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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 Department of Defense.

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, A314, A458, A473, 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 may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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

2. Referenced Documents

2.1 *ASTM Standards:*[3]

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

A276 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[4]

A473 Specification for Stainless Steel Forgings

A477 Specification for Hot-Worked, Hot-Cold Worked and Cold-Worked Alloy Steel Forgings and Forging Billets for High Strength at Elevated Temperatures[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

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

[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.

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[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] Withdrawn. 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.**

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 Practices 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
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, shapes, forgings, billets, or other semi-finished material used in this specification are defined as follows:

3.1.1.1 *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. Bar shall include shapes with all dimensions under 5 in. [125 mm]. Bar 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. Bar 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.

NOTE 1—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.

3.1.1.2 *billets, n*—semi-finished products, typically produced by rolling, forging, or continuous casting, that require subsequent hot working by rolling, forging, or extrusion. Billets typically have a cross-section area of 36 in.^{2} or less (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.

3.1.1.3 *blooms, n*—semi-finished products, typically produced by rolling or continuous casting, that require subsequent hot working by rolling or forging. Blooms 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.

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

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

3.1.1.6 *slabs or sheet bars*—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.

3.1.2 The terms random lengths, multiple lengths, and dead or exact lengths are defined as follows:

3.1.2.1 *dead lengths or exact lengths*—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.

3.1.2.2 *multiple lengths*—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.

3.1.2.3 *random lengths*—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].

3.1.3 The terms condition and finish are defined as follows:

3.1.3.1 *condition*—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.

[5] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil.
[6] Available from Automotive Industry Action Group (AIAG), 26200 Lahser Rd., Suite 200, Southfield, MI 48033, http://www.aiag.org.

3.1.3.2 *finish*—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.

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.

4.1.12 Special requirements.

NOTE 2—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. 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, whether intentionally added unspecified elements, residual elements, or trace 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.

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

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.

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°F to 1850°F [930°C to 1010°C]	[E]	x	
N08904	2000°F [1095°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]
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° to 2060°F [1025° to 1125°C]~~	~~[E]~~	~~x~~	~~x[F]~~
S32750	1880°F [1025°C]	[E]	x	x[F]
S32760	2010°F [1100°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]

[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 1750°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.

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 3—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 7.2.1, followed by strain hardening sufficient to meet the required mechanical properties. 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.

~~7.3.2All duplex stainless steels shall be furnished in the solution annealed condition in accordance with~~

7.3.2 Except as indicated in Table 2~~, with subsequent light cold drawing for cold finishing and straightening permitted.~~

~~7.3.3Except 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.~~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.

~~7.3.3.2~~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. It is permitted to condition the surface by removing surface defects provided that the depth of the