Designation: A 355 – 89 (Reapproved 2006)

# Standard Specification for Steel Bars, Alloys, for Nitriding[1]

This standard is issued under the fixed designation A 355; 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 alloy steel bars, suitable for surface hardening by nitriding, designated as Classes A, B, C, and D. Class A and Class D bars are general-purpose bars; Class B bars are free-machining bars; Class C bars contain 3.50 % nickel and are characterized by higher core strength. All classes are normally furnished in the hot-rolled, quenched, and tempered condition. However, centerless-ground or turned bars, in any of the classes, may be specified by the purchaser. Also, as-rolled, annealed, or unannealed bars suitable for forging may be purchased to this specification. When as-rolled, annealed, or unannealed bars are furnished, Sections 6, 10, and 11 are not applicable.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered 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

## 3. Ordering Information

3.1 Orders under this specification should include the following as required to adequately describe the desired materials:

3.1.1 Quantity (weight or number of pieces),
3.1.2 Name of material (alloy steel bars, for nitriding),
3.1.3 Surface finish (Section 14),
3.1.4 Cross-sectional shape,
3.1.5 Size,
3.1.6 Length (Section 13),
3.1.7 Class (Section 1),
3.1.8 Thermal treatment (Section 6),
3.1.9 Hardness (Section 11),
3.1.10 Microstructure when desired (Section 7),
3.1.11 Report of ladle analysis if desired (Section 9),
3.1.12 Straightness (Section 10),
3.1.13 ASTM designation A 355, and
3.1.14 End use, exceptions to the specification, or special requirements.

## 4. Process

4.1 The steel shall be made by the electric-furnace process only.

## 5. Discard

5.1 Sufficient discard shall be made from each ingot to ensure freedom from injurious piping and undue segregation.

## 6. Quenching and Tempering

6.1 The bars shall be given a liquid quench followed by a tempering treatment at a temperature not lower than 600°C (1112°F) to produce a fine spheroidized structure.

## 7. Microstructure

7.1 When specified the microstructure resulting from the heat treatment specified in Section 6 shall not show free ferrite in amounts exceeding those prescribed in Table 1. Other percentages of free ferrite may be supplied by agreement between the manufacturer and the purchaser.

7.2 The amount of free ferrite shall be determined by metallographic examination under suitable magnification of a specimen from the bars in the quenched and tempered condition. The number and location of tests and details of the basis of establishing free ferrite shall be as agreed upon between the manufacturer and the purchaser.

## 8. Decarburization

8.1 The maximum depth of total and partial decarburization of hot-rolled bars and heat-treated bars shall not exceed the amounts prescribed in Table 2.

8.2 Centerless-ground or turned bars shall be free from total and partial decarburization.

[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 A01.15 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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**TABLE 1 Permissible Free Ferrite**

| Diameter or Thickness, in. (mm) | Permissible Free Ferrite Area, max, % |
|---|---|
| 1.00 (25.4) and under | 2 |
| Over 1.00 to 3.00 (25.4 to 76.2), incl | 4 |
| Over 3.00 (76.2) | 6 |

**TABLE 2 Permissible Depth of Decarburization**

| Diameter or Distance Between Parallel Faces, in. (mm) | Depth of Decarburization, max, in. (mm) |
|---|---|
| ½ (12.7) and under | 0.030 (0.76) |
| Over ½ to 1 (12.7 to 25.4), incl | 0.035 (0.89) |
| Over 1 to 1½ (25.4 to 38.1), incl | 0.040 (1.02) |
| Over 1½ to 2 (38.1 to 50.8), incl | 0.050 (1.27) |
| Over 2 to 2½ (50.8 to 63.5), incl | 0.060 (1.52) |
| Over 2½ to 3 (63.5 to 76.2), incl | 0.070 (1.78) |
| Over 3 to 5 (76.2 to 127.0), incl | 0.085 (2.16) |
| Over 5 to 8 (127.0 to 203.2), incl | 0.125 (3.18) |

## 9. Heat Analysis

9.1 The steel shall conform to the requirements as to cast or heat (formerly ladle) analysis prescribed in Table 3.

## 10. Straightness

10.1 Unless otherwise specified, all material shall be supplied to a maximum straightness tolerance of ⅛ in. (3.18 mm) in any 5 ft (1.5 m) but it may not exceed the following:
Maximum straightness deviation, in. = ⅛ × (length in feet)/5

## 11. Hardness Test

11.1 The hardness of the steel after quenching and tempering shall conform to one of the ranges as specified in Table 4.

**TABLE 3 Chemical Requirements**

| | Class A | Class B | Class C | Class D |
|---|---|---|---|---|
| Carbon, % | 0.38–0.43 | 0.35–0.40 | 0.22–0.27 | 0.33–0.38 |
| Manganese, % | 0.50–0.70 | 0.70–0.95 | 0.50–0.70 | 0.50–0.70 |
| Phosphorus, max, % | 0.035 | 0.035 | 0.035 | 0.035 |
| Sulfur, max, % | 0.040 | 0.060 | 0.040 | 0.040 |
| Silicon, % | 0.15–0.35 | 0.15–0.35 | 0.15–0.35 | 0.15–0.35 |
| Chromium, % | 1.40–1.80 | 1.20–1.50 | 1.00–1.35 | 1.00–1.30 |
| Aluminum, % | 0.95–1.30 | 0.95–1.30 | 0.95–1.30 | 0.95–1.30 |
| Molybdenum, % | 0.30–0.40 | 0.15–0.25 | 0.20–0.30 | 0.15–0.25 |
| Selenium, % | . . . | 0.15–0.25 | . . . | . . . |
| Nickel, % | . . . | | 3.25–3.75 | . . . |

**TABLE 4 Hardness Requirements**

| Hardness Scale | Hardness | |
|---|---|---|
| | Range 1 | Range 2 |
| Brinell | 223 to 269 | 248 to 302 |
| Rockwell C | 19 to 28 | 24 to 32 |
| Rockwell B | 98 to 104 | 101 to 107 |

## 12. Permissible Variations in Dimensions

12.1 The hot-rolled bars shall not vary from the specified dimensions by more than the amounts prescribed in Specification A 29/A 29M.

12.2 The diameter of centerless ground bars shall not vary from that specified by more than the following:

| Specified Diameter, in. (mm) | Permissible Variations, Over or Under, in. (mm) |
|---|---|
| Under ¼ (6.35) | 0.0005 (0.013) |
| ¼ to 11⁄32 (6.35 to 8.73), incl | 0.001 (0.025) |
| Over 11⁄32 to 19⁄32 (8.73 to 15.08), incl | 0.0015 (0.038) |
| Over 19⁄32 to 1 3⁄32 (15.08 to 27.78), incl | 0.002 (0.051) |
| Over 1 3⁄32 (27.78) | 0.0025 (0.064) |

12.3 The diameter of turned bars shall not vary from that specified by more than the following:

| Specified Diameter, in. (mm) | Permissible Variations, Over or Under, in. (mm) |
|---|---|
| 2 (51) and under | 0.005 (0.13) |
| Over 2 to 4 (51 to 102), incl | 0.0075 (0.19) |
| Over 4 (102) | 0.010 (0.25) |

## 13. Length

13.1 Unless otherwise specified, the bars shall be furnished in lengths of 8 to 12 ft (2.4 to 3.7 m). However, 10 % of the bars will be accepted in shorter lengths, but in no case shall the lengths be less than 5 ft (1.5 m).

## 14. Workmanship, Finish, and Appearance

14.1 Hot-rolled bars shall be sound, and commercially free of excessive scale, cracks, seams, and other injurious imperfections.

14.2 Centerless-ground or turned bars shall have a clean smooth surface and shall be oiled to prevent rusting.

## 15. General Requirements

15.1 Material furnished under this specification shall conform to the requirements of the current edition of Specification A 29/A 29M unless otherwise provided for herein.

## 16. Keywords

16.1 alloy steel bars; nitriding steel; steel bars



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