



Designation: A866 – 01

Standard Specification for Medium Carbon Anti-Friction Bearing Steel¹

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1. Scope

1.1 This specification covers medium 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*:²

A29/A29M Specification for Steel Bars, Carbon and Alloy, Hot-Wrought, General Requirements for³

A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products⁴

E45 Test Methods for Determining the Inclusion Content of Steel⁴

E112 Test Methods for Determining Average Grain Size⁴

E381 Method of Macroetch Testing Steel Bars, Billets, Blooms, and Forgings⁵

E1019 Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Fusion Techniques⁴

E1077 Test Methods for Estimating the Depth of Decarburization of Steel Specimens

2.2 *ISO Standard*:

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 (weight or pieces),

3.1.2 Grade identification,

3.1.3 ASTM designation and year of issue,

3.1.4 Dimensions, and

3.1.5 Supplementary requirements, if included.

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 A01.28 on Bearing Steels.

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² *Annual Book of ASTM Standards*, Vol 01.05.

³ *Annual Book of ASTM Standards*, Vol 01.03.

⁴ *Annual Book of ASTM Standards*, Vol 03.01.

⁵ *Annual Book of ASTM Standards*, Vol 03.06.

4. Materials and Manufacture

4.1 *Process*:

4.1.1 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 composition 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 the manufacturer and the 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 the manufacturer and the 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 **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. 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 on the results of the macroetch and micro-inclusion rating tests detailed below. Quality tests shown in **7.2** through **7.4** are based upon procedures established in Practice **E45**.

7.2 *Sampling*—Samples taken in accordance with the following paragraphs shall be obtained from 4 by 4 in. (102 by 102 mm) rolled billets or forged sections. Tests may be made

TABLE 1 Chemical Composition^{A,B}

Number ^C	Name	C	Mn	P (max)	S (max)	Si	Cr	Mo	V	Cu (max)	O (max) ^D	Al (max)
...	1030	0.28 to 0.34	0.60 to 0.90	0.025	0.025	0.15 to 0.35	...	...	...	0.30	0.0020	0.050
...	1040	0.37 to 0.44	0.60 to 0.90	0.025	0.025	0.15 to 0.35	...	...	...	0.30	0.0020	0.050
...	1050	0.48 to 0.55	0.60 to 0.90	0.025	0.025	0.15 to 0.35	...	...	...	0.30	0.0020	0.050
...	1541	0.36 to 0.44	1.35 to 1.65	0.025	0.025	0.15 to 0.35	...	...	...	0.30	0.0020	0.050
...	1552	0.47 to 0.55	1.20 to 1.50	0.025	0.025	0.15 to 0.35	...	...	...	0.30	0.0020	0.050
...	4130	0.28 to 0.33	0.40 to 0.60	0.025	0.025	0.15 to 0.35	0.80 to 1.10	0.15 to 0.25	...	0.30	0.0020	0.050
...	4140	0.38 to 0.43	0.75 to 1.00	0.025	0.025	0.15 to 0.35	0.80 to 1.10	0.15 to 0.25	...	0.30	0.0020	0.050
...	4150	0.48 to 0.53	0.75 to 1.00	0.025	0.025	0.15 to 0.35	0.80 to 1.10	0.15 to 0.25	...	0.30	0.0020	0.050
...	5140	0.38 to 0.43	0.70 to 0.95	0.025	0.025	0.15 to 0.35	0.70 to 0.90	...	...	0.30	0.0020	0.050
...	5150	0.48 to 0.53	0.70 to 0.90	0.025	0.025	0.15 to 0.35	0.70 to 0.90	...	...	0.30	0.0020	0.050
...	6150	0.48 to 0.53	0.70 to 0.90	0.025	0.025	0.15 to 0.35	0.80 to 1.10	...	0.15 min	0.30	0.0020	0.050
B40	C56E2	0.52 to 0.60	0.60 to 0.90	0.025	0.015	0.40 max	...	...	...	0.30	0.0020	0.050
B41	56Mn4	0.52 to 0.60	0.90 to 1.20	0.025	0.015	0.40 max	...	...	...	0.30	0.0020	0.050
B43	43CrMo4	0.40 to 0.46	0.60 to 0.90	0.025	0.015	0.40 max	0.90 to 1.20	0.15 to 0.30	...	0.30	0.0020	0.050

^A Elements not quoted shall not be intentionally added to the steel without the agreement of the purchaser.

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

^C Steels B40, B41, and B43 meet the requirements of **ISO 683**, Part 17, Second Edition, Table 3.

^D Oxygen content applies to product analysis and shall be determined in accordance with Test Methods **E1019**.

TABLE 2 Dimensional Tolerances for Cold-Finished Coils

Size, in. (mm)	Total Tolerance, in. (mm)
Through 0.096 (2.44)	0.002 (0.05)
Over 0.096 (2.44) to 0.270 (6.86), incl	0.003 (0.08)
Over 0.270 (6.86) to 0.750 (19.1), incl	0.004 (0.10)

on smaller or larger sections by agreement with the 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 by 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 **Macroetch**—Specimens representative of cross sections of billets shall be macroetched and rated in accordance with Test Method **E381** in hydrochloric acid and water (1:1) at a temperature of 160 to 180°F (71 to 82°C). Such specimens shall not exceed S2, R2, and C2 of Test Method **E381**.

7.4 **Inclusion Rating**—The specimens shall be 3/8 by 3/4 in. (9.5 by 19.1 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 Practice **E45**, Plate I-r. 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**.

8. Grain Size

8.1 The grain size shall be from 5 to 8 as defined in Test Methods **E112** (see Plate 4, Austenitic Grain Size in Steels), with occasional grains as large as No. 3 permissible. Material not meeting this requirement may be normalized at 1700°F (925°C) or above, and retested.

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 Method **E1077**.

10. Microstructure and Hardness

10.1 Material may be ordered as hot rolled or thermally treated. When thermally treated, the acceptance criteria for microstructure and hardness shall be agreed upon between the manufacturer and the purchaser. No hardness limits shall apply for as-hot-rolled materials.

11. Inspection

11.1 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

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