

306.4.2 Flared Laps. See [para. 308.2.5](#) for requirements of lapped flanges for use with flared laps. A flared lap is suitable for use in Normal Fluid Service, provided that all of the following requirements are met:

- (a) The pipe used shall be of a specification and grade suitable for forming without cracks, surface buckling, or other defects.
- (b) The outside diameter of the lap shall be within the dimensional tolerances of the corresponding ASME B16.9 lap-joint stub end.
- (c) The radius of fillet shall not exceed 3 mm ($\frac{1}{8}$ in.).
- (d) The lap thickness at any point shall be at least 95% of the minimum pipe wall thickness, T , multiplied by the ratio of the pipe outside diameter to the diameter at which the lap thickness is measured.
- (e) Pressure design shall be qualified as required by [para. 304.7.2](#).

306.4.3 Forged Laps. A lap integrally hot-forged on a pipe end is suitable for Normal Fluid Service only when the requirements of [para. 332](#) are met. Its dimensions shall conform to those for lap-joint stub ends given in ASME B16.9.

(18) **306.4.4 Laps for Severe Cyclic Conditions**

- (a) A forged lap-joint stub end in accordance with [para. 306.1](#) or a lap integrally hot-forged on a pipe end in accordance with [para. 306.4.3](#) may be used under severe cyclic conditions.
- (b) A fabricated lap to be used under severe cyclic conditions shall conform to the requirements of [para. 306.4.1](#), except that welding shall be in accordance with [para. 311.1](#). A fabricated lap shall conform to a detail shown in [Figure 328.5.5](#), illustration (d) or (e).
- (c) A flared lap is not permitted under severe cyclic conditions.

306.5 Fabricated Branch Connections

The following requirements do not apply to fittings conforming to [para. 306.1](#).

306.5.1 General. A fabricated branch connection made and verified for pressure design in accordance with [para. 304.3](#), and welded in accordance with [para. 311.1](#), is suitable for use in Normal Fluid Service.

(18) **306.5.2 Fabricated Branch Connections for Severe Cyclic Conditions.** A fabricated branch connection to be used under severe cyclic conditions shall conform to the requirements of [para. 306.5.1](#), except that welding shall be in accordance with [para. 311.1](#), with fabrication limited to a detail equivalent to [Figure 328.5.4D](#), illustration (2) or (4), or to [Figure 328.5.4E](#).

306.6 Thermowells

Thermowells shall comply with ASME PTC 19.3 TW where applicable.

(b) or (d)

307 VALVES AND SPECIALTY COMPONENTS

The following requirements for valves shall also be met as applicable by other pressure-containing piping components, such as traps, strainers, and separators. See also [Appendix F](#), [paras. F301.4](#) and [F307](#).

307.1 General

307.1.1 Listed Valves. A listed valve is suitable for use in Normal Fluid Service, except as stated in [para. 307.2](#).

307.1.2 Unlisted Valves. Unlisted valves may be used only in accordance with [para. 302.2.3](#). Unless pressure-temperature ratings are established by the method set forth in ASME B16.34, pressure design shall be qualified as required by [para. 304.7.2](#).

307.2 Specific Requirements

307.2.1 Bonnet Bolting. A bolted bonnet valve whose bonnet is secured to the body by less than four bolts, or by a U-bolt, may be used only for Category D Fluid Service.

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

308 FLANGES, BLANKS, FLANGE FACINGS, AND GASKETS

308.1 General

308.1.1 Listed Components. A listed flange, blank, or gasket is suitable for use in Normal Fluid Service, except as stated elsewhere in [para. 308](#).

308.1.2 Unlisted Components. Unlisted flanges, blanks, and gaskets may be used only in accordance with [para. 302.2.3](#).

308.2 Specific Requirements for Flanges

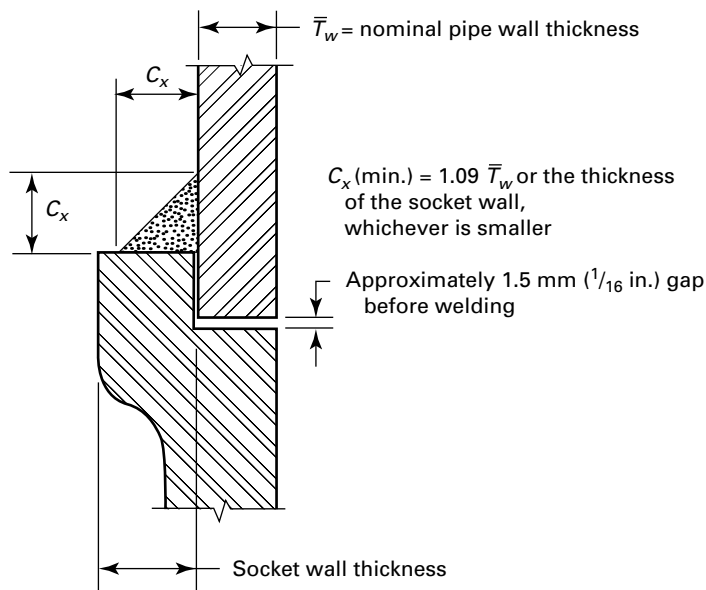
See [Appendix F](#), [paras. F308.2](#) and [F312](#).

Table 308.2.1 Permissible Sizes/Rating Classes for Slip-On Flanges Used as Lapped Flanges (18)

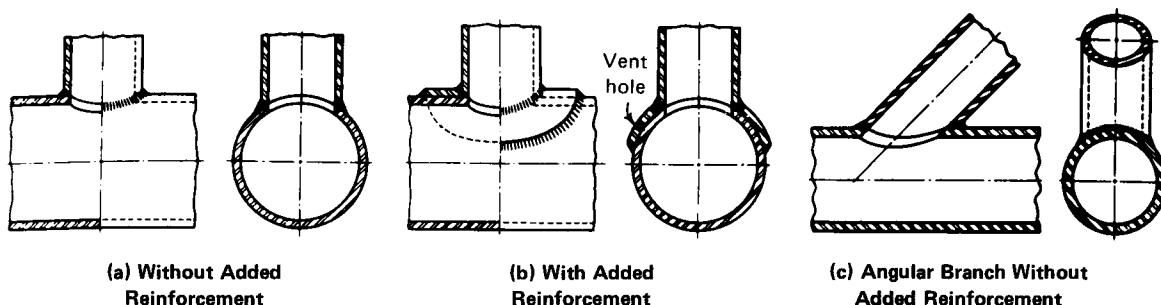
Rating Class	Maximum Flange Size	
	DN	NPS
150	300	12
300	200	8

GENERAL NOTE: Actual thickness of the slip-on flange at the bolt circle shall be at least equal to the minimum required flange thickness for lapped flanges in ASME B16.5.

Figure 328.5.2C Minimum Welding Dimensions for Socket Welding Components Other Than Flanges



Figures 328.5.4A, B, C Typical Welded Branch Connections



the run shall be attached by fully penetrated groove welds. The welds shall be finished with cover fillet welds having a throat dimension not less than t_c . See Figure 328.5.4D, illustrations (1) and (2).

(e) A reinforcing pad or saddle shall be attached to the branch pipe by either

(1) a fully penetrated groove weld finished with a cover fillet weld having a throat dimension not less than t_c , or

(2) a fillet weld having a throat dimension not less than $0.7t_{min}$. See Figure 328.5.4D, illustration (5).

(f) The outer edge of a reinforcing pad or saddle shall be attached to the run pipe by a fillet weld having a throat dimension not less than $0.5T_r$. See Figure 328.5.4D, illustrations (3), (4), and (5).

(g) Reinforcing pads and saddles shall have a good fit with the parts to which they are attached. A vent hole shall be provided at the side (not at the crotch) of any pad or saddle to reveal leakage in the weld between branch and run and to allow venting during welding and heat treatment. A pad or saddle may be made in more than one piece if joints between pieces have strength equivalent to pad or saddle parent metal, and if each piece has a vent hole.

(h) Examination and any necessary repairs of the completed weld between branch and run shall be made before adding a pad or saddle.

(i) Figure 328.5.4F shows additional integrally reinforced branch connections typical of MSS SP-97 fittings that abut the outside of the run attached by a full penetration groove weld. The welds shall be finished with cover fillets having a throat dimension not less than t_c . The cover

(b) The PWHT to be used after production welding shall be specified in the WPS and shall be used in qualifying the welding procedure.

(c) The engineering design shall specify the examination and/or other production quality control (not less than the requirements of this Code) to ensure that the final welds are of adequate quality.

331.1.2 Other Heat Treatments

(a) Heat treatment for bending and forming shall be in accordance with [para. 332.4](#).

(b) See [Table 302.3.5](#) for special heat treatment requirements for longitudinal or spiral (helical seam) welds in Elevated Temperature Fluid Service.

331.1.3 Definition of Thicknesses Governing PWHT

(a) The term *control thickness* as used in [Table 331.1.1](#) and [Table 331.1.3](#) is the lesser of

(1) the thickness of the weld

(2) the thickness of the materials being joined at the weld or the thickness of the pressure-containing material if the weld is attaching a nonpressure-containing material to a pressure-containing material.

(b) Thickness of the weld, which is a factor in determining the control thickness, is defined as follows:

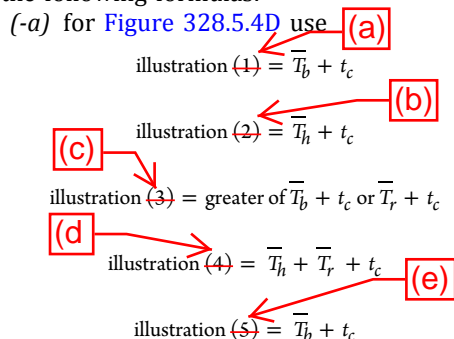
(1) groove welds (girth and longitudinal) — the thicker of the two abutting ends after weld preparation, including I.D. machining

(2) fillet welds — the throat thickness of the weld

(3) partial penetration welds — the depth of the weld groove

(4) material repair welds — the depth of the cavity to be repaired

(5) branch welds — the dimension existing in the plane intersecting the longitudinal axes, calculated as indicated for each detail using the thickness through the weld for the details shown in [Figure 328.5.4D](#) and [Figure 328.5.4F](#). This thickness shall be computed using the following formulas:



(-b) for [Figure 328.5.4F](#) use $\bar{T}_m + t_c$ for all illustrations

(c) The term *nominal material thickness* as used in [Table 331.1.3](#) is the thicker of the materials being joined at the weld.

331.1.4 Heating and Cooling. The heating method shall provide the required metal temperature, metal temperature uniformity, and temperature control, and may include an enclosed furnace, local flame heating, electric resistance, electric induction, or exothermic chemical reaction. Above 315°C (600°F), the rate of heating and cooling shall not exceed 335°C/h (600°F/hr) divided by one-half the maximum material thickness in inches at the weld, but in no case shall the rate exceed 335°C/h (600°F/hr). See [Table 331.1.1](#) for cooling rate requirements for P-Nos. 7, 10I, 11A, and 62 materials.

331.1.6 Temperature Verification. Heat treatment temperature shall be checked by thermocouple pyrometers or other suitable methods to ensure that the WPS requirements are met. See [para. 328.7](#) for attachment of thermocouples by the low energy capacitor discharge method of welding.

(a) If used, the heat treatment furnace shall be calibrated such that the PWHT can be controlled within the required temperature range.

(b) Any required PWHT shall be as required by the qualified WPS.

(c) For welds that require PWHT in accordance with [Table 331.1.1](#), the temperature of the material during PWHT shall be within the range specified. However, if specified by the designer, the range may be extended as permitted by [Table 331.1.2](#), provided the lower critical temperature of the material is not exceeded.

331.2 Specific Requirements

Where warranted by experience or knowledge of service conditions, alternative methods of heat treatment or exceptions to the basic heat treatment provisions of [para. 331.1](#) may be adopted as provided in [paras. 331.2.1](#) and [331.2.2](#).

331.2.1 Alternative Heat Treatment. Normalizing, or normalizing and tempering, or annealing may be applied in lieu of the required heat treatment after welding, bending, or forming, provided that the mechanical properties of any affected weld and base metal meet specification requirements after such treatment and that the substitution is approved by the designer.

331.2.2 Exceptions to Basic Requirements. As indicated in [para. 331](#), the basic practices therein may require modification to suit service conditions in some cases. In such cases, the designer may specify more-stringent requirements in the engineering design, including heat treatment and hardness limitations for lesser thickness, or may specify less stringent heat treatment and hardness requirements, including none.

When provisions less stringent than those in [para. 331](#) are specified, the designer must demonstrate to the owner's satisfaction the adequacy of those provisions by comparable service experience, considering service

Table D300 Flexibility Factor, *k*, and Stress Intensification Factor, *i* (Cont'd)

- GENERAL NOTES: (Cont'd)
- (b) The designer may use the more applicable stress intensification factors and flexibility factors from ASME B31J instead of the stress intensification factors and flexibility factors herein and is encouraged to do so when both $S_F > 0.5S_A$ and significant cycles are present. Alternatively, stress intensification factors and branch connection flexibility factors may be developed using ASME B31J, Nonmandatory Appendices A and B, respectively.
- NOTES:
- (1) The flexibility factor, *k*, in the Table applies to bending in any plane; also see para. 319.3.6. The flexibility factors, *k*, and stress intensification factors, *i*, shall apply over the effective arc length (shown by heavy centerlines in the illustrations) for curved and miter bends, and to the intersection point for tees.

(2) A single intensification factor equal to $0.9/h^{2/3}$ may be used for both *i_i* and *i_o* if desired.

(3) The values of *k* and *i* can be read directly from Chart A by entering with the characteristic *h* computed from the formulas given above. Nomenclature is as follows:
D_b = outside diameter of branch
R₁ = bend radius of welding elbow or pipe bend
r_x = see definition in para. 304.3.4(c)
r₂ = mean radius of matching pipe
s = miter spacing at centerline
 \bar{T} = for elbows and miter bends, the nominal wall thickness of the fitting
= for tees, the nominal wall thickness of the matching pipe
T_c = crotch thickness of branch connections measured at the center of the crotch where shown in the illustrations
 \bar{T}_r = pad or saddle thickness
 θ = one-half angle between adjacent miter axes

(4) Where flanges are attached to one or both ends, the values of *k* and *i* in the Table shall be corrected by the factors *C₁*, which can be read directly from Chart B, entering with the computed *h*.

(5) The designer is cautioned that cast butt welded fittings may have considerably heavier walls than that of the pipe with which they are used. Large errors may be introduced unless the effect of these greater thicknesses is considered.

(6) In large diameter thin-wall elbows and bends, pressure can significantly affect the magnitudes of *k* and *i*. To correct values from the Table, divide *k* by

$$1 + 6 \left(\frac{P_j}{E_j} \right) \left(\frac{r_2}{\bar{T}} \right)^{7/3} \left(\frac{R_1}{r^2} \right)^{1/3}$$

divide *i* by

$$1 + 3.25 \left(\frac{P_j}{E_j} \right) \left(\frac{r_2}{\bar{T}} \right)^{5/2} \left(\frac{R_1}{r^2} \right)^{2/3}$$

For consistency, use kPa and mm for SI units, and psi and in. for U.S. Customary units.

(7) If $r_x \geq \frac{1}{8} D_b$ and $T_c \geq 1.5\bar{T}$, a flexibility characteristic of $4.4\bar{T}/r_2$ may be used.

(8) Stress intensification factors for branch connections are based on tests with at least two diameters of straight run pipe on each side of the branch centerline. More closely loaded branches may require special consideration.

(9) When \bar{T}_r is $> 1\frac{1}{2}\bar{T}$, use $h = 4\bar{T}/r_2$.

(10) The out-of-plane stress intensification factor (SIF) for a reducing branch connection with branch-to-run diameter ratio of $0.5 < d/D < 1.0$ may be nonconservative. A smooth concave weld contour has been shown to reduce the SIF. Selection of the appropriate SIF is the designer's responsibility.

(11) The designer must be satisfied that this fabrication has a pressure rating equivalent to straight pipe.

(12) For welds to socket welded fittings, the stress intensification factor is based on the assumption that the pipe and fitting are matched in accordance with ASME B16.11 and a fillet weld is made between the pipe and fitting as shown in Figure 328.5.2C. For welds to socket welded flanges, the stress intensification factor is based on the weld geometry shown in Figure 328.5.2B, illustration (3), and has been shown to envelop the results of the pipe to socket welded fitting tests. Blending the toe of the fillet weld smoothly into the pipe wall, as shown in the concave fillet welds in Figure 328.5.2A, has been shown to improve the fatigue performance of the weld.

(13) Factors shown apply to bending. Flexibility factor for torsion equals 0.9.
- (c)
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