SPECIFICATION FOR COLD-DRAWN, STRESS-RELIEVED CARBON STEEL BARS SUBJECT TO MECHANICAL PROPERTY REQUIREMENTS

A03

SA-311/SA-311M

(Identical to ASTM Specification A 311/A 311M-95 (R2000) except for deletion of 5.1.11, revision of Table 1 footnote A, and editorial corrections to Table 2.)

1. Scope

1.1 This specification covers two classes, nine grades, and four conditions of stress-relieved cold-drawn carbon steel bars produced to mechanical property requirements. One class, B, is cold drawn with higher than normal (heavy) drafts to provide higher strength levels, and four grades provide improved machinability.

1.2 Supplementary Requirements, S1 through S6, of an optional nature are provided.

1.3 The values stated in inch-pound units or SI units are to be regarded as the 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 the specification.

2. Referenced Documents

2.1 *ASTM Standards:*

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

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

E 527 Practice for Numbering Metals and Alloys (UNS)

3. Terminology

3.1 *Definitions:*

3.1.1 *stress relieving* — heating to a suitable temperature, holding long enough to reduce residual stresses, and then cooling slowly enough to minimize the development of new residual stresses.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *heavy draft* — Using higher than normal drafts (approximately 10% through 35% reduction), followed by stress relieving, produces higher tensile and yield strengths provided an appropriate composition is used; for example, medium carbon with normal or higher manganese content.

4. Classification

4.1 The bars are furnished in the following classes and grades, and in the conditions shown in 6.4.

4.1.1 *Class A* — Normal-draft cold-drawn and stress-relieved rounds, squares, hexagons, and flats in the following grades:

Grades	UNS Designations
1018	G10180
1035	G10350
1045	G10450
1050	G10500
1541	G15410
1117	G11170
1137	G11370
1141	G11410
1144	G11440

4.1.2 *Class B* — Heavy-draft cold-drawn and stress-relieved rounds and hexagons in the following grades:

Grade	UNS Designations
1045	G10450
1050	G10500
1541	G15410
1141	G11410
1144	G11440

5. Ordering Information

5.1 Orders for material under this specification should include the following information as required to adequately describe the desired material:

5.1.1 Quantity (weight [mass] or number of pieces),

5.1.2 Name of material (carbon steel bars, cold drawn, stress relieved),

5.1.3 Condition (8.3),

5.1.4 Cross-sectional shape,

5.1.5 Size,

5.1.6 Length,

5.1.7 Class and grade,

5.1.8 Report of heat analysis, tensile properties Section 11,

5.1.9 ASTM designation A 311 or A 311M,

5.1.10 Application,

5.1.11 DELETED,

5.1.12 Supplementary requirements, if any, and

5.1.13 Additional requirements, if any.

NOTE 1— A typical ordering description is as follows: 10 000 lb carbon steel bars, cold drawn, stress relieved turned and polished, round 2.0 in. (50.8 mm) Diameter, 10 to 12 ft (3048 to 3658 mm) long, Class B, Grade 1050, (UNS G 10500), fine grain, test reports required, ASTM A 311/A 311M dated _____, hydraulic cylinder piston rods. [5000 kg carbon steel bars, cold drawn, stress relieved turned and polished round 50 mm diameter, 3050 to 3650 mm long, Class B, Grade 1050 (UNS G 10500), fine grain, test reports required, ASTM A 311M dated _____, hydraulic cylinder piston rods.]

6. Materials and Manufacture

6.1 *Melting Practice* — The steel shall be made by one or more of the following primary processes: open-hearth, basic-oxygen, or electric-furnace. The primary melting may incorporate separate degassing or refining and may be followed by secondary melting using electroslag remelting or vacuum arc remelting. Where secondary melting is employed, the heat shall be defined as all of the ingots remelted from a single primary heat.

6.2 *Cold Working:*

6.2.1 Class A bars shall be cold drawn using normal drafting practices.

6.2.2 Class B bars shall be cold drawn using heavy (higher than normal) drafting practices.

6.3 *Thermal Treatment* — After cold drawing, the bars shall be stress relieved at a temperature of not less than 550°F [288°C] to meet the mechanical requirements specified in Table 2.

6.4 *Condition* — The bars shall be furnished in the following cold finish conditions, as specified:

6.4.1 Cold drawn, stress relieved;

6.4.2 Cold drawn, stress relieved, turned, and polished;

6.4.3 Cold drawn, stress relieved, turned, ground, and polished; and

6.4.4 Cold drawn, stress relieved, ground, and polished.

NOTE 2— When turned bars are specified, turning may be performed prior to cold-drawing.

7. Chemical Composition

7.1 *Composition* — The cast or heat analysis shall conform to the chemical composition requirements specified in Table 1 for the grade ordered.

8. Mechanical Properties

8.1 *Requirements* — The bars shall conform to the requirements listed in Table 2.

8.2 *Number of Tests* — At least one tension test shall be made on each lot. A lot shall consist of bars of the same size from the same heat which have been stress relieved in the same stationary furnace charge. For continuous type of treatment, a lot shall consist of 25 tons [25 Mg] or less of the same size of each heat, treated in the same cycle.

8.3 *Specimens* — Tension test specimens shall be taken longitudinally in accordance with and from the locations specified in Test Methods and Definitions A 370.

8.4 *Test Methods* — Tension tests shall be made in accordance with Test Methods and Definitions A 370. The yield strength shall be determined at 0.2% offset

or at 0.005 in./in. [0.005 mm/mm] of gage length, total extension under load.

9. Workmanship, Finish, and Appearance

9.1 *Surface Finish* — Unless otherwise specified, the bars shall have a commercial bright smooth surface finish consistent with the cold finishing operations specified in 6.4.

9.2 Bars that are thermal treated after cold finishing may have a discolored or oxidized surface.

9.3 *Oiling* — The bars shall be given a surface coating of oil or other rust inhibitor to protect against rust during shipment.

9.4 *Workmanship* — The bars shall be free of pipe, cracks, and flakes. Within the limits of good manufacturing and inspection practices, the bars shall be free of injurious seams, laps, segregation, or other imperfections that, due to their nature, degree, or extent, will interfere with the use of the material in machining or fabrication of suitable parts.

10. General Requirements

10.1 Material furnished under this specification shall conform to the requirements of the current edition of Specification A 29/A 29M unless otherwise stated.

11. Certification and Test Reports

11.1 A manufacturer's certification that the material was manufactured and tested in accordance with this specification together with a report of the heat analysis and tension test results shall be furnished at the time of shipment (if requested). The report shall include the name of the manufacturer, ASTM designation and year date and revision letter, if any, class and grade, heat number, size, and grain size (if requested).

12. Keywords

12.1 carbon steel bars; cold finished steel bars; steel bars

TABLE 1
CHEMICAL REQUIREMENTS
(CAST OR HEAT ANALYSIS)[A]

UNS Designation	Grade	Carbon, %	Manganese, %	Phosphorus, max %	Sulfur, %
G10180	1018	0.15–0.20	0.60–0.90	0.040	0.050 max
G10350	1035	0.32–0.38	0.60–0.90	0.040	0.050 max
G10450	1045	0.43–0.50	0.60–0.90	0.040	0.050 max
G10500	1050	0.48–0.55	0.60–0.90	0.040	0.050 max
G15410	1541	0.36–0.44	1.35–1.65	0.040	0.050 max
G11170	1117	0.14–0.20	1.00–1.30	0.040	0.08–0.13
G11370	1137	0.32–0.39	1.35–1.65	0.040	0.08–0.13
G11410	1141	0.37–0.45	1.35–1.65	0.040	0.08–0.13
G11440	1144	0.40–0.48	1.35–1.65	0.040	0.24–0.33

[A] The intentional addition of Bi, Se, Te, and Pb is not permitted.

TABLE 2
MECHANICAL REQUIREMENTS

UNS No.	Grade Designation	Diameter, Thickness, or Distance Between Parallel Faces, in. [mm]	Tensile Strength, min., ksi [MPa]	Yield Strength, min., ksi [MPa]	Elongation in 2 in. [50 mm], min., %	Reduction of Area, min., %
		Class A — Normal Draft Cold Drawn and Stress Relieved Annealed				
G10180	1018	Up to 7/8 [20], incl	70 [485]	60 [415]	18	40
		Over 7/8 [20] to 1 1/4 [30], incl	65 [450]	55 [380]	16	40
		Over 1 1/4 [30] to 2 [50], incl	60 [415]	50 [345]	15	35
		Over 2 [50] to 3 [75], incl	55 [380]	45 [310]	15	35
G10350	1035	Up to 7/8 [20], incl	85 [590]	75 [520]	13	35
		Over 7/8 [20] to 1 1/4 [30], incl	80 [550]	70 [485]	12	35
		Over 1 1/4 [30] to 2 [50], incl	75 [520]	65 [450]	12	35
		Over 2 [50] to 3 [75], incl	70 [485]	60 [415]	10	30
G10450	1045	Up to 7/8 [20], incl	95 [655]	85 [585]	12	35
		Over 7/8 [20] to 1 1/4 [30], incl	90 [620]	80 [550]	11	30
		Over 1 1/4 [30] to 2 [50], incl	85 [585]	75 [520]	10	30
		Over 2 [50] to 3 [75], incl	80 [550]	70 [485]	10	30
G10500 and G15410	1050 and 1541	Up to 7/8 [20], incl	100 [690]	90 [620]	11	35
		Over 7/8 [20] to 1 1/4 [30], incl	95 [655]	85 [585]	11	30
		Over 1 1/4 [30] to 2 [50], incl	90 [620]	80 [550]	10	30
		Over 2 [50] to 3 [75], incl	85 [585]	75 [520]	10	30
G11170	1117	Up to 7/8 [20], incl	75 [520]	65 [450]	15	40
		Over 7/8 [20] to 1 1/4 [30], incl	70 [485]	60 [415]	15	40
		Over 1 1/4 [30] to 2 [50], incl	65 [450]	55 [380]	13	35
		Over 2 [50] to 3 [75], incl	60 [415]	50 [345]	12	30
G11370 and G11410	1137 and 1141	Up to 7/8 [20], incl	95 [655]	90 [620]	11	35
		Over 7/8 [20] to 1 1/4 [30], incl	90 [620]	85 [585]	11	30
		Over 1 1/4 [30] to 2 [50], incl	85 [585]	80 [550]	10	30
		Over 2 [50] to 3 [75], incl	80 [550]	75 [520]	10	30
G11440	1144	Up to 7/8 [20], incl	105 [725]	95 [655]	10	30
		Over 7/8 [20] to 1 1/4 [30], incl	100 [690]	90 [620]	10	30
		Over 1 1/4 [30] to 2 [50], incl	95 [655]	85 [585]	10	25
		Over 2 [50] to 3 [75], incl	90 [620]	80 [550]	10	20
		Over 3 [75] to 4 1/2 [115], incl	85 [585]	75 [520]	10	20
		Class B — Heavy Draft Cold Drawn and Stress Relieved Annealed				
UNS	Grade Designation	In. [mm], Round or Hexagon[A]	Tensile Strength, min., ksi [MPa]	Yield Strength, min., ksi [MPa]	Elongation in 2 in. [50 mm], min., %	Reduction of Area, min., %
G10450	1045	Up to 7/8 [20] incl	115 [795]	100 [690]	10	25
		Over 7/8 [20] to 1 1/4 [30], incl	115 [795]	100 [690]	10	25
		Over 1 1/4 [30] to 2 [50], incl	115 [795]	100 [690]	10	25
		Over 2 [50] to 3 [75], incl	115 [795]	100 [690]	9	25
		Over 3 [75] to 4 [102], incl	105 [725]	90 [620]	7	20
G10500 G15410 G11410 and G11440	1050 1541 1141 and 1144	Up to 7/8 [20], incl	115 [795]	100 [690]	8	25
		Over 7/8 [20] to 1 1/4 [30], incl	115 [795]	100 [690]	8	25
		Over 1 1/4 [30] to 2 [50], incl	115 [795]	100 [690]	8	25
		Over 2 [50] to 3 [75], incl	115 [795]	100 [690]	8	20
		Over 3 [75] to 4 1/2 [115], incl	115 [795]	100 [690]	7	20

[A] Maximum size for hexagons is 1 1/2 in. [40 mm].

SUPPLEMENTARY REQUIREMENTS

One or more of the following supplementary requirements shall apply only when specified by the purchaser in the inquiry or order. Details of these requirements shall be agreed upon between the manufacturer and the purchaser.

S1. Special Surface

S1.1 When inspection standards more restrictive than visual inspection are required, special surface may be specified.

S2. Restricted Cast or Heat Analysis

S2.1 When required, the purchaser may specify restrictive cast or heat analysis limits on one or more elements. The degree of restriction and the number of elements so restricted are both subject to agreement between the manufacturer and the purchaser.

S3. Restricted Decarburization

S3.1 The purchaser may specify a maximum affected depth of decarburization when required for special applications, subject to agreement between the manufacturer and the purchaser.

S4. Nonmetallic Inclusion Requirements (Microscopical)

S4.1 When nonmetallic inclusion requirements are specified, the samples for testing shall be taken on a longitudinal direction midway between the center and the surface of the material. The area of the sample to be examined should be agreed upon between the purchaser and the manufacturer, and the test specimen should be hardened by heating and quenched before being polished to avoid pits. The rating of the inclusion count should also be agreed upon and be based upon examination at a magnification of 100 diameters. Resulfurized steels are not subject to inclusion ratings.

S5. Restricted Incidental Elements

S5.1 The purchaser may specify limiting maximum requirements for copper, nickel, chromium, or molybdenum subject to agreement between the manufacturer and the purchaser.

S6. Grain Size

S6.1 The steel shall conform to either the coarse austenitic grain size (except as stated in S6.2), or the fine austenitic grain size requirement of Specification A 29/A 29M.

S6.2 Certain elements, or combinations of elements, such as manganese, sulfur, and lead tend to produce grain refinement and it is technically inappropriate to ensure coarse grain size as measured by the McQuaid-Ehn test on high manganese, high sulfur, and leaded steels such as 1144, 1151, and 11L41.