

ASME B16.34-2025
(Revision of ASME B16.34-2020)

Valves — Flanged, Threaded, and Welding End

AN AMERICAN NATIONAL STANDARD



**The American Society of
Mechanical Engineers**

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VALVES — FLANGED, THREADED, AND WELDING END

1 GENERAL

(25) 1.1 Scope

This Standard applies to new construction and covers pressure-temperature ratings, dimensions, tolerances, materials, nondestructive examination requirements, testing, and marking for cast, forged, and fabricated flanged, threaded, clamped, and welding end and wafer or flangeless valves of steel, nickel-base alloys, and other alloys shown in [Table 1](#). Wafer or flangeless valves, bolted or through-bolt types, that are installed between flanges or against a flange are treated as flanged-end valves. Alternative rules for NPS 2½ and smaller valves are given in [Mandatory Appendix V](#). Connectors intended for frequent disconnection or change, for instance at hose connections, are outside the scope of this Standard.

1.2 Applicability

1.2.1 Standards and Specifications. Standards and specifications adopted by reference in this Standard and the names of the sponsoring organizations are shown in [Mandatory Appendix VII](#). It is not considered practical to refer to a specific edition of each of the standards and specifications in the individual clause references. Instead, the specific edition references are included in [Mandatory Appendix VII](#). A product made in conformance with a prior edition of reference standards and in all other respects conforming to this Standard shall be considered to be in conformance even though the edition reference may have been changed in a subsequent revision of this Standard.

1.2.2 Time of Purchase, Manufacture, or Installation. The pressure-temperature ratings included in this Standard are applicable, upon publication, to all valves covered within its scope that meet its requirements. For unused valves, valves that have been maintained in inventory, the manufacturer may certify conformance to this edition provided that it can be demonstrated that all requirements of this edition have been met. However, where such components were installed under the pressure-temperature ratings of an earlier edition of ASME B16.34, those ratings shall apply except as may be governed by an applicable Code or regulation.

1.2.3 User Accountability. This Standard cites duties and responsibilities that are to be assumed by the valve user in the areas of, for example, application, installation, system hydrostatic testing, operation, and material selection.

1.2.4 Quality Systems. Requirements relating to a valve manufacturer's Quality System Program are described in [Nonmandatory Appendix C](#).

1.2.5 Relevant Units. This Standard states values in both SI (Metric) and U.S. Customary units. These systems of units are to be regarded separately as standard. Within the text, the U.S. Customary units are shown in parentheses or in separate tables following the SI tables. The values stated in each system are not exact equivalents; therefore, it is required that each system of units be used independently of the other. Combining values from the two systems constitutes nonconformance with the Standard.

1.3 Selection of Valve Types and Material Service Conditions

Criteria for selection of valve types and materials suitable for particular fluid service are not within the scope of this Standard.

1.4 Convention

For determining conformance with this Standard, the convention for fixing significant digits where limits (maximum and minimum values) are specified shall be as defined in ASTM E29. This requires that an observed or calculated value be rounded off to the nearest unit in the last right-hand digit used for expressing the limit. Decimal values and tolerances do not imply a particular method of measurement.

1.5 Denotation

1.5.1 Pressure Rating Designation. Class followed by a dimensionless number is the designation for pressure-temperature ratings. Standardized designations are as follows:

Class	150	300	600	900	1500	2500	4500
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Class 400, an infrequently used flanged-end valve designation, is regarded as an intermediate class designation.

1.5.2 Size. NPS followed by a dimensionless number is the designation for nominal valve size. NPS is related to the reference *nominal diameter*, DN, used in international standards. The relationship is, typically, as follows:

NPS	DN
$\frac{1}{4}$	8
$\frac{3}{8}$	10
$\frac{1}{2}$	15
$\frac{3}{4}$	20
1	25
$1\frac{1}{4}$	32
$1\frac{1}{2}$	40
2	50
$2\frac{1}{2}$	65
3	80
4	100

For $NPS \geq 4$, the related $DN = 25 \times NPS$ number.

1.6 Cryogenic Service

Valves in cryogenic service shall meet the additional requirements specified in MSS SP-134.

1.7 References

Codes, standards, and specifications, containing provisions to the extent referenced herein, constitute requirements of this Standard. These reference documents are listed in [Mandatory Appendix VII](#).

1.8 Cases

ASME issues Cases that are applicable to this Standard by, for example, adding new materials or alternative construction requirements. The Cases

- (a) modify the requirements of this Standard.
- (b) are applicable from their issue dates until the Cases are annulled.

(c) may be used only when agreed to by the purchaser and the manufacturer. When a Case has been so agreed to, the marking on the valve shall include the Case number.

(25) 1.9 Definitions

may: a term used to denote permission, neither a requirement nor a recommendation.

shall: a term used to denote a requirement.

should: a term used to denote a recommendation.

2 PRESSURE-TEMPERATURE RATINGS

2.1 General

Pressure-temperature ratings are designated by class numbers. Each class number is further identified as Standard, Special, or Limited Class.

2.1.1 Rating Designations. Pressure-temperature ratings are tabulated for Standard and Special Class Pressure Rating Designation numbers 150, 300, 600, 900, 1500, 2500, and 4500 in [Tables 2-1.1](#) through [2-3.19](#) in SI units and [Tables 2-1.1C](#) through [2-3.19C](#) in U.S. Customary Units. Ratings for Limited Class are determined by the method in [Mandatory Appendix V](#).¹

(a) Flanged-end valves shall be rated only as Standard Class. Flanged-end valves larger than NPS 60 are beyond the scope of this Standard.

(b) Class 4500 applies only to welding-end valves, nonstandard flanged-end valves designed in accordance with [para. 6.2.7.1](#), and clamped-end valves designed in accordance with [para. 6.2.7.2](#).

(c) Special Class and Limited Class valves shall not be supplied with special flanges or clamped ends.

(d) Threaded and socket welding-end valves larger than NPS $2\frac{1}{2}$ are beyond the scope of this Standard.

(e) Except as provided in [para. 2.5](#), the tabulated ratings are the maximum allowable working pressures, expressed as gage pressure, at the temperatures shown.

(f) Ratings intermediate to tabulated values are determined by linear interpolation between temperatures within a class number or between class numbers, except that for flanged-end valves interpolation between tabulated classes is not permitted. A further exception is that Class 400 valves having ASME B16.5 or ASME B16.47 flanged ends shall use the intermediate rating method of [para. 2.1.5](#).

(g) In all cases, valves shall be constructed so that the body, bonnet or cover, body bolting, and bonnet or cover bolting meet the 38°C (100°F) pressure rating requirements for the designated pressure class or pressure-temperature rating. However, pressure-temperature ratings for the valve may be otherwise limited by construction details or material design considerations, in which case the requirements of [paras. 4.3.3](#) and [7.2.6](#) shall be met.

2.1.2 Standard Class Valves. Valves conforming to the requirements of this Standard, except for those meeting the additional requirements of [section 8](#) for Special Class valves or of [Mandatory Appendix V](#) for Limited Class valves, shall be designated Standard Class valves. Ratings shall not exceed the values that are listed in [Tables 2-1.1](#) through [2-3.19](#) ([Tables 2-1.1C](#) through [2-3.19C](#)) with an identifying label "A — Standard Class."

2.1.3 Special Class Valves. Threaded- or welding-end valves that conform to all the requirements of [para. 2.1.2](#), and in addition have successfully passed the examinations required by [section 8](#), may be designated Special Class

¹ Throughout this Standard the metric unit used for pressure is *bar* where 1 bar is equivalent to 0.1 MPa. Use of the term bar for pressure is an aid in distinguishing between values for pressure and stress where stress values are given in MPa units. This also recognizes the common usage of the term bar for pressure in International Standards for piping components such as valves and fittings.

valves. Pressure-temperature ratings shall not exceed the values that are listed in [Tables 2-1.1 through 2-3.19](#) ([Tables 2-1.1C through 2-3.19C](#)) with an identifying label “B — Special Class.” Special Class ratings shall not be used for flanged-end valves.

2.1.4 Limited Class Valves. Welding- or threaded-end valves NPS 2½ and smaller that conform to the requirements of [Mandatory Appendix V](#) may be designated Limited Class valves. Pressure-temperature ratings shall not exceed the values calculated in accordance with [Mandatory Appendix V](#). Limited Class ratings shall not be used for flanged-end valves.

2.1.5 Intermediate Rated Valves. A Standard Class or Special Class welding- or threaded-end valve or a Standard Class 400 flanged-end valve may be assigned an intermediate pressure-temperature rating or Class in accordance with [para. 6.1.4](#), provided all other applicable requirements of this Standard are met. Correspondingly, an intermediate pressure rating or Class for Limited Class valves having welding ends or threaded ends may be assigned pressure-temperature ratings as determined by the method described in [Mandatory Appendix V](#) in conjunction with the interpolation procedure described in [para. 6.1.4](#).

2.1.6 Valves Fabricated by Welding. A valve made wholly or partly from segments of castings, forgings, bars, plates, or tubular product welded together will merit the applicable pressure-temperature rating only if

- (a) it conforms to all applicable requirements of this Standard
- (b) weld fabrication and heat treatment of welds are in accordance with the ASME Boiler and Pressure Vessel Code (ASME BPVC), Section VIII, Division 1²
- (c) nondestructive examination of welds is in accordance with ASME BPVC, Section VIII, Division 1, as required to warrant a joint efficiency, *E*, not less than
 - (1) 0.80 for flanged-end and Standard Class welding-end valves larger than NPS 6
 - (2) 1.00 for Special Class welding-end or threaded-end valves in all sizes (see [para. 8.3.3](#))
 - (3) 1.00 for valves in cryogenic service³

These requirements are not applicable to seal welds or attachment welds such as for backseat bushings, seat rings, lifting lugs, and auxiliary connections.

2.2 Rating Temperature

The temperature shown for a corresponding pressure rating is the temperature of the pressure-containing shell of the component. In general, this temperature is the same as that of the contained fluid. Use of a pressure rating

²Standard Welding Procedure Specifications published by the American Welding Society and listed in ASME BPVC, Section IX, Mandatory Appendix E are permitted within the limitations established by ASME BPVC, Section IX, Article V.

³This is applicable only to full-penetration butt welds.

corresponding to a temperature other than that of the contained fluid is the responsibility of the user, subject to the requirements of applicable codes and regulations.

2.3 Temperature Effects

2.3.1 High Temperature. Application at temperatures in the creep range will result in decreasing bolt loads as relaxation of flanges, bolts, and gaskets takes place. Flanged joints subject to thermal gradients may likewise be subject to decreasing bolt loads. Decreased bolt loads diminish the capacity of the flanged joint to sustain loads effectively without leakage. At elevated temperatures, flanged joints, and in particular Class 150, may develop leakage problems unless care is taken to avoid imposing severe external loads or severe thermal gradients.

2.3.2 Low Temperature. The pressure rating for service at any temperature below 38°C (100°F) shall be no greater than the rating shown in [Tables 2-1.1 through 2-3.19](#) ([Tables 2-1.1C through 2-3.19C](#)) for 38°C (100°F). Some of the materials listed in [Table 1](#), notably some carbon steels, may undergo a decrease in ductility when used at low temperatures to such an extent as to be unable to safely resist shock loading, sudden change of stress, or high stress concentration. Codes and regulations may have requirements for low temperature applications that are a function of the valve's dimensions as well as the material. The codes and regulations may also have supplementary requirements like heat treatment or impact testing. See [Nonmandatory Appendix D](#) for a further explanation. (25)

2.4 Guidance for the Use of Flanged Valve Ratings

Application of flanged-end valves at either high or low temperatures or in a service subject to rapid fluid temperature variations entails some risk of flanged joint leakage. Guidance in this regard is provided in ASME B16.5 and more extensively in ASME PCC-1. Precautions regarding the bolting of raised face flanges to cast iron flanges are given in ASME B16.5 and ASME B16.47.

2.5 Variances

Except as provided in [paras. 2.5.1 through 2.5.3](#), the pressure-temperature ratings are the maximum allowable working pressure for the corresponding temperature.

2.5.1 Safety Valves, Relief Valves, or Rupture Disk Operation. Under conditions of safety valve, relief valve, or rupture disk operation, pressure may exceed the rated pressure for a valve furnished under this Standard by no more than 10% of that defined by the pressure-temperature rating. Such conditions are necessarily of limited duration. Damage that may result from pressure excursions in excess of the aforementioned is solely the responsibility of the user.

2.5.2 Other Variances. Damage that may result from subjecting a valve to other operating variances (transients) in excess of its pressure rating is solely the responsibility of the user.

2.5.3 Pressure Testing Limitations. A valve user who conducts a pressure test or causes a pressure test to be conducted on a valve, either a valve alone or one that is installed in a piping system, needs to be concerned with pressure limits imposed by valves conforming to this Standard.

2.5.3.1 Valve in the Closed Position. In the closed position, a valve subjected to a pressure test at a pressure that exceeds its 38°C (100°F) rating, or, if applicable, exceeds the closed position pressure differential limit shown on its identification plate (see [para. 4.3.3](#)), may be damaged. Any damage resulting from such testing is solely the responsibility of the user.

2.5.3.2 Valve in the Open Position. In the open position, a valve subjected to a pressure test that exceeds the shell test pressure of [para. 7.1](#) may be damaged. Any damage resulting from such testing is solely the responsibility of the user.

2.6 Multiple Material Grades

Material for valve bodies, bonnets, or cover plates may meet the requirements of more than one specification or the requirements of more than one grade of a specification listed in [Table 1](#). In either case, the pressure-temperature ratings for any of these specifications or grades may be used provided the requirements of [para. 5.1](#) are satisfied; the material is marked in accordance with [para. 4.2.8](#); and account is taken of [para. 5.2.2](#).

2.7 Operating Conditions

2.7.1 Local Conditions. When a valve (or series of valves) is installed in a piping system that operates with different pressures (or temperatures) on either side of the closed valve, it is the responsibility of the user to ensure that the installed valve is suitable for the highest of the rating requirements considering combinations of pressure and temperature.

2.7.2 Trapped Liquids. Some double-seated valves can trap liquid in the center cavity between valve seats. Fluid trapped in the center cavity may render a valve inoperable and may result in pressure boundary failure due to excessive pressure buildup. Conditions that can result in valve damage from trapped fluid include thermal expansion from temperature increase and expansion of water from freezing conditions. Conditions that can result in an inoperable valve include liquids that become solid when cooled to ambient temperature and chemical reactions that change liquids to solids. Where such conditions are specified by the purchaser, the manufacturer shall ensure the valve provided is suitable.

3 NOMINAL PIPE SIZE

As applied in this Standard, the use of the phrase “nominal pipe size” or the designation NPS followed by a number is for the purpose of pipe or valve-end connection size identification. The number is not necessarily the same as the valve inside diameter. The relationship between inside diameter (see [para. 6.1.2](#)) and nominal pipe size is shown in [Nonmandatory Appendix A](#). The reference dimension, d , in [Table 3A](#) or [Table 3B](#) is the valve inside diameter as defined in [para. 6.1.2](#).

4 MARKING

4.1 General

Except as modified herein, valves shall be marked as required in MSS SP-25 and shall include the following requirements.

4.2 Identification Markings

4.2.1 Name. The manufacturer's name or trademark shall be shown.

4.2.2 Materials. Materials used for valve bodies, bonnets, and cover plates shall be identified in the following way:

(a) Cast valves shall be marked with the heat number or heat identification and symbols (letters and numbers) as given in the ASTM specification to designate the material grade.

(b) Forged or fabricated valves shall be marked with the ASTM specification number and grade identification symbol (letters and numbers). If the ASTM grade identification symbols are unique to the material product form or grade being used, that is, the symbols are not used with any other ASTM material product form or grade, the ASTM number may be omitted. When more than one material or grade of materials is used for a fabricated valve, each shall be identified. Also, when one material grade is used for a valve assembly, a single material marking on the body is all that is required.

(c) ASME BPVC, Section II specification number may be substituted for a corresponding ASTM specification number in (a) and (b), provided that the requirements of the ASME specification are identical or more stringent than the ASTM specification for the Grade, Class, or Type of material.

(d) A manufacturer may supplement these mandatory material identifications with his trade designation for the material grade, but confusion with the marking required herein shall be avoided.

4.2.3 Rating. The valve body shall be marked with the number that corresponds to the pressure rating class designation except that Special Class, Limited Class, Intermediate Rated — Standard Class, and Intermediate Rated — Special Class valves may instead be marked

with the valve's maximum allowable temperature and its associated rated pressure.

4.2.4 Temperature. Temperature markings are not required except as indicated in [paras. 4.2.3](#) and [4.3.3](#).

4.2.5 Size. The NPS designation number shall be shown.

4.2.6 Omission of Markings. On valves whose size or shape limits the body markings, they shall be omitted in the following order:

- (a) size
- (b) rating
- (c) material
- (d) manufacturer's name or trademark

4.2.7 Ring-Joint Flange. Valves having ring-joint end flanges shall have the edge (periphery) of each ring-joint end flange marked with the letter "R" and the corresponding ring-groove number. Groove numbers are listed in ASME B16.5 and ASME B16.47.

4.2.8 Multiple Material Marking. Material for valve bodies, bonnets, and cover plates that meet the requirements for more than one specification or grade of a specification listed in [Table 1](#) may, at the manufacturer's option, be marked with more than one of the applicable specification or grade symbols. These identification markings shall be placed to avoid confusion in identification. The acceptability of multiple marking shall be in accordance with the guidelines set out in ASME BPVC, Section II, Part D, Mandatory Appendix 7.

4.2.9 Case Number. When a valve relies on and meets the requirements of a Case, the Case number shall be included in the markings as "Case ##".

4.3 Identification Plate

4.3.1 Attachment. An identification plate that includes the manufacturer's name shall be secured to each valve.

4.3.2 Pressure Markings. The identification plate shall be marked with the applicable valve pressure rating at 38°C (100°F) and the pressure rating class designation number.

4.3.3 Special Markings. Valves whose construction limits use to less than the pressure-temperature values for the marked pressure rating class designation shall indicate these limitations on the identification plate. Examples in this category are valves using elastomeric gaskets or seating elements, valves with closure elements designed for closure pressure differentials lower than the basic rated pressure of the valve body, or valves using carbon steel bonnet bolts such as ASTM A307, Grade B.

(25) **4.3.4 Valves With Nonstandard Ends.** Valves furnished with any nonstandard type of end connection, such as clamped ends or special flange designs, shall indi-

cate the type, pressure rating, and any specific series designation on the identification plate.

4.4 Conformity

4.4.1 Designation. Valves conforming to Standard Class requirements shall include the designation "B16.34" on the identification plate. For Special Class valves, the identification plate shall include the designation "B16.34 SPL." For Limited Class valves, the identification plate shall include the designation "B16.34 LTD." The use of the prefix "ASME" to these designations is optional.

4.4.2 Compliance. The "B16.34" identification marking of [para. 4.4.1](#) designates that the valve was manufactured in conformance with ASME B16.34.

5 MATERIALS

5.1 General

The body, bonnet or cover, body joint bolting, and body-bonnet or cover bolting shall be constructed of materials as listed in the respective ASTM specifications referred to in [Table 1](#). Identical materials in accordance with ASME BPVC, Section II may also be used for these parts.

5.1.1 Application. It is not required that identical material or material form be used for body and bonnet or cover parts. The rating applied, however, shall be based on the valve body. The bonnet or cover shall be designed and material selected so as to comply with the body pressure-temperature rating. Selection of stems, disks, and other parts, such as bonnet gaskets and bolting, subject to pressure and other loading, shall be consistent with the applicable valve pressure-temperature rating. (25)

5.1.2 Carbon Steel Bonnet or Cover Bolting. It is permissible to use carbon steel, for example, ASTM A307, Grade B, for bonnet or cover bolting only for Class 300 and lower, provided the service temperature is limited to 200°C (400°F) and marking is in accordance with [para. 4.3.3](#).

5.1.3 Investment Castings. When investment castings are used for bodies, bonnets, or cover plates of valves NPS 4 and smaller where the ratings do not exceed Class 600, the requirements of the ASTM specifications referred to in [Table 1](#) shall be met, except that it is permissible to determine mechanical and chemical properties from a master heat and to use a 25 mm gage length × 6.25 mm diameter (1 in. × 0.25 in. diameter) tensile specimen in place of the standard 2 in. tensile specimen. A master heat is previously refined metal of a single furnace charge. Tensile specimens shall be cast in molds of the same refractory as the castings and shall be given the same heat treatment as the castings. When investment castings are used for sizes and pressure classes greater than those described in this paragraph, all the requirements of the

applicable material specification listed in [Table 1](#) shall be met.

5.1.4 Cast Surfaces. Cast surfaces of pressure boundary parts shall be in accordance with MSS SP-55 except that all Type I defects are unacceptable and defects in excess of Plates “a” and “b” for Type II through Type XII are unacceptable.

5.1.5 Mechanical Properties. Mechanical properties shall be obtained from test specimens that represent the final heat-treated condition of the material required by the material specification.

5.2 Material Selection

5.2.1 Service Conditions. Criteria for the selection of materials are not within the scope of this Standard. The possibility of material deterioration in service and the need for periodic inspections is the responsibility of the user. Carbide phase conversion to graphite, oxidation of ferritic materials, decrease in ductility of carbon steels at low temperatures even in applications above -10°C (20°F), and susceptibility to intergranular corrosion of austenitic materials or grain boundary attack of nickel-base alloys are among those items requiring attention by the user. A discussion of precautionary considerations can be found in ASME B31.3, Appendix F; ASME BPVC, Section II, Part D, Nonmandatory Appendix A; and ASME BPVC, Section III, Division 1, Nonmandatory Appendix W.

5.2.2 Responsibility. When service conditions dictate the implementation of special material requirements, e.g., using a Group 2 material above 538°C ($1,000^{\circ}\text{F}$), it is the user's responsibility to so specify to the manufacturer in order to ensure compliance with metallurgical requirements listed in the Notes to [Table 1](#) and the Notes in [Tables 2-1.1](#) through [2-3.19](#) ([Tables 2-1.1C](#) through [2-3.19C](#)).

5.3 Electrical Continuity

Internal parts that are insulated from the valve body may build up a static electric charge. An example is a ball valve with seats and seals of nonconductive materials. When service conditions require electrical continuity to prevent static discharge, the user is responsible for specifying static grounding.

5.4 Flange Removal

When an end flange is removed from a flanged-end valve body casting to make a welding-end valve casting, discontinuities may be observed that would not have been detrimental in the flanged body casting. The valve manufacturer that removes an end flange from a valve body casting during the course of manufacture has responsibility for the acceptability of the resultant welding-end valve casting. This responsibility

includes pressure testing the resultant weld-end valve in accordance with [section 7](#).

6 DIMENSIONS

6.1 Body Dimensions

6.1.1 Wall Thickness. For inspection purposes, the wall thickness of valve bodies at the time of manufacture except as indicated in [paras. 6.1.3](#) through [6.1.7](#), [6.2](#), and [6.7](#), shall be no less than the minimum values t_m either as shown in [Table 3A](#) or [Table 3B](#) or calculated using the equation shown in [Mandatory Appendix VI](#) (which yield essentially the same result). Linear interpolation may be used for wall thickness values intermediate to those listed or calculated. See [Nonmandatory Appendix B](#), [section B-4](#) for an explanation of the interpolation procedure. The minimum thickness requirement for the body wall is applicable only as measured from internal wetted surfaces. Minimum wall thickness determination shall not include liners, linings, or cartridges.

6.1.2 Inside Diameter. For the purpose of determining wall thickness, t_m , using [Table 3A](#) or [Table 3B](#), or the equations in [Mandatory Appendix VI](#), the inside diameter, d , shall be in accordance with the following requirements:

(a) The inside diameter, d , shall be the minimum diameter of the flow passage but not less than 90% of the basic inside diameter at the valve end subject to the considerations listed in (b) through (f).

(b) For socket welding- and threaded-end valves, the socket or thread diameters and associated counterbores or threaded bores need not be considered in establishing the value of d (see [paras. 6.2.3](#) and [6.2.4](#)).

(c) For multipiece valve construction, where the body consists of a central core to which are affixed two end pieces, the inside diameter, d , is determined by only one of the following methods:

(1) in accordance with (a).

(2) for the end pieces, the value of d shall be in accordance with (a), and for the central core piece the value of d shall be the inside diameter of the core piece. For a core piece with axial holes, whether through- or partial-threaded, the inner and outer ligaments shall also meet the requirements of dimensions f and g in [Figure 2](#). These ligaments shall be based upon the value of d for the core piece.

(d) For the special case of valves used between high- and low-pressure sections of a system where an end connection for a thinner pipe wall (or lower Class flange) on one end than on the other, the inside diameter, d , shall be based on the end connection with the heavier pipe wall (or higher Class flange). The valve wall thickness, t_m , shall be that associated with the higher Class rating.

(e) Localized variations of inside diameter associated with transitions to weld preparations need not be considered. Note, however, limitations of proximity of body neck in para. 6.1.5.

(f) Where linings, liners, or cartridges are used to form the flow passage or portions of the flow passage, the inside diameter, d , shall be that at the lining-body, liner-body, or cartridge-body interface.

(g) For inside diameters that lie between diameters listed in Table 3A or Table 3B, the minimum wall thickness, t_m , may be determined by linear interpolation using the method of Nonmandatory Appendix B, para. B-4.4.

6.1.3 Valve Body Necks. For inspection purposes, the wall thickness of valve body necks at the time of manufacture shall be no less than the minimum values determined by the following:

(a) Valve body necks, except for the special cases described in (b) through (d), shall maintain the minimum wall thickness as described in paras. 6.1.1 and 6.1.2 within a region of $1.1\sqrt{dt_m}$ measured from the outside of the body run along the neck direction. The diameter, d , is as defined in para. 6.1.2, and t_m is the minimum wall thickness as shown in Table 3A or Table 3B. Minimum wall thickness requirements are applicable to and measured from internally wetted surfaces, e.g., up to the point where the body-bonnet seal is affected.

Beyond the aforementioned $1.1\sqrt{dt_m}$ region, straight circular sections of valve body necks with inside diameter d' shall be provided with local wall thickness at least equal to t' where t' is taken from the appropriate (tabulated or intermediate) rating Class in Table 3A or Table 3B using an appropriate diameter d'' .

For $150 \leq \text{Class} \leq 2500$

$$d'' = \frac{2d'}{3}$$

For $2500 < \text{Class} \leq 4500$

$$d'' = \frac{d'}{48} \left(27 + \frac{P_c}{500} \right)$$

where P_c is the pressure class designation as defined in Nonmandatory Appendix B, para. B-1.3, d' is the body neck inside diameter, and d'' is the diameter used to determine body neck wall thickness requirement beyond that required for the $1.1\sqrt{dt_m}$ region.

(b) For the special case where $d' > 1.5d$, it is necessary that the wall thickness be equal to or greater than t' for the entire body neck length having diameter d' , including the aforementioned $1.1\sqrt{dt_m}$ region.

(c) For the special case of valve body necks having a small diameter relative to the body run diameter, i.e., $d/d' \geq 4$ (for example, a butterfly valve stem penetration), the minimum local wall thickness over a distance, L , where

$$L = t_m \left(1 + 1.1 \sqrt{\frac{d}{t_m}} \right)$$

measured starting from the intersection of the body inside diameter and the axis of the body neck outside diameter, shall be equal to t' where t' is obtained from Table 3A or Table 3B using the appropriate body neck inside diameter d' and the appropriate pressure class. This special case is illustrated in Figure 2. Beyond the aforementioned distance, L , valve body necks shall be provided with local minimum wall thickness based on d'' , in accordance with (a).

(d) For the special case of a body neck in which holes are drilled or tapped in the body neck wall parallel with the body neck axis, it is required that the sum of the ligaments at the inner and outer sides be equal to or greater than t_m or t' , as applicable. The inner ligament and the ligament at the bottom of the drill hole shall be no less than $0.25t_m$ or $0.25t'$, as applicable. Furthermore, it is required that this thickness shall extend for a length along the body length, starting at the top of the neck, at least equal to the depth of the hole plus a distance equal to one-half of the hole or bolt diameter.

6.1.4 Valves With Intermediate Ratings. The intermediate pressure-temperature rating class designation, P_{cl} , and minimum wall thickness, t_m , for threaded- or welding-end valves with intermediate pressure ratings shall be determined in accordance with Nonmandatory Appendix B, para. B-4.3. For Class 400 flanged-end valves the minimum wall thickness, t_m , and the intermediate pressure ratings shall be determined by interpolation in accordance with Nonmandatory Appendix B, para. B-4.3.

6.1.5 Contours at Body Ends. Contours at valve body ends shall be in accordance with the following requirements: (25)

(a) *Butt welding Ends.* The weld preparation (see para. 6.2.1) shall not reduce the body wall thickness to less than the values required by para. 6.1.1 or para. 6.1.4 within a region closer to the outside surface of the body neck than t_m measured along the run direction. The transition to the weld preparation shall be gradual, and the section shall be essentially circular through the entire length of the transition. Sharp discontinuities or abrupt changes in sections that infringe into the transition shall be avoided, except that test collars or bands, either welded or integral, are allowed. In no case shall the thickness be less than $0.77t_m$ at a distance of $2t_m$ from the weld end.

(b) *Socket Welding and Threaded Ends.* The distance from the centerline of generally cylindrical flow passages to the external surface of the body run shall be no less than 0.5 times the appropriate nominal pipe outside diameter listed in ASME B36.10M.

(c) **Completed Ends.** After the tests required by para. 7.1 have been completed, and at the manufacturer's discretion, semifinished butt welding ends may be machined to final dimensions, flange gasket seating surfaces may be machined to a final surface finish, or threaded ends may be converted to socket welding ends, all without any additional pressure testing.

(d) **Clamped Ends.** In the transition region behind the back surface of the clamped area, where clearance between the clamp body components and the body wall is required, it shall be permissible for the wall thickness to be reduced below the valve body t_m , but not less than the corresponding pipe minimum wall.

6.1.6 Local Areas. Local areas having less than minimum wall thickness are acceptable, provided that all of the following limitations are satisfied:

(a) Measured thickness is no less than $0.75t_o$.

(b) The area of subminimum thickness can be enclosed by a circle whose diameter is no greater than $0.35\sqrt{d_o t_o}$. For valve body necks, use $d_o = d'$ and $t_o = t'$ (see para. 6.1.3). For all other local areas, use $d_o = d$ (see para. 6.1.2) and $t_o = t_m$ (see para. 6.1.1 or para. 6.1.4, as appropriate).

(c) Enclosure circles are separated from each other by an edge-to-edge distance of no less than $1.75\sqrt{d_o t_o}$.

(25) **6.1.7 Additional Metal Thickness.** Additional metal thickness needed, e.g., for assembly loads, actuating (closing and opening) loads, shapes other than circular, and stress concentrations, shall be determined by individual manufacturers since these factors vary widely. In particular, inclined stem valves, intersections and openings in enlarged body cavities, and some types of fabricated body valves may require additional reinforcement to assure adequate strength and rigidity.

6.2 End Dimensions

6.2.1 Butt welding Ends. Unless otherwise specified by the purchaser, the details of the welding-end preparation shall be in accordance with ASME B16.25 with

(a) the inside diameter (denoted as dimension B in ASME B16.25) having the following tolerance:

Size	Tolerance for Dimension B , mm (in.)
NPS ≤ 10	± 1.0 (± 0.03)
$12 \leq \text{NPS} \leq 18$	± 2.0 (± 0.06)
$20 \leq \text{NPS}$	$+3.0, -2.0$ ($+0.12, -0.06$)

(b) the outside diameter at welding ends (denoted as dimension A in ASME B16.25) having a value not less than that shown for wrought or fabricated components.

In all cases, the thickness of the body run or nozzle transition (see para. 6.1.5) starting at a distance $2t_m$ from the butt welding end, shall be no less than $0.77t_m$.

6.2.2 Flanged Ends. Flanged ends shall be prepared with flange facing, nut-bearing surfaces, outside diameter, thickness, and drilling in accordance with ASME B16.5 or ASME B16.47, Series A or Series B requirements for

(a) flanged fittings for Class 150 and 300 valves

(b) flanges for Class 600 and higher valves

NPS 26 and larger diameter flanges shall be in accordance with ASME B16.47 Series A or Series B, where the Series type is specified by the purchaser. When required, valve end flanges may be furnished with tapped holes for engaging flange bolting. Thread engagement in a flange assembly with tapped holes shall provide full effective thread engagement, not including the chamfered thread, for a length at least equal to the nominal diameter of the bolt thread. For additional considerations, see para. 6.4.3.

6.2.3 Socket Welding Ends. The socket bore diameter, depth of socket, and end surfaces shall be in accordance with ASME B16.11. The minimum thickness of the socket wall extending over the socket depth, including any associated counterbore, shall be in accordance with Table 4.

6.2.4 Threaded Ends. End connections shall have taper pipe threads in accordance with ASME B1.20.1. The minimum thickness of the wall extending over the length of an internal thread, including any tap bore or counterbore, shall be in accordance with Table 4. Thread lengths and gaging requirements shall be in accordance with ASME B16.11.

6.2.5 Intermediate Rated Socket Welding and Threaded-End Valves. The minimum socket wall thickness and the minimum threaded-end wall thickness for valves with intermediate ratings may be determined by interpolation using the method of para. 6.1.4 using wall thickness values from Table 4.

6.2.6 End to End. End-to-end dimensions and face-to-face dimensions for butt welding-end valves and for valves with flanged ends shall be in accordance with ASME B16.10 or other dimensions by agreement between manufacturer and purchaser. For some valve types, both long and short pattern dimensions are listed in ASME B16.10. It should not be assumed that all designs of the type listed could be accommodated in the short pattern dimension series. For valve types not included in ASME B16.10, and for valves with clamped ends, dimensions shall be the manufacturer's standard.

6.2.7 Nonstandard Ends. End connections other than those described in paras. 6.2.1 to 6.2.4 may be provided in accordance with the requirements of para. 6.2.7.1 or para. 6.2.7.2. Such ends shall be analyzed and pressure-temperature rated to comply with the pressure-temperature rating method for Standard Class valves. In addition, the minimum section modulus of the body and the bolting shall be calculated in accordance with the methods

specified in para. 6.4.2.3. Weld fabrication shall be in accordance with para. 2.1.6.

6.2.7.1 Nonstandard Flanges. It is permissible to use flanged ends of the nominal size designations covered in this Standard and pressure class ratings covered in ASME B16.5 or ASME B16.47, when analyzed and designed in accordance with ASME BPVC, Section VIII, Division 1, Appendix 2 or ASME BPVC, Section VIII, Division 2, Part 5. Analysis of the flange design shall include bending moment strength to be equal to or greater than the bending moment capability based on the section modulus of the minimum required valve body thickness. Pressure-temperature rating shall be determined in accordance with the respective Class Rating Methods of [Nonmandatory Appendix B](#). Valve marking in accordance with [section 4](#) shall include the nonstandard flange class rating.

6.2.7.2 Clamped Connections. Alternative analysis of integral clamped end connections may be performed in accordance with ASME BPVC, Section VIII, Division 1, Appendix 24. Analysis of the clamped end design shall include bending moment strength to be compatible with bending moment capability based on the section modulus of the minimum required valve body thickness. The butt-welding bevel and tolerances for non-integral clamp connections shall be in accordance with ASME B16.5, and socket welding tolerances shall be in accordance with [Table 4](#) of this Standard. The pressure-temperature rating for the clamped connections provided by the clamp connection manufacturer shall equal or exceed the pressure-temperature rating for the valve. All valves with clamped connections shall be retained in the line by at least four fasteners, oriented either parallel or perpendicular to the axis of the valve.

6.3 Auxiliary Connections

6.3.1 General. Auxiliary connections, e.g., for bypass connections, shall be designed, fabricated, and examined so as to warrant at least the same pressure-temperature ratings as the valve and shall be installed prior to the shell test of the valve to which they are attached, except that upon agreement between the manufacturer and purchaser, auxiliary connections installed after the valve shell tests are acceptable. Welds in auxiliary connections assembled by welding shall be made by a qualified welder using a qualified welding procedure, both in accordance with ASME BPVC, Section IX.

6.3.2 Pipe Thread Tapping. Threads for threaded auxiliary connections may be tapped into the wall of a valve if the metal is thick enough to allow the effective thread length specified in [Figure 3](#). Where metal thickness is insufficient or the tapped hole needs reinforcement, a boss shall be added as shown in [Figure 4](#).

6.3.3 Socket Welding. Sockets for socket welding assembly of auxiliary connections may be provided in the wall of a valve if the metal is thick enough to accommodate the depth of the socket and the thickness of its shoulder specified in [Figure 5](#). Where the metal thickness is insufficient or the socket opening requires reinforcement, a boss shall be added as shown in [Figure 4](#). The length of the leg of the attachment weld shall be not less than 1.09 times the nominal pipe wall thickness of the auxiliary connection or 3.2 mm (0.12 in.), whichever is greater.

6.3.4 Butt Welding. Auxiliary connections may be attached by butt welding directly to the wall of the valve (see [Figure 6](#)). Where the size of the opening is such that reinforcement is necessary, a boss shall be added as shown in [Figure 4](#).

6.3.5 Bosses. Where bosses are required, the inscribed diameters shall be not less than those shown in [Figure 4](#), and the height shall provide metal thickness to satisfy the requirements of [Figure 3](#) or [Figure 5](#).

6.3.6 Size. Unless otherwise specified, the minimum auxiliary connection sizes shall be as follows:

Valve Size, NPS	Connection, NPS
$2 \leq \text{NPS} \leq 4$	$\frac{1}{2}$
$4 < \text{NPS} \leq 8$	$\frac{3}{4}$
$8 < \text{NPS}$	1

6.3.7 Designating Locations. A means of designating locations for auxiliary connections for some valve types is shown in [Figure 1](#). A letter designates each of these locations so that the desired locations for the illustrated types of valves may be specified without using further sketches or description.

6.4 Valve Joints

Valves with bolted or threaded bonnet or cover joints or body joints shall meet the following tensile or shear area requirements.

6.4.1 Bonnet or Cover Joints. Valve bonnet or cover joints, the joints between a valve body and a bonnet or cover are joints that are not subject to direct piping loads.

6.4.1.1 Bolted Bonnet or Cover Joints. Where bonnets or covers are joined to valve bodies by means of bolting, bolting shall be threaded in accordance with ASME B1.1 for inch bolting or ASME B1.13M for metric bolting and, as a minimum, shall satisfy the following bolt cross-sectional area requirements: (25)

$$P_c \frac{A_g}{A_b} \leq K_1 S_a \leq \text{Limit}$$

where

A_b = total effective bolt tensile stress area

A_g = area bounded by the effective outside periphery of a gasket or O-ring or other seal-effective periphery, except that in the case of a ring-joint the bounded area is defined by the pitch diameter of the ring

K_1 = 65.26/MPa when S_a is expressed in MPa units (K_1 = 0.45/psi when S_a is expressed in psi units)

Limit = 9 000 for $S_a \leq 172$ MPa (25,000 psi)
= 11 250 for $S_a > 172$ MPa (25,000 psi)

P_c = pressure rating class designation (see [Nonmandatory Appendix B, para. B-1.3](#))

S_a = allowable bolt stress at 38°C (100°F), MPa (psi). For bolting with an allowable stress in the 138 MPa to 172 MPa (20,000 psi to 25,000 psi) range, use 138 MPa (20,000 psi). For bolting with allowable stress > 172 MPa (25,000 psi), use 172 MPa (25,000 psi).

The allowable bolt stress values shall be taken from ASME BPVC, Section II, Part D using the listings for Section VIII, Division 1, or Section III, Division 1, Class 2 or Class 3. This algebraic expression requires that a consistent set of units be used.

6.4.1.2 Threaded Bonnet or Cover Joints. Where bonnets or covers are joined to valve bodies by means of threads, thread shear area, at a minimum, shall satisfy the following:

$$P_c \frac{A_g}{A_s} \leq 4200$$

where

A_s = total effective thread shear area

(25) **6.4.2 Body Joints.** Valves with bodies of sectional construction such that bolted or threaded body joints are subject to piping mechanical loads shall, at a minimum, satisfy the requirements of [paras. 6.4.2.1](#) through [6.4.2.3](#).

(25) **6.4.2.1 Bolted Body Joints.** Bolted body joints shall use bolting threaded in accordance with ASME B1.1 for inch dimensional bolting or ASME B1.13M for metric bolting and, at a minimum, shall satisfy the following bolt cross-sectional area requirement:

$$P_c \frac{A_g}{A_b} \leq K_2 S_a \leq \text{Limit}$$

where

K_2 = 50.76/MPa when S_a is expressed in MPa units
= 0.35/psi when S_a is expressed in psi units

Limit = 7 000 for $S_a \leq 172$ MPa (25,000 psi)
= 8 750 for $S_a > 172$ MPa (25,000 psi)

This algebraic expression requires that a consistent set of units be used.

6.4.2.2 Threaded Body Joints. Threaded body joints shall, as a minimum, satisfy the following thread shear area requirement:

$$P_c \frac{A_g}{A_s} \leq 3300$$

6.4.2.3 Section Modulus. The minimum section modulus, Z_{bn} , for the valve body nozzle shall be determined for the body section between the piping connection (flange, welding end, or threaded end) and the sectional body joint. If this body section has a cylindrical cross section, the following equation may be used to determine the section modulus. For other cross-sectional shapes, the section modulus shall be determined by traditional area methods.

$$Z_{bn} = \frac{\pi(D^4 - d^4)}{32D}$$

where

D = minimum valve body section outside diameter (O.D.)

d = inside diameter (flow passage) of valve body as defined in [para. 6.1.2](#)

O.D. = $d + 2t_m$

t_m = minimum wall thickness of valve body based on flow passage d and pressure class as defined in [para. 6.1.1](#)

Z_{bn} = minimum sectional modulus of valve body nozzle

This algebraic expression requires that a consistent set of units be used.

(a) For threaded-, flanged-, and welding-end valve bodies having a bolted sectional body joint, the section modulus of the sectional flange bolting shall meet the following:

$$Z_{fb} \times \left(\frac{S_a}{S_b} \right) \geq Z_{bn}$$

where

S_a = bolting allowable stress at 39°C (100°F)

S_b = allowable stress of valve body material at 39°C (100°F)

Z_{fb} = section modulus of bolting arrangement of a sectional body flanged joint

For a circular bolt circle bolting arrangement, the bolting section modulus, Z_{fb} , can be determined using the following equation. For noncircular bolting patterns, the section modulus shall be determined by traditional area methods.

$$Z_{fb} = \frac{CA_B}{4}$$

where

A_B = total root area of bolting
 C = diameter of bolt circle

This algebraic expression requires that a consistent set of units be used.

(b) For threaded-, flanged-, and welding-end valve bodies having a threaded sectional body joint, the section modulus determination, Z_{tj} , for the body section shall include consideration of the thread's impact on the section modulus dimensions. The threaded body joint, Z_{tj} , shall meet the following:

$$Z_{tj} = Z_{bn}$$

where

Z_{tj} = minimum sectional modulus of threaded sectional body joint

The section modulus, Z_{tj} , shall be determined using the following equation:

$$Z_{tj} = \frac{\pi(D_r^4 - d^4)}{32D_r}$$

where

D_r = valve body section O.D. at external thread root
 d = inside diameter (flow passage) of valve body as defined in para. 6.1.2

This algebraic expression requires that a consistent set of units be used.

- (25) **6.4.3 Additional Considerations.** Bolting or threading in excess of the minimum requirements of this Standard may be required because of, for example, valve design, special gasket compression requirements, special specified service conditions, or operation at high temperatures where differences in the creep characteristics between body and bolting materials could compromise joint sealing capability. Since these factors vary widely, these requirements shall be accounted for by individual manufacturers.

6.5 Stems

Stems, variously referred to as spindles, shafts, or pins, are collectively identified herein as stems.

6.5.1 Stem Retention

6.5.1.1 Retention by Stem Seal Elements. Valves shall be designed so that the stem seal retaining fasteners (e.g., packing gland fasteners) alone do not retain the stem. Specifically, the design shall be such that the stem shall not be capable of removal from the valve, while the valve is

under pressure, by the removal of the stem seal retainer (e.g., gland) alone.

6.5.1.2 Retention by Closure Member. Valves, including those intended for isolation, regulation, or flow reversal, shall be provided with a means so that, in the event of a structural failure of stem-to-closure attachment items, the stem will not be ejected through the pressure boundary while the valve is under pressure.

6.5.1.3 Material Deterioration. The requirements of para. 6.5.1.2 do not alter the user's responsibility for exercising control over in-service material deterioration or the need for periodic inspections. See para. 5.2.1.

6.5.2 Position Indication. Valves of the quarter-turn type (e.g., ball, plug, or butterfly) shall have a means to indicate the ball, plug, or disk position. The design shall be such that the components of the indicating means cannot be assembled to falsely indicate the valve open or closed position.

6.6 Installation Limitations

6.6.1 Single Flange Installation. Flanged and wafer or flangeless valves are intended for installation between flange pairs. These valves, however, can also be designed for installation against a single flange for the purpose of effecting closure in dead-end piping. Valves for the latter service shall be designed such that those parts necessary to support pressure loads acting across the seating element safely support the maximum differential pressure rating of the valve. Examples of such parts are end entry threaded seat retaining ferrules of ball valves and bolted seat seal retaining plates of butterfly valves. In the event that the valve design cannot accommodate these pressure loads, then the valve shall be marked to show such installation restriction.

6.6.2 Disk Clearance. Valves that can be bolted between flanges or against a flange (e.g., butterfly or swing check valves) may have a disk that will, upon rotation, project beyond the plane of the flange gasket. The valve design shall be such that there will be no interference between the valve disk and companion flanges or adjacent piping for the following pipe schedules:

Pressure Class	Valve Size, NPS	Pipe Schedule
150	2 ≤ NPS ≤ 24	40
300	2 ≤ NPS ≤ 24	80
600	2 ≤ NPS ≤ 6	80
600	8 ≤ NPS ≤ 14	100

For other valve sizes and pressure classes, pipe inside diameter and disk clearance shall be as agreed between manufacturer and purchaser.

6.7 Wafer or Flangeless Valves

The design of valves that can be bolted between flanges or against a flange (e.g., butterfly valves) shall conform to the applicable requirements for flanged valves and the requirements of (a) through (f) (see Figure 2).

(a) The design shall provide for boltup using all of the bolt holes and bolt circle of the specified flange.

(b) Bolt holes, parallel to the body run, may be either threaded or unthreaded. Threaded holes may be blind holes suitable for use with bolt studs. When threaded, full-thread engagement, excluding chamfers, shall be provided to a depth not less than one nominal bolt diameter.

(c) The required minimum valve body wall thickness, t_m , shall be measured from the valve body inside circumference out to the lesser of the valve body outside circumference or the circumference of a circle inscribed through the inner tangent points to the flange bolt holes.

(d) The inner ligament (e of Figure 2) of either a through-hole or a blind threaded hole in the vicinity of a stem penetration shall not be less than 25% of the required wall thickness of the body neck but in no case less than 2.5 mm (0.1 in.).

(e) The inner ligament (f and g of Figure 2) for holes parallel to the body run shall not be less than $0.25t_m$ but in no case less than 2.5 mm (0.1 in.). The sum of the inner and outer ligaments shall not be less than t_m .

(f) A ligament within the minimum body wall between two adjacent holes within the minimum body wall (j of Figure 2) shall be $0.25t_m$ or greater but not less than 2.5 mm (0.1 in.).

7 PRESSURE TESTING

7.1 Shell Test

- (25) **7.1.1 Shell Test Pressure.** Each valve shall be given a shell test at a gage pressure no less than 1.5 times the 38°C (100°F) pressure rating, rounded off to the next higher 1-bar increment if using SI units or 25-psi increment if using U.S. Customary units. The test shall be made with water, which may contain a corrosion inhibitor, with kerosene, or with other suitable fluid,⁴ provided such fluid has viscosity not greater than that of water. The test fluid temperature shall not exceed 50°C (125°F). The test shall be made with the valve in the partially open position.

7.1.2 Test Duration. The shell test duration, the test time required for inspection after the valve is fully prepared and is under shell test pressure, shall be not less than the following:

Test Valve Size	Duration, s
NPS ≤ 2	15
$2\frac{1}{2} \leq \text{NPS} \leq 6$	60
$8 \leq \text{NPS} \leq 12$	120
$14 \leq \text{NPS}$	300

7.1.3 Acceptability. Visually detectable leakage through the pressure boundary is not acceptable. The pressure boundary includes, along with the body, bonnet, or cover, all gasketed joints; however, leakage through the stem seals or stem packing shall not be cause for rejection. Stem seals or stem packing exempted from the shell test pressure leakage requirement shall be capable of retaining pressure up to the 38°C (100°F) pressure rating without visible leakage.

7.2 Valve Closure Tests

7.2.1 Closure Test Pressure. Each valve designed for shut-off or isolation service, such as a stop valve, and each valve designed for limiting flow reversal, such as a check valve, shall be given a closure test. The closure test shall follow the shell test except that for valves NPS 4 and smaller with ratings Class 1500 and lower the closure test may precede the shell test when a gas closure test is used. The test fluid shall be as in para. 7.1. The test pressure shall be not less than 110% of the 38°C (100°F) pressure rating except that, at the manufacturer's option, a gas closure test at gage pressure not less than 5.5 bar (80 psi) may be substituted for valve sizes and pressure classes as follows:

Valve Size, NPS	Pressure Class
NPS ≤ 4	$P_c \leq 2500$
NPS ≤ 12	$P_c \leq 300$

7.2.2 Closure Test Duration. The closure test duration, the time required for inspection after the valve is fully prepared and is under full pressure, shall not be less than the following.

Valve Size	Test Time, s
NPS ≤ 2	15
$2\frac{1}{2} \leq \text{NPS} \leq 8$	30
$10 \leq \text{NPS} \leq 18$	60
$20 \leq \text{NPS}$	120

7.2.3 Closure Test Acceptance. Closure test leakage acceptance criteria shall be by agreement between manufacturer and purchaser. Closure tightness requirements vary with intended service application and are therefore not within the scope of this Standard. For guidance in this regard, a purchaser has a variety of reference testing sources from which to select closure test criteria. For

⁴ There are hazards involved when gas is the fluid for testing. When gas is used, appropriate precautions are required.

example, see API Std 598, ISO 5208, MSS SP-61, or ANSI/FCI 70-2.

7.2.4 Double Seating. For valves of the double seating type, such as most gate-and-ball valves, the test pressure shall be applied successively on each side of the closed valve. The closure test shall include a method that fills the body cavity between the seats and the bonnet cavity with test fluid. As an alternative method, for valves with independent double seating (such as double disk gate valves), the pressure may be applied inside the bonnet or body with the disks closed.

7.2.5 Directional Seating. For other valve types, the test pressure shall be applied across the closure member in the direction producing the most adverse seating condition. For example, a globe valve shall be tested with pressure under the disk. A check valve, globe valve, or other valve type designed to be sold and marked as a one-way valve requires a closure test only in the appropriate direction.

7.2.6 Restricted Seating. Valves conforming to this Standard in all respects, except that they are designed for operating conditions that have the pressure differential across the closure member limited to values less than the 38°C (100°F) pressure rating and have closure members and/or actuating devices (direct, mechanical, fluid, or electrical) that would be subject to damage at high differential pressures, shall be tested as described in the preceding paragraphs except that the closure test requirement may be reduced to 110% of the maximum specified closed position differential pressure. This exception may be exercised as agreed between the user and manufacturer. The manufacturer's nameplate data shall include reference to any such limitations (see para. 4.3.3).⁵

7.3 Leakage Detection Devices

Leakage detection devices, e.g., pressure decay devices, may be used for detecting leakage provided that they are used at the pressures required for the shell and closure tests of paras. 7.1 and 7.2. When used, the valve manufacturer shall have demonstrated that the test results are equivalent to the requirements of paras. 7.1 and 7.2.

7.4 Surface Protection

Valves shall not be painted or otherwise coated with materials capable of sealing against leakage before the shell tests are completed except that

- (a) internal linings or coatings included in the design, e.g., nonmetal butterfly valve linings, are permitted
- (b) chemical corrosion protection treatment is permitted

(c) assembled valves having bodies and bonnets or cover plates that have been separately tested in accordance with para. 7.1, prior to having been painted or coated, may be painted or coated prior to final testing in accordance with para. 7.1

8 REQUIREMENTS FOR SPECIAL CLASS VALVES

8.1 Scope

This section defines the nondestructive examination (NDE) requirements and the rules for defect removal and repair for cast, forged, rolled, wrought, and fabricated valve bodies and bonnets or covers that are intended for use in Special Class valves.

8.2 General

Nondestructive examinations shall be performed on the cast, forged, rolled, wrought, or fabricated material after heat treatment required by the material specification either prior to or after the finish machining at the option of the manufacturer. Surfaces shall be clean and free of surface conditions that may mask unacceptable indications. Accessible surfaces (see paras. 8.3.1.2 and 8.3.2.2) do not include threads, drilled or threaded holes, for example, for bolting, packing, stems, or auxiliary connections.

8.3 Required Examination

8.3.1 Castings

8.3.1.1 Radiographic Examination. The radiographic procedures and acceptance standards to be used shall be in accordance with **Mandatory Appendix I**. Body and bonnet or cover sections requiring radiography are as given in this paragraph and as shown typically in **Figures 7** through **Figure 19**. For body and bonnet configurations not represented, it is permissible to construct a composite coverage area based on these illustrations and the descriptions that follow. The distance A over which film coverage is required, is expressed in multiples of t_m where t_m is the minimum wall thickness requirement as determined by para. 6.1. The value for film coverage of A is intended to be the greater of $3t_m$ or 70 mm (2.75 in.). It should be recognized, however, that in some cases the specified value of A will exceed the intent of the film coverage area as illustrated in **Figures 7** through **19**. For example, in **Figure 12** the body neck or run sections may not accommodate the full value of A as defined. In such cases the requirement may be satisfied by providing film coverage substantially as shown in the sketches. Also, if the full defined coverage width A would result in the film running substantially into an adjacent fillet or crotch section, the value of A may be reduced to a practical maximum value. Small variations in coverage are permitted when necessary to accommodate standard film sizes. Film coverage shall include the following areas:

⁵ Performance testing of valve actuating devices is not within the scope of this Standard.

(a) Body

(1) a band around each weld end extending back from the body end a distance equal to the greater of $3t_m$ or 70 mm (2.75 in.)

(2) a band around the body neck extending down from the top of body on pressure seal valves and from back of the flange on bolted bonnet valves a distance equal to the greater of $3t_m$ or 70 mm (2.75 in.)

(3) a band in the area of the junction between each seat and body shell having a width equal to the greater of $3t_m$ or 70 mm (2.75 in.) and an encompassing girth extending between the fillets of the intersecting sections, e.g., as shown approximately 210 deg for Figure 7

(b) Bonnet. The junction of the stem seal chamber with the bonnet closure plate or flange.

(c) Cover

(1) volumetric examination is not required for flat covers with or without raised faces

(2) for dished covers, a band in the vicinity of the junction between the dished and flanged sections having a width equal to the greater of $3t_m$ or 70 mm (2.75 in.)

8.3.1.2 Surface Examination. All exterior and all accessible interior surfaces of body, bonnet, and cover castings shall be given a surface examination. Table 1, Group 1 materials shall be given either a magnetic particle examination or a liquid penetrant examination. Table 1, Groups 2 and 3 materials shall be given a liquid penetrant examination. Magnetic particle examinations shall be in accordance with the procedure and acceptance standards of Mandatory Appendix II. Liquid penetrant examinations shall be in accordance with the procedure and acceptance standards of Mandatory Appendix III.

8.3.1.3 Ultrasonic Examination. An ultrasonic examination of the casting in accordance with para. 8.3.2.1 may be substituted for the radiographic examination, provided that the user agrees and that it can be demonstrated by the manufacturer that the ultrasonic examination produces interpretable results. The extent of coverage shall be as typically shown in Figures 7 through 19.

8.3.2 Forgings, Bars, Plates, and Tubular Products**8.3.2.1 Ultrasonic or Radiographic Examination.**

(a) The following material sections shall be ultrasonically examined in accordance with the procedure and acceptance standards in Mandatory Appendix IV or radiographically examined in accordance with the procedure and acceptance standards in Mandatory Appendix I.

(1) *body:* cylindrical sections at run ends and body neck

(2) *bonnet:* ring section excluding stuffing box and yoke arms

(3) *cover*

(-a) for dished covers, a band in the vicinity of the junction between the dished and flanged sections having a width equal to the greater of $3t_m$ or 70 mm (2.75 in.)

(-b) volumetric examination is not required for flat covers with or without raised faces

(b) If, during the examination, ultrasonic indications are noninterpretable due to, for example, grain size, the material shall be radiographed using the procedure requirements of para. 8.3.1.1. Subsurface linear indications are unacceptable when they exceed

(1) 4.8 mm (0.19 in.) long in sections under 13 mm (0.5 in.) thick

(2) 9.6 mm (0.38 in.) long in sections 13 mm to 25 mm (0.5 in. to 1 in.) thick

(3) 19.0 mm (0.75 in.) long in sections over 25 mm (1 in.) thick

8.3.2.2 Surface Examination. All exterior and all accessible interior surfaces of bodies, bonnets, and covers shall be given a surface examination. Table 1, Group 1 materials shall be given either a magnetic particle examination or a liquid penetrant examination. Table 1, Groups 2 and 3 materials shall be given a liquid penetrant examination. Magnetic particle examinations shall be in accordance with the procedure and acceptance standards of Mandatory Appendix II. Liquid penetrant examinations shall be in accordance with the procedure and acceptance standards of Mandatory Appendix III.

8.3.3 Welded Fabrication. Bodies and bonnets made by weld assembly of segments of castings, forgings, bars, tubular products, or plates, or combinations thereof, including fabrication welds, shall be examined as applicable by the methods of para. 8.3.1 for cast components, or para. 8.3.2 for forged, rolled, or wrought components. In addition, all fabrication welds shall receive nondestructive examination in accordance with ASME BPVC, Section VIII, Division 1, in a manner that results in a weld joint efficiency of 1.0. These requirements are not applicable to welds such as may be used for back-seat bushings, seat rings, lifting lugs, and auxiliary connections.

8.4 Defect Removal and Repair

8.4.1 Defect Removal. Defects in excess of acceptance standards shall be removed by suitable means. If removal of surface defects to an acceptable level does not result in reducing wall thickness below an acceptable value, the area shall be blended smoothly into the surrounding surface.

8.4.2 Repair by Welding. Where defect removal results in a wall thickness below an acceptable value, the resultant cavity shall, at the manufacturer's discretion, be scrapped or be repaired by welding, in accordance with the following requirements:

(a) The welding procedure and welding operator are qualified in accordance with ASTM A488 or ASME BPVC, Section IX.

(b) Weld repairs to fabrication welds are made in accordance with ASME BPVC, Section VIII, Division 1.

(c) Weld repairs are heat treated in accordance with the postweld heat treatment requirements of ASME BPVC, Section VIII, Division 1, Subsection C. The exemptions applicable to fabrication welds including groove, fillet, and circumferential butt welds also apply to repair welds. Postweld heat treatment (solution treatment) of repair welds in austenitic stainless steels is neither required nor prohibited except when required by the material specification.

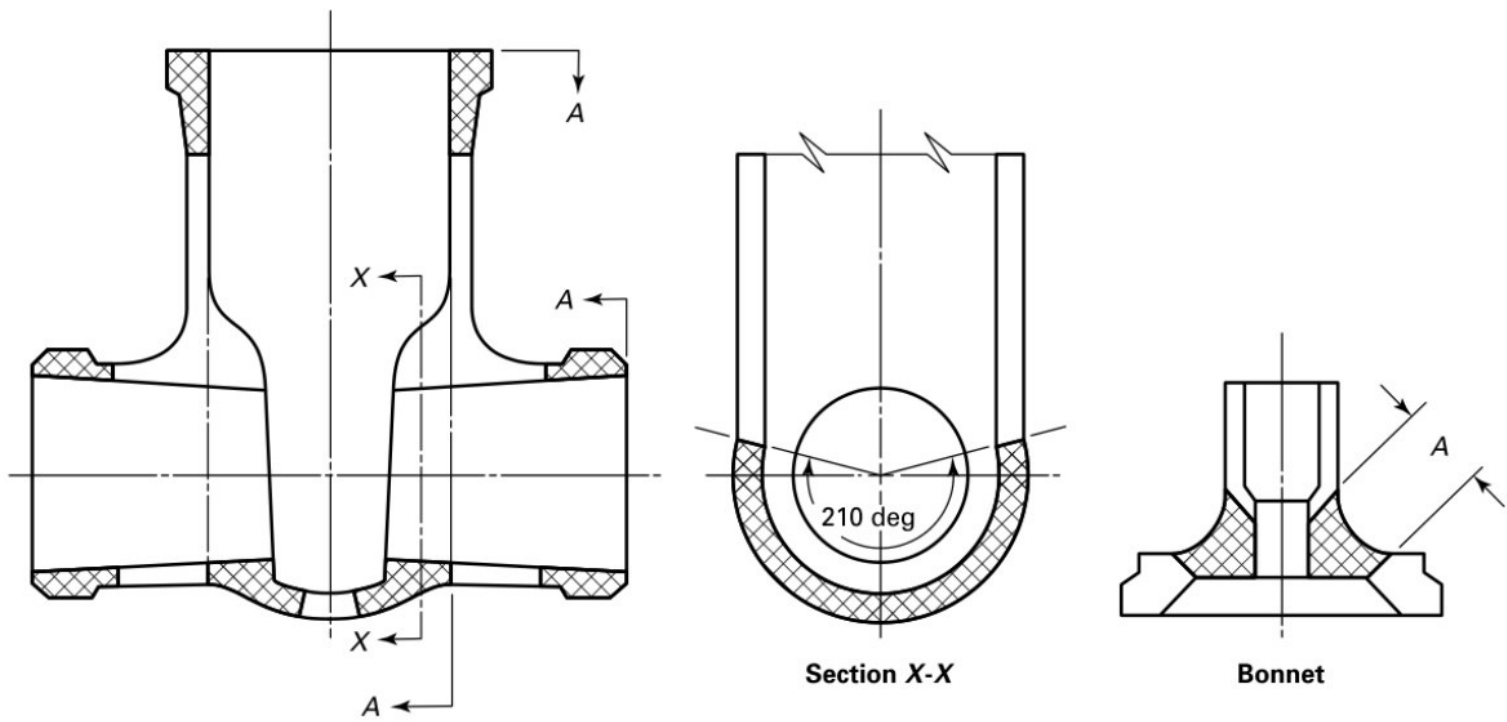
(d) The area is re-examined by the NDE method that originally disclosed the defect. The re-examination by magnetic particle or liquid penetrant methods of a repaired area originally disclosed by magnetic particle

or liquid penetrant examination shall be performed after postweld heat treatment when postweld heat treatment is performed. The re-examination by radiography or ultrasonic methods of a repaired area originally disclosed by radiography or ultrasonic examination may be performed either before or after postweld heat treatment when postweld heat treatment is performed. The acceptance standards shall be as in the original examination.

(e) Weld repairs made as a result of radiographic examination shall be radiographed after welding. The acceptance standards for porosity and slag inclusion in welds shall be in accordance with ASME BPVC, Section VIII, Division 1, UW-51.

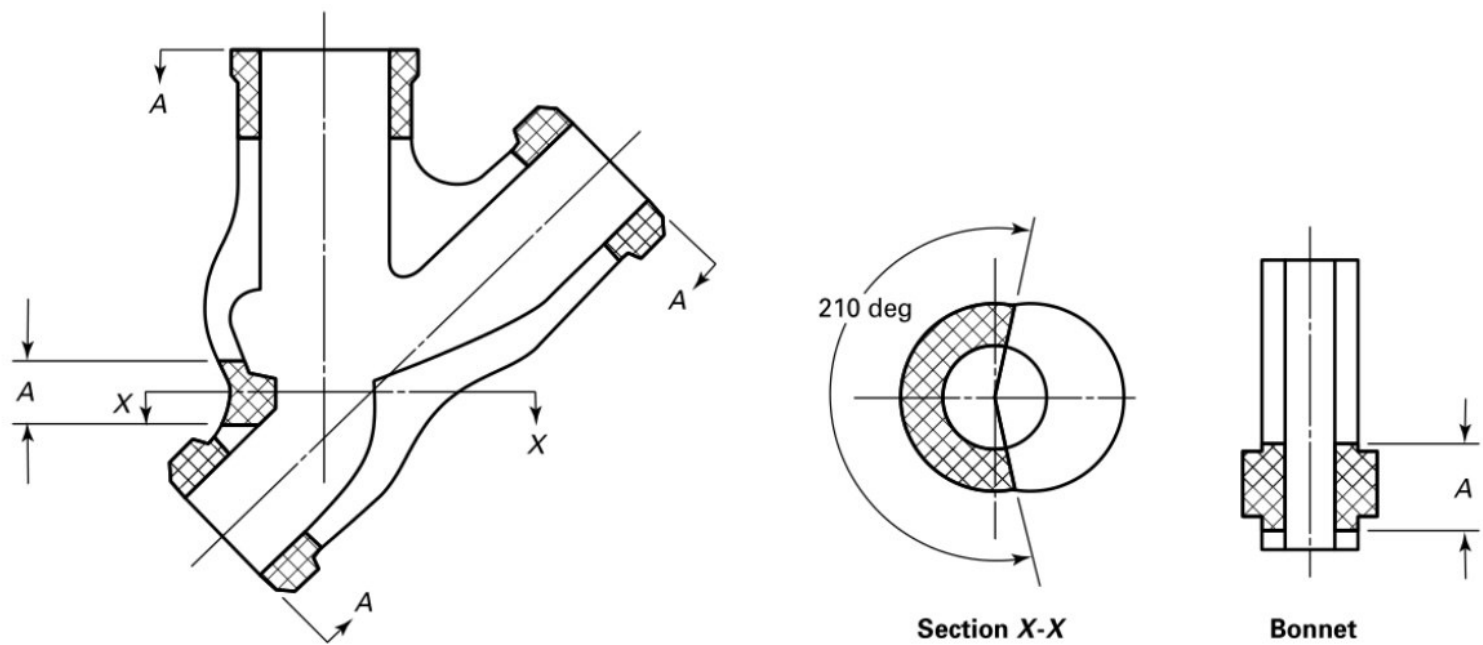
Figure 7
Gate Body (Pressure Seal Bonnet)

Typical casting sections showing required radiographic examination



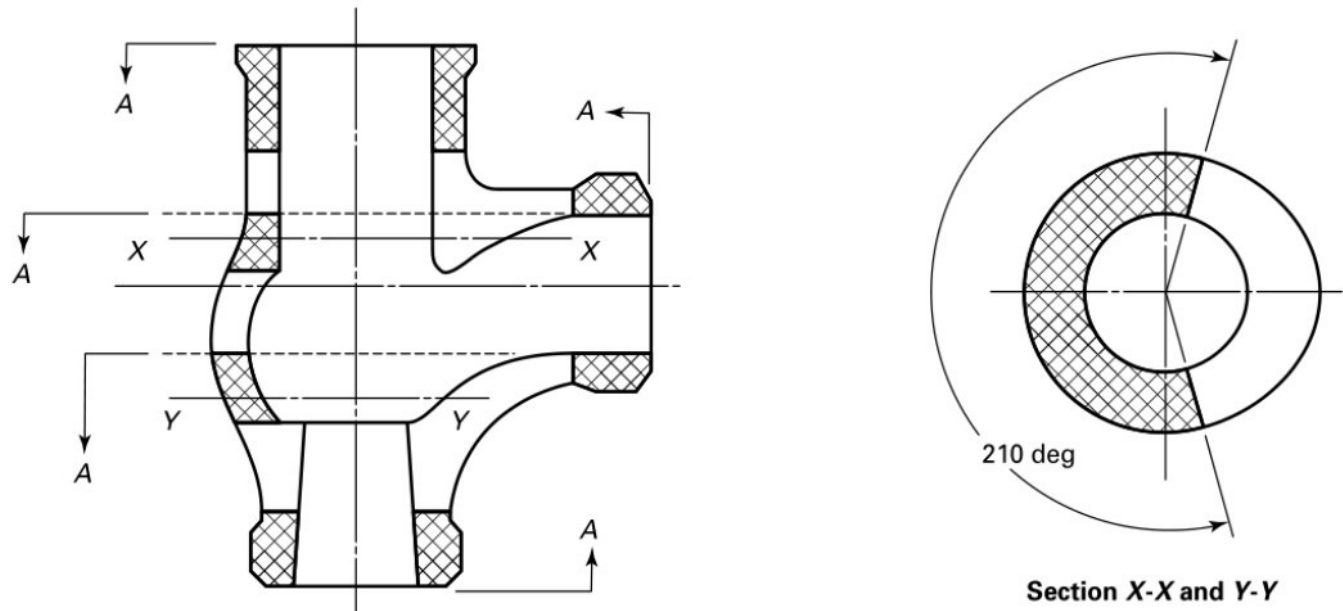
GENERAL NOTE: For definition of A, see [para. 8.3.1.1](#).

Figure 8
Y Pattern Globe Body (Pressure Seal Bonnet)



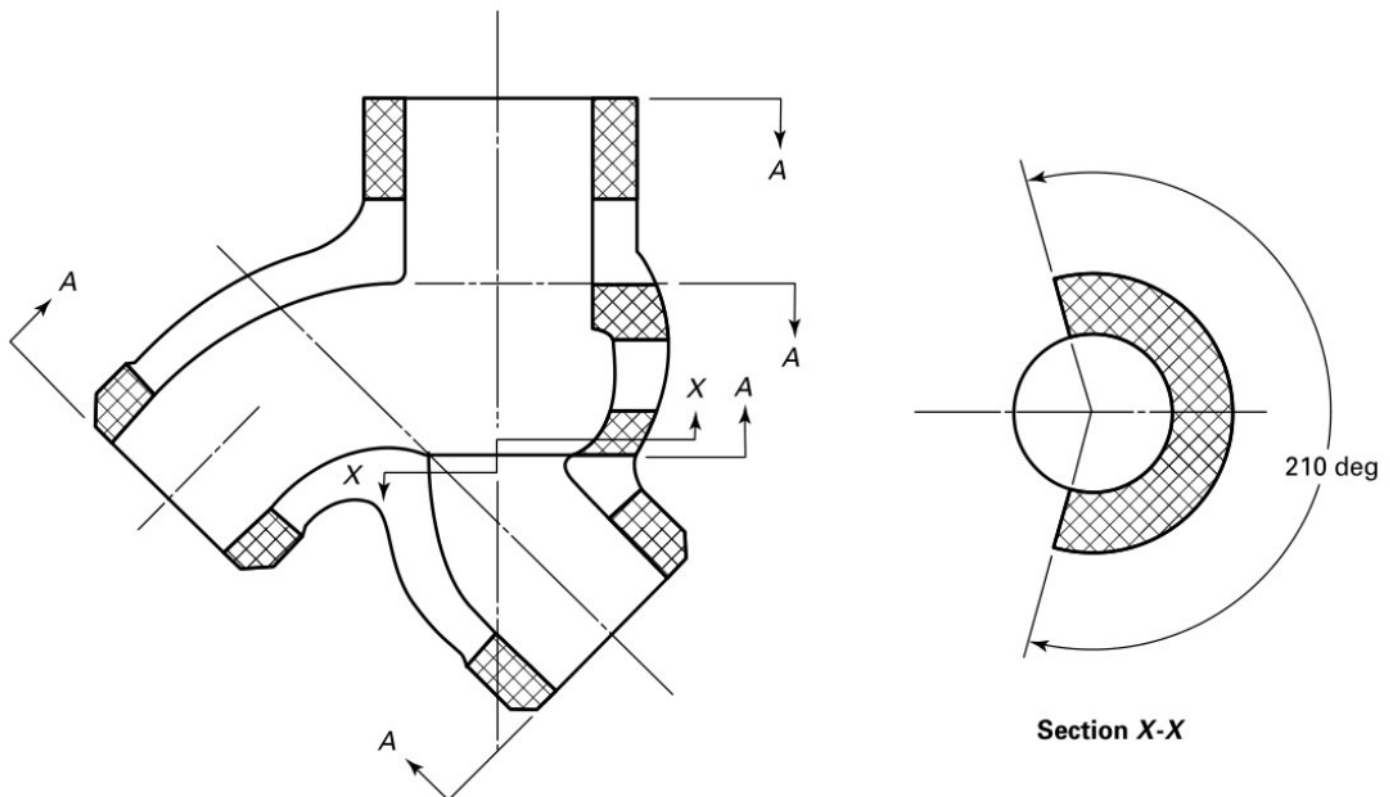
GENERAL NOTE: For definition of A, see [para. 8.3.1.1](#).

Figure 9
Angle Body (Pressure Seal Bonnet): Bonnet Same As Y Pattern Globe



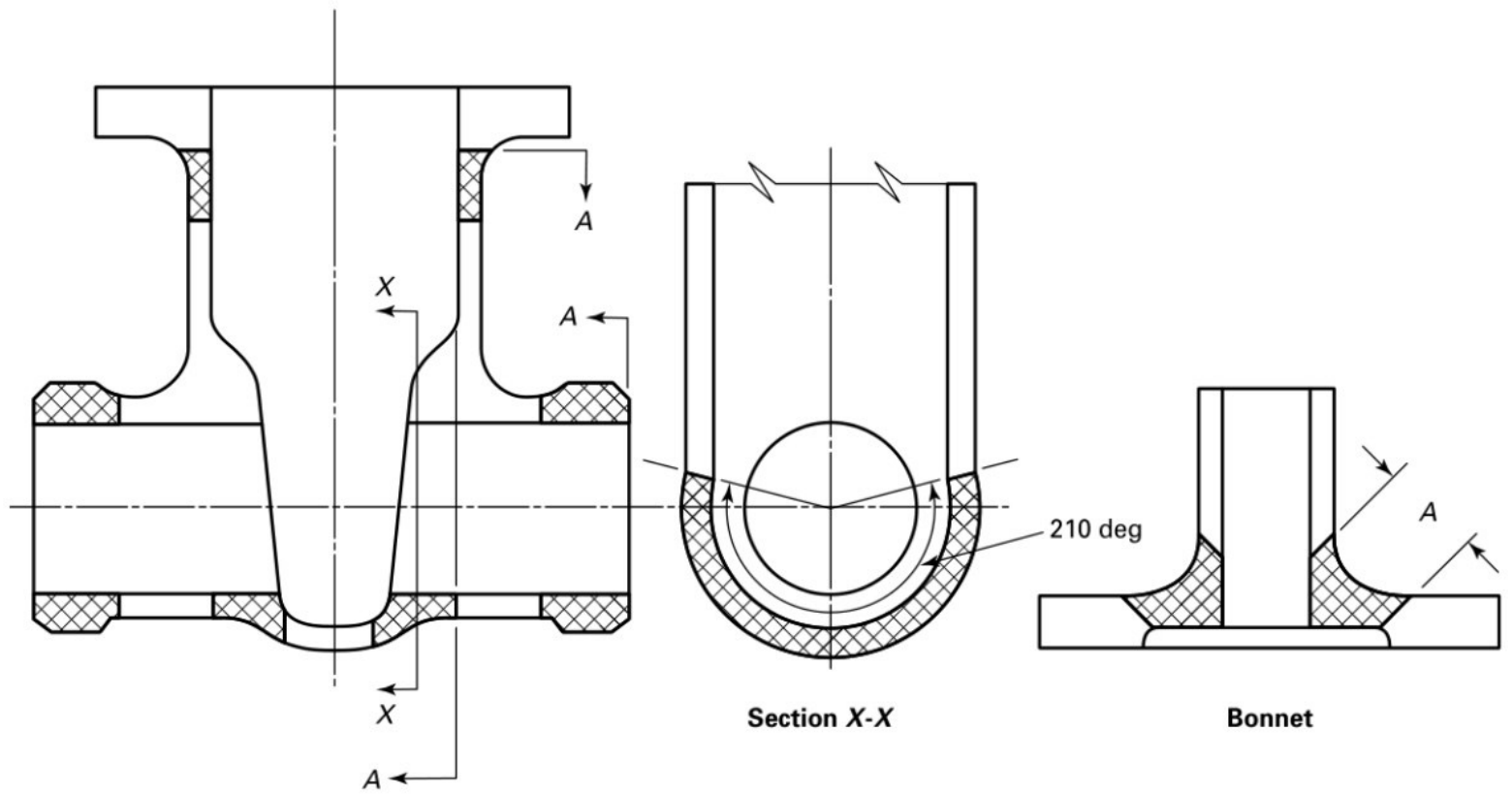
GENERAL NOTE: For definition of A, see [para. 8.3.1.1](#).

Figure 10
Elbow Down (Pressure Seal Bonnet)



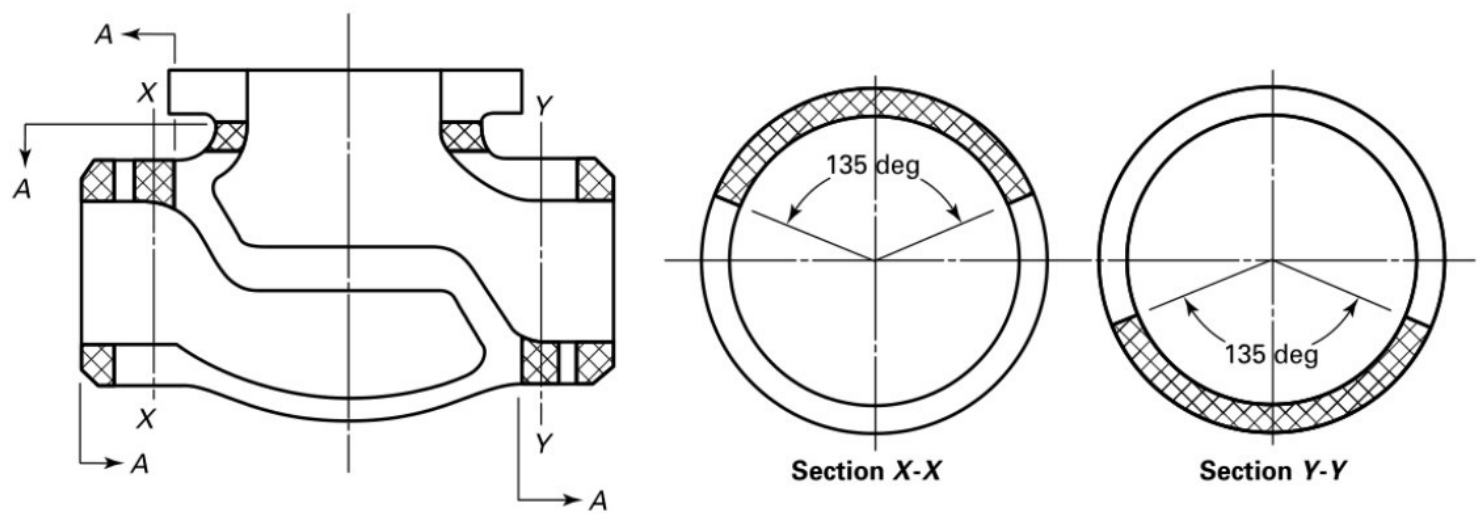
GENERAL NOTE: For definition of A, see [para. 8.3.1.1](#).

Figure 11
Gate Body (Flanged Bonnet)



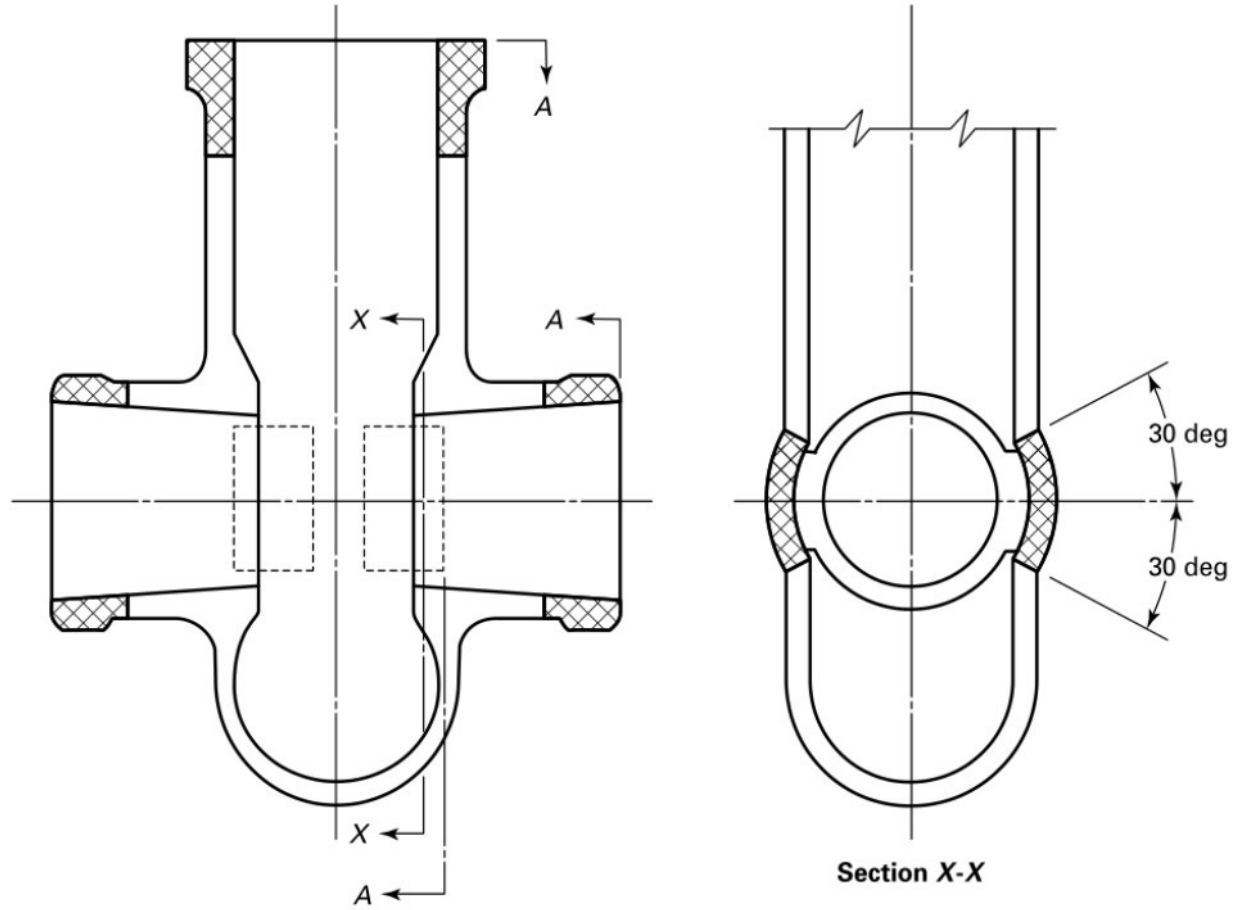
GENERAL NOTE: For definition of A, see [para 8.3.1.1](#).

Figure 12
Globe Body (Flanged Bonnet)



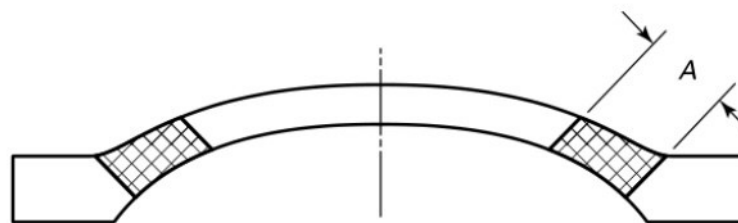
GENERAL NOTE: For definition of A, see [para 8.3.1.1](#).

Figure 15
Conduit Gate Body (Pressure Seal Bonnet)



GENERAL NOTE: For definition of A, see [para. 8.3.1.1](#).

Figure 16
Dished Cover

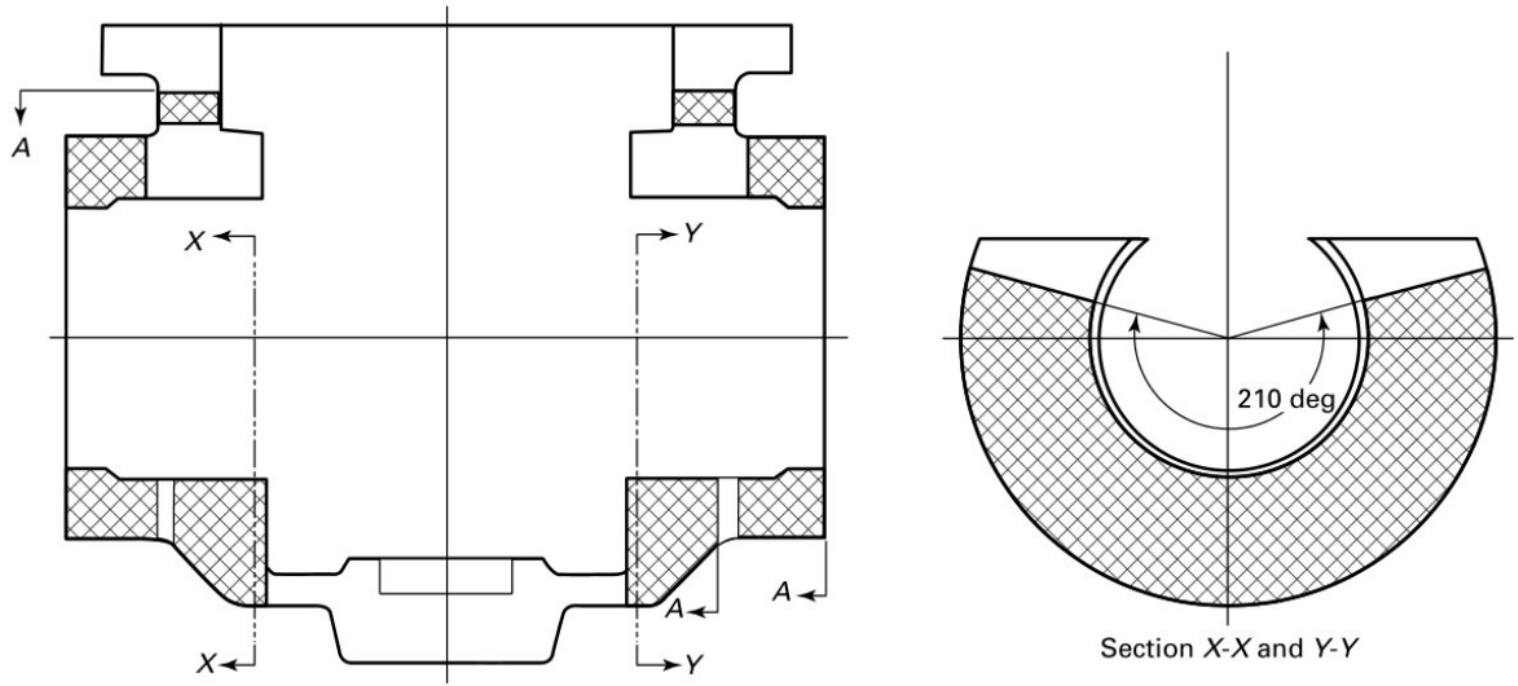


GENERAL NOTE: For definition of A, see [para. 8.3.1.1](#).

Figure 17
Flat Cover

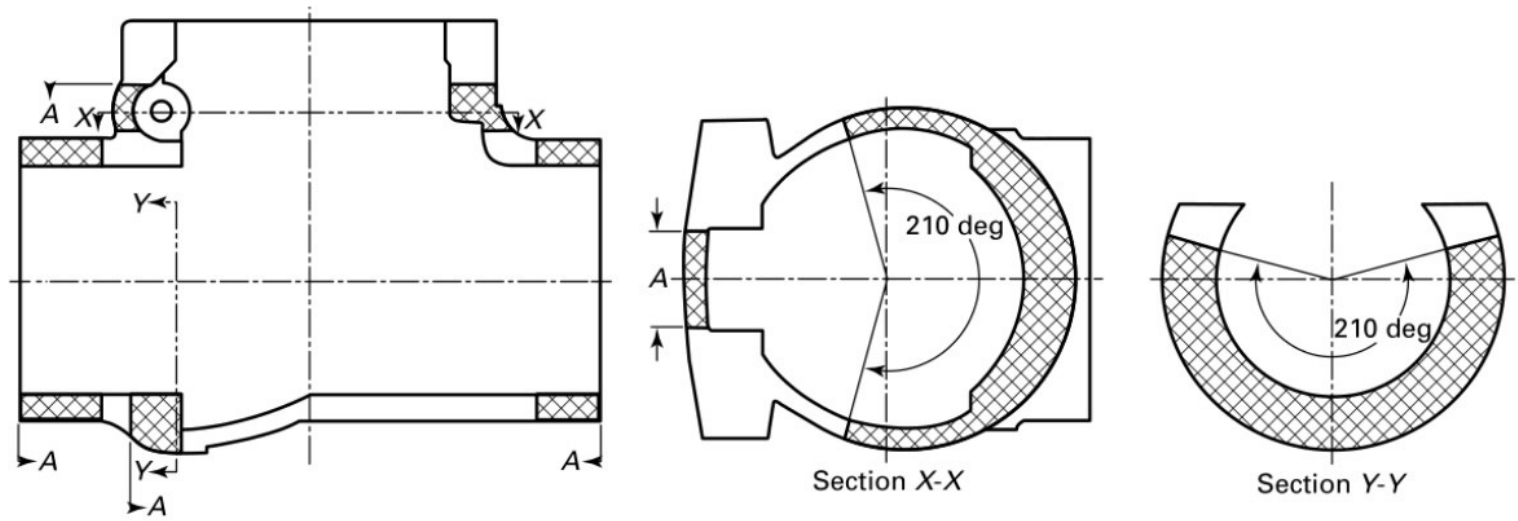


Figure 18
Top Entry Ball Valve



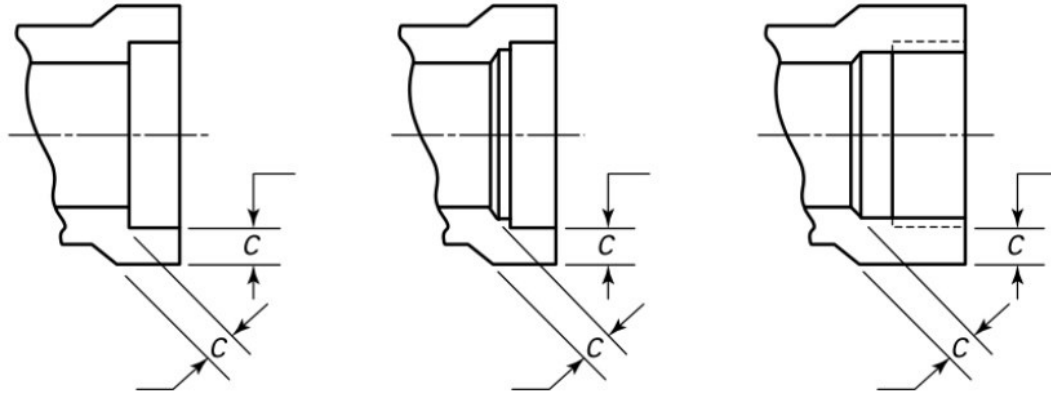
GENERAL NOTE: For definition of A, see [para. 8.3.1.1](#).

Figure 19
Swing Check



GENERAL NOTE: For definition of A, see [para. 8.3.1.1](#).

Table 4
Minimum Wall Thickness for Socket Welding and Threaded Ends



Classes 150 and 300			Class 600		Class 800 [Note (1)]		Class 900		Class 1500		Class 2500		Class 4500	
NPS	Minimum Wall Thickness, <i>C</i>													
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
1/8	3.0	0.12	3.0	0.12	3.0	0.12	3.6	0.14	3.6	0.14	5.3	0.21	5.6	0.22
1/4	3.0	0.12	3.3	0.13	3.3	0.13	4.1	0.16	4.1	0.16	6.6	0.26	7.4	0.29
3/8	3.0	0.12	3.6	0.14	3.6	0.14	4.3	0.17	4.3	0.17	7.1	0.28	9.4	0.37
1/2	3.3	0.13	4.1	0.16	4.1	0.16	5.3	0.21	5.3	0.21	8.1	0.32	11.2	0.44
3/4	3.6	0.14	4.3	0.17	4.3	0.17	6.1	0.24	6.1	0.24	8.6	0.34	13.0	0.51
1	3.8	0.15	5.1	0.20	5.1	0.20	6.9	0.27	6.9	0.27	9.9	0.39	15.7	0.62
1 1/4	3.8	0.15	5.3	0.21	5.3	0.21	7.1	0.28	8.1	0.32	11.7	0.46	19.1	0.75
1 1/2	4.1	0.16	5.6	0.22	5.8	0.23	7.9	0.31	8.9	0.35	13.0	0.51	21.3	0.84
2	4.6	0.18	6.1	0.24	6.9	0.27	9.7	0.38	10.7	0.42	15.7	0.62	25.9	1.02
2 1/2	5.6	0.22	7.6	0.30	7.9	0.31	10.4	0.41	12.4	0.49	18.5	0.73	31.0	1.22

NOTE: (1) Class 800 is not a tabulated ASME B16.34 designation. It is an intermediate class that is widely used for socket welding and threaded end valves.

MANDATORY APPENDIX I

RADIOGRAPHY EXAMINATION: PROCEDURE AND ACCEPTANCE STANDARDS

I-1 RADIOGRAPHY PROCEDURE

(a) ASTM E94, Standard Guide for Radiographic Examination, shall be used as a guide.

(b) The film shall be as close as practical to the part being radiographed.

(c) Any commercially available intensifying screen, except those of the fluorescent type, may be used.

(d) All film shall bear identification markers to properly orient the film for interpretation and to denote the actual part under examination. Film shall be marked to identify the organization producing the radiograph and the date exposed.

(e) Penetrameters shall be used on each radiograph. Penetrameters shall conform to the requirements of ASTM E94.

(f) Any commercially available film may be used, provided it is equal to or finer grained than Type 2, ASTM E94.

(g) The manufacturer, at his option, may use a double film technique and a combination of a single and double viewing so as to cover a greater latitude in part thickness with a single exposure.

(h) Radiographs shall be within the following photographic (H&D) density range:

(1) single film viewing — 1.5 min., 4.0 max.

(2) superimposed viewing of double film, each single film — 1.00 min., 2.5 max., with a double film — 4.0 max.

(i) Surfaces shall be such that radiographic contrast due to surface condition cannot mask or be confused with that of any defect.

(j) Single-wall thickness shall be radiographed wherever practical.

(k) The radiographic sensitivity shall be 2 – 4T for thickness up to and including 19 mm (0.75 in.) and 2 – 2T for thickness greater than 19 mm (0.75 in.).

I-2 ACCEPTANCE STANDARDS

(a) For wall thickness $t \leq 50$ mm ($t \leq 2$ in.) the comparative plates of ASTM E446 define acceptable indications as shown in [Table I-1](#).

(b) For wall thickness $50 \text{ mm} < t \leq 115 \text{ mm}$ ($2 \text{ in.} < t \leq 4.5 \text{ in.}$) the comparative plates of ASTM E186 define acceptable indications as shown in [Table I-2](#).

(c) For wall thickness $115 \text{ mm} < t \leq 305 \text{ mm}$ ($4.5 \text{ in.} < t \leq 12 \text{ in.}$) the comparative plates of ASTM E280 define acceptable indications as shown in [Table I-3](#).

Table I-1
Acceptance Criteria for Thickness per
Para. I-2(a)

Discontinuity Type	Category	Acceptable Comparative Plate ASTM E446
Gas	A	A2
Sand	B	B3
Shrink, Type 1	C	CA2
Shrink, Type 2	C	CB3
Shrink, Type 3	C	CC3
Shrink, Type 4	C	CD3
Hot tears and cracks	D & E	None
Inserts (chills, chaplets)	F	None

Table I-2
Acceptance Criteria for Thickness per
Para. I-2(b)

Discontinuity Type	Category	Acceptable Comparative Plate ASTM E186
Gas porosity	A	A3
Sand and slag inclusions	B	B3
Shrink, Type 1	C	CA3
Shrink, Type 2	C	CB3
Shrink, Type 3	C	CC3
Crack	D	None
Hot tear	E	None
Insert	F	None

Table I-3
Acceptance Criteria for Thickness per
Para. I-2(c)

Discontinuity Type	Category	Acceptable Comparative Plate ASTM E280
Gas porosity	A	A3
Sand and slag inclusions	B	B3
Shrink, Type 1	C	CA3
Shrink, Type 2	C	CB3
Shrink, Type 3	C	CC3
Crack	D	None
Hot tear	E	None
Insert	F	None

MANDATORY APPENDIX II

MAGNETIC PARTICLE EXAMINATION: PROCEDURE AND ACCEPTANCE STANDARDS

II-1 PROCEDURE

Magnetic particle examination procedure for castings shall be in accordance with ASTM E709, Standard Guide for Magnetic Particle Testing. For forgings, plates, and bars, the examination procedures shall be in accordance with ASTM A275, Magnetic Particle Examination of Steel Forgings.

(25) II-2 ACCEPTANCE STANDARDS¹

II-2.1 Castings

Maximum acceptable indications are as follows:

(a) *Linear Indications*

- (1) 8-mm (0.3-in.) long for materials up to 13-mm (0.5-in.) thick
- (2) 13-mm (0.5-in.) long for materials 13-mm to 25-mm (0.5-in. to 1.0-in.) thick
- (3) 18-mm (0.7-in.) long for materials over 25-mm (1.0-in.) thick

For linear indications, the indications shall be separated by a distance greater than the length of an acceptable indication. A linear indication is one with length in excess of 3 times the width.

(b) *Rounded Indications*

- (1) 8-mm (0.3-in.) diameter for materials up to 13-mm (0.5-in.) thick
- (2) 13-mm (0.5-in.) diameter for materials over 13-mm (0.5-in.) thick

Four or more rounded indications in a line separated by 1.5 mm (0.06 in.) or less edge-to-edge are unacceptable. Rounded indications are those that are not defined as linear indications.

II-2.2 Forgings and Rolled or Wrought Material

Maximum acceptable indications are as follows:

(a) *Linear Indications*

- (1) 5-mm (0.2-in.) long for materials up to 13-mm (0.5-in.) thick
- (2) 10-mm (0.4-in.) long for materials over 13-mm (0.5-in.) to 25-mm (1-in.) thick
- (3) 15-mm (0.6-in.) long for materials over 25-mm (1.0-in.) thick.

For linear indications, the indications shall be separated by a distance greater than the length of an acceptable indication. A linear indication is one with length in excess of 3 times the width.

(b) *Rounded Indications*

- (1) 5-mm (0.2-in.) diameter for materials up to 13-mm (0.5-in.) thick
- (2) 8-mm (0.3-in.) diameter for materials over 13-mm (0.5-in.) thick.

Four or more rounded indications in a line separated by 1.5 mm (0.06 in.) or less edge-to-edge are unacceptable. Rounded indications are those that are not defined as linear indications.

¹ An indication may be larger than the imperfection that causes it; however, the size of the indication is the basis for acceptance evaluation.

MANDATORY APPENDIX III

LIQUID PENETRANT EXAMINATION: PROCEDURE AND ACCEPTANCE STANDARDS

III-1 PROCEDURE

Liquid penetrant procedure shall be in accordance with ASTM E165.

(25) III-2 ACCEPTANCE STANDARDS¹

III-2.1 Castings

Maximum acceptable indications are as follows:

(a) Linear Indications

(1) 8-mm (0.3-in.) long for materials up to 13-mm (0.5-in.) thick

(2) 13-mm (0.5-in.) long for materials 13-mm to 25-mm (0.5-in. to 1.0-in.) thick

(3) 18-mm (0.7-in.) long for materials over 25-mm (1.0-in.) thick

For linear indications, the indications shall be separated by a distance greater than the length of an acceptable indication. A linear indication is one with length in excess of 3 times the width.

(b) Rounded Indications

(1) 8-mm (0.3-in.) diameter for materials up to 13-mm (0.5-in.) thick

(2) 13-mm (0.5-in.) diameter for materials over 13-mm (0.5-in.) thick

Four or more rounded indications in a line separated by 1.5 mm (0.06 in.) or less edge-to-edge are unacceptable. Rounded indications are those that are not defined as linear indications.

III-2.2 Forgings and Rolled or Wrought Material

Maximum acceptable indications are as follows:

(a) Linear Indications

(1) 5-mm (0.2-in.) long for materials 13-mm (0.5-in.) or less thick

(2) 10-mm (0.4-in.) long for materials over 13-mm (0.5-in.) to 25-mm (1.0-in.) thick

(3) 15-mm (0.6-in.) long for materials over 25-mm (1.0-in.) thick

For linear indications, the indications shall be separated by a distance greater than the length of an acceptable indication. A linear indication is one with length in excess of 3 times the width.

(b) Rounded Indications

(1) 5-mm (0.2-in.) diameter for materials up to 13-mm (0.5-in.) thick

(2) 8-mm (0.3-in.) diameter for materials over 13-mm (0.5-in.) thick

Four or more rounded indications in a line separated by 1.5 mm (0.06 in.) or less edge-to-edge are unacceptable. Rounded indications are those that are not defined as linear indications.

¹ An indication may be larger than the imperfection that causes it; however, the size of the indication is the basis for acceptance evaluation.

MANDATORY APPENDIX IV ULTRASONIC EXAMINATION: PROCEDURE AND ACCEPTANCE STANDARDS

IV-1 PROCEDURE

Ultrasonic examination procedure shall meet the requirements of ASTM A388 for forgings, bars, plates, and tubular products and ASTM A609 for castings.

IV-2 ACCEPTANCE STANDARDS

IV-2.1 Straight Beam Examination

Indications that are equal to or exceed that obtained from a 6.4-mm (0.25-in.) diameter, flat-bottomed hole in a calibration test piece of thickness equal to the defect depth are unacceptable.

IV-2.2 Angle Beam Examination

Indications that are equal to or exceed those obtained from a 60-deg V-notch, 25-mm (1.0-in.) long and having a depth not greater than 5% of the nominal wall thickness in a test piece are unacceptable.

MANDATORY APPENDIX V

REQUIREMENTS FOR LIMITED CLASS VALVES

V-1 GENERAL

This Appendix covers alternative requirements for valves having either threaded or welding ends and is specifically restricted to NPS 2½ and smaller. Valves complying with the requirements of this Appendix may be designated as Limited Class. There is no provision for this designation for flanged end valves.

V-1.2 Applicability

The paragraphs of this Appendix are numbered corresponding with those of the body of this Standard. All requirements for Standard Class valves are applicable to Limited Class except as otherwise modified by this Appendix.

V-2.1 General

Valves conforming to the requirements of this Appendix and identified as Limited Class shall be suitable for pressure-temperature ratings determined in accordance with [para. V-2.1.3](#). Threaded-end valves rated above Class 2500 and socket-weld-end valves rated above Class 4500 are not within the scope of this Standard.

V-2.1.3 Limited Class Rating Method. Pressure-temperature ratings for Limited Class valves are established for Groups 1 and 2 materials of [Table V-1](#) by the equation

$$p_{ld} = \frac{7000}{7000 - (y - 0.4)P_r} p_{sp}$$

where

P_r = pressure class rating index. For all designations Class 300 through 4500, P_r is equal to the Class designation number (e.g., for Class 300, $P_r = 300$). For Class 150, $P_r = 115$. For a rating designation between Class 150 and Class 300, the interpolation shall be made using $P_r = 115$ for Class 150. The equation is not valid for P_r greater than 4500.

p_{ld} = Limited Class rated working pressure for the specified material at temperature T

p_{sp} = Special Class rated working pressure for the specified material at temperature T as determined by the method of [Nonmandatory Appendix B](#). These Special Class working pressures are tabulated in [Tables 2-1.1](#) through

[2-3.19](#) ([Tables 2-1.1C](#) through [2-3.19C](#)) having a designation of "Special Class." The tabulated values shall be used for establishing Limited Class ratings.

y = a material coefficient having values as listed in [Table V-1](#)

In no case shall the working pressure increase with increasing temperature. This shall be verified by the manufacturer for all rating points greater than 480°C (900°F) for ferritic steels and 565°C (1,050°F) for austenitic steels.

V-2.1.6 Fabrication by Welding. Fabricated valves that are identified as Limited Class shall conform with the requirements of [para. 2.1.6\(c\)\(2\)](#) for Special Class.

V-4.2.3 Rating. Valves shall be marked on the valve body with the number for the appropriate pressure rating class designation except that Limited Class and Intermediate Rating Limited Class may instead be marked on the valve body with a specific rated pressure and temperature. For all valves in Limited Class, the identification plate shall show the applicable pressure rating at 38°C (100°F) and other markings required by MSS SP-25. Valves conforming to Limited Class requirements, and acknowledged as such, shall include the designation "B16.34LTD" on the identification plate.

V-6.1 Body Dimensions

Limited Class is restricted in application to valve body geometries that have internal wetted pressure boundary surfaces that are generally characterized by cylindrical passages, cylindrical or spherical chambers, and intersections thereof.

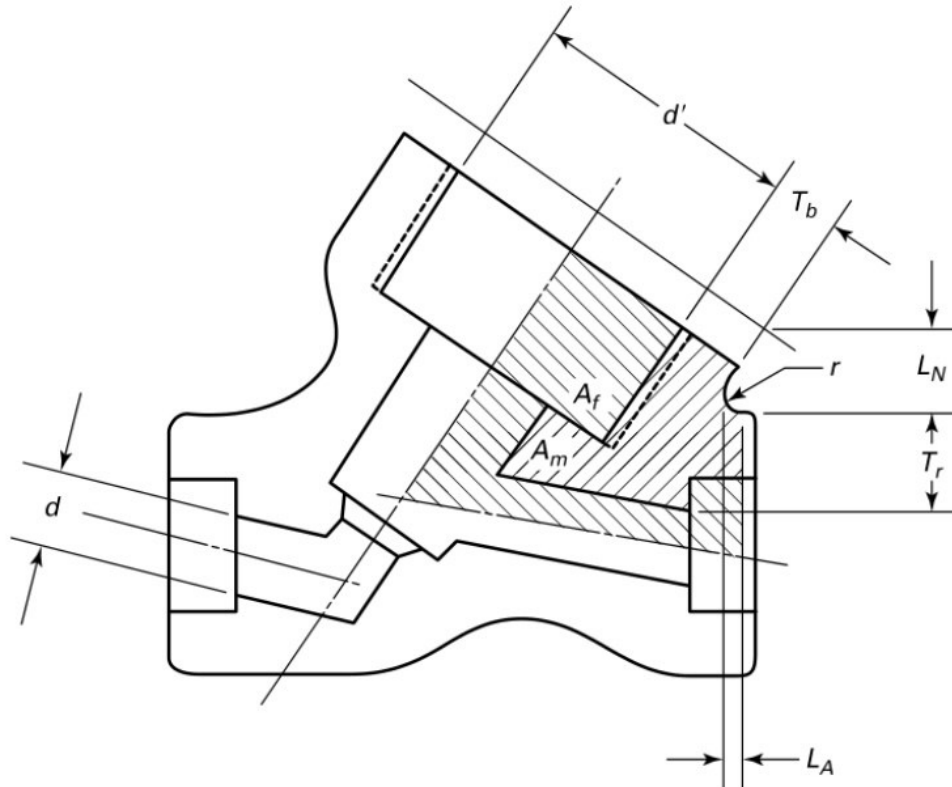
V-6.1.1 Wall Thickness. For inspection purposes, the minimum thickness of the wall surrounding the body run flow passage shall be as shown in [Table 3A](#) or [Table 3B](#) as applicable.

V-6.1.2 Inside Diameter. For the purpose of determining flow passageway wall thickness, the inside diameter, d (see [Figure V-1](#)), is the diameter of the cylindrical flow passage.

Table V-1
Material Coefficient, y

Material	Applicable Temperature					620°C (1,150°F) and Above
	480°C (900°F) and Below	510°C (950°F)	538°C (1,000°F)	565°C (1,050°F)	595°C (1,100°F)	
Ferritic steels	0.4	0.5	0.7	0.7	0.7	0.7
Austenitic steels	0.4	0.4	0.4	0.4	0.5	0.7
Other ductile materials	0.4	0.4	0.4	0.4	0.4	0.4

Figure V-1
Limited Class Stress Area Limits



V-6.1.3 Valve Body Necks. The minimum thickness of the wall for the body neck shall be that shown in [Table 3A](#) or [Table 3B](#) with d for this determination taken as two-thirds of d' where d' is the inside diameter of the body neck. In no case shall the body neck thickness be less than the minimum value determined for the flow passage in [para. V-6.1.1](#). For values of body neck inside diameter not shown in [Table 3A](#) or [Table 3B](#) as applicable, interpolation is permitted.

V-6.1.5 Contours for Body Run Transitions. The requirements of [para. 6.1.5](#) are not applicable to Limited Class.

V-6.1.8 Additional Metal Thickness. For Limited Class, it is required that metal thickness reinforcement be provided to satisfy the following:

$$S_o \geq p_o \left(\frac{A_f}{A_m} + 0.5 \right)$$

where

A_f = fluid area (see [Figure V-1](#))

A_m = metal area (see [Figure V-1](#))

p_o = rated working pressure at 38°C (100°F)

S_o = the lesser value of either two-thirds of the yield strength, one quarter of the ultimate tensile strength, or the allowable stress of the body material at 38°C (100°F) as listed in ASME BPVC, Section II, Part D, for either Section I or Section VIII, Division 1

The fluid area and metal area are determined from a drawing of the valve body crotch region in the mutual plane of the bonnet and flow passage center lines (see Figure V-1).¹ The fluid and metal areas are to be based on the most adverse combination of dimensions permitted by tolerances. In Figure V-1, the distances L_N and L_A that define fluid and metal area boundaries are determined as

$$L_N = 0.5r + 0.354\sqrt{T_b(d' + T_b)}$$

and L_A as the larger of

$$L_A = 0.5d' - T_b$$

or

$$L_A = T_r$$

where

d' = body neck inside diameter at crotch region

r = external fillet radius at crotch

T_b = neck wall thickness at crotch region

T_r = body run wall thickness at crotch region

If a calculated boundary lies beyond the body run end or neck end, the sections to be used for area determination shall terminate at the body run end or neck end.

¹ For guidance in regard to other valve configurations, see ASME BPVC, Section III, Subsection NB, NB-3545.

MANDATORY APPENDIX VI

BASIS EQUATIONS FOR MINIMUM WALL THICKNESS

VI-1 MINIMUM WALL THICKNESS EQUATIONS

Minimum wall thickness requirements may be satisfied by compliance with either the values shown in [Table 3A](#) or [Table 3B](#) as applicable or the use of the equations listed in this Appendix (see [Tables VI-1](#) and [VI-2](#)). Refer to [para. 1.2.5](#) concerning valid units.

VI-2 DESIGN VALUES

(25)

The wall thickness values obtained from [Table 3A](#), [Table 3B](#), or the equations given in this Appendix are not to be interpreted as design values. They are, in basic terms, minimum requirements that shall be met in order to be in conformance with this Standard.

Table VI-1
Basis Equations for Minimum Wall Thickness, mm

Class P_c	Diameter, d , mm	Metric Equation, t_m , mm	Round
150	$3 \leq d < 50$	$t_m(150) = 0.064d + 2.34$	off, one decimal
150	$50 \leq d \leq 100$	$t_m(150) = 0.020d + 4.50$	off, one decimal
150	$100 < d \leq 1\,500$	$t_m(150) = 0.0163d + 4.70$	off, one decimal
300	$3 \leq d < 25$	$t_m(300) = 0.080d + 2.29$	off, one decimal
300	$25 \leq d \leq 50$	$t_m(300) = 0.07d + 2.54$	off, one decimal
300	$50 < d \leq 1\,500$	$t_m(300) = 0.033d + 4.40$	off, one decimal
600	$3 \leq d < 25$	$t_m(600) = 0.086d + 2.54$	off, one decimal
600	$25 \leq d \leq 50$	$t_m(600) = 0.058d + 3.30$	off, one decimal
600	$50 < d \leq 1\,500$	$t_m(600) = 0.0675d + 2.79$	off, one decimal
900	$3 \leq d < 25$	$t_m(900) = 0.15d + 2.29$	off, one decimal
900	$25 \leq d \leq 50$	$t_m(900) = 0.059d + 4.83$	off, one decimal
900	$50 < d \leq 1\,300$	$t_m(900) = 0.10449d + 2.54$	off, one decimal
1500	$3 \leq d \leq 1\,300$	$t_m(1500) = 0.18443d + 2.54$	off, one decimal
2500	$3 \leq d \leq 1\,300$	$t_m(2500) = 0.34091d + 2.54$	off, one decimal
4500	$3 \leq d \leq 1\,300$	$t_m(4500) = 0.78488d + 2.54$	off, one decimal

GENERAL NOTES:

(a) For t_m , see [para. 6.1.1](#).

(b) For d , see [para. 6.1.2](#).

Table VI-1C
Basis Equations for Minimum Wall Thickness, in.

(25)

Class P_c	Diameter, d , in.	Inch Equation, t_m , in.	Round
150	$0.12 \leq d < 2$	$t_m (150) = 0.064d + 0.092$	off, two decimals
150	$2 \leq d \leq 4$	$t_m (150) = 0.020d + 0.18$	off, two decimals
150	$4 < d \leq 60$	$t_m (150) = 0.0163d + 0.185$	off, two decimals
300	$0.12 \leq d < 1$	$t_m (300) = 0.080d + 0.09$	off, two decimals
300	$1 \leq d \leq 2$	$t_m (300) = 0.07d + 0.10$	off, two decimals
300	$2 < d \leq 60$	$t_m (300) = 0.033d + 0.18$	off, two decimals
600	$0.12 \leq d < 1$	$t_m (600) = 0.086d + 0.10$	off, two decimals
600	$1 \leq d \leq 2$	$t_m (600) = 0.058d + 0.13$	off, two decimals
600	$2 < d \leq 60$	$t_m (600) = 0.0675d + 0.11$	off, two decimals
900	$0.12 \leq d < 1$	$t_m (900) = 0.15d + 0.09$	off, two decimals
900	$1 \leq d \leq 2$	$t_m (900) = 0.059d + 0.19$	off, two decimals
900	$2 < d \leq 50$	$t_m (900) = 0.10449d + 0.10$	off, two decimals
1500	$0.12 \leq d \leq 50$	$t_m (1500) = 0.18443d + 0.10$	off, two decimals
2500	$0.12 \leq d \leq 50$	$t_m (2500) = 0.34091d + 0.10$	off, two decimals
4500	$0.12 \leq d \leq 50$	$t_m (4500) = 0.78488d + 0.10$	off, two decimals

GENERAL NOTES:

(a) For t_m , see para. 6.1.1.(b) For d , see para. 6.1.2.

MANDATORY APPENDIX VII

REFERENCES

(25)

The following is a list of standards and specifications referenced in this Standard. Products covered by each ASTM specification are listed for convenience. (See specifications for exact titles and detailed contents.) Materials manufactured to other editions of the referenced ASTM specifications may be used to manufacture valves meeting the requirements of this Standard as long as the valve manufacturer verifies that each material meets the requirements of the referenced edition.

- ANSI/FCI 70-2-2021. Standard for Control Valve Seat Leakage Testing. American National Standards Institute.
- API Std 598-2023. Valve Inspection and Testing. American Petroleum Institute.
- ASME B1.1. Unified Inch Screw Threads (UN, UNR, and UNJ Thread Forms). The American Society of Mechanical Engineers.
- ASME B1.20.1. Pipe Threads, General Purpose (Inch). The American Society of Mechanical Engineers.
- ASME B16.5. Pipe Flanges and Flanged Fittings. The American Society of Mechanical Engineers.
- ASME B16.10. Face-to-Face and End-to-End Dimensions of Valves. The American Society of Mechanical Engineers.
- ASME B16.11. Forged Fittings, Socket-Welding and Threaded. The American Society of Mechanical Engineers.
- ASME B16.20. Metallic Gaskets for Pipe Flanges: Ring Joint, Spiral-Wound, and Jacketed. The American Society of Mechanical Engineers.
- ASME B16.21. Nonmetallic Flat Gaskets for Pipe Flanges. The American Society of Mechanical Engineers.
- ASME B16.25. Buttwelding Ends. The American Society of Mechanical Engineers.
- ASME B16.47. Large Diameter Steel Flanges. The American Society of Mechanical Engineers.
- ASME B18.2.1. Square Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series). The American Society of Mechanical Engineers.
- ASME B18.2.2. Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series). The American Society of Mechanical Engineers.
- ASME B31.3. Process Piping. The American Society of Mechanical Engineers.
- ASME B31T. Standard Toughness Requirements for Piping. The American Society of Mechanical Engineers.
- ASME B36.10M. Welded and Seamless Wrought Steel Pipe. The American Society of Mechanical Engineers.
- ASME Boiler and Pressure Vessel Code, Section I. Rules for Construction of Power Boilers. The American Society of Mechanical Engineers.
- ASME Boiler and Pressure Vessel Code, Section III. Rules for Construction of Nuclear Power Plant Components — Division 1. The American Society of Mechanical Engineers.
- ASME Boiler and Pressure Vessel Code, Section VIII. Rules for Construction of Pressure Vessels — Division 1. The American Society of Mechanical Engineers.
- ASME Boiler and Pressure Vessel Code, Section VIII. Rules for Construction of Pressure Vessels — Division 2, Alternative Rules. The American Society of Mechanical Engineers.
- ASME Boiler and Pressure Vessel Code, Section IX. Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators. The American Society of Mechanical Engineers.
- ASME PCC-1. Guidelines for Pressure Boundary Bolted Flange Joint Assembly. The American Society of Mechanical Engineers.
- ASTM A105/A105M-23. Carbon Steel Forgings for Piping Applications. ASTM International.
- ASTM A106/A106M-19a. Seamless Carbon Steel Pipe for High-Temperature Service. ASTM International.
- ASTM A182/A182M-23. Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service. ASTM International.
- ASTM A193/A193M-23. Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature or High-Pressure Service and Other Special Purpose Applications. ASTM International.
- ASTM A194/A194M-23. Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service, or Both. ASTM International.
- ASTM A203/A203M-23. Pressure Vessel Plates, Alloy Steel, Nickel. ASTM International.
- ASTM A204/A204M-17(2022). Pressure Vessel Plates, Alloy Steel, Molybdenum. ASTM International.

- ASTM A216/A216M-21. Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service. ASTM International.
- ASTM A217/A217M-22. Steel Castings, Martensitic Stainless and Alloy, for Pressure Containing Parts, Suitable for High-Temperature Service. ASTM International.
- ASTM A240/A240M-23a. Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications. ASTM International.
- ASTM A275/A275M-18(2023). Magnetic Particle Examination of Steel Forgings. ASTM International.
- ASTM A302/A302M-17(2022). Pressure Vessel Plates, Alloy Steel, Manganese-Molybdenum and Manganese-Molybdenum-Nickel. ASTM International.
- ASTM A307-21. Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength. ASTM International.
- ASTM A312/A312M-22a. Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes. ASTM International.
- ASTM A320/A320M-22a. Alloy Steel and Stainless Steel Bolting Materials for Low-Temperature Service. ASTM International.
- ASTM A333/A333M-2018. Standard Specification for Seamless and Welded Steel Pipe for Low Temperature Service and Other Applications With Required Notch Toughness. ASTM International.
- ASTM A335/A335M-23. Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service. ASTM International.
- ASTM A350/A350M-23. Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components. ASTM International.
- ASTM A351/A351M-18e1. Castings, Austenitic, for Pressure Containing Parts. ASTM International.
- ASTM A352/A352M-21. Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service. ASTM International.
- ASTM A354-17e2. Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners. ASTM International.
- ASTM A358/A358M-19. Electric-Fusion-Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High-Temperature Service and General Applications. ASTM International.
- ASTM A369/A369M-23. Carbon and Ferritic Alloy Steel Forged and Bored Pipe for High-Temperature Service. ASTM International.
- ASTM A376/A376M-22. Seamless Austenitic Steel Pipe for High-Temperature Service. ASTM International.
- ASTM A387/A387M-17a(2023). Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum. ASTM International.
- ASTM A388/A388M-23. Ultrasonic Examination of Steel Forgings. ASTM International.
- ASTM A430-91. Austenitic Steel Forged or Bored Pipe for High-Temperature Service (Withdrawn 1995 — replaced by ASTM A312/A312M-22a). ASTM International.
- ASTM A453/A453M-17. High-Temperature Bolting Materials, With Expansion Coefficients Comparable to Austenitic Stainless Steels. ASTM International.
- ASTM A479/A479M-23a. Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels. ASTM International.
- ASTM A488/A488M-18e2. Steel Castings, Welding, Qualifications of Procedures and Personnel. ASTM International.
- ASTM A494/A494M-22. Castings, Nickel and Nickel Alloy. ASTM International.
- ASTM A515/A515M-17(2022). Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service. ASTM International.
- ASTM A516/A516M-17. Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service. ASTM International.
- ASTM A537/A537M-20. Pressure Vessel Plates, Heat-Treated, Carbon-Manganese-Silicon Steel Plates. ASTM International.
- ASTM A540/A540M-15(2021). Alloy-Steel Bolting Materials for Special Applications. ASTM International.
- ASTM A609/A609M-12(2023). Castings, Carbon, Low-Alloy, and Martensitic Stainless Steel, Ultrasonic Examination Thereof. ASTM International.
- ASTM A672-19. Electric-Fusion-Welded Steel Pipe for High Pressure Service at Moderate Temperatures. ASTM International.
- ASTM A675/A675M-14(2019). Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties. ASTM International.
- ASTM A691-19. Carbon and Alloy Steel Pipe, Electric-Fusion Welded for High-Pressure Service at High Temperatures. ASTM International.
- ASTM A696-17(2022). Steel Bars, Carbon, Hot-Wrought or Cold-Finished, Special Quality, for Pressure Piping Components. ASTM International.
- ASTM A739-90a(2022). Steel Bars, Alloy, Hot-Wrought, for Elevated Temperature or Pressure-Containing Parts, or Both. ASTM International.
- ASTM A789/A789M-22. Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service. ASTM International.
- ASTM A790/A790M-23. Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe. ASTM International.
- ASTM A995/A995M-20. Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts. ASTM International.
- ASTM B127-19. Nickel-Copper Alloy Plate, Sheet, and Strip. ASTM International.
- ASTM B160-05(2019). Nickel Rod and Bar. ASTM International.

- ASTM B161-05(2019). Nickel Seamless Pipe and Tube. ASTM International.
- ASTM B162-99(2019). Nickel Plate, Sheet, and Strip. ASTM International.
- ASTM B163-22. Seamless Nickel and Nickel Alloy Condenser and Heat-Exchanger Tubes. ASTM International.
- ASTM B164-03(2019). Nickel-Copper Alloy Rod, Bar, and Wire. ASTM International.
- ASTM B165-19. Nickel-Copper Alloy Seamless Pipe and Tube. ASTM International.
- ASTM B166-19. Nickel-Chromium-Aluminum, Nickel-Chromium-Iron Alloys, and Nickel-Chromium-Cobalt-Molybdenum Alloy, Nickel-Chromium-Tungsten Alloy, and Nickel-Chromium, Molybdenum-Copper Alloy Rod, Bar, and Wire. ASTM International.
- ASTM B167-23. Nickel-Chromium-Aluminum Alloy (UNS N06699), Nickel-Chromium-Iron Alloys (UNS N06600, N06601, N06603, N06690, N06693, N06025, N06045, and N06696) and Nickel-Chromium-Cobalt-Molybdenum Alloy (UNS N06617), Nickel-Iron-Chromium-Tungsten Alloy (UNS N06674), Nickel-Chromium-Molybdenum-Copper Alloy (UNS N06235) Seamless Pipe and Tube. ASTM International.
- ASTM B168-19e1. Nickel-Chromium-Aluminum Alloy (UNS N06699), Nickel-Chromium-Iron Alloys (UNS N06600, N06601, N06603, N06690, N06693, N06025, N06045, and N06696), Nickel-Chromium-Cobalt-Molybdenum Alloy (UNS N06617), Nickel-Iron-Chromium-Tungsten Alloy (UNS N06674), and Nickel-Chromium-Molybdenum-Copper Alloy (UNS N06235) Plate, Sheet, and Strip. ASTM International.
- ASTM B333-03(2018). Nickel-Molybdenum Alloy Plate, Sheet, and Strip. ASTM International.
- ASTM B335-03(2018). Nickel-Molybdenum Alloy Rod. ASTM International.
- ASTM B407-22. Nickel-Iron-Chromium Alloy Seamless Pipe and Tube. ASTM International.
- ASTM B408-22. Nickel-Iron-Chromium Alloy Rod and Bar. ASTM International.
- ASTM B409-22. Nickel-Iron-Chromium Alloy Plate, Sheet, and Strip. ASTM International.
- ASTM B423-22. Nickel-Iron-Chromium-Molybdenum-Copper Alloy Seamless Pipe and Tube. ASTM International.
- ASTM B424-22. Nickel-Iron-Chromium-Molybdenum-Copper Alloys Plate, Sheet, and Strip. ASTM International.
- ASTM B425-19. Nickel-Iron-Chromium-Molybdenum-Copper Alloys Rod and Bar. ASTM International.
- ASTM B434-22. Nickel-Molybdenum-Chromium-Iron Alloys Plate, Sheet, and Strip. ASTM International.
- ASTM B435-22. Heat and Corrosion Resistant High Temperature Alloy Plate, Sheet, and Strip. ASTM International.
- ASTM B443-19. Nickel-Chromium-Molybdenum-Columbium Alloy and Nickel-Chromium-Molybdenum-Silicon Alloy Plate, Sheet, and Strip. ASTM International.
- ASTM B446-23. Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625), Nickel-Chromium-Molybdenum-Silicon Alloy (UNS N06219), and Nickel-Chromium-Molybdenum-Tungsten Alloy (UNS N06650) Rod and Bar. ASTM International.
- ASTM B462-18e1. Forged or Rolled Nickel Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service. ASTM International.
- ASTM B463-21. UNS N08020 Alloy Plate, Sheet, and Strip. ASTM International.
- ASTM B464-15(2020). Welded UNS N08020 Alloy Pipe. ASTM International.
- ASTM B468-10(2020). Welded UNS N08020 Alloy Tubes. ASTM International.
- ASTM B473-07(2018). UNS N08020, UNS N08024, and UNS N08026 Nickel Alloy Bar and Wire. ASTM International.
- ASTM B511-21. Nickel-Iron-Chromium-Silicon Alloy Bars and Shapes. ASTM International.
- ASTM B535-06(2022). Nickel-Iron-Chromium-Silicon Alloys Seamless Pipe and Tube. ASTM International.
- ASTM B536-19. Nickel-Iron-Chromium-Silicon Alloy Plate, Sheet, and Strip. ASTM International.
- ASTM B564-22. Nickel Alloy Forgings. ASTM International.
- ASTM B572-06(2016). UNS N06002, UNS N06230, UNS N12160, and UNS R30556 Rod. ASTM International.
- ASTM B573-06(2016). Nickel-Molybdenum-Chromium-Iron Alloy (UNS N10003, N10242) Rod. ASTM International.
- ASTM B574-23. Low-Carbon Nickel-Chromium-Molybdenum, Low-Carbon Nickel Molybdenum-Chromium-Tantalum, Low-Carbon Nickel Chromium-Molybdenum-Copper, Low-Carbon Nickel-Chromium-Molybdenum-Tungsten Alloy Rod. ASTM International.
- ASTM B575-17(2023). Low-Carbon Nickel-Chromium-Molybdenum, Low-Carbon Nickel-Chromium-Molybdenum-Copper, Low-Carbon Nickel-Chromium-Molybdenum-Tantalum, and Low-Carbon Nickel-Chromium-Molybdenum-Tungsten Alloy Plate, Sheet, and Strip. ASTM International.
- ASTM B581-17(2023). Nickel-Chromium-Iron-Molybdenum-Copper Alloy Rod. ASTM International.
- ASTM B582-07(2018). Nickel-Chromium-Iron-Molybdenum-Copper Alloy Plate, Sheet, and Strip. ASTM International.
- ASTM B599-20. Nickel-Iron-Chromium-Molybdenum-Columbium Stabilized Alloy Plate, Sheet, and Strip. ASTM International.
- ASTM B620-03(2018). Nickel-Iron-Chromium-Molybdenum Alloy (UNS N08320) Plate, Sheet, and Strip. ASTM International.

- ASTM B621-21. Nickel-Iron-Chromium-Molybdenum Alloy Rod. ASTM International.
- ASTM B622-17b. Seamless Nickel and Nickel-Cobalt Alloy Pipe and Tube. ASTM International.
- ASTM B625-21. Ni-Fe-Cr-Mo-Cu-N Alloy, Ni-Fe-Cr-Si Alloy, Cr-Ni-Fe-N Low-Carbon Alloy, Fe-Ni-Cr-Mo-Cu-N Alloy and Ni-Fe-Cr-Mo-N Alloy Plate, Sheet, and Strip. ASTM International.
- ASTM B637-18. Precipitation-Hardening and Cold Worked Nickel Alloy Bars, Forgings, and Forging Stock for Moderate or High Temperature Service. ASTM International.
- ASTM B649-21. Ni-Fe-Cr-Mo-Cu-N Low-Carbon Alloys and Cr-Ni-Fe-N Low-Carbon Alloy Bar and Wire, Ni-Cr-Fe-Mo-N Alloy Wire and Ni-Fe-Cr-Mo-N Alloy Bar. ASTM International.
- ASTM B672-02(2018). Nickel-Iron-Chromium-Molybdenum-Columbium Stabilized Alloy (UNS N08700) Bar and Wire (Withdrawn 2023). ASTM International.
- ASTM B677-23. Nickel-Iron-Chromium-Molybdenum, Iron-Nickel-Chromium-Molybdenum-Copper and Nickel-Iron-Chromium-Molybdenum-Nitrogen Seamless Pipe and Tube. ASTM International.
- ASTM B688-22. Chromium-Nickel-Molybdenum-Iron Plate, Sheet, and Strip. ASTM International.
- ASTM B691-18. Iron-Nickel-Chromium-Molybdenum Alloys (UNS N08367) Rod, Bar, and Wire. ASTM International.
- ASTM E29-22. Using Significant Digits in Test Data to Determine Conformance With Specifications. ASTM International.
- ASTM E94/E94M-22. Standard Guide for Radiographic Examination Using Industrial Radiographic Film. ASTM International.
- ASTM E165/E165M-23. Liquid Penetrant Inspection Method. ASTM International.
- ASTM E186-20. Reference Radiographs for Heavy-Walled (2 to 4½ in. [50.8 to 114-mm]) Steel Castings. ASTM International.
- ASTM E280-21. Reference Radiographs for Heavy-Walled (4½ to 12 in. [114 to 305-mm]) Steel Castings. ASTM International.
- ASTM E446-20. Standard Reference Radiographs for Steel Castings up to 2 in. [50.8 mm] in Thickness. ASTM International.
- ASTM E709-21. Standard Guide for Magnetic Particle Testing. ASTM International.
- ISO 5208:2015. Industrial valves — Pressure testing of metallic valves.¹ International Organization for Standardization.
- ISO 9000:2015. Quality management systems — Fundamentals and vocabulary.¹ International Organization for Standardization.
- ISO 9001:2015. Quality management systems — Requirements.¹ International Organization for Standardization.
- ISO 9004:2018. Quality management — Quality of an organization — Guidance to achieve sustained success.¹ International Organization for Standardization.
- MSS SP-25-2018. Standard Marking System for Valves, Fittings, Flanges, and Unions. Manufacturers Standardization Society of the Valve and Fittings Industry.
- MSS SP-55-2020. Quality Standard for Steel Casting for Valves, Flanges, and Fittings — Visual Method for Evaluation of Surface Irregularities. Manufacturers Standardization Society of the Valve and Fittings Industry.
- MSS SP-61-2019. Pressure Testing of Steel Valves. Manufacturers Standardization Society of the Valve and Fittings Industry.
- MSS SP-134-2012. Valves for Cryogenic Service Including Requirements for Body/Bonnet Extensions. Manufacturers Standardization Society of the Valve and Fittings Industry.

¹This publication may also be obtained from American National Standards Institute: www.ansi.org.

NONMANDATORY APPENDIX A

RELATIONSHIP BETWEEN NOMINAL PIPE SIZE AND INSIDE DIAMETER

The relationship between wall thickness and inside diameter shown in [Table 3A](#) or [Table 3B](#) is the basis for pressure rating of valves. By interpolation, a definitive design can be determined for any pressure-diameter-material combination.

Following the evolution of standard dimensions for flanges in a series of rating classes, corresponding standard relationships were established between nominal pipe sizes and the inside diameter of fittings matching the rating class of the flanges. These provided a useful

design basis for the corresponding flanged-end valves, subsequently extended in application to welding-end valves, which in many cases are identical except for the pipe ends. [Table A-1](#) is based on the dimensions given in ASME B16.5 dimensional tables as “Inside Diameter of Fitting.” The values for sizes greater than NPS 24 for the lower pressure classes and greater than NPS 12 for Class 2500 were obtained by linear extrapolation.

Table A-1
Inside Diameter, *d*

NPS	Class 150		Class 300		Class 600		Class 900		Class 1500		Class 2500		DN
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	
½	12.7	0.50	12.7	0.50	12.7	0.50	12.7	0.50	12.7	0.50	11.2	0.44	15
¾	19.1	0.75	19.1	0.75	19.1	0.75	17.5	0.69	17.5	0.69	14.2	0.56	20
1	25.4	1.00	25.4	1.00	25.4	1.00	22.1	0.87	22.1	0.87	19.1	0.75	25
1¼	31.8	1.25	31.8	1.25	31.8	1.25	28.4	1.12	28.4	1.12	25.4	1.00	32
1½	38.1	1.50	38.1	1.50	38.1	1.50	34.8	1.37	34.8	1.37	28.4	1.12	40
2	50.8	2.00	50.8	2.00	50.8	2.00	47.5	1.87	47.5	1.87	38.1	1.50	50
2½	63.5	2.50	63.5	2.50	63.5	2.50	57.2	2.25	57.2	2.25	47.5	1.87	65
3	76.2	3.00	76.2	3.00	76.2	3.00	72.9	2.87	69.9	2.75	57.2	2.25	80
4	101.6	4.00	101.6	4.00	101.6	4.00	98.3	3.87	91.9	3.62	72.9	2.87	100
5	127.0	5.00	127.0	5.00	127.0	5.00	120.7	4.75	111.0	4.37	91.9	3.62	125
6	152.4	6.00	152.4	6.00	152.4	6.00	146.1	5.75	136.4	5.37	111.0	4.37	150
8	203.2	8.00	203.2	8.00	199.9	7.87	190.5	7.50	177.8	7.00	146.1	5.75	200
10	254.0	10.00	254.0	10.00	247.7	9.75	238.0	9.37	222.3	8.75	184.2	7.25	250
12	304.8	12.00	304.8	12.00	298.5	11.75	282.4	11.12	263.4	10.37	218.9	8.62	300
14	336.6	13.25	336.6	13.25	326.9	12.87	311.2	12.25	288.8	11.37	241.3	9.50	350
16	387.4	15.25	387.4	15.25	374.7	14.75	355.6	14.00	330.2	13.00	276.1	10.87	400
18	438.2	17.25	431.8	17.00	419.1	16.50	400.1	15.75	371.3	14.62	311.2	12.25	450
20	489.0	19.25	482.6	19.00	463.6	18.25	444.5	17.50	415.8	16.37	342.9	13.50	500
22	539.8	21.25	533.4	21.00	511.0	20.12	489.0	19.25	457.2	18.00	377.7	14.87	550
24	590.6	23.25	584.2	23.00	558.8	22.00	533.4	21.00	498.3	19.62	412.8	16.25	600
26	641.4	25.25	635.0	25.00	603.3	23.75	577.9	22.75	539.8	21.25	447.5	17.62	650
28	692.2	27.25	685.8	27.00	647.7	25.50	622.3	24.50	584.2	23.00	482.6	19.00	700
30	743.0	29.25	736.6	29.00	695.2	27.37	666.8	26.25	625.3	24.62	517.4	20.37	750
32	793.7	31.25	787.4	31.00	736.6	29.00	711.2	28.00	...	...	...	...	...
34	844.5	33.25	838.2	33.00	781.0	30.75	755.6	29.75	...	...	...	...	...
36	895.3	35.25	889.0	35.00	828.5	32.62	800.1	31.50	...	...	...	...	...
38	946.1	37.25	939.8	37.00	872.9	34.37	844.5	33.25	...	...	...	...	...
40	996.9	39.25	990.6	39.00	920.7	36.25	889.0	35.00	...	...	...	...	...
42	1 047.7	41.25	1 041.4	41.00	965.2	38.00	933.4	36.75	...	...	...	...	...
44	1 098.5	43.25	1 092.2	43.00	1 012.6	39.87	977.9	38.50	...	...	...	...	...
46	1 149.3	45.25	1 143.0	45.00	1 057.1	41.62	1 022.3	40.25	...	...	...	...	...
48	1 200.1	47.25	1 193.8	47.00	1 104.9	43.50	1 066.8	42.00	...	...	...	...	...
50	1 250.9	49.25	1 244.6	49.00	1 149.3	45.25	1 111.2	43.75	...	...	...	...	...
52	1 301.7	51.25	1 295.4	51.00	1 193.8	47.00	...	...	...	...	...	...	...
54	1 352.5	53.25	1 346.2	53.00	1 241.2	48.87	...	...	...	...	...	...	...
56	1 403.3	55.25	1 397.0	55.00	1 285.7	50.62	...	...	...	...	...	...	...
58	1 454.1	57.25	1 447.8	57.00	1 330.1	52.37	...	...	...	...	...	...	...
60	1 504.9	59.25	1 498.6	59.00	1 374.6	54.12	...	...	...	...	...	...	...

NONMANDATORY APPENDIX B

METHOD USED FOR ESTABLISHING PRESSURE-TEMPERATURE RATINGS

B-1 GENERAL CONSIDERATIONS

(25) B-1.1 Introduction

Pressure-temperature ratings for this Standard have been determined by the procedures described in this Appendix. The method is general and considers dimensions of this and related standards.¹ Valve performance is related to stress and deformation. Valves require special consideration since they are mechanically operated devices that provide partial or complete restriction to fluid flow under a wide variety of conditions.

B-1.2 Materials

It is not required that identical materials be used for a valve body and bonnet or a valve body and cover. However, both shall be from materials listed in Table 1. The assigned pressure rating shall be based on the valve body. The bonnet or cover shall be designed and the material selected accordingly. Selection of material for and the design of stems, discs, and other parts, such as bonnet gaskets and bolting, subject to pressure loading, shall be consistent with the pressure-temperature rating.

B-1.3 Wall Thickness

Wall thickness requirements for valve bodies are specified in para. 6.1. The minimum wall thickness values, t_m , shown in Table 3A or Table 3B calculated using the applicable equation of Mandatory Appendix VI are all greater than those determined by the following equation. Equation (B-1) is included only as an item of general interest. Equation (B-1) is not to be used for design calculations and is not to be used as a substitute for either Table 3A or Table 3B values or Mandatory Appendix VI equations.

$$t = 1.5 \left[\frac{P_c d}{2S_F - 1.2P_c} \right] \quad (\text{B-1})$$

where

d = inside diameter or port opening as defined in para. 6.1.2 (see Table 3A or Table 3B and Nonmandatory Appendix A)

P_c = pressure class designation number, e.g., for Class 150, $P_c = 150$; or Class 300, $P_c = 300$

S_F = stress-based constant equal to 7,000

t = calculated thickness

The equation does not apply for values of P_c greater than 4,500. The resultant units for t will be the same as those used to express d .

B-1.4 Additional Considerations

(25)

The eq. (B-1) results in a wall thickness of 50% greater for Class 150 to 2500 and approximately 35% greater for Class 4500 than for a simple cylinder designed for a stress of 48.28 MPa (7000 psi) subjected to an internal pressure equal to the pressure rating class designation, P_c . The actual values in Table 3A or Table 3B are approximately 2.5 mm (0.1 in.) larger than those given by the equation. Additional metal thickness, particularly for ratings over Class 2500, needed for assembly stress, valve closing stresses, shapes other than circular, and stress concentrations, are determined by individual manufacturers, since these factors vary widely.

B-1.5 Material Properties

The pressure-temperature rating method uses allowable stresses, ultimate strengths, and yield strengths from referenced ASME BPVC Sections, including their published Code Cases. For materials listed herein that have ratings either at temperature values that are above those shown in a referenced Code section or that are not listed in any of the referenced Code sections, the allowable stress, ultimate strength, and yield strength data have been provided directly by the ASME Boiler and Pressure Vessel Subcommittee on Materials.

B-1.6 Material Groups

Materials are grouped in Table 1 based on identical or closely matched allowable stress, ultimate tensile stress, and yield strength values. When these values are not

¹ This method is appropriate for materials listed in Table 1 of this Standard. It may not be appropriate for other materials.

identical for each material listed, the lowest value has been used.

B-2 STANDARD CLASS RATING METHOD

B-2.1 Method for Group 1 Materials

Pressure-temperature ratings for Standard Class valves, Class 300 and higher, of materials listed in Table 1, Materials Group 1 were established by the equation

$$p_{st} = \frac{C_1 S_1}{8750} P_r \leq p_{ca} \quad (\text{B-2})$$

where

C_1 = 10 when S_1 is expressed in MPa units, the resultant p_{st} will be in bar units ($C_1 = 1$ when S_1 is expressed in psi units, the resultant p_{st} will be in psi units)

p_{ca} = ceiling pressure, bar (psi), at temperature T as specified in section B-5 for Standard Class

P_r = pressure class rating index. For designations 300 ≤ Class ≤ 4500 and above, P_r is equal to the class designation number, e.g., for Class 300, $P_r = 300$. For Class 150 and for the interpolation method required for rating designations between Class 150 and 300, see para. B-2.3.

p_{st} = Standard Class rated working pressure, bar, (psi) for the specified material at temperature T

S_1 = selected stress, MPa (psi) for the specified material at temperature T . The value of S_1 shall be established as follows:

(a) At temperatures below the creep range, S_1 shall be equal to or less than 60% of the yield strength at temperature T , but shall not exceed

(1) 60% of the specified minimum yield strength at 38°C (100°F)

(2) 1.25 times 25% of the ultimate tensile strength at temperature T

(b) At temperatures in the creep range, the value of S_1 shall be the allowable stress at temperature T , as listed in ASME Boiler and Pressure Vessel Code, Section II, Part D, for either Section I or Section VIII, Division 1; but not exceeding 60% of the listed yield strength at temperature.

(c) In no case shall the selected stress value increase with increasing temperature.

(d) The creep range is considered to be at temperatures in excess of 370°C (700°F) for Group 1 materials.

(e) When the allowable stresses listed for the referenced ASME BPVC Section show a higher and lower value for allowable stress and the higher value is noted to the effect that these stress values exceed two-thirds of the yield strength at temperature, then the lower value

shall be used. If lower allowable stress values do not appear and it is noted in the allowable stress table that the allowable stress values exceed two-thirds of the yield strength at temperature, then the allowable stress values to be used shall be determined as two-thirds of the tabulated yield strength at temperature.

(f) Ultimate tensile strength and yield strength values shall be as listed in ASME BPVC, Section II, Part D.

(g) Allowable stress values listed in ASME BPVC, Section II, Part D, for Section III, Class 2 or Class 3 values may only be used for a material not listed for either Section I or Section VIII, Division 1.

B-2.2 Method for Groups 2 and 3 Materials

Pressure-temperature ratings for Standard Class valves, 300 ≤ Class ≤ 4500, of materials corresponding to those in Materials Groups 2 and 3 of Table 1 are established by the method of para. B-2.1, except that in paras. B-2.1(a) and B-2.1(a)(1), 60% factor shall be changed to 70%, and, for Group 2 materials, the creep range is considered to be at temperatures in excess of 510°C (950°F) unless the material properties indicate lower temperatures should be used. For Group 3 materials, the creep temperature onset for B-2.1(d) shall be determined on an individual basis.

B-2.3 Method for Class 150 — All Materials

Pressure-temperature ratings for Standard Class valves, Class 150 rating designation, are established by the method given for the related materials in paras. B-2.1 and B-2.2, subject to the following exceptions:

(a) The value of P_r , the pressure class rating index in eq. (B-2), for Class 150 shall be 115. For a rating designation between Class 150 and Class 300, an interpolation shall be made using $P_r = 115$ psi for Class 150.

(b) The value for S_1 , the selected stress MPa (psi), for the specific material at temperature T , shall be in accordance with the requirements stated in either para. B-2.1 or para. B-2.2.

(c) The value of p_{st} , the rated working pressure, bar (psi), for Class 150, shall not exceed values at temperature, T , as given by eq. (B-3)

$$p_{st} \leq C_2 - C_3 T \quad (\text{B-3})$$

where

C_2 = 21.41 and C_3 = 0.03724 with T expressed in °C, the resultant p_{st} will be in bar units ($C_2 = 320$ and $C_3 = 0.3$ with T expressed in °F, the resultant p_{st} will be in psi units)

T = material temperature, °C (°F)

The value of T in eq. (B-3) shall not exceed 540°C (1,000°F). For values of T less than 38°C (100°F), use T equal to 38°C (100°F) in eq. (B-3).

B-3 SPECIAL CLASS RATING METHOD

Pressure-temperature ratings for Special Class valves (see para. 2.1.2) are established for all materials of Table 1 by the equation

$$p_{sp} = \frac{C_2 S_2}{7000} P_r \leq p_{cb} \quad (\text{B-4})$$

where

C_2 = 10 when S_2 is expressed in MPa units, the resultant p_{sp} will be in bar units ($C_2 = 1$ when S_2 is expressed in psi units, the resultant p_{sp} will be in psi units)

p_{cb} = ceiling pressure, bar (psi), at temperature T as specified in para. B-5 for Special Class

P_r = pressure class rating index. For all designations Class 300 and above, P_r is equal to the class designation number, e.g. for Class 300, $P_r = 300$. For Class 150, $P_r = 115$. For a pressure class designation between Class 150 and Class 300, the interpolation for the rated working pressures shall be made using $P_r = 115$ for Class 150.

p_{sp} = Special Class rated working pressure, bar (psi), for the specified material at temperature T

S_2 = selected stress for the specified material at temperature T , MPa (psi). The value of S_2 shall be established as follows:

(a) At temperatures below the creep range, S_2 shall be equal to or less than 62.5% of the yield strength at temperature T , but shall not exceed

(1) 62.5% of the specified minimum yield strength at 38°C (100°F)

(2) 25% of the ultimate tensile stress value at temperature T .

(b) At temperatures in the creep range, the value of S_2 shall be the allowable stress at temperature T , as listed in ASME BPVC, Section II, Part D, for either Section I or Section VIII, Division 1; but not exceeding 62.5% of the yield strength at temperature T .

(c) In no case shall the selected stress value increase with increasing temperature.

(d) The creep range is to be considered that at temperatures in excess of 370°C (700°F) for Group 1 materials and 510°C (950°F) for Group 2 materials, unless material properties indicate lower temperatures to be used. For Group 3 materials, the creep range temperature limits shall be determined on an individual basis.

(e) When the allowable stresses listed for the referenced ASME BPVC Section show a higher and a lower value for allowable stress and the

higher value is noted to the effect that these stress values exceed two-thirds of the yield strength at temperature, then the lower value shall be used. If lower allowable stress values do not appear and it is noted in ASME BPVC, Section II, Part D allowable stress table that the allowable stress values exceed two-thirds of the yield strength at temperature, then the allowable stress values shall be determined as the lesser of two-thirds of the tabulated yield strength or the listed allowable stress at temperature.

(f) Ultimate tensile and yield strength values shall be as listed in ASME BPVC, Section II, Part D.

(g) Allowable stress values listed in ASME BPVC, Section II, Part D, for Section III, Class 2 or Class 3 values only, may be used for a material not listed for either Section I or Section VIII, Division 1.

B-4 INTERMEDIATE RATING CLASS METHOD

B-4.1 Conception

Welding-end or threaded-end valves may be designed for an Intermediate Pressure Class designation. In this case it is necessary to perform multiple linear interpolation using the data in Tables 2-1.1 through 2-3.19 (Tables 2-1.1C through 2-3.19C) and Tables 3A and 3B in order to determine the intermediate pressure class designation, the intermediate pressure-temperature ratings, and the associated minimum wall thickness. Given at the start is the material identification, the intermediate working pressure, and its associated temperature.

B-4.2 Nomenclature

Definitions for paras. B-4.3 and B-4.4 are as follows:

d_I = a given inside diameter, reference para. 6.1.2

P_c = pressure class designation, reference para. B-1.3

P_{cl} = the calculated intermediate pressure class designation for p_I at T_I

P_r = pressure class rating index, reference para. B-2.1

P_{rl} = the calculated intermediate pressure class rating index for p_I at T_I

p_I = a given intermediate working pressure at T_I

T_I = a given temperature associated with p_I

t_I = the calculated required minimum wall thickness for P_{cl}

B-4.3 Interpolation for Intermediate Pressure Ratings

Given p_I at T_I and the valve material, refer to the applicable table for the pressure-temperature rating tabulation. For the given T_I , locate T_a and T_b , the temperatures above and below T_I . For the given p_I , locate p_{aL} and p_{aH} and also p_{bL} and p_{bH} , the bounding

Table B-1
Pressure–Temperature Matrix

T		P_{rL}	P_{rI}	P_{rH}	
T_a		p_{aL}	p_{aI}	p_{aH}	
T_I		p_{IL}	p_I	p_{IH}	
T_b		p_{bL}	p_{bI}	p_{bH}	

pressures lower and higher than p_I . These are identified with pressure class rating indices P_{rL} and P_{rH} . These are shown schematically in Table B-1.

(a) Interpolate to find intermediate pressures, p_{IL} and p_{IH} at intermediate temperature, T_I .

$$p_{IL} = p_{aL} - (p_{aL} - p_{bL}) \left(\frac{T_a - T_I}{T_a - T_b} \right) \quad (\text{B-5})$$

$$p_{IH} = p_{aH} - (p_{aH} - p_{bH}) \left(\frac{T_a - T_I}{T_a - T_b} \right) \quad (\text{B-6})$$

(b) Interpolate to find the intermediate pressure class rating index, P_{rI} .

$$P_{rI} = P_{rL} + (P_{rH} - P_{rL}) \left(\frac{p_I - p_{IL}}{p_{IH} - p_{IL}} \right) \quad (\text{B-7})$$

(c) Interpolate to find the intermediate pressure class designation, P_{cI} .

$$P_{cI} = P_{cL} + (P_{cH} - P_{cL}) \left(\frac{P_{rI} - P_{rL}}{P_{rH} - P_{rL}} \right) \quad (\text{B-8})$$

Note that for $P_{cI} \geq 300$, $P_{cI} = P_{rI}$.

(d) Interpolate to find intermediate working pressures at temperature over the associated service temperature range applicable for P_{rI} . This interpolation is specifically required for the pressure rating at 38°C (100°F) that is needed for setting the hydrostatic test pressure and to meet the marking requirements and for setting the pressure associated with any maximum limiting temperature.

Table B-2
Class–Diameter Matrix

d		P_{cL}	P_{cI}	P_{cH}	
d_a		t_{aL}	—	t_{aH}	
d_I		t_{IL}	t_I	t_{IH}	
d_b		t_{bL}	—	t_{bH}	

For example, for $T = T_a$, the interpolated working pressure rating is

$$P_{aI} = P_{aL} + (P_{aH} - P_{aL}) \left(\frac{P_{rI} - P_{rL}}{P_{rH} - P_{rL}} \right) \quad (\text{B-9})$$

B-4.4 Wall Thickness for Intermediate Ratings

Given the valve inside diameter, d (para. 6.1.2), and the calculated intermediate pressure class designation, P_{cI} , [para. B-4.3(c)] refer to Table 3A or Table 3B for the minimum wall thickness tabulation. For the given inside diameter, d_I , locate d_a and d_b , the diameters above and below d_I . For the given P_{cI} , locate P_{cL} and P_{cH} , the pressure class designation lower and higher than P_{cI} . The bounding minimum wall thickness is at the row-column intersection as shown schematically in Table B-2.

(a) Interpolate to find intermediate minimum wall thicknesses, t_{IL} and t_{IH} , at intermediate diameter, d_I .

$$t_{IL} = t_{aL} + (t_{bL} - t_{aL}) \left(\frac{d_I - d_a}{d_b - d_a} \right) \quad (\text{B-10})$$

$$t_{IH} = t_{aH} + (t_{bH} - t_{aH}) \left(\frac{d_I - d_a}{d_b - d_a} \right) \quad (\text{B-11})$$

(b) Interpolate to find the intermediate minimum wall thickness, t_I .

$$t_I = t_{IL} + (t_{IH} - t_{IL}) \left(\frac{P_{cI} - P_{cL}}{P_{cH} - P_{cL}} \right) \quad (\text{B-12})$$

B-5 MAXIMUM RATINGS

The rules for establishing Standard Class and Special Class pressure–temperature ratings include consideration of ceiling pressures, P_{ca} or P_{cb} , that effectively sets limits on the selected stress. The ceiling pressure–temperature values set an upper bound for high strength materials and are imposed to limit deflection. By definition, ceiling pressure values also apply to intermediate ratings (para. 2.1.5). Ceiling pressure values are listed in Table B-3 (Table B-3C). Except for Limited Class, ratings in excess of these are not permitted under this Standard.

NONMANDATORY APPENDIX C

QUALITY SYSTEM PROGRAM

The products manufactured in accordance with this Standard shall be produced under a quality system program following the principles of an appropriate standard from the ISO 9000 series.¹ A determination of the need for registration and/or certification of the product manufacturer's quality system program by an independent organization shall be the responsibility of the manufacturer. Detailed documentation demonstrating

program compliance shall be available to the purchaser at the manufacturer's facility. A written summary description of the program used by the product manufacturer shall be available to the purchaser upon request. The product manufacturer is defined as the entity whose name or trademark appears on the product in accordance with the marking or identification requirements of this Standard.

¹ The series is also available from the American National Standards Institute (ANSI) and the American Society for Quality (ASQ) as American National Standards that are identified by the prefix "Q," replacing the prefix "ISO." Each standard of the series is listed under References in [Mandatory Appendix VII](#).

NONMANDATORY APPENDIX D

LOW-TEMPERATURE APPLICATIONS

(25)

D-1 GENERAL

Low-temperature limits are typically provided by referencing codes such as the ASME B31 Piping Codes. The referencing codes do not provide identical requirements, and the instructions for determining the coldest acceptable use temperature are sometimes complex.

D-2 EXAMPLES

ASME B31T establishes a low-temperature service limit for piping components. If the intended operating temperature is equal to or colder than the low-temperature service limit, additional requirements such as impact testing and heat treatment may be required. Examples of the requirements in ASME B31T-2018 are shown in [Table D-2-1](#) to help the users of this standard understand the approach taken. These examples are simplifications of the rules in

ASME B31T, i.e., not all of the provisions are explained here.

According to ASME B31T, the coldest acceptable use temperature is a function of the following:

- (a) the material
- (b) the thickness of the material for some steels
- (c) the stresses applied to the installed flange or flanged fitting at the cold condition

ASME B31T allows flanges and flanged fittings to be qualified for colder use temperatures if impact testing demonstrates the material has adequate toughness at that condition.

It is the responsibility of the user to ensure the correct material is selected to meet the installation's cold use temperature requirements and to communicate any additional requirements such as heat treatment and impact testing to the manufacturer prior to the time of purchase.

Table D-2-1
Example Minimum Use Temperatures

Material Group	Temperature Class	ASTM Specification	Coldest Temperature Without Impact Testing, °C (°F)	Notes
1.1 to 1.4	Normal carbon steels	A105	-29 (-20)	(1)
		A350 Gr. LF1	-29 (-20)	(2)
		A216 Gr. WCB, WCC	-29 (-20)	...
		A515 Gr. 65, 70	-13 (18)	(3)
		A515 Gr. 60	-29 (-20)	(3)
		A516 Gr. 65, 70 (not normalized)	-29 (-20)	(3)
	Low-temperature carbon steels	A516 Gr. 60 (not normalized)	-48 (-55)	(3)
		A516 Gr. 60, 65, 75 (normalized)	-48 (-55)	(3)
		A350 Gr. LF2 Cl. 1	-46 (-50)	(2)
		A350 Gr. LF6 Cl. 1, 2	-51 (-60)	(2)
		A352 Gr. LCB, LCC	-46 (-50)	(2)
		A537 Cl. 1	-48 (-55)	(3)
	Normal low-alloy steels	A217 Gr. WC1	-29 (-20)	...
		A203 Gr. A, B, D, E	-29 (-20)	...
	Low-temperature low-alloy steels	A352 Gr. LC1	-59 (-75)	(2)
		A352 Gr. LC2	-73 (-100)	(2)
		A352 Gr. LC3	-101 (-150)	(2)
		A350 Gr. LF3	-101 (-150)	(2)
1.5 to 1.18	Normal low-alloy steels	A182 Gr. F1, F2, F5, F5A, F9, F11, F12, F22, F91, F92	-29 (-20)	...
		A217 Gr. WC4, WC5, WC6, WC9, C5, C12, C12A	-29 (-20)	...
		A204 Gr. A, B, C	-29 (-20)	...
		A387 Gr. 11, 22, 91	-29 (-20)	...
2.1 to 2.12 (except 2.8)	Normal stainless steels	A351 Gr. CH20, CK20	-29 (-20)	(4)
		A240 Type 304, 304L, 316, 316L, 321, 347	-29 (-20)	(5)
		A240 Type 317, 317L, 321H, 348	-29 (-20)	(5)
		A182 Gr. F310	-29 (-20)	(4), (6)
		A240 Gr. 309S, 310S	-29 (-20)	(4), (5)
	Low-temperature stainless steels	A182 Gr. F304H, F316H, F317L, F321, F321H, F347, F347H, F348, F348H	-198 (-325)	...
		A182 Gr. F310	-198 (-325)	(4), (7)
		A240 Gr. 309S, 310S	-198 (-325)	(4), (8)
		A240 Type 317, 317L, 321, 321H, 347, 348	-198 (-325)	(8)
		A351 Gr. CF8C	-198 (-325)	...
		A182 Gr. F304, F316, F304L, F316L	-254 (-425)	...
		A351 Gr. CH8, CG8M (not listed)	-198 (-325)	...
		A351 Gr. CF3, CF8, CF3M, CF8M	-254 (-425)	...
		A240 Type 304, 304L, 316, 316L	-254 (-425)	(8)
2.8	Low-temperature duplex stainless steels	A182 Gr. F51, F53, F55	Not listed in ASME B31T	...
		A995 Gr. CE8MN (2A), CD3MWCuN (6A)	-51 (-60)	...
		A995 Gr. CD4MCuN	Not listed in ASME B31T	...
		A240 Gr. S31803, S32750	Not listed in ASME B31T	...
		A240 Gr. S32760	-51 (-60)	...
3.1 to 3.19	Low-temperature nickel alloys	All listed ASME B16.5 materials	-198 (-325)	...

Table D-2-1
Example Minimum Use Temperatures (Cont'd)

NOTES:

- (1) Class 400 and higher ASTM A105 flanges require heat treatment.
- (2) Materials require impact testing.
- (3) The minimum temperature for many carbon steel flanges is subject to a governing thickness correction. Minimum temperature becomes warmer for thicker flanges. Based on the material T-Number for the carbon steel flange from ASME B31T, Table 3.2-1, determine the minimum temperature as a function of flange thickness from ASME B31T, Figure I-1 (Figure I-1M) or Table I-1.
- (4) This material may have low impact properties at room temperature after being exposed to high service temperature.
- (5) Material not solution heat treated after forming.
- (6) Carbon content $> 0.10\%$.
- (7) Carbon content $\leq 0.10\%$.
- (8) Material solution heat treated after forming.