INTERNATIONAL STANDARD

ISO 5658-2

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Reaction to fire tests — Spread of flame —

Part 2:
Lateral spread on building products in vertical configuration

Essais de réaction au feu — Propagation du feu —

Partie 2: Propagation latérale sur les produits de bâtiment en position verticale

Reference number
ISO 5658-2:1996(E)

Contents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 5658-2 was prepared by Technical Committee ISO/TC 92, *Fire safety,* Subcommittee SC 1, *Reaction to fire.*

ISO 5658 consists of the following parts, under the general title *Reaction to fire tests — Spread of flame*:

— *Part 1: Guidance on flame spread*
(Technical Report)

— *Part 2: Lateral spread on building products in vertical configuration*

— *Part 3: Lateral ignition and flame spread of building products in vertical configuration (LIFT) method*
(Technical Report)

— *Part 4: Intermediate scale spread of flame*

Annex A forms an integral part of this part of ISO 5658. Annexes B to F are for information only.

Introduction

This part of ISO 5658 is based on the method of the International Maritime Organization (IMO) published as IMO Resolution A.653(16)[5], and has been developed as an International Standard in order to allow its wider use. The major differences between ISO 5658-2 and the IMO test are that ISO 5658-2 is limited in scope to testing the spread of flame over vertical specimens and does not include the stack for estimating heat release rate.

ISO/TR 5658-1 describes the development of standard tests for flame spread and explains the theory of flame spread for various orientations. The relationship, both theoretical and mathematical, which exists between ISO 5658-2 and ISO/TR 5658-3 is also explained.

ISO 5658-2 provides a simple method by which lateral surface spread of flame on a vertical specimen can be determined for comparative purposes. This method is particularly useful for research, development and quality control purposes.

ISO/TR 5658-3 provides a more scientific method by which the ignitability and spread of flame parameters of building products can be determined. The data derived from this test are suitable for use in fire growth (mathematical) models. The same test apparatus is used for the procedures specified in this part of ISO 5658 and ISO/TR 5658-3.

Fire is a complex phenomenon: its behaviour and its effects depend upon a number of interrelated factors. The behaviour of materials and products depends upon the characteristics of the fire, the method of use of the materials and the environment to which they are exposed. The methodology of "reaction to fire" tests is explained in ISO/TR 3814[1].

A test such as is specified in this part of ISO 5658 deals only with a simple representation of a particular aspect of the potential fire situation typified by a radiant heat source and flame; it cannot alone provide any direct guidance on behaviour or safety in fire.

A precision statement based on an interlaboratory trial using this test method is given in annex E.

This test procedure does not rely on the use of asbestos-based materials.

The attention of all users of the test is drawn to the following caution.

CAUTION — So that suitable precautions may be taken to safeguard health, the attention of all concerned in fire tests is drawn to the possibility that toxic or harmful gases may be evolved during exposure of test specimens. The advice on safety given in annex A should also be noted.

Reaction to fire tests — Spread of flame —

Part 2:
Lateral spread on building products in vertical configuration

1 Scope

1.1 This part of ISO 5658 specifies a method of test for measuring the lateral spread of flame along the surface of a specimen of a product orientated in the vertical position. It provides data suitable for comparing the performance of essentially flat materials, composites or assemblies, which are used primarily as the exposed surfaces of walls.

1.2 This part of ISO 5658 is applicable to the measurement and description of the properties of materials, products or assemblies in response to radiative heat in the presence of a pilot flame under controlled laboratory conditions. It should not be used alone to describe or appraise the fire hazard or fire risk of materials, products or assemblies under actual fire conditions.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this part of ISO 5658. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this part of ISO 5658 are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/IEC Guide 52:1990, *Glossary of fire terms and definitions.*

3 Definitions

For the purposes of this part of ISO 5658, the definitions given in ISO/IEC Guide 52 and the following definitions apply.

3.1 assembly: Fabrication of materials and/or composites, for example sandwich panels.

NOTE 1 The assembly may include an air gap.

3.2 average heat for sustained burning: Average of the values of heat for sustained burning, expressed in megajoules per square metre (MJ/m^2), measured at a number of specified positions.

3.3 backing board: Non-combustible board with the same dimensions as the specimen, used in every test to back the specimen (see 9.7).

3.4 composite: Combination of materials which are generally recognized in building construction as discrete entities, for example coated or laminated materials.

3.5 critical heat flux at extinguishment: Incident heat flux, expressed in kilowatts per square metre (kW/m^2), at the surface of a specimen at the point along its horizontal centreline where the flame ceases to advance and may subsequently go out. The heat flux value reported is based on interpolations of measurements with a non-combustible calibration board.

3.6 exposed surface: That surface of the specimen subjected to the heating conditions of the test.

3.7 flame front: Furthest extent of travel of a sustained flame centrally along the length of the test specimen.

3.8 flashing: Existence of flame on or over the surface of the specimen for periods of less than 1 s.

3.9 heat for sustained burning: Product of the time from the start of exposure of a specimen to the arrival of the flame front at a specified position and the incident radiant heat flux corresponding to that position measured on a non-combustible calibration board. Expressed in megajoules per square metre (MJ/m^2).

NOTE 2 The positions are specified in table 1 (see clause 10).

3.10 irradiance (at a point of a surface)**:** Quotient of the radiant heat flux incident on an infinitesimal element of surface containing the point, by area of that element.

3.11 material: Single substance or uniformly dispersed mixture, for example metal, stone, timber, concrete, mineral fibre, polymers.

3.12 product: Material, composite or assembly about which information is required.

3.13 radiant heat flux: Power emitted, transferred or received in the form of radiation.

3.14 specimen: Representative piece of the product which is to be tested together with any substrate or treatment.

NOTE 3 The specimen may include an air gap.

3.15 spread of flame: Propagation of a flame front over the surface of a product under the influence of imposed irradiance.

3.16 substrate: Material which is used, or is representative of that used, immediately beneath a surface product, e.g. skimmed plasterboard beneath a wall-covering.

3.17 sustained flaming: Existence of flame on or over the surface of the specimen for periods of more than 4 s.

3.18 transitory flaming: Existence of flame on or over the surface of the specimen for periods of between 1 s and 4 s.

3.19 lateral spread of flame: Progression of the flame front in a lateral direction over the specimen length.

4 Principles of the test

4.1 The test method consists of exposing conditioned specimens in a well-defined field of radiant heat flux and measuring the time of ignition, the lateral spread of flame, and its final extinguishment.

4.2 A test specimen is placed in a vertical position adjacent to a gas-fired radiant panel where it is exposed to a defined field of radiant heat flux. A pilot flame is sited close to, but usually not contacting, the hotter end of the specimen to ignite volatile gases issuing from the surface (see figure 1).

4.3 Following ignition, any flame front which develops is noted and a record is made of the progression of the flame front horizontally along the length of the specimen in terms of the time it takes to travel various distances.

4.4 The results are expressed in terms of flame spread distance versus time, flame front velocity versus heat flux, the critical heat flux at extinguishment and the average heat for sustained burning.

5 Suitability of a product for testing

5.1 Surface characteristics

5.1.1 A product having one of the following characteristics is suitable for evaluation using this method:

a) an essentially flat exposed surface, i.e. all surface irregularities are within ± 1 mm of plane;

b) a surface irregularity which is evenly distributed over the exposed surface provided that

   1) at least 50 % of the surface of a representative square area, 155 mm by 155 mm, lies within a depth of 6 mm from a plane across the highest points of the exposed surface, and/or

   2) any cracks, fissures or holes do not exceed 8 mm in width or 10 mm in depth and the total area of such cracks, fissures or holes at the surface does not exceed 30 % of a representative square area, 155 mm by 155 mm, of the exposed surface.

5.1.2 Where a product has areas of its surface which are distinctly different, but each of these separate areas satisfies the surface characteristics specified in 5.1.1, then each of these separate areas shall be tested to evaluate fully the product.

5.1.3 When an exposed surface does not comply with the requirements of either 5.1.1 a), or 5.1.1 b), the product may be tested in a modified form with an essentially flat exposed surface. The modification shall be stated in the report.

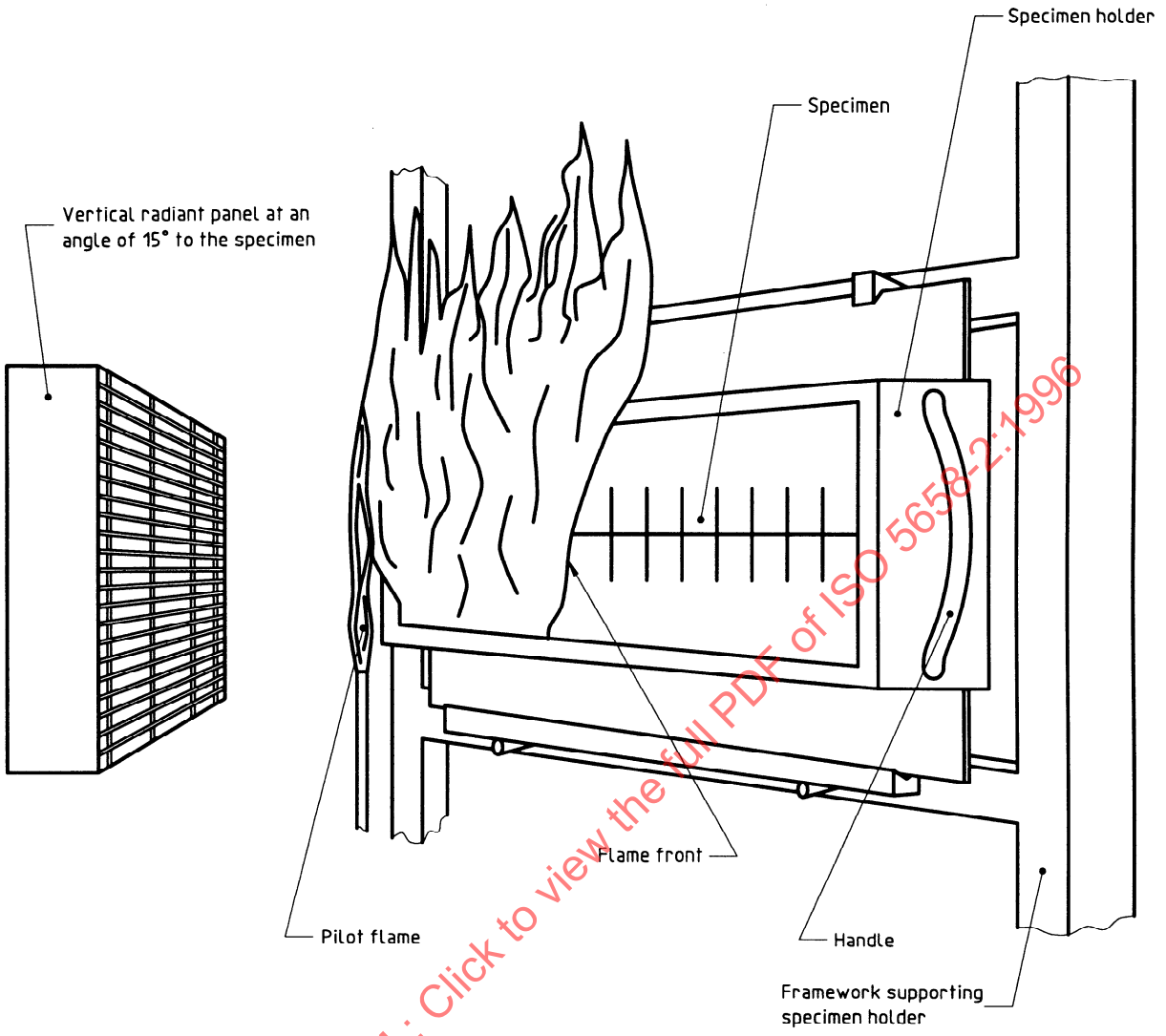


Figure 1 — Schematic of test

5.2 Thermally unstable products

The test method may not be suitable for assessing products that react in particular ways under exposure to the specified heating conditions (see 11.12). Products showing these characteristics should be assessed using other test methods, as given in, for example, ISO 9705.

6 Test specimens

6.1 The exposed surface

The product shall be tested on that face which will normally be exposed in use, taking account of the following.

a) If it is possible for either or both of the faces to be exposed in use then, if the core is asymmetrical, both faces shall be tested.

b) If the face of the product contains a surface irregularity that is specifically directional, e.g. corrugations, grain or machine-induced orientation which may, in use, run horizontally or vertically, the product shall be tested in both orientations.

c) If the exposed face contains distinct areas of different surface finish or texture, then the appropriate number of specimens shall be provided for each distinct area of such finish or texture to be evaluated.

d) Textile materials shall be tested for spread of flame in both the warp and the weft directions.

e) If a bright metallic-faced specimen is to be tested, it shall be tested both as-received and also finished with a thin coat of lamp black or colloidal graphite, applied before conditioning for test.

6.2 Number and size of specimens

6.2.1 At least six specimens shall be provided for test.

6.2.2 Three specimens shall be tested for each potentially exposed surface or orientation.

With specimens which could be exposed from either side and also having directional irregularities on one side only, at least nine specimens will be needed, i.e. three for testing with the irregularities vertical, three with the irregularities horizontal and three for testing the opposite side which is smooth.

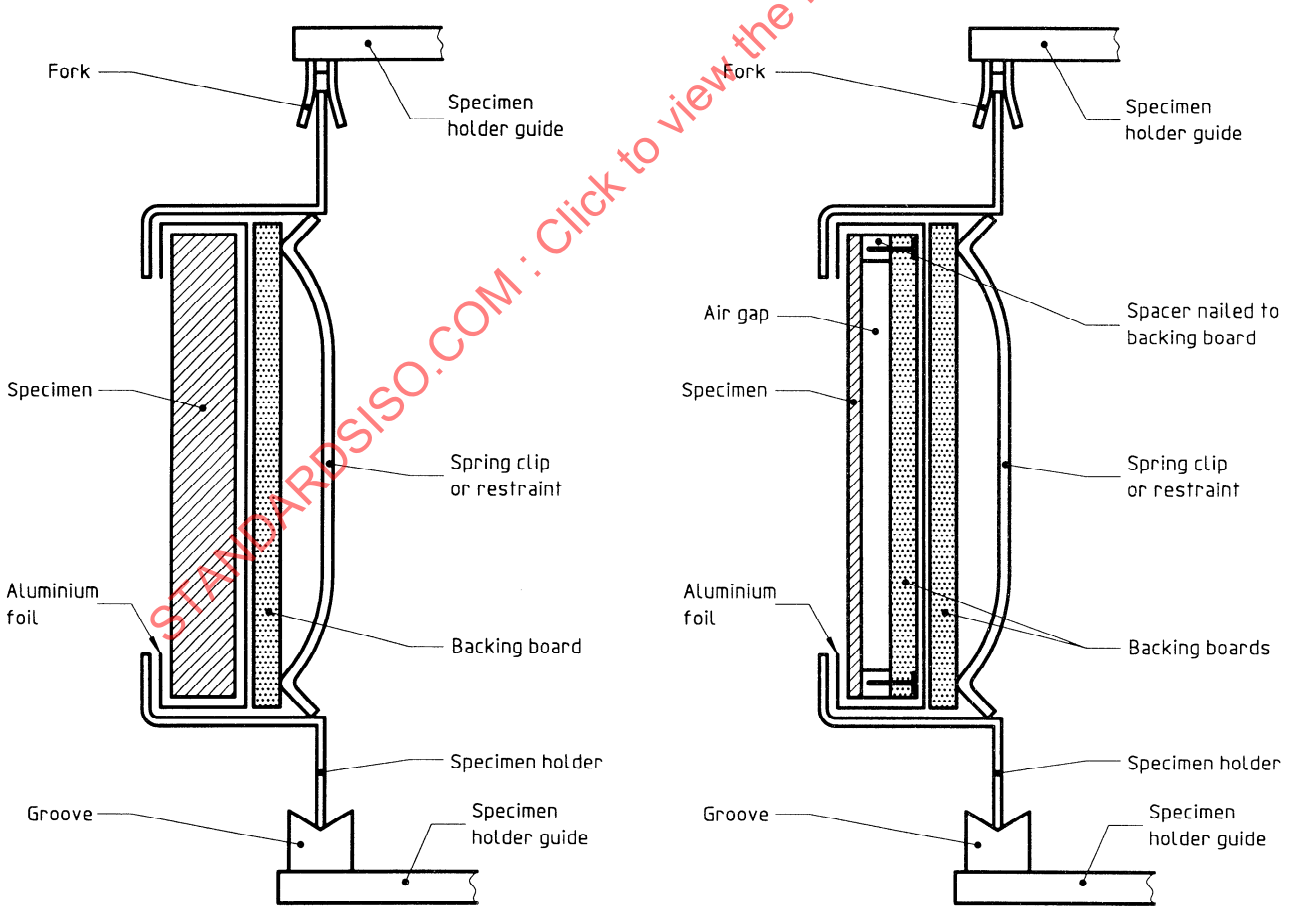
6.2.3 The specimens shall be 800 mm $_{-5}^{0}$ mm long by 155 mm $_{-5}^{0}$ mm wide and shall be representative of the product.

6.2.4 The thickness of specimens of products with irregular surfaces (see 6.1) shall be measured from the highest point of the surface. Products of thickness 50 mm or less, shall be tested using their full thickness. For products of normal thickness greater than 70 mm, the unexposed face shall be cut away to reduce the thickness to 70 mm $_{-3}^{0}$ mm.

For products of thicknesses in the range of 50 mm to 70 mm, it is necessary to use an extension clip or restraint at the rear of the specimen holder (see figure 2).

6.3 Construction of specimens

6.3.1 For thin materials or composites used in the fabrication of an assembly, the presence of air or an air gap and/or the nature of any underlying construction may significantly affect the characteristics of the exposed surface. The influence of the underlying layers should be understood and care taken to ensure that the test result obtained on any assembly is relevant to its use in practice.



a) Specimen with backing board

b) Specimen with backing boards and spacers forming an air gap

Figure 2 — Typical mounting of specimens

6.3.2 When the product is a surface coating it shall be applied to the selected substrate using a method and application rate recommended for its use.

6.3.3 When the product is a material or composite which would normally be attached to a substrate, then it shall be tested in conjunction with the selected substrate using the recommended fixing technique, e.g. bonded with the appropriate adhesive or mechanically fixed. The procedure for fixing the specimens to the substrate shall be clearly stated in the test report [see clause 13 f)].

6.4 Conditioning

6.4.1 All specimens shall be conditioned to constant mass at a temperature of (23 ± 2) °C, and a relative humidity of (50 ± 5) %, and maintained in this condition until required for testing. 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 % of the mass of the specimen, or 0,1 g, whichever is the greater.

6.4.2 Backing boards and spacers (see 9.7) shall be conditioned for at least 12 h before use in the conditions specified in 6.4.1.

6.5 Preparation

6.5.1 Reference line

Mark a horizontal line centrally at half height along the length of each specimen. Draw vertical marks every 50 mm along the line. The zero mark shall correspond with the start of the exposed area of the specimen (see 7.4). Care shall be taken to avoid the possibility of the line influencing the performance of the specimen, for example by damaging the surface, or increasing its absorbency.

NOTE 4 Some materials discolour or burn so that the line and/or the marks are obscured. The use of a stainless steel grid approximately 10 mm above the surface of the specimen allows the position of the flame front to be determined.

6.5.2 Products without air gaps

Where a product will normally be used without an air gap behind it, then after the conditioning procedures specified in 6.4, the edges and the rear face of the specimen shall be wrapped in a single rectangular sheet of aluminium foil of thickness 0,02 mm to 0,03 mm and dimensions of $(175 + 2a)$ mm by $(820 + 2a)$ mm, where a is the thickness of the specimen, so that about 10 mm of foil laps evenly over the edges of the front face of the specimen. The foil shall be pressed down flat onto the front face of the specimen [see figure 2 a)]. The specimen, wrapped in foil, shall then be placed on a backing board and both inserted in a specimen holder (see figure 3).

6.5.3 Products with air gaps

Where a product will normally be used with an air gap behind it, then after the conditioning procedures specified in 6.4, the specimen shall be placed over conditioned spacers positioned around its perimeter [see figure 2 b)] and mounted on a backing board so that a (25 ± 2) mm air gap is provided between the unexposed face of the specimen and the backing board (see 9.7). The rear edges of the whole assembly shall then be wrapped in a single rectangular sheet of aluminium foil of thickness 0,02 mm to 0,03 mm and dimensions of $(175 + 2b)$ mm by $(820 + 2b)$ mm, where b is the total thickness of the assembly of specimen, spacers and backing board, so that about 10 mm of foil laps evenly over the edges of the front face of the specimen. The foil shall be pressed down flat onto the front face of the specimen [see figure 2 b)]. The assembly, wrapped in foil, shall then be placed on a backing board and both inserted in a specimen holder (see figure 3).

Products containing air gaps of less than 25 mm should preferably be tested under their end use conditions.

A suitable technique for mounting thin flexible materials is to staple closely the specimen along the edges to the spacers on the perimeter of the backing board.

6.5.4 Storage of specimens

The wrapped assemblies of specimen, backing board and spacers prepared as specified in 6.5.2 or 6.5.3 shall be stored until required for testing in the conditioning atmosphere specified in 6.4.1.

7 Test apparatus

7.1 General

The test apparatus (see figure 4) consists of four main components: a radiant panel support framework and a specimen support framework, which are linked together to bring the test specimen into the required configuration in relation to the radiant panel, the specimen holder, and a pilot flame burner.

7.2 The radiant panel support framework

This framework provides the support for the radiant panel together with the necessary pipework for air and gas, safety devices, regulators and flowmeters.

Dimensions in millimetres

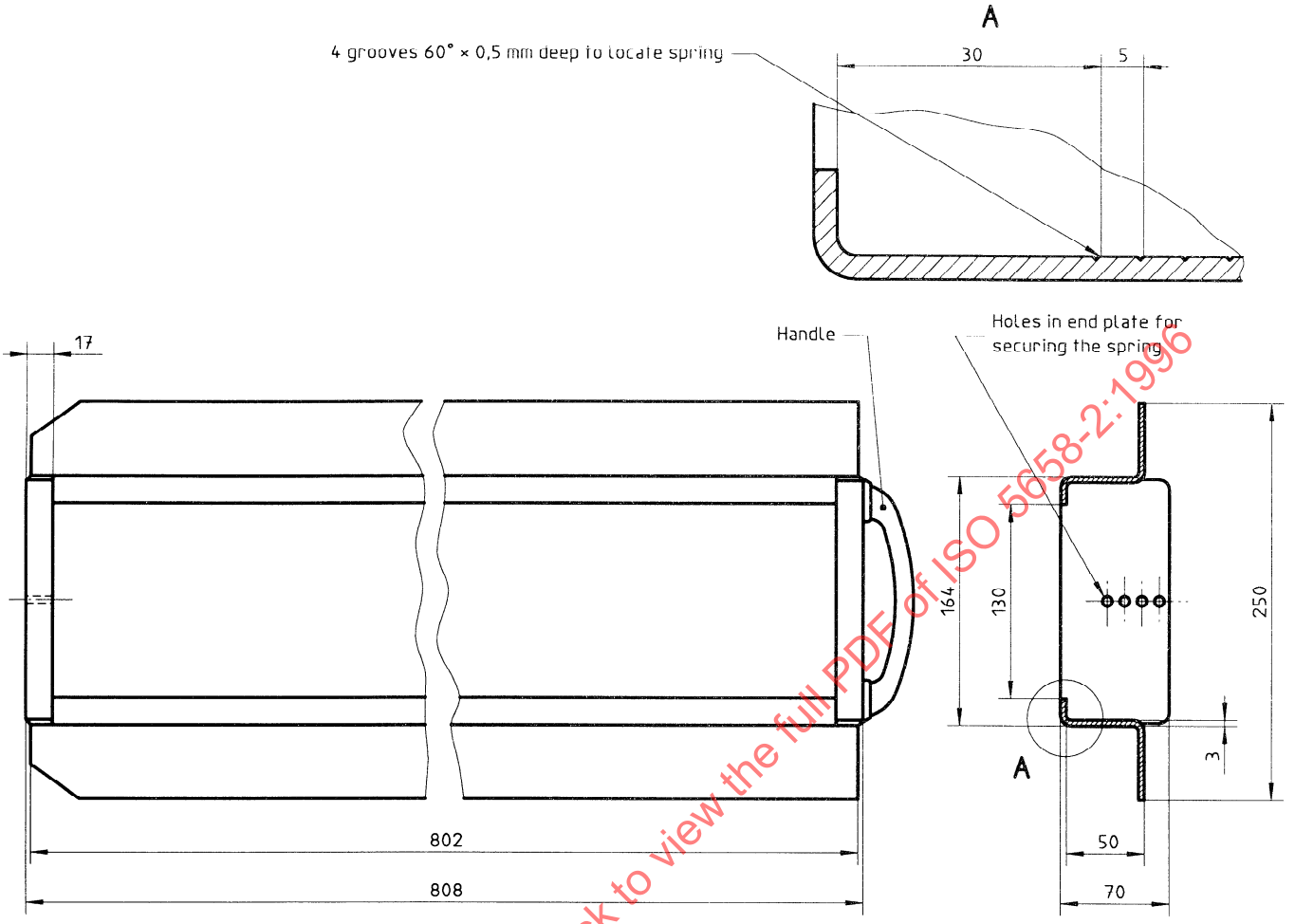


Figure 3 — Construction of typical specimen holder

7.2.1 Tubular steel frame

This frame shall consist of 40 mm by 40 mm, square-section steel tube, as shown in figure 4, and shall support the radiant panel with its centre (1 200 ± 100) mm above floor level, with the radiating face of the panel vertical. The angle between the face of the panel and the front face of the support framework shall be 15° ± 3°.

7.2.2 Radiant panel

This panel shall consist of an assembly of porous refractory tiles mounted at the front of a stainless steel plenum chamber to provide a flat radiating surface of dimensions approximately 480 mm by 280 mm. The plenum chamber shall contain baffle plates and diffusers to distribute the gas/air mixture evenly over the radiating surface. A wire screen shall be provided immediately in front of the radiating face of the panel to increase irradiance.

NOTE 5 In view of future testing, it may be advantageous to mount the panel from a ring capable of being turned to bring the panel into position above a horizontal specimen.

7.2.3 Gas and air supplies

The combustion gas and air shall be fed to be radiant panel via suitable pressure and flow regulators, safety equipment and flowmeters.

NOTE 6 The gas/air mixture enters the plenum chamber through one of the shorter sides to facilitate easy connection when the panel is mounted from the tubular steel frame.

Dimensions in millimetres

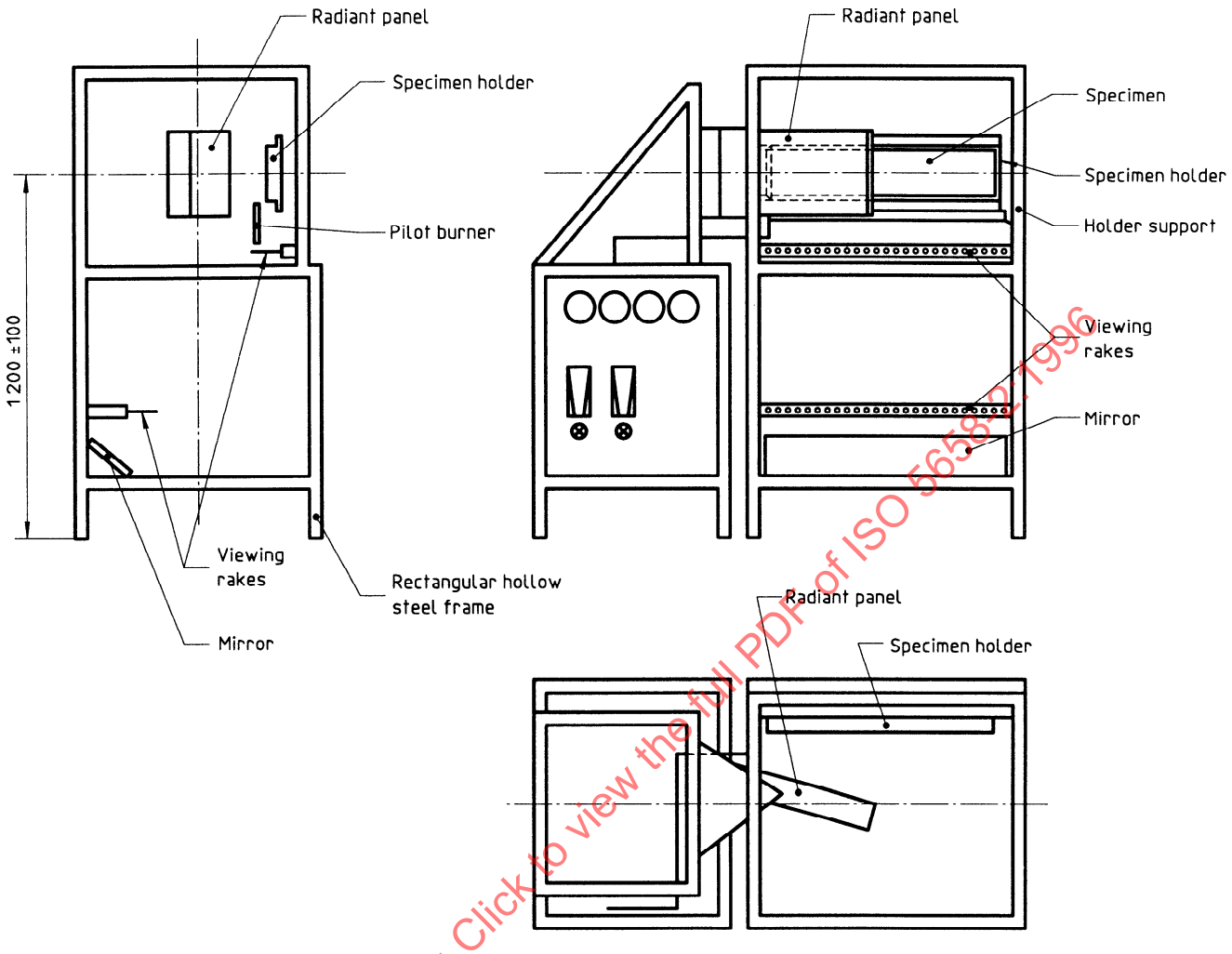


Figure 4 — Test apparatus

A suitable supply system includes the following:

a) a supply of natural gas, methane or propane with a flow rate of at least 1,0 l/s at a pressure sufficient to overcome the friction losses through the supply lines, regulators, control valve, flowmeters, radiant panel, etc.;

b) an air supply with a flow rate of at least 9 l/s at a pressure sufficient to overcome the friction losses through the supply lines, etc.;

c) separate isolation valves for gas and air;

d) a non-return valve and pressure regulator in the gas supply line;

e) an electrically operated valve to shut off the gas supply automatically in the event of failure of electrical power, failure of air pressure or decrease in temperature at the burner surface;

f) a particulate filter and a flow control valve in the air supply;

g) a flowmeter for natural gas, methane or propane suitable for indicating flows of 0,5 l/s to 1,5 l/s at ambient temperature and pressure to a resolution of 1 % or better. An absolute calibration is unnecessary;

NOTE 7 This is used to assist in setting the gas flow to a value which gives a suitable panel temperature.

h) a flowmeter for air suitable for indicating flows of 5 l/s to 15 l/s at ambient temperature and pressure to a resolution of 1 % or better. An absolute calibration is unnecessary.

NOTE 8 All the above items can normally be accommodated within and supported from the tubular steel framework.

7.3 The specimen support framework

7.3.1 General

This framework incorporates the guide rails which support the specimen holder and locate it at the required position of test, the pilot flame burner, a mirror and the viewing rakes.

7.3.2 Tubular steel frame

This frame shall consist of 40 mm by 40 mm square-section steel tube as shown in figure 4, and shall be linked to the radiant panel support framework by means of adjustable fixing bolts and spacer tubes. It shall be capable of adjustment to vary the angle between the panel and the front face of the specimen from 12° to 18°.

7.3.3 Specimen holder guides

Guides, as shown in figure 2, shall be provided for locating the top and bottom edges of the specimen holder. They shall be made of steel capable of resisting heat and corrosion during a large number of tests. The lower guide shall be 700 mm long and shall have a groove machined in one of its narrow faces. The top edge of the specimen holder shall be located by means of one or more forks. The guides shall be mounted from one side of the tubular steel framework by lengths of steel studding and fixing nuts, which enable their positions to be adjusted in relation to the support frame and to each other.

7.3.4 Viewing mirror

A mirror 750 mm long by 120 mm wide shall be pivoted from the bottom of the side of the support frame opposite to that supporting the specimen holder. The location and angular position shall be such that it is possible to view the specimen in the mirror under the radiant panel, with the viewing rakes (see 7.3.5), superimposed across the face of the specimen (see figure 5).

NOTE 9 A video camera, placed at a location to provide a clear view of the whole test specimen, along with an appropriate video recording device, may be used to supplement the viewing mirror.

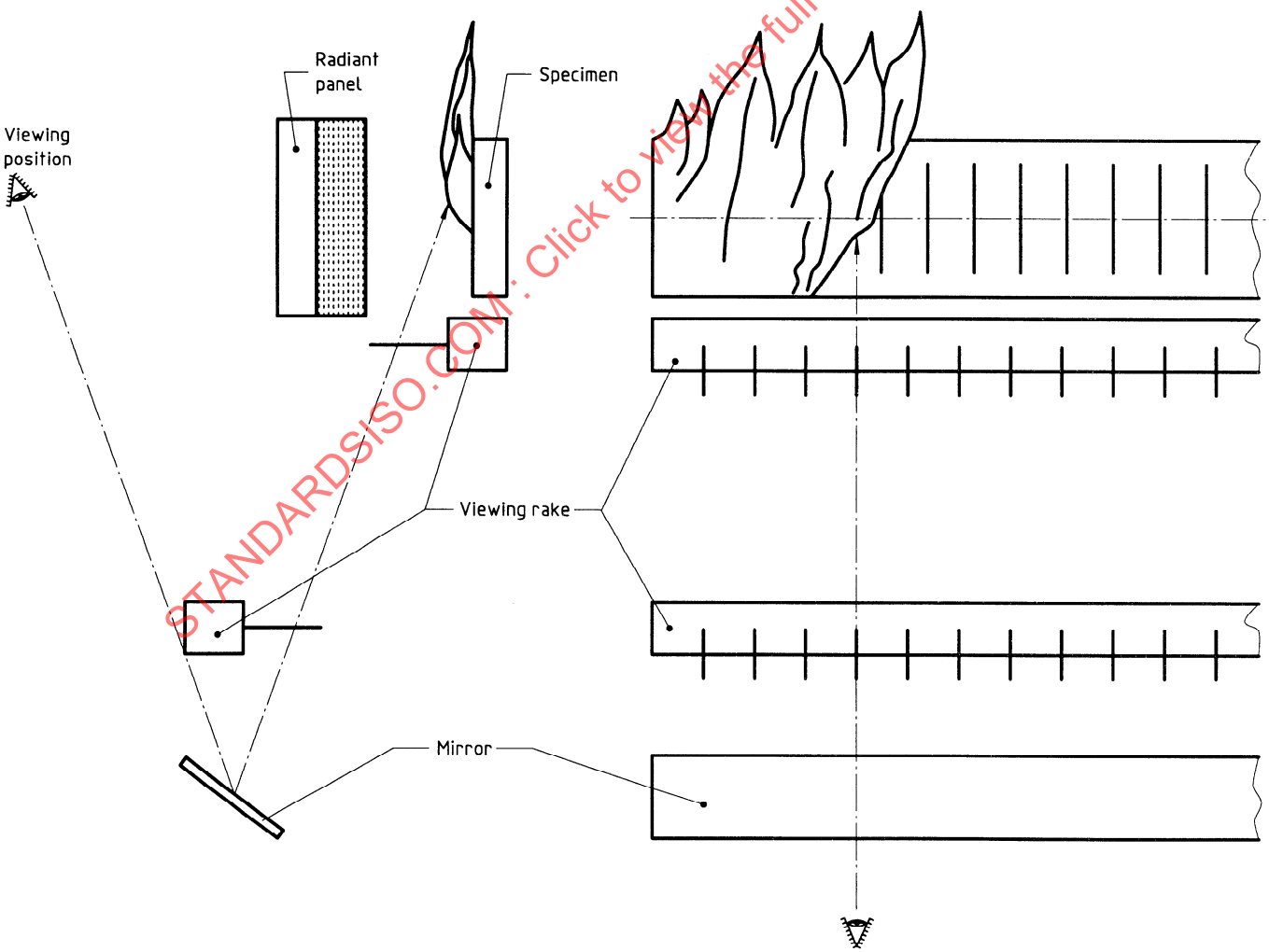


Figure 5 — Schematic of apparatus for the measurement of the time of arrival of the flame front

7.3.5 Viewing rakes

Viewing rakes are used to increase the precision of timing of the progress of the flame front along the specimen.

They shall be heat-resistant steel members 700 mm long and provided with 100 mm long steel pins fixed along one edge at 50 mm intervals. The rakes shall be fixed from the bottom specimen holder guide so that the pins project horizontally in front of the line of the mounted test specimen.

NOTE 10 In some circumstances it may be more satisfactory to use the V-marks on the specimen holder to facilitate observation of flame spread.

7.4 Specimen holder

The specimen holder shall be made from 3 mm thick stainless steel to the dimensions given in figure 3. It shall be provided with a quick-action clamp to retain the test specimen in position and to press it against the front flanges.

The front flanges shall be provided with serrated edges together with V-marks at 50 mm intervals to facilitate observation of flame spread. The zero mark shall correspond to the edge of the vertical flange at the end of the specimen adjacent to the radiant panel.

The number of specimen holders required will depend upon the amount of testing envisaged, but a minimum of three is recommended in addition to the one which will be used to hold the dummy specimen.

7.5 Pilot flame burner

The pilot flame burner shall be approximately 200 mm length of twin-bore porcelain, 6 mm in diameter, with each longitudinal bore 1,5 mm in diameter.

NOTE 11 The porcelain insulator normally used for sleeving thermocouple wire is suitable.

It shall be mounted from a bracket on the tubular steel frame of the specimen support framework (7.3.2) so that its position relative to the face of the test specimen is as shown in figure 6. The pilot flame burner shall be supplied with a mixture of propane and air, via suitable control and regulating valves and flowmeters (see figure 7).

Other gases (e.g. methane, acetylene) may be substituted for propane but the flame characteristics are different and may influence the ignition behaviour of specimens. In cases of dispute, it is essential that propane is used.

WARNING — Acetylene is a hazardous gas and must be used with extreme caution (see A.1).

8 Test environment

8.1 The dimensions of the room in which the tests are carried out are not critical provided it is large enough. A room of volume 45 m^3 with a ceiling height of not less than 2,4 m and an appropriate fume exhaust system has been found suitable.

A fume exhaust system should be installed above the ceiling and should have a capacity of at least 0,5 m^3/s. The ceiling grill opening to this exhaust system should be surrounded by a refractory fibre fabric curtain hanging from a square on the ceiling 1,3 m by 1,3 m down to (1,7 ± 0,1) m from the floor of the room. The specimen support frame and radiant panel should be located beneath this hood in such a way that all combustion fumes are withdrawn from the room.

8.2 The apparatus shall be sited in an environment substantially free from draughts with a clearance of at least 1 m between it and the walls of the test room. Material on the ceiling, floor or walls having a combustible finish shall not be located within 2 m of the radiant heat source.

8.3 The exterior air supply to replace that removed by the exhaust system for fumes shall be arranged in such a way that the ambient temperature remains reasonably stable and within the range 10 °C to 30 °C.

8.4 Measurements shall be taken of air speeds near a dummy specimen while the exhaust system for fumes is operating but with the radiant panel and its air supply turned off. The air flow perpendicular to the lower edge and at the midlength of the specimen shall not exceed 0,2 m/s in any direction, when measured at a distance of 100 mm from the specimen.

9 Additional equipment and instrumentation

9.1 Heat flux meter

At least 3 heat flux meters of the Schmidt-Boelter (thermopile) type with a nominal range of 0 to 50 kW/m^2 and a time constant of not more than 3 s (corresponding to a time to reach 95 % of final output of not more than 10 s) shall be provided, one to form a working instrument and two to be retained as reference standards.

NOTE 12 Suitable instruments are commercially available, and are sometimes referred to as "heat flux transducers", or "heat flux gauges".

The target sensing radiator shall be flat, shall occupy an area not more than 10 mm in diameter, and shall be coated with a durable matt black finish. It shall be contained within a water-cooled body whose front face shall be flat, circular, at least 25 mm in diameter and coincident with the plane of the receiving face

and the target. The whole front of the water-cooled body shall be highly polished. Radiation shall not pass through a window before reaching the target. The temperature of the cooling water should be controlled so that the heat flux meter body temperature remains within a few degrees of room temperature.

NOTE 13 Water cooling of the heat flux meter is required to standardize and define the measurement and to safeguard the heat flux meter. Failure to supply water cooling may result in overheating and damage to the receiver and loss of calibration of the heat flux meter. In some cases repairs and re-calibration are possible.

Dimensions in millimetres

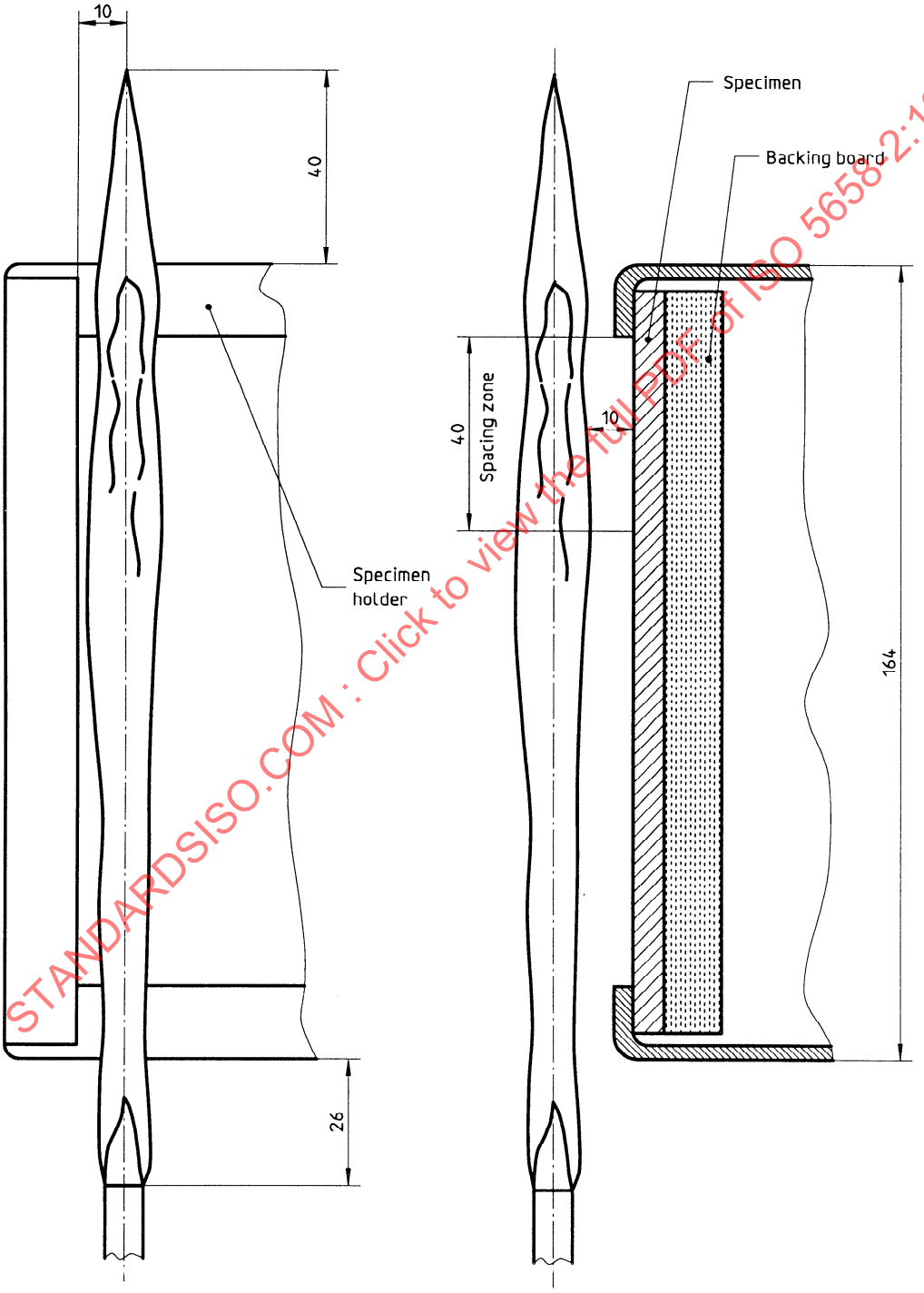


Figure 6 — Position of pilot flame burner and pilot flame

Dimensions in millimetres

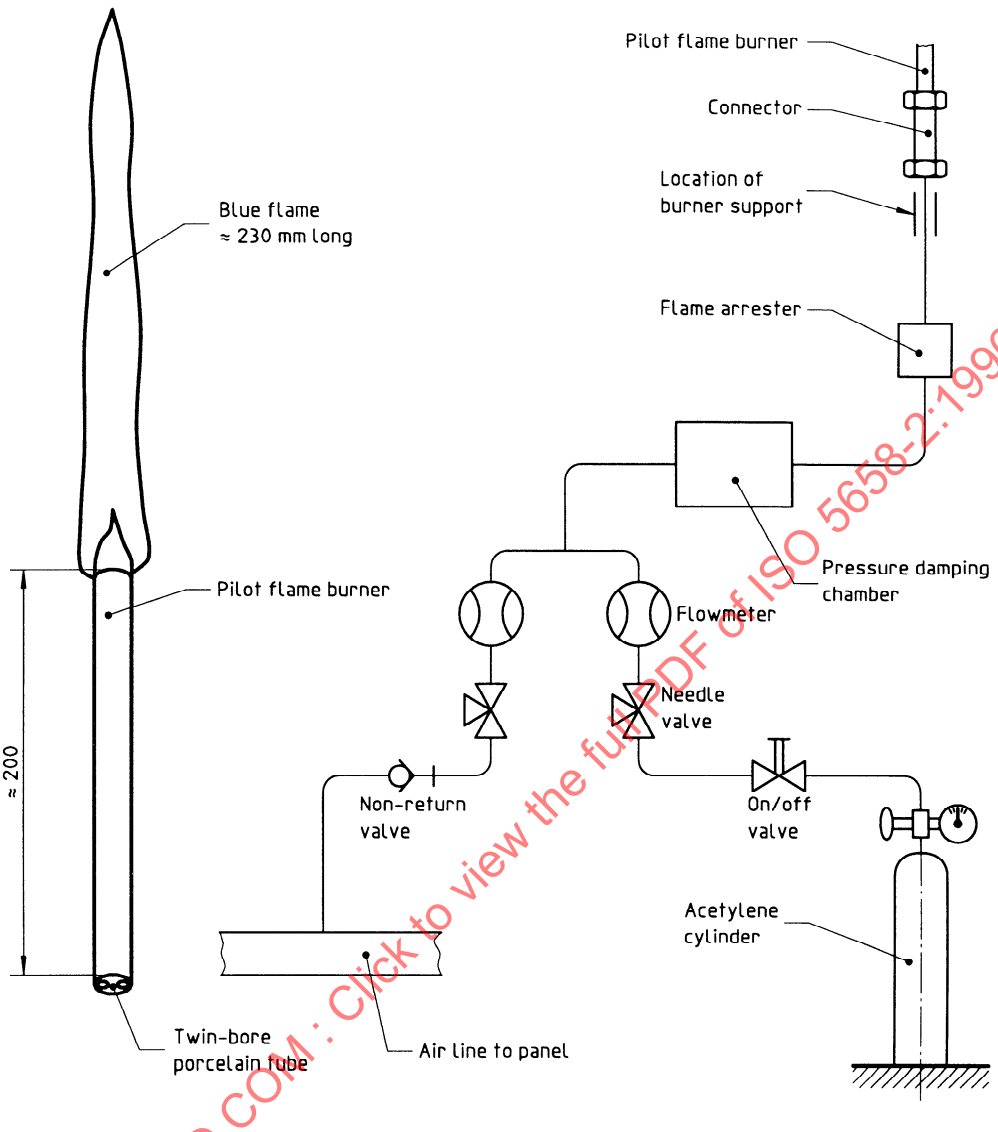


Figure 7 — Pilot flame, burner and gas/air connections (schematic)

If heat flux meters with a diameter less than 25 mm are used, these shall be inserted into a copper sleeve of 25 mm outside diameter in such a way that good thermal contact is maintained between the sleeve and the water-cooled heat flux meter body. The end of the sleeve and the receiving face of the heat flux meter shall lie in the same plane.

The heat flux meters shall be robust, simple to set up and use, insensitive to draughts and stable in calibration. They shall have an accuracy of ± 3 % and a repeatability to ± 0,5 %. The calibration of the working heat flux meter shall be checked every 2 months by comparison with the two reference standard heat flux meters (see annex C), which shall be kept securely and not used for any other purpose.

9.2 Total radiation pyrometer

The pyrometer used shall have a sensitivity substantially constant between the wavelengths of 1 µm and 9 µm. The instrument shall be mounted on the specimen support frame in such a manner that it can be used to view a centrally-located area on the panel surface of about 150 mm by 300 mm.

9.3 Recorder

The output from the radiation pyrometer and the heat flux meter(s) shall be recorded using an appropriate method.

NOTES

14 A strip chart recording millivoltmeter having an input resistance of at least 1 MΩ is suitable. The sensitivity should be selected to require less than full-scale deflection with the total radiation pyrometer or heat flux meter chosen. The effective operating temperature of the radiant panel would not normally exceed 935 °C.

15 A small digital millivoltmeter capable of indicating signal changes of 10 μV or less is convenient for monitoring changes in operating conditions of the radiant panel.

9.4 Timing devices

A chronograph and either an electric clock with a sweep second hand or a digital clock shall be provided to measure time of ignition and flame advance.

The chronograph for timing ignition and initial flame advance may comprise a strip chart recorder with a paper speed of at least 5 mm/s.

Both the chronograph paper drive and the electric clock shall be operated through a common switch to initiate simultaneous operation when the specimen is exposed. This may be hand operated or actuated automatically as a result of complete specimen insertion.

9.5 Dummy specimen

The dummy specimen shall be cut from a non-combustible board (for example, calcium silicate board) of oven-dry density (950 ± 100) kg/m^3, and shall measure 800 mm long, 155 mm wide and (25 ± 2) mm thick. Thinner non-combustible boards of the same density can also be used if they are fixed together to make a (25 ± 2) mm thick board without any noticeable gap. The dummy specimen shall remain in the specimen position during operation of the equipment and shall be removed only when a test specimen is to be inserted.

9.6 Calibration board

The calibration board shall be made of non-combustible board (for example, calcium silicate board) (25 ± 2) mm thick of oven-dry density (950 ± 100) kg/m^3. Thinner non-combustible boards of the same density can also be used if they are fixed together to make a (25 ± 2) mm thick board without any noticeable gap. The calibration board shall be provided with eight 25 mm diameter holes at the positions given in figure 8 to accommodate a heat flux meter for measuring the irradiance in the plane corresponding to the exposed surface of a specimen under test. Either a single heat flux meter may be used, inserted in each hole in turn, or a number of heat flux meters may be used, but holes which are not occupied by a heat flux meter shall be filled with removable plugs of the same material as the calibration board.

The receiving face(s) of the heat flux meter(s) shall (all) be in the plane of the exposed surface of the calibration board.

The calibration board shall be mounted in a specimen holder (see figure 3) with the first heat flux meter position 50 mm from the exposed end of the board, measured to the centre of the heat flux meter receiver.

NOTE 16 Approximately 14 mm of the hotter end of the board will be covered by the end flange.

9.7 Backing boards and spacers

Backing boards shall be cut from non-combustible board (for example, calcium silicate board) (12,5 ± 3) mm thick with the same dimensions as the dummy specimen and an oven-dry density of (950 ± 100) kg/m^3. Spacers used to create the air gap specified in 6.5.3 shall be made of the same material as the backing board, cut into (25 ± 2) mm wide strips and attached to the whole perimeter of the backing board.

Backing boards and spacers may be re-used if they are not contaminated by combustible residues. Immediately before re-use, however, they shall be conditioned in the atmosphere specified in 6.4.1 for at least 24 h. If there is any doubt about the cleanliness of a backing board or spacer, it shall be placed in a ventilated oven at a temperature of approximately 250 °C for a period of 2 h to remove any volatile residue. If there is still any doubt about the condition, it shall be discarded.

10 Setting-up and calibration procedure

10.1 Setting-up

Most of the adjustments of the components of the test apparatus may be made in the cold condition. Both in the original adjustment of the operating conditions for the test and in the periodic verification of this adjustment, the heat flux at the surface of the specimen is the controlling criterion. It should be noted that the reading of the heat flux meter is affected slightly by rising currents of air, warmed from the calibration board. This heat flux is measured by a heat flux meter mounted in the calibration board (see figure 8).

The initial position of the refractory surface of the radiant panel with respect to the specimen shall correspond with the dimensions shown in figure 9.

The procedure for setting the test conditions initially shall be as follows.

a) Set an air flow rate of about 8 l/s through the panel. Turn on the gas supply, light the radiant panel and allow it to come to thermal equilibrium with a dummy specimen mounted in front of it.

NOTE 17 When operating correctly there will be no visible flaming from the panel except when viewed parallel to the surface from one side. From this direction a thin blue flame very close to the surface of the panel will be observed. An oblique view of the panel after a 15 min warm-up period should show a bright orange radiating surface.

Dimensions in millimetres

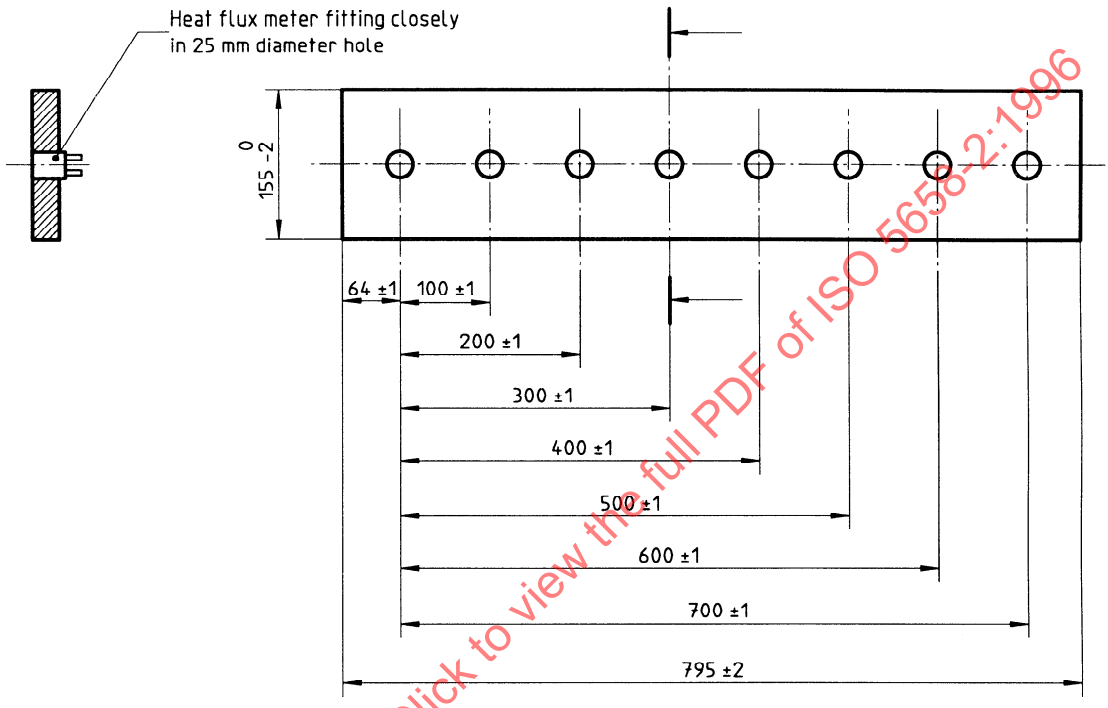


Figure 8 — Calibration board for heat flux measurements

Dimensions in millimetres

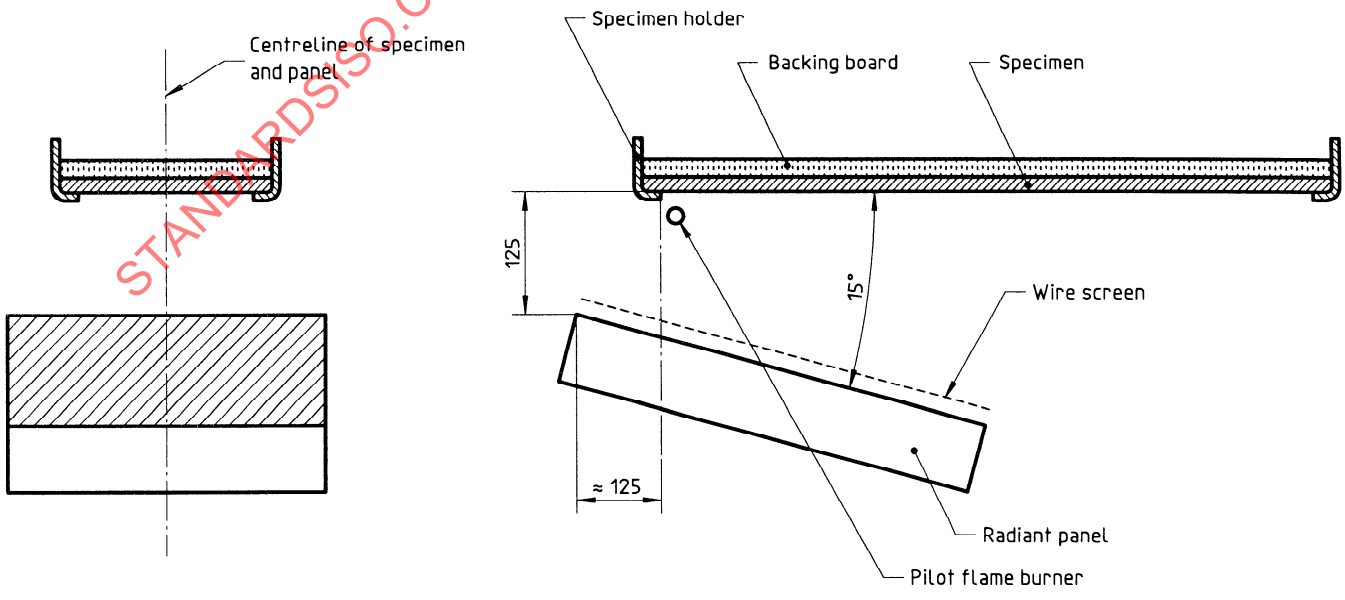


Figure 9 — Position of radiant panel in relation to specimen

b) Adjust the gas flow rate until the heat flux(es) measured with the water-cooled heat flux meter(s) mounted in the calibration board correspond(s) to the values shown in table 1 for the 50 mm and 350 mm positions. If necessary, make small changes in air flow rate to achieve no significant flaming from the panel surface. After making each adjustment allow the calibration board to reach temperature equilibrium before measuring the radiant heat flux. It may be necessary to make small changes in the longitudinal position of the specimen.

c) Once the values shown for the 50 mm and 350 mm positions have been achieved, determine the heat flux for each of the other positions given in table 1 and ensure that the values are within the given tolerances.

NOTE 18 In processing the results of the test it is assumed that the heat flux at a given position on an actual test specimen is equal to that measured at the same position with the calibration board.

d) If a change in panel-specimen axial position is necessary to meet the requirements for heat flux at the 50 mm and 350 mm positions, this shall be accomplished by adjusting the screws connecting the two frames, so that the position of the pilot flame in relation to the specimen remains unchanged.

NOTE 19 The specimen stop screw adjustment may be changed to meet the heat flux requirements, in which case the position of the pilot burner mount may require adjustment to maintain the pilot burner flame spacing of (10 ± 2) mm in front of the specimen surface.

e) Once the operating conditions have been achieved, all future panel operation shall take place with the air flow rate needed to attain them, and with the gas flow rate being varied to achieve the required heat flux. If a total-radiation pyrometer is used to monitor panel operation, a record of its signal shall be kept following successful completion of this calibration procedure.

Table 1 — Standardization of heat flux along the calibration board

Position (distance of heat flux meter from hot end of board) mm	**Heat flux** kW/m²	**Tolerance on heat flux** kW/m²
0	49,5	1)
50	50,5	± 0,5
100	49,5	1)
150	47,1	± 2,4
200	43,1	1)
250	37,8	± 1,9
300	30,9	1)
350	23,9	± 0,2
400	18,2	1)
450	13,2	± 0,7
500	9,2	1)
550	6,2	± 0,6
600	4,3	1)
650	3,1	± 0,3
700	2,2	1)
750	1,5	± 0,3

1) These positions, for which tolerances are not specified, are used for initial setting up of operating conditions only and the values of heat flux at these positions are given to aid the production of a smooth heat flux/distance relationship. The heat flux meter may be located at these positions by withdrawing the specimen holder 50 mm.

10.2 Verification

Confirm the heat flux distribution (see table 1) on the calibration board by calibrations at daily and monthly intervals, as follows.

a) Daily verification: measure the heat flux at positions 50 mm and 350 mm from the exposed end.

b) Monthly verification: measure the heat flux at positions 50 mm, 150 mm, 250 mm, 350 mm, 450 mm, 550 mm, 650 mm and 750 mm from the exposed end.

10.3 Adjustment of the pilot flame

Adjust the gas and air supply to provide a flame length of about 230 mm so that, when viewed in a darkened room, the flame extends about 40 mm above the vertical specimen holder (see figure 6).

NOTE 20 The propane and air flow rates required are likely to be about 0,4 l/min and 1 l/min respectively.

Adjust the spacing of the flame from the dummy specimen by moving the burner towards or away from the plane of the exposed surface of the dummy specimen using the screws provided. The spacing of the flame from the dummy specimen is defined by the charring behaviour of 3 mm thick softwood strips of 10 mm and 12 mm width. The strips shall be slid along the dummy specimen surface under the pilot burner flame, along a 40 mm length of the flame, for an exposure time of about 2 s. The 10 mm strips shall not be charred but the 12 mm strips shall show char (see figure 10). Note the flow rates of gas and air to the pilot burner.

The pilot flame shall be checked and if necessary adjusted in the way stated above every day. The nature of some specimens may make this necessary more frequently.

10.4 Impinging pilot flame

When retesting is required as specified in 11.11, rotate the pilot burner tube in its holder until the flame (defined in 10.3) impinges over the top half of the exposed specimen height.

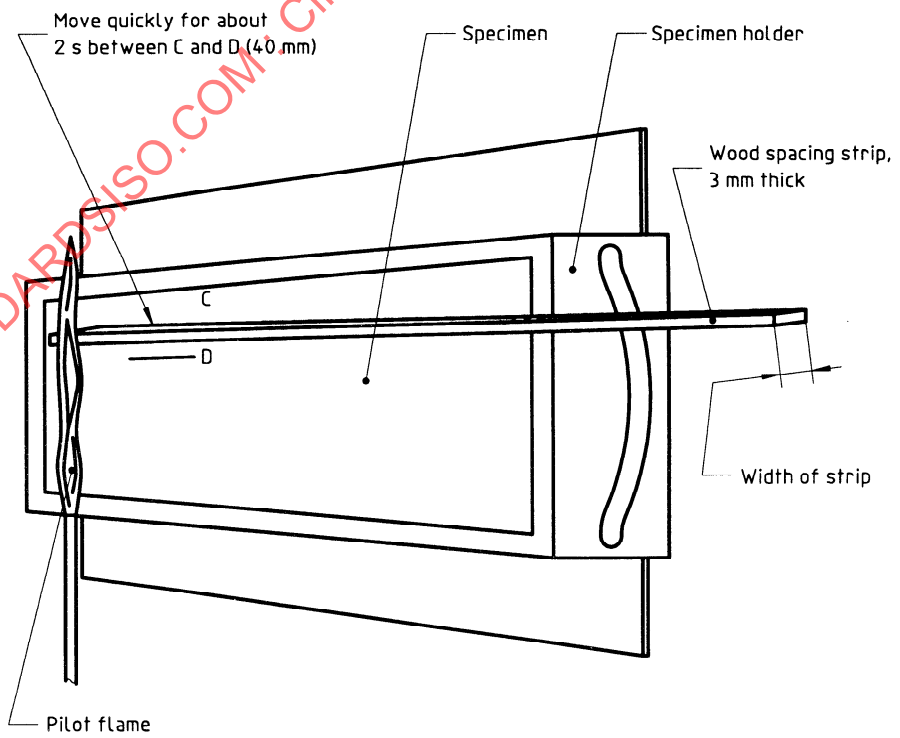


Figure 10 — Measurement of spacing between specimen and pilot flame using wood strips
(see 10.3)

11 Test procedure

11.1 Mount the dummy specimen in a specimen holder in the position facing the radiant panel and start the fume exhaust system.

11.2 Operate the radiant panel to realise the test conditions specified in table 1.

11.3 When the radiant panel has attained thermal equilibrium, light the pilot flame, set the normal flow rates of fuel and air to it, check the flame length and if necessary adjust the fuel and air flow rates.

11.4 Insert a conditioned specimen, wrapped in aluminium foil and placed on a backing board as specified in 6.5.2 or 6.5.3, in a cool specimen holder away from the heat of the panel, and insert the clamp to press the specimen against the front flanges.

11.5 Remove the dummy specimen holder and insert the specimen in the test position, taking no more than 15 s to complete the operation. Immediately start the clock, the chronograph and, if using one, the video camera clock (see note 9 in 7.3.4).

11.6 Operate the event marker of the chronograph to indicate the time of ignition and arrival of the flame front at the first few positions during the initial rapid burning of the specimen. Record the time of arrival at each given position of the flame front as the time at which it coincides with the longitudinal centreline of the specimen and with the position of two corresponding pins of the viewing rakes. Record these times manually both from measurements on the chronograph chart and observations of the clock. As far as possible the arrival of the flame front at each 50 mm position along the specimen shall be recorded. Record both the time and the position along the centreline of the specimen at which flame ceases to advance.

In cases where the marked line is obscured by the surface of a specimen scorching in advance of the flame, then the operator shall judge the centreline of the specimen by eye.

11.7 Throughout the exposure of the specimen make no change in the fuel supply rate to the radiant panel to compensate for variations in its operating level.

11.8 Terminate the test if:

a) the specimen fails to ignite after a 10 min exposure;

b) flame ceases to spread along the specimen and is extinguished and no further flaming of any type ensues within the next 10 min;

c) surface flaming reaches the end of the specimen;

d) the specimen burns in one position only and the flame front does not spread from this position within 30 min of the test starting.

11.9 When the test is terminated remove the specimen and reinsert the dummy specimen in its holder.

11.10 Repeat the operations described in 11.4 to 11.9 for two additional specimens, allowing the radiant panel to attain temperature equilibrium before each test.

11.11 Conditions of re-test are as follows.

a) If one of the three specimens does not ignite, test one further specimen with the non-impinging pilot flame.

b) If two or three of the first set of specimens do not ignite following exposure for 10 min, test one further specimen with an impinging pilot flame (see 10.4). If this specimen ignites, test two additional specimens under this condition.

In case b) the test report shall clearly state that repeatable ignition was not obtained with the normal pilot flame or with the impinging pilot flame, or was obtained with the latter alone, and shall make clear which pilot flame applies to a given set of flame spread results.

11.12 The test method shall be deemed to be inappropriate if the specimen exhibits behaviour such that the exposed surface is not available for the measurement of flame spread, such as:

a) any softening, melting or disintegration of material resulting in the specimen sagging out of the specimen holder; or

b) the detachment of the facing from the substrates.

The test method is, however, appropriate if ignition of the exposed surface occurs within the resulting flame front before the onset of the inappropriate behaviour, as described in a) and b).

11.13 Throughout the test, careful observation shall be made of the behaviour of the product and a special note shall be made of the following phenomena:

a) flashing;

b) transitory flaming (unstable flame front).

Observations shall also be made of other phenomena such as debris falling away from the specimen and whether or not it is flaming, intumescence and/or deformation of the specimen, separations, spalling,

fissures and cracks, sparks, melting, changes in form, etc. Guidelines on the reporting of unusual behaviour are given in annex D.

12 Expression of fire performance of a product

Report experimental results in terms of the radiant heat fluxes measured with the calibration board in place. Do not compensate for changes in thermal output of the radiant panel during the exposure of the specimen. Derive and list the following data from the test results for each specimen tested:

a) average heat for sustained burning — an average of the values of heat for sustained burning (see 3.2 and 3.9) measured at 50 mm intervals, the first at 150 mm and then at each subsequent position up to and including the 400 mm position (or the final position if the test is terminated before the 400 mm position is reached);

b) critical heat flux at extinguishment.

Calculate the average of the results of a) and of b) for the three specimens tested.

13 Test report

The test report shall include the time for the flame front to pass each of the standard 50 mm positions, the observations made on each specimen tested and the derived fire characteristics. The following information shall be supplied:

a) reference to this part of ISO 5658;

b) name and address of testing laboratory;

c) name and address of sponsor;

d) name and address of manufacturer/supplier;

e) full description of the product tested including tradename, together with its construction, orientation, thickness, density and where appropriate the face subjected to test; in the case of specimens which have been painted or varnished, the quantity and number of coats applied shall be recorded as well as the nature of the supporting materials;

f) description of the substrate used and method of fixing the specimen onto the substrate;

g) data from the test including:

   1) number of specimens tested;

   2) type of pilot flame used (see 11.11);

   3) duration of each test (see 11.8);

   4) observations of the movement of the flame front recorded in accordance with 11.6;

   5) other observations of the behaviour of the product (see 11.12);

   6) derived fire characteristics as described in clause 12;

h) limiting use statement, such as: "These test results relate only to the behaviour of the product under the particular conditions of this test, and they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use";

i) any explanation of the reason for tests to be deemed invalid shall be given.

Annex A
(normative)

Safety precautions

A.1 Hazards of acetylene and other gases

Acetylene is a very flammable gas and forms explosive mixtures with air over a wide range of concentrations (see table A.1)

Table A.1 — Fire and explosion hazards of gases

	Acetylene	Methane	Propane
Lower and upper explosive limits (%)	3 to 82	5 to 15	2,2 to 9,5
Ignition temperature (°C)	335	537	468

CAUTION — Under certain conditions, acetylene forms explosive compounds with copper, silver and mercury. This is important with respect to the acetylene supply lines (see figure 7).

A.2 Ignition hazards

The use of this test method involves the generation of very high irradiances which can cause ignition of some materials such as clothing following even brief exposures. It is important that precautions are taken to avoid accidental ignitions of this type.

A.3 Toxic fume hazards

The attention of the user of this test is drawn to the fact that the fumes from burning materials usually include carbon monoxide and other noxious gases. In many instances other toxic products may be produced. It is important that precautions are taken to avoid exposure to these fumes.

A.4 Eye protection

The possibility of the violent ejection of molten hot material or sharp fragments from some kinds of specimens when irradiated cannot totally be discounted and eye protection should be used by the operator.