JIS G3467 Steel Tubes for Fired Heater

1. Scope

This Japanese Industrial Standard specifies the carbon steel tubes, alloy steel tubes, stainless steel tubes and nickel-chromium-iron alloy tubes. Hereinafter referred to as the "tubes", for heating the process fluids in the fired heaters mainly used in petroleum refinery, petrochemical industry, etc.

Remarks

When previously agreed upon by the manufacturer, the purchaser may designate part or all of the supplementary quality requirements Z2, Z3, Z4 and Z6 specified in Appendix, in addition to the items specified in this text.

Appendix Z 2 Elevated temperature yield point or proof stress

Appendix Z 3 Ultrasonic examination

Appendix Z 4 Eddy current examination

Appendix Z 6 Corrosion test

2. The units and numerical values given in { }in this Standard are based on the International System of Units (SI) and are appended for informative reference.

2. Classes and Symbols

The tubes shall be classified into 19 classes and their symbols shall be as given in Table 1

Table 1. Symbols of Classes

Classification		Symbol of class	Classification	Symbol of class
Carbon steel tube		STF 410	Austenitic stainless steel tube	SUS 304TF SUS 304HTF SUS 309TF SUS 310TF SUS 316TF SUS 316HTF SUS 321TF SUS 321HTF SUS 347TF SUS 347HTF
Alloy steel tube	Molybdenum steel tube	STFA 12		
	Chromium-molybdenum steel tube	STFA 22 STFA 23 STFA 24 STFA 25 STFA 26	Nickel-chromium-iron alloy tube	NCF 800 TF NCF 800H TF

World Standard Comparative Table

KS		ASTM		JIS		DIN	
NUMBER	GRADE	NUMBER	GRADE	NUMBER	GRADE	NUMBER	GRADE
D 3587		A161		G-3467	STF370 (STF38)	-	-
	STF410 (STF42)	A161	LC, T1		STF410 (STF42)	-	-
	STFA12				STFA12	-	-
	STFA22				STFA22	-	-
	STFA23	A200	T11		STFA23	-	-
	STFA24	A200	T22		STFA24	-	-
	STFA25	A200	T5		STFA25	-	-
	STFA26	A200	T9		STFA26	-	-
D 3587	STS304TF	A271	TP304	G-3467	SUS304TF	-	-
	STS304HTF	A271	TP304H		SUS304HTF	-	-
	STS309STF				SUS309STF	-	-
	STS310STF				SUS310STF	-	-
	STS316TF	A271	TP316		SUS316TF	-	-
	STS316HTF	A271	TP316H		SUS316HTF	-	-
	STS312TF				STS312TF		
	STS321TF	A271	TP321		SUS321TF	-	-
	STS321HTF	A271	TP321H		SUS321HTF	-	-
	STS347TF	A271	TP347		SUS347TF	-	-
	STS347HTF	A271	TP347H		SUS347HTF	-	-
D 3587	NCF800TF NCF800HTF	A200	T4, T7, T91, T21	G-3467	NCF800TF NCF800HTF	-	-

3. Chemical Composition

Table 2. Chemical Composition

Unit: %

Symbol of class	C	Si	Mn	P	S	Ni	Cr	Mn	Others
STF 410	0.30 max	0.10 ~0.35	0.30 ~1.00	0.035 max	0.035 max	-	-	-	-
STFA 12	0.10 ~0.20			0.035 max	0.035 max	-	-	0.45 ~0.65	-
STFA 22	0.15 max	0.10 ~0.50	0.30 ~0.80	0.035 max	0.035 max	-	0.80 ~1.25	0.45 ~0.65	-
STFA 23	0.15 max	0.50 max 0.50 max	0.30 ~0.60 0.30 ~0.60	0.030 max	0.030 max	-	1.00 ~1.50	0.45 ~0.65	-
STFA 24	0.15 max	0.50 max 0.50 max	0.30 ~0.60 0.30 ~0.60	0.030 max	0.030 max	-	1.90 ~2.60	0.87 ~1.13	-
STFA 25	0.15 max	0.25 ~1.00	0.30 ~0.60	0.030 max	0.030 max	-	4.00 ~6.00	0.45 ~0.65	-
STFA 26	0.15 max			0.030 max	0.030 max	-	8.00 ~10.00	0.90 ~1.10	-
SUS 304 TF	0.08 max	1.00 max	2.00 max	0.040 max	0.030 max	8.00 ~11.00	18.00 ~20.00	-	
SUS 304HTF	0.04 ~0.10	0.75 max	2.00 max	0.040 max	0.030 max	8.00 ~11.00	18.00 ~20.00	-	-
SUS 309TF	0.15 max	1.00 max	2.00 max	0.040 max	0.030 max	12.00 ~15.00	22.00 ~24.00	-	-
SUS 310TF	0.15 max	1.50 max	2.00 max	0.040 max	0.030 max	19.00 ~22.00	24.00 ~26.00	-	-
SUS 316HTF	0.08 max	1.00 max	2.00 max	0.040 max	0.030 max	10.00 ~14.00	16.00 ~18.00	2.00 ~3.00	-
SUS 316HTF	0.04 ~0.10	0.75 max	2.00 max	0.030 max	0.030 max	11.00 ~14.00	16.00 ~18.00	2.00 ~3.00	
SUS 321TF	0.08 max	1.00 max	2.00 max	0.040 max	0.030 max	9.00 ~13.00	17.00 ~19.00	-	Ti 5】C% min
SUS 321HTF	0.04 ~0.10	0.75 max	2.00 max	0.030 max	0.030 max	9.00 ~13.00	17.00 ~20.00	-	Ti 4】C% ~0.60
SUS 347TF	0.08	1.00	2.00	0.040	0.030	9.00	17.00	-	Nb 10】C%

SUS347HTF	max 0.04 ~0.10	max 0.75 max	max 2.00 max	max 0.030 max	max 0.030 max	~13.00 9.00 ~13.00	~19.00 17.00 ~20.00	-	min Nb 8】C% ~1.00
NCF 800TF	0.10 max	1.00 max	1.50 max	0.030 max	0.015 max	30.00 ~35.00	19.00 ~23.00	-	Cu0.75max Al 0.15~0.60 Ti 0.15~0.60
NCF 800HTF	0.05 ~0.10	1.00 max	1.50 max	0.030 max	0.015 max	30.00 ~35.00	19.00 ~23.00	-	Cu0.75max Al 0.15~0.60 Ti 0.15~0.60

Remark

When product analysis is required by, the tolerances for the values in the above table for the carbon steel tube shall be as specified in Table 2 of JIS G 0321, To the alloy steel tube and the stainless steel tube, the chemical composition given above applies. For the nickel-chromium-iron alloy tube, agreement shall be

4. Mechanical Properties

Table 3. Mechanical Properties

Symbol of class	Division of finish	Tensile strength N/Π {kgf/Π}	Yield point or proof stress N/Π {kgf/Π}	Elongation %			
				No. 11 test piece No. 12 test piece	No. 5 test piece	No. 4 test piece	
				Longitudinal direction	Transverse direction	Longitudinal direction	Transverse direction
STF 410	-	410min{42}	245 min{25}	25 min	20 min	24 min	19 min
STFA 12	-	380min {39}	205 min {21}	30 min	25 min	24 min	19 min
STFA 22	-	410 min {42}	205 min {21}	30 min	25 min	24 min	19 min
STFA 23	-	410 min {42}	205 min {21}	30 min	25 min	24 min	19 min
STFA 24	-	410 min {42}	205 min {21}	30 min	25 min	24 min	19 min
STFA 25	-	410 min {42}	205 min {21}	30 min	25 min	24 min	19 min

STFA 26	-	410 min {42}	205 min {21}	30 min	25 min	24 min	19 min
SUS 304 TF	-	520 min {53}	205 min {21}	35 min	25 min	30 min	22 min
SUS 304HTF	-	520 min {53}	205 min {21}	35 min	25 min	30 min	22 min
SUS 309TF	-	520 min {53}	205 min {21}	35 min	25 min	30 min	22 min
SUS 310TF	-	520 min {53}	205 min {21}	35 min	25 min	30 min	22 min
SUS 316HTF	-	520 min {53}	205 min {21}	35 min	25 min	30 min	22 min
SUS 316HTF	-	520 min {53}	205 min {21}	35 min	25 min	30 min	22 min
SUS 321TF	-	520 min {53}	205 min {21}	35 min	25 min	30 min	22 min
SUS 321HTF	-	520 min {53}	205 min {21}	35 min	25 min	30 min	22 min
SUS 347TF	-	520 min {53}	205 min {21}	35 min	25 min	30 min	22 min
SUS347HTF	-	520 min {53}	205 min {21}	35 min	25 min	30 min	22 min
NCF 800TF	Cold finished	520 min {53}	205 min {21}	30 min	-	-	-
	Hot finished	450 min {46}	175 min {18}	30 min	-	-	-
NCF 800HTF	-	450 min {46}	175 min {18}	30 min	-	-	-

Remark

1. When the tube under 8 mm in thickness is subjected to tensile test by using No. 12 test piece or No. 5 test piece the minimum value of elongation shall be calculated by subtracting 1.5 % from the value of elongation given in Table 3 for a decrease each 1 mm and rounding off the result to a whole number according to JIS Z 8401. Examples of

calculation are shown in Reference Table

2. To the tube under 20 mm in outside diameter. the elongation value given in Table 3 shall not be applied. However. the value shall be recorded.

4.2 Flattening Resistance

The pipe shall be tested in accordance with 10.3 and shall be free from flaws or cracks on its wall surfaces. The distance between the flattening 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 flattening plates (mm)

t: Wall thickness of tube (mm)

D: outside diameter of tube (mm)

e: constant individually defined for each class 0.08 for carbon steel tube and alloy steel tube 0.09 for stainless steel tube and nickel-chromium-iron alloy tube

5. Austenite Grain Size

The tube of SUS 321 HTB and NCF 800 HT shall be tested in accordance with 10.4 and the resulting average austenite grain size shall be Grain Size No. 7 and No. 5 or coarser.

6. Hydrostatic Characteristic or Nondestructive Characteristic

The tested hydrostatic characteristic or nondestructive characteristic shall conform to either of the following two. The preference shall be in accordance with the designation made by the purchaser or left to the direction of the manufacturer.

6.1 Hydrostatic Characteristic

When a hydrostatic pressure specified by the purchaser or, in its absence, the pressure P calculated from the formula below (10 MPa max.) is applied, the tube shall withstand it without leakage.

When a hydrostatic pressure test is made in compliance with the designation the purchaser and the test pressure exceeds either 10 MPa or the value P calculated from the following formula, the test pressure shall be agreed upon by the purchaser and the manufacturer. The designated hydrostatic pressure shall be graduated in 0.5 MPa for pressure under 10 MPa and in 1 MPa for pressures 10 MPa or over.

$P = 2st/D$

Where

P: test pressure (MPa)

t: wall thickness of tube (mm)

D: outside diameter of tube (mm)

s: 60% (N/mm^2) of minimum value of yield point or proof stress specified in Table 3 for carbon steel tube and alloy steel tube

6.2 Nondestructive Characteristic

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

7. Dimensions, Mass and Dimensional Tolerances

(1) The outside diameter, wall thickness and mass of the tube shall be as specified in Attached Table 1 and Attahced Table 2, unless specially designated.

Attached Table 1. Dimensions and Mass of Steel Tubes for Fired Heater Made of Carbon Steel, Alloy Steel and Nickel-Chromium-Iron Alloy

Unit: kg/m

Nominal diameter		Outside diameter (mm)	wall thickness (mm)	4.0	4.5	5.0	5.5	6.0	6.5	7.0	8.0	9.5	11.0	12.5	14.0	16.0	18.0	20.0	22.0	25.0	28.0
A	B																				
50	2	60.5		5.57	6.21	6.84	7.46	8.06	8.66	9.24	10.4	11.9									
65	2 1/2	76.3			7.97	8.79	9.60	10.4	11.2	12.0	13.5	15.6									
80	3	89.1			9.39	10.4	11.3	12.3	13.2	14.2	16.0	18.6	21.2								
90	3 1/2	101.6			10.8	11.9	13.0	14.1	15.2	16.3	18.5	21.6	24.6	27.5							
100	4	114.3				13.5	14.8	16.0	17.3	18.5	21.0	24.6	28.0	31.4	34.6						
125	5	139.8				16.6	18.2	19.8	21.4	22.9	26.0	30.5	34.9	39.2	43.4	48.8					
150	6	165.2					21.7	23.6	25.4	27.3	31.0	36.5	41.8	47.1	52.2	58.9	65.3				
200	8	216.3							33.6	36.1	41.1	48.4	55.7	62.8	69.8	79.0	88.0	96.8	105		
250	10	267.4							41.8	45.0	51.2	60.4	69.6	78.0	87.5	99.2	111	122	133	149	165

Remark

1. Calculate the value of mass from the following formula assuming 1 cm of steel to be 7.85 g, and round off the result to 3 significant figures in accordance with JIS Z 8401

   $W = 0.02466\ t\ (D-t)$

Where

W: unit mass of tube (kg/m)

t: wall thickness of tube (mm)

D: outside diameter of tube (mm)

2. In dealings, the unit mass of the tube shall be the value given in the above table in creased by 14 % for hot finished seamless steel tube, and by 10 % for cold finished seamless steel tube.

Attached Table 2. Dimensions and Mass of Stainless Steel Tubes for Fired Heater

Unit: kg/m

Nominal diameter A	Nominal diameter B	Outside diameter (mm)	Class	Wall thickness (mm)	4.0	4.5	5.0	5.5	6.0	6.5	7.0	8.0	9.5	11.0	12.5	14.0	16.0	18.0	20.0	22.0	25.0	28.0
50	2	60.5	SUS 304 TF, SUS 304 HTF SUS 321 TF, SUS 321 HTF		5.63	6.28	6.91	7.54	8.15	8.74	9.33	10.5	12.1									
			Other than the above		5.67	6.32	7.00	7.58	8.20	8.80	9.39	10.5	12.1									
65	2 1/2	76.3	SUS 304 TF, SUS 304 HTF SUS 321 TF, SUS 321 HTF			8.05	8.88	9.70	10.5	11.3	12.1	13.6	15.8									
			Other than the above			8.10	8.94	9.76	10.6	11.4	12.2	13.7	15.9									
80	3	89.1	SUS 304 TF, SUS 304 HTF SUS 321 TF, SUS 321 HTF			9.48	10.5	11.5	12.4	13.4	14.3	16.2	18.8	21.4								
			Other than the above			9.54	10.5	11.5	12.5	13.5	14.4	16.3	19.0	21.5								
90	3 1/3	101.6	SUS 304 TF, SUS 304 HTF SUS 321 TF, SUS 321 HTF			10.9	12.0	13.2	14.3	15.4	16.5	18.7	21.8	24.8	27.7							
			Other than the above			11.0	12.1	13.3	14.4	15.5	16.6	18.8	21.9	25.0	27.9							
100	4	114.3	SUS 304 TF, SUS 304 HTF SUS 321 TF, SUS 321 HTF				13.6	14.9	16.2	17.5	18.7	21.2	24.8	28.3	31.7	35.0						
			Other than the above				13.7	15.0	16.3	17.6	18.8	21.3	25.0	28.5	31.9	35.2						
125	5	139.8	STS 304 TF, STS 304 HTF STS 321 TF, STS 321 HTF				16.8	18.4	20.0	21.6	23.2	26.3	30.8	35.3	39.6	43.9	49.3					
			Other than the above				17.0	18.5	20.1	21.7	23.3	26.4	31.0	35.5	39.9	44.2	49.5					
150	6	165.2	SUS 304 TF, SUS 304 HTF SUS 321 TF, SUS 321 HTF					21.9	23.8	25.7	27.6	31.3	36.8	42.3	47.5	52.7	59.5	66.0				
			Other than the above					22.0	23.9	25.9	27.8	31.5	37.1	42.5	47.9	53.1	59.8	66.4				
200	8	216.3	SUS 304 TF, SUS 304 HTF SUS 321 TF, SUS 321 HTF							34.0	36.5	41.5	48.9	56.3	63.5	70.6	79.8	88.9	97.8	106		
			Other than the above							34.2	36.7	41.8	49.3	56.6	63.9	71.0	80.3	89.5	98.4	107		

250	10	267.4	SUS 304 TF, SUS 304 HTF SUS 321 TF, SUS 321 HTF						42.2	45.4	51.7	61.0	70.3	79.4	88.4	100	112	123	134	151	167
			Other than the above						42.5	45.7	52.0	61.4	70.7	79.9	88.9	101	113	124	135	152	168

Remark

1. Calculate the numerical values of mass from the following formula assuming 1cm of steel to 7.93 g for SUS 304 TF, SUS 304 HTF, SUS 321 TF and SUS 321 HTF, and to be 7.98 g for the other tubes and round off the result to 3 significant figures in accordance with JIS Z 8401.

W =0.024 91 t (D-t): SUS 304 TF, SUS 304 HTF, SUS 321 TF and SUS 321HTF

W =0.025 07 t (D-t): other tubes

Where

W: unit mass of tube (kg/m)

t: wall thickness(mm)

D: outside diameter (mm)

2. In dealings, the unit mass of the tube shall be the numerical value given in the above table increased by 14 % for finished seamless steel tube, and by 1 % for cold finished seamless steel tube.

(2) The tolerances on outside diameter, wall thickness and thickness dispersion shall be as given in Table 4

Table 4. Tolerances on Outside diameter, Wall thickness and Thickness Dispersion

Remark

The "wall thickness dispersion" means the ratio of the difference between the maximum and the minimum of wall thickness measured in the same section to the ordered wall thickness. This shall not be applied to the tube under 5.6 mm in thickness.

(3) The tolerances on the length of the tube shall be as specified in Table 5.

Table 5. Tolerances on Length

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

Remark

When an accurate length is particularly required, the tolerances shall be agreed upon by the purchaser and the manufacturer.

8.apperance

8.1 The tube shall be practically straight and its both ends shall be at right angles to its axis.

8.2 The inside and outside surfaces of the tube shall be well-finished and free from defects injurious to use.

9. Method of Manufacture

(1) The tube shall be manufactured from killed steel by seamless process.

(2) The carbon steel tube and the alloy steel tube shall be heat-treated in accordance with Table 6.

The stainless steel tube and the nickel-chromium-iron alloy shall be heat-treated in accordance with Table 7 and be pickled or treated equivalently. However, heat treatments not given above shall be agreed upon by the purchaser and the manufacturer.

Table 6. Heat treatments for Carbon Steel Tubes and Alloy Steel Tubes.

Symbol of class	Heat treatment	
STF 410	Hot finished seamless steel tube	As manufactured. However, as required, low temperature annealing or normalizing may be performed.
	Cold finished seamless steel tube	Low temperature annealing or normalizing
STFA 12	Low temperature annealing, isothermal annealing, full annealing or normalizing followed by tempering	
STFA 22	Low temperature annealing, isothermal annealing, full annealing or normalizing followed by tempering	
STFA 23 STFA 24 STFA 25 STFA 26	Isothermal annealing. full annealing or normalizing followed by tempering	

Remark.

Tempering temperature for STFA 23, STFA 24, STFA 25 and STFA 26 shall be 650 X C or more.

Table 7. Heat Treatment for Austenitic Stainless steel Tubes and Nickel-Chromium-Iron Alloy Tubes.

Symbol of classes	Solution treatment xC	Annealing xC
SUS 304TF	1010 min., rapid cooling	-
SUS 304HTF	1040 min., rapid cooling	-
SUS 309TF	1030 min., rapid cooling	-
SUS 310TF	1030 min., rapid cooling	-
SUS 316TF	1010 min., rapid cooling	-
SUS 316HTF	1040 min., rapid cooling	-
SUS 321TF	920 min., rapid cooling	-
SUS 321HTF	Cold finished 1095 min., rapid cooling	-
	Hot finished 1050 min., rapid cooling	-
SUS 347TF	980 min., rapid cooling	-

SUS 347HTF	Cold finished 1095 min., rapid cooling Hot finished 1050 min., rapid cooling	- -
NCF 800 TF NCF 800H TF	- 1100 min., rapid cooling	950 min., rapid cooling -

Remark

For SUS 321 TF and SUS 347 TF, stabilizing heat treatment may be designated. In this case, the heat treatment temperature shall be 850 to 930 X

10. Test

10.1 Chemical Analysis

10.1.1 Chemical Analysis

General matters of chemical analysis and method of sampling analysis specimens 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 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 1237, JIS G 1253, JIS G 1256, JIS G 1257, JIS G 1281

10.2 Tensile Test

10.2.1 Test Piece

The test specimen shall be No. 11, and shall be No. 12 A, No. 12 B, No.12 C, 4 or No. 5 test piece specified in JIS Z 2201 cut off from the tube in the longitudinal direction.

10.2.2 Test Method

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

10.3 Flattening Test

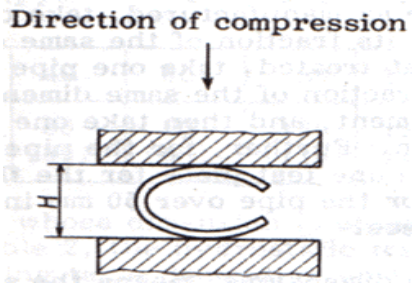
10.3.1 Test Piece

A test piece 50 mm or over in length shall be cut off from the end of a tube. For the tube whose outside diameter is 100 mm or over and whose wall thickness is 15 % or over of the outside diameter,

C-shape test piece made by removing part of the circumference of a whole test piece may be used.

10.3.2 Test method

The test piece shall be placed at ordinary temperature between two flat plates and flattened by compression until the distance occurrence of flaws or cracks on its wall surface. The C-shape test piece. However, shall be place as shown in figure.



10.4 Austenite Grain Size Test

10.4.1 Test Piece

A length of approximately 20 mm shall be cut off from one end of the tube to serve as a test piece

10.4.2 Method of Test

Grain size number specified in JIS G 0051 shall be measured.

10.5 Hydrostatic test or Nondestructive Examination

Either a hydrostatic test or nondestructive examination shall be made in accordance with (1) or (2), respectively

(1) The tube shall be subjected to the hydrostatic pressure kept at the specified pressure and shall withstand it without leakage.

(2) The method of nondestructive examination shall be in accordance with JIS G 0582 or JIS G 0583

11. Inspection

11.1 Inspection

The inspection shall be as follows.

(1) General matters of inspection shall be as specified in JIS G 0303.

(2) The chemical composition, mechanical properties, hydrostatic or nondestructive characteristic, appearance and dimensions shall confirm to the requirements specified in 3., 4., 6., 7. and 8.

The tube of SUS 321 HTF and NCF 800 HTF shall be subjected to the austenite grain size test and the results shall conform to the requirements of 5.

However, appropriate nondestructive examination when agreed upon by the purchaser and the manufacturer.

Further, when the special quality requirements given in Appendix are specified by agreement between the purchaser and the manufacturer, the results of inspection shall conform to the relevant requirements specified in Z 2, Z 3, Z 4 and Z 6.

(3) Either the hydrostatic test or the nondestructive examination shall be performed for each pipe.

(4) The number of specimens for the product analysis shall be agreed upon by the purchaser and the manufacturer.

(5) The sampling of specimens and the number of test pieces for the tensile test, flattening test and austenite grain size test shall be as follows. Take one specimen from each 50 tubes or its fraction of the same dimensions () for the tubes as to be tested manufactured, or take one specimen from each 50 tubes or its fraction of the same dimensions () and concurrent heat treatment for the tubes to be heat treated, and then in either case take one tensile test piece from this specimen.

Further, take one flattening test piece from one end of the specimen and one austenite grain size test piece from other end.

Note () The "same dimensions" means "the same outside diameter combined with the same wall thickness".

11.2 Reinspection

The tube is entitled to a retest specified in 4.4 of JIS G 0303 for final acceptance.

12.Marking

The tubes which have 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 smaller tubes and a request from the purchaser, the tubes may be bundled together and marked on each bundle by a suitable method.

Further, when approved by the purchaser, part of the items may be omitted

(1) Symbol of class

(2) Symbol representing the method of manufacture(²)

(3) Dimensions

(4) Manufacture's name or its abbreviation

(5) Symbol representing the designation of special quality requirement Z

Note(³) Symbols representing the method of manufacture shall be as follows.

However, -- may be replaced by a blank.

Hot finished seamless steel tube -S -H

Cold finished seamless steel tube -S -C

14. Report

The manufacturer shall, in general, submit to the purchaser a detailed statement carrying the test results, method of manufacture, ordered dimensions, quantity, work number indicating the history of manufacture, etc.

Appendix Special Quality Requirements

The supplementary quality requirements shall apply only when requested by the purchaser, and shall be executed by the manufacturer on the designated items.

Z 2 Elevated Temperature Yield Point or Proof Stress

(1) The value of elevated temperature yield point or proof stress and the testing temperature of the tube shall be be agreed upon by the purchaser and the manufacturer.

(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 agreed upon by the purchaser and the manufacturer.

(3) The method of sampling the test specimens and the number of test pieces shall be as follows. Take one test specimen from each lot of the same heat. and then from one test specimen take one test piece from each lot of the same testing temperature.

Z 3 Ultrasonic Examination

(1) The criteria of the working sensitivity in the ultrasonic examination shall be the division UB or UC specified in JIS G 0582, and there shall be no signal greater than those

produced by the artificial defects of the reference test block.

(2) The test method of the ultrasonic examination shall be as specified in JIS G 0582.

(3) The ultrasonic examination shall be performed for each tube and the results shall conform to the requirements specified in (1).

Z 4 Eddy Current Examination

(1) The criteria of the working sensitivity in the eddy current examination shall be the division EV, or EX specified in JIS G 0583, and there shall be no signal greater than those produced by the artificial defects of the reference test block.

(2) The test method of the eddy current examination shall be as specified in JIS G 0583.

(3) The eddy current examination shall be performed for each pipe and the results shall conform to the requirements specified in (1).

Z Corrosion Test

(1) Corrosion Resistance

The corrosion resistance to the intergranular corrosion test shall be as follows. In this case, the kind of intergranular corrosion test to be applied shall be as agreed upon by the purchaser and the manufacturer.

(a) Etch structure screening by 10 % oxalic acid etch test shall be as given in Appendix Table 1.

Appendix Table 1. Screening by 10 % Oxalic Acid Etch Test

(b) The weight loss of the tube by ferric sulfate-sulfuric acid test shall be as given in Appendix Table 2.

Appendix Table 2. Weight Loss by Ferric Sulfate-Sulfuric Acid Test

Symbol of class	Condition	Weight loss g/(m h)
SUS 304 TF SUS 316 TF	As received (Solution-treated)	To be agreed upon by purchaser and manufacturer.

(c) The weight loss by 65 % nitric acid test shall be as given in Appendix Table 3.

Appendix Table 3. Weight Loss by 65 % Nitric Acid Test

Symbol of class	Condition	Weight loss g/(m^2h)
SUS 304 TF	As received (Solution-treated)	To be agreed upon by purchaser and manufacturer.

(d) The corrosion ratio by nitric-hydrofluoric acid test shall be as given in Appendix Table 4.

Appendix Table 4.

Symbol of class	Corrosion ratio
SUS 316 TF	1.5 max.

(e) The state of the bent surface after the copper sulfate-sulfuric acid test shall be as given in Appendix Table 5.

Appendix Table 5. State of Bent Surface after Copper Sulfate-Sulfuric Acid Test

Symbol of class	Condition	State of bent surface
SUS 304 TF SUS 316 TF	As received (Solution-treated)	Intergranular cracks shall not be generated.
SUS 321 TF SUS 347 TF	Sensitized	Intergranular cracks shall not be generated.

(2) An adequate length 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 one of the following Standards

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

(4) The test results shall comply with the requirements specified in (1).

(5) The sampling of specimens and the number of test pieces shall be as specified for the grain size test in 11.1 (5) of the text.

However, if required, the test piece given above shall be taken from each set of tubes of the same heat and concurrent 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)

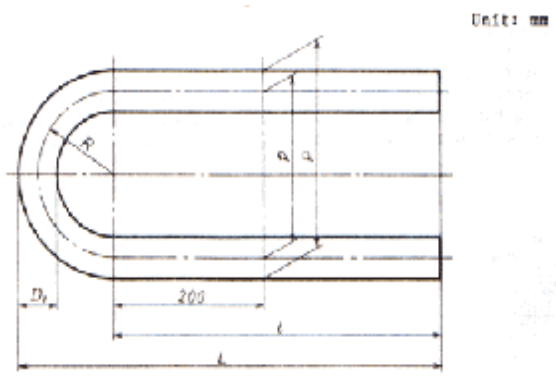
(1) The U-bent tube shall be manufactured by cold bending process and the bend radius shall be at least 1.5 times the outside diameter of the tube.

(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 defect injurious to use.

3. Dimensional tolerances on the bent portion shall be as specified in Annex2. Table 1, and tolerances on the length after bending shall be as specified in Annex 2 Table 2.

Annex 2 Fig. 1



R: bend radius

D1: outside diameter of bent portion

t1: minimum wall thickness of bent portion

P: p+Dn

L: ラ+R+Dn/2

Dn: nominal outside diameter

tn: nominal wall thickness

p: pitch

ラ: length of straight portion

Annex 2 Table 1. Dimensional tolerances on bent portion

Variation rate of outside diameter D_1-D_n /D_n X100%		Reduction rate of wall thickness t_n-t_1 /t_n X100%	Tolerances on pitch (p) or P mm
Short radius side	Long radius side		
D_n /4R X100 max. Where, the minimum value of D-Dn is 0.5mm	D_n /8R X100 max. Where, the minimum value of D-Dn is 0.5 mm	D_n /2.5R X100 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 90XC 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.

Material Comparison Tables (ASTM, KS, JIS, DIN, BS, NBN, NF, UNI)

ASTM Standard	UNS NO.	KOREA/JAPANES			GERMAN				BRITISH			BELGIAN			FRENCH			ITALIAN		
		KS/JIS Symbol	KS/JIS Number	Remarks	DIN Type	DIN Number	Material Number	Remarks	B.S Number	B.S Grade	Remarks	NBN Type	NBN Grade	Remarks	AFNOR Type	NF Number	Remarks	UNI Type	UNI Number	Remarks
A 161 Seamless Low-C and C-Mo Steel Tubes for Refinery Service Carbon Steel																				
	K01504	STF 410 / STF 410	D3587 / G3467	(31)	St35.8	17175	1.0305		3056	HFS 320	(31)	D 37.1	629	(3b)	C 10 d		(3a)	C 14	5462	(3b)
	K11522	SFTA12 / STFA12	D3578 / G3467	(34)	16Mo5		1.5423	(3a)			(3)	16 Mo 5	629	(3b)	15 D 5		(3a)	16Mo5	5462	(3b)
Grade T1																				

Material Comparison Tables (ASTM, KS, JIS, DIN, BS, NBN, NF, UNI)

ASTM Standard	UNS NO.	KOREA/JAPANES			GERMAN				BRITISH			BELGIAN			FRENCH			ITALIAN		
		KS/JIS Symbol	KS/JIS Number	Remarks	DIN Type	DIN Number	Material Number	Remarks	B.S Number	B.S Grade	Remarks	NBN Type	NBN Grade	Remarks	AFNOR Type	NF Number	Remarks	UNI Type	UNI Number	Remarks
A 271 Seamless Austenitic Cr-Ni Steel Tubes for Refinery Service																				
TP 304	S30400	STS 304TF / SUS 304TF	D3587 / G3467		X5CrNi 18 9	17440	1.4301	(3b)	3605	304S18					Z6 CN 18.09	A35-573	(3b)	X5 CrNi 18 10	6904	Dalmine 913(3b)
TP 304H	S30409	STS 304HTF	D3587 / G3467		X6 CrNi 18 11		1.4948	WBL-640(3b)	3605	304S59					Z6 CN 19-10	A49-214		X8 CrNi	6904	(3b)

		/ SUS 304HTF																19 10		
TP 346	S31600	STS 316 TF / SUS 316TF	D3587 / G3467		X5 CrNiMO 18 10	17440	1.4401	(3b)	3605	316S18		X6 CrNi Mo17.12.2	911		Z6CND17-11	A35-573	(3b)	X5 CrNiMo 17 12	6904	(3b)
TP 321	S32100	STS 321TF / SUS 321TF	D3587 / G3467		X10 CrNiTi 18 9	17440	1.4541	(3b)	3605	321S18		X6CrNi Ti 18 10	911		Z6CNT18.10	A35-573	(3b)	X6 CrNiTi 18 11	6904	(3b)
TP 347	S34700	STS 347TF / SUS 347TF	D3587 / G3467		X5 CrNiNb 18 10	17440	1.4550	(3b)	3605	347S18		X6 CrNi Nb 18 10	911		Z6 CNNb 18.11	A32-573	(3b)	X6 CrNiNb 18 11	6904	Dalmine 991(3b)
TP 347H	S34709	STS 347HTF / SUS 347HTF	D3587 / G3467		X8 CrNiNb 16 13		1.4961	WBL-670(3b)	3605	347S59							(3)	X8 CrNiNb 18 11	6904	(3b)

JIS Number and Corresponding Foreign Standards

JIS			ASTM			NF			ISO			Index Number
Standard Number	Grade	Type	Standard Number	Grade	Type	Standard Number	Grade	Type	Standard Number	Grade	Type	
G3467	STF								2604/2	TS9H	C	C013
	(STF42)	C										
	STFA12	Mo	A161	T1	Mo							
	STFA22	CrMo										
	STFA23	CrMo	A200	T11	CrMo							
	STFA24	CrMo	A200	T22	CrMo							
	STFA25	CrMo	A200	T5	CrMo				2604/2	TS37	CrMo	

	STFA26	CrMo	A200	Tp	CrMo							
	SUS		A271	TP304	SUS				2604/2	TS47	SUS	
	304FT	SUS										
	SUS		A271	TP304H	SUS	A49-218	TUZ6CN 18.09		2604/2	TS48	SUS	
	304HTF											
	SUS				SUS							
	309SFT	SUS										
	SUS				SUS				2604/2	TS68	SUS	
	310STF	SUS										
	SUS		A271	TP316	SUS	A49-218	TUZ6CND 17.11		2604/2	TS61	SUS	
	316TF	SUS										
	SUS		A271	TP316H	SUS				2604/2	TS63	SUS	
	316HTF	SUS										
	SUS		A271	TP321	SUS				2604/2	TS53	SUS	
	321TF	SUS										
	SUS		A271	TP321H	SUS	A49-218	TUZ6CNT 18.10	SUS				
	321HTF	SUS										
	SUS		A271	TP347	SUS	A49-218	TUZ6CNNb 18.10	SUS	2604/2	TS50	SUS	
	347TF	SUS										
	SUS		A271	TP347H	SUS							
	347HTF	SUS										
	NCF8000TF	NiCr										
	NCF8000HTF	NiCr										