IS 2486-1 (1993): Metal fittings of insulators for overhead power lines with nominal voltage greater than 1000 V, Part 1: General requirements and tests [ETD 6: Electrical Insulators and Accessories]

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IS 2486 (Part 1) : 1993
(Reaffirmed 2003)

भारतीय मानक

1000 वो. से अधिक सांकेतिक वोल्टता वाले शिरोपरि पावर लाइनों के लिए विद्युत रोधकों की धातु फिटिंगें – विशिष्टि

भाग 1 सामान्य अपेक्षाएं और परीक्षण

(दूसरा पुनरीक्षण)

Indian Standard

METAL FITTINGS OF INSULATORS FOR OVERHEAD POWER LINES WITH NOMINAL VOLTAGE GREATER THAN 1 000 V — SPECIFICATION

PART 1 GENERAL REQUIREMENTS AND TESTS

(Second Revision)

UDC 621·315·65 : 621·315·1·027·5/·8

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May 1993

Price Group 6

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Electrical Insulators and Accessories Sectional Committee had been approved by the Electrotechnical Division Council.

This standard was first issued in 1963. The standard was first revised in the light of experience gained on the mechanical and electrical tests on the clamps and also to rationalize their test requirements.

The second revision of this standard has been carried out to update information on the testing facility available in the country and also to align the requirements with current national and international standards on the subject.

Part 2 of this standard covers the dimensions of the metal fittings for insulators.

The mechanical requirements for metal fittings of insulators are related to the failing load of the fittings. It is, therefore, left to the user to decide the relationship between the maximum working load and the specified minimum failing load taking into account all the circumstances governing the use of the metal fitting.

Bird guard insulator pins have not been included in this standard because of their limited application. It is recommended that, where necessary, the same line pin may be used with the bird guard insulator.

The conductor earth wire accessories and fittings for the overhead line conductors are specified separately in IS 2121 (Part 1) : 1981 and IS 2121 (Part 2) : 1981.

In the revision of this standard assistance has been derived from BS 3288 : Part 1 : 1973 Insulator and conductor fittings for overhead power lines : Part 1 Performance and general requirements issued by British Standards Institution (UK).

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

METAL FITTINGS OF INSULATORS FOR OVERHEAD POWER LINES WITH NOMINAL VOLTAGE GREATER THAN 1 000 V — SPECIFICATION

PART 1 GENERAL REQUIREMENTS AND TESTS

(Second Revision)

1 SCOPE

This standard (Part 1) gives the general requirements and tests for insulator fittings for use on overhead power lines having a nominal voltage greater than 1 000 V.

2 REFERENCE STANDARDS

The Indian Standards listed in Annex A are necessary adjuncts to this standard.

3 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

3.1 Arcing Fitting

A metal fitting or fittings attached to one or both ends of an insulator string and arranged to prevent damage to the insulator string by a power arc.

3.2 Failing Load

The greatest mechanical load which can be applied to a fitting under the prescribed conditions of test.

3.2.1 *Specified Minimum Failing Load*

The minimum failing load specified by the purchaser or declared by the supplier.

3.3 Insulator Pin

A stud passing up inside the metal base of the line post insulator and intended to be fixed rigidly to a supporting structure.

3.4 Suspension Insulator String Fitting

An assembly of metal parts used with a string insulator unit or an insulator string hung from a supporting structure and to carry a line conductor at its lower end. This assembly essentially comprises the following.

3.4.1 *Suspension Top Fitting*

A hook or anchor shackle or other fitting for flexibly suspending the suspension insulator string from the supporting structure either directly or through a hanger.

3.4.2 *Suspension Clamp Adopter*

A fitting for flexibly connecting the conductor suspension clamp to the suspension insulator string.

3.4.3 *Conductor Suspension Clamp*

A fitting holding the conductor and flexibly suspended from the clamp adopter.

3.5 Tension Insulator String Fitting

An assembly of metal parts used with a string insulator unit or an insulator string attached to a supporting structure and to secure in tension a line conductor. This assembly essentially comprises the following.

3.5.1 *Tension End Fitting*

A fitting for flexibly holding the tension insulator string to a supporting structure.

3.5.2 *Tension (Anchor) Clamp Adopter*

A fitting for flexibly connecting the conductor tension clamp to the tension insulator string.

3.5.3 *Conductor Tension (Anchor) Clamp*

A fitting for holding the conductor in tension position and flexibly connected to the clamp adopter.

3.6 Ball Hook

3.7 Socket Tongue

3.8 Anchor Shackle

3.9 Yoke Plate

3.10 Ball Eye

3.11 Arcing Horns

3.12 Grading Rings

3.13 Clevis Tongue

3.14 Twisted Shackle

NOTE — Specific comments are invited to define these parts (terms).

3.15 Lot

All the insulator fittings of same type and design manufactured under similar conditions of production, offered for acceptance; a lot may consist of the whole or part of the quantity offered.

A lot shall consist of only one type of fittings manufactured essentially from the same raw material and under identical conditions.

4 CATEGORIES OF TESTS

4.0 Tests are divided into three groups as given in **4.1**, **4.2** and **4.3**. Details of these tests are given under respective fittings.

4.1 Type Tests

Tests carried out to prove conformity with the specification. These are intended to prove the general qualities and design of a given type of insulator fitting.

4.2 Acceptance Tests

Tests carried out on samples taken at random from a lot for the purpose of acceptance of the lot.

4.3 Routine Tests

Tests carried out on each insulator fitting to check requirements which are likely to vary during production.

5 VISUAL EXAMINATION

The fitting shall be free from defects which would be likely to cause them to be unsatisfactory in service.

6 PROTECTION AGAINST CORROSION

All parts of metal fittings for insulator shall be either inherently resistant to atmospheric corrosion or be suitably protected against corrosion, both during storage and in service. All ferrous metal parts which will be exposed to the atmosphere in service, except those made of stainless steel shall be protected by hot dip galvanizing or other agreed means. The threads of nuts and tapped holes shall be cut after galvanizing and shall be well oiled or greased. All other threads shall be formed before galvanizing.

7 GENERAL REQUIREMENTS FOR TEST

7.1 Type Tests

Unless otherwise agreed, tests certificates giving the appropriate type test, made on not less than three fittings identical in all essential details with those to be supplied, shall be regarded as evidence of compliance.

7.2 Acceptance Tests

Unless otherwise agreed between the manufacturer and user the acceptance test shall be carried out according to the Sampling Plan given in Annex B.

7.3 Routine Tests

Where routine tests are specified they shall be applied to every fitting.

8 VERIFICATION OF DIMENSIONS

It shall be verified either that the test samples comply with the requirements of Part 2 of this standard (if so specified) or that they are in accordance with the relevant drawings, particularly as regards any dimensions to which special tolerances apply and details affect interchangeability (for example, dimensions for which gauges are specified).

Unless otherwise agreed the following tolerances are allowed on all dimensions to which special tolerances do not apply:

Dimensions	*Tolerance*
Up to and including 35 mm	± 0·7 mm
Over 35 mm	± 2 percent

9 PIN INSULATOR FITTINGS

9.1 Materials

9.1.1 The forged pins and studs shall be of steel complying with 2 of IS 1875 : 1978 or equivalent standard.

9.1.2 The nut shall conform to property **4.8** of IS 1367 (Part 6) : 1980.

9.1.3 For galvanizing, zinc conforming to Grade Zn98 of IS 209 : 1979 shall be used.

NOTE — For details *see* IS 2629 : 1966.

9.1.4 The thimbles, when used shall be of aluminium, lead or zinc.

9.2 General Requirements

9.2.1 The pins shall be a single piece obtained preferably by the process of forging. They shall not be made by joining, welding, shrink-fitting or any other process from more than one piece of material. They shall be of good finish, free from flaws and other defects. The finish of the collar shall be such that a sharp angle between the collar and the shank is avoided and that the collar or the seating surface of the metal base in the case of line post insulators shall bed down correctly on to the cross-arm when fixed to that through a hole and diameter of which is 2 mm greater than the diameter of the shank. All ferrous parts shall be protected against corrosion (*see* 6).

9.2.2 *Threads on Heads of Pin*

The dimensions shall comply with those given in IS 2486 (Part 2) : 1989.

9.3 Tests

9.3.1 *Type Tests*

The following shall constitute the type tests on insulator pins, studs, nuts and associated parts:

a) Freedom from defects (*see* **5** and **6**);
b) Verification of dimensions (*see* **8** and **9.2.2**);
c) Galvanizing test (*see* **9.4**);
d) Mechanical tests (*see* **9.5**); and
e) Chemical composition test (*see* **9.6**).

NOTE — Type tests (also *see* **7.1**) shall be made by the manufacturer or by an agreed independent authority.

9.3.2 *Acceptance Tests*

The following shall constitute the acceptance tests:

a) Verification of dimensions (*see* **8** and **9.2.2**),
b) Galvanizing test (*see* **9.4**), and
c) Mechanical tests (*see* **9.5**).

NOTE — *See* **7.2** for sampling procedure.

9.3.3 *Routine Test*

Visual examination given in **5** shall be the routine test.

9.4 Galvanizing Test

This test comprises of first verification of the uniformity of the coating of zinc (test by immersion in copper sulphate) and secondly verification of the weight of zinc per unit surface area (test by chemical dissolution). The second test is optional and shall be carried out only if so agreed by the manufacturer and the purchaser.

9.4.1 The uniformity of zinc coating of hot dip galvanized ferrous string fittings shall be determined in accordance with IS 2633 : 1986 and satisfy the requirements given in IS 4759 : 1984. Electrogalvanized ferrous fitting shall be checked in accordance with IS 1573 : 1986.

9.5 Mechanical Tests

9.5.1 *Insulator Pins (All Types Except Stud Pins)*

The shank of the insulator pin shall be rigidly attached to the testing machine. A rigid metal extension piece shall be attached direct to the head of the pin. A load shall be applied to the extension piece 25 mm above the top of the pin. The load, applied at right angles to the axis of the insulator pin, shall be increased to the specified minimum failing load at a steady rate. When the specified minimum failing load has been reached, the deflection measured at the top of the pin head shall not exceed 20 percent of the distance of this point from the support.

9.5.2 *Stud Pins*

The test for the stud pins shall be performed together with the line post insulator or suitable adopter. The stud pin(s) shall be attached to the insulator with which it is to be used in service and fixed to a metal bracket on the testing machine. A flexible wire rope not less than 40 mm in circumference shall be looped round the tie-wire groove and shall be pulled at right angles to axis of the insulator. The load shall be increased to the specified minimum failing load at a steady rate. This load shall not cause fracture of the insulator or of its stud.

9.6 Chemical Composition Test

Chemical composition test on the material shall be carried out in accordance with relevant specification.

10 INSULATOR STRING FITTINGS

10.1 Materials

10.1.1 The material of the fittings shall be so selected that yield strength of the material shall not be less than maximum working load.

10.1.2 All fittings except suspension clamp and strain clamp shall be made of drop forged or upset forged steel (IS 2004 : 1978) or heat treated malleable cast iron (IS 2107 : 1977 or IS 2108 : 1977) or cast iron containing spheroidal or modular graphite complying with IS 1865 : 1974 and shall be hot dipped galvanized (*see* **5**). The suspension clamp and strain clamp for alumining AAC and ACSR conductors shall be high strength aluminium alloy (IS 6051 : 1970). The composition of the alloy shall be declared by the manufacturer giving reference to the relevant Indian Standard. In strain clamp (compression type), the outer sleeve shall be of EC grade aluminium and inner sleeve of galvanized mild steel.

NOTE — For use with aluminium or steel cored aluminium conductors, aluminium linears are provided for clamps of materials other than of aluminium alloy.

10.1.3 The materials for various parts of suspension insulator fittings covered in **8** of IS 2486 (Part 2) : 1989 shall be as follows:

a) Ball hook	Forged steel (IS 2004 : 1978)
b) Anchor shackle and its cotter bolt and cotter pin	do
c) Socket tongue	Forged steel (IS 2004 : 1978) or heat treated malleable cast iron (IS 2107 : 1977 or IS 2108 : 1977)
d) Suspension clamp	*See* **10.1.2** and cotter bolt pin and U-bolt shall be forged steel (IS 2004 : 1978) and mild steel (IS 226 : 1975) respectively
e) Ball eye	Forged steel (IS 2004 : 1978)
f) Ball clevis	Forged steel (IS 2004 : 1978)
g) Socket clevis	Same as for c) above
h) Yoke plate	Mild steel [IS 1570 (Part 2) : 1979]
j) Clevis	Same as for c) above
k) Strain clamp	Heat treated malleable cast iron (IS 2107 : 1977 or IS 2108 : 1977), or high strength aluminium alloy (*see* **10.1.2** above)
m) Clevis tongue	Drop forged steel (IS 2004 : 1978)
n) Sag adjuster	Mild steel [IS 1570 (Part 2) : 1979]
p) Twisted shackle	Forged steel (IS 2004 : 1978)
q) Arcing horn	Mild steel (IS 226 : 1975)
r) Grading ring	Mild steel bar (IS 226 : 1975) or aluminium alloy (IS 5082 : 1981)

10.1.4 The fittings shall be free from defects (*see* **5**), corrosion protected (*see* **6**) and shall meet the requirements of galvanizing test (*see* **9.4**).

10.1.5 *Nuts*

The requirements given in **9.1.2** shall apply.

10.1.6 *Cotters Pins*

The cotter pins shall be provided with mild steel flat washers in addition to split pins.

10.1.7 Locking devices for ball and socket lockers shall be of phospher bronze conforming to IS 7814 : 1975 and stainless steel conforming to IS 6603 : 1972 with minimum hardness of 160 HV. The dimension shall conform to IS 2486 (Part 3) : 1974.

The split pin to be used on the cotter pin shall be of phospher-bronze conforming to IS 7814 : 1975, stainless steel conforming to IS 5522 : 1992 or brass conforming to IS 410 : 1977 with a minimum hardness of 160 HV.

10.1.8 Insulator metal caps shall be of malleable cast iron conforming to IS 2108 : 1977 or other suitable material having the necessary strength to enable the complete unit to satisfy the appropriate requirements of this standard.

10.1.8.1 Aluminium and aluminium alloys shall not be used for the manufacture of insulator caps.

10.2 General Requirements

10.2.1 All forgings and castings shall be of good finish and free from flaws and other defects. The edges on the outside of fittings,

such as the eye, clevis and holes, shall be rounded.

10.2.2 All parts of different fittings which provide the interconnection shall be made such that sufficient clearance is provided at the connection point to ensure free movement and suspension of the insulator string assembly. All eye and clevis connection shall be free in this manner but care shall be taken that too much clearance between eye and the tongues of the clevis is avoided.

10.2.3 Suspension clamps shall be so designed that the effects of vibration both on the conductor and fitting itself, are minimized. Sharp radii of curvature, ridges and ex-crescences, which might lead to localized pressure on or damage to the conductor, in service shall be avoided. The clamp shall permit the conductor to slip before the failure of the conductor occurs. The fitting shall have sufficient contact surface to minimize damage due to fault currents.

10.2.4 Non-tension joints shall be designed so that they meet the appropriate test requirements. The manufacturer shall assign rated current to a joint, which shall then be the basis for the electrical test (*see* **12.1.2.1**), otherwise the joint shall be tested as per **12.1.2.3**.

10.3 Type Tests

10.3.1 The following shall constitute the type tests for clamps which have passed successfully the routine tests:

a) Visual examination (*see* **5** and **6**),
b) Verification of dimensions (*see* **8**),
c) Slip strength tests (*see* **11.1**),
d) Ultimate strength tests (*see* **11.2**),
e) Electrical resistance test (for tension clamps only) [*see* **12.1.1** (a)],
f) Heating cycle test (for *tension clamps* only) [*see* **12.1.1** (b)], and
g) Galvanizing/electroplating tests (*see* **9.4**).

NOTE — Type tests are normally made once and unless otherwise agreed to, test certificates giving the results of type tests, made on not less than three fittings identical in all essential details with those to be supplied, are regarded as evidence of compliance.

10.3.2 The following shall constitute type tests on insulator string fittings except clamps:

a) Visual examination (*see* **5** and **6**),
b) Verification of dimensions (*see* **8**),
c) Mechanical test (*see* **11.2.2**),
d) Galvanizing test (*see* **9.4**), and
e) Chemical composition test (*see* **9.6**).

10.3.3 The following shall constitute type tests on non-tension components:

a) Visual examination (*see* **5** and **6**),
b) Verification of dimensions (*see* **8**),
c) Mechanical tests (optional), and

NOTE — Test method and its requirements to be mutually agreed between the manufacturer and the purchaser.

d) Chemical composition test (*see* **9.6**).

10.4 Acceptance Tests

10.4.1 The following shall constitute acceptance tests for clamps:

a) Visual examination test (*see* **5** and **6**),
b) Chemical composition test (*see* **9.6**),
c) Verification of dimensions (*see* **8**),
d) Mechanical tests (*see* **11.1**),
e) Ultimate strength test (*see* **11.2**),
f) Galvanizing test (*see* **9.4**), and
g) Electrical resistance test for compression/tension clamps (subject to agreement between the manufacturer and the user) [*see* **12.1.1** (a)].

10.4.2 Acceptance test on insulator string fittings:

a) Visual examination test (*see* **5** and **6**),
b) Chemical composition test (*see* **9.6**),
c) Verification of dimensions (*see* **8**),
d) Ultimate strength test (*see* **11.2**), and
e) Galvanizing test (*see* **9.4**).

10.4.3 Acceptance test on non-tension components:

a) Visual examination test (*see* **5** and **6**),
b) Chemical composition test (*see* **9.6**),
c) Verification of dimensions (*see* **8**),
d) Mechanical test (optional) (subject to agreement between the manufacturer and the user) (*see* **11.1.4**), and
e) Galvanising test (*see* **9.4**).

10.5 Routine Tests

10.5.1 Routine tests on clamps:

a) Visual examination (*see* **5** and **6**), and
b) Mechanical routine test on conductor tension (anchor) clamps only (*see* **11.3**).

10.5.2 Routine tests on insulator string fittings and earthing conductor fittings:

a) Visual examination (*see* **5** and **6**), and
b) Mechanical routine test (*see* **11.3**).

10.5.3 Routine test on non-tension components:
a) Visual examination (*see* **5** and **6**).

11 MECHANICAL TFSTS

11.1 Slip Strength Tests on Clamps

11.1.1 *Suspension Clamps*

The suspension clamp shall be vertically suspended by means of some flexible attachment. A suitable length of the specified conductor shall be fixed in the clamp with bolts and nuts tightened with the specified torque. A load shall then be gradually applied at one end of the conductor and the value of the load at which the conductor in the clamp begins to slip shall be noted (*see* Fig. 1). The conductor should not slip at a load of 8 percent of the breaking load of the conductor. The slip strength shall not exceed 15 percent of the breaking load of the conductor. For the purpose of this test, the breaking load of the conductor shall be taken as the value given in the relevant conductor specifications.

11.1.2 *Bolted Type Tension Clamps*

Tension clamp shall be held by means of some flexible attachment according to Fig. 2. A suitable length of the specified standard conductor shall be fixed in the clamp with bolts and nuts tightened with the specified torque. A tensile load of about 50 percent of the breaking load of the conductor shall be applied and the conductor shall be marked in such a way that movement relative to the clamp

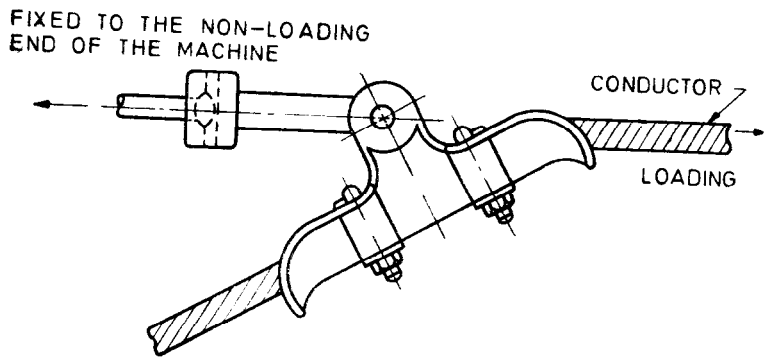

FIG. 1 APPARATUS FOR TESTING THE SLIP STRENGTH OF A SUSPENSION CLAMP

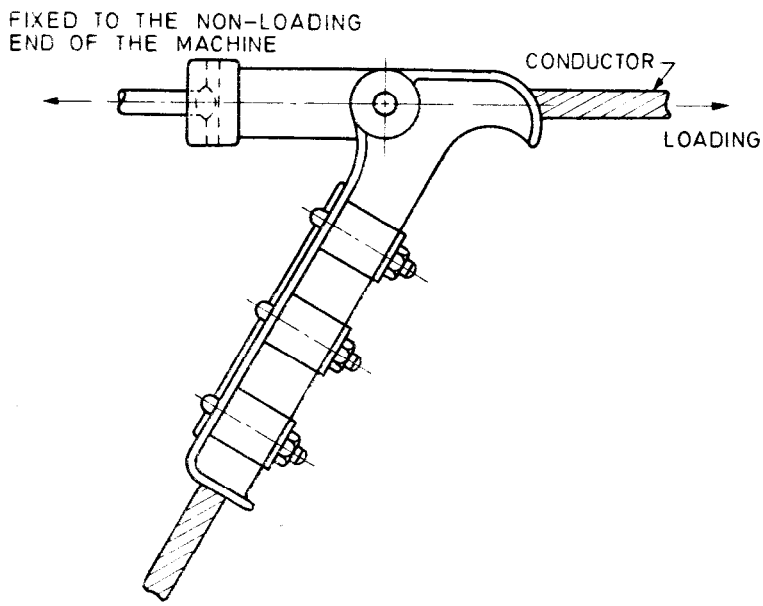

FIG. 2 APPARATUS FOR TESTING THE SLIP STRENGTH OF A TENSION CLAMP

can easily be detected. Without subsequent adjustment of the clamp, the load shall be steadily increased to 95 percent then reduced to 90 percent of the breaking load of the conductor and maintained for one minute. There shall be no movement of conductor relative to the clamp during this one minute period and no failure of the clamp. For the purpose of this test the breaking load of the conductor shall be taken as the value given in relevant conductor specifications.

11.1.3 *Compression Type Clamps*

The compression clamp shall be compressed with the specified conductor of suitable length and shall be held in the tensile testing machine by means of some flexible attachment. A tensile load of about 50 percent of the breaking load of the conductor shall be applied and the conductor shall be marked in such a way that movement relative to the clamp can be detected. Without subsequent adjustment of the clamp, the load shall be steadily increased to 95 percent then reduced to 90 percent of the breaking load of the conductor and maintained for one minute. There shall be no movement of the conductor relative to the clamp during this one minute period and no failure of the clamp. For the purpose of this test, the breaking load of the conductor shall be taken as the value given in relevant conductor specification.

11.1.4 *Mechanical Type Test (Optional) on Joints Other than Tee Joints*

When specified by the purchaser non-tension joints other than tee joints shall meet the requirements of the following test.

11.1.4.1 The joint shall be assembled in accordance with the manufacturer's recommendations on conductors of the sizes and types with which it is to be used. The assembly shall be mounted in a tensile testing machine and anchored in such a way that the test load is applied in the direction of the conductor.

11.1.4.2 If the nominal breaking load of the conductor is less than 12 kN a tensile load of about 5 percent of the breaking load of the conductor shall be applied and the conductor shall be marked in such a way that movement relative to the fitting can easily be detected. Without any subsequent adjustment of the fitting, the load shall be steadily increased to 10 percent of the breaking load. This load shall be maintained for 1 minute. There shall be no movement of the conductor relative to the fitting due to slip during this period of 1 minute and no failure of the fitting.

11.1.4.3 If the nominal breaking load of the conductor is 12 kN or more, a tensile load of 0·6 kN shall be applied and the conductor shall be marked in such a way that movement relative to the fitting can easily be detected. Without any subsequent adjustment of the fitting. the load shall be steadily increased to 1·2 kN. This load shall be maintained for 1 minute. There shall be no movement of the conductor relative to the fitting due to slip during this period of 1 minute and no failure of the fitting.

11.2 Mechanical Strength Tests

11.2.1 *Suspension Clamps*

The suspension clamp fittings shall be held in a tensile testing machine in a manner approximating, as nearly as possible to the arrangement to be used in service, the conductor being replaced by a rigid bar of suitable size (*see* Fig. 3). A tensile load equal to one-half of the specified minimum failing load (*see* **3.2.1**) shall be applied and increased at a steady rate. Failure of the fitting shall not occur at a load less than the 50 percent of breaking load of the relevant conductor, for which the fitting is designed.

11.2.2 *Insulator String Fittings*

The fitting shall be held in a tensile testing machine in a manner approximating, as nearly as posible, to arrangement to be used in service. A tensile load equal to 75 percent of the specified minimum failing load (*see* **3.2.1**) shall be applied and increased at a steady rate. Failure of the fitting shall not occur at a load less than the specified minimum failing load.

11.3 Mechanical Routine Tests

11.3.1 *Tension Joints and Anchor Clamps*

Mechanical tests shall not be made on tension joints or anchor clamps except by special agreement between the purchaser and the manufacturer. When required such tests shall be same as the type tests specified in **11.1**.

11.3.2 *Insulator String Fittings*

This test shall be applied only to castings, forgings and fittings which are fabricated by welding, in which the weld is stressed when the fitting is in service. A tensile load equal to 40 percent of the specified minimum failing load shall be applied to the fittings and mountained for 30 s, the fittings shall not be damaged by the test.

11.3.3 *Non-Tension Joints*

No routine test is recommended.

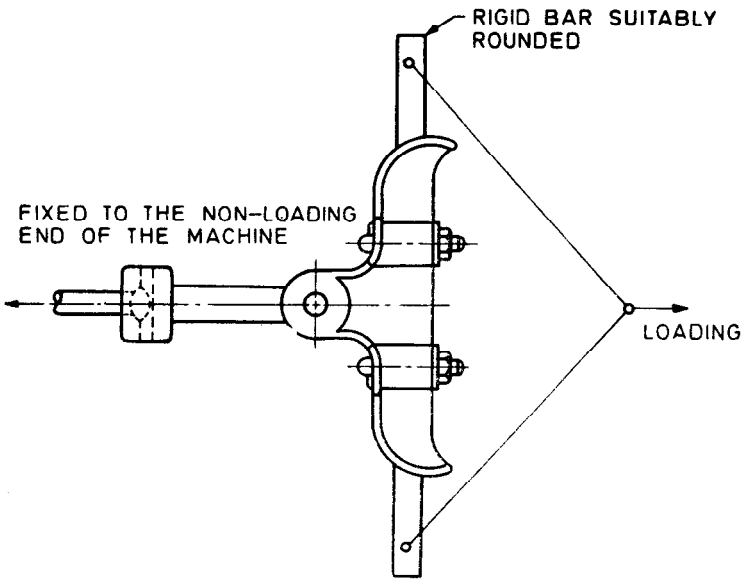

FIG. 3 APPARATUS FOR TESTING THE ULTIMATE STRENGTH OF A SUSPENSION CLAMP

12 ELECTRICAL TESTS

12.1 Type Tests

12.1.1 *Tension Joints and Anchor Clamps*

a) *Resistance Tests*

This test shall be made on tension joints and also on anchor clamps (including any jumper connections which form part of the fittings), if the design is such that the conductor is not continuous through the clamp.

The fitting shall be assembled in accordance with the manufacturer's recommendations on conductor of the size and type with which it is to be used. The electrical resistance shall be measured between points on the conductors on either side and 25 mm clear of the fitting and shall not exceed 75 percent of the measured resistance of the equivalent length of conductor. Where a fitting is composed of several parts electrically in series, the resistance of each part shall not exceed 75 percent of the measured resistance of the equivalent length of conductor.

The test shall be made with direct current. The current connections shall be at a distance not less than 50 times the diameter of the conductor from the fitting and shall be made so that effective contact is made with all those strands of the conductor which would be taken into account in calculating its equivalent resistance.

The test shall be repeated with the polarity reversed and the average of the two results taken as the measured value.

b) *Heating Cycle Test*

This test shall be made on all types of tension joints and also on anchor clamps (including any jumper connections which form part of the fitting), if the design is such that the conductor is not continuous through the clamp.

The test current shall be that power frequency current which raises the surface temperature of the conductor 40°C above the ambient temperature and maintains the temperature at a steady value. The minimum length of conductor used for determining this current shall be 2 m and the conductor temperature shall be measured near the centre of the test length.

The fitting shall be assembled in accordance with the manufacturer's recommendations on conductors of the size and type with which it is to be used. The assembly, to which a tensile load not exceeding 20 percent of the breaking load of the conductor may be applied, shall be erected indoors so that the conductor is roughly horizontal. Air shall be able to circulate freely around the assembly which shall not however be exposed to draughts. The minimum

length of conductor on each side of the fitting shall be 2 m.

The test current shall be passed continuously through the assembly for a period of 30 min or such longer period as may be necessary to bring the reference conductor to a temperature 40°C above the ambient temperature. The current shall then be interrupted and the conductor shall be allowed to cool to within 5°C above the ambient temperature. This sequence of operation shall be repeated so that 250 cycles of heating and cooling are applied. The fitting shall not be tightened or adjusted during the test.

During the last five cycles the maximum temperature, measured when the test current is flowing, at any point on the surface of the fitting, shall not exceed that of the conductor. At the end of the test the fitting shall meet the requirements of the resistance test specified in **12.1.1** (a). The fitting shall afterwards be opened and there shall be no sign of local heating, burning or fusing of any part of the fitting or of the conductor, as a result of the test.

12.1.2 *Non-Tension Joints*

12.1.2.1 *Heating cycle test*

This test shall be made on all kinds of non-tension joints, including tee joints. The test shall be made with alternating current at any convenient power frequency. The test current shall be as specified in **12.1.2.2** or **12.1.2.3** as may be appropriate.

NOTE — Some fittings are intended to be used in groups of two or more. In such cases the heating-cycle tests should be made on a complete assembly, as in service, and the test certificate should show clearly the arrangements used in the test.

The reference conductor, in which the fitting has been defined, shall be that one of the two or three conductors associated with the joint in the test which reaches the highest temperature. The minimum length of conductor used for determining this current shall be 2 m and the conductor temperature shall be measured near the centre of the test length.

The fitting shall be assembled in accordance with the manufacturer's recommendations on conductors of the sizes and types with which it is to be used. No tensile load shall be applied. The electrical resistance shall be measured between points on all the conductors 25 mm clear of the fitting. The measurements shall be made with direct current. The current connections shall be so made that effective contact is made with all those strands of the conductors which would be taken into account in calculating their equivalent resistances.

The assembly shall be erected indoors so that air can circulate freely around it, but it shall not be exposed to draughts. The minimum length of conductors emerging from each outlet of the fitting shall be 2 m.

The test current shall be passed continuously through the assembly (from main to branch conductor for a tee joint) for a period of 30 min or such longer period as may be necessary to bring the reference conductor to a temperature 40°C above the ambient temperature. The current shall then be interrupted and the reference conductor shall be allowed to cool to within 5°C above the ambient temperature. This sequence of operations shall be repeated so that 250 cycles of heating and cooling are applied. The fitting shall not be tightened or adjusted during the test.

During the last five cycles the maximum temperature, measured when the test current is flowing, at any point of the surface of the fitting, shall not exceed that of the hottest conductor. At the end of the test the resistances shall again be measured and shall not exceed 110 percent of the initial values. The fitting shall afterwards be opened and there shall be no sign of local heating, burning or fusing of any part of the fitting or of the conductor, as a result of the test.

12.1.2.2 *Test current for joints to which a rated current has been assigned*

The test current for joints to which a rated current has been assigned by the manufacturer shall be rated current multiplied by $\sqrt{2}$.

12.1.2.3 *Test current for joints to which no rated current has been assigned*

For joints to which no rated current has been assigned by the manufacturer, the test current shall be that power frequency current which raises the surface temperature of the reference conductor 40°C above the ambient temperature and maintains the temperature at a steady value.

12.1.3 *Insulation String Fittings and Suspension Clamps*

No electrical type test is recommended.

13 MARKING

13.1 The caps and clamps shall have marked on them the following:

a) Name and trade-mark of the manufacturer,

b) Year of manufacture, and

c) Country of manufacture.

13.1.1 The packages containing fittings may also be marked with the Standard Mark.

NOTE — The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and the rules and regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

14 PACKING

For packing, wooden cases shall be employed. The packing shall be fit to withstand rough handling during transit and storage at destination. The heads and threaded portions of pins and the fittings shall be properly protected against damage. The gross weight of the packing shall not normally exceed 50 kg. Different fittings shall be packed in different cases and shall be completed with their minor accessories fitted in place. All nuts shall be hand-tightened over the bolts and screwed up to the farthest points.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
209 : 1979	Specification for zinc (*third revision*)
226 : 1975	Structural steel (standard quality) (*fifth revision*)
410 : 1977	Specification for cold rolled brass sheet, strip and foil (*third revision*)
1367 (Part 1) : 1980	Technical supply conditions for threaded steel fasteners : Part 1 Introduction and general information (*second revision*)
1367 (Part 6) : 1979	Mechanical properties and test methods for nuts with specified proof loads (*second revision*)
1570 (Part 2) : 1979	Schedules for wrought steels : Part 2 Carbon steels unalloyed steels (*first revision*)
1573 : 1986	Electroplated coatings of zinc on iron and steel (*second revision*)
1865 : 1974	Iron castings with spheroidal or nodular graphite (*second revision*)
1875 : 1978	Carbon steel billets, blooms, slabs and bars for forgings (*second revision*)
2004 : 1978	Carbon steel forgings for general engineering purposes (*second revision*)
2107 : 1977	Whiteheart malleable iron castings (*first revision*)
2108 : 1977	Blackheart — malleable iron castings (*first revision*)
2121 (Part 1) : 1981	Conductors and earth wire accessories for overhead power lines : Part 1 Armour rods, binding wires and tapes for conductors (*first revision*)
2121 (Part 2) : 1981	Conductors and earth wire accessories for overhead power lines : Part 2 Mid-span joints and repair sleeves for conductors (*first revision*)
2486 (Part 2) : 1989	Insulator fittings for overhead power lines with nominal voltage greater than 1 000 V: Part 2 Dimensional requirements (*first revision*)

IS No.	Title
2486 (Part 3) : 1974	Insulator fittings for overhead power lines with nominal voltage greater than 1 000 V : Part 3 Locking devices
2629 : 1966	Recommended practice for hot-dip galvanizing of iron and steel
2633 : 1986	Method of testing uniformity of coatings on zinc coated articles (*second revision*)
4759 : 1984	Hot-dip zinc coatings on structural steel and other allied products (*second revision*)
4905 : 1968	Methods for random sampling
5082 : 1981	Wrought aluminium and aluminium alloy bars, rods, tubes and sections for electrical purposes (*first revision*)
5522 : 1992	Stainless steel for utensils sheets and strips (*second revision*)
5561 : 1971	Electric power connector
6051 : 1970	Code for designation of aluminium and its alloys
6603 : 1972	Stainless steel bars and flats
7814 : 1975	Phosphor bronze sheet, strip and foil

ANNEX B

(*Clause* 7.2)

SAMPLE SIZE AND CRITERIA FOR CONFORMITY

B-1 SAMPLING

B-1.1 Lot

All insulator fittings of same type and design manufactured under similar conditions of production, offered for acceptance. A lot may consist of the whole or part of the quantity offered.

B-1.2 The number of fittings to be selected at random from the lot shall be in accordance with col 1 and col 2 of Table 1. If required (*see* **B-2**) additional insulator fittings as given in col 3 of Table 1 shall also be selected at random. In order to ensure the randomness of selection, random number tables shall be used (*see* IS 4905 : 1968).

B-2 CRITERIA FOR CONFORMITY

Each of the insulator fittings selected in the first stage in accordance with col 1 and col 2 of Table 1 shall be subjected to all acceptance tests. A fitting shall be declared defective if it fails in any of these tests. The lot shall be considered as conforming to the requirements of acceptance tests if the number of defectives in the sample is less than or equal to corresponding acceptance number (*see* col 4). The lot shall be rejected if the number of defectives is equal to or greater than first rejection, r_1 (*see* col 5). If the number of defectives are in between '*a*' and r_1 a second sample of same size (*see* col 3) shall be selected from the lot at random and subjected to the tests. If the number of defectives in the two samples combined is less than r_2 (*see* col 6), the lot shall be considered as conforming to the requirements of acceptance tests, otherwise the lot shall be rejected.

Table 1 Sample Size and Criteria for Conformity

(*Clauses* B-1.2 *and* B-2)

Lot Size	Sample Size		*a*	r_1	r_2
	1 st stage	2nd stage			
(1)	(2)	(3)	(4)	(5)	(6)
101 to 500	5	5	0	2	2
501 to 1 000	8	8	0	2	2
1 001 to 3 000	13	13	0	2	2
3 001 to 10 000	20	20	0	3	4
10 001 to 35 000	32	32	1	4	5
35 001 and above	50	50	2	5	7

Standard Mark

The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

Bureau of Indian Standards

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards Monthly Additions'. Comments on this Indian Standard may be sent to BIS giving the following reference:

Doc : No. ET 06 (3158)

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Printed at Printwell Printers, Aligarh, India