

ASTM - A803/A803M

SPECIFICATION FOR SEAMLESS AND WELDED FERRITIC STAINLESS STEEL FEEDWATER HEATER TUBES

This specification covers seamless and welded ferritic stainless steel feedwater heater tubes including those bent, if specified, into the form of U-tubes for application in tubular feedwater heaters.

The tubing sizes covered shall be 5/8 to 1 in. [15.9 to 25.4 mm] inclusive outside diameter, and average or minimum wall thicknesses of 0.028 in. [0.7 mm] and heavier.

A. Heat Treatment :-

1. All finished straight tubing or straight tubing ready for U-bending shall be furnished in the solutionannealed condition. The annealing procedure shall consist of heating the material to a temperature of 1200°F [650°C] or higher and cooling (as appropriate for the grade) to meet the requirements of this specification.
2. If heat treatment of U-bends is specified, it shall satisfy the annealing procedure described in point A.1 and shall be done as follows:
 - i. The heat treatment shall be applied to the U-bend area plus approximately 6 in. [150 mm] of each leg beyond the tangent point of the U-bend.
 - ii. If the heat treatment specified in point A.2 is accomplished by resistance-heating methods wherein electrodes are clamped to the tubes, the clamped areas shall be visually examined for arc burns.
 - iii. Temperature control shall be accomplished through the use of optical or emission pyrometers, or both.
 - iv. The inside of the tube shall be purged with a protective or an inert gas atmosphere during heating and cooling to below 700°F [370°C] to prevent scaling of the inside surface.

B. Chemical Composition :-

The steel shall conform to the chemical composition in Table 1.

Table 1

UNS	S40900	S43035	S44627	S44626	S44635	S44660	S44700	S44800	S44400	S44735
Grade	TP409	TP439	TP XM-27	TP XM-33	25-4-4	26-3-3	29-4	29-4-2	18-2	29-4C
C, max	0.08	0.07	0.01 ^A	0.06	0.025	0.03	0.01	0.01	0.025	0.03
Mn, max	1	1	0.4	0.75	1	1	0.3	0.3	1	1
P, max	0.045	0.04	0.02	0.04	0.04	0.04	0.025	0.025	0.04	0.04
S, max	0.03	0.03	0.02	0.02	0.03	0.03	0.02	0.02	0.03	0.03
Si, max	1	1	0.4	0.75	0.75	1	0.2	0.2	1	1
Ni	0.50 max	0.50 max	0.5 ^B max	0.50 max	3.5–4.5	1.0–3.5	0.15 max	2.0–2.5	1.00 max	1.00 max
Cr	10.5–11.7	17.0–19.0	25.0–27.5	25.0–27.0	24.5–26.0	25.0–28.0	28.0–30.0	28.0–30.0	17.5–19.5	28.0–30.0
Mo	...	...	0.75–1.50	0.75–1.50	3.5–4.5	3.0–4.0	3.5–4.2	3.5–4.2	1.75–2.50	3.6–4.2
Al	...	0.15 max	...	...	...	...	...	...	...	...
Cu	...	...	0.20 max	0.20 max	...	...	0.15 max	0.15 max	...	...
N	...	0.04 max	0.015 max	0.040 max	0.035	0.040 max	0.020 max ^C	0.020 max ^C	0.035 max	0.045 max

Ti	6×C min; 0.75 max	0.20+4 (C+N) min; 1.10 max	...	7×(C + N) but no less than 0.20 min; 1.00 max	(Ti + Cb) = 0.2+4(C+N) min; 0.80 max	Ti + Cb = 6×(C+N) but no less than 0.20 min; 1.00 max	...	...	(Ti + Cb) = 0.20+4(C+N) min; 0.80 max	Ti + Cb = 6×(C+N) but no less than 0.20 min; 1.00 max
Cb	...	...	0.05–0.20	...	...	...	...	...	...	...

^A For small diameter or thin walls, or both, tubing, where many drawing passes are required, a carbon maximum of 0.015 % is necessary. Small outside diameter tubes are defined as those less than 0.500 in. [12.7 mm] in outside diameter and light wall tubes as those less than 0.049 in. [1.2 mm] in average wall thickness (0.040 in. [1 mm] in minimum wall thickness). ^B Nickel + copper.

^C Carbon + nitrogen = 0.025 max.

C. Mechanical Requirements :-

1. Tensile Properties —

- i. The material shall conform to the tensile properties shown in Table 2.
- ii. Table 3 gives the computed minimum elongation values for each 1/32 in. [0.8 mm] decrease in wall thickness.

Table 2

Grade	Tensile Strength, min, ksi [MPa]	Yield Strength, min, ksi [MPa]	Elongation ^A in 2 in. or 50 mm, min, %
TP 409	55 [380]	30 [205]	20
TP 439	60 [415]	30 [205]	20
TP XM-27	65 [450]	40 [275]	20
TP XM-33	68 [470]	45 [310]	20
25-4-4	90 [620]	75 [515]	20
26-3-3	85 [585]	65 [450]	20
29-4	80 [550]	60 [415]	20
29-4-2	80 [550]	60 [415]	20
18-2	60 [415]	35 [240]	20
29-4C	75 [515]	60 [415]	18

^A For longitudinal strip tests, a deduction of 0.90 % for 29-4C and 1 % for all other grades shall be made from the basic minimum elongation for each 1/32 in. [0.8 mm] decrease in wall thickness below 5/16 in. [8 mm]. Table 3 gives the computed minimum values.

Table 3^A

Wall Thickness ^B in.	Elongation in 2 in. or 50 mm, min, %		
	mm	29-4C	All Other
5/16 (0.312)	8	18	20
9/32 (0.281)	7.2	17	19
1/4 (0.250)	6.4	16	18
7/32 (0.219)	5.6	15	17
3/16 (0.188)	4.8	14	16
5/32 (0.156)	4	13	15
1/8 (0.125)	3.2	13	14
3/32 (0.094)	2.4	12	13
1/16 (0.062)	1.6	11	12

0.062 to 0.035, excl	1.6 to 0.9	10	12
0.035 to 0.022, excl	0.9 to 0.6	10	11
0.022 to 0.015, excl	0.6 to 0.4	10	11

^A Calculation elongation shall be rounded to the nearest whole number.

^B Where the wall thickness lies between two values shown above, the minimum elongation value shall be determined by the following equation:

Grade	Equation
29-4C	$E = 28.8t + 9.00$ [$E = 1.13t + 9.00$]
All other	$E = 32t + 10.00$ [$E = 1.25t + 10.00$]

Where: E = elongation in 2 in. or 50mm, %, and
 t = actual thickness of specimen, in. [mm].

2. Hardness —

- i. The tubes shall have a hardness number not to exceed those prescribed in Table 4. This hardness requirement is not to apply to the bend area of U-bend tubes which are not heat treated after bending.

Table 4

Grade	Brinell Hardness, max	Rockwell Hardness, B Scale, max
TP 409	207	95
TP 439	207	95
P XM-27	241	100
TP XM-33	241	100
25-4-4	270	27 ^A
26-3-3	265	25 ^A
29-4	241	100
29-4-2	241	100
18-2	217	95
29-4C	241	100

^A Rockwell Hardness, C scale.

3. Reverse Flattening Test (for Welded Product).
4. Flange Test (for Welded Product).
5. Flaring Test (for Seamless Tubes).
6. Pressure Test — The Pressure-tested shall be in accordance with one of the following paragraphs as specified by the purchaser:
 - i. Hydrostatic Test — Each tube shall be given an internal hydrostatic test in accordance with Specification A1016/ A1016M.
 - ii. Pneumatic Test — Each tube shall be examined by a pneumatic test (either air underwater or pneumatic leak test) in accordance with Specification A1016/A1016M.

D. Permissible Variations in Dimensions (Fig. 1) :-

1. Permissible variations from the specified outside diameter shall be in accordance with Specification A1016/A1016M.
2. At the bent portion of a U-tube for $R = 2 \times D$ or greater, neither the major nor minor diameter of the tube shall deviate from the nominal diameter prior to bending by more than 10 %. If less than $2 \times D$ is specified, tolerances could be greater.

3. Permissible Variations from the Specified Wall Thickness:

- i. Permissible variations from the specified minimum wall thickness shall not exceed +20, – 0 %.
- ii. Permissible variations from the specified average wall thickness are 610 % of the nominal wall thickness.
- iii. The wall thickness of the tube in the U-bent section shall not be less than value determined by the equation:

$$t_f = (4RT) / (4R+D)$$

where: t_f = wall thickness after bending, in. [mm],

T = minimum wall thickness, in. [mm],

R = center line bend radius, in. [mm], and

D = nominal outside tube diameter, in. [mm].

4. Permissible Variations from the Specified Length:

- i. Straight Lengths—The maximum permissible variations for lengths 24 ft [7.3 m] and shorter shall be +1/8 in. [+3 mm], –0; for lengths longer than 24 ft [7.3 m], an additional over tolerance of +1/8 in. [+3 mm] for each 10 ft [3 m], or fraction thereof, shall be permitted up to a maximum of +1/2 in. [+13 mm].
- ii. U-Bends—In the case of U-tubes, the length of the tube legs, as measured from the point of tangency of the bend and the tube leg to the end of the tube leg, shall not be less than specified, but may exceed the specified values by the amount given in Table 5. The difference in lengths of the tube legs shall not be greater than 1/8 in. [3 mm] unless otherwise specified.
- iii. The end of any tube may depart from square by not more than the amount given in Table 6.

Table 5: Tube Leg Length Tolerance

Leg Length, ft [m]	Plus Tolerance, in. [mm]
Up to 20 [6], incl	1/8 [3.2]
Over 20 to 30 [6 to 9], incl	5/32 [4.0]
Over 30 to 40 [9 to 12], incl	3/16 [4.8]

Table 6: Squareness of Ends Tolerance

Tube OD, in. [mm]	Tolerance, in. [mm]
Up to 5/8 [15.9], incl	0.010 [0.25]
Over 5/8 to 1 in. [15.9 to 25.4], incl	0.016 [0.41]

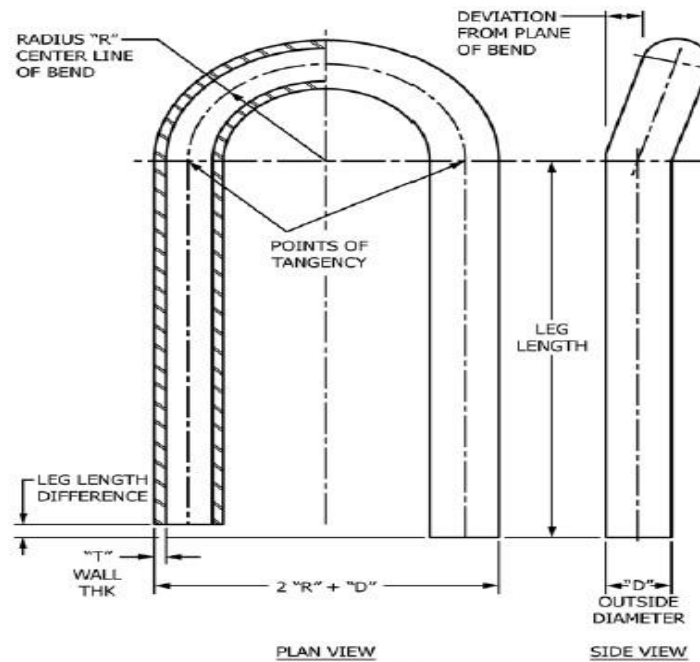


FIG. 1 Plane Bend for U-Tube

E. Non-destructive Test (Electric Test) :-

1. Each tube shall be pass through a non-destructive tester in accordance with Specification A1016/A1016M.

F. Supplementary Test :-

1. Non-destructive Eddy-Current Test.

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