



Designation: **A295/A295M—09 A295/A295M – 14**

## Standard Specification for High-Carbon Anti-Friction Bearing Steel<sup>1</sup>

This standard is issued under the fixed designation A295/A295M; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

*This standard has been approved for use by agencies of the U.S. Department of Defense.*

### 1. Scope\*

- 1.1 This specification covers high-carbon bearing-quality steel to be used in the manufacture of anti-friction bearings.
- 1.2 Supplementary requirements of an optional nature are provided and when desired shall be so stated in the order.
- 1.3 The values stated in either inch-pound or SI 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:<sup>2</sup>

- A29/A29M Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought
- A370 Test Methods and Definitions for Mechanical Testing of Steel Products
- A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
- A892 Guide for Defining and Rating the Microstructure of High Carbon Bearing Steels
- E45 Test Methods for Determining the Inclusion Content of Steel
- E112 Test Methods for Determining Average Grain Size
- E381 Method of Macroetch Testing Steel Bars, Billets, Blooms, and Forgings
- E1019 Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Fusion Techniques
- E1077 Test Methods for Estimating the Depth of Decarburization of Steel Specimens

#### 2.2 Other ISO Document:<sup>3</sup>

- ISO 683, Part 17 Ball and Roller Bearing Steels

### 3. Ordering Information

- 3.1 Orders for material under this specification should include the following information:
  - 3.1.1 Quantity,
  - 3.1.2 Grade identification,
  - 3.1.3 Specification designation and year of issue,
  - 3.1.4 Dimensions, and
  - 3.1.5 Supplementary requirements, if included.

### 4. Process

- 4.1 The steel shall be made by a process that is capable of providing a high quality product meeting the requirements of this specification.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.28 on Bearing Steels.

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<sup>2</sup> 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.

<sup>3</sup> Available from International Organization for Standardization (ISO), 1 rue de Varembé, Case postale 56, CH-1211, Geneva 20, Switzerland; 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, <http://www.iso.org>.

\*A Summary of Changes section appears at the end of this standard



## 5. Chemical Composition and Analysis

5.1 Typical examples of chemical compositions are shown in [Table 1](#). Other compositions may be specified.

5.2 An analysis of each heat of steel shall be made by the steel manufacturer in accordance with Test Methods, Practices, and Terminology [A751](#). The chemical composition thus determined shall conform to the requirements specified in [Table 1](#) for the ordered grade or to other requirements agreed upon between manufacturer and purchaser.

5.3 Product analysis may be made by the purchaser in accordance with Test Methods, Practices, and Terminology [A751](#). Permissible variations in product analysis shall be in accordance with Specification [A29/A29M](#).

## 6. Sizes, Shapes, and Dimensional Tolerances

6.1 The physical size and shape of the material shall be agreed upon between manufacturer and purchaser.

6.2 Dimensional tolerances for hot-rolled or hot-rolled and annealed bars, in straight lengths or coils, and cold-finished bars 0.500 in. [12.5 mm] and larger in diameter furnished under this specification shall conform to the requirements specified in the latest edition of Specification [A29/A29M](#).

6.3 Dimensional tolerances for cold-finished coils for ball and roller material shall be as shown in [Table 2](#).

6.4 Coil tolerances also apply to cold-finished straight lengths under 0.500 in. [12.5 mm] in diameter.

## 7. Quality Tests

7.1 The supplier shall be held responsible for the quality of the material furnished and shall make the necessary tests to ensure this quality. The supplier shall be required to report results of the micro-inclusion rating tests detailed below. Quality tests shown in [7.2](#) and [7.3](#) are based upon procedures established in Test Methods [E45](#).

7.2 *Sampling*—Samples taken in accordance with the following paragraphs shall be obtained from 4 by 4 in. [100 by 100 mm] rolled billets or forged sections. Tests may be made on smaller or larger sections by agreement between manufacturer and purchaser. A minimum 3 to 1 reduction of rolled billets or forged sections is required for strand cast products.

7.2.1 For top poured products, a minimum of six samples representing the top and bottom of the first, middle, and last usable ingots shall be examined.

7.2.2 For bottom poured products, a minimum of six samples shall be examined and they shall represent the top and bottom of three ingots. One ingot shall be taken at random from the first usable plate poured, one ingot, at random, from the usable plate poured nearest to the middle of the heat, and one ingot, at random, from the last usable plate poured. When two usable plates constitute a heat, two of the sample ingots shall be selected from the second usable plate poured. Where a single usable plate constitutes a heat, any three random ingots may be selected. Other methods of sampling shall be as agreed upon between manufacturer and purchaser.

7.2.3 For strand cast products, a minimum of six samples representing the first, middle, and last portion of the heat cast shall be examined. At least one sample shall be taken from each strand.

7.3 *Inclusion Rating*—The specimens shall be  $\frac{3}{8}$  by  $\frac{3}{4}$  in. [10 by 20 mm] and shall be taken from an area halfway between the center and outside of the billet. The polished face shall be longitudinal to the direction of rolling. The scale used for rating the specimens shall be the Jernkontoret chart described in Test Methods [E45](#), Plate I-F-I-A. Fields with sizes or numbers of all types of inclusions intermediate between configurations shown on the chart shall be classified as the lesser of the rating number. The worst field of each inclusion type from each specimen shall be recorded as the rating for the specimen. Two thirds of all specimens and at least one from each ingot tested, or from the first, middle, and last portion of the strands tested, as well as the average of all specimens, shall not exceed the rating specified in [Table 3](#). If specifically ordered and certified to Supplementary Requirement S4, Type A inclusion ratings shall not exceed 3.0 thin and 2.0 heavy. See S4.1.

TABLE 1 Composition<sup>A,B</sup>

Name	C	Mn	P (max)	S (max)	Si	Cr	Ni (max)	Mo	Cu (max)	O (max) <sup>C</sup>	Al (max) <sup>D</sup>
52100 <sup>E</sup>	0.93-1.05	0.25-0.45	0.025	0.015	0.15-0.35	1.35-1.60	0.25	0.10 (max)	0.30	0.0015	0.050
5195	0.90-1.03	0.75-1.00	0.025	0.015	0.15-0.35	0.70-0.90	0.25	0.10 (max)	0.30	0.0015	0.050
5090M	0.89-1.01	0.50-0.80	0.025	0.015	0.15-0.35	0.40-0.60	0.25	0.08-0.15	0.30	0.0015	0.050
1070M	0.65-0.75	0.80-1.10	0.025	0.015	0.15-0.35	0.20 (max)	0.25	0.10 (max)	0.30	0.0015	0.050
5160	0.56-0.64	0.75-1.00	0.025	0.015	0.15-0.35	0.70-0.90	0.25	0.10 (max)	0.30	0.0015	0.050

<sup>A</sup> Elements not quoted shall not be intentionally added to the steel without the agreement of the purchaser.

<sup>B</sup> Intentional additions of calcium or calcium alloys for deoxidation or inclusion shape control are not permitted unless specifically approved by the purchaser.

<sup>C</sup> Oxygen content applies to product analysis and shall be determined in accordance with Test Methods [E1019](#).

<sup>D</sup> Total aluminum content.

<sup>E</sup> Specified element ranges meet the requirements of ISO 683, Part 17, Table 3, NO. B1, 100CR6.



**TABLE 2 Dimensional Tolerances for Cold-Finished Coils**

Size, in. [mm]	Total Tolerance, in. [mm]
Through 0.096 [2.50]	0.002 [0.05]
Over 0.096 [2.50] to 0.270 [7.00], incl	0.003 [0.08]
Over 0.270 [7.00] to 0.750 [19.0], incl	0.004 [0.10]

**TABLE 3 Inclusion Rating**

Rating Units	
Thin Series	Heavy Series
A—2½	A—1½
B—2	B—1
C—½	C—½
D—1	D—1

**TABLE 3 Inclusion Rating**

Rating Units	
Thin Series	Heavy Series
A—2.5	A—1.5
B—2.0	B—1.0
C—0.5	C—0.5
D—1.0	D—1.0

**8. Grain Size**

8.1 The steels covered by this specification shall have the capability of showing a fine fracture grain size (approximately ASTM No. 8 in accordance with Test Methods E112) when quenched from normal austenitizing temperatures not exceeding 1550°F [840°C].

**9. Decarburization and Surface Imperfections**

9.1 Decarburization and surface imperfections shall not exceed the limits specified in Tables 4 and 5. Decarburization shall be measured using the microscopical methods described in Test Methods E1077.

**10. Microstructure**

10.1 When annealing is specified in the order, the structure shall be rated and reported in accordance with Guide A892 as follows:

10.1.1 *Carbide Size (CS)*—As the appropriate carbide size is dependent on application, the limits shall be as agreed upon between manufacturer and purchaser.

10.1.2 *Carbide Network (CN)*—As the network is influenced by section size, the limits shall be as agreed upon between manufacturer and purchaser.

10.1.3 *Lamellar Content (LC)*—52100 steels shall have a lamellar content not to exceed LC1. Lamellar content of other compositions shall be as agreed upon between manufacturer and purchaser.

10.2 The material shall be free from excessive carbide segregation.

**11. Hardness**

11.1 When annealing is specified in the order, the steel shall have a completely spheroidized microstructure and a hardness as specified in Table 6.

11.2 Small sizes where Rockwell B scale hardness readings are impractical shall have a maximum tensile strength of 110 000 psi (760 MPa); [760 MPa].

11.3 Hardness and tensile tests shall be in accordance with test methods described in Test Methods and Definitions A370.

**TABLE 4 Decarburization and Surface Imperfections for Coils and Bars for Balls and Rollers**

Size, in. [mm]	Decarburization or Surface Imperfections per Side, max, in. [mm]	
	Hot-Rolled or Hot-Rolled Annealed	Cold-Finished Annealed
Through 0.250 [6.50]	0.005 [0.13]	0.003 [0.08]
Over 0.250 [6.50] to 0.500 [12.5], incl	0.006 [0.15]	0.004 [0.10]
Over 0.500 [12.5] to 0.750 [19.0], incl	0.008 [0.20]	0.006 [0.15]
Over 0.750 [19.0] to 1.000 [25.0], incl	0.010 [0.25]	0.008 [0.20]