Designation: A 663/A 663M – 89 (Reapproved 2006)

Standard Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties[1]

This standard is issued under the fixed designation A 663/A 663M; 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 hot-wrought merchant quality carbon steel bars and bar size shapes produced to mechanical property requirements and intended for noncritical constructional applications (see 7.2).

1.2 Merchant quality hot-wrought steel bar is available in the following ranges of size and section:

1.2.1 Rounds, squares, and hexagons with diameters or distance across flats under 3 in. [75 mm].

1.2.2 Bar size shapes with maximum dimensions under 3 in. [75 mm].

1.2.3 Other bar sections with weight per foot under 40.84 lb/ft [60.78 kg/m].

1.2.4 Flats 6 in. [152 mm] or under in width, over 0.203 in. [over 5 mm in thickness up to 150 mm in width] in thickness, and under 40.84 lb/ft or 12 in.^{2} [77.4 cm^2] in cross-sectional area.

1.2.5 Flats over 6 in. to 8 in., inclusive in width, 0.230 in. and over [over 6 mm in thickness and over 50 mm through 200 mm in width] in thickness and under 40.84 lb/ft [60.78 kg/m] or 12 in.^{2} [77.4 cm^2] in cross-sectional area.

1.2.6 Hot-wrought merchant quality carbon steel bars subject to mechanical property requirements are hot wrought in straight lengths only.

1.3 Some applications may require one or more of the available designations shown under supplementary requirements.

NOTE 1—Special quality hot-wrought carbon steel bars subject to mechanical property requirements are covered in Specification A 675/A 675M.

1.4 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.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 29/A 29M Specification for Steel Bars, Carbon and Alloy, Hot-Wrought, General Requirements for

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

A 675/A 675M Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties

E 290 Test Methods for Bend Testing of Material for Ductility

3. Ordering Information

3.1 Orders for material under this specification should include the following information:

3.1.1 Quantity (weight or number of pieces),

3.1.2 Dimensions (cross-sectional shape, size, and length),

3.1.3 Name of material (merchant quality carbon steel bars),

3.1.4 Specification number and date of issue,

3.1.5 Grade designation,

3.1.6 Copper bearing steel (if required),

3.1.7 Heat analysis or test report (request, if required),

3.1.8 Application and processing, and

[1] This specification is under the jurisdiction of Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.15 on Bars.

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

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3.1.9 Supplementary requirements (if required).

4. Manufacture

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

5. Chemical Composition

5.1 The steel shall conform on heat analysis to the following chemical requirements:

Phosphorus, max, percent	0.04
Sulfur, max, percent	0.05
Copper, when copper steel is specified, min, percent	0.20

5.2 When tension tests are waived in accordance with 6.1.6, chemistry consistent with the mechanical properties desired shall be applied.

6. Mechanical Properties

6.1 *Tensile Requirements*:

6.1.1 The material as represented by the test specimen shall conform to the applicable requirements in Table 1.

6.1.2 Test specimens shall be prepared for testing from the material in its as-rolled condition. The tension specimen may be aged as described in Test Methods and Definitions A 370.

6.1.3 Test specimens shall be taken longitudinally and may be tested in full thickness or section, or they may be machined to the dimensions shown in Figs. 4 or 5 of Test Methods and Definitions A 370. If test specimens are selected conforming to the dimensions of Fig. 5, they shall be machined from a position midway between the center and the surface of the bar.

6.1.4 Test specimens for shapes and flats may be machined to the form and dimensions shown in Fig. 4 of Test Methods and Definitions A 370 or with both edges parallel. Test specimens for material over 1½ in. [40 mm] in thickness or diameter may be machined to a thickness or diameter of at least ¾ in. [20 mm] for a length of at least 9 in. [230 mm], or they may conform to the dimensions shown in Fig. 5 of Test Methods and Definitions A 370.

6.1.5 Tensile requirements shall be determined in accordance with Test Methods and Definitions A 370.

6.1.6 Shapes less than 1 in.^{2} [645 mm^2] in cross section and bars (other than flats) less than ½ in. [12.5 mm] in thickness or diameter need not be subject to tension tests by the manufacturer.

TABLE 1 Tensile Requirements

Grade Designation	Tensile Strength, ksi [MPa]	Yield Point,[A] min, ksi [MPa]	Elongation, min, %	
			8-in. or [200-mm] Gage Length	2-in. or [50-mm] Gage Length
45 [310]	45–55 [310–380]	25.0 [175]	27	33
50 [345]	50–60 [345–415]	28.0 [195]	25	30
55 [380]	55–65 [380–450]	30.0 [210]	23	26
60 [415]	60–72 [415–495]	33.0 [230]	21	22
65 [450]	65–77 [450–530]	36.0 [250]	17	20
70 [485]	70–85 [485–585]	39.0 [270]	14	18
75 [515]	75–90 [515–620]	41.0 [285]	14	18
80 [550]	80 min [550 min]	44.0 [305]	13	17

[A] When the tension test does not show a yield point (drop of the beam, halt of the pointer or sharp-kneed stress-strain diagram), yield strength shall be determined by either 0.5 % extension-under-load or 0.2 % offset. The minimum ksi (MPa) requirement does not change. The test report, if required, shall show yield strength.

6.1.7 For material over ¾ in. [19 mm] in thickness or diameter, a deduction from the percentage of elongation in 8 in. [200 mm] specified in Table 1 of 0.25 % shall be made for each increase of 1/32 in. [0.8 mm] in the specified thickness or diameter above ¾ in. [19 mm].

6.1.8 For material under 5/16 in. [8 mm] in thickness or diameter, a deduction from the percentage of elongation in 8 in. [200 mm] specified in Table 1 of 2.00 % shall be made for each decrease of 1/32 in. [0.8 mm] in the specified thickness or diameter below 5/16 in. [8 mm].

6.1.9 For material over 2 in. [50 mm] in thickness or diameter, a deduction from the percentage of elongation in 2 in. [50 mm] specified in Table 1 of 1.00 % shall be made for each 1 in. [25 mm] of specified thickness or diameter or fraction thereof over 2 in. [50 mm] in thickness or diameter.

6.2 *Number of Tests*:

6.2.1 Two tension tests shall be made from each heat, unless the finished material from a heat is less than 50 tons [45 Mg], when one tension test will be sufficient. However, for material 2 in. [50 mm] and under in thickness, when the material from one heat differs ⅜ in. [9.5 mm] or more in thickness, one tension test shall be made from both the thickest and the thinnest material rolled (larger than the sizes enumerated in 6.1.6), regardless of weight represented. For material over 2 in. [50 mm] thick, when the material from one heat differs 1 in. [25 mm] or more in thickness, one tension test shall be made from both the thickest and the thinnest material rolled that is more than 2 in. [50 mm] thick regardless of the weight represented.

6.3 *Test Reports*:

6.3.1 When test reports are required by the purchase order, the report shall show the results of each test required by 6.2, except that only one test need be reported when the amount of material from a heat in a shipment is less than 10 tons [9 Mg] and when the thickness variations described in 6.2 are not exceeded.

6.3.2 The thickness of the product tested may not necessarily be the same as an individual ordered thickness since it is the heat that is tested rather than each ordered item.

6.3.3 When Supplementary Requirements are specified, the report shall include a statement of compliance with the requirement or the results of tests when the requirement involves measured test values.

7. General Requirements

7.1 Material furnished under this specification shall conform to the requirements of the current edition of Specification A 29/A 29M, except as stated in 1.2 and 3.2.

7.2 Merchant quality bars shall be free from visible pipe; however, they may contain pronounced chemical segregation. Internal porosity, surface seams, and other surface irregularities may be present in this quality. Deoxidation practice and grain size are at the manufacturer's option.

7.3 Unless otherwise specified, the bars shall be furnished as rolled and not pickled, blast cleaned, or oiled.

8. Keywords

8.1 carbon steel bars; merchant quality steel bars; steel bars

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SUPPLEMENTARY REQUIREMENTS

One or more of the following supplementary requirements shall apply when specified by the purchaser.

S1. Special Straightness

S1.1 Bars may be specified to special straightness tolerance (refer to Specification A 29/A 29M).

S2. Cleaning

S2.1 The purchaser may specify that the surface of bars be descaled by pickling or blast cleaning.

S3. Coating

S3.1 The purchaser may specify oil on bars which have been descaled.

S4. Bend Tests

S4.1 *Requirements:*

S4.1.1 The bend test specimen shall stand being bent at room temperature through 180° without cracking on the outside of the bent portion, to an inside diameter which shall have the relation to the thickness or diameter of the specimen as given in Table S4.1.

S4.2 *Test Specimens:*

S4.2.1 Bend test specimens for material 1½ in. [40 mm] and under in diameter or thickness may be the full thickness of the section. For flat bars over 2 in. [50 mm] in width, the width may be reduced by milling to 1½ in. [40 mm].

S4.2.2 Bend test specimens for material over 1½ in. [40 mm] in diameter or thickness may be machined to a thickness or diameter of at least ¾ in. [20 mm] or to 1 in. by ½ in. [25 by 12.5 mm] in section. Machined sides of bend test specimens may have the corners rounded to a radius of not over 1/16 in. [1.6 mm] for material 2 in. [50 mm] and under in thickness, and not over ⅛ in. [3.2 mm] in radius for material over 2 in. [50 mm] in thickness.

TABLE S4.1 Bend Requirements

Grade Designation	Ratio of Bend Diameter to Thickness of Specimen for Thickness or Diameter of Bar, in. (mm)				
	¾ [20] and Under	Over ¾ [20] to 1 [25], incl	Over 1 [25] to 1½ [40], incl	Over 1½ [40] to 2 [50], incl	Over 2 [50] to under 3 [75]
45 [310]	flat	flat	½	1	1
50 [345]	flat	½	1	1½	2½
55 [380]	½	1	1½	2	2½
60 [415]	½	1	1½	2½	3
65 [450]	1	1½	2	3	3½
70 [485]	1½	2	2½	3	3½
75 [515]	2	2	3	3½	4
80 [550]	2	2½	3	3½	4

S4.3 *Number of Tests:*

S4.3.1 Two bend tests shall be made from each heat unless the finished material from a heat is less than 50 tons [45 Mg] when one bend test will be sufficient. However, for material 2 in. [50 mm] and under in thickness, when the material from one heat differs ⅜ in. [9.5 mm] or more in thickness, one bend test shall be made from the thickest and the thinnest material rolled, regardless of weight represented. For material over 2 in. [50 mm] thick, when the material from one heat differs 1 in. [25 mm] or more in thickness, one bend test shall be made from both the thickest and the thinnest material rolled that is more than 2 in. [50 mm] thick regardless of the weight represented.

S4.4 *Test Methods:*

S4.4.1 Bend tests shall be made in accordance with Test Methods E 290.

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