

# **STEEL PIPELINE FLANGES**

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**Standard Practice**  
**Developed and Approved by the**  
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Substantive changes in this 1996 edition are "flagged" by parallel bars as shown on the margins of this paragraph. The specific detail of the change may be determined by comparing the material flagged with that in the previous edition.

Non-toleranced dimensions in this Standard Practice are nominal, and unless otherwise specified, shall be considered "for reference only".

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## FOREWORD

The Manufacturers Standardization Society originally developed the Standard Practice in response to the continued requests for steel pipe flanges for pipeline use, particularly in sizes larger than those covered by ANSI Standard B16.5 on Steel Pipe Flanges and Flanged Fittings. The line pipe is uniquely characterized by high-strength, cold worked, thin-wall of the carbon steel grade, which necessitates special considerations for the welding end of the flanges.

The size and pressure class range was originally NPS 26 through NPS 36 in pressure classes customarily designated in ANSI Standard B16.5 as 300, 400, 600, and 900 lb. The 1970 edition deleted the slip-on flanges for lack of demand, and added a 150 lb. class and coverage for sizes NPS 12 through NPS 24. Additional coverage was also necessitated by the advent of the use of line pipe of grades having minimum specified yield strength higher than the 52,000 psi maximum contemplated at the time of initial development, and therefore still thinner walls.

In some instances, this advent widened the differential between the tensile properties of the flange steel versus that of the mating pipe steel. This, in turn necessitated greater flexibility in the selection of hub dimensions, so that various combinations of material-strength and flange-dimensions could be utilized to supply the flanges. Section 5 on Flange Design was introduced at this point, and is one of the key features of this standard. The 1972 edition included the coverage of blind flanges in all pressure classes and clarification of text requirements for better understanding and usage under the more diverse conditions.

The 1975 edition expanded the size range above size NPS 36. The drilling templates for the Class 150 flanges of the NPS 38 and larger sizes continued the previous philosophy of adopting the drilling template of the Class 125 of ANSI Standard B16.1. However, the drilling templates of the Class 300 flanges of the NPS 38 and larger sizes did not continue the adoption of the Class 250 of ANSI Standard B16.1 drilling templates; instead, these drilling templates were necessarily designed more compactly because of the increased loads. While these flanges are designated by the customary ANSI Standard Class 150, 300, 400, 600, and 900, their use is almost entirely confined to cross country transmission pipelines at atmospheric temperatures. The flanges have been designed primarily for use at their cold ratings which conform to the ANSI Standard B16.5 ratings of 100F, and are intended primarily for attachment to relatively thin-wall, high-strength cold worked pipe, and high-strength butt-welding fittings in pipeline service at temperatures of 450F and lower. However, flanges forged of other materials are capable of pressure temperature ratings as specified in Paragraph 2.2.

The 1980 edition was created to bring the document into closer editorial alignment with ANSI B16.5. However, out of recognition of the successful experience of the pipeline industry, room temperature ratings were extended to 250F. De-rating above 250F was accelerated such that the 450F ratings are the same as B16.5. Users are cautioned that when these flanges are bolted to valves and used at temperatures between 100F and 450F, the rating of the valve will not be as high as the flange.

The 1990 revision of this SP was required to update the reference standards list and delete the metric equivalents.

The 1991 revision of this SP was required to add blind flange machining guidance, flat face requirements and precautionary notes as well as update of referenced standards.

The 1996 revision adds a table with permissible imperfections in flange facing finish and clarifies annex A design criteria. There were several errata, or corrections made to references to other standards. Dimensional tolerances have been changed where necessary to conform with ASME B16.5 and B16.47.

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## 1. SCOPE

1.1 General — This standard covers pressure-temperature ratings, materials, dimensions, tolerances (by reference to ASME/ANSI B16.5), marking and testing. The welding neck type flanges shall be forged steel, and the blind flanges may be made of either forged steel or from steel plates.

1.1.1 Dimensional requirements for sizes NPS 10 and smaller are provided by reference to ASME/ANSI B16.5. When such flanges meet all other stipulations of this standard, they shall be considered as complying therewith.

## 1.2 References

1.2.1 Referenced Standards — Standards and specifications adopted by reference in this standard are shown in Annex C, for convenience of identifying edition number, date and source of supply.

A flange made in conformance with a prior edition of referenced standards and in all other respects conforming to this standard will be considered to be in conformance even though the edition reference may be changed in a subsequent revision of this Standard Practice.

1.2.2 Codes and Regulations — A flange used under the jurisdiction of the ASME Boiler and Pressure Vessel Code, the ANSI Code for Pressure Piping, or Governmental Regulations, is subject to any limitation of that code or regulation. This includes any maximum temperature limitation for a material, or rule governing the use of a material at a low temperature.

## 2. PRESSURE-TEMPERATURE RATINGS

2.1 General Flanges covered by this standard shall be designated as one of the following: Class 150, 300, 400, 600 and 900. Ratings in Table 3 are in U.S. customary units.

2.2 Rating for Other Materials and Temperatures above 450 F — NPS 26 and larger flanges forged of

steels covered in ASME/ANSI B16.5 whose bores are no larger than those which may be calculated for pipe complying with parallel ASTM pipe specifications, and which comply with all requirements (except dimensions) of American National Standard B16.5 are capable of being utilized at the pressure-temperature ratings given in that standard.

## 3. MATERIALS

3.1 The steel used in the manufacture of these flanges shall be selected by the manufacturer to meet the following requirements.

3.1.1 All materials used for flanges shall be killed steel.

3.1.2 The steel used shall be suitable for field welding to other flanges, fittings, or pipe manufactured under ASTM specifications A 105, A 53, A 106, A 350, A 381, A 694, A 707, or API Standard 5L.

3.1.3 The steel used shall have a maximum carbon content of 0.35 and a carbon equivalent computed by the following equation:

$$\text{C.E.} = \text{C} + \frac{\text{Mn}}{6} + \frac{\text{Cr} + \text{Mo} + \text{V}}{5} + \frac{\text{Ni} + \text{Cu}}{15}$$

that should not exceed 0.48%, based on ladle analysis. If the carbon equivalent factor exceeds 0.48%, the acceptance of the flanges shall be based on agreement between purchaser and manufacturer.

3.1.3.1 The choice and use of alloying elements, combined with the elements within the limits prescribed in paragraph 3.1.3 to give the required tensile properties prescribed in paragraphs 3.1.4 shall be made by the flange manufacturer and included and reported in the ladle analysis to identify the type of steel.

3.1.4 The steel used shall have tensile properties conforming to the requirements prescribed in Table 1 and capable of meeting the requirements of section 4 and the flange manufacturer's design conditions as given in Annex A.

3.1.4.1 The test specimens may be taken from the forgings or, at the manufacturers' option, from the billets or forging bar entering into the finished product, provided such test blank has undergone relatively the same forming and the equivalent heat treatment as the finished flange. The dimensions of the test blank must be such as to adequately reflect the heat treatment properties of the hub of the flange. Specimens shall be obtained from the midwall of the thinnest section of the hub of the flange or  $\frac{3}{4}$  in. from the surface of the test blank. The orientation of specimens taken from a flange shall be longitudinal.

3.2 **Bolting** — Bolting listed in Table 2 shall be used in flanged joints covered by this standard. Bolting of other material may be used if permitted by the applicable code or governmental regulation. All bolting materials are subject to the following limitations.

3.2.1 **High Strength Bolting** — Bolting materials having allowable stresses not less than those for

ASTM A193 Gr B7 are listed as high strength in Table 2. These and other materials of comparable strength may be used in any flanged joint.

3.2.2 **Intermediate Strength Bolting** — Bolting materials listed as intermediate strength in Table 2, and other bolting of comparable strength, may be used in any flanged joint, provided the user verifies their ability to seat the selected gasket and maintain a sealed joint under expected operating conditions.

3.2.3 **Low Strength Bolting** — Bolting materials having not more than 30 ksi specified minimum yield strength are listed as low strength in Table 2. These materials and others of comparable strength shall be used only in Class 150 and Class 300 joints, and only with gaskets described in 3.3.2.

TABLE 1. TENSILE REQUIREMENTS

| GRADE | YIELD POINT<br>MIN. | TENSILE STRENGTH<br>MIN. | ELONGATION IN 2 IN.<br>MIN. PERCENT |
|-------|---------------------|--------------------------|-------------------------------------|
|       | ksi                 | ksi                      |                                     |
| F36   | 36 <sup>(a)</sup>   | 60                       | 20                                  |
| F42   | 42                  | 60                       | 20                                  |
| F46   | 46                  | 60                       | 20                                  |
| F48   | 48                  | 62                       | 20                                  |
| F50   | 50                  | 64                       | 20                                  |
| F52   | 52                  | 66                       | 20                                  |
| F56   | 56                  | 68                       | 20                                  |
| F60   | 60                  | 75                       | 20                                  |
| F65   | 65                  | 77                       | 18                                  |
| F70   | 70                  | 80                       | 18                                  |

<sup>(a)</sup> Note: except as required in para. 4.2.

TABLE 2. LIST OF BOLTING SPECIFICATIONS

| ASTM BOLTING MATERIALS       |       |                                      |         |                             |         |
|------------------------------|-------|--------------------------------------|---------|-----------------------------|---------|
| HIGH STRENGTH <sup>(a)</sup> |       | INTERMEDIATE STRENGTH <sup>(b)</sup> |         | LOW STRENGTH <sup>(c)</sup> |         |
| SPEC-GR.                     | NOTES | SPEC-GR.                             | NOTES   | SPEC-GR.                    | NOTES   |
| A193-B7                      |       | A193-B5                              |         | A193-B8                     | CL1 (g) |
| A193-B16                     |       | A193-B6                              |         | A193-B8C                    | CL1 (g) |
| A320-L7                      | (d)   | A193-B6X                             |         | A193-B8M                    | CL1 (g) |
| A320-L7A                     | (d)   | A193-B7M                             |         | A193-B8T                    | CL1 (g) |
| A320-L7B                     | (d)   | A193-B8                              | CL2 (f) | A193-B8A                    | (g)     |
| A320-L7C                     | (d)   | A193-B8C                             | CL2 (f) | A193-B8CA                   | (g)     |
| A320-L43                     | (d)   | A193-B8M                             | CL2 (f) | A193-B8MA                   | (g)     |
| A354-BC                      |       | A193-B8T                             | CL2 (f) | A193-B8TA                   | (g)     |
| A354-BD                      |       | A320-B8                              | CL2 (f) | A307-B                      | (h)     |
| A540-B21                     |       | A320-B8C                             | CL2 (f) | A320-B8                     | CL1 (g) |
| A540-B22                     |       | A320-B8F                             | CL2 (f) | A320-B8C                    | CL1 (g) |
| A540-B23                     |       | A320-B8M                             | CL2 (f) | A320-B8M                    | CL1 (g) |
| A540-B24                     |       |                                      |         |                             |         |
|                              |       | A320-B8T                             | CL2 (f) | A320-B8T                    | CL1 (g) |
|                              |       | A449                                 | (i)     |                             |         |
|                              |       | A453-651                             | (e)     |                             |         |
|                              |       | A453-660                             | (e)     |                             |         |

## General Note:

Bolting materials shall not be used beyond temperature limits specified in the governing Code.

## NOTES:

- These bolting materials may be used with all listed materials and gaskets.
- These bolting materials may be used with all listed materials and gaskets; provided it has been verified that a sealed joint can be maintained under rated pressure and temperature.
- These bolting materials may be used with all listed materials but are limited to Class 150 and Class 300 joints. See 3.3 for recommended gasket practices.
- This ferritic material is intended for low temperature service, use A194 Gr. 4 or Gr. 7 nuts.
- This special alloy is intended for high temperature service with austenitic stainless steel.
- This austenitic stainless steel has been carbide solution treated and strain hardened. Use A194 nuts of corresponding material.
- This austenitic stainless material has been carbide solution treated but not strain hardened. Use A194 nuts of corresponding material.
- This carbon steel fastener shall not be used above 400 F or below -20 F, see also Note (c). Bolts with drilled or undersized heads shall not be used.
- Acceptable nuts for use with quenched and tempered bolts are A194 Gr. 2 and Gr. 2H. Mechanical property requirements for studs shall be the same as those for bolts.

**TABLE 3. PRESSURE-TEMPERATURE RATINGS  
MAXIMUM ALLOWABLE NON-SHOCK WORKING PRESSURES  
IN POUNDS PER SQUARE INCH (GAGE)**

| TEMP. F    | CLASS<br>150 | CLASS<br>300 | CLASS<br>400 | CLASS<br>600 | CLASS<br>900 |
|------------|--------------|--------------|--------------|--------------|--------------|
| -20 to 250 | 285          | 740          | 990          | 1480         | 2220         |
| 300        | 275          | 715          | 955          | 1430         | 2145         |
| 350        | 265          | 690          | 925          | 1380         | 2070         |
| 400        | 255          | 665          | 890          | 1330         | 2000         |
| 450        | 245          | 640          | 860          | 1285         | 1925         |

### 3.3 Gasket Material

3.3.1 The user is responsible for selection of gasket materials which will withstand the expected bolt loading without injurious crushing, and which are suitable for the service conditions. Particular attention should be given to gasket selection if a system hydrostatic test will exceed the test pressure specified in 8.2. Such a test involves the risk of excessive flange distortion.

3.3.2 Gasket dimensions for 1/16 inch sheet asbestos in Table 4 are based on a contact area equal to approximately twice the bolt root area. Class 150 flange joints should use these exclusively.

3.3.3 Ring joint gasket materials shall conform to ANSI B16.20 with dimensions as given in Table 5.

3.3.4 Sheet and ring joint gaskets for sizes NPS 10 and smaller shall conform to ASME/ANSI B16.5 dimensions and recommendations.

## 4. HEAT TREATMENT

4.1 The F42 and higher grades of flanges of all pressure classes and the class 400 and higher classes of Grade F36 flanges shall be normalized or quenched and tempered.

4.2 It is recognized that the cooling rate in a quenching operation may be slower in the thicker ring section of the flange than in the thinner hub section. Hence, the increase in yield strength due

to the quenching operation may be less in the ring section than in the hub section. This factor is accounted for in the Section on Design in Paragraph 5.3. NPS 38 and larger sizes of the 300 and higher classes of welding neck flanges shall have 42 ksi minimum yield strength in the ring section.

## 5. FLANGE DESIGN

5.1 Drilling Templates — Drilling templates are derived as follows:

5.1.1 Class 150 flange drilling templates are the same as ASME/ANSI B16.5 and Class 125 of ANSI/ASME B16.1.

5.1.2 Sizes 24 and smaller class 300 flanges have drilling templates which are the same as ASME/ANSI B16.5 and Class 250 of ANSI/ASME B16.1. Sizes 24 through 36 inclusive have drilling templates which are interpolations of Class 250 of ANSI/ASME B16.1 except the diameter of the bolt holes are only one-eighth inch larger than bolt diameters. Larger sizes are designed in accordance with Appendix 2 of Division 1 of Section VIII of ASME Boiler and Pressure Vessel Code.

5.1.3 Size 36 and smaller of Classes 400, 600, and 900 flanges have drilling templates which are extrapolations from ASME/ANSI B16.5. Larger sizes are designed in accordance with Appendix 2 of Division I of Section VIII of ASME Boiler and Pressure Vessel Code.

**5.2 Flange Ring Design** — The outside diameter and flange thickness of sizes NPS 24 and smaller flanges are in accordance with ASME/ANSI B16.5. Larger sizes are designed in accordance with Appendix 2 of Division 1 of Section VIII of ASME Boiler and Pressure Vessel Code and the flange ring shall have sufficient pressure capacity for the service based on its strength in the normalized condition. This capacity shall be substantiated by the Rules for Bolted Flange Connections, Appendix 2 of Division 1 of the ASME Unfired Pressure Code Section VIII, with allowable design stresses as given in Annex A of this standard.

### 5.3 Hub Design

**5.3.1** Sizes NPS 24 and smaller. When the mechanical (minimum yield strength) properties of all sections of the flanges are equal to or higher than those of the pipe to be matched, the hub dimensions may be the same as those of ASME/ANSI B16.5. Larger sizes are designed in accordance with Appendix 2 of Section VIII of ASME Boiler and Pressure Vessel Code.

**5.3.2** In addition, when the minimum yield strength of the hub portion of any flange or its representative test specimen is less than that specified for the pipe to be matched, the minimum thickness of the hub at the welding end shall be such that the product of its thickness times its yield strength (at welding end) shall at least equal the product of the specified nominal wall thickness and minimum specified yield strength of the pipe to be matched. Under these conditions, Sizes NPS 24 and smaller flanges may also have a single taper hub and the outside diameter of the hub at the base may be modified in accordance with ASME Section VIII Division 1 Appendix 2 calculations.

**5.3.3** When the manufacturer employs this option, the flange identification should be a combination of the class of material of the flange and of the pipe for which the flange has been designed. See 6.1.

**5.3.4** When the hub thickness at the welding end must be greater than the adjoining pipe, the joint design shall be as shown in any of the three sketches in Figure 1.

**5.4 Welding End** — The welding end shall be in accordance with Figure 2 for wall thickness (of intended mating pipe) of 0.88 in. and less. For thicker walls, refer to Figure 3.

### 5.5 Blind Flange

**5.5.1 a)** The outside diameter and thickness of blind flanges shall be as listed in Tables 6, 7, 8, 9 and 10. Thicknesses listed are based on material having mechanical properties for Grade F36 of Table 1. Drilling templates are per Paragraph 5.1. Thinner flanges of higher strength material may be furnished in accordance with Annex B rules.

**5.5.2 b)** Blind flanges need not be faced in the center if, when this center is raised, its diameter is at least 5 in. smaller than the nominal pipe size. When the center part is depressed, its diameter shall not be greater than the gasket ID specified in Table 4 less 2 inches (I.D. - 2 = max. depression O.D.).

**5.6** Dimensional requirements for NPS 10 and smaller shall be in accordance with ASME/ANSI B16.5.

**5.7 Flat Face Flanges** — This standard permits flat face flanges in all classes, by providing flanges having either the full thickness or the thickness with the raised face removed, without reduction of the pressure-temperature ratings subject to the following provisions.

**5.7.1** The thickness of a Class 150 or 300 flange from which the raised face has been removed shall be no less than the applicable dimension C of Tables 6 & 7 minus 0.06 in.

**5.7.2** The thickness of a flange of Class 400 or higher from which the raised face has been removed shall be no less than the applicable C dimension of Tables 8, 9 and 10.

**5.7.3** The flange facing shall conform with section 7.2 for the full width of seating of the gasket.

**5.8 Spot Facing** — All flanges shall have bearing surfaces for bolting which shall be parallel to the flange face within 1 deg. Any back facing or spot

facing required to accomplish parallelism shall not reduce the flange thickness *C* below the dimensions given in Tables 6, 7, 8, 9 and 10. Any spot facing or back facing shall be in accordance with MSS SP-9.

## 6. MARKING

6.1 Flanges shall be marked in accordance with the rules established in MSS Standard Practice SP-25, Standard Marking System for Valves, Fittings, Flanges, and Unions. In addition, the letters, "PL" shall precede the grade symbol marking. The grade symbol marked on the Welding Neck Flange shall designate the grade of material in the welding end of the hub. When flanges are produced under the option of Paragraph 5.3.1, the marking will also include the grade of the material of the pipe which the flange will match. For example, a flange having a grade F42 hub designed to be used with grade X60 pipe would contain the marking PL F42/X60 in addition to the marking specified in MSS SP-25.

6.2 Flanges in sizes NPS 10 and smaller produced to B16.5 dimensions and complying with all other requirements of this Standard Practice shall be marked in accordance with 6.1.

## 7. FACINGS

7.1 Flange Facing Finish — The finish of contact faces of pipe flanges shall be judged by visual comparison with Ra Standards (see ANSI B46.1) and not by instruments having stylus tracers and electronic amplification. The finishes required are given below. Other finishes may be furnished by agreement between user and manufacturer.

7.2 Raised Face — Either a serrated-concentric or serrated-spiral finish having from 125  $\mu$  in. to 250  $\mu$  in. average shall be furnished. The cutting tool employed should have an approximate 0.06 in. or larger radius, and there should be from 44 to 55 grooves per in.

7.3 Ring Joint — The side wall surface of gasket groove shall not exceed 63 microinch roughness.

7.4 Flange Facing Finish Imperfections in the flange facing finish shall not exceed the dimensions shown in Table 11. Adjacent imperfections shall be separated by a distance of at least four times the permissible radial projection. Protrusions above the separations are not allowed.

## 8. CODE LIMITATIONS

8.1 A product used under the jurisdiction of the ASME Boiler and Pressure Vessel Code or of the ANSI Code for Pressure Piping, is subject to any limitation of that code. This includes any maximum temperature limitation for a material, or a code rule governing the use of a material at a low temperature.

8.2 Flange Testing — Flanges are not required to be hydrostatically tested. Flanged joints may be subjected to system hydrostatic tests at pressures not exceeding 1.5 times the 100 F rating.

## 9. FLANGE BOLTING DIMENSIONS

9.1 Alloy-steel stud-bolts threaded at both ends or full length, or bolts with hexagonal heads conforming to American National Standard heavy dimensions (ANSI B18.2.1) may be used and shall have nuts conforming to American National Standard heavy dimensions (ANSI B18.2.2).

9.2 Carbon Steel bolts smaller than  $\frac{3}{4}$  in. shall have square heads or heavy hex heads (ANSI B18.2.1), and shall have heavy hex nuts (ANSI B18.2.2). Bolts  $\frac{3}{4}$  in. and larger shall have square heads or hex heads (ANSI B18.2.1), and shall have hex nuts or heavy hex nuts (ANSI B18.2.2).

9.3 Threads of carbon steel bolts and stud bolts shall be coarse series, Class 2A (ANSI B1.1), and nuts shall be coarse series, Class 2B.

9.4 All alloy steel bolting shall be threaded in accordance with ANSI B1.1. Nominal diameters 1 in. and smaller shall be of the coarse thread series; nominal diameters  $1\frac{1}{8}$  in. and larger shall be of the 8 thread series. Bolts, studs and stud-bolts shall have a Class 2A thread, and nuts shall have a class 2B thread.

9.5 Bolting to Cast Iron Flanges — Where Class 150 steel flanges are bolted to Class 125 cast iron flanges or Class 300 steel flanges are bolted to Class 250 cast iron flanges, it is recommended that low strength bolting be used. If intermediate or high-strength bolting is used, it is recommended that the mating flanges be flat faced and that full faced gaskets extending to the O.D. of the flange be used.

## 10. TOLERANCES

### 10.1 Facings

Outside Diameter, 0.06 in. raised face:

Sizes NPS 12 to NPS 24 inclusive:  $\pm 0.03$  in.

Sizes NPS 26 and Larger:  $\pm 0.08$  in.

Outside Diameter, 0.25 in. raised face:

Sizes NPS 12 to NPS 24 inclusive:  $\pm 0.02$  in.

Sizes NPS 26 and Larger:  $\pm 0.04$  in.

### 10.2 Flange Thickness

Sizes NPS 18 and Smaller  $+0.12$  in.

— zero

Sizes NPS 20 and larger  $+0.19$  in.

— zero

### 10.3 Hub Dimensions (including welding ends)

10.3.1 Nominal Outside Diameter of Welding End of welding neck flanges (Dimension H, in Tables 6, 7, 8, 9 and 10.

Sizes NPS 12 to NPS 24 in.  $+0.16$  in.

— 0.03 in.

Sizes NPS 26 and larger  $+0.21$  in.

— 0.06 in.

10.3.2 Nominal Inside Diameter of Welding Ends of welding neck flanges (Dimension B in the referenced Figures).

Sizes NPS 12 to 18 inclusive  $\pm 0.06$  in.

Sizes NPS 20 and larger  $+0.12$  in.

— 0.06 in.

10.3.3 Thickness of Hub — Regardless of tolerances specified for dimensions A and B, the thickness of hub at the welding end shall never be less than 87½ percent of the nominal thickness of the pipe to which the flange is to be attached.

### 10.4 Overall Length through Hub on Welding Neck Flanges

Sizes NPS 12 to NPS 24 incl.  $+0.12$  in.

— 0.18 in.

Sizes NPS 26 and larger  $\pm 0.19$  in.

### 10.5 Drilling and Facing

10.5.1 Bolt Circle Diameter,  $\pm 0.06$  in.

10.5.2 Center-to-Center of adjacent bolt holes,  $\pm 0.03$  in.

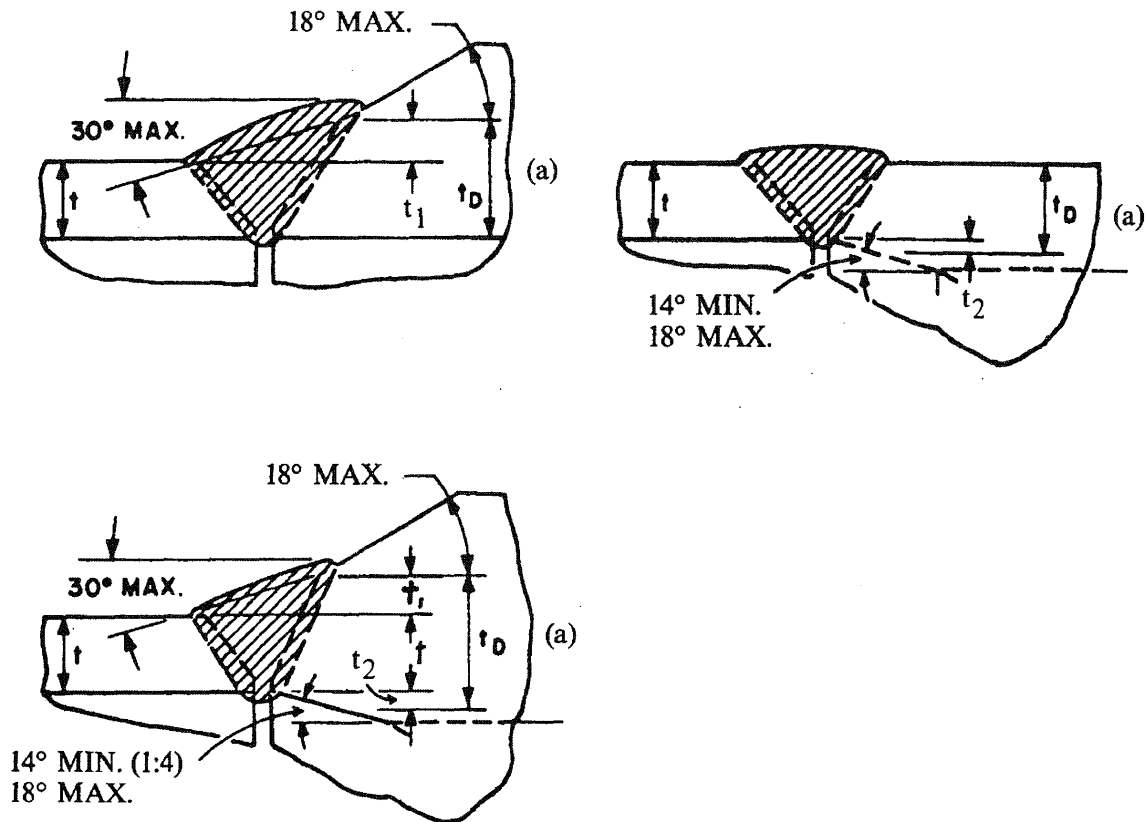
10.5.3 Eccentricity between bolt circle diameter and machined facing diameters.

Sizes NPS 12 to NPS 24, incl.  $0.06$  in.

Sizes NPS 26 and larger  $0.09$  in.

10.6 Sizes NPS 10 and Smaller Tolerances for these sizes shall be as specified in ASME/ANSI B16.5.

The listing of decimal tolerances does not imply method of measurement.



## NOTES:

## GENERAL:

When the minimum specified yield strengths of the sections to be joined are unequal, the deposited weld metal shall have mechanical properties at least equal to those of the section having the higher strength, and the minimum thickness,  $t_D$ , shall at least equal  $t$  times the ratio of minimum specified yield strength of pipe and flange, but not to exceed  $1.5t$ .

(a) Neither  $t_1$ ,  $t_2$ , nor  $t_1 + t_2$  shall exceed  $0.5t$ .

FIGURE 1 — ACCEPTABLE DESIGNS FOR UNEQUAL WALL THICKNESS<sup>(1)</sup>  
(See Paragraph 5.3)

<sup>(1)</sup> SUPPLEMENTARY FOOTNOTE: See ASME B31 Piping Codes for additional fabrication details.

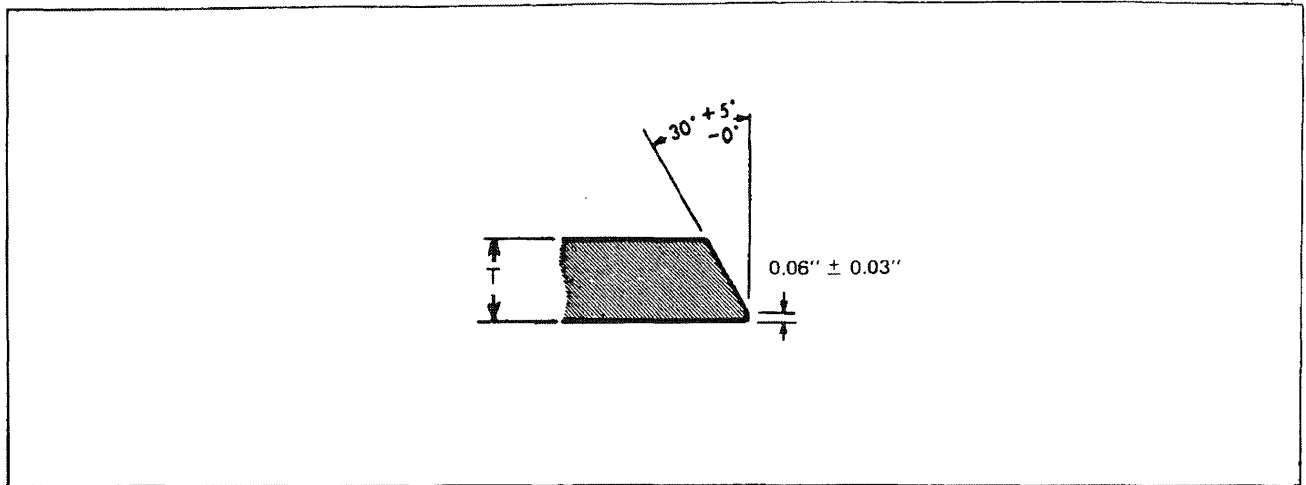


FIGURE 2 — BEVEL DETAIL FOR WALL THICKNESS (T)  $0.88^{(a)}$  OR LESS

NOTE: <sup>(a)</sup> Flange sizes 24 and smaller may be furnished with  $37\frac{1}{2}^\circ$  bevel at option of manufacturer.

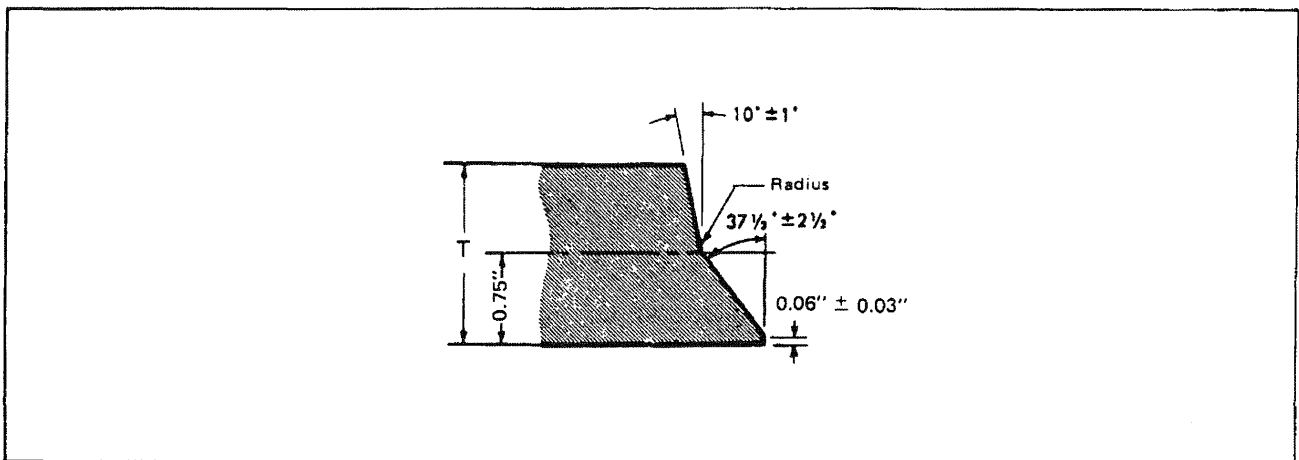


FIGURE 3 — BEVEL DETAIL FOR WALL THICKNESS (T) GREATER THAN 0.88

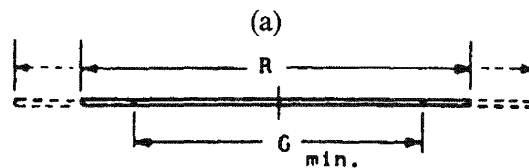
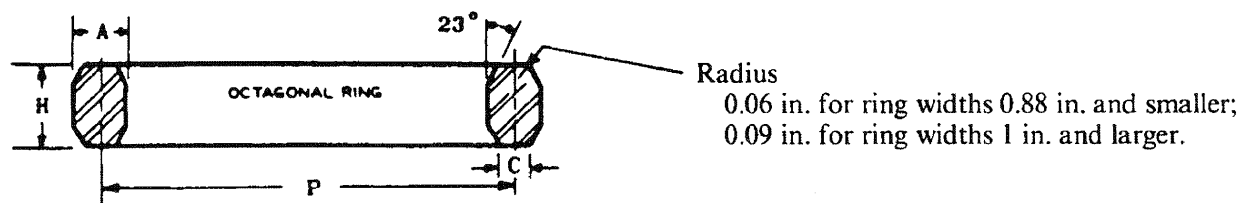


TABLE 4 — SHEET GASKET DIMENSIONS

Dimensions in inches

| NOM.<br>PIPE<br>SIZE | O.D.<br>GASKET<br><br>R <sup>(a)</sup>                                      | I. D. GASKET G MIN. |       |       |       |       |
|----------------------|-----------------------------------------------------------------------------|---------------------|-------|-------|-------|-------|
|                      |                                                                             | 150                 | 300   | 400   | 600   | 900   |
| 12                   | 15.00                                                                       | 12.75               | 12.75 | 12.75 | 12.75 | 12.75 |
| 14                   | 16.25                                                                       | 14.00               | 14.00 | 14.00 | 14.00 | 14.00 |
| 16                   | 18.50                                                                       | 16.00               | 16.00 | 16.00 | 16.00 | 16.00 |
| 18                   | 21.00                                                                       | 18.00               | 18.00 | 18.00 | 18.00 | 18.00 |
| 20                   | 23.00                                                                       | 20.00               | 20.00 | 20.00 | 20.00 | 20.00 |
| 22                   | 25.25                                                                       | 22.00               | 22.00 | 22.00 | 22.00 | —     |
| 24                   | 27.25                                                                       | 24.00               | 24.00 | 24.00 | 24.00 | 24.00 |
| 26                   | 29.50                                                                       | 26.00               | 27.62 | 27.00 | 26.62 | 26.38 |
| 28                   | 31.50                                                                       | 28.00               | 29.50 | 28.88 | 28.38 | 28.38 |
| 30                   | 33.75                                                                       | 30.00               | 31.62 | 30.88 | 30.38 | 30.38 |
| 32                   | 36.00                                                                       | 32.00               | 33.75 | 33.00 | 32.50 | 32.38 |
| 34                   | 38.00                                                                       | 34.00               | 35.62 | 34.88 | 34.25 | 34.38 |
| 36                   | 40.25                                                                       | 36.00               | 37.62 | 36.88 | 36.25 | 36.38 |
| 38                   | Same as<br>O.D. of<br>Raised<br>Face, R,<br>in Tables<br>6, 7, 8,<br>9 & 10 | 38.00               | 38.00 | 37.75 | 37.50 | 37.00 |
| 40                   |                                                                             | 40.00               | 40.00 | 39.75 | 39.50 | 39.00 |
| 42                   |                                                                             | 42.00               | 42.00 | 41.75 | 41.50 | 41.00 |
| 44                   |                                                                             | 44.00               | 44.00 | 43.75 | 43.50 | 43.00 |
| 46                   |                                                                             | 46.00               | 46.00 | 45.75 | 45.50 | 45.00 |
| 48                   |                                                                             | 48.00               | 48.00 | 47.75 | 47.50 | 47.00 |
| 50                   |                                                                             | 50.00               | 50.00 | 49.62 | 49.25 | —     |
| 52                   |                                                                             | 52.00               | 52.00 | 51.62 | 51.25 | —     |
| 54                   |                                                                             | 54.00               | 54.00 | 53.62 | 53.25 | —     |
| 56                   |                                                                             | 56.00               | 56.00 | 55.62 | 55.25 | —     |
| 58                   |                                                                             | 58.00               | 58.00 | 57.62 | 57.25 | —     |
| 60                   |                                                                             | 60.00               | 60.00 | 59.62 | 59.25 | —     |

NOTE: <sup>(a)</sup> Outside Diameter R may be made to fit the inside diameter of the bolts to act as a locating device when making a joint in the field, however, in no case should the contact area of the gasket be increased by changing the diameter of the raised face on the flange.

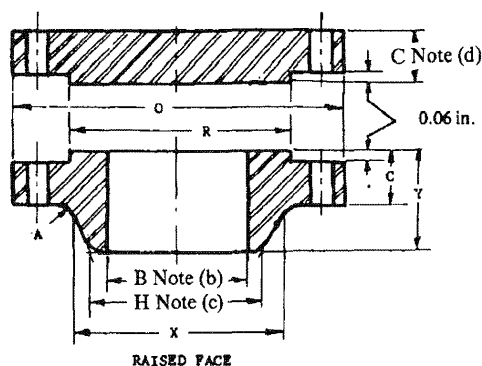
TABLE 5 — RING-JOINT GASKET DIMENSIONS <sup>(1)</sup>

Dimensions in inches

| CLASS 300, 400, AND 600      |                                  |                          |                                     |                           |             | CLASS 900                        |                          |                                     |                           |             |
|------------------------------|----------------------------------|--------------------------|-------------------------------------|---------------------------|-------------|----------------------------------|--------------------------|-------------------------------------|---------------------------|-------------|
| Nom-<br>inal<br>Pipe<br>Size | Pitch<br>Dia.<br>of<br>Ring<br>P | Width<br>of<br>Ring<br>A | Height of<br>Octagonal<br>Ring<br>H | Oct.<br>Ring<br>Flat<br>C | Ring<br>No. | Pitch<br>Dia.<br>of<br>Ring<br>P | Width<br>of<br>Ring<br>A | Height of<br>Octagonal<br>Ring<br>H | Oct.<br>Ring<br>Flat<br>C | Ring<br>No. |
| 12                           | 15.000                           | 0.438                    | 0.625                               | 0.305                     | R57         | 15.000                           | 0.438                    | 0.625                               | 0.305                     | R57         |
| 14                           | 16.500                           | 0.438                    | 0.625                               | 0.305                     | R61         | 16.500                           | 0.625                    | 0.812                               | 0.413                     | R62         |
| 16                           | 18.500                           | 0.438                    | 0.625                               | 0.305                     | R65         | 18.500                           | 0.625                    | 0.812                               | 0.413                     | R66         |
| 18                           | 21.000                           | 0.438                    | 0.625                               | 0.305                     | R69         | 21.000                           | 0.750                    | 0.938                               | 0.485                     | R70         |
| 20                           | 23.000                           | 0.500                    | 0.688                               | 0.341                     | R73         | 23.000                           | 0.750                    | 0.938                               | 0.485                     | R74         |
| 22                           | 25.000                           | 0.562                    | 0.750                               | 0.377                     | R81         | —                                | —                        | —                                   | —                         | —           |
| 24                           | 27.250                           | 0.625                    | 0.812                               | 0.413                     | R77         | 27.250                           | 1.000                    | 1.250                               | 0.681                     | R78         |
| 26                           | 29.500                           | 0.750                    | 0.938                               | 0.485                     | R93         | 29.500                           | 1.125                    | 1.375                               | 0.780                     | R100        |
| 28                           | 31.500                           | 0.750                    | 0.938                               | 0.485                     | R94         | 31.500                           | 1.250                    | 1.500                               | 0.879                     | R101        |
| 30                           | 33.750                           | 0.750                    | 0.938                               | 0.485                     | R95         | 33.750                           | 1.250                    | 1.500                               | 0.879                     | R102        |
| 32                           | 36.000                           | 0.875                    | 1.062                               | 0.583                     | R96         | 36.000                           | 1.250                    | 1.500                               | 0.879                     | R103        |
| 34                           | 38.000                           | 0.875                    | 1.062                               | 0.583                     | R97         | 38.000                           | 1.375                    | 1.625                               | 0.977                     | R104        |
| 36                           | 40.250                           | 0.875                    | 1.062                               | 0.583                     | R98         | 40.250                           | 1.375                    | 1.625                               | 0.977                     | R105        |

## SUPPLEMENTAL INFORMATION

NOTE: <sup>(1)</sup> For matching tolerances of ring-joint gasket dimensions, see ASME B16.20.  
Ring-Joint Gaskets are not contemplated for size 38, and larger flanges.

TABLE 6 — CLASS 150, 285 PSI AT ATMOSPHERIC TEMPERATURE RAISED FACE<sup>(a)</sup>

Dimensions in inches

| PIPE SIZE | FLANGE DIMENSIONS |                          |                   | HUB DIMENSIONS     | DRILLING          |                    |                     | Raised Face Dia. R | Fillet Radius (MIN) A |
|-----------|-------------------|--------------------------|-------------------|--------------------|-------------------|--------------------|---------------------|--------------------|-----------------------|
|           | OD of Flange O    | Thick. of Flange C (MIN) | Length Thru Hub Y | OD Large End Hub X | No. of Bolt Holes | Dia. of Bolt Holes | Dia. of Bolt Circle |                    |                       |
| 12        | 19.00             | 1.25                     | 4.50              | 14.38              | 12                | 1.00               | 17.00               | 15.00              | 0.38                  |
| 14        | 21.00             | 1.38                     | 5.00              | 15.75              | 12                | 1.12               | 18.75               | 16.25              | 0.38                  |
| 16        | 23.50             | 1.44                     | 5.00              | 18.00              | 16                | 1.12               | 21.25               | 18.50              | 0.38                  |
| 18        | 25.00             | 1.56                     | 5.50              | 19.88              | 16                | 1.25               | 22.75               | 21.00              | 0.38                  |
| 20        | 27.50             | 1.69                     | 5.69              | 22.00              | 20                | 1.25               | 25.00               | 23.00              | 0.38                  |
| 22        | 29.50             | 1.81                     | 5.88              | 24.00              | 20                | 1.38               | 27.25               | 25.25              | 0.38                  |
| 24        | 32.00             | 1.88                     | 6.00              | 26.12              | 20                | 1.38               | 29.50               | 27.25              | 0.38                  |
| 26        | 34.25             | 2.69                     | 4.75              | 26.62              | 24                | 1.38               | 31.75               | 29.50              | 0.38                  |
| 28        | 36.50             | 2.81                     | 4.94              | 28.62              | 28                | 1.38               | 34.00               | 31.50              | 0.44                  |
| 30        | 38.75             | 2.94                     | 5.38              | 30.75              | 28                | 1.38               | 36.00               | 33.75              | 0.44                  |
| 32        | 41.75             | 3.18                     | 5.69              | 32.75              | 28                | 1.62               | 38.50               | 36.00              | 0.44                  |
| 34        | 43.75             | 3.25                     | 5.88              | 34.75              | 32                | 1.62               | 40.50               | 38.00              | 0.50                  |
| 36        | 46.00             | 3.56                     | 6.19              | 36.75              | 32                | 1.62               | 42.75               | 40.25              | 0.50                  |
| 38        | 48.75             | 3.44                     | 6.19              | 39.00              | 32                | 1.62               | 45.25               | 42.25              | 0.50                  |
| 40        | 50.75             | 3.56                     | 6.44              | 41.00              | 36                | 1.62               | 47.25               | 44.25              | 0.50                  |
| 42        | 53.00             | 3.81                     | 6.75              | 43.00              | 36                | 1.62               | 49.50               | 47.00              | 0.50                  |
| 44        | 55.25             | 4.00                     | 7.00              | 45.00              | 40                | 1.62               | 51.75               | 49.00              | 0.50                  |
| 46        | 57.25             | 4.06                     | 7.31              | 47.12              | 40                | 1.62               | 53.75               | 51.00              | 0.50                  |
| 48        | 59.50             | 4.25                     | 7.56              | 49.12              | 44                | 1.62               | 56.00               | 53.50              | 0.50                  |
| 50        | 61.75             | 4.38                     | 8.00              | 51.25              | 44                | 1.88               | 58.25               | 55.50              | 0.50                  |
| 52        | 64.00             | 4.56                     | 8.25              | 53.25              | 44                | 1.88               | 60.50               | 57.50              | 0.50                  |
| 54        | 66.25             | 4.75                     | 8.50              | 55.25              | 44                | 1.88               | 62.75               | 59.50              | 0.50                  |
| 56        | 68.75             | 4.88                     | 9.00              | 57.38              | 48                | 1.88               | 65.00               | 62.00              | 0.50                  |
| 58        | 71.00             | 5.06                     | 9.25              | 59.38              | 48                | 1.88               | 67.25               | 64.00              | 0.50                  |
| 60        | 73.00             | 5.19                     | 9.44              | 61.38              | 52                | 1.88               | 69.25               | 66.00              | 0.50                  |

General Notes:

For matching tolerances see Section 10.

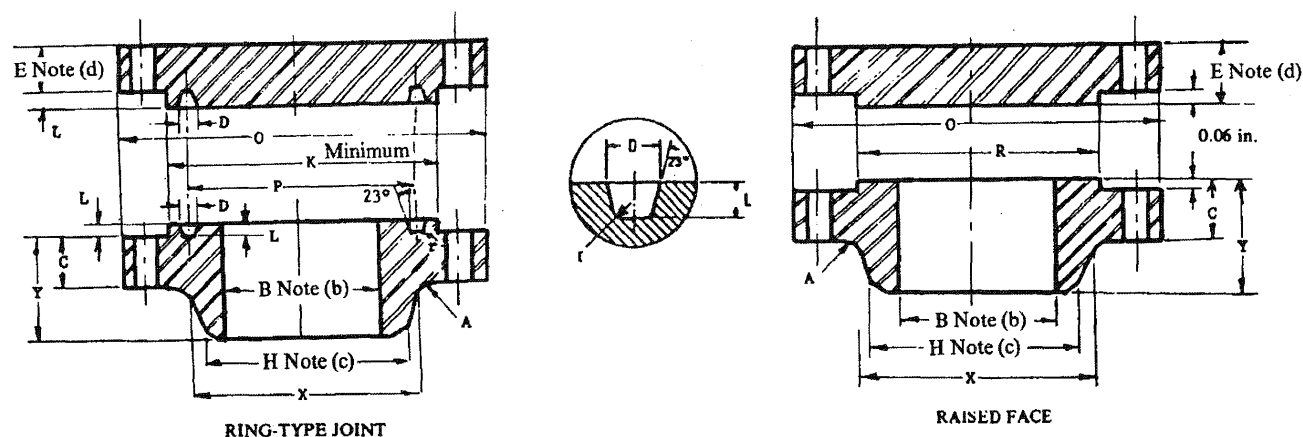
For matching end detail see Figures 1, 2 and 3.

(a) Rating for raised face flanges is predicated on the use of sheet gaskets shown in Table 2.

(b) Dimensions to be specified by customer.

(c) See Section 5.

(d) Where calculated blind thickness is less than the mating welding neck, the thicknesses were made equal. See paragraph 5.5 for material requirements.



**TABLE 7 — CLASS 300, 740 PSI AT ATMOSPHERIC TEMPERATURE RAISED FACE<sup>(a)</sup> AND RING-TYPE JOINTS**

Dimensions in inches

| Pipe Size | FLANGE DIMENSIONS |                 |                    |                      | HUB DIM.         | DRILLING                     |                   |                    | FACING DIMENSIONS   |                       |                      |                 |                      |          | Fillet Radius (min)<br>A | Groove Fillet Radius<br>r |
|-----------|-------------------|-----------------|--------------------|----------------------|------------------|------------------------------|-------------------|--------------------|---------------------|-----------------------|----------------------|-----------------|----------------------|----------|--------------------------|---------------------------|
|           | OD of Flange<br>O | Thick of Flange |                    | Length Thru Hub<br>Y |                  | OD (e) of Large End Hub<br>X | No. of Bolt Holes | Dia. of Bolt Holes | Dia. of Bolt Circle | Raised Face Dia.<br>R | Ring-Type Joint      |                 |                      |          |                          |                           |
|           |                   | Weld-Neck<br>C  | (d) Bld. Flg.<br>E |                      | Facing Dia.<br>K |                              |                   |                    |                     |                       | Depth of Groove<br>L | Pitch Dia.<br>P | Width of Groove<br>D | Ring No. |                          |                           |
|           |                   |                 |                    |                      |                  |                              |                   |                    |                     |                       |                      |                 |                      |          |                          |                           |
| 12        | 20.50             | 2.00            | 2.00               | 5.12                 | 14.75            | 16                           | 1.25              | 17.75              | 15.00               | 16.25                 | 0.312                | 15.000          | 0.469                | R57      | 0.38                     | 0.03                      |
| 14        | 23.00             | 2.12            | 2.12               | 5.62                 | 16.75            | 20                           | 1.25              | 20.25              | 16.25               | 18.00                 | 0.312                | 16.500          | 0.469                | R61      | 0.38                     | 0.03                      |
| 16        | 25.50             | 2.25            | 2.25               | 5.75                 | 19.00            | 20                           | 1.38              | 22.50              | 18.50               | 20.00                 | 0.312                | 18.500          | 0.469                | R65      | 0.38                     | 0.03                      |
| 18        | 28.00             | 2.38            | 2.38               | 6.25                 | 21.00            | 24                           | 1.38              | 24.75              | 21.00               | 22.62                 | 0.312                | 21.000          | 0.469                | R69      | 0.38                     | 0.03                      |
| 20        | 30.50             | 2.50            | 2.50               | 6.38                 | 23.12            | 24                           | 1.38              | 27.00              | 23.00               | 25.00                 | 0.375                | 23.000          | 0.531                | R73      | 0.38                     | 0.06                      |
| 22        | 33.00             | 2.62            | 2.62               | 6.50                 | 25.25            | 24                           | 1.62              | 29.25              | 25.25               | 27.00                 | 0.438                | 25.000          | 0.594                | R81      | 0.38                     | 0.06                      |
| 24        | 36.00             | 2.75            | 2.75               | 6.62                 | 27.62            | 24                           | 1.62              | 32.00              | 27.25               | 29.50                 | 0.438                | 27.250          | 0.656                | R77      | 0.38                     | 0.06                      |
| 26        | 38.25             | 3.12            | 3.31               | 7.25                 | 28.38            | 28                           | 1.75              | 34.50              | 29.50               | 31.88                 | 0.500                | 29.500          | 0.781                | R93      | 0.38                     | 0.06                      |
| 28        | 40.75             | 3.38            | 3.56               | 7.75                 | 30.50            | 28                           | 1.75              | 37.00              | 31.50               | 33.88                 | 0.500                | 31.500          | 0.781                | R94      | 0.44                     | 0.06                      |
| 30        | 43.00             | 3.62            | 3.75               | 8.25                 | 32.56            | 28                           | 1.88              | 39.25              | 33.75               | 36.12                 | 0.500                | 33.750          | 0.781                | R95      | 0.44                     | 0.06                      |
| 32        | 45.25             | 3.88            | 3.94               | 8.75                 | 34.69            | 28                           | 2.00              | 41.50              | 36.00               | 38.75                 | 0.562                | 36.000          | 0.906                | R96      | 0.44                     | 0.06                      |
| 34        | 47.50             | 4.00            | 4.12               | 9.12                 | 36.88            | 28                           | 2.00              | 43.50              | 38.00               | 40.75                 | 0.562                | 38.000          | 0.906                | R97      | 0.50                     | 0.06                      |
| 36        | 50.00             | 4.12            | 4.38               | 9.50                 | 39.00            | 32                           | 2.12              | 46.00              | 40.25               | 43.00                 | 0.562                | 40.250          | 0.906                | R98      | 0.50                     | 0.06                      |
| 38        | 46.00             | 4.25            | 4.25               | 7.12                 | 39.12            | 32                           | 1.62              | 43.00              | 40.50               | ---                   | ---                  | ---             | ---                  | ---      | 0.50                     | ---                       |
| 40        | 48.75             | 4.50            | 4.50               | 7.62                 | 41.25            | 32                           | 1.75              | 45.50              | 42.75               | ---                   | ---                  | ---             | ---                  | ---      | 0.50                     | ---                       |
| 42        | 50.75             | 4.69            | 4.69               | 7.88                 | 43.25            | 32                           | 1.75              | 47.50              | 44.75               | ---                   | ---                  | ---             | ---                  | ---      | 0.50                     | ---                       |
| 44        | 53.25             | 4.88            | 4.88               | 8.12                 | 45.25            | 32                           | 1.88              | 49.75              | 47.00               | ---                   | ---                  | ---             | ---                  | ---      | 0.50                     | ---                       |
| 46        | 55.75             | 5.06            | 5.06               | 8.50                 | 47.38            | 28                           | 2.00              | 52.00              | 49.00               | ---                   | ---                  | ---             | ---                  | ---      | 0.50                     | ---                       |
| 48        | 57.75             | 5.25            | 5.25               | 8.81                 | 49.38            | 32                           | 2.00              | 54.00              | 51.25               | ---                   | ---                  | ---             | ---                  | ---      | 0.50                     | ---                       |
| 50        | 60.25             | 5.50            | 5.50               | 9.12                 | 51.38            | 32                           | 2.12              | 56.25              | 53.50               | ---                   | ---                  | ---             | ---                  | ---      | 0.50                     | ---                       |
| 52        | 62.25             | 5.69            | 5.69               | 9.38                 | 53.38            | 32                           | 2.12              | 58.25              | 55.50               | ---                   | ---                  | ---             | ---                  | ---      | 0.50                     | ---                       |
| 54        | 65.25             | 6.00            | 6.00               | 9.94                 | 55.50            | 28                           | 2.38              | 61.00              | 57.75               | ---                   | ---                  | ---             | ---                  | ---      | 0.50                     | ---                       |
| 56        | 67.25             | 6.06            | 6.06               | 10.25                | 57.62            | 28                           | 2.38              | 63.00              | 59.75               | ---                   | ---                  | ---             | ---                  | ---      | 0.50                     | ---                       |
| 58        | 69.25             | 6.25            | 6.25               | 10.50                | 59.62            | 32                           | 2.38              | 65.00              | 62.00               | ---                   | ---                  | ---             | ---                  | ---      | 0.50                     | ---                       |
| 60        | 71.25             | 6.44            | 6.44               | 10.75                | 61.62            | 32                           | 2.38              | 67.00              | 64.00               | ---                   | ---                  | ---             | ---                  | ---      | 0.50                     | ---                       |

General Notes:

For matching tolerances see Section 10.

For welding end detail see Figures 1, 2 and 3.

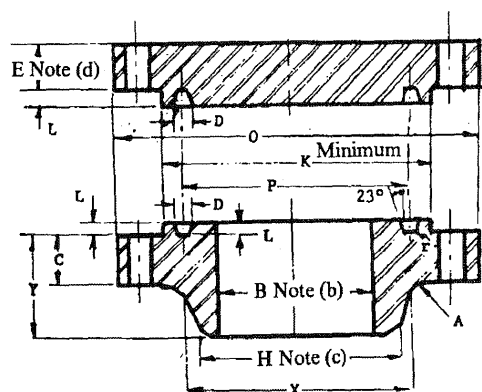
Notes: (a) Rating for raised face flanges is predicated on the use of sheet gaskets shown in Table 2.

(b) Dimensions to be specified by customer.

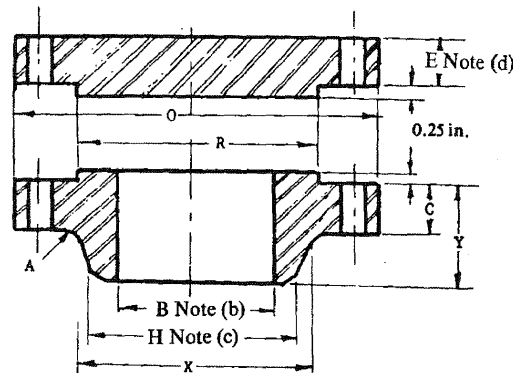
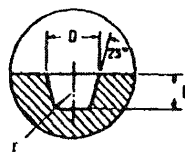
(c) See Section 5.

(d) Where calculated blind thickness is less than the mating welding neck, the thicknesses were made equal. See paragraph 5.5 for material requirements.

(e) Hub dimension for Size 24 and smaller flanges may vary as explained in paragraph 5.3.2.



RING-TYPE JOINT



RAISED FACE

TABLE 8 — CLASS 400, 990 PSI AT ATMOSPHERIC TEMPERATURE RAISED FACE<sup>(a)</sup> AND RING-TYPE JOINTS

Dimensions in inches

| Pipe<br>Size | FLANGE DIMENSIONS    |                 |                    |                         | HUB DIM.                 | DRILLING                |                          |                           |                             | FACING DIMENSIONS   |                            |                    |                         |             |      | Fillet<br>Radius<br>(min.)<br>A | Groove<br>Fillet<br>Radius<br>r |
|--------------|----------------------|-----------------|--------------------|-------------------------|--------------------------|-------------------------|--------------------------|---------------------------|-----------------------------|---------------------|----------------------------|--------------------|-------------------------|-------------|------|---------------------------------|---------------------------------|
|              | OD of<br>Flange<br>O | THICK OF FLANGE |                    | Length<br>Thru Hub<br>Y | OD Large<br>End Hub<br>X | No. of<br>Bolt<br>Holes | Dia. of<br>Bolt<br>Holes | Dia. of<br>Bolt<br>Circle | Raised<br>Face<br>Dia.<br>R | RING-TYPE JOINT     |                            |                    |                         |             |      |                                 |                                 |
|              |                      | Weld-Neck<br>C  | Bld. Flg. (d)<br>E |                         |                          |                         |                          |                           |                             | Facing<br>Dia.<br>K | Depth<br>of<br>Groove<br>L | Pitch<br>Dia.<br>P | Width of<br>Groove<br>D | Ring<br>No. |      |                                 |                                 |
|              |                      |                 |                    |                         |                          |                         |                          |                           |                             |                     |                            |                    |                         |             |      |                                 |                                 |
| 12           | 20.50                | 2.25            | 2.25               | 5.38                    | 14.75                    | 16                      | 1.38                     | 17.75                     | 15.00                       | 16.25               | 0.312                      | 15.000             | 0.469                   | R57         | 0.44 | 0.03                            |                                 |
| 14           | 23.00                | 2.38            | 2.38               | 5.88                    | 16.75                    | 20                      | 1.38                     | 20.25                     | 16.25                       | 18.00               | 0.312                      | 16.500             | 0.469                   | R61         | 0.44 | 0.03                            |                                 |
| 16           | 25.50                | 2.50            | 2.50               | 6.00                    | 19.00                    | 20                      | 1.50                     | 22.50                     | 18.50                       | 20.00               | 0.312                      | 18.500             | 0.469                   | R65         | 0.44 | 0.03                            |                                 |
| 18           | 28.00                | 2.62            | 2.62               | 6.50                    | 21.00                    | 24                      | 1.50                     | 24.75                     | 21.00                       | 22.62               | 0.312                      | 21.000             | 0.469                   | R69         | 0.44 | 0.03                            |                                 |
| 20           | 30.50                | 2.75            | 2.75               | 6.62                    | 23.12                    | 24                      | 1.62                     | 27.00                     | 23.00                       | 25.00               | 0.375                      | 23.000             | 0.531                   | R73         | 0.44 | 0.06                            |                                 |
| 22           | 33.00                | 2.88            | 2.88               | 6.75                    | 25.25                    | 24                      | 1.75                     | 29.25                     | 25.25                       | 27.00               | 0.438                      | 25.000             | 0.594                   | R81         | 0.44 | 0.06                            |                                 |
| 24           | 36.00                | 3.00            | 3.00               | 6.88                    | 27.62                    | 24                      | 1.88                     | 32.00                     | 27.25                       | 29.50               | 0.438                      | 27.250             | 0.656                   | R77         | 0.44 | 0.06                            |                                 |
| 26           | 38.25                | 3.50            | 3.88               | 7.62                    | 28.62                    | 28                      | 1.88                     | 34.50                     | 29.50                       | 31.88               | 0.500                      | 29.500             | 0.781                   | R93         | 0.44 | 0.06                            |                                 |
| 28           | 40.75                | 3.75            | 4.12               | 8.12                    | 30.81                    | 28                      | 2.00                     | 37.00                     | 31.50                       | 33.88               | 0.500                      | 31.500             | 0.781                   | R94         | 0.50 | 0.06                            |                                 |
| 30           | 43.00                | 4.00            | 4.38               | 8.62                    | 32.94                    | 28                      | 2.12                     | 39.25                     | 33.75                       | 36.12               | 0.500                      | 33.750             | 0.781                   | R95         | 0.50 | 0.06                            |                                 |
| 32           | 45.25                | 4.25            | 4.56               | 9.12                    | 35.00                    | 28                      | 2.12                     | 41.50                     | 36.00                       | 38.75               | 0.562                      | 36.000             | 0.906                   | R96         | 0.50 | 0.06                            |                                 |
| 34           | 47.50                | 4.38            | 4.81               | 9.50                    | 37.19                    | 28                      | 2.12                     | 43.50                     | 38.00                       | 40.75               | 0.562                      | 38.000             | 0.906                   | R97         | 0.56 | 0.06                            |                                 |
| 36           | 50.00                | 4.50            | 5.06               | 9.88                    | 39.38                    | 32                      | 2.12                     | 46.00                     | 40.25                       | 43.00               | 0.562                      | 40.250             | 0.906                   | R98         | 0.56 | 0.06                            |                                 |
| 38           | 47.50                | 4.88            | 4.88               | 8.12                    | 39.50                    | 32                      | 1.88                     | 44.00                     | 40.75                       | -----               | -----                      | -----              | -----                   | -----       | 0.56 | -----                           |                                 |
| 40           | 50.00                | 5.12            | 5.12               | 8.50                    | 41.50                    | 32                      | 2.00                     | 46.25                     | 43.00                       | -----               | -----                      | -----              | -----                   | -----       | 0.56 | -----                           |                                 |
| 42           | 52.00                | 5.25            | 5.25               | 8.81                    | 43.62                    | 32                      | 2.00                     | 48.25                     | 45.00                       | -----               | -----                      | -----              | -----                   | -----       | 0.56 | -----                           |                                 |
| 44           | 54.50                | 5.50            | 5.50               | 9.19                    | 45.62                    | 32                      | 2.12                     | 50.50                     | 47.25                       | -----               | -----                      | -----              | -----                   | -----       | 0.56 | -----                           |                                 |
| 46           | 56.75                | 5.75            | 5.75               | 9.62                    | 47.75                    | 36                      | 2.12                     | 52.75                     | 49.50                       | -----               | -----                      | -----              | -----                   | -----       | 0.56 | -----                           |                                 |
| 48           | 59.50                | 6.00            | 6.00               | 10.12                   | 49.88                    | 28                      | 2.38                     | 55.25                     | 51.50                       | -----               | -----                      | -----              | -----                   | -----       | 0.56 | -----                           |                                 |
| 50           | 61.75                | 6.19            | 6.25               | 10.56                   | 52.00                    | 32                      | 2.38                     | 57.50                     | 53.62                       | -----               | -----                      | -----              | -----                   | -----       | 0.56 | -----                           |                                 |
| 52           | 63.75                | 6.38            | 6.44               | 10.88                   | 54.00                    | 32                      | 2.38                     | 59.50                     | 55.62                       | -----               | -----                      | -----              | -----                   | -----       | 0.56 | -----                           |                                 |
| 54           | 67.00                | 6.69            | 6.75               | 11.38                   | 56.12                    | 28                      | 2.62                     | 62.25                     | 57.88                       | -----               | -----                      | -----              | -----                   | -----       | 0.56 | -----                           |                                 |
| 56           | 69.00                | 6.88            | 6.94               | 11.75                   | 58.25                    | 32                      | 2.62                     | 64.25                     | 60.12                       | -----               | -----                      | -----              | -----                   | -----       | 0.56 | -----                           |                                 |
| 58           | 71.00                | 7.00            | 7.12               | 12.06                   | 60.25                    | 32                      | 2.62                     | 66.25                     | 62.12                       | -----               | -----                      | -----              | -----                   | -----       | 0.56 | -----                           |                                 |
| 60           | 74.25                | 7.31            | 7.44               | 12.56                   | 62.38                    | 32                      | 2.88                     | 69.00                     | 64.38                       | -----               | -----                      | -----              | -----                   | -----       | 0.56 | -----                           |                                 |

General Notes:

For matching tolerances see Section 10.

For welding end detail see Figures 1, 2 and 3.

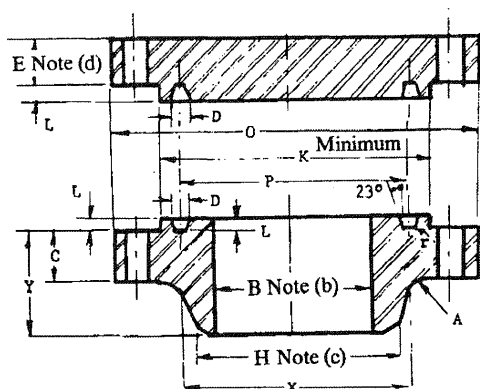
Notes: (a) Rating for raised face flanges is predicated on the use of sheet gaskets shown in Table 2.

(b) Dimensions to be specified by customer.

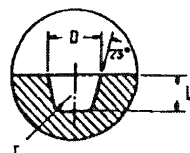
(c) See Section 5.

(d) Where calculated blind thickness is less than the mating welding neck, the thicknesses were made equal. See paragraph 5.5 for material requirements.

(e) Hub dimension for Size 24 and smaller flanges may vary as explained in paragraph 5.3.2.



RING-TYPE JOINT



RAISED FACE

TABLE 9 — CLASS 600, 1480 PSI AT ATMOSPHERIC TEMPERATURE RAISED FACE<sup>(a)</sup> AND RING-TYPE JOINTS

Dimensions in inches

| Pipe Size | FLANGE DIMENSIONS |                 |               |                 | HUB DIM.                |                   | DRILLING           |                     |                  | FACING DIMENSIONS |                 |            |                 |          |      | Fillet Radius (min) | Groove Fillet Radius |
|-----------|-------------------|-----------------|---------------|-----------------|-------------------------|-------------------|--------------------|---------------------|------------------|-------------------|-----------------|------------|-----------------|----------|------|---------------------|----------------------|
|           | OD of Flange      | THICK. OF FLAN. |               | Length Thru Hub | (e)<br>OD Large End Hub | No. of Bolt Holes | Dia. of Bolt Holes | Dia. of Bolt Circle | Raised Face Dia. | RING-TYPE JOINT   |                 |            |                 |          |      |                     |                      |
|           |                   | Weld-Neck       | Bld. Flg. (d) |                 |                         |                   |                    |                     |                  | Facing Dia.       | Depth of Groove | Pitch Dia. | Width of Groove | Ring No. |      |                     |                      |
|           | O                 | C               | E             | Y               | X                       |                   |                    |                     | R                | K                 | L               | P          | D               |          | A    | r                   |                      |
| 12        | 22.00             | 2.62            | 2.62          | 6.12            | 15.75                   | 20                | 1.38               | 19.25               | 15.00            | 16.25             | 0.312           | 15.000     | 0.469           | R57      | 0.44 | 0.03                |                      |
| 14        | 23.75             | 2.75            | 2.75          | 6.50            | 17.00                   | 20                | 1.50               | 20.75               | 16.25            | 18.00             | 0.312           | 16.500     | 0.469           | R61      | 0.44 | 0.03                |                      |
| 16        | 27.00             | 3.00            | 3.00          | 7.00            | 19.50                   | 20                | 1.62               | 23.75               | 18.50            | 20.00             | 0.312           | 18.500     | 0.469           | R65      | 0.44 | 0.03                |                      |
| 18        | 29.25             | 3.25            | 3.25          | 7.25            | 21.50                   | 20                | 1.75               | 25.75               | 21.00            | 22.62             | 0.312           | 21.000     | 0.469           | R69      | 0.44 | 0.03                |                      |
| 20        | 32.00             | 3.50            | 3.50          | 7.50            | 24.00                   | 24                | 1.75               | 28.50               | 23.00            | 25.00             | 0.375           | 23.000     | 0.531           | R73      | 0.44 | 0.06                |                      |
| 22        | 34.25             | 3.75            | 3.75          | 7.75            | 26.25                   | 24                | 1.88               | 30.62               | 25.25            | 27.00             | 0.438           | 25.000     | 0.594           | R81      | 0.44 | 0.06                |                      |
| 24        | 37.00             | 4.00            | 4.00          | 8.00            | 28.25                   | 24                | 2.00               | 33.00               | 27.25            | 29.50             | 0.438           | 27.250     | 0.656           | R77      | 0.44 | 0.06                |                      |
| 26        | 40.00             | 4.25            | 4.94          | 8.75            | 29.44                   | 28                | 2.00               | 36.00               | 29.50            | 31.88             | 0.500           | 29.500     | 0.781           | R93      | 0.50 | 0.06                |                      |
| 28        | 42.25             | 4.38            | 5.19          | 9.25            | 31.62                   | 28                | 2.12               | 38.00               | 31.50            | 33.88             | 0.500           | 31.500     | 0.781           | R94      | 0.50 | 0.06                |                      |
| 30        | 44.50             | 4.50            | 5.50          | 9.75            | 33.94                   | 28                | 2.12               | 40.25               | 33.75            | 36.12             | 0.500           | 33.750     | 0.781           | R95      | 0.50 | 0.06                |                      |
| 32        | 47.00             | 4.62            | 5.81          | 10.25           | 36.12                   | 28                | 2.38               | 42.50               | 36.00            | 38.75             | 0.562           | 36.000     | 0.906           | R96      | 0.50 | 0.06                |                      |
| 34        | 49.00             | 4.75            | 6.06          | 10.62           | 38.31                   | 28                | 2.38               | 44.50               | 38.00            | 40.75             | 0.562           | 38.000     | 0.906           | R97      | 0.56 | 0.06                |                      |
| 36        | 51.75             | 4.88            | 6.38          | 11.12           | 40.62                   | 28                | 2.62               | 47.00               | 40.25            | 43.00             | 0.562           | 40.250     | 0.906           | R98      | 0.56 | 0.06                |                      |
| 38        | 50.00             | 6.00            | 6.12          | 10.00           | 40.25                   | 28                | 2.38               | 45.75               | 41.50            | ----              | ----            | ----       | ----            | ----     | 0.56 | ----                |                      |
| 40        | 52.00             | 6.25            | 6.38          | 10.38           | 42.25                   | 32                | 2.38               | 47.75               | 43.75            | ----              | ----            | ----       | ----            | ----     | 0.56 | ----                |                      |
| 42        | 55.25             | 6.62            | 6.75          | 11.00           | 44.38                   | 28                | 2.62               | 50.50               | 46.00            | ----              | ----            | ----       | ----            | ----     | 0.56 | ----                |                      |
| 44        | 57.25             | 6.81            | 7.00          | 11.38           | 46.50                   | 32                | 2.62               | 52.50               | 48.25            | ----              | ----            | ----       | ----            | ----     | 0.56 | ----                |                      |
| 46        | 59.50             | 7.06            | 7.31          | 11.81           | 48.62                   | 32                | 2.62               | 54.75               | 50.25            | ----              | ----            | ----       | ----            | ----     | 0.56 | ----                |                      |
| 48        | 62.75             | 7.44            | 7.69          | 12.44           | 50.75                   | 32                | 2.88               | 57.50               | 52.50            | ----              | ----            | ----       | ----            | ----     | 0.56 | ----                |                      |
| 50        | 65.75             | 7.75            | 8.00          | 12.94           | 52.88                   | 28                | 3.12               | 60.00               | 54.50            | ----              | ----            | ----       | ----            | ----     | 0.56 | ----                |                      |
| 52        | 67.75             | 8.00            | 8.25          | 13.25           | 54.88                   | 32                | 3.12               | 62.00               | 56.50            | ----              | ----            | ----       | ----            | ----     | 0.56 | ----                |                      |
| 54        | 70.00             | 8.25            | 8.56          | 13.75           | 57.00                   | 32                | 3.12               | 64.25               | 58.75            | ----              | ----            | ----       | ----            | ----     | 0.56 | ----                |                      |
| 56        | 73.00             | 8.56            | 8.88          | 14.25           | 59.12                   | 32                | 3.38               | 66.75               | 60.75            | ----              | ----            | ----       | ----            | ----     | 0.62 | ----                |                      |
| 58        | 75.00             | 8.75            | 9.12          | 14.56           | 61.12                   | 32                | 3.38               | 68.75               | 63.00            | ----              | ----            | ----       | ----            | ----     | 0.62 | ----                |                      |
| 60        | 78.50             | 9.19            | 9.56          | 15.31           | 63.38                   | 28                | 3.62               | 71.75               | 65.25            | ----              | ----            | ----       | ----            | ----     | 0.69 | ----                |                      |

General Notes:

For matching tolerances see Section 10.

For welding end detail see Figures 1, 2 and 3.

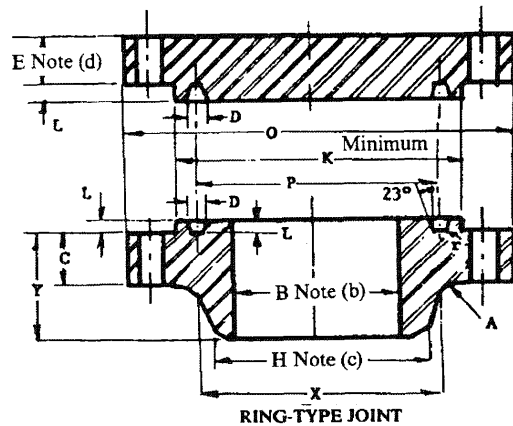
Notes: (a) Rating for raised face flanges is predicated on the use of sheet gaskets shown in Table 2.

(b) Dimensions to be specified by customer.

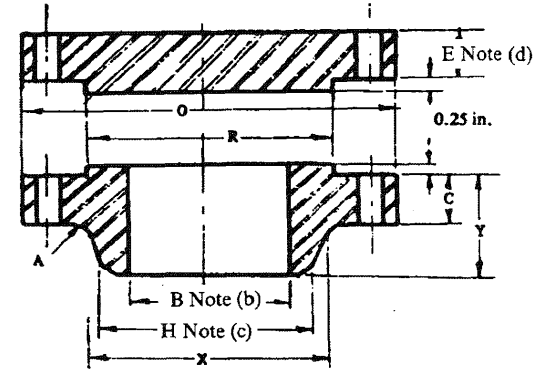
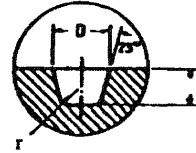
(c) See Section 5.

(d) Where calculated blind thickness is less than the mating welding neck, the thicknesses were made equal. See paragraph 5.5 for material requirements.

(e) Hub dimension for Size 24 and smaller flanges may vary as explained in paragraph 5.3.2.



RING-TYPE JOINT



RAISED FACE

TABLE 10—CLASS 900, 2220 PSI AT ATMOSPHERIC TEMPERATURE RAISED FACE(a) AND RING-TYPE JOINTS Dimensions in inches

| Pipe<br>Size | FLANGE DIMENSIONS    |                 |                               |                         | HUB DIM.<br><br>OD<br>Large<br>End Hub<br><br>X | DRILLING                |                          |                           | FACING DIMENSIONS           |                     |                            |                    |                            |             | Fillet<br>Radius<br>(min)<br>A | Groove<br>Fillet<br>Radius<br>r |
|--------------|----------------------|-----------------|-------------------------------|-------------------------|-------------------------------------------------|-------------------------|--------------------------|---------------------------|-----------------------------|---------------------|----------------------------|--------------------|----------------------------|-------------|--------------------------------|---------------------------------|
|              | OD of<br>Flange<br>O | THICK OF FLANGE |                               | Length<br>Thru Hub<br>Y |                                                 | No. of<br>Bolt<br>Holes | Dia. of<br>Bolt<br>Holes | Dia. of<br>Bolt<br>Circle | Raised<br>Face<br>Dia.<br>R | RING-TYPE JOINT     |                            |                    |                            |             |                                |                                 |
|              |                      | Weld-Neck<br>C  | Bld. Fig. <sup>(d)</sup><br>E |                         |                                                 |                         |                          |                           |                             | Facing<br>Dia.<br>K | Depth<br>of<br>Groove<br>L | Pitch<br>Dia.<br>P | Width<br>of<br>Groove<br>D | Ring<br>No. |                                |                                 |
|              |                      |                 |                               |                         |                                                 |                         |                          |                           |                             |                     |                            |                    |                            |             |                                |                                 |
| 12           | 24.00                | 3.12            | 3.12                          | 7.88                    | 16.50                                           | 20                      | 1.50                     | 21.00                     | 15.00                       | 16.50               | 0.312                      | 15.000             | 0.469                      | R57         | 0.44                           | 0.03                            |
| 14           | 25.25                | 3.38            | 3.38                          | 8.38                    | 17.75                                           | 20                      | 1.62                     | 22.00                     | 16.25                       | 18.38               | 0.438                      | 16.500             | 0.656                      | R62         | 0.44                           | 0.06                            |
| 16           | 27.75                | 3.50            | 3.50                          | 8.50                    | 20.00                                           | 20                      | 1.75                     | 24.25                     | 18.50                       | 20.62               | 0.438                      | 18.500             | 0.656                      | R66         | 0.44                           | 0.06                            |
| 18           | 31.00                | 4.00            | 4.00                          | 9.00                    | 22.25                                           | 20                      | 2.00                     | 27.00                     | 21.00                       | 23.38               | 0.500                      | 21.000             | 0.781                      | R70         | 0.44                           | 0.06                            |
| 20           | 33.75                | 4.25            | 4.25                          | 9.75                    | 24.50                                           | 20                      | 2.12                     | 29.50                     | 23.00                       | 25.50               | 0.500                      | 23.000             | 0.781                      | R74         | 0.44                           | 0.06                            |
| 24           | 41.00                | 5.50            | 5.50                          | 11.50                   | 29.50                                           | 20                      | 2.62                     | 35.50                     | 27.25                       | 30.38               | 0.625                      | 27.250             | 1.062                      | R78         | 0.44                           | 0.09                            |
| 26           | 42.75                | 5.50            | 6.31                          | 11.25                   | 30.50                                           | 20                      | 2.88                     | 37.50                     | 29.50                       | 32.75               | 0.688                      | 29.500             | 1.188                      | R100        | 0.44                           | 0.09                            |
| 28           | 46.00                | 5.62            | 6.75                          | 11.75                   | 32.75                                           | 20                      | 3.12                     | 40.25                     | 31.50                       | 35.00               | 0.688                      | 31.500             | 1.312                      | R101        | 0.50                           | 0.09                            |
| 30           | 48.50                | 5.88            | 7.18                          | 12.25                   | 35.00                                           | 20                      | 3.12                     | 42.75                     | 33.75                       | 37.25               | 0.688                      | 33.750             | 1.312                      | R102        | 0.50                           | 0.09                            |
| 32           | 51.75                | 6.25            | 7.62                          | 13.00                   | 37.25                                           | 20                      | 3.38                     | 45.50                     | 36.00                       | 39.50               | 0.688                      | 36.000             | 1.312                      | R103        | 0.50                           | 0.09                            |
| 34           | 55.00                | 6.50            | 8.06                          | 13.75                   | 39.62                                           | 20                      | 3.62                     | 48.25                     | 38.00                       | 42.00               | 0.812                      | 38.000             | 1.438                      | R104        | 0.56                           | 0.09                            |
| 36           | 57.50                | 6.75            | 8.44                          | 14.25                   | 41.88                                           | 20                      | 3.62                     | 50.75                     | 40.25                       | 44.25               | 0.812                      | 40.250             | 1.438                      | R105        | 0.56                           | 0.09                            |
| 38           | 57.50                | 7.50            | 8.50                          | 13.88                   | 42.25                                           | 20                      | 3.62                     | 50.75                     | 43.25                       | —                   | —                          | —                  | —                          | —           | 0.75                           | —                               |
| 40           | 59.50                | 7.75            | 8.81                          | 14.31                   | 44.38                                           | 24                      | 3.62                     | 52.75                     | 45.75                       | —                   | —                          | —                  | —                          | —           | 0.81                           | —                               |
| 42           | 61.50                | 8.12            | 9.12                          | 14.62                   | 46.31                                           | 24                      | 3.62                     | 54.75                     | 47.75                       | —                   | —                          | —                  | —                          | —           | 0.81                           | —                               |
| 44           | 64.88                | 8.44            | 9.56                          | 15.38                   | 48.62                                           | 24                      | 3.88                     | 57.62                     | 50.00                       | —                   | —                          | —                  | —                          | —           | 0.88                           | —                               |
| 46           | 68.25                | 8.88            | 10.06                         | 16.18                   | 50.88                                           | 24                      | 4.12                     | 60.50                     | 52.50                       | —                   | —                          | —                  | —                          | —           | 0.88                           | —                               |
| 48           | 70.25                | 9.19            | 10.38                         | 16.50                   | 52.88                                           | 24                      | 4.12                     | 62.50                     | 54.50                       | —                   | —                          | —                  | —                          | —           | 0.94                           | —                               |

General Notes:

For matching tolerances see Section 10.

For welding end detail see Figures 1, 2 and 3.

Notes: (a) Rating for raised face flanges is predicated on the use of sheet gaskets shown in Table 2.

(b) Dimensions to be specified by customer.

(c) See Section 5.

(d) Where calculated blind thickness is less than the mating welding neck, the thicknesses were made equal. See paragraph 5.5 for material requirements.

(e) Hub dimension for Size 24 and smaller flanges may vary as explained in paragraph 5.3.2.

TABLE 11 — PERMISSABLE IMPERFECTIONS IN FLANGE FACING FINISH<sup>(a)</sup>

| NPS     | MAXIMUM RADIAL <sup>(b)</sup><br>PROJECTION OF IMPERFECTIONS<br>WHICH ARE NO DEEPER THAN<br>THE BOTTOM OF THE<br>SERRATIONS, IN. | MAXIMUM DEPTH AND RADIAL<br>PROJECTION OF IMPERFECTIONS<br>WHICH ARE DEEPER THAN<br>THE BOTTOM OF THE<br>SERRATIONS, IN. |
|---------|----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 12 - 14 | 0.31                                                                                                                             | 0.18                                                                                                                     |
| 16      | 0.38                                                                                                                             | 0.18                                                                                                                     |
| 18 - 24 | 0.50                                                                                                                             | 0.25                                                                                                                     |
| 26 - 36 | 0.50                                                                                                                             | 0.25                                                                                                                     |
| 38 - 48 | 0.56                                                                                                                             | 0.28                                                                                                                     |
| 50 - 60 | 0.62                                                                                                                             | 0.31                                                                                                                     |

- NOTES: <sup>(a)</sup> Imperfections less than half the depth of the serrations shall not be cause for rejection. See paragraph 7.4.
- <sup>(b)</sup> A radial projection shall be measured by the difference between an inner radius and an outer radius encompassing the imperfection where the radius is struck from the center line of the bore.

## ANNEX A

### DESIGN CRITERIA

This Annex is an integral part of this Standard Practice which is placed after the main text for convenience.

These flanges were designed in accordance with the formula of paragraphs UA 45 - UA 59 (inclusive) of Section VIII Unfired Pressure Vessel, Division 1. (1950ed.) Currently, the equivalent paragraphs are found in Appendix 2 of ASME Section VIII Division 1. This Annex is presented as a description of the basis for this Standard. Any deviations from the dimensions, material, or provisions of this standard are the responsibility of the User/Designer. The maximum allowable stresses were established as follows.

|                               | SIZES 12-36 incl. | SIZES 38-60 incl. |
|-------------------------------|-------------------|-------------------|
|                               | ksi               | ksi               |
| Longitudinal Hub Stress       | 30                | 30                |
| Radial Flange Stress          | 20                | 25                |
| Tangential Flange Stress      | 20                | 25                |
| Average Stress                | 20                | 25                |
| Bolt Stress (2½" and Smaller) | 20                | 25                |
| Bolt Stress (Larger than 2½") |                   | 23                |

1. The suggested ASME Section VIII, Division 1 values of 3700 and 2.75 for Y and M factors of 0.06 in. thick, flat, asbestos ring gaskets were assumed.
2. The widths of the gaskets were established as those whose surface areas would be at least twice the new bolt area.
3. For the Class 300, 400, 600 and 900 flanges, the slope and the O.D. of the hub at the base are designed for welding ends having equivalent yield strength and thickness as those of the mating pipe. The wall thickness of the intended mating pipe was based upon API 5LX-52 with a 0.68 design factor for the NPS 26-36 sizes, and API 5LX-65 with 0.72 design factor for the NPS 38 and larger sizes. When the manufacturer of the NPS 26-36 sizes elects to utilize the alternative permitted in paragraph 5.3.1, or when the mating pipe has a minimum specified yield strength exceeding 65,000 psi, it will be necessary for him to recalculate the design in accordance with the requirements of paragraph 5.3.1.
4. The design of the 38 NPS and larger sizes of the 300 and higher classes of welding neck flanges is predicated upon the flange material having a minimum specified yield strength of at least 42,000 psi in the ring section of the flange and a minimum yield at the welding end at least equal to that specified for the mating pipe. When the yield strength of the welding end of the flange is less than specified, compensation in accordance with paragraph 5.3.1.b may be made, but the hub slope and diameter at larger end must be preserved.
5. The design of all sizes is predicated on the use of heat treated carbon steel bolt studs for Class 150 flanges and alloy steel bolt studs for Class 300, 400, 600, and 900 flanges. Bolt diameters shall be ⅛ in. less than the bolt hole sizes shown in the tables.

## ANNEX B

### BLIND FLANGE DESIGN CRITERIA

This Annex is an integral part of this Standard Practice which is placed after the main text for convenience.

Blind flanges were designed in accordance with the formula of Paragraph UG34 of Section VIII (Pressure Vessels, Division 1) of the ASME Boiler and Pressure Vessel Code. The thicknesses listed in Tables 6, 7, 8, 9 and 10 were based on material having mechanical properties for Grade F36 of Table 1 with allowable stresses as listed below:

|                     | SIZES 26-60      |
|---------------------|------------------|
|                     | KSI              |
| Blind Flange Stress | 26<br>(1.5x17.5) |

Where the calculated blind flange thickness is less than the mating welding neck, the thicknesses were made equal to the welding neck thicknesses.

Blind flanges may be produced using any of the higher strength grades of materials listed in Table 1. The thicknesses may then be reduced in accordance with the following formula, but in no case shall they be thinner than the corresponding welding neck flange:

$$E' = E \sqrt{\frac{60000}{UTS_F}}$$

where  $E'$  = Reduced blind flange thicknesses based on higher grade material.

$E^{(a)}$  = Present blind thickness based on F36 grade material (See Tables 6-10).

$UTS_F$  = Tensile strength of higher grade material from Table 1.

Blinds produced to a thinner thickness from higher strength material should be identified in the marking with the higher grade material designation. All other marking required by Section 6 shall be included.

NOTE: <sup>(a)</sup>  $E'$  shall not be less than the corresponding welding neck flange thickness "C".

## | ANNEX C |

## Referenced Standards and Applicable Dates

This Annex is an integral part of this Standard Practice which is placed after the main text for convenience.

ANSI, ANSI/ASME, ASME/ANSI, ASME

|                                                                   |                                                       |
|-------------------------------------------------------------------|-------------------------------------------------------|
| B1.1-1989                                                         | Unified Inch Screw Threads                            |
| B16.1-1989                                                        | Cast Iron Pipe Flanges and Flanged Fittings           |
| B16.5-1988-92 add                                                 | Pipe Flanges and Flanged Fittings                     |
| B16.20-1993                                                       | Ring-Joint Gaskets and Grooves for Steel Pipe Flanges |
| B16.47-1990-92 add                                                | Large Diameter Steel Flanges                          |
| B18.2.1-1981 (R 1992)                                             | Square and Hex Bolts and Screws (Inch Series)         |
| B18.2.2-1987 (R 1993)                                             | Square and Hex Nuts (Inch Series)                     |
| B31.1-B31.8-1994                                                  | Code for Pressure Piping                              |
| B46.1-1985                                                        | Surface Texture, Surface Roughness, Waviness, and Lay |
| Boiler and Pressure Vessel Code 1992 Edition (including addendum) |                                                       |

ASTM

|           |                                                                                                                                  |
|-----------|----------------------------------------------------------------------------------------------------------------------------------|
| A 53-93a  | Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless                                                              |
| A 105-92  | Forgings, Carbon Steel, for Piping Components                                                                                    |
| A 106-93  | Seamless Carbon Steel Pipe for High-Temperature Service                                                                          |
| A 193-93a | Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service                                                   |
| A 194-94a | Carbon and Alloy Steel Nuts for Bolts for High-Pressure                                                                          |
| A 307-92a | Carbon Steel Bolts and Studs, 60,000 PSI Tensile                                                                                 |
| A 320-94a | Alloy Steel Bolting Materials for Low Temperature Service                                                                        |
| A 350-93  | Forgings, Carbon and Low Alloy Steel, Requiring Notch Toughness Testing for Piping Components                                    |
| A 354-92a | Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners                                          |
| A 381-93  | Metal-Arc-Welded Steel Pipe for Use with High-Pressure Transmission Systems                                                      |
| A 449-92  | Quenched and Tempered Steel Bolts and Studs                                                                                      |
| A 453-92  | Bolting Materials, High-Temperature, 50 to 120 ksi Yield Strength, With Expansion Coefficients. Comparable to Austenetic Steels. |
| A 540-92  | Alloy-Steel Bolting Materials for Special Applications                                                                           |
| A 694-93  | Forgings, Carbon and Alloy Steel, for Pipe Flanges, Fittings, Valves, and Parts for High-Pressure Transmission Service           |
| A 707-92  | Flanges, Forged, Carbon and Alloy Steel for Low-Temperature Service                                                              |

API

|    |                                           |
|----|-------------------------------------------|
| 5L | Line Pipe, Thirty-Ninth Edition, May 1991 |
|----|-------------------------------------------|

MSS

|            |                                                                  |
|------------|------------------------------------------------------------------|
| SP-9-1992  | Spot Facing for Bronze, Iron and Steel Flanges                   |
| SP-25-1993 | Standard Marking System for Valves, Fittings, Flanges and Unions |

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ANNEX C  
Referenced Standards (con't.)

Publications of the following organizations appear on the previous page:

|      |                                                                                                                                |
|------|--------------------------------------------------------------------------------------------------------------------------------|
| ANSI | American National Standards Institute, Inc.<br>11 West 42nd Street, 13th floor, New York, NY 10036                             |
| API  | American Petroleum Institute<br>1220 L Street, N.W., Washington, D.C. 20005-8029                                               |
| ASME | The American Society of Mechanical Engineers<br>345 East 47th Street, New York, NY 10017-2392                                  |
| ASTM | American Society for Testing and Materials<br>100 Barr Harbor Drive, West Conshohocken, PA 19428-2959                          |
| MSS  | Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.<br>127 Park Street, N.E., Vienna, VA 22180-4602 |

