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**Carbon steel pipes for high temperature
service**

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry, through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by The Japan Iron and Steel Federation (JISF) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently **JIS G 3456:2016** is replaced with this Standard.

However, **JIS G 3456: 2016** may be applied in the **JIS** mark certification based on the relevant provisions of Article 19 Clause 1, etc. of the Industrial Standardization Law until 19 June 2020.

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Attention is drawn to the possibility that some parts of this Standard may conflict with patent rights, applications for a patent after opening to the public or utility model rights. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying any of such patent rights, applications for a patent after opening to the public or utility model rights.

Carbon steel pipes for high temperature service

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 9329-2** : 1997, Edition 1, and **ISO 9330-2** : 1997, Edition 1, with some modifications of the technical contents.

Supplementary quality requirements that can be applied upon agreement between the purchaser and the manufacturer in addition to the requirements in the main body are given in Annex JA. The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standards. A list of modifications with the explanations is given in Annex JB.

1 Scope

This Standard specifies requirements for the carbon steel pipes (hereafter referred to as pipes) used mainly for service at temperatures over 350 °C. The requirements in this Standard normally apply to pipes with an outside diameter of 10.5 mm to 660.4 mm.

NOTE The International Standards corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 9329-2 : 1997 *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 2 : Unalloyed and alloyed steels with specified elevated temperature properties*

ISO 9330-2 : 1997 *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 2 : Electric resistance and induction welded unalloyed and alloyed steel tubes with specified elevated temperature properties* (Overall evaluation : MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standards and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS G 0320 *Standard test method for heat analysis of steel products*

JIS G 0321 *Product analysis and its tolerance for wrought steel*

JIS G 0404 *Steel and steel products — General technical delivery requirements*

JIS G 0415 *Steel and steel products — Inspection documents*

- JIS G 0567 *Method of elevated temperature tensile test for steels and heat-resisting alloys*
- JIS G 0582 *Automated ultrasonic examination of steel pipes and tubes*
- JIS G 0583 *Automated eddy current examination of steel pipes and tubes*
- JIS Z 2241 *Metallic materials — Tensile testing — Method of test at room temperature*
- JIS Z 8401 *Guide to the rounding of numbers*

3 Symbol of grade

This Standard covers the following three grades of pipe, which are designated by the symbols shown in Table 1.

Table 1 Symbols of grades and manufacturing processes

Symbols of grades	Symbols of manufacturing processes		
	Pipe manufacturing process	Finishing method	Marking
STPT370 STPT410 STPT480	Seamless : S	Hot-finished : H Cold-finished : C	As given in 13 b).
	Electric resistance welded : E	Hot-finished : H Cold-finished : C As electric resistance welded : G	

4 Manufacturing process

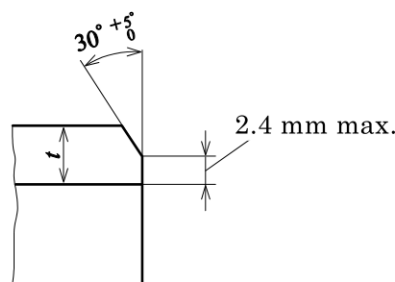
The manufacturing process shall be as follows.

- The pipes shall be manufactured from killed steel by a suitable combination of pipe manufacturing process and finishing method selected from Table 1. For pipes of grade STPT480, only seamless processing is applicable. The symbols of manufacturing processes are given in Table 1.
- The pipes shall be heat treated in accordance with Table 2. Other heat treatment may be performed upon agreement between the purchaser and the manufacturer.

Table 2 Heat treatment

Symbol of grade	Hot-finished seamless steel pipe	Cold finished seamless steel pipe	Hot-finished electric resistance welded steel pipe	Cold finished electric resistance welded and as electric resistance welded steel pipe
STPT370 STPT410	As manufactured. Low temperature annealing or normalizing may be applied as required.	Low temperature annealing or normalizing	As manufactured. Low temperature annealing or normalizing may be applied as required.	Low temperature annealing or normalizing
STPT480			—	—

- c) Pipes shall be furnished with plain ends, unless otherwise specified. If the purchaser has requested bevelled ends, the shape of the bevelled ends shall be as agreed between the purchaser and the manufacturer. For pipes 22 mm or under in wall thickness, in the absence of a specific request of the shape by the purchaser, the bevelled ends as shown in Figure 1 shall be applied.



t : wall thickness 22 mm max.

Figure 1 Shape of bevelled end

- d) If the pipe is electric resistance welded, the weld bead on the external and internal surfaces of the pipe shall be removed so as to obtain a weld joint smooth along the contour of the pipe, unless otherwise specified. If impracticable, the removal of the weld bead on the internal surface need not be performed.

5 Chemical composition

In heat analysis performed according to 11.1, the steel shall show the composition given in Table 3. Other alloy elements than given in the table may be added as necessary. In product analysis, if one is requested by the purchaser, the pipe shall show the composition given in Table 3 when subjected to the analysis specified in 11.1. To the values in Table 3, the tolerances given in Table 3 of **JIS G 0321** shall apply for seamless steel pipes, and those given in Table 2 of **JIS G 0321** for electric resistance welded steel pipes.

Table 3 Chemical composition

Unit : %

Symbol of grade	C	Si	Mn	P	S
STPT370	0.25 max.	0.10 to 0.35	0.30 to 0.90	0.035 max.	0.035 max.
STPT410	0.30 max.	0.10 to 0.35	0.30 to 1.00	0.035 max.	0.035 max.
STPT480	0.33 max.	0.10 to 0.35	0.30 to 1.00	0.035 max.	0.035 max.

6 Mechanical properties

6.1 Tensile strength, yield point or proof stress, and elongation

When tested in accordance with 11.2.3, the pipes shall satisfy the requirements for tensile strength, yield point or proof stress, and elongation given in Table 4. For tensile test of pipes under 8 mm in thickness performed using a Test piece No. 12 or Test piece No. 5, the elongation requirement given in Table 5 shall apply.

Table 4 Tensile strength, yield point or proof stress, and elongation

Symbol of grade	Tensile strength N/mm ²	Yield point or proof stress N/mm ²	Elongation ^{a)} %			
			Tensile test piece			
			No. 11 or No. 12	No. 5	Upper value: No. 4 ^{b)} Lower value: No. 14A ^{b)}	
			Tensile test direction			
			Parallel to pipe axis	Perpendicular to pipe axis	Parallel to pipe axis	Perpendicular to pipe axis
STPT370	370 min.	215 min.	30 min.	25 min.	28 min. 24 min.	23 min. 20 min.
STPT410	410 min.	245 min.	25 min.	20 min.	24 min. 21 min.	19 min. 17 min.
STPT480	480 min.	275 min.	25 min.	20 min.	22 min. 19 min.	17 min. 15 min.

NOTE : 1 N/mm² = 1 MPa

Notes ^{a)} For pipes of outside diameter under 40 mm, the elongation values in this table do not apply, though their elongation test results shall be recorded. In this case, elongation requirement agreed between the purchaser and the manufacturer may be applied.

^{b)} Parallel to pipe axis. Where feasible, however, these test pieces may be taken in a direction perpendicular to the pipe axis.

Table 5 Elongation values for Test piece No. 12 (parallel to pipe axis) and Test piece No. 5 (perpendicular to pipe axis) taken from pipes under 8 mm in wall thickness

Unit : %

Symbol of grade	Test piece used	Elongation						
		Wall thickness						
		Over 1 mm up to and incl. 2 mm	Over 2 mm up to and incl. 3 mm	Over 3 mm up to and incl. 4 mm	Over 4 mm up to and incl. 5 mm	Over 5 mm up to and incl. 6 mm	Over 6 mm up to and incl. 7 mm	Over 7 mm to and excl. 8 mm
STPT370	No. 12	21 min.	22 min.	24 min.	26 min.	27 min.	28 min.	30 min.
	No. 5	16 min.	18 min.	19 min.	20 min.	22 min.	24 min.	25 min.
STPT410	No. 12	16 min.	18 min.	19 min.	20 min.	22 min.	24 min.	25 min.
STPT480	No. 5	11 min.	12 min.	14 min.	16 min.	17 min.	18 min.	20 min.

Test piece No. 12 shall be taken in parallel to the pipe axis, and Test piece No. 5, in perpendicular to the pipe axis.

NOTE The elongation values in this table are given by deducting 1.5, for every 1 mm decrease in wall thickness from 8 mm, from the values given in Table 4 and rounding the results to the whole number according to Rule A in **JIS Z 8401**.

6.2 Flattening property

The test piece shall be free from cracks when flattened between two platens according to 11.2.4 until the distance H between the platens reaches the value calculated by (1).

For pipes of outside diameter 60.5 mm or under, the purchaser may request a bend test in place of a flattening test.

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

where, H : distance between platens (mm)
 t : wall thickness of pipe (mm)
 D : outside diameter of pipe (mm)
 e : constant defined for each grade of pipe :
0.08 for STPT370,
0.07 for STPT410 and STPT480

NOTE For the flattening test, see 11.2.4.

6.3 Bendability

The bendability requirement applies where the purchaser specifies a bend test instead of a flattening test for pipes of outside diameter 60.5 mm or under. When bent to an angle of 90° with an inside radius six times the pipe outside diameter in accordance with 11.2.5, the test piece shall be free from cracks. The bending angle is measured from the straight position before bending.

Alternatively, the purchaser may specify a bend test with an inside radius four times the pipe outside diameter and a bending angle of 180°.

7 Hydraulic test characteristics or nondestructive test characteristics

When subjected to either the hydraulic test or nondestructive test according to 11.3, the pipe shall satisfy the relevant requirements in the following. If not specified by the purchaser, which of the tests to perform shall be left to the discretion of the manufacturer.

a) **Hydraulic test characteristics** The following shall apply.

- 1) If the purchaser has not specified a test pressure, the pipe shall withstand the minimum hydraulic test pressure given in Table 6 without leakage.

For pipes of dimensions other than given in Table 7, the test pressure to be applied shall be determined as follows.

- 1.1) If the outside diameter of the pipe under test is within the range covered in Table 7, select the smaller value of the two outside diameters in the table that are closest to the outside diameter of the pipe under test.
- 1.2) If the wall thickness of the pipe under test is within the range of wall thickness of the schedule numbers applicable to the outside diameter selected in 1.1), select the larger value of the two wall thicknesses in the table that are closest to the wall thickness of the pipe under test.
- 1.3) Refer to Table 6 to find the test pressure value that corresponds to the outside diameter and schedule number defined in 1.1) and 1.2), and use it for testing the pipe.
- 1.4) For pipes with dimensions not falling under 1.1) or 1.2) and not indicated in Table 7, the test pressure shall be as agreed between the purchaser and the manufacturer.

In the case of electric resistance welded steel pipes whose outside diameter is indicated in Table 7 but wall thickness is not, select the larger schedule number of the two wall thicknesses in the table that are closest to the wall thickness of the pipe under test, and find in Table 6 a test pressure value that corresponds to the selected schedule number.

- 1.5) Where the test pressure value corresponding to the schedule number defined in 1.2) or 1.4) is found to be larger than the value P calculated according to Formula (2), use the value P in place of the value selected in Table 6.
- 2) If the purchaser has specified the test pressure, the pipe shall be tested using the specified pressure and withstand it without leakage. Where the specified test pressure is found to be larger than the value P calculated according to Formula (2) or 20 MPa, a test pressure value agreed between the purchaser and the manufacturer shall apply. The test pressure value specified shall be in 0.5 MPa increments for values lower than 10 MPa and in 1 MPa increments for values 10 MPa or higher.

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

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

Table 6 Minimum hydraulic test pressure

Unit : MPa

Nominal wall thickness	Schedule number : Sch									
	10	20	30	40	60	80	100	120	140	160
Minimum hydraulic test pressure	2.0	3.5	5.0	6.0	9.0	12	15	18	20	20

- b) **Nondestructive test characteristics** When subjected to either a ultrasonic examination or an eddy current examination, the pipe shall satisfy the following nondestructive test characteristics. In place of these examinations, other nondestructive test specified in JIS may be carried out upon agreement between the purchaser and the manufacturer, in which case the judgement criteria shall be at least equal to that applied in the ultrasonic examination or the eddy current examination.

NOTE Other nondestructive test method is, for example, the automated flux leakage examination specified in JIS G 0586.

- 1) In the ultrasonic examination, the signals from a reference sample containing Category UD reference standard specified in JIS G 0582 shall be used as an alarm level; any signal from the pipe equal to or greater than the alarm level shall be a cause for rejection. An alarm level lower in severity than the signals from the said reference standard may be used at the discretion of the manufacturer. Further, the minimum depth of square notches used for testing pipes given other finishing than cold finishing shall be 0.3 mm.
- 2) In the eddy current examination, the signals from a reference sample containing Category EY reference standard specified in JIS G 0583 shall be used as an alarm level; any signal from the pipe equal to or greater than the alarm level shall be a cause for rejection. An alarm level lower in severity than the signals from the said reference standard may be used at the discretion of the manufacturer.

8 Dimensions, mass and dimensional tolerances

8.1 Dimensions and unit mass

The outside diameter, wall thickness and unit mass of pipes shall be in accordance with Table 7. Dimensions not specified in Table 7 may be used upon the agreement between the purchaser and the manufacturer, in which case, the unit mass shall be calculated by the following formula assuming the mass of steel of 1 cm³ to be 7.85 g, and rounding off the result to three significant figures, or four-digit integer for any value exceeding 1 000 kg/m, according to Rule A of JIS Z 8401.

$$W = 0.024\,66\,t\,(D - t)$$

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

t : wall thickness of pipe (mm)

D : outside diameter of pipe (mm)

0.024 66 : conversion factor for obtaining W

NOTE The unit mass values in Table 7 are the results of the calculation given above.

Table 7 Dimensions and unit mass of carbon steel pipes for high temperature service

Nominal diameter ^{a)}		Out-side diameter	Nominal wall thickness ^{a)} (schedule number : Sch)																			
			10		20		30		40		60		80		100		120		140		160	
A	B	mm	Wall thickness mm	Unit mass kg/m	Wall thickness mm	Unit mass kg/m	Wall thickness mm	Unit mass kg/m	Wall thickness mm	Unit mass kg/m	Wall thickness mm	Unit mass kg/m	Wall thickness mm	Unit mass kg/m	Wall thickness mm	Unit mass kg/m	Wall thickness mm	Unit mass kg/m	Wall thickness mm	Unit mass kg/m	Wall thickness mm	Unit mass kg/m
6		10.5	—	—	—	—	1.7	0.369	—	—	—	—	2.4	0.479	—	—	—	—	—	—	—	—
8		13.8	—	—	—	—	2.2	0.629	—	—	—	—	3.0	0.799	—	—	—	—	—	—	—	—
10		17.3	—	—	—	—	2.3	0.851	—	—	—	—	3.2	1.11	—	—	—	—	—	—	—	—
15		21.7	—	—	—	—	2.8	1.31	—	—	—	—	3.7	1.64	—	—	—	—	—	—	—	—
20		27.2	—	—	—	—	2.9	1.74	—	—	—	—	3.9	2.24	—	—	—	—	—	—	—	—
25		34.0	—	—	—	—	3.4	2.57	—	—	—	—	4.5	3.27	—	—	—	—	—	—	—	—
32		42.7	—	—	—	—	3.6	3.47	—	—	—	—	4.9	4.57	—	—	—	—	—	—	—	—
40		48.6	—	—	—	—	3.7	4.10	—	—	—	—	5.1	5.47	—	—	—	—	—	—	—	—
50		60.5	—	—	—	—	3.9	5.44	—	—	—	—	5.5	7.46	—	—	—	—	—	—	—	—
65		76.3	—	—	—	—	5.2	9.12	—	—	—	—	7.0	12.0	—	—	—	—	—	—	—	—
80		89.1	—	—	—	—	5.5	11.3	—	—	—	—	7.6	15.3	—	—	—	—	—	—	—	—
90		101.6	—	—	—	—	5.7	13.5	—	—	—	—	8.1	18.7	—	—	—	—	—	—	—	—
100		114.3	—	—	—	—	6.0	16.0	—	—	—	—	8.6	22.4	—	—	—	—	—	—	—	—
125		139.8	—	—	—	—	6.6	21.7	—	—	—	—	9.5	30.5	—	—	—	—	—	—	—	—
150		165.2	—	—	—	—	7.1	27.7	—	—	—	—	11.0	41.8	—	—	—	—	—	—	—	—
200		216.3	—	—	6.4	33.1	8.2	42.1	10.3	52.3	12.7	63.8	12.7	63.8	15.1	74.9	18.2	88.9	20.6	99.4	23.0	110
250		267.4	—	—	6.4	41.2	7.8	49.9	9.3	59.2	12.7	79.8	15.1	93.9	18.2	112	21.4	130	25.4	152	28.6	168
300		318.5	—	—	6.4	49.3	8.4	64.2	10.3	78.3	14.3	107	17.4	129	21.4	157	25.4	184	28.6	204	33.3	234
350		355.6	6.4	55.1	7.9	67.7	9.5	81.1	11.1	94.3	15.1	127	19.0	158	23.8	195	27.8	225	31.8	254	35.7	282
400		406.4	6.4	63.1	7.9	77.6	9.5	93.0	12.7	123	16.7	160	21.4	203	26.2	246	30.9	286	36.5	333	40.5	365
450		457.2	6.4	71.1	7.9	87.5	11.1	122	14.3	156	19.0	205	23.8	254	29.4	310	34.9	363	39.7	409	45.2	459
500		508.0	6.4	79.2	9.5	117	12.7	155	15.1	184	20.6	248	26.2	311	32.5	381	38.1	441	44.4	508	50.0	565
550		558.8	—	—	—	—	—	—	15.9	213	22.2	294	28.6	374	34.9	451	41.3	527	47.6	600	54.0	672
600		609.6	—	—	—	—	—	—	17.5	256	24.6	355	31.0	442	38.9	547	46.0	639	52.4	720	59.5	807
650		660.4	—	—	—	—	—	—	18.9	299	26.4	413	34.0	525	41.6	635	49.1	740	56.6	843	64.2	944
Note ^{a)}			The designation of the pipes shall consist of nominal diameter and nominal wall thickness (schedule number : Sch), where the nominal diameter is expressed by the numeral of the diameter followed by the letter A or B, whichever diameter designation is applied.																			

Note ^{a)} The designation of the pipes shall consist of nominal diameter and nominal wall thickness (schedule number : Sch), where the nominal diameter is expressed by the numeral of the diameter followed by the letter A or B, whichever diameter designation is applied.

8.2 Dimensional tolerances

The tolerances on the outside diameter, wall thickness and eccentricity of pipes shall be as given in Table 8. If the purchaser has requested a specific length, the pipe length shall be equal to or greater than the specified length.

For electric resistance welded pipes, the wall thickness at the weld shall be subjected only to the minus tolerance (lower limit) in Table 8, and not to the plus tolerance (upper limit).

Table 8 Tolerances on outside diameter, wall thickness and eccentricity

Division	Tolerance on outside diameter ^{a)}	Tolerance on wall thickness	Tolerance on eccentricity ^{c)}
Hot-finished seamless steel pipe	Under 50 mm ±0.5 mm	Under 4 mm ±0.5 mm 4 mm or over ±12.5 %	20 % or under of wall thickness
	50 mm or over to and excl. 160 mm ±1 %		
	160 mm or over to and excl. 200 mm ±1.6 mm		
	200 mm or over ^{b)} ±0.8 %		
Cold-finished seamless steel pipes, cold-finished electric resistance welded steel pipe, hot-finished electric resistance welded steel pipe, and as electric resistance welded steel pipe	Under 40 mm ±0.3 mm	Under 2 mm ±0.2 mm	—
	40 mm or over ^{b)} ±0.8 %	2 mm or over ±10 %	

Notes ^{a)} For local repaired parts, tolerances in this table do not apply.

^{b)} For pipes with an outside diameter of 350 mm or over, the circumferential length may be measured, in which case the tolerance applied shall be ±0.5 %. The measured circumferential length (l) shall be converted to the outside diameter (D) as follows.

$$D = l / \pi$$

where, D : outside diameter (mm) l : circumferential length (mm) π : 3.141 6

^{c)} Eccentricity shall be expressed by the ratio, in percentage, of the difference between the maximum and minimum wall thicknesses measured on the same cross-section of the pipe to the wall thickness value specified in the order. However, this shall not apply to pipes under 5.6 mm in wall thickness.

9 Appearance

The appearance of pipe shall be as follows.

- The pipe shall be straight for practical purposes, with both ends being at right angles to the pipe axis.

- b) Both internal and external surfaces of the pipe shall be finished smoothly and free from defects detrimental to use.
- c) Pipes may be repaired by grinding, machining or other method, provided the wall thickness after repair remains within the specified tolerance.
- d) The repaired surface shall be smooth along the contour of the tube.

10 Supplementary quality requirements

Supplementary quality requirements that can be applied upon agreement between the purchaser and the manufacturer shall be as given in Annex JA.

11 Tests

11.1 Chemical analysis

11.1.1 General requirements and sampling method

General requirements for chemical analysis and sampling method for heat analysis shall be in accordance with Clause 8 of JIS G 0404. The sampling method for product analysis, if one is requested by the purchaser, shall be in accordance with Clause 4 of JIS G 0321.

11.1.2 Analytical method

The heat analysis method shall be in accordance with JIS G 0320. The product analysis method shall be in accordance with JIS G 0321.

11.2 Mechanical tests

11.2.1 General

General requirements for mechanical tests shall be in accordance with Clauses 7 and 9 of JIS G 0404. Among the sampling methods given in 7.6 of the said standard, however, only Class A sampling method shall apply.

11.2.2 Sampling method and number of test pieces

For pipes supplied as manufactured, take one sample from each unit of 50 or its fraction of pipes of the same dimensions. For heat-treated pipes, take one sample from each unit of 50 or its fraction of pipes of the same dimensions and from the same heat treatment batch. From each of the samples, take one tensile test piece and one flattening or bend test piece. Pipes of the same dimensions means pipes of the same outside diameter and wall thickness. Pipes from the same heat treatment batch means a group of pipes from continuous furnace operation under consistent heat treatment conditions; pipes after any stop of furnace operation are not considered as belonging to the same heat treatment batch. For pipes of the same dimensions that are all from the same heat, “same heat treatment batch” may be replaced with “same heat treatment conditions”.

11.2.3 Tensile test

The test piece and test method shall be as follows.

- a) **Test piece** Test piece used shall be of No. 11, No. 12 (No. 12A, No. 12B or No. 12C), No. 14A, No. 4 or No. 5 specified in **JIS Z 2241**. The diameter of Test piece No. 4 shall be 14 mm (gauge length 50 mm). Test pieces No. 11 and No. 12 shall be taken in parallel to the pipe axis, Test pieces No. 14A and No. 4, either in parallel or perpendicular to the pipe axis, and Test piece No. 5, in perpendicular to the pipe axis. Test piece No. 12 or No. 5 taken from the electric resistance welded steel pipe shall not contain the weld.
- b) **Test method** The test method shall be in accordance with **JIS Z 2241**.

11.2.4 Flattening test

The test piece and test method shall be as follows.

In the case of seamless steel pipes, this test is only performed upon request from the purchaser ¹⁾.

Note ¹⁾ Even when the test is omitted at the discretion of the manufacturer, the pipes shall satisfy the specified flattening property requirements.

- a) **Test piece** The test piece shall be 50 mm or greater in length. Where the pipe wall thickness is 15 % or more of the pipe outside diameter, a C-shape test piece obtained by cutting out a section from a ring test piece may be used.
- b) **Test method** At room temperature (5 °C to 35 °C), flatten the test piece between two platens until the distance (H) between them reaches the value given by Formula (1) in 6.2, and then examine for cracks. For testing the electric resistance welded steel pipe, place the test piece as shown in Figure 2 such that the line across the pipe section passing through the weld is perpendicular to the direction of compression. In the case of using a C-shaped test piece, refer to Figure 3.

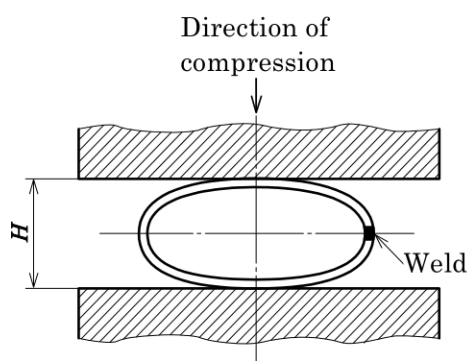


Figure 2 Flattening test (ring test piece)

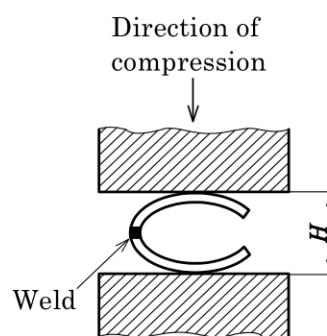


Figure 3 Flattening test (C-shaped test piece)

11.2.5 Bend test

The test piece and test method shall be as follows.

- a) **Test piece** Cut an adequate length from a sample pipe.
- b) **Test method** At room temperature (5 °C to 35 °C), bend the test piece around a

mandrel to not less than the angle specified in **6.3** with an inside radius not more than the value specified in **6.3**, and examine for cracks. In this test, the weld shall be positioned at about 90° from the outermost part of the bend.

11.3 Hydraulic test or nondestructive test

Either the hydraulic test or the nondestructive test shall be carried out according to the following.

- a) **Frequency of test** Either the hydraulic test or the nondestructive test shall be performed on each pipe.
- b) **Test method** The test method shall be as follows.
 - 1) **Hydraulic test** Hold the pipe under at least the minimum hydraulic test pressure specified in **7 a)** for at least 5 s to see if it has endured the pressure without leakage.
 - 2) **Nondestructive test**, as follows. If agreed between the purchaser and the manufacturer, other test method specified in **JIS** may be used.
 - 2.1) The ultrasonic examination specified in JIS G 0582 shall apply. Test level may be severer than Category UD.
 - 2.2) The eddy current examination specified in JIS G 0583 shall apply. Test level may be severer than Category EY.

12 Inspection and reinspection

12.1 Inspection

The inspection shall be as follows.

- a) General requirements shall be as specified in **JIS G 0404**.
- b) Chemical composition shall conform to the requirements in Clause **5**.
- c) Mechanical properties shall conform to the requirements in Clause **6**.
- d) Hydraulic test characteristics or nondestructive test characteristics shall conform to the requirements in Clause **7**.
- e) Dimensions shall conform to the requirements in Clause **8**.
- f) Appearance shall conform to the requirements in Clause **9**.
- g) Where a part or all of the supplementary quality requirements specified in Annex JA are applied upon agreement between the purchaser and the manufacturer, the pipe shall satisfy all of the specified requirements.

12.2 Reinspection

Pipes having failed the mechanical tests may be subjected to the retest in accordance with **9.8** of JIS G 0404 for further acceptance judgement.

13 Marking

Each of the pipes having passed the inspection shall be marked with the following information. Where this is difficult for small diameter pipes, or if requested by the purchaser, the marking may be given on each bundle of pipes by a suitable means. The following items of information may be indicated in any order, and those which are deemed inessential for identification of the product may be omitted upon agreement between the purchaser and the manufacturer.

- a) Symbol of grade
- b) Symbol of manufacturing process

The symbol of manufacturing process shall be as follows. The dashes may be replaced with blanks.

Hot-finished seamless steel pipe : – S– H

Cold-finished seamless steel pipe : – S – C

As electric resistance welded steel pipe : – E – G

Hot-finished electric resistance welded steel pipe : – E – H

Cold-finished electric resistance welded steel pipe : – E – C

- c) Dimensions, expressed by nominal diameter × nominal wall thickness, or outside diameter × wall thickness

Example : 50A × Sch40 or 60.5 × 3.9

- d) Manufacturer's name or identifying brand
- e) Symbol Z indicating the supplementary quality requirement (if specified)

14 Report

Unless otherwise specified, the manufacturer shall submit an inspection document to the purchaser. Reporting of test results shall be in accordance with Clause **13** of **JIS G 0404**. Unless otherwise specified in the order, the inspection document shall be in accordance with **5.1** of **JIS G 0415**.

Where any alloy elements not given in Table 3 have been intentionally added, the content of these elements shall also be reported in the document.

Annex JA (normative)

Supplementary quality requirements

JA.1 Yield point or proof stress in tensile test at elevated temperature (Z2) ¹⁾

The following shall apply.

- a) The required values of yield point or proof stress and the test temperature for the tensile test of pipes at elevated temperature shall be as agreed between the purchaser and the manufacturer.
- b) For this test, one sample shall be taken from a unit of pipes of the same heat, and from each of these samples, one test piece for testing at each of the specified temperatures shall be taken.
- c) The test piece and test method used for this test shall be in accordance with **JIS G 0567**.

Where taking a test piece following requirements in the above standard is difficult, the shape of test piece shall be a matter of agreement between the purchaser and the manufacturer.

Note ¹⁾ In ordering of pipes, the symbol Z2 may be used to designate this requirement.

JA.2 Ultrasonic examination and inspection (Z3) ²⁾

The following shall apply.

- a) The applied criteria for detection sensitivity shall be Category UB or UC specified in **JIS G 0582**, and the pipe shall not produce any signals equal to or greater than the signals from a reference sample containing Category UB or UC reference standard. Which of the criteria to use for testing shall be specified by the purchaser. If not specified by the purchaser, the selection shall be left to the discretion of the manufacturer.
- b) The test method shall be in accordance with **JIS G 0582**.
- c) The ultrasonic examination shall be performed on each pipe, where the pipe shall conform to the requirements specified in a).

Note ²⁾ In ordering of pipes, the symbol Z3 may be used to designate this requirement.

JA.3 Eddy current examination and inspection (Z4) ³⁾

The following shall apply.

- a) The applied criteria for detection sensitivity shall be Category EU, EV, EW or EX specified in **JIS G 0583**, and the pipe shall not produce any signals equal to or greater than the signals from a reference sample containing Category EU, EV, EW

or EX reference standard. Which of the criteria to use for testing shall be specified by the purchaser. If not specified by the purchaser, the selection shall be left to the discretion of the manufacturer.

- b) The test method shall be in accordance with **JIS G 0583**.
- c) The eddy current examination shall be performed on each pipe, where the pipe shall conform to the requirements specified in **a)**.

Note ³⁾ In ordering of pipes, the symbol Z4 may be used to designate this requirement.

Annex JB (informative)
Comparison table between JIS and corresponding International Standards

JIS G 3456 : 2019 Carbon steel pipes for high temperature service				ISO 9329-2 : 1997 Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 2 : Unalloyed and alloyed steels with specified elevated temperature properties ISO 9330-2 : 1997 Welded steel tubes for pressure purposes — Technical delivery conditions — Part 2 : Electric resistance and induction welded unalloyed and alloyed steel tubes with specified elevated temperature properties (Overall evaluation : MOD)				
(I) Requirements in JIS		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between JIS and the International Standard by clause		(V) Justification for the technical deviation and future measures	
No. and title of clause	Content		No. of clause	Content	Classification by clause	Detail of technical deviation		
1 Scope	Carbon steel pipes used for service at temperatures over 350 °C.	ISO 9329-2 ISO 9330-2	1	Unalloyed and alloyed steel pipes with specified elevated temperature properties intended for pressure purposes.	Deletion	JIS scope only covers unalloyed (carbon) steel pipes, and has no specific reference to pressure purposes.	1 Overall harmonization of this JIS with the corresponding ISOs was difficult due to the difference in scope (JIS : application specific, ISO : processing method specific) and dimensional system applied, as well as due to the fact that this JIS is cited in Japanese mandatory regulations.	
2 Normative references							2 The two corresponding ISOs were instead fully incorporated in other JISs , JIS G 7220 and JIS G 7224 , which were	
3 Symbol of grade	Three steel grades		4.1	Unalloyed and alloyed steel grades: different steel grades are specified in the two standards.	Deletion	JIS excludes alloyed steel grades from the scope.		

(I) Requirements in JIS		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between JIS and the International Standard by clause		(V) Justification for the technical deviation and future measures
No. and title of clause	Content		No. of clause	Content	Classification by clause	Detail of technical deviation	
4 Manufacturing process	Seamless process or electric resistance welding.	ISO 9329-2 ISO 9330-2	5.3	ISO 9329-2 : seamless process ISO 9330-2 : electric resistance welding	Addition	JIS adds cold-finished seamless steel pipes.	established as ISO-identical Japanese Industrial Standards with an aim of furthering harmonization with ISO and promoting the spread of ISO-specified products.
5 Chemical composition	Composition of 3 steel grades		6.1	ISO 9329-2 : 4 unalloyed steel grades and 14 alloyed steel grades ISO 9330-2 : 4 unalloyed steel grades and 3 alloyed steel grades	Deletion	JIS excludes alloyed steel grades.	3 There is a recognized need for continued existence of this JIS as a standard providing application-specific requirements independent from ISO standards. 4 To meet this need, and to prevent creating confusion in the market, this JIS is sustained without changing its requirements from the previous edition.
6 Mechanical properties	Tensile strength, flattening property, and bendability at room temperature		6.2.1	Tensile strength, flattening property, bendability, expanding property and impact value at room temperature	Deletion	JIS excludes impact value and expanding property.	

(I) Requirements in JIS		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between JIS and the International Standard by clause		(V) Justification for the technical deviation and future measures
No. and title of clause	Content		No. of clause	Content	Classification by clause	Detail of technical deviation	
7 Hydraulic test characteristics or nondestructive test characteristics	Either hydraulic test characteristics or nondestructive test characteristics are applied.	ISO 9329-2 ISO 9330-2	9.5	Either hydraulic test characteristics or nondestructive test characteristics are applied.	Alteration	JIS specifies the same test item as ISO but different requirements from ISO.	5 In future : More ISO contents will be incorporated into this JIS to ensure better harmonization with ISO.
8.1 Dimensions and unit mass	Dimensions and unit masses of pipes		7.1	Outside diameters, wall thicknesses and masses of pipes are selected from ISO 4200 and ISO 1129.	Alteration	JIS applies a different dimensional system from ISO.	
8.2 Dimensional tolerances	Tolerances on outside diameter, wall thickness and eccentricity of the pipes		7.3	Tolerances on outside diameter, wall thickness, length and straightness of the pipes	Alteration	For outside diameter and wall thickness, JIS applies tolerances that are either stricter or less strict than ISO tolerances.	
9 Appearance	Requirements for appearance		8.1	Requirements for appearance	Identical		
10 Supplementary quality requirements	Supplementary quality requirements		—	—	Addition	JIS adds supplementary quality requirements which can be applied upon agreement between the purchaser and the manufacturer.	

(I) Requirements in JIS		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between JIS and the International Standard by clause		(V) Justification for the technical deviation and future measures
No. and title of clause	Content		No. of clause	Content	Classification by clause	Detail of technical deviation	
11.1 Chemical analysis	General requirements of chemical analysis	ISO 9329-2 ISO 9330-2	9.3	General requirements and sampling method for chemical analysis	Identical		
11.2 Mechanical tests	Sampling method and number of test pieces		9.4	Sampling method and applicable test piece shapes	Alteration	JIS specifies the same test item as ISO but different requirements from ISO.	
11.3 Hydraulic test or nondestructive test	Details of hydraulic and nondestructive test methods		9.5	Hydraulic test and nondestructive test	Deletion Addition	JIS adds the eddy current examination and delete electromagnetic examination.	
12 Inspection and reinspection	Inspection requirements		9.10	Test methods and results	Alteration	JIS only specifies inspection requirements.	
13 Marking	Information to be included in the marking		10	Information to be included in the marking	Alteration	JIS specifies fewer marking items than ISO.	
14 Report	Report requirements		12	Report requirements	Alteration	JIS specifies one type of inspection documents, while ISO specifies four.	
Annex JA (normative) Supplementary quality requirements	Tensile test at elevated temperature, ultrasonic examination and eddy current examination		6.2.2 9.10.6	Properties at elevated temperature Nondestructive testing	Addition	JIS adds the eddy current examination.	

Overall degree of correspondence between JIS and International Standard(s) (ISO 9329-2 : 1997, ISO 9330-2 : 1997): MOD	
NOTE 1	Symbols in sub-columns of classification by clause in the above table indicate as follows: — Identical : Identical in technical contents. — Deletion : Deletes the specification items(s) or content(s) of International Standard. — Addition : Adds the specification item(s) or content(s) which are not included in International Standard. — Alteration : Alters the specification content(s) which are included in International Standard.
NOTE 2	Symbol in column of overall degree of correspondence between JIS and International Standard(s) in the above table indicates as follows: — MOD : Modifies International Standard(s).

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Errata for JIS (English edition) can be downloaded in PDF format at Webdesk (purchase information page) of our website (<https://www.jsa.or.jp/>).

In addition, printed errata are available in our journal *Standardization and Quality Control*, and also in *Monthly Information* that is distributed to the subscribers of JIS (English edition).

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