IS 10810-62 (1993): Methods of test for cables, Part 62: Fire resistance test for bunched cables [ETD 9: Power Cables]

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भारतीय मानक (Reaffirmed 2003)

केबलों की परीक्षण पद्धतियां

भाग 62 गुच्छेदार केबलों के लिए अग्नि प्रतिरोध परीक्षण

Indian Standard

METHOD OF TESTS FOR CABLES

PART 62 FLAME RETARDANCE TEST FOR BUNCHED CABLES

Power Cables Sectional Committee, ET 09 [Ref : Doc : ET 09 (2240/62)]

1 Scope

1.1 This standard covers the method for testing of a bunch of cables mounted vertically to determine their relative ability to resist flame propagation.

1.2 This standard recommends three test categories, these being assessed by the amount of combustible (non-metallic) material contained in one meter of bunched cables being tested.

2 Significance

2.1 The propagation of flame along a bunch of cables depends on a number of features, such as:

a) the volume of non-metallic material exposed to the fire and to any flame which may be produced by the combustion of the cables;

b) the geometrical configuration of the cables and their relationship to any enclosure;

c) the temperature at which it is possible to ignite gases emitted from the cables;

d) the quality of combustible gas released from the cables for a given temperature rise;

e) the volume of air passing through the cable installation; and

f) the construction of the cable, for example, armoured or unarmoured.

2.2 All of the foregoing assume that the cables are able to be ignited when involved in an external fire.

2.3 The fire test should demonstrate that the bunched cables do not propagate fire even if its outer covering and insulation have been destroyed in the area of flame impingement.

2.4 The objective of the fire test should be to approximately simulate the installation condition and provide consistent results.

3 Terminology

3.1 *Flame Retardance Bunched Cables*

The flame retardance bunched cables are those cables which do not propagate flame to the top of the cables after the flame source is removed and are self extinguishing to prove their relative ability to resist fire propagation.

4 Test Apparatus

4.1 The test apparatus (*see* Fig. 1A) should comprise of vertical test chamber having a width of 1 000 ± 100 mm, a depth of 2 000 ± 100 mm and height of 4 000 ±100 mm and the floor of the chamber should be raised 150±10 mm above the ground level. The test chamber should be nominally airtight along its sides, air being admitted, without any substantial obstruction, at the base of the test chamber through an aperture of 800± 20 mm x 400 ± 10 mm situated 150 ± 10 mm from the front wall of the test chamber.

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Price Group 6

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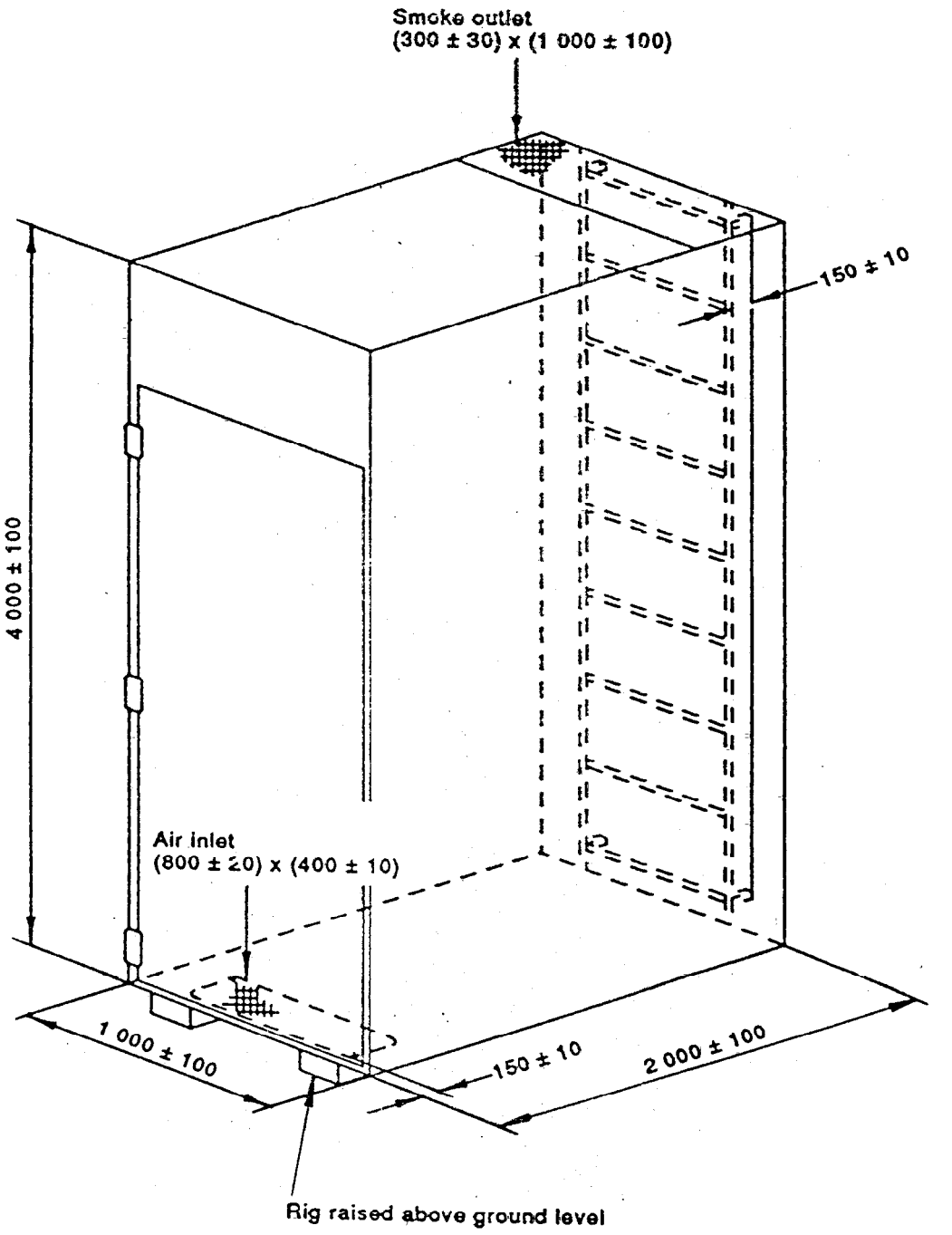
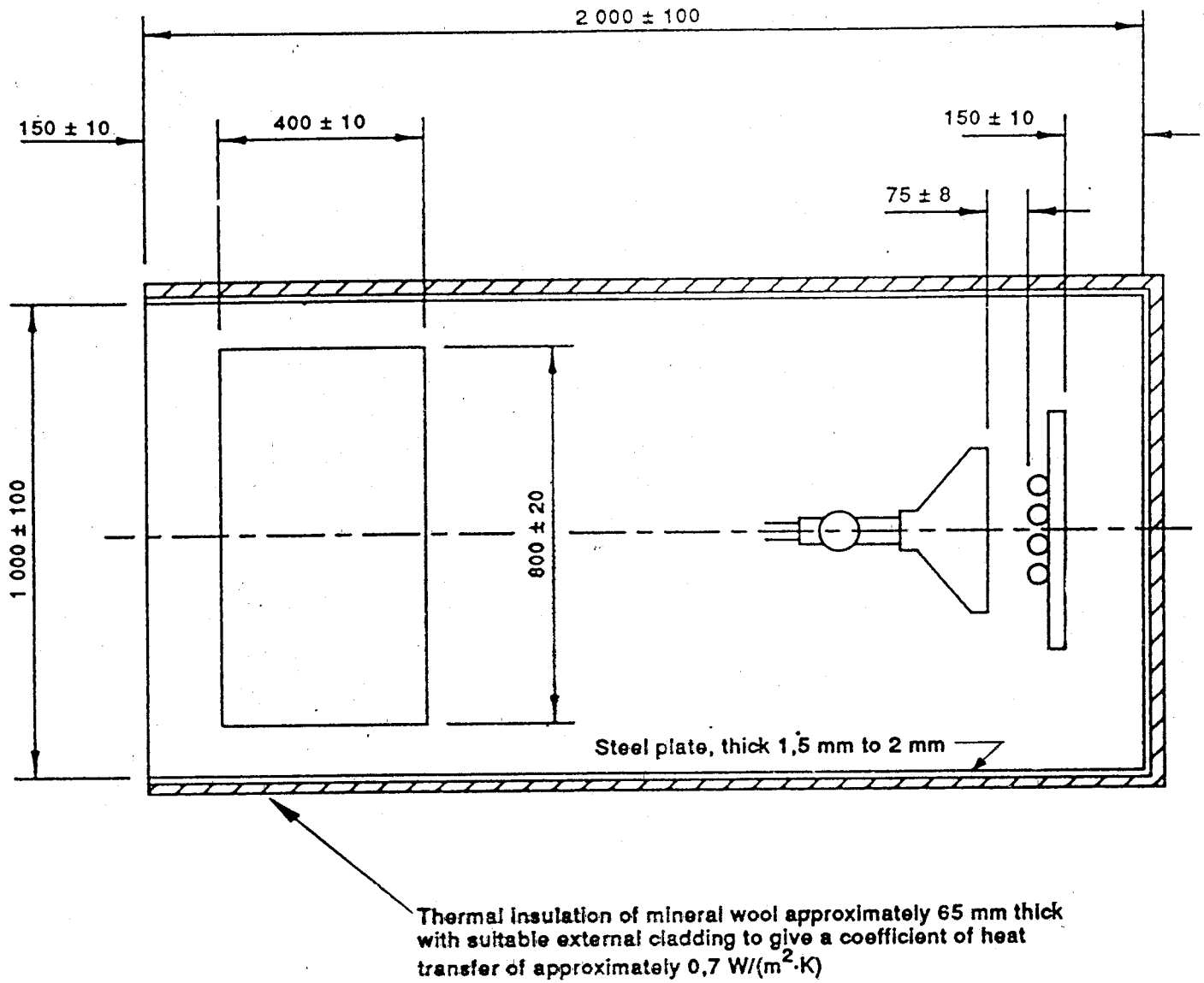


All dimensions in millimetres.

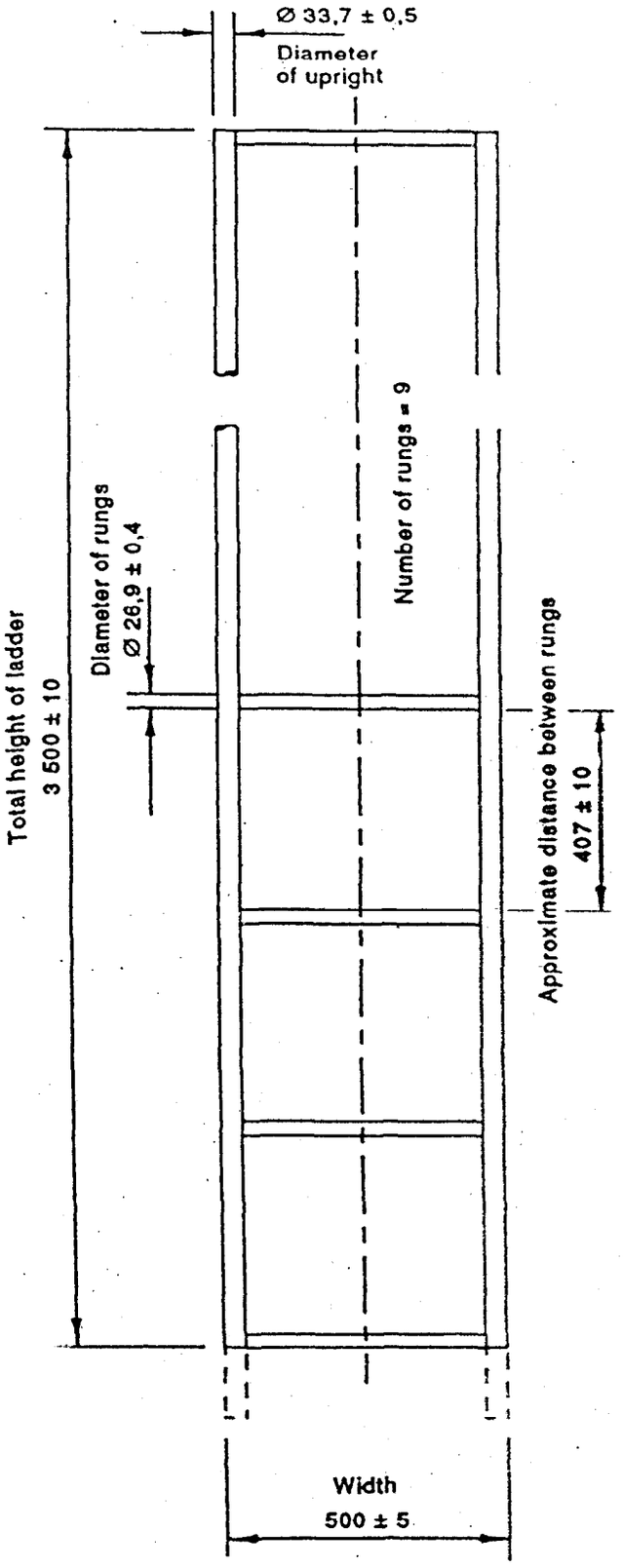
FIG. 1A FLAME TEST APPARATUS (RIG)

4.2 An outlet 300 ± 5 mm x 1 000 ± 10 mm should be made at the rear edge of the top of the test chamber. The back and sides of the test chamber should be thermally insulated to give a coefficient of heat transfer of approximately 0.7 W/ (M^2K). For example, a steel plate 1.5 mm thick covered with 65 mm of mineral wool with a suitable external cladding is satisfactory (*see* Fig. 1B). The cables to be tested should be fixed to a suitable steel ladder (*see* Fig. 2A or 2B) mounted within the test chamber such that the distance between the ladder and the rear wall of the chamber is 150 ± 10 mm.



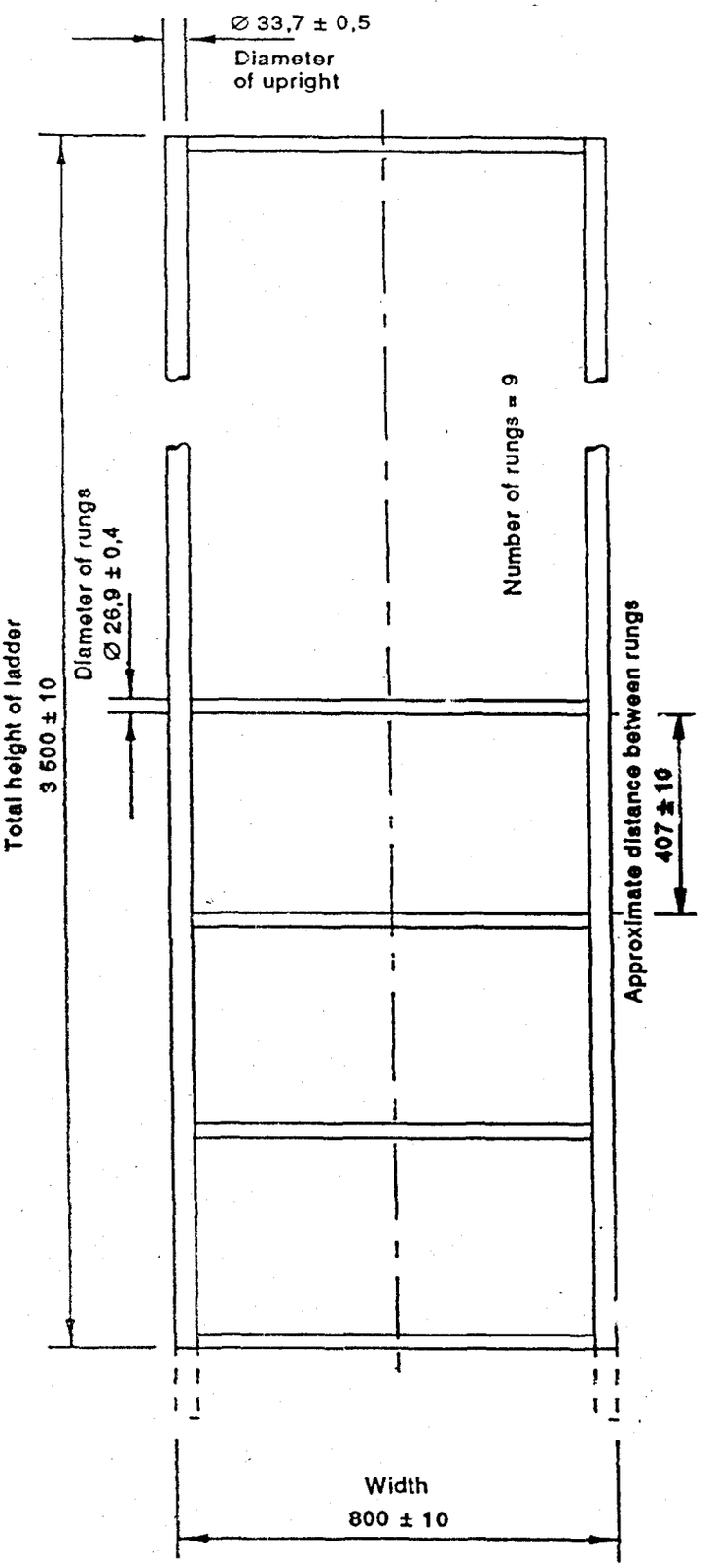
All dimensions in millimetres.

FIG. 1B THERMAL INSULATION OF BACK AND SIDES OF THE TEST CHAMBER



All dimensions in millimetres.

FIG. 2A STANDARD TUBULAR LADDER FOR CABLE TEST



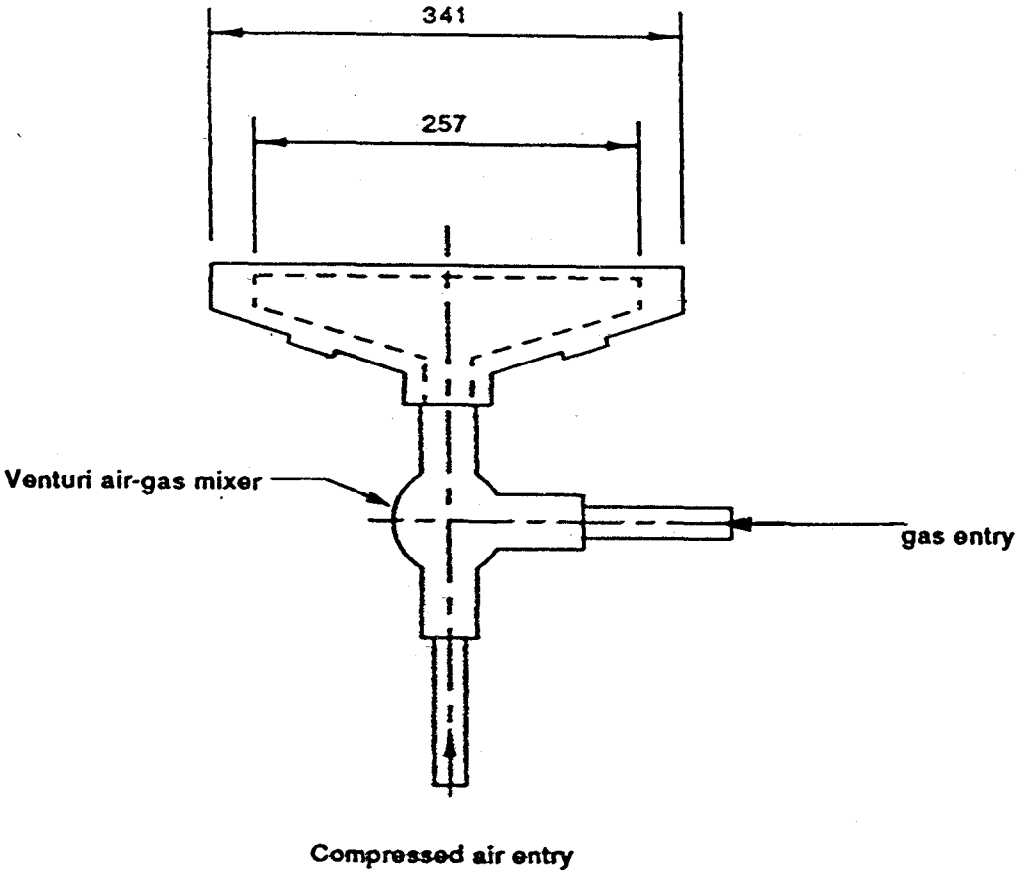
All dimensions in millimetres.

FIG. 2B WIDE TUBULAR LADDER FOR CABLE TEST

4.3 Smoke cleaning attachment, if used, should be such as to collect the smoke leaving the chamber but not cause a change in the air flow rate through the test chamber.

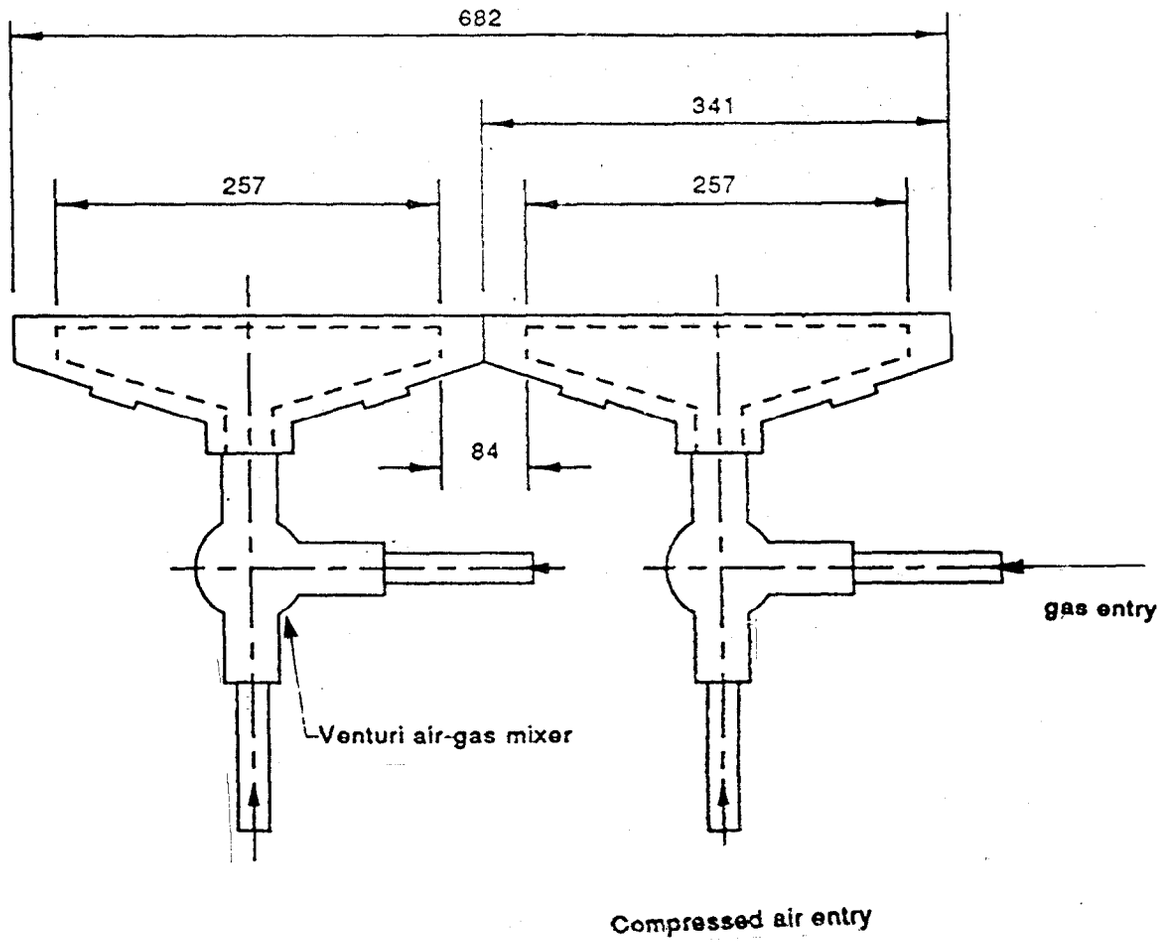
5 Ignition Source

5.1 The ignition source should be one or two ribbon type LPG burners whose flame producing surface consists of a flat metal plate 341 mm long and 30 mm wide through which 242 holes of 1.32 mm in diameter are drilled on 3.2 mm centres in three staggered rows of 81, 80 and 81 holes each to form an array having the nominal dimensions 257 mm x 4.5 mm as shown in Fig. 3A and 3B. As the burner plate may be drilled without the use of a drilling jig the spacing of the holes may vary slightly. Additionally, a row of small holes may be milled on each side of the burner plate to serve as pilot holes with the function of keeping the flame burning.



All dimensions in millimetres.

FIG. 3A BURNER



All dimensions in millimetres

FIG. 3B BURNERS

5.2 The burner should be fitted with an accurate means of controlling the input of fuel and air to the burner (*see* Fig. 4). For the purpose of this test the air shall have a dew point not higher than 0°C and the input should be 76.7 ± 4.7 litres per minute, the LPG flow rate should be 9.56 ± 0.5 litres per minute (*see* Note 1) at one atmosphere and ambient temperature to provide a nominal 70 000 ± 1 600 BTU/hour.

NOTES

1 Gross calorific value of LPG is 122 BTU/litre, required heat for the test is 70 000 BTU/hour, therefore, required LPG flow rate is:

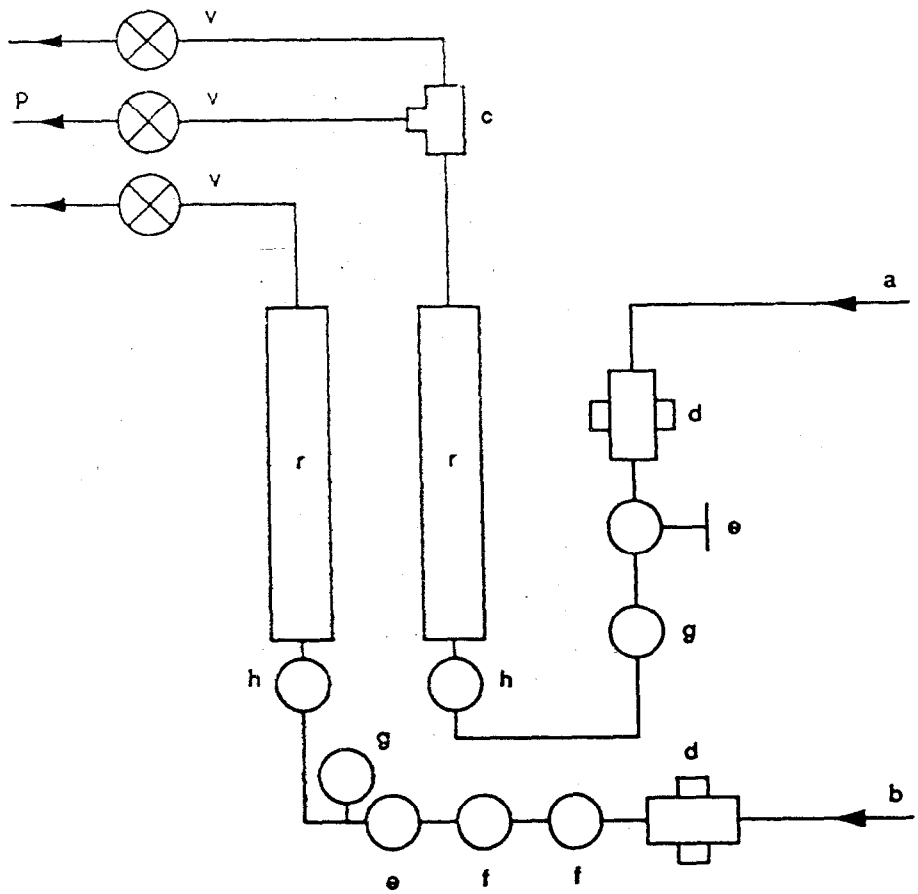
$$\frac{20\,000}{122} = 573.8 \text{ litres/hour}$$

or

$$\frac{573.8}{60} = 9.56 \text{ litres/minute}$$

The flow rate of LPG of 9.56 litres/minute is equivalent to the flow rate of 13.3 litres/minute of propane gas, in order to achieve heat of 70 000 BTU/hour.

2 The calibration of the LPG rotameter should be checked after installation with a mass flow meter to ensure that the pipe work and the venturi have not affected the calibration. Corrections for variations in temperature and pressure from that specified on the LPG rotameter should be applied when necessary.



For lines to the flowmeter and pilot flame. 1/4 inch or 8 mm outer diameter is suitable.
For air and propane to the burner 15 mm outer diameter is suitable.
Ignition transformer and a safety switch for the solenoid valve will complete the ciruitry.

KEY

a Propane input
b Air input
c Reducing tee-piece
d On/off valve
e Pressure regulator
f Filter
g Pressure gauge
h Control valve
r Flowmeters (rotameter type)
v solenoid valve
p Pilot line (optional)

FIG. 4 TYPICAL EXAMPLE OF GAS FLOW CONTROLS

6 Test Specimen

6.1 The specimen should comprise a number (*N*) of pieces of cable each 3.5 m long. The guidance for calculation of *N* is given in Annex A.

6.2 The total number of 3.5 m lengths of cable in the test sample should be in accordance with one of the three categories as follows:

Category A – The number of cable lengths required to give a total volume of non-metallic material of 7 litres per metre.

Category B – The number of cable lengths required to give a total volume of non-metallic material of 3.5 litres per metre.

Category C – The number of cable lengths required to give a total volume of non-metallic material of 1.5 litres per metre.

Note —When calculating the number of cable lengths in the test sample, the values should be rounded to the nearest whole number.

7 Conditioning

7.1 The cables mounted on the ladder shall be conditioned at room temperature for 3 hours before commencing the test. The chamber should be dry.

8 Procedure

8.1 *Guidance on Cable Selection*

The limited capacity of the ladder necessitates consideration of the cable size selected for testing to ensure that the volume of non-metallic material may be accommodated within the prescribed method of mounting. For this purpose, four categories of mounting procedures have been prescribed. Their nomenclature are:

AF/R, AF, BF, CF

8.1.1 The following selecton criteria shall be applicable for cable size larger than 35 mm^2.

8.1.1.1 *Category AF/R*

The size of cable selected shall not require more than the capacity of 300 mm on each side of the ladder width including half one cable diameter but not exceeding 20 mm space.

8.1.1.2 *Category AF*

The size of cables selected shall not require more than the capacity of 600 mm of ladder width including half one cable diameter but not exceeding 20 mm space.

8.1.1.3 *Category BF*

The size of the cable selected shall not require more than the capacity of 300 mm of ladder with including half one cable diameter but not exceeding 20 mm space.

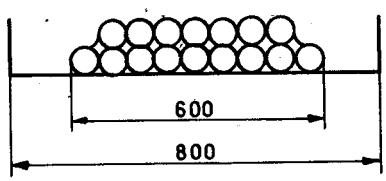
8.1.1.4 *Category CF*

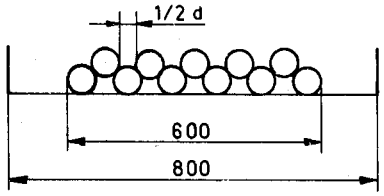
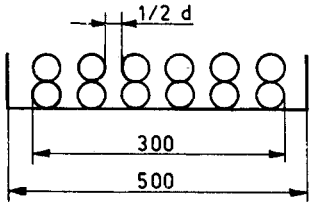
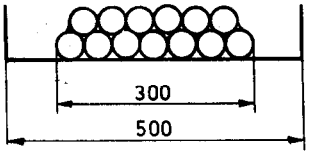
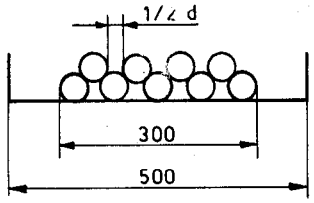
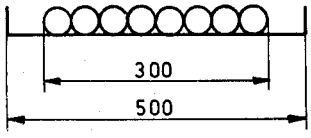
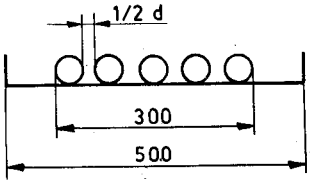
The size of cable selected shall require at least 2 cables to be mounted.

8.1.2 For cable sizes equal to or smaller than 35 mm^2 and also for telephone cables, there is no restriction on conductor size selected for all the three categories of non-metallic material.

8.2 *Method of Mounting the Test Sample*

The method of mounting of test sample of all categories shall be as follows.

Volume	*Cable Size*	*Category*	*Cable Arrangement*
7 Litre	Up to 35 sq mm	AF	

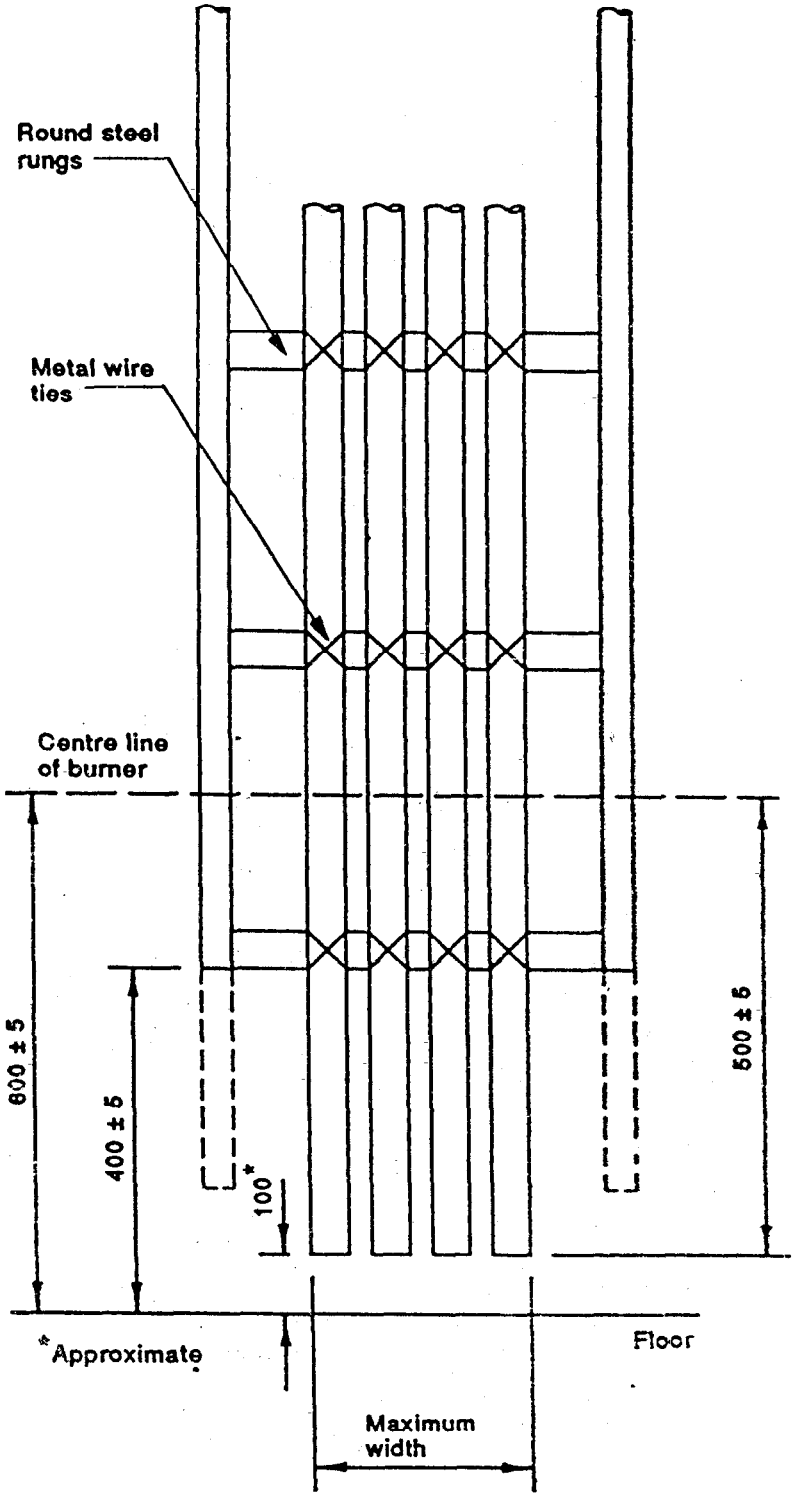
Volume	*Cable Size*	*Category*	*Cable Arrangement*
	Above 35 sq mm	AF	
		AF/R	
3.5 litre	Up to 35 sq mm	BF	
	Above 35 sq mm	BF	
1.5 litre	Up to 35 sq mm	CF	
	Above 35 sq mm	CF	

Notes

1 All dimensions are in millimetres.

2 For samples of sizes up to 35 sq mm touching formation has been specified. While for cables of sizes above 35 sq mm, formation with specified gap of 1/2 of the diameter (*d*) of single cable, not exceeding 20 mm is specified.

3 For arrangement of test samples on the ladder, *see* Fig. 5.



All dimensions in millimetres.

FIG. 5 ARRANGEMENT OF TEST SAMPLE ON LADDER

8.2.1 *Method of attachment*

For cable having a conductor cross section exceeding 35 mm^2, each cable is attached individually to each

rung of the ladder by means of a metal wire between 0.5 and 1.0 mm diameter.

In all other cases, the same method is used whenever possible, for example, cables mounted in a single layer, but in this case, the wires are placed obliquely across the layer.

If several layers are required to make up a bunch, the cables are attached in discrete bunches of a width equal to 5 cables using the specified metal wire, each separate bunch being attached to that adjacent by the outer cable pieces.

For consistency, especially for small diameter cables, for example, < 35 mm^2, it is recommended that discrete bunches touching are secured together at every rung.

8.2.2 *Positioning of test specimen*

For cables having a conductor cross-section not equal to or less than 35 mm^2, the cables are placed touching on the front of the ladder so as not to exceed 300 mm in width, there being a minimum distance of 50 mm between the edges of the bunched cables and the ladder uprights.

Cables, having conductor cross section greater than 35 mm^2, are attached to the front of the ladder in a single layer with a space between each cable of 0.5 x cable diameter by this space may not exceed 20 mm. The gaps etween the ladder upright and the edge of the cable for different categories shall be as follows:

For categories AF and AF/R the gap between the ladder upright and the edge of the cable should be atleast 100 mm. For category AF/R where the number of cable *N*, is such that the bunch width exceeds 300 mm, the remaining cables are to be mounted on the rear of the ladder starting from the centre.

For categories BF and CF the gap between the ladder upright and the edge of the cable is 50 mm.

8.3 *Positioning of Ignition Source*

The burner should be arranged horizontally at a distance of 75 ± 5 mm from the front surface of the cable sample and 600 ± 5 mm above the floor of the test chamber. The point of application of the burner flame should lie in the centre between two cross-bars on the ladder and at least 500 mm above the lower end of the sample. When two burners are used in tandem, they shall be positioned as shown in Fig. 3B.

8.4 *Test Conditions*

8.4.1 The test should not be carried out if the external wind speed measured by an anemometer fitted on the top of the test chamber is greater than 8 m/s, and if the temperature of the walls of the chamber is below 5°C or above 40°C measured at a point 1 500 mm above floor level, 50 mm from a side wall and 100 mm from the door. The cabin door shall be closed throughout the test.

8.4.2 The air flow to the chamber through the 800 ± 20 mm x 400 ± 10 mm aperture at the base, shall be regulated at a constant rate of 5 ± 0.5 m^3/min at a constant controlled temperature of 20 ± 10°C. These measurements shall be monitored throughout the test and the air flow measurements close to the device taken on the inlet side.

8.5 *Time of Applicable of Flame*

In the case of cable sample in category A and category B, the test flame shall be applied for 40 minutes. The cable samples in category C should have the test flame applied for 20 minutes.

8.6 After burning has ceased or after a maximum time of 1 h from the completion of the test flame period, the flame shall be extinguished and the cable wiped clean.

All soot is to be ignored if, when wiped off, the original surface is undamaged. Softening or any deformation of the non-metallic material is also to be ignored. The extent of the damage is measured from the bottom edge of the burner to the onset of char, which is defined as follows:

Press against the cable surface with a sharp object, where the surface changes from a resilient to a brittle (crumbling) surface, indicates the onset of char.

9 Retest Procedure

9.1 In the case of doubt, two further tests shall be undertaken as detailed in **8**. The test shall be deemed to be satisfactory, if both tests meet the requirements.

10 Tabulation of Observation

Category of Cable	*No. of Cable Length*	*Period of Application of Flame (Min)*	*Length of Affected Portion (n)*

11 Calculation

11.1 No calculation is involved.

12 Report

Designation of Material	*Length of Affected Portion (M)*

12.1 *Conclusion*

Specimen meets/does not meet the requirements of the specification.

ANNEX A

(*Clause* 6.1)

NUMERICAL DETERMINATION OF TEST PIECES

A-1 In order to calculate the number of test pieces, it is necessary to determine the volume per metre of non-metallic material.

A-2 A cable sample, the length of which shall not be less than 0.3 m, is carefully cut to ensure that the surfaces are at right angles to the cable axis, thus enabling precise measurements of the length L of the test piece.

A-3 Each non-metallic material C_i constituting more than 5 percent by weight of all non-metallic materials shall be extracted from the test piece and weighed.

A-4 Where semi-conducting screen cannot be removed from the insulating material, the components may be considered as one for the purposes of measuring their weight and density. In the case of non-metallic tape the volume may be calculated from the geometrical dimensions in preference to weight and density.

A-5 The density of each non-metallic component shall be measured using relevant standard method. Fibrous components (tapes or textiles) shall be assumed to have an effective density of unity.

A-6 The volume V_i (litres per metre of cables) of each non-metallic material C_i is calculated as follows:

$$V_i = \frac{M_i}{P_i \times L}$$

M_i being the mass of the component C_i (kg) and P_i being the density of the component C_i (kg/dm^3).

A-7 The total volume V, of the non-metallic materials contained in one metre of cable is equal to the sum of the individual volumes.

A-8 The number of test pieces to be mounted is obtained by dividing the volume per metre of the test category specified in **6**, by the total volume of non-metallic material per metre of cable.

EXPLANATORY NOTE

In preparing this standard, assistance has been derived from IEC Pub 332-2(1982) and its draft revision, IEC Doc : 20(Sectt) 242.

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