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GB

National Standard of the People's Republic of China

GB 5310 – 1995

Seamless Steel Tubes and Pipes for High Pressure Boiler

高压锅炉用无缝钢管

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Issued by: State Bureau of Quality and Technical Supervision

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Preface

This standard is not an equivalent of the standards of American ASTM A335 – 90 “Code for Seamless Ferrite Alloy Steel Tubes and Pipes Used in High Temperature”, ASTM A106 – 91 “Code for Seamless Carbon Steel Tubes and Pipes Used in High Temperature”, German DIN 17175 – 79 “Seamless Steel Tubes and Pipes Made of Heat Resistant Steel”, ISO/DIS 9329 – 2: 1992 “Seamless Steel Used Under Pressure – Delivery Technical Specifications Part 2: Specified High Temperature Property Non-alloy Steel and Alloy Steel (Steel Tubes and Pipes)”.

This standard has added 5 brands compared with the original standard.

This standard has included the manufacturing process of high pressure boiler tubes and pipes, which is directly made of continuous casting billet or steel ingot. And it has specified that steel used directly to make high pressure boiler tubes and pipes with continuous casting billet or steel ingot must be refined in external furnace.

This standard has revised the U type impact test to V type impact test.

This standard has revised articles of temper insulation time, flattening test and non-destructive test, etc. of steel tubes and pipes.

Appendix A and Appendix B in this standard are prompt appendixes, high temperature property data are for reference in design and application.

This standard was first issued in 1985 and has been first revised this time.

This standard was put into effect on March 1, 1996, and this standard substitutes GB 5310 – 85 from the date of the effectiveness of this standard.

This standard is put forward by The Ministry of Metallurgical Industry of the People’ Republic of China.

Drafting units of this standard: Chengdu Seamless Steel Tubes and Pipes Plant, Information and Standard Research Institute of The Ministry of Metallurgical Industry.

Main drafters of this standard: Liu Yali, You Kemin, Li yongquan, Ren Gang.

National Standard of People's Republic of China
Seamless Steel Tubes and Pipes for
High Pressure Boiler

GB/5310—1995
superseding
GB/T 5310-85

1. Scope

This standard has specified the dimensions, shapes, weights, technical requirements, test methods, inspection rules, packing, marking, and quality certificates for seamless steel tubes and pipes of high pressure boiler.

This standard applies to manufacturing seamless steel tubes and pipes of quality carbon constructional steel, alloy constructional steel, heat resistant stainless steel used for high pressure steam boiler and pipes and above.

2. Reference standards

The articles included in the following standards shall become articles of this standard by referred to in this standard. The versions shown in this standard are all effective when this standard published. All the standards may be revised, the users may try to find out the possibility to use the latest version of following standards.

GB 222 – 84 Method of sampling steel for determination of chemical composition and permissible variations for product analysis

GB 223.5 – 88 Methods for chemical analysis of iron, steel and alloy- The reduced molybdosilicate spectro-photometric method for the determination of acid-soluble silicon content

GB/T223.10 – 91 Method for chemical analysis of iron, steel and alloy – The cupferron separation-chrome azurol S photometric method for the determination of aluminum content

GB/T223.11 – 91 Method for chemical analysis of iron, steel and alloy – The ammonium persulfate oxidation volumetric method for the determination of chromium content

GB/T223.12 – 91 Method for chemical analysis of iron, steel and alloy – The sodium carbonate separation-diphenyl carbazide photometric method for the determination of chromium content

GB/223.14 – 89 Method for chemical analysis of iron, steel and alloy – The N-benzoyl-N-phenylhydroxylamine extraction photometric method for the determination of vanadium content

GB/223.17 – 89 Method for chemical analysis of iron, steel and alloy – The diantipyrymethane photometric method for the determination of titanium content

GB/223.19 – 89 Method for chemical analysis of iron, steel and alloy – The neocuproine-chloroform extraction photometric for the determination of copper content

GB/T 223.23 – 94 Method for chemical analysis of iron, steel and alloy – The dimethyloxime

spectrophotometric method for the determination of nickel content

GB 223.26 – 89 Method for chemical analysis of iron, steel and alloy – The thiocyanate direct photometric method for the determination of molybdenum content

GB /T 223.27 – 94 Method for chemical analysis of iron, steel and alloy – The thiocyanate-butyl acetate extraction spectrophotometric method for the determination of molybdenum content

GB 223.37 – 89 Method for chemical analysis of iron, steel and alloy – The indophenol blue photometric method for the determination of nitrogen content after distillation separation

GB 223.40 – 85 Method for chemical analysis of iron, steel and alloy – The anion-exchange separation-sulphochlorophenol S photometric method for the determination of niobium content

GB 223.41 – 85 Method for chemical analysis of iron, steel and alloy – The anion-exchange separation-pyrogallol photometric method for the determination of tantalum content

GB/T 223.44 – 94 Method for chemical analysis of iron, steel and alloy – Determination of tungsten content

GB 223.59 – 87 Method for chemical analysis of iron, steel and alloy – The sodium arsenite-sodium nitrite titrimetric method for the determination of phosphorus content

GB 223.63 – 88 Method for chemical analysis of iron, steel and alloy – The sodium (potassium) periodate photometric method for the determination of manganese content

GB 223.68 – 89 Method for chemical analysis of iron, steel and alloy – The potassium iodate titration method after combustion for the determination of sulfur content

GB 223.69 – 89 Method for chemical analysis of iron, steel and alloy – The gas-volumetric method after combustion for the determination of carbon content

GB/T 223.75 – 91 Method for chemical analysis of iron, steel and alloy – The methanol distillation-curcumin photometric method for the determination of boron content

GB 224 – 87 Determination of depth of decarburization of steel

GB 226 – 91 Etch test for macrostructure and defect of steels

GB 228 – 87 Metallic materials-Tensile testing

GB 241 – 90 Metal tubes-hydrostatic pressure testing

GB 242 – 82 Metallic materials- Tube-Drift expanding test

GB 246 – 82 Metallic materials- Tube-flattening test

GB 1979 – 80 Constructional steel macrostructure defect rating diagram

GB 2102 – 88 Acceptance, packing, marking and quality certificate of steel tubes and pipes

GB/T 229 – 1994 Metallic materials-Charpy notch impact test

GB 3652 – 83 Metal-tube material high temperature tensile test method

GB 4163 – 84 Stainless steel pipe and tubing-methods for ultrasonic test

GB 5777 – 86 Seamless steel pipe and tubing- methods for ultrasonic test

GB 6395 – 86 Metal-high temperature tensile persistent test method

GB 6397 – 86 Metallic materials-Test pieces for tensile testing

GB 7735 – 87 Steel tubes-The inspection method on eddy current test

GB 10561 – 89 Steel-Determination of content of non-metallic inclusion-Micrographic method using standard diagrams

GB/T 12606 – 90 Magnetic leakage flux testing method of steel tubes and bars

GB/T 13298 – 91 Metal-Inspection method of microstructure

YB/T 5137 – 93 Seamless steel tubes and pipes round tube fillets for high pressure

YB/T 5148 – 93 Metal-Determination method of average grain size

3. Dimensions, shapes and weights

3.1 Outer diameter and wall thickness

3.1.1 The outer diameter and wall thickness of hot rolled (extruded, expanded) and cold drawn (rolled) steel tubes and pipes shall be in conformity with the stipulations in Table 1 and Table 2 respectively. Steel tubes and pipes with size other than those specified in Table 1 and Table 2 may be supplied through mutual consultation according to the client's demands.

**Table 1 Outer diameter and wall thickness of hot rolled
(extruded, expanded) steel tubes and pipes**

Nominal od, mm	Nominal wall thickness, mm														
	2.0	2.5	2.8	3.0	3.2	3.5	4.0	4.5	5.0	5.5	6.0	(6.5)	7.0	(7.5)	8.0
	Theory weight, kg/m														
22	0.986	1.20	1.33	1.41	1.48	-	-	-	-	-	-	-	-	-	-
25	1.13	1.39	1.53	1.63	1.72	1.86	-	-	-	-	-	-	-	-	-
28	-	1.57	1.74	1.85	1.96	2.11	-	-	-	-	-	-	-	-	-
32	-	-	2.02	2.15	2.27	2.46	2.76	3.05	3.33	-	-	-	-	-	-
38	-	-	2.43	2.59	2.75	2.98	3.35	3.72	4.07	4.41	-	-	-	-	-
42	-	-	2.71	2.89	3.06	3.32	3.75	4.16	4.56	4.95	5.83	-	-	-	-
48	-	-	3.12	3.33	3.54	3.84	4.34	4.83	5.30	5.76	6.21	6.65	7.08	-	-
51	-	-	3.33	3.55	3.77	4.10	4.64	5.16	5.67	6.17	6.66	7.13	7.60	8.05	8.48
57	-	-	-	-	-	4.62	5.23	5.83	6.41	6.98	7.55	8.09	8.63	9.16	9.67
60	-	-	-	-	-	4.88	5.52	6.16	6.78	7.39	7.99	8.53	9.15	9.71	10.26
76	-	-	-	-	-	6.26	7.10	7.93	8.75	9.56	10.36	11.14	11.91	12.67	13.42
83	-	-	-	-	-	-	7.79	8.71	9.62	10.51	11.39	12.26	13.12	13.96	14.80
89	-	-	-	-	-	-	8.38	9.38	10.36	11.33	12.28	13.22	14.15	15.07	15.98
102	-	-	-	-	-	-	-	10.82	11.96	13.09	14.20	15.31	16.40	17.48	18.54
108	-	-	-	-	-	-	-	11.49	12.70	13.90	15.09	16.27	17.43	18.59	19.73
114	-	-	-	-	-	-	-	-	13.44	14.72	15.98	17.23	18.47	19.70	20.91
121	-	-	-	-	-	-	-	-	14.30	15.67	17.02	18.35	19.68	20.99	22.29
133	-	-	-	-	-	-	-	-	15.78	17.29	18.79	20.28	21.75	23.21	24.66
146	-	-	-	-	-	-	-	-	-	-	20.71	22.36	23.99	25.62	27.22
159	-	-	-	-	-	-	-	-	-	-	22.64	24.44	26.24	28.02	29.79
168	-	-	-	-	-	-	-	-	-	-	-	25.89	27.79	29.68	31.56
194	-	-	-	-	-	-	-	-	-	-	-	-	32.28	34.49	36.69
219	-	-	-	-	-	-	-	-	-	-	-	-	-	39.12	41.63
245	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
273	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
299	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
325	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
351	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
377	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
426	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
450	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
480	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
530	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: Dimensions in brackets are not recommended.

Table 1 (continue)

Nominal od, mm	Nominal wall thickness, mm														
	9.0	10	11	12	13	14	(15)	16	(17)	18	(19)	20	22	(24)	25
	Theory weight, kg/m														
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51	9.32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
57	10.65	11.59	12.48	13.32	-	-	-	-	-	-	-	-	-	-	-
60	11.32	12.33	13.29	14.20	-	-	-	-	-	-	-	-	-	-	-
76	14.87	16.28	17.63	18.94	20.20	21.40	22.56	23.67	24.73	25.74	26	-	-	-	-
83	16.42	18.00	19.53	21.01	22.44	23.82	25.15	26.44	27.67	28.85	29.99	31.07	-	-	-
89	17.76	19.48	21.16	22.79	24.36	25.89	27.37	28.80	30.18	31.52	32.80	34.03	-	-	-
102	20.64	22.69	24.68	26.63	28.53	30.38	32.18	33.93	35.63	37.29	38.89	40.44	43.40	-	-
108	21.97	24.17	26.31	28.41	30.46	32.45	34.40	36.30	38.15	39.95	41.70	43.40	46.66	49.71	51.17
114	23.30	25.65	27.94	30.18	32.38	34.52	36.62	38.67	40.66	42.61	44.51	46.36	49.91	53.27	54.87
121	24.86	27.37	29.84	32.26	34.62	36.94	39.21	41.43	43.60	45.72	47.79	49.81	53.71	57.41	59.18
133	27.52	30.33	33.09	35.81	38.47	41.08	43.65	46.16	48.63	51.05	53.41	55.73	60.22	64.51	66.58
146	30.41	33.54	36.62	39.65	42.64	45.57	48.46	51.29	54.08	56.82	59.50	62.14	67.27	72.20	74.60
159	33.29	36.74	40.15	43.50	46.80	50.06	53.27	56.42	59.53	62.59	65.60	68.55	74.33	79.90	82.61
168	35.29	38.96	42.59	46.16	49.69	53.17	56.59	59.97	63.30	66.58	69.81	72.99	79.21	85.22	88.16
194	41.06	45.37	49.64	53.86	58.02	62.14	66.21	70.23	74.20	78.12	81.99	85.82	93.31	100.61	104.19
219	46.61	51.54	56.42	61.26	66.04	70.77	75.46	80.10	84.68	89.22	93.71	98.15	106.88	115.41	119.60
245	52.38	57.95	63.47	68.95	74.37	79.75	85.08	90.35	95.58	100.76	105.89	110.97	120.98	130.80	135.63
273	58.59	64.86	71.07	77.24	83.35	89.42	95.43	101.40	107.32	113.19	119.01	124.78	136.17	147.37	152.89
299	64.36	71.27	78.12	84.93	91.69	98.39	105.05	111.66	118.22	124.73	131.19	137.60	150.28	162.76	168.92
325	-	-	-	-	100.02	107.37	114.67	121.92	129.12	136.27	143.37	150.43	164.38	178.14	184.95
351	-	-	-	-	108.36	116.35	124.29	132.18	140.02	147.81	155.56	163.25	178.49	193.53	200.98
377	-	-	-	-	116.69	125.32	133.90	142.44	150.92	159.35	167.74	176.07	192.59	208.92	217.01
426	-	-	-	-	-	142.24	152.03	161.77	171.46	181.10	190.70	200.24	219.18	237.92	247.22
450	-	-	-	-	-	150.52	160.91	171.24	181.52	191.76	201.94	212.08	232.20	252.12	262.01
480	-	-	-	-	-	160.88	172.00	183.08	194.10	205.07	216.00	226.87	248.47	269.88	280.51
500	-	-	-	-	-	167.79	179.40	190.97	202.48	213.95	225.37	236.74	259.32	281.72	292.84
530	-	-	-	-	-	178.14	190.50	202.80	215.06	227.27	239.42	251.53	275.60	299.47	311.33

Note: Dimensions in brackets are not recommended.

Table 1 (finished)

Nominal od, mm	Nominal wall thickness, mm																
	26	28	30	32	(34)	36	38	40	(42)	45	(48)	50	56	60	63	(65)	70
	Theory weight, kg/m																
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
89	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
102	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
108	52.58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
114	56.42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
121	60.91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
133	68.60	72.50	76.20	79.70	-	-	-	-	-	-	-	-	-	-	-	-	-
146	76.94	81.48	85.82	89.96	93.91	97.65	-	-	-	-	-	-	-	-	-	-	-
159	85.27	90.45	95.43	100.22	104.81	109.19	-	-	-	-	-	-	-	-	-	-	-
168	91.04	96.67	102.09	107.32	112.35	117.18	121.82	126.26	-	-	-	-	-	-	-	-	-
194	107.71	114.62	121.33	127.84	134.15	140.27	146.18	151.91	157.43	165.35	-	-	-	-	-	-	-
219	123.74	131.88	139.82	147.57	155.11	162.46	169.61	176.57	183.32	193.09	202.41	208.38	-	-	-	-	-
245	140.41	149.83	159.06	168.08	176.91	185.54	193.98	202.21	210.25	221.94	233.18	240.44	-	-	-	-	-
273	158.37	169.17	179.77	190.18	200.39	210.40	220.21	229.83	239.25	253.01	266.33	274.96	-	-	-	-	-
299	175.04	187.12	199.01	210.70	222.19	233.48	244.58	255.48	266.18	281.86	297.10	307.02	335.57	353.62	-	-	-
325	191.71	205.07	218.24	231.21	243.99	256.56	268.94	281.12	293.11	310.72	327.88	339.07	371.48	392.09	-	-	-
351	208.38	223.03	237.48	251.73	265.79	279.64	293.31	306.77	320.04	339.57	358.66	371.13	407.38	430.56	-	-	-
377	225.05	240.98	256.71	272.25	287.58	302.73	317.67	332.42	346.97	368.42	389.43	403.19	443.29	469.03	487.82	500.10	529.94
426	256.46	274.81	292.96	310.91	328.67	346.23	363.59	380.75	397.72	422.80	447.43	463.61	510.96	541.53	563.95	578.65	614.53
450	271.85	291.38	310.72	329.85	348.79	367.53	386.08	404.42	422.57	449.43	475.84	493.20	544.10	577.04	601.24	617.12	655.96
480	291.09	312.10	332.91	353.53	373.94	394.17	414.19	434.02	453.65	482.72	511.35	530.19	585.53	621.43	647.84	665.20	707.74
500	303.91	325.91	347.71	369.31	390.71	411.92	432.93	453.74	474.36	504.91	535.02	554.85	613.15	651.02	678.91	697.26	742.27
530	323.14	346.62	369.90	392.98	415.87	438.55	461.04	483.34	505.43	538.20	570.53	591.84	654.57	695.41	725.52	745.35	794.05

Note: Dimensions in brackets are not recommended.

Table 2 Outer diameter and wall thickness of cold drawn (rolled) steel tubes and pipes

Nominal od, mm	Nominal wall thickness, mm																				
	2.0	2.2	2.5	2.8	3.0	3.2	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	9.0	10	11	12	13
	Theory weight, kg/m																				
10	0.395	0.423	0.462	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	0.493	0.532	0.586	0.635	0.666	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	0.690	0.749	0.832	0.911	0.962	1.01	1.08	1.18	-	-	-	-	-	-	-	-	-	-	-	-	-
22	0.986	1.07	1.20	1.33	1.41	1.48	1.60	1.78	1.94	2.10	2.24	-	-	-	-	-	-	-	-	-	-
25	1.13	1.24	1.39	1.53	1.63	1.72	1.86	2.07	2.27	2.47	2.64	2.81	-	-	-	-	-	-	-	-	-
28	1.28	1.40	1.57	1.74	1.85	1.96	2.11	2.37	2.61	2.84	3.05	3.26	3.45	3.62	-	-	-	-	-	-	-
32	1.48	1.62	1.82	2.02	2.15	2.27	2.46	2.76	3.05	3.33	3.59	3.85	4.09	4.32	4.53	4.73	-	-	-	-	-
38	1.78	1.94	2.19	2.43	2.59	2.75	2.98	3.35	3.72	4.07	4.41	4.73	5.05	5.35	5.64	5.92	6.44	-	-	-	-
42	-	-	2.44	2.71	2.89	3.06	3.32	3.75	4.16	4.56	4.95	5.33	5.69	6.04	6.38	6.71	7.32	-	-	-	-
48	-	-	2.80	3.12	3.33	3.54	3.84	4.34	4.83	5.30	5.76	6.21	6.65	7.08	7.49	7.89	8.66	9.37	-	-	-
51	-	-	2.99	3.33	3.55	3.77	4.10	4.64	5.16	5.67	6.17	6.66	7.13	7.60	8.05	8.48	9.32	10.11	10.85	11.54	-
57	-	-	3.36	3.74	3.99	4.25	4.62	5.23	5.83	6.41	6.98	7.55	8.09	8.63	9.16	9.67	10.65	11.59	12.48	13.32	-
60	-	-	-	-	4.22	4.48	4.88	5.52	6.16	6.78	7.39	7.99	8.58	9.15	9.71	10.26	11.32	12.33	13.29	14.20	-
63	-	-	-	-	4.44	4.72	5.14	5.82	6.49	7.15	7.80	8.43	9.06	9.67	10.26	10.85	11.98	13.07	14.11	15.09	-
70	-	-	-	-	4.96	5.27	5.74	6.51	7.27	8.01	8.75	9.47	10.18	10.88	11.56	12.23	13.54	14.80	16.00	17.16	18.27
76	-	-	-	-	-	-	-	7.10	7.93	8.75	9.56	10.36	11.14	11.91	12.67	13.42	14.87	16.28	17.63	18.94	20.20
83	-	-	-	-	-	-	-	7.79	8.71	9.62	10.51	11.39	12.26	13.12	13.96	14.80	16.42	18.00	19.53	21.01	22.44
89	-	-	-	-	-	-	-	8.38	9.38	10.36	11.33	12.28	13.22	14.15	15.07	15.98	17.76	19.48	21.16	22.79	24.36
102	-	-	-	-	-	-	-	-	10.82	11.96	13.09	14.20	15.31	16.40	17.48	18.54	20.64	22.69	24.68	26.63	-
108	-	-	-	-	-	-	-	-	11.49	12.70	13.90	15.09	16.27	17.43	18.59	19.73	21.97	24.17	26.31	28.41	-
114	-	-	-	-	-	-	-	-	12.15	13.44	14.72	15.98	17.23	18.49	19.70	20.91	23.30	25.65	27.94	30.18	-

3.1.2 The permissible variation of outer diameter and wall thickness shall be in conformity with the stipulations in Table 3.

The permissible dimension variation of hot expanded pipes shall be decided through consultation between both the supplier and the client.

Steel tubes and pipes with size other than the variations specified in Table 3 may be produced through mutual consultation according to the client's demands and it must be specified in the contract.

Table 3 Permissible variations of outer diameter and wall thickness

Steel tubes and pipes category	Dimension of steel tubes and pipes (mm)		Permissible variations		
			Common grade	High grade	
Hot rolled (extruded) tubes and pipes	Outer diameter D	≤159	±1.0%(min. ±0.5mm)		
		>159	±1.0%		
	Wall thickness S	<3.5	+15% -10%	Min.+0.48mm -0.32mm	±10%(Min.±0.2mm)
		3.5~20	+15% -10%	±10%	
		>20	D<219	±10%	
			D≥219	+12.5% -10.0%	±10%
Cold drawn (rolled) tubes and pipes	Outer diameter D	≤30	±0.20mm		
		>30~50	±0.30mm		
		>50	±0.8%		
	Wall thickness S	2~3	+12% -10%	±10%	
		>3	±10%		

3.2 Length

3.2.1 Ordinary length

The ordinary length of steel tubes and pipes shall be 4000 ~ 12000mm.

Under sized steel tubes and pipes with a weight not exceeding 5% of the total delivery weight of that batch and a length not shorter than 3000mm can be delivered through mutual consultation between the supplier and the client.

3.2.2 Cut lengths and multiple lengths

The cut lengths and multiple lengths shall be within the ordinary length limit, the permissible variation for full length shall be +20mm. Each cut length shall leave a notch tolerance according to the stipulations below:

$D \leq 159\text{mm}$ 5 ~ 10mm

$D > 159\text{mm}$ 10 ~ 15mm

3.3 Degree of curvature

The degree of curvature of steel tubes and pipes shall not be greater than the stipulations below:

$S \leq 15\text{mm}$ 1.5mm/m

$S > 15 \sim 30\text{mm}$ 2.0mm/m

$S > 30\text{mm}$ 3.0mm/m

The total degree of curvature of header shall not be greater than 12mm.

3.4 End shape

Both ends of steel tubes and pipes shall be cut into right angle and burrs shall be removed.

3.5 Unevenness of ellipticity and wall thickness

The unevenness of ellipticity and wall thickness shall not exceed 80% of the tolerance of outer diameter and wall thickness respectively through mutual consultation according to the client's demands and it must be specified in the contract.

3.6 Delivery weight

3.6.1 Steel tubes and pipes shall be delivered in actual weight and it may also be delivered in theory weight.

For theory weight of quality carbon constructional steel, alloy constructional steel, see Table 1 and Table 2. The theory weight of every meter steel tubes and pipes (steel density, 7.85kg/dm^3) shall be calculated based on formula (1):

$$W = 0.02466(D - S)S \quad \dots\dots\dots(1)$$

Where: W - theory weight of every meter steel tubes and pipes, kg;

S - nominal wall thickness of steel tubes and pipes, mm;

D - nominal outer diameter of steel tubes and pipes, mm.

The theory weight of austenite stainless hot resistant steel tubes and pipes shall be 1.015 times of that indicated in Table 1 and Table 2.

3.6.2 The permissible variation between actual weight and theory weight of the delivery steel tubes and pipes which has been mutually consulted according to the client's demands and specified in the contract, shall be:

single steel tube and pipe..... $\pm 10\%$

steel tubes and pipes with minimum weight of 10t each batch $\pm 7.5\%$

3.7 Marking example

Steel tubes and pipes made of 12Cr1MoVG, with outer diameter of 108mm, wall thickness of 8mm:

a) Hot rolled (extruded, expanded) steel tubes and pipes with diameter and wall thickness of common grade accuracy, length of 5500mm cut lengths, its marking will be: steel tubes and pipes 12Cr1MoVG-108 x 8 x 5500 cut length-GB 5310 - 1995

b) Cold drawn (rolled) steel tubes and pipes, with high grade accuracy of diameter, common grade accuracy

of wall thickness, length of 8000mm, its marking will be: steel tubes and pipes drawn (rolled) 12Cr1MoVG-108H x 8 x 8000-GB 5310 – 1995

4. Technical requirements

4.1 Steel brand and chemical composition

4.1.1 Steel brand and chemical composition (heat analysis) shall be in conformity with the stipulations in Table 4 and the pipes shall be accepted according to smelting constitution.

4.1.2 If buyer requires product analysis, it shall be noted in the contract.

The permissible variation of chemical composition of finished steel tubes and pipes shall be in conformity with the stipulations in GB 222.

4.2 Manufacturing process

4.2.1 Manufacturing process of steel

Steel may be made by Martin furnace, electrical furnace, or by Martin furnace, electrical furnace, oxygen converter plus external furnace refining; steels of 1Cr18Ni9, 1Cr19Ni11Nb and 10Cr9Mo1VNb are made by electrical furnace plus external furnace refining or electroslag remelting; steel using directly steel ingot or continuous casting billet to roll pipes must be refined in external furnace; steel ingot may also be made by electroslag remelting process.

It may also be made by other process through mutual consultation between the supplier and the client. If the client specifies a certain smelting process, it must be noted in the contract.

4.2.2 Manufacturing process of forged, rolled pipe billets

Manufacturing of forged, rolled pipe billets shall conform to the requirements in YB/T 5137.

4.2.3 Manufacturing process of steel tubes and pipes

Steel tubes and pipes shall be made by seamless process of hot rolled (extruded, expanded) or cold drawn (rolled). If the client specifies a certain pipe making process, it must be noted in the contract.

4.3 Delivery status

Steel tubes and pipes shall be delivered after heat treatment carried out according to the heat treatment system specified in Table 5. The heat treatment system shall be filled in the quality certificate.

Table 4 Steel brand and chemical composition

Steel category	NO.	Steel grade	Chemical composition, %													S	P
			C	Mn	Si	Cr	Mo	V	Ti	B	W	Ni	Al	Nb	N		
			≤														
Quality carbon constructional steel	1	20G	0.17~ 0.24	0.35~ 0.65	0.17~ 0.37	-	-	-	-	-	-	-	-	-	-	0.030	0.030
	2	20MnG	0.17~ 0.24	0.70~ 1.00	0.17~ 0.37	-	-	-	-	-	-	-	-	-	-	0.030	0.030
	3	25MnG	0.22~ 0.30	0.70~ 1.00	0.17~ 0.37	-	-	-	-	-	-	-	-	-	-	0.030	0.030
Alloy constructional steel	4	15MoG	0.12~ 0.20	0.40~ 0.80	0.17~ 0.37	-	0.25~ 0.35	-	-	-	-	-	-	-	-	0.030	0.030
	5	20MoG	0.15~ 0.25	0.40~ 0.80	0.17~ 0.37	-	0.44~ 0.65	-	-	-	-	-	-	-	-	0.030	0.030
	6	12CrMoG	0.08~ 0.15	0.40~ 0.70	0.17~ 0.37	0.40~ 0.70	0.40~ 0.55	-	-	-	-	-	-	-	-	0.030	0.030
	7	15CrMoG	0.12~ 0.18	0.40~ 0.70	0.17~ 0.37	0.80~ 1.10	0.40~ 0.55	-	-	-	-	-	-	-	-	0.030	0.030
	8	12Cr2MoG	0.08~ 0.15	0.40~ 0.70	≤0.50	2.00~ 2.50	0.90~ 1.20	-	-	-	-	-	-	-	-	0.030	0.030
	9	12Cr1MoVG	0.08~ 0.15	0.40~ 0.70	0.17~ 0.37	0.90~ 1.20	0.25~ 0.35	0.15~ 0.30	-	-	-	-	-	-	-	0.030	0.030
	10	12Cr2MoWVTiB	0.08~ 0.15	0.45~ 0.65	0.45~ 0.75	1.60~ 2.10	0.50~ 0.65	0.28~ 0.42	0.08~ 0.18	0.002~ 0.008	0.30~ 0.55	-	-	-	-	0.030	0.030
	11	12Cr3MoVSiTiB	0.09~ 0.15	0.50~ 0.80	0.60~ 0.90	2.50~ 3.00	1.00~ 1.20	0.25~ 0.35	0.22~ 0.38	0.005~ 0.011	-	-	-	-	-	0.030	0.030
	12	10Cr9Mo1VNb	0.08~ 0.12	0.30~ 0.60	0.20~ 0.50	8.00~ 9.50	0.85~ 1.05	0.18~ 0.25	-	-	-	≤0.40	≤0.040	0.06~ 0.10	0.030~ 0.070	0.010	0.020
Stainless hot resistant steel	13	1Cr18Ni9	≤0.15	≤2.00	≤1.00	17.00~ 19.00	-	-	-	-	-	8.00~ 10.00	-	-	-	0.030	0.035
	14	1Cr19Ni11Nb	0.04~ 0.10	≤2.00	≤1.00	17.00~ 20.00	-	-	-	-	-	9.00~ 13.00	-	Nb+Ta ≥80%~ 1.00%	-	0.030	0.030

Note:

Requirement of residual elements content of 20GIS, 20MnG: Cu≤0.20%, Cr≤0.25%, Ni≤0.25%, V≤0.08%, Mo≤0.15%. Rest of steel grades: Cu≤0.20%, Cr≤0.30%, Ni≤0.30%.

Acid dissolved aluminum in steel 20G not more than 0.010% shall not be taken as delivery basis, but, it has to be filled in the quality certificate.

3. Nitrogen content of steel made by oxygen converter plus external furnace refining shall not be more than 0.008%.

4.4 Mechanical property

4.4.1 The mechanical property of steel tubes and pipes under delivery status shall conform to the stipulations in Table 6.

Vertical impact test shall be carried out for steel tubes and pipes with outer diameter greater than or equal to 76mm and wall thickness greater than or equal to 14mm.

Lateral mechanical property test may be carried out instead of vertical mechanical property test for steel tubes and pipes with outer diameter greater than or equal to 219mm and wall thickness greater than or equal to 25mm.

Ballistic work of one specimen of a group of three specimens is permitted to be 30% lower than the minimum value specified in Table 6, however, the arithmetical mean of the three specimens shall not be less than the value specified in Table 6.

Table 5 Heat treatment system of steel tubes and pipes

No.	grade	Heat treatment system
1	20G	900~930 °C normalizing, it may replace normalizing, when finishing temperature of hot rolled pipes lower than 900 °C.
2	20MnG 25MnG	900~930 °C normalizing, it may replace normalizing, when finishing temperature of hot rolled pipes lower than 900 °C.
3	15MoG ¹⁾ 20MoG ¹⁾	910~940 °C normalizing
4	12CrMoG ¹⁾	900~930 °C normalizing. 670~720 °C tempering, insulation period: periodical furnace more than 2h, continuous furnace more than 1h
5	15CrMoG ¹⁾	930~960 °C normalizing. 680~720 °C tempering, insulation period: periodical furnace more than 2h, continuous furnace more than 1h
6	12Cr2MoG ¹⁾	900~960 °C normalizing. 700~750 °C tempering. It may be heated to 900~960 °C, insulate for over 1h when furnace cooled down to 700 °C. Air-cooled.
7	12Cr1MoVG ¹⁾	980~1020 °C normalizing, insulating period shall be countered based on wall thickness, 1min for every millimeter, but not less than 20 minutes. 720~760 °C tempering, insulating period: periodical furnace more than 2h, continuous furnace more than 1h, when wall thickness is more than 30mm~40mm, forced cooling shall be used; when wall thickness is more than 40mm, modified treatment shall be carried out, quenching temperature 950~990 °C, tempering temperature 720~760 °C, insulating period: periodical furnace more than 2h.
8	12Cr2MoWVTiB	1000~1035 °C normalizing, insulating period shall be countered based on wall thickness, 1.5min for every millimeter, but not less than 20 minutes. 760~790 °C tempering, insulating period: periodical furnace more than 2h, continuous furnace more than 1h.
9	12Cr3MoVSiTiB	1040~1090 °C normalizing, insulating period shall be countered based on wall thickness, 1.5min for every millimeter, but not less than 20 minutes. 720~770 °C tempering, insulating period: periodical furnace more than 2h, continuous furnace more than 1h.
10	10Cr9Mo1VNb	1040~1060 °C normalizing, insulating period shall be countered based on wall thickness, 1.5min for every millimeter, but not less than 20 minutes. 770~790 °C tempering, insulating period: periodical furnace more than 2h, continuous furnace more than 1h.
11	1Cr18Ni9	Solution treatment: solution temperature $\geq 1040^{\circ}\text{C}$
12	1Cr19Ni11Nb	Solution treatment: hot rolled (extruded, expanded) pipes, solution temperature $\geq 1050^{\circ}\text{C}$, cold drawn (rolled) pipes solution temperature $\geq 1095^{\circ}\text{C}$.

1) When the finishing temperature of hot rolled 15MoG, 20MoG, 12CrMoG, 15CrMoG, 12Cr2MOG, 12Cr1MoVG steel tubes and pipes conforms to the normalizing temperature specified in Table 5, hot rolling may replace normalizing.

Table 6 Mechanical property of steel tubes and pipes

No.	Steel category	Grade	Vertical mechanical property				Lateral mechanical property			
			Tensile strength σ_b MPa	Yield point σ_s MPa	Extension rate δ_5 %	Ballistic work Ak _v J	Tensile strength σ_b MPa	Yield point σ_s MPa	Extension rate δ_5 %	Ballistic work Ak _v J
			\geq				\geq			
1	Quality carbon construction steel	20G	410~550	245	24	35	400	215	22	27
2		20MnG	≥ 415	240	22	35	-	-	-	27
3		25MnG	≥ 485	275	20	35	-	-	-	27
4	Alloy construction al steel	15MoG	450~600	270	22	35	-	-	20	27
5		20MoG	≥ 415	220	22	35	-	-	-	27
6		12CrMoG	410~560	205	21	35	-	-	-	27
7		15CrMoG	440~640	235	21	35	440	225	20	27
8		12Cr2MoG ¹⁾	450~600	280	20	35	-	-	18	27
9		12Cr1MoVG	470~640	255	21	35	440	255	19	27
10		12Cr2MoWVTiB	540~735	345	18	35	-	-	-	27
11		12Cr3MoVSiTiB	610~805	440	16	35	-	-	-	27
12		10Cr9Mo1VNb	≥ 585	415	20	35	-	-	-	27
13	Stainless hot resistant steel	1Cr18Ni9	≥ 520	205	35	-	-	-	-	-
14		1Cr19Ni11Nb	≥ 520	205	35	-	-	-	-	-

1) For steel tubes and pipes made of 12Cr2MoG, when wall thickness not more than 3mm and outer diameter not more than 30mm or wall thickness more than 16mm~40mm, the yield point is allowed to decrease by 10MPa; when wall thickness more than 40mm, the yield point is allowed to decrease by 20MPa.

4.4.2 For the minimum value of high temperature specified disproportionate extension stress and recommended creep rupture strength of 100000h, see Appendix A (prompted appendix) and Appendix B (prompted appendix). The supplier may provide the high temperature specified disproportionate extension stress value ($\sigma^{t_{0.2}}$) for reference according to the client' demand and noted in the contract the test temperature.

4.5 Process property

4.5.1 Flattening test

flattening test shall be performed for steel tubes and pipes with outer diameter greater than or equal to 22mm ~ 400mm and wall thickness not greater than 40mm, the distance between flat plates after steel tubes and pipes are flattened shall be calculated based on formula (2)

$$H = \frac{(1+a)S}{a+S/D} \dots\dots\dots(2).$$

Where: H – distance between flat plates, mm;

S – nominal wall thickness of steel tubes and pipes, mm;

D – nominal outer diameter of steel tubes and pipes, mm;

a – unit length deformation coefficient. Quality carbon constructional steel, alloy constructional steel use 0.08; stainless hot resistant steel use 0.09; when $S/D \geq 0.125$, value a shall be reduced by 0.01.

Flaw or crack is not allowed on the specimen after flattening test.

4.5.2 Flaring test

Steel tubes and pipes with wall thickness less than or equal to 8mm may carry out flaring test according to buyer's request and it must be noted in the contract.

Flaring test shall be carried out under cold status, top center taper shall be 30° , or 45° , or 60° . The OD flaring rate of specimen after flaring shall conform to the stipulations in Table 7, and flaw or crack is not allowed on the specimen after flaring.

Table 7 Flaring rate of steel tubes and pipes outer diameter

Steel category	Flaring rate of steel tubes and pipes outer diameter, %		
	Inside/ outside diameter		
	≤ 0.6	$> 0.6 \sim 0.8$	> 0.8
Quality carbon constructional steel	10	12	17
Alloy constructional steel	8	10	15
Stainless hot resistant steel	9	15	17

4.5.3 Hydraulic test

Hydraulic test shall be carried out for pipes one by one and the test pressure shall be calculated based on formula (3). The maximum test pressure shall be 20MPa, and pressure stable time shall not be less than 10s.

Water leakage or sweating on steel tubes and pipes is not allowed under test pressure.

$$P = \frac{2SR}{D} \dots\dots\dots(3)$$

Where: P – test pressure, MPa;

S – nominal wall thickness of steel tubes and pipes, mm;

D – nominal outer diameter of steel tubes and pipes, mm;

R – permissible stress, quality carbon constructional steel and alloy constructional steel shall be 80% of the yield point specified in Table 6, 70% of the yield point specified in Table 6 for stainless hot resistant steel.

Steel tubes and pipes qualified after eddy current testing may not be tested hydraulically. Leakage flux inspection test may be performed instead of hydraulic test through mutual consultation and it must be noted in the contract, for this, the specimen pipes shall use external surface vertical rectangular groove with a depth of 12.5% of nominal wall thickness of steel tubes and pipes, and the minimum value 0.5mm, the maximum value 1.5mm.

4.6 Macroscopic inspection

Macroscopic inspection shall be carried out for steel tubes and pipes directly rolled with continuous casting billet or steel ingot. White points, inclusions, rimholes, skull patch and lamination are not seen by naked eyes on the acid dipped coupon of steel pipe section.

4.7 Steel tubes and pipes directly rolled with continuous casting billet or steel ingot shall be inspected for non-metal inclusions. Non-metal inclusions of steel tubes and pipes shall be rated based on JK serial rating diagram in GB 10561, its inclusion grades of A, B, C, D shall not be higher than 2.5 grade respectively and it shall be judged according to the most severe one. More strict grade inspection may be carried out on the finished steel according to buyer's request and mutual consultation between the supplier and the client.

4.8 Actual grain size

The actual grain size of finished steel tubes and pipes of quality carbon constructional steel and alloy constructional steel shall not be less than grade 4, the maximum and minimum grade difference on the two test coupons shall not be higher than grade 3. For actual grain size of finished steel tubes and pipes of 12Cr2MoWVTiB, 12Cr3MoVSiTiB and 10Cr9Mo1VNb, they shall be delivered based on the actual inspection results.

4.9 Microscopic structure

The microscopic structure of finished tubes and pipes, 20G, 20MnG and 25MnG steel tubes and pipes shall be ferrite plus pearlite. 15MoG, 20MoG, 12CrMoG, 15CrMoG, 12Cr2MoG and 12Cr1MoVG steel tubes and pipes shall be ferrite plus pearlite (including granular bainite), incomplete phase change product (e.g. yellow block martensite, etc) shall not be existed between $AC_1 \sim AC_3$. 12Cr2MoWVTiB, 12Cr3MoVSiTiB shall be temper bainite and free ferrite is not allowed to exist. 10Cr9Mo1VNb steel tubes and pipes shall be sorbite or sorbite plus temper bainite.

4.10 Decarburized layer

Fully-decarburized layer shall be inspected for finished cold drawn (rolled) steel tubes and pipes with outer

diameter less than and equal to 76mm, its depth shall be:

External surface fully-decarburized layer, depth not exceeding 0.3mm;

Internal surface fully-decarburized layer, depth not exceeding 0.4mm;

The sum of both shall not exceed 0.6mm.

4.11 Surface quality

4.11.1 Cracks, crease, rolling fold, rolling skin and separation layer are not allowed on internal and external surface of steel tubes and pipes and these defects must be removed completely. Removed depth shall not exceed negative tolerance of nominal wall thickness and its actual wall thickness at removed area shall not be less than the permissible minimum value of wall thickness tolerance.

On internal and external surface of steel tubes and pipes, the permissible depth on straight length is as follows:

Cold drawn (rolled) pipes: not more than 4% of wall thickness, and the maximum depth not exceeding 0.2mm;

Hot rolled (extruded) pipes: not more than 5% of wall thickness, and the maximum depth not exceeding 0.4mm;

Hot expanded pipes: the maximum depth not exceeding 0.5mm.

Other local defects not exceeding negative tolerance of wall thickness are allowed to exist.

4.11.2 Oxide scale inside and outside steel tubes and pipes shall be removed, however, oxide films not obstructing the inspection are allowed to exist.

4.12 Non-destructive test

Ultrasonic inspection shall be carried out for steel tubes and pipes one by one according to the stipulation in GB 5777, cold drawn (rolled) according to C5 grade, hot rolled (extruded, expanded) pipes according to grade C8.

Other non-destructive test may be performed as well according to buyer's request and through mutual consultation between both parties.

5. Inspection and test method

5.1 Dimensions and shapes of steel tubes and pipes shall be measured one by one with measuring tools meeting the accuracy requirements.

5.2 The internal and external surface of steel tubes and pipes shall be visually inspected one by one under sufficient lighting conditions.

5.3 For inspection items and test methods of steel tubes and pipes, see Table 8.

Table 8 Inspection items, test methods and sampling quantity of steel tubes and pipes

No.	Inspection item	Test method	Sampling quantity
1	Chemical composition	GB 222 GB 223	One sample for each furnace
2	Tension test	GB 228	Take respectively one specimen on two steel tubes and pipes of each batch
3	Impact test	GB/T 229	Take respectively three specimens on two steel tubes and pipes of each batch
4	Hydraulic test	GB 241	Every pipe
5	Flattening test	GB 246	Take respectively one specimen on two steel tubes and pipes of each batch
6	Flaring test	GB 242	Take respectively one specimen on two steel tubes and pipes of each batch
7	Grain size inspection	YB/T5148	Take respectively one specimen on two steel tubes and pipes of each batch
8	Non-metal inclusion inspection	GB 10561	Take respectively one specimen on two steel tubes and pipes of each batch
9	Microscopic inspection	GB/ T 13298	Take respectively one specimen on two steel tubes and pipes of each batch
10	Macroscopic inspection	GB 226 GB 1979	Take respectively one specimen on two steel tubes and pipes of each batch
11	Decarburized layer inspection	GB 224	Take respectively one specimen on two steel tubes and pipes of each batch
12	Ultrasonic inspection	GB 5777 GB4163	Every pipe
13	Eddy current inspection	GB 7735	Every pipe
14	Leakage flux inspection	GB/T 12606	Every pipe

6. Inspection rules

6.1 Inspection and acceptance

The inspection and acceptance of steel tubes and pipes shall be carried out by supplier's technical supervision department.

6.2 Batch organization rules

Steel tubes and pipes shall be inspected and accepted in batches. Each batch shall be composed of steel tubes and pipes of the same brand, the same heat number, the same mother furnace, the same size and the same heat treatment system (furnaces). Steel tubes and pipes quantity of each batch shall not be more than the stipulations below:

Outer diameter not greater than 76mm, wall thickness not greater than 3.5mm.....400;

Outer diameter greater than 351mm.....50;

Other size.....200.

6.3 Sampling quantity

For sampling quantity of each batch of steel tubes and pipes for property inspection, see table 8.

6.4 Re-inspection and judgement rules

6.4.1 Double specimens shall be taken for re-inspection when fully-decarburized layer inspection of finished steel tubes and pipes not qualified. During re-inspection, even if there is one specimen not qualified, it must be picked out and the rest of the steel tubes and pipes may be inspected one by one, or discarded, they are not allowed to be heat treated again.

6.4.2 The re-inspection and judgement rules for other inspection items shall follow the stipulations in GB 2102.

7. Packing, marking and quality certificate

Packing, marking and quality certificate of steel tubes and pipes shall conform to the stipulations in GB 2102.

Steel tubes and pipes may be applied with anti-corrosion paint according to the client's request and it must be noted in the contract.

Appendix A (prompted appendix)**Table A High temperature specified non-proportionate extension stress****($\sigma_{0.2}$) minimum value (MPa)**

No.	Grade	Temperature °C										
		100	150	200	250	300	350	400	450	500	550	600
1	20G	-	-	215	196	177	157	137	98	49	-	-
2	20MnG	219	214	208	197	183	175	168	156	151	-	-
3	25MnG	252	245	237	226	210	201	192	179	172	-	-
4	15MoG	-	-	225	205	180	177	160	155	150	-	-
5	20MoG	207	199	202	187	182	177	169	168	150	-	-
6	15CrMoG	-	-	269	256	242	228	216	285	198	-	-
7	12Cr2MoG	191	187	185	185	185	185	185	182	173	159	-
8	12Cr1MoVG	-	-	-	-	230	225	219	211	201	187	-
9	12Cr2MoWVTiB	-	-	-	-	368	357	352	343	328	305	274
10	12Cr3MoVSiTiB	-	-	-	-	403	397	398	379	364	342	-
11	10Cr9Mo1VNb	-	-	380	370	360	350	340	325	300	260	200
12	1Cr18Ni9	171	155	144	136	128	124	119	115	111	106	-
13	1Cr19Ni11Nb	239	227	216	207	200	195	191	190	189	188	-