

Design

# INVOICE FOR ISSUE OF TOYOTA ENGINEERING STANDARD

NO. : TSG3150G

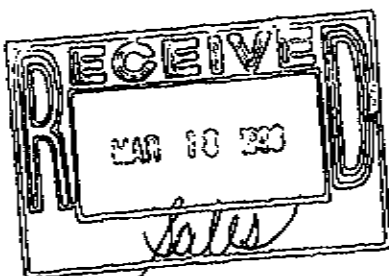
TITLE : CARBON STEEL TUBES FOR MACHINE STRUCTURAL PURPOSES

CLASS : **C**

PUBLICATION RECORD

(Asterisk mark "\*" in this standard denotes the changed portion from previous issue.) :

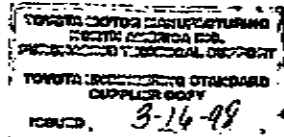
Revised  
Changed Tables 2, 4 & 10



Date: '98.2.18  
Engineering Information  
Management Dept.  
Engineering Administration Div.  
TOYOTA MOTOR CORPORATION



NOTE: In the case of revision, the old standard which has been issued before should be discarded in proper manner (such as shredding or fire) to avoid possible use of obsolete standards information.





TOYOTA ENGINEERING STANDARD

TSG3150G

CLASS

C

CARBON STEEL TUBES FOR MACHINE STRUCTURAL PURPOSES

## 1. Scope

This standard covers carbon steel tubes for machine structural purposes (hereinafter referred to as "tubes") which comprise automotive parts.

Remark: In this standard, units and numerical values given in ( ) are based on the customary units system, and are given for reference.

## 2. Classification

Classification and codes for the tubes shall be as shown in Tables 1 and 2.

Table 1 Classification and Codes of Tubes for General Purposes

Classification	Code	Type code	(Reference) Equivalent standard		
			JIS	ASTM	
			G3445	A513	A519
Class 11	A	STKM11A	STKM11A	1008	—
	B	STKM12A	STKM12A	—	
Class 12	B	STKM12B	STKM12B		
	C	STKM12C	STKM12C		
Class 13	A	STKM13A	STKM13A		1020
	B	STKM13B	STKM13B		
	C	STKM13C	STKM13C	1020	
Class 14	A	STKM14A	STKM14A	—	
	B	STKM14B	STKM14B	1026	
	C	STKM14C	STKM14C		
Class 15	A	STKM15A	STKM15A	—	
	C	STKM15C	STKM15C		
Class 16	A	STKM16A	STKM16A	—	
	C	STKM16C	STKM16C		
Class 17	A	STKM17A	STKM17A	1050	
	C	STKM17C	STKM17C	—	

Prepared and Written by :

Metallic Material Dept.

Material Engineering Div. I

Engineering Administration Div.

© TOYOTA MOTOR CORPORATION

Established / 7 th Revised :

Feb. 1998

NOTES: The recipient of this standard shall undertake the following confidentiality obligations upon the receipt of this standard.  
 \* The recipient shall discard by shredding or fire, or return to Toyota Motor Corporation if appropriate, the documents contained in this standard when they are no longer necessary due to the termination of the work concerned or the revision of current version of this standard.  
 \* This standard and the technical information related thereto are owned by and under sole control of Toyota Motor Corporation. They shall not be disclosed in whole or in part to any third party without prior written consent of Toyota Motor Corporation.



Table 2 Classification and Codes of Tubes for Propeller Shafts

Classification	Code	Type code	(Reference)	Application	
			Equivalent standard		
			JASO C 301		
Class 13	B	STKM13B	EP	STKM13B-P <sub>1</sub>	Tube manufactured from hot-rolled steel strip
			ER	STKM13B-P <sub>2</sub>	Tube manufactured from hot-rolled steel strip that has been subjected to intense skin pass rolling.
			B70	-	Tensile strength of 690 MPa (70 kgf/mm <sup>2</sup> ). Tube manufactured from hot-rolled steel strip that has been subjected to intense skin pass rolling.
			B80	-	Tensile strength of 780 MPa (80 kgf/mm <sup>2</sup> ). Tube manufactured from hot-rolled steel strip of HAZ softening resistant type that has been subjected to intense skin pass rolling.

Remarks: (Common to Tables 1 and 2)

1. Tubes are classified into A, B and C, indicating the condition of tubes after working, in accordance with the degree of cold working and annealing: A for soft materials, B for materials of medium hardness, and C for hard materials.
2. The type code is determined by the manufacturing methods: S for seamless tubes, B for electric-resistance-welded tubes, EP, ER, B70 and B80 for electric-resistance-welded tubes for propeller shafts.
3. Type code shall be indicated immediately after a hyphen (-) following the classification code.

Example: STKM13B-ER

4. When the tube is specified as STKM○C on drawings already issued, check whether it is a drawn tube or not at every engineering change. In the case of the drawn tube, the method of indication shall be altered to that specified in TSG3153G.

NOTES: The recipient of this standard shall undertake the following confidentiality obligations upon the receipt of this standard.  
 \* The recipient shall refrain from disclosing or file, or return to Toyota Motor Corporation if appropriate, the documents contained in this standard when they are no longer necessary due to the completion of the work concerned or the revision of current version of this standard.  
 \* This standard and the technical information related thereto are owned by and under sole control of Toyota Motor Corporation. They shall not be disclosed in whole or in part to any third party without prior written consent of Toyota Motor Corporation.

Established / 7<sup>th</sup> Revised:

Feb. 1998



3. Quality

- (1) Tubes shall be practically straight and both ends shall be perpendicular to the tube axis.
- (2) Tubes shall be free of defects detrimental in actual use.
- (3) Chemical composition of the tubes shall be as shown in Tables 3 and 4.

Table 3 Chemical Composition of Tubes for General Purposes

Unit: mass %

Code	Type code	C	Si	Mn	P	S
STKM11A	S, B	0.12 max.	0.35 max.	0.60 max.	0.040 max.	0.040 max.
STKM12A		0.20 max.				
STKM12B						
STKM12C		0.25 max.	0.30 to 1.00			
STKM13A						
STKM13B		0.30 max.	0.40 to 1.00			
STKM13C						
STKM14A		0.25 to 0.35	0.40 max.	0.40 to 1.00		
STKM14B						
STKM14C		0.35 to 0.45				
STKM15A						
STKM15C		0.45 to 0.55				
STKM16A						
STKM16C						
STKM17A						
STKM17C						

Table 4 Chemical Composition of Tubes for Propeller Shafts

Unit: mass %

Code	Type code	C	Si	Mn	P	S	Nb	Mo	Other composition
STKM13B	BP	0.25 max.	0.35 max.	0.30 to 0.90	0.040 max.	0.040 max.	—	—	—
	BR								
	E70	0.010 to 0.050							
	E80	0.015 to 0.050	0.20 to 0.40	(1)					

Note:(1) Addition of 0.050 max. of Ti is permissible.

NOTES The recipient of this standard shall undertake the following confidentiality obligations upon the receipt of this standard.  
 \* The recipient shall decide by shredding or fire, or return to Toyota Motor Corporation if appropriate, the documents contained in this standard when they are no longer necessary due to the termination of the work concerned or if a revision of current version of this standard.  
 \* This standard and the technical information related thereto are owned by and under the control of Toyota Motor Corporation. They shall not be disclosed in whole or in part to any third party without prior written consent of Toyota Motor Corporation.

Established / 7 th Revised:  
 Feb. 1998



(4) Details concerning tensile test, bending test, and flattening test shall be in accordance with Tables 5 and 6. The bending test is applicable to tubes 50 mm or less in the outside diameter and the flattening test is applicable to those more than 50 mm in the outside diameter. There shall be no occurrence of flaws and cracks in the tube wall when the tube is deformed to a state specified in each table.

Values for the bending test and flattening test may be specified also, if necessary, for tubes of dimensions different from those specified above.

Table 5 Mechanical Properties of Tubes for General Purposes

Code	Tensile test				Bending test		Flattening test
	Yield point or proof stress (MPa) (kgf/cm <sup>2</sup> )	Tensile strength (MPa) (kgf/cm <sup>2</sup> )	Elongation (%)		Bending angle (°)	Inside radius (D: Outside diameter)	Distance between flat plates (D: Outside diameter)
			No. 11 test piece No. 12 test piece	No. 5 test piece			
			Longitudinal	Lateral			
STEM11A	—	290 {30} min.	35 min.	30 min.	180.	60	$\frac{1}{2}$ D
STEM12A	175 {18} min.	340 {35} min.			90	60	$\frac{2}{3}$ D
STEM12B	275 {28} min.	390 {40} min.	25 min.	20 min.	—	—	—
STEM12C	355 {36} min.	470 {48} min.	20 min.	15 min.	—	—	—
STEM13A	215 {22} min.	370 {38} min.	30 min.	25 min.	90	60	$\frac{2}{3}$ D
STEM13B	305 {31} min.	440 {45} min.	20 min.	15 min.			$\frac{3}{4}$ D
STEM13C	380 {39} min.	510 {52} min.	15 min.	10 min.	—	—	—
STEM14A	245 {25} min.	410 {42} min.	25 min.	20 min.	90	60	$\frac{3}{4}$ D
STEM14B	355 {36} min.	500 {51} min.	15 min.	10 min.	90	80	$\frac{7}{8}$ D
STEM14C	410 {42} min.	550 {56} min.			—	—	—
STEM15A	275 {28} min.	470 {48} min.	22 min.	17 min.	90	60	$\frac{3}{4}$ D
STEM15C	430 {44} min.	580 {59} min.	12 min.	7 min.	—	—	—
STEM16A	325 {33} min.	510 {52} min.	20 min.	15 min.	90	80	$\frac{7}{8}$ D
STEM16C	460 {47} min.	620 {63} min.	12 min.	7 min.	—	—	—
STEM17A	345 {35} min.	550 {56} min.	20 min.	15 min.	90	80	$\frac{7}{8}$ D
STEM17C	480 {49} min.	650 {66} min.	10 min.	5 min.	—	—	—

NOTES: The recipient of this standard shall undertake the following confidentiality obligations upon the receipt of this standard.  
 1. The recipient shall disclose by shipping or file, or name to Toyota Motor Corporation if appropriate, the disclosure contained in this standard when they are no longer necessary due to the advancement of the work concerned or the revision of current version of this standard.  
 2. This standard and the technical information related thereto are owned by and under sole control of Toyota Motor Corporation. They shall not be disclosed in whole or in part to any third party without prior written consent of Toyota Motor Corporation.

Established / 7 th Revised :  
 Feb. 1998



Table 6 Mechanical Properties of Tubes for Propeller Shafts

Code	Tensile test				Bending test		Flattening test	Torsion test (Ref.)
	Yield point or proof stress (MPa) (kgf/mm <sup>2</sup> )	Tensile strength (MPa) (kgf/mm <sup>2</sup> )	Elongation %		Bending angle (°)	Inside radius (D: Outside diameter)	Distance between flat plates (D: Outside diameter)	Torsional proof stress (1.2 D) (MPa) (kgf/mm <sup>2</sup> )
			No. 11 test piece	No. 5 test piece				
			No. 12 test piece	test piece				
		Longitudinal	Lateral					
STH13B-EP	355 min. (36)	440 min. (45)	20 min.	15 min.	90	60	$\frac{1}{4} D$	185 min. (19)
STH13B-ER	410 min. (42)	470 min. (48)						205 min. (21)
STH13B-E70	530 min. (54)	690 min. (70)	10 min.	5 min.	—	—	$\frac{1}{8} D$	285 min. (29)
STH13B-E80	755 min. (76)	780 to 930 (80 to 95)						360 min. (37)

Remarks: (Common to Tables 5 and 6)

1. Tensile test pieces shall, as a rule, be taken in the longitudinal direction of the materials (see Section 5.2.1.).
2. When the tensile test is to be conducted using a No. 12 or No. 5 test piece sampled from tube less than 8 mm in its wall thickness, the value of elongation shall be reduced by 1.5 % for every 1 mm-reduction in the wall thickness. Round to the whole number in accordance with JIS Z 8401 or ASTM E29, and report as the minimum elongation value.
3. Specifications for elongation given in Tables 5 and 6 do not apply to the tubes less than 40 mm in the outside diameter. However, if necessary, specification for elongation may be determined upon consultation among the departments concerned.
4. Stretching test may be specified depending upon the tube usage.
5. When the tensile test pieces are to be taken from an electric-resistance-welded tubes (B), No. 12 or No. 5 test piece shall be taken from a portion not containing seam.

#### 4. Standard Dimensions and Permissible Dimensional Deviation

##### 4.1 Standard Dimensions

Standard dimensions of the electric-resistance-welded tubes (B, EP, ER, E70, E80) shall be in accordance with table 7. Standard dimensions of seamless tubes (S) are not specified.

However, dimensions that are highly available in Japan are indicated for reference in Attached Table 1.

NOTES: The recipient of this standard shall undertake the following confidentially (only when upon the receipt of this standard).  
 \* The recipient shall disclaim by stamping or etc. its name in Toyota Motor Corporation if appropriate, the documents enclosed in this standard when they are no longer necessary due to the non-existence of the work, completion of the development process or any other reasons.  
 \* This standard and the technical information related thereto are owned by and under sole control of Toyota Motor Corporation. They shall not be disclosed in whole nor in part to any third party without prior written consent of Toyota Motor Corporation.

Established / 7<sup>th</sup> Revised:  
 Feb. 1998



Table 7 Standard Dimensions and Mass of Electric-Resistance-Welded Tubes

Unit: kg/m (Mass)

Thickness (mm)										
Outside diameter (mm)	1.2	1.6	1.8	2.0	2.3	2.6	2.9	3.2	3.5	4.0
15.9	0.435	0.564	/	0.686	/	/	/	/	/	/
19.1	0.530	0.690	/	0.843	0.953	/	/	/	/	/
22.2	0.621	0.813	/	0.996	1.13	/	/	/	/	/
25.4	0.716	0.939	/	1.15	/	1.50	1.61	/	/	/
28.6	0.811	1.07	/	1.31	/	1.67	/	/	/	/
31.8	0.906	1.19	/	1.47	1.67	/	/	2.26	/	/
34.9	0.979	1.27	/	1.57	/	/	2.22	/	/	/
38.0	1.00	1.32	/	1.63	/	/	2.32	/	/	/
38.1	1.09	1.44	/	1.78	2.03	/	/	/	/	/
42.7	1.23	1.62	/	2.01	2.29	2.57	/	3.12	3.38	/
45.0	1.30	1.71	/	2.12	2.42	2.71	3.01	3.30	/	/
48.6	1.46	1.85	/	/	2.63	/	3.27	3.58	/	/
50.8	1.47	1.94	/	2.41	2.75	3.06	3.43	/	4.08	4.53
54.8	1.56	2.07	/	/	2.93	3.29 ER	3.65	/	4.36	4.95
57.0	/	2.19	/	/	3.10	3.48	3.87	4.25	4.62	/
60.5	/	2.32 B80	2.61 (B70)	/	3.30	3.71	4.12	4.52	/	5.39
63.5	/	2.44	/	/	/	/	/	/	/	/
65.0	/	2.58 EP ER	/	3.11 (B70)	/	φ65.0×2.7 t 4.14 ER	/	4.68	5.31	/
68.9	/	2.66	/	/	3.78 ER	/	/	5.18 (ER)	/	/
70.0	/	/	/	/	/	/	/	5.27	5.74	/
75.0	/	B70 EP 2.90 ER	/	/	4.12	4.63 ER	5.16	/	/	/
82.5	/	/	3.59 (B70) EP	3.98 EP ER	4.55 ER	/	/	/	/	/
91.0	/	/	/	/	4.97 ER	5.59	/	6.65	/	8.51

- Remarks: 1. Values marked with EP, ER, B70, B80 are applicable also to tubes for propeller shafts. Values marked with (EP), (ER), (B70) are applicable only to tubes for propeller shafts.
2. Use of tubes with dimensions other than the standard dimensions shall be subject to consultation among the departments concerned. Tube dimensions other than those given in Table 7 shall be in accordance with TSG3153G, as a rule.
3. The numerical value of mass was calculated by the equation (1) on the basis of 1 cm<sup>3</sup> of steel being equivalent to 7.85 g.

$$M = 0.02466t (D-t) \dots\dots\dots (1)$$

where, M: mass of tube (kg/m)  
 t: wall thickness of tube (mm)  
 D: outside diameter of tube (mm)

NOTES: The recipient of this standard shall undertake the following confidentiality obligations upon the receipt of this standard:  
 \* The recipient shall declare by signing or file, or record in Toyota Motor Corporation if appropriate, the documents contained in this standard when they are no longer necessary due to the termination of the work concerned or the revision of current version of this standard.  
 \* This standard and the technical information it related thereto are owned by and under sole control of Toyota Motor Corporation. They shall not be disclosed in whole or in part to any third party without prior written consent of Toyota Motor Corporation.

Established / 7 th Revised:  
 Feb. 1998



TOYOTA ENGINEERING STANDARD

TSG3150G

## 4.2 Permissible Dimensional Deviation

- (1) Permissible dimensional deviation for the tubes for general use shall be in accordance with Table 8.
- (2) Permissible dimensional deviation for the tubes for propeller shafts shall be in accordance with Tables 9 and 10.

Table 8 Permissible Dimensional Deviation on Tubes for General Use

Grade of permissible deviation	Item	Outside diameter		Thickness	
		Division of nominal outside diameter	Permissible deviation	Division of nominal thickness	Permissible deviation
No. 1	Less than 50 mm		$\pm 0.5$ mm	Less than 4 mm	+0.6 mm -0.5 mm
	50 mm min.		$\pm 1$ %	4 mm min.	+15 % -12.5 %
No. 2	Less than 50 mm		$\pm 0.25$ mm	Less than 3 mm	$\pm 0.30$ mm
	50 mm min.		$\pm 0.5$ %	3 mm min.	$\pm 10$ %
No. 3	Less than 25 mm		$\pm 0.12$ mm	Less than 2 mm	$\pm 0.15$ mm
	25 and over to 40 mm excl.		$\pm 0.15$ mm		
	40 and over to 50 mm excl.		$\pm 0.18$ mm		
	50 and over to 60 mm excl.		$\pm 0.20$ mm		
	60 and over to 70 mm excl.		$\pm 0.23$ mm		
	70 and over to 80 mm excl.		$\pm 0.25$ mm	2 mm min.	$\pm 8$ %
	80 and over to 90 mm excl.		$\pm 0.30$ mm		
	90 and over to 100 mm excl.		$\pm 0.40$ mm		
100 mm min.		$\pm 0.5$ %			

NOTES: The recipient of this standard shall undertake the following confidentiality obligations upon the receipt of this standard:  
 1. The recipient shall prevent by shredding or fire, or means as Toyota Motor Corporation of appropriate, the disclosure contained in this standard when they are no longer necessary due to the termination of the work concerned or the revision of current version of this standard.  
 2. This standard and the technical information related thereto are owned by, and under sole control of Toyota Motor Corporation. They shall not be disclosed in whole or in part to any third party without prior written consent of Toyota Motor Corporation.

Established / 7<sup>th</sup> Revised:

Feb. 1998





Table 9 Permissible Dimensional Deviation on Tubes for Propeller Shafts (1)

Type Item	Common to STKM13B-EP, ER		STKM13B-EP		STKM13B-ER	
	Outside diameter		Thickness			
Grade of permissible deviation	Division of nominal outside diameter	Permissible deviation	Division of nominal thickness	Permissible deviation	Division of nominal thickness	Permissible deviation
No. 2	Less than 50 mm	±0.25 mm	Less than 3 mm	±0.25 mm	—	—
	50 mm min.	±0.5 %	3 mm min.	±8 %		
No. 3	Less than 60 mm	±0.20 mm	1.6 mm max.	+0.20 mm -0.15 mm	1.6 and over to 3.0 mm incl.	±0.15 mm
	60 and over to 70 mm excl.	±0.23 mm	Over 1.6 to 2.3 mm incl.	±0.20 mm		
	70 and over to 80 mm excl.	±0.25 mm	Over 2.3 to 3.0 mm incl.	±0.25 mm	Over 3.0 to 5.0 mm incl.	±5 %
	80 and over to 90 mm excl.	±0.30 mm				
	90 and over to 100 mm excl.	±0.40 mm	Over 3.0 mm	±8 %		
100 mm min.	±0.5 %					

Table 10 Permissible Dimensional Deviation on Tubes for Propeller Shafts (2)

Unit: mm

Type Item	Common to STKM13B-E70, E80					
	Outside diameter		Thickness (inclusive of bead portion)		Deflection	
Grade of permissible deviation	Division of outside diameter	Permissible deviation	Division of nominal thickness	Permissible deviation	Division of nominal length	Permissible deviation
No. 3	54 and over to 90 excl.	±0.15	1.6 and over to 3.0 incl.	±0.10	631 max.	0.35 max.

Remarks: (Common to Tables 8, 9 and 10)

1. Roundness of the tube outside diameter shall be 75 % of the tolerance on outside diameter.
2. Permissible deviation on uneven wall thickness of the tubes for propeller shafts shall be 50 % of the range of permissible deviation on wall thickness.
3. Grade of the permissible dimensional deviation shall be indicated after a hyphen (-) immediately following the classification and production codes, and may be specified on design drawings if necessary.

Example: STKM13B-E-No. 3

NOTES: The recipient of this standard shall undertake the following confidentiality obligation upon the receipt of this standard.  
 \* The recipient shall discard by shredding or inc. or return to Toyota Motor Corporation if appropriate, the documents contained in this standard when they are no longer necessary due to the termination of the work concerned by the revision of current version of this standard.  
 \* This standard and the sections of information related thereto are covered by and under sole control of Toyota Motor Corporation. They shall not be disclosed in whole or in part to any third party without prior written consent of Toyota Motor Corporation.

Established / 7 th Revised :

Feb. 1998



Remarks: 4. Tubes of permissible dimensional deviation grade No. 4 specified on drawings already issued are all drawn tubes. Therefore, at every engineering change, the method of indication should be altered to that specified in TSG3153G.

(Applicable to Table 10 only)

1. For the measurement of deflection, place rollers (bearing) at the position of about 10 mm from each end of the tube and rotate the tube. Read, using a dial gage, the amount of deflection at the position approximately the midpoint from the rollers on each end.
2. Within 30 mm from each end of the tube, permissible deviation on outside diameter shall be  $\pm 0.20$  mm.

- (3) The height of beads on the inner wall shall be in accordance with Table 11. (See Fig. 1)

Table 11 Height of Beads on Inner Wall

Grade of permissible deviation	Height of beads on inner wall	Remarks
No. 1	Not specified	Beads remain.
No. 2	Shall be crushed	Max. about $\pm 0.3$ mm
No. 3	$\pm 0.20$ mm $-0.10$ mm	Removed by cutting.

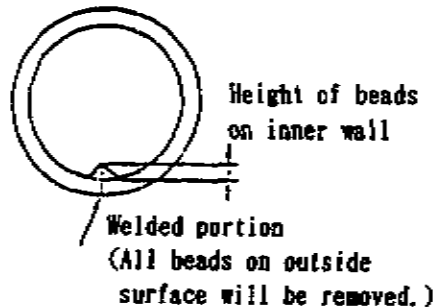


Fig. 1

NOTES: The recipient of this standard shall undertake the following confidentiality obligations upon the receipt of this standard. The recipient shall discard by shredding or fire, or return to Toyota Motor Corporation if appropriate, the documents contained in this standard when they are no longer necessary due to the termination of the loan, cancellation or the expiration of version of this standard. This standard and the technical information related thereto are owned by, and shall only remain of Toyota Motor Corporation. They shall not be disclosed in whole or in part to any third party without prior written consent of Toyota Motor Corporation.

Established / 7<sup>th</sup> Revised:  
Feb. 1998



- Remarks:
1. The height of beads on the inner wall may be specified at random regardless of the grade of permissible dimensional deviation.
  2. The minimum wall thickness of a portion which has been removed of the bead on the inner wall shall be within the range of permissible deviation on thickness.
  3. The tubes of the permissible deviation grade No.4 specified on drawings already issued are all drawn tubes. Therefore, at every engineering change, the method of indication should be altered to that specified in TSG3153G.

4.3 Deviation on Inside Diameter

For the deviation on inside diameter, value calculated from the permissible deviations on outside diameter and the wall thickness by the equation (2) may be used as the target value.

$$\Delta d = \sqrt{(\Delta D)^2 + (2\Delta t)^2} \dots\dots\dots (2)$$

where,  $\Delta d$ : deviation on inside diameter as a target (mm)  
 $\Delta D$ : permissible deviation on outside diameter (mm)  
 $\Delta t$ : permissible deviation on wall thickness (mm)

5. Test

The tubes shall be tested in accordance with the following testing methods.

5.1 Chemical Analysis

Chemical composition shall be tested in accordance with TSG1000G.

5.2 Tensile test

5.2.1 Test Pieces

Of test pieces specified in TSG2204G, those specified in Table 12 shall be cut out from the tube.

Table 12

Test pieces	Applicable tubes
No. 11 test piece	For tubes of smaller outside diameter
No. 12 test piece	For tubes of larger outside diameter
No. 5 test piece	Flat test pieces cut in the direction parallel to the tube axis if precisely specified

NOTES. The recipient of this standard shall undertake the following confidentiality obligations upon the receipt of this standard.  
 \* The recipient shall discard by shredding or fire, or return to Toyota Motor Corporation if appropriate, the documents contained in this standard when they are no longer necessary due to the completion of the work concerned or the revision of current version of this standard.  
 \* This standard and the technical information related thereto are owned by and under sole control of Toyota Motor Corporation. They shall not be disclosed in whole or in part to any third party without prior written consent of Toyota Motor Corporation.

Established / 7 th Revised :  
 Feb. 1998



5.2.2 Test Method

Test shall be conducted in accordance with TSG2203G.

5.3 Bending Test

Bending test shall be conducted in accordance with TSG2352G.

5.4 Flattening Test

Flattening test shall be conducted in accordance with TSG2351G.

5.5 Stretching Test

Stretching test shall be conducted in accordance with TSG2350G.

5.6 Torsion Test

5.6.1 Test Pieces

Tube which has its both ends welded to the jig shall be used as the test piece.  
The length of the tube shall be 10D (D=outside diameter) or more (see Fig. 2).

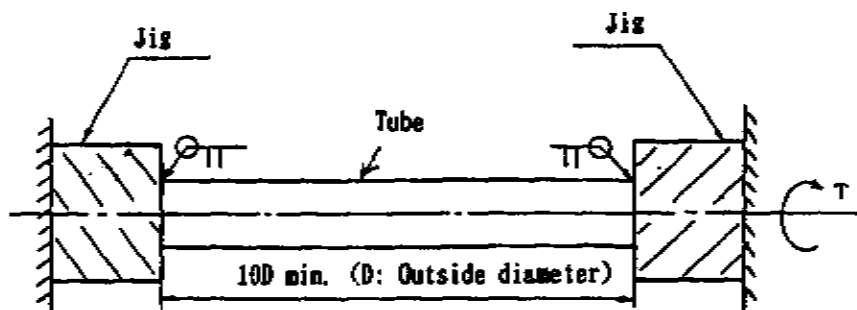


Fig. 2 Method for Torsion Test

NOTES: The recipient of this standard shall undertake the following confidentiality obligations upon the receipt of this standard.  
\* The recipient shall discuss by sharing or file, or return to Toyota Motor Corporation if appropriate, the documents contained in this standard when they are no longer necessary due to the termination of the work concerned or the revision of current version of this standard.  
\* This standard and the technical information related thereto are owned by and under the control of Toyota Motor Corporation. They shall not be disclosed in whole or in part to any third party without prior written consent of Toyota Motor Corporation.

Established / 7<sup>th</sup> Revised:  
Feb. 1998



## 5.6.2 Test Method

Set the test piece onto the torsion tester as shown in Fig. 2 and apply torque to the plastic deformation (or breakage) of the tube test piece. 0.2 % torsional proof stress  $\tau_{0.2}$  (MPa) (kgf/mm<sup>2</sup>) is the value obtained by dividing the torque ( $T_{0.2}$ ), at which 0.2 % permanent set occurs on propeller shaft, by the section modulus by the equations (3) and (4).

(1) Find the spiral angle  $\theta_{0.2}$ .

$$\theta_{0.2} \text{ (deg)} = \frac{0.002 \cdot L}{r} \cdot \frac{180}{\pi} \quad \text{..... (3)}$$

where,  $r$ : radius of the tube (mm)

$L$ : length of the tube (mm)

(2) Read  $T_{0.2}$  from the Torque-Torsional angle curve (see Fig. 3).

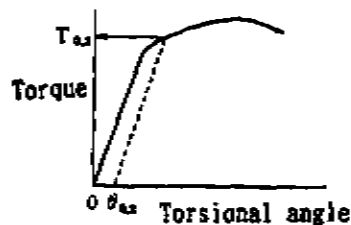


Fig. 3

(3) Find the torsional proof stress  $\tau_{0.2}$  (0.2 %).

$$\tau_{0.2} = \frac{T_{0.2}}{Z_p} \text{ (mm}^2\text{)} \quad \text{..... (4)}$$

where,  $Z_p$ : section modulus =  $\frac{\pi}{16} \left[ \frac{D_1^4 - D_2^4}{D_1} \right]$

$D_1$ : outside diameter of the tube (mm)

$D_2$ : inside diameter of the tube (mm)

NOTES: The recipient of this standard shall undertake the following confidentiality obligations upon the receipt of this standard.  
 \* The recipient shall decide by checking or not, or return to Toyota Motor Corporation if appropriate, the documents contained in this standard when they are no longer necessary due to the termination of the work concerned or the revision of current version of this standard.  
 \* This standard and the technical information related thereto are issued by and under sole control of Toyota Motor Corporation. They shall not be disclosed in whole nor in part to any third party without prior written consent of Toyota Motor Corporation.

Established / 7<sup>th</sup> Revised :

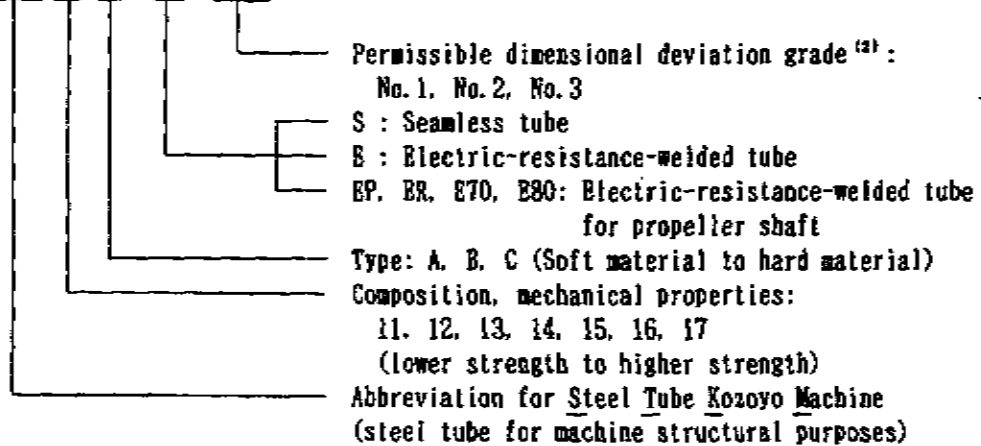
Feb. 1998



6. Drawing Indication and Explanation on Codes

Drawing indication method and explanation on codes for tubes are as follows.

Example: **STKM 13 B - ER - No. 3**



Note:(2) Grade of permissible dimensional deviation may be specified on a design drawing if necessary.

Applicable Standards

- TSG1000G General Rule for Chemical Analysis of Steel Materials
- TSG2203G Tensile Test Method for Metallic Materials
- TSG2204G Test Pieces for Tensile Test for Metallic Materials
- TSG2350G Metallic Tube Stretching Test Method
- TSG2351G Metallic Tube Aspect Test Method
- TSG2352G Metallic Tube Bending Test Method
- TSG3153G Cold-Drawn Carbon Steel Structural Tubes
- JIS Z 8401 Rules for Rounding Off of Numerical Values
- ASTM E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

NOTES: The recipient of this standard shall undertake the following confidentiality obligations upon the receipt of this standard.  
 \* The recipient shall disclose by circulating or file, or return to Toyota Motor Corporation if appropriate, the documents contained in this standard when they see no longer necessary due to the termination of the work concerned or the revision of current version of this standard.  
 \* This standard and the technical information related thereto are owned by and under sole control of Toyota Motor Corporation. They shall not be disclosed in whole nor in part to any third party without prior written consent of Toyota Motor Corporation.

Established / 7<sup>th</sup> Revised :

Feb. 1998



Attached Table 1 Dimension of Seamless Steel Tube (highly available steel tubes)

Unit: mm

Thickness (mm)	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0
6.0																
8.0																
10.0																
12.0																
15.0																
17.3																
17.5																
18.0																
19.0																
20.0																
21.7																
25.0																
25.4																
27.2																
30.0																
31.8																
34.0																
38.1																
40.0																
42.7																
45.0																
48.6																
50.8																
51.0																
54.0																
57.0																
60.3																
60.5																
63.5																
65.0																
70.0																
75.0																
76.2																
76.3																
80.0																
82.6																
88.9																
89.1																
90.0																
101.6																
110.0																
114.3																
120.0																
130.0																
139.8																
140.0																
150.0																
152.4																

NOTES: The recipient of this standard shall assume the following confidentiality obligations upon the receipt of this standard.  
 - The recipient shall discuss by themselves or five, or refer to Toyota Motor Corporation if appropriate, the documents contained in this standard when they are no longer necessary due to the accumulation of the work concerned or the revision of current version of this standard.  
 - This standard and the technical information related thereto are owned by and under sole control of Toyota Motor Corporation. They shall not be disclosed in whole or in part to any third party without prior written consent of Toyota Motor Corporation.

Established / 7<sup>th</sup> Revised:  
 Feb. 1998