

A355 Chrome Alloy Steel Pipe, Fittings & Flanges

Scope This specification covers nominal wall and minimum wall seamless ferritic alloy-steel pipe intended for high temperature service. Pipe ordered to this specification shall be suitable for bending, flanging and similar forming operations, and for fusion welding.

Material & Manufacture Pipe may be either hot finished or cold drawn with the finishing heat treatment noted below.

Heat Treatment Requirements	P5, P9, P11, and P22			
	Grade	Heat Treatment Type	Normalizing Temperature Range F [C]	Subcritical Annealing or Tempering Temperature Range F [C]
P5 (b,c)	Full or Isothermal Anneal			
		Normalize and Temper	*****	1250 [675]
		Subcritical Anneal (P5c only)	*****	1325 - 1375 [715 - 745]
P9	Full or Isothermal Anneal			
		Normalize and Temper	*****	1250 [675]
P11	Full or Isothermal Anneal			
		Normalize and Temper	*****	1200 [650]
P22	Full or Isothermal Anneal			
		Normalize and Temper	*****	1250 [675]
P91	Normalize and Temper		1900-1975 [1040 - 1080]	1350-1470 [730 - 800]
	Quench and Temper		1900-1975 [1040 - 1080]	1350-1470 [730 - 800]

Chemical Requirements	Element	Grade UNS Designation	P-5	P-9	P-11	P-22	P-91	P-91 shall also include the following:
			K41545	S50400	K11597	K21590	K91560	
COMPOSITION %	Carbon		0.15 max	0.15 max	0.05 - 0.15	0.05 - 0.15	0.08 - 0.12	V at 0.18 - 0.25
	Manganese		0.30 - 0.60	0.30 - 0.60	0.30 - 0.60	0.30 - 0.60	0.30 - 0.60	N at 0.030 - 0.070
	Phosphorous, max		0.025	0.025	0.025	0.025	0.020	Ni at 0.40 max
	Sulfur, max		0.025	0.025	0.025	0.025	0.010	Al at 0.02 max
	Silicon		0.50 max	0.25 - 1.00	0.50 - 1.00	0.50 max	0.20 - 0.50	Cb at 0.06 - 0.10
	Chromium		4.00 - 6.00	8.00 - 10.00	1.00 - 1.50	1.90 - 2.60	8.00 - 9.50	Ti at 0.01 max
	Molybdenum		0.45 - 0.65	0.90 - 1.10	0.44 - 0.65	0.87 - 1.13	0.85 - 1.05	Zr at 0.01 max

Tensile Requirements	Seamless					P91 shall not have a hardness not exceeding 250 HB/265 HV [25HRC].
	P-5	P-9	P-11	P-22	P-91	
Tensile Strength, min., psi						
ksi	60	60	60	60	85	
MPa	415	415	415	415	585	
Yield Strength, min., psi						
ksi	30	30	30	30	60	
MPa	205	205	205	205	415	

Permissible Variation in Wall Thickness	NPS [DN] Designator	Tolerance, % from Specified	
		Over	Under
	1/8 to 2 1/2 [6 to 65] incl., all t/D ratios	20.0%	12.5%
	Above 2 1/2 [65], t/D < or = 5%	22.5%	12.5%
	Above 2 1/2 [65], t/D > 5%	15.0%	12.5%

(t = Specified Wall Thickness; D = Specified Outside Diameter)

Elongation Requirements	Calculated Minimum Elongation Values				
	Elongation in 2 in. or 50 mm, min %				
	Wall Thickness		P5, P9, P11, P22		P91
	in.	mm	Longitudinal	Transverse	Longitudinal
5/16 (0.312)	8	30	20	20	
9/32 (0.281)	7.2	28	19	19	
1/4 (0.250)	6.4	27	18	18	
7/32 (0.219)	5.6	26		17	
3/16 (0.188)	4.8	24		16	
5/32 (0.156)	4	22		15	
7/8 (0.125)	3.2	21		14	
3/32 (0.094)	2.4	20		13	
1/18 (0.062)	1.6	18		12	

Permissible Variations in Outside Diameter	Outside Diameter at any point shall not vary from standard specified more than:				
	NPS [DN] Designator	Over		Under	
		in.	mm	in.	mm
	1/8 to 1 1/2 [6 to 40], incl.	1/64 (0.015)	0.40	1/64 (0.015)	0.40
	Over 1 1/2 to 4 [40 to 100], incl.	1/32 (0.031)	0.79	1/32 (0.031)	0.79
	Over 4 to 8 [100 to 200], incl.	1/16 (0.062)	1.59	1/32 (0.031)	0.79
	Over 8 to 12 [200 to 300], incl.	3/32 (0.093)	2.38	1/32 (0.031)	0.79
	Over 12 [300]	+/- 1% of the specified outside diameter			