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BUREAU OF INDIAN STANDARDS

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भारतीय मानक मसौदा

भवन निर्माण उपकरणों या भवन संरचनाओं में उपयोग की जाने वाली ताप रोधन सामग्रियो के लिए अग्नि प्रदर्शन — परीक्षण पद्धती

(IS XXXX)

Draft Indian Standard

Fire Performance for Thermal Insulation Materials to be Used in Building Equipment or Building Structures — Method of Test

(IS XXXX)

ICS 91.100.60

Thermal Insulation Sectional Committee, CHD 27	Last Date for Comments: 10 March 2025

Thermal Insulation Sectional Committee, CHD 27

FOREWORD

(*Formal clause will be added later*)

The sectional committee responsible for formulation of standards on thermal insulation decided to formulate this standard for testing fire propagation for the thermal insulation materials being used in building equipment and building structures. This standard is being formulated keeping, the increasing demand of these materials, in view.

This test method provides details regarding fire performance of the material and classifies the material in Class '0' fire rating category and to be used in conjunction with IS 13286.

The test results as per this standard relate only to the behavior of the test specimens of the product under the specified conditions of test and they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

In reporting the result of the test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'.

Draft Indian Standard

FIRE PERFORMANCE FOR THERMAL INSULATION MATERIALS TO BE USED IN BUILDING EQUIPMENTS OR BUILDING STRUCTURES — METHOD OF TEST

1 SCOPE

1.1 This Indian Standard checks the Fire Performance of the material and classifies the product in Class '0' Fire Rating by prescribing the method of test for fire propagation for thermal insulation materials in addition to the testing of material as per IS 13286 for Surface Spread of Flame.

1.2 This test can be carried out only after the material has passed the test for Class '1' Fire Rating as per IS 13286 – Surface Spread of Flames.

1.3 The material shall be classified as Class '0' if the material is a Class 1 material as per IS 13286 and has a Fire Propagation Index *I* of not more than 12 and Sub-Index i_1, of not more than 6 as per test method described herewith.

2 REFERENCES

The standards given below contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
IS 3069 : 2020	Glossary of terms, symbols and units relating to thermal insulation materials (*second revision*)

3 TERMINOLOGY

For the purpose of this standard, the terms and definitions given in IS 3069 and the following shall be apply.

3.1 Assembly

A fabrication of materials and/or composites that can contain air gaps.

3.2 Calorific Value

Quantity of heat produced by complete combustion, at a constant pressure of 1.013 25 bar, of a unit volume or mass of gas, the constituents of the combustible mixture is being taken at reference conditions and the products of combustion being brought back to the same conditions.

NOTE

1) In the gross calorific value, water produced by combustion is assumed to be condensed.

2) In the net calorific value, water produced by combustion is assumed to be in the vapor state.

3.3 Composite

A combination of materials which are recognized in building construction as discrete entities, e.g. coated or laminated materials.

3.4 Essentially Flat Surface

A surface from which the specimens having an irregularity of less than ± 3 mm from a flat plane can be obtained.

3.5 Exposed Surfaces

The surfaces of the product subjected to the heating conditions of the test.

3.6 Fire propagation Index

A comparative measure of the contribution to the growth of fire made by an essentially flat material, composite or assembly. It is primarily intended for the assessment of the performance of internal wall and ceiling linings.

3.7 Wobbe Index

Ratio of the calorific value of a gas per unit volume and the square root of its relative density under the same reference conditions. It can be expressed either in MJ/m^3 of dry gas under the reference conditions or MJ/kg of dry gas.

4 SUITABILITY OF A PRODUCT FOR TESTING

4.1 Surface Characteristics

4.1.1 A product having one of the following is suitable for evaluation by this method.

a) a flat exposed surface (*see* **3.4** and **3.5**);
b) a surface irregularity which is evenly distributed over the exposed surface (*see* **A-1**) provided that;
   1) at least 50 percent of the surface of a representative square area of 225 mm × 225 mm lies within a depth of 6 mm from a plane taken across the highest points on the exposed surface.
   2) any cracks, fissures or holes does not exceed 7.5 mm in width nor 10 mm in depth, and the total area of such cracks, fissures or holes at the surface does not exceed 30 percent of a representative square area of 225 mm× 225 mm of the exposed surface.

4.1.2 When the requirements of **4.1.1** a) or **4.1.1** b) does not comply with an exposed surface, the product may be tested in a modified form with a flat exposed surface and this shall be stated in the test report.

4.2 Asymmetrical Products

A product which may have faces that differ or may contain laminations of different materials arranged in a different order in relation to the two faces. If either of these faces can be exposed in use within a room, void or cavity, then both faces shall be subjected to the test.

4.3 Products with Particular Burning Characteristics

For assessing products that react in specific ways under exposure to the specified heating conditions (*see* **10.2**), this method may be unsuitable. In this case, provision is either made to apply a suffix to the result (*see* **11.4.2** and **12 (g)**), or prohibit assessment because the product is unsuitable for testing by this method (*see* **11.4.3**).

5 TEST SPECIMENS

5.1 Number of Specimens

The test sample shall comprise minimum of three and a maximum of five specimens for each face to be tested.

5.2 Size of Specimens

Note — Specific advice on the testing of assemblies is also given in **A-2** and Annex B below.

5.2.1 The specimens shall be in square shape, with sides 225 mm ± 1.5 mm long.

5.2.2 Products of normal thickness 50 mm or less shall be used. If the products have normal thickness greater than 50 mm, the specimens shall be obtained by cutting away the unexposed face of the product to reduce the thickness to 50^{+0}_{-3} mm.

5.3 Edge Effects

Where the specimen is backed by an air gap (*see* Annex B), it shall be ensured that the perimeter of the specimen does not permit the flame to penetrate into the cavity. Similarly, where a surface is applied with a flame-retardant coating, the edge detail shall be such as to prevent ignition of the underlying layers.

5.4 Conditioning of Specimens

All the specimens shall be conditioned to constant mass (*see* **A-3**) at a temperature of 27 °C ± 2 °C and a relative humidity of (65 ± 5) percent, and maintained in this condition until required for the testing.

NOTE — Constant mass is considered to be attained when two successive weighing operations, carried out at an interval of 24 h, do not differ by more than 0.1 percent of the mass of the specimen, or 0.1 g, whichever is the greater.

6 TEST APPARATUS

6.1 General

6.1.1 All dimensions given in the following description of the test apparatus are nominal unless tolerances are specified.

6.1.2 The test apparatus (*see* fig. 1, 2 and 3) shall consist of a combustion chamber with a specimen holder fixed to one face. The combustion chamber shall contain two electrical heating elements and a horizontal gas burner tube and shall be surmounted by cowl and a removable steel chimney.

6.2 Combustion Chamber

The walls of the chamber shall be made from 12 mm thick calcium silicate board having a nominal dry density of 1 400 kg/m^3. The calcium silicate shall also have the following properties:

Properties	Value
Flexural strength	23 MPa
Hardness	80 Shore D
Maximum service temperature	1 000 °C
Thermal conductivity	0.49 W/m K
Shrinkage (750 ºC for 12 h)	0.14 percent to 1.1 percent
Coefficient thermal expansion	6.6×10^{-6}

The internal dimensions of the chamber shall be 190 mm × 190 mm × 90 mm.

An air inlet slot measuring 96 mm × 25 mm and mica observation window measuring 50 mm × 50 mm shall be provided together with a hole for the discharge of combustion gases and a suitable fixing for the chimney and cowl. A steel baffle plate 200 mm × 40 mm shall be fixed horizontally to the top of the combustion chamber above the window. Four steel rods shall be fitted to combustion chamber to enable the specimen holder to be located and fixed firmly in position during each of the test.

6.3 Specimen Holder

The specimen holder shall be made from calcium silicate board having the same dry density and properties as that of the walls of the combustion chamber (*see* **6.2**). The holder shall be recessed to take the specimen of area 225 mm × 225 mm and a recess depth of 12.5 mm, 25 mm or 50 mm, depending upon the thickness of the specimen which has to be tested.

6.4 Gasket

1 mm thick non-combustible compressible gasket, shall be provided for interposing between the specimen holder and the combustion chamber to assist in obtaining an adequate seal (*see* **A-2**).

6.5 Chimney and Cowl

The chimney shall have 38 mm internal diameter and 190 mm long and made of 1 mm thick steel. It shall be provided with a removable steel cowl also made of 1.0 mm thick steel, 76 mm internal diameter and 152 mm high having two diametrically opposite bushed circular holes to take the thermocouples and their locating devices as specified in fig. 3. The chimney and cowl shall have a low reflectivity surface and shall have an overall mass in the range of 530 g to 550 g (*see* **A-4.3**).

6.6 Gas Burner

The gas burner shall comprise of a horizontal stainless steel tube of wall thickness 1.5 mm and 9 mm bore closed at each end and fitted with a central gas supply pipe. The burner tube shall have a row of 14 holes of 1.5 mm diameter at 12.5 mm centres arranged so that the gas jets impinge horizontally on the specimen 25 mm above the floor of the combustion chamber. When the calibration sheet (*see* **9.1**) is in position, the holes in the tube shall be 3^{+1}_{-0} mm from the face of the calibration sheet.

6.7 Electric Heating Elements

The two heating elements shall be pencil type electric elements, each of 1 000 W rating and of 16 mm maximum diameter. The heating coil shall be 190 mm in length with a pitch of approximately 1 turn per mm. The elements shall be supported horizontally with their centres at a distance of 45 mm from the face of the specimen and arranged at 64 mm vertical centres symmetrically in the combustion chamber. Each heating element shall be enclosed in a transparent silica tube of 17 mm ± 1 mm internal diameter, having a wall thickness of 1.1 mm ± 0.25 mm and a length of 210 mm ± 2 mm. The heating elements shall be connected in parallel with copper busbars and the end terminals shall be protected with suitable guards that, if made of metal, shall be effectively earthed. The framework of the apparatus, including the chimney and the cowl, shall be earthed.

6.8 Thermocouples

The thermocouples shall be 0.2 mm diameter nickel chrome/nickel aluminium conductors contained in a 1 mm diameter mineral insulated 18-8 stainless steel sheath with a grounded hot junction. They shall be provided with aluminous porcelain insulators (not recrystallized alumina) of 1.3 mm bore, 3.5 mm external diameter and 50 mm length. Provision shall be made to ensure that the extreme tips of the sheaths containing the hot junctions of the thermocouples are correctly located 3 mm beyond the ends of the insulators and midway between the inside of the cowl and the outside of the chimney (*see* **A-4.4** and Fig.3).

7 ANCILLARY EQUIPMENT

7.1 Manometer

The manometer shall be capable of being read to within an accuracy of 0.05 kPa and capable of reading up to at least 1.0 kPa.

7.2 Gas Flowmeter

The flowmeter shall be a direct-reading instrument graduated in l/min with a maximum flow not greater than 5 l/min and capable of being read to an accuracy of 0.05 l/min. It shall be calibrated for use with a gas whose relative density to air at 15 ℃ and 0.75 kPa is 0.365, and shall have an accuracy of ± 2 percent of maximum flow.

7.3 Gas Pressure Regulating and Control Valves

The valves vary according to the type of flowmeter used but shall be capable of maintaining the flow of gas to the flowmeter at the levels and pressure specified in **8.2**.

7.4 Millivolt Temperature Indicator

An indicator shall be provided which is capable of monitoring the millivolt output of the thermocouples. This shall be either a digital or potentiometric device which is precalibrated to be capable of indicating temperatures to the nearest 1 ℃and shall have a response time no worse than 10 ms/℃ (1 s/100 °C). It may be provided with means for cold junction compensation but if this is not provided, it shall be capable of negative readings (capable of indicating that the hot junctions of the thermocouples are at a lower temperature than their cold junctions). A suitable potentiometric chart recorder is a multi-range recorder capable of operating in the ranges –25 ℃ to + 225 ℃ (–1 mV to +9 mV) and –100 ℃ to +900 ℃ (–5 mV to +45 mV) with an accuracy of 0.5 percent of full scale deflection.

A single-range chart recorder shall not be used unless it has resolution comparable to that of the multirange recorder and an accuracy described above.

7.5 Wattmeter

The wattmeter shall be capable of measuring up to 2 kW with an accuracy of ± 2 percent, and shall be of a type that integrates amperage and voltage and does not assume constant voltage input.

7.6 Variable Transformer

The variable transformer shall be capable of handling a maximum of 2 kVA and of regulating the voltage output from zero to a maximum value equal to that of the input voltage. The voltage output shall vary linearly over the range.

7.7 Electric Oven

The oven shall be capable of maintaining a temperature of 103 °C ± 2 °C, and shall be of sufficient size to accommodate the calibration sheet (*see* **9.1**).

7.8 Gas Igniter

A commercially available battery-powered gas igniter operating on a heated coil or continuous spark is suitable.

7.9 Desiccator

The desiccator (or desiccating cabinet), required to house the calibration sheet, shall contain self-indicating silica gel.

7.10 Timing Device

The timing device shall be capable of recording elapsed time to the nearest second and shall be accurate to within 1 s in 1 h.

7.11 Balance

The balance shall be capable of weighing to an accuracy of 0.1 g.

8 SETTING UP PROCEDURE

8.1 Siting of Apparatus

The apparatus shall be located in a draught-free room of volume not less than 15 m^3 and shall be protected from direct sunlight. If the extraction of combustion products from the room is necessary during the test, this shall be effected in such a way as to avoid causing draughts over the apparatus. The apparatus shall be set level with cowl vertical and the chimney.

8.2 Gas Supply

Standard test gas G112 (*see* Note) shall be supplied to the apparatus at a pressure not exceeding 1.0 kPa. The flow shall be capable of being adjusted, by means of the gas control valves, to give a heat output of 525 W ± 10 W. A method of calculating the required flow rate is described in **A-5**.

NOTE — Standard test gas G112 shall have the following properties at 15 °C and 1.013 25 bar:

Composition by volume – 17 percent CH_4, 59 percent H_2 and 24 percent N_2.

Net Wobbe Index – 19.48 MJ/m^3

Gross Wobbe Index – 22.36 MJ/m^3

Net Calorific Value – 11.81 MJ/m^3

Gross Calorific Value – 13.56 MJ/m^3

Relative Density – 0.367

8.3 Interconnection of Ancillary Equipment and Test Apparatus

8.3.1 A line diagram of the connections between the test apparatus and the ancillary equipment is shown in Fig.4.

8.3.2 *Electricity supply*

The electric elements of the apparatus shall be connected in series with the variable transformer and the wattmeter.

8.3.3 *Temperature measurement*

The thermocouples shall be connected to and in series with the temperature indicator by means of compensating leads (*see* **A-4.4**). The cold junctions shall be maintained at a constant temperature throughout the test. The hot junctions of the thermocouples in the cowl shall be checked for correct location before each calibration and test (*see* **6.8**).

9 CALIBRATION

9.1 Calibration Sheet

A square calibration sheet with sides 225 mm ± 1.5 mm long shall be cut from a 225 mm ± 1.5 mm thick asbestos-free, heat treated calcium silicate board with an oven dry density (*see* Annex C) of 850 kg/m^3 ± 10 percent. The shrinkage in the plane of the board shall be less than 0.3 percent after heat soaking for 4 h at 1 000 °C. The calibration sheet shall be kept in the desiccator after oven drying or after completion of a previous calibration test.

9.2 Frequency of Calibration

Calibration of the apparatus shall be carried out to ensure consistency of operation and to give a reference against which the performance of a product is measured (*see* **A-4**). The repeatability of the calibration value, *C*, shall be established (*see* **9.4.2**); calibration shall be carried out before the start of a test of each group of up to five specimens, unless the apparatus is in continuous daily use, in which case not more than ten specimens shall be tested between calibrations.

9.3 Calibration Procedure

9.3.1 Ensure that the test apparatus is at ambient temperature at the start of the test (*see* **A-6**).

9.3.2 Check that the hot junctions of the thermocouples in the cowl are correctly located.

9.3.3 Keep the calibration sheet in the desiccator and do not remove until immediately before it is required for mounting in the specimen holder. At the start of the test, insert the sheet into the specimen holder. Where necessary (*see* **A-2**), back the sheet with non-combustible material that has been conditioned prior to use by the method described for test specimens in **5.4**, and ensure that when the holder is clamped on to the combustion chamber, the face of the sheet is in contact with the walls of the combustion chamber.

9.3.4 Adjust the gas flow to give a heat output of 525 W ± 10 W (*see* **A-5**) and then turn off.

9.3.5 Switch on the thermocouple output indicator and record the initial output E_i, in mV, measured by the thermocouples inside the cowl.

9.3.6 After allowing any residual gas within the combustion chamber to disperse, simultaneously turn on the gas supply and ignite the jets using the gas igniter; time the test from the time of ignition. After 2 min 45 s, turn on the electrical supply to give an indicated input of 1 800 W; at 5 min after the time of ignition, reduce this indicated input to 1 500 W.

9.3.7 Record the output from the thermocouples, E_r, in mV, at:
a) 0.5 min intervals, up to and including 3 min from the time at which the gas was ignited; then
b) 1 min intervals, up to 10 min from the time at which the gas was ignited; then
c) 2 min intervals, up to 20 min from the time at which the gas was ignited.
If a multi-range chart recorder is used, select the lower range scale of the chart recorder from the start of the test and adjust it to the higher range when 95 percent full scale deflection is indicated.

9.3.8 Calculate the actual output rise E_c, in mV, for the calibration sheet from the following expression:

$$E_c = \frac{E_r - E_i}{2}$$

where

E_c is the output rise indicated from the thermocouples of the flue gases for the calibration sheet, in mV;
E_r is the output indicated from the thermocouples at the intervals specified in **9.3.7**, in mV;
E_i is the initial output indicated from the thermocouples in **9.3.5**, in mV.

NOTE — For instruments that do not have cold junction compensation, the initial output measured by the thermocouples in **9.3.5**, E_i may be negative, in which case the expression for E_c becomes the following:

$$E_c = \frac{E_r - (-E_i)}{2} = \frac{E_r + E_i}{2}$$

9.3.9 For the calibration sheet, calculate the calibration value, *C*, from the expression:

$$C = \sum_{t-0.5}^{3} \frac{\theta_c}{10\,t} + \sum_{t-4}^{10} \frac{\theta_c}{10t} + \sum_{t-12}^{20} \frac{\theta_c}{10t}$$

where

θ_c is the actual temperature rise to the nearest °C converted from E_c;
t is the time, in min, at the intervals specified in **9.3.7**.

9.4 Calibration Requirements

9.4.1 At 3 min, 5 min, 10 min and 20 min from the time at which the gas is ignited, the actual temperature rise θ_c above the initial temperature converted from E_i shall be within the tolerance limits specified in Table 1.

NOTE — A typical calibration curve is shown in Fig.5.

Table 1 Allowable limits for calibration

(*Clause* 9.4.1)

Time from ignition of gas, *t*, mins	**Limits for rise above initial temperature,** °C
3	27 to 39
5	85 to 110
10	175 to 205
20	230 to 260

9.4.2 The calibration value, *C*, shall not differ by more than 1 between consecutive calibrations (*see* **A-4**). When the apparatus is not in continuous use, at least two calibration tests shall be carried out to establish this consistency.

10 TEST PROCEDURE

10.1 Procedure

10.1.1 Once a satisfactory repeatable calibration is achieved, allow the apparatus and specimen holder to cool to ambient temperature, remove a specimen from the conditioning chamber and mount it in the specimen holder. Where necessary (*see* **A-2**), back it with non-combustible packing, previously conditioned in accordance with **5.4**, to ensure that when the holder is clamped on to the combustion chamber, the face of the test specimen is in contact with the walls of the combustion chamber.

10.1.2 Carry out the test procedure as specified in **9.3.1**, **9.3.2** and **9.3.4** to **9.3.7** inclusive.

10.1.3 Decomposition of the specimen during this test may result in the formation of soot deposits on the thermocouple hot junctions, which may interfere with the accurate measurement of gas temperatures. To minimize this effect, clean the thermocouples at least 30 s before every temperature reading after the first 3 min of test (*see* **9.3.7**), by removing them from the chimney and cleaning them with a fine wire brush or fine wire wool, then replacing them.

10.1.4 Record the mV output from the thermocouples of the flue gases throughout the duration of the test. Note the actual mV output at the intervals specified in **9.3.7** and the mV rises above the initial mV reading.

10.1.5 Calculate E_s, the output from the thermocouples for the test specimen, in mV, by the same method specified for E_c in **9.3.8** and convert it to temperature rise for the flue gases, θ_s.

10.1.6 The determination of the fire propagation index requires results from three specimens, but if any specimen exhibits the behaviour described in **10.2**, test to be carried up to a maximum of five specimens in an attempt to obtain three valid test results (*see* **11.4.4**).

10.2 Observations during Test

Throughout the test, carefully observe the material's behaviour within the apparatus (*see* **A-7**) and take special note of any of the following phenomena:

a) deformation or spalling or intumescence of the specimen that tends to block the burner ports so that the required gas input cannot be maintained;
b) slumping or melting of the specimen that results in material escaping from the air inlet or being confined to the recess of the specimen holder, where it is not exposed to the heating conditions;
c) air flow through the apparatus being restricted owing to obstruction of the inlet port by soot accumulation in the chimney or by fallen material.

Occurrence of any of the above phenomena shall deem the test on that specimen to be invalid.

11 CALCULATION

11.1 Test Results

The fire propagation index and the individual subindices for each specimen shall be calculated to the first decimal place from the valid test results which are obtained on three specimens (*see* **10.1.6**).

11.2 Index of Performance of Specimens

The Performance Index, *S*, for each of the specimens tested shall be calculated from the subindices, s_1, s_2 and s_3, according to the respective temperature ranges as follows:

$S = s_1 + s_2 + s_3$

where

s_1, s_2 and s_3 are obtained by the expressions

$$s_1 = \sum_{t-0.5}^{3} \frac{\theta_s - \theta_c}{10\ t}$$

$$s_2 = \sum_{t-4}^{10} \frac{\theta_s - \theta_c}{10\ t}$$

$$s_3 = \sum_{t-12}^{20} \frac{\theta_s - \theta_c}{10\ t}$$

where

θ_s is as defined in **10.1.5**;
θ_c is as defined in **9.3.9**;
t is as defined in **9.3.9**.

Only positive values of $(\theta_s - \theta_c)$ shall be used in the calculation.

11.3 Fire Propagation Index

The *Overall Performance Index, I* (fire propagation index), of the product shall be calculated from the individual results of each test as follows:

$I = i_1 + i_2 + i_3$

where i_1, i_2 and i_3 are given by the expressions

$$i_1 = \frac{(s_1)_A + (s_1)_B + (s_1)_C}{3}$$

$$i_2 = \frac{(s_2)_A + (s_2)_B + (s_2)_C}{3}$$

$$i_3 = \frac{(s_3)_A + (s_3)_B + (s_3)_C}{3}$$

where

A, B and C refers to individual specimens giving valid test results; s_1, s_2 and s_3 are as defined in **11.2**.

NOTE — The indices of performance are calculated to the first decimal point as already mentioned in **11.1**. Though they are stated with this precision, it is not suggested that this degree of accuracy is achieved by the test.

11.4 Expression of Results

11.4.1 The fire propagation index *I* shall be stated without a suffix where the first three specimens tested give valid results.

11.4.2 The fire propagation index *I* shall be stated with a suffix "R" where more than 3 specimens (four or five) have to be tested to obtain three valid results.

11.4.3 Where less than three valid results are obtained from five specimens, no fire propagation index shall be stated and the product shall be designated not-suitable for assessment by this method.

12 TEST REPORT

12.1 The test report shall quote the individual results obtained for each specimen tested. Any observations made during the test and comments on any difficulties experienced during testing as described in **10.2** shall also be given, together with the following:

a) Name and address of testing laboratory;
b) Name and address of sponsor;
c) Name and address of manufacturer/supplier, if known;
d) Date of test; and
e) Full description of the product tested sufficient to describe its construction and to allow its identification. Different materials will need to be described in different ways but the description shall always contain sufficient information to enable the product to be accurately identified and differentiated from other similar products.

12.2 All the components of the specimen shall be described and the description shall include as much information as possible, including the following where applicable:

a) Trade name(s);
b) Generic names / identification of material(s);
c) Thickness(es);
d) Density(ies) or mass(es) per unit area;
e) Significant details related to the fire performance of the material, e.g. type and level of any flame retardant treatment;
f) Details of the form in which the specimens were tested (material, composite or assembly), together with specimen thickness and, where appropriate, orientation, backing material and the face or faces subjected to the test and whether the material was tested in a modified form;
g) The fire propagation index, I, for the product, with the suffix "R", if applicable as per **11.4.2**, and the subindices i_1 and i_2; along with Fire Performance Rating of material as Class '0' when valid results are achieved by the material as stated in **1.3**.
h) The statement that the suffix "R" to the fire propagation index indicates that the results should be treated with caution; and
i) The statement: "The test results relate only to the behavior of the test specimens of the product under the particular conditions of test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use".

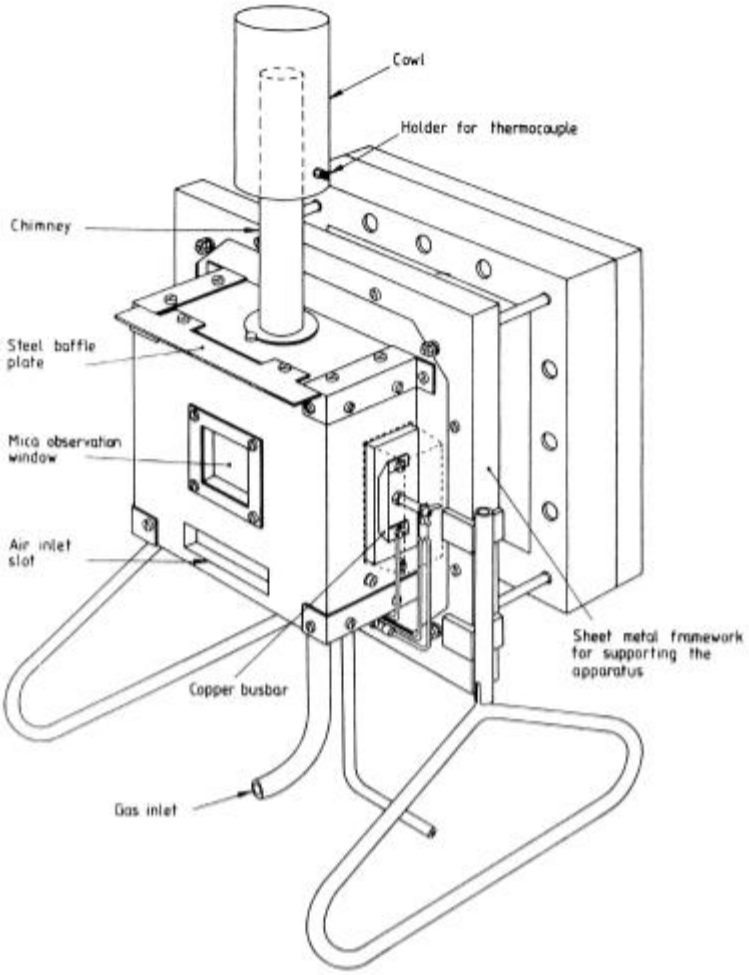


Figure 1 — Diagrammatic representation of the apparatus: front

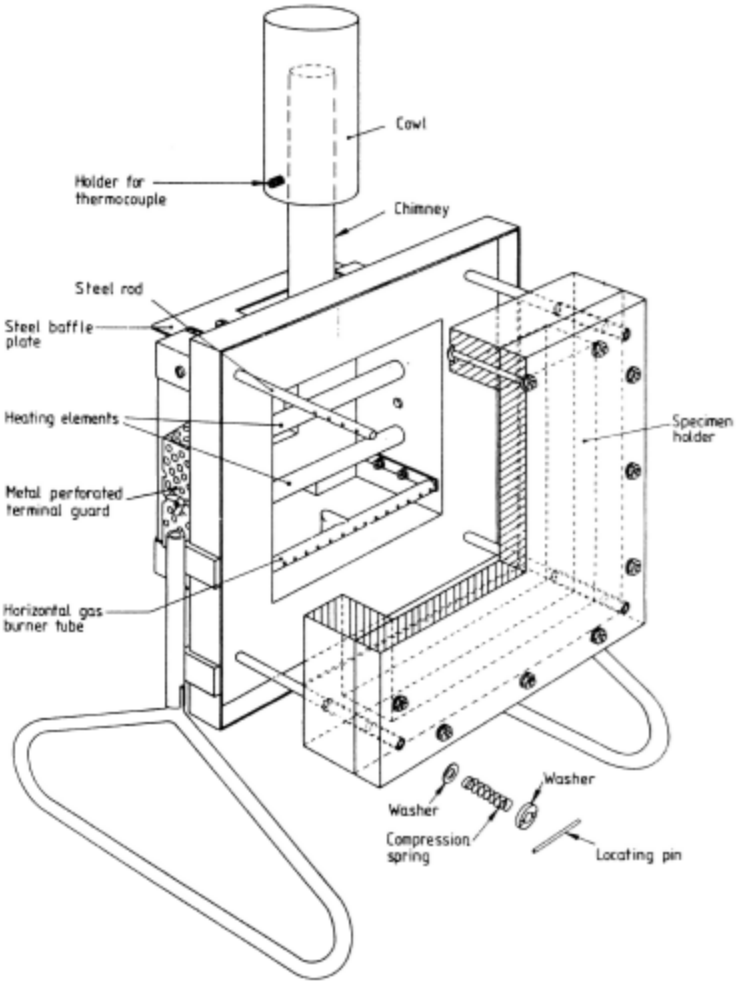
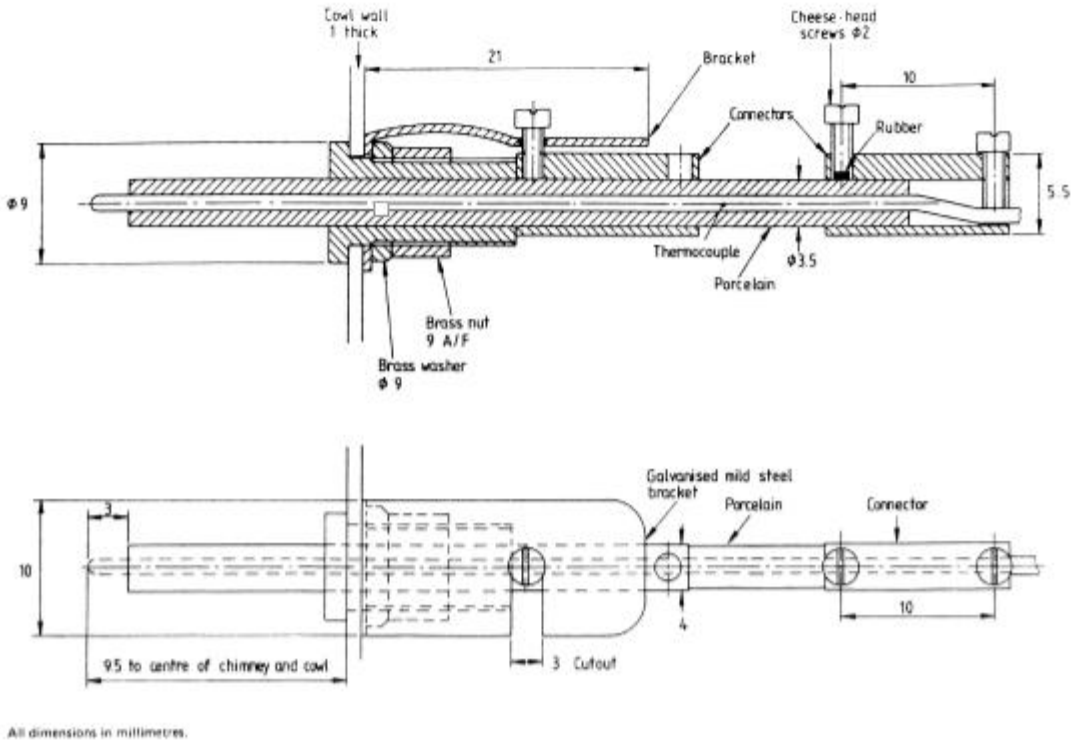


Figure 2 — Diagrammatic representation of the apparatus: rear



All dimensions in millimetres.

Figure 3 — Thermocouple locating device

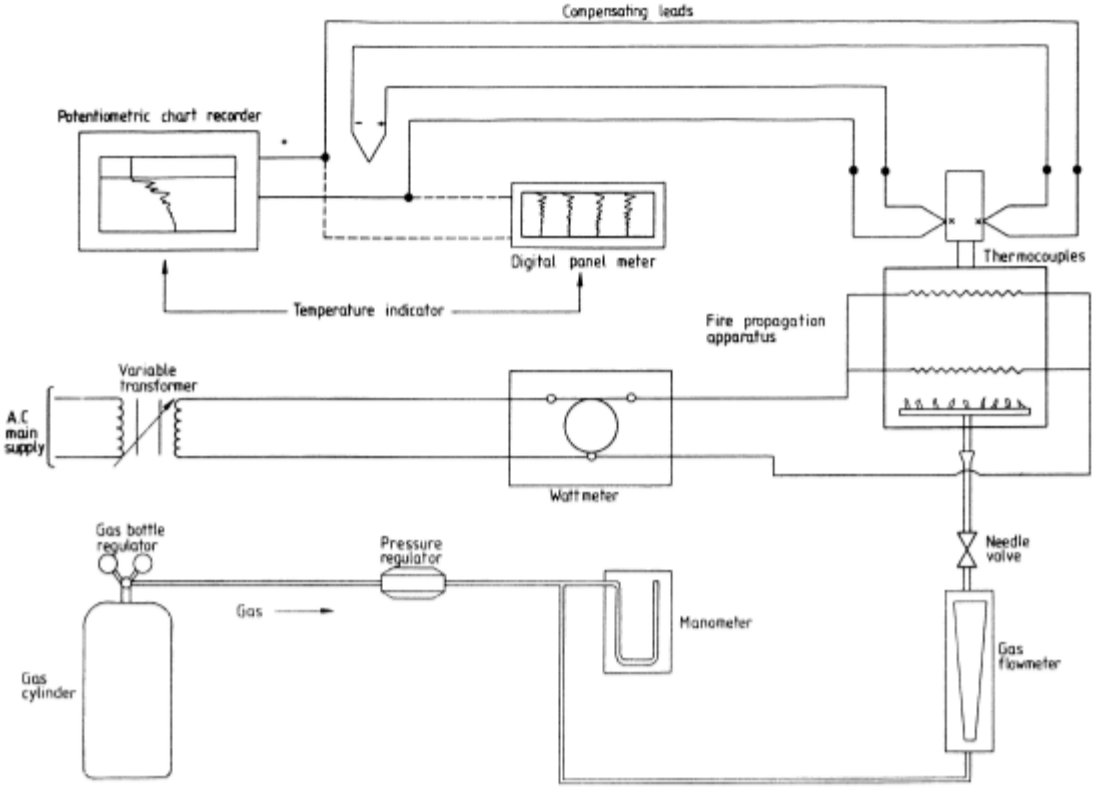


Figure 4 — Layout of apparatus and ancillary equipment

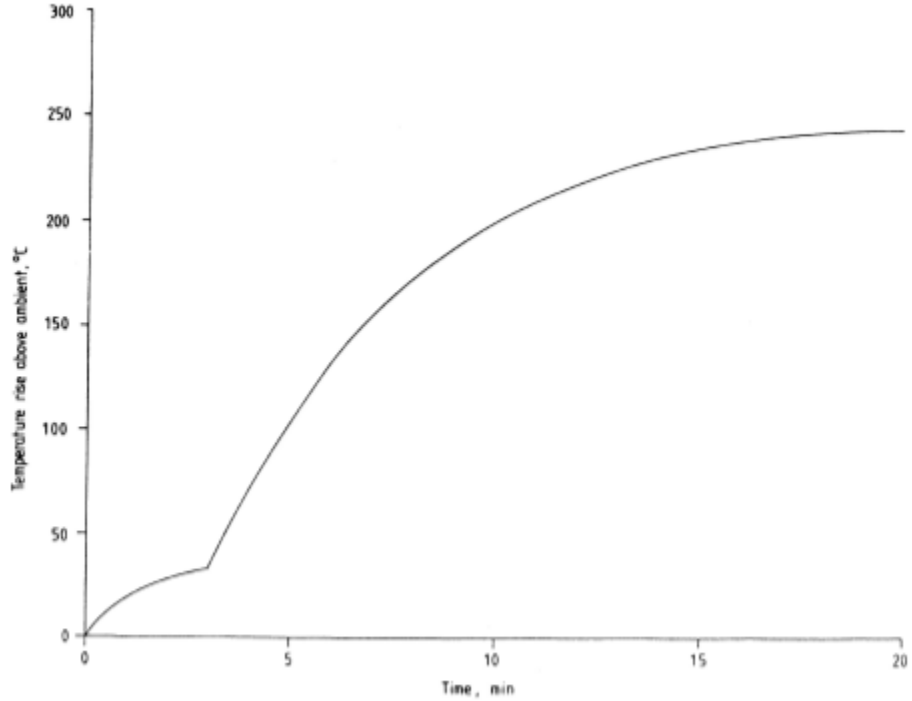


Figure 5 — Typical calibration curve

ANNEX A

GUIDANCE FOR OPERATORS

A-1 SURFACE IRREGULARITIES

For assessing the area of surface irregularity (*see* **4.1.1**), the surface is to be machined to a depth of 6 mm below the highest point and machined surface area is estimated.

A-2 SPECIMEN CONSTRUCTION

Where non-combustible packing is required (*see* **10.1.1**), the sheet immediately behind the specimen should be of non-combustible board similar to that specified in **9.1**. Behind this, or where the 12.7 mm board cannot be accommodated owing to lack of space, millboard or a non-combustible board may be used as required to fill the holder. This may be necessary when the gasket prevents the face of the specimen being in close contact with the walls of the combustion chamber.

A-3 CONDITIONING OF SPECIMENS

Constant mass is to be checked as it is proof of satisfactory conditioning; cellulosic materials may require more than two weeks to achieve equilibrium with the atmosphere but some plastic materials take less time. Other factors like curing before conditioning may need to be taken into consideration.

A-4 CALIBRATION

A-4.1 General

When the apparatus is not in continuous use, at least two calibration tests have to be carried out in order to establish consistency. In case the temperature rise for an apparatus is either outside the allowable limits (*see* Table 1) or if the calibration value (*see* **9.4.2**) does not give the specified repeatability, the following points should be considered.

A-4.2 Density of the Calibration Sheet

A low density sheet may give a high calibration value (*C*). When consistency of calibration is being checked the same calibration sheet should be used for successive tests.

A-4.3 Chimney/Cowl

A heavy chimney and cowl will tend to give a low calibration value. A highly polished surface will give a high calibration value and reduce heat loss (*see* **6.5**).

A-4.4 Temperature Measuring System

This is a frequent source of erroneous results and great care should be exercised to ensure that the hot junctions of thermocouples etc. are precisely located. The sheathed thermocouples should be not less than 100 mm long.

A-4.5 Gas Supply

The gas flow should not show an initial surge due to pressure build up behind the on/off valve. If this occurs, a by-pass valve should be introduced. Ignition should always coincide with supply of gas to the burner.

A-5 CALCULATION OF GAS FLOW RATE

A-5.1 The Wobbe index of the test gas G112 (*see* **8.2**) will normally be provided by the gas supplier and is specified to be 19.48 MJ/m^3 for test gas G112. In addition, the calorific value of the specific supply of the test gas to be used should be obtained to check the relative density of the gas and ensure that it complies with the requirement of **8.2** by substituting the actual values in the following expression:

$$Relative\ Density = \left(\frac{calorific\ value}{Wobbe\ index}\right)^2$$

A-5.2 The gas flow rate should be calculated as per the following example.

For a gas of calorific value 11.81 MJ/m^3, and for the required heat output from the burner of 525 W ± 10 W (*see* **9.3.4**), the required rate of flow calculated as follows.

$$\frac{527.5 \times 60}{11.81 \times 1000} L/\min = 2.68\, L/min$$

A-6 COOLING APPARATUS

It is important to ensure the cooling of the apparatus to ambient temperature between tests and it may take approximately 2 h to achieve this cooling. Care should be taken to ensure that the cooling is thorough and not merely superficial, particularly if artificial means of cooling are used.

A-7 PRODUCT TESTING

Failure to achieve valid test results from certain types of product described in **10.2** may be recognized by the following behavior.

A-7.1 Failure to Maintain the Required Gas Flow as indicated by the Flowmeter

An attempt should be made to maintain the required flow by opening the flow regulator without increasing the inlet pressure to the flowmeter beyond 1 kPa.

A-7.2 Melting or Slumping of Products

Escape of molten products through the air inlet is obviously visible during the test but slumping of a product within the combustion chamber may occur and can only be noted by continual close observation. Shrinkage of some specimens into the specimen holder may only be observed on completion of the tests.

A-7.3 Restriction of the Flow of Air and/or Combustion Products through the Apparatus

This may be indicated by a drop in the temperature curve caused by blockage of the air inlet by a collapsed sample or blockage of the throat of the chimney by massive carbon deposits. Severe blockage may result in flames emerging from the air inlet.

ANNEX B

(*Clauses* 5.2 *and* 5.3)

EFFECT OF THERMAL CHARACTERISTICS ON THE PERFORMANCE OF ASSEMBLIES

B-1 With thin materials or composites, particularly those with a high thermal conductivity, the presence of an air gap and the nature of any underlying construction may significantly affect the ignition performance of the exposed surface. Increasing the thermal capacity of the underlying construction increases the heat sink effect and may delay ignition of the exposed surface. Any backing provided to the test specimen and in intimate contact with it, such as the non-combustible packing pieces, may alter this heat sink effect and may be fundamental to the test result itself. The influence of the underlying layers on the performance of the assembly should be understood and care should be taken to ensure that the result obtained on any assembly is relevant to its use in practice.

B-1.1 The following advice is offered on the construction and preparation of test specimens.

a) Where the thermal properties of the product are such that no significant heat loss to the underlying layers can occur, for example, a material or composite greater than approximately 6 mm thick of high thermal capacity and/or low thermal conductivity, then the product should be tested backed only by the specimen holder.
b) Where the product is normally used as a free-standing sheet and the characteristics noted in a) do not apply, then an air space should be provided at the back of the product by testing over non-combustible perimeter battens 20 mm wide and 12.5 mm thick.

c) Where the product is to be used over a low density non-combustible substrate and the characteristics noted in a) do not apply, then the product should be tested in conjunction with that substrate.
d) Where the product is to be used over a combustible substrate and the characteristics noted in a) do not apply, then the product should be tested in conjunction with that substrate.

ANNEX C

(*Clause* 9.1)

DETERMINATION OF DRY DENSITY OF CALIBRATION SHEET

C-1 The calibration sheet shall be dried at a temperature of 103 °C ± 2 °C to constant mass (*see* note to **5.4**) and allowed to cool in the desiccator. Weighing must be carried out to an accuracy of ± 0.1 g. The thickness of the sheet should be measured at the quarter and midpoints of each side to an accuracy of 0.1 mm, the measuring instrument having flat contacting surfaces. The mean of the twelve readings should be taken as the thickness of the board and the linear dimensions of each side should be measured to an accuracy of 0.5 mm.