Manufacturer shall provide the source of the conversion factors which shall be subject to verification and acceptance by the Authorized Inspector or Certified Individual.

(f) Dimensions shown in the text, tables, and figures, whether given as decimals or fractions, may be taken as decimals or fractions and do not imply any manufacturing precision or tolerance on the dimensions.

(g) Material that has been manufactured and certified to either the U.S. Customary or SI material specification (e.g., SA-516M) may be used regardless of the unit system used in design. Standard fittings (e.g., flanges, elbows, etc.) that have been certified to either U.S. Customary units or SI units may be used regardless of the units system used in design.

(h) All entries on a Manufacturer’s Data Report and data for Code-required nameplate marking shall be in units consistent with the fabrication drawings for the component using U.S. Customary, SI, or local customary units. Units (either primary or alternative) may be shown parenthetically. Users of this Code are cautioned that the receiving jurisdiction should be contacted to ensure the units are acceptable.

**U-5 TOLERANCES**

The Code does not fully address tolerances. When dimensions, sizes, or other parameters are not specified with tolerances, the values of these parameters are considered nominal, and allowable tolerances or local variances may be considered acceptable when based on engineering judgment and standard practices as determined by the designer.
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(19) FLANGES AND PIPE FITTINGS

(a) The following standards covering flanges and pipe fittings are acceptable for use under this Division in accordance with the requirements of UG-11. Pressure-temperature ratings shall be in accordance with the appropriate standard except that the pressure-temperature ratings for ASME B16.9 and ASME B16.11 fittings shall be calculated as for straight seamless pipe in accordance with the rules of this Division including the maximum allowable stress for the material. The thickness tolerance of the ASME standards shall apply.

(1) ASME B16.1, Gray Iron Pipe Flanges and Flanged Fittings, Classes 25, 125, and 250. Permitted only for pressure vessel parts used on pressure vessels constructed in accordance with Part UCLA of this Division.

(2) ASME B16.5, Pipe Flanges and Flanged Fittings, [see UG-11(a)(2)]

(3) ASME B16.9, Factory-Made Wrought Butt welding Fittings

(4) ASME B16.11, Forged Fittings, Socket-Welding and Threaded

(5) ASME B16.15, Cast Copper Alloy Threaded Fittings, Classes 125 and 250

(6) ASME B16.20, Metallic Gaskets for Pipe Flanges — Ring-Joint, Spiral-Wound, and Jacketed

(b) Where tapped holes are provided for studs, the threads shall be full and clean and shall engage the stud for a length not less than the larger of \( \frac{1}{2}d_s \) or

\[
\frac{1}{2}d_s \times \frac{0.75d_s}{\text{maximum allowable stress value of stud material at design temperature}}\]

\[
\times \text{maximum allowable stress value of tapped material at design temperature}
\]

in which \( d_s \) is the nominal diameter of the stud, except that the thread engagement need not exceed \( \frac{1}{2}d_s \).

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FLANGES AND PIPE FITTINGS

(7) ASME B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500, and 2500

(8) ASME B16.42, Ductile Iron Pipe Flanges and Flanged Fittings, Class 150 and 300

(9) ASME B16.47, Large Diameter Steel Flanges, NPS 26 Through NPS 60

(10) A forged nozzle flange may use the ASME B16.5/B16.47 pressure-temperature ratings for the flange material being used, provided all of the following are met:

- For ASME B16.5 applications, the forged nozzle flange shall meet all dimensional requirements of a flanged fitting given in ASME B16.5 with the exception of the inside diameter. The inside diameter of the forged nozzle flange shall not exceed the inside diameter of the same size lap joint flange given in ASME B16.5. For ASME B16.47 applications, the inside diameter shall not exceed the weld hub diameter \( A \) given in the ASME B16.47 tables.

- For ASME B16.5 applications, the outside diameter of the forged nozzle neck shall be at least equal to the hub diameter of the same size class ASME B16.5 lap joint flange. For ASME B16.47 applications, the outside diameter of the hub shall at least equal the \( X \) diameter given in the ASME B16.47 tables. Larger hub diameters shall be limited to nut stop diameter dimensions. See Figure 2-4, sketches (12) and (12a). The bolt material shall have an allowable stress equal to or greater than SA-193 B8 Cl. 2 at the specified bolt size and temperature.

- The combination of vessel MAWP (corrected for the static pressure acting on the flange) at the design temperature cannot exceed the pressure-temperature rating of the flange.

- The actual assembly bolt load (see Nonmandatory Appendix S) shall comply with ASME PCC-1, Nonmandatory Appendix O.

(4) The vessel MAWP (corrected for the static pressure acting on the flange) with external moment and external axial force shall satisfy the following equation (the units of the variables in this equation shall be consistent with the pressure rating):

\[
16M_E + 4F_G \leq \pi G^2 [F_R - F_D] + F_M P_R
\]

where

\( F_R \) = external tensile axial force
\( F_M \) = moment factor, in accordance with Table UG-44-1
\( G \) = gasket reaction diameter
\( M_E \) = external moment
\( P_D \) = vessel MAWP (corrected for static pressure acting on the flange) at design temperature
\( P_R \) = flange pressure rating at design temperature

Pipe Flanges, Flanged Fittings, and Valves, Classes, Add "Metric/Inch Standard"
(g) Material that has been manufactured and certified to either the U.S. Customary or SI material specification (e.g., SA-516 or SA-516M) may be used regardless of the unit system used in design. Standard fittings (e.g., flanges, elbows, etc.) that have been certified to either U.S. Customary units or SI units may be used regardless of the units system used in design.

(h) All entries on a Manufacturer's Data Report and data for Code-required nameplate marking shall be in units consistent with the fabrication drawings for the component using U.S. Customary, SI, or local customary units. Units (either primary or alternative) may be shown parenthetically. Users of this Code are cautioned that the receiving Jurisdiction should be contacted to ensure the units are acceptable.

1.5 TOLERANCES

The Code does not fully address tolerances. When dimensions, sizes, or other parameters are not specified with tolerances, the values of these parameters are considered nominal, and allowable tolerances or local variances may be considered acceptable when based on engineering judgment and standard practices as determined by the designer.

1.6 TECHNICAL INQUIRIES

A procedure for submittal of Technical Inquiries to the ASME Boiler and Pressure Vessel Code Committee is contained in the front matter.

1.7 TABLES

| Table 1.1 Year of Acceptable Edition of Referenced Standards in This Division |
|-----------------------------|------------------|-----------------|
| Title | Number | Year |
| Marketing and Labeling Systems | ANSI/UL-969 | Latest edition |
| Fitness-For-Service | API 579-1/ASME FFS-1 | 2016 |
| Materials and Fabrication of 2½Cr-1Mo, 2½Cr-1Mo-½V, 3Cr-1Mo, and 3Cr-1Mo-½V Steel | API RP 934-A | 2008 (2012 Addendum) |
| Heavy Wall Pressure Vessels for High-Temperature, High-Pressure Hydrogen Service | API Standard 527 | 2014, Fourth edition |
| Seat Tightness of Pressure Relief Valves | API Standard 560 | Latest edition |
| Fired Heaters for General Refinery Service | ASCE/SEI 7 | 2016 |
| Data for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (inch Series) | B18.2.2 | Latest edition |
| Unified Inch Screw Threads (UN and UNR Thread Form) | ASME B1.1 | Latest edition |
| Metric Screw Threads — M Profile | ASME B1.13M | Latest edition |
| Pipe Threads, General Purpose, Inch | ASME B1.20.1 | Latest edition |
| Metric Screw Threads — MJ Profile | ASME B1.21M | Latest edition |
| Pipe Flanges and Flanged Fittings, NPS ½ Through NPS 24 Metric/Inch Standard | ASME B16.5 | 2013 |
| Factory Made Wrought Steel Butt welding Fittings | ASME B16.9 | Latest edition |
| Forged Steel Fittings, Socket-Welding and Threaded | ASME B16.11 | Latest edition |
| Metallic Gaskets for Pipe Flanges — Ring Joint, Spiral-Wound and jacketed | ASME B16.20 | Latest edition |
| Large Diameter Steel Flanges, NPS 26 Through NPS 60 Metric/Inch Standard | ASME B16.47 | 2017 |
| Metric Heavy Hex Screws | ASME B18.2.3.3M | Latest edition |
| Metric Heavy Hex Bolts | ASME B18.2.3.5M | Latest edition |
| Metric Fasteners for Use in Structural Applications | ASME B18.2.3.6M | Latest edition |
| Conformity Assessment Requirements | ASME B18.2.6M | Latest edition |
| Guidelines for Pressure Boundary Bolted Flange Joint Assembly | ASME CA-1 | Latest edition |
| Repair of Pressure Equipment and Piping | ASME PCC-1 | 2013 |
| Pressure Relief Devices | ASME PCC-2 | 2018 |
| Qualifications for Authorized Inspection | ASME PTC-25 | 2014 |
| Standard Reference Photographs for Magnetic Particle Indications on Ferrous Castings | ASTM A1033 | Latest edition |
| Cast Copper Alloy Threaded Fittings, Classes 125 and 250 | ASTM E125 | 1963 (R2008) |
| (Note [1]) | | |

Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves, Classes 150, 300, 600, 900, 1500, and 2500 | ASME B16.24 | 2016 |
least the most severe condition of coincident pressure and temperature expected in normal operation. Only the chambers that come within the scope of this Division need be constructed in compliance with its provisions. Additional design requirements for chambers classified as jacketed vessels are provided in 4.11.

4.1.8.2 Common Element Design. It is permitted to design each common element for a differential pressure less than the maximum of the design pressures of its adjacent chambers (differential pressure design) or a mean metal temperature less than the maximum of the design temperatures of its adjacent chambers (mean metal temperature design), or both, only when the vessel is to be installed in a system that controls the common element operating conditions.

(a) Differential Pressure Design (Dependent Pressure Chamber). When differential pressure design is permitted, the common element design pressure shall be the maximum differential design pressure expected between the adjacent chambers. The common element and its corresponding differential pressure shall be indicated in the “Remarks” section of the Manufacturer’s Data Report (see 2.3.4) and marked on the vessel (see Annex 2-F). The differential pressure shall be controlled to ensure the common element design pressure is not exceeded.

(b) Mean Metal Temperature Design (Dependent Pressure Chamber). When mean metal temperature design is used, the common element maximum design temperature determined in accordance with 4.1.5.2(d) may be less than the greater of the maximum design temperatures of its adjacent chambers; however, it shall not be less than the lower of the maximum design temperatures of its adjacent chambers. The common element and its corresponding design temperature shall be indicated in the “Remarks” section of the Manufacturer’s Data Report (see 2.3.4) and marked on the vessel (see Annex 2-F). The fluid temperature, flow and pressure, as required, shall be controlled to ensure the common element design temperature is not exceeded.

4.1.9 CLADDING AND WELD OVERLAY

4.1.9.1 The design calculations for integrally clad plate or overlay weld clad plate may be based on a thickness equal to the nominal thickness of the base plate plus $S_C/S_B$ times the nominal thickness of the cladding, less any allowance provided for corrosion, provided all of the following conditions are met.

(a) The clad plate conforms to one of the specifications listed in the tables in Part 3 or is overlay weld clad plate conforming to Part 3.

(b) The joints are completed by depositing corrosion resisting weld metal over the weld in the base plate to restore the cladding.

(c) The allowable stress of the weaker material is at least 70% of the allowable stress of the stronger material.

4.1.9.2 When $S_C$ is greater than $S_B$, the multiplier $S_C/S_B$ shall be taken equal to unity.

4.1.10 INTERNAL LININGS

Corrosion resistant or abrasion resistant linings are those not integrally attached to the vessel wall, i.e., they are intermittently attached or not attached at all. In either case, such linings shall not be given any credit when calculating the thickness of the vessel wall.

4.1.11 FLANGES AND PIPE FITTINGS

4.1.11.1 The following standards covering flanges and pipe fittings are acceptable for use under this Division in accordance with the requirements of Part 1.

(a) ASME B16.5, Pipe Flanges and Faced Flanged Fittings
(b) ASME B16.3, Factory-Made Wrought Steel Butt-Welding Fittings
(c) ASME B16.11, Forged Fittings, Socket-Welding and Threaded
(d) ASME B16.15, Cast Bronze Threaded Fittings, Classes 125 and 250
(e) ASME B16.20, Metallic Gaskets for Pipe Flanges - Ring-Joint, Spiral-Wound, and Jacketed
(f) ASME B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500, and 2500
(g) ASME B16.47, Large Diameter Steel Flanges, NPS 26 Through NPS 60

4.1.11.2 Pressure-temperature ratings shall be in accordance with the applicable standard except that the pressure-temperature ratings for ASME B16.9 and ASME B16.11 fittings shall be calculated as for straight seamless pipe in accordance with the rules of this Division including the maximum allowable stress for the material.

4.1.11.3 A forged nozzle flange (i.e., long weld neck flange) may be designed using the ASME B16.5/B16.47 pressure-temperature ratings for the flange material being used, provided all of the following are met.

(a) For ASME B16.5 applications, the forged nozzle flange shall meet all dimensional requirements of a flanged fitting given in ASME B16.5 with the exception of the inside diameter. The inside diameter of the forged nozzle flange shall not exceed the inside diameter of the same size and class lap joint flange given in ASME B16.5. For ASME B16.47 applications, the inside diameter shall not exceed the weld hub diameter “A” given in the ASME B16.47 tables.