 ARTICLE 3
DESIGN

HG-300  DESIGN PRESSURE

(a) The design pressure is the pressure used in the formulas of this Article, in conjunction with the allowable stress values, design rules, and dimensions specified for determining the minimum required thicknesses for the parts of a boiler. The design pressure for a heating boiler shall be at least 30 psi (200 kPa).

(b) The term maximum allowable working pressure refers to gage pressure, or the pressure in excess of the atmospheric pressure in the boiler. The maximum allowable working pressure, as stamped on the boiler per HG-530, must be less than or equal to the design pressure for any of its parts.

(c) No boiler shall be operated at a pressure higher than the maximum allowable working pressure except when the safety valves or relief valves are discharging, at which time the maximum allowable working pressure shall not be exceeded by more than the amount specified in HG-400.1 and HG-400.2.

HG-301  CYLINDRICAL PARTS UNDER INTERNAL PRESSURE

HG-301.1  General. The required thickness and the design pressure of cylindrical shells, tubes, pipe, and headers shall be determined in accordance with the following formulas:

\[
t = \frac{PR}{SE - 0.6P}
\]

\[
P = \frac{Set}{R + 0.6t}
\]

where

\(E\) = efficiency of longitudinal joint or of ligament between tube holes, whichever is the lesser. For welded joints, use the efficiency specified in HW-702. For seamless shells, use \(E = 1\).

\(P\) = design pressure [but not less than 30 psi (200 kPa)]

\(R\) = inside radius of cylinder

\(S\) = maximum allowable stress value from Table HF-300.1 (HF-300.1M) or Table HF-300.2 (HF-300.2M)

\(t\) = required wall thickness

HG-301.2  Tubes.

(a) The required thickness of tubes and pipes used as tubes shall be determined in accordance with the formulas in HG-301.1, adding to that value a minimum additional thickness of 0.04 in. (1 mm) as an allowance for rolling and structural stability. The additional 0.04 in. (1 mm) thickness is not required for tubes strength welded to tubesheets, headers, or drums.

(b) Except as provided for in HF-204.3, in no case shall the thickness of a tube or pipe used as a tube when installed by welding or rolling be less than 0.061 in. (1.5 mm) at the point where it attaches to the tubesheet, header, or drum. There is no minimum thickness requirement for nonferrous tubes installed by brazing, except that the thickness used must meet the brazing qualification requirements of Section IX, Part QB.

HG-305  FORMED HEADS, PRESSURE ON CONCAVE SIDE

HG-305.1  General. The required thickness at the thinnest point after forming of ellipsoidal, torispherical, and hemispherical heads under pressure on the concave side (plus heads) shall be computed by the appropriate formulas in this paragraph.

(a) Notation. The symbols used in this paragraph are defined as follows:

\(D\) = inside diameter of the head skirt; or inside length of the major axis of an ellipsoidal head; or inside diameter of a cone head at the point under consideration, measured perpendicular to the longitudinal axis

\(E\) = lowest efficiency of any joint in the head. For welded joints, use the efficiency specified in HW-702. For seamless heads, use \(E = 1\), except for hemispherical heads furnished without a skirt, in which case use the efficiency of the head-to-shell joint.

\(L\) = inside spherical or crown radius

\(P\) = design pressure [but not less than 30 psi (200 kPa)]

\(S\) = maximum allowable stress value as given in Table HF-300.1 (HF-300.1M) or Table HF-300.2 (HF-300.2M)

\(t\) = required wall thickness after forming

Welded pipe or tubing shall be treated in the same manner as seamless, but with allowable tensile stress taken from the welded product values of the stress tables.