§ 179.400–6 Bursting and buckling pressure.

(a) [Reserved]

(b) The outer jacket of the required evacuated insulation system must be designed in accordance with §179.400–8(d) and in addition must comply with the design loads specified in Section 6.2 of the AAR Specifications for Tank Cars (IBR, see §171.7 of this subchapter). The designs and calculations must provide for the loadings transferred to the outer jacket through the support system.


§ 179.400–7 Tank heads.

(a) Tank heads of the inner tank and outer jacket must be flanged and dished, or ellipsoidal.

(b) Flanged and dished heads must have—

(1) A main inside dish radius not greater than the outside diameter of the straight flange;

(2) An inside knuckle radius of not less than 6 percent of the outside diameter of the straight flange; and

(3) An inside knuckle radius of at least three times the head thickness.

§ 179.400–8 Thickness of plates.

(a) The minimum wall thickness, after forming, of the inner shell and any 2:1 ellipsoidal head for the inner tank must be that specified in §179.401–1, or that calculated by the following formula, whichever is greater:

\[ t = \frac{Pd}{2SE} \]

Where:

- \( t \) = minimum thickness of plate, after forming, in inches;
- \( P \) = minimum required bursting pressure in psig;
- \( d \) = inside diameter, in inches;
- \( S \) = minimum tensile strength of the plate material, as prescribed in AAR Specifications for Tank Cars, appendix M, Table M1, in psi;
- \( E = 0.9 \), a factor representing the efficiency of welded joints, except that for seamless heads, \( E = 1.0 \).

(b) The minimum wall thickness, after forming, of any 3:1 ellipsoidal head for the inner tank must be that specified in §179.401–1, or that calculated by the following formula, whichever is greater:

\[ t = \frac{PL(3 + \sqrt{L/r})}{8SE} \]

Where:

- \( t \) = minimum thickness of plate, after forming, in inches;
- \( P \) = minimum required bursting pressure in psig;
- \( L \) = main inside radius of dished head, in inches;
- \( r \) = inside knuckle radius, in inches;
- \( S \) = minimum tensile strength of plate material, as prescribed in AAR Specifications for Tank Cars, appendix M, Table M1, in psi;
- \( E = 0.9 \), a factor representing the efficiency of welded joints, except for seamless heads, \( E = 1.0 \).

(c) The minimum wall thickness, after forming, of a flanged and dished head for the inner tank must be that specified in §179.401–1, or that calculated by the following formula, whichever is greater:

\[ t = \frac{P(3 + \sqrt{L/r})}{8SE} \]

Where:

- \( t \) = minimum thickness of plate, after forming, in inches;
- \( P \) = minimum required bursting pressure in psig;
- \( L \) = main inside radius of dished head, in inches;
- \( r \) = inside knuckle radius, in inches;
- \( S \) = minimum tensile strength of plate material, as prescribed in AAR Specifications for Tank Cars, Appendix M, Table M1, in psi;
- \( E = 0.9 \), a factor representing the efficiency of welded joints, except that for seamless heads, \( E = 1.0 \).

(d) The minimum wall thickness, after forming, of the outer jacket shell may not be less than 7⁄16 inch. The minimum wall thickness, after forming, of the outer jacket heads may not be less than 1⁄2 inch and they must be made from steel specified in §179.16(c). The annular space is to be evacuated, and the cylindrical portion of the outer jacket between heads, or between stiffening rings if used, must be designed to withstand an external pressure of 37.5 psig (critical collapsing pressure), as determined by the following formula:

\[ P_c = \frac{2.6E(t/D)^{2.5}}{([L/D]) - 0.45(t/D)^{0.5}} \]

Where:

- \( P_c \) = Critical collapsing pressure (37.5 psig minimum) in psig;
§ 179.400–10 Sump or siphon bowl.

A sump or siphon bowl may be in the bottom of the inner tank shell if—

(a) It is formed directly into the inner tank shell, or is formed and welded to the inner tank shell and is of

plate which may be considered effective is 4W.) The closed section between an external ring and the outer jacket must be provided with a drain opening.

(d) The stiffening ring must have a moment of inertia large enough to support the critical collapsing pressure, as determined by either of the following formulas:

\[ I = \frac{0.035D^3 L P_c}{E}, \]

or

\[ I' = \frac{0.046D^3 L P_c}{E}. \]

Where:

- \( I \) = required moment of inertia of stiffening ring about the centroidal axis parallel to the vessel axis, in inches to the fourth power;
- \( I' \) = required moment of inertia of combined section of stiffening ring and effective width of jacket plate about the centroidal axis parallel to the vessel axis, in inches to the fourth power;
- \( D \) = outside diameter of the outer jacket, in inches;
- \( L \) = one-half of the distance from the centerline of the stiffening ring to the next line of support on one side, plus one-half of the distance from the centerline to the next line of support on the other side of stiffening ring. Both distances are measured parallel to the axis of the vessel, in inches. (A line of support is:
  1. A stiffening ring which meets the requirements of this paragraph, or
  2. A circumferential line of a head at one-third the depth of the head from the tangent line);
- \( P_c \) = critical collapsing pressure (37.5 psig minimum) in psig;
- \( E \) = modulus of elasticity of stiffening ring material, in psi.

(e) Where loads are applied to the outer jacket or to stiffening rings from the system used to support the inner tank within the outer jacket, additional stiffening rings, or an increased moment of inertia of the stiffening rings designed for the external pressure, must be provided to carry the support loads.