Designation: A 20/A20M – 02

Standard Specification for General Requirements for Steel Plates for Pressure Vessels[1]

This standard is issued under the fixed designation A 20/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 (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 a group of common requirements which, unless otherwise specified in the individual material specification, shall apply to rolled steel plates for pressure vessels under each of the following specifications issued by ASTM:

Title of Specification	ASTM Designation[3]
Pressure Vessel Plates, Alloy Steel, Chromium-Manganese Silicon	A 202/A 202M
Pressure Vessel Plates, Alloy Steel, Nickel	A 203/A 203M
Pressure Vessel Plates, Alloy Steel, Molybdenum	A 204/A 204M
Pressure Vessel Plates, Alloy Steel, Manganese-Vanadium	A 225/A 225M
Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength	A 285/A 285M
Pressure Vessel Plates, Carbon Steel, Manganese-Silicon	A 299/A 299M
Pressure Vessel Plates, Alloy Steel, Manganese-Molybdenum and Manganese-Molybdenum-Nickel	A 302/A 302M
Pressure Vessel Plates, Alloy Steel, 9 Percent Nickel Double-Normalized and Tempered	A 353/A 353M
Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum	A 387/A 387M
Pressure Vessel Plates, Carbon Steel, High Strength Manganese	A 455/A 455M
Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service	A 515/A 515M
Pressure Vessel Plates, Carbon Steel, Moderate- and Lower-Temperature Service	A 516/A 516M
Pressure Vessel Plates, Alloy Steel, High-Strength, Quenched and Tempered	A 517/A 517M
Pressure Vessel Plates, Alloy Steel, Quenched and Tempered Manganese-Molybdenum and Manganese-Molybdenum-Nickel	A 533/A 533M
Pressure Vessel Plates, Heat-Treated, Carbon-Manganese-Silicon Steel	A 537/A 537M
Pressure Vessel Plates, Alloy Steel, Quenched and Tempered Chromium-Molybdenum	A 542/A 542M
Pressure Vessel Plates, Alloy Steel, Quenched and Tempered Nickel-Chromium-Molybdenum	A 543/A 543M
Pressure Vessel Plates, Alloy Steel, Quenched and Tempered 8 and 9 Percent Nickel	A 553/A 553M
Pressure Vessel Plates, Carbon Steel, Manganese-Titanium for Glass or Diffused Metallic Coatings	A 562/A 562M
Pressure Vessel Plates, Carbon Steel, High Strength, for Moderate and Lower Temperature Service	A 612/A 612M
Pressure Vessel Plates, Five Percent Nickel Alloy Steel, Specially Heat Treated	A 645/A 645M
Pressure Vessel Plates, Carbon-Manganese, for Moderate and Lower Temperature Service	A 662/A 662M
Pressure Vessel Plates, Carbon Steel, Quenched and Tempered, for Welded Layered Pressure Vessels	A 724/A 724M
Pressure Vessel Plates, Alloy Steel and High-Strength Low-Alloy Steel, Quenched and Tempered	A 734/A 734M
Pressure Vessel Plates, Low-Carbon Manganese-Molybdenum-Columbium Alloy Steel, for Moderate and Lower Temperature Service	A 735/A 735M
Pressure Vessel Plates, Low-Carbon Age-Hardening Nickel-Copper-Chromium-Molybdenum-Columbium Alloy Steel	A 736/A 736M
Pressure Vessel Plates, High-Strength Low-Alloy Steel	A 737/A 737M
Pressure Vessel Plates, Heat-Treated, Carbon-Manganese-Silicon Steel, for Moderate and Lower Temperature Service	A 738/A 738M
Pressure-Vessel Plates, Quenched and Tempered, Manganese-Chromium-Molybdenum-Silicon-Zirconium Alloy Steel	A 782/A 782M
Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum-Vanadium	A 832/A 832M
Pressure Vessel Plates, Produced by the Thermo-Mechanical Control Process (TMCP)	A 841/A 841M
Pressure Vessel Plates, 9 % Nickel Alloy, Produced by the Direct-Quenching Process	A 844/A 844M

1.1.1 This specification also covers a group of supplementary requirements which are applicable to several of the above specifications as indicated therein. These are provided for use when additional testing or inspection is desired and apply only when specified individually by the purchaser in the order.

1.2 Appendix X1 describes the production and some of the characteristics of coiled product from which pressure vessel plates may be produced.

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

[3] These designations refer to the latest issue of the respective specification which appears in the *Annual Book of ASTM Standards*, Vol 01.04.

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 individual material specification shall prevail over those of this general specification.

1.8 The purchaser may specify additional requirements that do not negate any of the provisions of this general specification or of the individual material specifications. Such additional requirements, the acceptance of which are subject to negotiation with the supplier, must be included in the order information (see 4.1.8).

1.9 For purposes of determining conformance with this specification and the various material specifications referenced in 1.1, values shall 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 E 29.

1.10 The values stated in either inch-pound units or SI units are to be regarded as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents. Therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with this specification.

1.11 This specification and the applicable material specifications are expressed in both inch-pound units and SI units. However, unless the order specifies the applicable "M" specification designation (SI units), the material shall be furnished to inch-pound units.

2. Referenced Documents

2.1 *ASTM Standards:*

A 202/A202M Specification for Pressure Vessel Plates, Alloy Steel, Chromium-Manganese-Silicon[4]

A 203/A203M Specification for Pressure Vessel Plates, Alloy Steel, Nickel[4]

A 204/A204M Specification for Pressure Vessel Plates, Alloy Steel, Molybdenum[4]

A 225/A225M Specification for Pressure Vessel Plates, Alloy Steel, Manganese-Vanadium-Nickel[4]

A 285/A285M Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength[4]

A 299/A299M Specification for Pressure Vessel Plates, Carbon Steel, Manganese-Silicon[4]

A 302/A302M Specification for Pressure Vessel Plates, Alloy Steel, Manganese-Molybdenum and Manganese-Molybdenum-Nickel[4]

A 353/A353M Specification for Pressure Vessel Plates, Alloy Steel, 9 Percent Nickel, Double-Normalized and Tempered[4]

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products[5]

A 387/A387M Specification for Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum[4]

A 435/A435M Specification for Straight-Beam Ultrasonic Examination of Steel Plates[4]

A 455/A455M Specification for Pressure Vessel Plates, Carbon Steel, High Strength Manganese[4]

A 515/A515M Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service[4]

A 516/A516M Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service[4]

A 517/A517M Specification for Pressure Vessel Plates, Alloy Steel, High-Strength, Quenched and Tempered[4]

A 533/A533M Specification for Pressure Vessel Plates, Alloy Steel, Quenched and Tempered Manganese-Molybdenum and Manganese-Molybdenum-Nickel[4]

A 537/A537M Specification for Pressure Vessel Plates, Heat-Treated, Carbon-Manganese-Silicon Steel[4]

A 542/A542M Specification for Pressure Vessel Plates, Alloy Steel, Quenched and Tempered, Chromium-Molybdenum, and Chromium-Molybdenum-Vanadium[4]

A 543/A543M Specification for Pressure Vessel Plates, Alloy Steel, Quenched and Tempered Nickel-Chromium-Molybdenum[4]

A 553/A553M Specification for Pressure Vessel Plates, Alloy Steel, Quenched and Tempered 8 and 9 Percent Nickel[4]

A 562/A562M Specification for Pressure Vessel Plates, Carbon Steel, Manganese-Titanium for Glass or Diffused Metallic Coatings[4]

A 577/A577M Specification for Ultrasonic Angle-Beam Examination of Steel Plates[4]

A 578/A578M Specification for Straight-Beam Ultrasonic Examination of Plain and Clad Steel Plates for Special Applications[4]

A 612/A612M Specification for Pressure Vessel Plates, Carbon Steel, High Strength, for Moderate and Lower Temperature Service[4]

A 645/A645M Specification for Pressure Vessel Plates, Five Percent Nickel Alloy Steel, Specially Heat Treated[4]

A 662/A662M Specification for Pressure Vessel Plates, Carbon-Manganese-Silicon Steel, for Moderate and Lower Temperature Service[4]

A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment[6]

A 724/A724M Specification for Pressure Vessel Plates, Carbon-Manganese-Silicon Steel, Quenched and Tempered, for Welded Layered Pressure Vessels[4]

A 734/A734M Specification for Pressure Vessel Plates, Alloy Steel and High-Strength Low-Alloy Steel, Quenched and Tempered[4]

A 735/A735M Specification for Pressure Vessel Plates, Low-Carbon Manganese-Molybdenum-Columbium Alloy Steel, for Moderate and Lower Temperature Service[4]

A 736/A736M Specification for Pressure Vessel Plates, Low-Carbon Age-Hardening Nickel-Copper-Chromium-Molybdenum-Columbium and Nickel-Copper Manganese-Molybdenum-Columbium and Alloy Steel[4]

A 737/A737M Specification for Pressure Vessel Plates,

[4] *Annual Book of ASTM Standards*, Vol 01.04.
[5] *Annual Book of ASTM Standards*, Vol 01.03.
[6] *Annual Book of ASTM Standards*, Vol 01.05.

High-Strength, Low-Alloy Steel[4]
A 738/A738M Specification for Pressure Vessel Plates, Heat-Treated, Carbon-Manganese-Silicon Steel, for Moderate and Lower Temperature Service[4]
A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products[4]
A 770/A770M Specification for Through-Thickness Tension Testing of Steel Plates for Special Applications[4]
A 782/A782M Specification for Pressure-Vessel Plates, Quenched and Tempered, Manganese-Chromium-Molybdenum-Silicon-Zirconium Alloy Steel[4]
A 832/A832M Specification for Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum-Vanadium[4]
A 841/A841M Specification for Steel Plates for Pressure Vessels, Produced by the Thermo-Mechanical Control Process (TMCP)[4]
A 844/A844M Specification for Steel Plates, 9 % Nickel Alloy, for Pressure Vessels, Produced by the Direct-Quenching Process[4]
A 941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys[7]
E 21 Test Methods for Elevated Temperature Tension Tests of Metallic Materials[8]
E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[9]
E 112 Test Methods for Determining Average Grain Size[8]
E 208 Test Method for Conducting Drop-Weight Test to Determine Nil-Ductility Transition Temperature of Ferritic Steels[8]
E 709 Guide for Magnetic Particle Examination[10]

2.2 *American Society of Mechanical Engineers Code:*
ASME Boiler and Pressure Vessel Code, Section IX, Welding Qualifications[11]

2.3 *U.S. Military Standard:*
MIL-STD-163 Steel Mill Products Preparation for Shipment and Storage[12]

2.4 *U.S. Federal Standard:*
Fed. Std. No. 123, Marking for Shipment (Civil Agencies)[12]

2.5 *Automotive Industry Action Group Standard:*
B 1 Bar Code Symbology Standard[13]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *capped steel*—rimmed steel in which the rimming action is limited by an early capping operation. Capping may be carried out mechanically by using a heavy metal cap on a bottle-top mold or it may be carried out chemically by an addition of aluminum or ferrosilicon to the top of the molten steel in an open-top mold.

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 18 mm] *exclusive* includes 60 in. [1500 mm], but does not include 72 in. [1800 mm].

3.1.3 *heat treatment terms*—see 3.1.7, 3.1.11, and Terminology A 941.

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 *killed steel*—steel deoxidized, either by addition of strong deoxidizing agents or by vacuum treatment, to reduce the oxygen content to such a level that no reaction occurs between carbon and oxygen during solidification.

3.1.6 *manufacturer (material manufacturer)*—an organization that performs or directly controls one or more operations, such as melting, rolling, coiling, and heat treating, that affect the chemical composition or mechanical properties of the material.

3.1.7 *normalizing*—a heat treating process in which a steel plate is reheated to a uniform temperature above the upper critical temperature and then cooled in air to below the transformation range.

3.1.8 *plate-as-rolled*—when used in relation to the location and number of tests, the term refers to the unit plate rolled from a slab or directly from an ingot. It does not refer to the condition of the plate.

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

3.1.10 *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]

3.1.10.1 *Discussion*—Steel products are available in various thickness, width, and length combinations depending upon equipment and processing capabilities of various manufacturers and processors. Historic limitations of a product based upon dimensions (thickness, width, and length) do not take into account current production and processing capabilities. To qualify any product to a particular product specification requires 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 product can not be qualified to that specification. This general requirements standard contains permitted variation for the commonly available sizes. Permitted variation for other sizes are subject to agreement between the customer and the manufacturer or processor, whichever is applicable.

3.1.11 *precipitation heat treatment*—a subcritical temperature thermal treatment performed to cause precipitation of submicroscopic constituents, etc., to result in enhancement of some desirable property.

3.1.12 *processor*— an organization that performs operations, such as decoiling, cutting to length, marking, inspecting, examining, and testing.

[7] *Annual Book of ASTM Standards*, Vol 01.01.
[8] *Annual Book of ASTM Standards*, Vol 03.01.
[9] *Annual Book of ASTM Standards*, Vol 14.02.
[10] *Annual Book of ASTM Standards*, Vol 03.03.
[11] Available from ASME, 345 E. 47th St., New York, NY 10017.
[12] Available from the procuring activity or as directed by the contracting office or from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.
[13] Available from Automotive Industry Action Group, 26200 Lahser Road, Suite 200, Southfield, MI 48034.

3.1.13 *rimmed steel*—steel containing sufficient oxygen to give a continuous evolution of carbon monoxide while the ingot is solidifying, resulting in a case or rim of metal virtually free of voids.

3.1.14 *semikilled steel*—incompletely deoxidized steel containing sufficient oxygen to form enough carbon monoxide during solidification to offset solidification shrinkage.

4. Ordering Information

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

4.1.1 Quantity (weight or number of plates),

4.1.2 Dimensions,

4.1.3 Name of material (plates, carbon steel; plates, alloy steel),

4.1.4 Specification designation (including type, class, and grade as applicable) and year of issue,

4.1.5 Condition (as-rolled, normalized, quenched and tempered, etc. If heat treatment of material is to be performed by the fabricator, this must be so stated. Also, if purchaser specifies a heat-treatment cycle, it must be stated),

4.1.6 Impact test requirements, if any (Section 12). (For Charpy V-notch test, include specimen orientation, testing temperature, and acceptance criteria. For drop-weight test give testing temperature),

4.1.7 Either plates from coil or discrete cut lengths of flat product may be supplied unless one is specifically excluded on the order. (See Appendix X1.)

4.1.8 If the processor (see 5.5.2) intends to qualify plates cut from a coiled product as pressure vessel plates, the order to the manufacturer (see 5.5.1) should state the intended ASTM specification designation, grade, and type (as applicable).

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 produced by one of the following primary steelmaking processes: open hearth, basic oxygen, electric furnace. The steel may be further refined by secondary processes, including but not restricted to: vacuum-secondary processes, including but not restricted to: vacuum-arc remelt (VAR), electroslag remelt (ESR), and ladle treatment.

5.2 The steel may be cast in ingots or may be strand cast.

5.2.1 *Strand Cast Slabs*:

5.2.1.1 When 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 material specification is A 299/A 299M, A 515/A 515M, A 516/A 516M, A 537/A 537M, A 662/A 662M, or A 737/A 737M

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 A 578/A 578M, 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 A 770/A 770M.

5.4 Plates are produced in either discrete cut lengths of flat product or from coils.

5.4.1 Plates produced from coil means plates that have been leveled or flattened and cut to length from a coiled product and that are furnished without heat treatment. For the purposes of this paragraph, stress relieving is not considered to be a heat treatment.

5.4.2 Plates that are annealed, normalized, normalized-and-tempered, or quenched-and-tempered after decoiling shall be considered to be discrete cut lengths of flat products.

5.5 When plates are produced from coils:

5.5.1 The manufacturer directly controls one or more of the operations (that is, melting, rolling, coiling, etc.) that affect the chemical composition or the mechanical properties, or both, of the material.

5.5.2 The processor decoils, cuts to length, and marks; performs and certifies tests, examination repairs, inspection, or operations not intended to affect the properties of the material. The processor may subsequently heat treat the plates (see Section 6). Specific sections of this specification for which the processor is responsible are 9, 10, 11, 12, 13, 14, 15, 16, and 20.

5.5.2.1 Coiled product is excluded from qualification to individual material specifications governed by this specification until decoiled, leveled, cut to length and tested by the processor in accordance with the specified requirements.

5.5.3 Plates produced from coils shall not contain splice welds, unless approved by the purchaser.

6. Heat Treatment

6.1 When material is required to be heat treated, the heat treatment may be performed either by the manufacturer or processor or by the fabricator unless otherwise specified in the material specification.

6.2 When the heat treatment required by the material specification is to be performed by the purchaser or the

purchaser's agent, and the material is to be supplied by the material producer in a condition other than that required by the material specification, the order shall so state.

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

6.3 When heat treatment is to be performed, the material shall be heat treated as specified in the material specification. The purchaser may specify the heat treatment to be used provided it is not in conflict with the requirements of the material specification.

6.4 When normalizing is to be performed by the fabricator, it may be accomplished by heating uniformly for hot forming. The temperature to which the plates are heated for hot forming shall not significantly exceed the normalizing temperature.

6.5 When no heat treatment is required, the manufacturer or processor may opt to heat treat the plates by normalizing, stress relieving, or normalizing and then stress relieving to meet the material 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 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 A 751.

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 A 751.

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.

7.3 *Referee Analysis*—For referee purposes, Test Methods, Practices, and Terminology A 751 shall be used.

TABLE 1 Limits on Elements (see 7.1.3 and 7.2.4)

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

[A] 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.

[B] 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.

[C] 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 %.

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

[E] 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 %.

8. Metallurgical Structure

8.1 Where 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 E 112, 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 When a fine austenitic grain size is specified, aluminum shall be used as the grain refining element unless the order provides otherwise as specified in 8.2.4.

8.2.2 When a fine austenitic grain size is specified, except as otherwise provided in 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 Methods E 112, Plate IV. One test per heat shall be made.

8.2.2.1 When 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, alternately, 0.015 % acid soluble aluminum.

8.2.3 When specified on the 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 supplier, 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 specified on the order. In addition, the McQuaid-Ehn test of 8.2.3 shall be required.

9. Quality

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

9.2 *Surface Imperfections*:

9.2.1 All injurious surface imperfections shall be removed by the manufacturer of discrete cut length plates. For plates provided from coils, the processor shall remove the injurious imperfections, rather than the manufacturer.

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 this minimum, shall be cause for rejection of the plate; however, by agreement with the purchaser, the metal so removed may be replaced with weld metal as provided in 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 the edges 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 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 a plate; however, by agreement with the purchaser, the defects may be removed and replaced with weld metal as provided in 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 when 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 as provided in 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 assure complete removal of the defect.

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

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

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

9.4.6 If the plate material 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 A 370.

10.2 Yield strength may be determined either by the 0.2 % offset method or the 0.5 % extension under load method unless otherwise stated in the material specification.

10.3 *Rounding Procedures*—For purposes of determining conformance with the specification, a calculated value shall be rounded to the nearest 1 ksi [5 MPa] tensile and yield strength, 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 E 29.

11. Tension Tests

11.1 *Number of Tests*—Except as specified in 11.1.1, one tension test shall be taken from each plate-as-rolled, except for plates subjected to heat treatment by quenching and tempering. Two tension tests shall be taken from each quenched and tempered plate. When plates are furnished by the manufacturer or processor in accordance with 11.4.2 and qualified by heat-treated specimens (including normalized, normalized and

tempered, and quenched and tempered), one tension test specimen shall be taken from each plate-as-rolled (see section 3.1.8 for the definition of plate-as-rolled).

11.1.1 *Plates Produced from Coils*—Coiled product is excluded from qualification to individual material specifications governed by this specification until decoiled, leveled, cut to length, and properly tested by the processor in accordance with ASTM specification requirements. When plates are produced from coils, a minimum of three tension tests shall be made from each coil qualified, except as otherwise indicated as follows for qualification of a portion of a coil.

11.1.1.1 The first test coupon shall be taken immediately prior to the first plate produced to the qualifying 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 produced to the qualifying 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 shipment may be made from a test coupon taken from a location adjacent to the innermost portion shipped.

11.1.1.2 All material between any two test locations that meet the requirements of the material specification is acceptable.

11.1.1.3 All material between a test location that fails to meet the requirements of the material specification and an adjacent acceptable test is rejectable. However, other tests may be made after cutting back the coil in either direction.

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

11.3 *Location of Tests*—The tension test specimen shall be taken from a corner of the plate. For quenched and tempered plates, the tension test specimens shall be taken from a corner of the plate at both ends of the plate.

11.4 *Tests from Heat-Treated Plates*:

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

11.4.3 When approved by the purchaser, the procedures of paragraph 11.4.2 may be implemented on plates heat treated by the manufacturer or processor.

11.4.4 When the plate is 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 1*T* from any as-heat treated edge where *T* is the thickness of the plate and shall be at least ½ in. [12.5 mm] from flame cut or heat-affected-zone surfaces.

11.4.4.2 A steel thermal buffer pad, 1*T* by 1*T* by at least 3*T*, 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 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 3*T* by 3*T* by *T* and each tension 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 specimens are available, the test specimens may be heat treated separately in the device. This method shall require prior approval of the purchaser.

11.5 *Specimen Preparation*:

11.5.1 Tension test specimens for plates ¾ 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 1½ -in. [40-mm] wide or the ½ -in. [12.5-mm] wide rectangular tension test specimen of Methods and Definitions A 370. The 1½ -in. [40-mm] wide specimen may have both edges parallel. The ½ -in. [12.5–mm] wide specimen may have a maximum nominal thickness of ¾ 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 material and conform to the requirements for the 1½ -in. [40–mm] wide rectangular tension test specimen of Methods and Definitions A 370 when adequate testing machine capacity is available.

11.5.3 For plates over ¾ 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] round specimen of Methods and Definitions A 370. The axis of the specimen shall be located, as nearly as practicable, 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 material, 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 individual plate specifications:

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 which is obtainable in thicker material, adjustments in elongation requirements in 2-in. [50-mm] gage length must 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] listed in the individual plate specifications:

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 specimens under tension test, resulting in a decrease in the percentage of elongation as the gage length is increased. The effect is not so pronounced in the thicker plates. On such material, when so stated in the material specification for plates up to ¾ 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 provided 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 plate specifications covered by these general requirements specify elongation requirements in both 8-in. [200-mm] and 2-in. [50-mm] gage lengths. Unless otherwise provided in the individual plate specification, it is not the intent that both requirements apply simultaneously and that the elongation be determined in both gage lengths. Instead, it is intended that the elongation be determined only 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 A 20/20M and the individual material specifications 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 A 20/A 20M 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 A 20/A 20M 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 plates subjected to quenching-and-tempering, and except as specified in 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-asrolled. For plates subjected to quenching-and-tempering, 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 Material Specification*—When the material specification requires heat treatment but the plates are ordered without such heat treatment, and when 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 material specification and the purchase order and the plate qualified by specimens taken from the heat-treated coupon.

12.1.1.2 *Plates Produced from Coils*—When the plates are produced from coils and when Charpy V-Notch tests are specified, the number of impact tests required shall be the same as the number specified in 11.1.1 for tension tests. The test coupons shall be taken from the material after flattening.

12.1.2 *Orientation of Test Specimens*— The long axes of the 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 material specification or 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 A 370 using Charpy V-notch (Type A) specimens as shown in Test Methods and Definitions A 370. Except as provided in 12.1.4.1, full-size (10 by 10 mm) specimens shall be used when the plate thickness permits, and their central axis shall correspond as near as practical to the ¼ *t* plane in the plate thickness *t*. Where the plate thickness is insufficient to obtain full-size specimens, subsize specimens shall be used. The subsize specimens may have a width of full material thickness or may be reduced in thickness to produce the largest possible standard sub-size specimen listed in Test Methods and Definitions A 370.

12.1.4.1 For materials that normally have absorbed energy values in excess of 180 ft·lbf [245 J] when tested using full-size specimens at the specified testing temperature, subsize 0.394 by 0.268 in. [10 by 6.7 mm] specimens may be used in lieu of full-size specimens. However, when this option is used, the acceptance value shall be 75 ft·lbf [100 J] minimum for each specimen and the lateral expansion in mils [µm] shall be reported.

12.1.5 *Test Temperature*—The test temperature should be specified on the order. At the supplier's option, the actual test temperature may be lower than the specified test temperature. When a test temperature is not specified, tests shall be conducted at a temperature no higher than listed in Table A1.15

[A2.15] for the class, grade, and thickness of the material specified. The actual test temperature shall be reported with the test results.

12.1.6 *Acceptance Criteria*—Unless otherwise agreed upon, the acceptance criteria shall be as listed in Table A1.15 [A2.15] for the class, grade, and thickness of the material specified.

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

12.1.6.2 When the acceptance criteria is based on lateral expansion opposite the notch, the acceptance value shall be the same for all sizes of 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 When specified, one drop-weight test, consisting of a set of two specimens, shall be made to the same frequency stated in 12.1.1 in accordance with Method E 208.

12.2.2 The test coupons shall be obtained adjacent to a tension test coupon. For plates produced from coils, the test coupon locations shall be the same as for Charpy V-notch tests. (See 12.1.) The provisions of 11.4 shall also apply.

12.2.3 The testing temperature shall be as specified in the material specification or order.

12.2.4 Acceptance shall be on the basis of *no-break* performance of both 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 processor, each subdivided plate (a plate separated from a master plate) shall be legibly marked with the name, brand, or trademark of the processor 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 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 material specification. One cubic metre of rolled steel is assumed to have a mass of 7850 kg, unless otherwise stated in the material 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].

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 material ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy him that the material is being furnished in accordance with the specification. 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 works.

15.2 When plates are produced from coils, 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." When plates are produced from coils 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 material ordered.

16. Retests

16.1 *Tension Test*—In addition to the provisions of Test Methods and Definitions A 370, the following retest provisions shall apply:

16.1.1 If any test specimen shows defective machining, or develops flaws, it may be discarded and another 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 ¾ in. [20 mm] from the center of the gage length of a 2-in. [50-mm] specimen or is outside the middle half of the gage length of an 8-in. [200-mm] specimen as indicated by scribe marks on the specimen before testing, one retest shall be allowed.

16.1.3 If the results from an original tension test specimen fails to meet the specified requirements but are within 2 ksi [14 MPa] of the required tensile strength or within 1 ksi [7 MPa] of the required yield strength or yield point, or within 2 percentage points of the required elongation or reduction in 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 A 370 shall apply except that the 5 ft·lbf [7 J] absolute minimum for an individual specimen, as specified in Test Methods and Definitions A 370, does not apply when two thirds of the specified minimum average is less than 5 ft·lbf [7 J].

16.2.2 When 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 ⅔ 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 and16.2.2, 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 When 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 specimens.

17. Retreatment

17.1 If any heat-treated material fails to meet the mechanical requirements of the applicable specification, the material may be reheat treated. All mechanical-property tests shall be repeated and the plate surface shall be reexamined for defects when the material is resubmitted for inspection.

18. Rejection

18.1 Any rejection based on product analysis made in accordance with the material specification shall be reported to the supplier and samples that represent the rejected material 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 may make claim for a rehearing within that time.

18.2 Material that shows injurious defects subsequent to its 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 material specification, applicable supplementary requirements, and the 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 material is furnished shall be included on 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 time at temperature. This exclusion does not apply to those materials 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 specimens only, or both plates and test specimen were heat treated.

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

19.5 When required by the purchaser order, the manufacturer shall also furnish a certification that has material has been manufacturerd and tested in accordance with the requirements of the material specification. For plates provided from coils, the processor shall furnish the required certification.

19.6 For plates produced from coils, the results of all tests required by 11.1.1 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 subseqenent test report.

19.9 A Material Test Report, Certificate of Inspection, 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 A 700.

20.2 *For USA Government Procurement*—Packaging, packing, and marking of material for military procurement shall be in accordance with the requirements of MIL-STD-163, Level A, Level C, or commercial as specified in the contract or purchase order. 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 when desired by the purchaser. Several of those that are considered suitable for use with each material specification are listed in the specification. Other tests may be performed by agreement between the supplier and the purchaser. These supplementary requirements shall apply only when specified in the order, in which event the specified tests shall be made by the supplier before shipment of the plates.

S1. Vacuum Treatment

S1.1 The steel shall be made by a process which 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 specimens representing the plate for acceptance purposes for mechanical properties shall be thermally treated to simulate a post-weld heat treatment below the critical temperature (Ac_3), using the heat treatment parameters (such as temperature range, time, and cooling rates) specified in the order. The test results for such heat-treated test specimens shall meet the applicable product specification requirements.

S4. Additional Tension Test

S4.1 *Other Than Quenched-and-Tempered Plates*—In addition to the required single-tension test, a second tension test shall be made on a specimen taken from a corner of the plate-as-rolled on the end opposite the single specimen and in a direction parallel to the single specimen. The results obtained on testing this second specimen shall conform to the requirements of the specification.

S4.2 *Quenched-and-Tempered Plates 2 in.* [50 mm] *or Greater in Thickness*—In addition to the required tension tests, two additional specimens shall be taken from the bottom corner of the plate. One shall be taken at the center of the plate thickness and the other immediately beneath the surface. Mandatory conformance of these additional tests with specified properties shall be a matter of agreement between the manufacturer and the purchaser.

S4.3 For plates produced from coils, the additional tension test shall be taken immediately after the last plate produced to the qualifying specification.

S5. Charpy V-Notch Impact Test

S5.1 Charpy V-notch impact tests shall be conducted in accordance with 12.1.