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JAPANESE INDUSTRIAL STANDARD

**Steel Heat Exchanger Tubes
for Low Temperature Service**

 **JIS G 3464**—1988

Translated and Published

by

Japanese Standards Association

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



JAPANESE INDUSTRIAL STANDARD

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Steel Heat Exchanger Tubes for
Low Temperature Service

G 3464-1988

1. Scope

This Japanese Industrial Standard specifies the steel tubes, hereinafter referred to as the "tubes", used for the purpose of exchanging heat on the inside and outside of the tube at exceptionally low temperatures below freezing point, such as heat exchanger tubes, condenser tubes, etc.

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

Appendix 1 Z1 Hardness

Appendix 1 Z3 Ultrasonic examination

Appendix 1 Z4 Eddy current examination

Appendix 2 U-bend tube

2. The austenitic steel tubes among the steel tubes specified in JIS G 3463 may be used. In this case, the impact test need not be particularly performed.

3. 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.

Further, the traditional units accompanied by numerical values in this Standard shall be converted to the SI units and numerical values on Jan. 1, 1991.

2. Classes and Symbols

The tubes shall be classified into three classes and their symbols shall be as given in Table 1-1 or Table 1-2.

Table 1-1. Symbols of Classes

(Applicable till the end of 1990)

Classification	Symbol of class
Carbon steel tube	STBL 39
Nickel steel tube	STBL 46 STBL 70

Applicable Standards: See page 22.

Table 1-2. Symbols of Classes
(Applicable on and after Jan. 1, 1991)

Classification	Symbol of class	(Reference) Former symbol
Carbon steel tube	STBL 380	STBL 39
Nickel steel tube	STBL 450 STBL 690	STBL 46 STBL 70

3. Chemical Composition

The tube shall be tested in accordance with 9.1 and the resulting ladle analysis values shall conform to Table 2-1 or Table 2-2

Table 2-1. Chemical Composition
(Applicable till the end of 1990)

Symbol of class	Unit: %					
	C	Si	Mn	P	S	Ni
STBL 39	0.25 max.	0.35 max.	1.35 max.	0.035 max.	0.035 max.	-
STBL 46	0.18 max.	0.10 to 0.35	0.30 to 0.60	0.030 max.	0.030 max.	3.20 to 3.80
STBL 70	0.13 max.	0.10 to 0.35	0.90 max.	0.030 max.	0.030 max.	8.50 to 9.50

Remarks 1. When it is practically difficult to apply the impact test due to the dimensions of a tube, STBL 39 shall, by way of compensation, contain 0.010 % or more of acid soluble aluminium, or alternatively, 0.015 % or more of total aluminium.

2. When product analysis is required by the purchaser, the tolerances for the values given in the above table shall be as specified in Table 2 in JIS G 0321 for the seamless steel tube of STBL 39, and likewise in Table 1 for the electric resistance welded steel tube.

The tubes of STBL 46 and STBL 70 shall be in accordance with Table 2-1.

Table 2-2. Chemical Composition
(Applicable on and after Jan. 1, 1991)

Symbol of class	Unit: %					
	C	Si	Mn	P	S	Ni
STBL 380	0.25 max.	0.35 max.	1.35 max.	0.035 max.	0.035 max.	-
STBL 450	0.18 max.	0.10 to 0.35	0.30 to 0.60	0.030 max.	0.030 max.	3.20 to 3.80
STBL 690	0.13 max.	0.10 to 0.35	0.90 max.	0.030 max.	0.030 max.	8.50 to 9.50

Remarks 1. When it is practically difficult to apply the impact test due to the dimensions of a tube, STBL 380 shall, by way of compensation, contain 0.010 % or more of acid soluble aluminium, or alternatively, 0.015 % or more of total aluminium.

2. When product analysis is required by the purchaser, the tolerances for the values given in the above table shall be as specified in Table 2 in JIS G 0321 for the seamless steel tube of STBL 380, and likewise in Table 1 for the electric resistance welded steel tube.

The tubes of STBL 450 and STBL 690 shall be in accordance with Table 2-2.

4. Mechanical Properties

4.1 Tensile Strength, Yield Point or Proof Stress and Elongation The tube shall be tested in accordance with 9.2 and the resulting tensile strength, yield point or proof stress and elongation shall conform to Table 3-1 or Table 3-2.

Table 3-1. Mechanical Properties
(Applicable till the end of 1990)

Symbol of class	Tensile strength kgf/mm ² {N/mm ² }	Yield point or proof stress kgf/mm ² {N/mm ² }	Elongation %		
			Outside diameter 20 mm or over	Outside diameter 10 mm or over to and excl. 20 mm	Outside diameter under 10 mm
			No. 11 test piece No. 12 test piece	No. 11 test piece	No. 11 test piece
STBL 39	39 {382} min.	21 {206} min.	35 min.	30 min.	27 min.
STBL 46	46 {451} min.	25 {245} min.	30 min.	25 min.	22 min.
STBL 70	70 {686} min.	53 {520} min.	21 min.	16 min.	13 min.

- Remarks
1. The purchaser may designate the upper limit of tensile strength. In this case, the upper limit of tensile strength shall be the value 12 kgf/mm² {118 N/mm²} added to the value specified in the Table 3-1 for STBL 39, and 15 kgf/mm² {147 N/mm²} added for STBL 46 and STBL 70.
 2. When the tube under 8 mm in thickness is subjected to tensile test by using No. 12 test piece, the minimum value of elongation shall be calculated by subtracting 1.5 % from the value of elongation given in Table 3-1 for each decrease of 1 mm and rounding off the result to a whole number according to JIS Z 8401. Examples of calculation are shown in Reference Table 1.
 3. When a tensile test piece is to be taken from the electric resistance welded steel tube, a No. 12 test piece shall be taken from a seamless portion.

Table 3-2. Mechanical Properties
(Applicable on and after Jan. 1, 1991)

Symbol of class	Tensile strength N/mm ²	Yield point or proof stress N/mm ²	Elongation %		
			Outside diameter 20 mm or over	Outside diameter 10 mm or over to and excl. 20 mm	Outside diameter under 10 mm
			No. 11 test piece No. 12 test piece	No. 11 test piece	No. 11 test piece
STBL 380	380 min.	205 min.	35 min.	30 min.	27 min.
STBL 450	450 min.	245 min.	30 min.	25 min.	22 min.
STBL 690	690 min.	520 min.	21 min.	16 min.	13 min.

- Remarks 1. The purchaser may designate the upper limit of tensile strength. In this case, the upper limit of tensile strength shall be the value 120 N/mm² added to the value specified in the Table 3-2 for STBL 380, and 150 N/mm² added for STBL 450 and STBL 690.
2. When the tube under 8 mm in thickness is subjected to tensile test by using No. 12 test piece, the minimum value of elongation shall be calculated by subtracting 1.5 % from the value of elongation given in Table 3-2 for each decrease of 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.
3. When a tensile test piece is to be taken from the electric resistance welded steel tube, a No. 12 test piece shall be taken from a seamless portion.

4.2 Flattening Resistance The tube shall be tested in accordance with 9.3 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:

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

H : distance between flat plates (mm)

t : wall thickness of tube (mm)

D : outside diameter of tube (mm)

e : constant 0.08

4.3 Flaring Resistance The tube shall be flared into a bell shape to 1.14 times the outside diameter and then no flaws shall be generated.

4.4 Absorbed Energy Absorbed energy shall be as follows.

(1)-1 (Applicable till the end of 1990) The tube shall be tested in accordance with 9.5 and the absorbed energy of the tube in the Charpy impact test shall comply with Table 4-1. In this case, the testing temperature for the tube of STBL 39, STBL 46 and STBL 70 shall be -45°C, -100°C and -196°C, respectively.

Table 4-1. Absorbed Energy in Charpy Impact Test
(Applicable till the end of 1990)

Dimensions of test piece mm	Absorbed energy in Charpy impact test $\frac{\text{kgf}\cdot\text{m}}{\text{J}}$		
	Average value of one set (3 pieces)	Each value of 2 pieces out of 3	Value of each piece
10 x 10	2.1 {20.6} min.	2.1 {20.6} min.	1.4 {13.7} min.
10 x 7.5	1.8 {17.7} min.	1.8 {17.7} min.	1.2 {11.8} min.
10 x 5	1.4 {13.7} min.	1.4 {13.7} min.	1.0 {9.81} min.

Remark: To the tube not fit to provide a test piece 10 x 5 mm, the impact test shall not be applied.

(1)-2 (Applicable on and after Jan. 1, 1991) The tube shall be tested in accordance with 9.5 and the absorbed energy of the tube in the Charpy impact test shall comply with Table 4-2. In this case, the testing temperature for the tube of STBL 380, STBL 450 and STBL 690 shall be -45°C, -100°C and -196°C, respectively.

Table 4-2. Absorbed Energy in Charpy Impact Test
(Applicable on and after Jan. 1, 1991)

Dimensions of test piece mm	Absorbed energy in Charpy impact test J		
	Average value of one set (3 pieces)	Each value of 2 pieces out of 3	Value of each individual piece
10 x 10	21 min.	21 min.	14 min.
10 x 7.5	18 min.	18 min.	12 min.
10 x 5	14 min.	14 min.	10 min.

Remark: To the tube not fit to provide a test piece 10 x 5 mm, the impact test shall not be applied.

- (2) The electric resistance welded steel tube shall be subjected to the impact test for the weld in addition to the Charpy impact test specified in (1), and the absorbed energy obtained shall comply with Table 4-1 or Table 4-2. In this case, the testing temperature shall be -45°C.

5. Hydrostatic Characteristic or Nondestructive Characteristic

The tube shall be tested in accordance with 9.6 and the resulting 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 discretion of the manufacturer.

5.1-1 Hydrostatic Characteristic (Applicable till the end of 1990) When the hydrostatic pressure specified by the purchaser or, in the absence of a specified value, pressure P (5 MPa max.) calculated from the formula below is applied, the tube shall withstand it without leakage. In this case, the purchaser may specify values of pressure lower or higher than those given in Attached Table 1-1.

When a hydrostatic pressure test is made in compliance with the designation of the purchaser and the test pressure exceeds either 50 kgf/cm² {49 bar} or the value P , the test pressure shall be agreed upon by the purchaser and the manufacturer. The designated hydrostatic test pressure shall be graduated in 5 kgf/cm² {4.9 bar}.

The value P in the following formula shall be obtained by computing to the unit digit and rounding off to the nearest 5 kgf/cm² {4.9 bar}.

$$P = \frac{200st}{D}$$

where P : test pressure (kgf/cm² {10⁻¹ bar}) (¹)
 t : wall thickness of tube (mm)
 D : outside diameter of tube (mm)
 s : 60 % of the minimum value of yield point or proof stress specified in Table 4-1 (kgf/mm² {N/mm²})

Note (¹) 1 bar=10⁵ Pa

5.1-2 Hydrostatic Characteristic (Applicable on and after Jan. 1, 1991) When the hydrostatic pressure specified by the purchaser or, in the absence of a specified value, pressure P (5 MPa max.) calculated from the formula below is applied, the tube shall withstand it without leakage. In this case, the purchaser may specify values of pressure lower or higher than those given in Attached Table 1-2.

When a hydrostatic pressure test is made in compliance with the designation of the purchaser and the test pressure exceeds either 5 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 test pressure shall be graduated in 0.5 MPa for the values under 10 MPa, and in 1 MPa for the value 10 MPa or over.

The value P in the following formula shall be obtained by computing to the unit digit and rounding off to the nearest 0.5 MPa or 1 MPa similarly.

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

where P : test pressure (MPa)
 t : wall thickness of tube (mm)
 D : outside diameter of tube (mm)
 s : 60 % of the minimum value of yield point or proof stress specified in Table 4-2 (N/mm²)

5.2 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 0582 or the division EY of the working sensitivity specified in JIS G 0583, respectively.

6. Dimensions, Mass and Dimensional Tolerances

6.1 Dimensions and Mass The outside diameter, wall thickness and mass of the tubes shall conform to Attached Table, unless specially designated.

6.2 Dimensional Tolerances The dimensional tolerances shall be as follows.

- (1) The tolerances on the outside diameter of the tube shall be as specified in Table 5.
- (2) The tolerances on the wall thickness of the tube and the wall thickness deviation shall be as specified in Table 6.
- (3) The tolerances on the length of the tube shall be as specified in Table 7.

Table 5. Tolerances on Outside Diameter

Unit: mm

Division of outside diameter	Tolerances on outside diameter				
	Hot finished seamless steel tube	Quenched and tempered cold finished seamless steel tube	Cold finished seamless tube after heat treatment other than quenching and tempering	Electric resistance welded steel tube not cold finished	Cold finished electric resistance welded steel tube
Up to 25	+ 0.4 - 0.8	± 0.25	± 0.10	± 0.15	± 0.10
25 and over, up to 40			± 0.15	± 0.20	± 0.15
40 and over, up to 50			± 0.20	± 0.25	± 0.20
50 and over, up to 60			± 0.25	± 0.30	± 0.25
60 and over, up to 80		± 0.30	± 0.30	± 0.40	± 0.30
80 and over, up to 100	+ 0.4 - 1.2	± 0.40	± 0.40	+ 0.40 - 0.60	± 0.40
100 and over, up to 120		+ 0.40 - 0.60	+ 0.40 - 0.60	+ 0.40 - 0.80	+ 0.40 - 0.60
120 and over, up to 160		+ 0.40 - 0.80	+ 0.40 - 0.80	+ 0.40 - 1.00	+ 0.40 - 0.80
160 and over, up to 200	+ 0.4 - 1.8	+ 0.40 - 1.20	+ 0.40 - 1.20	+ 0.40 - 1.20	+ 0.40 - 1.20
200 and over	+ 0.4 - 2.4	+ 0.40 - 1.60	+ 0.40 - 1.60	+ 0.40 - 1.60	+ 0.40 - 1.60

- Remarks 1. To the tolerances on the outside diameter of electric resistance welded steel tube not cold finished, the tolerances on the outside diameter of cold finished seamless steel tube may be applied, when specially requested by the purchaser.
2. The purchaser may designate the permissible deviations of outside diameter of quenched and tempered cold finished seamless steel tube under 40 mm in outside diameter as ± 0.20 mm.

Table 6. Tolerances on Wall Thickness and Wall Thickness Deviation

Division of method of manufacture Division of outside diameter mm Division of thickness mm		Hot finished seamless steel tube		Cold finished seamless steel tube		Electric resistance welded steel tube	
		Up to 100	100 and over	Up to 40	40 and over	Up to 40	40 and over
Permissible deviation of wall thickness %	Under 2	-	-	+ 0.4 mm 0		+ 0.3 mm 0	
	2 and over, up to 2.4	+ 40 0	-				
	2.4 and over, up to 3.8	+ 35 0	+ 35 0		+ 22 0		+ 18 0
	3.8 and over, up to 4.6	+ 33 0	+ 33 0	+ 20 0		+ 18 0	
	4.6 and over	+ 28 0	+ 28 0				
Permissible wall thickness deviation %	-	Within 22.8 of wall thickness		-		-	

Remark: The "wall thickness deviation" means the ratio of the difference between the maximum and the minimum of the measured wall thickness in the same section to the ordered wall thickness. This is not applicable to tubes under 5.6 mm in wall thickness.

Table 7. Tolerances on Tube Length

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

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

7. 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.

8. Method of Manufacture

The method of manufacture shall be as follows:

- (1)-1 (Applicable till the end of 1990) The tube of STBL 39 shall be manufactured by the seamless or electric resistance welding process and that of STBL 46 and STBL 70 by the seamless process, and all the tubes shall be made from the fine-grained killed steel.
- (1)-2 (Applicable on and after Jan. 1, 1991) The tube of STBL 380 shall be manufactured by the seamless or electric resistance welding process and that of STBL 450 and STBL 690 by the seamless process, and all the tubes shall be made from the fine-grained killed steel.
- (2) All the tubes shall be subjected to heat treatments specified in Table 8-1 or Table 8-2. Other heat treatments shall be agreed upon by the parties concerned.

Table 8-1. Heat Treatment
(Applicable till the end of 1990)

Symbol of class	Heat treatment
STBL 39	Normalizing or normalizing and successive tempering
STBL 46	
STBL 70	Double normalizing and successive tempering or quenching and tempering.

Table 8-2. Heat Treatment
(Applicable on and after Jan. 1, 1991)

Symbol of class	Heat treatment
STBL 380	Normalizing or normalizing and successive tempering
STBL 450	
STBL 690	Double normalizing and successive tempering or quenching and tempering.

9. Tests

9.1 Chemical Analysis

9.1.1 Chemical Analysis General matters of chemical analysis and method of sampling analysis samples shall be in accordance with 3. of JIS G 0303.

9.1.2 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 1224	JIS G 1253
JIS G 1256	JIS G 1257		

9.2 Tensile Test

9.2.1 Test Piece The test specimen shall be No. 11, No. 12 A, No. 12 B or No. 12 C test piece specified in JIS Z 2201 and shall be cut off from the tube longitudinally.

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

9.3 Flattening Test

9.3.1 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 wall thickness is 15 % or over of the outside diameter, a C-shape test piece made by removing part of the circumference of a whole test piece may be used.

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

Fig. 1. Flattening Test
(for Whole Test Piece)

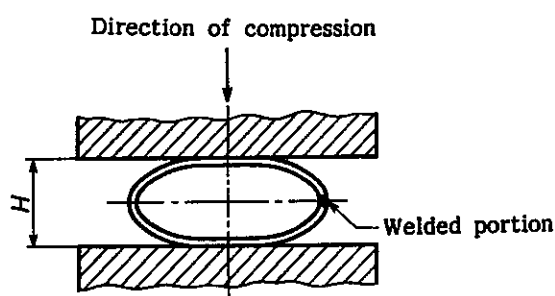
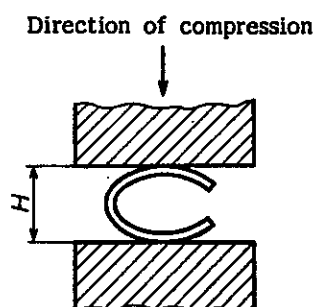


Fig. 2. Flattening Test
(for C-shape Test Piece)



9.4 Flaring Test

9.4.1 Test Pieces An adequate length of tube shall be cut off from one end of the tube as a test piece.

9.4.2 Method of Test The test piece shall be flared at one of the tube ends at ordinary temperature into a bell shape and to the specified size with a conical tool forming an angle of 60° and checked for any flaws or other defects.

9.5 Charpy Impact Test

9.5.1 Test Piece The Charpy impact test piece shall be No. 4 test piece specified in JIS Z 2202. However, the width of the test piece may be altered to 7.5 mm or 5 mm according to the dimensions of the tube. This is to be cut off longitudinally.

The Charpy impact test piece of the weld of electric resistance welded steel tube shall, as a rule, No. 4 test piece specified in JIS Z 2202 to be taken transversely.

The finishing condition and length of the Charpy impact test piece for weld may be decided by agreement between the purchaser and the manufacturer.

9.5.2 Test Method The test method shall be in accordance with the method of Charpy impact test specified in JIS Z 2242.

9.6 Hydrostatic Test or Nondestructive Examination Either a hydrostatic test or a nondestructive examination shall be made in accordance with (1) or (2), respectively.

- (1) The tube shall be subjected to a hydrostatic pressure and kept at the designated or specified pressure to see if it withstands the pressure without leakage.
- (2) The test method of nondestructive examination shall be in accordance with either JIS G 0582 or JIS G 0583.

10. Inspection

10.1 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, dimensions and appearance shall conform to the requirements specified in 3., 4., 5., 6. and 7. However, appropriate nondestructive examinations other than those specified in 9.6 (2) may substitute for the said nondestructive examination when agreed upon by the purchaser and the manufacturer.
Further, when the supplementary quality requirements given in Appendix 1 are specified or a U-bend tube given in Appendix 2 is designated by agreement between the purchaser and the manufacturer, the results of inspection shall conform to the requirements of Z1, Z3 and Z4 in Appendix 1 and the requirements in Appendix 2, respectively.
- (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 method of sampling test specimens and the number of test pieces for tensile test, flattening test and flaring test shall be as follows. Take one tube as the specimen from each 50 tubes or its fraction of the same dimensions ⁽²⁾ which are subjected to a concurrent heat treatment, and then from the test specimen take one tensile test piece. Further, from one end of the test specimen take one flattening test piece and from the others take one flaring test piece.
- (6) The method of sampling the test specimens and the number of test pieces for Charpy impact test shall be as follows. Take one tube as the specimen from each 100 tubes or its fraction of the same dimensions ⁽²⁾ subjected to a concurrent heat treatment, and then take one set (3 pieces) of test pieces from each specimen.
For the electric resistance welded steel tube, take one set (3 pieces) of Charpy impact test pieces for the welded zone, in addition to the above-mentioned Charpy impact test pieces.

Note ⁽²⁾ The "same dimensions" means the same outside diameter combined with the same wall thickness.

10.2 Reinspection The reinspection shall be as follows:

- (1) The tube which fails to pass the tests specified in 9.2 to 9.4 may be retested in accordance with 4.4 in JIS G 0303 to determine whether it is acceptable or not.
- (2) When the tube fails to pass the test specified in 9.5, but satisfies the following two conditions as well as the specified limit of the average value of the absorbed energy, a retest may be conducted to determine whether it is acceptable or not.
 - (a) In the case where the values for two out of the three are equal to or higher than the average value specified in Table 4-1 or Table 4-2 but each individual one fails to satisfy the specified value,
 - (b) In the case where the values for two out of the three satisfy the value specified for two pieces given in Table 4-1 or Table 4-2 but fail to satisfy the average value specified in the relevant Table.

In this case, three additional test pieces shall be taken from the same lot for a retest, and each value of the three test pieces shall conform to the average value of one set (3 pieces) specified in Table 4-1 or Table 4-2.

11. Marking

Each tube having passed the inspection shall be marked with the following items. However, in the case of either smaller tubes or a request from the purchaser, the tubes may be bundled together and marked for each bundle by suitable means. The order of arranging the items is not specified.

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

- (1) Letter symbol of grade
- (2) Letter symbol indicating the manufacturing process ⁽³⁾
- (3) Dimensions
- (4) Manufacturer's name or its abbreviation
- (5) Letter symbol Z denoting the supplementary quality requirement

Note ⁽³⁾ The letter symbol indicating the manufacturing process shall be as follows, provided that the dash may be replaced by a blank.

Hot finished seamless steel tube-S-H

Cold finished seamless steel tube-S-C

Electric resistance welded steel tube other than
hot finished or cold finished ones-E-G

Hot finished electric resistance welded steel tube-E-H

Cold finished electric resistance welded steel tube-E-C

12. 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.

Attached Table. Dimensions and Mass of Steel Heat Exchanger Tubes for Low Temperature Service

Unit: kg/m

Wall thick- ness (mm) Out- side diameter (mm)	1.2	1.6	2.0	2.3	2.9	3.5	4.5	5.5	6.5
15.9	0.435	0.564	0.686						
19.0		0.687	0.838	0.947					
25.4			1.15	1.31	1.61				
31.8				1.67	2.07	2.44			
38.1					2.52	2.99	3.73		
45.0						3.58	4.49	5.36	
50.8						4.08	5.14	6.14	7.10

Remarks 1. The numerical value of mass shall be obtained by calculating according to the following formula, assuming 1 cm³ of steel to be 7.85 g and by rounding 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 transaction, the unit mass of the tube to be taken as the standard shall be the value given in the above table increased by 15 % for hot finished seamless steel tube, by 10 % for cold finished seamless steel tube, and by 9 % for electric resistance welded steel tube.

Reference Table 1. Calculation Examples of Elongation Values for No. 12 Test Piece of Tubes under 8 mm in Wall Thickness

(Applicable till the end of 1990)

Symbol of class	Value of elongation for each division of wall thickness %						
	Over 7 mm, up to 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
STBL 39	35	34	32	30	29	28	26
STBL 46	30	28	27	26	24	22	21
STBL 70	21	20	18	16	15	1	12

Reference Table 2. Calculation Examples of Elongation Values for No. 12 Test Piece of Tubes under 8 mm in Wall Thickness

(Applicable on and after Jan. 1, 1991)

	Value of elongation for each division of wall thickness %						
Symbol of class	Over 7 mm, up to 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
STBL 380	35	34	32	30	29	28	26
STBL 450	30	28	27	26	24	22	21
STBL 690	21	20	18	16	15	14	12

Appendix 1. Special Quality Requirements

The special quality requirements apply only when required by the purchaser and the manufacturer shall perform the designated items on the straight tube.

Z 1 Hardness The hardness shall be as follows:

- (1) The hardness of the tube shall be as given in Appendix 1 Table.

Appendix 1 Table. Hardness

Symbol of class	Rockwell hardness HRB (Mean of three points)
STBL 39	85 max.
STBL 46	90 max.
STBL 70	-

- (2) An adequate length shall be cut off from an end of the tube 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 on each test piece.

Further, tubes of 2 mm or under in wall thickness shall not be tested. As for the electric resistance welded steel tube, the test shall be performed in the portion other than the weld and heat-affected zone.

- (4) The hardness shall comply with the requirements specified in Appendix 1 Table.
- (5) The sampling of specimens and the number of test pieces shall be as specified for the tensile test in 10.1 (5) of the text.
- (6) Reinspection The tube is entitled to a retest in accordance with 4.4 of JIS G 0303 for a final acceptance.

Z 3 Ultrasonic Examination The ultrasonic examination shall be as follows:

- (1) The criteria of the 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 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 The eddy current examination shall be as follows:

- (1) The criteria of the 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 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 tube and the results shall conform to the requirements specified in (1).

Appendix 2. U-Bend Tube

The U-bend tube shall be applicable only when required by the purchaser and shall be executed by the manufacturer.

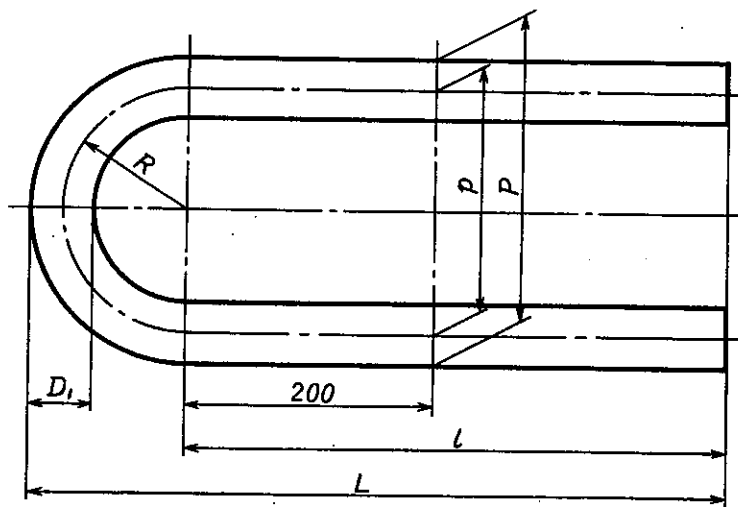
1. Method of Manufacture

The method of manufacture shall be as follows (see Appendix 2 Figure).

- (1) The U-bend tube shall be manufactured by cold bending process and the bending radius shall be at least 1.5 times the outside diameter of the tube.
 - (2) The bent portion of the tube shall, in general, not be subjected to a heat treatment. However, when required by the purchaser, agreement may be made on heat treatment.
2. The bent portion shall be free from defects injurious to use.
 3. The dimensional tolerances for bent portion shall be as specified in Appendix 2 Table 1 and the tolerances on length after bending shall be as specified in Appendix 2 Table 2.

Appendix 2 Figure

Unit: mm



R : bend radius

D_n : nominal outside diameter

D_1 : outside diameter of bent portion

t_n : nominal wall thickness

t_b : minimum wall thickness of bent portion

p : pitch

P : $p + D_n$

l : length of straight portion

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

Appendix 2 Table 1. Dimensional Tolerances for Bent Portion

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

Appendix 2 Table 2. Tolerances on length of Bend Tube

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

4. The measurement of dimensions of bent portion shall be as follows.

Take one specimen from a U-bent tube of the smallest bending radius of the tubes of the same dimension bent concurrently. Measure the outside diameters in two directions at 90 degrees in the bent portion and the wall thickness at four locations on the circumference and obtain the variation rate of outside diameters and the reduction rate of wall thickness.

Applicable Standards:

- JIS G 0303-General Rules for Inspection of Steel
- JIS G 0321-Product Analysis and its Tolerance for Wrought Steel
- JIS G 0582-Ultrasonic Examination of 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 1224-Methods for Determination of Aluminium in Iron and Steel
- 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-Atomic Absorption Spectrochemical Analysis of Iron and Steel
- JIS Z 2201-Test Pieces for Tensile Test for Metallic Materials
- JIS Z 2202-Test Pieces for Impact Test for Metallic Materials
- JIS Z 2241-Method of Tensile Test for Metallic Materials
- JIS Z 2242-Method of Impact 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

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