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**Copper and copper alloy seamless
pipes and tubes**

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Foreword

This translation has been made based on the original Japanese Industrial Standard 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 Japan Copper Brass Association (JCBA)/Japanese Standards Association (JSA) 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 H 3300**:2009 is replaced with this Standard.

However, **JIS H 3300**:2009 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 October 21, 2013.

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- Name of invention: Copper alloy tube for heat exchanger
- Date of registration of establishment: 2006-04-21
- Patent number: 3794971
- Patent holder: Kobelco Co., Ltd
2-7-1 Nishishinjuku, Shinjuku-ku, Tokyo
- Name of invention: Seamless copper alloy tube for heat exchanger excellent in 0.2 % proof stress and fatigue strength
- Date of registration of establishment: 2002-05-10
- Patent number: 3303778
- Patent holder: Mitsubishi Materials Co., Ltd
1-3-2 Ôtemachi, Chiyoda-ku, Tokyo
- Name of invention: Heat resistant copper alloy materials
- Date of registration of establishment: 2006-11-10
- Patent number: 3878640
- Patent holder: Mitsubishi Shindoh Co., Ltd
4-7-35 Kitashinagawa, Shinagawa-ku, Tokyo
- Name of invention: Seamless tube
- Date of registration of establishment: 2009-07-31
- Patent number: 4349640
- Patent holder: Sumitomo Light Metal Industries, Ltd
5-11-3 Shinbashi, Minato-ku, Tokyo

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Copper and copper alloy seamless pipes and tubes

1 Scope

This Japanese Industrial Standard specifies expanded copper and copper alloy seamless pipes and tubes (hereafter referred to as “tubes”), having a round section.

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 H 0321 *General rules for inspection of non-ferrous metal materials*
- JIS H 0500 *Glossary of terms used in wrought copper and copper alloys*
- JIS H 0501 *Methods for estimating average grain size of wrought copper and copper alloys*
- JIS H 0502 *Method of eddy current testing for copper and copper alloy pipes and tubes*
- JIS H 0505 *Measuring methods for electrical resistivity and conductivity of non-ferrous materials*
- JIS H 1051 *Methods for determination of copper in copper and copper alloys*
- JIS H 1052 *Methods for determination of tin in copper and copper alloys*
- JIS H 1053 *Methods for determination of lead in copper and copper alloys*
- JIS H 1054 *Methods for determination of iron in copper and copper alloys*
- JIS H 1055 *Methods for determination of manganese in copper and copper alloys*
- JIS H 1056 *Methods for determination of nickel in copper and copper alloys*
- JIS H 1057 *Methods for determination of aluminium in copper and copper alloys*
- JIS H 1058 *Methods for determination of phosphorus in copper and copper alloys*
- JIS H 1059 *Methods for determination of arsenic in copper and copper alloys*
- JIS H 1060 *Methods for determination of cobalt in copper and copper alloys*
- JIS H 1061 *Methods for determination of silicon in copper and copper alloys*
- JIS H 1062 *Methods for determination of zinc in copper and copper alloys*
- JIS H 1074 *Copper and copper alloys—Determination of zirconium content*
- JIS H 1292 *Methods for X-ray fluorescence spectrometric analysis of copper alloys*
- JIS K 0116 *General rules for atomic emission spectrometry*
- JIS K 8085 *Ammonia solution*
- JIS S 3200-1 *Equipment for water supply service—Test methods of hydrostatic pressure*

JIS S 3200-7 *Equipment for water supply service—Test methods of effect to water quality*

JIS Z 2241 *Metallic materials—Tensile testing—Method of test at room temperature*

JIS Z 2244 *Vickers hardness test—Test method*

JIS Z 2245 *Rockwell hardness test—Test method*

JIS Z 2611 *General rules for photoelectric emission spectrochemical analysis of metal materials*

3 Terms and definitions

For the purposes of this Standard, the terms and definitions given in **JIS H 0500** apply.

4 Grade, class and designation

The grade (hereafter expressed as alloy No.), class and designation of tubes shall be in accordance with table 1. A product designation shall consist of the designation symbol given in table 1 and the symbol of temper grade suffixed to it (see table 3 to table 6).

Table 1 Grade, class and designation of tubes

Alloy No.	Class	Designation	Informative	
			Name	Characteristics and application examples
C 1020	Common	C 1020 T ^{a)}	Oxygen-free copper	Excellent electric and heat conductivity, workability and drawability, and good weldability, corrosion resistance and weathering resistance. Free from hydrogen embrittlement when heated to an elevated temperature in the reducing atmosphere. Applicable to heat exchangers, electric or chemical industries use.
	Special	C 1020 TS ^{a)}		
C 1100	Common	C 1100 T ^{a)}	Touch-pitch copper	Excellent electric and heat conductivity, good drawability, corrosion resistance and weathering resistance. Applicable to electric parts, etc.
	Special	C 1100 TS ^{a)}		
C 1201	Common	C 1201 T	Phosphorus deoxidized copper	Good flaring and bending properties, drawability, weldability, corrosion resistance, weathering resistance and heat conductivity. C 1220 is free from hydrogen embrittlement when heated to an elevated temperature in reducing atmosphere. C 1201 has better electric conductivity than C 1220. Applicable to heat exchangers, chemical industries use, gas pipes, etc. C 1220 is also applicable to water supply and hot water supply.
	Special	C 1201 TS		
C 1220	Common	C 1220 T		
	Special	C 1220 TS		
Note ^{a)} For tubes for electric conduction use, the letter “C” shall be suffixed to the designation in this table.				

Table 1 (concluded)

Alloy No.	Class	Designation	Informative			
			Name	Characteristics and application examples		
C 1565	Common	C 1565 T	High strength copper	<p>Good flaring and bending properties, drawability, weldability, corrosion resistance and weathering resistance, and higher strength than phosphorus deoxidized copper.</p> <p>C 1565 has excellent heat conductivity.</p> <p>C 1862 has excellent thermal resistance.</p> <p>C 5010 and C 5015 have excellent ductility.</p> <p>Applicable to heat exchangers, piping, parts of various apparatuses, pressure vessels, general freezers and air conditioners, high pressure cooling medium heat pump type hot water supply, etc.</p>		
	Special	C 1565 TS				
C 1862	Common	C 1862 T				
	Special	C 1862 TS				
C 5010	Common	C 5010 T				
	Special	C 5010 TS				
C 5015	Common	C 5015 T				
	Special	C 5015 TS				
C 2200	Common	C 2200 T			Red brass	<p>Fine gloss, good flaring and bending properties, drawability and weathering resistance.</p> <p>Applicable to cosmetics cases, water supply and drain pipes, joints, etc.</p>
	Special	C 2200 TS				
C 2300	Common	C 2300 T				
	Special	C 2300 TS				
C 2600	Common	C 2600 T	Brass	<p>Good flaring and bending properties, drawability and properties on plating.</p> <p>Applicable to heat exchangers, curtain rods, sanitary tubes, parts for various apparatuses and machinery, antenna rods, etc.</p> <p>C 2800 has high strength.</p> <p>Applicable to sugar plants, ship, parts for various apparatuses and machinery.</p>		
	Special	C 2600 TS				
C 2700	Common	C 2700 T				
	Special	C 2700 TS				
C 2800	Common	C 2800 T				
	Special	C 2800 TS				
C 4430	Common	C 4430 T	Brass for condenser	<p>Good corrosion resistance. Especially, C 6870, C 6871 and C 6872 have excellent sea water resistance.</p> <p>Applicable to condensers for steam and nuclear power plant, condensers for ship, heater and water supply, distillater, oil coolers, heat exchangers for desalinators, etc.</p>		
	Special	C 4430 TS				
C 6870	Common	C 6870 T				
	Special	C 6870 TS				
C 6871	Common	C 6871 T				
	Special	C 6871 TS				
C 6872	Common	C 6872 T				
	Special	C 6872 TS				
C 7060	Common	C 7060 T			Cupronickel for condenser	<p>Good corrosion resistance, especially against sea water, and suitable for use at relatively high temperature.</p> <p>Applicable to condensers for ships, heater and water supply, chemical industries use, desalinators, etc.</p>
	Special	C 7060 TS				
C 7100	Common	C 7100 T				
	Special	C 7100 TS				
C 7150	Common	C 7150 T				
	Special	C 7150 TS				
C 7164	Common	C 7164 T				
	Special	C 7164 TS				

5 Quality

5.1 Appearance

Tubes shall have a workmanlike finish and homogeneity, and straight tubes shall be free from defects detrimental to practical use. Tubes in coil may be marked clearly at such detrimental defects, so that the defects can be removed at the time of use.

Judgement of defects detrimental to practical use and marking of such defects shall be subject to the agreement between the purchaser and the manufacturer.

5.2 Chemical composition

The chemical composition of tubes, when tested by 7.2, shall satisfy the requirements given in table 2.

Table 2 Chemical composition of tubes

Unit: %

Alloy No.	Cu	Pb	Fe	Sn	Zn	Al	As	Mn	Ni	P	Si	Co	Cu+ Fe+ Mn+ Ni	Others
C 1020	99.96 min.	—	—	—	—	—	—	—	—	—	—	—	—	—
C 1100	99.90 min.	—	—	—	—	—	—	—	—	—	—	—	—	—
C 1201	99.90 min.	—	—	—	—	—	—	—	—	0.004 or over to and excl. 0.015	—	—	—	—
C 1220	99.90 min.	—	—	—	—	—	—	—	—	0.015 to 0.040	—	—	—	—
C 1565	99.90 min.	—	—	—	—	—	—	—	—	0.020 to 0.040	—	0.040 to 0.055	—	—
C 1862	99.40 min.	—	—	0.07 to 0.12	0.02 to 0.10	—	—	—	0.02 to 0.06	0.046 to 0.062	—	0.16 to 0.21	—	—
C 5010	99.20 min.	—	—	0.58 to 0.72	—	—	—	—	—	0.015 to 0.040	—	—	—	—
C 5015	99.00 min.	—	—	0.58 to 0.72	—	—	—	—	—	0.004 to 0.015	—	—	—	Zr: 0.04 to 0.08
C 2200	89.0 to 91.0	0.05 max.	0.05 max.	—	Residual	—	—	—	—	—	—	—	—	—
C 2300	84.0 to 86.0	0.05 max.	0.05 max.	—	Residual	—	—	—	—	—	—	—	—	—
C 2600	68.5 to 71.5	0.05 max.	0.05 max.	—	Residual	—	—	—	—	—	—	—	—	—
C 2700	63.0 to 67.0	0.05 max.	0.05 max.	—	Residual	—	—	—	—	—	—	—	—	—

Table 2 (concluded)

Unit: %

Alloy No.	Cu	Pb	Fe	Sn	Zn	Al	As	Mn	Ni	P	Si	Co	Cu + Fe + Mn + Ni	Others
C 2800	59.0 to 63.0	0.10 max.	0.07 max.	—	Re-sidual	—	—	—	—	—	—	—	—	—
C 4430	70.0 to 73.0	0.05 max.	0.05 max.	0.9 to 1.2	Re-sidual	—	0.02 to 0.06	—	—	—	—	—	—	—
C 6870	76.0 to 79.0	0.05 max.	0.05 max.	—	Re-sidual	1.8 to 2.5	0.02 to 0.06	—	—	—	—	—	—	—
C 6871	76.0 to 79.0	0.05 max.	0.05 max.	—	Re-sidual	1.8 to 2.5	0.02 to 0.06	—	—	—	0.20 to 0.50	—	—	—
C 6872	76.0 to 79.0	0.05 max.	0.05 max.	—	Re-sidual	1.8 to 2.5	0.02 to 0.06	—	0.20 to 1.0	—	—	—	—	—
C 7060	—	0.05 max.	1.0 to 1.8	—	0.50 max.	—	—	0.20 to 1.0	9.0 to 11.0	—	—	—	99.5 min.	—
C 7100	—	0.05 max.	0.50 to 1.0	—	0.50 max.	—	—	0.20 to 1.0	19.0 to 23.0	—	—	—	99.5 min.	—
C 7150	—	0.05 max.	0.40 to 1.0	—	0.50 max.	—	—	0.20 to 1.0	29.0 to 33.0	—	—	—	99.5 min.	—
C 7164	—	0.05 max.	1.7 to 2.3	—	0.50 max.	—	—	1.5 to 2.5	29.0 to 32.0	—	—	—	99.5 min.	—

5.3 Mechanical properties and physical properties test items

The test items of mechanical properties (tensile strength, elongation and hardness) and physical properties of tubes shall be as given in Annex A.

5.4 Mechanical properties

The mechanical properties (tensile strength, elongation and hardness) of tubes, when tested by 7.3 and 7.4, shall satisfy the requirements in table 3. High strength copper tubes and copper alloy tubes for pressure vessels shall be tested by 7.3, and the resultant minimum proof strength shall satisfy the requirement in table 4. The hardness test shall be performed only when requested by the purchaser, and if the hardness test is applied, the tensile strength and elongation need not be applied.

The mechanical properties of tubes outside the specified range shall be subject to the agreement between the purchaser and the manufacturer.

Table 3 Mechanical properties of tubes

Alloy No.	Temper grade	Product designation	Tensile test				Hardness test ^{a)}				
			Division of outside diameter mm	Division of wall thickness mm	Tensile strength N/mm ²	Elongation %	Division of wall thickness mm	Vickers hardness HV ^{b)}	Rockwell hardness ^{c)}		
									HR30TS or HR30TW	HR15TS or HR15TW	HRFS or HRFW
C 1020	O	C 1020 T-O C 1020 TS-O	4 or over up to and incl. 100	0.25 or over up to and incl. 30	205 min.	40 min.	0.25 min.	69 max.	—	60 max.	50 max.
	OL	C 1020 T-OL C 1020 TS-OL	4 or over up to and incl. 100	0.25 or over up to and incl. 30	205 min.	40 min.	0.25 min.	73 max.	—	65 max.	55 max.
	½H	C 1020 T-½H C 1020 TS-½H	4 or over up to and incl. 100	0.25 or over up to and incl. 25	245 to 325	—	—	70 to 110	30 to 60	—	—
	H	C 1020 T-H C 1020 TS-H	25 or under	0.25 or over up to and incl. 3	315 min.	—	—	100 min.	55 min.	—	—
Over 25 up to and incl. 50			0.9 or over up to and incl. 4	—		—	—	—	—	—	
Over 50 up to and incl. 100			1.5 or over up to and incl. 6	—		—	—	—	—	—	
C 1100	O	C 1100 T-O C 1100 TS-O	5 or over up to and incl. 250	0.5 or over up to and incl. 30	205 min.	40 min.	—	—	—	—	—
	½H	C 1100 T-½H C 1100 TS-½H	5 or over up to and incl. 250	0.5 or over up to and incl. 25	245 to 325	—	—	70 to 110	30 to 60	—	—
	H	C 1100 T-H C 1100 TS-H	5 or over up to and incl. 100	0.5 or over up to and incl. 6	275 min.	—	—	88 min.	—	—	80 min.
Over 6 up to and incl. 10			265 min.	—	—	83 min.	—	—	75 min.		
C 1201 C 1220	O	C 1201 T-O C 1201 TS-O C 1220 T-O C 1220 TS-O	4 or over up to and incl. 250	0.25 or over up to and incl. 30	205 min.	40 min.	0.25 min.	69 max.	—	60 max.	50 max.
	OL	C 1201 T-OL C 1201 TS-OL C 1220 T-OL C 1220 TS-OL	4 or over up to and incl. 250	0.25 or over up to and incl. 30	205 min.	40 min.	0.25 min.	73 max.	—	65 max.	55 max.
	½H	C 1201 T-½H C 1201 TS-½H C 1220 T-½H C 1220 TS-½H	4 or over up to and incl. 250	0.25 or over up to and incl. 25	245 to 325	—	—	70 to 110	30 to 60	—	—

Table 3 (continued)

Alloy No.	Temper grade	Product designation	Tensile test				Hardness test ^{a)}				
			Division of outside diameter mm	Division of wall thickness mm	Tensile strength N/mm ²	Elongation %	Division of wall thickness mm	Vickers hardness HV ^{b)}	Rockwell hardness ^{c)}		
									HR30TS or HR30TW	HR15TS or HR15TW	HRFS or HRFW
C 1201 C 1220	H	C 1201 T-H C 1201 TS-H C 1220 T-H C 1220 TS-H	25 or under	0.25 or over up to and incl. 3	315 min.	—	—	100 min.	55 min.	—	—
			Over 25 up to and incl. 50	0.9 or over up to and incl. 4					—	—	—
			Over 50 up to and incl. 100	1.5 or over up to and incl. 6					—	—	—
			Over 100 up to and incl. 200	2 or over up to and incl. 6	275 min.	—	—	—	—	—	
			Over 200 up to and incl. 350	3 or over up to and incl. 8	255 min.	—	—	—	—	—	
C 1565	O	C 1565 T-O C 1565 TS-O	4 or over up to and incl. 250	0.15 or over up to and incl. 30	240 min.	35 min.	0.15 min.	73 max.	—	65 max.	—
	½H	C 1565 T-½H C 1565 TS-½H	4 or over up to and incl. 250	0.15 or over up to and incl. 25	270 to 350	—	—	70 to 120	30 to 65	—	—
	¾H	C 1565 T-¾H C 1565 TS-¾H	4 or over up to and incl. 250	0.15 or over up to and incl. 25	295 to 420	—	—	75 to 150	35 to 75	—	—
	H	C 1565 T-H C 1565 TS-H	25 or under	0.15 or over up to and incl. 3	400 min.	—	—	100 min.	55 min.	—	—
Over 25 up to and incl. 51			0.15 or over up to and incl. 4								
Over 51 up to and incl. 100			0.3 or over up to and incl. 6	350 min.	—	—	—	—	—		
C 1862	O	C 1862 T-O C 1862 TS-O	4 or over up to and incl. 250	0.15 or over up to and incl. 30	270 min.	30 min.	0.15 min.	110 max.	—	80 max.	—
	½H	C 1862 T-½H C 1862 TS-½H	4 or over up to and incl. 250	0.15 or over up to and incl. 25	305 to 385	—	—	75 to 150	35 to 75	—	—
	¾H	C 1862 T-¾H C 1862 TS-¾H	4 or over up to and incl. 250	0.15 or over up to and incl. 25	325 to 470	—	—	80 to 165	40 to 80	—	—
	H	C 1862 T-H C 1862 TS-H	25 or under	0.15 or over up to and incl. 3	450 min.	—	—	110 min.	60 min.	—	—
Over 25 up to and incl. 51			0.15 or over up to and incl. 4								
Over 51 up to and incl. 100			0.3 or over up to and incl. 6	400 min.	—	—	—	—	—		

Table 3 (continued)

Alloy No.	Temper grade	Product designation	Tensile test				Hardness test ^{a)}				
			Division of outside diameter mm	Division of wall thickness mm	Tensile strength N/mm ²	Elongation %	Division of wall thickness mm	Vickers hardness HV ^{b)}	Rockwell hardness ^{c)}		
									HR30TS or HR30TW	HR15TS or HR15TW	HRFS or HRFW
C 5010	O	C 5010 T-O C 5010 TS-O	4 or over up to and incl. 250	0.15 or over up to and incl. 30	240 min.	40 min.	0.15 min.	73 max.	—	65 max.	—
	½H	C 5010 T-½H C 5010 TS-½H	4 or over up to and incl. 250	0.15 or over up to and incl. 25	270 to 350	—	—	70 to 130	30 to 70	—	—
	¾H	C 5010 T-¾H C 5010 TS-¾H	4 or over up to and incl. 250	0.15 or over up to and incl. 25	295 to 420	—	—	75 to 165	35 to 80	—	—
	H	C 5010 T-H C 5010 TS-H	25 or under	0.15 or over up to and incl. 3	400 min.	—	—	100 min.	55 min.	—	—
	Over 25 up to and incl. 51		0.15 or over up to and incl. 4								
	Over 51 up to and incl. 100		0.3 or over up to and incl. 6	350 min.	—	—	—	—	—	—	
C 5015	O	C 5015 T-O C 5015 TS-O	4 or over up to and incl. 250	0.15 or over up to and incl. 30	270 min.	35 min.	0.15 min.	100 max.	—	75 max.	—
	½H	C 5015 T-½H C 5015 TS-½H	4 or over up to and incl. 250	0.15 or over up to and incl. 25	290 to 385	—	—	70 to 130	30 to 70	—	—
	¾H	C 5015 T-¾H C 5015 TS-¾H	4 or over up to and incl. 250	0.15 or over up to and incl. 25	325 to 470	—	—	75 to 165	35 to 80	—	—
	H	C 5015 T-H C 5015 TS-H	25 or under	0.15 or over up to and incl. 3	450 min.	—	—	100 min.	55 min.	—	—
	Over 25 up to and incl. 51		0.15 or over up to and incl. 4								
	Over 15 up to and incl. 100		0.3 or over up to and incl. 6	400 min.	—	—	—	—	—	—	
C 2200	O	C 2200 T-O C 2200 TS-O	10 or over up to and incl. 150	0.5 or over up to and incl. 15	225 min.	35 min.	1.1 or under	—	30 max.	—	—
							Over 1.1	—	—	—	70 max.
	OL	C 2200 T-OL C 2200 TS-OL	10 or over up to and incl. 150	0.5 or over up to and incl. 15	225 min.	35 min.	1.1 or under	—	37 max.	—	—
							Over 1.1	—	—	—	78 max.
½H	C 2200 T-½H C 2200 TS-½H	10 or over up to and incl. 150	0.5 or over up to and incl. 6	275 min.	15 min.	—	—	38 min.	—	—	
H	C 2200 T-H C 2200 TS-H	10 or over up to and incl. 100	0.5 or over up to and incl. 6	365 min.	—	Over 0.5 up to and incl. 6	—	55 min.	—	—	

Table 3 (continued)

Alloy No.	Temper grade	Product designation	Tensile test				Hardness test ^{a)}				
			Division of outside diameter mm	Division of wall thickness mm	Tensile strength N/mm ²	Elongation %	Division of wall thickness mm	Vickers hardness HV ^{b)}	Rockwell hardness ^{c)}		
									HR30TS or HR30TW	HR15TS or HR15TW	HRFS or HRFW
C 2300	O	C 2300 T-O C 2300 TS-O	10 or over up to and incl. 150	0.5 or over up to and incl. 15	275 min.	35 min.	1.1 or under	—	36 max.	—	—
							Over 1.1	—	—	—	75 max.
	OL	C 2300 T-OL C 2300 TS-OL	10 or over up to and incl. 150	0.5 or over up to and incl. 15	275 min.	35 min.	1.1 or under	—	39 max.	—	—
							Over 1.1	—	—	—	85 max.
½H	C 2300 T-½H C 2300 TS-½H	10 or over up to and incl. 150	0.5 or over up to and incl. 6	305 min.	20 min.	—	—	43 min.	—	—	
H	C 2300 T-H C 2300 TS-H	10 or over up to and incl. 100	0.5 or over up to and incl. 6	390 min.	—	Over 0.5 up to and incl. 6	—	65 min.	—	—	
C 2600	O	C 2600 T-O C 2600 TS-O	4 or over up to and incl. 250	0.3 or over up to and incl. 15	275 min.	45 min.	0.8 or under	77 max.	40 max.	—	—
							Over 0.8	82 max.	—	—	80 max.
	OL	C 2600 T-OL C 2600 TS-OL	4 or over up to and incl. 250	0.3 or over up to and incl. 15	275 min.	45 min.	0.8 or under	116 max.	60 max.	—	—
							Over 0.8	103 max.	—	—	90 max.
	½H	C 2600 T-½H C 2600 TS-½H	4 or over up to and incl. 100	0.3 or over up to and incl. 6	375 min.	20 min.	—	99 min.	53 min.	—	—
			Over 100 up to and incl. 250	2 or over up to and incl. 10	355 min.						
H	C 2600 T-H C 2600 TS-H	4 or over up to and incl. 100	0.3 or over up to and incl. 6	450 min.	—	Over 0.5 up to and incl. 6	154 min.	70 min.	—	—	
		Over 100 up to and incl. 250	2 or over up to and incl. 10	390 min.							
C 2700	O	C 2700 T-O C 2700 TS-O	4 or over up to and incl. 250	0.3 or over up to and incl. 15	295 min.	40 min.	0.8 or under	—	40 max.	—	—
							Over 0.8	—	—	—	80 max.
	OL	C 2700 T-OL C 2700 TS-OL	4 or over up to and incl. 250	0.3 or over up to and incl. 15	295 min.	40 min.	0.8 or under	—	60 max.	—	—
							Over 0.8	—	—	—	90 max.
½H	C 2700 T-½H C 2700 TS-½H	4 or over up to and incl. 100	0.3 or over up to and incl. 6	375 min.	20 min.	—	—	53 min.	—	—	
		Over 100 up to and incl. 250	2 or over up to and incl. 10	355 min.							

Table 3 (concluded)

Alloy No.	Temper grade	Product designation	Tensile test				Hardness test ^{a)}				
			Division of outside diameter mm	Division of wall thickness mm	Tensile strength N/mm ²	Elongation %	Division of wall thickness mm	Vickers hardness HV ^{b)}	Rockwell hardness ^{c)}		
									HR30TS or HR30TW	HR15TS or HR15TW	HRFS or HRFW
C 2700	H	C 2700 T-H C 2700 TS-H	4 or over up to and incl. 100	0.3 or over up to and incl. 6	450 min.	—	Over 0.5 up to and incl. 6	—	70 min.	—	—
			Over 100 up to and incl. 250	2 or over up to and incl. 10	390 min.						
C 2800	O	C 2800 T-O C 2800 TS-O	10 or over up to and incl. 250	1 or over up to and incl. 15	315 min.	35 min.	—	—	—	—	—
	OL	C 2800 T-OL C 2800 TS-OL	10 or over up to and incl. 250	1 or over up to and incl. 15	315 min.	35 min.	0.8 or under	—	60 max.	—	—
							Over 0.8	—	—	—	90 max.
	½H	C 2800 T-½H C 2800 TS-½H	10 or over up to and incl. 250	1 or over up to and incl. 6	375 min.	15 min.	—	—	55 min.	—	—
H	C 2800 T-H C 2800 TS-H	10 or over up to and incl. 100	1 or over up to and incl. 6	450 min.	—	—	—	—	—	—	
C 4430	O	C 4430 T-O C 4430 TS-O	5 or over up to and incl. 250	0.8 or over up to and incl. 10	315 min.	30 min.	Over 0.8	100 max.	—	—	—
C 6870 C 6871 C 6872	O	C 6870 T-O C 6870 TS-O C 6871 T-O C 6871 TS-O C 6872 T-O C 6872 TS-O	5 or over up to and incl. 50	0.8 or over up to and incl. 10	375 min.	40 min.	Over 0.8	110 max.	—	—	—
			Over 50 up to and incl. 250	0.8 or over up to and incl. 10	355 min.	40 min.	Over 0.8	100 max.	—	—	—
C 7060	O	C 7060 T-O C 7060 TS-O	5 or over up to and incl. 250	0.8 or over up to and incl. 5	275 min.	30 min.	0.8 or over up to and incl. 5	110 max.	—	—	—
C 7100	O	C 7100 T-O C 7100 TS-O	5 or over up to and incl. 50	0.8 or over up to and incl. 5	315 min.	30 min.	—	—	—	—	—
C 7150	O	C 7150 T-O C 7150 TS-O	5 or over up to and incl. 250	0.8 or over up to and incl. 5	365 min.	30 min.	0.8 or over up to and incl. 5	120 max.	—	—	—
C 7164	O	C 7164 T-O C 7164 TS-O	5 or over up to and incl. 50	0.8 or over up to and incl. 5	430 min.	30 min.	0.8 or over up to and incl. 5	130 max.	—	—	—

NOTE : 1 N/mm² = 1 MPa

Notes ^{a)} If more than one hardness value is specified, the selection of one hardness value, unless specified by the purchaser, shall be left to the discretion of the manufacturer.

^{b)} The minimum test load of Vickers hardness shall be 4.903 N.

^{c)} As a ball indenter used in the measurement, either a steel ball (S) or superalloy ball (W) shall be applied. The selection between the two, unless specified by the purchaser, shall be left to the discretion of the manufacturer.

Table 4 Minimum proof stress of high strength copper tubes and copper alloy tubes for pressure vessels

Alloy No.	Temper grace	Product designation	Division of outside diameter mm	Minimum 0.2 % proof stress ^{a)} N/mm ²
C 1565	O	C 1565 T-O C 1565 TS-O	—	70
	½H	C 1565 T-½H C 1565 TS-½H	—	120
	¾H	C 1565 T-¾H C 1565 TS-¾H	—	130
	H	C 1565 T-H C 1565 TS-H	51 or under	175
Over 51 up to and incl. 100			155	
C 1862	O	C 1862 T-O C 1862 TS-O	—	105
	½H	C 1862 T-½H C 1862 TS-½H	—	135
	¾H	C 1862 T-¾H C 1862 TS-¾H	—	145
	H	C 1862 T-H C 1862 TS-H	51 or under	195
Over 51 up to and incl. 100			175	
C 5010	O	C 5010 T-O C 5010 TS-O	—	70
	½H	C 5010 T-½H C 5010 TS-½H	—	120
	¾H	C 5010 T-¾H C 5010 TS-¾H	—	130
	H	C 5010 T-H C 5010 TS-H	51 or under	175
Over 51 up to and incl. 100			155	
C 5015	O	C 5015 T-O C 5015 TS-O	—	100
	½H	C 5015 T-½H C 5015 TS-½H	—	110
	¾H	C 5015 T-¾H C 5015 TS-¾H	—	140
	H	C 5015 T-H C 5015 TS-H	51 or under	180
Over 51 up to and incl. 100			160	
C 2800	O	C 2800 T-O C 2800 TS-O	—	125
C 4430	O	C 4430 T-O C 4430 TS-O	—	103
C 7060	O	C 7060 T-O C 7060 TS-O	—	103
C 7150	O	C 7150 T-O C 7150 TS-O	—	125

NOTE : 1 N/mm² = 1 MPa

Note ^{a)} Tubes may be given minimum straightening treatment for being supplied into the tester.

5.5 Grain size

The grain size of tubes, when tested by **7.5**, shall satisfy the requirements in table 5. The grain size test shall be performed only when requested by the purchaser, and if grain size test is applied, the mechanical properties in table 3 need not be applied.

Table 5 Grain size of tubes

Unit: mm

Alloy No.	Temper grade	Product designation	Grain size
C 1020 C 1201 C 1220	O	C 1020 T-O, C 1020 TS-O C 1201 T-O, C 1201 TS-O C 1220 T-O, C 1220 TS-O	0.025 to 0.060
	OL	C 1020 T-OL, C 1020 TS-OL C 1201 T-OL, C 1201 TS-OL C 1220 T-OL, C 1220 TS-OL	0.040 max.
C 1565 C 1862 C 5010 C 5015	O	C 1565 T-O, C 1565 TS-O C 1862 T-O, C 1862 TS-O C 5010 T-O, C 5010 TS-O C 5015 T-O, C 5015 TS-O	0.040 max.
C 2200 C 2300 C 2600 C 2700	O	C 2200 T-O, C 2200 TS-O C 2300 T-O, C 2300 TS-O C 2600 T-O, C 2600 TS-O C 2700 T-O, C 2700 TS-O	0.025 to 0.060
	OL	C 2200 T-OL, C 2200 TS-OL C 2300 T-OL, C 2300 TS-OL C 2600 T-OL, C 2600 TS-OL C 2700 T-OL, C 2700 TS-OL	0.035 max.
C 4430 C 6870 C 6871 C 6872 C 7060 C 7100 C 7150 C 7164	O	C 4430 T-O, C 4430 TS-O C 6870 T-O, C 6870 TS-O C 6871 T-O, C 6871 TS-O C 6872 T-O, C 6872 TS-O C 7060 T-O, C 7060 TS-O C 7100 T-O, C 7100 TS-O C 7150 T-O, C 7150 TS-O C 7164 T-O, C 7164 TS-O	0.010 to 0.045

5.6 Flareability

Tubes of temper grades O and OL that are 100 mm or under in outside diameter, when tested by the flaring test in **7.6**, shall be free from cracks generated on the surface.

Judgement of degree of cracks shall be subject to the agreement between the purchaser and the manufacturer.

5.7 Flattenability

Tubes of temper grades O and OL that are over 100 mm in outside diameter, when tested by the flattening test in **7.7**, shall be free from cracks generated on the surface.

Judgement of degree of cracks shall be subject to the agreement between the purchaser and the manufacturer.

5.8 Non-destructive inspection characteristics

Tubes, when tested by the eddy current test in 7.8, the hydraulic pressure test in 7.9 or the pneumatic pressure test in 7.10 shall be free from defects or leakage detrimental to practical use. This inspection shall be performed only when requested by the purchaser.

Selection of which test to perform shall be subject to the agreement between the purchaser and the manufacturer.

5.9 Electric conductivity

The electric conductivity of tubes, when tested by 7.11, shall satisfy the requirements in table 6. This test shall be performed only when requested by the purchaser.

IACS is the international annealed copper standard, of which the electric conductivity is defined as being 100 %IACS.

Table 6 Electric conductivity of tubes

Alloy No.	Temper grade	Product designation	Division of wall thickness mm	Electric conductivity (20 °C) %IACS
C 1020 C 1100	O OL	C 1020 T-O, C 1020 T-OL C 1020 TS-O, C 1020 TS-OL C 1100 T-O C 1100 TS-O	2 or under	100 min.
			Over 2	100 min.
	½H	C 1020 T-½H C 1020 TS-½H C 1100 T-½H C 1100 TS-½H	2 or under	97 min.
			Over 2	98 min.
	H	C 1020 T-H C 1020 TS-H C 1100 T-H C 1100 TS-H	2 or under	96 min.
			Over 2	97 min.

5.10 Hydrogen embrittlement

Tubes of C 1020 and C 1201, when tested by the hydrogen embrittlement test in 7.12, shall be free from numerous bubbles from the vicinity of grain boundaries or the structure indicating grain boundary separations typical to the hydrogen embrittlement. However, for tubes of C 1201, this test shall be performed only when requested by the purchaser.

5.11 Season cracking

Tubes of C 2600, C 2700, C 2800, C 4430, C 6870, C 6871 and C 6872, when tested by the season cracking test in 7.13, shall be free from cracks generated on the surface. This test may be omitted upon agreement between the purchaser and the manufacturer.

5.12 Leaching performance

The leaching performance of tubes of C 1220 that are intended for water supply piping, when tested by the leaching performance test in 7.14, shall satisfy the requirements in table 7.

Table 7 Leaching performance of tubes of C 1220 intended for water supply piping

Alloy No.	Standard items	Unit	Criterion value
C 1220	Turbidity	degrees	2 max.
	Chromaticity	degrees	5 max.
	Odour		No abnormality
	Taste		No abnormality
	Eluted amount of copper and copper compounds	mg/L	1.0 max.

6 Dimensions and tolerances

6.1 Designation of dimensions

For dimensions of straight tubes, the purchaser shall specify any two dimensions selected among the three dimensions, namely, outside diameter, inside diameter and wall thickness, as well as the length. The unspecified dimension, if necessary, may be calculated by the equation: Outside diameter = inside diameter + wall thickness \times 2.

The dimensions of tubes in coil shall be subject to the agreement between the purchaser and the manufacturer.

6.2 Representative dimensions

Representative dimensions of copper tubes for ordinary piping and water supply shall be as given in table 8.

Tolerances on wall thickness of tubes shall be as given in table 11, for the dimension specified in 6.3.

Table 8 Representative dimensions and mean outside diameter tolerances of copper tubes for ordinary piping and water supply

Unit: mm

Nominal diameter ^{a)}		Representative dimensions				Mean outside diameter tolerance ^{e)}
(A)	(B)	Outside diameter	Wall thickness			
			Type K ^{b)}	Type L ^{b)}	Type M ^{b)}	
8	1/4	9.52	0.89	0.76	—	±0.03
10	3/8	12.70	1.24	0.89	0.64	±0.03
15	1/2	15.88	1.24	1.02	0.71	±0.03
—	5/8	19.05	1.24	1.07	—	±0.03
20	3/4	22.22	1.65	1.14	0.81	±0.03
25	1	28.58	1.65	1.27	0.89	±0.04
32	1 1/4	34.92	1.65	1.40	1.07	±0.04
40	1 1/2	41.28	1.83	1.52	1.24	±0.05
50	2	53.98	2.11	1.78	1.47	±0.05
65	2 1/2	66.68	—	2.03	1.65	±0.05
80	3	79.38	—	2.29	1.83	±0.05
100	4	104.78	—	2.79	2.41	±0.05
125	5	130.18	—	3.18	2.77	±0.08
150	6	155.58	—	3.56	3.10	±0.08

Notes ^{a)} For nominal diameter, either (A) or (B) shall be used. However, if required, the letter A for the (A) series and the letter B for the (B) series shall be suffixed to each numerical figure expressing the nominal diameter for identification.

^{b)} Type K tubes are mainly used for piping service of medicine, and Type M tubes are mainly used for water supply, feed water, hot water supply, cool or warm water and town gas transmission. Type L tubes are used for both of the said applications.

^{c)} The “mean outside diameter tolerance” is defined as the allowable limit on the difference between the mean value of the maximum and minimum outside diameters (mean outside diameter) measured at an arbitrary cross-section of the tube and the outside diameter.

6.3 Dimensional tolerances

The tolerances on dimensions of tubes shall be as follows.

- a) **Tolerances on diameter** The tolerances on mean diameter of the tubes shall be as given in table 9.

In the case where only either the plus or minus side tolerance is designated, the tolerance value in this table shall be doubled.

For copper alloy tubes for ordinary piping and water supply of temper grade other than O and OL, the mean outside diameter tolerance specified in table 8 shall be applied. For copper alloy tubes for heat exchanger (C 4430, C 6870, C 6871, C 6872, C 7060, C 7100, C 7150 and C 7164), the tolerance on outside diameter in table 10 shall be applied.

Table 9 Tolerances on mean diameter ^{a)} of tubes

Unit: mm

Division of mean diameter	Alloy No.			
	C 1020, C 1100, C 1201, C 1220, C 1565, C 1862, C 5010, C 5015, C 2200, C 2300, C 2600, C 2700, C 2800		C 4430, C 6870, C 6871, C 6872, C 7060, C 7100, C 7150, C 7164	
	Class		Class	
	Common	Special	Common	Special
4 or over up to and incl. 15	±0.08	±0.05	—	—
Over 15 up to and incl. 25	±0.09	±0.06	—	—
Over 25 up to and incl. 50	±0.12	±0.08	—	—
Over 50 up to and incl. 75	±0.15	±0.10	±0.15	±0.10
Over 75 up to and incl. 100	±0.20	±0.13	±0.20	±0.13
Over 100 up to and incl. 125	±0.27	±0.15	±0.27	±0.15
Over 125 up to and incl. 150	±0.35	±0.18	±0.35	±0.18
Over 150 up to and incl. 200	±0.50	—	±0.50	—
Over 200 up to and incl. 250	±0.65	—	±0.65	—
Over 250 up to and incl. 350	±0.40 % ^{b)}	—	±0.40 % ^{b)}	—

Tolerances on for tubes having mean diameter outside the specified range shall be as agreed upon between the purchaser and the manufacturer.

Notes ^{a)} The “mean diameter” is defined as the mean value obtained from the maximum and minimum outside diameters or from the maximum and minimum inside diameters measured at an arbitrary cross-section of the tube.

^{b)} The percentage value shows the ratio to the mean diameter.

Table 10 Tolerances on outside diameter of copper alloy tubes for heat exchanger

(Alloy No. C 4430, C 6870, C 6871, C 6872, C 7060, C 7100, C 7150, C 7164)

Unit: mm

Division of outside diameter	Class		
	Common	Special	
		Thickness division 1.1 or under	Thickness division over 1.1
5 or over up to and incl. 10	0 -1.5 %	0 -0.10	0 -0.10
Over 10 up to and incl. 20		0 -0.20	0 -0.17
Over 20 up to and incl. 30		0 -0.30	0 -0.22
Over 30 up to and incl. 50		0 -0.40	0 -0.30

The tolerances for copper alloy tubes for heat exchanger having outside diameters that are outside the specified range shall be subject to the agreement between the purchaser and the manufacturer.

b) **Tolerances on wall thickness** The tolerances on wall thickness shall be as follows.

1) The wall thickness tolerances for tubes other than copper alloy tubes for heat exchanger (C 4430, C 6870, C 6871, C 6872, C 7060, C 7100, C 7150 and C 7164) shall be as given in table 11 or table 12. However, when the inside diameter is specified, table 11 and table 12 shall be applied by calculating the outside diameter with the equation: Outside diameter = inside diameter + wall thickness × 2.

In the case where only either the plus or minus side tolerance is designated, the tolerance values in table 11 and table 12 shall be doubled.

2) The tolerance on wall thickness of copper alloy tubes for heat exchanger (C 4430, C 6870, C 6871, C 6872, C 7060, C 7100, C 7150 and C 7164) shall be ±10 %.

Table 11 Tolerances on wall thickness of tubes (common class)

Unit: mm

Division of outside diameter	Division of wall thickness									
	0.25 or over up to and incl. 0.4	Over 0.4 up to and incl. 0.6	Over 0.6 up to and incl. 0.8	Over 0.8 up to and incl. 1.4	Over 1.4 up to and incl. 2	Over 2 up to and incl. 3	Over 3 up to and incl. 4	Over 4 up to and incl. 5.5	Over 5.5 up to and incl. 7	Over 7 ^{a)}
4 or over up to and incl. 15	±0.06	±0.07	±0.10	±0.13	±0.15	±0.18				
Over 15 up to and incl. 25	±0.07	±0.08	±0.10	±0.15	±0.18	±0.20	±0.30	±0.40	±0.45	
Over 25 up to and incl. 50		±0.09	±0.11	±0.15	±0.18	±0.20	±0.30	±0.40	±0.45	±8 %
Over 50 up to and incl. 100			±0.15	±0.18	±0.22	±0.25	±0.30	±0.40	±0.45	±8 %
Over 100 up to and incl. 175				±0.22	±0.25	±0.30	±0.35	±0.42	±0.45	±9 %
Over 175 up to and incl. 250					±0.30	±0.35	±0.40	±0.45	±0.50	±9 %
The tolerances for tubes having wall thicknesses outside the specified range shall be subject to the agreement between the purchaser and the manufacturer.										
Note ^{a)} The percentage values for tubes of wall thickness division over 7 mm indicate the ratio to the wall thickness.										

Table 12 Tolerances on wall thickness of tubes (special class)

Unit: mm

Division of outside diameter	Division of wall thickness						
	0.25 or over up to and incl. 0.4	Over 0.4 up to and incl. 0.6	Over 0.6 up to and incl. 0.8	Over 0.8 up to and incl. 1.4	Over 1.4 up to and incl. 2	Over 2 up to and incl. 3	Over 3 up to and incl. 4
4 or over up to and incl. 15	±0.03	±0.05	±0.06	±0.08	±0.09	±0.10	
Over 15 up to and incl. 25	±0.04	±0.05	±0.06	±0.09	±0.10	±0.13	±0.15
Over 25 up to and incl. 50		±0.06	±0.08	±0.09	±0.10	±0.13	±0.18
Over 50 up to and incl. 100			±0.10	±0.13	±0.15	±0.18	±0.20

For tubes having wall thicknesses outside the specified range, the tolerances in table 11 shall be applied.

- c) **Tolerances on out-of-roundness** The tolerances on out-of-roundness¹⁾ of tubes shall be as given in table 13. Special class shall be applied to copper tubes for ordinary piping and water supply. However, the out-of-roundness shall not be applied to tubes of temper grades O and OL, tubes in a coil form, copper alloy tubes for heat exchanger, and tubes under 0.4 mm in wall thickness. When either the outside diameter or the wall thickness is unspecified, whichever the unspecified value shall be calculated by the equation, outside diameter = inside diameter + wall thickness × 2, and thereby the ratio of the wall thickness to the outside diameter shall be calculated.

Note¹⁾ The “out-of-roundness” of tube is defined as the proportion of the specified outside diameter to the difference between the largest and smallest diameters measured on an arbitrary cross-section of the tube.

Table 13 Out-of-roundness of tubes

Division of wall thickness/ outside diameter ratio mm	Class	
	Common	Special
0.01 or over up to and incl. 0.03	3 % max. of outside diameter	1.5 % max. of outside diameter
Over 0.03 up to and incl. 0.05	2 % max. of outside diameter	1.0 % max. of outside diameter
Over 0.05 up to and incl. 0.10	1.5 % max. ^{a)} of outside diameter	0.8 % max. ^{b)} of outside diameter
Over 0.10	1.5 % max. ^{a)} of outside diameter	0.7 % max. ^{b)} of outside diameter

The tolerances for tubes having out-of-roundness outside the specified range shall be subject to the agreement between the purchaser and the manufacturer.

Notes^{a)} When the resultant value is 0.1 mm or under, the tolerance shall be 0.1 mm.
^{b)} When the resultant value is 0.05 mm or under, the tolerance shall be 0.05 mm.

- d) **Tolerances on length** The tolerances on length of straight tubes shall be as given in table 14. The tolerances on length of copper alloy tubes for heat exchanger shall be as given in table 15.

The tolerances for tubes having length outside the specified range shall be subject to the agreement between the purchaser and the manufacturer.

Table 14 Tolerances on length of straight tubes

(Alloy No. C 1020, C 1100, C 1201, C 1220, C 1565, C 1862, C 5010,
C 5015, C 2200, C 2300, C 2600, C 2700, C 2800)

Unit: mm

Division of length	Division of outside diameter		
	25 or under	Over 25 up to and incl. 100	Over 100
600 or under	+2 0	+3 0	+3 0
Over 600 up to and incl. 1 800	+3 0	+3 0	+6 0
Over 1 800 up to and incl. 4 200	+6 0	+6 0	+6 0
Over 4 200 up to and incl. 9 000	+10 0	+10 0	+10 0

Table 15 Tolerances on length of copper alloy straight tubes for heat exchanger

(Alloy No. C 4430, C 6870, C 6871, C 6872,)
C 7060, C 7100, C 7150, C 7164)

Unit: mm

Division of length	Tolerance
9 000 or under	+5 0
Over 9 000 up to and incl. 18 000	+10 0
Over 18 000 up to and incl. 30 000	+15 0

6.4 Maximum permissible bend of straight tubes

The maximum permissible bend²⁾ of straight tubes shall be as given in table 16. The maximum permissible bend shall be applied to straight tubes with an outside diameter 6 mm or over up to and including 90 mm, and shall not be applied to tubes of temper grades O and OL.

The maximum permissible bend for straight tubes having a length outside the specified range shall be subject to the agreement between the purchaser and the manufacturer.

Note ²⁾ The “bend” is defined as the depth of an arc over the reference length of the tube, as shown in figure 1.

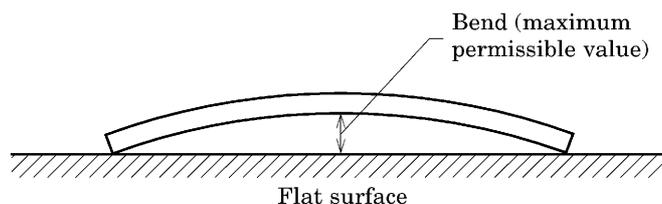


Figure 1 Bend of straight tube

Table 16 Maximum permissible bend of straight tubes

Unit: mm

Division of length	Reference length	Maximum value
1 000 or over up to and incl. 2 000	Whole length	5
Over 2 000 up to and incl. 2 500		8
Over 2 500 up to and incl. 3 000		12
Over 3 000 up to and incl. 9 000	3 000	12

7 Tests

7.1 Sampling

The sampling of test shall be as follows.

- a) Sampling for chemical analysis For the sample for analysis, an amount required for analysis shall be taken at the time of casting.

Alternatively, analysis sample may be taken from an ingot or a product.

- b) For tensile test, hardness test, grain size test, flaring test, flattening test, electric conductivity test, hydrogen embrittlement test and season cracking test, test piece shall be prepared from a tube drawn at random from each group consisting of 100 tubes or tubes 2 000 kg in mass and its fraction, of the same grade, class, temper grade and sectional dimensions.
- c) For hydraulic pressure test and pneumatic pressure test, the number of tubes equivalent to 0.2 % of the total number of a group of tubes of the same grade, class, temper grade and sectional dimension shall be drawn at random. However, for tubes of C 4430, C 6870, C 6871, C 6872, C 7060, C 7100, C 7150 and C 7164, 100 % testing shall be performed.

The tests may be performed on the tubes as processed, before giving them heat treatment.

- d) The eddy current flaw detection shall be performed along the entire length of the tube excluding the end dead zone.

7.2 Chemical analysis

The method of analysis of chemical composition shall be in accordance with the following standards:

JIS H 1051, JIS H 1052, JIS H 1053, JIS H 1054, JIS H 1055, JIS H 1056, JIS H 1057, JIS H 1058, JIS H 1059, JIS H 1060, JIS H 1061, JIS H 1062, JIS H 1074, JIS K 0116, JIS Z 2611

In addition to the above, **JIS H 1292** may also be applied if the elements to be determined and chemical components within the determination range are specified in the said standard.

The emission spectrochemical analysis may be applied for C 1201, C 1220, C 1565, C 1862, C 5010 and C 5015 upon agreement between the purchaser and the manufacturer.

7.3 Tensile test

The tensile test shall be carried out in accordance with **JIS Z 2241**. For this test, No. 11 test piece specified in **JIS Z 2241** shall be used.

Where No. 11 test piece cannot be used, No. 12A, No. 12B, No. 12C, No. 14B or No. 14C test piece shall be used. The sectional area of the test piece shall be determined either by direct measurement of the dimension or by calculation using the mass of the test piece.

7.4 Hardness test

The hardness test shall be carried out in accordance with **JIS Z 2244** or **JIS Z 2245**. The Rockwell hardness shall be measured on the inner surface of the tube.

7.5 Grain size test

The grain size test shall be carried out in accordance with **JIS H 0501**. The measurement shall be made on the section parallel to the tube axis.

The measurement may be made on the section perpendicular to the tube axis upon agreement between the purchaser and the manufacturer.

7.6 Flaring test

The flaring test shall be carried out by thrusting a conical wedge having a vertical angle of 60° into one of the tube ends until its outside diameter extends to the ratio as given in table 17.

Table 17 Flaring ratio

Alloy No.	Division of outside diameter and wall thickness	
	Outside diameter 20 mm or under, and wall thickness over 0.5 mm	Outside diameter over 20 mm up to and including 100 mm, or wall thickness 0.5 mm or under
C 1020, C 1100, C 1201, C 1220, C 1565, C 1862, C 5010, C 5015	1.4	1.3
C 2200, C 2300, C 2600, C 2700, C 2800	1.2	1.15
C 4430, C 6870, C 6871, C 6872, C 7060, C 7100, C 7150, C 7164	1.25	

7.7 Flattening test

The flattening test shall be performed by placing the test piece, cut out from the tube end to have an approximate length of 100 mm, between two flat plates as shown in figure 2, and pressing it until the distance between the flat plates reaches the value three times the wall thickness of the tube.

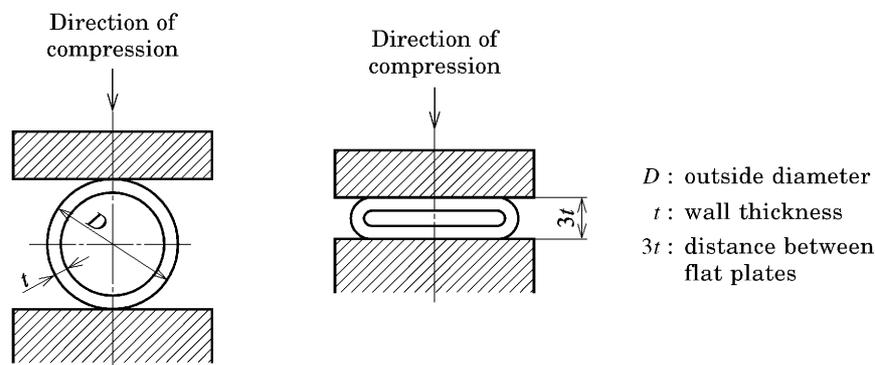


Figure 2 Flattening test

7.8 Eddy current test

The eddy current test shall be performed by the encircling coil technique specified in **JIS H 0502**. The test may be performed on tubes before annealing. The size of the reference defects (drill hole diameter) shall be as given in table 18.

The size of the reference defect for tubes having a diameter outside the specified range shall be subject to the agreement between the purchaser and the manufacturer.

Table 18 Size of reference defects (drill hole diameter)

Unit: mm

Division of outside diameter	Alloy No.				
	C 1020, C 1100, C 1201, C 1220 C 1565, C 1862, C 5010, C 5015		C 2200, C 2300 C 2600, C 2700 C 2800	C 4430, C 6870, C 6871, C 6872 C 7060, C 7100, C 7150, C 7164	
	Application		Application	Application	
	Other than heat exchanger	Heat exchanger	All	Other than heat exchanger	Heat exchanger
4 or over up to and incl. 10	0.9	0.6	0.7	0.7	0.6
Over 10 up to and incl. 20	1.0	0.6	0.8	0.8	0.6
Over 20 up to and incl. 25	1.1	0.8	0.9	0.9	0.8
Over 25 up to and incl. 30	1.1	0.9	0.9	0.9	0.9
Over 30 up to and incl. 40	1.3	1.1	1.1	1.1	1.1
Over 40 up to and incl. 45	1.5	1.2	1.3	1.3	1.2
Over 45 up to and incl. 50	1.5	1.3	1.3	1.3	1.3

7.9 Hydraulic pressure test

The hydraulic pressure test shall be performed by applying the pressure calculated by the following formula. Unless otherwise specified, this pressure shall not exceed 6.85 MPa.

For tubes of C 1220 that are intended for water supply piping, the hydraulic pressure test shall be performed in accordance with the method specified in **JIS S 3200-1**.

$$P = \frac{2S \times t}{D - 0.8t}$$

- where, P : test pressure (MPa)
 S : allowable stress of material specified in table 19 (N/mm²)
 t : wall thickness of tube (mm)
 D : outside diameter of tube (mm)

Table 19 Allowable stress of material

Unit: N/mm²

Alloy No.	Allowable stress
C 1020, C 1100, C 1201, C 1220, C 1565, C 1862, C 5010, C 5015	41
C 2200, C 2300, C 2600, C 2700, C 2800, C 4430, C 6870, C 6871, C 6872, C 7060, C 7100, C 7150, C 7164	48
NOTE : 1 N/mm ² = 1 MPa	

7.10 Pneumatic pressure test

The pneumatic pressure test shall be performed by using a pressure of 0.4 MPa or greater and by submerging the tube under water for at least 5 s.

7.11 Electric conductivity test

The electric conductivity test shall be carried out in accordance with **JIS H 0505**. When using the eddy current type electric conductivity tester, it shall be agreed between the purchaser and the manufacturer.

7.12 Hydrogen embrittlement test

The hydrogen embrittlement test shall be performed by heating the test piece in hydrogen gas current containing at least 10 % (volume fraction) of hydrogen at 850 °C ± 25 °C for 30 min to 120 min, and polishing and etching the surface of the heated test piece to examine the grain boundaries with a microscope of 75 to 200 magnifications. The test piece may be heated to the temperature above 875 °C upon agreement between the purchaser and the manufacturer.

7.13 Season cracking test

The season cracking test shall be carried out according to the following procedure of the ammonia test method.

- a) The test piece with a length not less than 75 mm cut from a tube shall be degreased and dried, and placed in the desiccator containing ammonia solution specified in **JIS K 8085** which has been diluted with equal amount of pure water to 11.8 % (mass fraction) min. such that the test piece is positioned 50 mm to 100 mm below the liquid surface, and after keeping it in this ammonia atmosphere for 2 h at the ordinary temperature (see figure 3), the test piece shall be removed from the desiccator.
- b) This test piece shall be rinsed with 100 g/L sulfuric acid solution and polished on the surface and visually examined for cracks. For tubes of temper grades O and OL, the test piece may be flattened until one diameter becomes 50 % to 60 % of the original diameter (3 times the wall thickness for tubes with an outside diameter not more than 6 times the wall thickness) and then visually examined for cracks.

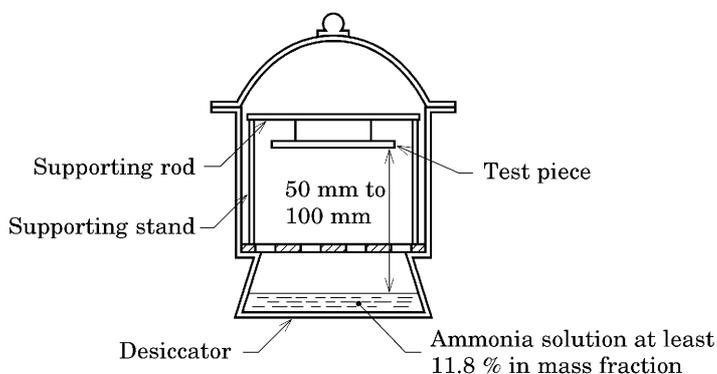


Figure 3 Ammonia test method

7.14 Leaching performance test

The leaching performance test of C 1220 tubes that are used for water supply piping shall be carried out in accordance with the method specified in **JIS S 3200-7**.

8 Inspection

The inspection shall be as follows.

- a) General requirements shall be as specified in **JIS H 0321**.
- b) Appearance shall satisfy the specification given in **5.1**.
- c) Chemical composition shall satisfy the specification given in **5.2**.
- d) Mechanical properties and physical properties shall satisfy the specifications given in **5.4** to **5.12**.
- e) Dimensions and tolerances shall satisfy the specification given in clause **6**.
- f) The hydraulic pressure test and leaching performance test of C 1220 tubes used for water supply piping are conducted as a type inspection³⁾.

Note ³⁾ The type inspection is an inspection performed for judging whether or not all the quality requirements indicated in the quality design of the product are satisfied (as opposed to a delivery inspection).

9 Marking

Each package, bundle, coil or product of tubes shall be marked by a suitable means such as labelling with the following information.

- a) Number of this Standard and product designation (designation symbol and temper grade)

Example: **JIS H 3300** C 2200 TS-OL

- b) Dimensions
- c) Manufacturing number
- d) Manufacturer's name or its identifying brand

10 Report

The manufacturer shall submit, when requested at the time of order from the purchaser, the report (certificate) containing the results of the test and/or inspection agreed upon between the purchaser and the manufacturer.

Annex A (normative)

Mechanical properties and physical properties test items of copper and copper alloy seamless tubes

This Annex shows the mechanical and physical properties test items of copper and copper alloy seamless tubes.

A.1 Test items of tubes

Table A.1 and table A.2 show the test items of tubes.

Table A.1 Mechanical properties and physical properties test items of tubes (excluding those for pressure vessels)

Alloy No.	Temper grade	Product designation	Division of outside diameter mm	Test items of mechanical properties and physical properties										
				Tensile strength	Elongation	Hardness	Grain size	Flareability	Flattenability	Non-destructive inspection characteristics	Electric conductivity	Hydrogen embrittlement	Season cracking	Leaching performance
C 1020	O	C 1020 T-O C 1020 TS-O	4 or over up to and incl. 50	○	○	△	△	○	—	△	△	○	—	—
			Over 50 up to and incl. 100	○	○	△	△	○	—	—	△	○	—	—
	OL	C 1020 T-OL C 1020 TS-OL	4 or over up to and incl. 50	○	○	△	△	○	—	△	△	○	—	—
			Over 50 up to and incl. 100	○	○	△	△	○	—	—	△	○	—	—
	½H	C 1020 T-½H C 1020 TS-½H	4 or over up to and incl. 50	○	—	△	—	—	—	△	△	○	—	—
			Over 50 up to and incl. 100	○	—	△	—	—	—	—	△	○	—	—
	H	C 1020 T-H C 1020 TS-H	50 or under	○	—	△	—	—	—	△	△	○	—	—
			Over 50 up to and incl. 100	○	—	△	—	—	—	—	△	○	—	—

Table A.1 (continued)

Alloy No.	Temper grade	Product designation	Division of outside diameter mm	Test items of mechanical properties and physical properties										
				Tensile strength	Elongation	Hardness	Grain size	Flareability	Flattenability	Non-destructive inspection characteristics	Electric conductivity	Hydrogen embrittlement	Season cracking	Leaching performance
C 1100	O	C 1100 T-O C 1100 TS-O	5 or over up to and incl. 50	○	○	△	—	○	—	△	△	—	—	—
			Over 50 up to and incl. 100	○	○	△	—	○	—	—	△	—	—	—
			Over 100 up to and incl. 250	○	○	△	—	—	○	—	△	—	—	—
	½H	C 1100 T-½H C 1100 TS-½H	5 or over up to and incl. 50	○	—	△	—	—	—	△	△	—	—	—
			Over 50 up to and incl. 100	○	—	△	—	—	—	—	△	—	—	—
			Over 100 up to and incl. 250	△	—	△	—	—	—	—	△	—	—	—
	H	C 1100 T-H C 1100 TS-H	50 or under	○	—	△	—	—	—	△	△	—	—	—
			Over 50 up to and incl. 100	○	—	△	—	—	—	—	△	—	—	—
	C 1201 C 1220	O	C 1201 T-O C 1201 TS-O C 1220 T-O C 1220 TS-O	4 or over up to and incl. 100	○	○	△	△	○	—	△ ^{a)}	—	△ ^{b)}	—
Over 100 up to and incl. 250				○	○	△	△	—	○	△ ^{a)}	—	△ ^{b)}	—	△ ^{c)}
OL		C 1201 T-OL C 1201 TS-OL C 1220 T-OL C 1220 TS-OL	4 or over up to and incl. 100	○	○	△	△	○	—	△ ^{a)}	—	△ ^{b)}	—	△ ^{c)}
			Over 100 up to and incl. 250	○	○	△	△	—	○	△ ^{a)}	—	△ ^{b)}	—	△ ^{c)}
½H		C 1201 T-½H C 1201 TS-½H C 1220 T-½H C 1220 TS-½H	4 or over up to and incl. 100	○	—	△	—	—	—	△ ^{a)}	—	△ ^{b)}	—	△ ^{c)}
			Over 100 up to and incl. 250	△	—	△	—	—	—	△ ^{a)}	—	△ ^{b)}	—	△ ^{c)}
H		C 1201 T-H C 1201 TS-H C 1220 T-H C 1220 TS-H	100 or under	○	—	△	—	—	—	△ ^{a)}	—	△ ^{b)}	—	△ ^{c)}
			Over 100 up to and incl. 350	△	—	△	—	—	—	△ ^{a)}	—	△ ^{b)}	—	△ ^{c)}

Table A.1 (continued)

Alloy No.	Temper grade	Product designation	Division of outside diameter	Test items of mechanical properties and physical properties										
				Tensile strength	Elongation	Hardness	Grain size	Flareability	Flattenability	Non-destructive inspection characteristics	Electric conductivity	Hydrogen embrittlement	Season cracking	Leaching performance
C 1565 C 1862 C 5010 C 5015	O	C 1565 T-O C 1565 TS-O	4 or over up to and incl. 100	○	○	△	△	○	—	△	—	—	—	—
		C 1862 T-O C 1862 TS-O C 5010 T-O C 5010 TS-O C 5015 T-O C 5015 TS-O	Over 100 up to and incl. 250	○	○	△	△	—	○	△	—	—	—	—
	½H	C 1565 T-½H C 1565 TS-½H	4 or over up to and incl. 100	○	—	△	—	—	—	△	—	—	—	—
		C 1862 T-½H C 1862 TS-½H C 5010 T-½H C 5010 TS-½H C 5015 T-½H C 5015 TS-½H	Over 100 up to and incl. 250	△	—	△	—	—	—	△	—	—	—	—
	¾H	C 1565 T-¾H C 1565 TS-¾H	4 or over up to and incl. 100	○	—	△	—	—	—	△	—	—	—	—
		C 1862 T-¾H C 1862 TS-¾H C 5010 T-¾H C 5010 TS-¾H C 5015 T-¾H C 5015 TS-¾H	Over 100 up to and incl. 250	△	—	△	—	—	—	△	—	—	—	—
	H	C 1565 T-H C 1565 TS-H C 1862 T-H C 1862 TS-H C 5010 T-H C 5010 TS-H C 5015 T-H C 5015 TS-H	100 or under	○	—	△	—	—	—	△	—	—	—	—

Table A.1 (continued)

Alloy No.	Temper grade	Product designation	Division of outside diameter mm	Test items of mechanical properties and physical properties											
				Tensile strength	Elongation	Hardness	Grain size	Flareability	Flattenability	Non-destructive inspection characteristics	Electric conductivity	Hydrogen embrittlement	Season cracking	Leaching performance	
C 2200 C 2300	O	C 2200 T-O C 2200 TS-O C 2300 T-O C 2300 TS-O	10 or over up to and incl. 50	○	○	△	△	○	—	△	—	—	—	—	
			Over 50 up to and incl. 100	○	○	△	△	○	—	—	—	—	—	—	
			Over 100 up to and incl. 150	○	○	△	△	—	○	—	—	—	—	—	
	OL	C 2200 T-OL C 2200 TS-OL C 2300 T-OL C 2300 TS-OL	10 or over up to and incl. 50	○	○	△	△	○	—	△	—	—	—	—	
			Over 50 up to and incl. 100	○	○	△	△	○	—	—	—	—	—	—	
			Over 100 up to and incl. 150	○	○	△	△	—	○	—	—	—	—	—	
	½H	C 2200 T-½H C 2200 TS-½H C 2300 T-½H C 2300 TS-½H	10 or over up to and incl. 50	○	○	△	—	—	—	△	—	—	—	—	
			Over 50 up to and incl. 150	○	○	△	—	—	—	—	—	—	—	—	
	H	C 2200 T-H C 2200 TS-H C 2300 T-H C 2300 TS-H	10 or over up to and incl. 50	○	—	△	—	—	—	△	—	—	—	—	
			Over 50 up to and incl. 100	○	—	△	—	—	—	—	—	—	—	—	
	C 2600 C 2700	O	C 2600 T-O C 2600 TS-O C 2700 T-O C 2700 TS-O	4 or over up to and incl 50	○	○	△	△	○	—	△	—	—	□	—
				Over 50 up to and incl. 100	○	○	△	△	○	—	—	—	—	□	—
Over 100 up to and incl. 250				○	○	△	△	—	○	—	—	—	□	—	
OL		C 2600 T-OL C 2600 TS-OL C 2700 T-OL C 2700 TS-OL	Over 4 up to and incl. 50	○	○	△	△	○	—	△	—	—	□	—	
			Over 50 up to and incl. 100	○	○	△	△	○	—	—	—	—	□	—	
			Over 100 up to and incl. 250	○	○	△	△	—	○	—	—	—	□	—	
½H		C 2600 T-½H C 2600 TS-½H C 2700 T-½H C 2700 TS-½H	4 or over up to and incl. 50	○	○	△	—	—	—	△	—	—	□	—	
			Over 50 up to and incl. 250	○	○	△	—	—	—	—	—	—	□	—	

Table A.1 (continued)

Alloy No.	Temper grade	Product designation	Division of outside diameter mm	Test items of mechanical properties and physical properties												
				Tensile strength	Elongation	Hardness	Grain size	Flareability	Flattenability	Non-destructive inspection characteristics	Electric conductivity	Hydrogen embrittlement	Season cracking	Leaching performance		
C 2600 C 2700	H	C 2600 T-H C 2600 TS-H C 2700 T-H C 2700 TS-H	4 or over up to and incl. 50	○	—	△	—	—	—	—	△	—	—	□	—	
			Over 50 up to and incl. 250	○	—	△	—	—	—	—	—	—	—	□	—	
C 2800	O	C 2800 T-O C 2800 TS-O	10 or over up to and incl. 50	○	○	—	—	○	—	—	△	—	—	□	—	
			Over 50 up to and incl. 100	○	○	—	—	○	—	—	—	—	—	□	—	
			Over 100 up to and incl. 250	○	○	—	—	—	○	—	—	—	—	□	—	
	OL	C 2800 T-OL C 2800 TS-OL	10 or over up to and incl. 50	○	○	△	—	○	—	—	△	—	—	□	—	
			Over 50 up to and incl. 100	○	○	△	—	○	—	—	—	—	—	□	—	
			Over 100 up to and incl. 250	○	○	△	—	—	○	—	—	—	—	□	—	
	½H	C 2800 T-½H C 2800 TS-½H	10 or over up to and incl. 50	○	○	△	—	—	—	—	△	—	—	□	—	
			Over 50 up to and incl. 250	○	○	△	—	—	—	—	—	—	—	□	—	
	H	C 2800 T-H C 2800 TS-H	10 or over up to and incl. 50	○	—	—	—	—	—	—	△	—	—	□	—	
			Over 50 up to and incl. 100	○	—	—	—	—	—	—	—	—	—	□	—	
	C 4430 C 6870 C 6871 C 6872	O	C 4430 T-O C 4430 TS-O C 6870 T-O C 6870 TS-O C 6871 T-O C 6871 TS-O C 6872 T-O C 6872 TS-O	5 or over up to and incl. 50	○	○	—	△	○	○	○	—	—	—	□	—
				Over 50 up to and incl. 100	○	○	—	△	○	○	—	—	—	—	□	—
Over 100 up to and incl. 250				○	○	—	△	—	○	—	—	—	—	□	—	

Table A.1 (concluded)

Alloy No.	Temper grade	Product designation	Division of outside diameter mm	Test items of mechanical properties and physical properties										
				Tensile strength	Elongation	Hardness	Grain size	Flareability	Flattenability	Non-destructive inspection characteristics	Electric conductivity	Hydrogen embrittlement	Season cracking	Leaching performance
C 7060 C 7100 C 7150 C 7164	O	C 7060 T-O C 7060 TS-O	5 or over up to and incl. 50	○	○	—	△	○	○	○	—	—	—	—
		C 7100 T-O C 7100 TS-O	Over 50 up to and incl. 100	○	○	—	△	○	○	—	—	—	—	—
		C 7150 T-O C 7150 TS-O C 7164 T-O C 7164 TS-O	Over 100 up to and incl. 250	○	○	—	△	—	○	—	—	—	—	—
<p>NOTE : The symbol “○” in the table indicates mandatory test items, “△” indicates test items that are to be applied when requested by the purchaser, and “□” indicates test items which may be omitted upon agreement between the purchaser and the manufacturer.</p> <p>Notes a) C 1220 tubes, when applied for piping of water works, shall be subjected to the hydraulic pressure test in 7.9 as part of the type inspection.</p> <p>b) Shall not be applied to C 1220 tubes.</p> <p>c) C 1220 tubes, when applied for piping of water works, shall be subjected to the leaching performance test in 7.14 as part of the type inspection.</p>														

Table A.2 Mechanical and physical properties test items of high strength copper tubes and copper alloy tubes for pressure vessels

Alloy No.	Temper grade	Product designation	Division of outside diameter mm	Test items of mechanical and physical properties test items									
				Tensile strength	Proof stress	Elongation	Hardness	Grain size	Flareability	Flattenability	Non-destructive inspection characteristics	Season cracking	
C 1565 C 1862 C 5010 C 5015	O	C 1565 T-O C 1565 TS-O	4 or over up to and incl. 100	○	○	○	△	△	○	—	△	—	
		C 1862 T-O C 1862 TS-O C 5010 T-O C 5010 TS-O C 5015 T-O C 5015 TS-O	Over 100 up to and incl. 250	○	○	○	△	△	—	○	△	—	
	½H	C 1565 T-½H C 1565 TS-½H	4 or over up to and incl. 100	○	○	—	△	—	—	—	△	—	
		C 1862 T-½H C 1862 TS-½H C 5010 T-½H C 5010 TS-½H C 5015 T-½H C 5015 TS-½H	Over 100 up to and incl. 250	○	○	—	△	—	—	—	△	—	
	¾H	C 1565 T-¾H C 1565 TS-¾H	4 or over up to and incl. 100	○	○	—	△	—	—	—	△	—	
		C 1862 T-¾H C 1862 TS-¾H C 5010 T-¾H C 5010 TS-¾H C 5015 T-¾H C 5015 TS-¾H	Over 100 up to and incl. 250	○	○	—	△	—	—	—	△	—	
	H	C 1565 T-H C 1565 TS-H C 1862 T-H C 1862 TS-H C 5010 T-H C 5010 TS-H C 5015 T-H C 5015 TS-H	100 or under	○	○	—	△	—	—	—	△	—	
	C 2800	O	C 2800 T-O C 2800 TS-O	10 or over up to and incl. 50	○	○	○	—	—	○	—	○	□
				Over 50 up to and incl. 100	○	○	○	—	—	○	—	—	□
				Over 100 up to and incl. 250	○	○	○	—	—	—	○	—	□

Table A.2 (concluded)

Alloy No.	Temper grade	Product designation	Division of outside diameter mm	Test items of mechanical and physical properties test items								
				Tensile strength	Proof stress	Elongation	Hardness	Grain size	Flareability	Flattenability	Non-destructive inspection characteristics	Season cracking
C 4430	O	C 4430 T-O C 4430 TS-O	5 or over up to and incl. 50	○	○	○	—	△	○	○	○	□
			Over 50 up to and incl. 100	○	○	○	—	△	○	○	—	□
			Over 100 up to and incl. 250	○	○	○	—	△	—	○	—	□
C 7060	O	C 7060 T-O C 7060 TS-O	5 or over up to and incl. 50	○	○	○	—	△	○	○	○	—
			Over 50 up to and incl. 100	○	○	○	—	△	○	○	—	—
			Over 100 up to and incl. 250	○	○	○	—	△	—	○	—	—
C 7150	O	C 7150 T-O C 7150 TS-O	5 or over up to and incl. 50	○	○	○	—	△	○	○	○	—
			Over 50 up to and incl. 100	○	○	○	—	△	○	○	—	—
			Over 100 up to and incl. 250	○	○	○	—	△	—	○	—	—

NOTE : The symbol “○” in the table indicates mandatory test items, “△” indicates test items that are to be applied when requested by the purchaser, and “□” indicates test items which may be omitted upon agreement between the purchaser and the manufacturer.

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