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नेपाल गुणस्तर
NEPAL STANDARD

METHOD OF TEST FOR CABLES

PART 9 MEASUREMENT OF SMOKE DENSITY OF ELECTRIC CABLES UNDER FIRE CONDITIONS

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METHOD OF TESTS FOR CABLES

PART 9 MEASUREMENT OF SMOKE DENSITY OF ELECTRIC CABLES UNDER FIRE CONDITIONS

1. Scope

This standard gives the test method for the measurement of smoke emitted when electric cables are burnt under defined conditions.

2. Significance

2.1. The assessment of smoke density is an important factor for evaluating the behavior of electric cables under fire conditions. The smoke evolved by one or more burning cables is not necessarily reflected by the testing of the individual components and, therefore, test method is recommended for cable assemblies.

2.2. This draft describes the test apparatus and the procedure, but leaves open the question of sample mounting. This is because further experiment is required in order to precisely define the best method for minimum dispersion of results with different operators.

2.3. The draft includes a proposal for standardizing the performance of the test chamber and equipment by the use of a blank test based on a defined volume of smoke.

3. Terminology

3.1. As given in NS 340 (Vocabulary-Cables, Conductors and Accessories).

4. Test Apparatus

4.1. The equipment shall comprise a cubic enclosure with inside dimensions of 3000±30mm and constructed for suitable material fixed into a steel angle frame. One side shall have a door, with a glass observation window. Transparent sealed windows (size 100 ± 10mm X 100 ±10mm) shall be provided on two opposite sides to permit the transmission of a beam of light from the horizontal photometric system. The distance from floor to the centre of these windows shall be 2150±100 mm (See fig:1 for plan view).

4.2. The walls of the enclosure shall include orifices for the passage of cables etc. and to permit the enclosure to be at atmospheric pressure. The total area of the orifices shall not exceed 50 cm^2. The enclosure should not be directly exposed to sunlight or extreme climatic conditions.

Note: It must be possible to extract fumes from the enclosure after each test through a duct fitted with valve which can be closed during the test. The duct may include a fan to increase the rate of extraction.

4.2.1. The ignition fluid shall be contained in a tray made from galvanized sheet metal with jointed edges, pyramidal trunk or rectangular section, and having the following interior dimensions:

Bottom	210 X ±10 x 110 ± 10 mm
Top	240 ± 10 X 140 ± 10 mm
Height	80± 10mm

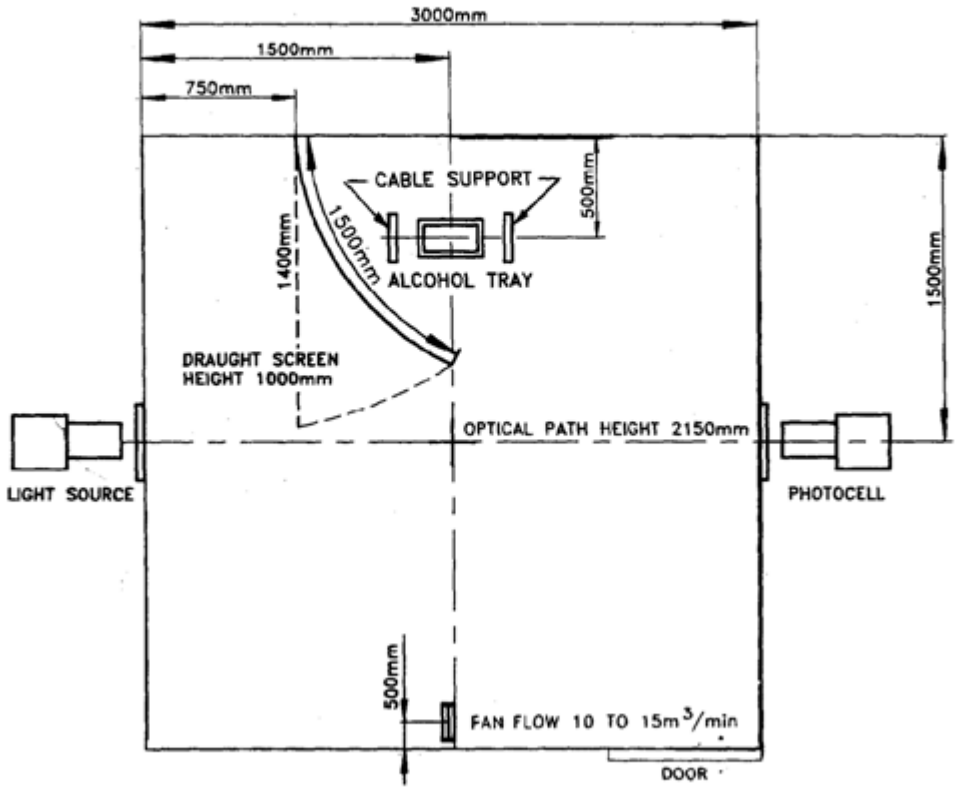


FIG. 1 PLAN VIEW OF TEST CHAMBER

4.2.2. The weight of the tray shall be approximately 250g.

4.2.3. The tray shall be supported on metal trestle.

4.3. *Smoke Mixing*

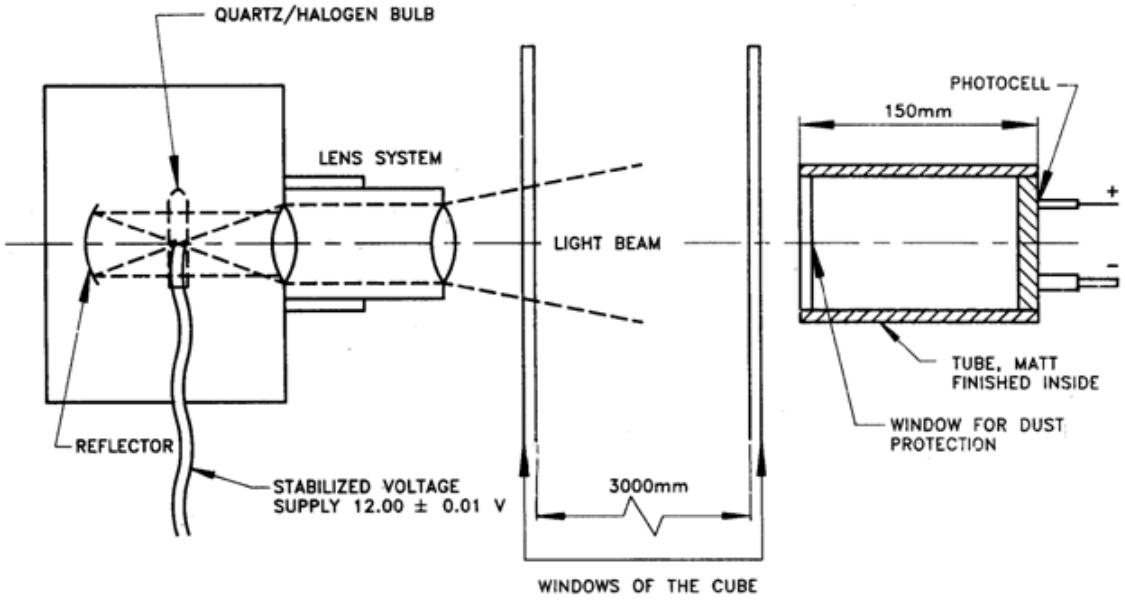
In order to ensure uniform distribution of the smoke, a table type fan shall be placed on the floor of the cube as shown in Fig 1. The fan shall have a blade sweep of 300 mm ±20 percent and a flow rate of 10 o 15 m^3/min. air shall be blown horizontally by the fan.

4.4. *Photometric System*

4.4.1. The photometric system is illustrated in Fig. 2. The light source and the receiver shall be placed externally in the centre of two opposite walls of the cube without making physical contact with these walls. The light beam shall traverse the cube through the glass windows in the side walls.

4.4.2. The light source shall be a halogen lamp with a tungsten filament with a clear quartz bulb, having the following characteristics:

Power	100 W
Stabilized Voltage	12±0.01 V
Nominal Luminous Flux	2000-2500 lumens
Nominal Color Temperature	2800-3200 k



Notes:

1. The light source and the photocell must be physically isolated from the walls of the cube.
2. The diameter of the cone of light on the opposite face from the source of approximately 1.5m.

FIG:2 PHOTOMETRIC SYSTEM

4.4.2.1. The lamp shall be mounted in a housing and the beam adjusted by lens system to give an evenly illuminated circular areas of diameter 1.5 ±0.1 m on the interior of the opposite wall.

4.4.3. The receptor photocell shall be mounted at one end of a 150 ± 10m tube with a dust protection window at the other end. The inside of the tube shall be matt black to prevent reflections. The photocell shall be connected to a potentiometric recorder to produce a linear proportional output. The sell shall be resistance loaded to operate in its linear range and the input impedance of the recorder should be at least 10 times greater than load resistance of the cell.

5. Material

5.1. Ignition Fluid

The ignition fluid shall be 1±0.01 liters of distilled alcohol, having the following composition:

Ethanol	90±1 percent
Methanol	4±1 percent
Water	6±1 percent

6. Test Specimen

6.1. The size and number of test pieces and their assembly is given in 6.2 to 6.4.

Note- The method of handling some samples of large diameter cables has been shown to influence the results significally. For example, identical cable selected from drums having differing barrel dimensions may produce different values of absorbance. Where more than one test piece is involved, it is essential to define their disposition and whether they are bound tightly or unbound or precisely spaced. Where cables are small, that is 10 mm in diameter, their disposition in the test assembly must be defined because a substantial number are normally involved offering many possible arrangements.

6.2. Lengths of cable, measuring 1000 ± 50mm shall be carefully straightened.

6.3. Number of Test Specimen

10 mm dia	Under Consideration
10 mm to 25mm dia	3
25 mm to 40 mm dia	2
40mm dia	1

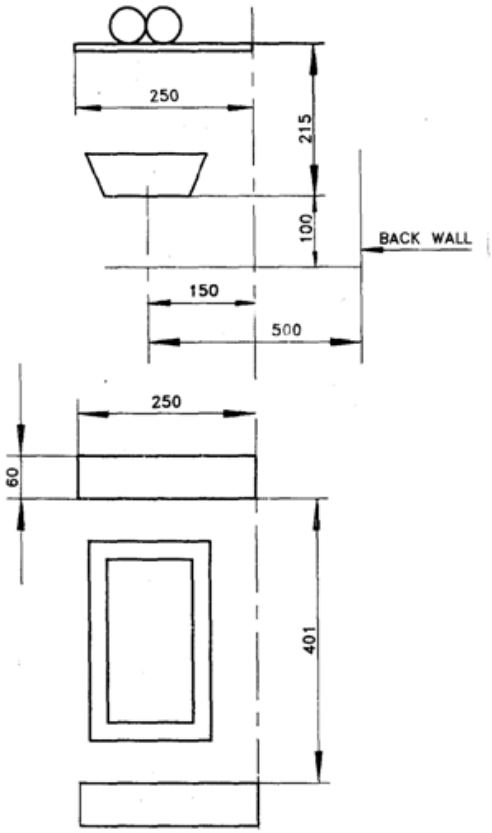


FIG. 3 METHOD OF SUPPORT OF TEST PIECE

6.4. *Assembly of Test Piece*

6.4.1. The assembly shall be tested as a flat horizontal unit placed symmetrically above the tray by means of vertical supports equipped with horizontal brackets (Fig.3) such that the vertical distance of the bottom of the test assembly from the bottom of the tray is 215 ±5mm.

6.4.2. The bundles or the individual test pieces shall be held together in close contact throughout the length. The binders shall be metallic and placed at the ends of 300 ± 20 mm from each end of the test piece.

7. Conditioning

7.1. The cable sample shall be conditioned for at least 24 hours at 27 ±2°C .

8. Procedure

8.1. *Calibration of the Test Equipment*

8.1.1. In order to ensure that results with different apparatus are comparable, it is essential to eliminate any dispersion in results caused by deviation in the test apparatus. A standardization procedure as given in Annex 'A' uses a defined density of smoke.

8.1.2. The photometric system is energized before the blank test (see 8.3). When stability has been attained, the zero and full scale reading of the recorder shall be adjusted to correspond respectively to 0 and 100 percent transmission of the light. The full reading of the recorder corresponding 100 percent transmission of the light represents l_o the initial transmittance.

Note- Periodically, it is necessary to verify the performance of the photocell by placing in the light beam standard neutral density filters which must cover the entire optical entry part of the photocell. The values of absorbance (or optical density) measured by the photocell must fall within ±5 percent of the standard values. The filters shall also permit the verification of linearity of response of the detector which must be proportional to the absorbance of light in the range used.

8.2. In order to avoid the effect of humidity deforming the absorbance level a blank test is carried out prior to any single test of series of tests carried out in rapid succession.

8.3. Ignite 1 ± 0.001 litre of alcohol (see 5.1) in the tray with no cables place. The door of the cube is left partly open to allow air to enter the enclosure. The cube shall then be purged of all combustion products by operating the extraction system.

8.4. The interior temperature of the test cube shall measure 30±5˚C prior to the beginning of each test.

8.5. The following series of operation are carried out:

a) Close the valve in the extraction system;
b) Place test piece on its support ;
c) Measure alcohol and pour into tray (see Fig .1):
d) Start the air circulation fan;
e) Ignite the alcohol, start chronometer and chart recorder; and
f) Close door.

8.6.

a) The test is finished when there is no change in light transmittance for 5 minutes after the source has extinguished;
b) Remove test piece for observation;
c) Purge the cube of combustion products prior to the next test; and
d) If no blank test is to be performed, it may be necessary to clean the windows of the photometric system to regain 100 percent transmission after stabilization of the voltage.

9. Tabulation of Observation

External Dia of Cable	Number of Cables n	Initial Light Transmittance l_o	Final Light Transmittance l_t

10. Calculation

10.1. The standard absorbance (A_0) is calculated as under:

Measured absorbance (A_m)= $\log_{10} \frac{lo}{lt}$

Standard absorbance across 1 meter cube:

$A_o = \frac{Am\ X\ cube\ factor}{n}$

Where cube factor= $\frac{Volume\ of\ cube\ (m3)}{Length\ of\ light\ path\ (m)}$

n= Number of individual cables.

11. Report

11.1. The result obtained are reported as under:

Designation of Material	Measured Absorbance	Standard Absorbance

11.2. The following criteria should be used in judging acceptability of smoke density rating data:

11.2.1. Repeatability

Two individual results (not average) determined by a single operator in one laboratory should not be considered suspect (at 95 percent confidence level) unless they differ by more than 18 percent absolute.

11.2.2. Reproducibility

Two results from different laboratories (based on the average of three tests) should not be considered suspect (at 95 percent confidence level) unless they differ by more than 15 percent absolute.

ANNEX A

(Clause 8.1)

CALIBRATION ON TEST APPARATUS

A-1 Preparation of Test Solution

A.1.1. Solutions of one litre of toluene mixed with the alcohol used for the test shall be made up in the following respective volume 4:96 and 10:90, using a pipette and a volumetric flask for accuracy of measurement.

A-1.2. Test Procedure

Follow the procedure for the bank test (8.3) noting the transmittance level (l_t) at the end of the test.

A-1.3 Verification Procedure

Calculate the measured absorbance (Am) as follows:

$$A_m = \log_{10} \frac{lo}{lt}$$

Where,

lo= Initial Transmittance,

Calculate the standard absorbance (Ao)

$$A_o = \frac{Am}{Percent\ toluence} \times \frac{Volume\ of\ cube\ (m3)}{Optional\ path\ length\ (m)}$$

Recommended values of $\bar{A}_o$ are:

4 percent Toluene	0.18 to 0.26
10 percent Toluene	0.80 to 1.20

Reference:

This Standards has been formulated based on **IS 10810 (Part 63) :1993 (Reaffirmed 2019) Methods of Test for Cables part 63 Measurement Of Smoke Density Of Electric Cables Under Fire Conditions.**