



Designation: A534 – 17 (Reapproved 2022)

Standard Specification for Carburizing Steels for Anti-Friction Bearings¹

This standard is issued under the fixed designation A534; 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 U.S. Department of Defense.

1. Scope*

1.1 This specification covers the requirements for carburizing 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 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

[A29/A29M Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought](#)

[A255 Test Methods for Determining Hardenability of Steel](#)

[A304 Specification for Carbon and Alloy Steel Bars Subject to End-Quench Hardenability Requirements](#)

[A510/A510M Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel](#)

[A519/A519M Specification for Seamless Carbon and Alloy Steel Mechanical Tubing](#)

[A751 Test Methods and Practices for Chemical Analysis of Steel Products](#)

[A752 Specification for General Requirements for Wire Rods and Coarse Round Wire, Alloy Steel \(Withdrawn 2011\)](#)³

[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 Inert Gas Fusion Techniques](#)

[E1077 Test Methods for Estimating the Depth of Decarburization of Steel Specimens](#)

2.2 *ISO Standard:*⁴

[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 Alloy grade identification,

3.1.3 Specification designation and year of issue,

3.1.4 Dimensions, shape, and

3.1.5 Supplementary requirements.

4. Materials and Manufacture

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 and Practices [A751](#). The chemical composition thus determined shall conform to the requirements specified in [Table 1](#) for the

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 and Power Transmission 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.

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.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)
...	4118H	0.17 - 0.23	0.60 - 1.00	0.025	0.015	0.15 - 0.35	0.30 - 0.70	...	0.08 - 0.15	0.30	0.0020	0.050
...	4320H	0.17 - 0.23	0.40 - 0.70	0.025	0.015	0.15 - 0.35	0.35 - 0.65	1.55 - 2.00	0.20 - 0.30	0.30	0.0020	0.050
...	4620H	0.17 - 0.23	0.35 - 0.75	0.025	0.015	0.15 - 0.35	...	1.55 - 2.00	0.20 - 0.30	0.30	0.0020	0.050
...	4720H	0.17 - 0.23	0.45 - 0.75	0.025	0.015	0.15 - 0.35	0.30 - 0.60	0.85 - 1.25	0.15 - 0.25	0.30	0.0020	0.050
...	4817H	0.14 - 0.20	0.30 - 0.70	0.025	0.015	0.15 - 0.35	...	3.20 - 3.80	0.20 - 0.30	0.30	0.0020	0.050
...	4820H	0.17 - 0.23	0.40 - 0.80	0.025	0.015	0.15 - 0.35	...	3.20 - 3.80	0.20 - 0.30	0.30	0.0020	0.050
...	5120H	0.17 - 0.23	0.60 - 1.00	0.025	0.015	0.15 - 0.35	0.60 - 1.00	...	...	0.30	0.0020	0.050
...	8617H	0.14 - 0.20	0.60 - 0.95	0.025	0.015	0.15 - 0.35	0.35 - 0.65	0.35 - 0.75	0.15 - 0.25	0.30	0.0020	0.050
...	8620H	0.17 - 0.23	0.60 - 0.95	0.025	0.015	0.15 - 0.35	0.35 - 0.65	0.35 - 0.75	0.15 - 0.25	0.30	0.0020	0.050
...	9310H	0.07 - 0.13	0.40 - 0.70	0.025	0.015	0.15 - 0.35	1.00 - 1.45	2.95 - 3.55	0.08 - 0.15	0.30	0.0020	0.050
ISO	20Cr3+H	0.17 - 0.23	0.60 - 1.00	0.025	0.015	0.40 max	0.60 - 1.00	...	...	0.30	0.0020	0.050
ISO	20Cr4+H	0.17 - 0.23	0.60 - 0.90	0.025	0.015	0.40 max	0.90 - 1.20	...	...	0.30	0.0020	0.050
ISO	20MnCr4-2+H	0.17 - 0.23	0.65 - 1.10	0.025	0.015	0.40 max	0.40 - 0.75	...	...	0.30	0.0020	0.050
ISO	17MnCr5+H	0.14 - 0.19	1.00 - 1.30	0.025	0.015	0.40 max	0.80 - 1.10	...	...	0.30	0.0020	0.050
ISO	19MnCr5+H	0.17 - 0.22	1.10 - 1.40	0.025	0.015	0.40 max	1.00 - 1.30	...	...	0.30	0.0020	0.050
ISO	15CrMo4+H	0.12 - 0.18	0.60 - 0.90	0.025	0.015	0.40 max	0.90 - 1.20	...	0.15 - 0.25	0.30	0.0020	0.050
ISO	20CrMo4+H	0.17 - 0.23	0.60 - 0.90	0.025	0.015	0.40 max	0.90 - 1.20	...	0.15 - 0.25	0.30	0.0020	0.050
ISO	20MnCrMo4-2+H	0.17 - 0.23	0.65 - 1.10	0.025	0.015	0.40 max	0.40 - 0.75	...	0.10 - 0.20	0.30	0.0020	0.050
ISO	20MnNiCrMo3-2+H	0.17 - 0.23	0.60 - 0.95	0.025	0.015	0.40 max	0.35 - 0.70	0.40 - 0.70	0.15 - 0.25	0.30	0.0020	0.050
ISO	20NiCrMo7+H	0.17 - 0.23	0.40 - 0.70	0.025	0.015	0.40 max	0.35 - 0.65	1.60 - 2.00	0.20 - 0.30	0.30	0.0020	0.050
ISO	18CrNiMo7-6+H	0.15 - 0.21	0.50 - 0.90	0.025	0.015	0.40 max	1.50 - 1.80	1.40 - 1.70	0.25 - 0.35	0.30	0.0020	0.050
ISO	18NiCrMo14-6+H	0.15 - 0.20	0.40 - 0.70	0.025	0.015	0.40 max	1.30 - 1.60	3.25 - 3.75	0.15 - 0.25	0.30	0.0020	0.050
ISO	16NiCrMo16-5+H	0.14 - 0.18	0.25 - 0.55	0.025	0.015	0.40 max	1.00 - 1.40	3.80 - 4.30	0.20 - 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 listed as ISO meet the requirements of ISO 683, Part 17, Third Edition, Table 3 and Table 5.

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

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 and Practices A751. Permissible variations in product analysis shall be in accordance with Specification A29/A29M, Practices, and Terminology.

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 shall conform to the requirements specified in Specifications A29/A29M, A510/A510M, A519/A519M, or A752 as appropriate for the material or as agreed between manufacturer and purchaser.

6.3 The dimensional tolerances for the forgings shall conform to the requirements of the engineering drawing.

7. Quality Assurance

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 micro-inclusion rating tests detailed below. Quality tests shown in 7.2 through 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 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 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 usable portion of the heat cast shall be examined. At least one sample shall be taken from each strand.

7.3 *Inclusion Rating*—The polished face of 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 or forged sections. 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, Method A, 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 2.

8. Grain Size

8.1 The grain size shall be six or finer as defined in Test Methods E112 (see Plate 4, austenitic grain size in steels).

TABLE 2 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

TABLE 3 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
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 4 Decarburization and Surface Imperfections for Bars and Tubes

Size, in. (mm)	Decarburization and Surface Imperfections per side, max, in. (mm)				
	Hot-Rolled Bars	Annealed		Cold-Finished	
		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)

Material not meeting this requirement may be normalized at 1700 °F (927 °C) or above and retested.

9. Hardenability

9.1 Each heat shall be tested for hardenability in accordance with Test Methods [A255](#) or ISO 683 Part 17 for the ISO chemical compositions in [Table 1](#). The “J” values for hardenability shall conform to limits specified in Specification [A304](#), ISO 683 Part 17, or as agreed upon by manufacturer and purchaser.

10. Decarburization and Surface Imperfections

10.1 Decarburization and surface imperfections shall not exceed the limits specified in [Tables 3 and 4](#). Decarburization shall be measured using the microscopical methods described in Test Methods [E1077](#).

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 upon.

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 shipment. Special requirements agreed to at the time of purchase must be noted on the certification.