Standard Specification for
High-Carbon Anti-Friction Bearing Steel

This standard is issued under the fixed designation A 295; 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 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 inch-pound units are to be regarded as the standard.

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
A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
A 892 Guide for Defining and Rating the Microstructure of High Carbon Bearing Steels
E 45 Practice for Determining the Inclusion Content of Steel
E 381 Method of Macroetch Testing, Inspection, and Rating Steel Products, Comprising Bars, Billets, Blooms, and Forgings
E 1019 Test Methods for Determination of Carbon, Sulfur, Nitrogen, Oxygen, and Hydrogen in Steel and in Iron, Nickel, and Cobalt Alloys
E 1077 Test Method for Estimating the Depth of Decarburization of Steel Specimens

2.2 Other Documents:
SAE J418a Grain Size Determination of Steel
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.

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 A 751. 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 A 751. Permissible variations in product analysis shall be in accordance with Specification A 29/A 29M.

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. (12.7 mm) and larger in diameter furnished under this specification shall conform to the requirements specified in the latest edition of Specification A 29/29M.

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. 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
TABLE 1 Composition\textsuperscript{A,B}

<table>
<thead>
<tr>
<th>Element</th>
<th>52100\textsuperscript{C}</th>
<th>5195</th>
<th>UNS K19526</th>
<th>1070M</th>
<th>5160</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>0.93-1.05</td>
<td>0.90-1.03</td>
<td>0.89-1.01</td>
<td>0.65-0.75</td>
<td>0.56-0.64</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.25-0.45</td>
<td>0.75-1.00</td>
<td>0.50-0.80</td>
<td>0.80-1.10</td>
<td>0.75-1.00</td>
</tr>
<tr>
<td>Phosphorus (max)</td>
<td>0.025</td>
<td>0.025</td>
<td>0.025</td>
<td>0.025</td>
<td>0.025</td>
</tr>
<tr>
<td>Sulfur (max)</td>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
</tr>
<tr>
<td>Silicon</td>
<td>0.15-0.35</td>
<td>0.15-0.35</td>
<td>0.15-0.35</td>
<td>0.15-0.35</td>
<td>0.15-0.35</td>
</tr>
<tr>
<td>Chromium</td>
<td>1.35-1.60</td>
<td>0.70-0.90</td>
<td>0.40-0.60</td>
<td>0.40 (max)</td>
<td>0.70-0.90</td>
</tr>
<tr>
<td>Nickel (max)</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Copper (max)</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>0.10 (max)</td>
<td>0.10 (max)</td>
<td>0.08-0.15</td>
<td>0.10 (max)</td>
<td>0.10 (max)</td>
</tr>
<tr>
<td>Aluminum (max)</td>
<td>0.050</td>
<td>0.050</td>
<td>0.050</td>
<td>0.050</td>
<td>0.050</td>
</tr>
<tr>
<td>Oxygen (max)</td>
<td>0.0015</td>
<td>0.0015</td>
<td>0.0015</td>
<td>0.0015</td>
<td>0.0015</td>
</tr>
</tbody>
</table>

\textsuperscript{A} Elements not quoted shall not be intentionally added to the steel without the agreement of the purchaser.

\textsuperscript{B} Intentional additions of calcium or calcium alloys for deoxidation or inclusion shape control are not permitted unless specifically approved by the purchaser.

\textsuperscript{C} Oxygen content applies to product analysis and shall be determined in accordance with Test Method E 1019.

TABLE 2 Dimensional Tolerances for Cold-Finished Coils

<table>
<thead>
<tr>
<th>Size, in. (mm)</th>
<th>Total Tolerance, in. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Through 0.096 (2.44)</td>
<td>0.002 (0.05)</td>
</tr>
<tr>
<td>Over 0.096 (2.44) to 0.270 (6.86), incl</td>
<td>0.003 (0.08)</td>
</tr>
<tr>
<td>Over 0.270 (6.86) to 0.750 (19.1), incl</td>
<td>0.004 (0.10)</td>
</tr>
</tbody>
</table>

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) (SAE J418a) when quenched from normal austenitizing temperatures not exceeding 1550°F (843°C).

9. Decarburization and Surface Imperfections

9.1 Decarburization and surface imperfections shall not exceed the limits specified in Table 4 and Table 5. Decarburization shall be measured using the microscopical methods described in Test Method E 1077.

10. Microstructure

10.1 When annealing is specified in the order, the structure shall be rated and reported in accordance with Guide A 892 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.

TABLE 3 Inclusion Rating

<table>
<thead>
<tr>
<th>Thin Series</th>
<th>Rating Units</th>
<th>Heavy Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>A—(2\frac{1}{6})</td>
<td>B—2</td>
<td>A—(1\frac{1}{6})</td>
</tr>
<tr>
<td>B—(1\frac{1}{6})</td>
<td>C—(1\frac{1}{6})</td>
<td></td>
</tr>
<tr>
<td>C—(1\frac{1}{6})</td>
<td>D—1</td>
<td>D—1</td>
</tr>
</tbody>
</table>
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).

11.3 Hardness and tensile tests shall be in accordance with test methods described in Test Methods and Definitions A 370.

12. **Inspection**

12.1 The manufacturer shall afford the purchaser’s inspector all reasonable facilities necessary to satisfy him that the material is being produced and furnished in accordance with this specification. Mill inspection by the purchaser shall not interfere unnecessarily with the manufacturer’s operations. All tests and inspections shall be made at the place of manufacture, unless otherwise agreed to.

13. **Certification and Reports**

13.1 Upon request of the purchaser in the contract or order, a manufacturer’s certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment. Special requirements agreed to at the time of purchase shall be noted on the certification.

### SUPPLEMENTARY REQUIREMENTS

One or more of the supplementary requirements described below apply when included in the purchaser’s order or contract. When so included, a supplementary requirement shall have the same force as if it were in the body of the specification. Supplementary requirements’ details not fully described shall be agreed upon between the purchaser and the supplier, but shall not negate any of the requirements in the body of the specification.

**S1. Titanium Content**

S1.1 The purchaser may specify that the analysis of titanium be provided by agreement with the steel manufacturer.

**S2. “SAM” Inclusion Rating System**

S2.1 The purchaser may specify that the “SAM” inclusion rating system described in Method E of Practice E 45, be used in addition to the micro-inclusion rating system described in 7.4.

S2.2 **Sampling**—See 7.2.

S2.3 **Limits**—The “SAM” rating for B-type inclusions shall not exceed fifteen. The “SAM” rating for D-type inclusions shall not exceed ten.
S3. Magnetic Particle Method

S3.1 The purchaser may specify that the magnetic particle method described below be used in addition to the micro-inclusion rating system described in 7.4. The magnetic particle method measures bearing steel cleanliness by evaluating the total length of macro-inclusions for a stated area or per unit area. Results are commonly expressed in millimeters per square metre.

S3.2 Sampling—See 7.2.

S3.3 Test specimens shall be straight cylinder quarter section samples prepared and examined in accordance with the magnetic particle method of Practice E 45.

S3.4 For purposes of calculation, an inclusion length shall be taken as the mean length of the length bracket into which it falls; that is, an inclusion in the \( \frac{1}{16} \) to \( \frac{1}{8} \) in. bracket shall be taken as being \( \frac{3}{32} \) in. in length. The sum of all lengths for each specimen shall be determined and expressed as total length per area inspected. The average total length per area inspected of all six specimens shall not exceed 200 mm/m² (or equivalent).

S4. Sulfur Requirement for Machinability

S4.1 A sulfur content in the range of 0.015–0.030 % may be specified for improved machinability.

S4.2 When this supplementary requirement is specified, the sulfide (Type A) ratings of 7.4 shall be 3.0 thin and 2.0 heavy.

S4.3 The manufacturer’s certification shall state that material was produced to this supplementary requirement when applicable.

S5. Sample Reduction Ratio

S5.1 For the sampling described in 7.2, the purchaser may specify that the reduction ratio from as-cast section to test section be provided.