



Designation: A20/A20M – 09

# Standard Specification for General Requirements for Steel Plates for Pressure Vessels<sup>1</sup>

This standard is issued under the fixed designation A20/A20M; 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 ( $\epsilon$ ) 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 general requirements specification<sup>2</sup> covers a group of common requirements that, unless otherwise specified in the applicable product specification, apply to rolled steel plates for pressure vessels covered by each of the following product specifications issued by ASTM:

Title of Specification	ASTM Designation <sup>A</sup>
Pressure Vessel Plates, Alloy Steel, Chromium-Manganese Silicon	A202/A202M
Pressure Vessel Plates, Alloy Steel, Nickel	A203/A203M
Pressure Vessel Plates, Alloy Steel, Molybdenum	A204/A204M
Pressure Vessel Plates, Alloy Steel, Manganese-Vanadium	A225/A225M
Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength	A285/A285M
Pressure Vessel Plates, Carbon Steel, Manganese-Silicon	A299/A299M
Pressure Vessel Plates, Alloy Steel, Manganese-Molybdenum and Manganese-Molybdenum-Nickel	A302/A302M
Pressure Vessel Plates, Alloy Steel, 9 Percent Nickel Double-Normalized and Tempered	A353/A353M
Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum	A387/A387M
Pressure Vessel Plates, Carbon Steel, High Strength Manganese	A455/A455M
Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service	A515/A515M
Pressure Vessel Plates, Carbon Steel, Moderate- and Lower-Temperature Service	A516/A516M
Pressure Vessel Plates, Alloy Steel, High-Strength, Quenched and Tempered	A517/A517M
Pressure Vessel Plates, Alloy Steel, Quenched and Tempered Manganese-Molybdenum and Manganese-Molybdenum-Nickel	A533/A533M
Pressure Vessel Plates, Heat-Treated, Carbon-Manganese-Silicon Steel	A537/A537M
Pressure Vessel Plates, Alloy Steel, Quenched and Tempered Chromium-Molybdenum	A542/A542M
Pressure Vessel Plates, Alloy Steel, Quenched and Tempered Nickel-Chromium-Molybdenum	A543/A543M
Pressure Vessel Plates, Alloy Steel, Quenched and Tempered 8 and 9 Percent Nickel	A553/A553M

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.11 on Steel Plates for Boilers and Pressure Vessels.

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<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications, see related Specification SA-20/SA-20M in Section II of that Code.

Title of Specification	ASTM Designation <sup>A</sup>
Pressure Vessel Plates, Carbon Steel, Manganese-Titanium for Glass or Diffused Metallic Coatings	A562/A562M
Pressure Vessel Plates, Carbon Steel, High Strength, for Moderate and Lower Temperature Service	A612/A612M
Pressure Vessel Plates, Five Percent Nickel Alloy Steel, Specially Heat Treated	A645/A645M
Pressure Vessel Plates, Carbon-Manganese, for Moderate and Lower Temperature Service	A662/A662M
Pressure Vessel Plates, Carbon Steel, Quenched and Tempered, for Welded Layered Pressure Vessels	A724/A724M
Pressure Vessel Plates, Alloy Steel and High-Strength Low-Alloy Steel, Quenched and Tempered	A734/A734M
Pressure Vessel Plates, Low-Carbon Manganese-Molybdenum-Columbium Alloy Steel, for Moderate and Lower Temperature Service	A735/A735M
Pressure Vessel Plates, Low-Carbon Age-Hardening Nickel-Copper-Chromium-Molybdenum-Columbium Alloy Steel	A736/A736M
Pressure Vessel Plates, High-Strength Low-Alloy Steel	A737/A737M
Pressure Vessel Plates, Heat-Treated, Carbon-Manganese-Silicon Steel, for Moderate and Lower Temperature Service	A738/A738M
Pressure-Vessel Plates, Quenched and Tempered, Manganese-Chromium-Molybdenum-Silicon-Zirconium Alloy Steel	A782/A782M
Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum-Vanadium	A832/A832M
Pressure Vessel Plates, Produced by the Thermo-Mechanical Control Process (TMCP)	A841/A841M
Pressure Vessel Plates, 9 % Nickel Alloy, Produced by the Direct-Quenching Process	A844/A844M
Pressure Vessel Plates, 9 % Nickel Alloy, Produced by the Direct-Quenching Process	A844/A844M
Pressure Vessel Plates, 9 % Nickel Alloy, Produced by the Direct-Quenching Process	A844/A844M
Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum-Tungsten	A1017/A1017M
Pressure Vessel Plates, Alloy Steel, Higher Strength Chromium-Molybdenum-Tungsten	A1041/A1041M

<sup>A</sup> These designations refer to the latest issue of the respective specification which appears in the *Annual Book of ASTM Standards*, Vol 01.04.

1.1.1 This general requirements specification also covers a group of supplementary requirements that are applicable to several of the above product specifications as indicated therein. Such requirements are provided for use if additional testing or additional restrictions are required by the purchaser, and apply only if specified individually in the purchase order.

1.2 Appendix X1 provides information on coil as a source of plates for pressure vessels.

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

1.3 **Appendix X2** provides information on the variability of tensile properties in plates for pressure vessels.

1.4 **Appendix X3** provides information on the variability of Charpy-V-Notch impact test properties in plates for pressure vessels.

1.5 **Appendix X4** provides information on cold bending of plates, including suggested minimum inside radii for cold bending.

1.6 These materials are intended to be suitable for fusion welding. When the steel is to be welded, it is presupposed that a welding procedure suitable for the grade of steel and intended use or service will be utilized.

1.7 In case of any conflict in requirements, the requirements of the applicable product specification prevail over those of this general requirements specification.

1.8 Additional requirements that are specified in the purchase order and accepted by the supplier are permitted, provided that such requirements do not negate any of the requirements of this general requirements specification or the applicable product specification.

1.9 For purposes of determining conformance with this general requirements specification and the applicable product specification, values are to be rounded to the nearest unit in the right-hand place of figures used in expressing the limiting values in accordance with the rounding method of Practice E29.

1.10 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.

1.11 This general requirements specification and the applicable product specification are expressed in both inch-pound units and SI units; unless the order specifies the applicable “M” specification designation (SI units), the plates are to be furnished to inch-pound units.

## 2. Referenced Documents

### 2.1 *ASTM Standards*:<sup>3</sup>

**A202/A202M** Specification for Pressure Vessel Plates, Alloy Steel, Chromium-Manganese-Silicon<sup>4</sup>

**A203/A203M** Specification for Pressure Vessel Plates, Alloy Steel, Nickel

**A204/A204M** Specification for Pressure Vessel Plates, Alloy Steel, Molybdenum

**A225/A225M** Specification for Pressure Vessel Plates, Alloy Steel, Manganese-Vanadium-Nickel

**A285/A285M** Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength

**A299/A299M** Specification for Pressure Vessel Plates, Carbon Steel, Manganese-Silicon

**A302/A302M** Specification for Pressure Vessel Plates, Alloy Steel, Manganese-Molybdenum and Manganese-Molybdenum-Nickel

**A353/A353M** Specification for Pressure Vessel Plates, Alloy Steel, 9 Percent Nickel, Double-Normalized and Tempered

**A370** Test Methods and Definitions for Mechanical Testing of Steel Products

**A387/A387M** Specification for Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum

**A435/A435M** Specification for Straight-Beam Ultrasonic Examination of Steel Plates

**A455/A455M** Specification for Pressure Vessel Plates, Carbon Steel, High-Strength Manganese

**A515/A515M** Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service

**A516/A516M** Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service

**A517/A517M** Specification for Pressure Vessel Plates, Alloy Steel, High-Strength, Quenched and Tempered

**A533/A533M** Specification for Pressure Vessel Plates, Alloy Steel, Quenched and Tempered, Manganese-Molybdenum and Manganese-Molybdenum-Nickel

**A537/A537M** Specification for Pressure Vessel Plates, Heat-Treated, Carbon-Manganese-Silicon Steel

**A542/A542M** Specification for Pressure Vessel Plates, Alloy Steel, Quenched-and-Tempered, Chromium-Molybdenum, and Chromium-Molybdenum-Vanadium

**A543/A543M** Specification for Pressure Vessel Plates, Alloy Steel, Quenched and Tempered Nickel-Chromium-Molybdenum

**A553/A553M** Specification for Pressure Vessel Plates, Alloy Steel, Quenched and Tempered 8 and 9 % Nickel

**A562/A562M** Specification for Pressure Vessel Plates, Carbon Steel, Manganese-Titanium for Glass or Diffused Metallic Coatings

**A577/A577M** Specification for Ultrasonic Angle-Beam Examination of Steel Plates

**A578/A578M** Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications

**A612/A612M** Specification for Pressure Vessel Plates, Carbon Steel, High Strength, for Moderate and Lower Temperature Service

**A645/A645M** Specification for Pressure Vessel Plates, 5 % and 5 12 % Nickel Alloy Steels, Specially Heat Treated

**A662/A662M** Specification for Pressure Vessel Plates, Carbon-Manganese-Silicon Steel, for Moderate and Lower Temperature Service

**A700** Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment

**A724/A724M** Specification for Pressure Vessel Plates, Carbon-Manganese-Silicon Steel, Quenched and Tempered, for Welded Pressure Vessels

**A734/A734M** Specification for Pressure Vessel Plates, Alloy Steel and High-Strength Low-Alloy Steel, Quenched-and-Tempered

<sup>3</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>4</sup> Withdrawn. The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

- A735/A735M** Specification for Pressure Vessel Plates, Low-Carbon Manganese-Molybdenum-Columbium Alloy Steel, for Moderate and Lower Temperature Service
- A736/A736M** Specification for Pressure Vessel Plates, Low-Carbon Age-Hardening Nickel-Copper-Chromium-Molybdenum-Columbium and Nickel-Copper-Manganese-Molybdenum-Columbium Alloy Steel
- A737/A737M** Specification for Pressure Vessel Plates, High-Strength, Low-Alloy Steel
- A738/A738M** Specification for Pressure Vessel Plates, Heat-Treated, Carbon-Manganese-Silicon Steel, for Moderate and Lower Temperature Service
- A751** Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
- A770/A770M** Specification for Through-Thickness Tension Testing of Steel Plates for Special Applications
- A782/A782M** Specification for Pressure-Vessel Plates, Quenched-and-Tempered, Manganese-Chromium-Molybdenum-Silicon Zirconium Alloy Steel
- A832/A832M** Specification for Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum-Vanadium
- A841/A841M** Specification for Steel Plates for Pressure Vessels, Produced by Thermo-Mechanical Control Process (TMCP)
- A844/A844M** Specification for Steel Plates, 9 % Nickel Alloy, for Pressure Vessels, Produced by the Direct-Quenching Process
- A941** Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys
- A1017/A1017M** Specification for Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum-Tungsten
- A1041/A1041M** Specification for Pressure Vessel Plates, Alloy Steel, Higher Strength Chromium-Molybdenum-Tungsten
- E21** Test Methods for Elevated Temperature Tension Tests of Metallic Materials
- E29** Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- E112** Test Methods for Determining Average Grain Size
- E208** Test Method for Conducting Drop-Weight Test to Determine Nil-Ductility Transition Temperature of Ferritic Steels
- E709** Guide for Magnetic Particle Testing
- 2.2 *American Society of Mechanical Engineers Code*:<sup>5</sup>  
**ASME Boiler and Pressure Vessel Code** Section IX, Welding Qualifications
- 2.3 *U.S. Federal Standard*:<sup>6</sup>  
**Fed. Std. No. 123** Marking for Shipment (Civil Agencies)
- 2.4 *Automotive Industry Action Group Standard*:<sup>7</sup>  
**B 1** Bar Code Symbology Standard

### 3. Terminology

#### 3.1 Definitions of Terms Specific to This Standard:

3.1.1 *coil*—hot-rolled steel in coil form for processing into finished plates.

3.1.2 *exclusive*—when used in relation to ranges, as for ranges of thicknesses in the tables of permissible variations in dimensions, the term is intended to exclude only the greater value of the range. Thus, a range from 60 to 72 in. [1500 to 1800 mm] *exclusive* includes 60 in. [1500 mm], but does not include 72 in. [1800 mm].

3.1.3 *heat treatment terms*—see 3.1.8, and Terminology A941.

3.1.4 *hot forming*—a forming operation producing permanent deformation, performed after the plate has been heated to the temperature required to produce grain refinement.

3.1.5 *manufacturer*—the organization that directly controls the conversion of steel ingots or slabs, by hot rolling, into plate-as-rolled or into coil; and for plates produced from plate-as-rolled, the organization that directly controls, or is responsible for, one or more of the operations involved in finishing the plates. Such finishing operations include leveling, cutting to length, testing, inspection, conditioning, heat treatment (if applicable), packaging, marking, loading for shipment, and certification.

3.1.5.1 *Discussion*—The finishing operations need not be done by the organization that did the hot rolling of the plate. For plates produced from coil, see also 3.1.13.1.

3.1.6 *plate identifier*—the alpha, numeric, or alphanumeric designation used to identify the plate.

3.1.7 *plates*—flat hot-rolled steel, ordered to thickness or weight and typically to width and length, commonly available by size as follows:

Width, in. [mm]	Thickness, in. [mm]
Over 8 [200]	over 0.229 [6.0 mm and over]
Over 48 [1200]	over 0.179 [4.6 mm and over]

3.1.7.1 *Discussion*—Steel plates are available in various thickness, width, and length combinations dependent upon equipment and processing capabilities of various manufacturers and processors. Historic limitations of a plate based upon dimensions (thickness, width, and length) do not take into account current production and processing capabilities. To qualify any plate to a particular product specification requires that all appropriate and necessary tests be performed and that the results meet the limits prescribed in that product specification. If the necessary tests required by a product specification can not be conducted, the plate can not be qualified to that specification. This general requirements specification contains permitted variations for the commonly available sizes. Permitted variations for other sizes are subject to agreement between the purchaser and the manufacturer or processor, whichever is applicable.

3.1.8 *precipitation heat treatment*—a subcritical temperature thermal treatment performed to cause precipitation of submicroscopic constituents, and so forth, to result in enhancement of some desirable property.

3.1.9 *processor*—the organization that directly controls, or is responsible for, operations involved in the processing of coil

<sup>5</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

<sup>6</sup> Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://dodssp.daps.dla.mil>.

<sup>7</sup> Available from Automotive Industry Action Group (AIAG), 26200 Lahser Rd., Suite 200, Southfield, MI 48033, <http://www.aiag.org>.

into finished plates. Such processing operations include decoiling, leveling, cutting to length, testing, inspection, conditioning, heat treatment (if applicable), packaging, marking, loading for shipment, and certification.

3.1.9.1 *Discussion*—The processing operations need not be done by the organization that did the hot rolling of the coil. If only one organization is involved in the hot rolling and processing operations, that organization is termed the *manufacturer* for the hot rolling operation and the *processor* for the processing operations. If more than one organization is involved in the hot rolling and processing operations, the organization that did the hot rolling is termed the *manufacturer* and the organization that does one or more processing operations is termed a *processor*.

3.2 Refer to Terminology **A941** for additional terms used in this standard.

## 4. Ordering Information

4.1 Orders should include the following information, as necessary, to adequately describe the desired product.

- 4.1.1 Quantity (weight [mass] or number of plates),
- 4.1.2 Dimensions,
- 4.1.3 Name of product (for example, plates, carbon steel; plates, alloy steel),
- 4.1.4 Specification designation (including type, class, and grade as applicable) and year-date,
- 4.1.5 Condition (as-rolled, normalized, quenched and tempered, etc. If heat treatment of plate is to be performed by the fabricator, this is to be stated. Also, if purchaser specifies a heat-treatment cycle, this is to be stated),
- 4.1.6 Impact test requirements, if any (see Section **12**). (For Charpy V-notch test, include test specimen orientation, testing temperature, and acceptance criteria. For drop-weight test, give testing temperature),
- 4.1.7 Exclusion of either plates produced from coil or plates produced from plate-as-rolled, if applicable. (See **5.4** and **Appendix X1**.)
- 4.1.8 Limits for grain refining elements other than aluminum, if applicable (see **8.2.4**),
- 4.1.9 Paint marking (see **13.2.1**),
- 4.1.10 Supplementary requirements, if any (test specimen heat treatment, special impact test requirements, etc.), and
- 4.1.11 Additional requirements, if any.

## 5. Materials and Manufacture

5.1 The steel shall be made in an open-hearth, basic-oxygen, or electric-arc furnace, possibly followed by additional refining in a ladle metallurgy furnace (LMF), or by another method; or secondary melting by vacuum-arc remelting (VAR), electroslag remelting (ESR), or another method.

5.2 The steel may be strand cast or cast in stationary molds.

### 5.2.1 Strand Cast Slabs:

5.2.1.1 If heats of the same nominal chemical composition are consecutively strand cast at one time, the heat number assigned to the cast product (slab) may remain unchanged until all of the steel in the slab is from the following heat.

5.2.1.2 When two consecutively strand cast heats have different nominal chemical composition ranges, the manufacturer shall remove the transition material by any established procedure that positively separates the grades.

5.3 The ratio of reduction of thickness from a strand-cast slab to plate shall be at least 3.0:1, except that reduction ratios as low as 2.0:1 are permitted if all of the following limitations are met:

5.3.1 The purchaser agrees to the use of such reduction ratios.

5.3.2 The applicable product specification is **A299/A299M**, **A515/A515M**, **A516/A516M**, **A537/A537M**, **A662/A662M**, or **A737/A737M**.

5.3.3 The specified plate thickness is 3.0 in. [75 mm] or more.

5.3.4 One or more of the following low hydrogen practices are used: vacuum degassing during steelmaking; controlled soaking of the slabs or plates; or controlled slow cooling of the slabs or plates.

5.3.5 The sulfur content is 0.004 % or less, based upon heat analysis.

5.3.6 One or more of the following practices are used: electromagnetic stirring during strand casting; soft reduction during strand casting; heavy pass reductions or other special practices during plate rolling; or combined forging and rolling during plate rolling.

5.3.7 The plates are ultrasonically examined in accordance with Specification **A578/A578M**, Level C based on continuous scanning over 100 % of the plate surface.

5.3.8 The plates are through-thickness tension tested in accordance with Specification **A770/A770M**.

5.4 Unless otherwise specified in the purchase order, plates shall be produced from plate-as-rolled or from coil.

5.5 Coils are excluded from qualification to the applicable product specification until they are decoiled, leveled, cut to length, and tested by the processor in accordance with the specified requirements (see Sections **9**, **10**, **11**, **12**, **13**, **14**, **15**, **16**, and **20**.)

5.5.1 Plates produced from coil shall not contain splice welds, unless approved by the purchaser.

## 6. Heat Treatment

6.1 If plates are required to be heat treated, the heat treatment shall be performed by the manufacturer, the processor, or the fabricator, unless otherwise specified in the applicable product specification.

6.2 If the heat treatment required by the applicable product specification is to be performed by the purchaser or the purchaser's agent, and the plates are to be supplied by the manufacturer or processor in a condition other than that required by the applicable product specification, the order shall so state.

6.2.1 If plates are ordered without the heat treatment required by the applicable product specification, heat treatment of the plates to conform to the requirements of the applicable product specification shall be the responsibility of the purchaser.

6.3 If heat treatment is to be performed, the plates shall be heat treated as specified in the applicable product specification.

The purchaser may specify the heat treatment to be used, provided it is not in conflict with the requirements of the applicable product specification.

6.4 If normalizing is to be performed by the fabricator, the plates shall be either normalized or heated uniformly for hot forming, provided that the temperature to which the plates are heated for hot forming does not significantly exceed the normalizing temperature.

6.5 If no heat treatment is required, the manufacturer or processor shall have the option of heat treating the plates by normalizing, stress relieving, or normalizing and then stress relieving to meet the requirements of the applicable product specification.

6.6 If approved by the purchaser, cooling rates faster than those obtained by cooling in air are permissible to achieve specified mechanical properties, provided that the plates are subsequently tempered in the temperature range from 1100 to 1300°F [595 to 705°C].

## 7. Chemical Composition

### 7.1 Heat Analysis

7.1.1 Sampling for chemical analysis and methods of analysis shall be in accordance with Test Methods, Practices, and Terminology **A751**.

7.1.2 For each heat, the heat analysis shall include determination of the content of carbon, manganese, phosphorus, sulfur, silicon, nickel, chromium, molybdenum, copper, vanadium, columbium; any other element that is specified or restricted by the applicable product specification for the applicable grade, class, and type; aluminum, if the aluminum content is to be used in place of austenitic grain size testing of the heat (see 8.2.2.1); and any other austenitic grain refining element for which limits are specified in the purchase order (see 8.2.4).

7.1.3 Heat analyses shall conform to the heat analysis requirements of the applicable product specification for the applicable grade, class, and type. In addition, for elements that are listed in **Table 1** but are not specified or restricted in the applicable product specification for the applicable grade, class, and type, heat analyses shall conform to the applicable heat analysis limits given in **Table 1**.

### 7.2 Product Analysis:

7.2.1 Sampling for chemical analysis and methods of analysis shall be in accordance with Test Methods, Practices, and Terminology **A751**.

7.2.2 For each plate-as-rolled, the purchaser shall have the option of chemically analyzing a broken tension test specimen or a sample taken from the same relative location as that from which the tension test specimen was obtained.

7.2.3 For elements that are specified or restricted by the applicable product specification for the applicable grade, class, and type, product analyses shall conform to the product analysis requirements of the applicable product specification for the applicable grade, class, and type.

7.2.4 For elements that are listed in **Table 1** but are not specified or restricted by the applicable product specification for the applicable grade, class, and type, product analyses shall conform to the applicable product analysis limits given in **Table 1**.

**TABLE 1 Limits on Elements (see 7.1.3 and 7.2.4)**

Copper, max % <sup>A</sup>	Heat analysis	0.40
	Product analysis	0.43
Nickel, max % <sup>A</sup>	Heat analysis	0.40
	Product analysis	0.43
Chromium, max % <sup>A,B</sup>	Heat analysis	0.30
	Product analysis	0.34
Molybdenum, max % <sup>A,B</sup>	Heat analysis	0.12
	Product analysis	0.13
Vanadium, max % <sup>C</sup>	Heat analysis	0.03
	Product analysis	0.04
Columbium, max % <sup>D</sup>	Heat analysis	0.02
	Product analysis	0.03
Titanium, max % <sup>E</sup>	Heat analysis	0.03
	Product analysis	0.04

<sup>A</sup> In addition for each heat, based upon the heat analysis, the sum of copper, nickel, chromium, and molybdenum shall not exceed 1.00 %, unless one or more of those elements are specified or restricted by the applicable product specification for the applicable grade, class, and type.

<sup>B</sup> In addition for each heat, based upon the heat analysis, the sum of chromium and molybdenum shall not exceed 0.32 %, unless one or both of those elements are specified or restricted by the applicable product specification for the applicable grade, class, and type.

<sup>C</sup> By agreement between the purchaser and the supplier, the heat analysis limit for vanadium is permitted to be increased to a value not higher than 0.10 %, and the product analysis limit for vanadium is permitted to be increased to a value not higher than 0.11 %.

<sup>D</sup> By agreement between the purchaser and the supplier, the heat analysis limit for columbium is permitted to be increased to a value not higher than 0.05 %, and the product analysis limit for columbium is permitted to be increased to a value not higher than 0.06 %.

<sup>E</sup> By agreement between the purchaser and the supplier, the heat analysis limit for titanium is permitted to be increased to a value not higher than 0.04 %, and the product analysis limit for titanium is permitted to be increased to a value not higher than 0.05 %.

7.3 *Referee Analysis*—For referee purposes, Test Methods, Practices, and Terminology **A751** shall be used.

## 8. Metallurgical Structure

8.1 If coarse austenitic grain size is specified, the steel shall have a carburized austenitic grain size number in the range from 1 to 5, inclusive, as determined by the McQuaid-Ehn Test. Determinations shall be in accordance with Test Methods **E112**, Plate IV, by carburizing for 8 h at 1700°F [925°C]. At least 70 % of the grains in the area examined shall conform to the specified grain size requirement. One test per heat shall be made.

### 8.2 Fine Austenitic Grain Size:

8.2.1 If fine austenitic grain size is specified, aluminum shall be used as the grain refining element, except as allowed by **8.2.4**.

8.2.2 If fine austenitic grain size is specified, except as allowed by **8.2.2.1**, the steel shall have a carburized austenitic grain size number of 5 or higher (finer) as determined by the McQuaid-Ehn test in accordance with Test Methods **E112**, Plate IV. One test per heat shall be made.

8.2.2.1 If aluminum is used as the grain refining element, the fine austenitic grain size requirement shall be deemed to be fulfilled if, on heat analysis, the aluminum content is not less than 0.020 % total aluminum or, alternatively, 0.015 % acid soluble aluminum.

8.2.3 If specified in the purchase order, one McQuaid-Ehn test (see 8.1) per heat shall be made and the austenitic grain size of the steel, as represented by the test, shall be Number 5 or finer.

8.2.4 By agreement between the purchaser and the manufacturer or processor, elements other than aluminum may be used for grain refining. In such instances, the heat analysis limits for the element, or elements, permitted shall be as specified in the purchase order. In addition, the McQuaid-Ehn test of 8.2.3 shall be required.

## 9. Quality

9.1 *General*—Plates shall be free of injurious defects and shall have a workmanlike finish.

### 9.2 *Surface Imperfections:*

9.2.1 For plates produced from plate-as-rolled, all injurious surface imperfections shall be removed by the manufacturer. For plates produced from coil, all injurious surface imperfections shall be removed by the processor.

9.2.1.1 Shallow imperfections shall be ground to sound metal; the ground area shall be well faired and the thickness of the ground plate shall not be reduced below the minimum thickness permitted.

9.2.1.2 All surface imperfections, the removal of which will reduce the plate thickness below the minimum thickness permitted, shall be cause for rejection of the plate, except that, by agreement with the purchaser, the metal so removed may be replaced with weld metal (see 9.4).

### 9.3 *Edge Imperfections:*

9.3.1 Laminar-type discontinuities 1 in. [25 mm] and less in length visible to the unaided eye on an edge of a plate as prepared for shipment by the manufacturer or processor are acceptable and do not require exploration.

9.3.2 All larger discontinuities shall be explored to determine their depth and extent. Discontinuities shall be considered continuous when located in the same plane within 5 % of the plate thickness and separated by a distance less than the length of the smaller of two adjacent discontinuities.

9.3.3 Indications visible to the unaided eye on the cut edges of a plate as prepared for shipment by the manufacturer or processor shall not exceed the limits given in Columns 1 and 2 of Table A1.14 [A2.14].

9.3.4 Larger indications shall be removed by the manufacturer or processor by grinding, provided that the resultant cavity does not exceed the limits given in Columns 3 and 4 of Table A1.14 [A2.14].

9.3.5 Indications of greater magnitude shall be cause for rejection of the plate, except that, by agreement with the purchaser, the defects may be removed and replaced with weld metal (see 9.4).

9.3.6 Indications on the edges of a plate cut during the fabrication shall be cause for rejection of the plate at the discretion of the purchaser if the magnitude exceeds the limits given in Columns 5 and 6 of Table A1.14 [A2.14]. The defects may be removed and replaced with weld metal (see 9.4).

9.3.7 Fabricators should be aware that edge cracks may initiate upon bending a sheared or burned edge during the

fabrication process. This is not considered to be a fault of the steel, but is rather a function of the induced cold work or heat affected zone.

### 9.4 *Repair by Welding:*

9.4.1 Repair welding shall be permitted only with the approval of the purchaser.

9.4.2 Preparation for repair welding shall include inspection to confirm complete removal of the defect.

9.4.3 Repairs shall be made utilizing welding procedures qualified in accordance with Section IX of the **ASME Boiler and Pressure Vessel Code** and repair welding shall be done by welders or welding operators meeting the qualification requirements of Section IX.

9.4.4 The weld metal shall have the A-number analysis corresponding to the equivalent ASME P-number of the plate, except that A-1 or A-2 analysis weld metal may be employed for P-1 plates. Other weld metals may be employed that are compatible with the plate being repaired, if so approved by the purchaser. Such weld metals shall be qualified in accordance with the requirements of Section IX of the **ASME Boiler and Pressure Vessel Code**.

9.4.5 If Charpy impact tests of the plate are required, the welding procedure qualification tests shall also include Charpy impact tests of the weld, the heat-affected zone, and the plate, and the test results shall be reported to the purchaser.

9.4.6 If the plate is subjected to normalizing, quenching and tempering, hot forming, or post-weld heat treating, the welding procedure qualification test plates and the weld repaired plate shall be subjected to the thermal heat treatment as specified by the purchaser.

9.4.7 In addition, repair welds shall meet the requirements of the construction code specified by the purchaser.

## 10. Test Methods

10.1 All tests shall be conducted in accordance with Test Methods and Definitions **A370**.

10.2 Yield strength shall be determined by either the 0.2 % offset method or the 0.5 % extension under load method, unless otherwise stated in the applicable product specification.

10.3 *Rounding Procedures*—For purposes of determining conformance with the applicable product specification, a calculated value shall be rounded to the nearest 1 ksi [5 MPa] for tensile and yield strengths, and to the nearest unit in the right-hand place of figures used in expressing the limiting value for other values, in accordance with the rounding method given in Practice **E29**.

## 11. Tension Tests

### 11.1 *Number of Test Coupons:*

11.1.1 *Plates Produced from As-Rolled Plates*—For other than quenched and tempered plates, one tension test coupon shall be taken from each plate-as-rolled. Two tension test coupons shall be taken from each quenched and tempered plate, as heat treated. If plates are furnished by the manufacturer or processor in accordance with 11.4.2 and qualified by using test specimens taken from heat-treated test coupons (including normalized, normalized and tempered, and quenched and tempered), one tension test coupon shall be

taken from each plate-as-rolled (see Terminology [A941](#) for the definition of plate-as-rolled).

11.1.2 *Plates Produced from Coil and Furnished without Heat Treatment or with Stress Relieving Only*—Except as allowed by [11.1.2.1](#) and [11.1.4](#), a minimum of three tension coupons shall be taken from each coil as follows:

11.1.2.1 The first test coupon shall be taken immediately prior to the first plate to be qualified to the applicable product specification, the second test coupon shall be taken from the approximate center lap, and the third test coupon shall be taken immediately after the last plate to be qualified to the applicable product specification. If, during decoiling, the amount of material decoiled is less than that required to reach the next standard test location, a test for qualification of that particular portion of the coil shall be made from a test coupon taken from a location adjacent to the innermost portion decoiled.

11.1.2.2 All plates between any two test locations that meet the requirements of the applicable product specification are acceptable.

11.1.2.3 All plates between a test location that fails to meet the requirements of the applicable product specification and an adjacent test location that meets the requirements of the applicable product specification are rejectable, except that the processor has the option to make other tests after cutting back the coil in either direction.

11.1.3 *Plates Produced from Coil and Furnished Heat Treated by Other than Stress Relieving*—For other than quenched and tempered plates, one tension test coupon shall be taken from each coil. Two tension test coupons shall be taken from each quenched and tempered plate, as heat treated.

11.1.4 *Plates Produced from Coil and Qualified Using Test Specimens Taken from Test Coupons Heat Treated by Other than Stress Relieving*—One tension test coupon shall be taken from each coil.

11.2 *Orientation of Test Specimens*—The longitudinal axis of the tension test specimens shall be transverse to the final rolling direction of the plate.

11.3 *Location of Test Coupons*—Tension test coupons shall be taken from a corner of the plate. For quenched and tempered plates, the two tension test coupons shall be taken from opposite ends of the plate.

#### 11.4 *Tests from Heat-Treated Plates:*

11.4.1 If heat treatment is performed by the manufacturer or processor, the test specimens shall be taken from the plate in the heat-treated condition or from full-thickness coupons simultaneously heat treated with the plate.

11.4.2 If heat treatment is to be performed by the fabricator, the plates shall be accepted on the basis of tests made on test specimens taken from full-thickness coupons heat treated in accordance with the requirements specified in the applicable product specification or the purchase order. If the heat-treatment temperatures are not specified, the manufacturer or processor shall heat treat the coupons under conditions it considers appropriate. The purchaser shall be informed of the procedure followed in heat treating the specimens.

11.4.3 If approved by the purchaser, the procedures of [11.4.2](#) may be implemented on plates heat treated by the manufacturer or processor.

11.4.4 For plates that are heat treated with a cooling rate faster than still-air cooling from the austenitizing temperature, one of the following shall apply in addition to other requirements specified herein:

11.4.4.1 The gage length of the tension test specimen shall be taken at least  $1T$  from any as-heat treated edge, where  $T$  is the thickness of the plate, and shall be at least  $\frac{1}{2}$  in. [12.5 mm] from flame-cut or heat-affected-zone surfaces.

11.4.4.2 A steel thermal buffer pad,  $1T$  by  $1T$  by at least  $3T$ , shall be joined to the plate edge by a partial penetration weld completely sealing the buffered edge prior to heat treatment.

11.4.4.3 Thermal insulation or other thermal barriers shall be used during the heat treatment adjacent to the plate edge where the test specimens are to be removed. It shall be demonstrated that the cooling rate of the tension test specimen is no faster than, and not substantially slower than, that attained by the method described in [11.4.4.2](#).

11.4.4.4 When test coupons cut from the plate but heat treated separately are used, the coupon dimensions shall be not less than  $3T$  by  $3T$  by  $T$  and each tension test specimen cut from it shall meet the requirements of [11.4.4.1](#).

11.4.4.5 If cooling rate data for the plate and cooling rate control devices for the test coupons are available, the test coupons may be heat treated separately in the device, provided that this method is approved by the purchaser.

#### 11.5 *Test Specimen Preparation:*

11.5.1 Tension test specimens for plates  $\frac{3}{4}$  in. [20 mm] and under in thickness shall be the full thickness of the plates. The test specimens shall conform to the requirements for either the  $1\frac{1}{2}$ -in. [40-mm] wide or the  $\frac{1}{2}$ -in. [12.5-mm] wide rectangular tension test specimen of Test Methods and Definitions [A370](#). The  $1\frac{1}{2}$ -in. [40-mm] wide test specimen may have both edges parallel. The  $\frac{1}{2}$ -in. [12.5-mm] wide specimen may have a maximum nominal thickness of  $\frac{3}{4}$  in. [20 mm].

11.5.2 For plates up to 4 in. [100 mm], inclusive, in thickness, tension test specimens may be the full thickness of the plate and conform to the requirements for the  $1\frac{1}{2}$ -in. [40-mm] wide rectangular tension test specimen of Test Methods and Definitions [A370](#) if adequate testing machine capacity is available.

11.5.3 For plates over  $\frac{3}{4}$  in. [20 mm] in thickness, except as permitted in [11.5.2](#), tension test specimens shall conform to the requirements for the 0.500-in. [12.5-mm] diameter test specimen of Test Methods and Definitions [A370](#). The axis of the test specimen shall be located midway between the center of thickness and the top or bottom surface of the plate.

#### 11.6 *Elongation Requirement Adjustments:*

11.6.1 Due to the specimen geometry effect encountered when using the rectangular tension test specimen for testing thin plate, adjustments in elongation requirements must be provided for thicknesses under 0.312 in. [8 mm]. Accordingly, the following deductions shall be made from the base elongation requirements in the applicable product specification:

Plate Nominal Thickness Range, in. [mm]	Elongation Deduction, %
0.299–0.311 [7.60–7.89]	0.5
0.286–0.298 [7.30–7.59]	1.0
0.273–0.285 [7.00–7.29]	1.5
0.259–0.272 [6.60–6.99]	2.0
0.246–0.258 [6.20–6.59]	2.5
0.233–0.245 [5.90–6.19]	3.0
0.219–0.232 [5.50–5.89]	3.5
0.206–0.218 [5.20–5.49]	4.0
0.193–0.205 [4.90–5.19]	4.5
0.180–0.192 [4.60–4.89]	5.0

11.6.2 Due to the inherently lower elongation that is obtainable in thicker plate, adjustments in elongation requirements in 2-in. [50-mm] gage length shall be provided for thicknesses over 3.5 in. [90 mm]. Accordingly, the following deductions shall be made from the base elongation requirements in 2 in. [50 mm] prescribed in the applicable product specification:

Plate Nominal Thickness Range, in. [mm]	Elongation Deduction, %
3.501–3.999 [90.00–102.49]	0.5
4.000–4.499 [102.50–114.99]	1.0
4.500–4.999 [115.00–127.49]	1.5
5.000–5.499 [127.50–139.99]	2.0
5.500–5.999 [140.0–152.49]	2.5
6.000 and thicker [152.50 and thicker]	3.0

11.6.3 A characteristic of certain types of alloy steels is a local disproportionate increase in the degree of necking down or contraction of the test specimens during the tension test, resulting in a decrease in the percentage of elongation as the gage length is increased. The effect is not so pronounced in thicker plates. For such material, if so stated in the applicable product specification for plates up to  $\frac{3}{4}$  in. [20 mm], inclusive, in thickness, if the percentage of elongation of an 8-in. [200-mm] gage length test specimen falls not more than 3 percentage points below the amount prescribed, the elongation shall be considered satisfactory if the percentage of elongation in 2 in. [50 mm] across the break is not less than 25 %.

11.6.4 The tensile requirements tables in many of the product specifications covered by this general requirements specification specify elongation requirements in both 8-in. [200-mm] and 2-in. [50-mm] gage lengths. Unless otherwise provided in the applicable product specification, both requirements are not required to be applied simultaneously, and the elongation need only be determined in the gage length appropriate for the test specimen used. After selection of the appropriate gage length, the elongation requirement for the alternative gage length shall be deemed not applicable.

11.7 This specification does not provide requirements for product tension testing subsequent to shipment (see 15.1). Therefore, the requirements of 11.1 through 11.6 and Section 16 apply only for tests conducted at the place of manufacture prior to shipment. Compliance to Specification A20/20M and the applicable product specification does not preclude the possibility that product tension test results may vary outside specified ranges. The tensile properties will vary within the same plate-as-rolled or piece, be it as-rolled, control-rolled, or heat-treated. The purchaser should, therefore, be aware that tension testing in accordance with the requirements of Specification A20/A20M does not provide assurance that all products of a plate-as-rolled will be identical in tensile properties with the products tested. If the purchaser wishes to have more

confidence than that provided by Specification A20/A20M testing procedures, additional testing or requirements, such as Supplementary Requirement S4, should be imposed.

11.8 Appendix X2 provides additional information on the variability of tensile properties in plates for pressure vessels.

## 12. Notch-Toughness Tests

### 12.1 Charpy V-Notch Tests:

12.1.1 *Number of Tests*—Except for quenched and tempered plates, and except as allowed by 12.1.1.1 and 12.1.1.2, one impact test (3 specimens) for each specified orientation (see 12.1.2) shall be made from each plate-as-rolled. For quenched and tempered plates, one impact test shall be made from each plate, as heat treated.

12.1.1.1 *Plates Ordered Without the Heat Treatment Specified by the Applicable Product Specification*—If the applicable product specification requires heat treatment but the plates are ordered without such heat treatment and Charpy V-notch tests are specified, one coupon shall be taken from each plate-as-rolled. The coupon shall be heat treated in accordance with the applicable product specification and the purchase order and the plate shall be qualified by test specimens taken from the heat-treated coupon.

12.1.1.2 *Plates Produced from Coil*—If Charpy V-notch tests are specified, the number of impact tests required shall be the same as the number specified for tension tests in 11.1.2 or 11.1.3, whichever is applicable. The test coupons shall be taken from the material after decoiling and leveling.

12.1.2 *Orientation of Test Specimens*—The long axis of the test specimens shall be oriented either longitudinal (parallel to the final direction of rolling) or transverse (transverse to the final direction of rolling), as specified in the applicable product specification or the purchase order.

12.1.3 *Location of Test Coupons*—The impact test coupons shall be taken adjacent to the tension test coupons. The impact test coupons shall be subject to the same requirements as those specified for tension tests in 11.4, except that the provisions of 11.4.4.1 apply to the area under the notch of the impact test specimen instead of to the gage length of the tension test specimen.

12.1.4 *Test Method*—Impact testing shall be performed in accordance with Test Methods and Definitions A370 using Charpy V-notch (Type A) specimens as shown in Test Methods and Definitions A370. Except as allowed by 12.1.4.1, full-size specimens (0.394 by 0.394 in. [10 by 10 mm]) shall be used if the plate thickness permits, and their central axis shall correspond as near as practical to the  $\frac{1}{4} t$  plane in the plate thickness  $t$ . If the plate thickness is insufficient to obtain full-size specimens, the largest possible subsize specimens shall be used.

12.1.4.1 For plates that normally have absorbed energy values in excess of 180 ft-lbf [245 J] if tested using full-size specimens at the specified testing temperature, subsize 0.394 by 0.264 in. [10 by 6.7 mm] specimens may be used in lieu of full-size specimens; however, if this option is used, the acceptance value shall be 75 ft-lbf [100 J] minimum for each test specimen and the lateral expansion in mils [micrometres] shall be reported.



12.1.5 *Test Temperature*—The test temperature shall be as specified in the purchase order, except that the manufacturer or processor shall have the option of using a lower test temperature. If a test temperature is not specified in the purchase order, tests shall be conducted at a temperature no higher than is given in Table A1.15 [A2.15] for the applicable product specification, grade, class, and plate thickness. The actual test temperature used shall be reported with the test results.

12.1.6 *Acceptance Criteria*—Unless otherwise agreed upon, the acceptance criteria shall be as given in Table A1.15 [A2.15] for the applicable product specification, grade, class, and plate thickness.

12.1.6.1 If the acceptance criteria is based upon energy absorption of a full-size specimen, the acceptance criteria for the various subsize specimens shall be as given in Table A1.16 [A2.16], except as otherwise provided in 12.1.4.1.

12.1.6.2 If the acceptance criterion is based upon lateral expansion opposite the notch, the acceptance value shall be the same for all sizes of test specimens.

12.1.7 *Marking*—The letters “LTV” shall be stenciled or stamped on each plate following the class number, grade, etc.

12.1.8 *Variability*—The impact properties of steel can vary within the same plate-as-rolled or piece, be it as-rolled, control-rolled, or heat-treated. The purchaser should, therefore, be aware that testing of one plate-as-rolled does not provide assurance that all locations within a plate-as-rolled will be identical in toughness with the location tested. Normalizing or quenching and tempering the product will reduce the degree of variation.

12.1.8.1 **Appendix X3** provides additional information on the variability of Charpy V-notch test properties in plates for pressure vessels.

#### 12.2 *Drop-Weight Tests:*

12.2.1 Where specified, one drop-weight test, consisting of a set of two test specimens, shall be made to the same frequency stated in 12.1.1 in accordance with Method E208.

12.2.2 The test coupons shall be obtained adjacent to a tension test coupon. For plates produced from coil, the test coupon locations shall be the same as for Charpy V-notch tests. (See 12.1.) The provisions of 12.1.3 shall also apply.

12.2.3 The testing temperature shall be as specified in the applicable product specification or the purchase order.

12.2.4 Acceptance shall be on the basis of *no-break* performance of both test specimens at the specified testing temperature.

12.2.5 The plates shall be marked as required in 12.1.7, except that the letters “LTD” shall be used instead of “LTV.”

### 13. Identification of Plates

#### 13.1 *Required Markings:*

13.1.1 Except as allowed by 13.4, plates shall be legibly marked with the following information: applicable ASTM designation (see 1.1) (year of issue not required); “G” or “MT” if applicable (see 13.1.2); applicable grade, type, and class; heat number; plate identifier; and name, brand, or trademark of the manufacturer (for plates produced in discrete cut lengths of flat product) or the processor (for plates produced from coil and for subdivided plates (see 13.4)).

13.1.2 Plates that are required to be heat treated, but have not been so heat treated, shall be marked, by the manufacturer or processor, with the letter “G” (denoting green) following the required ASTM designation mark, except that “G” marking is not necessary if such plates are for shipment, for the purpose of obtaining the required heat treatment, to an organization under the manufacturer’s control. Such plates shall have been qualified for shipment on the basis of test specimens that have been so heat treated. Plates that are required to be heat treated, and have been so heat treated, shall be marked, by the party that performed the heat treatment, with the letters “MT” (denoting material treated) following the required ASTM designation mark.

NOTE 1—Any stress relief of test specimens intended to simulate post-weld heat treatment is not included in the above heat treatment.

#### 13.2 *Types of Marking:*

13.2.1 Except as allowed by 13.4, the required markings for plates over ¼ in. [6 mm] in thickness shall be by steel die stamping, unless paint marking is specified in the purchase order.

13.2.2 Except as allowed by 13.4, the required markings for plates ¼ in. [6 mm] and under in thickness shall be by paint marking or by steel die stamping using low-stress (either round-nose or interrupted-dot) impressions.

#### 13.3 *Location of Markings:*

13.3.1 Except as allowed by 13.4, the required markings for plates with a maximum lengthwise or crosswise dimension more than 72 in. [1800 mm] shall be in at least two places on each finished plate, at least 12 in. [300 mm] from the edges of the plate.

13.3.2 Except as allowed by 13.4, the required markings for plates with a maximum lengthwise and crosswise dimension of 72 in. [1800 mm] or less shall be in at least one place on each finished plate, approximately midway between the center and an edge of the plate.

#### 13.4 *Subdivided Plates:*

13.4.1 By agreement between the purchaser and the manufacturer or processor, each subdivided plate (a plate separated from a master plate) shall be legibly marked with the name, brand, or trademark of the organization that subdivided the plate plus a code traceable to the required markings, provided that the information required in 13.1, cross referenced to that code, is furnished with the plates.

13.4.2 By agreement between the purchaser and the manufacturer or processor, subdivided plates that are from the same master plate and placed in secured lifts shall have the information required in 13.1 paint marked on the top piece of each lift or shown on a substantial tag attached to each lift.

13.5 *Bar Coding*—In addition to the requirements of 13.1 to 13.4 inclusive, the manufacturer or processor shall have the option of using bar coding as a supplementary identification method.

NOTE 2—Bar coding should be consistent with AIAG Standard B 1.

### 14. Permissible Variations in Dimensions or Mass

14.1 One cubic foot of rolled steel shall be assumed to weigh 490 lb, unless otherwise stated in the applicable product specification. One cubic metre of rolled steel is assumed to

have a mass of 7850 kg, unless otherwise stated in the applicable product specification.

14.2 For carbon steel plates the permissible variations for dimensions shall not exceed the applicable limits stated in Annex A1, Table A1.1 to Table A1.9, and Table A1.13 [Annex A2, Table A2.1 to Table A2.9, and Table A2.13].

14.3 For alloy steel plates the permissible variations for dimensions shall not exceed the applicable limits stated in Annex 1, Table A1.1 to Table A1.4, Table A1.8, and Table A1.10 to Table A1.13. [Annex 2, Table A2.1 to Table A2.4, Table A2.8 and Table A2.10 to Table A2.13].

14.4 *Conversions of Permitted Variations from Fractions of an Inch to Decimals*—Permitted variations in dimensions for products covered by this specification are generally given as fractions of inch and these remain the official permitted variations, where so stated. If the material is to be measured by equipment reporting dimensions as decimals, conversion of permitted variations from fractions of an inch to decimals shall be made to three decimal places; using the rounding method prescribed in Practice E29.

## 15. Inspection and Testing

15.1 The inspector representing the purchaser shall have entry at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works that concern the manufacture of the plate ordered. The manufacturer shall afford the inspector all reasonable facilities to be satisfied that the plate is being furnished in accordance with this general requirements specification, the applicable product specification, and the purchase order. All tests (except product analysis) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the manufacturer's works.

15.2 If plates are produced from coil, 15.1 shall apply to the "processor" instead of to the "manufacturer" and the "place of process" shall apply instead of the "place of manufacture." If plates are produced from coil and the processor is different from the manufacturer, the inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works that concern the manufacture of the plate ordered.

## 16. Retests

16.1 *Tension Test*—In addition to the provisions of Test Methods and Definitions A370, the following retest provisions shall apply:

16.1.1 Any test specimen shows defective machining, or develops flaws, it may be discarded and another test specimen substituted.

16.1.2 If the percentage of elongation of any tension test specimen is less than that specified, and any part of the fracture is more than  $\frac{3}{4}$  in. [20 mm] from the center of the gage length of a 2-in. [50-mm] test specimen or is outside the middle half of the gage length of an 8-in. [200-mm] test specimen as indicated by scribe marks on the test specimen before testing, one retest shall be allowed.

16.1.3 If the results from an original tension test specimen fail to meet the specified requirements but are within 2 ksi [10 MPa] of the required tensile strength or within 1 ksi [5 MPa] of the required yield strength or yield point, or within 2 percentage points of the required elongation or reduction of area, one retest shall be permitted to replace the failing test.

16.1.4 The results of the retest shall meet the specified requirements.

### 16.2 Charpy V-Notch Tests:

16.2.1 The retest provisions of Test Methods and Definitions A370 shall apply, except that the 5 ft-lbf [7 J] absolute minimum for an individual specimen shall not apply if two thirds of the specified minimum average is less than 5 ft-lbf [7 J].

16.2.2 If Charpy V-notch impact test lateral expansion values are specified, if the value of one specimen falls below the specified minimum value and not below  $\frac{2}{3}$  of the specified minimum value, and if the average of the three specimens equals or exceeds the specified minimum value, a retest of three additional specimens may be made. Each of the three retest specimens shall equal or exceed the specified minimum value.

16.2.3 If the required values are not obtained on Charpy V-notch retests as specified in 16.2.1 and 16.2.2, or if the values in the initial test are below the values required for retest, no further retests are permitted unless the plate is heat treated or reheat treated. After heat treatment or reheat treatment, a set of three specimens shall be tested and each shall equal or exceed the specified minimum value.

16.2.4 If the option of 12.1.4.1 is used and the test result falls below the 75 ft-lbf [100 J] minimum specified, another test may be made using full-size test specimens.

## 17. Retreatment

17.1 If any heat-treated plate fails to meet the mechanical requirements of the applicable product specification, the manufacturer or processor shall have the option of heat treating the plate again. All mechanical-property tests shall be repeated and the plate surface shall be reexamined for surface defects when it is resubmitted for inspection.

## 18. Rejection

18.1 Any rejection based upon product analysis made in accordance with the applicable product specification shall be reported to the supplier and samples that represent the rejected plate shall be preserved for 2 weeks from the date of notification of such rejection. In case of dissatisfaction with the results of the tests, the supplier shall have the option of making claim for a rehearing within that time.

18.2 Plates that show injurious defects subsequent to their acceptance at the manufacturer's or processor's works may be rejected. In such cases, the manufacturer or processor shall be notified.

## 19. Test Reports

19.1 The manufacturer or processor shall report the results of all tests required by the applicable product specification, the applicable supplementary requirements, and the purchase order. The heat number, the plate identifier of the plate tested, and

the nominal plate thickness shall be shown on the test report. The year-date of the specification to which the plates are furnished shall be included in the test report.

19.1.1 In reporting elongation values, both the percentage increase and the original gage length shall be stated.

NOTE 3—Where **Table 1** applies and the amount of any element listed therein is less than 0.02 %, the applicable analysis for that element may be reported as “<0.02 %.”

19.2 For plates rolled from a strand-cast slab with a reduction ratio in the range from 2.0:1 to 3.0:1, exclusive, the specific practices (see **5.3.4** and **5.3.6**) that were used by the manufacturer shall be reported, and the test reports shall state that the limitations of **5.3** have been met.

19.3 All heat treatment, exclusive of subcritical heating to soften thermally cut edges, shall be reported, including temperature ranges and times at temperature. This exclusion does not apply to those plates with specified minimum tensile strengths of 95 ksi [655 MPa] or higher, unless such subcritical heating is accomplished at temperatures at least 75 °F [40 °C] below the minimum tempering temperature. The reports shall state whether the plates only, the test coupons only, or both plates and test coupons were heat treated.

19.4 If Charpy V-notch tests are specified, the test specimen size used shall be reported.

19.5 If so specified in the purchaser order, the manufacturer shall also furnish a certificate of compliance stating that the plates have been manufactured, inspected, and tested in accordance with the requirements of the applicable product specification. For plates produced from coil, the processor shall furnish the required certification.

19.6 For plates produced from coil and furnished without heat treatment or with stress relieving only, the results of all tests required by **11.1.2** shall be reported for each qualifying coil.

19.7 A signature is not required on the test report; however, the document shall clearly identify the organization submitting the report. Notwithstanding the absence of a signature, the organization submitting the report is responsible for the content of the report.

19.8 Copies of the original manufacturer’s test report shall be included with any subsequent test report.

19.9 A test report, certificate of compliance, or similar 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 must meet the requirements of the invoked ASTM standard(s) and conform to any existing EDI agreement between the purchaser and the supplier. Notwithstanding the absence of a signature, the organization submitting the EDI transmission is responsible for the content of the report.

## 20. Packaging, Marking, and Loading for Shipment

20.1 Packaging, marking, and loading for shipment shall be in accordance with those procedures recommended by Practices **A700**.

20.2 *For USA Government Procurement*—Marking for shipment of material for civil agencies shall be in accordance with **Fed. Std. No. 123**.

## 21. Keywords

21.1 general delivery requirement; pressure containing parts; pressure vessel steels; steel plates; steel plates for pressure vessel applications

## SUPPLEMENTARY REQUIREMENTS

The following standardized supplementary requirements are for use if desired by the purchaser. Those that are considered suitable for use with a product specification are listed in the product specification. Other tests may be performed by agreement between the manufacturer or processor and the purchaser. These supplementary requirements shall apply only if specified in the purchase order, in which event the specified tests shall be made by the manufacturer or processor before shipment of the plates.

### S1. Vacuum Treatment

S1.1 The steel shall be made by a process that includes vacuum degassing while molten. Unless otherwise agreed upon with the purchaser, it is the responsibility of the manufacturer to select suitable process procedures.

### S2. Product Analysis

S2.1 A product analysis shall be made of each plate as rolled. The specimens for analysis shall be taken adjacent to or from a broken tension test specimen.

### S3. Simulated Post-Weld Heat Treatment of Mechanical Test Coupons

S3.1 Prior to testing, the test coupons representing the plate for acceptance purposes for mechanical properties shall be thermally treated to simulate a post-weld heat treatment below the critical temperature ( $A_{c3}$ ), using the heat treatment parameters (such as temperature range, time, and cooling rates) specified in the purchase order. For tests using specimens taken from such heat treated test coupons, the test results shall meet the requirements of the applicable product specification.