Anupam Metals India

PIPES & TUBES

ASTM A312
Chemical Requirements

Grade	UNS Designation[A]	Composition, %[B]																
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Titanium	Columbium	Tantalum, max	Nitrogen[C]	Vanadium	Copper	Cerium	Boron	Aluminum
...	S20400	0.030	7.0-9.0	0.045	0.030	1.00	15.0-17.0	1.50-3.00	...	...	...	...	0.15-0.30	...	...	...	...	...
TPXM-19	S20910	0.06	4.0-6.0	0.045	0.030	1.00	20.5-23.5	11.5-13.5	1.50-3.00	...	0.10-0.30	...	0.20-0.40	0.10-0.30	...	...	...	...
TPXM-10	S21900	0.08	8.0-10.0	0.045	0.030	1.00	19.0-21.5	5.5-7.5	...	...	...	...	0.15-0.40	...	...	...		
TPXM-11	S21904	0.04	8.0-10.0	0.045	0.030	1.00	19.0-21.5	5.5-7.5	...	...	...	...	0.15-0.40	...	...	...		
TPXM-29	S24000	0.08	11.5-14.5	0.060	0.030	1.00	17.0-19.0	2.3-3.7	...	...	...	...	0.20-0.40	...	...	...		
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	8.0-13.0	...	...	...	...	...	...	...	...		
TP304H	S30409	0.04-0.10	2.00	0.045	0.030	1.00	18.0-20.0	8.0-11.0	...	...	...	...	...	...	...	...		
...	S30415	0.04-0.06	0.80	0.045	0.030	1.00-2.00	18.0-19.0	9.0-10.0	...	...	...	...	0.12-0.18	...	...	0.03-0.08		
TP304N	S30451	0.08	2.00	0.045	0.030	1.00	18.0-20.0	8.0-18.0	...	...	...	...	0.10-0.16	...	...	...		
TP304LN	S30453	0.035	2.00	0.045	0.030	1.00	18.0-20.0	8.0-12.0	...	...	...	...	0.10-0.16	...	...	...		
...	S30600	0.018	2.00	0.02	0.02	3.7-4.3	17.0-18.5	14.0-15.5	0.20	...	...	...	...	...	0.50	max	...	
...	S30615	0.16-0.24	2.00	0.030	0.03	3.2-4.0	17.0-19.5	13.5-16.0	...	...	...	...	...	...	...	...	...	0.80-1.50
...	S30815	0.05-0.10	0.80	0.040	0.030	1.40-2.00	20.0-22.0	10.0-12.0	...	...	...	...	0.14-0.20	...	...	0.03-0.08		
TP309S	S30908	0.08	2.00	0.045	0.030	1.00	22.0-24.0	12.0-15.0	0.75	...	...	...	...	...	...			
TP309H	S30909	0.04-0.10	2.00	0.045	0.030	1.00	22.0-24.0	12.0-15.0	...	...	...	...	...	...	...			
TP309Cb	S30940	0.08	2.00	0.045	0.030	1.00	22.0-24.0	12.0-16.0	0.75	...	10 X C min, 1.10 max	...	...	...	...			
TP309HCb	S30941	0.04-0.10	2.00	0.045	0.030	1.00	22.0-24.0	12.0-16.0	0.75	...	10 X C min, 1.10 max	...	...	...	...			
	S31002	0.015	2.00	0.020	0.015	0.15	19.0-22.0	24.0-26.0	0.10	...	...	...	0.10	...				
TP310S	S31008	0.08	2.00	0.045	0.030	1.00	24.0-26.0	19.0-22.0	0.75	...	...	...	...	...	...			
TP310H	S31009	0.04-0.10	2.00	0.045	0.030	1.00	24.0-26.0	19.0-22.0	...	...	...	...	...	...	...			
TP310Cb	S31040	0.08	2.00	0.045	0.030	1.00	24.0-26.0	19.0-22.0	0.75	...	10 X C min, 1.10 max	...	...	...	...			
TP310HCb	S31041	0.04-0.10	2.00	0.045	0.030	1.00	24.0-26.0	19.0-22.0	0.75	...	10 X C min, 1.10 max	...	...	...	...			
...	S31060	0.025	2.00	0.030	0.015	0.4	24.0-26.0	20.5-23.5	1.6-2.6	...	...	...	0.09-0.15	...	...	...		
...	S31254	0.020	1.00	0.030	0.010	0.80	19.5-20.5	17.5-18.5	6.0-6.5	...	...	...	0.18-0.22	...	0.50-1.00	...		
	S31272	0.08-012	1.5-2.00	0.030	0.015	0.25-0.75	14.0-16.0	14.0-16.0	1.00-1.40	0.30-0.60							0.004-0.008	
TP316	S31600	0.08	2.00	0.045	0.030	1.00	16.0-18.0	11.0-14.0[E]	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	...	...	...	...	...	...	...		
TP316H	S31609	0.04-0.10	2.00	0.045	0.030	1.00	16.0-18.0	11.0-14.0[E]	2.00-3.00	...	...	...	...	...	...	...		
...	S31635	0.08	2.00	0.045	0.030	0.75	16.0-18.0	10.0-12.0	2.00-3.00	5X (C+N) min, 0.70	...	...	0.10	...	...	...	...	...
TP316N	S31651	0.08	2.00	0.045	0.030	1.00	16.0-18.0	11.0-14.0[F]	2.00-3.00				0.10-0.16	...	...	...		
TP316LN	S31653	0.035	2.00	0.045	0.030	1.00	16.0-18.0	11.0-14.0[F]	2.00-3.00	...	...	...	0.10-0.16	...	...	...		
TP317	S31700	0.08	2.00	0.045	0.030	1.00	18.0-20.0	11.0-14.0	3.0-4.0	...	...	...	...	...	...	...		
TP317L	S31703	0.035	2.00	0.045	0.030	1.00	18.0-20.0	11.0-15.0	3.0-4.0	...	...	...	...	...	...	...		
...	S31725	0.03	2.00	0.040[F]	0.030	1.00	18.0-20.0	13.5-17.5	4.0-5.0	...	...	...	0.10	...	0.75	...		
...	S31726	0.03	2.00	0.040[F]	0.030	1.00	17.0-20.0	14.5-17.5	4.0-5.0	...	...	...	0.10-0.20	...	0.75	...		
TP321	S32100	0.08	2.00	0.045	0.030	1.00	17.0-19.0	9.0-12.0	...	G	...	...	0.10	...	...	...		
TP321H	S32109	0.04-0.10	2.00	0.045	0.030	1.00	17.0-19.0	9.0-12.0	...	H	...	...	...	...	...	...		

Continued

Grade	UNS Desig-nationA	Composition,%B																
		Carbon	Manga-nese	Phos-phorus	Sulfur	Silicon	Chromium	Nickel	Molyb-denum	Tita-nium	Colum-bium	Tanta-lum, max	Nitrogen[C]	Vana-dium	Copper	Cerium	Boron	Aluminum
...	S32615	0.07	2.00	0.045	0.030	4.8–6.0	16.5–19.5	19.0–22.0	0.30–1.50	...	...	...	...	...	1.50–2.50	...		
...	S32654	0.020	2.0–4.0	0.030	0.005	0.50	24.0–25.0	21.0–23.0	7.0–8.0	...	...	...	0.45–0.55	...	0.30–0.60	...		
...	S33228	0.04–0.08	1.00	0.020	0.015	0.30	26.0–28.0	31.0–33.0	...	...	0.60–1.00	...	...	...	...	0.05–0.10	...	0.025
...	S34565	0.03	5.0–7.0	0.030	0.010	1.00	23.0–25.0	16.0–18.0	4.0–5.0	...	0.10		0.40–0.60	...	...	...	...	
TP347	S34700	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	...	...	I	...	...	...	...	...		
TP347H	S34709	0.04–0.10	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	...	...	J	...	...	...	...	...		
TP347LN	S34751	0.005–0.020	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	...	...	0.20–0.50FK	...	0.06–0.10	...	...	...	...	...
TP348	S34800	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	...	...	I	0.10	...	...	...	...		
TP348H	S34809	0.04–0.10	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	...	...	J	0.10	...	...	...	...		
...	S35045	0.06–0.10	1.50	...	0.015	1.00	25.0–29.0	32.0–37.0	...	0.15–0.60	...	...	...	...	0.75	...	...	0.15–0.60
...	S35315	0.04–0.08	2.00	0.040	0.030	1.20–2.00	24.0–26.0	34.0–36.0	...	...	...	...	0.12–0.18	...	...	0.03–0.08	...	...
TPXM-15	S38100	0.08	2.00	0.030	0.030	1.50–2.50	17.0–19.0	17.5–18.5	...	...	...	...	...	...	...	...		
...	N08367	0.030	2.00	0.040	0.030	1.00	20.0–22.0	23.5–25.5	6.0–7.0	...	...	...	0.18–0.25	...	0.75	...	...	...
...	N08904	0.020	2.00	0.040	0.030	1.00	19.0–23.0	23.0–28.0	4.0–5.0	...	...	...	0.10	...	1.00–2.00	...	...	...
...	N08926	0.020	2.00	0.030	0.010	0.50	24.0–26.0	19.0–21.0	6.0–7.0	...	...	...	0.15–0.25	...	0.50–1.50	...	...	...

A New designation established in accordance with Practice E 527 and SAE J1086.
B Maximum, unless otherwise indicated.
C The method of analysis for nitrogen shall be a matter of agreement between the purchaser and manufacturer.
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 and TP316L. 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. [1.20 mm] in average wall thickness (0.044 in. [1.10 mm] in minimum wall thickness).
E For welded TP316, TP316N, TP316LN, and TP316H pipe, the nickel range shall be 10.0–14.0 %.
F For welded pipe, the phosphorus maximum shall be 0.045 %.
G The titanium content shall be not less than five times the carbon content and not more than 0.70 %.
H The titanium content shall be not less than four times the carbon content and not more than 0.60 %.
I The columbium content shall be not less than ten times the carbon content and not more than 1.00 %.
J The columbium content shall be not less than eight times the carbon content and not more than 1.0 %.
K Grade S34751 shall have a columbium (niobium) plus tantalum content of not less than 15 times the carbon content.

Annealing Requirements

Grade or UNS Designation[A]	Heat Treating Temperature[B]	Cooling/Testing Requirements
All grades not individually listed below:	1900°F [1040°C]	C
TP321H, TP347H, TP348H		
Cold finished	2000°F [1100°C]	D
Hot finished	1925°F [1050°C]	D
TP304H, TP316H		
Cold finished	1900°F [1040°C]	D
Hot finished	1900°F [1040°C]	D
TP309H, TP309HCb, TP310H, TP310HCb	1900°F [1040°C]	D
S30600	2010–2140°F [1100–1170°C]	D
S30815, S31272	1920°F [1050°C]	D
S31254, S32654	2100°F [1150°C]	D
S33228	2050–2160°F [1120–1180°C]	D
S34565	2050–2140°F [1120–1170°C]	D
S35315	2010°F [1100°C]	D
N08367	2025°F [1110°C]	D
N08904	2000°F [1100°C]	D
N08926	2010°F [1100°C]	D

A New designation established in accordance with Practice E 527 and SAE J1086.

B Minimum, unless otherwise stated.

C Quenched in water or rapidly cooled by other means, at a rate sufficient to prevent reprecipitation of carbides, as demonstrable by the capability of passing Practices A 262, Practice E. The manufacturer is not required to run the test unless it is specified on the purchase order . Note that Practices A 262 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.

D Quenched in water or rapidly cooled by other means.

Permitted Variations in Wall Thickness

	Tolerance, % from Nominal	
NPS Designator	Over	Under
1/8 to 21/2 incl., all t/D ratios	20.0	12.5
3 to 18 incl., t/D up to 5 % incl.	22.5	12.5
3 to 18 incl., t/D > 5 %	15.0	12.5
20 and larger, welded, all t/D ratios	17.5	12.5
20 and larger, seamless, t/D up to 5 % incl.	22.5	12.5
20 and larger, seamless, t/D > 5%	15.0	12.5

where:
t = Nominal Wall Thickness
D = Ordered Outside Diameter

Tensile Requirements

Grade	UNS Designation	Tensile Strength, min ksi[Mpa]	Yield Strength, min ksi[MPa]
...	S20400	95[635]	48[330]
TPXM-19	S20910	100[690]	55[380]
TPXM-10	S21900	90[620]	50[345]
TPXM-11	S21904	90[620]	50[345]
TPXM-29	S24000	100[690]	55[380]
TP304	S30400	75[515]	30[205]
TP304L	S30403	70[485]	25[170]
TP304H	S30409	75[515]	30[205]
...	S30415	87[600]	42[290]
TP304N	S30451	80[550]	35[240]
TP304LN	S30453	75[515]	30[205]
...	S30600	78[540]	35[240]
...	S30615	90[620]	40[275]
...	S30815	87[600]	45[310]
TP309S	S30908	75[515]	30[205]
TP309H	S30909	75[515]	30[205]
TP309Cb	S30940	75[515]	30[205]
TP309HCb	S30941	75[515]	30[205]
	S31002		73[500]30[205]
TP310S	S31008	75[515]	30[205]
TP310H	S31009	75[515]	30[205]
TP310Cb	S31040	75[515]	30[205]
TP310HCb	S31041	75[515]	30[205]
...	S31050:		
t≤0.25in.		84[580]	39[270]
t≤>0.25in.		78[540]	37[255]
...	S31254:		
t≤0.187in.[5.00mm]		98[675]	45[310]
t>0.187in.[5.00mm]		95[655]	45[310]
	S31272	65[450]	29[200]
TP316	S31600	75[515]	30[205]
TP316L	S31603	70[485]	25[170]
TP316H	S31609	75[515]	30[205]
...	S31635	75[515]	30[205]
TP316N	S31651	80[550]	35[240]
TP316LN	S31653	75[515]	30[205]
TP317	S31700	75[515]	30[205]
TP317L	S31703	75[515]	30[205]
...	S31725	75[515]	30[205]
...	S31726	80[550]	35[240]
TP321	S32100:		
Welded		75[515]	30[205]
Seamless:			
≤3/8in.		75[515]	30[205]
>3/8in.		70[485]	25[170]
TP321H	S32109:		
Welded		75[515]	30[205]
Seamless:			
≤3/16in.		75[515]	30[205]
>3/16in.		70[480]	25[170]
...	S32615	80[550]	32[220]
...	S32654	109[750]	62[430]
...	S33228	73[500]	27[185]
...	S34565	115[795]	60[415]
TP347	S34700	75[515]	30[205]
TP347H	S34709	75[515]	30[205]
TP347LN	S34751	75[515]	30[205]
TP348	S34800	75[515]	30[205]
TP348H	S34809	75[515]	30[205]
...	S35045	70[485]	25[170]
...	S35315	94[650]	39[270]
TPXM-15	S38100	75[515]	30[205]
...	N08367:		
t≤0.187		100[690]	45[310]
t≤0.187		95[655]	45[310]
...	N08904	71[490]	31[215]
...	N08926	94[650]	43[296]

Elongationin 2in.or 50mm (or4D),min,%:	Longi-tudinal	Trans-verse
All Grades except S31050 and S32615	35	25
S32615, S31050	25	...
N08367	30	...

Stainless Steel Pipes Weight Chart

SIZE INCH	OD MM	SCH-5S MM	SCH-5S Kg/M	SCH-10S MM	SCH-10S Kg/M	SCH-40S MM	SCH-40S Kg/M	SCH-80S MM	SCH-80S Kg/M	SCH-160S MM	SCH-160S Kg/M
1/4	13.7			1.65	0.50	2.24	0.64	3.02	0.81		
3/8	17.1			1.65	0.64	2.31	0.86	3.20	1.12		
½	21.3	1.65	0.81	2.11	1.02	2.77	1.29	3.73	1.65	4.75	1.98
3/4	26.7	1.65	1.03	2.11	1.30	2.87	1.71	3.91	2.23	5.54	2.95
1	33.4	1.65	1.31	2.77	2.13	3.38	2.54	4.55	3.29	6.35	4.31
1-1/4	42.2	1.65	1.68	2.77	2.73	3.56	3.44	4.85	4.53	6.35	5.70
1-1/2	48.3	1.65	1.93	2.77	3.16	3.68	4.11	5.08	5.49	7.14	7.36
2	60.3	1.65	2.42	2.77	3.99	3.91	5.52	5.54	7.60	8.71	11.28
2-1/2	73.0	2.11	3.75	3.05	5.35	5.16	8.77	7.01	11.59	9.53	15.15
3	88.9	2.11	4.59	3.05	6.56	5.49	11.47	7.62	15.51	11.10	21.68
3-1/2	101.6	2.11	5.26	3.05	7.53	5.74	13.78	8.08	18.92		
4	114.3	2.11	5.93	3.05	8.50	6.02	16.32	8.56	22.67	13.49	34.05
5	141.3	2.77	9.61	3.40	11.74	6.55	22.10	9.53	31.44	15.88	49.86
6	168.3	2.77	11.48	3.40	14.04	7.11	28.70	10.97	43.22	18.26	68.58
8	219.1	2.77	14.90	3.80	20.12	8.18	43.20	12.70	65.64	23.01	112.89
10	273.0	3.40	22.95	4.19	28.20	9.27	61.22	12.70	82.78	28.58	174.90
12	323.8	3.96	31.71	4.57	36.53	9.53	74.94	12.70	98.96	33.32	242.31
14	355.6	3.96	34.87	4.78	41.99	9.53	82.50	12.70	109.05	35.71	285.96
16	406.4	4.19	42.20	4.78	48.07	9.53	94.61	12.70	125.20	40.49	370.82
18	457.2	4.19	47.53	4.78	54.15	9.53	106.83	12.70	141.35	45.24	466.24
20	508.0	4.78	60.23	5.54	69.70	9.53	118.95	12.70	157.51	50.01	573.33
22	558.8	4.78	66.31	5.54	76.75	9.53	131.07	12.70	173.66	53.90	682.15
24	609.6	5.54	83.80	6.35	95.92	9.53	143.20	12.70	189.82	59.54	820.41
26	660.4					9.53	155.22	12.70	205.85		
28	711.2					9.53	167.39	12.70	222.06		
30	762.0	6.35	120.15	7.92	149.55	9.53	179.56	12.70	238.28		
32	812.8					9.53	191.73	12.70	254.50		
34	863.6					9.53	203.90	12.70	270.72		
36	914.4					9.53	215.83	12.70	286.62		

ASTM A106

Chemical Requirements

	Composition, %		
Grade A	Grade B	Grade C	
Carbon, maxA	0.25	0.30	0.35
Manganese	0.27–0.93	0.29–1.06	0.29–1.06
Phosphorus, max	0.035	0.035	0.035
Sulfur, max	0.035	0.035	0.035
Silicon, min	0.10	0.10	0.10
Chrome, maxB	0.40	0.40	0.40
Copper, maxB	0.40	0.40	0.40
Molybdenum, maxB	0.15	0.15	0.15
Nickel, maxB	0.40	0.40	0.40
Vanadium, maxB	0.08	0.08	0.08

A For each reduction of 0.01 % below the specified carbon maximum, an increase of 0.06 % manganese above the specified maximum will be permitted up to a maximum of 1.35 %.
B These five elements combined shall not exceed 1 %.

Tensile Requirements

	Grade A	Grade B	Grade C
Tensile strength, min, psi [Mpa]	48 000 [330]	60 000 [415]	70 000 [485]
Yield strength, min, psi [Mpa]	30 000 [205]	35 000 [240]	40 000 [275]

	Grade A		Grade B		Grade C	
	Longitu-dinal	Transverse	Longitu-dinal	Transverse	Longitu-dinal	Transverse
Elongation in 2 in. [50 mm], min, %:						
Basic minimum elongation transverse strip tests, and for all small sizes tested in full section	35	25	30	16.5	30	16.5
When standard round 2-in. [50-mm] gage length test specimen is used	28	20	22	12	20	12
For longitudinal strip tests	A		A		A	
For transverse strip tests, a deduction for each 1/32-in. [0.8-mm] decrease in wall thickness below 5/16 in. [7.9 mm] from the basic minimum elongation of the following percentage shall be made		1.25		1.00		1.00

A The minimum elongation in 2 in. [50 mm] shall be determined by the following equation:

for inch-pound units, and

$$e = 625\,000A^{0.2} / U^{0.9}$$

$$e = 1\,940A^{0.2} / U^{0.9}$$

for SI units,
where:
e = minimum elongation in 2 in. [50 mm], %, rounded to the nearest 0.5 %,
A = cross-sectional area of the tension test specimen, in.2 [mm2], based upon specified outside diameter or nominal specimen width and specified wall thickness,
rounded to the nearest 0.01 in. 2 [1 mm2]. (If the area thus calculated is equal to or greater than 0.75 in. 2 [500 mm2], then the value 0.75 in.2 [500 mm2] shall be used.), and
U = specified tensile strength, psi [MPa].

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Chemical Requirements

Element	Composition,%								
	Grade1[A]	Grade3	Grade4	Grade6[A]	Grade7	Grade8	Grade9	Grade10	Grade11
Carbon,max	0.30	0.19	0.12	0.30	0.19	0.13	0.20	0.20	0.10
Manganese	0.40–1.06	0.31–0.64	0.50–1.05	0.29–1.06	0.90max	0.90max	0.40–1.06	1.15–1.50	0.60max
Phosphorus,max	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.035	0.025
Sulfur,max	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.015	0.025
Silicon	...	0.18–0.37	0.08–0.37	0.10min	0.13–0.32	0.13–0.32	...	0.10–0.35	0.35max
Nickel	...	3.18–3.82	0.47–0.98	...	2.03–2.57	8.40–9.60	1.60–2.24	0.25max	35.0–37.0
Chromium	...	...	0.44–1.01	...	...	...	...	0.15max	0.50max
Copper	...	...	0.40–0.75	...	...	...	0.75–1.25	0.15max	...
Aluminum	...	...	0.04–0.30	...	...	...	...	0.06max	...
Vanadium,max	...	...	...	...	...	...	...	0.12	...
Columbium,max	...	...	...	...	...	...	...	0.05	...
Molybdenum,max	...	...	...	...	...	...	...	0.05	0.50max
Cobalt	...	...	...	...	...	...	...	...	0.50max

[A] For each reduction of 0.01 % carbon below 0.30 %, an increase of 0.05 % manganese above 1.06 % would be permitted to a maximum of 1.35 % manganese.

Stress Relieving of Test Pieces

Metal Temperature[A,B]				Minimum Holding Time, h/in. [min/mm] of Thickness
Grades 1, 3, 6, 7, and 10		Grade 4[C]		
°F	°C	°F	°C	
1100	600	1150	620	1 [2.4]
1050	565	1100	600	2 [4.7]
1000	540	1050	565 3	[7.1]

[A] For intermediate temperatures, the holding time shall be determined by straight-line interpolation.

[B] grade 8 shall be stress relieved at 1025 to 1085°F, [550 to 585°C], held for a minimum time of 2 h for thickness up to 1.0 in. [25.4 mm], plus a minimum of 1 h for each additional inch [25.4 mm] of thickness and cooled at a minimum rate of 300°F [165°C]/h in air or water to a temperature not exceeding 600°F [315°C]. C Unless otherwise specified, Grade 4 shall be stress relieved at 1150°F [620°C].

Seamless & Welded Carbon Steel Pipe For Low-temperature Service

Tensile Requirement

	Grade 1		Grade 3		Grade 4		Grade 6		Grade 7		Grade 8		Grade 9		Grade 10		Grade 11
Tensile strength, min	psi 55 000	MPa 380	psi 65 000	MPa 450	psi 60 000	MPa 415	psi 60 000	MPa 415	psi 65 000	MPa 450	psi 100 000	MPa 690	psi 63 000	Mpa 435	psi 80 000	MPa 550	psi 65 000	MPa 450
Yield strength, min	30 000	205	35 000	240	35 000	240	35 000	240	35 000	240	75 000	515	46 000	315	65 000	450	35 000	240
	Longi-tudinal	Trans-verse	Longi-tudinal	Trans-verse	Longi-tudinal	Trans-verse	Longi-tudinal	Trans-verse	Longi-tudinal	Trans-verse	Longi-tudinal	Trans-verse	Longi-tudinal	Trans-verse	Longi-tudinal	Trans-verse	Longi-tudinal	
Elongation in 2 in. or 50 mm, (or 4D), min, %:																		
Basic minimum elongation for walls 5/16 in. [8 mm] and over in thickness, strip tests, and for all small sizes tested in full section	35	25	30	20	30	16.5	30	16.5	30	22	22	...	28	...	22	...	18[A]	
When standard round 2-in. or 50-mm gage length or proportionally smaller size test specimen with the gage length equal to 4D (4 times the diameter) is used	28	20	22	14	22	12	22	12	22	14	16	...	...	...	16	...	...	
For strip tests, a deduction for each 1/32in. [0.8 mm] decrease in wall thickness below 5/16 in. [8 mm] from the basic minimum elongation of the following percentage	1.75[B]	1.25[B]	1.50[B]	1.00[B]	1.50[B]	1.00[B]	1.50[B]	1.00[B]	1.50[B]	1.00[B]	1.25[B]	...	1.50[B]	...	1.25[B]	...	. . .	

Wall Thickness		Elongation in 2 in. or 50 mm, min, %[C]																			
		Grade 1		Grade 3		Grade 4		Grade 6		Grade 7		Grade 8		Grade 9		Grade 10	
in.	mm	Longi-tudinal	Trans-verse	Longi-tudinal	Trans-verse	Longi-tudinal	Trans-verse	Longi-tudinal	Trans-verse	Longi-tudinal	Trans-verse	Longi-tudinal	Trans-verse	Longi-tudinal	Trans-verse	Longi-tudinal	Trans-verse
5/16 (0.312)	8	35	25	30	20	30	16	30	16	30	22	22	...	28	...	22	...
9/32 (0.281)	7.2	33	24	28	19	28	15	28	15	28	21	21	...	26	...	21	...
1/4 (0.250)	6.4	32	23	27	18	27	15	27	15	27	20	20	...	25	...	20	...
7/32 (0.219)	5.6	30	...	26	...	26	...	26	...	26	...	18	...	24	...	18	...
3/16 (0.188)	4.8	28	...	24	...	24	...	24	...	24	...	17	...	22	...	17	...
5/32 (0.156)	4	26	...	22	...	22	...	22	...	22	...	16	...	20	...	16	...
1/8 (0.125)	3.2	25	...	21	...	21	...	21	...	21	...	15	...	19	...	15	...
3/32 (0.094)	2.4	23	...	20	...	20	...	20	...	20	...	13	...	18	...	13	...
1/16 (0.062)	1.6	21	...	18	...	18	...	18	...	18	...	12	...	16	...	12	...

[A] Elongation of Grade 11 is for all walls and small sizes tested in full section.
[B] The following table gives the calculated minimum values
[C] Calculated elongation requirements shall be rounded to the nearest whole number.
Note—The preceding table gives the computed minimum elongation values for each 1/32-in. [0.80-mm] decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value is determined by the following equation:

Grade	Direction of Test	Equation
1	Longitudinal	E = 56t + 17.50 [E = 2.19t + 17.50]
	Transverse	E = 40t + 12.50 [E = 1.56t + 12.50]
3	Longitudinal	E = 48t + 15.00 [E = 1.87t + 15.00]
	Transverse	E = 32t + 10.00 [E = 1.25t + 10.00]
4	Longitudinal	E = 48t + 15.00 [E = 1.87t + 15.00]
	Transverse	E = 32t + 6.50 [E = 1.25t+ 6.50]
6	Longitudinal	E = 48t + 15.00 [E = 1.87t + 15.00]
	Transverse	E = 32t + 6.50 [E = 1.25t + 6.50]
7	Longitudinal	E = 48t + 15.00 [E = 1.87t + 15.00]
	Transverse	E = 32t + 11.00 [E = 1.25t + 11.00]
8 and 10	Longitudinal	E = 40t + 9.50 [E = 1.56t + 9.50]
9	Longitudinal	E = 48t + 13.00 [E = 1.87t + 13.00]

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

Impact Requirements for Grades 1,3,4,5,6,7,9 and 10

Size of Specimen, mm	Minimum Average Notched Bar Impact Value of Each Set of Three Specimens[A]		Minimum Notched Bar Impact Value of One Specimen Only of a Set[A]	
	ft·lbf	J	ft·lbf	J
10 by 10	13	18	10	14
10 by 7.5	10	14	8	11
10 by 6.67	9	12	7	9
10 by 5	7	9	5	7
10 by 3.33	5	7	3	4
10 by 2.5	4	5	3	4

A. Straight line interpolation for intermediate values is permitted.

Impact Temperature

Grade	Minimum Impact Test Temperature	
	°F	°C
1	−50	−45
3	−150	−100
4	−150	−100
6	−50	−45
7	−100	−75
8	−320	−195
9	−100	−75
10	−75	−60

Impact Temperature Reduction

Specimen Width Along Notch or Actual Material Thickness		Temperature Reduction, Degrees Colder[A]	
in.	mm	°F	°C
0.394	10 (standard size)	0	0
0.354	9	0	0
0.315	8	0	0
0.295	7.5 (3/4 std. size)	5	3
0.276	7	8	4
0.262	6.67 (2/3 std. size)	10	5
0.236	6	15	8
0.197	5 (1/2 std. size)	20	11
0.158	4	30	17
0.131	3.33 (1/3 std. size)	35	19
0.118	3	40	22
0.099	2.5 (1/4 std. size)	50	28

A. Straight line interpolation for intermediate values is permitted.

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Chemical Requirement

Grade	UNS Designation[A]	Composition,%							
		Carbon	Manga-nese	Phosp-horus, max	Sulfur, max	Silicon	Chromium	Molybdenum	Others
P1	K11522	0.10–0.20	0.30–0.80	0.025	0.025	0.10–0.50	...	0.44–0.65	...
P2	K11547	0.10–0.20	0.30–0.61	0.025	0.025	0.10–0.30	0.50–0.81	0.44–0.65	...
P5	K41545	0.15 max	0.30–0.60	0.025	0.025	0.50 max	4.00–6.00	0.45–0.65	...
P5b	K51545	0.15 max	0.30–0.60	0.025	0.025	1.00–2.00	4.00–6.00	0.45–0.65	...
P5c	K41245	0.12 max	0.30–0.60	0.025	0.025	0.50 max	4.00–6.00	0.45–0.65	...[B]
P9	S50400	0.15 max	0.30–0.60	0.025	0.025	0.25–1.00	8.00–10.00	0.90–1.10	...
P11	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	...
P12	K11562	0.05–0.15	0.30–0.61	0.025	0.025	0.50 max	0.80–1.25	0.44–0.65	...
P15	K11578	0.05–0.15	0.30–0.60	0.025	0.025	1.15–1.65	...0.44–0.65	..	..
P21	K31545	0.05–0.15	0.30–0.60	0.025	0.025	0.50 max	2.65–3.35	0.80–1.06	...
P22	K21590	0.05–0.15	0.30–0.60	0.025	0.025	0.50 max	1.90–2.60	0.87–1.13	...
P23	K41650	0.04–0.10	0.10–0.60	0.030 max	0.010 max	0.50 max	1.90–2.60	0.05–0.30	V0.20–0.30 Cb0.02–0.08 B0.0010–0.006 N 0.0015max Al 0.030 max W 1.45–1.75 Ni 0.40 max Ti 0.005–0.060 Ti/N $ 3.5C
P24	K30736	0.05–0.10	0.30–0.70	0.020	0.010	0.15–0.45	2.20–2.60	0.90–1.10	V0.20–0.30 Ti 0.06–0.10 N 0.012 max Al 0.02 max B 0.0015–0.007
P36	K21001	0.10–0.17	0.80–1.20	0.030max	0.025max	0.25–0.50	0.30max	0.25–0.50	Ni 1.00 1.30 Cu 0.50-0.80 Cb 0.015-0.045 V 0.02 max N 0.02 max Al 0.050 max
P91	K91560	0.08–0.12	0.30–0.60	0.020	0.010	0.20–0.50	8.00–9.50	0.85–1.05	V0.18–0.25 N0.030–0.070 Ni 0.40 max Al 0.02 max Cb 0.06–0.10 Ti 0.01 max Zr 0.01 max
P92	K92460	0.07–0.13	0.30–0.60	0.020	0.010	0.50max	8.50–9.50	0.30–0.60	V0.15–0.25 N 0.03–0.07 Ni 0.40 max Al 0.02 max Cb 0.04–0.09 W 1.5–2.00 B 0.001–0.006 Ti 0.01 max Zr 0.01 max
P122	K92930	0.07–0.14	0.70max	0.020	0.010	0.50max	10.00–11.50	0.25–0.60	V0.15–0.30 W 1.50–2.50 Cu 0.30–1.70 Cb 0.04–0.10 B 0.0005–0.005 N 0.040–0.100 Ni 0.50 max Al 0.020 max Ti 0.01 max Zr 0.01 max
P911	K91061	0.09–0.13	0.30–0.60	0.020max	0.010max	0.10–0.50	8.5–9.5	0.90–1.10	V0.18–0.25 Ni 0.40 max Cb 0.060–0.10 B 0.0003–0.006 N 0.04–0.09 Al 0.02 max W 0.90–1.10 Ti 0.01 max Zr 0.01 max

A New designation established in accordance with Practice E527 and SAE J 1086, Practice for Numbering Metals and Alloys (UNS).

B Grade P 5c shall have a titanium content of not less than 4 times the carbon content and not more than 0.70 %; or a columbium content of 8 to 10 times the carbon content.

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.

Heat Treatment Requirements[A]

Grade	Heat Treat Type	Normalizing Temperature, min or range °F [°C]	Cooling Media	Subcritical Annealing or Tempering Temperature, min or range °F [°C]
P1	full or isothermal anneal	...	...	...
	normalize and temper	...	...	1200 [650]
	subcritical anneal	...	...	1200-1300 [650-705]
P2	full or isothermal anneal	...	...	...
	normalize and temper	...	...	1250 [675]
	subcritical anneal	...	...	1200-1300 [650-705]
P5	full or isothermal anneal	...	...	...
	normalize and temper	...	...	1250 [675]
P5b	full or isothermal anneal	...	...	...
	normalize and temper	...	...	1250 [675]
P5c	subcritical anneal	...	...	1325-1375 [715-745]
P9	full or isothermal anneal	...	...	...
	normalize and temper	...	...	1250 [675]
P11	full or isothermal anneal	...	...	...
	normalize and temper	...	...	1200 [650]
P12	full or isothermal anneal	...	...	...
	normalize and temper	...	...	1200 [650]
	subcritical anneal	...	...	1200-1300 [650-705]
P15	full or isothermal anneal	...	...	...
	normalize and temper	...	...	1200 [650]
P21	full or isothermal anneal	...	...	...
	normalize and temper	...	...	1250 [675]
P22	full or isothermal anneal	...	...	...
	normalize and temper	...	...	1250 [675]
P23	normalize and temper	1900-1975 [1040-1080]	air or accelerated cooling	1350-1470 [730-800]
P24	normalize and temper	1800–1870 [980–1020]	air or accelerated cooling	1350–1420 [730–770]
P36	normalize and temperB	1650 [900]	...	1100 [595]
P91	normalize and temper	1900-1975 [1040-1080]	...	1350-1470 [730-800][C]
	quench and temperD	1900-1975 [1040-1080]	...	1350-1470 [730-800]
P92	normalize and temper	1900-1975 [1040-1080]	E	1350-1470 [730-800]
P122	normalize and temper	1900-1975 [1040-1080]	...	1350-1470 [730-800]
P911	normalize and temper	1900-1975 [1040-1080]	E	1365-1435 [740-780]

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

[B] Alternatively, Grade P36, Class 2 shall be cooled from the austenitizing temperature by accelerated cooling in air or by liquid quenching.

[C] Except when Supplementary Requirement S7 is specified by the purchaser.

[D] When mutually agreed upon between the manufacturer and the purchaser, quenching and tempering shall be permitted for thicknesses greater than 3 in. [75 mm].

[E] Accelerated cooling from the normalizing temperature shall be permitted for section thicknesses greater than 3 in. [75 mm].

Tensile Requirements

	Grade								
	P1, P2	P12	P23	P24	P91	P92, P911 P36 Class 1	P122	P36Class 2	All Others
Tensile strength, min:									
ksi	55	60	74	85	85	90	90	95.5	60
Mpa	380	415	510	585	585	620	620	660	415
Yield strength, min:									
ksi	30	32	58	60	60	64	58	66.5	30
Mpa	205	220	400	415	415	440	400	460	205

Elongation Requirements

	All grades except P23, P36 P91, P92, P122, and P911		P23, P24, P91, P92, P122, and P 911		P36
	Longi-tudinal	Transverse	Longi-tudinal	Transverse	Longi-tudinal
Elongation in 2 in. or 50 mm, (or 4D), min, %: Basic minimum elongation for wall 5/16 in. [8 mm] and over in thickness, strip tests, and for all small sizes tested in full section	30	20	20	. . .	15
When standard round 2-in. or 50-mm gage length or proportionally smaller size specimen with the gage length equal to 4D (4 times the diameter) is used	22	14	20	13	. . .
For strip tests a deduction for each 1/32-in. [0.8 mm] decrease in wall thickness below in. [8 mm] from the basic minimum elongation of the following percentage points shall be made	1.50[A]	1.00[A]	1.00[A]	. . .	1.00[A]

Calculated Minimum Elongation Values

Wall Thickness		Elongation in 2 in. or 50 mm, min, %			
		All grades except P23, P36, P91, P92, P122, and P911		P23, P24, P91, P92, P122, and P911	P36
in.	mm	Longitudinal	Transverse	Longitudinal	Longitudinal
5/16 (0.312)	8	30	20	20	15
9/32 (0.281)	7.2	28	19	19	14
1/4 (0.250)	6.4	27	18	18	13
7/32 (0.219)	5.6	26	. . .	17	12
3/16 (0.188)	4.8	24	. . .	16	11
5/32 (0.156)	4	22	. . .	15	10
1/8 (0.125)	3.2	21	. . .	14	9
3/32 (0.094)	2.4	20	. . .	13	8
1/16 (0.062)	1.6	18	. . .	12	7

Permissible Variations in Outside Diameter

	Over		Under	
NPS [DN] Designator	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]	6 1 % of the specified outside diameter			

Permitted Variations in Wall Thickness

NPS [DN] Designator	Tolerance, % from Specified	
	Over	Under
1/8 to 2 1/2 [6 to 65] incl., all t/D ratiosA	20.0	12.5
Above 2 1/2 [65], t/D # 5 %A	22.5	12.5
Above 2 1/2 [65], t/D > 5 %A	15.0	12.5

^ t = Specified Wall Thickness; D = Specified Outside Diameter.

Steel Seamless Pipe Dimensions & Weight

Asa Pipe Schedules
Wall = Wall Thickness In Milli Meter
Wt = Weight In Kg Per Meter

Nominal Pipe size	O D mm	Schedule 10		Schedule 20		Schedule 30		Standard		Schedule 40		Schedule 60		Extra Strong		Schedule 80		Schedule 100		Schedule 120		Schedule 140		Schedule 160		Schedule Extra Strong	
Inches		Wall	Wt.	Wall	Wt.	Wall	Wt.	Wall	Wt.	Wall	Wt.	Wall	Wt.	Wall	Wt.	Wall	Wt.	Wall	Wt.	Wall	Wt.	Wall	Wt.	Wall	Wt.	Wall	Wt.
1/8	10.3							1.7	0.357	1.7	0.357			2.4	0.470	2.4	0.470										
1/4	13.7							2.2	0.625	2.2	0.625	3.0	0.804	3.0	0.804												
3/8	17.1							2.3	0.848	2.3	0.804	3.2	1.10	3.2	1.10									4.8	1.95		
1/2	21.3							2.8	1.26	2.8	1.26	3.7	1.62	3.7	1.62	4.6	1.96	7.5	2.54								
3/4	26.7							2.9	1.68	2.9	1.68	3.9	2.19	3.9	5.5	4.8	2.89	7.5	3.83								
1	33.4							3.4	2.50	3.4	2.50	4.5	3.23	4.5	3.23	6.4	4.23	9.1	5.45								
11/4	42.2							3.6	3.38	3.6	3.38	4.9	4.46	4.9	4.46	6.4	5.60	9.7	7.75								
11/2	48.3							3.7	4.05	3.7	4.05	5.1	5.40	7.1	7.23	10.2	9.54										
2	60.3							3.9	5.43	3.9	5.43	5.5	7.47	5.5	7.47	8.7	11.1	11.1	13.4								
21/2	73.0							5.2	8.62	5.2	8.62	7.0	11.4	7.0	11.4	9.5	14.9	14.0	20.4								
3	88.9							5.5	11.3	5.5	11.3	7.6	15.3	7.6	15.3	11.3	21.3	15.2	27.2								
31/2	101.6							5.7	13.6	5.7	13.6	8.1	18.6	8.1	18.6	16.2	34.0										
4	114.3							6.0	16.1	6.0	16.1	8.6	22.3	8.6	22.3	11.1	28.3	13.5	33.5	17.1	41.1						
5	141.3							6.6	21.8	6.6	21.8	9.5	30.9	9.5	30.9	12.7	40.2	15.9	49.0	19.0	57.4						
6	168.3							7.1	28.2	7.1	28.2	11.0	42.5	11.0	42.5	14.3	54.2	18.3	67.5	21.9	79.1						
8	219			6.4	33.3	7.0	36.7	8.2	42.5	8.2	42.5	10.3	53.1	12.7	64.6	12.7	64.6	15.1	76.8	18.3	90.7	20.6	101	23.0	112.0	22.2	108.0
10	273.0			6.4	41.7	7.8	50.9	9.3	60.2	12.7	81.5	12.7	81.5	12.7	81.5	15.1	95.8	18.3	115.0	21.4	133.0	25.4	155	28.6	172.0	25.4	155.0
12	323.9			6.4	49.7	8.4	65.1	9.5	73.8	10.3	79.7	14.3	109.0	12.7	97.4	17.4	132.0	21.4	160.0	25.4	187.0	28.6	208	33.3	239.0	25.4	187.0
14	355.6	6.4	54.6	7.9	68.1	9.5	81.2	9.5	81.2	11.1	94.3	15.1	126.0	12.7	107.0	19.0	158.0	23.8	195.0	27.8	224	31.8	253	35.7	281.0		
16	406.4	6.4	62.6	7.9	77.9	9.5	93.1	9.5	81.2	11.1	94.3	15.1	128.0	12.7	123.0	21.4	203.0	26.2	245.0	30.9	286.0	36.5	333	40.5	365.0		
18	457.2	6.4	70.5	7.9	87.8	11.1	122.0	9.5	105.0	14.3	156.0	19.0	206.0	12.7	139.0	23.8	254.0	29.4	310.0	34.9	363.0	39.7	408	15.2	459.0		
20	508.0	6.4	78.5	9.5	117.0	12.7	155.0	9.5	117.0	15.1	183.0	20.6	248.0	12.7	155.0	26.2	311.0	32.5	381.0	38.1	441.0	44.4	508	50.0	564.0		
22	558.8	6.4	86.4	9.5	129.0	12.7	171.0	9.5	129.0	22.2	294.0	12.7	171.0	28.6	373.0	34.9	451.0	41.3	526.0	47.6	6000	54.0	671.0				
24	609.6	6.4	94.7	9.5	141.0	14.3	210.0	9.5	141.0	17.4	255.0	24.6	355.0	12.7	187.0	30.9	441.0	38.9	547.0	45.00	639.0	52.4	719.0	59.5	807.0		
26	660.4	7.9	128.0	12.7	203.0			9.5	153.0					12.7	203.0												
28	711.2	7.9	138.0	12.7	219.0	15.9	272.0	9.5	165.0					12.7	219.0												
30	762.0	7.9	147.0	12.7	234.0	15.9	292.0	9.5	176.0					12.7	234.0												
32	812.8	7.9	157.0	12.7	250.0	15.9	312	9.5	188.0					12.7	250.0												
34	863.6	7.9	167.0	12.7	266.0	15.9	332.0	9.5	200.0					12.7	266.0												
36	914.4	7.9	177.0	12.7	282.0	15.9	351.0	9.5	212.0					12.7	281.0												

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