Designation: A484/A484M – 20a

Standard Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings[1]

This standard is issued under the fixed designation A484/A484M; 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.

NOTE—Table 1 was corrected editorially and the yeardate changed on May 5, 2020.

1. Scope*

1.1 This specification[2] covers general requirements that shall apply to wrought stainless steel bars, shapes, forgings, and billets or other semi-finished material (except wire) for forging, under the latest revision of each of the following ASTM specifications: A276/A276M, A314, A458, A477, A479/A479M, A564/A564M, A565/A565M, A582/A582M, A638/A638M, A705/A705M, and A831/A831M.

1.2 In the case of conflict between a requirement of a product specification and a requirement of this specification, the product specification shall prevail. In the case of conflict between a requirement of the product specification or a requirement of this specification and a more stringent requirement of the purchase order, the purchase order shall prevail. The purchase order requirements shall not take precedence if they, in any way, violate the requirements of the product specification or this specification; for example, by waiving a test requirement or by making a test requirement less stringent.

1.3 The requirements for introduction of new materials in specifications referencing this specification are given in Annex A1.

1.4 General requirements for flat-rolled stainless steel products other than bar are covered in Specification A480/A480M.

1.5 General requirements for wire products in coils are covered in Specification A555/A555M.

1.6 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined

1.7 Unless the order specifies an "M" designation, the material shall be furnished to inch-pound units.

1.8 *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:*[3]

A262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

A276/A276M Specification for Stainless Steel Bars and Shapes

A314 Specification for Stainless Steel Billets and Bars for Forging

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A458 Specification for Hot-Worked, Hot-Cold-Worked, and Cold-Worked Alloy Steel Bars for High Strength at Elevated Temperatures (Withdrawn 1988)[4]

A477 Specification for Hot-Worked, Hot-Cold Worked and Cold-Worked Alloy Steel Forgings and Forging Billets for High Strength at Elevated Temperatures (Withdrawn 1988)[4]

A479/A479M Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels

A480/A480M Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

[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 A01.17 on Flat-Rolled and Wrought Stainless Steel.

Current edition approved May 5, 2020. Published May 2020. Originally approved in 1963. Last previous edition approved in 2020 as A484/A484M – 20. DOI: 10.1520/A0484_A0484M-20A.

[2] For ASME Boiler and Pressure Vessel Code Applications, see related Specification SA-484/SA-484M in Section II of that code.

[3] 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.

[4] The last approved version of this historical standard is referenced on www.astm.org.

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

TABLE 1 Product Analysis Tolerances

NOTE 1—This table specifies tolerances over the maximum limits or under the minimum limits of the chemical requirements of the applicable material specification (see 1.1); it does not apply to heat analysis.

Element	Upper Limit of Maximum of Specified Range, %	Tolerances over the Maximum (Upper Limit) or Under the Minimum (Lower Limit)
Carbon	to 0.010, incl	0.002
	over 0.010 to 0.030, incl	0.005
	over 0.030 to 0.20, incl	0.01
	over 0.20 to 0.60, incl	0.02
	over 0.60 to 1.20, incl	0.03
Manganese	to 1.00, incl	0.03
	over 1.00 to 3.00, incl	0.04
	over 3.00 to 6.00, incl	0.05
	over 6.00 to 10.00, incl	0.06
	over 10.00 to 15.00, incl	0.10
	over 15.00 to 20.00, incl	0.15
Phosphorus	to 0.040, incl	0.005
	over 0.040 to 0.20, incl	0.010
Sulfur	to 0.040, incl	0.005
	over 0.040 to 0.20, incl	0.010
	over 0.20 to 0.50, incl	0.020
Silicon	to 1.00, incl	0.05
	over 1.00 to 3.00, incl	0.10
	over 3.00 to 7.00 incl	0.15
Chromium	over 4.00 to 10.00, incl	0.10
	over 10.00 to 15.00, incl	0.15
	over 15.00 to 20.00, incl	0.20
	over 20.00 to 30.00, incl	0.25
Nickel†	to 1.00, incl	0.03
	over 1.00 to 5.00, incl	0.07
	over 5.00 to 10.00, incl	0.10
	over 10.00 to 20.00, incl	0.15
	over 20.00 to 30.00, incl	0.20
	over 30.00 to 40.00, incl	0.25
	over 40.00	0.30
Molybdenum	over 0.20 to 0.60, incl	0.03
	over 0.60 to 2.00, incl	0.05
	over 2.00 to 7.00, incl	0.10
	over 7.00 to 15.00, incl	0.15
	over 15.00 to 30.00, incl	0.20
Titanium	to 1.00, incl	0.05
	over 1.00 to 3.00, incl	0.07
	over 3.00	0.10
Cobalt	over 0.05 to 0.50, incl	0.01
	over 0.50 to 2.00, incl	0.02
	over 2.00 to 5.00, incl	0.05
	over 5.00 to 10.00, incl	0.10
	over 10.00 to 15.00, incl	0.15
	over 15.00 to 22.00, incl	0.20
	over 22.00 to 30.00, incl	0.25
Columbium[A] + Tantalum	to 1.50, incl	0.05
	over 1.50 to 5.00, incl	0.10
	over 5.00	0.15
Tantalum	to 0.10, incl	0.02
Copper	to 0.50, incl	0.03
	over 0.50 to 1.00, incl	0.05
	over 1.00 to 3.00, incl	0.10
	over 3.00 to 5.00, incl	0.15
	over 5.00 to 10.00, incl	0.20
Aluminum	to 0.15, incl	−0.005, +0.01
	over 0.15 to 0.50, incl	0.05
	over 0.50 to 2.00, incl	0.10
	over 2.00 to 5.00, incl	0.20
	over 5.00 to 10.00, incl	0.35
Nitrogen	to 0.02, incl	0.005
	over 0.02 to 0.19, incl	0.01
	over 0.19 to 0.25, incl	0.02
	over 0.25 to 0.35, incl	0.03
	over 0.35 to 0.45, incl	0.04
	over 0.45	0.05
Tungsten	to 1.00, incl	0.03
	over 1.00 to 2.00, incl	0.05
	over 2.00 to 5.00, incl	0.07
	over 5.00 to 10.00, incl	0.10
	over 10.00 to 20.00, incl	0.15
Vanadium	to 0.50, incl	0.03
	over 0.50 to 1.50, incl	0.05
Selenium	all	0.03

† Editorially corrected.

[A] Columbium (Cb) and niobium (Nb) are considered interchangeable names for element 41 in the periodic table and both names are acceptable for use.

A555/A555M Specification for General Requirements for Stainless Steel Wire and Wire Rods

A564/A564M Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes

A565/A565M Specification for Martensitic Stainless Steel Bars for High-Temperature Service

A582/A582M Specification for Free-Machining Stainless Steel Bars

A638/A638M Specification for Precipitation Hardening Iron Base Superalloy Bars, Forgings, and Forging Stock for High-Temperature Service

A700 Guide for Packaging, Marking, and Loading Methods for Steel Products for Shipment

A705/A705M Specification for Age-Hardening Stainless Steel Forgings

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

A831/A831M Specification for Austenitic and Martensitic Stainless Steel Bars, Billets, and Forgings for Liquid Metal Cooled Reactor Core Components (Withdrawn 2005)[4]

E112 Test Methods for Determining Average Grain Size

E139 Test Methods for Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials

2.2 *Federal Standards:*[5]

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

Fed Std. No. 183 Continuous Marking of Iron and Steel Products

2.3 *Military Standards:*[5]

MIL-STD-129 Marking for Shipment and Storage

MIL-STD-163 Preservation of Steel Products for Shipment (Storage and Overseas Shipment)

2.4 *Other Standard:*[6]

Primary Metals Bar Code Standard

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *bars, n*—straight lengths that are produced by processing that includes hot deformation, such as rolling, forging, or extrusion; the permitted cross-sections include round, rectangular, and complex shapes; shall include shapes with all dimensions under 5 in. [125 mm]; shall include hot-rolled flats with width of 10 in. [250 mm] or less, and with thickness 0.125 in. [3.00 mm] or greater; shall include flats with width of 10 in. [250 mm] or less, and with thickness 0.125 in. [3.00 mm] or greater, cut from strip or plate provided that the long direction of the cut bar is parallel to the final rolling direction of the strip or plate.

3.1.1.1 *Discussion*—All cold-reduced flat material with thickness less than 0.1875 in. [5.00 mm] and width 0.375 in. [9.50 mm] and over is classified as strip.

3.1.2 *billets, n*—semi-finished products, typically produced by rolling, forging, or continuous casting, that require subsequent hot working by rolling, forging, or extrusion; typically have a cross-section area of 36 in.^{2} [230 cm^2] or less and shape that is square or rectangular with width less than twice the thickness; rectangular cross sections with width equal to or greater than twice the thickness are classified as slabs or sheet bars.

3.1.3 *blooms, n*—semi-finished products, typically produced by rolling or continuous casting, that require subsequent hot working by rolling or forging; typically have a cross section area of greater than 36 in.^{2} (230 cm^2) and shape that is square or rectangular with width less than twice the thickness; rectangular cross sections with width equal to or greater than twice the thickness are classified as slabs or sheet bars.

3.1.4 *condition, n*—identification of the final step or steps thermomechanical processing as required to describe the metallurgical state of the material as delivered (examples include hot-worked; hot-worked and annealed; hot-worked, annealed, and cold-worked for increased mechanical properties; and hot-worked, quenched, and tempered).

3.1.5 *dead lengths or exact lengths, n*—bars, typically hot-sheared, hot-sawed, or machine-cut after machine-straightening, meeting the permitted variations in length as listed in the tolerance tables of this specification.

3.1.6 *finish, n*—description of the surface finish and applicable dimensional tolerances of the product as delivered, most typically by identification of the process applied to the product, and identification of the applicable category of product dimensional tolerances; examples of finishing operations include blasting, pickling, rough turning, machine straightening, centerless grinding, polishing, and light cold drawing for surface finish but not for increased mechanical properties; see also 8.1.1 for *hot-finished* bars and 8.1.3 for *cold-finished* bars.

3.1.7 *forgings, n*—parts, including bars, billets, semi-finished products, or complex shapes, produced by hot mechanical working using hammers, presses, or forging machines.

3.1.8 *multiple lengths, n*—lengths that are specified as containing a predetermined number of units of length associated with production of a particular part, commonly including an allowance of ¼ in. [6.5 mm] per unit for cutting to insure obtaining the required number of pieces.

3.1.9 *random lengths, n*—a length range not less than 24 in. [1 m]; for example, 10 to 12 ft [3 to 4 m], 14 to 17 ft [4 to 5 m], or 15 to 20 ft [5 to 6 m].

3.1.10 *shapes, n*—bar having a cross section other than circular, rectangular, or hexagonal.

3.1.11 *slabs or sheet bars, n*—products, typically produced by blooming, slabbing, or sheet bar mills or by continuous casting, that are shipped without further hot working to be further processed into plate, sheet, or strip; it is permitted to heat treat, cut to shape, or surface condition a slab or sheet bar.

4. Ordering Information

4.1 It is the responsibility of the purchaser to specify all requirements that are necessary for material ordered under this specification. Such requirements to be considered include, but are not limited to, the following:

4.1.1 Quantity (weight or number of pieces),

4.1.2 Dimensions, including shape or form with diameter or width and thickness as applicable, length, and prints or sketches as applicable,

4.1.3 Type or UNS designation,

4.1.4 ASTM specification designation and edition year if other than the latest edition,

4.1.5 Condition,

4.1.6 Finish,

4.1.7 Supplementary Requirements when invoked,

4.1.8 Whether bars are to be rolled as bars or cut from strip or plate, when applicable,

4.1.9 Preparation for delivery,

4.1.10 Marking requirements,

4.1.11 Surface preparation, for shapes, and

4.1.12 Special requirements.

NOTE 1—A typical ordering description is as follows: 5000 lb [2000 kg]; 1.000 in. [25 mm] round bar by 10 to 12 ft [3 to 4 m]; Type 304 or S30400; Specification A479/A479M; annealed, centerless ground; plus optional requirements, such as special marking instructions.

[5] Available from Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094 or from http://assist.daps.dla.mil.

[6] Available from Automotive Industry Action Group (AIAG), 26200 Lahser Rd., Suite 200, Southfield, MI 48033, http://www.aiag.org.

5. Materials and Manufacture

5.1 The material shall be made by any process.

5.2 The material shall be furnished in one of the conditions detailed in the applicable product specification, for example, hot-worked; hot-worked and annealed; hot-worked, annealed, and cold-worked; or hot-worked, annealed, and heat-treated.

5.3 The material shall be furnished in one of the finishes as detailed in Section 8 or further described in the applicable product specification, for example, hot-finished or cold-finished.

6. Chemical Composition

6.1 *Heat or Cast Analysis*—The chemical analysis of each heat shall be determined in accordance with the applicable materials specification and Test Methods, Practices, and Terminology A751.

6.1.1 The analysis of each heat shall be made from a test sample taken during the pouring of the melt or from the in-process product later in the manufacturing flow.

6.1.2 The heat analysis shall conform to the chemical requirements for each of the specified elements for the grade ordered, as listed in the applicable product specification.

6.1.3 All commercial metals contain small amounts of elements other than those which are specified. It is neither practical nor necessary to specify limits for unspecified elements that can be present. The producer is permitted to analyze for unspecified elements and is permitted to report such analyses. The presence of an unspecified element and the reporting of an analysis for that element shall not be a basis for rejection unless the presence of that element cause the loss of a property typically expected for that metal, for the type and quality ordered.

6.1.4 The purchaser is permitted to require in the purchase order a maximum limit for an individual element not specified in the product specification. Such a requirement for an element not listed in the product specification, when acknowledged in the order acceptance, shall be treated as a specified element, with determination of chemical analysis and reporting of that analysis.

6.1.5 The purchaser is permitted to make the requirements for any element more stringent, that is, require higher minimums for elements having minimum requirements or ranges with minimum requirements, or requiring lower maximums for elements having specified maximums, or ranges with maximums. The purchaser is not permitted to make chemical requirements less stringent.

6.1.6 Analysis limits shall be established for specific elements rather than groups of elements, including but not limited to *all others*, *rare earths*, and *balance*, unless all elements in such a group are similar in technical effect and are associated in typical methods of chemical analysis.

6.2 *Product Analysis*—When required, a product analysis shall be determined in accordance with Test Methods, Practices, and Terminology A751. The chemical composition thus determined shall conform to the tolerances shown in Table 1.

6.3 The steel shall not contain an unspecified element for the ordered grade to the extent that the steel conforms to the requirements of another grade in the referencing product specification, and any of the product specifications within the scope of this general requirements specification, for which that element has a specified minimum.

7. Heat Treatment

7.1 The heat treatments shown in this section are to be followed unless otherwise specified in the applicable product specification.

7.2 *Austenitic Grades:*

7.2.1 Except for strain-hardened grades (see 7.2.4), hot-rolled grades (see 7.2.5), and UNS N08020 (see 7.2.6), all austenitic stainless steels shall be furnished in the solution annealed condition in accordance with Table 2, with subsequent light cold drawing for cold finishing and straightening permitted.

7.2.2 Except as indicated in Table 2, the austenitic grades shall be annealed, at the option of the manufacturer, by a separate annealing treatment or by process annealing.

7.2.2.1 The separate annealing treatment shall consist of heating the material to the minimum annealing temperature for the grade as listed in Table 2, holding for a sufficient time to permit grain boundary carbides to enter into solution, and cooling rapidly enough to prevent unacceptable grain boundary carbide precipitation. Except as indicated in Table 2, austenitic stainless steels solution annealed by a separate annealing treatment shall be capable of meeting the requirements of Practice E of Practices A262. Practice E of Practices A262 is not required unless specified on the purchase order.

7.2.2.2 Process annealing shall consist of completing hot working above the minimum annealing temperature required for each grade as indicated in Table 2, and cooling rapidly enough to prevent unacceptable grain boundary carbide precipitation. Except as indicated in Table 2, austenitic stainless steels solution annealed by process annealing shall be capable of meeting the requirements of Practice E of Practices A262. Practice E of Practices A262 is not required unless specified on the purchase order.

7.2.3 For the stabilized grades, Types 321, 321H, 347, 347H, 348, and 348H, the manufacturer is permitted, if necessary, to use a lower temperature resolution anneal or a stabilization anneal after a high temperature anneal in order to maximize resistance to intergranular corrosion.

NOTE 2—Solution annealing temperatures above 1950 °F [1065 °C] may impair the resistance to intergranular corrosion after subsequent exposure to sensitizing conditions for the stabilized grades. When intergranular corrosion is of concern, the purchaser should specify Practice E of Practices A262 (to be conducted on specimens exposed to a sensitizing treatment). Consideration should be given to the corrosive media before using a stabilization anneal at less than 1800 °F [980 °C], as such a treatment may not be fully effective for all media.

7.2.4 *Strain-Hardened Austenitic Grades*—When a particular austenitic grade is desired with increased mechanical properties, the purchaser is permitted to specify a strain hardened condition. This condition is produced by solution annealing the product in accordance with Table 2, followed by strain hardening sufficient to meet the required mechanical

TABLE 2 Annealing Requirements

Designation/Type	Temperature[A]	Cooling/Testing Requirements	Permitted Annealing[B]	
			Separate	Process
	Austenitic (Chromium-Nickel) (Chromium-Nickel-Manganese)			
All austenitic grades except as listed below	1900 °F [1040 °C]	C	x	x[D]
All Cr-Ni-Mn grades, 302, S30215, S30452, S30600, S30615, 308, S30815, S30880, 309, 309S, 310, 310S, 314, 317, S31725, S31726, S32615, S38100	1900 °F [1040 °C]	E	x	x[D]
309Cb, 310Cb, 316Cb, 316Ti, 321, 347, 348	1900 °F [1040 °C]	E	x	
304H, 309H, 310H, 316H	1900 °F [1040 °C]	E	x	
321H, 347H, 348H				
Hot-worked	1925 °F [1050 °C]	E	x	
Cold-worked	2000 °F [1095 °C]	E	x	
S31254, S32050	2100 °F [1150 °C]	E	x	
S31727, S32053	1975 ° to 2155 °F [1080° to 1180 °C]	E	x	
S33228	2050° to 2140 °F [1120° to 1170 °C]	E	x	
S34565	2050° to 2140 °F [1120° to 1170 °C]	E	x	
S35315	2010 °F [1100 °C]	E	x	
N08367	2025 °F [1105 °C]	E	x	
N08700	2000 °F [1095 °C]	E	x	
N08020	1700 to 1850 °F [930 to 1010 °C]	E	x	
N08810	2050 °F [1120 °C]	E	x	
N08811	2100 °F [1150 °C]	E	x	
N08904	2000 °F [1095 °C]	E	x	
N08925, N08926	2010 to 2100 °F [1100 to 1150 °C]	E	x	
	Austenitic-ferritic (Duplex)			
S32100	1900 °F [1040 °C]	E	x	x[F]
S31260	1870° to 2010 °F [1020° to 1100 °C]	E	x	x[F]
S31266	2100 °F [1150 °C]	E	x	
S31803	1900 °F [1040 °C]	E	x	x[F]
S32101	1870 °F [1020 °C]	E	x	x[F]
S32202	1800 to 1975 °F [980 to 1080 °C]	E	x	x[F]
S32205	1900 °F [1040 °C]	G	x	x[F]
S32304	1800 °F [980 °C]	E	x	x[F]
S32506	1870° to 2050 °F [1020° to 1120 °C]	E	x	x[F]
S32550	1900 °F [1040 °C]	E	x	x[F]
S32750	1880 °F [1025 °C]	E	x	x[F]
S32760	2010 °F [1100 °C]	E	x	x[F]
S32808	1925 to 2100 °F [1050 to 1150 °C]	E	x	x[F]
S32900	1750° ± 25 °F [955°± 15 °C]	E	x	x[F]
S32906	1830° to 2100 °F [1000° to 1150 °C]	E	x	x[F]
S32950	1850° ± 25 °F [1010°± 15 °C]	E	x	x[F]
S82441	1830 °F [1000 °C]	E	x	x[F]

[A] Minimum annealing temperature unless otherwise specified.
[B] Permitted annealing procedure, see 7.2.2.
[C] Quenched in water or rapidly cooled by other means at a rate sufficient to prevent reprecipitation of carbides, as demonstrable by the capability of passing Practice E of Practices A262. Performance of the test is not required unless specified in the purchase order.
[D] Minimum temperature at which hot rolling is completed shall be 1850 °F [1010 °C].
[E] Quenched in water or rapidly cooled by other means.
[F] Minimum temperature at which hot rolling is completed shall be the minimum temperature for separate annealing.
[G] Quenched in water.

properties. Annealing in accordance with Table 2 is permitted between strain hardening steps. The solution annealed and strain hardened material shall be capable of meeting the intergranular corrosion test requirements of Practice E of Practices A262. Practice E of Practices A262 is not required unless specified on the purchase order.

7.2.4.1 Individual product specifications are permitted to define particular strain hardened conditions as functions of grade, size, and degree of strain hardening.

7.2.5 *Hot-Rolled Austenitic Grades*—Individual product specifications are permitted to define requirements for particular hot-rolled austenitic grades without annealing.

7.2.6 Except when strain-hardened (see 7.2.4), UNS N08020 shall be furnished in the stabilized annealed condition in accordance with Table 2, with subsequent light cold drawing for cold finishing and straightening permitted.

7.3 *Austenitic-ferritic (Duplex) Grades:*

7.3.1 The austenitic-ferritic (duplex) grades shall be furnished in the solution annealed condition in accordance with Table 2, with subsequent light cold drawing for cold finishing and straightening permitted.

7.3.2 Except as indicated in Table 2, the duplex grades shall be annealed, at the option of the manufacturer, by a separate annealing treatment or by process annealing.

7.3.2.1 The separate annealing treatment shall consist of heating the material to the minimum annealing temperature for the grade as listed in Table 2, holding for a sufficient time to

permit dissolution of intermetallic phases, and cooling rapidly enough to prevent unacceptable precipitation of intermetallic phases.

7.3.2.2 Process annealing shall consist of completing hot working above the minimum annealing temperature required for each grade as indicated in Table 2, and cooling rapidly enough to prevent unacceptable precipitation of intermetallic phases.

7.4 *Ferritic Grades*—Ferritic grades shall be annealed to meet their respective mechanical testing requirements as shown in the applicable product specification.

7.5 *Martensitic Grades:*

7.5.1 All martensitic grades shall be supplied in either the annealed condition or in the tempered condition as specified by the purchaser. Tempered material shall be normalized, or shall be liquid quenched from 1700 °F [925 °C], minimum, followed by tempering in accordance with 7.5.2, 7.5.3, or 7.5.4.

7.5.2 Types 403 and 410 tempered material shall be held at the tempering temperature for at least 1 h/in. (25.4 mm) of cross section as follows:

7.5.2.1 *Condition 1*—1250 °F [675 °C] minimum, 1400 °F [760 °C] maximum.

7.5.2.2 *Condition 2*—1100 °F [595 °C] minimum, 1400 °F [760 °C] maximum.

7.5.2.3 *Condition 3*—1050 °F [565 °C] minimum, 1400 °F [760 °C] maximum.

7.5.3 Types XM-30, 414, and 431 tempered materials shall be held at 1100 °F [595 °C], minimum for at least 1 h/in. [25 mm] of cross section. Maximum tempering temperature shall be 1400 °F [760 °C].

7.5.4 S41500 shall be heated to 1750 °F [955 °C] minimum, air cooled to 200 °F [95 °C] or lower prior to any optional intermediate temper and prior to the final temper. The final temper shall be between 1050 °F [565 °C] and 1150 °F [620 °C].

7.5.5 When the purchaser elects to perform the hardening and tempering heat treatment, martensitic materials shall be supplied by the manufacturer in the annealed condition (see 7.5.1). In this case the purchaser shall be responsible to apply the proper heat treatment and to conduct the tests deemed necessary to assure that the required properties are obtained.

8. Finish

8.1 The following types of finishes are permitted, as applicable to the product ordered:

8.1.1 *Hot-finished Bars*—Hot-finished bars shall have the surface finish that results from hot processing, with or without certain additional surface modification. Hot-finished bars are commonly produced by hot rolling, forging, pressing, extruding, or similar hot working procedures applied to ingots, blooms, or billets. The resulting products are typically subject to various additional operations affecting the surface of the bars, including but not limited to one or more of the following: annealing or other heat treatment; cleaning by blasting, pickling, or other descaling methods; rough turning; and machine straightening. The producer is permitted to use centerless grinding, polishing, or other operations commonly associated with cold finishing in order to provide improved dimensional tolerances or surface condition for the hot-finished bar. The dimensional tolerances applicable to hot-finished bars are less stringent than those applicable to cold-finished bars.

8.1.2 *Bars Cut from Strip or Plate*—Bars cut from flat-rolled stainless steel products shall have two surfaces that are pickled or descaled, and two cut surfaces, except when the bar is heat treated subsequent to cutting, in which case all surfaces shall be descaled or pickled.

8.1.3 *Cold-finished Bar*—Cold-finished bars shall have the surface finish that results from hot-finished bars being further processed by additional mechanical operations on the surface of the bar, including but not limited to light cold drawing, burnishing, centerless grinding, and polishing to provide closer tolerances and improved surface finish. The dimensional tolerances applicable to cold-finished bars are more stringent than those applicable to hot-finished bars.

8.1.4 *Bars and Billets or Other Semi-finished Material for Reforging*—Material intended for reforging shall be delivered in the hot-finished condition or in the cold-drawn condition. The cold-drawn condition alternative is only permitted for austenitic and austenitic-ferritic stainless steel forgings. When delivered in the hot-finished condition, it is permitted to condition the surface by removing surface defects provided that the depth of the conditioning does not exceed that which affects the surface condition or dimensions of the article to be forged from the bar or billet. When delivered in the cold-drawn condition, it is permitted to hot forge forgings from cold-drawn bar provided this bar has been cold-drawn from material in the solution-annealed condition.

8.1.5 *Shapes*—Shapes shall be descaled by machining, grinding, blasting, or pickling.

8.1.5.1 Shapes shall be subject to either Class A or Class C surface preparation as specified on the purchase order. Class A consists of grinding for the removal of imperfections of a hazardous nature, such as fins, tears, and jagged edges, provided the underweight tolerance is not exceeded and the maximum depth of grinding at any one point does not exceed 10 % of the thickness of the section. Class C consists of grinding for the removal of all visible surface imperfections, provided that the underweight tolerance is not exceeded and the maximum depth of grinding at any point does not exceed 10 % of the thickness of the section.

8.1.6 *Forgings*—Forgings shall be descaled by machining, blasting, or pickling. The selection of the descaling methods shall be at the option of the producer unless a particular descaling method is specified in the purchase order.

9. Dimensions, Mass, and Permissible Variations

9.1 Unless otherwise specified on the purchase order, the material shall conform to the permitted variations in dimensions as specified in the following:

9.1.1 *Bars*—Tables 3-12.

9.1.2 *Shapes*—Tables 13-19 and Figs. 1 and 2.

9.1.3 *Forgings*—As specified in the purchase order, or in prints or sketches accompanying the purchase order.

9.1.4 *Billets or Other Semi-finished Material for Reforging*—Billets and other semi-finished material shall conform to the shape and dimensions specified by the purchaser within a permitted variation of ±5 %.

TABLE 3 Permitted Variations in Size of Hot-finished Round, Turned,[A] and Square Bars

Specified Size, in. [mm]	Permitted Variations from Specified Size, in. [mm]		Out-of-Round[B] or Out-of-Square,[C] in. [mm]
	Over	Under	
5/16 to 7/16 [8.00 to 11.00], incl[D]	0.006 [0.15]	0.006 [0.15]	0.009 [0.23]
Over 7/16 to 5/8 [11.00 to 15.50], incl[D]	0.007 [0.18]	0.007 [0.18]	0.010 [0.26]
Over 5/8 to 7/8 [15.50 to 22.00], incl	0.008 [0.20]	0.008 [0.20]	0.012 [0.30]
Over 7/8 to 1 [22.00 to 25.00], incl	0.009 [0.23]	0.009 [0.23]	0.013 [0.34]
Over 1 to 1 1/8 [25.00 to 28.00], incl	0.010 [0.25]	0.010 [0.25]	0.015 [0.38]
Over 1 1/8 to 1 1/4 [28.00 to 31.50], incl	0.011 [0.28]	0.011 [0.28]	0.016 [0.42]
Over 1 1/4 to 1 3/8 [31.50 to 34.50], incl	0.012 [0.30]	0.012 [0.30]	0.018 [0.46]
Over 1 3/8 to 1 1/2 [34.50 to 38.00], incl	0.014 [0.35]	0.014 [0.35]	0.021 [0.53]
Over 1 1/2 to 2 [38.00 to 50.00], incl	1/64 [0.40]	1/64 [0.40]	0.023 [0.60]
Over 2 to 2 1/2 [50.00 to 63.00], incl	1/32 [0.80]	0	0.023 [0.60]
Over 2 1/2 to 3 1/2 [63.00 to 90.00], incl	3/64 [1.20]	0	0.035 [0.90]
Over 3 1/2 to 4 1/2 [90.00 to 115.00], incl	1/16 [1.60]	0	0.046 [1.20]
Over 4 1/2 to 5 1/2 [115.00 to 140.00], incl	5/64 [2.00]	0	0.058 [1.50]
Over 5 1/2 to 6 1/2 [140.00 to 165.00], incl	1/8 [3.00]	0	0.070 [1.80]
Over 6 1/2 to 8 [165.00 to 200.00], incl	5/32 [4.00]	0	0.085 [2.20]
Over 8 to 12 [200.00 to 300.00], incl[A]	3/16 [4.80]	0	3/32 [2.40]
Over 12 to 15 [300.00 to 400.00], incl[A]	7/32 [5.50]	0	7/64 [2.80]
Over 15 to 25 [400.00 to 625.00], incl[A]	1/4 [6.50]	0	1/8 [3.20]

[A] Turned bars are generally available from 2 to 25 in. [50 to 625 mm] in diameter, over 8 in. [200 mm] only turned bars are available.
[B] Out-of-round is the difference between the maximum and minimum diameters of the bar measured at the same cross section.
[C] Out-of-square section is the difference in the two dimensions at the same cross section of a square bar, each dimension being the distance between opposite faces.
[D] Size tolerances have not been evolved for round sections in the size range of 5/16 in. [8.00 mm] to approximately 5/8 in. [15.5 mm] in diameter which are produced on rod mills in coils.

TABLE 4 Permitted Variations in Size of Hot-finished Hexagonal and Octagonal Bar

Specified Sizes Measured Between Opposite Sides, in. [mm]	Permitted Variations from Specified Size, in. [mm]		Maximum Difference in 3 Measurements for Hexagons Only, in. [mm]
	Over	Under	
1/4 to 1/2 [6.50 to 13.00], incl	0.007 [0.18]	0.007 [0.18]	0.011 [0.28]
Over 1/2 to 1 [13.00 to 25.00], incl	0.010 [0.25]	0.010 [0.25]	0.015 [0.38]
Over 1 to 1 1/2 [25.00 to 38.00], incl	0.021 [0.53]	0.021 [0.53]	0.025 [0.64]
Over 1 1/2 to 2 [38.00 to 50.00], incl	1/32 [0.80]	1/3 [0.80]	1/32 [0.80]
Over 2 to 2 1/2 [50.00 to 63.00], incl	3/64 [1.20]	3/64 [1.20]	3/64 [1.20]
Over 2 1/2 to 3 1/2 [63.00 to 90.00], incl	1/16 [1.60]	1/16 [1.60]	1/16 [1.60]

TABLE 5 Permitted Variations in Thickness and Width for Hot-finished Flat Bars Rolled as Bars

Specified Width, in. [mm]	Permitted Variations in Thickness for Thicknesses Given, in. [mm]												Permitted Variations in Width, in. [mm]	
	1/8 to 1/2 [3.2 to 13], incl		Over 1/2 to 1 [13 to 25], incl		Over 1 to 2 [25 to 50], incl		Over 2 to 4 [50 to 100], incl		Over 4 to 6 [100 to 150], incl		Over 6 to 8 [150 to 200], incl			
	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under
To 1 [25.00], incl	0.008 [0.20]	0.008 [0.20]	0.010 [0.25]	0.010 [0.25]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.015 [0.40]	0.015 [0.40]
Over 1 to 2 [25.00 to 50.00], incl	0.012 [0.30]	0.012 [0.30]	0.015 [0.40]	0.015 [0.40]	0.031 [0.80]	0.031 [0.80]	. . .	. . .	. . .	. . .	. . .	. . .	0.031 [0.80]	0.031 [0.80]
Over 2 to 4 [50.00 to 100.00], incl	0.015 [0.40]	0.015 [0.40]	0.020 [0.50]	0.020 [0.50]	0.031 [0.80]	0.031 [0.80]	0.062 [1.60]	0.031 [0.80]	. . .	. . .	. . .	. . .	0.062 [1.60]	0.031 [0.80]
Over 4 to 6 [100.00 to 150.00], incl	0.015 [0.40]	0.015 [0.40]	0.020 [0.50]	0.020 [0.50]	0.031 [0.80]	0.031 [0.80]	0.062 [1.60]	0.031 [0.80]	0.093 [2.40]	0.062 [1.60]	. . .	. . .	0.093 [2.40]	0.062 [1.60]
Over 6 to 8 [150.00 to 200.00], incl	0.016 [0.40]	0.016 [0.40]	0.025 [0.65]	0.025 [0.65]	0.031 [0.80]	0.031 [0.80]	0.062 [1.60]	0.031 [0.80]	0.093 [2.40]	0.062 [1.60]	0.125 [3.20]	0.156 [4.00]	0.125 [3.20]	0.156 [4.00]
Over 8 to 10 [200.00 to 250.00], incl	0.020 [0.50]	0.020 [0.50]	0.031 [0.80]	0.031 [0.80]	0.031 [0.80]	0.031 [0.80]	0.062 [1.60]	0.031 [0.80]	0.093 [2.40]	0.062 [1.60]	0.125 [3.20]	0.156 [4.00]	0.156 [4.00]	0.187 [4.80]

10. Workmanship, Finish, and Appearance

10.1 The material shall be of uniform quality consistent with good manufacturing and inspection practices. Imperfections shall be of such a nature or degree for the type and quality ordered, that they shall not adversely affect the forming, machining, or fabrication of finished parts.

TABLE 6 Permitted Variations in Dimensions for Flat Bars Cut from Strip or Plate

Order Thickness	Permitted Variation in Thickness, in. [mm]		Permitted Variation[A] in Width				Permitted Variation in Length[B]	
			Widths to 4 [100]		Widths Over 4 [100]			
	Over	Under	Over	Under	Over	Under	Over	Under
Over 0.114 to 0.130 [2.90 to 3.30], incl	0.010	0.010	0.094	0.031	0.094	0.094	0.188	0
	[0.25]	[0.25]	[2.40]	[0.80]	[2.40]	[2.40]	[4.80]	
Over 0.130 to 0.145 [3.30 to 3.70], incl	0.012	0.012	0.094	0.031	0.094	0.094	0.188	0
	[0.30]	[0.30]	[2.40]	[0.80]	[2.40]	[2.40]	[4.80]	
Over 0.145 to less than 3/16, [3.70 to 4.80]	0.014	0.014	0.094	0.031	0.094	0.094	0.188	0
	[0.35]	[0.35]	[2.40]	[0.80]	[2.40]	[2.40]	[4.80]	
3/16 to 3/8 [4.80 to 9.00], excl	0.050	0.010	0.094	0.031	0.094	0.094	0.188	0
	[1.25]	[0.25]	[2.40]	[0.80]	[2.40]	[2.40]	[4.80]	
3/8 to 3/4 [9.00 to 19.00], excl	0.060	0.010	0.094	0.031	0.094	0.094	0.188	0
	[1.50]	[0.25]	[2.40]	[0.80]	[2.40]	[2.40]	[4.80]	
3/4 to 1 [19.00 to 25.00], excl	0.065	0.010	0.094	0.031	0.094	0.094	0.188	0
	[1.65]	[0.25]	[2.40]	[0.80]	[2.40]	[2.40]	[4.80]	
1 to 2 [25.00 to 50.00], excl	0.075	0.010	0.094	0.031	0.094	0.094	0.188	0
	[1.90]	[0.25]	[2.40]	[0.80]	[2.40]	[2.40]	[4.80]	
2 to 3 [50.00 to 75.00], excl	0.150	0.010	0.125	0.062	0.125	0.125	0.250	0
	[3.80]	[0.25]	[3.00]	[1.60]	[3.00]	[3.00]	[6.50]	
3 to 4 [75.00 to 100.00], excl	0.210	0.010	0.125	0.062	0.125	0.125	0.250	0
	[5.30]	[0.25]	[3.00]	[1.60]	[3.00]	[3.00]	[6.50]	
4 to 6 [100.00 to 150.00], excl	0.300	0.010	0.125	0.062	0.125	0.125	0.250	0
	[7.60]	[0.25]	[3.00]	[1.60]	[3.00]	[3.00]	[6.50]	
6 to 8 [150.00 to 200.00], excl	0.420	0.010	0.125	0.062	0.125	0.125	0.250	0
	[10.65]	[0.25]	[3.00]	[1.60]	[3.00]	[3.00]	[6.50]	
8 to 10 [200.00 to 250.00], excl	0.540	0.010	0.125	0.062	0.125	0.125	0.250	0
	[13.70]	[0.25]	[3.00]	[1.60]	[3.00]	[3.00]	[6.50]	

[A] By agreement between purchaser and seller, tolerances can be shifted as desired to any combination of plus-minus tolerance between all minus and all plus.
[B] Not applicable when bars are ordered random length.

TABLE 7 Permitted Variations in Size of Cold-finished Round Bars

Specified Size, in. [mm]	Permitted Variations from Specified Size, in. [mm][A,B]	
	Over	Under
1/16 to 5/16 [1.50 to 8.00], excl	0.001 [0.03]	0.001 [0.03]
5/16 to 1/2 [8.00 to 13.00], excl	0.0015 [0.04]	0.0015 [0.04]
1/2 to 1 [13.00 to 25.00], excl	0.002 [0.05]	0.002 [0.05]
1 to 1 1/2 [25.00 to 38.00], excl	0.0025 [0.06]	0.0025 [0.06]
1 1/2 to 3 1/4 [38.00 to 83.00], incl[C]	0.003 [0.08]	0.003 [0.08]
3 1/4 to 4 [83.00 to 100], incl[C]	0.005 [0.13]	0.005 [0.13]

[A] Unless otherwise specified, size tolerances are over and under as shown in the above table. When required, however, they may be specified all over and nothing under, or all under and nothing over, or any combination of over and under, if the total spread in size tolerance for a specified size is not less than the total spread shown in the table.
[B] When it is necessary to heat treat or heat treat and pickle after cold finishing, size tolerances are double those shown in the table.
[C] Cold-finished bars over 4 in. [100 mm] in diameter are produced; size tolerances for such bars are not included herein.

TABLE 8 Permitted Variations in Size of Cold Finished Hexagonal, Octagonal, and Square Bars

Specified Size,[A] in. [mm]	Permitted Variations from Specified Size, in. [mm][B]	
	Over	Under
1/8 to 5/16 [3.00 to 8.00], excl	0	0.002 [0.05]
5/16 to 1/2 [8.00 to 13.00], excl	0	0.003 [0.08]
1/2 to 1 [13.00 to 25.00], incl	0	0.004 [0.10]
Over 1 to 2 [25.00 to 50.00], incl	0	0.006 [0.15]
Over 2 to 3 [50.00 to 75.00], incl	0	0.008 [0.20]
Over 3 [75.00]	0	0.010 [0.25]

[A] Distance across flats.
[B] When it is necessary to heat treat or heat treat and pickle after cold finishing, size tolerances are double those shown in the table.

11. Sampling

11.1 A lot for product analysis shall consist of all bars, shapes, or forgings made from the same heat.

11.2 For other tests required by the product specification, a lot shall consist of all bar products of the same size, or forgings weighing less than 1000 lb [500 kg] each, from the same heat, and produced under the same processing conditions. All austenitic, ferritic, austenitic-ferritic, and free-machining grades, martensitic grades annealed to Condition A, and precipitation or age-hardening grades when solution treated are permitted to be heat treated in the same furnace or in several furnaces utilizing controlled processing and equipment (see Appendix X1). When heat treating martensitic stainless steels to Condition T or H, and when age hardening the precipitation hardening grades, a lot shall consist of the same size, same heat, and the same heat treat charge in a batch-type furnace or under the same conditions in a continuous furnace.

11.2.1 For forgings weighing from 1000 lb [500 kg] to 5000 lb [2500 kg] each, a lot shall consist of one size classification from each heat and each heat-treating charge. Where continuous heat-treating furnaces are used, a lot shall consist of one size classification from each heat, heated in a period of 8 h or less.

11.2.2 For all classes of forgings weighing from 5000 to 7000 lb [2300 to 3200 kg], each unit shall be considered a lot.

11.2.3 For all classes of forgings weighing more than 7000 lb [3200 kg], each unit shall be considered a double lot, and two tension tests shall be required, one from each end of each forging. In the case of ring forgings, the tension test specimens shall be removed from each of two locations on the

TABLE 9 Permitted Variations in Width and Thickness of Cold-finished Flat Bars

Width, in. [mm]	Permitted Variations in Width, Over and Under, in. [mm][A]	
	For Thicknesses ¼ in. [6.5] and Under	For Thicknesses Over ¼ in. [6.5]
1/16 to 3/8 [1.50 to 9.50], incl	0.005 [0.12]	0.005 [0.12]
Over 3/8 to 1 [9.50 to 25.00], incl	0.004 [0.10]	0.004 [0.10]
Over 1 to 2 [25.00 to 50.00], incl	0.006 [0.15]	0.004 [0.10]
Over 2 to 3 [50.00 to 75.00], incl	0.008 [0.20]	0.004 [0.10]
Over 3 to 4½ [75.00 to 115.00], incl	0.010 [0.25]	0.005 [0.13]
Thickness, in. [mm]	Permitted Variations in Thickness, Over and Under, in. [mm][A]	
Up to .029 [0.70], incl	0.001 [0.03]	
Over .029 to .035 [0.70 to 1.00], incl	0.0015 [0.04]	
Over .035 to 1 [1.00 to 25.00], incl	0.002 [0.05]	
Over 1 to 2 [25.00 to 50.00], incl	0.003 [0.08]	
Over 2 to 3 [50.00 to 75.00], incl	0.004 [0.10]	
Over 3 to 4½ [75.00 to 115.00], incl[B]	0.005 [0.13]	

[A] When it is necessary to heat treat or heat treat and pickle after cold finishing, size tolerances are double those shown in the table.
[B] Cold-finished flat bars over 4½ in. [115 mm] wide or thick are produced; width and thickness tolerances for such bars are not included herein.

TABLE 10 Permitted Variations in Length of Hot-finished or Cold-finished Bars

Specified Size of Rounds, Squares, Hexagons, Octagons, and Widths of Flats,[A] in. [mm]	Permitted Variations in Length, in. [mm][B]			
	For Lengths up to 12 ft[C] [4 m], incl		For Lengths Over 12 to 25 ft [4 to 8 m], incl	
	Over	Under	Over	Under
Up to 6 [150.00], incl	1 [25]	0	1¼ [31.50]	0
Over 6 to 9 [150.00 to 225.00], incl	1¼ [31.5]	0	1½ [38.00]	0
Over 9 to 12 [225.00 to 300.00], incl	1½ [38]	0	2 [50.00]	0

[A] The maximum width of bar flats is 10 in. [250 mm].
[B] Random Lengths—When ordered as random lengths, permissible variation is 2 ft [0.6 m] over and under the specified length. When ordered as random lengths subject to a minimum length requirement, permissible variation is 2 ft [0.6 m] over and nothing under the specified length.
[C] For lengths under 3 ft [1 m] and sizes up to ½ in. [13.00 mm] incl., the permissible variation in length is 1/32 in. [0.80 mm] over and nothing under.

TABLE 11 Permitted Variations in Length of Hot-finished or Cold-finished Bars Machine Cut After Machine Straightening[A]

NOTE 1—These tolerances are not applicable when bars are ordered random length.

Specified Size of Rounds, Squares, Hexagons, Octagons, and Width of Flats,[B] in. [mm]	Permitted Variations in Length, in. [mm]			
	For Lengths up to 12 ft [4 m], incl		For Lengths Over 12 to 25 ft [4 to 8 m], incl	
	Over	Under	Over	Under
To 3 [75], incl		0		0
Over 3 [75] to 12 [225 to 300], incl	½ [13.0]	0	½ [13.0]	0

[A] Table 11 does not apply to product produced on coil to bar equipment.
[B] The maximum width of bar flats is 10 in. [250 mm].

TABLE 12 Permitted Variations in Straightness of Machine Straightened Hot-finished or Cold-finished Bars[A]

Measurement is taken on the concave side of the bar with a straightedge. Unless otherwise specified, hot-finished or cold-finished bars for machining purposes are furnished machine straightened to the following tolerances.

Hot-finished
1/8 in. [3.00 mm] in any 5 ft [1.50 m]; but may not exceed 1/8 in. [3.00 mm] × (length in ft/5) [m/1.50]
Cold-finished
1/16 in. [1.5 mm] in any 5 ft [1.5 m]; but may not exceed 1/16 in. [1.5 mm] × (length in ft/5) [m/1.50]

[A] Straightness tolerances have not been established for sizes less than ½ in. [13.00 mm].

TABLE 13 Permitted Variations for Hot-finished Angles

NOTE 1—For unequal leg angles, the longer leg determines the tolerance for the length of each leg.

Weight[A]
For angles of 6 lb/ft [9.0 kg/m] or less, the weight tolerances shall not exceed ±7½ %. For angles over 6 lb/ft [9 kg/m], the weight tolerance shall not exceed ±4½ %.
Length of Legs
For angles having legs or flanges up to 6 in. [150 mm], incl, the length tolerance shall not exceed ±1/8 in. [3.00 mm]. For angles having legs or flanges over 6 in., the length tolerance shall not exceed +3/16 in. [5.00 mm] and –1/8 in.
Squareness of Legs
The tolerance for the right angle between the legs is ±2°.

[A] For equal leg angles, the theoretical weight per foot is:

$$\text{weight/foot} = (24\ W \times t - 12t^2)\ (0.2871\ \text{lb/ft})$$

where:

W = specified length of the leg, in inches, and
t = specified thickness, in inches.

For unequal leg angles, the theoretical weight per foot is:

$$\text{weight/foot} = [12\ W1 \times t + 12\ W2 \times t - 12t^2]\ (0.2871\ \text{lb/ft})$$

where:

$W1$ and $W2$ = specified leg lengths, in inches, and
t = specified leg thickness, in inches.

periphery, approximately 180° apart, and insofar as practicable, from opposite ends of the forging.

12. Number of Tests and Retests

12.1 Unless otherwise specified in the product specification, one sample per heat shall be selected for chemical analysis and one mechanical test sample shall be selected from each lot of bars and shapes and from each lot of forgings. Except for bars cut from strip or plate, tension tests of bars and shapes shall be made in the longitudinal direction or, at the manufacturer's option unless otherwise specified in the purchase order, in the transverse (through thickness) direction. Material tensile tested in the transverse direction and meeting the specified tensile property requirements need not be tested in the longitudinal direction. Testing for bars cut from strip or plate shall conform to the requirements of the applicable product specification for the strip or plate and to Specification A480/A480M. Hardness tests on bars shall be conducted midway between the center and surface of the product. Tension tests on forgings shall be prepared from suitable prolongations, or at the option of the supplier, excess forgings may be provided for test. All tests shall conform to the chemical and mechanical requirements of the product specification.

12.2 One intergranular corrosion test, when required, and one grain size test, when required shall be made on each lot. Often, it is convenient to obtain test material from the specimen selected for mechanical testing.

12.3 If any test specimen shows defective machining or flaws, it is permitted to discard the specimen and to substitute another specimen.

TABLE 14 Permitted Variations in Size of Hot-finished Channels

Specified Size of Channel, in. [mm]	Size Tolerances, Over and Under, in. [mm]				
	Depth of Section[A]	Width of Flanges	Thickness of Web for Thickness Given		Out-of-Square[B] of Either Flange, in./in. [mm/ mm] of Flange Width
			To 3/16 incl [5.00 mm]	Over 3/16 [5.00 mm]	
To 1½ [38.00], incl	3/64 [1.20]	3/64 [1.20]	0.015 [0.41]	0.023 [0.60]	3/64 [1.20]
Over 1½ to 3 [38.00 to 75.00], excl	3/32 [2.40]	3/32 [2.40]	0.023 [0.60]	0.030 [0.80]	3/64 [1.20]

[A] Channel depth is measured at back of web.
[B] For channels 5/8 in. [15.50 mm] and under in depth, the out-of-square tolerance is 5/64 in./in. [2.00 mm/mm] of depth. Out-of-squareness is determined by placing a square against the bottom surface of the web and measuring the amount of toe-in or toe-out of either flange. Measurements for depth of section and width of flanges are over-all.

TABLE 15 Permitted Variations in Size of Hot-finished Tees

Specified Size of Tee, in. [mm][A]	Width or Depth, in.[B]		Thickness of Flange, in. [mm]		Thickness of Stem, in. [mm]		Stem Out-of-Square[C] in. [mm]
	Over	Under	Over	Under	Over	Under	
To 1½ [38.00], incl.	5/64 [2.00]	5/64 [2.00]	0.015 [0.38]	0.015 [0.38]	0.008 [0.20]	0.030 [0.75]	3/64 [1.20]
Over 1½ to 2 [38.00 to 50.00], incl	3/32 [2.40]	3/32 [2.40]	0.018 [0.46]	0.018 [0.46]	0.015 [0.38]	0.030 [0.75]	3/32 [2.40]
Over 2 to 3 [50.00 to 75.00], excl	9/64 [3.60]	9/64 [3.60]	0.023 [0.60]	0.023 [0.60]	0.023 [0.60]	0.030 [0.75]	9/64 [3.60]

[A] The longer member of an unequal tee determines the size for tolerances.
[B] Measurements for both width and depth are over-all.
[C] Stem out-of-square is the variation from its true position of the center line of stem measured at the point.

TABLE 16 Permitted Variations in Size of Hot-extruded Shapes

Specified Size, in [mm]	Section Tolerances, in. [mm]	
	Over	Under
Dimensions under 1 [25]	0.020 [0.50]	0.020 [0.50]
Dimensions 1 to 3 [25 to 75], excl	0.031 [0.80]	0.031 [0.80]
Dimensions 3 to 4 [75 to 100], incl	0.046 [1.20]	0.046 [1.20]
Over 4 [100]	0.062 [1.60]	0.062 [1.60]

TABLE 17 Angularity Tolerance for Extruded Shapes

Plus and minus	max 2°

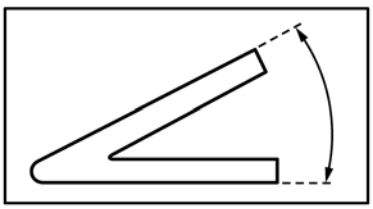


TABLE 18 Length Tolerances for Extruded Shape Length[A,B]

Specified Size	For Lengths up to 12 ft [4 m], incl.		For Lengths over 12 ft [4 m]	
	Over	Under	Over	Under
Up to 3 in. [75 mm], excl	3/16 in. [4.8 mm]	0	¼ in. [6.5 mm]	0

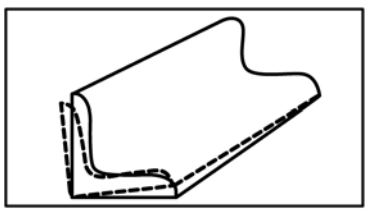
[A] Multiple Lengths—Unless otherwise specified, ¼ in. [6.5 mm] is added to the total length of each piece for each multiple contained.
[B] Random Lengths—When ordered as random lengths, permissible variation is 2 ft [0.6 m] over and under the specified length. When ordered as random lengths subject to a minimum length requirement, permissible variation is 2 ft [0.6 m] over and nothing under the specified length.

12.4 If the results of any test are not in conformance with the requirements of this specification or the requirements of the applicable product specification, it is permitted to retest a new sample of two specimens, to replace the original failed sample. If one of the retest specimens fails, the lot shall be rejected.

TABLE 19 Twist Tolerances

NOTE 1—The amount of spiraling in an extruded shape is called twist. It can be measured by the height of the high corner from a flat reference base (established rise).

NOTE 2—Using the following calculation the twist tolerance must not exceed what is shown in the table.



$$\text{rise in 5 ft} = \frac{\text{established rise} \times \text{number of ft in length}}{5}$$

Section Width	Rise in 5 ft
½ to 1½ in. [13 to 39 mm]	0.125 in. [3.00 mm]
Over 1½ to 4 in. [39 to 100 mm]	0.188 in. [4.80 mm]
Over 4 in. [100 mm]	0.250 in. [6.50 mm]

13. Retreatment

13.1 Where the failure of a lot is attributable to inadequate heat treatment, the producer may reheat treat the material and submit the retreated material for test.

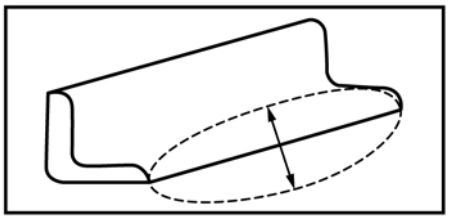
14. Test Methods

14.1 The properties enumerated in the applicable product specification shall be tested in accordance with the following ASTM methods:

14.1.1 *Chemical Analysis*—Test Methods, Practices, and Terminology A751.

14.1.2 *Tension Tests*—Test Methods and Definitions A370.

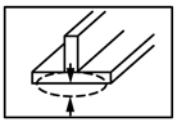
14.1.3 *Stress Rupture*—Test Methods E139.



NOTE 1—Camber or bow tolerances shall not exceed 0.025 in. [0.60 mm] × length in ft [m⅓].

Camber tolerances for hot finished or extruded shapes camber (or bow) is the greatest deviation of a side from a straight line. Measurement is taken on the concave side of the shapes with a straight edge.

FIG. 1 Camber or Bow Tolerances



NOTE 1—Allowable deviation from flat is max 0.010 in. [0.25 mm] per 1 in. [25 mm] of width. Maximum deviation on dimensions of less than 1 in. [25 mm] is 0.010 in. [0.250 mm].

The transverse flatness tolerance is the maximum deviation from a reference base across any cross-section flat surface.

FIG. 2 Transverse Flatness Tolerances

14.1.4 *Brinell Hardness*—Test Methods and Definitions A370.

14.1.5 *Rockwell Hardness*—Test Methods and Definitions A370.

14.1.6 *Intergranular Corrosion*—Practice E of Practices A262.

14.1.7 *Grain Size*—Test Methods E112.

14.1.8 *Charpy V-Notch Impact Test*—Test Methods and Definitions A370.

15. Inspection

15.1 *Civilian Procurement*—Inspection of the material shall be as agreed upon between the purchaser and the supplier as part of the purchase contract.

15.2 *Government Procurement*—Unless otherwise specified in the contract or purchase order, the seller is responsible for the performance of all inspection and test requirements in this specification, the seller is permitted to use their own facilities or other suitable facilities for the performance of the inspection and testing, and the purchaser shall have the right to perform any of the inspection and tests set forth in this specification. The manufacturer shall afford the purchaser's inspector all reasonable facilities necessary to satisfy purchaser that the material is being furnished in accordance with the specification. Inspection by the purchaser shall not interfere unnecessarily with the manufacturer.

16. Rejection and Rehearing

16.1 The purchaser is permitted to reject material that fails to conform to the requirements of this specification. Rejection shall be reported to the producer or supplier promptly, preferably in writing. In case of dissatisfaction with the results of a test, the producer or supplier is permitted to make claim for a rehearing.

17. Certification

17.1 A report of the results of all tests required by the product specification shall be supplied to the purchaser. This material test report shall reference the product specification designation and year date indicating that the material was manufactured, sampled, tested, and inspected in accordance with requirements of the product specification and has been found to meet those requirements. The material test report shall report the melting process when the purchase order requires either a specific type of melting or requires that the melting process used is to be reported.

17.1.1 The report shall indicate the type of steel. If certifying that the material conforms to the requirements for more than one type of steel, the manufacturer may indicate each type of steel on the report, or may issue a separate report for each type of steel.

17.2 A signature is not required on the report. However, the document shall clearly identify the organization submitting the report. Not withstanding the absence of a signature, the organization submitting the document is responsible for its content.

17.3 A document printed from or used in electronic form from an electronic data interchange (EDI) transmission shall be regarded as having the same validity as a counterpart printed in the certifier's facility. The content of the EDI transmitted document shall meet the requirements of the invoked ASTM standard(s) and conform to any existing EDI agreement between the purchaser and the supplier. Not withstanding the absence of a signature, the organization submitting the EDI transmission is responsible for the content of the report.

NOTE 3—The industry definition of EDI invoked herein is the computer-to-computer exchange of business information in a standard format such as ANSI ASC X12.

17.4 When finished material is supplied to a purchase order specifying the product specification, the organization supplying that material shall provide the purchaser with a copy of the original manufacturer's test report.

17.4.1 When the original manufacturer's test report was provided by EDI to the organization supplying the finished material to the purchaser, the organization supplying the finished material shall provide to the purchaser a printed form of the original test report or shall retransmit the test report by EDI to the purchaser. In either case, the test report shall be complete with the full identification of the original manufacturer and with all data provided on the test report of the original manufacturer.

18. Product Marking

18.1 *Civilian Procurement:*

18.1.1 Bars and shapes shall be marked or tagged with the name of manufacturer, purchaser's name and order number, ASTM specification designation, heat number, grade or type, condition, finish, and where appropriate, the size, length, and weight. Unless otherwise specified, the method of marking is at the option of the manufacturer. Marking shall be made by hot stamping, cold stamping, or painting of bars, or by marking tags attached to bundles, lifts, or boxes.

18.1.2 Forgings shall be legibly die stamped with the manufacturer's symbol or name, material specification designation, grade or type, and heat identification. When die stamping is not permitted by the purchaser, electric pencil or electro-etching shall be used.

18.2 *Government Procurement:*

18.2.1 When specified in the contract or order, and for direct procurement by or direct shipment to the government, marking for shipment, in addition to any requirements specified in the contract or order, shall be in accordance with MIL-STD-129 for military agencies and in accordance with Fed. Std. No. 123 for civil agencies.

18.2.2 For government procurement by the Defense Supply Agency, bars and shapes shall be marked continuously for identification in accordance with Fed. Std. No. 183.

19. Packaging and Package Marking

19.1 Unless otherwise specified, the bars and shapes shall be packaged and loaded in accordance with Practices A700.

19.2 When specified in the contract or order, and for direct procurement by or direct shipment to the government, when Level A is specified, preservation, packaging, and packing shall be in accordance with the Level A requirements of MIL-STD-163.

20. Keywords

20.1 general delivery requirements; stainless steel bars; stainless steel billets; stainless steel forgings; stainless steel shapes

ANNEXES

(Mandatory Information)

A1. REQUIREMENTS FOR THE INTRODUCTION OF NEW MATERIALS

A1.1 New materials may be proposed for inclusion in specifications referencing this specification, subject to the following conditions:

A1.1.1 The application for the addition of a new grade to a specification shall be made to the chair of the subcommittee that has jurisdiction over that specification.

A1.1.2 The application shall be accompanied by a statement from at least one user indicating that there is a need for the new grade to be included in the applicable specification.

A1.1.3 The application shall be accompanied by test data as required by the applicable specification. Test data from a minimum of three test lots, as defined by the specification, each from a different heat, shall be furnished.

A1.1.4 The application shall provide recommendations for all requirements appearing in the applicable specification.

A1.1.5 The application shall state whether the new grade is covered by patent.

A2. REQUIREMENTS FOR THE INTRODUCTION OF MATERIALS FROM OTHER A01 OR B02.07 SPECIFICATIONS

A2.1 Wrought materials that are already covered by another A01 or B02.07 specification may be proposed for inclusion in specifications referencing this specification of general requirements subject to the following conditions:

A2.1.1 Application for the addition of a grade that is already covered in another A01 or B02.07 specification shall be made to the chair of the subcommittee that has jurisdiction over that the specification to which the grade is to be added.

A2.1.2 The chemical requirements, the specified mechanical properties, and the heat treatment requirements of the grade being added shall be the same as those for the grade in the A01 or B02.07 specification in which the grade is presently covered.

A2.1.3 The application shall provide recommendations for all requirements appearing in the applicable specification.

A2.1.4 The application shall state whether or not the grade is covered by patent.

APPENDIXES

(Nonmandatory Information)

X1. RATIONALE REGARDING DEFINITION OF LOT FOR MECHANICAL PROPERTIES AND CORROSION TESTING

X1.1 It is generally recognized that material described as a lot must be "produced under the same processing conditions," which means the same manufacturing order number, same size, same heat, same heat-treating procedure, and same subsequent processing. Under those conditions, single samples can be selected to be representative of the total lot, with at least one sample for each 20 000 pounds of material.

X1.2 Following the principle described in X1.1 generally requires that the producer control each of several furnace loads constituting the same lot so that:

X1.2.1 Set point temperature and process tolerance match,

X1.2.2 Time at temperature for all thermal treatment shall match within 10 %,

X1.2.3 All furnaces used be similar in size and meet the uniformity requirements of a documented furnace quality assurance program, and

X1.2.4 The quench systems are the same with respect to volume, type of quenchant, and circulation rate.

X1.2.5 Further, it would be expected that grouped loads be handled within a relatively short time period, and that hardness testing be performed on at least one sample per charge.

X1.3 The old definition of a lot for mechanical testing based on simply the words "same size, heat, and heat treatment charge in a batch furnace" assumes that heat treating is the only process affecting properties. This kind of definition ignores the effects of other processing, prior to and subsequent to heat treating. Moreover, it assumes that each heat-treated batch will be uniform and unique rather than reproducible. In reality, heat treating is a process which can be controlled easily throughout a batch and from batch to batch, with the net result that multiple batches can be considered part of a single lot if equipment and processing parameters meet the mandates of X1.1 and X1.2.

X1.4 The sampling specified for mechanical properties is not a statistical sampling plan. Therefore, it provides only typical data. Assurance of uniformity within the lot can be obtained only by the producer adequately controlling the processing parameters.

X2. BAR CODING

X2.1 Bar coding to identify steel is not specifically addressed in Committee A01 specifications. Committee A01 endorses the AIAG bar code standard for primary metals for steel products and proposes that this bar coding standard be considered as a possible auxiliary method of identification.

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A484/A484M – 19) that may impact the use of this standard. (Approved March 1, 2020.)

(1) Revised Section 17 on certification.

Committee A01 has identified the location of selected changes to this standard since the last issue (A484/A484M – 18a) that may impact the use of this standard. (Approved Sept. 1, 2019.)

(1) Revised subsections 7.2.4 and 8.1.4.