

JIS

JAPANESE INDUSTRIAL STANDARD

**Testing methods of tubing
for electrical insulation**

JIS C 2133—1992

Translated and Published

by

Japanese Standards Association

Printed in Japan

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

JAPANESE INDUSTRIAL STANDARD
Testing methods of tubing for electrical insulation

J I S
C 2133-1992

1. Scope

This Japanese Industrial Standard specifies the testing methods of tubing for electrical insulation to be used for electrical machinery and apparatus, electronic equipment, electric wires, etc. (hereafter referred to as the "tubing").

Remarks 1. The following Standards are cited in this Standard:

JIS B 7502-Micrometer Callipers for External Measurement

JIS B 7503-Dial Gauges Reading in 0.01 mm

JIS B 7507-Vernier Callipers

JIS B 7516-Metal Rules

JIS B 7721-Tensile Testing Machines

JIS C 2110-Testing Methods for Electric Strength of Solid Insulating Materials

JIS C 2320-Electrical Insulating Oils

JIS K 2240-Liquefied Petroleum Gases

JIS K 6301-Physical Testing Methods for Vulcanized Rubber

JIS K 7112-Methods for Determining the Density and Specific Gravity of Plastics

JIS K 7212-General Rules for Tests for Thermal Ageing Properties of Thermoplastics in the Form of Sheet by Means of Ovens

JIS R 3503-Glass Apparatus for Chemical Analysis

JIS Z 1511-Gummed Paper Tapes (for packaging)

2. The International Standard corresponding to this Standard is given below.

IEC 684 Specification for flexible insulating sleeving

Part 1 (1980) : Definitions and general requirements

Part 2 (1984) : Methods of test

3. The units and numerical values given in { } in this Standard are based on the traditional units and are appended for informative reference.

2. Definitions

For the purpose of this Standard, the following principal definitions apply:

- (1) tubing The generic name of tubing including extracted tubing, heat-shrinkable tubing and braided tubing.
- (2) sleeving The textile tube made of inorganic or organic fiber. This is not included in the definition of tubing.
- (3) braided tubing A product made by such a way that the sleeving is coated or impregnated with a resin and then heat treated.
- (4) resin peeling Such a phenomenon that the resin separates from the sleeving in the braided tubing.

- (5) fluidizing and dripping (due to melt) Such a phenomenon that the transfer of resin in the direction of gravity is recognized because all or a part of the resin composing the tubing is thermally softened at a high temperature.

If the resin is liquefied and falls as drips, such a phenomenon is called dripping.

- (6) provision When it is simply stated "provision" without designation of Standard, in general it means the provision for the kind of product in the relevant product standard. If there is special business agreement, the agreement may be understood as the "provision".

3. Test items

The test items specified in this Standard are as given in Table 1.

Table 1. Test items

Test item	Applicable clause for test method	Test item	Applicable clause for test method
Appearance	5.	Insulation resistance	16.
Dimensions	6.	Volume resistivity	17.
Dimensional stability on storage	7.	Flammability	18.
Longitudinal change	8.	Corrosion resistance	19.
Density	9.	Immersion	20.
Heat shock	10.	Thermal endurance	21.
Bending after heating	11.	Loss in mass on heating	22.
Bending at low temperature	12.	Deformation at elevated temperature	23.
Tensile strength and elongation	13.	Limited shrinkage	24.
Modulus at elongation	14.	Resistance to damp heat	25.
Dielectric strength	15.		

4. General conditions

- (1) Test conditions Unless otherwise specified, all the tests shall be carried out at a temperature of $20 \pm 15^{\circ}\text{C}$ and a relative humidity of $(65 \pm 20) \%$, and these conditions are denoted as normal state (for testing).
- (2) Heat-shrinkable tubing Unless otherwise specified, all the tests shall be carried out on the heat-shrinkable tubing.

5. Appearance

Examine the appearance by the naked eye, hand touch, etc. for presence of any flaw, unevenness of tubing surface, color, marking, etc.

6. Dimensions

6.1 Bore

6.1.1 **Method A** Use pin gauges with a length range of 20 mm to 100 mm. Insert the gauge without applying excess pressure into the tubing⁽¹⁾, and take the outside diameter of the maximum pin gauge capable of being inserted as the bore of specimen tubing. The pin gauges may be plug gauges with outside diameters prepared at adequate intervals.

Note ⁽¹⁾ The gauge may be immersed into water or adequate lubricant so that the specimen easily slides on the gauge.

6.1.2 **Method B** This method is applicable to flat tubing or large bored tubing. Uniformly press the tubing to such an extent that the hole is completely closed so that no clearance is observed and the wall thickness does not change, and then measure the inside width of flattened tubing i.e. the folded diameter with the vernier calliper of JIS B 7507. Calculate the bore of tubing from the said inside width by means of the following formula:

$$D = \frac{2L}{\pi}$$

where, D : bore of tubing (mm)

L : actually measured inside width of flattened tubing (mm)

π : ratio of circumference to its diameter

6.1.3 **Method C**

- (1) **Measuring apparatus** Use the taper pins with the taper ratios shown in Table 2 made of stainless steel or chromium plated steel. The taper pin may be divided into several taper pins having the same taper ratio. At the measurement of the bore of tubing, select the taper pin with a diameter and taper ratio adequate for the bore of the specimen tubing.

Table 2. Shapes and dimensions of taper pins

Diameter of taper pin (d) mm	Taper ratio	Scale spacing of taper part (corresponding diameter scale) mm
$d \leq 5$	1/100	10 (0.1)
$4 \leq d \leq 25$	1/ 50	10 (0.2)
$20 \leq d$	1/ 20	10 (0.5)

The taper pin shall have a smooth surface at its taper part, the scales with the appropriate spacing shown in Table 2, and the scale and the letter shall be so marked that the peripheries of scale and letter do not protrude from the taper surface.

- (2) **Procedure** Select a gauge so that a part of taper pin enters into the specimen, slide the specimen on the gauge until no clearance is observed on the circumference between the edge of the specimen and the gauge without applying excess force⁽²⁾. Take the diameter of taper pin on the gauge at the said point as the bore of the specimen.

Note ⁽²⁾ The gauge may be immersed into water or adequate lubricant so that the specimen easily slides on the gauge.

Read the scale appearing closest to the specimen, measure the distance from the edge of specimen to the scale with rule, and then calculate the bore of specimen by means of interpolation method.

6.2 Average wall thickness

6.2.1 Method A Use a metal mandrel of uniform diameter not less than 80 % of the bore of the specimen, which can be inserted freely into the specimen. Insert the said mandrel into the specimen and measure the outside diameter of the specimen with the micrometer calliper for external measurement specified in JIS B 7502 or the dial gauge specified in JIS B 7503. In this procedure, the pressure applied to the specimen by the external micrometer shall be the minimum level necessary for the measurement. Take $\frac{1}{2}$ of the difference between the outside diameter of specimen and the outside diameter of metal mandrel inserted, as the wall thickness.

6.2.2 Method B Measure the wall thickness at least at four points on the circumference of the specimen in the directions at right angles from each other, using the dial gauge specified in JIS B 7503, and then calculate the average value.

6.3 Minimum and maximum wall thickness Measure the thickness by using an optical profile projector, optical comparator, suitable micrometer, etc.

7. Dimensional stability on storage⁽³⁾

Note (3) This test item is applicable only to heat-shrinkable tubing.

7.1 Test device An adequate thermostatic chamber. Replacement of air is not required.

7.2 Specimens Cut three tubes of 100 mm long from the sample before shrinkage and use them as the specimens.

7.3 Test procedure Heat the specimens in the thermostatic chamber maintained at a temperature $40 \pm 3^\circ\text{C}$ for 336 ± 2 h, take the specimens and cool them in the atmosphere at a temperature $23 \pm 2^\circ\text{C}$ and relative humidity $(50 \pm 5) \%$. Measure the bores of the specimens after cooling in accordance with the test method of 6.1.

7.4 Record Record the average value on three specimens as the results.

8. Longitudinal change

8.1 Test device

(1) **Rule** The metal rule with 0.5 mm scale specified in JIS B 7516.

(2) **Thermostatic chamber** The thermostatic chamber of type B specified in JIS K 7212.

8.2 Specimens Cut three tubes of 100 mm long from the sample so that the cut face is perpendicular to its axes, and use them as the specimens.

8.3 Test procedure Measure the lengths of specimens, keep the specimens horizontal by supporting the central part of specimen in the thermostatic chamber maintained at a specified temperature, and heat them for a specified duration. After heating, cool the specimens to normal state and measure the lengths again. Carry out the measurement of length at an accuracy of 0.5 mm and calculate the rate of longitudinal change to the original value on each specimen from the following formula:

$$dL = \frac{L_2 - L_1}{L_1} \times 100 (\%)$$

where, dL : longitudinal change (%)

L_1 : length of specimen (mm)

L_2 : length of specimen after heating (mm)

8.4 Record Record the three individual values of longitudinal change.

9. Density

Measure the density accurately to 0.01 g/cm³ at a temperature $23 \pm 2^\circ\text{C}$ in accordance with JIS K 7112.

10. Thermal shock

10.1 Test device

- (1) Thermostatic chamber The thermostatic chamber shall be as specified in 8.1 (2).
- (2) Tensile testing machine The tensile testing machine of constant rate of separation specified in JIS B 7721.

10.2 Specimens Cut three tubes of 75 mm long from the sample, and use them as the specimens. When the elongation after heating is measured, prepare the specimens in accordance with 13.2.

10.3 Test procedure Heat the specimens in the thermostatic chamber maintained at a specified temperature for $4\text{ h} \pm 10\text{ min}$. Take out the specimens, cool them naturally to the normal state, and examine them with naked eye for presence of the dripping, crack, fluidizing and change in color. When the tensile test is carried out after heating, heat the specimens prepared in accordance with 13.2 under the same conditions and measure the elongation in accordance with the test procedure of 13.3.

10.4 Record Record the following items:

- (1) The heating temperature
- (2) Existence or nonexistence of dripping, cracks, fluidizing and change in color after heating test
- (3) The elongation before and after the heating test (%)

11. Bending after heating

11.1 Test device

- (1) Thermostatic chamber The thermostatic chamber shall be as specified in 8.1 (2).
- (2) Mandrel A mandrel of a specified diameter

11.2 Specimens Cut three tubes each of length sufficient to wind round the mandrel by one turn from the sample, and use them as the specimens. When the bore of the sample is not exceeding 2 mm, insert a metal wire which fits with the bore into the specimen so that the specimen does not collapse when wound around the mandrel.

When the bore of the sample exceeds 15 mm, cut three strips of 6 mm wide parallel to the longitudinal axis of the sample and use them as the specimens.

Use a metal wire of soft material which will not chemically affect the tubing.

11.3 Test procedure Suspend the specimens prepared in 11.2 in the thermostatic chamber maintained at a specified temperature, for $48 \pm 1\text{ h}$. Then take out the specimens and cool them naturally to the normal state. Wind the specimen round the mandrel for one turn in a close helix without jerking. For specimens of strip shape, the inside surface of tubing shall be in contact with the mandrel. Wind the specimen round the mandrel within 5 s and allow the specimen under the wound state for further 5 min. Examine the specimen under wound state by naked eye for presence of cracks, peeling of resin, peeling between layers and change in color.

If especially stated, carry out the test of 15.1 on the specimens heated under the same conditions for detection of cracks of tubing with a bore not exceeding 15 mm.

11.4 Record Record existence or nonexistence of cracks, peeling of resin, peeling between layers, and change in color.

12. Bending at low temperature

12.1 Test device

- (1) Low temperature chamber
- (2) Mandrel A mandrel of a specified diameter

12.2 Specimens Cut three tubes each of length sufficient to wind round the mandrel by one turn from the sample, and use them as the specimens. Unless otherwise specified, adjust the specimen as stated below. When the bore of sample is not exceeding 2 mm, insert a metal wire which just fits with the bore into the specimen. When the bore of sample is exceeding 2 mm but less than 8 mm, insert metal wires of a suitable number so that the specimen does not collapse when wound round the mandrel. When the bore of sample is exceeding 8 mm, cut three strips of 6 mm wide parallel to the longitudinal axis of the sample, and use them as the specimens.

If especially specified, carry out the test without filling the inside of the tubing.

12.3 Test procedure Suspend the specimens and the mandrel in the low temperature chamber maintained at a specified temperature for 60 ± 10 min, and wind the specimen round the mandrel of a specified diameter for one turn in close helix at the temperature. Wind the specimen round the mandrel within 5 s, maintain the assembly at that temperature for 5 min and then return it to the normal state. Examine the specimen with the naked eye for presence of cracks, peeling of resin and peeling between layers.

12.4 Record Record existence or nonexistence of cracks, peeling of resin and peeling between layers.

13. Tensile strength and elongation

13.1 Test device The tensile testing machine of constant separation rate specified in JIS B 7721.

13.2 Specimens In general, cut five tubes of about 150 mm long from the sample, when the bore of sample is less than 8 mm, and use them as the specimens. Measure the outside diameter of the tubing in which the mandrel has been inserted by the method of 6.2.1 at five positions at the minimum, and calculate the sectional area of the tubular specimen from the minimum value so measured and the diameter of mandrel by means of the following formula:

$$S = \frac{\pi}{4} (D^2 - d^2)$$

where, S : sectional area (mm²)
 D : outside diameter of tubing (mm)
 d : diameter of mandrel (mm)

When the bore of sample is 8 mm or more, cut the tubing parallel to its axis, punch the sample in the longitudinal direction into five dumbbell specimens of No. 3 or No. 4, and use them as the specimen. Measure the thickness of the parallel part of the specimen at five points and calculate the cross sectional area of the dumbbell specimen as the product of the minimum thickness so measured and the inside width of the punching die blade.

The bench mark distance shall be 20 mm and attach the bench marks in the middle of specimen.