

SCOPE

- I 1.1 This practice covers the design of flanged joints for piping, and the selection of flanges, flange facings, gaskets and bolting for piping, and equipment flanged nozzles and manways.
- I 1.2 Orifice flanges and valve bonnets are not within the scope of this practice.
- I 1.3 An asterisk (*) indicates that additional information is required. If a job is contracted, this information is to be furnished in the job specification.

SUMMARY OF ADDITIONAL REQUIREMENTS

- I 2.1 Table 1 lists the practices, codes, standards and specifications that shall be used with this practice. Where specific references to ASME, ANSI or ASTM requirements are made in this practice, the Owner's Engineer may authorize the use of equivalent or more stringent provisions of other applicable recognized codes or standards.

TABLE 1

PRACTICES			
IP 3-10-1	Piping Selection and Design Criteria	IP 3-16-3	Heat/Weather Shields for Flanges and Flangeless Valves
IP 18-10-1	Additional Requirements for Materials		
CODES AND STANDARDS			
ASME Code		ASTM Standards	
Section VIII Pressure Vessels, Division 1		A193 / A193M Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service	
B31.3 Process Piping		A194 / A194M Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service	
ASME Standards		A320 / A320M Alloy Steel Bolting Materials for Low-Temperature Service	
B16.1 Cast Iron Pipe Flanges and Flanged Fittings		F436 / F436M Hardened Steel Washers	
B16.5 Pipe Flanges and Flanged Fittings		API Standard	
B16.20 Metallic Gaskets for Pipe Flanges-Ring-Joint, Spiral-Wound, and Jacketed		590 Steel Line Blanks	
B16.21 Nonmetallic Flat Gaskets for Pipe Flanges			
B16.47 Large Diameter Steel Flanges: NPS 26 through NPS 60			

DEFINITIONS

- I 3.1 **Hydrogen Service**, as used herein, is any fluid service when the hydrogen partial pressure exceeds 90 psi (620 kPa) with a design temperature of 450°F (230°C) or greater.
- I 3.2 **Combustible liquids**. High flash liquids [flash points 100°F (38°C) or higher] when handled at temperatures more than 15°F (8°C) below their flash point.
- I 3.3 **Flammable liquids**. Low flash liquids [flash point below 100°F (38°C)]; and high flash liquids [flash point 100°F (38°C) or higher] when handled at temperatures above or within 15°F (8°C) of their flash point.
- I 3.4 **Flammable materials**. Flammable liquids; hydrocarbon vapors; and other vapors, such as hydrogen and carbon disulfide, that are readily ignitable when released to atmosphere.

FLANGED JOINTS

- R 4.1 The selection of flanged facings and gaskets shall be per Table 2, or per Table 3 if asbestos based gaskets are used.
- S,R * 4.2 **Electrically insulated flanged joints** require approval of the Owner's Engineer. **Insulating flanged joints are required for:**
 - a. Isolation of all lines heated by electric impedance heating systems.
 - b. Protection of marine terminal loading stations to electrically isolate on-board (tanker or barge) piping from the pier piping under any of the following circumstances:
 - 1. At cathodically protected marine terminals.
 - 2. Where loading arms or electrically bonded oil cargo hoses are used.
 - 3. For loading and unloading products classified as flammable liquids.

R 4.3 **For flanged joints with fluid operating temperatures below -50°F (-45°C)**, the flanged joint design must compensate for the differential contraction of the flanges and bolts so that change in gasket seating pressure will not result in leakage.

R * 4.4 When specified, **hot service thermal insulation of flanges** is permitted where all of the following conditions are met:

Max. Fluid Operating Temp.	550°F (290°C) (1)(2)
Max. Design Pressure	600 psig (4140 kPa) (2)
Flange Material	Carbon Steel, or Low Alloy Steel (to 5% Cr) (3)
Bolting Material	Grade B7 or B16 per Par. 7.1
Service Restrictions	Not for hydrogen service, highly corrosive fluids such as concentrated acids, or toxic materials such as phenol or hydrogen sulfide

Notes:

- (1) **For temperatures below 300°F**, consideration shall be given to the possibility of corrosion under the insulation.
- (2) **Steam service flanges** may be insulated to a maximum fluid operating temperature of 750°F (400°C) and a maximum design pressure of 650 psig (4480 kPa).
- (3) **For hydrocarbon services**, the flange periphery shall, in addition, be fitted with a leak band.

S,R * 4.5 **For any flammable material or combustible liquid service where the piping system is lined with plastic or low melting point [below 700°F (370°C)] material**, flanged joints shall be designed to prevent leakage under exposure to heat sufficient to destroy or melt the lining material (lapped over flange faces). External insulation of the flanges may be considered for this purpose subject to the Owner's Engineer approval and the requirements of **Par. 4.4** above.

S,R * 4.6 **For wafer or lug type valve installations in piping systems with a design temperature greater than 400°F (200°C)**, flanges and bolting material shall be selected to have the same nominal coefficient of thermal expansion as the body material of the valve.

R 4.7 **Steel flanges mating to flat-faced cast iron flanges** shall be **flat faced**. Full faced gaskets shall be used.

R * 4.8 **Proprietary flanged piping connectors, quick opening closures, or clamps** shall not be used without prior approval of the Owner's Engineer.

FLANGES

R * 5.1 **Flanges** shall be per the following standards and the additional requirements of this practice. Flanges of materials other than those listed or flanges with special dimensions for mating to equipment shall be per ASME B31.3 and shall be approved by the Owner's Engineer.

FLANGE MATERIAL	NPS SIZE RANGE		APPLICABLE STANDARD
	in.	mm	
Carbon Steel	1/2 thru 24	15 thru 600	ASME B16.5
Ferritic Alloy Steel			
Austenitic Cr-Ni Steel	26 thru 60	650 thru 1500	ASME B16.47 Series B (1)
3-1/2% Ni Steel			
Cast Iron	1 thru 48	25 thru 1200	ASME B16.1
Nickel; Nickel Copper (Monel)	1/2 thru 24	15 thru 600	ASME B16.5
Nickel-Chromium-Iron (Inconel)	26 thru 60	650 thru 1500	ASME B31.3
Hastelloy B-2 and C-276			
Aluminum Bronze	1/2 thru 24	15 thru 600	ASME B31.3 (2)
Aluminum Alloy	1/2 thru 24		ASME B31.3, Appendix L (2)

Notes:

- (1) **Except where ASME B16.47 Series A flanges** may be required to accommodate **flangeless or lug type valves or other similar flangeless components, or to mate with existing equipment flanges**.
- (2) Dimensions including flange face finish per **ASME B16.5**.

R * 5.2 **For ring joint Class 900 or higher flanges**, the ring groove corner radius ("R" dimension of ASME B16.5) shall be 1/8 ± 0.03 ins. (3 ± 0.8 mm) when **all** of the following apply:

- a. Size exceeds NPS 3, **and**
- b. Design Temperature exceeds 500°F (260°C), **and**
- c. Flange material is either solid austenitic stainless, or low alloy with austenitic stainless weld overlay.

- C 5.3 The use of **dual certified stainless steel flanges** is permitted for the specified grade within the ASME B16.5 pressure-temperature limits as follows:
- Up to 1000°F (540°C), the "straight" grade pressure-temperature limits may be used per ASME B31.3 Code Cases 8-18 and 8-34.
 - Above 1000°F (540°C), the pressure-temperature limits shall be calculated in accordance with the requirements of ASME B16.5, Annex D, using the "L" grade allowable stresses per ASME B31.3.
 - Dual certified flanges shall be marked per ASME B16.5 but showing both grades (e.g., 304/304L).
- R * 5.4 **The use of lap joint flanges** requires approval by the Owner's Engineer and is subject to the following limitations:
- They shall not be used where the combined longitudinal stress in the pipe where attached to the lap-joint stub-end, resulting from pressure, weight, and thermal expansion, exceeds the ASME B31.3 basic allowable stress at the pipe design temperature.
 - The flange may be of a material different from that of the pipe provided the flanged joint will not be subject to galvanic corrosion (e.g., carbon steel flanges may be used on lap-joint stub-ended 18Cr 8 Ni pipe in above ground services).
 - Stub-ends for lap-joint flanges, if fabricated by welding, shall be made with full penetration welds.
- R * 5.5 **The use of slip-on flanges** is subject to the following limitations:
- They shall not be used for Class 400 or higher flanges unless approved by the Owner's Engineer.
 - They shall not be used at design temperatures above 750°F (400°C) or where the specified corrosion allowance exceeds 0.125 in. (3 mm).
 - They shall not be welded directly to welding fittings unless approved by the Owner's Engineer.
 - Aluminum alloy slip-on flanges shall not be used.
- C 5.6 **Cast iron flanges** are permitted only if furnished as integral flanges on cast iron piping or equipment.
- R 5.7 **Threaded flanges on cast iron or ductile iron pipe** shall be steel.
- R 5.8 **Aluminum alloy flanges** shall be either wrought or forged forms. Castings shall not be used.

GASKETS

- R * 6.1 **Gasket selection** shall be per [Table 2](#) for **fluid services compatible with flexible graphite**. Gaskets for other services shall be approved by the Owner's Engineer.
- Where permitted by local authorities, **asbestos based gaskets** may be used with the Owner's Engineer approval per [Table 3](#) and other limits specified locally.

- R 6.2 **Gasket designs** shall be per the following standards and the additional requirements of this practice.

GASKET TYPE	STANDARDS
Compressed Asbestos Fiber (CAF) sheet	ASME B16.21
Metal Reinforced Flexible Graphite (RFG) sheet	Dimensions per ASME B16.21
Corrugated Metal flexible Graphite Covered (CMGC)	Dimensions per ASME B16.21
Grooved Metal profile flexible Graphite Covered (GMGC)	Manufacturer's Standards
Corrugated Double Jacketed (DJ)	ASME B16.20 with Corrugated Jacket
Spiral Wound (SW)	ASME B16.20
Ring Joint (RJ)	ASME B16.20 for Oval Shape

- R * 6.3 The asbestos content for Compressed Asbestos Fiber (CAF) gaskets shall be a minimum of 70% (by weight). The binder shall be NBR polymer (ASTM D2000 Type B Class F) unless specified otherwise. The grade of asbestos and binders or impregnants used shall be suitable for the service fluids and temperature. Gasket shall contain an anti-stick release agent or be graphited on both sides, and shall have a minimum tensile strength across the grain of 4000 psi (27.6 MPa).
- R 6.4 The **design** of Reinforced Flexible Graphite (RFG) and Corrugated Metal flexible Graphite Covered (CMGC) gaskets shall be in accordance with manufacturer's standards subject to Owner's Engineer approval and the dimensions of ASME B16.21. The flexible graphite covering for these gaskets shall contain a minimum of 95% pure carbon and have a nominal density of 70 lb/ft³ (1120 kg/m³).