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SPECIFICATION FOR PORCELAIN INSULATORS FOR OVERHEAD POWER LINES (BELOW 1 000 V)

ලංකා ප්‍රමිති කාර්යාංශය
BUREAU OF CEYLON STANDARDS

SRI LANKA STANDARD SPECIFICATION FOR PORCELAIN INSULATORS FOR OVERHEAD POWER LINES (BELOW 1 000 V)

SLS 346 : 1975

Gr. 8

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Sri Lanka Standards are subject to periodical revision in order to accommodate the progress made by industry. Suggestions for improvement will be recorded and brought to the notice of the Committees to which the revisions are entrusted.

This Standard does not purport to include all the necessary provisions of a contract.

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SRI LANKA STANDARD SPECIFICATION FOR PORCELAIN INSULATORS FOR OVERHEAD POWER LINES (BELOW 1 000 V)

FOREWORD

This Sri Lanka Standard Specification for Porcelain Insulators for Overhead Power Lines (below 1 000 V) has been prepared by the Drafting Committee on Porcelain Insulators. It was approved by the Electrical Engineering Divisional Committee of the Bureau of Ceylon Standards and was authorised for adoption and publication by the Council of the Bureau on 1975-04-02.

This standard is confined to shackle type insulators which are commonly used for overhead power lines. Pin insulators used for telegraph and telephone lines are covered by a separate standard.

Standard dimensions have been given in the International System (SI) in view of the future changeover to this system.

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 CS 102:1971.* The number of significant places to be retained in the rounded off value shall be the same as that of the specified value in this standard.

The publications of the International Electrotechnical Commission, Indian Standards Institution and British Standards Institution were consulted in the preparation of this standard, and the assistance gained therefrom is hereby acknowledged.

1. SCOPE

This standard applies to porcelain insulators for overhead power lines designed for voltages below 1 000 V. This standard covers only shackle-type insulators.

2 DEFINITIONS

For the purposes of this Sri Lanka Standard the following definitions shall apply:

*CS 102:1971 – Presentation of Numerical Values.

2·1 **Shackle insulator**—An insulator consisting of one porcelain part and intended to be mounted vertically or horizontally between and in contact with the two ends of 'U' strap or a pair of straps and used to secure a line conductor in tension. The term excludes the 'U' strap or other straps for attaching the insulator to a supporting structure.

2·2 **Lot of Insulators**—Insulators of the same type and design belonging to one batch of manufacture offered for acceptance.

2·3 **Flashover**—A disruptive discharge external to the insulator, connecting these parts which normally have the operating voltage between them.

2·4 **Puncture**—A local or total destruction of the insulating material caused by a discharge passing through it.

Note: A fragment breaking away from the rim of shed or damage to the insulator due to the heat of a surface discharge shall not be considered a puncture.

2·5 **Dry or wet power frequency flashover voltage**—The mean value of the measured power frequency voltages which cause flashover of the insulator under the conditions prescribed in Clauses 7·2·4 and 7·2·5 respectively.

2·6 **Dry or wet power-frequency withstand voltage**—The power frequency voltage which the insulator shall withstand, dry or wet under the conditions prescribed in Clauses 7·2·4 and 7·2·5 respectively for the specified time without flashover or puncture.

2·7 **Failing Load**—The greatest mechanical load which shall be applied to the insulator under the test conditions prescribed under Clause 7·2·7.

2·8 **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.

2·9 **Acceptance tests**—Tests carried out on samples taken from a lot for the purpose of acceptance of the lot.

2·10 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 are to be expressed for the purpose of comparison shall be as given below:

Ambient temperature	20°C
Barometric pressure	101·3 kPa (760 mm Hg)
Absolute humidity	11 g of water per cubic metre

Note: The above atmospheric conditions are only reference conditions for purposes of comparison and they are not expected to be conditions in which tests are carried out nor necessarily those in which the insulators are expected to be used.

3·2 Tests for the purpose of this standard shall preferably be carried out at a temperature of 29±2°C and humidity 75±5 per cent and at the prevailing atmospheric pressure.

4. GENERAL REQUIREMENTS

4·1 The porcelain shall be sound, free from defects, throughly vitrified and smoothly glazed.

4·2 The design of the insulator shall be such that the stresses due to expansion and contraction in any part of the insulator shall not lead to its deterioration.

4·3 All surfaces of the insulators shall be efficiently glazed except for the points on which the porcelain is supported during firing, which may be left unglazed.

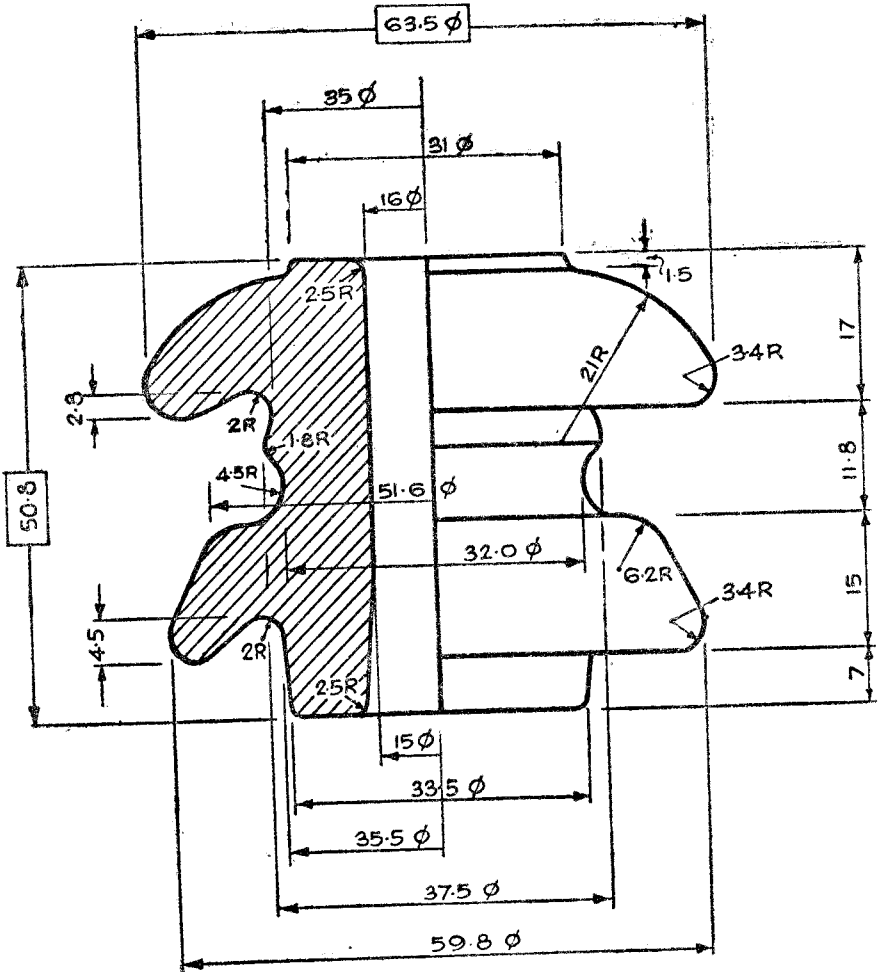
4·4 The insulators shall be in one piece.

5 DIMENSIONS

5·1 The Figures 1 and 2 illustrate the general shapes of the insulators covered by this specification.

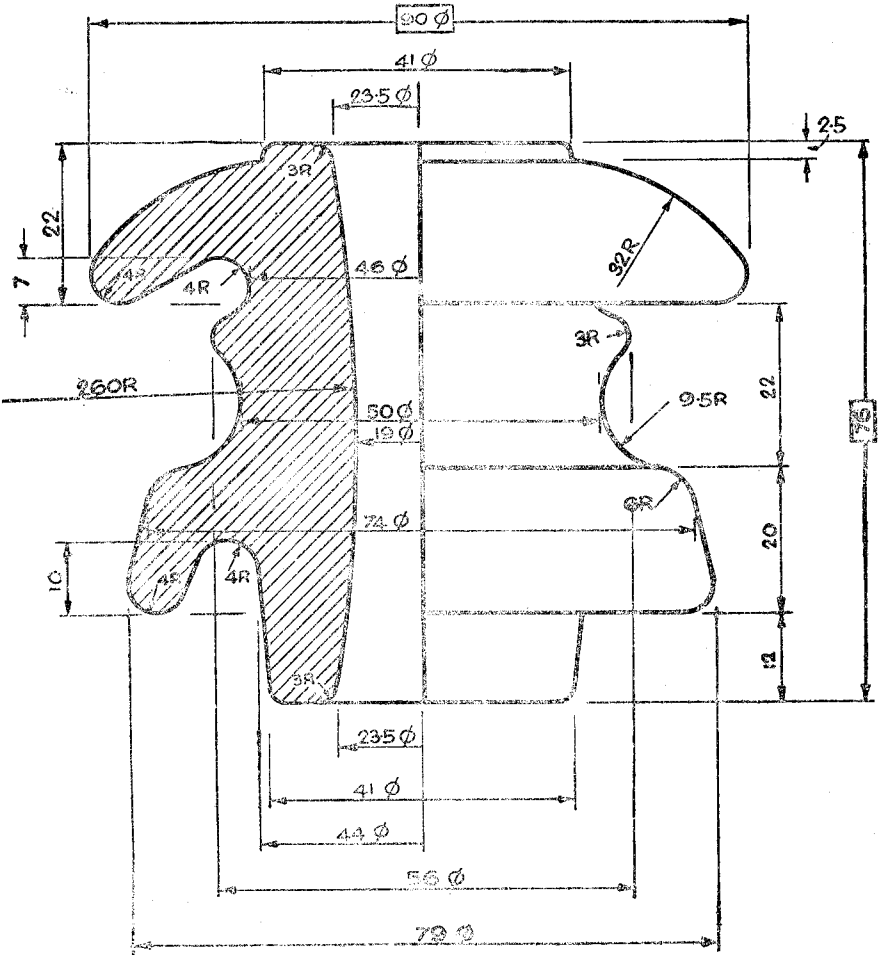
5·2 The insulators shall comply with the dimensions given in Figures 1 and 2.

5·2·1 In Figures 1 and 2 the enclosed dimensions are mandatory. Other dimensions of profile are given for guidance. Insulators having different non-mandatory dimensions and profile shall be acceptable provided they conform to this standard in all other respects.



All dimensions in millimetres

Fig. 1. Shackle Insulator – Type 1



All dimensions in millimetres

Fig. 2. Shackle Insulator—Type 2.

6. INSULATOR CHARACTERISTICS

Insulators shall have the electrical and mechanical charheteristics given in Table 1.

TABLE 1-CHARACTERISTICS OF INSULATORS

Dry one minute power frequency withstand voltage kV (rms)	Wet one minute power frequency withstand voltage kV (rms)	Power frequency puncture withstand voltage kV (rms)	Minimum failing load kN (kgf)
23	10	1·3 x the actual dry flashover voltage	11 (1122) – Type 1 16 (1632) – Type 2

7. TESTS

7·1 Type tests

The following shall be carried out as type tests on selected samples of insulators drawn preferably at random from a regular production lot.

(a) Visual examination (Clause 7·2·1).

(b) Verification of dimensions (Clause 7·2·2).

(c) Temperature cycle test (Clause 7·2·3).

(d) Dry one minute power frequency withstand test and dry flashover test (Clause 7·2·4).

(e) Wet one-minute power frequency withstand test and wet flashover test (Clause 7·2·5).

(f) Power frequency puncture withstand test (Clause 7·2·6).

(g) Mechanical failing load test (Clause 7·2·7).

(h) Porosity test (Clause 7·2·8).

7·1·1 The number of insulators to be subjected to type tests shall be 6. All samples shall be subjected to the tests (a), (b), and (c). The 6 samples shall then be divided into two groups of 3 samples each. The tests (d), (e) and (f) shall be carried out on all 3 samples of one group. The tests (g) and (h) shall be carried out on all the samples in the other group.

7·1·1·1 **Criteria for Acceptance**–All samples subjected to these type tests shall pass all the tests for proving conformity with the requirements of this standard.

7·1·2 **Acceptance Tests**–The following shall constitute acceptanc tests:

(a) Verification of dimensions

(b) Temperature Cycle test

(c) Porosity test

Samples drawn as described in Clause 7·1·4 shall be subjected to the above tests in the order given after having subjected them to the routine test.

7·1·3 **Routine Test**–A visual examination for defects described in Clause 7·2·1 shall be made on all insulators.

7·1·4 **Sampling for Acceptance**

7·1·4·1 The number of insulators for sample tests shall be selected at random from the lot in accordance with Table 2. If required (see Clause 7·1·5) additional insulators shall also be selected at random.

TABLE 2–NUMBER OF INSULATORS TO BE SELECTED

Lot size (1)	Sample size of insulators (2)
up to 500	To be agreed between the purchaser and the supplier.
501 to 800	12
801 to 3200	16
3201 to 8000	18
8001 and above	20

7·1·5 Re-test and Rejection

7·1·5·1 If only one insulator fails to comply with any one of the tests given in Clauses 7·2·2, 7·2·3, and 7·2·8 a fresh quantity equal to twice the first quantity shall be subjected to re-testing. The re-testing shall comprise the test in which failure occured preceded by those tests which may be considered to have influenced the results of the original tests. If no failure occurs, the lot shall be accepted.

7·1·5·2 If two or more insulators fail to comply with any of the tests given in Clauses 7·2·2, 7·2·3, and 7·2·8 or if any failure occurs on insulators subjected to re-testing described in Clause 7·1·5·1, the complete lot shall be withdrawn for further examination by the manufacturer after which the lot or any part thereof may be re submitted for tests.

The number then selected shall be three times the first quantity chosen for test. This re testing shall comprise the test in which the failure occured preceded by those tests which may be considered to have influenced the results of the original tests.

If any failure occurs, the lot shall be rejected.

7·1·5·3 No part of the lot withdrawn as described in Clause 7·1·5·2 shall constitute part of any other lot submitted for the first time.

7·2 Methods of Test

7·2·1 Visual Examination–This test shall apply to all insulators. A visual examination of the insulator shall be made. The insulator shall be free from physical distortion of shape, and the vitrified glaze shall be hard and smooth, free from cracks or any other defect likely to be prejudicial to the satisfactory performance in service.

7·2·2 Verification of Dimensions

7·2·2·1 It shall be verified that the insulator is in accordance with the relevant drawings. Unless otherwise agreed by the customer and the supplier, a tolerance of $\pm (0{\cdot}04d + 1{\cdot}5)$ mm shall be allowed for all dimensions in millimetres. d is the dimension measured.

7·2·2·2 If one or more insulators fail to comply with this test, a re-test in accordance with Clause 7·1·5 shall be made.

7·2·3 Temperature Cycle Test

7·2·3·1 The shackle insulators should be without 'U' straps. The insulators shall be quickly and completely immersed in a water bath maintained at a temperature of 70°C above that of the cold water and left submerged for a period of 15 minutes. They shall then be withdrawn and quickly and completely immersed, without being placed in an intermediate container, in a bath of cold water for the same period of 15 minutes.

7·2·3·2 The complete test shall comprise five transfers: cold to hot, hot to cold, cold to hot, hot to cold, cold to hot. The time taken to transfer the insulators from one bath to the other shall be as possible and shall not exceed 30 seconds. The quantity of water in the test tanks shall be large enough not to cause a temporary variation of more than 5°C in the water, when the insulators are immersed.

7·2·3·3 After the completion of the immersion, the insulator shall be examined to verify that the insulating parts have not cracked and that the glaze is undamaged.

7·2·3·4 If one or more insulators fail to comply with this test, a re-test in accordance with Clause 7·1·5 shall be made.

7·2·4 Dry one minute power frequency withstand test and dry flashover test

7·2·4·1 The insulator shall be tested under the conditions prescribed in Appendix B.

7·2·4·2 The value of the test voltage shall be as specified in Table 1, taking into account the atmospheric conditions (see Appendix A).

7·2·4·3 A voltage equal to half the test voltage shall be applied and then increased to reach the test voltage in a time not less than 10 seconds. The test voltage shall be maintained at this value for one minute. The insulator shall not flashover or puncture during the one-minute test.

7·2·4·4 A voltage equal to 75 per cent of the dry one minute test voltage shall then be applied and increased at a constant rate till flashover occurs, in 5 to 30 seconds. The dry flashover voltage shall be the arithmetic mean of 10 consecutive readings, and the value after correction to reference standard atmospheric conditions (see Appendix A) shall be recorded.

7·2·5 Wet one minute power frequency withstand test and wet flashover test

7·2·5·1 The insulator shall be tested under the conditions prescribed in Appendix B.

7·2·5·2 Before the commencement of the test the insulator shall be exposed to artificial rain with the following characteristics:

Precipitation rate	–	3 millimetres/minute
Vertical component		
Tolerance	–	± 10 per cent
Direction	–	about 45° to the vertica
Water resistivity	–	10 000 ohm cm
Tolerance	–	± 10 per cent
Water temperature	–	Not differing by more than 10°C from that of the insulator.

The artificial rain which may be produced in accordance with Appendix D shall be maintained throughout the test, and the test voltage shall be applied as indicated below.

7·2·5·3 The value of the test voltage shall be as specified in Table 1 taking into account the atmospheric conditions (see Appendix A).

7·2·5·4 A voltage equal to half the test voltage shall be applied and then increased at a constant rate to reach the test voltage in a time not less than 10 seconds. The test voltage shall be maintained at this value for one minute. The insulator shall not flashover or puncture during the test.

7·2·5·5 A voltage equal to 75 per cent of the wet one minute test voltage shall then be applied and increased at a constant rate until flashover occurs in from 5 to 30 seconds. The wet flash over voltage shall be the arithmetic mean of 10 consecutive readings, and the values after correction to reference standard atmospheric conditions (see Appendix A) shall be recorded.

7·2·6 Power frequency puncture withstand test

7·2·6·1 The insulator shall be tested under the conditions prescribed in Appendix B.

7·2·6·2 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 be 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 test voltage shall be applied between a metallic spindle passing through the insulator packed with metal wool, foil, or other conducting material to establish intimate contact throughout the spindle hole and a suitable electrode in intimate contact with the surfaces of the conductor groove.

7·2·6·3 During immersion in the insulating fluid, precaution shall be taken to avoid air pockets under insulator sheds. The voltage shall be increased rapidly to the specified dry one-minute power frequency test voltage and then steadily increased at a rate of about 1000 volts per second until the minimum specified puncture withstand voltage is reached. No puncture shall occur at this voltage in the minimum time necessary to measure it.

7·2·7 **Mechanical Failing Load Test**

7·2·7·1 The shackle insulator shall be mounted between close fitting parallel straps using a special through bolt of the same diameter as that for which the insulator is designed. The straps shall be attached to a metal bracket on the testing machine. The insulator shall then be subjected to a load equal to one half of the specified mechanical failing load, the load being applied in the plane of the external conductor groove by means of a loop of flexible wire rope with a diameter not exceeding the radius of the conductor groove.

This load shall be steadily increased at a rate of about 20 per cent of the specified mechanical failing load per minute until breakage occurs

7·2·7·2 Breakage shall not occur at a load less than the minimum failing load given in Table 1.

7·2·8 Porosity test

7·2·8·1 Freshly broken porcelain fragments from the insulators, 50 per cent of the surface area free of glaze shall be immersed in one per cent alchoholic solution of fuchsin (1 g fuchsin in 100g of menthenol) under a pressure of not less than 15MPa for a time such that the product of the test duration in hours and the test pressure in MPa is not less than 180.

7·2·8·2 The fragments shall then be removed from the solution washed, dried and broken. Examination with naked eye of the freshly broken surface shall not reveal any dye penetration. Penetration into small cracks formed during the initial breaking shall be neglected.

7·2·8·3 If one or more insulators fail to comply with this test, a re test in accordance with Clause 7·1·5 shall be made.

APPENDIX A

(Clauses 3·2, 7·2·4·2, 7·2·4·4, 7·2·5·3 and 7·2·5·5)

CORRECTION OF TEST VOLTAGES FOR ATMOSPHERIC CONDITIONS

A–1 General

A–1·1 Variations in barometric pressure and air humidity of the atmosphere cause variation in the electric strength of the air and hence also in the 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 A-1.

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

$$d = \frac{2 \cdot 89\ p}{273 + t}$$

where

p = atmospheric pressure in kN/m^2, and

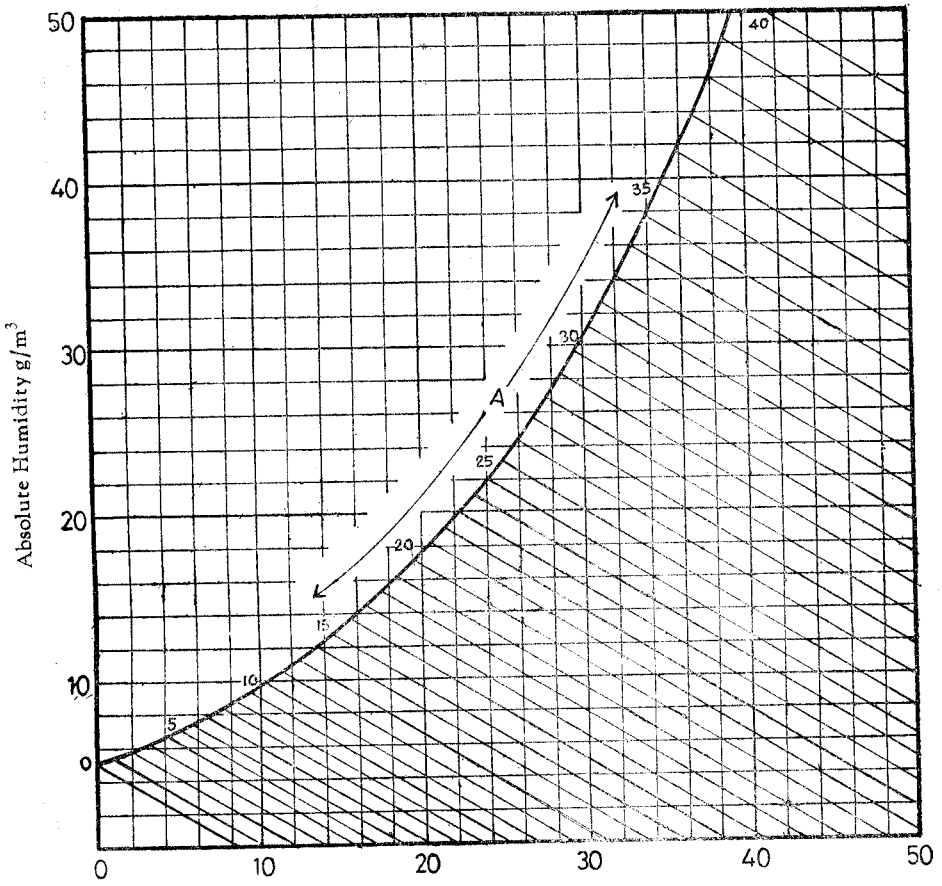
t = temperature in degrees Celsius

The above formula gives an accurate value for the correction factor only for values of d between 0·95 and 1·05. For a wider range of d, and for higher accuracy, instead of d, the factor k shall be used. The values of k corresponding to factor d are given below:

d	k
0·70	0·72
0·75	0·77
0·80	0·82
0·85	0·86
0·90	0·91
0·95	0·95
1·00	1·00
1·05	1·05
1·10	1·09
1·15	1·13

(b) Correction factor for humidity (h) Fig. A-1 gives the absolute humidity value for wet and dry bulb temperatures (when the velocity of air over the wet bulb exceeds 3 metres per second) for the standard atmospheric pressure of 101·3 kPa. For better

accuracy a correction should be applied to absolute humidity value obtained from Fig. A-1 for any deviation of ambient atmospheric pressure from the standard value of 101·3kPa. This correction should be obtained from Figs. A-2 and A-3 as follows.



Dry Bulb Thermometer Reading °C
A=Wet bulb thermometer reading °C

Fig. A – 1. Determination of absolute humidity

Locate the point corresponding to the deviation of ambient atmospheric pressure from 101·3 kPa on the left hand side of Fig. A–3 and join it with right hand side top corner by a straight line Then locate the point on the curve in Fig. A–2 corresponding to the observed value of the difference of dry and wet bulb temperature Draw a vertical line through this point to intersect the straight line drawn in Fig. A–3. Read the correction to be applied to humidity from the right hand side of Fig. A–3, corresponding to the point of intersection. This correction is positive for a positive deviation and negative for negative deviation from the standard atmospheric pressure.

For the corrected value of absolute humidity thus obtained, the correction factor h of Table A–1 shall be determined from Fig A–4.

TABLE A–1–CORRECTION OF VOLTAGES FOR ATMOSPHERIC CONDITIONS

(Clause A–2·1)

Test	Adjustment Required
Dry one minute power frequency withstand test. Dry–power frequency flashover test	Voltage applied shall be the appropriate value specified in Table 1 multiplied by k and divided by h.
Wet one minute power-frequency withstand test.	Measured voltage shall be divided by k and multiplied by h
Wet power-frequency flashover test.	Voltage applied shall be the appropriate value specified in Table 1 multiplied by k.
Power-frequency puncture withstand test.	Measured voltage shall be divided by k.
	No adjustment required.

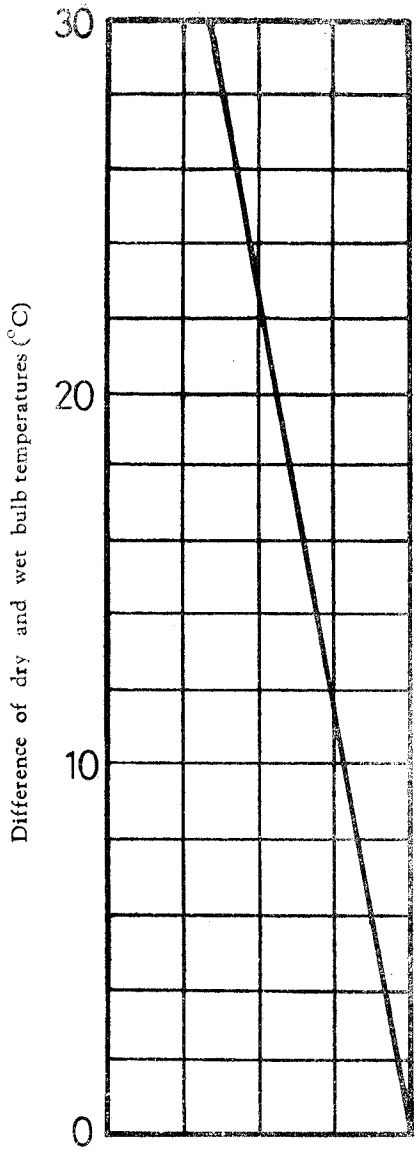
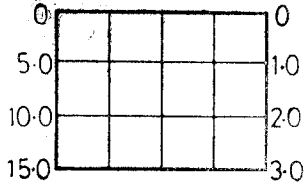


Fig. A—2



Deviation of ambient atmospheric pressure from standard pressure (Pa)

Fig. A—3

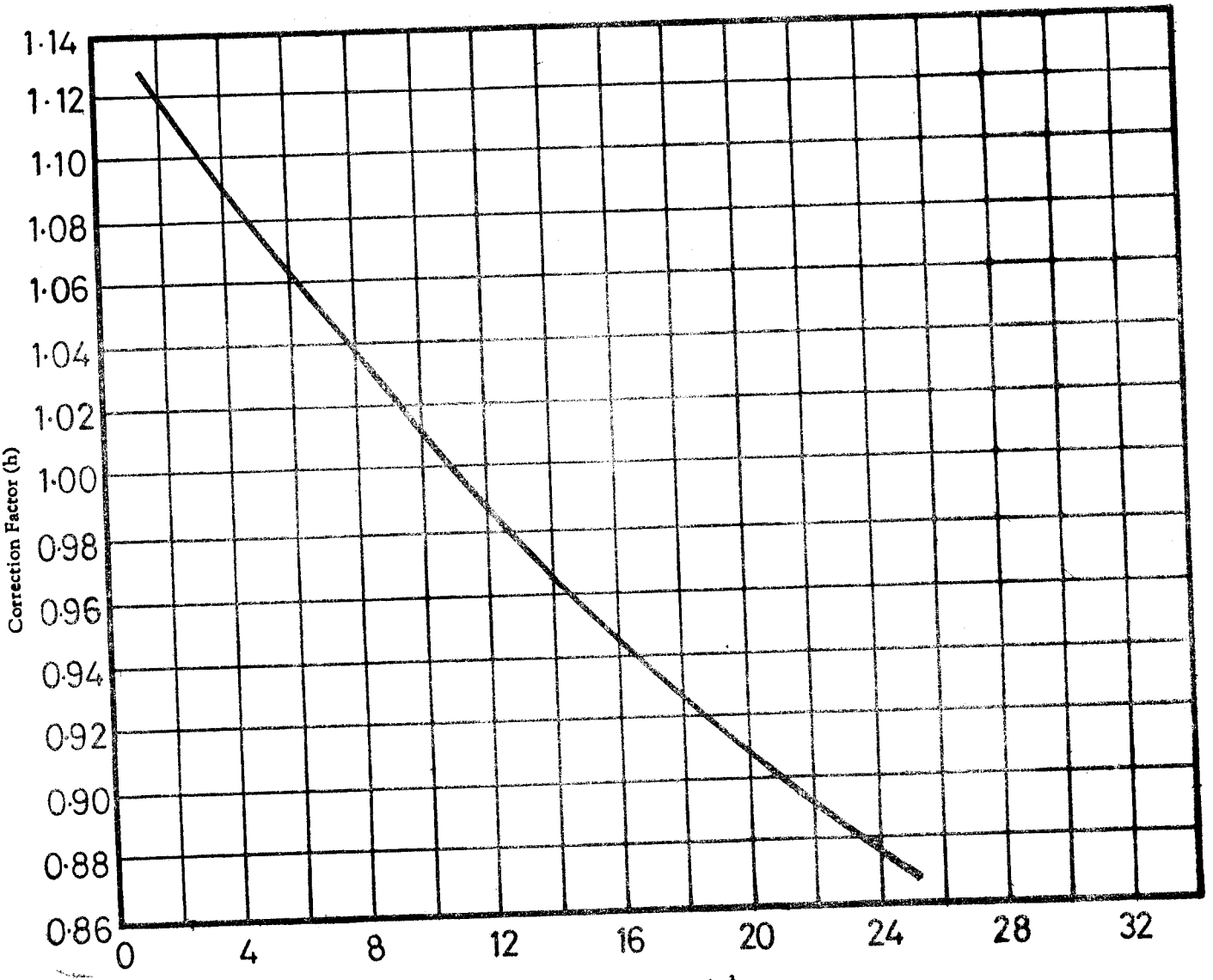


Fig. A – 4 – Humidity Correction Factor

APPENDIX-B

(Clauses 7·2·4·1, 7·2·5·1, and 7·2·6·1)

HIGH VOLTAGE TEST

B-1 Arrangement of Insulator

B-1·1 The insulator shall be clean and dry and in thermal equilibrium with its surroundings.

B-1·2 The insulator shall be mounted vertically between and in contact with two smooth metallic straps 40 mm wide and of any suitable thickness. A bolt of suitable diameter shall pass through the axial hole of the insulator and one end of each of the straps. The straps shall extend in one direction from the bolt and shall remain parallel for a distance from the test specimen of not less than the height of the specimen. The other ends of the straps shall be suitably connected to a grounded support.

B-1·3 The live electrode shall consist of one turn of 3·25 mm conductor placed around the wire groove and served back on itself. This conductor shall be carried away from the test specimen parallel and in an opposite direction to the supporting straps. The test terminals shall be attached to the end of the conductor.

B-2 Power Frequency Tests

B-2·1 The power frequency tests shall be made in accordance with Appendix C.

B-2·1·1 The transformer test circuit shall be such that when the test object is short circuited at the test voltage the current is not less than 0·1A if dry tests are to be made, and not less than 0·5A if wet tests are to be made.

B-3 Excessive Humidity

B-3·1 Precautions shall be taken to avoid formation of dew on the surfaces of the insulator especially when the relative humidity is high (above 85 percent). For example, the insulator should be maintained at the ambient temperature of the test location for sufficient time for equilibrium to be reached before the test commences.

APPENDIX-C

ALTERNATING VOLTAGE

C-1 Characteristics of Alternating Voltage

C-1·1 The alternating voltage used in high voltage testing is characterised by:

(a) frequency,

(b) peak value,

(c) r.m.s. value and

(d) shape of the voltage (wave form).

C-2 Explanation of Terms

C-2·1 **Peak value**-The maximum value of the alternating voltage; but it excludes small high frequency oscillations arising, for instance, from partial discharges in the circuit.

C-2·2 **R.M.S. Value**-The square root of the mean of the square of the voltage during a complete cycle of the alternating voltage.

C-2·3 **Value of alternating test voltage**-The value defined by its peak value (see Clause C 2·1) divided by $\sqrt{2}$.

C-2·4 **Residue curve**-A wave form curve representing only the harmonics in a voltage wave obtained by eliminating the fundamental wave.

C-3 Requirements of Alternating Test Voltage

C-3·1 The test voltage should be an alternating voltage having a frequency in the range of 40 to 60 Hz. Its form shall approximate to a sine curve and have both half cycles reasonably alike. The extent of the deviation from a sine curve, while, under consideration, is provisionally considered acceptable if one of the following conditions is satisfied. For each procedure two values are given; the higher may be considered acceptable but the lower is desirable and should be aimed at in specifying new test equipment:

(a) The ratio peak r.m.s. is equal to $\sqrt{2} \pm 7$ per cent, alternatively $\sqrt{2} \pm 4$ per cent.

(b) Peak value of the residual is not more than 10 per cent, alternatively 5 per cent of the peak value of the actual wave;

(c) R.M.S. value of the residual is not more than 10 per cent alternatively 5 per cent of the r.m.s. value of the actual wave;

(d) Maximum difference between the actual wave form and a sinusoidal curve of the same frequency and peak value is less than 10 per cent, alternatively 5 per cent of this peak value when the two curves are superimposed in such a way as to make this difference as small as possible.

C-4 Measurement of Alternating Test Voltage

C-4·1 Measurement with approved devices-The alternating test voltage value and the deviation from a sine wave should be measured with a device which satisfies the requirements for 'approved measuring devices' described in IEC Publication 60*.

C-4·2 Measurement with Sphere-Gap-The measurement of the peak value of the test voltage may also be made with a sphere-gap. The procedure usually consists in establishing a relation between the spacing at which disruptive discharge occurs and some other circuit variable related to the test voltage.

C-4·2·1 If this relation is dependent on the presence of the test object, the sphere-gap, the precipitation in wet test, etc, it is important that the conditions are the same during the calibration and the actual test.

C-4·2·2 The calibration is preferably made at 100 per cent of the test voltage but if necessary, extrapolation may be made from a value not less than 80 per cent of the test

*IEC 60-High Voltage Test Techniques.

voltage. Extrapolation may be unsatisfactory if the current of the test circuit is not proportional to voltage or if modifications have occured in the voltage shape or frequency at 100 per cent test voltage.

C-4·2·3 The measurement by sphere-gap shall be made in accordance with IEC publication 52*.

C-5 Test Procedure

C-5·1 **General**-The voltage should be applied to the test object starting at a value low enough to prevent overvoltages due to switching transients. It should be raised sufficiently slowly to permit accurate reading of the measuring instrument but not slowly as to cause unnecessary prolongation of the stress of the test object near the test voltage. These requirements are in general met if the rate of rise above 75 per cent of the estimated final test voltage is about 2 per cent per second of this voltage.

C-5·2 **Withstand test**-The test voltage should be raised to the specified value in the manner described in Clause C 5·1. It should be maintained for the specified time and then rapidly decreased but not suddenly interrupted so as to avoid the possibility of switching transients which may affect the test results. The test is generally satisfactory if no disruptive discharge occurs on the test object.

APPENDIX-D

GENERAL REQUIREMENTS CONCERNING TEST PROCEDURE AND TEST OBJECT

D-1 **Arrangement of the test object** – If the clearance to extraneous structures is at least 1·5 times the flashover distance between the electrodes of the test object, the effect of such structures on the disruptive discharge voltage of the test object will usually be small. For test objects on which the voltage distribution is sufficiently independent of the effect of neighbouring objects, the clearances may be reduced. In order to prevent flashover to these structures, however, it may be necessary to make this clearance greater than the minimum value given above.

*IEC 52 – Recommendations for voltage measurement by means of sphere gaps (one sphere earthed)

D-2 Dry tests-The test object shall be tested at the ambient temperature and the test object shall be dry and clean.

D-3 Wet tests

D-3·1 General-It is generally recognised that wet tests are not intended to reproduce actual operating conditions but to provide a criterion based on accumulated experience that satisfactory service operation will be obtained. The test should give re-producible results in the same and in different laboratories.

D-3·2 Test procedures-The test object shall be subjected to a spray of water of prescribed resistivity provided by a nozzle so located as to comply with Clause D-1. The spray consisting of small drops shall fall on the test object at an angle of approximately 45° to the vertical as determined by visual obsevatrion or by measurements of the vertical and horizontal components of the precipitation rate.

D-3·2·1 The vertical component of the spray shall be measured with a collecting vessel having a horizontal opening of area 100 to 750 cm^2; when both the vertical and horizontal components are required the horizontal component shall be measured with a collecting vessel having a similar vertical opening directed towards the nozzles. The collecting vessel should be located on the side of the test object facing the nozzles and as close to the test object as is possible without collecting splashes from it.

D-3·2·2 For test objects of length greater than 0·50 m measurements of the rate of precipitation shall be made near the ends and the middle, and the values obtained for any one position shall not differ by more than 25 per cent from the average for the three positions; for test objects of 0·50 m length or less the measurement shall be made near the middle only.

D-3·2·3 The test object should be sprayed for at least one minute before the application of voltage. Alternatively, more consistent results may be obtained if the test object is thoroughly wetted with water of the prescribed resistivity and the temperature before the application of voltage.

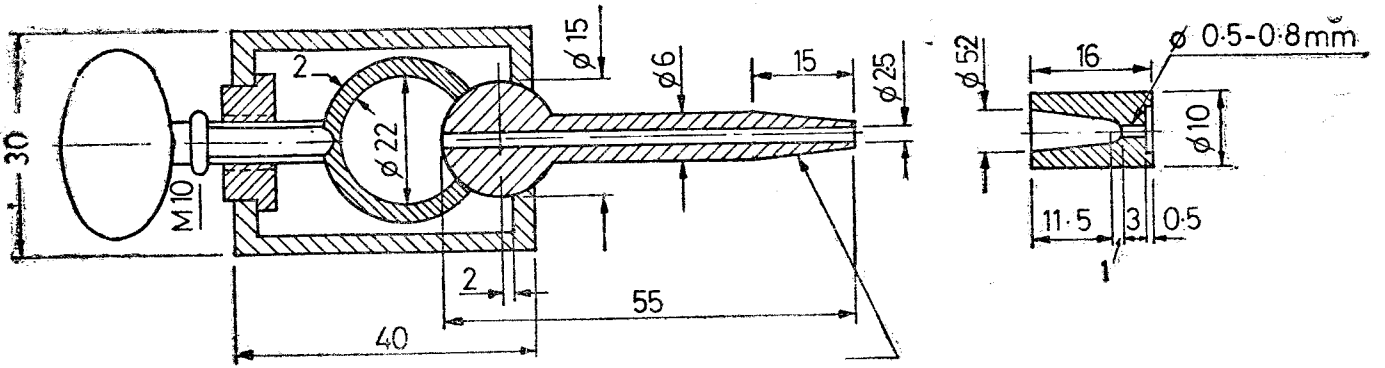
D-4 Types of nozzle and water pressure

D-4·1 Typical nozzles used for producing spray are given in Figures D-1. a, D-1. b, and D-1. c.

D-4·2 The length of the jet of water depends on the diameter of the capillary and the water pressure. Practical values for guidance are given below, in Table D-1.

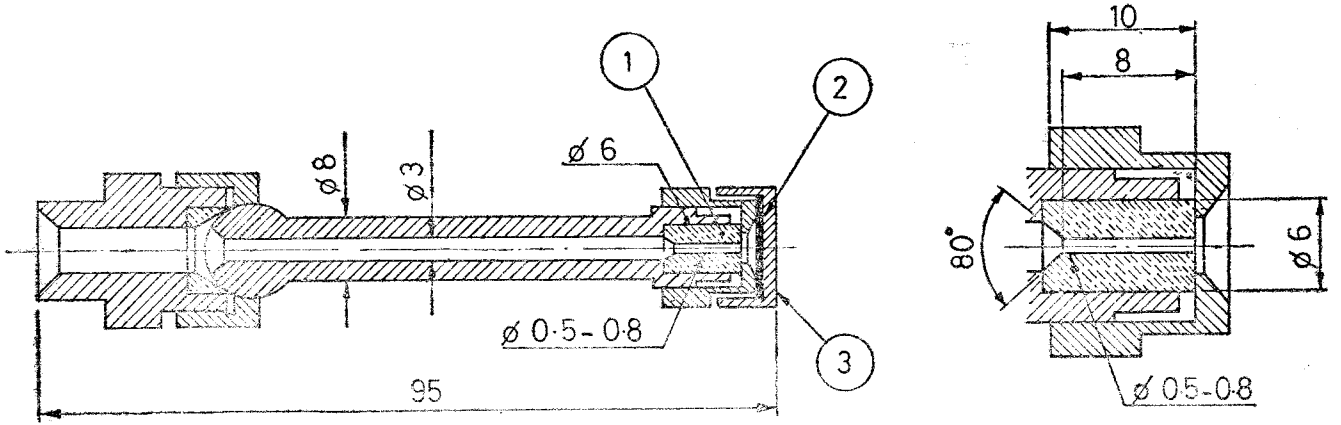
Type of Nozzle	Diameter of the Capillary mm	*Water Pressure above Atmosphere MPa (kgf/cm²)	Length of water jet m	Approximate Maximum Testing Voltage kV (r.m.s)
Fig. D-1 a,b	0·5	0·1 (1)	4	650
Fig D-1 a,b	0·5	0·2 (2)	5	800
Fig. D-1 a,b	0·5	0·3 (3)	6	950
Fig. D-1 a,b	0·8	0·4 (4)	7	1100
Fig. D-1 c	1·5	0·25-0·45 (2·5-4·5)	2-3	—

* The water pressure has to be measured in front of the branch connection to the nozzles.



Con. 12%

Fig. D—1·a



All dimensions in millimetres

1. Mouthpiece of plastic to reduce the risk of blocking by dirt. 2. Rubber 3. Covet to block water

Fig. D—1·b

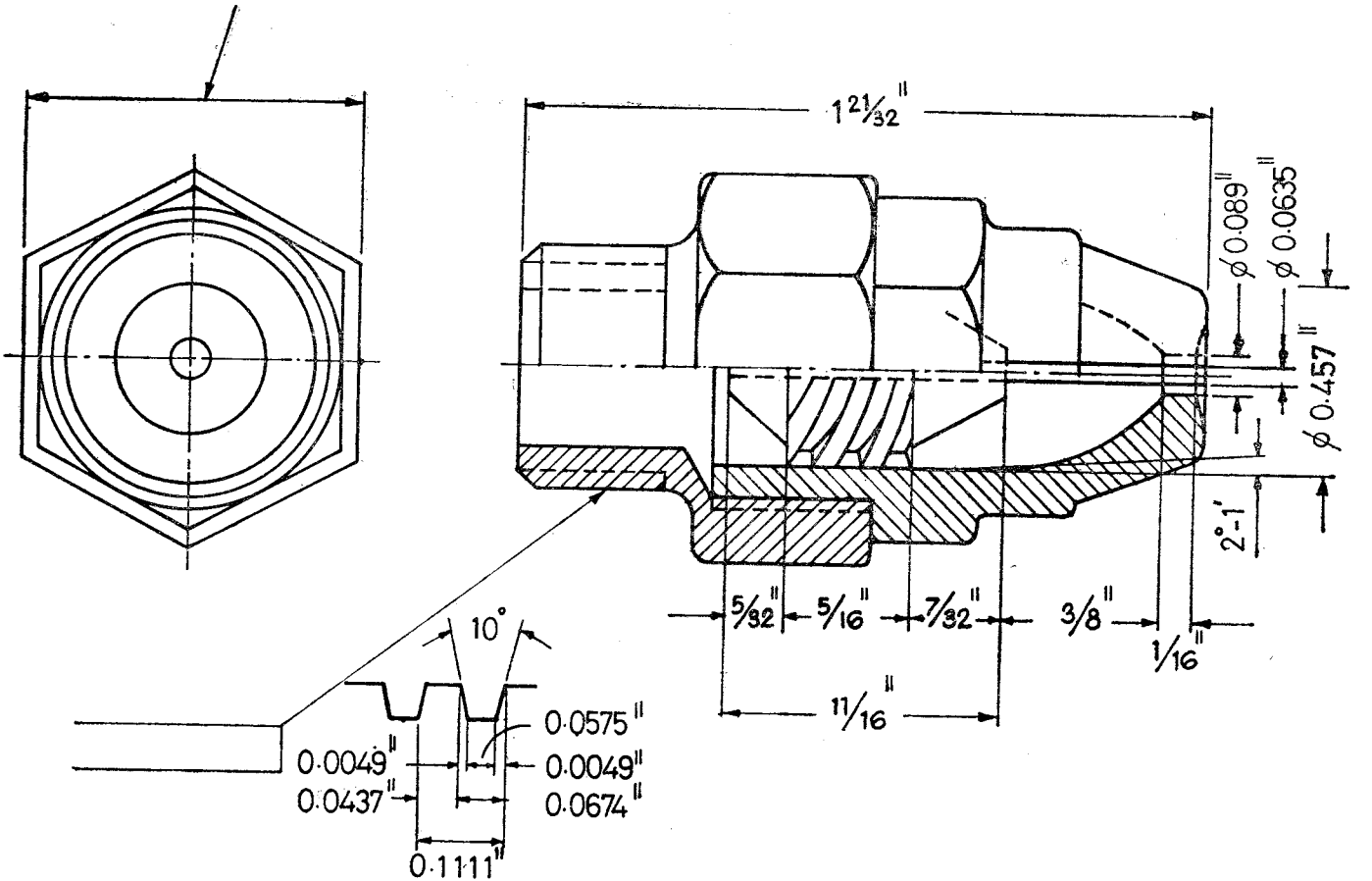


Fig. D—1. c – Nozzle according to practice in U.S.A.

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