



Designation: A756 – 17 (Reapproved 2022)

Standard Specification for Stainless Anti-Friction Bearing Steel¹

This standard is issued under the fixed designation A756; 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 the requirements for chromium-carbon bearing quality stainless 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 standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

A484/A484M Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings

A751 Test Methods and Practices for Chemical Analysis of Steel Products

E45 Test Methods for Determining the Inclusion Content of Steel

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 Inert Gas Fusion Techniques

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

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 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.

2.2 Other Standards:

ISO 683 Part 17 Ball and Roller Bearing Steels³

SAE J418a Grain Size Determination of Steel⁴

3. Ordering Information

3.1 Orders for material under 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, shape, and

3.1.5 Supplementary Requirements, if desired.

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

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 and Practices A751. The chemical composition thus determined shall conform to the requirements specified in Table 1 for the ordered grade or to requirements agreed upon between the manufacturer and the purchaser.

5.3 Product analysis may be made by the purchaser in accordance with Test Methods and Practices A751. Permissible variations in product analysis shall be made in accordance with Specification A484/A484M.

6. Dimensions, Mass, and Permissible Variations

6.1 The 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

³ Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.

⁴ Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, <http://www.sae.org>.

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

TABLE 1 Chemical Composition^{A, B}

ISO ^C	Name	C	Mn	P (max)	S (max)	Si	Cr	Ni	Mo	Cu (max)	O (max) ^D	Al (max)	Other
...	440C	0.95–1.20	1.00 max	0.040	0.030	1.00 max	16.00–18.00	0.75 max	0.40–0.65	0.50	0.0020	0.050	...
...	X30CrMoN15-1	0.25–0.35	1.00 max	0.030	0.025	1.00 max	14.00–16.00	0.30–0.50	0.85–1.10	...	0.0020	...	N 0.300–0.500
ISO	X47Cr14	0.43–0.50	1.00 max	0.040	0.015	1.00 max	12.50–14.50	...	...	...	0.0020	...	...
ISO	X65Cr14	0.60–0.70	1.00 max	0.040	0.015	1.00 max	12.50–14.50	...	0.75 max	...	0.0020	...	...
ISO	X108CrMo17	0.95–1.20	1.00 max	0.040	0.015	1.00 max	16.00–18.00	...	0.40–0.80	...	0.0020	...	...
ISO	X40CrMoVN16-2	0.37–0.45	0.60 max	0.025	0.015	0.60 max	15.00–16.50	0.30 max	1.50–1.90	...	...	...	V 0.20–0.40
ISO	X89CrMoV18-1	0.85–0.95	1.00 max	0.040	0.015	1.00 max	17.00–19.00	...	0.90–1.30	...	0.0020	...	V 0.07–0.12

^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 listed as ISO meet the requirements of ISO 683, Part 17, Third Edition, Table 3.

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

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 A484/A484M.

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. (12.7 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 on the results of the macroetch and microinclusion rating tests detailed below. Quality tests shown in 7.2 through 7.4 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 in. by 4 in. (102 mm by 102 mm) rolled billets or forged sections. Tests may be made 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 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 the manufacturer and the 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 the full cross section of bars, billets, or blooms shall be macroetched and rated in accordance with Method E381 in hydrochloric acid and water (1:1) at a temperature of 160 °F to 180 °F (71 °C to 82 °C). Such specimens shall not exceed S2, R2, C2 of Method E381. Indications due to sulfur segregation (commonly referred to as Type A segregates) are not to be included in the rating. For ingot cast material only, if the size and weight of the bars, billets, or blooms prevent the full cross section from being macroetched, an oversize quarter-section may be used as an alternative. The quarter-section must meet the reduction requirement of 7.2 and contain both the surface and center of the original cross section before reduction.

7.4 *Inclusion Rating*—The specimens shall be 3/8 in. by 3/4 in. (9.5 mm 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 Test Methods E45, Plate 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.

8. Response to Heat Treatment

8.1 For chemical composition 440C, specimens with sections 3/8 in. (9.5 mm) in thickness, cut from a bar, billet, or forging, shall be placed in a furnace that is at 1875 °F ± 10 °F (1023.8 °C ± 5.5 °C), allowed to heat to 1875 °F ± 10 °F, held at heat 25 min, and cooled in still air. Hardness of such specimens shall be not lower than 58 HRC.

8.2 Samples heat treated as in 8.1 shall show a fracture grain size of No. 6 or finer. (See SAE J418a.)

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 to 0.270 (2.44 to 6.86), incl	0.003 (0.08)
Over 0.270 to 0.750 (6.86 to 19.1), incl	0.004 (0.10)

TABLE 3 Inclusion Rating

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

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 (6.35)	0.005 (0.13)	0.003 (0.08)
Over 0.250 (6.35) to 0.500 (12.7), incl	0.006 (0.15)	0.004 (0.10)
Over 0.500 (12.7) to 0.750 (19.1), incl	0.008 (0.20)	0.006 (0.15)
Over 0.750 (19.1) to 1.000 (25.4), incl	0.010 (0.25)	0.008 (0.20)

TABLE 5 Decarburization and Surface Imperfections for Bars and Tubes

Size, in. (mm)	Decarburization or Surface Imperfections per Side, max, in. (mm)				
	Hot-Rolled Bars	Hot-Rolled Annealed		Cold-Finished Annealed	
		Bars	Tubes	Bars	Tubes
Through 1.000 (25.4)	0.012 (0.31)	0.015 (0.38)	0.012 (0.31)	0.012 (0.31)	0.010 (0.21)
Over 1.000 (25.4) to 2.000 (50.8), incl	0.017 (0.43)	0.022 (0.56)	0.020 (0.51)	0.015 (0.38)	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)

TABLE 6 Maximum Hardness for Annealed Material

Product	Condition	Maximum Hardness	
		Brinell	Rockwell
Coils	hot-rolled-annealed	...	25 HRC
Bars and tubes	hot-rolled-annealed	255 HB	...
Coils, bars, and tubes	cold-drawn-annealed	255 HB	100 HRB
Coils, bars, and tubes	annealed-cold-drawn	as agreed upon between the purchaser and the manufacturer	

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 Methods **E1077**.

10. Microstructure and Hardness

10.1 The material shall be free of excessive carbide segregation.

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

10.3 Small sizes where Rockwell B scale hardness readings are impractical shall show a maximum tensile strength of 115 000 psi (792 MPa).

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 tests and inspections shall be made at the place of manufacture, unless otherwise agreed to.

12. Certification and Reports

12.1 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 the shipment.

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. Residual Elements

S1.1 The purchaser may specify that the analysis of titanium, aluminum, and/or oxygen (Test Methods **E1019**) be provided by agreement with the steel manufacturer. The number and location of samples shall be by agreement between the purchaser and manufacturer.

S2. Calcium Additions

S2.1 Intentional additions of calcium or calcium alloys for deoxidation or inclusion shape control are not permitted unless specifically approved by the purchaser. The use of lime or fluorspar, or both, in the steelmaking slag is acceptable.

S3. Magnetic Particle Method

S3.1 The purchaser may specify that the magnetic particle method described be used in addition to the microinclusion rating system described in **7.4**. The magnetic particle method measures bearing steel cleanliness by evaluating the total

length of macroinclusions for a stated area or per unit area. Results are commonly expressed in millimetres 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 Test Methods **E45**.

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. Sample Reduction Ratio

S4.1 For the sampling described in **7.2**, the purchaser may specify that the reduction ratio from as-cast section to test section be provided.

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A756-09(2014)^{e1}) that may impact the use of this standard. (Approved Sept. 1, 2017.)

- (1) **Table 1**—ISO chemical composition designations revised.
- (2) **Table 1**—Grade X40CrMoVN16-2 was added. Corrected chemistry for Grade X65Cr14.
- (3) **7.3**—Macroetch was revised. Defined specimen to include full cross section of steel. For ingot cast material, added

oversize quarter-section as an alternative. Excluded sulfur segregation from the rating.

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