

Specified Width, in.	Tolerance Over Specified Width, in. (No Tolerance Under)
Over 12 to 30, incl	$\frac{1}{8}$
Over 30 to 48, incl	$\frac{3}{16}$
Over 48 to 60, incl	$\frac{1}{4}$
Over 60 to 80, incl	$\frac{5}{16}$
Over 80	$\frac{3}{8}$

TABLE 6 Camber Tolerances for Heavy-Thickness Sheet (Coils Only)

NOTE 1—Camber is the deviation of a side edge from a straight line. Such a deviation is measured by placing a straightedge on the concave side and measuring the greatest distance between the sheet edge and the straightedge.

Camber should not exceed 1 in. in any 20 ft of length.

11. Rejection and Rehearing

11.1 Material that is reported to be defective subsequent to the acceptance at the purchaser's works shall be set aside, adequately protected, and correctly identified. The manufacturer shall be notified as soon as possible so that an investigation may be initiated.

11.2 Samples that are representative of the rejected material shall be made available to the manufacturer. In the event that the manufacturer is dissatisfied with the rejection, he may request a rehearing.

12. Test Reports and Certification

12.1 When test reports are required by the purchase order or the material specification, the supplier shall report the results of all tests required by the material specification and the order.

12.2 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 material specification.

12.3 A signature is not required on test reports or certifications. 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.

12.4 When test reports are required, copies of the original material manufacturer's test report shall be included with any subsequent test report.

12.5 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