

## Carbon Steel Tubes for Machine Structural Purposes

### 1. Scope

This Japanese Industrial Standard specifies the carbon steel tubes, hereinafter referred to as the "tubes", used for machinery, automobiles, bicycles, furniture, appliances and other machine parts.

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

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

### 2. Grade and Designation

The grade and designation of the tube shall be as given in Table 1.

The subclassification letter symbols A, B and C are used to indicate distinction of method of manufacturing the tube, cold working process, heat treatment, etc.

Table 1. Grade and Designation

Grade		Designation
Grade 11	A	STKM 11 A
Grade 12	A	STKM 12 A
	B	STKM 12 B
	C	STKM 12 C
Grade 13	A	STKM 13 A
	B	STKM 13 B
	C	STKM 13 C
Grade 14	A	STKM 14 A
	B	STKM 14 B
	C	STKM 14 C
Grade 15	A	STKM 15 A
	C	STKM 15 C
Grade 16	A	STKM 16 A
	C	STKM 16 C
Grade 17	A	STKM 17 A
	C	STKM 17 C
Grade 18	A	STKM 18 A
	B	STKM 18 B
	C	STKM 18 C
Grade 19	A	STKM 19 A
	C	STKM 19 C
Grade 20	A	STKM 20 A

Chemical Composition

The tube shall be tested in accordance with 8.1 and the resulting ladle analysis values shall conform to Table 2.

Table 2. Chemical Composition

Grade	Designation	C	Si	Mn	P	S	Unit No. of V
Grade 11	A STKM 11 A	0.12 max.	0.35 max.	0.60 max.	0.040 max.	0.040 max.	-
Grade 12	A STKM 12 A	0.20 max.	0.35 max.	0.60 max.	0.040 max.	0.040 max.	-
	B STKM 12 B						
	C STKM 12 C						
Grade 13	A STKM 13 A	0.25 max.	0.35 max.	0.30 to 0.90	0.040 max.	0.040 max.	-
	B STKM 13 B						
	C STKM 13 C						
Grade 14	A STKM 14 A	0.30 max.	0.35 max.	0.30 to 1.00	0.040 max.	0.040 max.	-
	B STKM 14 B						
	C STKM 14 C						
Grade 15	A STKM 15 A	0.25 to 0.35	0.35 max.	0.30 to 1.00	0.040 max.	0.040 max.	-
	C STKM 15 C						
Grade 16	A STKM 16 A	0.35 to 0.45	0.40 max.	0.40 to 1.00	0.040 max.	0.040 max.	-
	C STKM 16 C						
Grade 17	A STKM 17 A	0.45 to 0.55	0.40 max.	0.40 to 1.00	0.040 max.	0.040 max.	-
	C STKM 17 C						
Grade 18	A STKM 18 A	0.18 max.	0.55 max.	1.50 max.	0.040 max.	0.040 max.	-
	B STKM 18 B						
	C STKM 18 C						
Grade 19	A STKM 19 A	0.25 max.	0.55 max.	1.50 max.	0.040 max.	0.040 max.	-
	C STKM 19 C						
Grade 20	A STKM 20 A	0.25 max.	0.55 max.	1.60 max.	0.040 max.	0.040 max.	0.15 max.

Remarks 1. When the purchaser requires product analysis for the tubes made of killed steel, the tolerances for the values given above shall be as specified in Table 2 in JIS G 0321 for seamless steel tubes and in Table 1 for electric resistance welded or butt welded steel tubes.

2. For the tubes of Grade 15 made by electric resistance welding process, the lower limit of carbon content may be altered by agreement between the parties concerned.
3. For the tubes of Grade 20, Nb in combination with V may be added. In this case, the maximum content of Nb + V shall be 0.15 %.

#### 4. Mechanical Properties

4.1 Tensile Strength, Yield Point or Proof Stress, and Elongation The tube shall be tested in accordance with 8.2 and the resulting tensile strength, yield point or proof stress, and elongation shall comply with Table 3-1 or Table 3-2.

4.2 Bending Strength or Flattening Strength The tube shall be tested in accordance with 8.3 or 8.4 and shall be free from flaws or cracks on their wall surfaces. The bending test, however, shall be applied to the tubes 50 mm or larger in outside diameter in lieu of flattening test when especially specified by the purchaser.

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

Grade	Designation	Tensile strength kgf/mm <sup>2</sup> (N/mm <sup>2</sup> )	Yield point or proof stress kgf/mm <sup>2</sup> (N/mm <sup>2</sup> )	Elongation %		Flattening strength Distance between flat plates (H) (D is outside dia. of the tube)	Bending strength	
				No. 4, No. 11, No. 12 test pieces Longitudinal direction	No. 4, No. 5 test pieces Transverse direction		Bend angle	Inside radius (D is outside dia. of the tube)
Grade 11	A STKM 11 A	30 min. [294] min.	—	35 min.	30 min.	$\frac{1}{2} D$	180°	$\frac{1}{2} D$
	A STKM 12 A	35 min. [343] min.	18 min. (177) min.	35 min.	30 min.	$\frac{2}{3} D$	90°	$\frac{1}{2} D$
Grade 12	B STKM 12 B	40 min. [392] min.	28 min. (275) min.	25 min.	20 min.	$\frac{2}{3} D$	90°	$\frac{1}{2} D$
	C STKM 12 C	48 min. (471) min.	36 min. (353) min.	20 min.	15 min.	—	—	—
	A STKM 13 A	38 min. [373] min.	22 min. (216) min.	30 min.	25 min.	$\frac{2}{3} D$	90°	$\frac{1}{2} D$
Grade 13	B STKM 13 B	45 min. (441) min.	31 min. (304) min.	20 min.	15 min.	$\frac{3}{4} D$	90°	$\frac{1}{2} D$
	C STKM 13 C	52 min. (510) min.	39 min. (382) min.	15 min.	10 min.	—	—	—
	A STKM 14 A	42 min. [412] min.	25 min. (245) min.	25 min.	20 min.	$\frac{3}{4} D$	90°	$\frac{1}{2} D$
Grade 14	B STKM 14 B	51 min. (500) min.	36 min. (353) min.	15 min.	10 min.	$\frac{7}{8} D$	90°	$\frac{1}{2} D$
	C STKM 14 C	56 min. (549) min.	42 min. (412) min.	15 min.	10 min.	—	—	—
	A STKM 15 A	48 min. (471) min.	28 min. (275) min.	22 min.	17 min.	$\frac{3}{4} D$	90°	$\frac{1}{2} D$
Grade 15	C STKM 15 C	59 min. (579) min.	44 min. (431) min.	12 min.	7 min.	—	—	—
	A STKM 16 A	52 min. (510) min.	33 min. (324) min.	20 min.	15 min.	$\frac{7}{8} D$	90°	$\frac{1}{2} D$
Grade 16	C STKM 16 C	63 min. (618) min.	47 min. (461) min.	12 min.	7 min.	—	—	—
	A STKM 17 A	56 min. (549) min.	35 min. (343) min.	20 min.	15 min.	$\frac{7}{8} D$	90°	$\frac{1}{2} D$
Grade 17	C STKM 17 C	66 min. (647) min.	49 min. (481) min.	10 min.	5 min.	—	—	—
	A STKM 18 A	45 min. (441) min.	28 min. (275) min.	25 min.	20 min.	$\frac{7}{8} D$	90°	$\frac{1}{2} D$
Grade 18	B STKM 18 B	50 min. (490) min.	32 min. (314) min.	23 min.	18 min.	$\frac{7}{8} D$	90°	$\frac{1}{2} D$
	C STKM 18 C	52 min. (510) min.	39 min. (382) min.	15 min.	10 min.	—	—	—
	A STKM 19 A	50 min. (490) min.	32 min. (314) min.	23 min.	18 min.	$\frac{7}{8} D$	90°	$\frac{1}{2} D$
Grade 19	C STKM 19 C	56 min. (549) min.	42 min. (412) min.	15 min.	10 min.	—	—	—
Grade 20	A STKM 20 A	55 min. (539) min.	40 min. (392) min.	23 min.	18 min.	$\frac{7}{8} D$	90°	$\frac{1}{2} D$

- Remarks
1. When the tensile test is carried out on No. 12 or No. 5 test piece for the tube under 8 mm in wall thickness, the minimum value of elongation shall be calculated by subtracting 1.5 % from the value of elongation given in Table 3-1 for each 1 mm decrease in wall thickness and rounding off to an integer in accordance with JIS Z 8401. Examples of calculation are given in Reference Table.
  2. The values of elongation in Table 3-1 shall not be applied to the tubes 40 mm or smaller in outside diameter. However, it may be agreed upon by the purchaser and the manufacturer, when especially required.
  3. For electric resistance welded steel tubes and butt-welded steel tubes, the tensile test pieces shall be No. 12 or No. 5, and they shall be taken from a portion not involving welded seams.
  4. For the flattening test, the minimum distance between the flat plates (H) shall be 5 times the plate thickness.

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

Grade	Designation	Tensile strength N/mm <sup>2</sup>	Yield point or proof stress N/mm <sup>2</sup>	Elongation %		Flattening strength Distance between flat plates (H) (D is outside dia. of the tube)	Bending strength	
				No. 4, No. 11, No. 12 test pieces Longitudinal direction	No. 4, No. 5 test pieces Transverse direction		Bend angle	Inside radius (D is outside dia. of the tube)
Grade A	STKM 11 A	290 min.		85 min.	30 min.	$\frac{1}{2} D$	180°	4 D
	STKM 12 A	340 min.	175 min.	85 min.	30 min.	$\frac{2}{3} D$	90°	6 D
Grade B	STKM 12 B	390 min.	275 min.	25 min.	20 min.	$\frac{2}{3} D$	90°	4 D
	STKM 12 C	470 min.	355 min.	20 min.	15 min.			
Grade C	STKM 13 A	370 min.	215 min.	30 min.	25 min.	$\frac{2}{3} D$	90°	4 D
	STKM 13 B	440 min.	305 min.	20 min.	15 min.	$\frac{3}{4} D$	90°	6 D
Grade H	STKM 13 C	510 min.	395 min.	15 min.	10 min.			
	STKM 14 A	410 min.	245 min.	25 min.	20 min.	$\frac{3}{4} D$	90°	6 D
Grade II	STKM 14 B	500 min.	355 min.	15 min.	10 min.	$\frac{1}{8} D$	90°	8 D
	STKM 14 C	550 min.	410 min.	15 min.	10 min.			
Grade A	STKM 15 A	470 min.	275 min.	22 min.	17 min.	$\frac{3}{4} D$	90°	6 D
	STKM 15 C	540 min.	430 min.	12 min.	7 min.			
Grade C	STKM 16 A	510 min.	325 min.	20 min.	15 min.	$\frac{1}{8} D$	90°	8 D
	STKM 16 C	620 min.	460 min.	12 min.	7 min.			
Grade A	STKM 17 A	550 min.	345 min.	20 min.	15 min.	$\frac{1}{8} D$	90°	8 D
	STKM 17 C	650 min.	490 min.	10 min.	5 min.			
Grade A	STKM 18 A	440 min.	275 min.	25 min.	20 min.	$\frac{1}{8} D$	90°	6 D
	STKM 18 B	490 min.	315 min.	23 min.	18 min.	$\frac{1}{8} D$	90°	8 D
Grade C	STKM 18 C	510 min.	380 min.	15 min.	10 min.			
	STKM 19 A	490 min.	315 min.	23 min.	18 min.	$\frac{1}{8} D$	90°	6 D
Grade C	STKM 19 C	550 min.	410 min.	15 min.	10 min.			
	STKM 20 A	540 min.	390 min.	23 min.	18 min.	$\frac{1}{8} D$	90°	6 D

- When the tensile test is carried out on No. 11 or No. 5 test piece for the tube under 8 mm in wall thickness, the minimum value of elongation shall be calculated by subtracting 1.5 % from the values of elongation given in Table 3-2 for each 1 mm decrease in wall thickness and rounding off to an integer in accordance with JIS Z 8401. Examples of calculation are given in Reference Table.
- The values of elongation in Table 3-2 shall not be applied to the tubes 40 mm or smaller in outside diameter. However, it may be agreed upon by the purchaser and the manufacturer, when especially required.
- For electric resistance welded steel tubes and butt-welded steel tubes, the tensile test pieces shall be No. 12 or No. 5, and they shall be taken from a portion not involving welded seams.
- For the flattening test, the minimum distance between the flat plates (H) shall be 5 times the plate thickness.

Reference Table. Calculated Examples of Elongation Applied to No. 5 Test Piece (Transverse Direction) and No. 12 Test Piece (Longitudinal Direction) for Tubes under 8 mm in Wall Thickness

Grade	Designation	Type of test piece	Elongation for each division of wall thickness								1 mm or less
			Over 7 mm to and excl. 8 mm	Over 6 mm up to and incl. 7 mm	Over 5 mm up to and incl. 6 mm	Over 4 mm up to and incl. 5 mm	Over 3 mm up to and incl. 4 mm	Over 2 mm up to and incl. 3 mm	Over 1 mm up to and incl. 2 mm		
Grade 11	A	STKM 11 A	No. 5	30	28	27	26	24	22	21	20
			No. 12	35	34	32	30	29	28	26	25
Grade 12	A	STKM 12 A	No. 5	30	28	27	26	24	22	21	20
			No. 12	35	34	32	30	29	28	26	25
	B	STKM 12 B	No. 5	20	18	17	16	14	12	11	10
			No. 12	25	24	22	20	19	18	16	15
	C	STKM 12 C	No. 5	15	14	12	10	9	8	6	5
			No. 12	20	18	17	16	14	12	11	10
Grade 13	A	STKM 13 A	No. 5	25	24	22	20	19	18	16	15
			No. 12	30	28	27	26	24	22	21	20
	B	STKM 13 B	No. 5	15	14	12	10	9	8	6	5
			No. 12	20	18	17	16	14	12	11	10
	C	STKM 13 C	No. 5	10	8	7	6	4	2	1	0
			No. 12	15	14	12	10	9	8	6	5
Grade 14	A	STKM 14 A	No. 5	20	18	17	16	14	12	11	10
			No. 12	25	24	22	20	19	18	16	15
	B	STKM 14 B	No. 5	10	8	7	6	4	2	1	0
			No. 12	15	14	12	10	9	8	6	5
	C	STKM 14 C	No. 5	10	8	7	6	4	2	1	0
			No. 12	15	14	12	10	9	8	6	5
Grade 15	A	STKM 15 A	No. 5	17	16	14	12	11	10	8	7
			No. 12	22	20	19	18	16	14	13	11
			No. 5	7	6	4	2	1	-	-	0
Grade 16	C	STKM 15 C	No. 12	12	10	9	8	6	4	3	1
			No. 5	15	14	12	10	9	8	6	5
			No. 12	20	18	17	16	14	12	11	10
Grade 17	A	STKM 16 A	No. 5	7	6	4	2	1	-	-	0
			No. 12	12	10	9	8	6	4	3	1
	B	STKM 16 B	No. 5	15	14	12	10	9	8	6	5
			No. 12	20	18	17	16	14	12	11	10
	C	STKM 16 C	No. 5	5	4	2	-	-	-	-	0
			No. 12	10	8	7	6	4	2	1	0
Grade 18	A	STKM 17 A	No. 5	20	18	17	16	14	12	11	10
			No. 12	25	24	22	20	19	18	16	15
	B	STKM 17 B	No. 5	18	16	15	14	12	10	9	8
			No. 12	23	22	20	18	17	16	14	13
	C	STKM 17 C	No. 5	10	8	7	6	4	2	1	0
			No. 12	15	14	12	10	9	8	6	5
Grade 19	A	STKM 18 A	No. 5	18	16	15	14	12	10	9	8
			No. 12	23	22	20	18	17	16	14	13
			No. 5	10	8	7	6	4	2	1	0
Grade 20	C	STKM 18 C	No. 12	15	14	12	10	9	8	6	5
			No. 5	18	16	15	14	12	10	9	8
			No. 12	23	22	20	18	17	16	14	13

Remark: The symbol "-" indicates a case where elongation is not specified.

Dimensional Tolerances

- (1) The tolerances on outside diameter and wall thickness for the tubes shall be as given in Table 4 and Table 5, respectively.

Table 4. Tolerances on Outside Diameter

Division	Tolerances on outside diameter	
No. 1	Under 50 mm	$\pm 0.5$ mm
	50 mm or over	$\pm 1$ %
No. 2	Under 50 mm	$\pm 0.25$ mm
	50 mm or over	$\pm 0.5$ %
No. 3	Under 25 mm	$\pm 0.12$ mm
	25 mm or over to and excl. 40 mm	$\pm 0.15$ mm
	40 mm or over to and excl. 50 mm	$\pm 0.18$ mm
	50 mm or over to and excl. 60 mm	$\pm 0.20$ mm
	60 mm or over to and excl. 70 mm	$\pm 0.23$ mm
	70 mm or over to and excl. 80 mm	$\pm 0.25$ mm
	80 mm or over to and excl. 90 mm	$\pm 0.30$ mm
	90 mm or over to and excl. 100 mm	$\pm 0.40$ mm
100 mm or over	$\pm 0.5$ %	

- Remarks 1. For hot finished seamless steel tube, the outside diameter tolerances No. 1 shall be applied.
2. The tolerances on outside diameter of quenched and tempered tubes shall be as agreed upon by the purchaser and the manufacturer.

Table 5. Tolerances on Wall Thickness

Division	Tolerances on wall thickness	
No. 1	Under 4 mm	+ 0.6 mm - 0.5 mm
	4 mm or over	+ 15 % - 12.5 %
No. 2	Under 3 mm	± 0.3 mm
	3 mm or over	± 10 %
No. 3	Under 2 mm	± 0.15 mm
	2 mm or over	± 8 %

Remark: For hot finished seamless steel tubes, the tolerances No. 1 shall be applied.

- (2) The tolerances on the tube length shall be in the range of 0 to + 50 mm. However, when tolerances outside this range are especially required, agreement shall be made between the purchaser and the manufacturer.

#### 6. Appearance

- (1) The tubes shall be practically straight, and the two ends shall be at right angles to the axis of the tube.
- (2) The tubes shall be free from defects detrimental to practical use.
- (3) The surface finish of the tubes, when especially specified shall be agreed upon by the purchaser and the manufacturer.

#### 7. Method of Manufacture

Method of manufacturer shall be as follows:

- (1) The tubes of Grades 11, 12 and 13 shall be manufactured by seamless process, electric resistance welding process, or butt welding process, and those of other grades shall be manufactured by seamless process or electric resistance welding process.
- (2) The tube shall be as manufactured or as cold-finished condition, or they shall be subjected to appropriate heat treatment.

#### 8. Test

##### 8.1 Chemical Analysis

8.1.1 Chemical Analysis The general requirements for chemical analysis and method of sampling specimens for analysis shall be in accordance with the 3. in JIS G 0303.

8.1.2 Analytical Method The analytical method shall be in accordance with one of the following Standards.

JIS G 1211

JIS G 1212

JIS G 1213

JIS G 1214

JIS G 1215

JIS G 1221

JIS G 1237

JIS G 1253

JIS G 1256

JIS G 1257

#### 8.1 Tensile Test

8.2.1 Test Piece The test piece shall be No. 11, No. 12 A, No. 12 B, No. 12 C, No. 4 or No. 5 test piece specified in JIS Z 2201 and shall be cut from the tube. The gauge length for No. 4 test piece, however, shall be 40 mm.

8.2.2 Test Method The test method shall be in accordance with JIS Z 241.

#### 8.3 Bending Test

8.3.1 Test Piece A suitable length of a tube shall be cut off from one end of the tube to be made into a test piece.

8.3.2 Test Method The test piece shall be bent, at ordinary temperature, around a cylinder with the bend angle and inside radius specified in Table 3-1 and Table 3-2, and checked for the occurrence of flaws or cracks. In the case of electric resistance welded steel tubes and butt-welded steel tubes, the weld shall be placed in the outermost part of the bent portion.

#### 8.4 Flattening Test

8.4.1 Test Piece A test piece 50 mm or over in length shall be cut off from one end of a tube. For the tube of wall thickness  $\frac{1}{16}$  or over of its outside diameter, a test piece made into C-shape by removing part of the circumference of a full-section test piece may be used.

8.4.2 Test Method The test piece shall be placed between two flat plates, flattened by compression at ordinary temperature until the distance between the plates comes to the value specified in Table 3, and checked for the occurrence of flaws or cracks on its wall surface. In the case of electric resistance welded steel tubes and butt-welded steel tubes, the weld shall be placed at right angles to the direction of compression as shown in Fig. 1. Further, the C-shape test piece shall be placed as shown in Fig. 2.

Fig. 1. Flattening Test (for Full-section Test Piece)

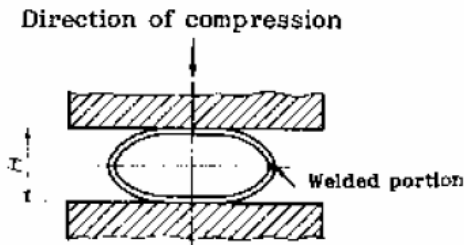
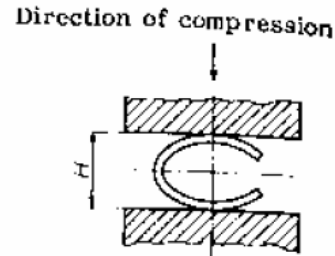


Fig. 2. Flattening Test (for C-shape Test Piece)



## 9. Inspection

### 9.1 Inspection Inspection shall be as follows:

- (1) The general requirements for inspection shall be in accordance with JIS G 0303.
- (2) The chemical composition, mechanical properties, dimensions and appearance shall conform to the requirements specified in 3., 4., 5. and 6. The bending test and the flattening test, however, may be omitted when approved by the purchaser.
- (3) The purchaser may specify a flaring test, hydrostatic test, etc., in addition to those specified in (2). In this case, the test items, sampling method, test method and acceptance criteria shall be previously agreed upon by the manufacturer.
- (4) The number of specimens for product analysis shall be as agreed upon by the purchaser and the manufacturer.
- (5) The method of sampling specimens and the number of test pieces for tensile test, bending test and flattening test shall be as given in Table 6.

Table 6. Method of Sampling Specimens and Number of Test Pieces

Grade	Designation	Division of outside diameter	Method of sampling specimens and number of test pieces
Grade B No. 11 to 20	STKM 11 A	100 mm or under	Take one specimen from each 1000 m or its fraction of the tubes of the same dimensions. From the specimen, take one flattening or bend test piece for the tubes 50 mm or under in outside diameter; and one flattening test piece for the tubes over 50 mm in outside diameter, in addition to each one tensile test piece in either case.
	STKM 12 A		
	STKM 12 B		
	STKM 13 A		
	STKM 13 B		
	STKM 14 A	Over 100 mm up to and incl. 200 mm	Take one specimen from each 500 m or its fraction of the tubes of the same dimensions. From the specimen, take one tensile test piece and one flattening test piece.
	STKM 14 B		
	STKM 15 A		
	STKM 16 A		
	STKM 17 A	Over 200 mm	Take one specimen from each 250 m or its fraction of the tubes of the same dimensions. From the specimen, take one tensile test piece and one flattening test piece.
	STKM 18 A		
	STKM 18 B		
	STKM 19 A		
	STKM 20 A		
Grade C No. 12 to 19	STKM 12 C	100 mm or under	Take one specimen from each 1000 m or its fraction of the tubes of the same dimensions. From the specimen, take one tensile test piece.
	STKM 13 C		
	STKM 14 C		
	STKM 15 C	Over 100 mm up to and incl. 200 mm	Take one specimen from each 500 m or its fraction of the tubes of the same dimensions. From the specimen, take one tensile test piece.
	STKM 16 C		
	STKM 17 C	Over 200 mm	Take one specimen from each 250 m or its fraction of the tubes of the same dimensions. From the specimen, take one tensile test piece.
	STKM 18 C		
STKM 19 C			

4.2 Reinspection The tube may be retested in accordance with 4.4 in JIS 4303.

10. Marking

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

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

- (1) Designation of grade
- (2) Letter symbol indicating the manufacturing process<sup>(1)</sup>
- (3) Dimensions
- (4) Manufacturer's name or its abbreviation

Note (1) The letter symbol indicating the manufacturing process shall be as follows. However, the sign - may be replaced by a blank.

Hot finished seamless steel tube	S-H
Cold finished seamless steel tube	<u>S-C</u>
Electric resistance welded steel tube other than hot finished or cold finished ones	E-G
Hot finished electric resistance welded steel tube	E-H
Cold finished electric resistance welded steel tube	E-C
Butt-welded steel tube	B
Cold finished butt-welded steel tube	B-C

11. Report

The manufacturer shall, as a rule, submit to the purchaser a report on the test results, manufacturing process, ordered dimensions, quantity and work lot number traceable to the history of manufacture, etc.