



ASTM A213 Tubing Standard Specification (ASME SA213)

Standard Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes

ASTM A213 covers seamless ferritic and austenitic steel boiler, superheater, and heat-exchanger tubes, designated Grades T5, TP304, Grades containing the letter, H, in their designation, have requirements different from those of similar grades not containing the letter, H. These different requirements provide higher creep-rupture strength than normally achievable in similar grades without these different requirements.

The tubing sizes and thicknesses usually furnished to this specification are 1/8 in. [3.2 mm] in inside diameter to 5 in. [127 mm] in outside diameter and 0.015 to 0.500 in. [0.4 to 12.7 mm], inclusive, in minimum wall thickness or, if specified in the order, average wall thickness. Tubing having other diameters may be furnished, provided such tubes comply with all other requirements of this specification

General use A213/SA213 alloy tubing grades are T5, T9, T11, T12, T22, T91, stainless tubing are TP304/304L, TP316/316L.

For more info please visit <https://www.octalsteel.com/resources/astm-a213-tubing>

Chemical Composition Limits, %, for ASTM A213 Alloy Steel Tubing

Grade	UNS Designation	Composition, %							
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Nickel	Chromium	Molybdenum
T5	K41545	0.15	0.30-0.60	0.025	0.025	0.5	...	8.00-10.00	0.90-1.10
T9	K90941	0.15	0.30-0.60	0.025	0.025	0.25-1.00	...	4.00-6.00	0.45-0.65
T11	K11597	0.05-0.15	0.30-0.60	0.025	0.025	0.50-1.00	...	1.00-1.50	0.44-0.65
T12	K11562	0.05-0.15	0.30-0.61	0.025	0.025	0.5	...	0.80-1.25	0.44-0.65
T21	K31545	0.05-0.15	0.30-0.60	0.025	0.025	0.50-1.00	...	2.65-3.35	0.80-1.06
T22	K21590	0.05-0.15	0.30-0.60	0.025	0.025	0.5	...	1.90-2.60	0.87-1.13
T91	K90901	0.07-0.14	0.30-0.60	0.02	0.01	0.20-0.50	0.4	8.0-9.5	0.80-1.05

For T91 other than above also includes Nickel 0.4, Va 0.18-0.25, Ni 0.06-0.10, Ni 0.03-0.07, Al 0.02, Ti 0.01, Zr 0.01.

A Maximum, unless range or minimum is indicated. Where ellipses (...) appear in this table, there is no requirement, and analysis for the element need not be determined or reported.

B It is permissible to order T2 and T12 with a sulfur content of 0.045 max.

C Alternatively, in lieu of this ratio minimum, the material shall have a minimum hardness of 275 HV in the hardened condition, defined as after austenitizing and cooling to room temperature but prior to tempering. Hardness testing shall be performed at mid-thickness of the product. Hardness test frequency shall be two samples of product per heat treatment lot and the hardness testing results shall be reported on the material test report.

Chemical Composition Limits, %, for Austenitic and Ferritic Stainless Steel of A213/SA213

Grade	UNS Designation	Composition, %							
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum
TP304	S30400	0.08	2.00	0.045	0.030	1.00	18.0-20.0	8.0-11.0	...
TP304L	S30403	0.035 ^D	2.00	0.045	0.030	1.00	18.0-20.0	8.0-12.0	...
TP316	S31600	0.08	2.00	0.045	0.030	1.00	16.0-18.0	10.0-14.0	2.00-3.00
TP316L	S31603	0.035 ^D	2.00	0.045	0.030	1.00	16.0-18.0	10.0-14.0	2.00-3.00
TP321	S2100	0.08	2.00	0.045	0.030	1.00	17.0-19.0	9.0-12.0	...

For TP321 also includes Ti 5(C+N)-0.70

A: Maximum, unless a range or minimum is indicated. Where ellipses (...) appear in this table, there is no minimum and analysis for the element need not be determined or report

B: The method of analysis for Nitrogen shall be a matter of agreement between the purchaser and the producer.

C: For these alloys, there is no common grade designation. The UNS number uniquely identifies these alloys

D: For small diameter or thin walls, or both, where many drawing passes are required, a carbon maximum of 0.040% is necessary in Grades TP304L, TP304LN, TP316L, and TP316LN.

Heat Treatment and Grain Size Requirements of A213/SA213

Grade	UNS Number	Heat Treat Type	Austenitizing/ Solutioning Temperature, min or range °F [°C]	Cooling Media	Subcritical Annealing or Tempering Temperature, min or range °F [°C]	ASTM Grain Size No. ^B
T5	K11547	Full or isothermal	...	...		...
		anneal	...	...		...
		normalize and	...	...		...
		temper	...	...		...
T9	K90941	Full or isothermal	...	...	1200 to 1350 [650 to 730]	...
		anneal	...	...		...
		normalize and	...	...	1250 [675]	...
		temper	...	...		...
T11	K11597	Full or isothermal	...	...		...
		anneal	...	...		...
		normalize and	...	...	1200 [650]	...
		temper	...	...		...
T12	K11562	Full or isothermal	...	...		...
		anneal	...	...		...
		normalize and	...	...		...
		temper	...	...		...
T21	K31545	Full or isothermal	...	...	1200 to 1350 [650 to 730]	...
		anneal	...	...		...
		normalize and	...	...		...
		temper	...	...		...
T22	K21590	Full or isothermal	...	...		...
		anneal	...	...		...
		normalize and	...	...	1250 [675]	...
		temper	...	...		...
T91	K90901	normalize and	1900-1975		1350-1470 [730-800]	...
		temper	[1040-1080]			...
TP304	S30400	solution treatment	1900 [1040] ^F	water or other rapid cool	...	...
TP304L	S30403	solution treatment	1900 [1040] ^F	water or other rapid cool	...	...
TP316	S31600	solution treatment	1900 [1040] ^F	water or other rapid cool	...	...
TP316L	S31603	solution treatment	1900 [1040] ^F	water or other rapid cool	...	...
TP321	S2100	solution treatment	1900 [1040] ^{F,H}	water or other rapid cool	...	...

A: Where ellipses (...) appear in this table there is no requirement.

B: ASTM Grain Size No. listed, or coarser, unless otherwise indicated.

F: Quenched in water or rapidly cooled by other means, at a rate sufficient to prevent re-precipitation of carbides, as demonstrable by the capability of tubes, heat treated by either separate solution annealing or by direct quenching, passing Practices A262, Practice E. The manufacturer is not required to run the test unless it is specified on the purchase order (see Supplementary Requirement S4). Note that Practices A262 requires the test to be performed on sensitized specimens in the low-carbon and stabilized types and on specimens representative of the as-shipped condition for other types. In the case of low-carbon types containing 3 % or more molybdenum, the applicability of the sensitizing treatment prior to testing shall be a matter for negotiation between the seller and the purchaser.

H: A solution treating temperature above 1950 °F [1065 °C] may impair resistance to intergranular corrosion after subsequent exposure to sensitizing conditions in the indicated grades. When specified by the purchaser, a lower temperature stabilization or resolution anneal shall be used subsequent to the higher-temperature solution anneal prescribed in this table.



Tensile and Hardness Properties of ASME A213

Grade	UNS Designation	Tensile Strength, min, ksi [MPa]	Yield Strength, min, ksi [MPa]	Elongation in 2 in. or 50 mm, min, % ^{B,C}	Hardness ^A	
					Brinell/Vickers	Rockwell
Low Alloy Steels:						
T5b	K51545	60 [415]	30 [205]	30	179 HBW/190HV	89 HRB
T9	K90941	60 [415]	30 [205]	30	179 HBW/190HV	89 HRB
T12	K11562	60 [415]	32 [220]	30.00	163 HBW/170 HV	85 HRB
T23	K40712	74 [510]	58 [400]	20	220 HBW/230 HV	97 HRB
T24	K30736	85 [585]	60 [415]	20.00	250 HBW/265 HV	25 HRC
T91	K90901	85 [585]	60 [415]	20	190 to 250 HBW/196 to 265 HV	90 HRB to 25 HRC
Austenitic Stainless Steels:						
TP304	S30400	75 [515]	30 [205]	35	192 HBW/200 HV	90 HRB
TP304L	S30403	70 [485]	25 [170]	35.00	192 HBW/200 HV	90 HRB
TP316	S31600	75 [515]	30 [205]	35	192 HBW/200 HV	90 HRB
TP316L	S31603	70 [485]	25 [170]	35.00	192 HBW/200 HV	90 HRB
TP321	S2100	75 [515]	30 [205]	35	192 HBW/200 HV	90 HRB

A: Max, unless a range or a minimum is specified.

B: When standard round 2 in. or 50 mm gage length or smaller proportionally sized specimens with gage length equal to 4D (4 times the diameter) is used, the minimum elongation shall be 22 % for all low alloy grades except T23, T24, T91, T92, T122, and T911; and except for TP444.

C: For longitudinal strip tests, a deduction from the basic minimum elongation values of 1.00 % for TP444, T23, T24, T91, T92, T122, and T911, and of 1.50 % for all other low alloy grades for each 1/32-in. [0.8-mm] decrease in wall thickness below 5/16 in. [8 mm] shall be made.

Flattening Test

B: One flattening test shall be made on specimens from each end of one finished tube, not the one used for the flaring test, from each lot.

Flaring Test

Flaring Test—One flaring test shall be made on specimens from each end of one finished tube, not the one used for the flattening test, from each lot.

Hydrostatic or Nondestructive Electric Test

Each tube shall be subjected to the nondestructive electric test or the hydrostatic test. The type of test to be used shall be at the option of the manufacturer, unless otherwise specified in the purchase order.

Number of Tubes in a Lot Heat Treated by the Continuous Process or by Direct Quench After Hot Forming

Size of Tube	Size of Lot
2 in. [50.8 mm] and over in outside diameter and 0.200 in. [5.1 mm] and over in wall thickness	not more than 50 tubes
2 in. [50.8 mm] and over in outside diameter and under 0.200 in. [5.1 mm] in wall thickness	not more than 75 tubes
Less than 2 in. [50.8 mm] but over 1 in. [25.4 mm] in outside diameter	not more than 75 tubes
1 in. [25.4 mm] or less in outside diameter	not more than 125 tubes



Elongations - Computed Minimum Values

Wall Thickness		Elongation in 2 in. or 50 mm, min, %		
in.	mm	S44400, T23, T24, T91, T92, T122, and T911	T 36	All Other Ferritic Grades
5/16 [0.312]	8	20	15	30
9/32 [0.281]	7.2	19	14	29
1/4 [0.250]	6.4	18	13	27
7/32 [0.219]	5.6	17	12	26
3/16 [0.188]	4.8	16	11	24
5/32 [0.156]	4.0	15	10	23
1/8 [0.125]	3.2	14	9	21
3/32 [0.094]	2.4	13	8	20
1/16 [0.062]	1.6	12	7	18
0.062 to 0.035, excl	1.6 to 0.9	12	7	17
0.035 to 0.022, excl	0.9 to 0.6	11	6	17
0.022 to 0.015 incl	0.6 to 0.4	11	6	16

A: Calculated elongation requirements shall be rounded to the nearest whole number

Tolerances of Average Wall Thickness for Hot Formed Tubes

NPS [DN] Designator	Tolerance in %, from specified	
	Over	Under
1/8 to 2 1/2 [6 to 65] incl, all t/D ratios ^A	20	12.5
Above 2 1/2 [65], t/D ≤ 5 % ^A	22.5	12.5
Above 2 1/2 [65], t/D > 5 % ^A	15	12.5

A: t = specified wall thickness D = specified outside diameter

Permissible variations from the specified minimum wall thickness shall be in accordance with Specification A1016/A1016M.

Tolerances of Wall Thickness for Cold Formed Tubing

Permissible variations from the specified average wall thickness shall be +/- 10 % of the specified average wall thickness for cold formed tubes and, unless otherwise specified by the purchaser, shall be in accordance with above table for hot formed tubes.