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GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

FUNCTIONAL REQUIREMENT SPECIFICATION (FRS) FOR SOLID CORE PORCELAIN POST, OPERATING ROD AND SECTIONING INSULATORS WITH 1600 MM CD FOR 25 kV A.C. 50 Hz SINGLE PHASE OVERHEAD TRACTION EQUIPMENT

No. TI/SPC/OHE/INSPOR/XXXX

ISSUED BY

TRACTION INSTALLATION DIRECTORATE
RESEARCH DESIGNS AND STANDARDS ORGANISATION
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FUNCTIONAL REQUIREMENT SPECIFICATION (FRS) FOR SOLID CORE PORCELAIN POST, OPERATING ROD AND SECTIONING INSULATORS WITH 1600 MM CD FOR 25 KV A.C. 50 Hz SINGLE PHASE OVERHEAD TRACTION LINES

1.0 SCOPE

1.1 This draft specification covers the requirements and method of test for solid core porcelain Post , Operating Rod and sectioning insulators with 1600 mm Creepage Distance for polluted zones, used on single phase overhead electric traction line having a nominal voltage of 25 kV (line-earth) ac at 50 Hz. The system voltage may, however, go up to 27.5kV.

1.2 Wherever mentioned "Director General (TI), RDSO, Lucknow" in this specification shall be read as "Competent Authority of Vendor Approval Agency".

1.3 Reference has been made in this specification to the latest edition of the following Indian and other standard specifications:

SN	SPECIFICATION	DESCRIPTION
1.	IEC Publication 60383	Insulators for overhead lines with a nominal voltage above 1000 V
2.	IS : 8704:2018 or latest IEC Publication 60507:2013 or latest	Artificial Pollution Test on High Voltage Ceramic and Glass Insulators to be Used on a.c. Systems
3.	IEC Publication 60575	Thermal-mechanical performance test and mechanical performance test on string insulator units.
4.	IEC Publication 60672-2-	Ceramic and glass insulating materials Part 2: Methods of test
5.	IEC Publication 60815	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions
6.	IEC Publication 61467:2008	Insulators for overhead lines – Insulator strings and sets for lines with a nominal voltage greater than 1 000 V – AC power arc tests.

7.	IS:2071 (Part I):2016 or latest	High-voltage Test Techniques
8.	IS: 4218:2001 (REAFFIRMED 2018)	ISO general purpose metric screw threads.
9.	JIS:C3802	Permissible limits of visual defects for insulating porcelains
10.	ETI/OHE/13(4/84)with A& C Slip no. 1 to 4 or latest Issued by Research Designs & Standards Organization(RDSO)	Specification for Hot-dip zinc galvanization of steel masts (rolled and fabricated), tubes and fitting used on 25 kV a.c. OHE.

1.4 In case of any conflict between the contents of the above IEC, IS, JIS specifications and this specification, the latter shall prevail.

1.5 Any deviations from this specification, calculated to improve the performance, utility and efficiency of the insulator proposed by the Firm/Vendor will be given due consideration, provided that full particulars with justification therefore are furnished. In such a case the firm/vendor shall quote according to this specification and indicate the deviation (s) separately in a "Statement of Deviations" with the prices, if any, for such deviations.

1.6 The dimensions & Electrical parameters mentioned in this specification are applicable/suitable for altitude up to 1000 m above sea level. Further, if altitude increases up to 1600 m, the altitude correction factor for electrical parameter shall be application as per IEC 60071-2:2018 or latest. However, if altitude increases above 1600 m, the design & dimensions of insulators shall be finalised during design stage and altitude correction factor for electrical parameter shall be applicable as per IEC 60071-2:2018 or latest.

1.7 The "Make in India" Policy of Government of India shall be applicable.

2.0 TERMINOLOGY

2.1 For the purpose of this specification, the following definitions shall apply:

2.2 Solid Core Porcelain Insulator: An insulator consisting of a porcelain element of solid coreconstruction and associated metal fittings intended to give support to a live part which isto be insulated from earth or from another live part.

2.2.1 Post Insulator: A post insulator in used for supporting rigidly the live contacts of 25 kV isolator switches, the 25 kV bus bars at sub-station/switching stations, the 25 kV bus bars over portals and at such other locations. Creepage distance of this insulator shall be 1600 mm.

2.2.2 Operating Rod Insulator: The insulator used in the operating rod of a 25 kV isolator for opening and closing of the isolators. Creepage distance of this insulator shall be 1600 mm.

2.2.3 Sectioning Insulator: The insulating element of a piece of equipment (called section insulator assembly) which is used for separating adjacent sections of the overhead traction line belonging to different elementary electrical sections in the normal condition and which provides a continuous mechanical and electrical path for passage of the pantograph of electric rolling stock. Creepage distance of this insulator shall be 1600 mm.

2.3 Dry Lightning Impulse Withstand Voltage: The lightning impulse voltage, which the insulator withstands, dry, under the test conditions prescribed in Clause 5.2.15

2.4 Wet Power Frequency Withstand Voltage: The power frequency voltage, which the insulator withstands, wet, under the test conditions prescribed in Clause 5.2.16

2.5 Mechanical Failing Load: The greatest mechanical load, which, under the prescribed conditions, causes separation or breakage of metal fittings or total breakage of the Insulator.

2.6 Creepage Distance: The shortest distance along the contours of the external surfaces of the ceramic insulating part of the insulator between those parts, which normally have the operating voltage between them. The distance measured over the surface of the cement used, as jointing material shall not be considered as forming part of the creepage distance.

2.6.1 If high resistance coatings are applied to the parts of the insulator, such coatings shall be considered as effective insulating surfaces and distances over them shall be included in the creepage distance. The surface resistivity of such high resistance coatings is usually about 10^6 ohm, but may be as low as 10^4ohm.

2.7 Bulk Density: The quotient obtained by dividing the mass of the test specimen by the apparent volume (including open and closed pores).

2.8 Lot of Insulators: All the insulators of the same type and design manufactured under identical conditions of production, offered for acceptance. A lot may consist of the whole or part of the quantity ordered.

2.9 Batch of Insulators: A batch of insulators shall be the complete number of insulators manufactured at one time for the purpose of conducting prescribed type tests during the process of inspection and testing of prototype. Along with this batch of insulators, shall also be manufactured the required number of test specimen for the same purpose. A special marking shall be given to identify the batch of insulators and test specimens manufactured together.

2.10 Type Tests: Tests carried out to prove conformity with the requirement of the specification. These tests are intended to prove the general quality and design of a given type of insulator. They shall be repeated when the design or the material of the insulator is changed.

2.11 Acceptance Tests: These tests are for the purpose of verifying the mechanical

characteristics as well as the required properties of the ceramic portion of insulator and other characteristics as considered necessary. They are made on insulators picked up at random from lots offered for acceptance.

2.12 Routine Tests: These tests are for the purpose of eliminating insulators with manufacturing defects. They are made on every insulator offered for acceptance.

3.0 BASIC FEATURES

3.1 Porcelain

3.1.1 The porcelain shall be sound, free from defects, thoroughly vitrified and full glazed. All types of insulators shall be manufactured with aluminous porcelain only and they shall be fired in shuttle kiln only with precise temperature control. The quality of the porcelain as well as the process by which the insulator is manufactured shall be such that when the insulator is subjected to flashover at the maximum arc current of 6 kA for 0.2 s followed by 2 kA for 0.2 s followed after a pause of 60 s by a further 6 kA for 0.2 s, it shall not part.

3.1.2 In Alumina content, a variation of approx. 3-4 % has been observed between EDXA (at CPRI) & wet chemical analysis test (at firm's premises) results. The minimum alumina content checked through SEM & EDXA test shall be more than 40%. However, when tested as per wet chemical analysis (at firm's premises), minimum alumina content shall be 45%. No quartz powder shall be added as raw material. The values of essential ceramic properties of the insulator are indicated in theTable-1.

Table - 1 (Ceramic properties)

S.	Property	Value
1	Bulk density	2.6 g/cm³ (minimum) on test specimen. 2.5 g/cm³ (minimum) on fired porcelain.
2	Modulus of elasticity	105 Gpa (Minimum)
3	Flexural strength Unglazed Glazed	 140 Mpa(minimum) 160 Mpa(minimum)

3.2 Glaze- The glaze shall be brown in colour, unless otherwise specified. It shall cover the entire porcelain of the insulator.

3.3 Metal fitting

3.3.1 Metal fittings shall be made of spheroidal graphite cast iron to Grade: 400/15 of IS: 1865 or Forged steel fittings to BS-970 (Part-II). Approval of the type test of the insulator implies employment of metal fitting of the particular make & design approved during type test. In event of insulator manufacturer resort to change in material or design, all prototype tests will be required to be repeated. In addition to the above, RDSO may carry out the checks of incoming metal fittings.

3.3.2 All metal fittings shall be hot-dip galvanized in accordance with specification no. ETI/OHE/13(4/84) with A&C Slip 1 to 4 or latest. The minimum weight of zinc coating shall be as follows:

i) 1000 g/m² for all types of metal fittings.

The metal fittings shall be galvanized after machining. The galvanized surface shall be smooth.

NOTE:

(i) The threads of the tapped holes in the metal fittings of operating rod and post insulators shall be cut after galvanization and protected against corrosion by application of suitable grease. All the tapped holes shall be suitable for galvanized bolts and shallconform to IS: 4218 .

(ii) In case of Insulators manufacturers change the material of Metal Fitting/manufacturer of Metal Fitting. The tests mentioned at Sl. No. (1), (2), (4), (5), (6) & (9) of clause no. 5.1.5 shall be carried out.

4.0 STANDARD ATMOSPHERIC CONDITIONS FOR TESTS

4.1 Standard atmospheric conditions for tests on insulators shall be as given below:-

Temperature	t	20° C.
Barometric pressure	b	1013 mbar.
Absolute humidity	h	11 g of water per m³ corresponding to63% relative humidity at 20° C.

Note

A pressure of 1013 mbar corresponds to a pressure of 760 mm of mercury at 0° C. If the height of the barometer is h mm of mercury and the temperature of the mercury is t ° C, the atmospheric pressure in mbar is:

$$P = \frac{1013\ h}{760}\ (1 - 1.80 \times 10^{-4} \times t)$$

4.2 Electrical tests shall, however, be carried out under conditions obtaining at the time of the tests. The barometric pressure, air temperature and humidity at the time of tests shall be recorded for the purpose of calculating the corrections to test voltage in accordance with Appendix "1".

5.0 TESTS

5.1 Type Tests

5.1.1 Only after the design and drawings have been approved for prototype tests and a written advise giving to that effect, shall the manufacturer take up manufacture of the batch of the insulators and test specimens for prototype tests. It is to be clearly understood that any

change or modification required by the above authorities to be done in the batch of insulators shall be done expeditiously, not withstanding approval having already being given for the design and drawings. Such change or modification shall be incorporated in the drawing.

5.1.2 Prior to giving a call to the Director General (TI), RDSO, Lucknow for inspection and testing of the prototype, the manufacturer shall submit a detailed test schedule of prototype testing indicating the name of the test with internal test report (Test report of Routine test) and the number of days required to complete all the tests at one stretch. Once the schedule is approved, the tests shall invariably be done accordingly. However, during the process of type testing or even later, the purchaser reserves the right to conduct any additional test(s) besides these specified herein, on any insulator so as to test the insulator to his satisfaction or for gaining additional information and knowledge. In case any dispute or disagreement arises between the manufacturer and representative of the Director General (TI), RDSO during the process of testing asregards the procedure for type tests and/or the interpretation and acceptability of the results of type test it shall be brought to the notice of the Director General (TI), RDSO as the case may be, whose decision shall be final and binding. Only after the prototype is completed and ready in each and every respect, shall the manufacturer give the actual call for the inspection and testing with at least 15 days notice for the purpose.

5.1.3 The single batch / firing cycle of insulators and test specimens to be offered for type tests shall be not less than the following:

Post insulator: 55 insulators and 9 test specimens*
Operating Rod insulators: 45 insulators and 9 test specimens*
Sectioning insulator: 35 insulators and 9 test specimens*

(* Out of the 9 test specimens, 6 shall be glazed and 3 shall be unglazed)

5.1.3.1 The distribution of insulators for specific type tests shall be as follow:

Descriptions	Post	Sectioning	Others
a) Mechanical load test	30	10	20
b) Mechanical performance test	10	10	10
c) Thermal mechanical performance test	3	3	3
d) High voltage electrical tests	3	3	3
e) Power Arc test	3	3	3
f) Artificial pollution test	1	1	1
g) Verification of dimension	5	5	5
Total	55	35	45

5.1.4 Sequence for conducting the prototype tests:

Out of the batch of insulators, the quantity indicated in clause 5.1.3.1 of this specification for mechanical load tests and mechanical performance test shall be picked up at random and subjected to temperature cycle test. Only after passing the temperature cycle test, shall the insulators be subjected to mechanical load and mechanical performance tests. Only if the

insulators pass the mechanical load and mechanical performance tests, shall other tests be taken up. If they do not pass these tests, all the remaining insulators shall be destroyed in the presence of the inspecting official and the manufacturer shall offer a fresh batch of insulators of improved quality for type tests.

After completion of mechanical load and mechanical performance test, the thermal mechanical performance test, high voltage electrical tests, Power pollution test shall be taken up at the works of the manufacturer or at any reputed laboratory, as the case may be. In case any of the tests is to be conducted at any independent laboratory, the inspecting official shall seal the insulators required for that test before he leaves the manufacturer's works. It shall be ensured that the identification marks given on the seal, porcelain shell and the metal fittings are indicated in the test report given by the independent laboratory.

5.1.5 The following type tests shall be carried out on the batch of the insulators at the works of the manufacturer or at any Government/NABL accredited laboratory in the presence of the representative of the Director General (TI), RDSO, Lucknow and in accordance with the relevant procedures laid down in these specifications. However, for the tests to be conducted at any Government/NABL accredited laboratory, the witnessing of the tests by representative of Director General (TI), RDSO, Lucknow may be decided by the RDSO.

SN	Name of test	Clause No.
1.	Visual examination	5.2.1
2.	Verification of dimensions	5.2.2
3.	Temperature cycle test.	5.2.3
4.	Mechanical failing load test.	5.2.4
5.	Mechanical performance test.	5.2.5
6.	Verification of eccentricity.	5.2.6
7.	Thermal-mechanical performance test	5.2.7
8.	Porosity test	5.2.8
9.	Galvanization test	5.2.9
10.	Determination of Bulk density	5.2.10
11.	Analysis of Chemical composition	5.2.11
12.	Analysis by x-ray Diffractometry (XRD) and Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray analysis (EDXA).	5.2.12
13.	Test for Flexural Strength	5.2.13
14.	Test for Modulus of elasticity	5.2.14
15.	Dry lightning impulse withstand voltage test	5.2.15
16.	Wet power frequency withstand voltage test and wet power frequency maximum withstand voltage test	5.2.16
17.	Visible discharge test	5.2.17
18.	Power arc test	5.2.18
19.	Artificial pollution test	5.2.19

NOTE:

i) Temperature cycle test shall be conducted on 40 insulators in the case of post insulator, on 30 insulators in the case of Operating Rod insulators AND on 20 insulators in case of sectioning insulator. Only after passing this test, shall the insulators be subjected to mechanical load and mechanical performance tests.

ii) In the mechanical load test, 10 insulators each shall be tested for tensile, bending, torsion and eccentric loading as applicable to the type of the insulator indicated in clause 5.1.3.1.

iii) The mechanical performance test shall be conducted on 10 insulators in each type.

iv) The Artificial pollution test shall be conducted on one insulator in each type.

v) The Galvanisation test shall be conducted on 3 samples of each type of metal fitting of the insulators broken in the mechanical load test and mechanical performance test for each type of insulator.

vi) Test for Flexural Strength shall be conducted on 3 glazed and 3 unglazed test specimens separately.

vii) Test for Modulus of elasticity shall be conducted on 3 glazed test specimens. If the facility for conducting this test on glazed test specimen is not available, the test shall be conducted on 3 insulators as per DIN 40685 Part II.

viii) The porosity test shall be conducted on at least three fragments or piece of porcelain from the insulators broken in the mechanical load and mechanical performance tests.

ix) Analysis of Chemical composition shall be done on one fragment of the unglazed test specimen broken in the test for flexural strength and on one fragment of the insulator broken in the mechanical load and mechanical performance tests.

x) All other tests shall be conducted on three insulators or three broken insulators or three fragments or pieces of porcelain from the insulators broken in the mechanical load and mechanical performance tests, as applicable to the type of test.

xi) XRD and SEM & EDXA analyses shall be conducted on one insulator broken in the mechanical load and mechanical performance tests. The Inspecting Official will seal three pieces of porcelain out of the insulator selected. One sealed piece will be sent to the NABL approved government laboratory for conducting the test and submitting the report. The manufacturer & RDSO shall retain one sealed piece each.

5.2 Detailed Description of Prototype Tests:

5.2.1 Visual examination

The insulator shall be visually examined to see that it is free from physical distortion of shape and that the vitrified glaze is hard and smooth and the surface is free from cracks or any other defect likely to be prejudicial to satisfactory performance in service. The cement for jointing shall be finished with the edge of the metal fittings and in any case shall not project more than 2 mm above the edge. The exposed surface of the cement shall not show any sign of crack or blow hole. The metal fittings shall be smooth without any excrescence before accepting the lot for test, each insulator shall be checked for the following defects in case of type tests and 15% of the lot of insulators shall be checked for these defects in case of acceptance tests.

5.2.1.1 Glaze defects: The glaze defects shall no appropriate class of the insulator as specified in JIS-C-3802.

5.2.1.2 Tilt, Mis-alignment and Threads of metal fittings. Generally no tilt of metal fitting is acceptable for all types of insulators. However a maximum tolerance of 2 mm for the tilt of metal fitting shall be permitted if the tilt could not be avoided totally. Wherever thread cutting is required in the metal fittings, each insulator shall be checked for the diameter of thread and depth of threaded portion as per the specification / approved drawing using suitable gauges. The mis-alignment shall be checked for each insulator separately for the following types of insulators as detailed below:

5.2.1.2.1 Sectioning insulator:

Each metal fitting shall be checked for the critical dimensions of the metal fittings using suitable gauges.

The insulators which do not comply with the requirements of the specification / approved drawings in case of the above defects shall be rejected and destroyed in presence of the inspecting official. The details of rejection such as batch number and quantity shall form part of the type / acceptance reports.

The insulators which do not comply with the requirements of the specification / approved drawings in case of the above defects shall be rejected and destroyed in presence of the inspecting official. The details of rejection such as batch number and quantity shall form part of the type / acceptance reports.

5.2.2 **Verification of dimensions:**

The dimensions of the insulator shall be verified to see that they are in accordance with the approved drawings. Unless otherwise specified, a tolerance of +/-(0.03 d + 0.3) mm shall be permissible on any dimension of the porcelain shell only, "d" being the dimension in mm.

5.2.3 **Temperature Cycle Test:**

The insulators for this test shall be complete along with their metal fittings. They shall be completely immersed in a water bath maintained at a temperature of at least 70° C above than of cold water and left submerged for a period of T minutes, the value of T being given by the formula T=15+0.7M, where M is the mass of one insulator in kg. The insulators shall then be withdrawn as quickly as possible and completely immersed, without being placed in an intermediate container, in a bath of cold water for the same period of T minutes.

This process of heating and cooling cycle shall be performed five times in succession. The time taken to transfer all the insulators from one bath to the other shall be as short as possible and shall not exceeded 30s. The quantity of water in the two baths shall be sufficient so as not to cause a temperature variation of more than 5°C between the water in the two baths when the insulators are immersed.

Each insulator shall then be examined with the naked eye to see that the porcelain shell has not cracked, the glaze is not damaged and the metal fittings are not loose. Each insulator shall then be struck lightly with a wooden mallet to verify that there is no crack or loosening of

the metal fittings.

5.2.4 **Mechanical failing load tests:**

These tests shall comprise tensile, bending, eccentric loading and torsion tests.

5.2.4.1 Tensile test:

This test shall be done on all the insulators except the sectioning insulator. The load shall be applied to the insulator in line with its axis. It shall be increased at a rate agreed to between the manufacturer and the purchaser to 70% of the specified minimum tensile failing load. It shall be maintained at this value for one minute and then raised at the same rate until separation or breakage of metal fitting or total breakage of the insulator occurs. The separation or breakage of metal fitting or total breakage of the insulator or any permanent deformation in the insulator and its components shall not occur before the load reaches the minimum tensile ailing failing load specified inTable-5.

5.2.4.2 Bending tests:

This test shall be done on all the insulators except the sectioning insulator. One end of the insulator shall be rigidly fixed in a suitable fixture so as not to cause the failure of the metal fitting of this end during the test, which is for the porcelain shell only. The load shall be applied to the other end of the insulator in line with the diameter and in a direction perpendicular to the axis of the insulator and shall be increased at a rate agreed to between the manufacturer and the purchaser to 70% of the specified minimum failing bending moment, taking into account the distance between the top of the fixture and the point at which the load is applied. It shall be maintained at this value for one minute and then raised at the same rate until the total breakage of the porcelain shell occurs.

The failing bending moment shall be calculated by multiplying the value of the load in kgf and the distance from the point of application of load to the point of breakage in m and this value shall be not less than the minimum bending moment specified inTable-5.

Note
(1) The choice of the end to be fixed rigidly shall be left to the manufacturer.
(2) The recommended rates of increase of load in the tensile and bending tests are: Tensile test: 200 to 300 kgf/s
Bending test: 15 to 30 kgf/s

5.2.4.3 Eccentric loading test:

This test shall be done only on the sectioning insulator. The load shall be applied by means of suitable jigs such that the line of application of the load is 80 mm away from and parallel to the longitudinal axis of the insulator. Care shall be taken to ensure that during the test, the jigs do not move and the distance of the load from the centerline of the insulator does not become less than 80 mm.
The load shall be increased at a rate agreed to between the manufacturer and the purchaser to 70% of the specified minimum eccentric tensile failing load. It shall be maintained at this value for one minute and then raised at the same rate until separation or breakage of metal fitting or total breakage of the insulator occurs. The separation or breakage of metal fittings or total breakage of the insulator or any permanent deformation in the insulator and its

components shall not occur before the load reaches the minimum eccentric tensile failing load specified inTable-5.

5.2.4.4 Torsion test:

This test shall be done only on the post insulator. The insulator shall be subjected to a torsional load without causing any bending whatsoever. Depending upon the length of the lever arm used for imparting the torsion, the load corresponding to the minimum torsional failing moment shall be calculated and 60% of the value of load so calculated shall be gradually applied at the end of the lever arm and maintained at that value for one minute. The load shall then be raised at the same rate till breakage of the porcelain shell takes place. The torsional moment shall be calculated with the load at which the porcelain shell breaks by multiplying the load and the lever arm length and that breakage shall occur at a torsional moment not less than the minimum specified in Table -5.

5.2.5 **Mechanical Performance Test:**

This test shall be done on all the insulators in accordance with Clause 4 of IEC Publication 60575. The insulator shall be subjected to a tensile load (eccentric tensile load in the case of sectioning insulator) equal to 60% of the specified minimum failing load and immediately removed. This shall be done 4 times in quick succession. Thereafter the insulator shall be subjected to the tensile test (eccentric tensile test in the case of sectioning insulator) in accordance with Clause 5.2.4. The separation or breakage of the metal fittings orthe total breakage of the insulator or any permanent deformation in the insulator and its components shall occur not below the specified minimum failing load specified in Table-5. In case of the sectioning insulator, the line of application of the load shall be 80 mm away from and parallel to the longitudinal axis of the insulator.

5.2.6 **Verification of eccentricity:**

Insulators, which have undergone mechanical load test, shall be examined to verify the eccentricity of the metal fittings with respect to the porcelain shell by breaking the porcelain shell as near to the edge of the metal fitting as is possible. The eccentricity shall be not more than 2 mm in any case.

5.2.7 **Thermal Mechanical Performance Test:**

This test shall be done on all the insulators in accordance with Clause 3 of IEC Publication 60575. Before starting the thermal cycle, the insulator shall be subjected at room temperature to 60% of the tensile load (eccentric tensile load in case of sectioning insulator) specified in Table -5. It shall then be subjected to four 24-hour cycles of cooling and heating of 12 hours duration each while maintaining the load. Each 24-hour cycle shall comprise cooling to -30-$\pm5^{\circ}$C and then heating to +40 $\pm5^{\circ}$C, the temperature figures being of the surrounding air. The sequence shall be first cooling and then heating. The test equipment shall be such as to permit the minimum and maximum temperatures being maintained during at least four consecutive hours of the cycle.

The tensile load shall be completely removed and re-applied towards the end of each heating period, the last one excepted. On completion of the fourth 24 hours cycle and cooling to room temperature, the tensile load shall be removed. On the same day, after removal of the load the insulator shall be subjected individually to mechanical load test in accordance with

Clause 5.2.4. The separation or breakage of the metal fittings or the total breakage of the insulator or any permanent deformation in the insulator and its components shall occur not below the minimum failing load specified in Table-5. In the case of the sectioning insulator, the line of application of the load shall be 80mm away from and parallel to the longitudinal axis of each insulator, both during the thermal cycles and during the mechanical load test. In the case of the sectioning insulator, the line of application of the load shall be 80mm away from and parallel to the longitudinal axis of each insulator, both during the thermal cycles and during the mechanical load test.

5.2.8 **Porosity Test:**

Fragments or pieces of porcelain from the insulator broken during any of the above tests shall be taken for this test. The unglazed area of the fragments shall be at least 75% of the total surface while some of the fragments shall be taken from the central parts of the ends of the porcelain.

They shall be immersed in 1% alcoholic solution of fuchsin (1 g fuchsin in 100 g of methylated spirit) under a pressure not less than 150 kg/cm^2 for a period such that the product of the test duration in hours and the test pressure in kg/cm^2 is not less than 1800. The fragments or pieces shall then be removed from the solution, washed, dried and broken. Examination of the freshly broken surfaces with the naked eye shall not reveal any dye penetration. Any dye penetration into small cracks formed during the initial breaking process shall be neglected.

5.2.9 **Galvanization test:**

The uniformity, adherence and mass of zinc coating shall be tested in accordance with specification No. ETI/OHE/13 (4/84) with A&C Slip 1 to 4 or latest and the results of the tests shall meet the requirements specified. The mass of zinc coating shall be as specified in clause 3.3.2 hereof.

5.2.10 **Determination of Bulk Density:**

This test shall be conducted in accordance with clause 5 of IS 672-2- Method B of IEC Publication 60672-2. The test specimens shall consist of at least three fragments of total mass between 50g and 80g. Chips liable to become detached during further handling shall be eliminated and any dust shall be carefully removed by brushing under a water jet. The mass (m1) in g of the dry test specimen shall be determined. It shall be placed in a vessel on a wide-mesh brass netting located 1cm from the bottom and covered with distilled water.

The distilled water shall than be heated up to the boiling point and maintained at that temperature for 30 minutes. It shall then be allowed to cool to ambient temperature. The test specimen shall be removed, wiped lightly with a damp cloth to remove water on the surface only and the mass (m2) in g of the specimen when suspended in distilled water at about 23°C shall be determined. The mass (m3) in g in air of the soaked sample shall be determined. The bulk density shall be calculated as follows:

$$\text{Bulk density} = \frac{m1 \times pw}{m3 - m2}$$

where pw is the density in g/cm^3 of water at the test temperature

The test shall be made on at least three samples of unglazed test specimens broken in the test for flexural strength and on at least three samples of porcelain shell obtained from the insulators broken during the mechanical load tests. The results of the tests shall be not less than the value specified in Table-1 for each sample of test specimen and porcelain shell.

5.2.11 **Analysis of Chemical composition:**

One fragment or piece from the core of the insulator broken during mechanical load tests and one fragment or piece of porcelain of the unglazed test specimen broken during the test for flexural strength shall be subjected to complete chemical analysis. The test report shall be submitted along with the type test and acceptance test reports.

5.2.12 **XRD and SEM & EDXA Analysis:**

One piece (sample) shall be selected by the inspector and same shall be sent to CPRI or any other NABL approved government laboratory (clause No 5.6.2) from lot size of every 1000 insulators or part thereof offered during inspection, and from this selected piece (sample) the CPRI or any other NABL approved government laboratory shall further divide into three fragments and shall conduct the XRD, SEM and EDXA tests as per following method:

Fragment-1 shall be used for phase analysis by XRD. Fragment-2 shall be used for EDXA chemical composition.

Fragment-3 shall be used for SEM Microstructure.
Results shall be based on the values obtained during the analysis at five different regions on each fragment and reported as aggregate or range for each fragment.

SEM & EDXA Analysis: By this method, the Microstructure and chemical composition analysis will be made and the followings will be evaluated:

i) Total Al_2O_3(Alumina)
ii) Percentage impurities viz. Fe_2O_3, TiO_2,CaO
iii) Percentage of Mullite & other Alumino Silicates
iv) Micro-structural Details. For free alumina in glassy matrix, porosity, defects and for variation in composition between different regions in the glassy matrix apart from the free alumina phase.

XRD Analysis: By the method, the followings will be evaluated :-

i) Percentage free a alpha – Alumina (Corundum Phase)
ii) Percentage free a alpha – Quartz (Quartz Phase)

5.2.13 **Test for Flexural Strength:**

This test shall be conducted in accordance with clause: 6 of IEC Publication 60672-2. The method of test shall be Method A - Three point bend method. The choice of the shape of test specimens shall be left to the manufacturer. The test shall be conducted both for the unglazed as well as glazed test specimens and the value for flexural strength for each specimen shall be not less than the value specified in Table-1.

5.2.14 **Test for Modulus of Elasticity:**

This test shall be conducted in accordance with Clause: 7 of IEC Publication 60672-2 or by dynamic method with ultrasonic resonance frequency measurement using elasto sonic non-destructive testing equipment. The value of the Modulus of Elasticity for each specimen shall be not less than the value specified in Table-1.

5.2.15 **Dry lightning impulse withstand voltage test:**

The insulator shall be tested dry under the conditions described in Appendix "2". The impulse generator shall be adjusted to apply a standard 1.2/50 wave at the specified impulse withstand voltage adjusted for the atmospheric conditions at the time of test. Fifteen such voltage waves shall be applied to the insulator. If there is no flashover or puncture, the insulator shall be deemed to have passed the test. However, two flashovers on the external insulations are permissible. The insulator shall pass the impulse withstand voltage test with voltages of both positive and negative polarity. The insulators shall not be damaged by these tests, but slight marks on the surface of the insulating parts or chipping of the cement used for jointing of metal fitting shall be permissible. The original oscillograms recorded during the test shall form part of the type test report.

5.2.16 **Wet power frequency withstand voltage test and wet power frequency maximum withstand voltage test.**

The insulator shall be arranged as described in Appendix "2" and exposed for at least 1 minute before application of voltage and throughout the test to artificial rain produced in accordance with Clause 4.4 of IS: 2071 (Part-I). The test voltage to be applied to the insulator shall be the specified wet power frequency withstands voltage adjusted for the atmospheric conditions at the time of test. A voltage of about 75% of the test voltage so determined shall be applied and then increased gradually to reach the test voltage in a time of not less than 5s. The test voltage shall be maintained at this value for 1 minute. The insulators shall not flashover or puncture while the test voltage is applied.

The test shall then be repeated at successively higher voltage in step of 2.5 kV or 5 kV until the insulator is unable to withstand the applied voltage for a period of 1 minute. The voltage corrected as described in Appendix "1", of the test immediately preceding the last test shall be taken as the maximum wet power frequency withstands voltage.

5.2.17 **Visible discharge test**

The room in which the test is to be done shall be darkened completely and a period of at least five minutes shall be allowed for the observer to become accustomed to the darkness. A power frequency voltage of the value specified in Table-4 shall be applied in accordance with the procedure laid down in Appendix "2" and maintained at that value for five minutes. During the period, there shall be no signs of visible corona. The voltage shall then be raised gradually and the value at which corona first appears shall be recorded. The voltage shall then be reduced gradually and the value at which the corona just disappears shall also be recorded.

5.2.18 **Power Arc test:**

The Power Arc test comprises flashing over at the maximum are current of 6 kA for 0.2 sec. followed by 2 kA for 0.2 sec. followed after a pause of 60 s by 6 kA for 0.2 sec. and the

insulator shall not part.

It is understood that facilities available at present in the country do not permit of the test being conducted in the sequence required and therefore the Power Arc test shall be done at 6 kA for 0.2 sec. followed after a pause of 180 sec. by 2 kA for 0.2 sec. followed after a pause of 180 sec. by 6 kA for 0.2 sec. (till such time as this sequence is modified) with the no load voltage of the power source i.e. 7 to 10 kV. The insulator shall not part at the end of the test. Chipping/breakage of sheds shall however be permitted. After completion of the test the insulator shall be subjected to mechanical load test in accordance with Clause: 5.2.4 of this specification. The original oscillographs recorded during the test shall form part of the type test report.

5.2.19 **Artificial Pollution Test:**

The artificial pollution test shall be carried out at the declared maximum withstand Equivalent Salt Deposit Density (ESDD) at 30 kV in accordance with IS: 8704 or IEC Publication 60507, using solid layer (steam fog) method. The insulator shall be in the vertical position during the test. The sectioning insulator however shall be tested in the horizontal position. The leakage current shall be recorded. If the insulator does not pass the test at the specified value of ESDD, the test shall be reported at lower values.

5.3 Acceptance criteria of prototype test

5.3.1 A single batch / firing cycle of insulators and test specimens manufactured and offered for type tests in accordance with Clause: 5.1.3 shall pass all the type tests stipulated in Clause: 5.1.5 hereof.

5.3.2 Apart from the passing all the type tests, the quality index calculated on the basis of the results of tensile load test and mechanical performance test shall be 2.5 minimum.

5.3.3 The results of bending test shall be computed for (X – 3σn-1) and this value shall not be less than the specified minimum failing bending moment.

5.3.4 Acceptance criteria for the results of XRD and SEM & EDXA analyses shall be as under:

SN	Property	Criteria
1. 1(i)	Alumina (i) Alpha Alumina	>40% > 30%
2.	Composition Variation within porcelain glassy matrix	<20%
3.	Impurity	<2%
4.	Alpha Quartz	Values shall be recorded and should preferably be Zero.

5.3.5 In case a batch of insulators fails in the type test, manufacturer shall brought out in black & white, the reason of such failure & corrective action taken by him. Only after RDSO's satisfaction, the firm can offer fresh batch of insulators for type tests for conducting test as per list given in clause 5.1.5.

5.3.6 Only after approval of the original tracings of drawings incorporating changes, if any, necessitated during the type tests and clear written approval of the results of the tests on the prototype is communicated by the Director General (, TI), RDSO to the manufacturer, shall be taken up bulk manufacture of the insulator which shall be strictly with the same materials and process of manufacture as adopted for the prototype. In no circumstances shall materials other than those adopted in the design/drawings and/or during the manufacture of prototype be used for bulk manufacture on the plea that they had been obtained prior to the approval of the prototype.

5.3.7 If the prototype of an insulator conforming to this specification has already been approved in connection with previous supplies to Indian Railways, fresh testing of prototype of the insulator may be waived at the discretion of the RDSO, provided that no changes whatsoever in the design or materials or process of manufacture have been made. However, the RDSO reserves the right to test any insulator if he deems it necessary to do so in the light of experience gained from previous supplies.

5.3.8 Notwithstanding approval having been accorded to manufacture the bulk of the insulators on the basis of the results of the type tests, the RDSO reserves the right to conduct any type and number of tests, including destructive tests at any time during the process of bulk manufacture without prior advice to the manufacturer. All facilities shall be made available to the RDSO to conduct such tests without any charge.

5.4 Acceptance Tests

5.4.1 The following shall constitute the acceptance tests.

1. Visual examination.
2. Verification of dimensions.
3. Temperature cycle test.
4. Mechanical load test.
5. Mechanical performance test.
6. Verification of eccentricity.
7. Porosity test.
8. Galvanization test.
9. Determination of bulk density.
10. Analysis of chemical composition.
11. Analysis by X-Ray Diffractometry (XRD) and Scanning Electron Microscopy (SEM) and Energy Dispersive X-Ray Analysis (EDXA).This test shall be conducted as per Clause 5.6.2.

5.4.2 The tests shall be conducted as laid down in the relevant clauses hereof.

The visual examination shall be conducted as per clause 5.2.1 , 15% of the lot offered and then other acceptance test shall be conducted on the samples selected from the lot for conducting acceptance test. If any failure occurs, a further quantity of 30% of the lot shall be visually examined. If any insulator fails in the tests, the entire lot shall be rejected.

5.4.3 The lot offered shall be considered for acceptance tests only after the lot has been inspected and cleared of CUSTOMER HOLD POINTS indicated in the approved Quality Assurance Plan of the manufacturer.

5.5 Customer hold point (CHP):

5.5.1 Stage inspection at Customer Hold Point (CHP) for shells and metal fittings will not be carried out for insulators manufactured by sources appearing in Approved Vendors category of RDSO's list of approved vendors.

5.5.2 For insulators from Developmental Vendor, CHP will be conducted by the nominated Inspecting agency.

5.5.3 For CHP inspection, the inspecting official shall pick up at random a minimum of 5% of the lot offered and conduct the test prescribed for clearance of the CHP. If the samples pass the test, the inspecting official shall give written permission to the manufacturer to proceed with the next step in the manufacturing process. This written permission shall form part of the acceptance test report. This procedure shall be repeated for each CHP. If during the test report for CHP the sample fails, the Inspecting official shall advise the manufacturer in writing. The manufacturer shall rectify the defect and offer the insulators again for test. This written advice will also form part of the acceptance test report. A distinct numbering shall be given to identify the manufacturing/firing schedule. The format of the report on CHP, issued by Director General (TI), RDSO, shall be followed.

5.6 Sampling Plans shall be as under:-

5.6.1 The number of insulators (sample size) to be picked up at random (by any random number generation method) from the lot offered for acceptance tests as tabulated below:

Table 2
Number of insulators (item wise) sample size to be selected

Post Insulator and Operating rod Insulators

S.N	Lot Size	Sample size
i	Less than 500	5%(Min. 6 Nos.& Max 25 Nos)
ii	501 to 800	35
iii	801 and above	45

Sectioning Insulator

SN.	Lot Size	Sample size
i	Less than 500	3%(Min. 4 Nos.& Max 15 Nos)
ii	501 to 800	25
iii	801 and above	35

5.6.2 The sample size for conducting XRD SEM & EDXA analyses will be at least one insulator for every 1000 insulators or part thereof offered for CHP clearance (Developmental Vendors) / Acceptance test (Approved Vendors). The insulator shall be selected normally from the firing cycles in which large numbers of insulators have been fired. The ID of the

sample shall be Type, Batch and Firing cycle. The Inspecting Official will seal three pieces of porcelain out of the insulator selected. One sealed piece will be sent to NABL approved government laboratory for conducting the test and submit the report. The manufacturer shall retain one sealed piece and one sealed piece shall be retained at RDSO/Inspecting agency. The result of the XRD SEM & EDXA analysis shall also be a part of acceptance test report and this shall be incorporated in all the test reports from which the insulators have been selected.

5.6.3 If the lot of insulators offered for acceptance tests are manufactured in more than one manufacturing/firing schedule, then the number of insulators to be picked up at random in accordance with Clause 5.6 shall be proportionately distributed among the manufacturing/firing schedules giving specific serial numbers to identify the manufacturing/ firing schedule and subjected to different tests as under:

5.6.4 The dimensions of three insulators shall be verified.
Then all the insulators shall be tested for temperature cycle test.
If the entire insulators pass the temperature cycle test, then the number of insulators as indicated in Table -3 shall be tested for mechanical load and mechanical performancetests.

At least one fragment of porcelain from each of the insulators broken during the mechanical load test and mechanical performance test shall be tested for porosity.

5.6.5 At least 3 samples of each type of metal fittings from the insulator broken in the mechanical load test and the mechanical performance test shall be tested for galvanization.

5.6.6 At least one fragment of porcelain from each insulator broken during the mechanical load test and mechanical performance test shall be tested for bulk density while any one fragment of porcelain broken during the mechanical load test and the mechanical performance test shall be analyzed for chemical composition.

5.6.7 At least 3 insulators broken during the mechanical load test and the mechanical performance test shall be verified in regard to eccentricity.

Table – 3

Distribution of Insulators for Mechanical load and mechanical performance tests

Post and Operating rod insulators:

Number of samples	Distribution		
	Bending Test	Torsion (for Post) or Tensile (for Operating rod) test	Mechanical Performance test
25	10	10	5
35	15	15	5
45	20	20	5

Sectioning Insulator:

Number of samples	Distribution	
	Eccentric tensile test	Eccentric mechanical performance test
15	10	5
20	15	5
25	20	5

5.7 Acceptance Criteria of Acceptance test

5.7.1 If any insulator fails either in the porosity test or in the test for determination of the bulk density or XRD, and SEM & EDXA analyses or in the minimum percentage of alumina content, the lot shall be rejected and every insulator of the lot shall be destroyed in the presence of the Inspecting Official.

5.7.2 If the lot of insulators offered for acceptance tests are manufactured in more than one manufacturing/firing schedule and if only one insulator of any of the manufacturing/firing schedules fail either in mechanical load test or in the mechanical performance test, a re- test procedure shall be followed in accordance with clause: 5.8 of this specification, if more than one insulator manufactured in a particular manufacturing/firing schedule fails either in mechanical load test or in the mechanical performance test or in both the tests taken together, then all the insulators manufactured in that manufacturing/firing schedule shall be destroyed in the presence of the inspecting official.

The manufacturer shall have the option to offer all the remaining insulators of the lot manufactured in the manufacturing/firing schedule other than the one rejected and destroyed as a fresh lot again or to manufacture more insulators afresh to obtain the full lot size and then offer the insulators along with the above left over insulators as a fresh lot later. If the failure is only to hooks failing in the case of stay and polluted zone), then all the hooks of the lot obtained by the manufacturer shall be destroyed in the presence of the inspecting official and the lot shall be offered again with hooks of improved quality.

5.7.3 Despite the insulators passing in the tensile load test and in the mechanical performance test, if the quality index calculated on the basis of the results of tensile load test and mechanical performance test is less than 2.5, the lot shall be rejected and every insulator of the lot shall be destroyed in the presence of the Inspecting Official**.**

5.7.4 Despite the insulators passing in the bending moment test, if the value of X-3σn- 1 is not achieved in the lot of insulators shall be destroyed in the presence of the Inspecting Official.

5.7.5 If the results of test(s) other than the mechanical load test, mechanical performance test, determination of bulk density, porosity tests, XRD, and SEM & EDXA analyses and the minimum percentage of alumina content do not meet the requirements of this specification, then the balance samples shall be subjected to the particular test(s) in which it has failed.

If all the remaining samples meet the requirements of the specification the lot shall be accepted.

5.7.6 When a lot is rejected and every insulator of the lot is destroyed in the presence of the Inspecting Official, the procedure given in Clause: 5.8.2 of this specification shall also be complied with by the Inspecting official.

5.8 Re-test Procedure:

If only one insulator fails either in the tensile load test or in the mechanical performance test, the remaining insulators of the lot shall first be subjected to the routine tensile load test and those insulators, which do not pass the test, shall be destroyed in the presence of the Inspecting Official. From out of those insulators, which have passed the routine tensile load test, a fresh sample size equal to twice the quantity indicated in Clause 5.6 shall be picked up at random and subjected to the acceptance tests, the insulators for each testbeing twice that indicated in Clause: 5.6. If any failure occurs in any test including meeting the X-3σn-1 and Quality Index, the lot shall be rejected.

5.8.1 If only one insulator fails in the bending moment test, the remaining insulators of the lot shall first be subjected to the bending moment test at 70% of the specified load and those insulators, which do not pass the test, shall be destroyed in the presence of the Inspecting Official. From out of those insulators, which have passed the routine bending moment test, a fresh sample size equal to twice the quantity indicated in clause 5.6 shall be picked up at random and subjected to the acceptance tests, the insulators for each test being twice that indicated in clause 5.6. If any failure occurs in any test including meeting the X-3σn-1and Quality Index, the lot shall be rejected.

5.8.2 If any lot is rejected after following the re-test procedure given in Clause: 5.8 the insulators forming the lot shall be destroyed in the presence of the Inspecting Official. If part of the quantity of insulators manufactured during a particular manufacturing/firing schedule has been included in forming the lot offered for acceptance tests and that the lot fails for any reason after the re- test procedure, then the remaining insulators of that manufacturing/firing schedule shall be considered as suspect and therefore they shall be destroyed in thepresence of the inspecting official, even though they are not included in the lot. Full details in regard to the rejection and destruction of insulators under this clause shall be advised to Director General (TI), RDSO, Lucknow, and the Purchaser.

5.9 The following shall form part of the acceptance test report:

5.9.1 The written consent given by the Inspecting Official in regard to the passing of the insulators at each CHP.

5.9.2 A certificate by the Inspecting official to the effect that he has checked the records of the routine tests conducted by the manufacturer.

5.9.3 A statement from the manufacturer, countersigned by the inspecting official, showing the rejection rate of insulators in the routine tests conducted by the manufacturer for each manufacturing/firing schedule for the lot offered.

5.9.4 CPRI's or Government/NABL accredited laboratory tests report of XRD, EDXA& SEM analysis.

5.9.5 The test report shall also include the details of number of insulators manufactured in each

manufacturing/firing schedule for the lot offered. If the lot has been formed from out of insulators manufactured in more than one manufacturing/firing schedule, then the samples to be picked up at random for acceptance tests shall be more or less equally distributed between the different manufacturing/firing schedules. Serial numbers shall be given to the insulators to identify the manufacturing/firing schedule from which they have been picked up and this shall also be clearly indicated in the acceptance test report.

5.10 The manufacturer shall, as far as practicable, offer the insulators manufactured in one manufacturing/firing schedule in one lot for acceptance tests.

In case the insulators manufactured in a particular manufacturing/firing schedule have to be divided into two lots for acceptance tests and in case one of the two lots has been accepted based upon the results of the acceptance tests while the other lot is rejected subsequently, then the insulators of the lot already accepted become suspect and therefore the manufacturer shall have to replace, free of cost, all the insulators dispatched against the accepted lot under advise to Director General (TI), RDSO, Lucknow and the Purchaser.

5.11 The manufacturer shall offer for acceptance tests of batches/firing cycle same or dated later but not of those batches, which are prior to the last inspected lot.

5.12 **Routine Tests**

5.12.1 **The following shall constitute the routine tests.**

a) Visual examination
b) Ultrasonic test
c) Routine mechanical load test
d) Routine porosity test
e) Routine temperature cycle followed by wooden mallet test to checksoundness of insulator.

Note:

Every insulator shall pass the routine tests in the order given above. The manufacturer shall conduct the tests. The Purchaser shall have the right to witness routine tests. The Inspecting Official shall maintain the detailed record of the number of insulators tested, number rejected and other essential data for the purpose of examination.

5.13 Description of Routine Tests:

5.13.1 **Routine Visual Examination**

The visual examination shall be conducted on each insulator as per clause 5.2.1.

5.13.2 **Routine Ultrasonic Test**

This test shall be made on every porcelain shell after the extension piece required for routine porosity test has been cut off, the ends of the shell machined and prior to fitment of the metal fittings. Using suitable ultrasonic testing equipment, which can produce ultrasonic waves of frequency between 0.8 and 5 MHz and the speed of propagation of the waves not less than 5800 m/s, the porcelain shell shall be tested both in the longitudinal direction as well as in the

transverse direction using appropriate probes. The ultrasonic test in the longitudinal direction shall be done on both sides. There shall be no defective echo between the initial echo and the back wall echo and the amplitude of the back wall echo shall be equal to the initial echo. Any porcelain shell, which does not comply with this acceptance criteria and shows cracks or internal flaws of any nature shall be rejected and destroyed. The test may be repeated on the insulators after fitment of the metal fittings. Every insulator passing in the ultrasonic test shall be affixed with a clear label or stamp of the glazed portion so as not to be covered by the metal fittings.

5.13.3 **Routine Mechanical Load Test:**

All insulators except for sectioning insulator shall be subjected to axial tensile load of 70% of the value specified in Table-5. In the case of sectioning insulator, the tensile load shall be applied eccentric as indicated in clause 5.2.4.3. If any insulator cracks or its metal fittings loosen or deform or crack, it shall be rejected. If the metal fitting gets marked at the locations where they are connected to the fixtures in the testing machine/mechanism, such marks shall not be regarded as deformations. Every insulator passing in the routine mechanical load test shall be affixed with a clear label or stamp on the glazed porcelain so as not to be covered by the metal fittings.

5.13.4 **Routine Porosity Test:**

The porcelain shell shall have been manufactured with an extension at the top end having a diameter equal to that of the core and of length at least half the dimension of the diameter. This extension piece shall be carefully cut-off and then broken into fragments. The porcelain shell and the fragments shall be marked for identification that they belong to one porcelain shell. Some fragments from the central portion of the extension shall be tested for porosity as per Clause: 5.2.8 If any of the fragments so tested shows porosity, the porcelain shell from which the fragments were obtained shall be rejected and destroyed. If none of the fragments shows any porosity, then the porcelain shell from which the fragments have been obtained shall be considered as having passed the test. Such porcelain shells shall be affixed with a clear label or stamp on the glazed portion so as not to be covered by the metal fittings.

5.13.5 **Routine temperature cycle following by mallet test:**

The routine temperature cycle test shall be conducted as per clause 5.2.3 on each shell manufactured. The number of heating and cooling cycle shall be three and the period of immersion in hot and cold bath shall be 15 minutes. After completion of the routine temperature cycle test, each shell shall be subjected to a mallet test on both ends, so that uniform force is applied on all the insulators. The insulators, which fail in this test, shall be rejected and destroyed. Every insulator passing in the routine temperature cycle test shall be affixed with a clear label or stamp on the glazed portion so as not to be covered by the metal fittings.

6.0 REQUIREMENTS

6.1 Since the insulator is of aluminous porcelain, its dimensions both of core and shed shall be such that its weight shall be a minimum for the creepage distance specified and the mechanical and electrical characteristics it is required to meet.

6.2 The sheds of an insulator shall be of equal diameter and with lips at the extremities for all type of insulators, except for the sectioning insulator, which has a symmetric shed profile. The shed profile shall be free from ribs on the underside so as to avoid accumulation of dust and pollutants.

6.3 The dimensional parameters characterizing the insulator profile shall generally conform to IEC Publication 60815.

6.4 The ends of the porcelain shell shall be either straight/ conical and sanded/ glazed. If the ends are conical, the angle shall be 4° to 12°. Similarly, the internal angle of the metal fittings shall be 4° to12°.

6.5 The jointing of the metal fittings with the porcelain shell shall be with Portland cement, which shall neither react chemically with the metal fittings nor cause their fracture on account of expansion or contraction causing loosening of the metal fittings. The jointing process shall be done by a mechanized method and care shall be taken to ensure that the porcelain shell and the metal fittings are properly aligned and that no part of the porcelain shall come in direct contact with the metal fittings. It is permissible to use cork sheet or thick paper between the metal fittings and the porcelain shell to absorb any mechanical shocks.

7.0 VOLTAGES FOR HIGH VOLTAGE TESTS.

7.1 The values of voltages at Standard Atmospheric conditions for the various high voltagetests on the insulators shall be as given in Table -4.

One of the requirements of the insulator is to withstand artificial pollution test. The insulator shall withstand 30 kV for 15 minutes at ESDDs of 0.05 mg/cm^2 and 0.15 mg/cm^2 for standard and polluted zone insulators respectively when tested in accordance with clause 5.2.18.

Table – 4
Values of voltages for high voltage tests

Type of insulators	Visible discharge test KV (rms)	Wet power frequency withstand voltage test		Dry lightning impulse withstand voltage test	
		Insulator vertical kV (rms)	Insulator horizontal kV (rms)	Positive wave kV(peak)	Negative Wave kV(peak)
1	2	3	4	5	6
Post	35	100	--	240	260

Operating Rod	35	100	125	240	260
Sectioning	35	--	125	240	260

Note: These values apply to both standard and polluted zone insulators.

8.0 MINIMUM MECHANICAL FAILING LOADS AND BENDING & TORSIONAL MOMENTS.

8.1 The minimum mechanical failing loads and bending and torsional moments shall be in accordance with Table -5.

Table - 5

Minimum mechanical failing loads and bending and torsional moments

Type of insulator	Tension (kgf)	Tension with 80 mm eccentricity of load(kgf)	Bending moment (kgf. m)	Torsional moment (kgf.m)
1	2	3	4	5
Post	6000	-	370	550
Operating rod	2200	-	70	-
Sectioning	-	5000	-	-

9.0 MARKING

9.1 The porcelain shell as well as the metal fittings of each insulator shall be legibly and indelibly marked. The marking on the porcelain shell shall be with 10 mm figures while that on metal fittings shall be with 6 mm relief figures to show the following:

a) Name or trade mark of the manufacturer,
b) Month (optional for the metal fitting) and year of manufacturer,
c) Part number and
d) Any other identification marks specified by the purchaser

9.2 The marking on the porcelain shell shall be applied before firing.

10.0 DRAWING AND THEIR APPROVAL

10.1 The manufacturer shall submit three prints in each of the following drawings showing all the details in scale 1:1, separately for each type of insulator (in the Performa for the drawing enclosed) as per Railway Standards in sizes of 210mm x 297mm(A4 Size) or any integral multiple thereof for approval for the purpose of prototype test only.

a) Assembly drawing of the insulator
b) Porcelain shell drawing
c) Metal fittings drawings

10.2 The drawings approved for the prototype tests only shall be modified, if need be, as a result of changes necessitated during testing or as desired by the purchaser. The modification shall be first got approved by the Director General (TI) RDSO, Lucknow and then incorporated in the drawing and each such modification shall be got signed on the drawings by the Director General (TI) RDSO, Lucknow. If there are no modifications at all the drawings approved for prototype tests shall be treated as final.

10.3 After the insulator has passed all the type tests the manufacture shall submit the original tracings of all the drawings which have been approved for prototype tests only along with two sets of reproducible to Director General (TI), RDSO, Lucknow (India) and they will be signed by the authority concerned of the Director General (TI), RDSO, Lucknow in token of approvalfor bulk manufacture.

11.0 AFTER SALES SERVICE

11.1 The manufacturer shall respond promptly and in a workman like manner to any call given by Indian Railways for any assistance by way of attending to failures, investigation into the causesof the failures including tests, if any, to be done and such other items with a view to seeing that the insulator serves the purpose for which it is intended.

12.0 PACKING

12.1 The insulators shall be securely packed in wooden crate not more than two insulators shall be packed in a crate so as to facilitate manual loading and un-loading by one person.

12.2 In case of overseas supplies, packing shall be sea-worthy.

13.0 ISO PROCEDURE

All the provisions contained in RDSO's ISO procedures laid down in document No.- QO-D-8.1-11, version No: 2.6 dated 07.07.2023 or latest (Titled " Vendor- change in approved status") and subsequent versions/amendments thereof, shall be binding and applicable on the successful vendor/vendors in the contracts floated by Railways to maintain quality of products supplied to Railways.

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APPENDIX "1"

CORRECTION OF TEST VOLTAGES FOR ATMOSPHERIC CONDITIONS

1.0. GENERAL

1.1. Variation in barometric pressure and humidity of the atmosphere cause variation in the electric strength of the air and hence in the flashover voltage of an insulator exposed to atmosphere.

2.0. CORRECTION FACTORS

2.1. When the atmospheric conditions around an insulator curing test differ from the reference conditions, adjustments are required to be made to certain of the test voltages by the application of the following correction factors in accordance with table A-1 at the end of this Appendix.

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

$$d = \frac{0.289\,p}{273 + t} \quad \text{(d lies between 0.95 and 1.05)}$$

where p = atmospheric pressure in mbar, and t = temperature in ^{o}C

For a wider range of density and for higher accuracy, the factor k shall be used instead of factor d. The values of factor k corresponding to various values of 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

2.1(b) Correction factor (h) for humidity: Figure: A-1 attached gives the values of absolute humidity value 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 1013 mbar. For better accuracy, a correction should be applied to the absolute humidity value obtained from Figure:A-1 for any deviation of ambient atmospheric pressure from the standard valueof 1013 mbar. This correction is obtained from Figure:A-2 as follows:-

Locate the point corresponding to the deviation of ambient atmospheric pressure from 1013mbar on the left hand side of Figure: A-2B and join it with the right hand side top corner by a straight line. Then locate the point on the curve in Figure: A-2A 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 Figure: A-2B. Read the correction to be applied to humidity from the right "hand side of Figure A-2B corresponding to the point of intersection. The 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 b-1 shall be determined from Figure: A-3.

Table 1.1

Correction of voltages for atmospheric conditions

Kind of test	Adjustment required
Dry lightning Impulse withstand voltage	Voltage applied shall be the appropriate value specified in Table-4 multiplied by k and divided by h.
Wet power frequency withstand voltage	Voltage applied shall be the appropriate value specified in Table-4 multiplied by k.
Wet power frequency Maximum withstand voltage	Measured voltage shall be divided by k

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APPENDIX "2"

HIGH VOLTAGE TESTS

1.0 ARRANGEMENT OF INSULATOR

1.1 **General-** The insulators shall be clean and dry and in thermal equilibrium with its surroundings.

1.2 The insulators shall be hung vertically from earthed supported by means of a wire rope or metal rod. The distance between the top of insulators metal fitting and the point of support shall be not less than 1 m. At the lower end of the insulator shall be attached, if required a metallic rod or weight adequate to ensure that the insulator remains in vertical position during test.

1.2.1 No object shall be near to the axis of the insulator than 1 m or 1.5 times the length of the insulator whichever is the greater.

1.2.2 The test voltage shall be applied between the metal rod at the bottom of the insulators and the earth point of the suspension.

1.3 Insulator tested in horizontal position:

1.3.1 The insulator shall be anchored by mean of a cable or metal rod connected to earth. The distance between the top of the insulator metal fitting and the point of anchorage shall be not less than 1m.

1.3.2 The other end of the insulators shall be provided with a metal rod about 1 m long and the whole arrangement maintained in an approximately horizontal position by any convenient means.

1.3.3 No object shall be nearer the axis of the insulator than 1 m or 1.5 times the length of the insulator whichever is the greater.

1.3.4 The test voltage shall be applied between the end of the metal rod and the earthed point of anchorage.

2.0 HIGH VOLTAGETEST

2.1 The high voltage test shall be conducted in accordance with IS: 2071 Part I.

3.0 PRECAUTION AGAINEST EXCESSIVE HUMIDITY

3.1 Special precautions shall be taken to avoid condensation on the surface of the insulator when the relative humidity is high. For example, the insulator shall be maintained at the ambient temperature at the test location for a sufficient period to attain thermal equilibrium before commencing the test. Except by arrangement between the manufacturer and the purchaser, the test shall not be made if the relative humidity exceeds 85%.

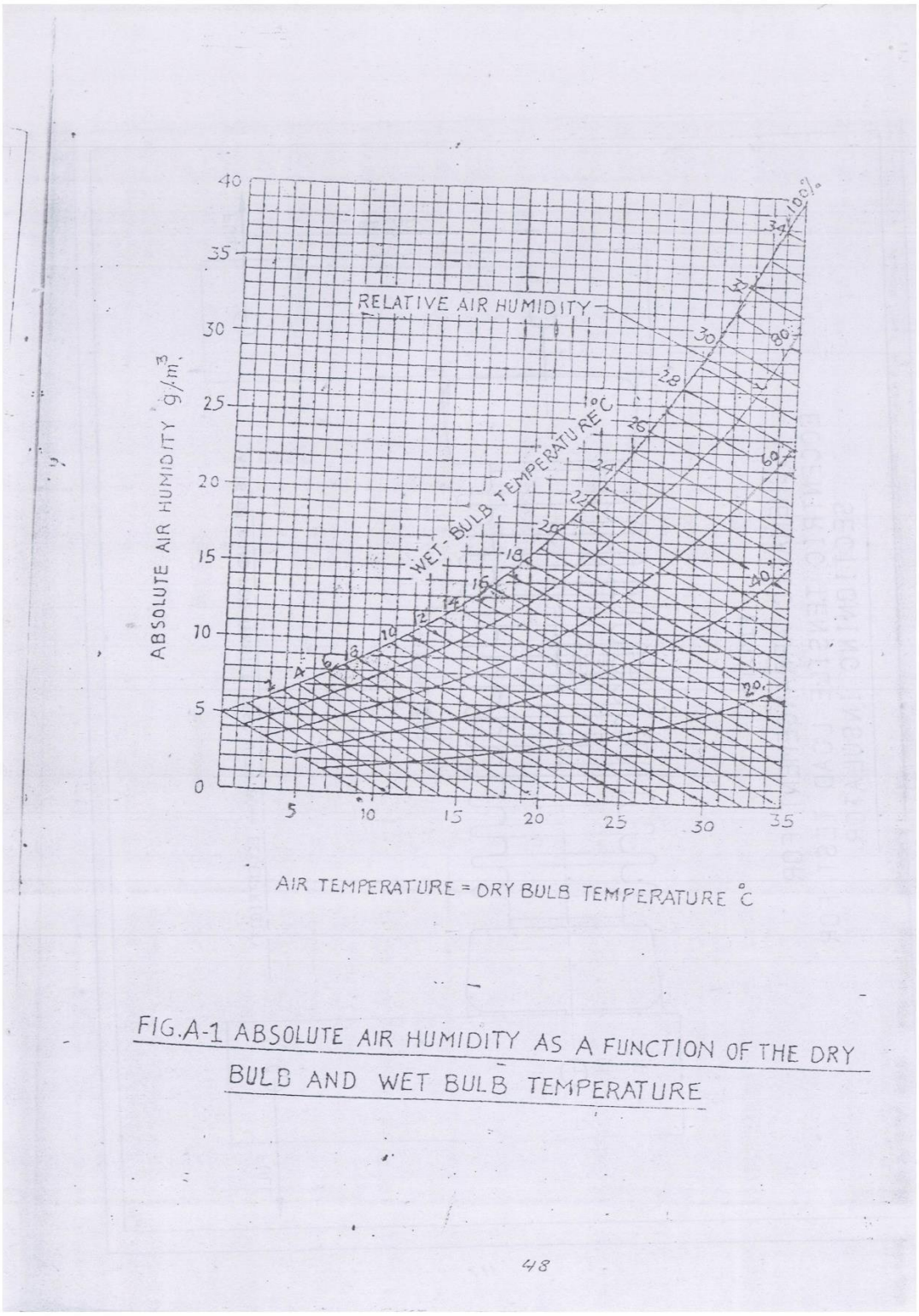

FIG.A-1 ABSOLUTE AIR HUMIDITY AS A FUNCTION OF THE DRY BULB AND WET BULB TEMPERATURE

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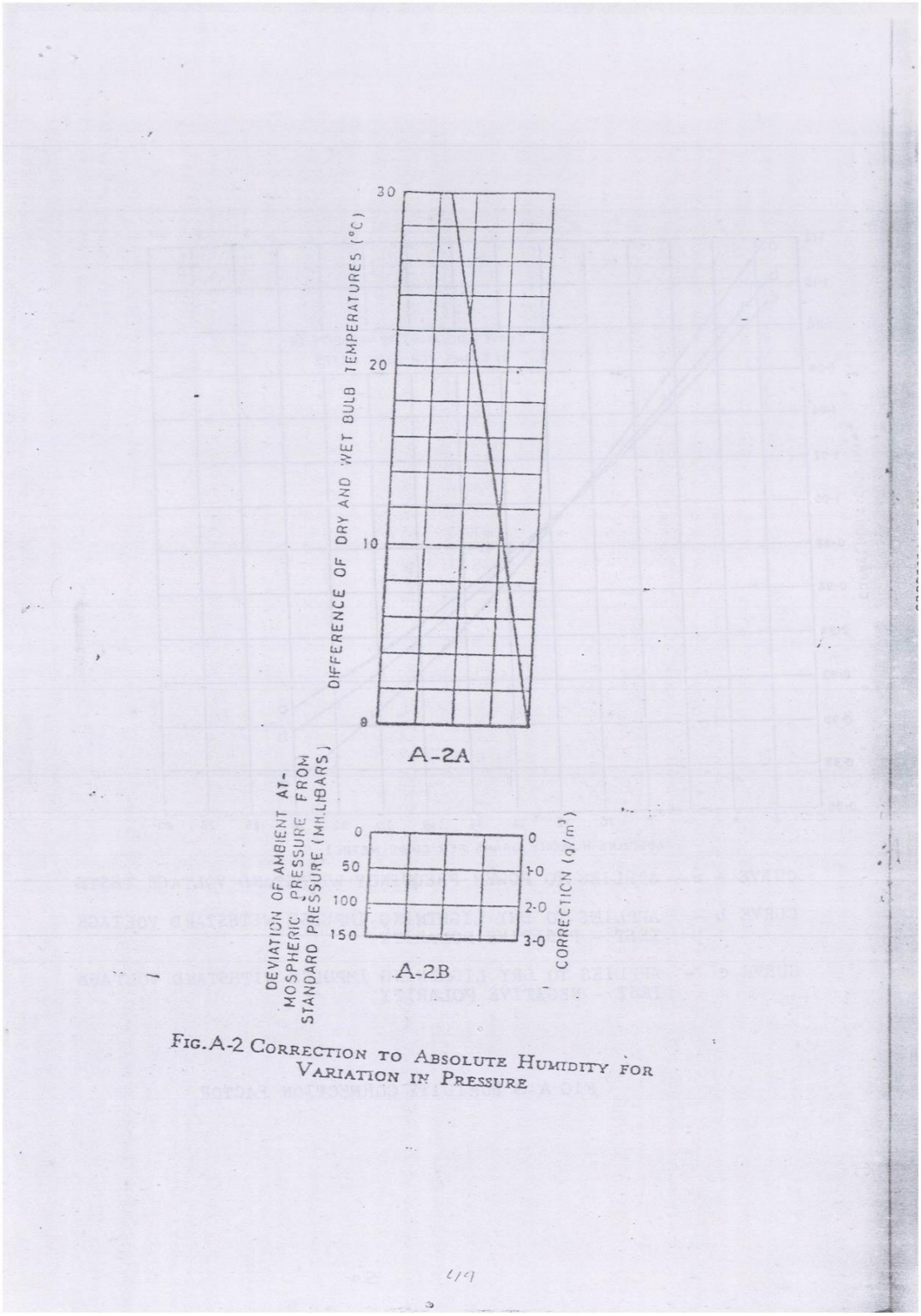
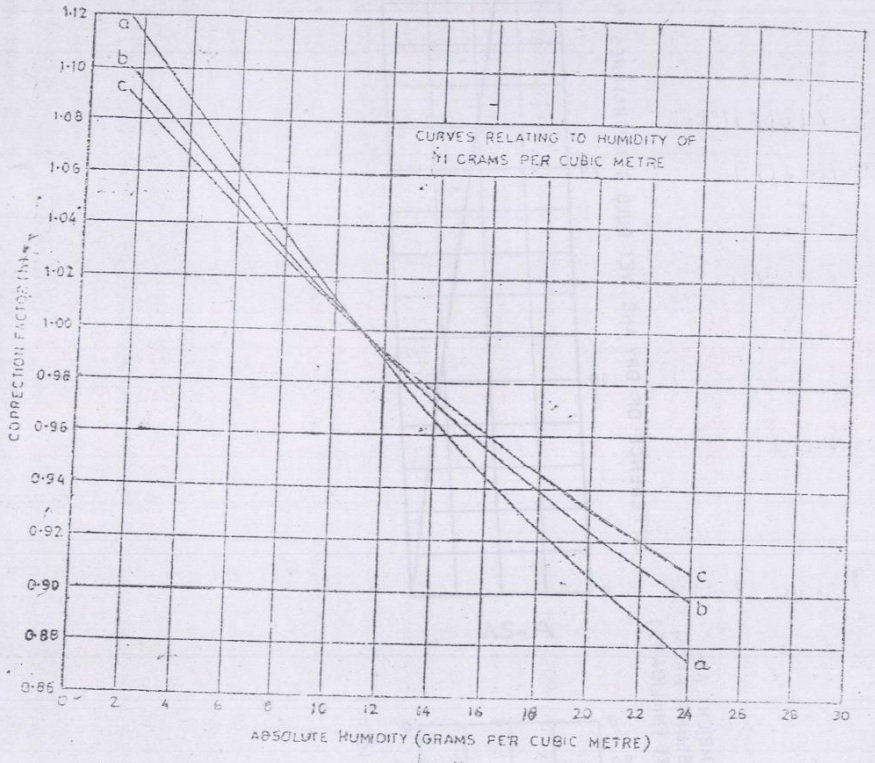


FIG. A-2 CORRECTION TO ABSOLUTE HUMIDITY FOR VARIATION IN PRESSURE



CURVE – a – APPLIES TO POWER FREQUENCY WITHSTAND VOLTAGE TESTS

CURVE b – APPLIES TO DRY LIGHTNING IMPULSE WITHSTAND VOLTAGE TEST – POSITIVE POLARITY

CURVE c – APPLIES TO DRY LIGHTNING IMPULSE WITHSTAND VOLTAGE TEST – NEGATIVE POLARITY

FIG A-3 HUMIDITY CORRECTION FACTOR

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