SPECIFICATION FOR GENERAL REQUIREMENTS FOR STEEL PLATES FOR PRESSURE VESSELS

SA-20/SA-20M

(Identical with ASTM Specification A 20/A 20M-97a$^{\epsilon 1}$) 01

1. Scope

1.1 This specification 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
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, Improved Transition Properties	A 442/A 442M
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

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Title of Specification	ASTM Designation
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 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.

1.6 In case of any conflict in requirements, the requirements of the individual material specification shall prevail over those of this general specification.

1.7 The purchaser may specify additional requirements which 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).

1.8 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.

1.9 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.

1.10 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/A 202M Specification for Pressure Vessel Plates, Alloy Steel, Chromium-Manganese-Silicon

A 203/A 203M Specification for Pressure Vessel Plates, Alloy Steel, Nickel

A 204/A 204M Specification for Pressure Vessel Plates, Alloy Steel, Molybdenum

A 225/A 225M Specification for Pressure Vessel Plates, Alloy Steel, Manganese-Vanadium-Nickel

A 285/A 285M Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength

A 299/A 299M Specification for Pressure Vessel Plates, Carbon Steel, Manganese-Silicon

A 302/A 302M Specification for Pressure Vessel Plates, Alloy Steel, Manganese-Molybdenum and Manganese-Molybdenum-Nickel

A 353/A 353M Specification for Pressure Vessel Plates, Alloy Steel, 9 Percent Nickel, Double-Normalized and Tempered

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

A 387/A 387M Specification for Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum

A 435/A 435M Specification for Straight-Beam Ultrasonic Examination of Steel Plates

A 442/A 442M Specification for Pressure Vessel Plates, Carbon Steel, Improved Transition Properties

A 455/A 455M Specification for Pressure Vessel Plates, Carbon Steel, High Strength Manganese

A 515/A 515M Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service

A 516/A 516M Specification for Pressure Vessel Plates, Carbon Steel, Moderate- and Lower-Temperature Service

A 517/A 517M Specification for Pressure Vessel Plates, Alloy Steel, High-Strength, Quenched and Tempered

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A 533/A 533M Specification for Pressure Vessel Plates, Alloy Steel, Quenched and Tempered Manganese-Molybdenum and Manganese-Molybdenum-Nickel
A 537/A 537M Specification for Pressure Vessel Plates, Heat-Treated, Carbon-Manganese-Silicon Steel
A 542/A 542M Specification for Pressure Vessel Plates, Alloy Steel, Quenched and Tempered Chromium-Molybdenum, and Chromium-Molybdenum-Vanadium
A 543/A 543M Specification for Pressure Vessel Plates, Alloy Steel, Quenched and Tempered Nickel-Chromium-Molybdenum
A 553/A 553M Specification for Pressure Vessel Plates, Alloy Steel, Quenched and Tempered 8 and 9 Percent Nickel
A 562/A 562M Specification for Pressure Vessel Plates, Carbon Steel, Manganese-Titanium for Glass or Diffused Metallic Coatings
A 577/A 577M Specification for Ultrasonic Angle-Beam Examination of Steel Plates
A 578/A 578M Specification for Straight-Beam Ultrasonic Examination of Plain and Clad Steel Plates for Special Applications
A 612/A 612M Specification for Pressure Vessel Plates, Carbon Steel, High Strength, for Moderate and Lower Temperature Service
A 645/A 645M Specification for Pressure Vessel Plates, Five Percent Nickel Alloy Steel, Specially Heat Treated
A 662/A 662M Specification for Pressure Vessel Plates, Carbon-Manganese, for Moderate and Lower Temperature Service
A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment
A 724/A 724M Specification for Pressure Vessel Plates, Carbon Steel, Quenched and Tempered, for Welded Layered Pressure Vessels
A 734/A 734M Specification for Pressure Vessel Plates, Alloy Steel and High-Strength Low-Alloy Steel, Quenched and Tempered
A 735/A 735M Specification for Pressure Vessel Plates, Low-Carbon Manganese-Molybdenum-Columbium Alloy Steel, for Moderate and Lower Temperature Service
A 736/A 736M Specification for Pressure Vessel Plates, Low-Carbon Age-Hardening Nickel-Copper-Chromium-Molybdenum-Columbium and Nickel-Copper-Manganese-Molybdenum-Columbium Alloy Steel
A 737/A 737M Specification for Pressure Vessel Plates, High-Strength, Low-Alloy Steel
A 738/A 738M Specification for Pressure Vessel Plates, Heat-Treated, Carbon-Manganese-Silicon Steel, for Moderate and Lower Temperature Service
A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
A 770/A 770M Specification for Through-Thickness Tension Testing of Steel Plates for Special Applications
A 782/A 782M Specification for Pressure Vessel Plates, Quenched and Tempered Manganese-Chromium-Molybdenum-Silicon-Zirconium Alloy Steel
A 832/A 832M Specification for Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum-Vanadium
A 841/A 841M Specification for Steel Plates for Pressure Vessels, Produced by the Thermo-Mechanical Control Process (TMCP)
A 844/A 844M Specification for Steel Plates, 9% Nickel Alloy, for Pressure Vessels, Produced by the Direct-Quenching Process
E 21 Practice for Elevated Temperature Tension Tests of Metallic Materials
E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
E 44 Definitions of Terms Relating to Heat Treatment of Metals
E 112 Test Methods for Determining Average Grain Size
E 208 Test Method for Conducting Drop-Weight Test to Determine Nil-Ductility Transition Temperature of Ferritic Steels
E 709 Practice for Magnetic Particle Examination

2.2 *American Society of Mechanical Engineers Code:*

ASME Boiler and Pressure Vessel Code, Section IX, Welding Qualifications

2.3 *U.S. Military Standard:*

MIL-STD-163 Steel Mill Products Preparation for Shipment and Storage

2.4 *U.S. Federal Standard:*

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

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *capped steel* — rimmed steel in which the rimming section 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.

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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 3.7, 3.10, and Definitions E 44.

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, 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]

3.1.11 *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.

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 Supplementary requirements, if any (test specimen heat treatment, special impact test requirements, etc.), and

4.1.10 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

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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 a minimum of 3 to 1.

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, 19, and 20.

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* of each heat shall be made by the manufacturer to determine the percentage of elements specified in the individual material specification. This analysis shall be made from a test specimen preferably taken during the pouring of the heat. The chemical composition thus determined shall be reported to the purchaser, or the purchaser's representative, and shall conform to the heat analysis requirements of the applicable specification.

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7.1.1 Unspecified elements may be present. Unless otherwise specified in the material specification, limits on elements shall be as stated in Table 1.

7.1.1.1 Each of the elements listed in Table 1 shall be included in the report of the heat analysis. When the amount of an element present is less than 0.02%, the analysis may be reported as "<0.02%".

7.2 *Product Analysis* representing each plate as-rolled may be made by the purchaser from a broken tension test specimen or from a sample taken from the same relative location as that from which the tension test specimen was obtained. The chemical composition thus determined, as to elements required or restricted, shall conform to the product analysis requirements specified in the applicable specification.

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

8. Metallurgical Structure

8.1 When a coarse austenitic grain size is specified, the steel shall have a carburized austenitic grain size number of 1 to 5 as determined by the McQuaid-Ehn test. Determination shall be in accordance with Methods E 112, Plate IV, by carburizing for 8 h at 1700°F [925°C]. Conformance to this grain size of 70% of the grains in the area examined shall constitute the basis of acceptance. 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].

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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 postweld 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 3.8 for the definition of plate-as-rolled).

11.1.1 *Plates Produced from Coils* — When plates are produced from coils, a minimum of three tension tests shall be made from each coil qualified, except as otherwise indicated below 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

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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 $\frac{1}{2}$ 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 $\frac{3}{4}$ 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 Methods and Definitions A 370. The $1\frac{1}{2}$ in. [40 mm] wide 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 material and conform to the requirements for the $1\frac{1}{2}$ 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 $\frac{3}{4}$ 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] 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

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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 [140.00–152.49]	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 $^{3}/_{4}$ 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% 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/A 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.

11.7.1 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-as-rolled. 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.

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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 $\frac{1}{4}$ *t* plane in the plate thickness *t*. Where the plate thickness is insufficient to obtain full-size specimens, sub-size specimens shall be used. The sub-size 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, sub-size 0.4 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 sub-size 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.

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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 Except as specified in 13.2, the name or brand of the manufacturer, heat number, plate identifier, and slab number, and specification number and grade, class and type, where indicated in the material specification, shall be legibly steel die stamped unless stenciling is specified by the purchaser on each finished plate in two places not less than 12 in. [300 mm] from the edges. The year-date of the specification to which the material is furnished need not be included in the marking. For plates produced from coils, the processor's identity shall be used rather than the identity of the manufacturer. Plates, the maximum lengthwise and crosswise dimensions of which do not exceed 72 in. [1800 mm], shall have the marking stamped in one place approximately midway between the center and an edge. The manufacturer's or processor's test identification number shall be legibly stamped on each test specimen.

13.1.1 Bar coding is acceptable as a supplementary identification method. Bar coding should be consistent with the Automotive Industry Action Group (AIAG) standard prepared by the Primary Metals Subcommittee of the AIAG Bar Code Project Team.

13.2 For plates under $\frac{1}{4}$ in. [6 mm] in thickness, the marking specified in 13.1 shall be legibly stenciled instead of stamped.

13.3 Plates that are required to be heat treated, but have not been so heat treated, shall be marked by the manufacturer with the letter "G" (denoting green) following the specification designation mark required by 13.1. Such plates shall have been qualified for shipment on the basis of test specimens that have been so heat treated. "G" marking is not required for such plates that are for shipment, for the purpose of obtaining the required heat treatment, to a processor under the manufacturer's control.

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

13.4 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 specification designation mark required by 13.1.

NOTE 2 — Any stress relief of test specimens intended to simulate post-weld heat treatment is not included in the above required heat treatment.

13.5 *Subdivided Material:*

13.5.1 Material separated from a master plate by a supplier shall be identified in accordance with the requirements of 13.1 through 13.4, except that the trademark, brand, or name of the organization subdividing the material shall be used, rather than the identity of the manufacturer.

13.5.2 By agreement between the purchaser and the supplier, a code traceable to the original required identification may be used to identify each piece of subdivided material, provided the trademark, brand, or name of the organization subdividing the material is also placed on the material and the original required identification, cross referenced to the code, is furnished with the material.

13.5.3 As an alternative, by agreement between the purchaser and the supplier, subdivided pieces from the same heat and slab of material may be bundled or placed in secured lifts and the identification specified in 13.6.1 shall then either be marked or stenciled on the top piece of each lift, or shown on a substantial tag attached to each lift or bundle.

13.5.4 For applications other than pressure vessels and by agreement between the purchaser and the supplier, another method of identifying and packaging the material may be used.

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 meter 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, Tables A1.1 to A1.9, and Table A1.13 [Annex A2, Tables A2.1 to 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 A1, Tables A1.1 to A1.4, A1.8, and A1.10 to A1.13 [Annex A2, Tables A2.1 to A2.4, A2.8, and A2.10 to A2.13].

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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 Tests* — 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 $^{3}/_{4}$ 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% units 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 $^{2}/_{3}$ 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 must 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 must 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

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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.

19.2 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 specimens were heat treated.

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

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

19.5 For plates produced from coils, both the manufacturer and processor shall be identified on the test report.

19.6 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.

19.7 Copies of the original manufacturer's test report shall be included with any subsequent test report.

19.8 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

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TABLE 1
LIMITS ON UNSPECIFIED ELEMENTS (SEE 7.1.1)

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 %[C]	Heat analysis	0.02
	Product analysis	0.03

NOTES:
[A] The sum of copper, nickel, chromium, and molybdenum shall not exceed 1.00% on heat analysis. When one or more of these elements are specified, the sum does not apply; in which case, only the individual limits on the remaining unspecified elements will apply.
[B] The sum of chromium and molybdenum shall not exceed 0.32% on heat anaylsis. When one or more of these elements are specified, the sum does not apply; in which case, only the individual limits on the remaining unspecified elements will apply.
[C] By agreement, the heat analysis limits for vanadium or columbium may be increased up to 0.10% and 0.05% on heat analysis and 0.11% and 0.06% on product analysis, respectively.

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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 The test specimens representing the plate shall be thermally treated after the final heat treatment for mechanical properties to simulate heat treatments below the critical temperature that the plate may receive during fabrication after heat treatment for mechanical properties. The test results of such test specimens shall represent the plate for purposes of acceptance. The temperature range, time, and cooling rates shall be as specified in the order.

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.

S5.2 The orientation of the test bars, whether longitudinal or transverse to the direction of rolling, shall be as stated on the order.

S5.3 The test temperature and the required acceptance criteria, if other than those required in 12.1, shall be as stated on the order.

S5.4 The recorded results shall include test-bar orientation, specimen size, test temperature, absorbed energy values, and, when specified on the order for other than Class VI material, lateral expansion opposite the notch. The percent shear fracture appearance shall also be recorded when specified on the order.

S6. Drop-Weight Test (for Plates 0.625 in. [16 mm] and Over in Thickness)

S6.1 Drop-weight tests shall be made in accordance with the requirements of Test Method E 208. The specimens shall represent the plates in the final condition of heat treatment. Agreement shall be reached between

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the purchaser and the manufacturer or processor as to the number of plates to be tested and whether a maximum NDT temperature is mandatory or if the test results are for information only.

S7. High-Temperature Tension Tests

S7.1 A short-time elevated temperature tension test shall be made to represent each plate or each heat of steel as indicated by the purchaser. The material for testing shall be obtained as required for the room temperature tension tests specified in the body of the specification. The hot tests shall be made in accordance with the requirements of Practice E 21. Mandatory conformance of these additional tests with specified properties shall be a matter for agreement between the manufacturer or processor and the purchaser.

S8. Ultrasonic Examination in Accordance with A 435/A 435M

S8.1 All plates shall be ultrasonically examined in accordance with the requirements of Specification A 435/A 435M.

S9. Magnetic Particle Examination

S9.1 All plate edges shall be examined by magnetic particles in accordance with the procedures covered in Practice E 709. The acceptability of defects revealed by this examination shall be judged in accordance with the requirements for quality in 9.3.

S10. Charpy V-Notch Impact Transition Curve

S10.1 Sufficient impact tests of the same specimen size shall be made from the plate test material to establish a transition curve. The test temperature range shall be wide enough to establish the upper and lower shelf energies, with sufficient testing at intermediate temperatures to permit plotting a reasonable smooth curve. A plot of the data is not required. The manufacturer shall report the specimen orientation, test temperature, and absorbed energy for each specimen tested. Lateral expansion and percent shear shall also be reported when specified in the order. The number of plates tested and the specimen orientation shall be the same as in 12.1 unless otherwise specified in the order.

S11. Ultrasonic Examination in Accordance with A 577/A 577M

S11.1 All plates shall be ultrasonically examined in accordance with the requirements of Specification A 577/A 577M.

S12. Ultrasonic Examination in Accordance with A 578/A 578M

S12.1 All plates shall be ultrasonically examined in accordance with the requirements of Specification A 578/A 578M. The acceptance level shall be as specified on the order.

S13. NDT Temperature Determination

S13.1 The NDT temperature shall be established in accordance with Method E 208 using coupons from a single plate. The number of plates to be so tested shall be subject to agreement between the purchaser and the manufacturer or processor.

S14. Bend Test

S14.1 Bend tests shall be performed with material in the condition prescribed by the individual specification. The frequency of testing shall be as agreed upon. The longitudinal axis of the test specimen shall be transverse to the final rolling direction of the plate. The test specimen shall be taken from the middle of a plate end. The width of the specimen shall be $1\frac{1}{4}$ to $1\frac{5}{8}$ in. [30 to 40 mm]. The specimen thickness shall be the full thickness of the material for plates $1\frac{1}{2}$ in. [40 mm] and under in thickness. For plates over $1\frac{1}{2}$ in. [40 mm] in thickness, the specimen thickness may be reduced to $1\frac{1}{2}$ in. [40 mm], but one surface shall be as rolled. When bent, the as-rolled surface shall be on the outer curve of the bend. The sides of the specimen may have the corners rounded to a radius of not more than $\frac{1}{16}$ in. [1.5 mm]. The bend test specimen shall withstand being bent cold through 180° without cracking on the outside of the bent portion, around a pin the diameter of which shall have a relation to the thickness of the specimen as prescribed in Table S14.1 for the individual material specification. If a bend test specimen fails due to conditions of bending more severe than required by the specification, a retest shall be permitted, either on a duplicate specimen or on a remaining portion of the failed specimen. If a sheared or gas-cut specimen fails due to conditions associated with the sheared or gas-

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cut edges, a retest shall be permitted on a duplicate specimen with machined edges.

S15. Reduction of Area Measurement

S15.1 A reduction of area measurement shall be taken while making the required tension test. Reduction of area shall be determined only on the 0.500 in. [12.5 mm] round specimen as shown in Fig. 5 of Test Methods and Definitions A 370. The minimum acceptance limit shall be 40%.

S16. Thermal Stress Relief of Mechanical Test Coupons

S16.1 Test coupons representing the plates shall be thermally stress relieved by gradually and uniformly heating them to a temperature between 1100 and 1200°F [595 and 650°C], or a temperature range otherwise agreed upon between the manufacturer or processor and the purchaser, holding at temperature for at least 1 h/in. [2.4 min/mm] of thickness and cooling in still air to a temperature not exceeding 600°F [315°C].

S17. Vacuum Carbon-Deoxidized Steel

S17.1 Material shall be vacuum carbon-deoxidized, in which case the silicon content at the time of vacuum deoxidizing shall be 0.12% maximum, and the content of deoxidizers such as aluminum, zirconium, and titanium should be kept low enough to allow deoxidation by carbon. The test report shall indicate that the steel was vacuum carbon-deoxidized. The minimum heat analysis and product analysis requirements for silicon do not apply to vacuum carbon-deoxidized steel.

S19. Restricted Chemical Requirements

S19.1 Restricted heat analysis and product analysis limits are applicable as defined on the order.

S20. Maximum Carbon Equivalent for Weldability

S20.1 Plates shall be supplied with a specific maximum carbon equivalent value. This value shall be based on heat analysis. The required chemical analysis as well as the carbon equivalent shall be reported.

S20.2 The carbon equivalent shall be calculated using the following formula:

$$CE = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$$

S20.3. The maximum value of the carbon equivalent for carbon steels (including C-Mn, C-Mn-Si, C-Mn-Si-Al steels), are given in Table S20.1.

S21. Restricted Unspecified Elements

S21.1. The maximum limits on certain elements are 0.35% Cu, 0.25% Ni, 0.25% Cr, and 0.08% Mo on heat analysis. The sum of Cu, Ni, Cr, and Mo shall not exceed 0.70% on heat analysis.

S22. Through-Thickness Tension Tests

S22.1 Through-thickness tension tests shall be made in accordance with the requirements of Specification A 770/A 770M. (See Ordering Information in Specification A 770/A 770M for the additional information that may be needed.)

S24. Strain Age Test

S24.1 Test coupons shall be given a strain age treatment designated by the purchaser. Charpy V-notch tests shall be conducted on the strain aged specimens. Heat treatment, strain aging, test temperature, and acceptance criteria shall be as agreed upon between the manufacturer and purchaser.

S25. Weldability

S25.1 Weldability tests shall be conducted. The type of test and the acceptance criteria shall be as agreed upon between the manufacturer and purchaser.

S26. Low-Sulfur Steels

S26.1 The steel shall be made to 0.010% sulfur maximum. Lower sulfur levels and sulfide shape control practices can be specified by agreement between purchaser and supplier.

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S27. Restrictive Plate Flatness

S27.1 Carbon steel plates, as-rolled or normalized, shall conform to the permissible restrictive variations from flatness as detailed in Table S27.1 or S27.1a.

S27.2 High-strength low-alloy steel plates, as-rolled or normalized, shall conform to the permissible restrictive variations from flatness as detailed in Table S27.2 or S27.2a.

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TABLE S14.1
BEND DIAMETERS

Specification Designation	Grade, Type, or Class	Ratio of Pin Diameter to Specimen Thickness					
		Plate Thickness[A]					
		1 in. and under [25 mm and under]	Over 1 to 1½ in., incl [Over 25 to 40 mm, incl]	Over 1½ to 2 in., incl [Over 40 to 50 mm, incl]	Over 2 to 4 in., incl [Over 50 to 100 mm, incl]	Over 4 to 8 in., incl [Over 100 to 200 mm, incl]	Over 8 in. [Over 200 mm]
A 202	A	2	2½	3	...	...	...
	B	2½	3	3½	...	...	...
A 203	A	1	1½	1½	1½	2	...
	B	1½	2	2	2	2½	...
	D	1	1½	1½	1½	...	...
	E	1½	2	2	2	...	...
A 204	A	1	1½	1½	1½	2	...
	B	1½	2	2	2	2½	...
	C	2	2½	2½	3	3	...
A 225	A	1½	2	2	2	...	...
	B	2	2½	2½	3	...	...
A 285	Sheared or Gas-Cut	1	1½	2	...	...	...
	Universal-Mill	1½	2½	3	...	...	...
A 299	...	3	3½	4	4	4	...
A 302	A	2	2½	2½	3	3	3
	B	2½	3	3	3½	3½	3½
	C	2½	3	3	3½	3½	3½
	D	2½	3	3	3½	3½	3½
A 353	...	2[B]	2½[C]	3	...	...	...
A 387	2, 11, 12	1½	2	2	2	2½	2½
	5, 21, 22	2	2½	2½	3	3½	3½
A 442	55	1	1½	...	...	...	...
	60	1	1½	...	...	...	...
A 455	...	3	...	...	...	...	...

(*Continued*)

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TABLE S14.1
BEND DIAMETERS (CONT'D)

Specification Designation	Grade, Type, or Class	Ratio of Pin Diameter to Specimen Thickness					
		Plate Thickness[A]					
		1 in. and under [25 mm and under]	Over 1 to 1½ in., incl [Over 25 to 40 mm, incl]	Over 1½ to 2 in., incl [Over 40 to 50 mm, incl]	Over 2 to 4 in., incl [Over 50 to 100 mm, incl]	Over 4 to 8 in., incl [Over 100 to 200 mm, incl]	Over 8 in. [Over 200 mm]
A 515	55	½	1	1	1½	2	2½
	60	1	1½	1½	2	2½	...
	65	1½	2	2	2	2½	...
	70	2	2	2	2½	3	...
A 516	55	½	1	1	1½	2	2½
	60	1	1½	1½	2	2½	...
	65	1½	2	2	2	2½	...
	70	2	2	2	2½	3	...
A 517	all	2	3	3	3	...	...
A 533	all	3½	3½	3½	3½	3½	3½
A 537	1	1½	1½[C]	2	2	...	...
	2	2	2[C]	2½	2½	...	...
A 542	all	3½	3½	3½	3½	3½	3½
A 543	all	3½	3½	3½	3½	3½	3½
A 553	all	2[B]	2½[C]	3	...	...	...
A 562	...	½	1	1½	...	...	...
A 612	...	2	...	...	...	...	...
A 645	...	2[B]	2½[C]	3	3	3	3
A 662	A	1½	1½	1½	...	...	...
	B	2	2	2	...	...	...
	C	2½	2½	2½	...	...	...
A 724	A	3	...	...	...	...	...
	B	3	...	...	...	...	...

NOTES:
[A] The listing of a bend test diameter ratio for a particular plate thickness is not intended to imply that plates of that thickness are available. See the individual material specification for applicable thickness limits for the various types and classes. Pin diameter-to-thickness ratios for thicker plates shall conform to the largest ratio shown in the table.
[B] ¾ in. [20 mm] and under.
[C] Over ¾ to 1¼ in. [20 to 32 mm] and under.

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TABLE S20.1
MAXIMUM CARBON EQUIVALENT FOR WELDABILITY

Specified Minimum UTS	Maximum Carbon Equivalent Value	
ksi [MPa]	Thickness up to 2 in. [50 mm] incl	Thickness over 2 in. [50 mm]
60 ≤ UTS < 70 [415 ≤ UTS < 485]	0.45	0.46
70 ≤ UTS < 80 [485 ≤ UTS < 550]	0.47	0.48[A]
UTS ≥ 80 [UTS ≥ 550]	0.48[A,B]	. . .

NOTES:
[A] If simulated PWHT of the test coupons is specified (S3), the maximum carbon equivalent value may be increased up to 0.50 upon agreement between purchaser and supplier.
[B] Applicable to quenched-and-tempered material; for other conditions, maximum carbon equivalent shall be by agreement between purchaser and supplier.

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TABLE S27.1
PERMISSIBLE VARIATIONS FROM FLATNESS FOR CARBON STEEL PLATES AS-ROLLED OR NORMALIZED ORDERED TO RESTRICTIVE FLATNESS

Note 1 — *Flatness Variations for Length* — The longer dimension specified is considered the length, and variation in flatness along the length shall not exceed the tabular amount for the specified width in plates up to 12 ft in length, or in any 12 ft of longer plates.

Note 2 — *Flatness Variations for Width* — The flatness variation across the width shall not exceed the tabular amount for the specified width.

Note 3 — When the longer dimension is under 36 in., the variation in flatness along the length and across the width shall not exceed 1/4 in. in each direction. When the longer dimension is from 36 to 72 in., inclusive, the permissible flatness variation shall not exceed 75% of the tabular amount for the specified width, but in no case less than 1/4 in.

Note 4 — The variations given in this table apply to plates that have a minimum specified tensile strength not over 60 ksi or comparable chemistry or hardness. For plates specified to a higher minimum tensile strength or compatible chemistry or hardness, the permissible variations are 1 1/2 times the amounts shown in the table below.

Note 5 — This table and these notes cover the flatness variations of circular and sketch plates based on the maximum dimensions of those plates.

Note 6 — Waviness tolerances for rectangular plates, universal mill plates, and circular and sketch plates do not apply.

Note 7 — A "Z" indicates that there is no published restricted value for the size.

Note 8 — Plates shall be in a horizontal position on a flat surface when flatness is measured.

Specified Thickness, in.	Permissible Variations from a Flat Surface for Specified Widths, in.					
	48 to 60, excl	60 to 72, excl	72 to 84, excl	84 to 96, excl	96 to 108, excl	108 to 120, incl
To 1/4, excl	3/4	15/16	Z	Z	Z	Z
1/4 to 3/8, excl	9/16	3/4	7/8	15/16	1 1/16	1 1/8
3/8 to 1/2, excl	5/16	5/16	3/8	7/16	1/2	9/16
1/2 to 3/4, excl	5/16	5/16	5/16	3/8	1/2	1/2
3/4 to 1, excl	5/16	5/16	5/16	5/16	3/8	7/16
1 to 2, incl	1/4	5/16	5/16	5/16	5/16	3/8

TABLE S27.1a
PERMISSIBLE VARIATIONS FROM FLATNESS FOR CARBON STEEL PLATES AS-ROLLED OR NORMALIZED ORDERED TO RESTRICTIVE FLATNESS

Note 1 — *Flatness Variations for Length* — The longer dimension specified is considered the length, and variation in flatness along the length shall not exceed the tabular amount for the specified width in plates up to 3700 mm in length, or in any 3700 mm of longer plates.

Note 2 — *Flatness Variations for Width* — The flatness variation across the width shall not exceed the tabular amount for the specified width.

Note 3 — When the longer dimension is under 900 mm, the variation in flatness along the length and across the width shall not exceed 6 mm in each direction. When the longer dimension is from 900 to 1800 mm, inclusive, the permissible flatness variation shall not exceed 75% of the tabular amount for the specified width, but in no case less than 6 mm.

Note 4 — The variations given in this table apply to plates that have a minimum specified tensile strength not over 415 mpa or comparable chemistry or hardness. For plates specified to a higher minimum tensile strength or compatible chemistry or hardness, the permissible variations are 1 1/2 times the amounts shown in the table below.

Note 5 — This table and these notes cover the flatness variations of circular and sketch plates based on the maximum dimensions of those plates.

Note 6 — Waviness tolerances for rectangular plates, universal mill plates, and circular and sketch plates do not apply.

Note 7 — A "Z" indicates that there is no published restricted value for the size.

Note 8 — Plates shall be in a horizontal position on a flat surface when flatness is measured.

Specified Thickness, mm	Permissible Variations from a Flat Surface for Specified Widths, mm					
	1200 to 1500, excl	1500 to 1800, excl	1800 to 2100, excl	2100 to 2400, excl	2400 to 2700, excl	2700 to 3000, incl
To 6, excl	18	24	Z	Z	Z	Z
6 to 10, excl	15	18	22	24	27	29
10 to 12, excl	8	8	10	11	13	15
12 to 20, excl	7	8	8	10	13	13
20 to 25, excl	7	8	8	8	10	11
25 to 50, excl	7	7	7	8	8	8

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TABLE S27.2
PERMISSIBLE VARIATIONS FROM FLATNESS FOR HIGH-STRENGTH LOW-ALLOY STEEL PLATES AS-ROLLED OR NORMALIZED ORDERED TO RESTRICTIVE FLATNESS

Note 1 — *Flatness Variations for Length* — The longer dimension specified is considered the length, and variation in flatness along the length shall not exceed the tabular amount for the specified width in plates up to 12 ft in length, or in any 12 ft of longer plates.

Note 2 — *Flatness Variations for Width* — The flatness variation across the width shall not exceed the tabular amount for the specified width.

Note 3 — When the longer dimension is under 36 in., the variation in flatness along the length and across the width shall not exceed $^{3}/_{8}$ in. in each direction. When the longer dimension is from 36 to 72 in., inclusive, the permissible flatness variation shall not exceed 75% of the tabular amount for the specified width, but in no case less than $^{3}/_{8}$ in.

Note 4 — This table and these notes cover the flatness variations of circular and sketch plates based on the maximum dimensions of those plates.

Note 5 — Waviness tolerances for rectangular plates, universal mill plates, and circular and sketch plates do not apply.

Note 6 — A "Z" indicates that there is no published restricted value for the size.

Note 7 — Plates shall be in a horizontal position on a flat surface when flatness is measured.

Specified Thickness, in.	Permissible Variations from a Flat Surface for Specified Widths, in.					
	48 to 60, excl	60 to 72, excl	72 to 84, excl	84 to 96, excl	96 to 108, excl	108 to 120, incl
To $^{1}/_{4}$, excl	$1^{1}/_{16}$	$1^{7}/_{16}$	Z	Z	Z	Z
$^{1}/_{4}$ to $^{3}/_{8}$, excl	$^{7}/_{8}$	$1^{1}/_{16}$	$1^{5}/_{16}$	$1^{7}/_{16}$	$1^{1}/_{2}$	$1^{11}/_{16}$
$^{3}/_{8}$ to $^{1}/_{2}$, excl	$^{1}/_{2}$	$^{1}/_{2}$	$^{9}/_{16}$	$^{11}/_{16}$	$^{3}/_{4}$	$^{13}/_{16}$
$^{1}/_{2}$ to $^{3}/_{4}$, excl	$^{7}/_{16}$	$^{7}/_{16}$	$^{1}/_{2}$	$^{9}/_{16}$	$^{5}/_{8}$	$^{11}/_{16}$
$^{3}/_{4}$ to 1, excl	$^{7}/_{16}$	$^{7}/_{16}$	$^{1}/_{2}$	$^{1}/_{2}$	$^{9}/_{16}$	$^{11}/_{16}$
1 to 2, incl	$^{3}/_{8}$	$^{7}/_{16}$	$^{7}/_{16}$	$^{1}/_{2}$	$^{1}/_{2}$	$^{1}/_{2}$

TABLE S27.2a
PERMISSIBLE VARIATIONS FROM FLATNESS FOR HIGH-STRENGTH LOW-ALLOY STEEL PLATES AS-ROLLED OR NORMALIZED ORDERED TO RESTRICTIVE FLATNESS

Note 1 — *Flatness Variations for Length* — The longer dimension specified is considered the length, and variation in flatness along the length shall not exceed the tabular amount for the specified width in plates up to 3700 mm in length, or in any 3700 mm of longer plates.

Note 2 — *Flatness Variations for Width* — The flatness variation across the width shall not exceed the tabular amount for the specified width.

Note 3 — When the longer dimension is under 900 mm, the variation in flatness along the length and across the width shall not exceed 10 mm in each direction. When the longer dimension is from 900 to 1800 mm, inclusive, the permissible flatness variation shall not exceed 75% of the tabular amount for the specified width, but in no case less than 10 mm.

Note 4 — This table and these notes cover the variations for flatness of circular and sketch plates based on the maximum dimensions of those plates.

Note 5 — Waviness tolerances for rectangular plates, universal mill plates, and circular and sketch plates do not apply.

Note 6 — A "Z" indicates that there is no published restricted value for the size.

Note 7 — Plates shall be in a horizontal position on a flat surface when flatness is measured.

Specified Thickness, mm	Permissible Variations from a Flat Surface for Specified Widths, mm					
	1200 to 1500, excl	1500 to 1800, excl	1800 to 2100, excl	2100 to 2400, excl	2400 to 2700, excl	2700 to 3000, incl
To 6, excl	27	36	Z	Z	Z	Z
6 to 10, excl	22	27	33	36	39	43
10 to 12, excl	12	12	15	17	19	21
12 to 20, excl	11	11	13	15	16	18
20 to 25, excl	11	11	12	13	15	17
25 to 50, excl	10	11	11	12	13	13

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ANNEXES

(Mandatory Information)

A1. PERMISSIBLE VARIATIONS IN DIMENSIONS, ETC. — INCH-POUND UNITS

A1.1 Listed below are permissible variations in dimensions, and notch toughness information, expressed in inch-pound units of measurement.

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TABLE A1.1
PERMISSIBLE VARIATIONS IN THICKNESS FOR RECTANGULAR PLATES

Specified Thickness, in.	Tolerance Over Specified Thickness for Widths Given, in.											
	48 and under	Over 48 to 60, excl	60 to 72, excl	72 to 84, excl	84 to 96, excl	96 to 108, excl	108 to 120, excl	120 to 132, excl	132 to 144, excl	144 to 168, excl	168 to 182, excl	182 and over
To 1/4, excl	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	...	...	...
1/4 to 5/16, excl	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	...	...	...
5/16 to 3/8, excl	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.05	...	...
3/8 to 7/16, excl	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.05	0.06	0.06	...
7/16 to 1/2, excl	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.05	0.06	0.06	...
1/2 to 5/8, excl	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.05	0.06	0.07	...
5/8 to 3/4, excl	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.06	0.07	0.07
3/4 to 1, excl	0.03	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.07	0.08	0.09
1 to 2, excl	0.06	0.06	0.06	0.06	0.06	0.07	0.08	0.10	0.10	0.11	0.13	0.16
2 to 3, excl	0.09	0.09	0.09	0.10	0.10	0.11	0.12	0.13	0.14	0.15	0.15	...
3 to 4, excl	0.11	0.11	0.11	0.11	0.11	0.13	0.14	0.14	0.14	0.15	0.17	...
4 to 6, excl	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.20	0.20	...
6 to 10, excl	0.23	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.27	0.28	...
10 to 12, excl	0.29	0.29	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.35	...
12 to 15, incl	0.29	0.29	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	...

NOTES:
(1) Permissible variation under specified thickness, 0.01 in.
(2) Thickness to be measured at 3/8 to 3/4 in. from the longitudinal edge.
(3) For thickness measured at any location other than that specified in Note (2), the permissible maximum over-tolerance shall be increased by 75%, rounded to the nearest 0.01 in.

TABLE A1.2
PERMISSIBLE VARIATIONS OVER IN WIDTH AND LENGTH FOR SHEARED PLATES (NOTE 1) AND LENGTH ONLY FOR UNIVERSAL MILL PLATES (NOTE 2)

Note 1 — Carbon steel and high-strength low-alloy steel plates 1½ in. and under in thickness. Alloy steel plates 1¼ in. and under in thickness.
Note 2 — Carbon steel and high-strength low-alloy steel plates 2½ in. and under in thickness. Alloy steel plates 2 in. and under in thickness.
Note 3 — Permissible variation under specified width and length: ¼ in.

Specified Dimensions, in.		Variations over Specified Width and Length for Thicknessses, in., Given							
		To 3/8, excl		3/8 to 5/8, excl		5/8 to 1, excl		1 to 2, incl[A]	
Length	Width	Width	Length	Width	Length	Width	Length	Width	Length
To 120, excl	over 8 to 60, excl	3/8	1/2	7/16	5/8	1/2	3/4	5/8	1
	60 to 84, excl	7/16	5/8	1/2	11/16	5/8	7/8	3/4	1
	84 to 108, excl	1/2	3/4	5/8	7/8	3/4	1	1	1 1/8
	108 and over	5/8	7/8	3/4	1	7/8	1 1/8	1 1/8	1 1/4
120 to 240, excl	over 8 to 60, excl	3/8	3/4	1/2	7/8	5/8	1	3/4	1 1/8
	60 to 84, excl	1/2	3/4	5/8	7/8	3/4	1	7/8	1 1/4
	84 to 108, excl	9/16	7/8	11/16	15/16	13/16	1 1/8	1	1 3/8
	108 and over	5/8	1	3/4	1 1/8	7/8	1 1/4	1 1/8	1 3/8
240 to 360, excl	over 8 to 60, excl	3/8	1	1/2	1 1/8	5/8	1 1/4	3/4	1 1/2
	60 to 84, excl	1/2	1	5/8	1 1/8	3/4	1 1/4	7/8	1 1/2
	84 to 108, excl	9/16	1	11/16	1 1/8	7/8	1 3/8	1	1 1/2
	108 and over	11/16	1 1/8	7/8	1 1/4	1	1 3/8	1 1/4	1 3/4
360 to 480, excl	over 8 to 60, excl	7/16	1 1/8	1/2	1 1/4	5/8	1 3/8	3/4	1 5/8
	60 to 84, excl	1/2	1 1/4	5/8	1 3/8	3/4	1 1/2	7/8	1 5/8
	84 to 108, excl	9/16	1 1/4	3/4	1 3/8	7/8	1 1/2	1	1 7/8
	108 and over	3/4	1 3/8	7/8	1 1/2	1	1 5/8	1 1/4	1 7/8
480 to 600, excl	over 8 to 60, excl	7/16	1 1/4	1/2	1 1/2	5/8	1 5/8	3/4	1 7/8
	60 to 84, excl	1/2	1 3/8	5/8	1 1/2	3/4	1 5/8	7/8	1 7/8
	84 to 108, excl	5/8	1 3/8	3/4	1 1/2	7/8	1 5/8	1	1 7/8
	108 and over	3/4	1 1/2	7/8	1 5/8	1	1 3/4	1 1/4	1 7/8
600 to 720, excl	over 8 to 60, excl	1/2	1 3/4	5/8	1 7/8	3/4	1 7/8	7/8	2 1/4
	60 to 84, excl	5/8	1 3/4	3/4	1 7/8	7/8	1 7/8	1	2 1/4
	84 to 108, excl	5/8	1 3/4	3/4	1 7/8	7/8	1 7/8	1 1/8	2 1/4
	108 and over	7/8	1 3/4	1	2	1 1/8	2 1/4	1 1/4	2 1/2
720 and over	over 8 to 60, excl	9/16	2	3/4	2 1/8	7/8	2 1/4	1	2 3/4
	60 to 84, excl	3/4	2	7/8	2 1/8	1	2 1/4	1 1/8	2 3/4
	84 to 108, excl	3/4	2	7/8	2 1/8	1	2 1/4	1 1/4	2 3/4
	108 and over	1	2	1 1/8	2 3/8	1 1/4	2 1/2	1 3/8	3

[A] Permissible variations in length apply also to carbon-steel and High-Strength Low-Alloy Steel Universal Mill plates up to 12 in. in width for thicknesses over 2 to 2½ in., incl.

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TABLE A1.3
PERMISSIBLE VARIATIONS IN ROLLED WIDTH FOR UNIVERSAL MILL CARBON-STEEL, HIGH-STRENGTH LOW-ALLOY STEEL AND ALLOY-STEEL PLATES 15 IN. AND UNDER IN THICKNESS

Specified Width, in.	Variations Over Specified Width for Thicknesses Given, in.					
	To 3/8, excl	3/8 to 5/8, excl	5/8 to 1, excl	1 to 2, incl	Over 2 to 10, incl	Over 10 to 15, incl
Over 8 to 20, excl	1/8	1/8	3/16	1/4	3/8	1/2
20 to 36, excl	3/16	1/4	5/16	3/8	7/16	9/16
36 and over	5/16	3/8	7/16	1/2	9/16	5/8

GENERAL NOTE: Permissible variation under specified width shall be 1/8 in.

TABLE A1.4
PERMISSIBLE VARIATIONS IN DIAMETER FOR SHEARED CIRCULAR CARBON-STEEL, HIGH-STRENGTH LOW-ALLOY STEEL AND ALLOY-STEEL PLATES 1 IN. AND UNDER IN THICKNESS

Specified Diameter, in.	Permissible Variations Over Specified Diameter for Thicknesses Given, in.		
	To 3/8, excl	3/8 to 5/8, excl	5/8 to 1, incl
To 32, excl	1/4	3/8	1/2
32 to 84, excl	5/16	7/16	9/16
84 to 108, excl	3/8	1/2	5/8
108 to 130, incl	7/16	9/16	11/16

GENERAL NOTE: No permissible variations under specified diameter.

TABLE A1.5
PERMISSIBLE VARIATIONS IN WIDTH AND LENGTH FOR RECTANGULAR CARBON-STEEL AND HIGH-STRENGTH LOW-ALLOY STEEL PLATES WHEN GAS CUTTING IS SPECIFIED OR REQUIRED

Specified Thickness, in.	Variations Over for All Specified Widths or Lengths, in.
To 2, excl	1/2
2 to 4, excl	5/8
4 to 6, excl	3/4
6 to 8, excl	7/8
8 to 15, incl	1

NOTES:
(1) These variations may be taken all under or divided over and under, if so specified.
(2) Plates with universal rolled edges will be gas cut to length only.

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TABLE A1.6
PERMISSIBLE VARIATIONS IN DIAMETER FOR GAS-CUT CIRCULAR CARBON-STEEL AND HIGH-STRENGTH LOW-ALLOY STEEL PLATES

Specified Diameter, in.	Variations Over Specified Diameter for Thicknesses Given, in.					
	To 1, excl	1 to 2, excl	2 to 4, excl	4 to 6, excl	6 to 8, excl	8 to 15, incl
To 32, excl	3/8	3/8	1/2	1/2	5/8	3/4
32 to 84, excl	3/8	1/2	1/2	5/8	3/4	7/8
84 to 108, excl	1/2	9/16	5/8	3/4	7/8	1
108 to 130, excl	1/2	9/16	11/16	7/8	1	1 1/8
130 and over	5/8	3/4	7/8	1	1 1/8	1 1/4

GENERAL NOTE: No permissible variations under specified diameter.

TABLE A1.7
PERMISSIBLE CAMBER FOR CARBON STEEL SHEARED OR GAS-CUT RECTANGULAR PLATES ALL THICKNESSES

Maximum permissible camber, in. = 1/8 in. × (number of feet of length/5)

GENERAL NOTE: Camber, as it relates to plates, is the horizontal edge curvature in the length, measured over the entire length of the plate in the flat position.

TABLE A1.8
PERMISSIBLE CAMBER FOR CARBON STEEL, HIGH-STRENGTH LOW-ALLOY STEEL AND ALLOY STEEL UNIVERSAL MILL PLATES AND HIGH-STRENGTH LOW-ALLOY STEEL AND ALLOY STEEL SHEARED OR GAS-CUT RECTANGULAR PLATES

Dimension, in.		Camber for Thickness and Widths Given
Thickness	Width	
To 2, incl	all	1/8 in. × (number of feet of length/5)
Over 2 to 15, incl	to 30, incl	3/16 in. × (number of feet of length/5)
Over 2 to 15, incl	over 30	1/4 in. × (number of feet of length/5)

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TABLE A1.9
PERMISSIBLE VARIATIONS FROM FLATNESS FOR CARBON-STEEL PLATES

Specified Thickness, in.	Variations from a Flat Surface for Specified Widths, in.										
	Over 8 to 36, excl	36 to 48, excl	48 to 60, excl	60 to 72, excl	72 to 84, excl	84 to 96, excl	96 to 108, excl	108 to 120, excl	120 to 144, excl	144 to 168, excl	168 and over
To 1/4, excl	9/16	3/4	15/16	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	...	...
1/4 to 3/8, excl	1/2	5/8	3/4	15/16	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	...	...
3/8 to 1/2, excl	1/2	9/16	5/8	5/8	3/4	7/8	1	1 1/8	1 1/4	1 7/8	2 1/8
1/2 to 3/4, excl	7/16	1/2	9/16	5/8	5/8	3/4	1	1	1 1/8	1 1/2	2
3/4 to 1, excl	7/16	1/2	9/16	5/8	5/8	5/8	3/4	7/8	1	1 3/8	1 3/4
1 to 2, excl	3/8	1/2	1/2	9/16	9/16	5/8	5/8	5/8	11/16	1 1/8	1 1/2
2 to 4, excl	5/16	3/8	7/16	1/2	1/2	1/2	1/2	9/16	5/8	7/8	1 1/8
4 to 6, excl	3/8	7/16	1/2	1/2	9/16	9/16	5/8	3/4	7/8	7/8	1
6 to 8, excl	7/16	1/2	1/2	5/8	11/16	3/4	7/8	7/8	1	1	1
8 to 10, excl	1/2	1/2	5/8	11/16	3/4	13/16	7/8	15/16	1	1	1
10 to 12, excl	1/2	5/8	3/4	13/16	7/8	15/16	1	1	1	1	1
12 to 15, incl	5/8	3/4	13/16	7/8	15/16	1	1	1	1	1	...

GENERAL NOTES:

(A) *Flatness Variations for Length* — The longer dimension specified is considered the length, and variation in flatness along the length shall not exceed the tabular amount for the specified width in plates up to 12 ft in length, or in any 12 ft of longer plates.

(B) *Flatness Variations for Width* — The flatness variation across the width shall not exceed the tabular amount for the specified width.

(C) When the longer dimension is under 36 in., the variation in flatness along the length and across the width shall not exceed 1/4 in. in each direction. When the longer dimension is from 36 to 72 in., inclusive, the flatness variation shall not exceed 75% of the tabular amount for the specified width, but in no case less than 1/4 in.

(D) The tolerances given in this table apply to plates that have a minimum specified tensile strength not over 60 000 psi or compatible chemistry or hardness. For plates specified to a higher minimum tensile strength or compatible chemistry or hardness, the limits given in the table are increased to 1 1/2 times the amounts in the above table.

(E) This table and notes cover the flatness tolerances of circular and sketch plates, based on the maximum dimensions of those plates.

(F) Plates shall be in a horizontal position on a flat surface when flatness is measured.

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TABLE A1.10
PERMISSIBLE VARIATIONS IN WIDTH AND LENGTH FOR RECTANGULAR ALLOY-STEEL PLATES WHEN GAS CUTTING IS SPECIFIED OR REQUIRED

Specified Thickness, in.	Variations Over for All Specified Widths and Lengths, in.
To 2, excl	3/4
2 to 4, excl	1
4 to 6, excl	1 1/8
6 to 8, excl	1 5/16
8 to 15, incl	1 1/2

NOTES:
(1) These variations may be taken all under or divided over and under, if specified.
(2) Plates with universal rolled edges will be gas cut to length only.

TABLE A1.11
PERMISSIBLE VARIATIONS IN DIAMETER FOR GAS-CUT CIRCULAR ALLOY-STEEL PLATES

Specified Diameter, in.	Variations Over Specified Diameter for Thicknesses Given, in.					
	To 1, excl	1 to 2, excl	2 to 4, excl	4 to 6, excl	6 to 8, excl	8 to 15, incl
To 32, excl	1/2	3/4	3/4	3/4	1	1
32 to 84, excl	1/2	5/8	7/8	1	1 1/8	1 1/4
84 to 108, excl	5/8	3/4	1	1 1/8	1 1/4	1 3/8
108 to 130, incl	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2

GENERAL NOTE: No permissible variations under specified diameter.

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TABLE A1.12
PERMISSIBLE VARIATIONS FROM FLATNESS FOR HIGH-STRENGTH LOW-ALLOY AND ALLOY-STEEL PLATES

Specified Thickness, in.	Variations from a Flat Surface for Specified Widths, in.										
	Over 8 to 36, excl	36 to 48, excl	48 to 60, excl	60 to 72, excl	72 to 84, excl	84 to 96, excl	96 to 108, excl	108 to 120, excl	120 to 144, excl	144 to 168, excl	168 and over
To 1/4, excl	13/16	1 1/8	1 3/8	1 7/8	2	2 1/4	2 3/8	2 5/8	2 3/4	...	...
1/4 to 3/8, excl	3/4	15/16	1 1/8	1 3/8	1 3/4	1 7/8	2	2 1/4	2 3/8	...	...
3/8 to 1/2, excl	3/4	7/8	15/16	15/16	1 1/8	1 5/16	1 1/2	1 5/8	1 7/8	2 3/4	3 1/8
1/2 to 3/4, excl	5/8	3/4	13/16	7/8	1	1 1/8	1 1/4	1 3/8	1 5/8	2 1/4	3
3/4 to 1, excl	5/8	3/4	7/8	7/8	15/16	1	1 1/8	1 5/16	1 1/2	2	2 5/8
1 to 2, excl	9/16	5/8	3/4	13/16	7/8	15/16	1	1	1	1 5/8	2 1/4
2 to 4, excl	1/2	9/16	11/16	3/4	3/4	3/4	3/4	7/8	1	1 1/4	1 5/8
4 to 6, excl	9/16	11/16	3/4	3/4	7/8	7/8	15/16	1 1/8	1 1/4	1 1/4	1 1/2
6 to 8, excl	5/8	3/4	3/4	15/16	1	1 1/8	1 1/4	1 5/16	1 1/2	1 1/2	1 1/2
8 to 10, excl	3/4	13/16	15/16	1	1 1/8	1 1/4	1 5/16	1 3/8	1 1/2	1 1/2	1 1/2
10 to 12, excl	3/4	15/16	1 1/8	1/4	1 5/16	1 3/8	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2
12 to 15, incl	7/8	1	1 3/16	1 5/16	1 3/8	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2

NOTES:
(1) *Flatness Tolerances for Length* — The longer dimension specified is considered the length and variations from a flat surface along the length shall not exceed the tabular amount for the specified width in plates up to 12 ft in length, or in any 12 ft of longer plates.
(2) *Flatness Tolerances for Width* — The flatness variation across the width shall not exceed the tabular amount for the specified width.
(3) When the longer dimension is under 36 in., the variation shall not exceed 3/8 in. When the larger dimension is from 36 to 72 in., incl, the variation shall not exceed 75% of the tabular amount for the specified width.
(4) This table and notes cover the tolerances for flatness of circular and sketch plates, based on the maximum dimensions of those plates.
(5) Plates shall be in a horizontal position on a flat surface when flatness is measured.

TABLE A1.13
WAVINESS TOLERANCES FOR RECTANGULAR PLATES, UNIVERSAL MILL PLATES, AND CIRCULAR AND SKETCH PLATES

Flatness Tolerance from Tables A1.9 and A1.12	When Number of Waves in 12 ft is:						
	1	2	3	4	5	6	7
5/16	5/16	1/4	3/16	1/8	1/8	1/16	1/16
3/8	3/8	5/16	3/16	3/16	1/8	1/16	1/16
7/16	7/16	5/16	1/4	3/16	1/8	1/8	1/16
1/2	1/2	3/8	5/16	3/16	3/16	1/8	1/16
9/16	9/16	7/16	5/16	1/4	3/16	1/8	1/8
5/8	5/8	1/2	3/8	1/4	3/16	1/8	1/8
11/16	11/16	1/2	3/8	5/16	3/16	3/16	1/8
3/4	3/4	9/16	7/16	5/16	1/4	3/16	1/8
13/16	13/16	5/8	7/16	5/16	1/4	3/16	1/8
7/8	7/8	11/16	1/2	3/8	1/4	3/16	1/8
15/16	15/16	11/16	1/2	3/8	5/16	1/4	3/16
1	1	3/4	9/16	7/16	5/16	1/4	3/16
1 1/8	1 1/8	7/8	5/8	1/2	3/8	1/4	3/16
1 1/4	1 1/4	15/16	11/16	1/2	3/8	5/16	1/4
1 3/8	1 3/8	1 1/16	3/4	9/16	7/16	5/16	1/4
1 1/2	1 1/2	1 1/8	7/8	5/8	1/2	3/8	1/4
1 5/8	1 5/8	1 1/4	15/16	11/16	1/2	3/8	5/16
1 3/4	1 3/4	1 5/16	1	3/4	9/16	7/16	5/16
1 7/8	1 7/8	1 7/16	1 1/16	13/16	9/16	7/16	5/16
2	2	1 1/2	1 1/8	7/8	5/8	1/2	3/8
2 1/8	2 1/8	1 5/8	1 3/16	7/8	11/16	1/2	3/8
2 1/4	2 1/4	1 11/16	1 1/4	15/16	11/16	9/16	3/8
2 3/8	2 3/8	1 13/16	1 5/16	1	3/4	9/16	7/16
2 1/2	2 1/2	1 7/8	1 7/16	1 1/16	13/16	9/16	7/16
2 5/8	2 5/8	2	1 1/2	1 1/8	13/16	5/8	7/16
2 3/4	2 3/4	2 1/16	1 9/16	1 1/8	7/8	5/8	1/2
2 7/8	2 7/8	2 3/16	1 5/8	1 3/16	15/16	11/16	1/2
3	3	2 1/4	1 11/16	1 1/4	15/16	11/16	9/16
3 1/8	3 1/8	2 3/8	1 3/4	1 5/16	1	3/4	9/16

GENERAL NOTE: Waviness denotes the deviation of the top or bottom surface from a horizontal line, when the plate is resting on a flat surface, as measured in an increment of less than 12 ft of length. The waviness tolerance is a function of the flatness tolerance as obtained from Tables A1.9 and A1.12.

TABLE A1.14
VISIBLE EDGE INDICATIONS EXTENDING APPROXIMATELY PARALLEL TO ROLLED SURFACES

Plate Specification and Thickness	Acceptable		Remove by Grinding		Acceptable on Edges Cut in Fabrication	
	Depth	Length[B]	Depth	Length[B]	Depth	Length[B]
Column	1	2	3	4	5	6
Nonkilled,[A] to 2 in., incl	1/8 in. max	any	over 1/8 in. to 1/4 in., incl	over 1 in.	1/4 in. max	any
Killed,[C] to 6 in., incl	1/16 in. max	any	over 1/16 in. to 1/8 in., incl	over 1 in.	1/8 in. max	any
Killed,[C] over 6 in.	1/8 in. max	any	over 1/8 in. to 1/2 in., incl	over 1 in.	1/2 in. max	any

NOTES:
[A] Specifications: A 285; A 433; A 442 in thicknesses to 1 in., incl; or A 455.
[B] Laminar-type discontinuities 1 in. and less in length are acceptable and do not require exploration.
[C] The specification in 1.1 of the Scope, of this standard other than those listed in the above footnote *A*.

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TABLE A1.15
GENERALLY AVAILABLE GRADE-THICKNESS-MINIMUM TEST TEMPERATURE COMBINATIONS MEETING CHARPY V-NOTCH REQUIREMENTS INDICATED (NORMALIZED OR QUENCHED AND TEMPERED CONDITION)

Acceptance Criteria Charpy V-Notch Energy Absorption				Test Temperature, °F for Plate Thicknesses (Unless Otherwise Agreed Upon)			
Class[A]	Average For 3 Specimens[C] ft-lbf, min	Minimum For 1 Specimen[C] ft-lbf	Specification and Grade[B]	1 in. and Under	Over 1 in. to 2 in., incl.	Over 2 in. to 3 in., incl.	Over 3 in. to 5 in., incl.
I	10	7	A 285 Grade A	+40	+60	...	...
			A 285 Grade B	+50	+70	...	...
			A 285 Grade C	+60	+80	...	...
			A 442 Grade 55	+30	...	...	...
			A 442 Grade 60	+35	...	...	...
II	13	10	A 455	+25	...	...	...
III	13	10	A 203 Grade A	−90	−90	−75	...
			A 203 Grade D	−150	−150	−125	...
			A 442 Grade 55 (1½ in. max thickness)	...	−20	...	...
			A 442 Grade 60 (1½ in. max thickness)	...	−15	...	...
			A 516 Grade 55	−60	−60	−50	−50
			A 516 Grade 60	−60	−50	−50	−50
			A 516 Grade 65	−60	−50	−40	−25
			A 537 Class 1 (Over 2½–4 in.)	...	...	−75	−50
			A 662 Grade A	−75	−75	...	...
			A 662 Grade B	−60	−60	...	...
IV	15	12	A 203 Grade B	−90	−90	−75	...
			A 203 Grade E	−150	−150	−125	...
			A 203 Grade F (4 in. max)	...	...	−160	−160
			A 299	+20	+30	+30	+40
			A 516 Grade 70	−50	−40	−30	−20
			A 537 Class 1 (2½ in. max)	−80	−75	−75	...
			A 537 Class 2 (Over 2½–4 in.)	...	...	−75	−50
			A 662 Grade C	−50	−50	...	...

(Continued)

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TABLE A1.15 (CONT'D)
GENERALLY AVAILABLE GRADE-THICKNESS-MINIMUM TEST TEMPERATURE COMBINATIONS MEETING CHARPY V-NOTCH REQUIREMENTS INDICATED (NORMALIZED OR QUENCHED AND TEMPERED CONDITION)

Acceptance Criteria Charpy V-Notch				Test Temperature, °F for Plate Thicknesses (Unless Otherwise Agreed Upon)			
Energy Absorption							
Class[A]	Average For 3 Specimens[C] ft-lbf, min	Minimum For 1 Specimen[C] ft-lbf	Specification and Grade[B]	1 in. and Under	Over 1 in. to 2 in., incl.	Over 2 in. to 3 in., incl.	Over 3 in. to 5 in., incl.
V	20	15	A 203 Grade F	−160	−160	...	...
			A 537 Class 2 (2½ in. max)	−90	−90	−90	...
			A 612	−50	...	...	...
			A 724 Grade A	−50	...	...	...
	Lateral Expansion Mils. Minimum Each Specimen Transverse Test						
VI		15	A 353	−320	−320	...	...
			A 553 Type I	−320	−320	...	...
			A 553 Type II	−275	−275	...	...
			A 645	−275	−275	...	...
			A 517 all (2½ in. max thickness)	[B]	[B]	...	...
			A 724 Grade B	−50	...	...	...

NOTES:
[A] Class I is *Other Than Fully Killed* with a specified minimum tensile strength of 65 ksi or lower.
Class II is *Other Than Fully Killed* with a specified minimum tensile strength of over 65 ksi to 75 ksi.
Class III is *Fully Killed* with a specified minimum tensile strength of 65 ksi or lower.
Class IV is *Fully Killed* with a specified minimum tensile strength of over 65 ksi to 75 ksi.
Class V is *Fully Killed* with a specified minimum tensile strength of over 75 ksi to but not including 95 ksi.
Class VI is *Fully Killed* with a specified minimum tensile strength of 95 ksi and over.
[B] Testing temperature as specified on order but no higher than 32°F.
[C] Full size (10 by 10 mm) specimens.

TABLE A1.16
CHARPY V-NOTCH TEST ACCEPTANCE CRITERIA FOR VARIOUS SUB-SIZE SPECIMENS[A]

Full Size, 10 by 10 mm		3/4 Size, 10 by 7.5 mm		2/3 Size, 10 by 6.7 mm		1/2 Size, 10 by 5 mm		1/3 Size, 10 by 3.3 mm		1/4 Size, 10 by 2.5 mm	
ft-lbf	[J]	ft-lbf	[J]	ft-lbf	[J]	ft-lbf	[J]	ft-lbf	[J]	ft-lbf	[J]
40	[54]	30	[41]	27	[37]	20	[27]	13	[18]	10	[14]
35	[48]	26	[35]	23	[31]	18	[24]	12	[16]	9	[12]
30	[41]	22	[30]	20	[27]	15	[20]	10	[14]	8	[11]
25	[34]	19	[26]	17	[23]	12	[16]	8	[11]	6	[8]
20	[27]	15	[20]	13	[18]	10	[14]	7	[10]	5	[7]
16	[22]	12	[16]	11	[15]	8	[11]	5	[7]	4	[5]
15	[20]	11	[15]	10	[14]	8	[11]	5	[7]	4	[5]
13	[18]	10	[14]	9	[12]	6	[8]	4	[5]	3	[4]
12	[16]	9	[12]	8	[11]	6	[8]	4	[5]	3	[4]
10	[14]	8	[11]	7	[10]	5	[7]	3	[4]	2	[3]
7	[10]	5	[7]	5	[7]	4	[5]	2	[3]	2	[3]

GENERAL NOTE: [A] Interpolation shall be made for specimens with widths intermediate of those listed. Interpolated values shall be rounded to the nearest whole number as prescribed in Practice E 29.

TABLE A1.17
PERMISSIBLE VARIATIONS IN WIDTH FOR MILL EDGE CARBON STEEL AND HIGH-STRENGTH LOW-ALLOY STEEL PLATES PRODUCED ON STRIP MILLS

Note — Applies to either plates produced from coils or plates produced in discrete cut lengths of flat product.

Specified Width, in.	Variations over Specified Width, in[A]
To 14, excl	7/16
14 to 17, excl	1/2
17 to 19, excl	9/16
19 to 21, excl	5/8
21 to 24, excl	11/16
24 to 26, excl	13/16
26 to 28, excl	15/16
28 to 35, excl	1 1/8
35 to 50, excl	1 1/4
50 to 60, excl	1 1/2
60 to 65, excl	1 5/8
65 to 70, excl	1 3/4
70 to 80, excl	1 7/8
80 and over	2

NOTE:
[A] No permissible variation under specified width.

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TABLE A2.1
PERMISSIBLE VARIATIONS IN THICKNESS FOR RECTANGULAR PLATES

Specified Thickness, mm	Tolerance Over Specified Thickness for Widths Given in Millimetres, mm										
	1200 and Under	Over 1200 to 1500, excl	1500 to 1800, excl	1800 to 2100, excl	2100 to 2400, excl	2400 to 2700, excl	2700 to 3000, excl	3000 to 3300, excl	3300 to 3600, excl	3600 to 4200, excl	4200 and Over
5.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	1.0	. . .	. . .
5.5	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	1.0	1.4	. . .
6.0	0.8	0.8	0.8	0.8	0.8	0.8	0.9	1.0	1.1	1.4	. . .
7.0	0.8	0.8	0.8	0.8	0.8	0.8	0.9	1.0	1.2	1.5	1.7
8.0	0.8	0.8	0.8	0.8	0.8	0.8	0.9	1.0	1.2	1.5	1.7
9.0	0.8	0.8	0.8	0.8	0.8	0.8	1.0	1.0	1.3	1.5	1.8
10.0	0.8	0.8	0.8	0.8	0.8	0.8	1.0	1.0	1.3	1.5	1.8
11.0	0.8	0.8	0.8	0.8	0.8	0.8	1.0	1.0	1.3	1.5	1.8
12.0	0.8	0.8	0.8	0.8	0.8	0.9	1.0	1.0	1.3	1.5	2.0
14.0	0.8	0.8	0.8	0.8	0.9	0.9	1.0	1.1	1.3	1.6	2.0
16.0	0.8	0.8	0.8	0.8	0.9	0.9	1.0	1.1	1.3	1.6	2.0
18.0	0.8	0.8	0.8	0.8	0.9	1.0	1.1	1.2	1.4	1.8	2.2
20.0	0.8	0.8	0.8	0.8	0.9	1.0	1.2	1.2	1.4	1.8	2.2
22.0	0.8	0.9	0.9	0.9	1.0	1.1	1.3	1.3	1.5	2.0	2.4
25.0	0.9	0.9	1.0	1.0	1.0	1.2	1.3	1.5	1.5	2.1	2.6
28.0	1.0	1.0	1.1	1.1	1.1	1.3	1.4	1.8	1.8	2.3	2.8
30.0	1.1	1.1	1.2	1.2	1.2	1.4	1.5	1.8	1.8	2.5	3.0
32.0	1.2	1.2	1.3	1.3	1.3	1.5	1.6	2.0	2.0	2.7	3.3
35.0	1.3	1.3	1.4	1.4	1.4	1.6	1.7	2.3	2.3	2.8	3.5
38.0	1.4	1.4	1.5	1.5	1.5	1.7	1.8	2.3	2.3	3.0	3.8
40.0	1.5	1.5	1.6	1.6	1.6	1.8	2.0	2.5	2.5	3.3	3.8
45.0	1.6	1.6	1.7	1.8	1.8	2.0	2.3	2.8	2.8	3.5	4.0
50.0	1.8	1.8	1.8	2.0	2.0	2.3	2.5	3.0	3.0	3.8	4.0
55.0	2.0	2.0	2.0	2.2	2.2	2.5	2.8	3.3	3.3	4.0	4.0
60.0	2.3	2.3	2.3	2.4	2.4	2.8	3.0	3.4	3.4	4.0	4.4
70.0	2.5	2.5	2.5	2.6	2.6	3.0	3.3	3.5	3.6	4.0	4.4
80.0	2.8	2.8	2.8	2.8	2.8	3.3	3.5	3.5	3.6	4.4	4.4
90.0	3.0	3.0	3.0	3.0	3.0	3.5	3.5	3.5	3.6	4.4	4.8
100.0	3.3	3.3	3.3	3.3	3.5	3.8	3.8	3.8	3.8	4.8	5.2
110.0	3.5	3.5	3.5	3.5	3.5	3.8	3.8	3.8	3.8	5.2	5.6
120.0	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	5.6	5.6
130.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	5.6	5.6
140.0	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	5.6	6.3
150.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.3	7.0
160.0	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	7.0	8.8
180.0	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	7.5	9.0
200.0	5.8	5.8	6.0	6.0	6.0	6.0	6.0	6.0	6.0	9.0	. . .
250.0	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	. . .	. . .
300.0	7.5	7.5	9.0	9.0	9.0	9.0	9.0	9.0	9.0	. . .	. . .

NOTES:
(1) Permissible variation under specified thickness, 0.3 mm.
(2) Thickness shall be measured 10 to 20 mm from the longitudinal edge.
(3) For specified thicknesses other than those shown, the tolerances for the next higher thickness shall apply.
(4) For thickness measured at any location other than that specified in Note 2, the permissible maximum over tolerance shall be increased by 75%, rounded to the nearest 0.1 mm.

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A2. PERMISSIBLE VARIATIONS IN DIMENSIONS, ETC. — SI UNITS

A2.1 Listed herein are permissible variations in dimensions, and notch toughness information, expressed in SI units.

TABLE A2.2
PERMISSIBLE VARIATIONS OVER IN WIDTH AND LENGTH FOR SHEARED PLATES (NOTE 1) AND LENGTH ONLY FOR UNIVERSAL MILL PLATES (NOTE 2)

Specified Dimensions, mm		Variations over Specified Width and Length for Thicknesses Given, mm							
		To 10, excl		10 to 16, excl		16 to 25, excl		25 to 50, incl[A]	
Length	Width	Width	Length	Width	Length	Width	Length	Width	Length
To 3 000 excl	To 1500 excl	10	13	11	16	13	19	16	25
	1500 to 2100 excl	11	16	13	17	16	22	19	25
	2100 to 2700 excl	13	19	16	22	19	25	25	29
	2700 and over	16	22	19	25	22	29	29	32
3 000 to 6 000 excl	To 1500 excl	10	19	13	22	16	25	19	29
	1500 to 2100 excl	13	19	16	22	19	25	22	32
	2100 to 2700 excl	14	22	17	24	21	29	25	35
	2700 and over	16	25	19	29	22	32	29	35
6 000 to 9 000 excl	To 1500 excl	10	25	13	29	16	32	19	38
	1500 to 2100 excl	13	25	16	29	19	32	22	38
	2100 to 2700 excl	14	25	17	32	22	35	25	38
	2700 and over	17	29	22	32	25	35	32	44
9 000 to 12 000 excl	To 1500 excl	11	29	13	32	16	35	19	41
	1500 to 2100 excl	13	32	16	35	19	38	22	41
	2100 to 2700 excl	14	32	19	35	22	38	25	48
	2700 and over	19	35	22	38	25	41	32	48
12 000 to 15 000 excl	To 1500 excl	11	32	13	38	16	41	19	48
	1500 to 2100 excl	13	35	16	38	19	41	22	48
	2100 to 2700 excl	16	35	19	38	22	41	25	48
	2700 and over	19	38	22	41	25	44	32	48
15 000 to 18 000 excl	To 1500 excl	13	44	16	48	19	48	22	57
	1500 to 2100 excl	16	44	19	48	22	48	25	57
	2100 to 2700 excl	16	44	19	48	22	48	29	57
	2700 and over	22	44	25	51	29	57	32	64
18 000 and over	To 1500 excl	14	51	19	54	22	57	25	70
	1500 to 2100 excl	19	51	22	54	25	57	29	70
	2100 to 2700 excl	19	51	22	54	25	57	32	70
	2700 and over	25	51	29	60	32	64	35	76

GENERAL NOTE: [A] Permissible variations in length apply also to carbon-steel and high-strength low-alloy steel Universal Mill plates up to 300 mm in width for thicknesses over 50 to 65 mm, incl.

NOTES:
(1) Carbon steel and high-strength low-alloy steel plates 40 mm and under in thickness. Alloy steel plates 30 mm and under in thickness.
(2) Carbon steel and high-strength low-alloy steel plates 65 mm and under in thickness. Alloy steel plates 50 mm and under in thickness.
(3) Permissible variation under in specified width and length: 6 mm.

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TABLE A2.3
PERMISSIBLE VARIATIONS IN ROLLED WIDTH FOR UNIVERSAL MILL CARBON-STEEL, HIGH-STRENGTH LOW-ALLOY AND ALLOY-STEEL PLATES 400 MM AND UNDER IN THICKNESS

	Variations Over Specified Width for Thickness Given, mm					
Specified Width, mm	To 10, excl	10 to 16, excl	16 to 25, excl	25 to 50, excl	Over 50 to 250, incl	Over 250 to 400, incl
Over 200 to 500, excl	3	3	5	6	10	13
500 to 900, excl	5	6	8	10	11	14
900 and over	8	10	11	13	14	16

GENERAL NOTE: Permissible variation under specified width shall be 3 mm.

TABLE A2.4
PERMISSIBLE VARIATIONS IN DIAMETER FOR SHEARED CIRCULAR CARBON STEEL, HIGH-STRENGTH LOW-ALLOY STEEL AND ALLOY-STEEL PLATES 25 MM AND UNDER IN THICKNESS

	Permissible Variations Over Specified Diameter for Thicknesses Given, mm		
Specified Diameters, mm	To 10, excl	10 to 16, excl	16 to 25, incl
To 800, excl	6	10	13
800 to 2100, excl	8	11	14
2100 to 2700, excl	10	13	16
2700 to 3300, excl	11	14	17
3300 and over	13	16	19

GENERAL NOTE: No permissible variations under specified diameter.

TABLE A2.5
PERMISSIBLE VARIATIONS IN WIDTH AND LENGTH FOR RECTANGULAR CARBON-STEEL AND HIGH-STRENGTH LOW-ALLOY STEEL PLATES WHEN GAS CUTTING IS SPECIFIED OR REQUIRED

Specified Thickness, mm	Variations Over for All Specified Widths or Lengths, mm
To 50, excl	13
50 to 100, excl	16
100 to 150, excl	19
150 to 200, excl	22
200 to 400, incl	25

NOTES:
(1) These variations may be taken all under or divided over and under, if so specified.
(2) Plates with universal rolled edges will be gas cut to length only.

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TABLE A2.6
PERMISSIBLE VARIATIONS IN DIAMETER FOR GAS-CUT CIRCULAR CARBON-STEEL AND HIGH-STRENGTH LOW-ALLOY STEEL PLATES

Specified Diameters, mm	Variations Over Specified Diameter for Thicknesses Given, mm					
	To 25, excl	25 to 50, excl	50 to 100, excl	100 to 150, excl	150 to 200, excl	200 to 400, excl
To 800, excl	10	10	13	13	16	19
800 to 2100, excl	10	13	13	16	19	22
2100 to 2700, excl	13	14	16	19	22	25
2700 to 3300, excl	13	14	17	22	25	29
3300 and over	16	19	22	25	29	32

GENERAL NOTE: No permissible variations under specified diameter.

TABLE A2.7
PERMISSIBLE CAMBER FOR CARBON STEEL SHEARED OR GAS-CUT RECTANGULAR PLATES ALL THICKNESSES

Maximum permissible camber, mm = length in millimetres/500

GENERAL NOTE: Camber, as it relates to plates, is the horizontal edge curvature in the length, measured over the entire length of the plate in the flat position.

TABLE A2.8
PERMISSIBLE CAMBER FOR CARBON STEEL, HIGH-STRENGTH LOW-ALLOY STEEL AND ALLOY STEEL UNIVERSAL MILL PLATES AND HIGH-STRENGTH LOW-ALLOY STEEL AND ALLOY STEEL SHEARED OR GAS-CUT RECTANGULAR PLATES

Width, mm	Camber for Width Given, mm
To 750, incl	Length/300
Over 750 to 1500	Length/250

GENERAL NOTE: Camber, as it relates to plates, is the horizontal edge curvature in the length, measured over the entire length of the plate in the flat position.

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TABLE A2.9
PERMISSIBLE VARIATIONS FROM FLATNESS FOR CARBON-STEEL PLATES

Specified Thickness, mm	Permissible Variations from a Flat Surface for Specified Widths, mm										
	To 900, excl	900 to 1200	1200 to 1500	1500 to 1800	1800 to 2100	2100 to 2400	2400 to 2700	2700 to 3000	3000 to 3600	3600 to 4200	4200 and Over
To 6, excl	14	19	24	32	35	38	41	44	48	...	...
6 to 10, excl	13	16	19	24	29	32	35	38	41	...	...
10 to 12, excl	13	14	16	16	19	22	25	29	32	48	54
12 to 20, excl	11	13	14	16	16	19	25	25	29	38	51
20 to 25, excl	11	13	14	16	16	16	19	22	25	35	44
25 to 50, excl	10	13	13	14	14	16	16	16	18	29	38
50 to 100, excl	8	10	11	13	13	13	13	14	16	22	29
100 to 150, excl	10	11	13	13	14	14	16	19	22	22	25
150 to 200, excl	11	13	13	16	18	19	22	22	25	25	25
200 to 250, excl	13	13	16	18	19	21	22	24	25	25	25
250 to 300, excl	13	16	19	21	22	24	25	25	25	25	25
300 to 400, incl	16	19	21	22	24	25	25	25	25	25	...

NOTES:
(1) *Flatness Variations for Length* — The longer dimension specified is considered the length, and variation in flatness along the length shall not exceed the tabular amount for the specified width in plates up to 4000 mm in length, or in any 4000 mm of longer plates.
(2) *Flatness Variations for Width* — The flatness variation across the width shall not exceed the tabular amount for the specified width.
(3) When the longer dimension is under 900 mm, the variation in flatness along the length and across the width shall not exceed 6 mm in each direction. When the longer dimension is from 900 to 1800 mm, inclusive, the flatness variation shall not exceed 75% of the tabular amount for the specified width, but in no case less than 6 mm.
(4) The tolerances given in this table apply to plates that have a minimum specified tensile strength not over 400 MPa or compatible chemistry or hardness. For plates specified to a higher minimum tensile strength or compatible chemistry or hardness, the limits given in the table are increased to $1\frac{1}{2}$ times the amounts in the above table.
(5) This table and notes cover the flatness tolerances of circular and sketch plates, based on the maximum dimensions of those plates.
(6) Plates shall be in a horizontal position on a flat surface when flatness is measured.

TABLE A2.10
PERMISSIBLE VARIATIONS IN WIDTH AND LENGTH FOR RECTANGULAR ALLOY-STEEL PLATES WHEN GAS CUTTING IS SPECIFIED OR REQUIRED

Specified Thickness, mm	Variations Over for All Specified Widths and Lengths, mm
To 50, excl	19
50 to 100, excl	25
100 to 150, excl	29
150 to 200, excl	33
200 to 400, incl	38

NOTES:
(1) These variations may be taken all under or divided over and under, if so specified.
(2) Plates with universal rolled edges will be gas cut to length only.

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TABLE A2.11
PERMISSIBLE VARIATIONS IN DIAMETER FOR GAS CUT CIRCULAR ALLOY-STEEL PLATES

Specified Diameter, mm	Variations Over Specified Diameter for Thicknesses Given, mm					
	To 25, excl	25 to 50, excl	50 to 100, excl	100 to 150, excl	150 to 200, excl	200 to 400, incl
To 800, excl	13	13	19	19	25	25
800 to 2100, excl	13	16	22	25	29	32
2100 to 2700, excl	16	19	25	29	32	35
2700 to 3300, incl	22	25	29	32	35	38

GENERAL NOTE: No permissible variations under specified diameter.

TABLE A2.12
PERMISSIBLE VARIATIONS FROM FLATNESS FOR HIGH-STRENGTH LOW-ALLOY AND ALLOY-STEEL PLATES

Specified Thickness, mm	Flatness Tolerances for Specified Widths, mm										
	To 900, excl	900 to 1200	1200 to 1500	1500 to 1800	1800 to 2100	2100 to 2400	2400 to 2700	2700 to 3000	3000 to 3600	3600 to 4200	4200 and over
To 6, excl	21	29	35	48	51	57	60	67	70	...	...
6 to 10, excl	19	24	29	35	44	48	51	57	60	...	...
10 to 12, excl	19	22	24	24	29	33	38	41	48	70	79
12 to 20, excl	16	19	21	22	25	29	32	35	41	57	76
20 to 25, excl	16	19	22	22	24	25	29	33	38	51	67
25 to 50, excl	14	16	19	21	22	24	25	25	25	41	57
50 to 100, excl	13	14	18	19	19	19	19	22	25	32	41
100 to 150, excl	14	18	19	19	22	22	24	29	32	32	38
150 to 200, excl	16	19	19	24	25	29	32	33	38	38	38
200 to 250, excl	19	21	24	25	29	32	33	35	38	38	38
250 to 300, excl	19	24	29	32	33	35	38	38	38	38	38
300 to 400, incl	22	25	30	33	35	38	38	38	38	38	38

NOTES:
(1) *Flatness Tolerances for Length* — The longer dimension specified is considered the length and variations from a flat surface along the length shall not exceed the tabular amount for the specified width in plates up to 4000 mm in length, or in any 4000 mm of longer plates.
(2) *Flatness Tolerances for Width* — The flatness variation across the width shall not exceed the tabular amount for the specified width.
(3) When the longer dimension is under 900 mm, the variation shall not exceed 10 mm. When the larger dimension is from 900 to 1800 mm, incl, the variation shall not exceed 75% of the tabular amount for the specified width.
(4) This table and notes cover the tolerances for flatness of circular and sketch plates, based on the maximum dimensions of those plates.
(5) Plates shall be in a horizontal position on a flat surface when flatness is measured.

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TABLE A2.13
WAVINESS TOLERANCES FOR RECTANGULAR PLATES, UNIVERSAL MILL PLATES AND CIRCULAR AND SKETCH PLATES

Flatness Tolerance from Tables A2.9 and A2.12	When Number of Waves in 4000 mm is:						
	1	2	3	4	5	6	7
8	8	6	5	3	3	2	2
10	10	8	5	5	3	2	2
11	11	8	6	5	3	3	2
13	13	10	8	5	5	3	2
14	14	11	8	6	5	3	2
16	16	13	10	6	5	3	2
17	17	13	10	8	5	5	2
19	19	14	11	8	6	5	2
21	21	16	11	8	6	5	2
22	22	17	13	10	6	5	2
24	24	17	13	10	8	6	5
25	25	19	14	11	8	6	5
29	29	22	16	13	10	6	5
32	32	24	17	13	10	8	6
35	35	27	19	14	11	8	6
38	38	29	22	16	13	10	6
41	41	32	24	17	13	10	8
44	44	33	25	19	14	11	8
48	48	37	27	21	14	11	8
51	51	38	29	22	16	13	10
54	54	41	30	22	17	13	10
57	57	43	32	24	17	14	10
60	60	46	33	25	19	14	11
64	64	48	37	27	21	14	11
67	67	51	38	29	21	16	11
70	70	52	40	29	22	16	13
73	73	56	41	30	24	17	13
76	76	57	43	32	24	17	14
79	79	60	44	33	25	19	14

GENERAL NOTE: Waviness denotes the deviation of the top or bottom surface from a horizontal line, when the plate is resting on a flat surface, as measured in an increment of less than 4000 mm of length. The waviness tolerance is a function of the flatness tolerance as obtained from Tables A2.9 and A2.12.

TABLE A2.14
VISIBLE EDGE INDICATIONS EXTENDING APPROXIMATELY PARALLEL TO ROLLED SURFACES

Plate Specification and Thickness	Acceptable		Remove by Grinding		Acceptable on Edges Cut in Fabrication	
	Depth	Length[B]	Depth	Length[B]	Depth	Length[B]
Column	1	2	3	4	5	6
Nonkilled,[A] to 50 mm, incl	3 mm, max	any	over 3 to 6 mm, incl	over 25 mm	6 mm max	any
Killed,[C] to 150 mm, incl	2 mm, max	any	over 2 to 3 mm, incl	over 25 mm	3 mm max	any
Killed,[C] over 150 mm	3 mm, max	any	over 3 to 13 mm, incl	over 25 mm	13 mm max	any

NOTES:
[A] Specifications: A 285; A 433; A 442 in thicknesses to 25 mm, incl; or A 455.
[B] Laminar-type discontinuities 25 mm and less in length are acceptable and do not require exploration.
[C] The specifications in 1.1 Scope, of this document other than those listed in the above footnote *A*.

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TABLE A2.15
GENERALLY AVAILABLE GRADE-THICKNESS-MINIMUM TEST TEMPERATURE COMBINATIONS MEETING CHARPY V-NOTCH REQUIREMENTS INDICATED (NORMALIZED OR QUENCHED AND TEMPERED CONDITION)

Acceptance Criteria Charpy V-Notch Energy Absorption				Test Temperature, °C for Plate Thicknesses (Unless Otherwise Agreed Upon)			
Class[A]	Average For 3 Specimens[B], J, min	Minimum For 1 Specimen[B], J	Specification and Grade	25 mm and Under	Over 25 mm to 50 mm, incl.	Over 50 mm to 75 mm, incl.	Over 75 mm to 125 mm, incl.
I	14	10	A 285 Grade A	+4	+16	...	...
			A 285 Grade B	+10	+21	...	...
			A 285 Grade C	+16	+27	...	...
			A 442 Grade 55	−1	...	...	...
			A 442 Grade 60	+2	...	...	...
II	18	14	A 455	−4	...	...	...
III	18	14	A 203 Grade A	−68	−68	−60	...
			A 203 Grade D	−101	−101	−87	...
			A 442 Grade 55 (38 mm max thickness)	...	−29	...	...
			A 442 Grade 60 (38 mm max thickness)	...	−26	...	...
			A 516 Grade 55	−51	−51	−46	−46
			A 516 Grade 60	−51	−46	−46	−46
			A 516 Grade 65	−51	−46	−40	−32
			A 537 Class 1 (Over 64–100 mm)	...	...	−60	−46
			A 662 Grade A	−60	−60	...	...
			A 662 Grade B	−51	−51	...	...
IV	20	16	A 203 Grade B	−68	−68	−60	...
			A 203 Grade E	−101	−101	−87	...
			A 203 Grade F (100 mm max)	...	...	−107	−107
			A 299	−7	−1	−1	+4
			A 516 Grade 70	−46	−40	−35	−29
			A 537 Class 1 (64 mm max)	−62	−60	−60	...
			A 537 Class 2 (Over 64–100 mm)	...	...	−60	−46
			A 662 Grade C	−46	−46	...	...

(Continued)

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TABLE A2.15
GENERALLY AVAILABLE GRADE-THICKNESS-MINIMUM TEST TEMPERATURE COMBINATIONS MEETING CHARPY V-NOTCH REQUIREMENTS INDICATED (NORMALIZED OR QUENCHED AND TEMPERED CONDITION) (CONT'D)

Acceptance Criteria Charpy V-Notch Energy Absorption				Test Temperature, °C for Plate Thicknesses (Unless Otherwise Agreed Upon)			
Class[A]	Average For 3 Specimens[B], J, min	Minimum For 1 Specimen[B], J	Specification and Grade	25 mm and Under	Over 25 mm to 50 mm, incl.	Over 50 mm to 75 mm, incl.	Over 75 mm to 125 mm, incl.
V	27	20	A 203 Grade F	−107	−107	...	...
			A 537 Class 2 (64 mm max)	−68	−68	−68	...
			A 612	−46	...	...	...
			A 724 Grade A	−46	...	...	...
	Lateral Expansion mm, Minimum Each Specimen Transverse Test						
VI	0.38	...	A 353	−196	−196	...	...
			A 553 Type I	−196	−196	...	...
			A 553 Type II	−170	−170	...	...
			A 645	−170	−170	...	...
			A 517 all (64 mm max thickness)	[C]	[C]	...	...
			A 724 Grade B	−46	...	...	...

GENERAL NOTE: The minimum temperatures listed are for longitudinal tests. For transverse tests, the available minimum temperature may be somewhat higher.

NOTES:
[A] Class I is *Other Than Fully Killed* with a specified minimum tensile strength of 450 MPa or lower.
Class II is *Other Than Fully Killed* with a specified minimum tensile strength of over 450 to 520 MPa, incl.
Class III is *Fully Killed* with a specified minimum tensile strength of 450 MPa or lower.
Class IV is *Fully Killed* with a specified minimum tensile strength of over 450 to 520 MPa, incl.
Class V is *Fully Killed* with a specified minimum tensile strength of over 520 MPa to but not including 655 MPa.
Class VI is *Fully Killed* with a specified minimum tensile strength of 655 MPa and over.
[B] Full size (10 by 10 mm) specimens.
[C] Testing temperatures as specified on order but no higher than 0°C.

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TABLE A2.16
PERMISSIBLE VARIATIONS IN WIDTH FOR MILL EDGE CARBON STEEL AND HIGH-STRENGTH LOW-ALLOY STEEL PLATES PRODUCED ON STRIP MILLS

Note — Applies to either plates produced from coils or plates produced in discrete cut lengths of flat product.

Specified Width, mm	Variations Over Specified Width, mm[4]
To 360, excl	11
360 to 430, excl	13
430 to 480, excl	14
480 to 530, excl	16
530 to 610, excl	17
610 to 660, excl	21
660 to 710, excl	24
710 to 890, excl	29
890 to 1270, excl	32
1270 to 1520, excl	38
1520 to 1650, excl	41
1650 to 1780, excl	44
1780 to 2030, excl	47
2030 and over	51

NOTE:
[4] No permissible variation under specified width.

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APPENDIX

(Nonmandatory Information)

X1. COILED PRODUCTS

X1.1 Continuous wide hot strip rolling mills are normally equipped with coilers. Regardless of the different types of systems employed during or following the rolling operations, it is common for the steel to be reeled into the coiler at temperatures in the stress-relieving range. In general, these temperatures are higher as material thickness increases. The coils subsequently cool to ambient temperature with outer and inner laps cooling more rapidly than central laps. The difference in cooling rate can result in measurable differences in the mechanical properties throughout a coil. Data confirm reduced yield and tensile strength, and increased percent elongation, for the product with slower cooling rates from the coiling temperature to ambient. These differences are in addition to the effects on mechanical properties caused by differences in heat analysis and chemical segregation.

X2. VARIATION OF TENSILE PROPERTIES IN PLATES

X2.1 The tension requirements of this specification are intended only to characterize the tensile properties of a plate-as-rolled for determination of conformance to the requirements of the material specifications. These testing procedures are not intended to define the upper or lower limits of tensile properties at all possible test locations within a plate-as-rolled. It is well known and documented that tensile properties vary within a plate-as-rolled or individual piece of steel as a function of chemical composition, processing, testing procedure and other factors. It is, therefore, incumbent on designers and engineers to use sound engineering judgment when using tension test results shown on mill test reports. The testing procedures of this specification have been found to provide material adequate for normal pressure vessel design criteria.

X2.2 A survey of the variation to be expected in tensile properties obtained from plates and structural shapes was conducted by the American Iron and Steel Institute (AISI). The results of this survey are contained in a *Contributions to the Metallurgy of Steel* entitled "The Variation of Product Analysis and Tensile Properties — Carbon Steel Plates, and Wide Flange Shapes" (SU/18, SU/19, and SU/20), published in September 1974. The data are presented in tables of probability that tensile properties at other than the official location may differ from those of the reported test location.

X2.3 This specification contains no requirements applicable to product tension tests; conformance to the material specifications is determined on the basis of tests performed at the place of manufacture prior to shipment, unless otherwise specified.

X2.4 A Task Group of ASTM Subcommittee A01.11 has determined, based on review of the AISI data (SU20), that the variation in tensile properties within a plate-as-rolled can be expressed as a function of specified requirements; one standard deviation equals approximately 3% of required tensile strength, 5% of required yield strength, and 3 percentage units of required elongation.

X3. VARIATION IN CHARPY V-NOTCH TESTS

X3.1 A survey of the variation to be expected in Charpy V-Notch test results obtained from three common fine grain plate steels was conducted by the American Iron and Steel Institute (AISI). The results of the survey are contained in a Contributions to the Metallurgy of Steel entitled, "The Variations of Charpy V-Notch Impact Test Properties in Steel Plates," (SU/24), published January 1979. The survey data consists of test values obtained from six locations in addition to the locations specified in 12.1.3 of this specification. The plate conditions tested involved as-rolled, normalized, and quench and tempered. Sufficient full-size specimens were taken from each sample so that three longitudinal and three transverse specimens could be broken at three test temperatures defined for each grade. The data is presented in tables of probability that impact properties at other than the official location which may differ from those of the reported test location. Additional data of the same type, but utilizing samples from thicker plates, was published by AISI as SU/27.

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