

JIS

JAPANESE INDUSTRIAL STANDARD

Stainless steel boiler and heat exchanger tubes

☞ JIS G 3463—1994

Translated and Published

by

Japanese Standards Association

**In the event of any doubt arising,
the original Standard in Japanese is to be final authority.**

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Stainless steel boiler and heat exchanger tubes

December, 1998

ERRATA

Page 21

The third figure from the top in the wall thickness 3.5 (mm) is corrected as follows,

Error 3.40

Correct 2.40

Remarks : This erratum is for correcting the second edition of this Standard.

Japanese Standards Association



1. Scope This Japanese Industrial Standards specifies the stainless steel tubes (hereafter referred to as "tubes") used for exchanging heat on the inside and outside of the tube, such as superheater tubes of boilers, and heat exchanger tubes, condenser tubes, catalysis tubes, etc. used in chemical and petroleum industries. However, it is not applicable to the heating furnace tube.

Remarks 1. The purchaser may designate in addition to the items specified in text, by prior agreement with the manufacturer, a part or all of the items in the special quality requirements Z1, Z2, Z3, Z4, and Z6 specified in Annex 1 and the item of U-bend tube specified in Annex 2.

Annex 1 Z1 Hardness

Annex 1 Z2 Elevated temperature yield point or proof stress

Annex 1 Z3 Ultrasonic examination

Annex 1 Z4 Eddy current examination

Annex 1 Z6 Corrosion test

Annex 2 U-bent tube

2. The standards cited in this Standard are shown in Attached Table 9.

2. Grades and symbols Tubes shall be classified into 35 grades, and their symbols shall be as given in Table 1.

3. Method of manufacture The method of manufacture shall be as follows.

- (1) The tube shall be manufactured by seamless process, or by automatic arc welding, laser welding or electric resistance welding process.
- (2) The tube shall be heat-treated as specified in Table 1. However, heat treatments not specified in Table 1 shall be subjected to the agreement between the purchaser and supplier.
- (3) The tube shall be adequately treated to remove the oxide film that may adversely affect inspection.

Table 1. Heat treatment

Classifi- cation	Symbol of grade	Heat treatment °C	
		Annealing	Solution treatment
Auste- nitic tube	SUS304TB	-	1010 min., rapid cooling
	SUS304HTB	-	1040 min., rapid cooling
	SUS304LTB	-	1010 min., rapid cooling
	SUS309TB	-	1030 min., rapid cooling
	SUS309STB	-	1030 min., rapid cooling
	SUS310TB	-	1030 min., rapid cooling
	SUS310STB	-	1030 min., rapid cooling
	SUS316TB	-	1010 min., rapid cooling
	SUS316HTB	-	1040 min., rapid cooling
	SUS316LTB	-	1010 min., rapid cooling
	SUS316TiTB	-	920 min., rapid cooling
	SUS317TB	-	1010 min., rapid cooling
	SUS317LTB	-	1010 min., rapid cooling
	SUS836LTB	-	1030 min., rapid cooling
	SUS890LTB	-	1030 min., rapid cooling
	SUS321TB	-	920 min., rapid cooling
	SUS321HTB	-	Cold finished 1095 min., rapid cooling
			Hot finished 1050 min., rapid cooling
	SUS347TB	-	980 min., rapid cooling
	SUS347HTB	-	Cold finished 1095 min., rapid cooling
			Hot finished 1050 min., rapid cooling
	SUSXM15J1TB	-	1010 min., rapid cooling
Austenitic- ferritic tube	SUS329J1TB	-	950 min., rapid cooling
	SUS329J3LTB	-	950 min., rapid cooling
	SUS329J4LTB	-	950 min., rapid cooling
Ferritic tube	SUS405TB	700 min., air cool- ing or slow cooling	-
	SUS409TB	700 min., air cool- ing or slow cooling	-
	SUS409LTB	700 min., air cool- ing or slow cooling	-
	SUS410TB	700 min., air cool- ing or slow cooling	-
	SUS410TiTB	700 min., air cool- ing or slow cooling	-
	SUS430TB	700 min., air cool- ing or slow cooling	-
	SUS430LXTB	700 min., air cool- ing or slow cooling	-
	SUS430J1LTB	720 min., air cool- ing or slow cooling	-
	SUS436LTB	720 min., air cool- ing or slow cooling	-
			-

Table 1. (continued)

Classifi- cation	Symbol of grade	Heat treatment °C	
		Annealing	Solution treatment
	SUS444TB	700 min., air cool- ing or slow cooling	-
	SUSXM8TB	700 min., air cool- ing or slow cooling	-
	SUSXM27TB	700 min., air cool- ing or slow cooling	-

Remarks: For SUS321TB, SUS316TiTB, and SUS347TB, stabilizing treatments may be designated. In this case, the temperature of heat treatments shall be 850°C to 930°C.

Informative reference: SUS836LTB and SUS890LTB correspond respectively to SUS317J4L and SUS317J5L specified in JIS G 4303, JIS G 4304 and JIS G 4305.

4. Chemical composition The tube shall be subjected to the test of 10.1 and the resulted cast analysis shall be as given in Table 2.

Table 2. Chemical composition

Symbol of grade	Unit: %									
	C	Si	Mn.	P	S	Ni	Cr	Mo	Others	
SUS304TB	0.08 max.	1.00 max.	2.00 max.	0.040 max.	0.030 max.	8.00 to 11.00	18.00 to 20.00	-	-	
SUS304HTB	0.04 to 0.10	0.75 max.	2.00 max.	0.040 max.	0.030 max.	8.00 to 11.00	18.00 to 20.00	-	-	
SUS304LTB	0.030 max.	1.00 max.	2.00 max.	0.040 max.	0.030 max.	9.00 to 13.00	18.00 to 20.00	-	-	
SUS309TB	0.15 max.	1.00 max.	2.00 max.	0.040 max.	0.030 max.	12.00 to 15.00	22.00 to 24.00	-	-	
SUS309STB	0.08 max.	1.00 max.	2.00 max.	0.040 max.	0.030 max.	12.00 to 15.00	22.00 to 24.00	-	-	
SUS310TB	0.15 max.	1.50 max.	2.00 max.	0.040 max.	0.030 max.	19.00 to 22.00	24.00 to 26.00	-	-	
SUS310STB	0.08 max.	1.50 max.	2.00 max.	0.040 max.	0.030 max.	19.00 to 22.00	24.00 to 26.00	-	-	
SUS316TB	0.08 max.	1.00 max.	2.00 max.	0.040 max.	0.030 max.	10.00 to 14.00	16.00 to 18.00	2.00 to 3.00	-	
SUS316HTB	0.04 to 0.10	0.75 max.	2.00 max.	0.030 max.	0.030 max.	11.00 to 14.00	16.00 to 18.00	2.00 to 3.00	-	
SUS316LTB	0.030 max.	1.00 max.	2.00 max.	0.040 max.	0.030 max.	12.00 to 16.00	16.00 to 18.00	2.00 to 3.00	-	
SUS316TiTB	0.08 max.	1.00 max.	2.00 max.	0.040 max.	0.030 max.	10.00 to 14.00	16.00 to 18.00	2.00 to 3.00	Ti 5 × C % min.	
SUS317TB	0.08 max.	1.00 max.	2.00 max.	0.040 max.	0.030 max.	11.00 to 15.00	18.00 to 20.00	3.00 to 4.00	-	
SUS317LTB	0.030 max.	1.00 max.	2.00 max.	0.040 max.	0.030 max.	11.00 to 15.00	18.00 to 20.00	3.00 to 4.00	-	
SUS836LTB	0.030 max.	1.00 max.	2.00 max.	0.040 max.	0.030 max.	24.00 to 26.00	19.00 to 24.00	5.00 to 7.00	N 0.25 max.	
SUS890LTB	0.020 max.	1.00 max.	2.00 max.	0.040 max.	0.030 max.	23.00 to 28.00	19.00 to 23.00	4.00 to 5.00	Cu 1.00 to 2.00	
SUS321TB	0.08 max.	1.00 max.	2.00 max.	0.040 max.	0.030 max.	9.00 to 13.00	17.00 to 19.00	-	Ti 5 × C % min.	
SUS321HTB	0.04 to 0.10	0.75 max.	2.00 max.	0.030 max.	0.030 max.	9.00 to 13.00	17.00 to 20.00	-	Ti 4 × C % to 0.60	

Table 2. (continued) Unit: %

Symbol of grade	C	Si	Mn	P	S	Ni	Cr	Mo	Others
SUS347TB	0.08 max.	1.00 max.	2.00 max.	0.040 max.	0.030 max.	9.00 to 13.00	17.00 to 19.00	-	Nb 10 × C % min.
SUS347HTB	0.04 to 0.10	1.00 max.	2.00 max.	0.030 max.	0.030 max.	9.00 to 13.00	17.00 to 20.00	-	Nb 8 × C % to 1.00
SUSXM15J1TB	0.08 max.	3.00 to 5.00	2.00 max.	0.045 max.	0.030 max.	11.50 to 15.00	15.00 to 20.00	-	
SUS329J1TB	0.08 max.	1.00 max.	1.50 max.	0.040 max.	0.030 max.	3.00 to 6.00	23.00 to 28.00	1.00 to 3.00	-
SUS329J3LTB	0.030 max.	1.00 max.	1.50 max.	0.040 max.	0.030 max.	4.50 to 6.50	21.00 to 24.00	2.50 to 3.50	N 0.08 to 0.20
SUS329J4LTB	0.030 max.	1.00 max.	1.50 max.	0.040 max.	0.030 max.	5.50 to 7.50	24.00 to 26.00	2.50 to 3.50	N 0.08 to 0.30
SUS405TB	0.08 max.	1.00 max.	1.00 max.	0.040 max.	0.030 max.	-	11.50 to 14.50	-	Al 0.10 to 0.30
SUS409TB	0.08 max.	1.00 max.	1.00 max.	0.040 max.	0.030 max.	-	10.50 to 11.75	-	Ti 6 × C % to 0.75
SUS409LTB	0.030 max.	1.00 max.	1.00 max.	0.040 max.	0.030 max.	-	10.50 to 11.75	-	Ti 6 × C % to 0.75
SUS410TB	0.15 max.	1.00 max.	1.00 max.	0.040 max.	0.030 max.	-	11.50 to 13.50	-	-
SUS410TfTB	0.08 max.	1.00 max.	1.00 max.	0.040 max.	0.030 max.	-	11.50 to 13.50	-	Ti 6 × C % to 0.75
SUS430TB	0.12 max.	0.75 max.	1.00 max.	0.040 max.	0.030 max.	-	16.00 to 18.00	-	-
SUS430LXTB	0.030 max.	0.75 max.	1.00 max.	0.040 max.	0.030 max.	-	16.00 to 19.00	-	Ti or Nb 0.10 to 1.00
SUS430J1LTB	0.025 max.	1.00 max.	1.00 max.	0.040 max.	0.030 max.	-	16.00 to 20.00	-	N 0.025 max. Nb 8 × (C % + N %) to 0.80 Cu 0.30 to 0.80

Table 2. (continued)

Symbol of grade	C	Si	Mn	P	S	Ni	Cr	Mo	Others
SUS436LTB	0.025 max.	1.00 max.	1.00 max.	0.040 max.	0.030 max.	-	16.00 to 19.00	0.75 to 1.25	N 0.025 max. Ti, Nb, Zr or combination thereof 8 × (C % + N %) to 0.80
SUS444TB	0.025 max.	1.00 max.	1.00 max.	0.040 max.	0.030 max.	-	17.00 to 20.00	1.75 to 2.50	N 0.025 max. Ti, Nb, Zr or combination thereof 8 × (C % + N %) to 0.80
SUSXM8TB	0.08 max.	1.00 max.	1.00 max.	0.040 max.	0.030 max.	-	17.00 to 19.00	-	thereof 8 × (C % + N %) to 0.80
SUSXM27TB	0.010 max.	0.40 max.	0.40 max.	0.030 max.	0.020 max.	-	25.00 to 27.50	0.75 to 1.50	Ti 12 × C % to 1.10 N 0.015 max.

Remarks 1. Even when the purchaser requires product analysis, the chemical composition given above likewise applies. However, the carbon content for SUS304LTB, SUS316LTB, SUS317LTB, SUS836LTB, SUS329J3LTB, SUS329J4LTB, SUS409LTB and SUS430LXTB shall be 0.035 % max. The carbon content for SUS430JLLTB, SUS436LTB and SUS444TB shall be 0.030 max.

Further, the carbon content for SUS890LTB and SUSXM27TB shall respectively be 0.025 % max. and 0.015 % max.

- To SUSXM15JLTB, SUS329J1LTB, SUS329J3LTB, SUS329J4LTB and SUS430JLLTB, alloy elements other than those specified in Table 2 may be added.
- The nickel content for SUS405TB, SUS409TB, SUS410TB, SUS410T1TB, SUS430TB, SUS430LXTB, SUS430JLLTB, SUS436LTB, SUS444TB and SUSXM8TB may contain 0.60 % max.
- SUSXM27TB may contain 0.50 % max. in Ni, 0.20 % max. in Cu, and 0.50 % max. in Ni + Cu.

Further, as required, alloy elements other than those given above may be added.

5. Mechanical properties

5.1 Tensile strength, yield point or proof stress, and elongation The tube shall be subjected to the test of 10.2, and the resulted tensile strength, proof stress, and elongation shall be as given in Table 3.

Table 3. Mechanical properties

Symbol of grade	Tensile strength N/mm ²	Proof stress N/mm ²	Elongation %		
			20 mm min. in outside diameter	10 mm or over to and excl. 20 mm in outside diameter	Under 10 mm in outside diameter
			No.11 test piece No.12 test piece	No.11 test piece	No.11 test piece
SUS304TB	520 min.	205 min.	35 min.	30 min.	27 min.
SUS304HTB	520 min.	205 min.	35 min.	30 min.	27 min.
SUS304LTB	480 min.	175 min.	35 min.	30 min.	27 min.
SUS309TB	520 min.	205 min.	35 min.	30 min.	27 min.
SUS309STB	520 min.	205 min.	35 min.	30 min.	27 min.
SUS310TB	520 min.	205 min.	35 min.	30 min.	27 min.
SUS310STB	520 min.	205 min.	35 min.	30 min.	27 min.
SUS316TB	520 min.	205 min.	35 min.	30 min.	27 min.
SUS316HTB	520 min.	205 min.	35 min.	30 min.	27 min.
SUS316LTB	480 min.	175 min.	35 min.	30 min.	27 min.
SUS316TiTB	520 min.	205 min.	35 min.	30 min.	27 min.
SUS317TB	520 min.	205 min.	35 min.	30 min.	27 min.
SUS317LTB	480 min.	175 min.	35 min.	30 min.	27 min.
SUS836LTB	520 min.	205 min.	35 min.	30 min.	27 min.
SUS890LTB	490 min.	215 min.	35 min.	30 min.	27 min.
SUS321TB	520 min.	205 min.	35 min.	30 min.	27 min.
SUS321HTB	520 min.	205 min.	35 min.	30 min.	27 min.
SUS347TB	520 min.	205 min.	35 min.	30 min.	27 min.
SUS347HTB	520 min.	205 min.	35 min.	30 min.	27 min.
SUSX15J1TB	520 min.	205 min.	35 min.	30 min.	27 min.
SUS329J1TB	590 min.	390 min.	18 min.	13 min.	10 min.
SUS329J3LTB	620 min.	450 min.	18 min.	13 min.	10 min.
SUS329J4LTB	620 min.	450 min.	18 min.	13 min.	10 min.
SUS405TB	410 min.	205 min.	20 min.	15 min.	12 min.
SUS409TB	410 min.	205 min.	20 min.	15 min.	12 min.
SUS409LTB	360 min.	175 min.	20 min.	15 min.	12 min.
SUS410TB	410 min.	205 min.	20 min.	15 min.	12 min.
SUS410TiTB	410 min.	205 min.	20 min.	15 min.	12 min.
SUS430TB	410 min.	245 min.	20 min.	15 min.	12 min.
SUS430LXTB	360 min.	175 min.	20 min.	15 min.	12 min.
SUS430J1LTB	390 min.	205 min.	20 min.	15 min.	12 min.

Table 3. (continued)

Symbol of grade	Tensile strength N/mm ²	Proof stress N/mm ²	Elongation %		
			20 mm min. in outside diameter	10 mm or over to and excl. 20 mm in outside diameter	Under 10 mm in outside diameter
			No.11 test piece No.12 test piece	No.11 test piece	No.11 test piece
SUS436LTB	410 min.	245 min.	20 min.	15 min.	12 min.
SUS444TB	410 min.	245 min.	20 min.	15 min.	12 min.
SUSXM8TB	410 min.	205 min.	20 min.	15 min.	12 min.
SUSXM27TB	410 min.	245 min.	20 min.	15 min.	12 min.

- Remarks 1. Exclusively for heat exchanger tube, the purchaser may, when necessary, designate the upper limit of tensile strength, which shall be the value wherein 200 N/mm² is added to the value given in Table 3.
2. When the tensile test is carried out on No. 12 test piece for the tube of under 8 mm in wall thickness, the minimum value of elongation shall be calculated by subtracting 1.5 % from the values of elongation given in Table 3 for each 1 mm decrease in wall thickness, and rounding off the result to an integer in accordance with JIS Z 8401. Examples of calculation are given in Informative reference Table 1.
3. When the tensile test piece is taken from the automatic arc welded tube, laser welded tube, and electric resistance welded tube, No. 12 test piece shall be taken from a seamless portion.

Informative reference Table 1.

Examples for calculation of elongation value in the case of No. 12 test piece for tubes of under 8 mm in wall thickness

Classification	Elongation value for each wall thickness division %						
	Over 7 mm to and excl. 8 mm	Over 6 mm up to and incl. 7 mm	Over 5 mm up to and incl. 6 mm	Over 4 mm up to and incl. 5 mm	Over 3 mm up to and incl. 4 mm	Over 2 mm up to and incl. 3 mm	Over 1 mm up to and incl. 2 mm
Austenitic tubes	35	34	32	30	29	28	26
Austenitic-ferritic tubes	18	16	15	14	12	10	9
Ferritic tubes	20	18	17	16	14	12	11

5.2 Flattening resistance The tube shall be tested in accordance with 10.3 and free from flaws or cracks on its wall surface. The distance between the flat plates in this test shall be in accordance with the following formula.

$$H = \frac{(1+e) t}{e + \frac{t}{D}}$$

where, H : distance between the flat plates (mm)

t : wall thickness of tube (mm)

D : outside diameter of tube (mm)

e : constant individually defined for each grade of tube

0.09 for austenitic tube

0.07 for austenitic-ferritic tube and ferritic tube

5.3 Flaring resistance When the austenitic tube is flared to 1.2 times the outside diameter, and the austenitic-ferritic tube or the ferritic tube to 1.14 times the outside diameter subjected to the test in 10.4, no flaws shall be generated.

5.4 reverse flattening resistance When the automatic are welded tube, laser welded tube, and electric resistance welded tube are subjected to the test of 10.5, they shall be free from flaws, cracks, etc. in the weld zone.

6. Austenite grain size When the tube of SUS321HTB is subjected to the test of 10.6, its austenite average grain size shall be No. 7 or coarser.

7. Hydraulic test characteristic or nondestructive examination characteristic When the tube is subjected to the test of 10.7, its hydraulic test characteristic or nondestructive examination characteristic shall conform to either of the following. The preference shall be in accordance with the designation made by the purchaser or left to the discretion of the manufacturer.

7.1 Hydraulic test characteristic When the hydraulic pressure is designated by the purchaser, apply the designated pressure; or, in its absence, the pressure P calculated from the formula below (10 MPa max.) is applied, the tube shall withstand it without leakage.

In this case, the purchaser may designate values of pressure lower or higher than the pressure P .

When a hydraulic test is made in accordance with the designation by the purchaser and the test pressure exceeds either the value P or 10 MPa, the test pressure shall be subjected to the agreement between the purchaser and supplier. In this case, the designated hydraulic test pressure shall be expressed in the nearest 0.5 MPa for under 10 MPa, and in the nearest 1 MPa for 10 MPa or over. In the case of calculation, the pressure P shall be calculated from the following formula and rounded off likewise to the nearest 0.5 MPa or 1 MPa.

$$P = \frac{2st}{D}$$

where, P : test pressure (MPa)

t : wall thickness of tube (mm)

D : outside diameter of tube (mm)

s : 60 % of the minimum value of proof stress specified in Table 3. (N/mm²)

7.2 Nondestructive examination characteristic Either an ultrasonic examination or an eddy current examination shall be made on the tube, and there shall be no signal equal to or greater than those produced by the artificial flaws of the reference test block which is the division UD of the working sensitivity in JIS G 0582 or the division EY of the working sensitivity specified in JIS G 0583, respectively.

8. Dimensions, mass, and dimensional tolerances

8.1 Dimensions and mass The outside diameter, wall thickness, and mass of the tube shall be as specified in Attached Tables 1 to 8 unless otherwise specified.

8.2 Dimensional tolerances The dimensional tolerances of the tube shall be as follows.

- (1) Tolerances on the outside diameter of the tube shall be as given in Table 4.

Table 4. Tolerances on outside diameter

Unit: mm

Division of outside diameter	Tolerances on outside diameter		
	Hot finished seamless tube	Cold finished seamless tube	Automatic arc welded tube Laser welded tube and Electric resistance welded tube
Under 40	+0.4	± 0.25	± 0.25
40 or over to and excl. 50	-0.8		
50 or over to and excl. 60			
60 or over to and excl. 80		± 0.30	± 0.30
80 or over to and excl. 100		± 0.40	± 0.40
100 or over to and excl. 120	+0.4 -1.2	+0.40 -0.60	+0.40 -0.60
120 or over to and excl. 160		+0.40 -0.80	+0.40 -0.80
160 or over to and excl. 200	+0.4 -1.8	+0.40 -1.20	+0.40 -1.20
200 or over	+0.4 -2.4	+0.40 -1.60	+0.40 -1.60

- Remarks 1. The tolerances on the outside diameter of ferritic cold finished seamless tube, automatic arc welded tube, laser welded tube, and electric resistance welded tube shall be ± 0.10 mm for outside diameter of under 25 mm, ± 0.15 mm for outside diameter of 25 mm or over to and excluding 40 mm, and ± 0.20 mm for outside diameter of 40 mm or over to and excluding 50 mm.
2. The purchaser may specify the tolerances on the outside diameter of cold finished seamless tube, automatic arc welded tube, laser welded tube, and electric resistance welded tube of under 40 mm in outside diameter as ± 0.20 mm.

- (2) The tolerances on the wall thickness and the eccentricity shall be as specified in Table 5.

Table 5. Tolerance on wall thickness and on eccentricity

Division of tolerance	Division of wall thick-ness	Hot finished seamless tube		Cold finished seamless tube		Automatic arc welded tube Laser welded tube Electric re-sistance welded tube	
		Division of outside diameter mm					
	mm	Under 100	100 or over	Under 40	40 or over	Under 40	40 or over
Tolerances on wall thickness %	Under 2	-	-	+0.4 mm 0	+22 0	+0.4 mm 0	+22 0
	2 or over to and excl. 2.4	+40 0	-	+20 0		+20 0	
	2.4 or over to and excl. 3.8	+35 0	+35 0				
	3.8 or over to and excl. 4.6	+33 0	+33 0				
	4.6 or over	+28 0	+28 0				
Tolerances on eccen-tricity %	-	22.8 max. of wall thickness		-		-	

Remarks: The eccentricity means the ratio of the difference between maximum and minimum of measured wall thickness in the same section to the specified wall thickness and this is not applicable to the tube of under 5.6 mm in wall thickness.

- (3) Tolerances on the length of the tube shall be as specified in Table 6.

Table 6. Tolerances on length

Division		Tolerances on length
50 mm or under in outside diameter	7 m or under in length	+7 mm 0
	Over 7 m in length	Add 3 mm to the plus side tolerances given above for an increase of every 3 m or its fraction in length. However, the maximum value shall be 15 mm.
Over 50 mm in outside diameter	7 m or under in length	+10 mm 0
	Over 7 m in length	Add 3 mm to the plus side tolerances given above for an increase of every 3 m or its fraction in length. However, the maximum value shall be 15 mm.

Remarks: When an accurate length is particularly required, the tolerances shall be subjected to the agreement between the purchaser and supplier.

9. Appearance The appearance shall be as follows.

- (1) The tube shall be practically straight and its both ends shall be at right angles to the axis of the tube.
- (2) The inside and outside surfaces of the tube shall be well-finished and free from defects injurious to use.

10. Tests

10.1 chemical analysis

10.1.1 Chemical analysis General matters common to chemical analysis and sampling of analysis samples shall be as specified in 3. of JIS G 0303.

10.1.2 Method of analysis The method of analysis shall be in accordance with any one of the following standards:

JIS G 1211, JIS G 1212, JIS G 1213, JIS G 1214, JIS G 1215, JIS G 1216,
JIS G 1217, JIS G 1218, JIS G 1219, JIS G 1223, JIS G 1224, JIS G 1228,
JIS G 1232, JIS G 1237, JIS G 1253, JIS G 1256, JIS G 1257

10.1.3 Number of product analysis samples The number of product analysis samples shall be subjected to the agreement between the purchaser and supplier.

10.2 Tensile test

10.2.1 Sampling of specimen and number of test pieces For sampling of a specimen and the number of test pieces, one specimen shall be sampled per each 50 tubes of the same dimensions⁽¹⁾ under simultaneous heat treatment or its fraction, and one tensile test piece shall be sampled therefrom. One flattening test piece shall be sampled from one end of the specimen, and one flaring test piece shall be sampled from the other end. One austenite grain size test piece shall be sampled from either of both ends of the specimen.

Further, for the automatic arc welded tube, laser welded tube, and electric resistance welded tube, one specimen shall be sampled per each 100 tubes of the same dimensions⁽¹⁾ under the simultaneous heat treatment or its fraction in addition to the test abovementioned, and one reverse flattening test piece shall be sampled therefrom.

Note ⁽¹⁾ The same dimensions herein mean the same outside diameter and the same wall thickness.

10.2.2 Test piece The test piece shall be any one of No. 11, No. 12A, No. 12B, or No. 12C test piece specified in JIS Z 2201 and sampled from the longitudinal direction of the tube.

10.2.3 Test method The test method shall be in accordance with JIS Z 2241.

10.3 Flattening test

10.3.1 Sampling of specimen and number of test pieces The sampling of a specimen and the number of test pieces shall be as given in 10.2.1.

10.3.2 Test piece A test piece of 50 mm or over in length shall be cut off from the end of a tube to serve as a test piece. For the tube whose wall thickness is 15 % or over of outside diameter, a C-shape test piece made by removing a part of the circumference of a ring-shaped test piece may be used.

10.3.3 Test method The test piece shall be placed at ordinary temperature between two flat plates and flattened by compression until the distance H between the plates comes to the specified value, and checked for occurrence of flaws or cracks on its wall surface. For the automatic arc welded tube, laser welded tube, and electric resistance welded tube, the weld zone shall be placed at right angles to the direction of compression as shown in Fig. 1, or the C-shape test piece shall be placed as shown in Fig. 2.

Fig. 1. Flattening test
(for ring-shaped test piece)

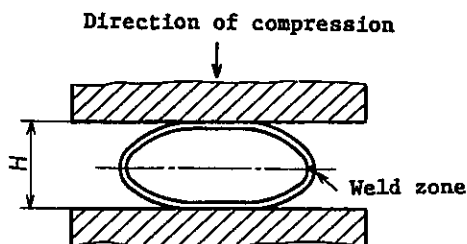
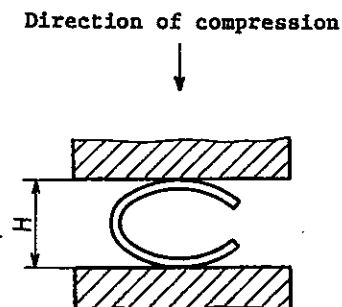


Fig. 2. Flattening test
(for C-shape test piece)



10.4 Flaring test

10.4.1 Sampling of specimen and number of test pieces The sampling of a specimen and the number of test pieces shall be as given in 10.2.1.

10.4.2 Test piece An adequate length of a tube shall be cut off from one end of a tube to serve as a test piece.

10.4.3 Test method The test piece shall be flared at one tube end at ordinary temperature in a trumpet-shape and to the specified size with a conical tool forming an angle of 60° and checked for any flaws or other defects.

10.5 Reverse flattening test

10.5.1 Sampling of specimen and number of test pieces The sampling of a specimen and the number of test pieces shall be as given in 10.2.1.

10.5.2 Test piece A 100 mm length of a tube shall be cut off from one end of a tube to serve as a test piece.

10.5.3 Test method The test piece shall be split in the direction of a tube axis at the opposite side of a welded line, opened up, flattened and then checked for any flaws, cracks or other defects injurious to use that may have occurred in the weld zone.

10.6 Austenite grain size test

10.6.1 Sampling of specimen and number of test pieces The sampling of a specimen and the number of test pieces shall be as given in 10.2.1.

10.6.2 Test piece An about 20 mm length of a tube shall be cut off from one end of a tube to serve as a test piece.

10.6.3 Test method The test method shall be as specified in JIS G 0551.

10.7 Hydraulic test or nondestructive examination

10.7.1 Number of specimens Either the hydraulic test or nondestructive examination shall be carried out on each one tube.

10.7.2 Hydraulic test When a hydraulic pressure is applied to a tube and kept at designated or specified pressure for 5 s or longer, whether the tube withstands that without leakage shall be examined.

10.7.3 Nondestructive examination The test method shall be as specified in JIS G 0582 or JIS G 0583. Either the hydraulic test or nondestructive examination shall be carried out on each one tube.

11. Inspection

11.1 Inspection The inspection shall be as follows.

(1) General matters common to the inspection shall be as specified in JIS G 0303.

- (2) The chemical composition shall conform to the requirements specified in 4.
- (3) The mechanical properties shall conform to the requirements specified in 5.
- (4) The austenite grain size of SUS321HTB shall conform to the requirements specified in 6.
- (5) The hydraulic test characteristic or nondestructive examination characteristic shall conform to the requirements specified in 7. However, the nondestructive examination may be substituted by an appropriate nondestructive examination other than that given in 10.7.3 subject to the agreement between the purchaser and supplier.
- (6) The dimensions shall conform to the requirements specified in 8.
- (7) The appearance shall conform to the requirements specified in 9.
- (8) When the special quality requirements given in Annex 1 or the U-bent tube of Annex 2 is designated subject to the agreement between the purchaser and supplier, the results of inspection shall conform to the relevant requirements specified in Z1, Z2, Z3, Z4, Z6 of Annex 1 and in Annex 2.

11.2 Reinspection The tube may be determined for acceptance or rejection by carrying out a retest specified in 4.4 of JIS G 0303.

12. Marking Tubes having passed the inspection shall be marked with the following items on each tube. However, the order of arranging the items is not specified.

Further, in the case of either small tubes or a request from the purchaser, the tubes may be bundled and marked by a suitable method on each bundle.

When approved by the purchaser, a part of the items may be omitted.

- (1) Symbol of grade
- (2) Symbol indicating the method of manufacture⁽²⁾.
- (3) Dimensions⁽³⁾
- (4) Manufacturer's name or abbreviation
- (5) Symbol Z indicating the designation of special quality requirements

Notes ⁽²⁾ Symbols indicating the method of manufacture shall be as follows. However, the sign of dash may be replaced by a space.

Hot finished seamless tube	: -S-H
Cold finished seamless tube	: -S-C

Automatic arc welded tube	: -A
Cold finished automatic arc welded tube	: -A-C
Weld zone work-finished automatic arc welded tube	: -A-B
Laser welded tube	: -L
Cold finished laser welded tube	: -L-C
Weld zone work-finished laser welded tube	: -L-B
Electric resistance welded tube other than hot finished or cold finished ones	: -E-G
Cold finished electric resistance welded tube	: -E-C

(³) The dimensions herein indicate the outside diameter and the wall thickness.

13. Report The manufacturer shall, as a rule, submit to the purchaser a detailed statement concerning to the test results, method of manufacture, ordered dimensions, quantity, a work number tracable to the history of manufacture, etc.

Attached Table 1. Dimensions and mass of SUS304TB, SUS304HTB, SUS304LTB, SUS321TB and SUS321HTB

Unit: kg/m

Outside diameter	Wall thickness (mm)																		
	1.2	1.6	2.0	2.3	2.6	2.9	3.2	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	8.0	9.5	11.0	12.5
15.9	0.439	0.570	0.692	0.779	0.861	0.939													
19.0	0.532	0.693	0.847	0.957	1.06	1.16													
21.7	0.613	0.801	0.981	1.11	1.24	1.36	1.47												
25.4	0.723	0.949	1.17	1.32	1.48	1.63	1.77	1.91											
27.2	0.777	1.02	1.26	1.43	1.59	1.76	1.91	2.07	2.31										
31.8	0.915	1.20	1.48	1.69	1.89	2.09	2.28	2.47	2.77	3.06									
34.0		1.29	1.59	1.82	2.03	2.25	2.46	2.66	2.99	3.31	3.61								
38.1		1.45	1.80	2.05	2.30	2.54	2.78	3.02	3.40	3.77	4.12	4.47							
42.7			2.03	2.31	2.60	2.88	3.15	3.42	3.86	4.28	4.70	5.10	5.49						
45.0			2.14	2.45	2.75	3.04	3.33	3.62	4.09	4.54	4.98	5.41	5.83	6.23					
48.6			2.32	2.65	2.98	3.30	3.62	3.93	4.44	4.94	5.43	5.90	6.37	6.82	7.25				
50.8			2.43	2.78	3.12	3.46	3.79	4.12	4.66	5.19	5.70	6.21	6.70	7.17	7.64	8.53	9.77	10.9	11.9
54.0			2.59	2.96	3.33	3.69	4.05	4.40	4.98	5.55	6.10	6.64	7.17	7.69	8.20	9.17	10.5	11.8	12.9
57.1			2.75	3.14	3.53	3.92	4.30	4.67	5.29	5.90	6.49	7.07	7.64	8.19	8.74	9.78	11.3	12.6	13.9
60.3			2.90	3.32	3.74	4.15	4.55	4.95	5.61	6.25	6.89	7.51	8.12	8.71	9.29	10.4	12.0	13.5	14.9
63.5				3.51	3.94	4.38	4.81	5.23	5.93	6.61	7.29	7.95	8.59	9.23	9.85	11.1	12.8	14.4	15.9
65.0				3.59	4.04	4.49	4.93	5.36	6.08	6.78	7.47	8.15	8.82	9.47	10.1	11.4	13.1	14.8	16.3
70.0				3.88	4.37	4.85	5.32	5.80	6.58	7.34	8.10	8.84	9.57	10.3	11.0	12.4	14.3	16.2	17.9
76.2				4.23	4.77	5.30	5.82	6.34	7.19	8.04	8.87	9.69	10.5	11.3	12.1	13.6	15.8	17.9	19.8
82.6							6.33	6.90	7.83	8.75	9.67	10.6	11.4	12.3	13.2	14.9	17.3	19.6	21.8
88.9							6.83	7.45	8.46	9.46	10.4	11.4	12.4	13.3	14.3	16.1	18.8	21.3	23.8
101.6								8.55	9.72	10.9	12.0	13.2	14.3	15.4	16.5	18.7	21.8	24.8	27.7
114.3									11.0	12.3	13.6	14.9	16.2	17.5	18.7	21.2	24.8	28.3	31.7
127.0									12.3	13.7	15.2	16.6	18.1	19.5	20.9	23.7	27.8	31.8	35.7
139.8												18.4	20.0	21.6	23.2	26.3	30.8	35.3	39.6

Remarks 1. The numerical value of mass shall be calculated according to the following formula by taking the mass of 1 cm³ of steel as 7.93 g, and rounded off to three significant figures in accordance with JIS Z 8401.

$$W = 0.02491t(D - t)$$

where, W : unit mass of tube (kg/m)

t : wall thickness of tube (mm)

D : outside diameter of tube (mm)

2. In dealing, the unit mass of the tube shall be increased by 15 % for hot finished seamless tube, and by 10 % for cold finished seamless tube, automatic arc welded tube, laser welded tube, and electric resistance welded tube. The increased unit mass shall be used as standard unit mass.

Attached Table 2. Dimensions and mass of SUS309TB, SUS309STB, SUS310TB, SUS310STB, SUS316TB, SUS316HTB, SUS316LTB, SUS316TiTB, SUS317TB, SUS317LTB, SUS347TB and SUS347HTB

Unit: kg/m

Outside diam- eter	Wall thickness (mm)																		
	1.2	1.6	2.0	2.3	2.6	2.9	3.2	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	8.0	9.5	11.0	12.5
15.9	0.442	0.574	0.697	0.784	0.867	0.945													
19.0	0.535	0.698	0.852	0.963	1.07	1.17													
21.7	0.617	0.806	0.988	1.12	1.24	1.37	1.48												
25.4	0.728	0.955	1.17	1.33	1.49	1.64	1.78	1.92											
27.2	0.782	1.03	1.26	1.44	1.60	1.77	1.93	2.08	2.33										
31.8	0.921	1.21	1.49	1.70	1.90	2.10	2.29	2.48	2.79	3.08									
34.0		1.30	1.60	1.83	2.05	2.26	2.47	2.68	3.01	3.33	3.64								
38.1		1.46	1.81	2.06	2.31	2.56	2.80	3.04	3.42	3.79	4.15	4.50							
42.7			2.04	2.33	2.61	2.89	3.17	3.44	3.88	4.31	4.73	5.13	5.52						
45.0			2.16	2.46	2.76	3.06	3.35	3.64	4.11	4.57	5.01	5.45	5.87	6.27					
48.6			2.34	2.67	3.00	3.32	3.64	3.96	4.47	4.98	5.47	5.94	6.41	6.86	7.30				
50.8			2.45	2.80	3.14	3.48	3.82	4.15	4.69	5.22	5.74	6.25	6.74	7.22	7.69	8.58	9.84	11.0	12.0
54.0			2.61	2.98	3.35	3.72	4.08	4.43	5.01	5.58	6.14	6.69	7.22	7.74	8.25	9.23	10.6	11.9	13.0
57.1			2.76	3.16	3.55	3.94	4.32	4.70	5.32	5.93	6.53	7.11	7.69	8.25	8.79	9.85	11.3	12.7	14.0
60.3			2.92	3.34	3.76	4.17	4.58	4.98	5.65	6.30	6.93	7.56	8.17	8.77	9.35	10.5	12.1	13.6	15.0
63.5				3.53	3.97	4.41	4.84	5.26	5.97	6.66	7.33	8.00	8.65	9.29	9.92	11.1	12.9	14.5	16.0
65.0				3.62	4.07	4.51	4.96	5.40	6.12	6.83	7.52	8.20	8.87	9.53	10.2	11.4	13.2	14.9	16.5
70.0				3.90	4.39	4.88	5.36	5.84	6.62	7.39	8.15	8.89	9.63	10.3	11.1	12.4	14.4	16.3	18.0
76.2				4.26	4.80	5.33	5.86	6.38	7.24	8.09	8.92	9.75	10.6	11.4	12.1	13.7	15.9	18.0	20.0
82.6							6.37	6.94	7.88	8.81	9.73	10.6	11.5	12.4	13.3	15.0	17.4	19.7	22.0
88.9							6.88	7.49	8.51	9.52	10.5	11.5	12.5	13.4	14.4	16.2	18.9	21.5	23.9
101.6								8.61	9.79	11.0	12.1	13.3	14.4	15.5	16.6	18.8	21.9	25.0	27.9
114.3									11.1	12.4	13.7	15.0	16.3	17.6	18.8	21.3	25.0	28.5	31.9
127.0									12.3	13.8	15.3	16.8	18.2	19.6	21.1	23.9	28.0	32.0	35.9
139.8												18.5	20.1	21.7	23.3	26.4	31.0	35.5	39.9

Remarks 1. The numerical value of mass shall be calculated according to the following formula by taking the mass of 1 cm³ of steel as 7.98 g, and rounded off to three significant figures in accordance with JIS Z 8401.

$$W = 0.02507t(D - t)$$

where, W : unit mass of tube (kg/m)

t : wall thickness of tube (mm)

D : outside diameter of tube (mm)

2. In dealing, the unit mass of the tube shall be increased by 15 % for hot finished seamless tube, and by 10 % for cold finished seamless tube, automatic arc welded tube, laser welded tube, and electric resistance welded tube. The increased unit mass shall be used as standard unit mass.

Attached Table 3. Dimensions and mass of SUS329J1TB, SUS329J3LTB and SUS329J4LTB

Unit: kg/m

Outside diam- eter	Wall thickness (mm)																		
	1.2	1.6	2.0	2.3	2.6	2.9	3.2	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	8.0	9.5	11.0	12.5
15.9	0.432	0.561	0.681	0.766	0.847	0.924													
19.0	0.523	0.682	0.833	0.941	1.04	1.14													
21.7	0.603	0.788	0.965	1.09	1.22	1.34	1.45												
25.4	0.711	0.933	1.15	1.30	1.45	1.60	1.74	1.88											
27.2	0.764	1.00	1.23	1.40	1.57	1.73	1.88	2.03	2.27										
31.8	0.900	1.18	1.46	1.66	1.86	2.05	2.24	2.43	2.72	3.01									
34.0		1.27	1.57	1.79	2.00	2.21	2.41	2.62	2.94	3.25	3.55								
38.1		1.43	1.77	2.02	2.26	2.50	2.74	2.97	3.34	3.70	4.05	4.39							
42.7			1.99	2.28	2.55	2.83	3.10	3.36	3.79	4.21	4.62	5.01	5.39						
45.0			2.11	2.41	2.70	2.99	3.28	3.56	4.02	4.47	4.90	5.32	5.73	6.13					
48.6			2.28	2.61	2.93	3.25	3.56	3.87	4.37	4.86	5.34	5.81	6.26	6.70	7.13				
50.8			2.39	2.73	3.07	3.40	3.73	4.06	4.59	5.10	5.61	6.10	6.59	7.05	7.51	8.39	9.61	10.7	11.7
54.0			2.55	2.91	3.27	3.63	3.98	4.33	4.90	5.46	6.00	6.54	7.06	7.56	8.06	9.02	10.4	11.6	12.7
57.1			2.70	3.09	3.47	3.85	4.23	4.60	5.20	5.80	6.38	6.95	7.51	8.06	8.59	9.62	11.1	12.4	13.7
60.3			2.86	3.27	3.68	4.08	4.48	4.87	5.52	6.15	6.77	7.38	7.98	8.57	9.14	10.3	11.8	13.3	14.6
63.5				3.45	3.88	4.31	4.73	5.15	5.83	6.50	7.17	7.82	8.45	9.08	9.69	10.9	12.6	14.1	15.6
65.0				3.53	3.97	4.41	4.85	5.27	5.98	6.67	7.35	8.02	8.67	9.32	9.95	11.2	12.9	14.6	16.1
70.0				3.81	4.29	4.77	5.24	5.70	6.47	7.22	7.96	8.69	9.41	10.1	10.8	12.2	14.1	15.9	17.6
76.2				4.16	4.69	5.21	5.72	6.23	7.08	7.90	8.72	9.53	10.3	11.1	11.9	13.4	15.5	17.6	19.5
82.6							6.22	6.78	7.70	8.61	9.51	10.4	11.3	12.1	13.0	14.6	17.0	19.3	21.5
88.9							6.72	7.32	8.32	9.31	10.3	11.2	12.2	13.1	14.0	15.9	18.5	21.0	23.4
101.6								8.41	9.56	10.7	11.8	12.9	14.1	15.1	16.2	18.3	21.4	24.4	27.3
114.3									10.8	12.1	13.4	14.7	15.9	17.2	18.4	20.8	24.4	27.8	31.2
127.0									12.1	13.5	14.9	16.4	17.8	19.2	20.6	23.3	27.3	31.3	35.1
139.8												18.1	19.7	21.2	22.8	25.8	30.3	34.7	39.0

Remarks 1. The numerical value of mass shall be calculated according to the following formula by taking the mass of 1 cm³ of steel as 7.80 g, and rounded off to three significant figures in accordance with JIS Z 8401.

$$W = 0.02450t(D - t)$$

where, W : unit mass of tube (kg/m)

t : wall thickness of tube (mm)

D : outside diameter of tube (mm)

2. In dealing, the unit mass of the tube shall be increased by 15 % for hot finished seamless tube, and by 10 % for cold finished seamless tube, automatic arc welded tube, laser welded tube, and electric resistance welded tube. The increased unit mass shall be used as standard unit mass.

Attached Table 4. Dimensions and mass of SUS430TB, SUS430LXTB,
SUS430J1LTB, SUS436LTB and SUSXM8TB

Unit: kg/m

Outside diam- eter	Wall thickness (mm)																		
	1.2	1.6	2.0	2.3	2.6	2.9	3.2	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	8.0	9.5	11.0	12.5
15.9	0.427	0.553	0.672	0.757	0.836	0.912													
19.0	0.517	0.673	0.822	0.929	1.03	1.13													
21.7	0.595	0.778	0.953	1.08	1.20	1.32	1.43												
25.4	0.702	0.921	1.13	1.29	1.43	1.58	1.72	1.85											
27.2	0.755	0.991	1.22	1.39	1.55	1.70	1.86	2.01	2.24										
31.8	0.888	1.17	1.44	1.64	1.84	2.03	2.21	3.40	2.69	2.97									
34.0		1.25	1.55	1.76	1.97	2.18	2.38	2.58	2.90	3.21	3.51								
38.1		1.41	1.75	1.99	2.23	2.47	2.70	2.93	3.30	3.66	4.00	4.34							
42.7			1.97	2.25	2.52	2.79	3.06	3.32	3.74	4.16	4.56	4.95	5.33						
45.0			2.08	2.38	2.67	2.95	3.24	3.51	3.97	4.41	4.84	5.26	5.66	6.05					
48.6			2.25	2.58	2.89	3.21	3.51	3.82	4.32	4.80	5.27	5.73	6.18	6.62	7.04				
50.8			2.36	2.70	3.03	3.36	3.68	4.00	4.53	5.04	5.54	6.03	6.50	6.97	7.42	8.28	9.49	10.6	11.6
54.0			2.52	2.88	3.23	3.58	3.93	4.28	4.84	5.39	5.93	6.45	6.97	7.47	7.96	8.90	10.2	11.4	12.5
57.1			2.67	3.05	3.43	3.80	4.17	4.54	5.14	5.73	6.30	6.87	7.42	7.96	8.48	9.50	10.9	12.3	13.5
60.3			2.82	3.23	3.63	4.03	4.42	4.81	5.45	6.07	6.69	7.29	7.88	8.46	9.03	10.1	11.7	13.1	14.5
63.5				3.40	3.83	4.25	4.67	5.08	5.76	6.42	7.08	7.72	8.35	8.96	9.57	10.7	12.4	14.0	15.4
65.0				3.49	3.92	4.36	4.78	5.21	5.90	6.59	7.26	7.92	8.56	9.20	9.82	11.0	12.8	14.4	15.9
70.0				3.77	4.24	4.71	5.17	5.63	6.39	7.13	7.86	8.58	9.29	9.98	10.7	12.0	13.9	15.7	17.4
76.2				4.11	4.63	5.14	5.65	6.16	6.99	7.80	8.61	9.41	10.2	11.0	11.7	13.2	15.3	17.3	19.3
82.6							6.15	6.70	7.61	8.50	9.39	10.3	11.1	12.0	12.8	14.4	16.8	19.1	21.2
88.9							6.63	7.23	8.21	9.19	10.1	11.1	12.0	13.0	13.9	15.7	18.2	20.7	23.1
101.6								8.31	9.44	10.6	11.7	12.8	13.9	15.0	16.0	18.1	21.2	24.1	26.9
114.3									10.7	12.0	13.2	14.5	15.7	16.9	18.2	20.6	24.1	27.5	30.8
127.0									11.9	13.3	14.8	16.2	17.6	18.9	20.3	23.0	27.0	30.9	34.6
139.8												17.9	19.4	21.0	22.5	25.5	29.9	34.3	38.5

Remarks 1. The numerical value of mass shall be calculated according to the following formula by taking the mass of 1 cm³ of steel as 7.70 g, and rounded off to three significant figures in accordance with JIS Z 8401.

$$W = 0.02419t(D - t)$$

where, W : unit mass of tube (kg/m)

t : wall thickness of tube (mm)

D : outside diameter of tube (mm)

2. In dealing, the unit mass of the tube shall be increased by 15 % for hot finished seamless tube, and by 10 % for cold finished seamless tube, automatic arc welded tube, laser welded tube, and electric resistance welded tube. The increased unit mass shall be used as standard unit mass.

Attached Table 5. Dimensions and mass of SUS405TB, SUS409TB, SUS409LTB, SUS410TB, SUS410T1TB, SUS444TB and SUSXM15J1TB

Unit: kg/m

Outside diam-eter	Wall thickness (mm)																		
	1.2	1.6	2.0	2.3	2.6	2.9	3.2	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	8.0	9.5	11.0	12.5
15.9	0.430	0.557	0.677	0.762	0.842	0.918													
19.0	0.520	0.678	0.828	0.935	1.04	1.14													
21.7	0.599	0.783	0.960	1.09	1.21	1.33	1.44												
25.4	0.707	0.927	1.14	1.29	1.44	1.59	1.73	1.87											
27.2	0.760	0.997	1.23	1.39	1.56	1.72	1.87	2.02	2.26										
31.8	0.894	1.18	1.45	1.65	1.85	2.04	2.23	2.41	2.71	2.99									
34.0		1.26	1.56	1.78	1.99	2.20	2.40	2.60	2.92	3.23	3.53								
38.1		1.42	1.76	2.00	2.25	2.49	2.72	2.95	3.32	3.68	4.03	4.37							
42.7			1.98	2.26	2.54	2.81	3.08	3.34	3.77	4.19	4.59	4.98	5.36						
45.0			2.09	2.39	2.68	2.97	3.26	3.54	3.99	4.44	4.87	5.29	5.70	6.09					
48.6			2.27	2.59	2.91	3.23	3.54	3.84	4.34	4.83	5.31	5.77	6.22	6.66	7.09				
50.8			2.38	2.72	3.05	3.38	3.71	4.03	4.56	5.07	5.58	6.07	6.55	7.01	7.47	8.34	9.55	10.7	11.7
54.0			2.53	2.90	3.25	3.61	3.96	4.30	4.87	5.42	5.97	6.50	7.01	7.52	8.01	8.96	10.3	11.5	12.6
57.1			2.68	3.07	3.45	3.83	4.20	4.57	5.17	5.76	6.34	6.91	7.47	8.01	8.54	9.56	11.0	12.3	13.6
60.3			2.84	3.25	3.65	4.05	4.45	4.84	5.48	6.11	6.73	7.34	7.93	8.52	9.08	10.2	11.8	13.2	14.5
63.5				3.43	3.86	4.28	4.70	5.11	5.80	6.46	7.12	7.77	8.40	9.02	9.63	10.8	12.5	14.1	15.5
65.0				3.51	3.95	4.39	4.82	5.24	5.94	6.63	7.31	7.97	8.62	9.26	9.89	11.1	12.8	14.5	16.0
70.0				3.79	4.27	4.74	5.21	5.67	6.43	7.18	7.91	8.64	9.35	10.1	10.7	12.1	14.0	15.8	17.5
76.2				4.14	4.66	5.18	5.69	6.20	7.03	7.86	8.67	9.47	10.3	11.0	11.8	13.3	15.4	17.5	19.4
82.6							6.19	6.74	7.66	8.56	9.45	10.3	11.2	12.0	12.9	14.5	16.9	19.2	21.3
88.9							6.68	7.28	8.27	9.25	10.2	11.2	12.1	13.0	14.0	15.8	18.4	20.9	23.3
101.6								8.36	9.51	10.6	11.8	12.9	14.0	15.1	16.1	18.2	21.3	24.3	27.1
114.3									10.7	12.0	13.3	14.6	15.8	17.1	18.3	20.7	24.2	27.7	31.0
127.0									12.0	13.4	14.9	16.3	17.7	19.1	20.5	23.2	27.2	31.1	34.9
139.8												18.0	19.5	21.1	22.6	25.7	30.1	34.5	38.7

Remarks 1. The numerical value of mass shall be calculated according to the following formula by taking the mass of 1 cm³ of steel as 7.75 g, and rounded off to three significant figures in accordance with JIS Z 8401.

$$W = 0.02435t(D - t)$$

where, W : unit mass of tube (kg/m)

t : wall thickness of tube (mm)

D : outside diameter of tube (mm)

2. In dealing, the unit mass of the tube shall be increased by 15 % for hot finished seamless tube, and by 10 % for cold finished seamless tube, automatic arc welded tube, laser welded tube, and electric resistance welded tube. The increased unit mass shall be used as standard unit mass.

Attached Table 6. Dimensions and mass of SUSXM27TB

Unit: kg/m

Outside diam- eter	Wall thickness (mm)																		
	1.2	1.6	2.0	2.3	2.6	2.9	3.2	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	8.0	9.5	11.0	12.5
15.9	0.425	0.551	0.670	0.754	0.833	0.909													
19.0	0.515	0.671	0.819	0.926	1.03	1.13													
21.7	0.593	0.775	0.950	1.08	1.20	1.31	1.43												
25.4	0.700	0.918	1.13	1.28	1.43	1.57	1.71	1.85											
27.2	0.752	0.987	1.21	1.38	1.54	1.70	1.85	2.00	2.24										
31.8	0.885	1.16	1.44	1.64	1.83	2.02	2.21	2.39	2.68	2.96									
34.0		1.25	1.54	1.76	1.97	2.17	2.38	2.57	2.89	3.20	3.49								
38.1		1.41	1.74	1.98	2.22	2.46	2.69	2.92	3.29	3.64	3.99	4.32							
42.7			1.96	2.24	2.51	2.78	3.05	3.31	3.73	4.14	4.54	4.93	5.31						
45.0			2.07	2.37	2.66	2.94	3.22	3.50	3.95	4.39	4.82	5.24	5.64	6.03					
48.6			2.25	2.57	2.88	3.19	3.50	3.80	4.30	4.78	5.25	5.71	6.16	6.59	7.02				
50.8			2.35	2.69	3.02	3.35	3.67	3.99	4.51	5.02	5.52	6.00	6.48	6.94	7.39	8.25	9.46	10.6	11.5
54.0			2.51	2.87	3.22	3.57	3.92	4.26	4.82	5.37	5.90	6.43	6.94	7.44	7.93	8.87	10.2	11.4	12.5
57.1			2.66	3.04	3.41	3.79	4.16	4.52	5.12	5.70	6.28	6.84	7.39	7.93	8.45	9.47	10.9	12.2	13.4
60.3			2.81	3.21	3.62	4.01	4.40	4.79	5.43	6.05	6.66	7.26	7.85	8.43	8.99	10.1	11.6	13.1	14.4
63.5				3.39	3.82	4.24	4.65	5.06	5.74	6.40	7.05	7.69	8.31	8.93	9.53	10.7	12.4	13.9	15.4
65.0				3.48	3.91	4.34	4.77	5.19	5.88	6.56	7.23	7.89	8.53	9.16	9.78	11.0	12.7	14.3	15.8
70.0				3.75	4.22	4.69	5.15	5.61	6.36	7.10	7.83	8.55	9.25	9.95	10.6	12.0	13.9	15.6	17.3
76.2				4.10	4.61	5.12	5.63	6.13	6.96	7.78	8.58	9.37	10.2	10.9	11.7	13.1	15.3	17.3	19.2
82.6							6.12	6.67	7.58	8.47	9.35	10.2	11.1	11.9	12.8	14.4	16.7	19.0	21.1
88.9							6.61	7.20	8.18	9.15	10.1	11.1	12.0	12.9	13.8	15.6	18.2	20.7	23.0
101.6								8.27	9.41	10.5	11.6	12.7	13.8	14.9	16.0	18.0	21.1	24.0	26.8
114.3									10.6	11.9	13.2	14.4	15.7	16.9	18.1	20.5	24.0	27.4	30.7
127.0									11.9	13.3	14.7	16.1	17.5	18.9	20.2	22.9	26.9	30.8	34.5
139.8												17.8	19.3	20.9	22.4	25.4	29.8	34.1	38.3

Remarks 1. The numerical value of mass shall be calculated according to the following formula by taking the mass of 1 cm³ of steel as 7.67 g, and rounded off to three significant figures in accordance with JIS Z 8401.

$$W = 0.024 \cdot 10t(D - t)$$

where, W : unit mass of tube (kg/m)

t : wall thickness of tube (mm)

D : outside diameter of tube (mm)

2. In dealing, the unit mass of the tube shall be increased by 15 % for hot finished seamless tube, and by 10 % for cold finished seamless tube, automatic arc welded tube, laser welded tube, and electric resistance welded tube. The increased unit mass shall be used as standard unit mass.

Attached Table 7. Dimensions and mass of SUS836LTB

Unit: kg/m

Outside diam- eter	Wall thickness (mm)																		
	1.2	1.6	2.0	2.3	2.6	2.9	3.2	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	8.0	9.5	11.0	12.5
15.9	0.447	0.579	0.703	0.792	0.876	0.955													
19.0	0.541	0.705	0.861	0.973	1.08	1.18													
21.7	0.623	0.814	0.998	1.13	1.26	1.38	1.50												
25.4	0.735	0.964	1.18	1.35	1.50	1.65	1.80	1.94											
27.2	0.790	1.04	1.28	1.45	1.62	1.78	1.94	2.10	2.35										
31.8	0.922	1.22	1.51	1.72	1.92	2.11	2.32	2.51	2.82	3.11									
34.0		1.31	1.62	1.85	2.07	2.28	2.50	2.70	3.04	3.36	3.67								
38.1		1.48	1.83	2.08	2.34	2.58	2.83	3.07	3.45	3.83	4.19	4.54							
42.7			2.06	2.35	2.64	2.92	3.20	3.47	3.92	4.35	4.77	5.18	5.58						
45.0			2.18	2.49	2.79	3.09	3.39	3.68	4.15	4.61	5.06	5.50	5.92	6.34					
48.6			2.36	2.70	3.03	3.35	3.68	4.00	4.52	5.02	5.52	6.00	6.47	6.93	7.37				
50.8			2.47	2.82	3.17	3.52	3.86	4.19	4.74	5.28	5.80	6.31	6.81	7.29	7.76	8.67	9.93	11.1	12.1
54.0			2.63	3.01	3.38	3.75	4.12	4.48	5.06	5.64	6.20	6.75	7.29	7.82	8.33	9.32	10.7	12.0	13.1
57.1			2.79	3.19	3.59	3.98	4.37	4.75	5.38	5.99	6.60	7.19	7.76	8.33	8.88	9.95	11.4	12.8	14.1
60.3			2.95	3.38	3.80	4.21	4.63	5.03	5.70	6.36	7.00	7.63	8.25	8.85	9.45	10.6	12.2	13.7	15.1
63.5				3.56	4.01	4.45	4.89	5.32	6.03	6.72	7.41	8.08	8.74	9.38	10.0	11.2	13.0	14.6	16.1
65.0				3.65	4.11	4.56	5.01	5.45	6.18	6.89	7.60	8.29	8.96	9.63	10.3	11.5	13.3	15.0	16.6
70.0				3.94	4.44	4.93	5.41	5.89	6.68	7.46	8.23	8.98	9.72	10.5	11.2	12.6	14.6	16.4	18.2
76.2				4.30	4.85	5.38	5.91	6.44	7.31	8.17	9.01	9.85	10.7	11.5	12.3	13.8	16.0	18.2	20.2
82.6							6.43	6.94	7.96	8.90	9.82	10.7	11.6	12.5	13.4	15.1	17.6	19.9	22.2
88.9							6.94	7.57	8.60	9.62	10.6	11.6	12.6	13.6	14.5	16.4	19.1	21.7	24.2
101.6								8.69	9.88	11.1	12.2	13.4	14.5	15.7	16.7	19.0	22.2	25.2	28.2
114.3									11.2	12.5	13.8	15.2	16.5	17.7	19.0	21.5	25.2	28.8	32.2
127.0									12.5	14.0	15.4	16.9	18.4	19.8	21.3	24.1	28.3	32.3	36.2
139.8												18.7	20.3	21.9	23.5	26.7	31.3	35.9	40.3

Remarks 1. The numerical value of mass shall be calculated according to the following formula by taking the mass of 1 cm³ of steel as 8.06 g, and rounded off to three significant figures in accordance with JIS Z 8401.

$$W = 0.02532t(D - t)$$

where, W : unit mass of tube (kg/m)

t : wall thickness of tube (mm)

D : outside diameter of tube (mm)

2. In dealing, the unit mass of the tube shall be increased by 15 % for hot finished seamless tube, and by 10 % for cold finished seamless tube, automatic arc welded tube, laser welded tube, and electric resistance welded tube. The increased unit mass shall be used as standard unit mass.

Attached Table 8. Dimensions and mass of SUS890LTB

Unit: kg/m

Outside diam- eter	Wall thickness (mm)																		
	1.2	1.6	2.0	2.3	2.6	2.9	3.2	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	8.0	9.5	11.0	12.5
15.9	0.446	0.579	0.703	0.791	0.875	0.953													
19.0	0.540	0.704	0.860	0.971	1.08	1.18													
21.7	0.622	0.813	0.996	1.13	1.26	1.38	1.50												
25.4	0.734	0.963	1.18	1.34	1.50	1.65	1.80	1.94											
27.2	0.789	1.04	1.27	1.45	1.62	1.78	1.94	2.10	2.35										
31.8	0.929	1.22	1.51	1.72	1.92	2.12	2.31	2.50	2.81	3.11									
34.0		1.31	1.62	1.84	2.06	2.28	2.49	2.70	3.03	3.36	3.67								
38.1		1.48	1.83	2.08	2.33	2.58	2.82	3.06	3.45	3.82	4.19	4.53							
42.7			2.06	2.35	2.64	2.92	3.20	3.47	3.91	4.35	4.77	5.17	5.57						
45.0			2.17	2.48	2.79	3.09	3.38	3.67	4.15	4.61	5.06	5.49	5.92	6.33					
48.6			2.36	2.69	3.02	3.35	3.67	3.99	4.51	5.02	5.51	5.99	6.46	6.92	7.36				
50.8			2.47	2.82	3.17	3.51	3.85	4.19	4.73	5.27	5.79	6.30	6.80	7.28	7.75	8.66	9.92	11.1	12.1
54.0			2.63	3.01	3.38	3.75	4.11	4.47	5.06	5.63	6.20	6.75	7.28	7.81	8.32	9.31	10.7	12.0	13.1
57.1			2.79	3.19	3.58	3.98	4.36	4.74	5.37	5.99	6.59	7.18	7.75	8.32	8.87	9.93	11.4	12.8	14.1
60.3			2.95	3.37	3.79	4.21	4.62	5.03	5.70	6.35	6.99	7.62	8.24	8.84	9.44	10.6	12.2	13.7	15.1
63.5				3.56	4.00	4.44	4.88	5.31	6.02	6.71	7.40	8.07	8.73	9.37	10.0	11.2	13.0	14.6	16.1
65.0				3.65	4.10	4.55	5.00	5.44	6.17	6.89	7.59	8.28	8.95	9.62	10.3	11.5	13.3	15.0	16.6
70.0				3.94	4.43	4.92	5.41	5.89	6.68	7.45	8.22	8.97	9.71	10.4	11.2	12.5	14.5	16.4	18.2
76.2				4.30	4.84	5.38	5.91	6.44	7.30	8.16	9.00	9.83	10.7	11.5	12.3	13.8	16.0	18.1	20.1
82.6							6.43	7.00	7.95	8.89	9.81	10.7	11.6	12.5	13.4	15.1	17.6	19.9	22.2
88.9							6.94	7.56	8.59	9.61	10.6	11.6	12.6	13.5	14.5	16.4	19.1	21.7	24.2
101.6								8.68	9.87	11.1	12.2	13.4	14.5	15.6	16.7	18.9	22.1	25.2	28.2
114.3									11.2	12.5	13.8	15.1	16.4	17.7	19.0	21.5	25.2	28.7	32.2
127.0									12.4	13.9	15.4	16.9	18.4	19.8	21.2	24.1	28.2	32.3	36.2
139.8												18.7	20.3	21.9	23.5	26.7	31.3	35.8	40.2

Remarks 1. The numerical value of mass shall be calculated according to the following formula by taking the mass of 1 cm³ of steel as 8.05 g, and rounded off to three significant figures in accordance with JIS Z 8401.

$$W = 0.025 \, 29t(D - t)$$

where, W : unit mass of tube (kg/m)

t : wall thickness of tube (mm)

D : outside diameter of tube (mm)

2. In dealing, the unit mass of the tube shall be increased by 15 % for hot finished seamless tube, and by 10 % for cold finished seamless tube, automatic arc welded tube, laser welded tube, and electric resistance welded tube. The increased unit mass shall be used as standard unit mass.

Attached Table 9. Cited standards

JIS G 0303	General rules for inspection of steel
JIS G 0551	Methods of austenite grain size test for steel
JIS G 0567	Method of elevated temperature tensile test for steels and heat-resisting alloys
JIS G 0571	Method of 10 per cent oxalic acid etch test for stainless steels
JIS G 0572	Method of ferric sulfate-sulfuric acid test for stainless steels
JIS G 0573	Method of 65 per cent nitric acid test for stainless steels
JIS G 0574	Method of nitric-hydrofluoric acid test for stainless steels
JIS G 0575	Method of copper sulfate-sulfuric acid test for stainless steels
JIS G 0582	Ultrasonic examination for steel pipes and tubes
JIS G 0583	Eddy current examination of steel pipes and tubes
JIS G 1211	Methods for determination of carbon in iron and steel
JIS G 1212	Methods for determination of silicon in iron and steel
JIS G 1213	Methods for determination of manganese in iron and steel
JIS G 1214	Methods for determination of phosphorus in iron and steel
JIS G 1215	Methods for determination of sulfur in iron and steel
JIS G 1216	Methods for determination of nickel in iron and steel
JIS G 1217	Methods for determination of chromium in iron and steel
JIS G 1218	Methods for determination of molybdenum in iron and steel
JIS G 1219	Methods for determination of copper in iron and steel
JIS G 1223	Methods for determination of titanium in iron and steel
JIS G 1224	Methods for determination of aluminium in iron and steel
JIS G 1228	Methods for determination of nitrogen in iron and steel
JIS G 1232	Methods for determination of zirconium in steel
JIS G 1237	Methods for determination of niobium in steel

Attached Table 9. (continued)

- JIS G 1253 Method for photoelectric emission spectrochemical analysis of iron and steel
- JIS G 1256 Method for X-ray fluorescence spectrometric analysis of iron and steel
- JIS G 1257 Iron and steel - Methods for atomic absorption spectrometric analysis
- JIS Z 2201 Test pieces for tensile test for metallic materials
- JIS Z 2241 Method of tensile test for metallic materials
- JIS Z 2245 Method of Rockwell and Rockwell superficial hardness test
- JIS Z 8401 Rules for rounding off of numerical values

Annex 1. Special quality requirements

The special quality requirements shall apply when requested by the purchaser and the manufacturer shall execute the designated items on the straight tube.

Z1 Hardness The hardness shall be as follows:

- (1) The hardness of the tube shall be as specified in Annex 1 Table 1.

Annex 1 table 1. Hardness

Symbol of grade	Rockwell hardness (mean value of three points)	
	HRB	HRC
SUS304TB, SUS304HTB, SUS304LTB, SUS309TB, SUS309STB, SUS310TB, SUS310STB, SUS316TB, SUS316HTB, SUS316LTB, SUS316TiTB, SUS317TB, SUS317LTB, SUS321TB, SUS321HTB, SUS347TB, SUS347HTB	90 max.	-
SUS329J1TB, SUS329J3LTB, SUS329J4LTB	-	29 max.
SUS836LTB, SUS409LTB, SUS410TiTB, SUS430TB, SUS430LXTB, SUS430J1LTB, SUSXM8TB, SUSXM27TB	90 max.	-
SUS890LTB, SUS405TB, SUS409TB, SUS410TB, SUS436LTB, SUS444TB, SUSXM15J1TB	95 max.	-

- (2) A suitable length of a tube shall be cut off from one end of the tube to serve as a test piece.
- (3) The test method shall be in accordance with JIS Z 2245 and the hardness on the cross section or inside surface of the test piece shall be measured at three points for each test piece.

Further, a tube of 2 mm or under in wall thickness shall not be tested. As for the automatic arc welded tube, laser welded tube and electric resistance welded tube, the test shall be carried out in the portion other than the weld and the heat-affected zones.

- (4) The hardness shall comply with the requirement specified in Annex 1 Table 1.
- (5) The sampling of a specimen and the number of test pieces shall be as specified for the tensile test in 10.2.1 of the text.
- (6) Reinspection Retest for tube may be carried out to determine acceptance or rejection according to 4.4 of JIS G 0303.

Z2 Elevated temperature yield point or proof stress The elevated temperature yield point or proof stress shall be as follows:

- (1) The value of elevated temperature yield point or proof stress and the testing temperature of the tube shall be subjected to the agreement between the purchaser and supplier.
- (2) The test piece and the test method shall be as specified in JIS G 0567.

However, when it is practically difficult to take the test piece of the shape specified in JIS G 0567, the shape of the test piece shall be subjected to the agreement between the purchaser and supplier.

- (3) For sampling of a specimen and the number of test pieces, one specimen shall be sampled from each lot of the same cast steel, and one test piece shall be sampled therefrom for each test temperature.

Z3 Ultrasonic examination The ultrasonic examination shall be as follows:

- (1) The criteria of working sensitivity in the ultrasonic examination shall be the division UA or UC specified in JIS G 0582 and there shall be no signal equal to or greater than the signal from an artificial flaw of reference test piece.
- (2) The method of the ultrasonic examination shall be in accordance with JIS G 0582.
- (3) The ultrasonic examination shall be performed on each tube and the result shall comply with the requirements specified in (1).

Remarks: Z3 applies exclusively to seamless tubes.

Z4 Eddy current examination The eddy current examination shall be as follows:

- (1) The criteria of working sensitivity in the eddy current examination shall be the division EV, EW, or EX specified in JIS G 0583 and there shall be no signal equal to or greater than the signal from an artificial flaw in the reference test piece.
- (2) The method of the eddy current examination shall be in accordance with JIS G 0583.
- (3) The eddy current examination shall be carried out on each tube and the result shall conform to the requirements specified in (1).

Z6 Corrosion test The corrosion test shall be as follows:

- (1) Corrosion resistance The corrosion resistance by the intergranular corrosion test of the tube shall comply with the following requirements. In this case, the intergranular corrosion test to be applied shall be subjected to the agreement between the purchaser and supplier.
 - (a) Evaluation by etch structure obtained in the 10 % oxalic acid etch test shall be as specified in Annex 1 Table 2.

Annex 1 Table 2. Evaluation by 10 % oxalic acid etch test

Symbol of grade	Condition	Structure for ferric sulfate-sulfuric acid test	Structure for 65 % nitric acid test	Structure for nitric-hydrofluoric acid test	Structure for copper sulfate-sulfuric acid test
SUS304TB	As delivered (solution treatment)	Ditch structure	Ditch structure End grain pitting II	-	Ditch structure
SUS316TB			-	Ditch structure	
SUS317TB					
SUS304LTB	Sensitization	Ditch structure	Ditch structure End grain pitting II	-	Ditch structure
SUS316LTB			-	Ditch structure	
SUS317LTB					
SUS321TB		-		-	
SUS347TB					

(b) The mass loss by ferric sulfate-sulfuric acid test shall be as specified in Annex 1 Table 3.

Annex 1 Table 3. Mass loss by ferric sulfate-sulfuric acid test

Symbol of grade	Condition	Mass loss g/(m ² h)
SUS304TB SUS316TB SUS317TB	As delivered (solution treatment)	Subject to the agreement between the purchaser and supplier.
SUS304LTB SUS316LTB SUS317LTB	Sensitization	Subject to the agreement between the purchaser and supplier.

(c) The mass loss by 65 % nitric acid test shall be as specified in Annex 1 Table 4.

Annex 1 Table 4. Mass loss by 65 % nitric acid test

Symbol of grade	Condition	Mass loss g/(m ² h)
SUS304TB	As delivered (solution treatment)	Subject to the agreement between the purchaser and supplier.
SUS304LTB	Sensitization	Subject to the agreement between the purchaser and supplier.

- (d) The corrosion rate ratio by nitric-hydrofluoric acid test shall be as specified in Annex 1 Table 5.

Annex 1 Table 5. Corrosion rate ratio by nitric-hydrofluoric acid test

Symbol of grade	Corrosion rate ratio
SUS316TB	1.5 max.
SUS317TB	1.5 max.
SUS316LTB	1.5 max.
SUS317LTB	1.5 max.

- (e) The state of the bent surface by copper sulfate-sulfuric acid test shall be as specified in Annex 1 Table 6.

Annex 1 Table 6. State of bent surface by copper sulfate-sulfuric acid test

Symbol of grade	Condition	State of bent surface
SUS304TB SUS316TB SUS317TB	As delivered (solution- treatment)	Intergranular corrosion crack shall not be generated.
SUS304LTB SUS316LTB SUS317LTB SUS321TB SUS347TB	Sensitiza- tion	Intergranular corrosion crack shall not be generated.

- (2) A suitable length of a tube shall be cut off from one end of the tube to serve as a test piece.
- (3) The test method shall be in accordance with any one of the following standards.

JIS G 0571, JIS G 0572, JIS G 0573, JIS G 0574, JIS G 0575

- (4) The test results shall conform to the requirements specified in (1).
- (5) The sampling of a specimen and the number of test pieces shall be as specified for the grain size test in 10.6.1 of the text. If requested, the test piece mentioned above shall be sampled for each lot of the tubes of the same cast steel processed under the simultaneous heat treatment.

Annex 2. U-bent tube

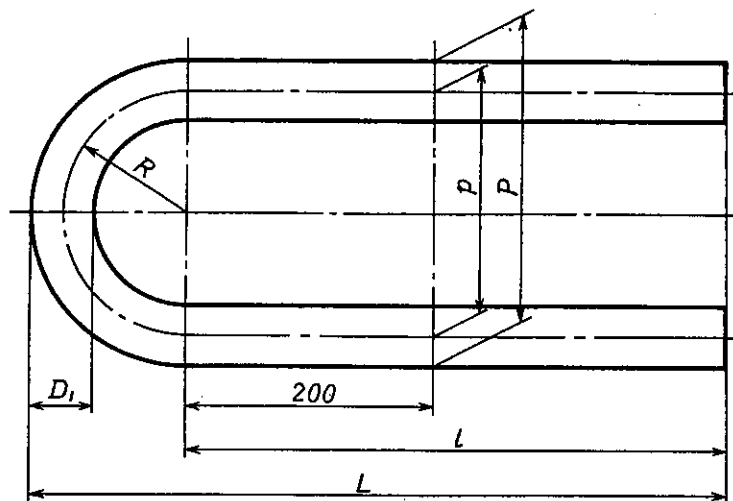
The U-bent tube shall apply when requested by the purchaser and shall be executed by the manufacturer.

1. Method of manufacture The method of manufacture shall be as follows: (see Annex 2 Fig. 1.)

- (1) The U-bent tube shall be manufactured by cold bending process and the bend radius shall be at least 1.5 times the outside diameter of the tube.
- (2) The bent portion of the tube shall, as a rule, not be heat-treated. However, when requested by the purchaser, a heat treatment may be agreed upon.
2. The bent portion shall be free from defects injurious to use.
3. Dimensional tolerances on the bent portion shall be as specified in Annex 2 Table 1, and tolerances on the length after bending shall be as specified in Annex 2 Table 2.

Annex 2 Fig. 1

Unit: mm



R : bend radius

D_n : nominal outside diameter

D_1 : outside diameter of bent portion

t_n : nominal wall thickness

t_1 : minimum wall thickness of bent portion

p : pitch

l : length of straight portion

P : $p + D_n$

L : $l + R + \frac{D_n}{2}$

Annex 2 Table 1. Dimensional tolerances on bent portion

Variation rate of outside diameter $\frac{D_1 - D_n}{D_n} \times 100 \%$		Reduction rate of wall thickness $\frac{t_n - t_1}{t_n} \times 100 \%$	Tolerances on pitch (p) or P mm
Short radius side	Long radius side		
$\frac{D_n}{4R} \times 100$ max. Where, the minimum value of $D_1 - D_n$ is 0.5 mm	$\frac{D_n}{8R} \times 100$ max. Where, the minimum value of $D_1 - D_n$ is 0.5 mm	$\frac{D_n}{2.5R} \times 100$ max.	± 1.5

Annex 2 Table 2. Tolerances on length of U-bent tube

Division of length	Tolerances on length (l or L) mm
7 m max. in length of straight portion after bending	+7 0
Over 7 m in length of straight portion after bending	+10 0

4. In order to measure the dimensions of the bent portion, one specimen shall be sampled from the U-bent tube with the smallest bending radius among tubes of the same dimensions bent simultaneously. The outside diameters in two directions at 90° to the bent portion and the wall thickness at four points on the circumference shall be measured to obtain the variation rate of outside diameter and the reduction rate of wall thickness.

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