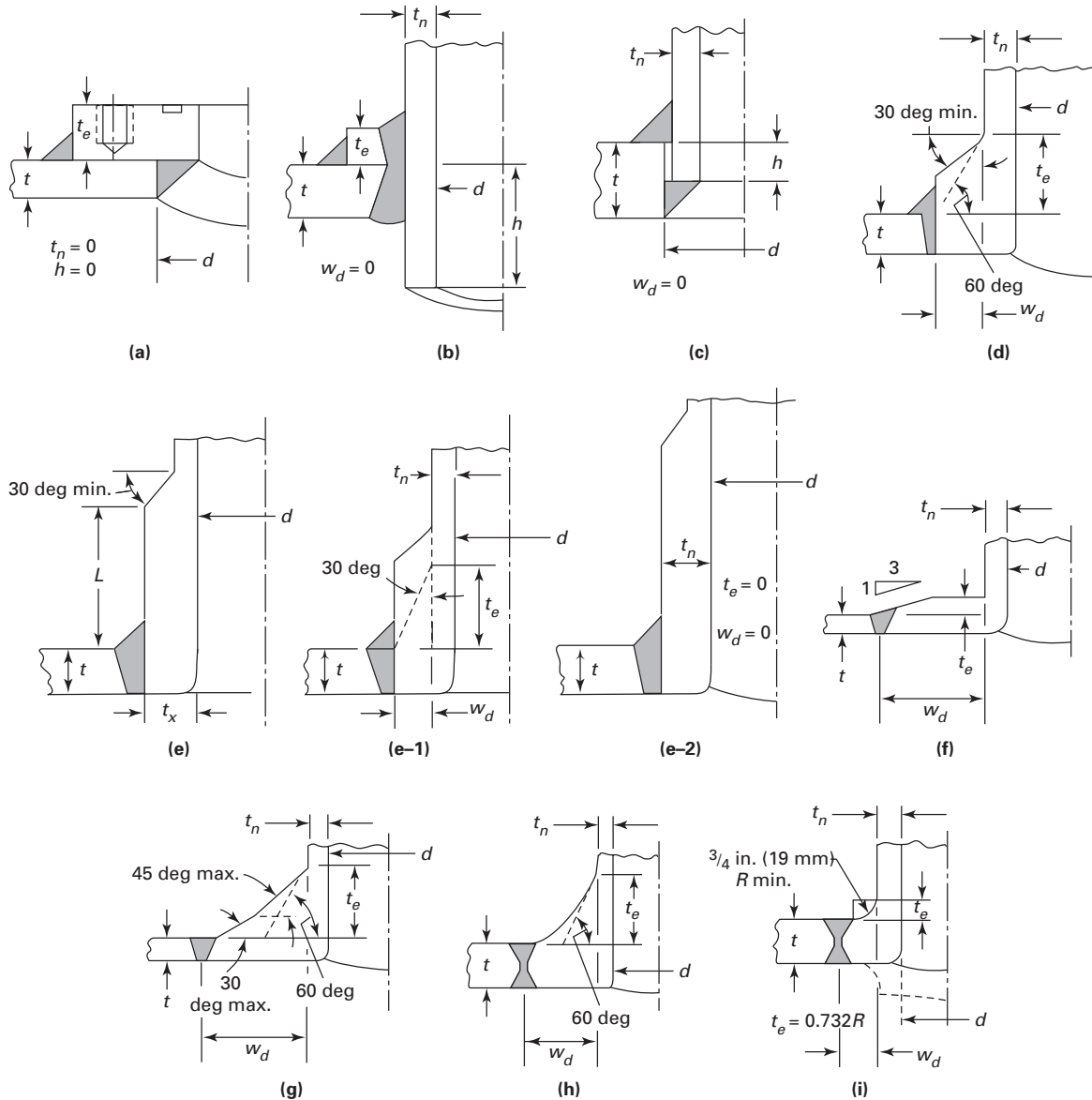


Figure PG-33.2
Some Representative Configurations Describing the Dimensions t_e , h , and d

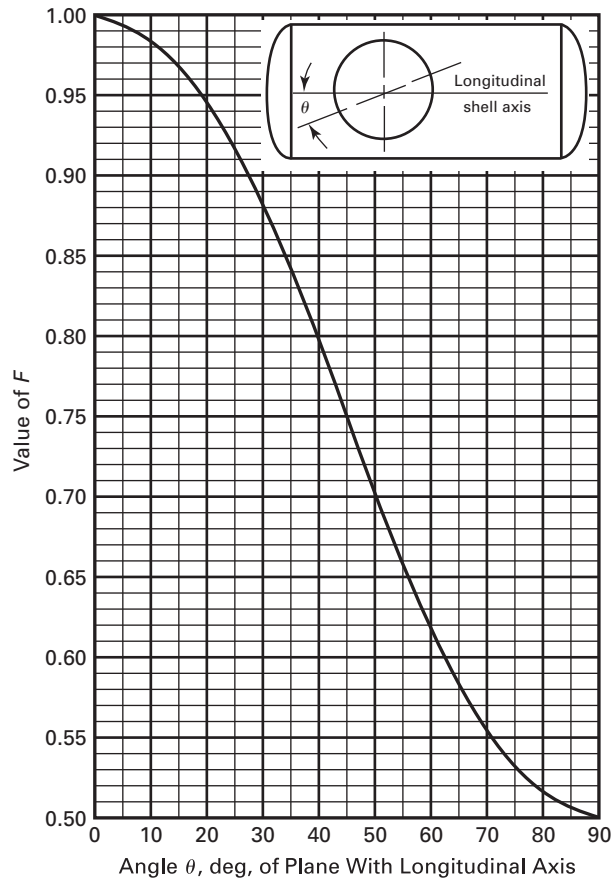


GENERAL NOTE: Use illustration (e) to determine whether illustration (e-1) or (e-2) applies:

- (1) If $L < 2.5t_x$, use illustration (e-1).
- (2) If $L \geq 2.5t_x$, use illustration (e-2).
- (3) The 30 deg min. transition shown at illustration (e) is typical for illustrations (e-1) and (e-2).

(19)

Figure PG-33.3
Chart for Determining Value of F



GENERAL NOTE: $F = 1 - 0.5 \sin^2 \theta$

nozzle wall available as compensation is the smaller of the values of A_2 given by the equations shown in Figure PG-33.1.

All metal in the nozzle wall extending inward from the outer surface of the vessel wall may be included. No allowance shall be taken for the fact that a differential pressure on an inwardly extending nozzle may cause opposing stress to that of the stress in the shell around the opening.

PG-36.4.3 Metal added as compensation (continuously about the nozzle) when welded to both the vessel and nozzle, and metal provided in attachment welds.

PG-36.5 Typical examples of the application of the above rules are presented in A-65 through A-69.

PG-37 STRENGTH OF COMPENSATION

PG-37.1 Material used for compensation shall have an allowable stress value equal to or greater than that of the material in the vessel wall, except that material of lower strength may be used provided the area of compensation is increased in inverse proportion to the ratio of

the allowable stress values of the two materials to compensate for the lower allowable stress value of the compensation. No credit may be taken for the additional strength of any compensation having a higher allowable stress value than that of the vessel wall. Deposited weld metal outside of either the vessel wall or any reinforcing pad used as reinforcement shall be credited with an allowable stress value equivalent to the weaker of the materials connected by the weld. Vessel-to-nozzle or pad-to-nozzle attachment weld metal within the vessel wall or within the pad may be credited with a stress value equal to that of the vessel wall or pad, respectively.

PG-37.2 The welds that attach elements of compensation that are not an integral part of the vessel wall shall have a strength, W , not less than the load carried by those elements defined as follows:

$$W = (A - A_1) S_v$$

where A , A_1 , and S_v are defined in PG-33.3 and Figure PG-33.1.

PG-37.3 When a reinforcing pad is required by the rules of PG-33, the welds attaching the nozzle to the pad and shell shall be checked independently to assure that the loads carried by the individual elements can be transmitted by the attaching welds. For detailed requirements and examples of calculating the strength of welds, see PW-15.

PG-37.4 Welds attaching elements of compensation need not satisfy the weld strength requirements of PG-37.2 under the following circumstances:

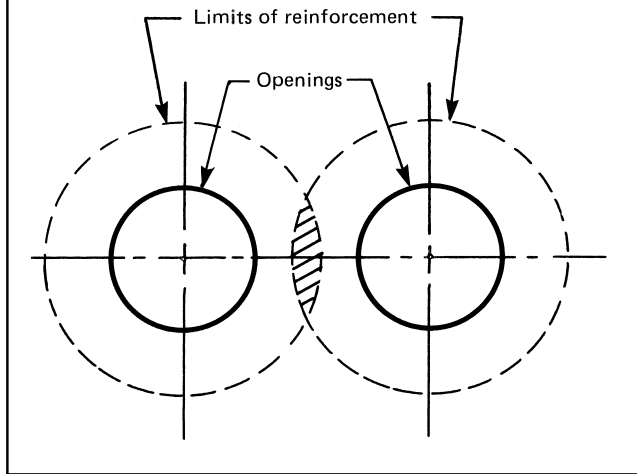
- (a) openings that are exempt in PG-32 from compensation calculations
- (b) openings designed by ligaments rules of PG-52 and PG-53 and/or
- (c) openings with elements of compensation attached by full penetration welds as listed in PW-15.1.6

PG-37.5 The minimum weld sizes shall not be smaller than the minimum required by PW-16.

PG-38 COMPENSATION FOR MULTIPLE OPENINGS

PG-38.1 When any two adjacent openings that require compensation are spaced at less than two times the distance defined in PG-36.2 so that their limits of compensation overlap (see Figure PG-38.1-1), the two openings shall be compensated in the plane connecting the centers of the openings in accordance with PG-33 with a compensation that has an area equal to the combined area of the compensation required for the separate openings. No portion of the cross section shall be considered as applying to more than one opening, or be evaluated more than once in a combined area. The available area of the head or shell between openings having an overlap area shall be proportioned between the two openings by the ratio of their diameters. (19)

Figure PG-38.1-1
Example of Two Openings Spaced With Limits of Reinforcement Overlapping



PG-38.2 When more than two openings are spaced at less than two times the distance defined in PG-36.2 so that their limits overlap with each other (see Figure PG-38.2-1) and are to be provided with a combined reinforcement, the minimum distance between centers of any two of these openings shall be $1\frac{1}{3}$ times their average diameter, and the area of reinforcement between any two openings shall be at least equal to 50% of the total required for the two openings. If the distance between centers of two such openings is less than $1\frac{1}{3}$ times their average diameter, no credit for reinforcement shall be taken for any of the material between these openings. Such openings must be reinforced as described in PG-38.3.

PG-38.3 Alternatively, any number of adjacent openings, in any arrangement, may be reinforced by using an assumed opening enclosing all such openings. The limits for reinforcement of the assumed opening shall be those given in PG-36.2.1 and PG-36.3.1. The nozzle walls of the actual openings shall not be considered to have reinforcing value. For shells and headers, when the diameter of the assumed opening exceeds the limits in PG-32.3.2, the recommendations in PG-32.3.3 may be considered.

PG-38.4 When a shell or drum has a series of openings (three or more) in a definite pattern, the distance between centers of any two adjacent finished openings shall not be less than $1\frac{1}{3}$ times their average diameter, and shall be reinforced per PG-38.1 for any two adjacent finished openings. Also, the net cross-sectional area between these adjacent openings within the limits of the actual shell wall, excluding the portion of the compensation not fused to the shell wall, shall equal at least $0.7F$ of the cross-sectional area obtained by multiplying the center-to-center distance of the openings by the required thickness of a seamless shell, where the factor F is taken

from Figure PG-33.3 for the plane under consideration (see Figure PG-38.4-1). Alternately, per PG-32.1.2, groups of openings may be designed in accordance with the rules for ligaments in PG-52 or PG-53.

PG-38.5 When a group of openings is provided with compensation by a thicker section butt welded into the shell or head, the edges of the inserted section shall be tapered as prescribed in PW-9.3.

PG-39 METHODS OF ATTACHMENT OF PIPE AND NOZZLE NECKS TO VESSEL WALLS

PG-39.1 General. Except as limited in PG-32, nozzles may be attached to the shell or head of a vessel by any of the methods of attachment given in this paragraph.

PG-39.2 Welded Connections. Attachment by welding shall be in accordance with the requirements of PW-15 and PW-16.

PG-39.4 Studded Connections. Connections may be made by means of bolt studs. The vessel shall have a flat surface machined on the shell, or on a built-up pad, or on a properly attached plate or fitting. Drilled holes to be tapped for straight threads shall not penetrate within one-fourth of the wall thickness from the inside surface of the vessel, unless at least the minimum thickness required as above is maintained by adding metal to the inside surface of the vessel. Where tapped holes are provided for studs, the threads shall be full and clean and shall engage the stud for a length not less than the larger of d_s or

Figure PG-38.2-1
Example of More Than Two Openings Spaced With Limits of Reinforcement Overlapping

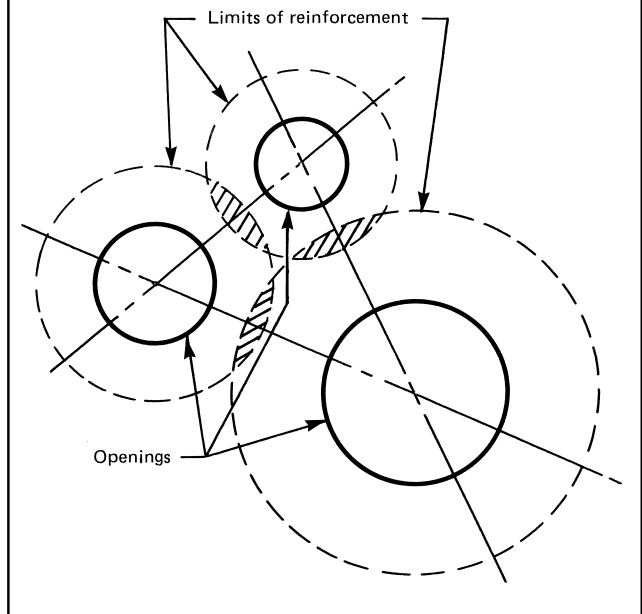
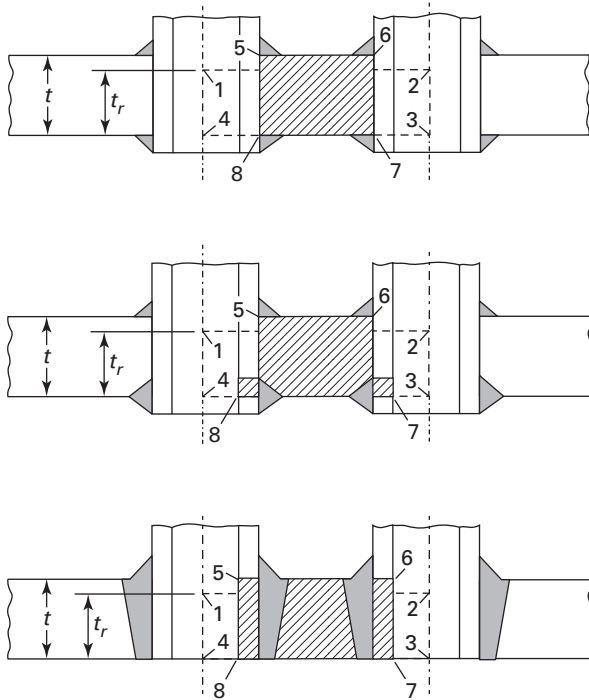


Figure PG-38.4-1
Illustrations of the Rule Given in PG-38.4



GENERAL NOTE: The cross-sectional area represented by 5, 6, 7, and 8 shall be at least equal to the area of the rectangle represented by 1, 2, 3, and 4 multiplied by $0.7F$, in which F is a value from Figure PG-33.3 and t_r is the required thickness of a seamless shell.

$$0.75d_s \times \frac{\text{Maximum allowable stress value of stud material at design temperature}}{\text{Maximum allowable stress value of tapped material at design temperature}}$$

in which d_s is the diameter of the stud, except that the thread engagement need not exceed $1\frac{1}{2}d_s$. Studded connections shall meet the requirements for compensation. No credit for compensation shall be allowed for any areas attached by studs only.

PG-39.5 Threaded Connections.

PG-39.5.1 Where a threaded connection is to be made to a boiler component it shall be into a threaded hole. The threads shall conform to the requirements of ASME B1.20.1 and provide for the pipe to engage the minimum number of threads specified in Table PG-39 after allowance has been made for curvature of the vessel wall. A built-up pad or properly attached plate or fitting may be used to provide the metal thickness and number of threads required in Table PG-39, or to furnish compensation when required.

PG-39.5.2 Threaded joints for boiler connections for external piping shall be in accordance with the following size and pressure limitations and shall not be used where the temperature exceeds 925°F (495°C).

Maximum Size, NPS (DN)	Maximum Pressure, psi (MPa)
3 (80)	400 (3)
2½ (65)	500 (3.5)
2 (50)	600 (4)
1½ (40)	900 (6)
1¼ (32)	1,000 (7)
1 (25)	1,200 (8)
¾ (20) and smaller	1,500 (10)

PG-39.5.3 Threaded connections for plug closures used for inspection openings, end closures, and similar purposes may be used within the size and pressure limitations of Table PG-39.

PG-39.6 Expanded Connections. Provided the requirements for compensation are met, a pipe, tube, or forging not exceeding 6 in. (150 mm) in outside diameter may be attached to shells, heads, headers, or fittings by inserting through an opening and expanding in accordance with the rules for tube attachment in Parts PWT and PFT, whichever is applicable.

The sharp edges left in drilling tube holes shall be removed on both sides of the plate with a file or other tool. The inner surface of the tube hole in any form of attachment may be grooved or chamfered.

PG-39.7 All welded connections shall be postweld heat treated after attachment unless specifically allowed otherwise.

PG-42 GENERAL REQUIREMENTS FOR FLANGES, PIPE FITTINGS, AND VALVES

PG-42.1 The following standards covering flanges and pipe fittings are acceptable for use under this Section in accordance with the requirements of PG-11. Pressure-temperature ratings shall be in accordance with the appropriate standard except that the pressure-temperature ratings for ASME B16.9 and ASME B16.11 fittings shall be calculated as for straight seamless pipe in accordance with the rules of this Section, including the maximum allowable stress for the material. The thickness tolerance of the ASME standards shall apply.

ASME B16.1, Gray Iron Pipe Flanges and Flanged Fittings, Classes 25, 125, and 250¹²

ASME B16.3, Malleable Iron Threaded Fittings, Classes 150 and 300

ASME B16.4, Gray Iron Threaded Fittings, Classes 125 and 250

ASME B16.5, Pipe Flanges and Flanged Fittings, NPS ½ Through NPS 24 Metric/Inch Standard (see PG-11.3)

- Pressure-temperature ratings per Table 2-1.1 through 2-3.19
- Facing dimensions (other than ring-joint) per Table 4