(d) Heads of the Type Shown in Figure HG-309, Sketch
(d). (No joint efficiency factor is required.)

(1) Head thickness

\[ t = \frac{5PL}{6S} \]

(2) Flange thickness

\[ T = F + \sqrt{F^2 + J} \]

where

\[ F = \frac{PB\sqrt{4L^2 - B^2}}{8S(A - B)} \]

and

\[ J = \left( \frac{M_o}{SB} \right) \left( \frac{A + B}{A - B} \right) \]

HG-312 CYLINDRICAL PARTS UNDER EXTERNAL PRESSURE

HG-312.1 Plain Type Furnaces. Plain furnaces that are complete cylinders shall conform to the following:

(a) The thickness of the furnace wall shall be not less than \( \frac{3}{4} \) in. (6 mm).

(b) The design temperature of the furnace shall be taken as 500°F (260°C).

(c) Furnaces shall be rolled to a circle, with a maximum deviation from the true circle of not more than \( \frac{1}{4} \) in. (6 mm).

(d) The thickness of the furnace wall shall be determined by the rules of HG-312.3. External pressure charts for use in determining minimum requirements are given in Section II, Part D, Subpart 3. Figure numbers in this Article are contained in that Subpart. The symbols defined as follows are used in the formulas of this paragraph:

\[ A = \text{factor determined from Section II, Part D, Subpart 3, Figure G and used to enter the applicable material chart in Section II, Part D, Subpart 3} \]

\[ B = \text{factor determined from the applicable material chart in Section II, Part D, Subpart 3 for maximum design, metal temperature [see (b)]} \]

\[ D_o = \text{outside diameter of furnace} \]

\[ L = \text{design length of plain furnace taken as the distance from center to center of weld attachment, in.; design length of ring reinforced furnace section, taken as the greatest center-to-center distance between any two adjacent stiffening rings; or the distance from the center of the first stiffening ring to the center of the furnace weld attachment, in. In case a flared-end assembly is used, the distance shall be measured to the point of tangency between the flare and the furnace and the adjacent stiffening ring.} \]

\[ P = \text{design pressure} \]

\[ t = \text{minimum required wall thickness of furnaces} \]

HG-312.2 Tubes. The wall thickness of tubes subject to external pressure shall conform to the following:

(a) The minimum wall thickness shall be determined by use of the procedure outlined in HG-312.3.

(b) The design temperature of tubes shall be the mean metal temperature as determined by the boiler Manufacturer.

(c) A minimum additional thickness of 0.04 in. (1 mm) shall be added as an allowance for rolling and structural stability. The additional 0.04 in. (1 mm) thickness is not required for tube strength welded to tubesheets, headers, or drums.

HG-312.3 Procedure for Determining Wall Thickness of Plain Furnaces and Tubes. The required wall thickness of the furnace and tubes shall be not less than determined by the following procedure:

Step 1. Assume a value for \( t \). Determine the ratio \( \frac{L}{D_o} \) and \( \frac{D_o}{t} \).

Step 2. Enter Section II, Part D, Subpart 3, Figure G at the value of \( \frac{L}{D_o} \) determined in Step 1. For values of \( \frac{L}{D_o} \) greater than 50, enter the chart at a value of \( \frac{L}{D_o} = 50 \). For values of \( \frac{L}{D_o} \) less than 0.05, enter the chart at a value of \( \frac{L}{D_o} = 0.05 \).

Step 3. Move horizontally to the line for the value of \( \frac{D_o}{t} \) determined in Step 1. Interpolation may be made for intermediate values of \( \frac{D_o}{t} \). From this point of intersection, move vertically downward to determine the value of factor \( A \).

Step 4. Using the value of \( A \) calculated in Step 3, enter the applicable material chart in Section II, Part D, Subpart 3 for the material under consideration. Move vertically to an intersection with the material/temperature line for the design temperature.

Step 5. From the intersection obtained in Step 4, move horizontally to the right and read the value of factor \( B \).

Step 6. Using this value of \( B \), calculate the value of the maximum allowable external working pressure \( P_a \) using the following equation:

\[ P_a = \frac{B}{D_o/t} \]

Step 7. Compare \( P_a \) with \( P \). If \( P_a \) is less than \( P \), a greater value of \( t \) must be selected or a smaller value of \( L \) or some combination of both to increase \( P_a \) so that it is equal to or greater than \( P \). (An example is included in Nonmandatory Appendix C.)

HG-312.4 Ring Reinforced Type Furnace. Ring reinforced furnaces as shown in Figure HG-312.4 may be constructed with completely circular stiffening rings provided...