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Mazdoor Kisan Shakti Sangathan
“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”
Jawaharlal Nehru
“Step Out From the Old to the New”

IS 731 (1971): Porcelain insulators for overhead power lines with a nominal voltage greater than 1000 V [ETD 6: Electrical Insulators and Accessories]
Indian Standard

SPECIFICATION FOR PROCELINE
INSULATORS FOR OVERHEAD POWER
LINES WITH A NOMINAL VOLTAGE
GREATER THAN 1 000 V

(Second Revision)

Ninth Reprint JANUARY 2006
(Incorporating Amendments No. 1 to 4 and
Including Amendments No. 5 and 6)

UDC 621.315.62 : 665.5

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 7       June 1972
AMENDMENT NO. 7 JULY 2008
TO
IS 731 : 1971 SPECIFICATION FOR PORCELAIN INSULATORS FOR OVERHEAD POWER LINES WITH A NOMINAL VOLTAGE GREATER THAN 1 000 V

( Second Revision )

[Page 13, clause 10.1.1(j)] — Substitute 'Mechanical Performance Test (10.9.1) and Thermal Mechanical Performance Test (only on string insulator units) (10.9.2)' for '24 hours mechanical strength test (for string insulators only when specified by the purchaser) (10.9)'.

(Page 19, clause 10.9) — Substitute 'Mechanical Performance Test and Thermal Mechanical Performance Test' for 'Twenty-four Hours Mechanical Test (for String Insulator Units only when Specified by Purchaser)'.

(Page 19, clause 10.9.1) — Substitute the following for the existing text:

10.9.1 Mechanical Performance Test

This test has an initial stage of mechanical loading and unloading, and a concluding stage of testing the insulator units to failure. The concluding stage is identical to an ordinary electromechanical or mechanical failing load test.

During the initial stage of the test, the insulator units shall be subjected to a tensile load equal to 60 percent of the specified electromechanical or mechanical failing load (whichever is applicable). Unless otherwise agreed, the tensile load shall be applied and immediately removed four times in succession. On the same day, after loading and unloading, the insulator units shall be subjected individually to an electromechanical or mechanical failing load test.

The performance of the insulator units will be determined by a comparison of the failing load values and the fracture pattern obtained during the electromechanical and mechanical failing load test and the same test carried out as the final stage of the mechanical performance test defined here.
Amend No. 7 to IS 731 : 1971

NOTES

1 The test may be more decisive if the 60 percent load is applied and removed more than four times in succession.

2 The insulator units may be coupled together in series and/or in parallel when subjected to the 60 percent load. When parallel coupled, the insulator units must be equally loaded.

3 The test may not give information on the internally stressed zone if the failure occurs in a metal part such as the socket or clevis of a cap or an insulator pin. In such cases, this test is not suitable for a sample test, but by agreement it may be used as a design test or special qualification test. It is possible to investigate the fundamental insulator design by using metal parts suitably strengthened so that failure occurs in the internally stressed zone of the insulator.

Precautions should be taken so that strengthening the metal parts does not affect the fundamental stress relation.

4 Voltage may be applied to the insulator units (Type B only) whenever it is desired in the course of the test to detect mechanical failure of the insulating part (puncture).

(Page 19, clause 10.9.1, last line) — Insert the following and renumber 10.9.2 as 10.9.3:

10.9.2 Thermal-Mechanical Performance Test

During the initial stage of the test, the insulator units shall be subjected to four 24-hours cycles of cooling and heating, and a tensile load equal to 60 percent of the specified electro-mechanical or mechanical falling load. The tensile load shall be applied to the insulator units at room temperature before starting the first thermal cycle.

Unless otherwise agreed, each 24-hour cycle shall comprise a cooling to −30 ± 5°C and a heating to +40 ± 5°C. The temperature figure refers to the surrounding air. The temperature sequence shall be first cooling, then heating. The test equipment shall be such as to permit the minimum and maximum temperatures each to be kept during at least four consecutive hours of the temperature cycle.

The tensile load shall be completely removed and re-applied towards the end of each heating period and then last one accepted.

On completion of the fourth 24-hour cycle and cooling to room temperature, the tensile load shall be removed. On the same day, after this load removal, the
insulator unit shall be subjected individually to an electromechanical or mechanical falling load test.

The performance of the insulator units will be determined by a comparison of the failing load values and the fracture pattern obtained during the electromechanical and mechanical failing load test and the same test carried out as the final stage of the mechanical performance test defined here.

Further the tolerances on the temperatures of the hot and cold cycles shall be respected in such a way so as to ensure a minimum difference of 70 degrees between the recorded hot and cold temperatures.

NOTES

1. This thermal-mechanical performance test has reference to the fundamental insulator design in respect of the internal stresses, and should not be repeated on types which differ in outward form only, that is, the disc of the insulating part or the coupling ends of the metal fittings. Changes in internal design or in manufacturing processes are reasons for re-testing. The test may not give information on the internally stressed zone if the failure occurs in a metal part such as the socket or clevis of a cap or an insulator pin. In such cases, it is possible to investigate the fundamental insulator design by using metal parts suitably strengthened so that failure occurs in the internally stressed zone of the insulator.

Precautions should be taken so that strengthening the metal parts does not affect the fundamental stress relation.

2. The insulator units may be coupled together in series and/or in parallel when subjected to the thermal cycles and the 60 percent load. When parallel coupled, the insulator units must be equally loaded.

3. Loose coupling pins, for example, those used with insulators of the long rod type, should not be included in the mechanical test since they are not part of the internal design of the insulator.

4. Voltage may be applied to the insulator units (Type B only) whenever desired in the course of the test, but without altering the test cycle, in order to detect mechanical failure of the insulating part (puncture).

(Page 21, clause 10.14.2) — Substitute '50 percent of the specified electromechanical failing load' for '40 percent of the specified electromechanical failing load'.

(ET 06)
AMENDMENT NO. 5 JULY 1987
TO
IS : 731-1971 SPECIFICATION FOR PORCELAIN INSULATORS FOR OVERHEAD POWER LINES WITH A NOMINAL VOLTAGE GREATER THAN 1 000 V
( Second Revision )

[ This amendment takes into account the sequence of carrying out acceptance tests and introduction of double plan of sampling procedure. ]

[ Page 14, Clause 10.1.2.2 (see also Amendment No. 3)] — Substitute the following for the existing clause:

'10.1.2.2 The insulators selected in accordance with 10.1.2.1 shall be divided approximately into three parts and subjected to the applicable acceptance tests in the following order:

<table>
<thead>
<tr>
<th>Part(s) of Samples</th>
<th>Tests on String Insulator Units</th>
<th>Tests on Rigid Insulator</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type A</td>
<td>Type B</td>
</tr>
<tr>
<td>First and Second Parts</td>
<td>10.5, 10.6, 10.9 ( when specified ), 10.8 and 10.11</td>
<td>10.5, 10.6, 10.9 ( when specified ), 10.8 and 10.11</td>
</tr>
<tr>
<td>Third Part</td>
<td>10.5, 10.6 and 10.12</td>
<td>10.5, 10.6 and 10.12</td>
</tr>
</tbody>
</table>

( Page 29, Appendix C ) — Substitute the following for the existing appendix:

APPENDIX C
( Clauses 10.1.2.1 and 10.1.23 )

SAMPLING PROCEDURE FOR INSULATORS FOR OVERHEAD POWER LINES

C-1. SCALE OF SAMPLING

C-1.1 Lot — In a consignment, all the insulators of the same type and design manufactured from the same material in the same factory under similar conditions of production shall be grouped together to constitute a lot.
<table>
<thead>
<tr>
<th>LOT SIZE</th>
<th>FOR DIMENSIONS AND TEMPERATURE CYCLE TEST</th>
<th>FOR MECHANICAL ELECTRO-MECHANICAL AND POROSITY TEST</th>
<th>FOR GALVANIZING AND PUNCTURE TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First Sample Size</td>
<td>Second Sample Size</td>
<td>Acceptance Number</td>
</tr>
<tr>
<td>(1) Up to 1000</td>
<td>8</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>1001 to 3000</td>
<td>13</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>3001 to 10000</td>
<td>20</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>10001 and above</td>
<td>32</td>
<td>32</td>
<td>1</td>
</tr>
</tbody>
</table>
C-1.2 The number of insulators to be selected from each lot shall depend upon the size of the lot and shall be in accordance with col 1 and 2 of Table 5 and procedure given in C-2.

C-1.2.1 These insulators shall be selected from the lot at random. In order to ensure the randomness of selection, procedure given in IS : 4905-1968 'Methods for random sampling' may be followed.

C-2. NUMBER OF TESTS AND CRITERIA FOR CONFORMITY

C-2.1 All the insulators selected at random according to col 1 and 2 of Table 5 shall be subjected to dimensions and temperature cycle tests. The insulators failing to satisfy either of the requirements shall be termed as defectives. The lot shall be considered as conforming to these requirements if the number of defectives found in the sample is less than or equal to corresponding acceptance number given in col 4 of Table 5. The lot shall be rejected if the number of defectives in the same lot is greater than or equal to the first rejection number \( r_1 \) given in col 5. If the number of defectives is between the acceptance number and the first rejection number, a second sample of the same size (see col 3 of Table 5) shall be selected from the lot at random and subjected to these tests. The number of defectives in the first sample and second sample shall be combined. If the combined number of defectives is less than the second rejection number \( r_2 \) given in col 6 of Table 5, the lot shall be considered as conforming to these requirements. Otherwise the lot shall be rejected without further testing.

C-2.2 The lot which has been found as conforming to the above requirements shall then be divided into two parts, as shown in col 7 and 9 of Table 5. The number of insulators to be tested for mechanical, electro-mechanical and porosity tests shall be in accordance with col 7 of Table 5. The lot shall be considered as conforming to these requirements if no defective is found in the sample and shall be rejected if there are two or more defectives. If there is one defective, a second sample of same size (see col 8 of Table 5) shall be selected at random and subjected to the tests. The lot shall be considered as conforming to these requirements if no defective is found in the second sample; otherwise the lot shall be rejected without further testing.

C-2.3 The lot which has been found as conforming to the requirements of C-2.1 shall then be tested for galvanizing test and puncture test. For this purpose, the sample size is given in col 9 of Table 5. The lot shall be considered as conforming to these requirements if no defective is found in the sample and shall be rejected if two or more defectives are found in the sample. If there is one defective, a second sample of same size (see col 10 of Table 5) shall be selected at random and subjected to the tests. The lot shall be considered as conforming to these requirements if no defective is found in the second sample; otherwise the lot shall be rejected without further testing.

C-2.4 The lot shall be considered as conforming to the requirements of acceptance tests if conditions in C-2.1, C-2.2 and C-2.3 are satisfied.

( ETDC 3 )
AMENDMENT NO. 6 JANUARY 1993

TO

IS 731 : 1971 SPECIFICATION FOR PORCELAIN INSULATORS FOR OVERHEAD POWER LINES WITH A NOMINAL VOLTAGE GREATER THAN 1 000 V

(Second Revision)

(Page 22, clause 10.15.5) — Add the following sentence to the clause:

'soamer pattern formed during routine electrical tests may be observable, but it shall not disqualify the insulator for acceptance.'

(Page 29, Table 5) — Add the following note to the table:

"NOTE — Sample size for Type A insulators can be as per Table 3 of IS 2544 : 1973*.'

(Page 29, foot-note) — Add the following foot-note:

"*Porcelain post insulators for systems with nominal voltage greater than 1 000 V (first revision)."

(ET 06)
Indian Standard

SPECIFICATION FOR PORCELAIN INSULATORS FOR OVERHEAD POWER LINES WITH A NOMINAL VOLTAGE GREATER THAN 1 000 V

(Second Revision)

Electrical Insulators and Accessories Sectional Committee, ETDC 3

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(Continued on page 2)
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<td>SHRI H. M. S. LINGAIAH</td>
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<td>Heavy Electricals (India) Ltd, Bhopal</td>
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<td>New Government Electric Factory, Bangalore</td>
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<td>Mysore Porcelains Ltd, Bangalore</td>
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<tr>
<td>DR U. S. Singh</td>
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<td>SHRI A. D. DUA (Alternate)</td>
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<tr>
<td>SHRI H. R. VARMA</td>
<td>Indian Electrical Manufacturers’ Association, Calcutta</td>
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<td>SHRI K. N. JAYARAM (Alternate)</td>
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<tr>
<td>SHRI Y. S. VENKATESWARAN,</td>
<td>Director General, BIS (Ex-officio Member)</td>
</tr>
<tr>
<td>Director (Elec tech)</td>
<td></td>
</tr>
</tbody>
</table>

### Secretary

SHRI R.C. JAIN
Assistant Director (Elec tech), BIS
Indian Standard

SPECIFICATION FOR PORCELAIN INSULATORS FOR OVERHEAD POWER LINES WITH A NOMINAL VOLTAGE GREATER THAN 1 000 V

(Second Revision)

0. FOREWORD

0.1 This Indian Standard (Second Revision) was adopted by the Indian Standards Institution on 18 November 1971, after the draft finalized by the Electrical Insulators and Accessories Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard has been prepared to achieve the following objects:

a) To define the terms used;
b) To define insulator characteristics and to prescribe the conditions under which the specified values of these characteristics shall be verified;
c) To prescribe test methods; and
d) To prescribe acceptance criteria.

0.3 This standard was originally issued as a tentative specification for porcelain insulators in 1956. It was first revised in 1963 to make it more comprehensive and up to date. This second revision has been undertaken with a view to rationalizing the classification of tests. In this revision, which includes all the amendments issued to date to the that revision, the classification of the insulators according to their construction has been incorporated and the requirements and methods of tests have been modified to keep the standard in line with the latest developments taking place in insulator technology.

0.4 The fittings normally used with overhead porcelain insulators are covered in IS:2486 (Part I)-1971* and IS:2486 (Part II)-1963†.

*Specification for insulator fittings for overhead power lines of 3.3 kV and above Part I General requirements and tests (first revision).
†Specification for insulator fittings for overhead power lines of 3.3 kV and above Part II Dimensional requirements.
In the preparation of this standard, assistance has been derived from the following publications:

IEC Pub 274 Tests on insulators of ceramic material or glass for overhead lines with a nominal voltage greater than 1 000 V. International Electrotechnical Commission.

BS 137 : Part I : 1970 Insulator of ceramic material or glass for overhead lines with a nominal voltage greater than 1 000 V. Part I Test. British Standards Institution.

Draft BS 137 : Part II : 1970 Insulators of ceramic material or glass for overhead lines with a nominal voltage greater than 1 000 V. Part II Requirements. British Standards Institution.

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*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard applies to the porcelain insulators for ac overhead power lines suitable for nominal system voltage greater than 1 000 volts and a frequency not greater than 100 Hz.

NOTE 1 — The specification applies to string insulator units, to insulator strings consisting of one-string insulator unit or an assembly of such units, and to rigid overhead line insulators. The specification applies to insulators of the same type when used in substations. It does not apply to insulators forming part of electrical apparatus or to parts used in their construction.

NOTE 2 — This specification applies to insulators for use on ac overhead lines and may be regarded as a provisional specification for insulators for use on dc overhead lines.

2. TERMINOLOGY

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

2.1 String Insulator Unit — An insulator consisting of a porcelain part with the necessary interconnecting metal-work to enable it to be flexibly attached to other string insulator units. Unless otherwise stated, for string insulator unit with ball and socket couplings the term includes the locking device (security clip) and for units with clevis and tongue coupling it includes the pin and other parts necessary for coupling.

*Rules for rounding off numerical values (revised).
2.2 **Insulator String** — One or more string insulator units intended to give flexible support to an overhead line. The insulator string is intended to be stressed only in tension.

2.2.1 **Suspension Insulator Set** — One insulator string or two or more strings suitably connected together, complete with fittings for flexible attachment to a supporting structure and to carry a line conductor or conductors at its lower end. The term 'set' includes all other metal parts and accessories as required in service.

2.2.2 **Tension Insulator Set** — One insulator string, or two or more strings suitably connected together, complete with fittings for flexible attachment to a supporting structure and to secure a line conductor or conductors in tension. The term 'set' includes all other metal parts and accessories as required in service.

2.3 **Rigid Insulator** — An insulator intended to give rigid support to an overhead line and to be stressed mainly by bending and compressive loads.

2.3.1 **Pin Insulator** — A rigid insulator consisting of a single piece of porcelain or of two or more porcelain components permanently connected together, and intended to be mounted rigidly on a supporting structure by an insulator pin passing up inside the insulator. Unless otherwise stated, this term excludes the insulator pin.

2.3.2 **Line Post Insulator** — A rigid insulator consisting of a porcelain part permanently secured in a metal base and intended to be mounted rigidly on a supporting structure by means of a stud attached to the base. Unless otherwise stated, this term includes the stud.

2.4 **Shell** — A single insulating member without cement or other connecting devices.

2.5 **Lot** — All the insulators of the 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 ordered.

2.6 **Flashover** — A disruptive discharge external to the insulator, connecting those parts which normally have the operating voltages between them.

2.7 **Puncture** — A disruptive discharge passing through the solid insulating parts of an insulator

   NOTE – A fragment breaking away from the rim of a shed or damage to the insulator due to the heat of a surface discharge is not considered a puncture.

2.8 **Dry Impulse Withstand Voltage** — The specified impulse voltage which the insulator shall withstand, under the conditions specified in **10.3** without flashover or puncture.
2.9 Fifty-Percent Dry Impulse Flashover Voltage — The impulse voltage which, under the conditions prescribed in 10.3 has a 50 percent probability of producing a flashover on the insulator.

2.10 Wet Power-Frequency Withstand Voltage — The specified power-frequency voltage which the insulator shall withstand (wet) under the conditions prescribed in 10.4 for the specified time (one minute) without flashover or puncture.

2.11 Wet Power-Frequency Flashover Voltage — The arithmetic mean value of the measured power-frequency voltages which cause flashover of the insulator under the conditions prescribed in 10.4.

2.12 Electromechanical Failing Load — The maximum load which can be reached when a string insulator unit is tested under the conditions prescribed in 10.7.

2.13 Mechanical Failing Load — The maximum load which can be reached when a string insulator unit or a rigid insulator is tested under the conditions prescribed in 10.8.

2.14 Puncture Voltage (of a String Insulator Unit or a Rigid Insulator) — The voltage which, under the conditions prescribed in 10.10, causes puncture.

2.15 Creepage Distance (of an Insulator) — The shortest distance or the sum of the shortest distances along the contours of the external surfaces of the porcelain insulating parts of the insulator between those parts which normally have the operating voltage between them. A distance over a cement surface shall not be considered as forming part of the creepage distance. If high-resistance coatings are applied to parts of the insulator, such coatings shall be considered effective creepage surfaces and the distance over them is included in the creepage distance (see Fig. 1).

NOTE 1 — The surface resistivity of such high-resistance coatings is usually about $10^3$ ohms, but may be as low as $10^7$ ohms.

NOTE 2 — If high-resistance coatings are applied to the whole surface of the insulator (the so-called stabilized insulator), the questions of surface resistivity and creepage distance should be subject to agreement between the user and the manufacturer.

2.15.1 Protected Creepage Distance — That part of the creepage distance on the illuminated side of the insulator which would lie in shadow if light were projected on to the insulator in a direction at $90^\circ$ to the longitudinal axis of the insulator (see Fig. 1).

2.16 Highest Voltage of a System — The highest rms line-to-line voltage which can be sustained under normal operating conditions at any time and at any point on the system. It excludes temporary voltage variations due to fault conditions and the sudden disconnection of large loads.
NOTE — These strucher are only illustrations for total creepage and protected creepage distances and the same should not be mistaken for standard configuration.

FIG. 1 INSULATOR CREEPAGE DISTANCES (CREEPAGE DISTANCE SHOWN DOTTED)
2.17 **Factor of Earthing** — The factor of earthing at a selected location of a three-phase system (generally the point of installation of an equipment), for a given system layout, is the ratio, expressed as a percentage, of the highest rms line-to-earth power-frequency voltage on a sound phase at the selected location during a fault to earth (affecting one or more phases at any point), to the line-to-line rms power-frequency voltage which would be obtained at the selected location with the fault removed.

NOTE 1 — This factor is a pure numerical ratio and characterizes in general terms the earthing conditions of a system as viewed from the selected location, independently of the actual operating values of the voltage at that location.

NOTE 2 — The factors of earthing are calculated from the phase-sequence impedance components of the system as viewed from the selected location, using for the rotating machines the subtransient reactances. The practical rule given in the Note under 2.18 results from such a calculation.

NOTE 3 — This factor is used for the choice of the insulation level of the equipment to be installed at a selected location, particularly in the case of systems in which the highest voltage for equipment is 100 kV or more.

2.18 **Earthed Neutral System** — A system in which the neutral is connected to earth, either solidly, or through a resistance or reactance of low enough value to reduce materially transient oscillations and to give a current sufficient for selective earth fault protection.

2.18.1 A three-phase system with effectively earthed neutral at a given location is a system characterized by a factor of earthing at this point which does not exceed 80 percent.

NOTE — This condition is obtained approximately when, for all system configurations, the ratio of zero-sequence reactance to the positive-sequence reactance is less than three and the ratio of zero-sequence resistance to positive-sequence reactance is less than one.

2.19 **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.

2.20 **Acceptance Tests** — Tests carried out on samples taken from the lot for the purpose of acceptance of the lot.

2.21 **Routine Tests** — Tests carried out on each insulator to check requirements which are likely to vary during production.

3. **REFERENCE ATMOSPHERIC CONDITIONS**

3.1 Reference atmospheric conditions at which insulator characteristics shall be expressed for the purpose of comparison shall be as given below:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature</td>
<td>20°C</td>
</tr>
<tr>
<td>Barometric pressure</td>
<td>1 013 mb</td>
</tr>
</tbody>
</table>
Absolute humidity 11 g of water per cubic metre corresponding to 63 percent relative humidity at 20°C.

NOTE 1 — A pressure of 1 013 m bar is equivalent to a pressure of 760 mm of mercury at 0°C. If the height of the barometer is \( h \) mm Hg and the temperature of the mercury if \( t \)°C, the atmospheric pressure in millibars is:

\[ p = \frac{1013h}{760}(1 - 1.80 \times 10^{-4}t) \]

NOTE 2 — The Indian Standard reference temperature of 27°C and corresponding humidity have not been specified because of the non-availability of the test voltage values and correction factors for these conditions. These conditions will replace those specified above when the corresponding test voltage values and correction factors are available.

3.2 Tests for the purpose of this standard shall preferably be carried out under conditions of temperature and humidity specified in IS : 196-1966* (that is, a temperature of 27 ± 2°C and relative humidity of 65 ± 2 percent), and at the prevailing atmospheric pressure. When this is not possible, test may be carried out under conditions naturally obtaining at the time of the test. The barometric pressure, air temperature and humidity shall be recorded for the purpose of corrections. Corrections of test voltages for atmospheric conditions is given in Appendix A.

4. GENERAL REQUIREMENTS

4.1 The porcelain shall be sound, free from defects, thoroughly vitrified and smoothly glazed.

4.2 Unless otherwise specified, the glaze shall be brown in colour. The glaze shall cover all the porcelain parts of the insulator except those areas which serve as supports during firing or are left unglazed for the purpose of assembly.

4.3 The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. The porcelain shall not engage directly with hard metal.

4.4 Cement used in the construction of the insulator shall not cause fracture by expansion or loosening by contraction, and proper care shall be taken to locate the individual parts correctly during cementing. The cement shall not give rise to chemical reaction with metal fittings, and its thickness shall be as uniform as possible.

5. CLASSIFICATION

5.1 Overhead line insulators are divided into two types according to their construction:

Type A — An insulator or an insulator unit in which the length of the shortest puncture path through solid insulating material is at least

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*Atmospheric conditions for testing.
equal to half the length of the shortest flashover path through air outside the insulator.

Type B - An insulator or an insulator unit in which the length of the shortest puncture path through solid insulating material is less than half the length of the shortest flashover path through air outside the insulator.

NOTE – Type A insulator are of solid core type.

6. BASIC INSULATION LEVELS

6.1 The basic insulation levels of the insulators shall be as given in Table 1A and Table 1B.

6.2 In this standard, power-frequency voltages are expressed as peak values divided by $\sqrt{2}$; and impulse voltages are expressed as peak values.

6.3 The withstand and flashover voltages are referred to the reference atmospheric conditions.

7. MECHANICAL LOADS

7.1 The insulators shall be suitable for the minimum failing loads specified in Table 2. The loads shall be transverse in the case of pin and line post insulators and axial in the case of string insulator units.

8. MARKING

8.1 Each insulator shall be legibly and indelibly marked to show the following:

   a) Name or trade-mark of the manufacturer,
   b) Month and year of manufacture,
   c) Minimum failing load in newtons, and
   d) Country of manufacture.

8.1.1 Markings on porcelain shall be printed and shall be applied before firing.

8.2 Insulators may also be marked with the ISI Certification 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.
### TABLE 1A TEST VOLTAGES FOR ALL INSULATORS UP TO AND INCLUDING 72.5 kV RATED VOLTAGE AND FOR INSULATORS FOR NON-EFFECTIVELY EARTHED SYSTEMS ABOVE 72.5 kV

(*Clauses 6.1 and 10.2*)

<table>
<thead>
<tr>
<th>Highest System Voltage</th>
<th>Visible Discharge Test</th>
<th>Wet Power-Frequency Withstand Test</th>
<th>Power-Frequency Puncture Withstand Test</th>
<th>Impulse Voltage Withstand Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) kV (rms)</td>
<td>(2) kV (rms)</td>
<td>(3) kV (rms)</td>
<td>(4) kV (rms)</td>
</tr>
<tr>
<td>3.6</td>
<td>3</td>
<td>21</td>
<td>78</td>
<td>1.3 times the actual dry flashover</td>
</tr>
<tr>
<td>7.2</td>
<td>5.5</td>
<td>27</td>
<td>90</td>
<td>voltage of the unit</td>
</tr>
<tr>
<td>12</td>
<td>9</td>
<td>35</td>
<td>105</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>18</td>
<td>55</td>
<td>140</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>27</td>
<td>75</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>72.5</td>
<td>53</td>
<td>140</td>
<td>310</td>
<td></td>
</tr>
<tr>
<td><em>123</em></td>
<td>88</td>
<td>230</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>145</td>
<td>105</td>
<td>275</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>245</td>
<td>154</td>
<td>460</td>
<td>–</td>
<td></td>
</tr>
</tbody>
</table>

*Even though the highest system voltage of 123 kV is not a standard value in IS : 585-1962 'Voltages and frequency for ac transmission and distribution systems', a number of older power systems are retaining the nominal system voltage of 110 kV which corresponds to the highest system voltage of 123 kV. The test voltages for this highest system voltage are, therefore, given for the benefit of such power systems.*

### TABLE 1B TEST VOLTAGES FOR INSULATORS FOR USE ON EFFECTIVELY EARTHED SYSTEMS ABOVE 72.5 kV

(*Clauses 6.1 and 10.2*)

<table>
<thead>
<tr>
<th>Highest System Voltage</th>
<th>Visible Discharge Test</th>
<th>Wet Power-Frequency Withstand Test</th>
<th>Power-Frequency Puncture Withstand Test on String Insulator Units</th>
<th>Impulse Voltage Withstand Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) kV (rms)</td>
<td>(2) kV (rms)</td>
<td>(3) kV (rms)</td>
<td>(4) kV (rms)</td>
</tr>
<tr>
<td><em>123</em></td>
<td>88</td>
<td>185</td>
<td>1.3 times the actual dry flashover</td>
<td></td>
</tr>
<tr>
<td>145</td>
<td>105</td>
<td>230</td>
<td>voltage of the unit</td>
<td></td>
</tr>
<tr>
<td>243</td>
<td>154</td>
<td>395</td>
<td></td>
<td></td>
</tr>
<tr>
<td>420</td>
<td>266</td>
<td>680</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Even though the highest system voltage of 123 kV is not a standard value in IS : 586-1962 'Voltages and frequency for ac transmission and distribution systems', a number of older power systems are retaining the nominal system voltage of 110 kV which corresponds to the highest system voltage of 123 kV. The test voltages for this highest system voltage are, therefore, given for the benefit of such power systems.*
TABLE 2 MINIMUM FAILING LOADS

(Claude 7.1)

<table>
<thead>
<tr>
<th>PIN INSULATOR</th>
<th>LIKE POST INSULATORS</th>
<th>STRING INSULATOR UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Failing Load</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recommended Pin Ball Shank Diameter</td>
</tr>
<tr>
<td>kN</td>
<td>kN</td>
<td>kN</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>45</td>
</tr>
<tr>
<td>10</td>
<td>—</td>
<td>70</td>
</tr>
<tr>
<td>—</td>
<td>—</td>
<td>90</td>
</tr>
<tr>
<td>—</td>
<td>—</td>
<td>120</td>
</tr>
<tr>
<td>—</td>
<td>—</td>
<td>160</td>
</tr>
<tr>
<td>—</td>
<td>—</td>
<td>190</td>
</tr>
</tbody>
</table>

NOTE 1 — In the case of Type B string insulator units, the electromechanical failing load shall be the minimum failing load given above.

NOTE 2 — 1 N = 0.101972 kgf.

9. CREEPAGE DISTANCES

9.1 For moderately polluted atmospheres, the minimum creepage distances shall be those given in Table 3. Recommended minimum creepage distance for insulators to be used with their axis approximately vertical in heavily polluted atmospheres are given in col 3 and 4 of Table 3; protected creepage distances (see also Fig. 1) being given for insulators of highest systems voltage of 36 kV and above under those conditions.

No minimum creepage distances are specified for clean atmospheric conditions.

TABLE 3 MINIMUM CREEPAGE DISTANCES

<table>
<thead>
<tr>
<th>HIGHEST SYSTEM VOLTAGE</th>
<th>MODERATELY POLLUTED ATMOSPHERES</th>
<th>HEAVILY POLLUTED ATMOSPHERES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TOTAL</td>
<td>Protected</td>
</tr>
<tr>
<td>(1) kV</td>
<td>(2) mm</td>
<td>(3) mm</td>
</tr>
<tr>
<td>3.6</td>
<td>75</td>
<td>130</td>
</tr>
<tr>
<td>7.2</td>
<td>130</td>
<td>230</td>
</tr>
<tr>
<td>12</td>
<td>230</td>
<td>320</td>
</tr>
<tr>
<td>24</td>
<td>430</td>
<td>560</td>
</tr>
<tr>
<td>36</td>
<td>580</td>
<td>840</td>
</tr>
<tr>
<td>72</td>
<td>1 100</td>
<td>1 700</td>
</tr>
<tr>
<td>123</td>
<td>1 850</td>
<td>2 800</td>
</tr>
<tr>
<td>145</td>
<td>2 250</td>
<td>3 400</td>
</tr>
<tr>
<td>245</td>
<td>3 800</td>
<td>5 600</td>
</tr>
<tr>
<td>420</td>
<td>6 480</td>
<td>9 660</td>
</tr>
</tbody>
</table>

NOTE — For insulator used in an approximately vertical position the values given in col 2 or 3 and 4 shall apply. For insulators used in an approximately horizontal position, the values given in col 2 shall apply, but the values in col 3 and 4 may be reduced by as much as 20 percent.
10. TESTS

10.1 General

10.1.1 Type Test — The following tests shall constitute the type tests:

a) Visual examination (10.13)
b) Verification of dimensions (10.5)
c) Visible discharge test (10.2)
d) Impulse voltage withstand test (10.3)
e) Wet power-frequency voltage withstand test (10.4)
f) Temperature cycle test (10.6)
g) Electro-mechanical failing load test (for string insulator units, Type B only) (10.7)
h) Mechanical failing load test (for string insulator units of Type A and those of Type B to which electromechanical failing load test (10.7) is not applicable and for rigid insulators only) (10.8)
i) 24 hours mechanical strength test (for string insulators only when specified by the purchaser) (10.9)
j) Puncture test (for insulators, Type B only) (10.10)
k) Porosity test (10.11)
l) Galvanizing test (10.12)

NOTE 1 — A radio interference test is under consideration.

NOTE 2 — Type tests are normally made once and unless otherwise agreed to, test certificate giving the results of type tests, made on not less than two insulators identical in all essential details with those to be supplied, are regarded as evidence of compliance. The tests should be carried out on two samples in the order mentioned below:

a) Tests on both insulators:
   i) Visual examination (10.13)
   ii) Verification of dimensions (10.5)
   iii) Visible discharge test (10.2)
   iv) Impulse voltage withstand test (10.3)
   v) Wet power frequency withstand test (10.4)
   vi) Temperature cycle test (10.6)

b) Tests on first insulator:
   i) Twenty-four hour mechanical strength test (for string insulators only when specified by the purchaser) (10.9)
   ii) Electromechanical failing load test (for string insulator units Type B only) (10.7)
   iii) Mechanical failing load test (for string insulator units Type A and for rigid insulators only) (10.8)
   iv) Porosity test (10.11).
c) *Tests on second insulator*:
   i) Puncture test (for insulator units, Type B only) *(10.10)*
   ii) Galvanizing test *(10.12)*.

   **NOTE 3** — Type test shall be made and certified by the manufacturer or by an agreed independent authority.

### 10.1.2 Acceptance Tests

The test samples shall be subjected to the following acceptance tests in the order indicated below:

a) Verification of dimensions *(10.5)*

b) Temperature cycle test *(10.6)*

c) Twenty four hours mechanical strength test (for string insulator units only when specified by the purchaser) *(10.9)*

d) Electro-mechanical failing load test (for string insulator units Type B only) *(10.7)*

e) Mechanical failing load test (for string insulator units Type A and for rigid insulators only) *(10.8)*

f) Puncture test (for string insulator units, Type B only) *(10.10)*

g) Porosity test *(10.11)*

h) Galvanizing test *(10.12)*.

#### 10.1.2.1

For carrying out acceptance tests specified in this standard the sampling procedure given in Appendix C shall be followed.

#### 10.1.2.2

The insulators selected in accordance with **10.1.2.1** shall be divided approximately into three parts and subjected to the applicable tests in the following order:

<table>
<thead>
<tr>
<th>Part(s) of Samples</th>
<th>Tests on String Insulator Units</th>
<th>Tests on Rigid Insulator</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type A * 10.5, 10.6, 10.8, 10.11* and Type B * 10.5, 10.6, 10.9 or 10.8*</td>
<td>Type A * 10.5, 10.6, 10.7 or 10.8* (whichever is applicable), Type B * 10.9* (when specified) and 10.11*</td>
</tr>
<tr>
<td>First and Second Part</td>
<td></td>
<td>Type A * 10.5, 10.6, 10.8* and Type B * 10.11*</td>
</tr>
<tr>
<td>Third Part</td>
<td>10.5, 10.6, 10.12</td>
<td>10.5, 10.6, 10.10 and 10.12</td>
</tr>
</tbody>
</table>

#### 10.1.2.3

The criterion of conformity to the requirements of the acceptance tests shall be as given in Appendix C.
10.1.3 **Routine Tests** — The following tests shall be carried out as routine tests:

a) Visual examination (10.13),

b) Mechanical routine test (for string insulator units only) (10.14),

c) Electrical routine test (for Type B string insulators and rigid insulators (10.15)).

**NOTE** — Attention is drawn to the fact that ultrasonic tests may be used on Type A insulator to detect internal flaws and cracks. Experience is necessary to interpret results of ultrasonic tests and, therefore, precis forms of tests cannot yet be adopted as standard.

10.2 **Visible Discharge Test** — The test room shall be darkened and a period of five minutes shall be allowed for the observer to become accustomed to darkness. A power-frequency test voltage of the specified value given in Table 1A or Table 1B shall be applied in accordance with Appendix B and maintained at this value for five minutes. During this time, observations shall be made and there shall be no sign of visible corona.

10.3 **Impulse Voltage Withstand Test**

10.3.1 The insulator shall be tested dry under the conditions prescribed in Appendix B.

10.3.2 The impulse generator shall be adjusted to produce a standard 1.2/50 impulse wave of peak value equal to the specified value of the impulse withstand voltage corrected for atmospheric conditions in accordance with Appendix A.

10.3.3 Five such impulse voltage waves shall be applied to the insulator. If there is no flashover or puncture, the insulator shall be considered to have passed the test. If during the application of these five waves puncture occurs or if there is more than one flashover, the insulator shall be considered to have failed to comply with the standard. If only one flashover occurs, a new series of ten impulse waves shall be applied. The insulator shall be considered to have passed this test only if during this new series of tests there is no flashover or puncture.

10.3.4 The insulator shall be capable of passing the impulse voltage withstand test with voltages of both positive and negative polarity. However, when it is evident which polarity will give the lower breakdown voltage, it shall suffice to test with that polarity.

10.3.5 To provide information when specially requested, the 50 percent impulse flashover voltage for positive and negative polarities may be determined by a suitable procedure [see IS : 2071 (Part II)-1974* ].

*Methods of high voltage testing: Part II Test procedures (first revision).
10.3.5.1 The impulse flashover voltages to be recorded shall be the positive and negative 50 percent impulse flashover voltage as measured above and corrected in accordance with Appendix A.

10.3.5.2 The insulator shall not be damaged by these tests, but slight marks on the surface of the insulating parts or chipping of the cement or other material used for assembly shall be permitted.

10.4 Wet Power-Frequency Voltage Withstand Test

10.4.1 The insulator shall be arranged as prescribed in Appendix B.

10.4.2 Before the commencement of the test, the insulator shall be exposed to the artificial rain produced in accordance with 3.3 of IS : 2071 (Part I)-1974* for at least one minute before application of voltage and then throughout the test.

10.4.3 The test voltage to be applied to the insulator shall be the specified value of the wet power-frequency withstand voltage adjusted for atmospheric conditions at the time of test (see Appendix A).

10.4.4 A voltage of about 75 percent of the test voltage as determined in 10.4.3 shall be applied and then increased gradually to reach the test voltage in a time not less than five seconds. The test voltage shall be maintained at this value for one minute [see IS : 2071 (Part II)-1974†].

The insulator shall not flashover or puncture during the application of the test voltage.

10.4.5 To provide information when specially requested, the wet flashover voltage of the insulator may be determined by increasing the voltage gradually from about 75 percent of the wet withstand voltage to reach the flashover voltage in not less than five seconds. The flashover voltage shall be the arithmetic mean of five consecutive readings and the value after correction to standard atmospheric conditions (see Appendix A) shall be recorded.

10.5 Verification of Dimensions — It shall be verified that the insulator unit is in accordance with the relevant drawings, particularly as regards any dimensions to which special tolerances apply (for example, spacing) and details affecting interchangeability (for example, ball and socket dimensions).

Unless otherwise specified, a tolerance of:

± (0.04 \( d \) + 1.5) mm when \( d \leq 300 \) mm

± (0.03 \( d \) + 6) mm when \( d > 300 \) mm

*Methods of high voltage testing: Part I General definitions and test requirements (first revision).
†Methods of high voltage testing: Part II Test procedures (first revision).
is allowed on all dimensions for which special tolerances do not apply ( \( d \) being the dimension in millimetres).

NOTE — Pending the publication of Indian Standard covering the spacing of string insulator units, the tolerance formula:

\[
\pm (0.03S + 0.3) \text{ mm}
\]

shall, unless otherwise specified, be applied to the spacing, where \( S \) is the spacing in millimetres.

**10.6 Temperature Cycle Test** — Insulators with their integral parts, if any, shall be quickly and completely immersed, without being placed in an intermediate container, in a water bath maintained at a temperature of 70°C higher than that of the cold bath used in the rest of the test and left submerged for 15 minutes. They shall then be withdrawn and quickly and completely immersed, without being placed in an intermediate container, in the cold water bath where they shall remain for 15 minutes. This heating and cooling cycle shall be performed three times in succession. The time taken to transfer from either bath to the other shall be as short as possible and never exceed 30 seconds.

The quantity of water in the test tanks shall be sufficiently large for the immersion of the insulators so as not to cause a temperature variation of more than ±5°C in the water.

On completion of the third cold cycle, the insulator shall be examined to verify that they have not cracked. Type A insulator shall then be subjected to the mechanical test prescribed in 10.14. Type B insulator shall be subjected for one minute to the power-frequency test prescribed in 10.15.

The insulators shall withstand the appropriate test without cracking or puncture or mechanical breakage.

NOTE 1 — For very large rigid insulators or string insulator units, the tests prescribed in 10.6 may be too severe and a test of reduced severity may then be applied by agreement between manufacturer and purchaser. For this purpose, very large rigid insulators or string insulator units shall be considered as those having one of the following dimensions:

- \( L \) greater than 120 cm
- \( D^2L \) greater than 80 000 cm²
- \( \phi \) greater than 2.5 cm
- \( d \) greater than 9 cm

\( L \) = length of insulator
\( D \) = greatest external diameter
\( \phi \) = the greatest thickness defined by the diameter of the greatest circle which can be inscribed within the outline of a section through the axis of the hollow insulator
\( d \) = core diameter for solid core insulator

NOTE 2 — The restriction against using an intermediate container does not exclude the use of a wire mesh basket having a low thermal capacity and giving free access for the water.

NOTE 3 — Also see IS : 5621-1970*.

*Specification for large hollow porcelains for use in electrical installation.
10.7 Electromechanical Failing Load Test (on Type B String Insulator Units Only)

10.7.1 This test shall be applied to string insulator units of such types where electrical discharge will serve to indicate mechanical failure. For other types, the insulators shall be submitted to the mechanical failing load test (see 10.8).

10.7.2 The insulator units shall be subjected individually to a power-frequency voltage and to a tensile load applied simultaneously between the metal parts.

10.7.3 For insulators with ball and socket couplings, the coupling pieces of the testing machine shall be in accordance with IS : 2486 (Part II)-1974*, as regards their essential dimensions.

10.7.4 The voltage shall be 50 percent to 60 percent of the specified wet power-frequency withstand voltage of the string insulator unit, and it shall be maintained at this value throughout the test.

10.7.5 The tensile load shall be gradually increased from a value of 75 percent of the specified electromechanical failing load until the specified electromechanical failing load is reached.

10.7.6 The insulator passes the test if the specified electromechanical failing load is reached, without puncture.

10.7.7 To provide information when specially requested, the load may be increased until the failing load as defined in 2.12 is reached and the value recorded.

10.8 Mechanical Failing Load Test

10.8.1 String Insulator Units

10.8.1.1 String insulator units of type A and those of type B to which the electromechanical failing load test (see 10.7) is not applicable shall be subjected individually to a tensile load applied between the metal parts.

10.8.1.2 For insulators with ball and socket couplings, the coupling pieces of the testing machine shall be in accordance with IS : 2486 (Part II)-1974*, as regards their essential dimensions.

10.8.1.3 The load shall be gradually increased from a value of 75 percent of the specified mechanical failing load until the specified mechanical failing load is reached.

10.8.1.4 The insulator passes the test if the specified mechanical failing load is reached.

*Specification for insulator fittings for overhead power lines of 3 3 kV and above: Part II Dimensional requirements (first revision).
10.8.1.5 To provide information when specially requested, the load may be increased until the failing load as defined in 2.13 is reached and the value recorded.

10.8.2 Rigid Insulators

10.8.2.1 Rigid insulators shall be mounted on a rigidly fixed pin capable of withstanding without appreciable deformation the loads to which it will be subjected during the test; insulators provided with integral metal fittings for mounting shall be mounted for test using these fittings. The insulator shall be subjected to a load equal to 75 percent of the specified mechanical failing load applied perpendicular to the axis of the insulator in the plane of the side groove by means of a wire rope encircling the side groove. The wire rope shall be such that localized stresses in the side groove of the insulator are avoided. If the insulator is provided with means of clamping the conductor, the load shall be applied to this clamp. The load shall be gradually increased until the specified mechanical failing load is reached.

10.8.2.2 The insulator passes the test if the specified mechanical failing load is reached.

10.8.2.3 To provide information when specially requested, the load may be increased until the failing load as defined in 2.13 is reached and the value recorded.

10.9 Twenty-four Hours Mechanical Test (for String Insulator Units only when Specified by Purchaser)

10.9.1 The insulator shall be subjected for 24 hours to a tensile load, applied axially which shall be two-thirds of the specified minimum failing load.

10.9.2 The insulator shall then pass the power-frequency routine test given in 10.15.

10.10 Puncture Test (for Insulators Type B Only)

10.10.0 The puncture test may be either a power-frequency puncture test or, by agreement between manufacturer and purchaser, an impulse overvoltage test.

10.10.1 Power-Frequency Puncture Test

10.10.1.1 The insulators, after having been cleaned and dried, shall be completely immersed in a tank containing a suitable insulating medium to prevent surface discharges on them. If the tank is made of metal, its dimensions shall be such that the shortest distance between any
part of the insulator and the side of the tank is not less than 1.5 times the
diameter of the largest insulator shed. The immersion medium shall be
at about room temperature.

10.10.1.2 The test voltage shall be applied between those parts which
normally have the operating voltage between them. During immersion
in the insulating medium, precautions shall be taken to avoid air pockets
under the sheds of the insulator.

10.10.1.3 The voltage shall be raised as rapidly as is consistent with
its value being indicated by the measuring instrument to the specified
puncture voltage. No puncture shall occur below the specified puncture
voltage.

10.10.1.4 To provide information when specially requested, the
voltage may then be raised until puncture occurs and the puncture
voltage is recorded.

NOTE — It is not possible to define exactly the properties of the immersion
medium, but one desirable property is a slight conductivity ( resistivity of the order of
$10^{-10} - 10^{-15}$ m)

10.10.2 Impulse Overvoltage Test

10.10.2.1 If this test is required, the details shall be agreed to
between the purchaser and the manufacturer.

10.11 Porosity Test

10.11.1 Porcelain fragments from the insulators or, by agreement, from
representative pieces of porcelain fired adjacent to them shall be
immersed in a 1 percent alcohol solution of fuchsin ( 1 g fuchsin in 100 g
methylated spirit ) under a pressure of not less than $15 \times 10^6$ N/m$^2$ for a
time such that the products of the test duration in hours and the test
pressure in N/m$^2$ is not less than $180 \times 10^6$.

10.11.2 The fragments shall then be removed from the solution, washed
dried and again broken.

10.11.3 Examination with the naked eye of the freshly broken surfaces
shall not reveal any dye penetration. Penetration into small cracks
formed during the initial breaking shall be neglected.

10.12 Galvanizing Test

10.12.1 This test comprises firstly 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 ( test by chemical
dissolution ). This second test is optional and shall be carried out only if
so agreed by the manufacturer and the purchaser.

10.12.2 The uniformity of zinc coating of galvanized metal fittings
shall satisfy the requirements given in IS : 2633-1972*.

*Methods of testing uniformity of coating on zinc coated articles (first revision).
10.43 Visual Examination Test

10.13.1 A visual examination shall be made on each insulator. The colour of the insulator shall approximate to the colour specified on the drawing. Some variation in the colour shade is permitted and shall not justify rejection of the insulator. The insulator shall be free from physical distortion of shape within tolerances specified.

The areas specified as glazed on the drawing shall be covered by a smooth hard glaze free from cracks and other defects prejudicial to satisfactory performance in service.

Out of those areas specified as glazed on the drawing, the total area not covered by glaze shall not exceed:

\[ 1 + \frac{DF}{2000} \text{cm}^3 \]

Also the area of any single glaze defect shall not exceed:

\[ 0.5 + \frac{DF}{20000} \text{cm}^2 \]

where

- \( D \) is the greatest diameter of the insulator, in centimetres.
- \( F \) is the creepage distance of the insulator, in centimetres.

10.14 Mechanical Routine Test (for String Insulator Unite only)

10.14.1 Type A string insulator units shall be subjected for at least 1 minute to a tensile load equal to 60 percent of the specified mechanical failing load.

10.14.2 Type B string insulator units shall be subjected for at least 10 seconds to a tensile load equal to 40 percent of the specified electro-mechanical failing load.

10.14.3 Insulators which break or whose metal parts are fractured or become detached during the test shall be rejected.

NOTE — Mechanical routine tests on Type A rigid insulators shall be made only by agreement between purchaser and manufacturer.

10.15 Electrical Routine Test (for Type B Insulators)

10.15.1 Type B string insulator units and rigid insulators shall be subjected to a power-frequency voltage. For string insulator units, the voltage shall be applied between the metal parts, but the normal metal work of interlinked insulators may be replaced by other suitable fittings.
10.15.2 Rigid insulators shall be placed head downwards in a tank containing water to a depth sufficient to cover the side conductor grooves, and the voltage shall be applied between the tank and water practically filling the pin hole or cavity of each insulator. Alternatively, metal electrodes may be used provided the electric stress in the porcelain is not reduced.

10.15.3 The test voltage shall be such as to produce frequent flashover (every few seconds).

10.15.4 The time of application of the test voltage shall be at least 5 consecutive minutes.

10.15.5 Insulators which puncture during the test shall be rejected.

NOTE 1 — This test should preferably be carried out after the mechanical routine test, in order to eliminate insulators which may have been partially damaged in the mechanical test.

NOTE 2 — For certain designs of rigid insulator Type B, it may not be possible to apply the test described above. By agreement between the purchaser and the manufacturer, the test on the assembled insulator may then be replaced by a test on the insulating parts before assembly.

APPENDIX A
(Clauses 3.2, 10.3.2, 10.3.5.1, 10.4.3 and 10.4.5)

CORRECTION OF TEST VOLTAGES FOR ATMOSPHERIC CONDITIONS

A-1. GENERAL

A-1.1 Variations in barometric pressure and in humidity of the atmosphere cause variation in the electric strength of the air and hence also in the withstand and flashover voltage of insulators exposed to the air; under-oil flashover and puncture strength, however, are not significantly affected by these changes.

A-2. CORRECTION FACTORS

A-2.1 When the atmospheric conditions in the neighbourhood of the insulator during the test differ from the reference conditions, adjustments should be made to certain of the test voltages by the application of the following correction factors in accordance with Table 4:

a) Correction factor for air density \( d \):

\[
d = \frac{0.289}{273 + t} \quad (\text{where } d \text{ lies between 0.95 to 1.05})
\]
where

\[ p = \text{atmospheric pressure in millibars, and} \]
\[ t = \text{temperature in degrees Celsius}. \]

For a wider range of density and for higher accuracy, instead of \( d \) the factor \( k \) shall be used as under. The values of \( k \) corresponding to factor \( d \) are given below:

<table>
<thead>
<tr>
<th>( d )</th>
<th>( k )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.70</td>
<td>0.72</td>
</tr>
<tr>
<td>0.75</td>
<td>0.77</td>
</tr>
<tr>
<td>0.80</td>
<td>0.82</td>
</tr>
<tr>
<td>0.85</td>
<td>0.86</td>
</tr>
<tr>
<td>0.90</td>
<td>0.91</td>
</tr>
<tr>
<td>0.95</td>
<td>0.95</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>1.05</td>
<td>1.05</td>
</tr>
<tr>
<td>1.10</td>
<td>1.09</td>
</tr>
<tr>
<td>1.15</td>
<td>1.13</td>
</tr>
</tbody>
</table>

**TABLE 4 CORRECTION OF VOLTAGES FOR ATMOSPHERIC CONDITIONS**  
(*Clause A-2.1*)

<table>
<thead>
<tr>
<th>TEST</th>
<th>ADJUSTMENT REQUIRED</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>10.2</td>
<td>Visible discharge test</td>
</tr>
<tr>
<td>10.3</td>
<td>Impulse voltage withstand test</td>
</tr>
<tr>
<td>10.3</td>
<td>Impulse voltage flashover test</td>
</tr>
<tr>
<td>10.4</td>
<td>Wet power-frequency voltage withstand test</td>
</tr>
<tr>
<td>10.4</td>
<td>Wet power-frequency voltage flashover test</td>
</tr>
<tr>
<td>10.10</td>
<td>Power-frequency puncture withstand test</td>
</tr>
</tbody>
</table>

b) Correction factor for humidity (\( h \)): Fig. 2 gives the absolute humidity values for wet and dry bulb temperatures (when the velocity of air over the wet bulb exceeds 3 m/s) for the standard atmospheric pressure of 1 013 millibars. For better accuracy, a correction should be applied to absolute humidity value obtained from Fig. 2 for any deviation of ambient atmospheric pressure from the standard value of 1 013 millibars. This correction should be obtained from Fig. 3 as follows.
Locate the point corresponding to the deviation of ambient atmospheric pressure from 1013 millibars on the left hand side of Fig. 3B and join it with right hand side top corner by a straight line. Then locate the point on the curve in Fig. 3A corresponding to the observed value of the difference of dry and wet bulb temperatures. Draw a vertical line through this point to intersect the straight line drawn in Fig. 3B. Read the correction to be applied to humidity from the right hand side of Fig. 3B corresponding to the point of intersection. This correction is positive for a positive deviation and negative for a negative deviation, from the standard atmospheric pressure.
FIG. 3 CORRECTION TO ABSOLUTE HUMIDITY FOR VARIATION IN PRESSURE

For the corrected value of absolute humidity thus obtained, the correction factor $h$ shall be determined from Fig. 4.
FIG. 4 HUMIDITY CORRECTION FACTOR

Curve a applies to power-frequency tests at approximately 50 Hz. Curve b applies to positive impulse tests. Curve c applies to negative impulse tests.
APPENDIX B
(Clauses 10.2, 10.3.1 and 10.4.1)
HIGH VOLTAGE TESTS

B 1. CONDITION OF THE INSULATORS

B-1.1 Before commencing the tests, the sample insulators shall be clean and dry and in thermal equilibrium with its surroundings (ambient medium).

B-2. METHODS OF SUPPORT

B-2.1 String Insulator Unit and Insulator String

B-2.1.1 The string insulator unit or insulator string shall be suspended vertically by means of an earthed wire rope or other suitable conductor from a supporting structure. The distance between the uppermost Point of the insulator metal work and the supporting structure shall be not less than 1 metre. No other object shall be nearer to the insulator than 1 metre or 1.5 times the length of the insulator string, whichever is the greater. A length of conductor in the form of a straight smooth metal rod or tube shall be attached to the lower integral fitting of the string insulator unit or insulator string so that it lies in a horizontal plane, and the distance from the lowest shed of a porcelain part to the upper surface of the conductor shall be as short as possible but greater than 0.5 times the diameter of the lowest insulator.

B-2.1.2 The diameter of the conductor shall be about 1.5 percent of the length of the string insulator unit or insulator string with a minimum of 25 mm.

B-2.1.3 The length of the conductor shall be at least 1.5 times that of the string insulator unit or insulator string, and it shall extend at least 1 metre on each side of the vertical axis.

B-2.1.4 Precautions shall be taken to avoid flashover from the ends of the conductor.

B-2.1.5 The test voltage shall be applied between the conductor and earth.

B-2.2 Rigid Insulator

B-2.2.1 The insulator shall be mounted on an earthed metallic vertical pin, with a smooth surface and a diameter not less than 16 mm. The pin shall be sufficiently long to ensure that the lowest edge of the insulator is at least 1 metre above the ground. No other object shall be nearer to the insulator than 1 metre or 1.5 times the height of the insulator, whichever is the greater.
B-2.2.2 A conductor not less than 5 mm diameter and extending in both directions at least twice the insulator height beyond the top shed shall be secured as nearly as possible horizontally in the side groove of the insulator by means of a metallic wire of about 1 mm diameter wrapped round the conductor for a distance approximately twice the diameter of the top shed and extending equally on each side of the insulator.

B-2.2.3 If the rigid insulator is provided with means of clamping, conductor shall be placed in the clamp.

B-2.2.4 The test voltage shall be applied between the conductor and earth.

NOTE — When to agreed, tests may also be made under conditions reproducing service conditions as closely as possible, taking account of all factors which may influence flashover voltage. Under these conditions, the characteristics may differ from the values measured using the standard methods of mounting.

B-3. TIME INTERVALS BETWEEN FLASHOVERS

B-3.1 The time intervals between consecutive flashovers shall be sufficient to avoid effects from the previous application of voltage in flashover or withstand tests.

B-4. MPULSE TESTS

B-4.1 The impulse tests shall be made in accordance with IS : 2071 (Parts I and II)-1974*.

B-4.2 The standard 1.2/50 impulse wave shall be used.

B-5. POWER-FREQUENCY TESTS

B-5.1 The power-frequency tests shall be made in accordance with IS : 2071 (Parts I and II)-1974*.

B-5.2 The test circuit shall be such that when the test object is short-circuited at the test voltage, the current is not less than 0.1 A if dry tests are to be made, and not less than 0.5 A if wet tests are to be made.

B-6. EXCESSIVE HUMIDITY

B-6.1 Precautions shall be taken to avoid condensation on the surface of the insulator, especially when the relative humidity is high. For example, the insulator shall be maintained at the ambient temperature of the test location for sufficient time for equilibrium to be reached before the test commences. Except by agreement between the manufacturer and the purchaser, tests shall not be made if the relative humidity exceeds 85 percent.

*Methods of high voltage testing:
Part I General definitions and test requirements (first revision).
Part II Test procedures (first revision).
APPENDIX C
(Clauses 10.1.2.1 and 10.1.2.3)

SAMPLING PROCEDURE

C-1. SAMPLE SIZE

C-1.1 The number of insulators to be selected at random from the lot shall be in accordance with col 1 and 2 of Table 5. If required (see C-2) additional insulators as given in col 3 of Table 5 shall also be selected at random.

<table>
<thead>
<tr>
<th>LOT SIZE</th>
<th>FIRST SAMPLE SIZE</th>
<th>SECOND SAMPLE SIZE</th>
<th>ACCEPTANCE NUMBER</th>
<th>REJECTION NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>N</td>
<td>( n_1 )</td>
<td>( n_2 )</td>
<td>( c_1 )</td>
<td>( c_2 )</td>
</tr>
<tr>
<td>101 to 500</td>
<td>5</td>
<td>10</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>501 ( \text{\textasciitilde} ) 800</td>
<td>7</td>
<td>14</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>801 ( \text{\textasciitilde} ) 1300</td>
<td>10</td>
<td>20</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>1 301 ( \text{\textasciitilde} ) 3 200</td>
<td>15</td>
<td>30</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>3 201 ( \text{\textasciitilde} ) 8 000</td>
<td>25</td>
<td>50</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>8 001 and above</td>
<td>35</td>
<td>70</td>
<td>2</td>
<td>7</td>
</tr>
</tbody>
</table>

C-1.2 All the insulators selected as in C-1.1 shall be subjected to the appropriate acceptance tests.

C-2. CRITERION OF CONFORMITY

C-2.1 The lot shall be considered as conforming to the requirements of the acceptance tests if the number of failures found in the first sample \( n_1 \) is less than or equal to \( c_1 \). If the number of failures is greater than or equal to \( c_2 \), the lot shall be considered as not conforming to the requirements of the acceptance tests and shall be rejected. If the number of failures is between \( c_1 \) and \( c_2 \), and a second sample of \( n_2 \) insulators shall be selected and subjected to acceptance tests. If the number of failures in the two samples combined is less than \( c_2 \), the lot shall be considered as conforming to the requirements of acceptance tests otherwise it shall be considered to have failed.
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Printed at New India Printing Press, Khurja, India