PART PWT

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PWT-10 Maximum Allowable Working Pressures for Seamless Steel and Electric Resistance Welded Steel Tubes or Nipples for Watertube Boilers, Where Expanded Into Drums or Headers, for Different Diameters and Gages of Tubes Conforming to the Requirements of Specifications SA-178 Grade A, SA-192, and SA-226 131

PART PWT
REQUIREMENTS
FOR WATERTUBE BOILERS

GENERAL

PWT-1 GENERAL

The rules in Part PWT are applicable to watertube boilers and parts thereof and shall be used in conjunction with the general requirements in Part PG as well as with the special requirements in the applicable Parts of this Section that apply to the method of fabrication used. The rules in Part PWT do not apply to external piping.

MATERIALS

PWT-5 GENERAL

PWT-5.1 Materials used in the construction of pressure parts for watertube boilers shall conform to one of the specifications in Section II and shall be limited to those for which allowable stress values are given in Tables 1A and 1B of Section II, Part D, for Section I construction or as otherwise specifically permitted in Part PG and Part PWT.

PWT-5.2 Mud drums of boilers shall be of either wrought steel or cast steel as designated in SA-216.

DESIGN

PWT-8 GENERAL

The rules in the following paragraphs apply specifically to the design of watertube boilers and parts thereof and shall be used in conjunction with the general requirements for design in Part PG as well as with the specific requirements for design in the applicable Parts of this Section that apply to the method of fabrication used.

PWT-9 TUBES AND PIPE

PWT-9.1 Economizer, boiler generator, and superheater tubes shall comply with the specifications as listed in PG-9.

PWT-9.2 Seamless steel pipe not exceeding NPS $1\frac{1}{2}$ (DN 40) complying with SA-53 or SA-106 may be threaded into the tubesheet, drum, or steel fitting of a watertube boiler. Steel fittings, if used, must fully cover the threads.

PWT-9.3 A tube in which a fusible plug is to be installed shall be not less than 0.22 in. (5.6 mm) in thickness at the plug in order to secure four full threads for the plug. (See also A-20.)

PWT-10 TUBE WALL THICKNESS

PWT-10.1 The minimum tube wall thickness at the maximum allowable working pressure for carbon or alloy steel tubes or nipples subjected to internal pressure for watertube boilers, economizers, and superheaters shall be determined in accordance with PG-27.2.1.

PWT-10.2 Where the outside diameter of a circular boiler pressure part exceeds 5 in. (127 mm), the minimum thickness shall be determined by the formula in PG-27.2.2.

PWT-10.3 For tubes of the materials listed in its title, Table PWT-10 may be used in lieu of the formula for determining the minimum wall thickness of tubes where expanded into drums or headers, provided the maximum mean wall temperature does not exceed 700°F (371°C).

PWT-11 TUBE CONNECTIONS

Tubes, pipe, and nipples may be attached to shells, heads, headers, and fittings by one of the following methods.

TABLE PWT-10
MAXIMUM ALLOWABLE WORKING PRESSURES FOR SEAMLESS STEEL AND ELECTRIC RESISTANCE WELDED STEEL TUBES OR NIPPLES FOR WATERTUBE BOILERS, WHERE EXPANDED INTO DRUMS OR HEADERS, FOR DIFFERENT DIAMETERS AND GAGES OF TUBES CONFORMING TO THE REQUIREMENTS OF SPECIFICATIONS SA-178 GRADE A, SA-192, AND SA-226

Customary Units

Wall Thickness, in.	Nearest Bwg. No.	Tube Outside Diameter, in.																
		1/2	3/4	1	1 1/8	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4	4	4 1/2	5
0.055	17 –	640	380	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
0.065	16	1,170	730	510	440	380	...	...	...	...	...	...	...	...	...	...	...	...	...
0.075	15 +	1,730	1,080	770	670	590	470	...	...	...	...	...	...	...	...	...	...	...	...
0.085	14 +	...	1,450	1,040	900	800	640	525	442	...	...	...	...	...	...	...	...	...	...
0.095	13	...	...	...	2,140	1,900	820	680	580	500	430	380	...	...	...	...	...	...	...
0.105	12 –	...	...	...	...	2,130	1,730	1,450	1,240	610	540	480	420	...	...	...	...	...	...
0.120	11	...	...	...	...	...	2,020	1,690	1,450	1,260	1,120	1,000	900	500	460	420	...	...	...
0.135	10 +	...	...	...	...	...	...	1,930	1,660	1,450	1,280	1,150	1,040	950	870	800	740	...	...
0.150	9 +	...	...	...	...	...	...	2,180	1,870	1,630	1,450	1,300	1,170	1,070	980	900	840	730	640
0.165	8	...	...	...	...	...	...	...	2,090	1,820	1,620	1,450	1,310	1,190	1,100	1,010	940	820	720
0.180	7	...	...	...	...	...	...	...	...	2,020	1,790	1,600	1,450	1,320	1,210	1,120	1,040	900	800
0.200	6 –	...	...	...	...	...	...	...	...	...	2,020	1,810	1,630	1,490	1,370	1,260	1,170	1,020	900
0.220	5	...	...	...	...	...	...	...	...	...	...	2,020	1,820	1,660	1,530	1,410	1,310	1,140	1,010
0.240	4 +	...	...	...	...	...	...	...	...	...	...	...	2,020	1,840	1,690	1,560	1,450	1,260	1,120
0.260	3 +	...	...	...	...	...	...	...	...	...	...	...	...	2,020	1,850	1,710	1,590	1,390	1,230
0.280	2 –	...	...	...	...	...	...	...	...	...	...	...	...	2,200	2,020	1,860	1,730	1,510	1,340
0.300	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,180	2,020	1,870	1,630	1,450
0.320	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,170	2,020	1,760	1,560
0.340	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,160	1,890	1,670
0.360	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,020	1,790
0.380	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,140	1,900
0.400	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,020
0.420	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,130

(continued)

TABLE PWT-10 (CONT'D)
MAXIMUM ALLOWABLE WORKING PRESSURES FOR SEAMLESS STEEL AND ELECTRIC RESISTANCE WELDED STEEL TUBES OR NIPPLES FOR WATERTUBE BOILERS, WHERE EXPANDED INTO DRUMS OR HEADERS, FOR DIFFERENT DIAMETERS AND GAGES OF TUBES CONFORMING TO THE REQUIREMENTS OF SPECIFICATIONS SA-178 GRADE A, SA-192, AND SA-226

SI Units

Wall Thickness, mm	Nearest Bwg. No.	Tube Outside Diameter, mm																
		12.7	19	25.4	28.6	31.8	38.1	44.4	50.8	57.2	63.5	69.8	76.2	82.6	88.9	95.2	101.6	114.3	127.0
1.40	17 –	4 413	2 620	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1.65	16	8 067	5 033	3 516	3 034	2 620	...	...	...	...	...	...	...	...	...	...	...	...	...
1.91	15 +	11 928	7 447	5 309	4 620	4 068	3 241	...	...	...	...	...	...	...	...	...	...	...	...
2.16	14 +	...	9 998	7 171	6 206	5 516	4 413	3 620	3048	...	...	...	...	...	...	...	...	...	...
2.41	13	...	...	...	14 755	13 101	5 654	4 689	3 999	3 448	2 965	2 620	...	...	...	...	...	...	...
2.67	12 –	...	...	...	...	14 686	11 928	9 998	8 550	4 206	3 723	3 310	2 896	...	...	...	...	...	...
3.05	11	...	...	...	...	...	13 928	11 653	9 998	8 688	7 722	6 895	6 206	3 448	3 172	2 896	...	...	...
3.43	10 +	...	...	...	...	...	...	13 307	11 446	9 998	8 826	7 929	7 171	6 550	5 999	5 516	5 102	...	...
3.81	9 +	...	...	...	...	...	...	15 031	12 894	11 239	9 998	8 964	8 067	7 378	6 757	6 206	5 792	5 033	4 413
4.19	8	...	...	...	...	...	...	...	14 411	12 549	11 170	9 998	9 032	8 067	7 585	6 964	6 481	5 654	4 964
4.57	7	...	...	...	...	...	...	...	...	13 928	12 342	11 032	9 998	9 101	8 343	7 722	7 171	6 206	5 516
5.08	6 –	...	...	...	...	...	...	...	...	...	13 928	12 480	11 239	10 274	9 446	8 688	8 067	7 033	6 206
5.59	5	...	...	...	...	...	...	...	...	...	...	13 928	12 549	11 446	10 549	9 722	9 032	7 860	6 964
6.10	4 +	...	...	...	...	...	...	...	...	...	...	...	13 928	12 687	11 653	10 756	9 998	8 688	7 722
6.60	3 +	...	...	...	...	...	...	...	...	...	...	...	...	13 928	12 756	11 790	10 963	9 584	8 481
7.11	2 –	...	...	...	...	...	...	...	...	...	...	...	...	13 928	13 928	12 825	11 928	10 411	9 239
7.62	...	...	...	...	...	...	...	...	...	...	...	...	...	...	15 031	13 928	12 894	11 239	9 998
8.13	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	14 962	13 928	12 135	10 756
8.64	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	14 893	13 032	11 515
9.14	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	13 928	12 342
9.65	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	14 755	13 101
10.16	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	13 928
10.67	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	14 686

GENERAL NOTES:
(a) These values have been calculated by the formula in PG-27.2.1, using allowable stress values at a temperature of 700°F (371°C), from Table 1A of Section II, Part D. Values above the solid line include an additional thickness of 0.04 in. (1.02 mm) to compensate for thinning of tube ends due to the expanding process.
(b) Where calculated allowable working pressures exceeded an even unit of 10 by more than 1, the next higher unit of 10 is given in the table.

PWT-11.1 Tubes may be attached by expanding, flaring, beading, and seal welding in the following combinations illustrated in Fig. PWT-11:

(a) expanded and flared [sketch (a)];

(b) expanded and beaded [sketch (b)];

(c) expanded, flared, seal welded, and re-expanded after welding [sketch (c)]; or

(d) expanded, seal welded, and re-expanded after welding or seal welded and expanded after welding [sketch (d)].

The end of all tubes that are flared shall project through the tubesheet or header not less than $\frac{1}{4}$ in. (6 mm) nor more than $\frac{3}{4}$ in. (19 mm) before flaring. Where tubes enter at an angle, the maximum limit of $\frac{3}{4}$ in. (19 mm) shall apply only at the point of least projection. Tubes that are expanded and flared without seal welding shall be flared to an outside diameter of at least $\frac{1}{8}$ in. (3.2 mm) greater than the diameter of the tube hole. For tubes that are seal welded, the maximum throat of seal welds shall be $\frac{3}{8}$ in. (10 mm).

PWT-11.2 Superheater, reheater, waterwall, or economizer tubes may be welded to tubular manifolds, headers, or drums and tube ends or weld necks may be welded to drums, all without expanding or flaring, provided the connections comply with the requirements of PW-15 and PW-16. The welds shall be postweld heat treated when required by PG-39.

PWT-11.3 Pipe used for tubes as provided in PWT-9.2 may be attached by threading instead of expanding and flaring, provided the requirements in PG-39.5 are conformed to.

PWT-11.4 Watertubes not exceeding 2 in. (51 mm) O.D. may be welded to tapered ferrules that are attached to the drum by a driven interference fit. In addition to the interference fit, the ferrules shall be held in place by retainer clamps attached to the drum with stud bolts. Fillet welds shall not be used to attach the tubes to the ferrules when exposed to primary furnace gases. Welded stud bolts shall comply with PW-273 and PW-28.6. When tapped holes are provided for the studs, the stud bolts shall comply with PG-39.4. The minimum cross-sectional area of the remaining studs shall be determined by the following equation, but shall not be less than that of a $\frac{3}{8}$ in. (10 mm) stud.

$$A = 0.25\pi D^2 NP/S$$

where

A = the root area of the stud, sq in. (mm^2)

S = the allowable stress of the stud material at its design temperature, psi (kPa)

N = the number of fittings retained by the stud

D = the outside diameter of the ferrule at the inside surface of the drum, in. (mm)

P = the design pressure, psi (kPa)

PWT-12 STAYBOLTING BOX TYPE HEADERS

The front and back sheets of staybolted box type headers may be joined together by welding provided:

PWT-12.1 The flat portion in the trough of the header as shown in Fig. PWT-12.1 does not exceed 90% of the allowable staybolt pitch permitted by PG-46, the weld is radiographed, and the welded structure is postweld heat treated; or

PWT-12.2 The inside width of the waterleg does not exceed 4 in. (102 mm), the distance from the weld to the nearest row of staybolts is not more than:

$$(p/2 + r)$$

where

p = pitch permitted by PG-46, in. (mm)

r = radius of waterleg bottom curvature, in. [not to exceed 2 in. (51 mm)]

The design pressure does not exceed 200 psi (1 400 kPa), the welded joint is not exposed to the products of combustion, and the welded structure is postweld heat treated. Radiographic examination is not required.

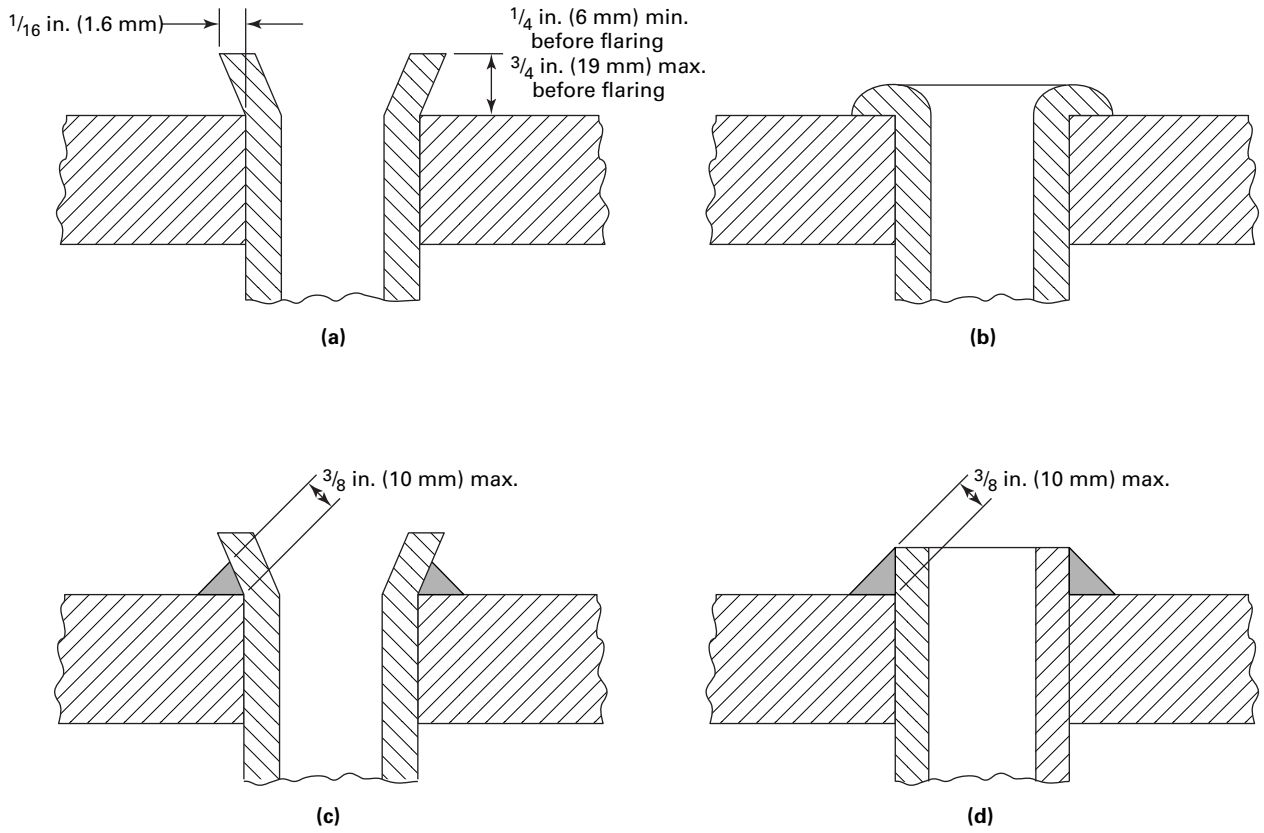
PWT-13 STAYING SEGMENT OF HEADS

The rules in PFT-25.2 shall be used to determine if staying is required.

PWT-14 FIRING DOORS

A watertube boiler shall have the firing doors of the inward-opening type, unless such doors are provided with substantial and effective latching or fastening devices or otherwise so constructed as to prevent them, when closed, from being blown open by pressure on the furnace side.

These latches or fastenings shall be of the positive self-locking type. Friction contacts, latches, or bolts actuated by springs shall not be used. The foregoing requirements for latches or fastenings shall not apply to coal openings of downdraft or similar furnaces.



A02 FIG. PWT-11 EXAMPLES OF ACCEPTABLE FORMS OF TUBE ATTACHMENT

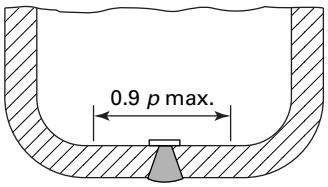


FIG. PWT-12.1 BOX TYPE HEADER JOINT

All other doors, except explosion doors, not used in the firing of the boiler may be provided with bolts or fastenings in lieu of self-locking latching devices.

Explosion doors, if used and if located in the setting walls within 7 ft (2.1 m) of the firing floor or operating platform, shall be provided with substantial deflectors to divert the blast.

01 PWT-15 ACCESS AND FIRING DOORS

The minimum size of an access or fire door opening, in which the minimum furnace dimension is 24 in. (610 mm), shall be not less than 12 in. × 16 in. (305 mm × 406 mm) or equivalent area, 11 in. (280 mm) to be the least dimension in any case. A circular opening shall be not less than 15 in. (381 mm) in diameter.

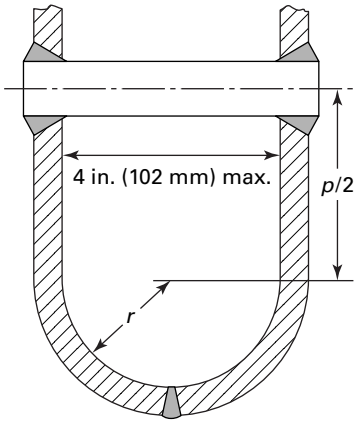


FIG. PWT-12.2 METHOD OF FORMING WATERLEG JOINTS BY WELDING

For furnace dimensions less than 24 in. (610 mm), the opening should be $2\frac{3}{4}$ in. × $3\frac{1}{2}$ in. (70 mm × 89 mm) or larger where possible. In cases where the size or shape of the boiler prohibits an opening of that size, two openings with a minimum size of 1 in. (25 mm) may be used, preferably oppposite each other, to permit inspection and cleaning of the furnace. If the burner is removable so as to permit inspection and cleaning through the burner opening, a separate access opening need not be provided.