THE GENERAL METALLIC MATERIALS OF CHINESE PRESSURE PIPING CODE

标准 Standard	现用牌号 New Grade	原用牌号 Old Grade	化学成份 Chemical Composition %, max									力学性能 Mechanical Requirement				
			C	Si	Mn	P	S	Cr	Ni	Mo	Other	T.S. min MPa	Y.S. min MPa	EL. min %	HB max	Other
GB/T 699	20	–	0.17–0.23	0.17–0.37	0.35–0.65	0.035	0.035	0.25	0.30	–	Cu:0.25	410	245	25	156	Z≥ 55%
GB/T 711	20	–	0.17–0.24	0.17–0.37	0.35–0.65	0.035	0.040	0.25	0.25	–	Cu:0.25	410	–	28	–	–
GB/T 713[1]	Q245R [2][3][4]	20g,20R	0.20	0.35	0.50–1.00	0.025	0.015	0.30	0.30	0.080	Alt≥ 0.020;Cu:0.30	400–520	245	25	–	A_{KV} ≥ 31J
	Q345R [2][3][4]	16Mng,16MnR	0.20	0.55	1.20–1.60	0.025	0.015	0.30	0.30	0.080	Alt≥ 0.020;Cu:0.30	510–640	345	21	–	A_{KV}≥ 34J
	15CrMoR	15CrMog,15CrMoR	0.12–0.18	0.15–0.40	0.40–0.70	0.025	0.010	0.80–1.20	0.30	0.45–0.60	Cu:0.30	450–590	295	19	–	A_{KV} ≥ 31J
	12Cr1MoVR	12Cr1MoVg	0.08–0.15	0.15–0.40	0.40–0.70	0.025	0.010	0.90–1.20	0.30	0.25–0.35	V:0.15–0.30;Cu:0.30	440–590	245	19	–	A_{KV}≥ 34J
GB/T 3077	15CrMo	–	0.12–0.18	0.17–0.37	0.40–0.70	0.035	0.035	0.80–1.10	0.30	0.40–0.55	Cu:0.30	440	295	22	179	Z ≥60%; A_{KU2} ≥ 94J
	12Cr1MoV	–	0.08–0.15	0.17–0.37	0.40–0.70	0.035	0.035	0.90–1.20	0.30	0.25–0.35	V:0.15–0.30;Cu:0.30	490	245	22	179	Z ≥ 50%; A_{KU2} ≥71J
GB/T 3087	20 [1]	–	0.17–0.23	0.17–0.37	0.35–0.65	0.035	0.035	0.25	0.30	–	Cu:0.25	410–550	245	20	–	–
GB/T 3274[1] (GB/T 700)	Q235A	–	0.22	0.35	1.40	0.045	0.050	0.30	0.30	–	Cu:0.30;N:0.008	370–500	235	26	–	–
	Q235B	–	0.20	0.35	1.40	0.045	0.045	0.30	0.30	–	Cu:0.30;N:0.008	370–500	235	26	–	A_{KV} ≥ 27J
	Q275A	–	0.24	0.35	1.50	0.045	0.050	0.30	0.30	–	Cu:0.30;N:0.008	410–540	275	22	–	–
	Q275B	–	0.21	0.35	1.50	0.045	0.045	0.30	0.30	–	Cu:0.30;N:0.008	410–540	275	22	–	A_{KV} ≥ 27J
GB 3531 [1]	16MnDR	–	0.20	0.15–0.50	1.20–1.60	0.025	0.012	0.25	0.40	0.08	Cu:0.25;Als ≥ 0.020	490–620	315	21	–	kv_2 ≥ 34J (–40℃)
	09MnNiDR	–	0.12	0.15–0.50	1.20–1.60	0.020	0.012	0.25	0.30–0.80	0.08	Cu:0.25;Nb:0.04, Als ≥ 0.020	440–570	300	23	–	kv_2 ≥ 34J (–70℃)
GB5310	20G	–	0.17–0.24	0.17–0.37	0.35–0.65	0.030	0.030	0.25	0.25	0.15	Cu:0.20;V:0.08	410–550	245	24	–	A_{KV} ≥ 35J
	15CrMoG	–	0.12–0.18	0.17–0.37	0.40–0.70	0.030	0.030	0.80–1.10	–	0.40–0.55	–	440–640	235	21	–	A_{KV} ≥ 35J
	12Cr1MoVG	–	0.08–0.15	0.17–0.37	0.40–0.70	0.030	0.030	0.90–1.20	–	0.25–0.35	V:0.15–0.30	470–640	255	21	–	A_{KV} ≥ 35J
GB/T5312[5]	410	–	0.21	0.35	0.40–1.20	0.035	0.035	0.25	0.30	0.10	Cu:0.30	410–530	235	22	–	–
	460	–	0.22	0.35	0.80–1.40	0.035	0.035	0.25	0.30	0.10	Cu:0.30	460–580	265	21	–	–
	490	–	0.23	0.35	0.80–1.50	0.035	0.035	0.25	0.30	0.10	Cu:0.30	490–610	285	21	–	–
GB 6479 [5]	20	–	0.17–0.24	0.17–0.37	0.35–0.65	0.030	0.030	0.25	0.25	0.15	Cu:0.20;V:0.08	410–550	245	24	–	A_{KU2} 39J
	16Mn	–	0.12–0.20	0.20–0.60	1.20–1.60	0.030	0.030	0.30	0.30	–	Cu:0.20	490–670	320	21	–	A_{KU2} 47J/ A_{KV}≥21J(–40℃)
	15CrMo	–	0.12–0.18	0.17–0.37	0.40–0.70	0.030	0.030	0.80–1.10	0.30	0.40–0.55	Cu:0.20	440–640	235	21	–	A_{KU2} ≥ 47J
	1Cr5Mo	–	0.15	0.50	0.60	0.030	0.030	4.00–6.00	0.60	0.45–0.60	Cu:0.20	390–590	195	22		A_{KU2} ≥ 94J

注：
1）当厚度不同时，规定的力学性能数值将有变化，详见标准。
2）Cr、Ni，Cu和Mo的含量总合不应大于0.70%。
3）Q245R、Q345R中可添加微量Nb,V,Ti元素,这3个元素的含量分别不应大于0.050%、0.10%、0.12%。
4）如钢中添加Nb，V,Ti等微量元素，Alt含量的下限不适用。
5）当壁厚大于16~40mm时，屈服强度允许降低10MPa。

NOTE:
1) The mechanical properties may vary because of the different thickness, See the standards.
2) The sum of Cr, Ni,Cu and Mo shall not exceed 0.70%.
3) The microelements of Nb,V and Ti can be added in Q245R、Q345R and the content shall not exceed 0.050% 0.10%、0.12% accordingly.
4) When the microelements Nb, V &T are added in steel,the lower limitation of Alt dosen' t apply.
5) When the thickness exceeds 16 ~ 40mm ,the yield strength can be reduced by 10MPa.

标准 Standard	现用牌号 New Grade	原用牌号 Old Grade	化学成份 Chemical Composition %, max									力学性能 Mechanical Requirement				
			C	Si	Mn	P	S	Cr	Ni	Mo	Other	T.S. min MPa	Y.S. min MPa	EL. min %	HB max	Other
GB/T 8163[1]	20	-	0.17–0.23	0.17–0.37	0.35–0.65	0.035	0.035	0.25	0.30	–	Cu:0.25	410–530	245	20	–	–
	Q345B	16Mn,16MnRE	0.20	0.55	1.0–1.60	0.040	0.040	–	–	–	V:0.02–0.15; Nb:0.015–0.060; Ti:0.02–0.20	470–630	345	20	–	–
GB/T 9711.1[7)8)9)]	L360 ···	-	0.30	–	1.25	0.030	0.030	–	–	–	–	460	360	19	–	–
	L415 ···	-	0.26	–	1.35	0.030	0.030	–	–	–	–	520	415	17	–	–
	L450 ···	-	0.26	–	1.40	0.030	0.030	–	–			535	450	17	–	–
	L485 ···	-	0.23	–	1.60	0.030	0.030	–	–	–	–	570	485	16	–	–
	L555 ···	-	0.18	–	1.80	0.030	0.030	–	–	–	–	625–825	555	15	–	–
GB/T 9711.2[7)9)10)]	L360 ···	-	0.20	0.45	1.60	0.025	0.020	–	–	–	–	460	360–515	20	–	$R_{t0.5}/R_m$:0.88max
	L415 ···	-	0.21	0.45	1.60	0.025	0.020	–	–	–	–	520	415–565	18	–	$R_{t0.5}/R_m$:0.88max
	L450 ···	-	0.16	0.45	1.60	0.025	0.020	–	–			535	450–570	18	–	$R_{t0.5}/R_m$:0.90max
	L485 ···	-	0.16	0.45	1.70	0.025	0.020	–	–	–	–	570	485–605	18	–	$R_{t0.5}/R_m$:0.90max
	L555 ···	-	0.16	0.45	1.80	0.025	0.020	–	–	–	–	625	555–675	18	–	$R_{t0.5}/R_m$:0.90max
GB 9948 [1)6)]	20	-	0.17–0.23	0.17–0.37	0.35–0.65	0.030	0.020	0.25	0.25	0.15	Cu:0.20;V:0.08	410–550	245	24	–	$A_{KV} \geq$ 35J
	15CrMo	-	0.12–0.18	0.17–0.37	0.40–0.70	0.030	0.020	0.80–1.10	0.30	0.40–0.55	Cu:0.20	440–640	235	21	170	$A_{KV} \geq$ 35J
	1Cr5Mo	-	0.15	0.50	0.60	0.030	0.020	4.00–6.00	0.60	0.45–0.60	Cu:0.20	390–590	195	22	187	$A_{KV} \geq$ 35J
	1Cr19Ni9	-	0.04–0.10	1.00	2.00	0.030	0.020	18.00–20.00	8.00–11.00	–	Cu:0.20	520	205	35	–	–
GB/T 18984 [1)6)]	16MnDG	-	0.12–0.20	0.20–0.55	1.20–1.60	0.025	0.020	–	–	–	–	490–665	325	30	–	$A_{KV} \geq$ 21J (–45℃)
	09Mn2VDG	-	0.12	0.17–0.37	1.85	0.025	0.020	–	–	–	V:0.12	450	300	30	–	$A_{KV} \geq$ 21J (–70℃)

注：

6)力学性能中的屈服强度值为下屈服强度ReL。

7)这些钢级与API 5L规范中的钢级类似对应如下(然而，所列对应钢级在其它方面可能不同)：L360-X52，L415-X60，L450-X65，L485一X70，L555-X80

8)列出的是焊接钢管的化学成分要求。其中，对于L450级以下钢级，最大C含量比规定值每降低0.01%，允许在规定的最大Mn含量上增加0.05%Mn含量。但不超过L360的钢级，Mn含量不应超过1.45%；对高于L360的钢级，Mn含量不应超过1.60%。对于L485和L555钢级，最大C含量比规定值每降低0.01%，允许在规定的最大Mn含量上增加0.05%Mn含量。但最大Mn含量不应超过0.2%。其它微量化学元素的规定等要求等详见标准。

9)力学性能中的屈服强度值为规定总伸长强度(proof strerngth,total extension) Rt0.5。屈强比及冲击试验规定等要求详见标准。

10)在规定的最大C含量以下，每降低0.01%C含量，允许在规定的最大Mn含量上增加0.05%Mn含量。但最大Mn含量不应超过0.2%。其它微量化学元素的规定及CEV要求等详见标准。

Note:

6) The value of yield strength is the lower one.

7) The comparison between these steel grades and the specification of API 5L shall be as the following: (however, the accordingly grades may be different at other factors)
L360-X52 L415-X60 L450-X65 L485-X70 L555-X80

8) The above table indicates the chemical requirements of the welded pipes.For grades below L450, the max. C content decreases each 0.01% than the specified one, an increase of 0.05 % Mn. may be permitted on the specified max. one. Hoever, for the grades below L360,the max. Mn. content is 1.45%, and for the grades above L360,a max.Mn content is 1.60%. For L485 and L555, the max. C content decreases each 0.01% than the specified one, an increase of 0.05 % Mn. may be permitted on the specified max. one up to 0.20%. As for the details for the other microelements,please refer the standards.

9) The value of yield strength is the specified total extension strength Rt0.5. As for the ratio of yield strength and the requirements of impact test, please refer the standards.

10) Under the specified max.C content, If decreasing each 0.01% C, an increase of 0.05 % Mn. may be permitted on the specified max. one up to max. Mn 0.20%, as for other microelements and the CEV, please refer the standards.

标准 Standard	现用牌号 New Grade	原用牌号 Old Grade	化学成份 Chemical Composition %, max									力学性能 Mechanical Requirement				
			C	Si	Mn	P	S	Cr	Ni	Mo	Other	T.S. (R_m) min MPa	Y.S. ($R_{p0.2}$) min MPa	EL. (A) min %	HB max	Other
GB/T 1220	022Cr19Ni10	00Cr19Ni10	0.030	1.00	2.00	0.045	0.030	18.00–20.00	8.00–12.00	–	–	480	175	40	187	Z ⩾ 60%
	022Cr17Ni12Mo2	00Cr17Ni14Mo2	0.030	1.00	2.00	0.045	0.030	16.00–18.00	10.00–14.00	2.00–3.00	–	480	175	40	187	Z ⩾ 60%
GB/T 1220, GB/T 1221	06Cr19Ni10	0Cr18Ni9	0.08	1.00	2.00	0.045	0.030	18.00–20.00	8.00–11.00	–	–	520	205	40	187	Z ⩾ 60%
	06Cr17Ni12Mo2	0Cr17Ni12Mo2	0.08	1.00	2.00	0.045	0.030	16.00–18.00	10.00–14.00	2.00–3.00	–	520	205	40	187	Z ⩾ 60%
	06Cr18Ni11Ti	0Cr18Ni10Ti	0.08	1.00	2.00	0.045	0.030	17.00–19.00	9.00–12.00	–	Ti:5C–0.70	520	205	40	187	Z ⩾ 50%
	06Cr18Ni11Nb	0Cr18Ni11Nb	0.08	1.00	2.00	0.045	0.030	17.00–19.00	9.00–12.00	–	Nb:10C–1.10	520	205	40	187	Z ⩾ 50%
GB/T 4237	022Cr19Ni10	00Cr19Ni10	0.030	0.75	2.00	0.045	0.030	18.00–20.00	8.00–12.00	–	N:0.10	485	170	40	201	–
	022Cr17Ni12Mo2	00Cr17Ni14Mo2	0.030	0.75	2.00	0.045	0.030	16.00–18.00	10.00–14.00	2.00–3.00	N:0.10	485	170	40	217	–
GB/T 4237, GB/T 4238	06Cr19Ni10	0Cr18Ni9	0.08	0.75	2.00	0.045	0.030	18.00–20.00	8.00–10.50	–	N:0.10	515	205	40	201	
	06Cr17Ni12Mo2	0Cr17Ni12Mo2	0.08	0.75	2.00	0.045	0.030	16.00–18.00	10.00–14.00	2.00–3.00	N:0.10	515	205	40	217	–
	06Cr18Ni11Ti [11]	0Cr18Ni10Ti [11]	0.08	0.75	2.00	0.045	0.030	17.00–19.00	9.00–12.00	–	N:0.10;Ti ⩾ 5C	515	205	40	217	–
	06Cr18Ni11Nb	0Cr18Ni11Nb	0.08	0.75	2.00	0.045	0.030	17.00–19.00	9.00–13.00	–	Nb:10C–1.00	515	205	40	201	–
GB/T 12771	06Cr19Ni10	0Cr18Ni9	0.08	0.75	2.00	0.040	0.030	18.00–20.00	8.00–11.00	–	–	520	210	35	–	–
	022Cr19Ni10	00Cr19Ni10	0.030	0.75	2.00	0.040	0.030	18.00–20.00	8.00–12.00	–	–	480	180	35	–	–
	06Cr18Ni11Ti	0Cr18Ni10Ti	0.08	0.75	2.00	0.040	0.030	17.00–19.00	9.00–12.00	–	Ti:⩾5C–0.70	520	210	35	–	–
	06Cr18Ni11Nb	0Cr18Ni11Nb	0.08	0.75	2.00	0.040	0.030	17.00–19.00	9.00–12.00	–	Nb:10C–1.10	520	210	35	–	–
	06Cr17Ni12Mo2	0Cr17Ni12Mo2	0.08	0.75	2.00	0.040	0.030	16.00–18.00	10.00–14.00	2.00–3.00	–	520	210	35	–	–
	022Cr17Ni12Mo2	00Cr17Ni14Mo2	0.030	0.75	2.00	0.040	0.030	16.00–18.00	10.00–14.00	2.00–3.00	–	480	180	35	–	–
GB 13296	06Cr19Ni10	0Cr18Ni9	0.07	1.00	2.00	0.035	0.030	17.00–19.00	8.00–11.00	–	–	520	205	35	–	–
	022Cr19Ni10	00Cr19Ni10	0.030	1.00	2.00	0.035	0.030	18.00–20.00	8.00–12.00	–	–	480	175	35	–	–
	06Cr18Ni11Ti	0Cr18Ni10Ti	0.08	1.00	2.00	0.035	0.030	17.00–19.00	9.00–12.00	–	Ti:⩾5C	520	205	35	–	–
	06Cr18Ni11Nb	0Cr18Ni11Nb	0.08	1.00	2.00	0.035	0.030	17.00–19.00	9.00–13.00	–	Nb+Ta:10C–1.00	520	205	35	–	–
	06Cr17Ni12Mo2	0Cr17Ni12Mo2	0.08	1.00	2.00	0.035	0.030	16.00–18.00	11.00–14.00	2.00–3.00	–	520	205	35	–	–
	022Cr17Ni12Mo2	00Cr17Ni14Mo2	0.030	1.00	2.00	0.035	0.030	16.00–18.00	12.00–15.00	2.00–3.00	–	480	175	40	–	–
GB/T 14976	06Cr19Ni10	0Cr18Ni9	0.07	1.00	2.00	0.035	0.030	17.00–19.00	8.00–11.00	–	–	520	205	35	–	–
	022Cr19Ni10	00Cr19Ni10	0.030	1.00	2.00	0.035	0.030	18.00–20.00	8.00–12.00	–	–	480	175	35	–	–
	06Cr18Ni11Ti	0Cr18Ni10Ti	0.08	1.00	2.00	0.035	0.030	17.00–19.00	9.00–12.00	–	Ti:⩾5C	520	205	35	–	–
	06Cr18Ni11Nb	0Cr18Ni11Nb	0.08	1.00	2.00	0.035	0.030	17.00–19.00	9.00–13.00	–	Nb⩾10C	520	205	35	–	–
	06Cr17Ni12Mo2	0Cr17Ni12Mo2	0.08	1.00	2.00	0.035	0.030	16.00–18.50	10.00–14.00	2.00–3.00	–	520	205	35	–	–
	022Cr17Ni12Mo2	00Cr17Ni14Mo2	0.030	1.00	2.00	0.035	0.030	16.00–18.00	12.00–15.00	2.00–3.00	–	480	175	35	–	–

注：
11）GB/T 4238 对该牌号中的元素N含量未加限定。

Note:
11) GB/T 4238 doesn't have any limitation to the content of Ni of this item grade.

标准 Standard	现用牌号 New Grade	原用牌号 Old Grade	化学成份 Chemical Composition %,max									力学性能 Mechanical Requirement				
			C	Si	Mn	P	S	Cr	Ni	Mo	Other	T.S. min MPa	Y.S. min MPa	EL. min %	HB max	Other
JB 4726[12][13][14]	20	-	0.17-0.23	0.17-0.37	0.60-1.00	0.030	0.020	0.25	0.25	-	Cu:0.25	390-540	215	24	106-159	$A_{KV} \geq 34J$
	16Mn	-	0.13-0.19	0.20-0.60	1.20-1.60	0.030	0.020	0.30	0.30	-	Cu:0.25	450-600	275	20	121-178	$A_{KV} \geq 31J(0℃)$
	15CrMo	-	0.12-0.18	0.10-0.60	0.30-0.80	0.030	0.020	0.80-1.25	0.30	0.45-0.65	Cu:0.25	440-610	275	20	118-180	$A_{KV} \geq 34J$
	12Cr1MoV	-	0.09-0.15	0.17-0.37	0.40-0.70	0.030	0.020	0.90-1.20	0.30	0.25-0.35	V:0.15-0.30; Cu:0.25	440-610	255	19	118-180	$A_{KV} \geq 34J$
	12Cr2Mo1	-	0.15	0.50	0.30-0.60	0.025	0.015	2.00-2.50	0.30	0.90-1.10	Cu:0.25	510-680	310	18	136-201	$A_{KV} \geq 41J$
	1Cr5Mo	-	0.15	0.50	0.60	0.030	0.020	4.00-6.00	0.50	0.45-0.65	Cu:0.25	590-760	390	18	174-229	$A_{KV} \geq 34J$
JB 4727[12][14][15]	16MnD	-	0.13-0.18	0.20-0.60	1.20-1.60	0.025	0.015	0.30	0.40	-	Nb:0.030; Cu:0.25; Als: ≥0.015	450-600	275	20	-	$A_{KV} \geq 27J(-40℃)$
	09MnNiD	-	0.12	0.15-0.35	1.20-1.60	0.025	0.015	0.30	0.45-0.85	-	Nb:0.050; Cu:0.25; Als:≥ 0.015	420-570	260	23		$A_{KV} \geq 47J(-70℃)$
JB 4728[13][14]	0Cr18Ni9	-	0.07	1.00	2.00	0.035	0.030	17.00-19.00	8.00-11.00	-	-	520	205	35	139-187	-
	00Cr19Ni10	-	0.03	1.00	2.00	0.035	0.030	18.00-20.00	8.00-12.00	-	-	480	175	35	128-187	-
	0Cr17Ni12Mo2	-	0.08	1.00	2.00	0.035	0.030	16.00-18.00	10.00-14.00	2.00-3.00	-	520	205	35	139-187	-
	00Cr17Ni14Mo2	-	0.03	1.00	2.00	0.035	0.030	16.00-18.00	12.00-15.00	2.00-3.00	-	480	175	35	128-187	-
	0Cr18Ni10Ti	-	0.08	1.00	2.00	0.035	0.030	17.00-19.00	9.00-12.00	-	Ti:≥5C	520	205	35	139-187	-
	0Cr18Ni12Mo2Ti	-	0.08	1.00	2.00	0.035	0.030	16.00-19.00	11.00-14.00	1.80-2.50	Ti:≥ 5C-0.7	520	205	35	139-187	-
YB/T 5089	06Cr19Ni10	0Cr18Ni9	0.08	1.00	2.00	0.045	0.030	18.00-20.00	8.00-11.00	-	-	-	-	-	-	-
	022Cr19Ni10	00Cr19Ni10	0.030	1.00	2.00	0.045	0.030	18.00-20.00	8.00-12.00	-	-	-	-	-	-	-
	06Cr18Ni11Ti	0Cr18Ni10Ti	0.08	1.00	2.00	0.045	0.030	17.00-19.00	9.00-12.00	-	Ti: ≥5C-0.7	-	-	-	-	-
	06Cr18Ni11Nb	0Cr18Ni11Nb	0.08	1.00	2.00	0.045	0.030	17.00-19.00	9.00-12.00	-	Nb ≥10C-1.10	-	-	-	-	-
	06Cr17Ni12Mo2	0Cr17Ni12Mo2	0.08	1.00	2.00	0.045	0.030	16.00-18.00	10.00-14.00	2.00-3.00	-	-	-	-	-	-
	022Cr17Ni12Mo2	00Cr17Ni14Mo2	0.030	1.00	2.00	0.045	0.030	16.00-18.00	10.00-14.00	2.00-3.00	-	-	-	-	-	-
DL 473	20	-	0.17-0.24	0.17-0.37	0.35-0.65	0.035	0.035	0.25	0.25	-	Cu:0.20	412-549	245	24	117-156	$A_{KV} \geq 27J$
	12Cr1MoV	-	0.08-0.15	0.17-0.37	0.40-0.70	0.035	0.035	0.90-1.20	0.30	0.25-0.35	V:0.15-0.30; Cu:0.20	440-610	255	21	132-183	$A_{KV} \geq 34J$
	12Cr2Mo1	-	0.08-0.15	0.50	0.30-0.60	0.030	0.030	2.00-2.50	0.30	0.90-1.10	Cu:0.20	450-600	280	20	135-180	$A_{KV} \geq 41J$

注：
12）对真空碳脱氧钢，允许Si含量小于或等于0.12%。
13）锻件分为Ⅰ、Ⅱ、Ⅲ、Ⅳ共4个级别，每个级别的检验项目规定不同。
14）锻件的厚度不同时，其力学性能规定不同，详见标准。
15）锻件分为Ⅱ、Ⅲ、Ⅳ共3个级别，每个级别的检验项目规定不同。

Note:
12) For the deoxidizing steel with vacuum carbon, the content of Si may be up to 0.12%.
13) The forgings have the grades of Ⅰ、Ⅱ、Ⅲ and Ⅳ, and the inspection items for each grade are different.
14) The mechanical properties vary with the differet thickness for forrgings, details, please refer the standards.
15) The forgings have the grades of Ⅰ Ⅱ Ⅲ and Ⅳ, and the inspection items for each grade are different.

THE GENERAL METALLIC MATERIALS OF ASME PRESSURE PIPING CODE

规范 Code	牌号 Grade	化学成份 Chemical Composition %, max									力学性能 Mechanical Requirement				
		C	Si	Mn	P	S	Cr	Ni	Mo	Other	T.S. min MPa	Y.S. min MPa	EL. min %	HB max	Other
ASTM A 53/ ASME SA 53	B [1] 无缝/S	0.30	–	1.20	0.05	0.045	0.40	0.40	0.15	Cu:0.40;V:0.08	415	240	e[2]	–	–
	B [1] 电阻焊/ERW	0.30	–	1.20	0.05	0.045	0.40	0.40	0.15	Cu:0.50;V:0.08	415	240	e[2]	–	–
ASTM A 105/ ASME SA 105/	A105 [1][3][4]	0.35	0.10–0.35	0.60–1.05	0.035	0.040	0.30	0.40	0.12	Cu:0.40;V:0.08	485	250	22	187	Z30%
ASTM A 106/ ASME SA 106	B [1][3]	0.30	0.10 min	0.29–1.06	0.035	0.035	0.40	0.40	0.15	Cu:0.40;V:0.08	415	240	22	–	–
	C [1][3]	0.35	0.10 min	0.29–1.06	0.035	0.035	0.40	0.40	0.15	Cu:0.40;V:0.08	485	275	20	–	–
ASTM A 182/ ASME SA 182	F5	0.15	0.50	0.30–0.60	0.030	0.030	4.0–6.0	0.50	0.44–0.65	–	485	275	20	143–217	Z ≥ 35%
	F9	0.15	0.50–1.00	0.30–0.60	0.030	0.030	8.0–10.0	–	0.90–1.10	–	585	380	20	179–217	Z ≥ 40%
	F91	0.08–0.12	0.20–0.50	0.30–0.60	0.020	0.010	8.0–9.5	0.40	0.85–1.05	[5]	585	415	20	248	Z ≥ 40%
	F11 CL1	0.05–0.15	0.50–1.00	0.30–0.60	0.030	0.030	1.00–1.50	–	0.44–0.65	–	415	205	20	121–174	Z ≥ 45%
	F11 CL2	0.10–0.20	0.50–1.00	0.30–0.80	0.040	0.040	1.00–1.50	–	0.44–0.65	–	485	275	20	143–207	Z ≥ 30%
	F11 CL3	0.10–0.20	0.50–1.00	0.30–0.80	0.040	0.040	1.00–1.50	–	0.44–0.65	–	515	310	20	156–207	Z ≥ 30%
	F12 CL1	0.05–0.15	0.50	0.30–0.60	0.045	0.045	0.80–1.25	–	0.44–0.65	–	415	220	20	121–174	Z ≥ 45%
	F12 CL2	0.10–0.20	0.10–0.60	0.30–0.80	0.040	0.040	0.80–1.25	–	0.44–0.65	–	485	275	20	143–207	Z ≥ 30%
	F22 CL1	0.05–0.15	0.50	0.30–0.60	0.040	0.040	2.00–2.50	–	0.87–1.13	–	415	205	20	170	Z ≥ 35%
	F22 CL3	0.05–0.15	0.50	0.30–0.60	0.040	0.040	2.00–2.50	–	0.87–1.13	–	515	310	20	156–207	Z ≥ 30%
	F304 [6]	0.08	1.00	2.00	0.045	0.030	18.0–20.0	8.0–11.0	–	–	515	205	30	–	Z ≥ 50%
	F304H	0.04–0.10	1.00	2.00	0.045	0.030	18.0–20.0	8.0–11.0	–	–	515	205	30	–	Z ≥ 50%
	F304L [6]	0.030	1.00	2.00	0.045	0.030	18.0–20.0	8.0–13.0	–	–	485	170	30	–	Z ≥ 50%
	F316 [6]	0.08	1.00	2.00	0.045	0.030	16.0–18.0	10.0–14.0	2.00–3.00	–	515	205	30	–	Z ≥ 50%
	F316H	0.04–0.10	1.00	2.00	0.045	0.030	16.0–18.0	10.0–14.0	2.00–3.00	–	515	205	30	–	Z ≥ 50%
	F316L [6]	0.030	1.00	2.00	0.045	0.030	16.0–18.0	10.0–15.0	2.00–3.00	–	485	170	30	–	Z ≥ 50%
	F321	0.08	1.00	2.00	0.045	0.030	17.0–19.0	9.0–12.0	–	Ti:5C–0.7	515	205	30	–	Z ≥ 50%
	F321H	0.04–0.10	1.00	2.00	0.045	0.030	17.0–19.0	9.0–12.0	–	Ti:4C–0.7	515	205	30	–	Z ≥ 50%
	F347	0.08	1.00	2.00	0.045	0.030	17.0–20.0	9.0–13.0	–	Nb:10C–1.10	515	205	30	–	Z ≥ 50%
	F347H	0.04–0.10	1.00	2.00	0.045	0.030	17.0–20.0	9.0–13.0	–	Nb:8C–1.10	515	205	30	–	Z ≥ 50%
	F51	0.030	1.00	2.00	0.030	0.020	21.0–23.0	4.5–6.5	2.5–3.5	N:0.08–0.20	620	450	25	–	Z ≥ 45%
	F60	0.030	1.00	2.00	0.030	0.020	22.0–23.0	4.5–6.5	3.0–3.5	N:0.14–0.20	655	485	25	–	Z ≥ 45%

注：
1）Cu，Ni，Cr，Mo和V的含量总合不应大于1.00%。
2）$e=1940A^{0.2}/U^{0.9}$；详见规范.
3）在规定的最大C含量以下，每降低0.01%C含量，允许在规定的最大Mn含量上增加0.06%Mn含量，直到1.35%为止。
4）Cr和Mo的含量总合不应大于0.32%。
5）Nb：0.06–0.10，N：0.03–0.07，Al：0.02，V：0.18–0.25，Ti：0.01，Zr:0.01。
6）F304、F304L、F316和F316L的N含量不应大于0.10%。

NOTE:
1) The sum of Cu, Ni, Cr, Mo and V shall not exceed 1.00 %.
2) $e = 1940A^{0.2}/U^{0.9}$ Details refer the specification.
3) Below the specified max.C, If the content C decreases each 0.01 %, an increase of 0.06% manganese will be permitted up to a maximum of 1.35%.
4) The sum of chromium and molybdenum shall not exceed 0.32 %.
5) Nb:0.06–0.10, N:0.03–0.07, Al:0.02, V:0.18–0.25, Ti:0.01, Zr:0.01.
6) Grades F304, F304L, F316 and F316L shall have a maximum nitrogen content of 0.10%.

规范 Code	牌号 Grade	化学成份 Chemical Composition %,max									力学性能 Mechanical Requirement				
		C	Si	Mn	P	S	Cr	Ni	Mo	Other	T.S. min MPa	Y.S. min MPa	EL. min %	HB max	Other
ASTM A 234/ ASME SA 234	WPB [7)8)9)10)11)]	0.30	0.10 min	0.29–1.06	0.050	0.058	0.40	0.40	0.15	Cu:0.40;V:0.08	415–655	240	22	197	–
	WPC [8)9)10)11)]	0.35	0.10 min	0.29–1.06	0.050	0.058	0.40	0.40	0.15	Cu:0.40;V:0.08	485–655	275	22	197	–
	WP5 CL1	0.15	0.50	0.30–0.60	0.040	0.030	4.0–6.0	–	0.44–0.65	–	415–585	205	22	217	–
	WP5 CL3	0.15	0.50	0.30–0.60	0.040	0.030	4.0–6.0	–	0.44–0.65	–	520–690	310	22	217	–
	WP9 CL1	0.15	1.00	0.30–0.60	0.030	0.030	8.0–10.0	–	0.90–1.10	–	415–585	205	22	217	–
	WP9 CL3	0.15	1.00	0.30–0.60	0.030	0.030	8.0–10.0	–	0.90–1.10	–	520–690	310	22	217	–
	WP91	0.08–0.12	0.20–0.50	0.30–0.60	0.020	0.010	8.0–9.5	0.40	0.85–1.05	[12)]	585–760	415	20	248	–
	WP11 CL1	0.05–0.15	0.50–1.00	0.30–0.60	0.030	0.030	1.00–1.50	–	0.44–0.65	–	415–585	205	22	197	–
	WP11 CL2	0.05–0.20	0.50–1.00	0.30–0.80	0.040	0.040	1.00–1.50	–	0.44–0.65	–	485–655	275	22	197	–
	WP11 CL3	0.05–0.20	0.50–1.00	0.30–0.80	0.040	0.040	1.00–1.50	–	0.44–0.65	–	520–690	310	22	197	–
	WP12 CL1	0.05–0.20	0.60	0.30–0.80	0.045	0.045	0.80–1.25	–	0.44–0.65	–	415–585	220	22	197	–
	WP12 CL2	0.05–0.20	0.60	0.30–0.80	0.045	0.045	0.80–1.25	–	0.44–0.65	–	485–655	275	22	197	–
	WP22 CL1	0.05–0.15	0.50	0.30–0.60	0.040	0.040	1.90–2.60	–	0.87–1.13	–	415–585	205	22	197	–
	WP22 CL3	0.05–0.15	0.50	0.30–0.60	0.040	0.040	1.90–2.60	–	0.87–1.13	–	520–690	310	22	197	–
ASTM A 240/ ASME SA 240	304	0.08	0.75	2.00	0.045	0.030	17.5–19.5	8.0–10.5	–	N:0.10	515	205	40	201	–
	304H	0.04–0.10	0.75	2.00	0.045	0.030	18.0–20.0	8.0–10.5	–	–	515	205	40	201	–
	304L	0.030	0.75	2.00	0.045	0.030	17.5–19.5	8.0–12.0	–	N:0.10	485	170	40	201	–
	316	0.08	0.75	2.00	0.045	0.030	16.0–18.0	10.0–14.0	2.00–3.00	N:0.10	515	205	40	217	–
	316H	0.04–0.10	0.75	2.00	0.045	0.030	16.0–18.0	10.0–14.0	2.00–3.00	–	515	205	40	217	–
	316L	0.030	0.75	2.00	0.045	0.030	16.0–18.0	10.0–14.0	2.00–3.00	N:0.10	485	170	40	217	–
	321	0.08	0.75	2.00	0.045	0.030	17.0–19.0	9.0–12.0	–	N:0.10; Ti:5(C+N)–0.7	515	205	40	217	–
	321H	0.04–0.10	0.75	2.00	0.045	0.030	17.0–19.0	9.0–12.0	–	Ti:4(C+N)–0.7	515	205	40	217	–
	347	0.08	0.75	2.00	0.045	0.030	17.0–19.0	9.0–13.0	–	Nb:10C–1.00	515	205	40	201	–
	TP347H	0.04–0.10	0.75	2.00	0.045	0.030	17.0–20.0	9.0–13.0	–	Nb:8C–1.00	515	205	40	201	–
ASTM A 312/ ASME SA 312	TP304	0.08	1.00	2.00	0.045	0.030	18.0–20.0	8.0–11.0	–	–	515	205	35	–	–
	TP304H	0.04–0.10	1.00	2.00	0.045	0.030	18.0–20.0	8.0–11.0	–	–	515	205	35	–	–
	TP304L	0.035	1.00	2.00	0.045	0.030	18.0–20.0	8.0–13.0	–	–	485	170	35	–	–
	TP316 [13)]	0.08	1.00	2.00	0.045	0.030	16.0–18.0	11.0–14.0	2.00–3.00	–	515	205	35	–	–
	TP316H [13)]	0.04–0.10	1.00	2.00	0.045	0.030	16.0–18.0	11.0–14.0	2.00–3.00	–	515	205	35	–	–
	TP316L	0.035	1.00	2.00	0.045	0.030	16.0–18.0	10.0–14.0	2.00–3.00	–	485	170	35	–	–

注：
7）采用棒料或板料制造的管件，C含量不应大于0.35%。
8）采用锻件制造的管件，C含量不应大于0.35%，Si含量不应大于0.35%，且无最小值限制。
9）在规定的最大C含量以下，每降低0.01%C含量，允许在规定的最大Mn含量上增加0.06%Mn含量，直到1.35%为止。
10）Cu，Ni，Cr和Mo含量总合不应大于1.00%。
11）Cr和Mo的含量总合不应大于0.32%。
12）V：0.18–0.25，Nb：0.06–0.10，N：0.03–0.07，Al:0.02,Ti:0.01,Zr:0.01
13）TP316和TP316H的焊管,Ni含量的范围可为10.0–14.0%

NOTE:
7) Fittings made from bars or plates shall have max.C 0.35.
8) Fittings made from forgings shall have C max.0.35 and Si max. 0.35 withou min.limitation.
9) Below the specified max.C, If the content C decreases each 0.01 %, an increase of 0.06% Mn will be permitted up to a maximum of 1.35%.
10) The sum of Cu, Ni, Cr, and Mo shall not exceed 1.00 %.
11) The sum of Cr and Mo shall not exceed 0.32 %.
12) V:0.18–0.25, Nb:0.06–0.10, N:0.03–0.07, Al:0.02, Ti:0.01, Zr:0.01.
13) For welded TP316 and TP316H pipe, the range of Ni shall be 10.0 14.0 %.

规范 Code	牌号 Grade	化学成份 Chemical Composition %, max									力学性能 Mechanical Requirement				
		C	Si	Mn	P	S	Cr	Ni	Mo	Other	T.S. min MPa	Y.S. min MPa	EL. min %	HB max	Other
ASTM A 312/ ASME SA 312	TP321 [14]	0.08	1.00	2.00	0.045	0.030	17.0–19.0	9.0–12.0	–	N:0.10;Ti:5C–0.70	515	205	35	–	–
	TP321H [14]	0.04–0.10	1.00	2.00	0.045	0.030	17.0–19.0	9.0–12.0	–	Ti:4C–0.60	515	205	35	–	–
	TP347	0.08	1.00	2.00	0.045	0.030	17.0–19.0	9.0–13.0	–	Nb:10C–1.00	515	205	35	–	–
	TP347H	0.04–0.10	1.00	2.00	0.045	0.030	17.0–19.0	9.0–13.0	–	Nb:8C–1.0	515	205	35	–	–
ASTM A 333/ ASME SA 333[25]	6 [15]	0.30	0.10 min	0.29–1.06	0.025	0.025	–	–	–	–	415	240	22	–	–
	9	0.20	–	0.40–1.06	0.025	0.025	–	1.60–2.24	–	Cu:0.75–1.25	435	315	(28)	–	–
	3	0.19	0.18–0.37	0.31–0.64	0.025	0.025	–	3.18–3.82	–	–	450	240	22	–	–
	8	0.13	0.13–0.32	0.90	0.025	0.025	–	8.40–9.60	–	–	690	515	16	–	–
ASTM A 335/ ASME SA 335	P5	0.15	0.50	0.30–0.60	0.025	0.025	4.00–6.00	–	0.45–0.65	–	415	205	22	–	–
	P5b	0.15	1.00–2.00	0.30–0.60	0.025	0.025	4.00–6.00	–	0.44–0.65	–	415	205	22	–	–
	P5c	0.12	0.50	0.30–0.60	0.025	0.025	4.00–6.00	–	0.45–0.65	[16]	415	205	22	–	–
	P9	0.15	0.25–1.00	0.30–0.60	0.025	0.025	8.0–10.0	–	0.90–1.10	–	415	205	22	–	–
	P91	0.08–0.12	0.20–0.50	0.30–0.60	0.020	0.010	8.00–9.50	0.40	0.85–1.05	[17]	585	415	20	250	–
	P11	0.05–0.15	0.50–1.00	0.30–0.60	0.025	0.025	1.00–1.50	–	0.44–0.65	–	415	205	22	–	–
	P12	0.05–0.15	0.50	0.30–0.61	0.025	0.025	0.80–1.25	–	0.44–0.65	–	415	220	22	–	–
	P22	0.05–0.15	0.50	0.30–0.60	0.025	0.025	1.90–2.60	–	0.87–1.13	–	415	205	22	–	–
ASTM A 350/ ASME SA 350[25]	LF2 CL1 & CL2 [18][19][20]	0.30	0.15–0.30	0.60–1.35	0.035	0.040	0.30	0.40	0.12	Cu:0.40;Nb:0.02 V:0.08,	485–655	250	22	197	–
	LF9 [19]	0.20	–	0.40–1.06	0.035	0.040	0.30	1.60–2.24	0.12	Cu:0.75–1.25, Nb:0.02;V:0.03	435–605	315	25	197	–
	LF3 CL1 & CL2 [19]	0.20	0.20–0.35	0.90	0.035	0.040	0.30	3.3–3.7	0.12	Cu:0.40;Nb:0.02 V:0.03	485–655	260	22	197	–

注：

14）壁厚＞9.53mm（3/8in）的TP321无缝管和壁厚＞4.76mm（3/16in.）的TP321H无缝管,其抗拉强度最小为485MPa(70ksi),屈服强度最小为170MPa(25ksi).

15) 在规定的最大C含量以下,每降低0.01%C含量,允许在规定的最大Mn含量上增加0.05%Mn含量,直到1.35%为止。

16）P5c应有4×C–0.7%的Ti含量，或应有（8–10）×C%的Nb含量。

17）P91应有V:0.18–0.25，N：0.03–0.07，Al:0.02，Nb：0.06–0.10，Ti：0.01，Zr:0.01.

18）在熔炼分析中，Cu，Ni,Cr，V和Mo的总合不超过1.00%。

19）在熔炼分析中，Cr和Mo的总合不超过0.32%。

20）经协商，Nb的含量熔炼分析时间可为0.05%，产品分析时可为0.06%。

NOTE:

14) For TP321 SMLS pipes with tichkness(T.) > 9.53mm (3/8 in.)and TP321H SMLS pipes with T >4.76mm (3/16 in.), the min. tension stenght is 485MPa (70ksi) and the min. yield strength is170MPa (25ksi).

15) Below the specified max.C, If the content C decreases each 0.01 %, an increase of 0.06% manganese will be permitted up to a maximum of 1.35%.

16) Grade P5c shall have a Ti content 4 × C–0.7%; or a Nb content (8–10) × C%.

17) Grade P91 shall have V:0.18–0.25, N:0.03–0.07, Al:0.02, Nb:0.06–0.10, Ti:0.01, Zr:0.01.

18) The sum of Cu, Ni, Cr,V and Mo shall not exceed 1.00% during heat analysis.

19) The sum of Cr and Mo shall not exceed 0.32 % during heat analysis.

20) Per agreement, the content of Nb may be 0.05 % during heat analysis and 0.06% during product analysis.

规范 Code	牌号 Grade	化学成份 Chemical Composition %, max									力学性能 Mechanical Requirement				
		C	Si	Mn	P	S	Cr	Ni	Mo	Other	T.S. min MPa	Y.S. min MPa	EL. min %	HB max	Other
ASTM A 387/ ASME SA 387[26]	5	0.15	0.55	0.25–0.66	0.035	0.030	3.90–6.10	–	0.40–0.70	–	415–585 (515–690)	205 (310)	18	–	Z ≥ 40%
	9	0.15	1.05	0.25–0.66	0.030	0.030	7.90–10.10	–	0.85–1.15	–	415–585 (515–690)	205 (310)	18	–	Z ≥ 40%
	91	0.06–0.15	0.18–0.56	0.25–0.66	0.025	0.012	7.90–9.60	0.43	0.80–1.10	V:0.16–0.27 Nb:0.05–0.11 N:0.025–0.080 Al:0.02;Ti:0.01 Zr:0.01	585-760	415	18	–	–
	11	0.04–0.17	0.44–0.86	0.35–0.73	0.035	0.035	0.94–1.56	–	0.40–0.70	–	415–585 (515–690)	240 (310)	22	–	–
	12	0.04–0.17	0.13–0.45	0.35–0.73	0.035	0.035	0.74–1.21	–	0.40–0.65	–	380–550 (450–585)	230 (275)	22	–	–
	22	0.04–0.15	0.50	0.25–0.66	0.035	0.035	1.88–2.62	–	0.85–1.15	–	415–585 (515–690)	205 (310)	18	Z	≥ 40%
ASTM A 403/ ASME SA 403	WP304	0.08	1.00	2.00	0.045	0.030	18.0–20.0	8.0–11.0	–	–	515	205	28	–	–
	WP304H	0.04–0.10	1.00	2.00	0.045	0.030	18.0–20.0	8.0–11.0	–	–	515	205	28	–	–
	WP304L	0.030	1.00	2.00	0.045	0.030	18.0–20.0	8.0–12.0	–	–	485	170	28	–	–
	WP316	0.08	1.00	2.00	0.045	0.030	16.0–18.0	10.0–14.0	2.00–3.00	–	515	205	28	–	–
	WP316H	0.04–0.10	1.00	2.00	0.045	0.030	16.0–18.0	10.0–14.0	2.00–3.00	–	515	205	28	–	–
	WP316L	0.030	1.00	2.00	0.045	0.030	16.0–18.0	10.0–14.0	2.00–3.00	–	485	170	28	–	–
	WP321	0.08	1.00	2.00	0.045	0.030	17.0–19.0	9.0–12.0	–	Ti:5(C+N_2)–0.70	515	205	28	–	–
	WP321H	0.04–0.10	1.00	2.00	0.045	0.030	17.0–19.0	9.0–12.0	–	Ti:4(C+N_2)–0.70	515	205	28	–	–
	WP347	0.08	1.00	2.00	0.045	0.030	17.0–19.0	9.0–12.0	–	Nb:10C–1.10	515	205	28	–	–
	WP347H	0.04–0.10	1.00	2.00	0.045	0.030	17.0–19.0	9.0–12.0	–	Nb:8C–1.10	515	205	28	–	–
ASTM A 420/ ASME SA 420[25]	WPL6 [21]	0.30	0.15–0.40	0.50–1.35	0.035	0.040	0.30	0.40	0.12	Cu:0.40;V:0.08, Nb:0.02	415–655	240	22	–	–
	WPL9	0.20	–	0.40–1.06	0.030	0.030	–	1.60–2.24	–	Cu:0.75–1.25	435-610	315	20	–	–
	WPL3 [22]	0.20	0.13–0.37	0.31–0.64	0.05	0.05	–	3.2–3.8	–	–	450–620	240	22	–	–
	WPL8 [23]	0.13	0.13–0.37	0.90	0.030	0.030	–	8.4–9.6	–	–	690–865	515	16	–	–
ASTM A 515/ ASME SA 515	65 [24]	0.28	0.13–0.45	0.98	0.035	0.035	–	–	–	–	450–585	240	23	–	–
	70 [24]	0.31	0.13–0.45	1.30	0.035	0.035	–	–	–	–	485–620	260	21	–	–
ASTM A 516/ ASME SA 516	65 [24]	0.24	0.13–0.45	0.79–1.30	0.035	0.035	–	–	–	–	450–585	240	23	–	–
	70 [24]	0.27	0.13–0.45	0.79–1.30	0.035	0.035	–	–	–	–	485–620	260	21	–	–
ASTM A 815/ ASME SA 815	S31803	0.030	1.0	2.00	0.030	0.020	21.0–23.0	4.5–6.5	2.5–3.5	N:0.08–0.20	620	450	20	290	–
	S32205	0.030	1.00	2.00	0.030	0.020	22.0–23.0	4.5–6.5	3.0–3.5	N:0.14–0.20	655	450	20	290	–

注：

21) 经协商，Nb的含量 熔炼分析时可为0.05%,产品分析时可为0.06%

22) 用钢板或锻件制造的管件,Mn含量最大为0.90%.

23) 用钢板制造的管件,Mn含量最大为0.98%.

24) C和Mn的含量因钢板的厚度不同而有所不同,请查阅相关规范.

25) 这些低温材料的冲击试验温度和冲击试验性能要求详见标准规定.

26) 因钢板的级别不同,力学性能要求不同,详见规范

Note:

21) Per agreement, the content of Nb may be 0.05 % during heat analysis and 0.06% during product analysis.

22) Fittings made from plates or forgings shall have Mn Max.0.90 %.

23) Fittings made from plates shall have Mn Max 0.98 %.

24) The contents of C and Mn may vary with the different thickness, please refer the relevant standards.

25) As for the impact test temperature and the test properties,please refer the relevant standards.

26) Because of the different Class,the plates' properties are different, refer the standards.