Designation: A 485 – 03

An American National Standard

Standard Specification for High Hardenability Antifriction Bearing Steel[1]

This standard is issued under the fixed designation A 485; 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 hardenability modifications of high-carbon bearing quality steel to be used in the manufacture of antifriction 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[2]

A 255 Test Method of End-Quench Test for Hardenability of Steel[2]

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products[3]

E 45 Test Methods For Determining the Inclusion Content of Steel[4]

E 381 Method of Macroetch Testing, Inspection, and Rating Steel Products, Comprising Bars, Billets, Blooms, and Forgings[4]

E 1019 Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel and in Iron, Nickel, and Cobalt Alloys[5]

E 1077 Test Method for Estimating the Depth of Decarburization of Steel Specimens[4]

2.2 *Other Standards:*

SAE J148a Grain Size Determination of Steel[6]

ISO 683 Part 17: Ball and Roller Bearing Steels[7]

3. Ordering Information

3.1 Orders for material under this specification should include the following information:

3.1.1 Quantity (weight or number of pieces),

3.1.2 Grade identification,

3.1.3 ASTM designation and year of issue,

3.1.4 Dimensions,

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, Practice, 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 furnished under this specification shall conform to the requirements specified in the latest edition of Specification A 29/A 29M.

---

[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.

Current edition approved April 10, 2003. Published July 2003. Originally approved in 1963. Last previous edition approved in 2000 as A 485–00.

[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.

[6] Available from The Engineering Society for Advanced Mobility of Land, Sea, Air and Space, 400 Commonwealth Drive, Warrendale, PA 15096-001.

[7] Available from the International Organization for Standardization (ISO), 1, rue de Varembé, Case postale 56, CH-1211, Genève 20, Switzerland.

Copyright © ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States.

Copyright ASTM International
Provided by IHS under license with ASTM
No reproduction or networking permitted without license from IHS
Not for Resale

TABLE 1 Chemical Composition[A,B]

Number[C]	Name	C	Mn	P (max)	S (max)	Si	Cr	Ni (max)	Ti (max)	Cu (max)	Mo	O (max)[D]	Al (max)
1	Grade 1	0.90–1.05	0.90–1.20	0.025	0.015	0.45–0.75	0.90–1.20	0.25	0.0050	0.30	0.10 (max)	0.0015	0.050
2	Grade 2	0.85–1.00	1.40–1.70	0.025	0.015	0.50–0.80	1.40–1.80	0.25	0.0050	0.30	0.10 (max)	0.0015	0.050
3	Grade 3	0.95–1.10	0.65–0.90	0.025	0.015	0.15–0.35	1.10–1.50	0.25	0.0050	0.30	0.20–0.30	0.0015	0.050
4	Grade 4	0.95–1.10	1.05–1.35	0.025	0.015	0.15–0.35	1.10–1.50	0.25	0.0050	0.30	0.45–0.60	0.0015	0.050
B2	100CrMnSi4–4	0.93–1.05	0.90–1.20	0.025	0.015	0.45–0.75	0.90–1.20	. . .	[E]	0.30	0.10 (max)	0.0015	0.050
B3	100CrMnSi6–4	0.93–1.05	1.00–1.20	0.025	0.015	0.45–0.75	1.40–1.65	. . .	[E]	0.30	0.10 (max)	0.0015	0.050
B4	100CrMnSi6–6	0.93–1.05	1.40–1.70	0.025	0.015	0.45–0.75	1.40–1.65	. . .	[E]	0.30	0.10 (max)	0.0015	0.050
B5	100CrMo7	0.93–1.05	0.25–0.45	0.025	0.015	0.15–0.35	1.65–1.95	. . .	[E]	0.30	0.15–0.30	0.0015	0.050
B6	100CrMo7–3	0.93–1.05	0.60–0.80	0.025	0.015	0.15–0.35	1.65–1.95	. . .	[E]	0.30	0.20–0.35	0.0015	0.050
B7	100CrMo7–4	0.93–1.05	0.60–0.80	0.025	0.015	0.15–0.35	1.65–1.95	. . .	[E]	0.30	0.40–0.50	0.0015	0.050
B8	100CrMnMoSi8–4–6	0.93–1.05	0.80–1.10	0.025	0.015	0.40–0.60	1.80–2.05	. . .	[E]	0.30	0.50–0.60	0.0015	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 B2 through B8 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 E 1019.
[E] A maximum titanium content may be agreed upon at the time of inquiry and order.

7. Quality Tests

7.1 The supplier shall be held responsible for the quality of the material furnished and shall make the necessary tests detailed below: Quality tests shown in 7.1 through 7.4 are based upon procedures established in Practice E 45.

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 on smaller or larger sections by agreement with the purchaser. A minimum of 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 taken from semi-finished or finished product representing 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 a heat is constituted by two usable plates, two of the sample ingots shall be selected from the second usable plate poured. When a heat consists of a single usable plate, 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 *Macroetch*—Specimens representative of cross-sections of billets shall be macroetched and rated in accordance with Method E 381 in hydrochloric acid and water (1.1) at 60 to 180°F (71 to 82°C). Such specimens shall not exceed S2, R2, C2 of Method E 381.

7.4 *Inclusion Rating*—Specimens approximately ⅜ by ¾ in. (9.5 by 19.1 mm) 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 chart described in Practice E 45, Method A, Plate I-r. Inclusion fields with sizes or numbers 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 2.

8. Grain Size

8.1 The steels covered by this specification shall have the capability of showing fine fracture grain size (approximately ASTM No. 8) (SAE J418a) when quenched from normal austenizing temperatures not exceeding 1550°F (843°C).

9. Hardenability

9.1 Each heat shall be tested for hardenability. Normalizing followed by spheroidize annealing shall precede heating for end quenching. In heating for end quenching, the test specimens shall be held for a minimum of 30 min at 1500 ± 8°F (815 ± 4.5°C). End-quench procedure shall be in accordance with Test Method A 255. The "J" values for hardenability as shown in Table 3 shall apply.

TABLE 2 Inclusion Rating

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

Copyright ASTM International
Provided by IHS under license with ASTM
No reproduction or networking permitted without license from IHS
Not for Resale

TABLE 3 Hardenability Values

	Rockwell C		
	Minimum Rockwell C Values at Sixteenth of Inch		
Grade	10	20	28
1	46	. . .	. . .
2	. . .	52	32
3	46	. . .	. . .
4	. . .	52	35

10. Decarburization and Surface Imperfections

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

11. Microstructure and Hardness

11.1 The material shall be free of excessive carbide segregation.

11.2 When annealing is specified in the order, the steel shall have a microstructure completely spheroidized, or as agreed upon, and the maximum hardness as specified in Table 5.

TABLE 5 Hardness Limits for Annealed Material

Product	Condition	Maximum Hardness	
		Brinell	Rockwell
Coils	hot-rolled, annealed	. . .	B 97
Bars and tubes	hot-rolled, annealed	217	. . .
Coils	annealed, cold drawn (stress relieved)	. . .	B 92
Coils, bars, and tubes	annealed, cold drawn[A]	260	. . .

[A] Cold swaged material is not included.

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 must be noted on the certification.

TABLE 4 Decarburization and Surface Imperfections for Bars and Tubes

Size, in. (mm)	Maximum Decarburization or Surface Imperfections per Side, in. (mm)				
	Hot-Rolled Bars	Hot-Rolled Annealed		Cold-Finished Annealed	
		Bars	Tubes	Bars	Tubes
Over 1.000 (25.4) to 2.000 (50.8), incl	0.017 (0.43)	0.022 (0.56)	0.020 (0.51)	0.017 (0.43)	0.014 (0.36)
Over 2.000 (50.8) to 3.000 (76.2), incl	0.025 (0.64)	0.030 (0.76)	0.030 (0.76)	0.025 (0.64)	0.019 (0.48)
Over 3.000 (76.2) to 4.000 (101.6), incl	0.035 (0.89)	0.045 (1.14)	0.035 (0.89)	. . .	0.024 (0.61)
Over 4.000 (101.6) to 5.000 (127.0), incl	0.055 (1.40)	0.065 (1.65)	0.040 (1.02)	. . .	0.028 (0.71)

Copyright ASTM International
Provided by IHS under license with ASTM
No reproduction or networking permitted without license from IHS
Not for Resale

SUPPLEMENTARY REQUIREMENTS

One or more of the supplementary requirements described below apply when included in 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. "SAM" Inclusion Rating System

S1.1 The purchaser may specify that the "SAM" inclusion rating method, described in Method E of Practice E 45, be used in addition to the micro-inclusion rating method described in 7.4.

S1.2 *Sampling*—See Section 7.

S1.3 *Limits*—The "SAM" rating for Type B inclusions shall not exceed 15. The "SAM" rating for Type D inclusions shall not exceed 10.

S2. Magnetic Particle Method

S2.1 The purchaser may specify that the magnetic particles 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 mm/m^2.

S2.2 *Sampling*—See 7.2.

S2.3 Test specimens shall be straight cylinder quarter section samples prepared and examined in accordance with the magnetic particle method of Practice E 45.

S2.4 For purposes of calculation, an inclusion length shall be taken as the mean length of the length bracket in which it falls; that is, an inclusion in the 1⁄16 to 1⁄8 in. bracket shall be taken as being 3⁄32 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/m^2 (or equivalent).

S3. Sulfur Requirements for Machinability

S3.1 The sulfur content shall be 0.015–0.030 %.

S3.2 The sulfide (type A) rating units in Table 2 shall be 3.0 thin and 2.0 heavy.

S3.3 The manufacturer's certification shall state that material was produced to this supplementary requirement when applicable.

S4. Calculated Hardenability

S4.1 A calculated hardenability shall be used in lieu of the requirements in Section 9. The method used shall be agreed upon between the purchaser and the steel supplier at the time of inquiry and order.

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.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).

Copyright ASTM International
Provided by IHS under license with ASTM
No reproduction or networking permitted without license from IHS
Not for Resale