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**Electric traction overhead lines — Fittings
— Test methods**

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Railway Electrical Engineering Association (JREEA)/Japanese Standards Association (JSA) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act applied mutatis mutandis pursuant to the provision of Article 16 of the said Act. This edition replaces the previous edition (**JIS E 2002 : 2010**), which has been technically revised.

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Electric traction overhead lines — Fittings — Test methods

1 Scope

This Japanese Industrial Standard specifies the mechanical test, electrical test, and material test of electric traction overhead line fittings (hereafter referred to as fittings) used for electric traction overhead lines of railways and tracks, and line feeder (including overhead return circuits). The fittings to which this Standard applies shall be as follows :

- a) **Electric traction overhead lines** — Fittings (see **JIS E 2201**)
- b) **Electric traction overhead lines** — Section insulators (see **JIS E 2219**)
- c) **Electric traction overhead lines** — Connecting sleeves of stranded conductors (see **JIS E 2220**)

This Standard is also applicable to fittings other than the above, provided that they are used for the same application.

2 Normative references

Part or all of the provisions of the following standards, 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 B 4652 *Hand torque tools — Requirements and test methods*

JIS B 7502 *Micrometers*

JIS B 7503 *Mechanical dial gauges*

JIS B 7507 *Vernier, dial and digital callipers*

JIS B 7512 *Steel tape measures*

JIS B 7516 *Metal rules*

JIS B 7721 *Tension/compression testing machines — Calibration and verification of the force-measuring system*

JIS C 1102-1 *Direct acting indicating analogue electrical measuring instruments and their accessories — Part 1 : Definitions and general requirements common to all parts*

JIS C 1102-2 *Direct acting indicating analogue electrical measuring instruments and their accessories Part 2 : Special requirements for ammeters and voltmeters*

JIS C 1102-9 *Direct acting indicating analogue electrical measuring instruments and their accessories Part 9 : Recommended test methods*

JIS C 1302 *Insulation resistance testers*

- JIS C 1602 *Thermocouples*
- JIS C 3102 *Annealed copper wires for electrical purposes*
- JIS C 3105 *Hard-drawn copper stranded conductors*
- JIS C 3109 *Hard-drawn aluminium stranded conductors*
- JIS E 2001 *Electric traction contact lines — Vocabulary*
- JIS E 2101 *Hard-drawn grooved trolley wires*
- JIS E 2201 *Electric traction overhead lines — Fittings*
- JIS E 2219 *Electric traction overhead lines — Section insulators*
- JIS E 2220 *Electric traction overhead lines — Connecting sleeves of stranded conductors*
- JIS G 0571 *Method of oxalic acid etching test for stainless steels*
- JIS G 3537 *Zinc-coated steel wire strands*
- JIS G 4309 *Stainless steel wires*
- JIS H 0401 *Test methods for hot dip galvanized coatings*
- JIS H 0505 *Measuring methods for electrical resistivity and conductivity of non-ferrous materials*
- JIS K 6911 *Testing methods for thermosetting plastics*
- JIS K 8891 *Methanol (Reagent)*
- JIS Z 2245 *Rockwell hardness test — Test method*
- JIS Z 2343-1 *Non-destructive testing — Penetrant testing — Part 1 : General principles — Method for liquid penetrant testing and classification of the penetrant indication*
- JIS Z 8401 *Rounding of numbers*
- JIS Z 8703 *Standard atmospheric conditions for testing*
- JIS Z 8704 *Temperature measurement — Electrical methods*

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in **JIS E 2001** apply.

4 Classification, types and symbols of fittings

The classification, types and symbols of fittings shall be in accordance with **JIS E 2201**, **JIS E 2219** and **JIS E 2220**.

5 Types of tests and measurement items

5.1 Types of tests

The tests for fittings are classified into mechanical test, electrical test, and material

test.

5.2 Measurement items of fittings

Measurement items of fittings shall be as given in Table 1 according to the type of tests.

Measurement items shall be selected according to the classification of fittings (application, structure, material and so on).

Table 1 Measurement items of fittings

Type of test	Measurement items	Classification of fittings									
		Fittings								Section insulator	Connecting sleeves of stranded conductors
		Pull-off arms	Steady arms	Suspension clamps	Feeder fittings	Connectors	Termination fittings	Wire clips	Wire turnbuckles		
Mechanical test	Tests of structure, appearance, shape and dimensions	○	○	○	○	○	○	○	○	○	○
	Tensile load test	○	○	○	○ a)	○	○	○	○	○	—
					—						
	Compressive load test	○	○	—	—	—	—	—	—	—	—
	Torsional test	○	○	○	—	—	—	—	—	—	—
	Sliding test	○	○	○	○	—	—	—	—	—	—
	Vibration test	○	○	○	○	○	—	—	—	○	—
	Reverse bend test	—	—	○	—	—	—	—	—	—	—
	Clamping torque test	—	—	—	—	○	○	○	—	○	—
	Adjusting torque test	—	—	—	—	—	—	—	○	—	—
	Compressive test	—	—	—	—	—	○	—	—	—	○
Electrical test	Joint electric resistance test	—	—	—	○	○	—	—	—	—	○
	Temperature rise test	—	—	—	○	○	—	—	—	—	—
	Overcurrent test	—	—	—	○	—	—	—	—	—	—
	Insulation test	—	—	—	—	—	—	—	—	○	—
	Withstand voltage test	—	—	—	—	—	—	—	—	○	—
	Puncture voltage test	—	—	—	—	—	—	—	—	○	—

Table 1 (concluded)

Type of test	Measurement items	Classification of fittings									
		Fittings								Section insulator	Connecting sleeves of stranded conductors
		Pull-off arms	Steady arms	Suspension clamps	Feeder fittings	Connectors	Termination fittings	Wire clips	Wire turnbuckles		
Material test	Penetrant test	Defect of castings	○	○	○	○	○	○	○	○	○
	Hardness test	Hardness of metal	○	○	○	—	○	—	○	○	—
	Plating thickness test	Amount of zinc deposit	○	○	○	—	○	○	○	—	○
	Solution treatment test	Metal structure	—	—	—	—	—	—	○	—	—
	Burning resistance test	Burning resistance	—	—	—	—	—	—	—	○	—
	Porosity test	Defect of insulation body	—	—	—	—	—	—	—	○	—
NOTE The ○ marks show the measurement items to be executed.											
Note ^{a)} For iron clamps of feeder fittings, endurable tensile load is not measured.											

6 Test methods

6.1 General

6.1.1 Environmental conditions

The environmental conditions, unless otherwise specified, shall be the ordinary temperature and ordinary humidity in accordance with **JIS Z 8703**.

6.1.2 Electric wires, jigs and fittings for test

The electric wires, jigs and fittings to be used for the test shall be in accordance with the following.

- a) The electric wires for test shall be as given in Table 2 according to the classification and type of fittings.

When specifying the use of round bars instead of stranded conductors, the round bars shall be of the diameter corresponding to the outer diameter of the applicable stranded conductors. In addition, trolley wires with performance equivalent to or better than that specified in **JIS E 2101** may be used.

- b) The jig for test shall be so constructed that it may be free from deformation, strain, etc. during the test, and excessive stress may not be exerted on the fittings and the electric wires for test, ensuring that measurement errors do not occur.
- c) The fittings for test shall have completed each test of structure, appearance, shape and dimensions in accordance with **6.2.2**.

Table 2 Electric wires for test

Classification of fittings		Type		Electric wires for test
Fittings	Pull-off arms	Pull-off arms	CS6, CS11, CS15 and CT	Applicable trolley wires of JIS E 2101
	Steady arms	Steady arms	CS and CT	Applicable trolley wires of JIS E 2101
	Suspension clamps	Dropper clips	CD	ϕ 5.00 mm of JIS G 4309
		Hanger ears	CH	Applicable trolley wires of JIS E 2101
	Feeder fittings	Feeding fittings	CB and CR	Applicable trolley wires of JIS E 2101 Class 1, 100 mm ² of JIS C 3105
		Electrical connectors (ear)	CC40, CC70, CC100 and CC	Applicable trolley wires of JIS E 2101
		Electrical connectors (clamp)	CC	Class 1, 100 mm ² of JIS C 3105
		Iron clamp	CC40, CC70 and CC100	Class 2 of applicable zinc-coated steel wire strands of JIS G 3537
	Connectors	Double ear	C85, C110 and C170	Applicable trolley wires of JIS E 2101
	Termination fittings	Strain clamp	BC325	Applicable hard-drawn copper stranded conductors of JIS C 3105
			BA510, PA200, PA300 and PA510	Applicable hard-drawn aluminium stranded conductors of JIS C 3109
		Wire terminal	T90, T135, T90S, T90T, T135S and T135T	Class 2 of applicable zinc-coated steel wire strands of JIS G 3537 Applicable trolley wires of JIS E 2101
		Type B fittings	B55, B90, B135, B55S, B90S, B135S, B55T, B90T and B135T	Class 2 of applicable zinc-coated steel wire strands of JIS G 3537
	Wire clips	Wire clip	38-2, 55-2, 90-1, 90-2, 135-1 and 135-2	Class 2 of applicable zinc-coated steel wire strands of JIS G 3537
Section insulators		Class C	85, 110, 150 and 170	Applicable trolley wires of JIS E 2101
		Class D	85	85 mm ² of JIS E 2101
Connecting sleeves of stranded conductor	Straight sleeve	SS		Class 2 of applicable zinc-coated steel wire strands of JIS G 3537
			SC, SH and SA	Class 1 of applicable hard-drawn copper stranded conductors of JIS C 3105
	Jumper sleeve	JC and JA		Applicable hard-drawn aluminium stranded conductors of JIS C 3109
	Parallel branch sleeve	PC and PA		
	Repair sleeve	RC and RA		
	Y branch sleeve	YC		Applicable annealed copper stranded wires for electrical purposes of JIS C 3102 Class 1 of applicable hard-drawn copper stranded conductors of JIS C 3105

NOTE See **JIS E 2201**, **JIS E 2219** and **JIS E 2220** for symbols of classification.

6.1.3 Accuracy and measuring range of testing machine and measuring instrument

The accuracy and measuring range of a testing machine and measuring instrument shall be as follows.

- a) The accuracy, except where separately specified, shall be in accordance with the

accuracy of a testing machine and measuring instrument specified in this Standard.

- b) The measuring range shall be such that the effective measuring value can be read off.

6.1.4 Measurement of test time

Measurement of test time shall start at the point where it reaches the specified value as given in **JIS E 2201**, **JIS E 2219** and **JIS E 2220**. When the test has been interrupted, the measurement shall start over again. When the vibration test is interrupted, addition to the test time and number of cycles before and after the point of interruption is permissible.

6.1.5 Test torque

The test torque of bolts, nuts, set screws, and socket head cap screws applied in the test of fittings shall be in accordance with Table 3.

Table 3 Test torque

Unit: N·m

Classification of fittings		Type		Nominal designation of screw thread	Test torque	Example of bolt to be applied (informative)
Fittings	Pull-off arms	Pull-off arms	CS6, CS11, CS15 and CT	M12	30.0	Socket head cap screws
	Steady arms	Steady arms	CS and CT	M10	30.0	U bolts and cup square neck bolts
	Suspension clamps	Dropper clip	CD	M10	30.0	Cup square neck bolts
		Hanger ear	CH	M12	35.0	Socket head cap screws
	Feeder fittings	Feeding fittings	CB and CR	M14	30.0	Socket head cap screws
		Electrical connector (ear)	CC40, CC70 CC100 and CC	M14	30.0	Socket head cap screws
		Electrical connector (clamp)	CC	M14	30.0	Socket head cap screws
		Iron clamp	CC40, CC70 and CC100	M14	60.0	Hexagon head bolts
	Connectors	Double ear	C85, C110 and C170	M14	100.0	Hexagon head bolts
	Termination fittings	Strain clamp	BC325	M16	120.0	U bolts
			BA510	M12	100.0	
	Wire clips	Wire clip	38-2	M10	40.0	U bolts
			55-2		55.0	
			90-1 and 90-2	M12	95.0	
			135-1 and 135-2		110.0	
Section insulators		Class C	85, 110, 150 and 170	M10	35.0	Set screws
				M12	40.0	
		Class D	85	M10	15.0	Set screws

6.2 Mechanical test

6.2.1 Installation of testing machine, measuring instrument, supporting stand, and fittings

The installation of the testing machine, measuring instrument, supporting stand, and fittings shall be as follows.

- a) The testing machine to be used for the load test shall be in accordance with **JIS B 7721**. However, for some types of fittings, an apparatus with a tension meter shall be used.
- b) The measuring instrument to be used for the measurement of dimensions, degree of deformation, etc. shall be in accordance with **JIS B 4652**, **JIS B 7502**, **JIS B 7503**, **JIS B 7507**, **JIS B 7512** or **JIS B 7516**.
- c) The supporting stand with which the mechanical test is carried out shall be rigid.
- d) The installation of fittings on electric wires and jigs in the mechanical test, unless otherwise specified, shall simulate the actual installation.

For the tensile load test of a hanger ear, the hanger shall be supported by the round bars, jigs, etc. with the diameter corresponding to the inner diameter of bend of the hanger.

6.2.2 Test of structure, appearance, shape and dimensions

Each test of structure, appearance and shape shall be carried out by visual observation, and the test of dimensions shall be carried out using a measuring instrument suitable for measurement of the positions of the fittings to be measured.

6.2.3 Tensile load test

The tensile load test shall be performed as follows.

- a) Installation of fittings for test, and position and direction of application of test load in the tensile load test shall be in accordance with Annex A.

“The gripping interval (L)”, which is the distance between the compression part of an electric wire and the chuck in the tensile load test of connecting sleeves of stranded conductors shall be 1 000 mm or over. If the applicable electric wire is 95 mm² or under, this interval shall be 500 mm or over.

- b) For measurement of the endurable tensile load, apply the load by increasing it appropriately until it reaches 75 % of the value specified in **JIS E 2201** and **JIS E 2219**, and then increase it continuously and gradually until it reaches the specified value and stabilizes, and hold for 1 min. After this measurement, fittings shall be checked for appearance and shape, and their dimensions measured.
- c) During increase of tensile load, bolts and nuts for the trolley wire connectors of double ear and section insulators shall be re-clamped at a tensile load of 8 kN, and those for the wire clip at 60 % of the specified value.
- d) For measurement of maximum tensile load, apply the load by increasing it appro-

priately until the specified value of the endurable tensile load is reached (for connecting sleeves of stranded conductors, 30 % of the tensile load of the applicable wire), and then further increase it continuously and gradually until breakdown occurs (this includes breakaway from electric wires, sliding and so on) and measure the maximum load.

6.2.4 Compressive load test

The compressive load test shall be as follows.

- a) Installation of fittings for test, and position and direction of application of test load in the compressive load test shall be in accordance with Annex A.
- b) For measurement of endurable compressive load, apply **6.2.3 b)** by replacing the tensile load with compressive load.
- c) For measurement of maximum compressive load, apply **6.2.3 d)** by replacing the tensile load with compressive load.

6.2.5 Torsional test

The torsional test shall be as follows.

- a) Installation of fittings for test, and position and direction of application of test load in the torsional test shall be in accordance with Annex B.
- b) For measurement of endurable torsional load, apply **6.2.3 b)** by replacing the tensile load with torsional load.
- c) For measurement of maximum torsional load, apply **6.2.3 d)** by replacing the tensile load with torsional load.

6.2.6 Sliding test

The sliding test shall be as follows.

- a) Installation of fittings for test, and position and direction of application of test load in the sliding test shall be in accordance with Annex C.
- b) For measurement of endurable sliding load, apply **6.2.3 b)** by replacing the tensile load with sliding load.

6.2.7 Vibration test

The vibration test shall be as follows.

- a) Installation of fittings for test, and position and direction of application of test load in the vibration test shall be in accordance with Annex D.
- b) Measurement of endurable number of cycles in vibration test shall be as follows.
 - 1) The supporting interval of trolley wires shall be 1 500 mm or over. When testing a section insulator, however, the interval between the trolley wire connector at either end of the trolley and the supporting point shall be 750 mm or over.
 - 2) The tensile force applied to the trolley wires shall be of such a degree as not to interfere with the test.

- 3) Mount the fittings on the trolley wire right above or in vicinity of the vibration application point.

One pair of specimen connectors is regarded as one unit in this test.

- 4) Apply the vibration to the trolley wire by pressing up its large arc surface repeatedly to vibrate. The vibration should be sinusoidal wave motion in the double amplitude (H).
- 5) In succession from the vibration test, using the same specimen, carry out the sliding test for pull-off arms, steady arms, suspension clamps and feeder fittings, and carry out the tensile load test for connectors and section insulators. Re-clamping as specified in 6.2.3 c) shall be omitted in these tensile load tests.

6.2.8 Reverse bend test

The reverse bend test shall be as follows.

- a) Installation of fittings for test, and position and direction of application of test load in the reverse bend test shall be in accordance with Annex E.
- b) For measurement of the endurable number of bending cycles, fix the round wire to the jig, bend it through approximately 90° around the circular arc with the radius of 1.6 times the diameter of the round wire (raising decimals to the next whole number) in any plane including the centre line of the round wire (first bend), return to the original state (second bend), then bend it through approximately 90° in the opposite direction (third bend), and then return again to the original state (fourth bend). After these reverse bendings, examine the round wire for any abnormalities.

6.2.9 Clamping torque test

The clamping torque test shall be as follows.

- a) For the clamping torque test, fix bolts, nuts, set screws, socket head cap screws, etc. to the electric wires to be used, fasten using a torque wrench by increasing the torque appropriately until it reaches approximately 75 % of the maximum clamping torque given in JIS E 2201 and JIS E 2219, and then further increase the torque continuously and gradually to apply the maximum clamping torque.
- b) Examine for deformation or breakage detrimental to practical use.

6.2.10 Adjusting torque test

The adjusting torque test shall be as follows.

- a) Installation of fittings for test, and position and direction of application of test load in the adjusting torque test shall be in accordance with Annex F.
- b) For measurement of the adjusting torque, with the wire turnbuckle in the state of maximum adjusted length, apply the specified tractive effort to both ends, and measure the torque when the centre of the wire turnbuckle rotates.

6.2.11 Compressive test