

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.

(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:

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

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 that for seamless heads, E = 1.0.

(d) The minimum wall thickness, after forming, of the outer jacket shell may not be less than $\frac{3}{16}$ inch. The minimum wall thickness, after forming, of the outer jacket heads may not be less than $\frac{1}{2}$ 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:

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

Where:

P_c = Critical collapsing pressure (37.5 psig minimum) in psig;

E = modulus of elasticity of jacket material, in psi;

t = minimum thickness of jacket material, after forming, in inches;

D = outside diameter of jacket, in inches;

L = distance between stiffening ring centers in inches. (The heads may be considered as stiffening rings located $\frac{1}{3}$ of the head depth from the head tangent line.)

[Amdt. 179-32, 48 FR 27708, June 16, 1983; 49 FR 42736, Oct. 24, 1984; 64 FR 51920, Sept. 27, 1999, as amended at 66 FR 45390, Aug. 28, 2001; 68 FR 75763, Dec. 31, 2003]

§ 179.400-9 Stiffening rings.

(a) If stiffening rings are used in designing the cylindrical portion of the outer jacket for external pressure, they must be attached to the jacket by means of fillet welds. Outside stiffening ring attachment welds must be continuous on each side of the ring. Inside stiffening ring attachment welds may be intermittent welds on each side of the ring with the total length of weld on each side not less than one-third of the circumference of the tank. The maximum space between welds may not exceed eight times the outer jacket wall thickness.

(b) A portion of the outer jacket may be included when calculating the moment of inertia of the ring. The effective width of jacket plate on each side of the attachment of the stiffening ring is given by the following formula:

$$W = 0.78(Rt)^{0.5}$$

Where:

W = width of jacket effective on each side of the stiffening ring, in inches;

R = outside radius of the outer jacket, in inches;

t = plate thickness of the outer jacket, after forming, in inches.

(c) Where a stiffening ring is used that consists of a closed section having two webs attached to the outer jacket, the jacket plate between the webs may be included up to the limit of twice the value of "W", as defined in paragraph (b) of this section. The outer flange of the closed section, if not a steel structural shape, is subject to the same limitations with "W" based on the "R" and "t" values of the flange. Where two separate members such as two angles, are located less than "2W" apart they may be treated as a single stiffening ring member. (The maximum length 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:

$$I = [0.035D^3 LP_c] / E,$$

or

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$$I' = [0.046D^3 LP_c] / E$$

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.

[Amdt. 179-32, 48 FR 27708, June 16, 1983, as amended at 66 FR 45391, Aug. 28, 2001]

§ 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 weldable quality metal that is compatible with the inner tank shell;

(b) The stress in any orientation under any condition does not exceed the circumferential stress in the inner tank shell; and

(c) The wall thickness is not less than that specified in § 179.401-1.

§ 179.400-11 Welding.

(a) Except for closure of openings and a maximum of two circumferential

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closing joints in the cylindrical portion of the outer jacket, each joint of an inner tank and the outer jacket must be a fusion double welded butt joint.

(b) The closure for openings and the circumferential closing joints in the cylindrical portion of the outer jacket, including head to shell joints, may be a single welded butt joint using a backing strip on the inside of the joint.

(c) Each joint must be welded in accordance with the requirements of AAR Specifications for Tank Cars, appendix W (IBR, see § 171.7 of this subchapter).

(d) Each welding procedure, welder, and fabricator must be approved.

[Amdt. 179-32, 48 FR 27708, June 16, 1983, as amended at 68 FR 75763, Dec. 31, 2003]

§ 179.400-12 Postweld heat treatment.

(a) Postweld heat treatment of the inner tank is not required.

(b) The cylindrical portion of the outer jacket, with the exception of the circumferential closing seams, must be postweld heat treated as prescribed in AAR Specifications for Tank Cars, appendix W (IBR, see § 171.7 of this subchapter). Any item to be welded to this portion of the outer jacket must be attached before postweld heat treatment. Welds securing the following need not be postweld heat treated when it is not practical due to final assembly procedures:

(1) the inner tank support system to the outer jacket,

(2) connections at piping penetrations,

(3) closures for access openings, and

(4) circumferential closing joints of head to shell joints.

(c) When cold formed heads are used on the outer jacket they must be heat treated before welding to the jacket shell if postweld heat treatment is not practical due to assembly procedures.

[Amdt. 179-32, 48 FR 27708, June 16, 1983, as amended at 68 FR 75763, Dec. 31, 2003]

§ 179.400-13 Support system for inner tank.

(a) The inner tank must be supported within the outer jacket by a support system of approved design. The system and its areas of attachment to the outer jacket must have adequate strength and ductility at operating