INTERNATIONAL STANDARD

ISO 10093

Second edition
1998-11-15

Plastics — Fire tests — Standard ignition sources

Plastiques — Essais au feu — Sources d'allumage normalisées

Reference number
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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 10093 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 4, *Burning behaviour*.

This second edition cancels and replaces the first edition (ISO 10093:1994), which has been technically revised.

This edition differs from the 1994 edition in that all methods that had not been standardized internationally were eliminated. The sources which were eliminated were S/DF4, which was based on the ASTM E 84 burner, and the sources S/C1, S/C2 and S/C3, which were small cribs used in British Standard tests. Two extra burners, S/DF5 and S/DF6, have been introduced in this revision. These are based on the IEC 60332-3:1992 and the ISO 9705:1993 ignition sources. Sources P/PF2 and P/PF3 in the 1994 edition have been integrated into a single source, P/PF2, with two definitions of fuel supply for the same burner.

Annexes A and B of this International Standard are for information only.

Introduction

Fires are caused by a wide range of possible ignition sources. Statistical analysis of fires has identified the main primary and secondary sources, especially for fires in buildings. The most frequent sources of fires have been found to be as follows:

a) cooking appliances;

b) space-heating appliances;

c) electric wiring, connectors and terminations;

d) other electrical appliances (such as washing machines, bedwarmers, televisions, water heaters);

e) cigarettes;

f) matches and smokers' gas lighters;

g) blow-lamps, blow-torches and welding torches;

h) rubbish burning;

i) candles.

The above list covers the major primary ignition sources for accidental fires. Other sources may be involved in fires raised maliciously. Research into causes of fires has shown that primary ignition sources (e.g. glowing cigarettes or dropped flaming matches) can set fire to waste paper, which then acts as a secondary ignition source of greater intensity.

When analysing and evaluating the various ignition sources for applications involving plastics materials, the following questions need to be answered on the basis of detailed fire statistics:

a) What is the significance of the individual ignition sources in various fire risk situations?

b) What proportion is attributable to secondary ignition sources?

c) Where does particular attention have to be paid to secondary ignition sources?

d) To what extent are different ignition sources responsible for fatal fire accidents?

The following laboratory ignition sources are intended to simulate actual ignition sources that have been shown to be the cause of real fires involving plastics. Laboratory ignition sources are preferred over actual ignition sources due to their consistency which results in greater data repeatability within a laboratory and greater reproducibility between laboratories.

These laboratory ignition sources may be used to develop new test procedures.

Plastics — Fire tests — Standard ignition sources

1 Scope

This International Standard describes and classifies a range of laboratory ignition sources for use in fire tests on plastics and products consisting substantially of plastics. These sources vary in intensity and area of impingement. They may be used to simulate the initial thermal abuse to which plastics may be exposed in certain actual fire risk scenarios.

2 Normative references

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

ISO 1337:1980, *Wrought coppers (having minimum copper contents of 99,85 %) — Chemical composition and forms of wrought products.*

ISO 5657:1997, *Reaction to fire tests — Ignitability of building products using a radiant heat source.*

ISO 8191-1:1987, *Furniture — Assessment of the ignitability of upholstered furniture — Part 1: Ignition source: smouldering cigarette.*

ISO 8191-2:1988, *Furniture — Assessment of the ignitability of upholstered furniture — Part 2: Ignition source: match-flame equivalent.*

ISO 9705:1993, *Fire tests — Full-scale room test for surface products.*

ISO 11925-2:1997, *Reaction to fire tests — Ignitability of building products subjected to direct impingement of flame — Part 2: Single flame source test.*

IEC 60332-3:1992, *Tests on electric cables under fire conditions — Part 3: Tests on bunched wires or cables.*

IEC 60695-2-1/0:1994, *Fire hazard testing — Part 2: Test methods — Section 1/sheet 0: Glow-wire test methods — General.*

IEC 60695-2-2:1991, *Fire hazard testing — Part 2: Test methods — Section 2: Needle-flame test.*

IEC 60695-2-4/1:1991, *Fire hazard testing — Part 2: Test methods — Section 4/sheet 1: 1 kW nominal pre-mixed test flame and guidance.*

IEC 60695-2-4/2:1994[1], *Fire hazard testing — Part 2: Test methods — Section 4/sheet 2: 500 W nominal test flames and guidance.*

IEC 60695-2-20:1995, *Fire hazard testing — Part 2: Glowing/Hot wire based test methods — Section 20: Hot-wire coil ignitability test on materials.*

1) Future editions of this standard are expected to be published under the designation IEC 60695-11-3.

IEC 60695-11-4:—[2], *Fire hazard testing — Part 11: Test flame — Section 4: 50 W apparatus and confirmational test methods.*

ASTM D 5025:1994, *Standard specification for a laboratory burner used for small-scale burning tests on plastic materials.*

DIN 50051:1977, *Testing of materials; Burning behaviour of materials; Burner.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1
afterflame
persistence of flaming of a material after the ignition source has been removed

3.2
afterflame time
length of time for which a material continues to flame, under specified test conditions, after the ignition source has been removed [also called duration of flame(s)]

3.3
afterglow
persistence of glowing of a material after cessation of flaming or, if no flaming occurs, after the ignition source has been removed

3.4
afterglow time
length of time for which a material continues to glow, under specified test conditions, after the ignition source has been removed and/or cessation of flaming

3.5
combustion
exothermic reaction of a substance with an oxidizer, generally accompanied by flames and/or glowing and/or emission of smoke

3.6
ease of ignition
ease with which a material can be ignited under specified test conditions

3.7
exposed surface
that surface subjected to the heating conditions of the test

3.8
flame (verb)
to undergo combustion in the gaseous phase with emission of light

3.9
flaming debris
material separating from the specimen during the test procedure and falling below the initial lower edge of the specimen and continuing to flame as it falls

3.10
glowing combustion
combustion of a material in the solid phase without flame but with emission of light from the combustion zone

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2) To be published.

3.11
ignitability
measure of the ease with which a specimen can be ignited due to the influence of an external heat source under specified test conditions

3.12
ignite (transitive verb)
to initiate combustion

3.13
ignite (intransitive verb)
to catch fire with or without the application of an external heat source

3.14
ignition
initiation of combustion

3.15
ignition source
applied source of heat which is used to ignite combustible materials or products

3.16
ignition temperature
minimum temperature of a material at which sustained combustion can be initiated under specified test conditions

3.17
irradiance
⟨at a point of a surface⟩ radiant flux incident on an infinitesimal element of the surface containing the point divided by the area of that element

3.18
minimum ignition time
minimum time of exposure of a material to an ignition source to obtain sustained combustion under specified test conditions

3.19
primary ignition source
the first applied ignition source

3.20
punking
propagation of a smouldering combustion front after removal of the ignition source

3.21
secondary ignition source
heat source which is activated following ignition from a primary source

3.22
sustained flaming
after withdrawal of the ignition source, the inception of a flame on the surface of a material that persists for at least 10 s

3.23
transitory flaming
after withdrawal of the ignition source, the appearance of flashes or flames which are not sustained for a continuous 10 s

4 Ignition processes

4.1 When plastics are exposed to thermal energy, flammable vapours may be generated from their surface. Under suitable conditions (especially high temperatures), a critical concentration of flammable vapour may form and spontaneous ignition will result. If a flame is present as the sole energy source, or as a supplementary source, the ignition process will be assisted; this mechanism is sometimes known as pilot ignition.

4.2 A specimen of plastic is regarded as ignited when flames appear on the surface of the plastic or when glowing combustion is evident.

4.3 After ignition has occurred, some burning plastics create additional fire hazards by forming flaming debris or drips. If this flaming debris falls on to combustible material, secondary ignition may occur and the fire will spread more rapidly.

4.4 The localized application of a heat source to some plastics results in glowing combustion. With some thermoplastic foams and foams from thermosetting materials the localized application of a heat source results in punking which produces a carbonaceous char.

5 Characteristics of ignition sources

5.1 The main characteristics of ignition sources and their relation to the test specimen may be defined by the following factors:

a) The intensity of the ignition source. This is a measure of the thermal load on the specimen resulting from the combined conduction, convection and radiation effects caused by the ignition source.

b) The area of impingement of the ignition source on the specimen.

c) The duration of exposure of the specimen and whether it is continuous or intermittent.

d) The presentation of the ignition source to the specimen and whether or not it impinges.

e) The orientation of the specimen in relation to the ignition source.

f) The ventilation conditions in the vicinity of the ignition source and exposed surface of the specimen.

5.2 The ignition sources described in clause 7 provide a range of intensities and areas of impingement to be considered for use in fire tests of plastics.

NOTE Factors c) to f) may be determined when the specific fire test conditions have been decided.

6 Experimental principles

6.1 Flame ignition sources of two types have been selected.

6.1.1 Diffusion flame source

To form a diffusion flame source, gas (usually propane, methane or butane) flows through stainless-steel tubes without ingress of air prior to the base of the flame.

NOTE These flames simulate natural flames well but they often fluctuate and are not convenient to direct if any angular presentation is required toward the specimen.

6.1.2 Premixed flame source

To form a premixed flame source, a gas burner (usually using propane, methane or butane) fitted with air inlet ports or an air intake manifold is used.

NOTES

1 Premixed flame sources are more directional than diffusion flame sources and are more suitable for some laboratory quality assurance tests.

2 Premixed flame sources are generally hotter than diffusion flame sources.

6.2 It is recommended (mandatory for some test methods) that gas burners are always set up to conform to precise gas flow rates and/or flame heights. Secondary checks of flame temperature or heat flux should be performed periodically but criteria on these parameters should not be an essential part of the laboratory procedure. After setting up the burner for a particular test (i.e. often at an acute angle to the test specimen), it is desirable to leave the burner in this orientation throughout a series of experiments. This objective is conveniently satisfied if the operator only has to maintain the gas flow constant to the burner.

6.3 The gas burners are connected to the gas supply by flexible tubing via a cylinder regulator providing an outlet pressure, on-off valve, fine-control valve and flowmeter.

6.4 Difficulties sometimes occur with the supply and measurement of butane or propane when the cylinders need to be stored in an environment cooler than the defined test conditions and/or some distance from the test rig. When difficulties occur, a sufficient length of tubing is needed inside the controlled environment (15 °C to 30 °C) to ensure that the gas equilibrates to the required temperature before flow measurement.

NOTE One way to facilitate this equilibration is to pass the gas (before flow measurement) through a metal tube immersed in water maintained at 25 °C.

6.5 It is important to exercise great care with the measurement and setting of the flow rate of the gas. It is necessary to check direct-reading flowmeters, even those obtained with a direct calibration for the gas used initially, and at regular intervals during testing, with a method capable of measuring accurately the absolute gas flow at the burner tube.

NOTE One way of doing this is to connect the burner tube with a short length of tubing (about 7 mm internal diameter) to a soap bubble flowmeter. Passage of a soap film meniscus in a glass tube (e.g. a calibrated burette) over a known period of time gives an absolute measurement of the flow. Also, fine-control valves that can each be preset to one of the desired gas flow rates, with simple means for switching from one to the other, have proved helpful.

7 Ignition sources

7.1 General

The classification of ignition sources available for use in testing plastics is shown in table 1. Each class will indicate whether a source simulates a primary or secondary ignition source by using a prefix, where "P" refers to primary and "S" refers to secondary.

Table 1 — Classification of ignition sources

Class	Type	Example
S_m	Smouldering	Cigarette
E	Electric	Overheated wire; arcs
DF	Diffusion flame	Match; candle
PF	Premixed flame	Laboratory-burner; blow-lamp
R	Non-contacting radiant	Electric fire; radiant heat from a developing or established accidental fire

NOTES

1 Where a heat flux figure is quoted for any of the following sources, this represents the measured heat flux at the point on the surface at which the flame impinges.

2 Where an area of impingement is quoted for any of the following sources, this represents the area the flame will cover when the closest edge of the burner orifice is situated 5 mm from a vertical flat surface.

7.2 Ignition source P/S_m1

7.2.1 This source is typical of a common cigarette, which is recognized to cause many fires involving upholstered furniture and bedding as discussed in ISO 8191-1. The untipped (unfiltered) cigarette shall comply with the following requirements:

length	70 mm ± 4 mm
diameter	8,0 mm ± 0,5 mm
mass	1,0 g ± 0,1 g
smouldering rate	12,0 min/50 mm ± 3,0 min/50 mm

7.2.2 The smouldering rate is verified on one specimen from each batch of 10 cigarettes used as follows:

a) condition the cigarette before the test for 72 h in indoor ambient conditions and then for at least 16 h in an atmosphere having a temperature of 20 °C ± 5 °C and a relative humidity of (50 ± 20) %;

b) mark the cigarette at 5 mm and 55 mm from the end to be lit;

c) light the cigarette and draw air through it until the tip glows brightly: do not consume more than 3 mm of the cigarette in this operation;

d) impale the cigarette in draught-free air on a horizontal wire spike, inserting not more than 13 mm of the spike into the unlit end of the cigarette;

e) record the time taken to smoulder from the 5 mm to the 55 mm mark.

7.3 Ignition source P/E1

7.3.1 This ignition source referenced in IEC 60695-2-1/0 is called a glow-wire. This source simulates overheating of electrical wiring, particularly within electrotechnical equipment, by heating the glow-wire to one of the following temperatures:

550 °C ± 10 °C

650 °C ± 10 °C

750 °C ± 10 °C

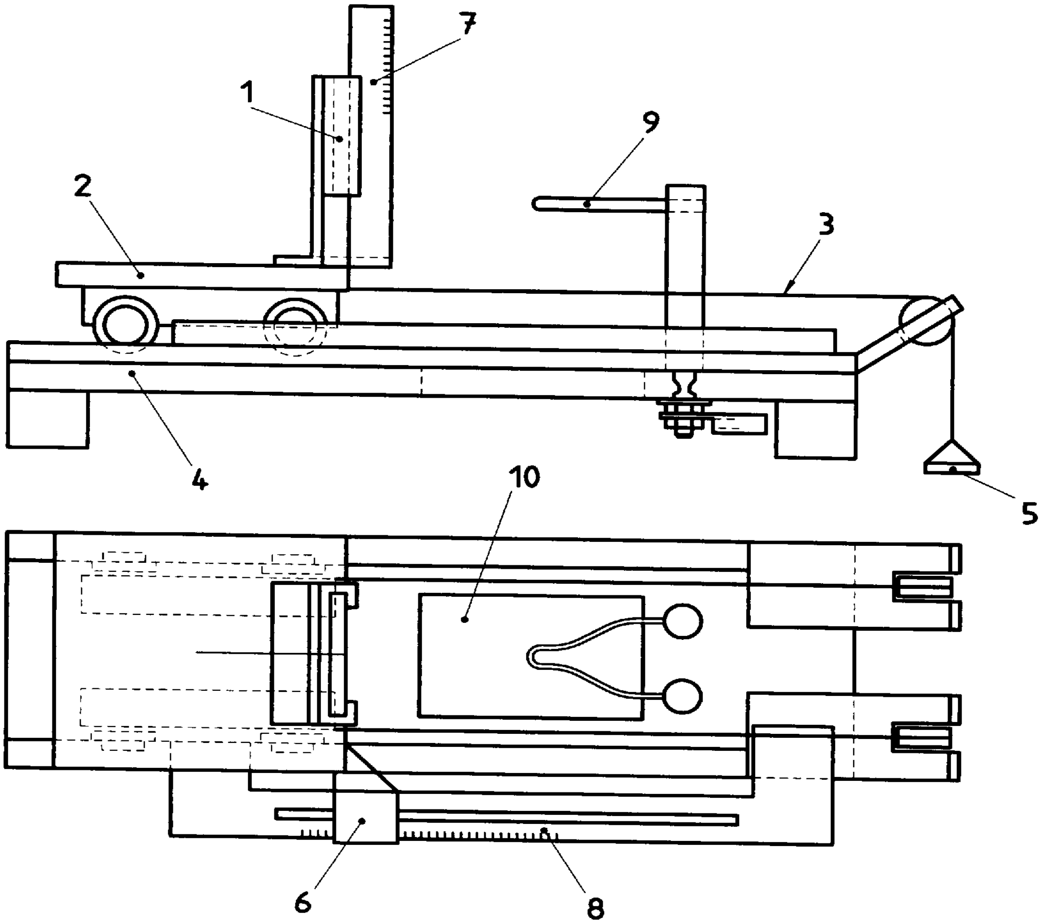
850 °C ± 15 °C

960 °C ± 15 °C

7.3.2 The glow-wire apparatus and ignition source is shown in figure 1. The glow-wire itself consists of a loop of nickel/chromium (80/20) wire 4 mm in nominal diameter.

7.3.3 The temperature of the glow-wire is measured by the use of a sheathed fine-wire thermocouple (NiCr/NiAl) having a nominal overall diameter of 0,5 mm.

7.3.4 The test apparatus positions the glow-wire in a horizontal plane while applying a force of 1,0 N ± 0,2 N to the specimen. This force is maintained when the glow-wire is moved horizontally towards the specimen or *vice versa*. The movement of the tip of the glow-wire into the specimen when pressed against it is mechanically limited to 7 mm.



Key

1 Positioning clamp
2 Carriage
3 Tensioning cord
4 Baseplate
5 Weight
6 Stop
7 Scale to measure height of flame
8 Scale for penetration
9 Glow-wire
10 Cut-out in baseplate for particles falling from specimen

Figure 1 — Ignition source P/E1

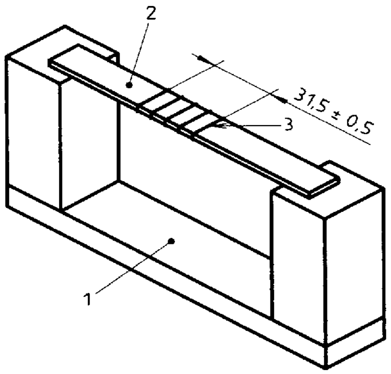
7.4 Ignition source P/E2

7.4.1 This ignition source, referenced in IEC 60695-2-20, is an electrically heated hot wire that simulates the overloading of a live part in direct contact with a test specimen.

7.4.2 Hot-wire ignition tests are carried out on bar-shaped specimens, of dimensions 125 mm ± 5 mm long, 13,0 mm ± 0,3 mm wide and 3,0 mm ± 0,1 mm thick. Specimens are wrapped with five turns of 0,5 mm diameter nickel/chromium (80/20) wire of approximate length 250 mm and with a nominal cold resistance of 5,28 Ω/m, spaced 6,35 mm ± 0,5 mm between turns. The test apparatus and ignition source are shown in figure 2.

7.4.3 The specimen is tested in a horizontal position by heating the wire electrically so that 0,26 W is generated per mm length of wire, and the wire has a temperature of approximately 930 °C.

Dimensions in millimetres



Key

1 Test fixture
2 Test specimen
3 Hot wire (five turns with 6,35 mm ± 0,5 mm between turns)

Figure 2 — Ignition source P/E2

7.5 Ignition source P/DF1

7.5.1 This ignition source, described in IEC 60695-2-2, is a needle flame which provides a low-intensity, low-area diffusion flame. This source may be used to simulate the effect of small flames resulting from fault conditions within electrical equipment.

7.5.2 The needle burner consists of a piece of stainless-steel hypodermic tubing with the tapered end cut off. The burner has a minimum length of 35 mm with a bore of 0,5 mm ± 0,1 mm and an outer diameter not exceeding 0,9 mm. The burner is connected with flexible tubing to a cylinder containing butane. The butane gas shall have a purity of at least 95 %.

NOTE Butane gas is the standard reference, but propane gas may be used.

7.5.3 With the axis of the needle burner in the vertical position, the gas supply is adjusted so that the length of the flame is 12 mm ± 1 mm. The ignition source is shown in figure 3.

Dimensions in millimetres

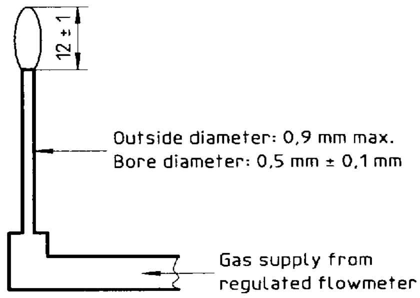


Figure 3 — Ignition source P/DF1

7.6 Ignition source P/DF2

7.6.1 This ignition source, described in ISO 8191-1, is a diffusion flame with a calorific output approximating to that of a burning match. A flame exposure time of 15 s ± 2,0 s will be approximately equivalent to the burning of one match.

7.6.2 The burner barrel consists of a stainless-steel tube of the following dimensions:

outside diameter	8,0 mm ± 0,1 mm
internal diameter	6,5 mm ± 0,1 mm
length	200 mm ± 5 mm

7.6.3 The burner tube is connected with flexible tubing to a cylinder containing propane and the flexible tubing between the flowmeter and the burner tube has an internal diameter of 8 mm and a length of 2,0 m ± 0,2 m. The flowmeter is calibrated to supply a propane gas flow rate at 25 °C of 45 ml/min ± 2 ml/min.

NOTES

1 Under the above conditions, the flame height is approximately 40 mm. The area of impingement on the exposed surface of a specimen is 7,5 cm^2 ± 0,2 cm^2 and the heat flux is 40 kW/m^2 ± 2 kW/m^2.

2 Propane gas is the standard reference, but butane gas may be used.

7.7 Ignition source P/DF3

7.7.1 This ignition source, described in ISO 8191-2, is a diffusion flame of approximately 125 mm in height. The burner barrel consists of a stainless-steel tube of the following dimensions:

outside diameter	8,0 mm ± 0,1 mm
internal diameter	6,5 mm ± 0,1 mm
length	200 mm ± 5 mm

7.7.2 The burner tube is connected with flexible tubing to a cylinder containing propane and the flexible tubing between the flowmeter and the burner tube has an internal diameter of 8,0 mm and a length of 2,0 m ± 0,2 m. The flowmeter is calibrated to supply a propane gas flow rate at 25 °C of 160 ml/min ± 5 ml/min.

NOTES

1 Under the above conditions, the flame height is approximately 125 mm. The area of impingement on the exposed surface of a specimen is 42 cm^2 ± 3 cm^2 and the heat flux is 36 kW/m^2 ± 2 kW/m^2.

2 Propane gas is the standard reference, but butane gas may be used.

7.8 Ignition source S/PF5

7.8.1 This ignition source, described in IEC 60332-3, is a gas burner which allows vertically oriented specimens to be exposed laterally to a large-area premixed flame. This source is used for assessing spread-of-flame characteristics of cables housed on ladders to simulate the thermal conditions when a developed fire impacts upon the cables.

7.8.2 The ignition source consists of either one or two identical ribbon-type propane gas burners Each burner has its own set of flowmeters, complete with venturi mixer and a flame-producing surface consisting of a flat metal plate 341 mm long and 30 mm wide through which 242 holes of approximately 1,32 mm diameter are drilled on approximately 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 × 4,5 mm as shown in figure 4 a). As the burner may be drilled without the use of a drilling rig, 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.

Each burner is fitted with accurate means of controlling the fuel and air input flow rates. Corrections for the variations in temperature and pressure from that specified on the propane rotameter are applied when necessary. Using air with a dew point not higher than 0 °C and flow rate of 76,7 l/min ± 4,7 l/min and a propane flow of 13,3 l/min ± 0,5 l/min at one atmosphere and 20 °C provides a nominal 20,5 kW ± 0,5 kW to each burner.

7.8.3 The plane of the burner plate is parallel to the surface of the vertical specimens. In IEC 60332-3, the burner plate is positioned 75 mm from and parallel to the specimen face. When two burners are used, they are mounted side by side as shown in figure 4 b).

The following controls are used to ensure constant flow of gas to the burners during use:

a) a pressure regulator;

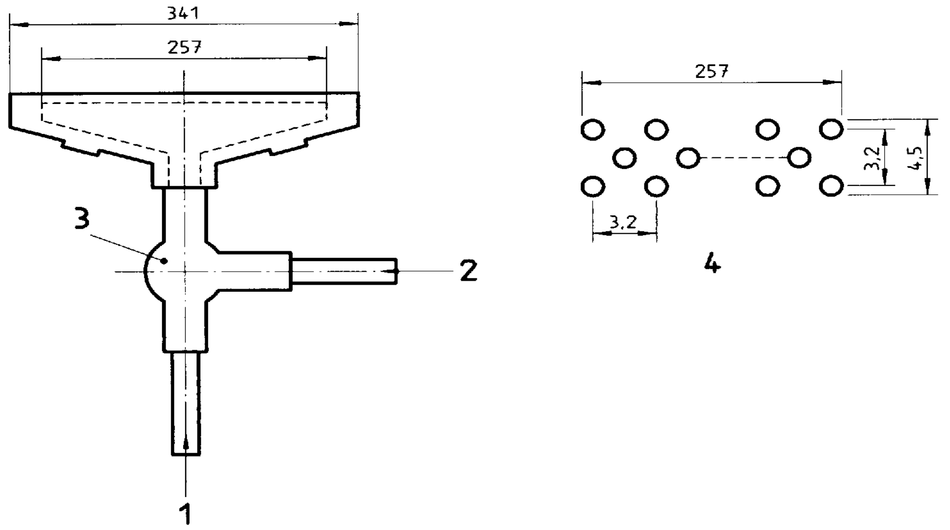
b) rotameters calibrated to read to the required precision;

c) a pressure gauge;

d) an on/off valve;

e) control valves.

Dimensions in millimetres
Values are approximate

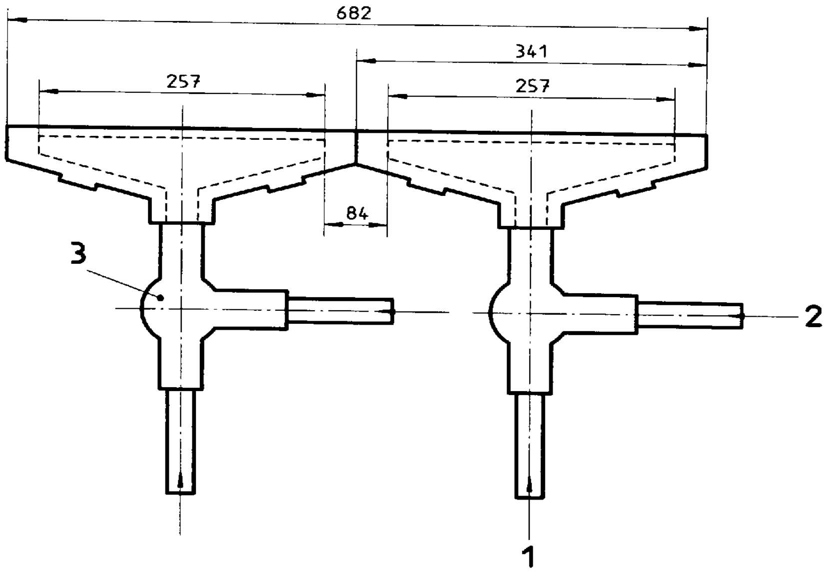


Key

1 Compressed-air entry
2 Propane gas entry
3 Venturi air-gas mixer
4 242 round holes, 1,32 mm in diameter, on 3,2 mm centres, staggered in three rows of 81, 80 and 81 holes, centred on the face of the burner

Figure 4 a) — Ignition source S/PF5 — Single burner

Dimensions in millimetres
Values are approximate



Key

1 Compressed-air entry
2 Propane gas entry
3 Venturi air-gas mixer

Figure 4 b) — Ignition source S/PF5 — Double-burner arrangement

7.9 Ignition source S/DF6

7.9.1 This ignition source, described in ISO 9705, is a gas burner which allows horizontally and vertically oriented specimens to be exposed from below to large-area diffusion flames. The source is used in ISO 9705 for igniting wall or wall and ceiling lining materials arranged in a small room. The source can supply heat for assessments at increments between 50 kW and 300 kW.

7.9.2 The ignition source is a propane gas burner consisting of an open-topped box 170 mm × 170 mm × 145 mm as shown in figure 5. The metered gas is fed into the base of the box and is dispersed through a 100 mm layer of 4 mm to 8 mm diameter particle size gravel and a 45 mm layer of 2 mm to 3 mm diameter particle size sand. The particulate layers are housed and separated on meshes of diameter 2,8 mm and 1,4 mm, respectively. The burner is supplied with propane (95 % purity) and the flow to the burner is measured with an accuracy of at least 3 % to enable the heat output of the burner to be controlled to within 5 % of the prescribed value.

7.9.3 The burner is placed underneath horizontal test specimens or with a side wall of the burner housing in contact with the surface of vertical specimens.

Dimensions in millimetres

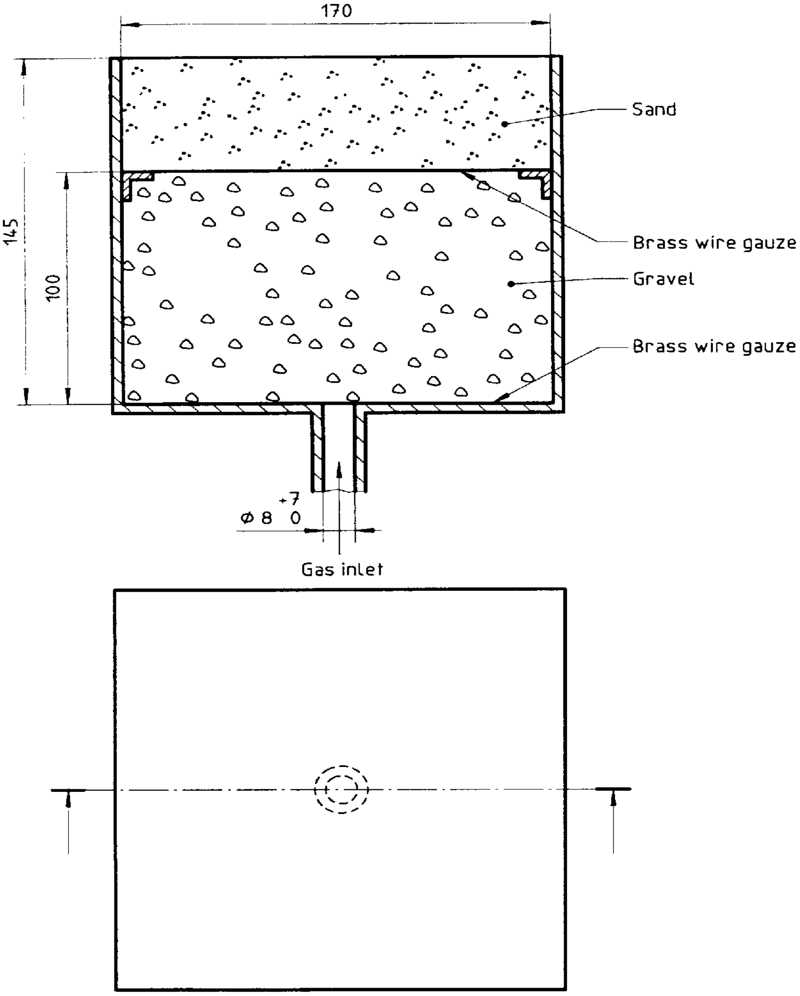


Figure 5 — Ignition source S/DF6

7.10 Ignition source P/PF1

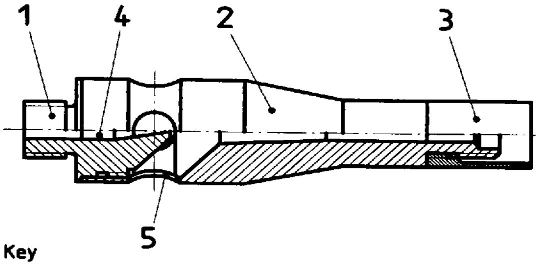
7.10.1 This ignition source is a laboratory burner described in ISO 11925-2. It provides a low-intensity premixed flame and is similar in heat output to ignition source P/DF2. The burner is constructed as shown in figure 6 and is designed so that it can be used vertically or titled at 45° with respect to the vertical axis. The burner is fitted with a fine-adjustment valve to ensure accurate control of the flame height.

NOTE This source is recommended for use in tests where a stable and directable flame is required.

7.10.2 The burner is connected with flexible tubing to a cylinder containing propane (95 % minimum purity). The burner is brought into a vertical position and the flame adjusted by means of a needle valve to a height of 20 mm ± 1 mm.

NOTE Under the above conditions, the gas flow rate is 25 ml/min ± 1 ml/min at 25 °C. The area of impingement on the exposed surface of a specimen is 4,2 cm^2 ± 0,3 cm^2 and the heat flux 37 kW/m^2 ± 2 kW/m^2.

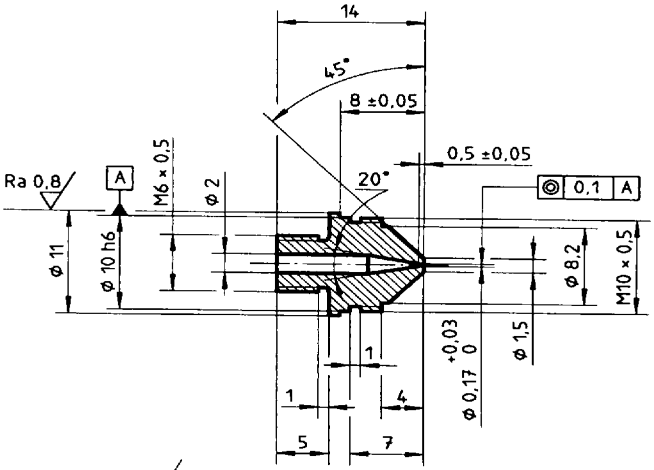
Dimensions in millimetres



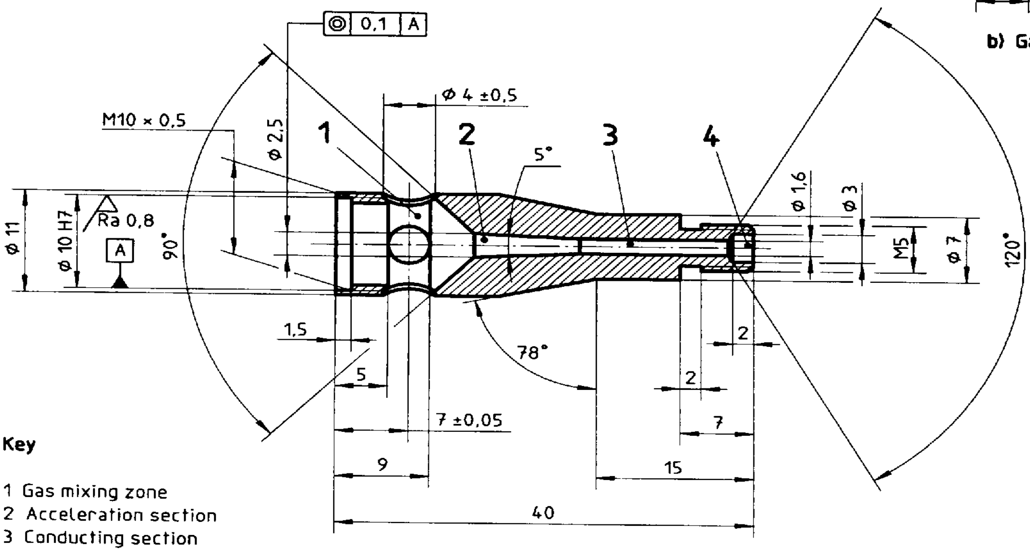
Key

1 Gas jet
2 Burner tube
3 Flame stabilizer
4 Choke tube
5 Notch fitted in during assembly

a) Burner assembly



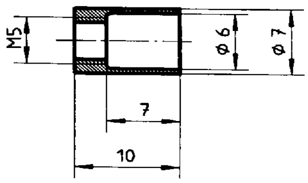
b) Gas jet



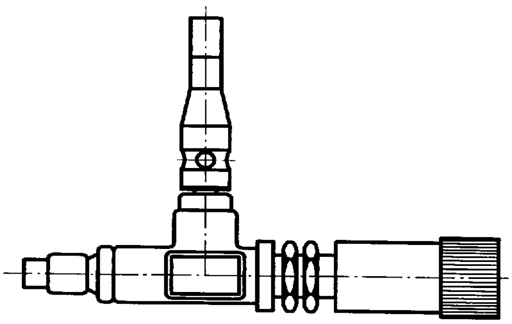
Key

1 Gas mixing zone
2 Acceleration section
3 Conducting section
4 Outlet

c) Burner tube



d) Flame stabilizer



e) Burner and adjustment valve

Figure 6 — Ignition source P/PF1

7.11 Ignition source P/PF2

7.11.1 This ignition source, described in IEC 60695-2-4/2, method A, for a 500 W flame and in IEC 60695-11-4 for a 50 W flame, is a laboratory burner.

This source is recommended for use at low gas flows to produce a 50 W flame, as given in table 2, for use in tests where a directable flame is required.

This source is also used at the higher gas flow rates to produce a 500 W flame as indicated in table 3 (similar to a small blow-torch as used in do-it-yourself applications).

7.11.2 The burner barrel consists of a metal tube, typically of brass or aluminum, with a length of 100 mm ± 10 mm and an internal diameter of 9,5 mm ± 0,3 mm. Air inlet openings having a minimum area of 225 mm^2 are spaced equidistantly around the base of the burner barrel. The burner orifice for the passage of gas has a diameter of 0,90 mm ± 0,03 mm. The ignition source is shown in figure 7.

7.11.3 A needle adjustment valve is used to restrict the burner orifice opening and to control the gas flow and pressure to the burner. The tube at the base of the burner is connected by flexible tubing to a cylinder containing methane. The flowmeter is calibrated to supply the specified gas at 25 °C.

Table 2 — 50 W, 20 mm high flame

Gas source	Flow rate ml/min	Area of impingement cm^2	Minimum gas purity %
Methane	105	1,8	98
Propane	42	1,8	98
Butane	33	1,8	95
NOTE The effect of pressure is negligible.			

Table 3 — 500 W, 125 mm high flame with 40 mm inner blue cone

Gas source	Flow rate ml/min	Pressure mmH_2O	Area of impingement cm^2	Minimum gas purity %
Methane	965	125 ± 25	18	98
Propane	380	550 ± 100	18	98
Butane	300	600 ± 125	18	95
NOTE Annex A provides a confirmatory procedure for calibration of this test flame.				

Dimensions in millimetres

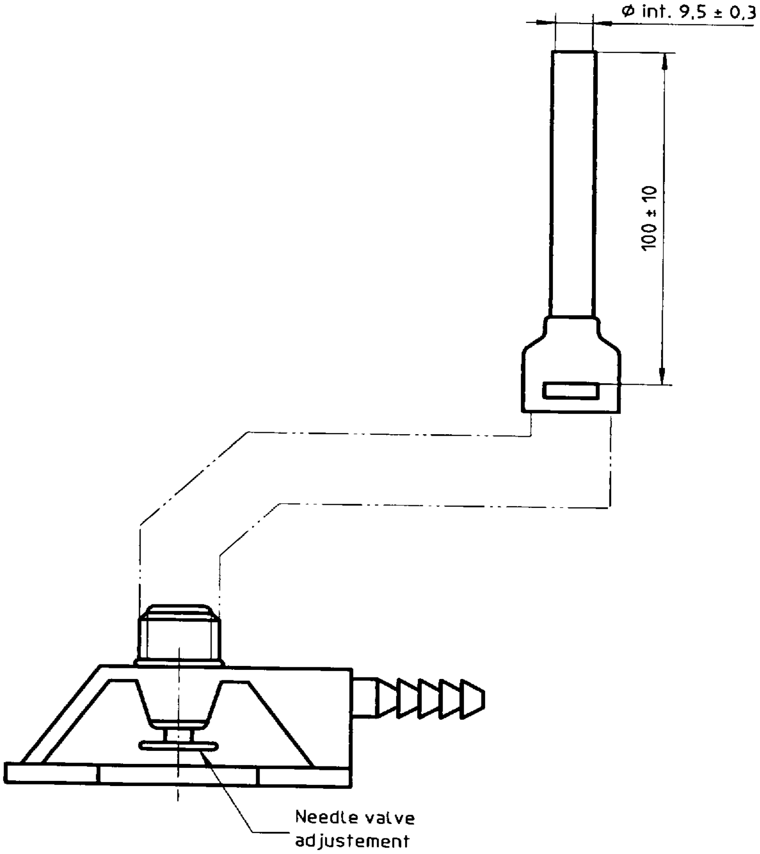


Figure 7 — Ignition source P/PF2

7.12 Ignition source S/PF4

7.12.1 This ignition source, described in IEC 60695-2-4/1, is referred to as a 1 kW ignition source providing a high-intensity premixed flame of uniform flux. It is intended to simulate the effect on materials of a secondary source arising from other flaming items in the vicinity, or from a fire in its early stages.

7.12.2 The burner (see figure 8) consists of a brass barrel tube of the following dimensions:

outside diameter	17,0 mm
internal diameter	12,0 mm
length	110 mm

NOTE The burner barrel is fitted with a gas injector and flame stabilizer which are removable for cleaning purposes.

7.12.3 Both air and propane are metered separately to the base of the burner barrel.

NOTES

1 Oil-free laboratory air is metered at 10 l/min ± 0,5 l/min at 23 °C, 1 atmosphere.

2 The propane gas supply is of purity greater than 98 % and is at a flow rate equivalent to 650 ml/min ± 30 ml/min at 23 °C, 1 atmosphere.

3 Annex A provides a confirmatory procedure for calibration of the test flame.

7.12.4 The area of impingement on the exposed surface of a specimen is approximately 20 cm^2 with an available power of 1 kW.

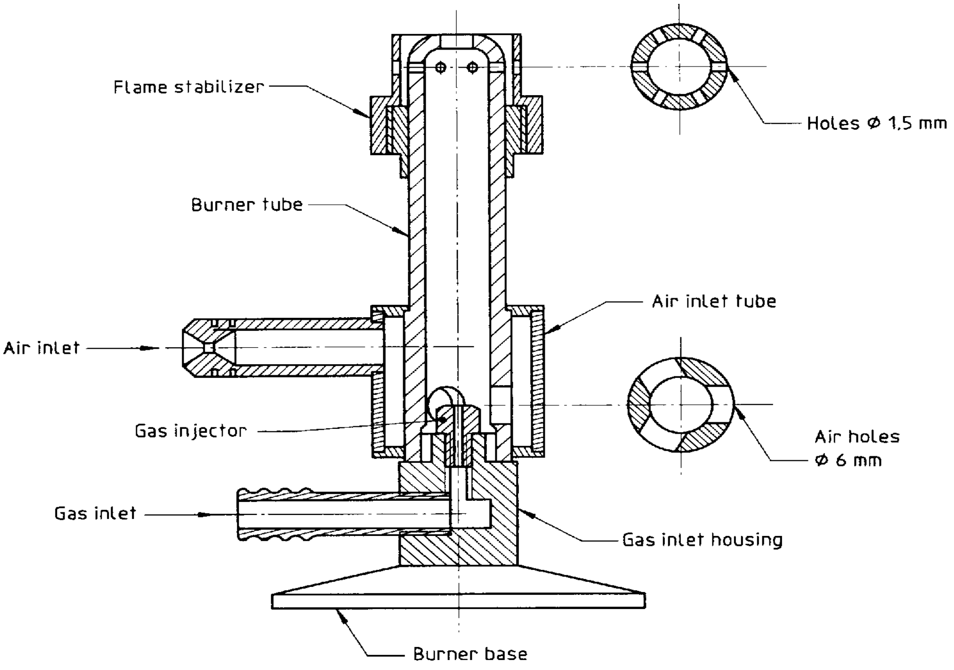


Figure 8 — Ignition source S/PF4

7.13 Ignition source S/R1

7.13.1 This ignition source, described in the ISO 5657 ignitability test, is a radiant cone heater which allows specimens to be exposed to thermal radiation on their upper surfaces at selected levels of constant heat flux within the range 10 kW/m^2 to 50 kW/m^2. It represents a non-contacting thermal radiant exposure from a primary fire, at heat fluxes of 10 kW/m^2 to 50 kW/m^2.

NOTES

1 The surface area of the specimen exposed to this thermal radiation is 154 cm^2.

2 The heat flux is checked with a calibrated radiometer prior to testing.

7.13.2 A pilot flame is applied at regular intervals to a position 10 mm above the centre of each specimen to ignite any volatile gases given off. Refer to figure 9 for diagram of test apparatus and ignition source.

NOTE Other similar ignition sources are described in ISO 5660-1:1993, *Fire tests — Reaction to fire — Part 1: Rate of heat release from building products — (Cone calorimeter method)*, and in ISO 5659-2:1994, *Plastics — Smoke generation — Part 2: Determination of optical density by a single-chamber test.* See table 4 for details.

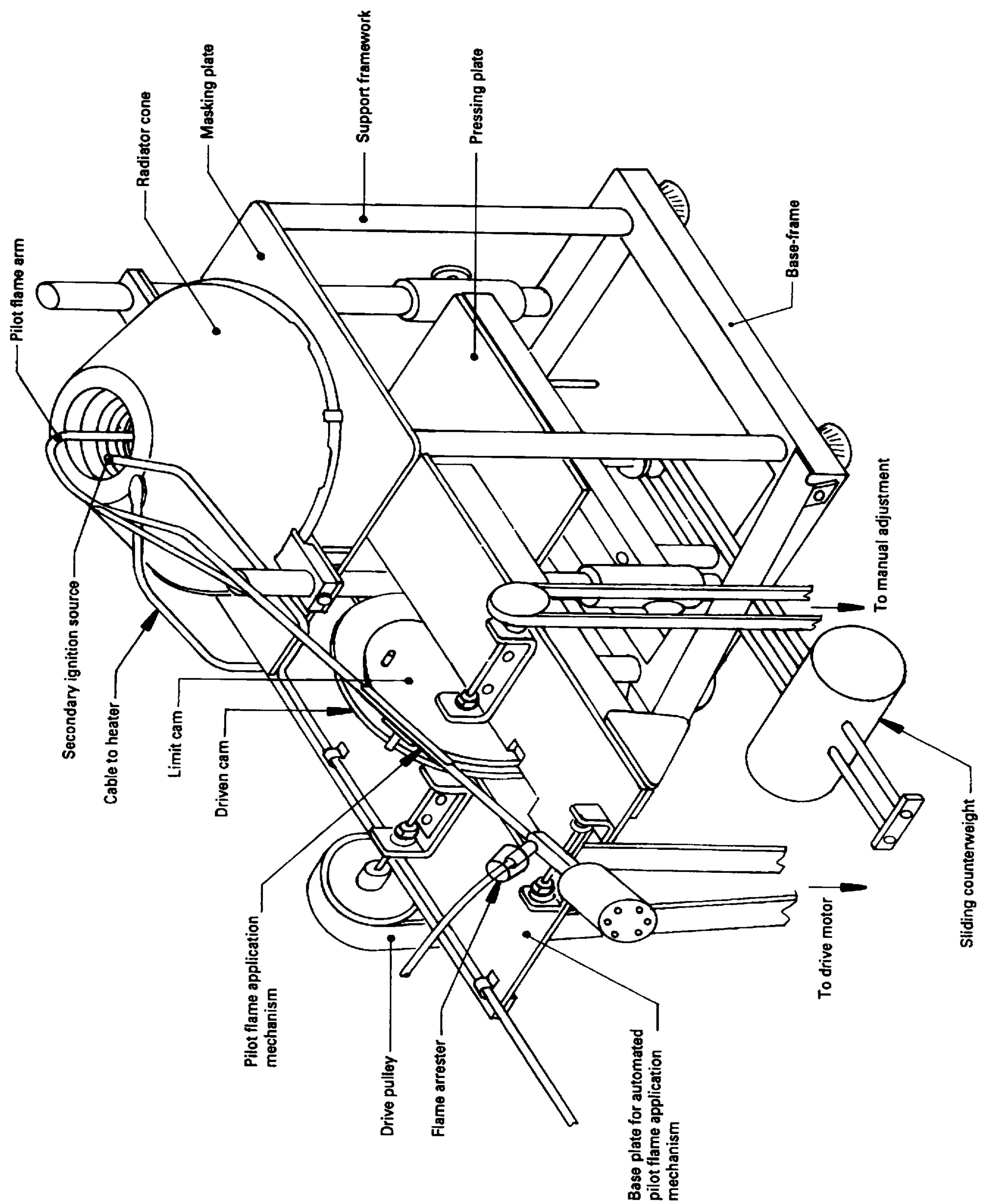


Figure 9 — Ignition source S/R1

Table 4 — Details of ignition sources based on conical radiators

	Flux range kW/m^2	Specimen size cm^2	Pilot ignition source	Specimen orientation
ISO 5657	10 to 50	154	propane flame	horizontal
ISO 5659	10 to 50	56	propane flame	horizontal
ISO 5660	10 to 100	100	spark igniter	horizontal or vertical

7.14 Ignition source S/R2

7.14.1 This radiant panel source simulates the thermal radiation levels likely to impinge on the floors of a building whose upper surfaces are heated by flames or hot gases (or both) from a developing fire in an adjacent room or compartment. It is under development within ISO/TC 92/SC 1.

7.14.2 When inclined at 30° to and directed at a horizontally mounted floor-covering specimen of 1 m length, the radiant panel generates heat fluxes from a nominal minimum of 1 kW/m^2 to a maximum of 11 kW/m^2. Refer to figure 10 for diagram of test apparatus and ignition source.

Dimensions in millimetres

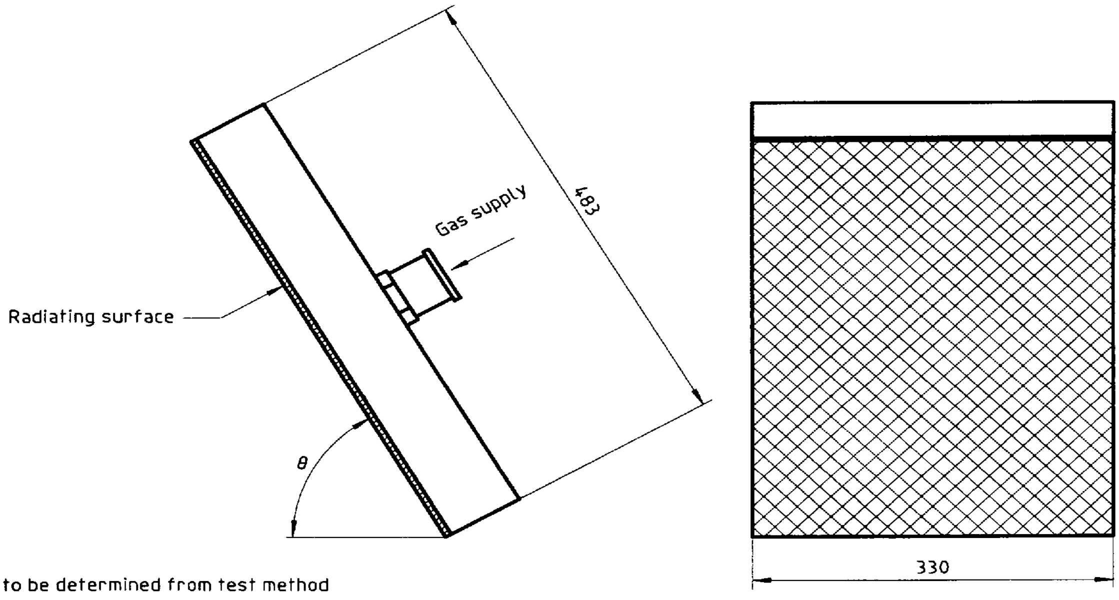


Figure 10 — Ignition source S/R2 (gas-fuelled radiant panel)

Annex A
(informative)

Confirmatory procedure for evaluating test flames

A.1 Usage

This annex forms an optional part of this International Standard.

A.2 General

This annex describes a confirmatory procedure for evaluating test flames. The procedure described is used in determining the calibration of ignition source P/PF2 (nominal 500 W and nominal 50 W ignition source) and P/PF4 (1 kW ignition source).

A.3 Principle

Using the prescribed test flame arrangement, the time for the temperature of the copper block described in figure A.1 or figure A.2 to increase from 100 °C to 700 °C is determined.

A.4 Apparatus

A.4.1 Copper block, in the fully machined but undrilled state, having a diameter of 9 mm and a mass of 10,00 g ± 0,05 g (see figure A.1) for the 500 W and 1 kW flames or a diameter of 5,5 mm and mass of 1,76 g ± 0,01 g (see figure A.2) for the 50 W flame.

A.4.2 Thermocouple, of sheathed fine wire, type K (NiCr/NiAl), with an outer sheath diameter of 0,5 mm, suitable for long-term operation at temperatures greater than 1 050 °C.

NOTE The preferred method of fastening the thermocouple to the copper block is by compressing the copper around the thermocouple (see figure A.3).

A.5 Procedure

A.5.1 Set up the arrangement as shown in figure A.3 in a draught-free environment, ensuring leak-free gas connections.

A.5.2 Move the burner away from the block to ensure no influence of the flame on the block during the preliminary adjustment of the gas flow, gas back pressure and air flow.

A.5.3 Ignite the flame and adjust the gas flow, gas back pressure and air flow, if necessary, to obtain the prescribed flame conditions. If required, ensure that the overall height of the flame, when viewed in subdued light against a dark background, is within the prescribed limits, and that the flame is symmetrical. Wait for a period of 5 min to allow the burner conditions to reach equilibrium. Check that the gas flow and back pressure and the blue-cone height are within the prescribed limits.

A.5.4 With the temperature/time indicating/recording devices operational, re-position the burner under the block.

A.5.5 Make three determinations of the time for the temperature of the block to increase from 100 °C ± 2 °C to 700 °C ± 3 °C. Allow the block to cool naturally in air to approximately 50 °C between determinations.

If the copper block has not been used before, make a preliminary run to condition the block surface. Disregard this result.

A.6 Results

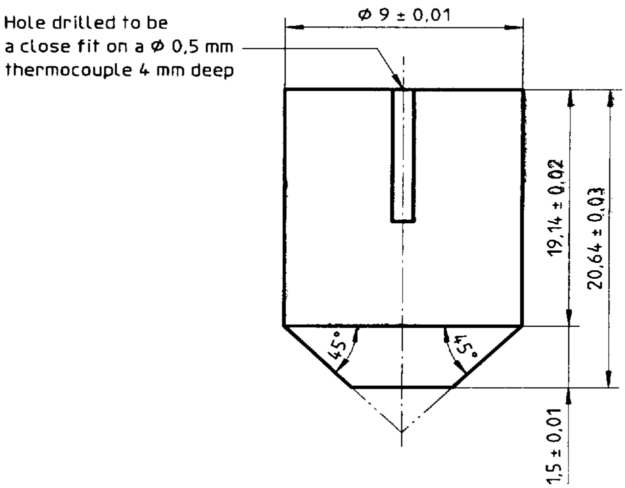
Calculate the mean time in seconds as the result.

A.7 Confirmation

The flame is confirmed and may be used for test purposes if the result is within the following ranges:

Test flame	Test times
nominal 500 W	54 s ± 2 s
P/PF4 (1 kW)	45 s ± 5 s
nominal 50 W	44 s ± 2 s

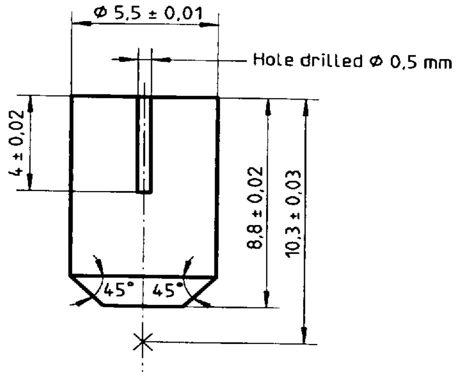
Dimensions in millimetres



Material: high-conductivity (electrolytic) copper, polished all over (ISO 1337 grade Cu-ETP)
Mass before drilling: 10,00 g ± 0,05 g

Figure A.1 — Copper block for 500 W and 1 kW flame calibration

Dimensions in millimetres
Tolerance ± 0,01 mm unless otherwise stated



Material: high-conductivity (electrolytic) copper, polished all over (ISO 1337 grade Cu-ETP)
Mass before drilling: 1,76 g ± 0,01 g

Figure A.2 — Copper block for source P/PF2, 50 W flame, calibration

Dimensions in millimetres

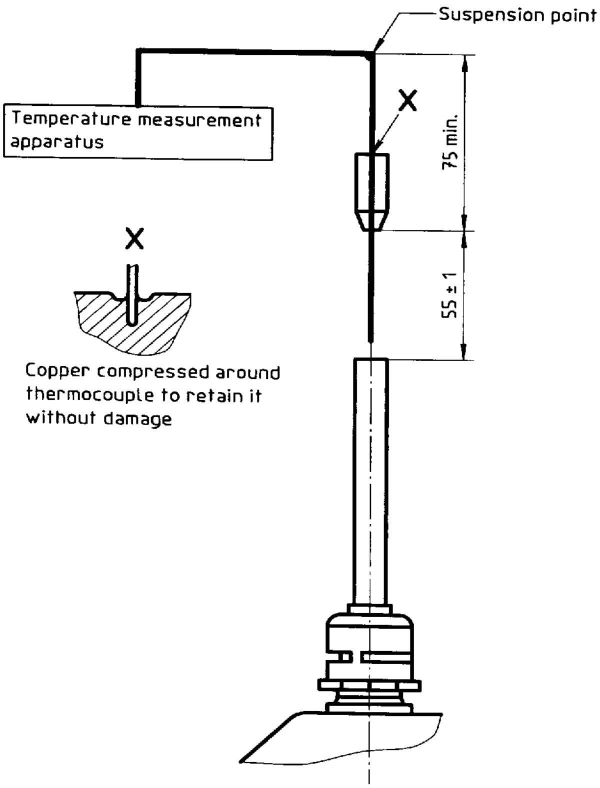


Figure A.3 — Confirmatory-test arrangement

Annex B
(informative)

Bibliography

[1] ASTM D 3713:1995, *Method for measuring response of solid plastics to ignition by a small flame.*

[2] ISO 9239-1:1997, *Reaction to fire tests — Horizontal surface spread of flame on floor-covering systems — Part 1: Flame spread using a radiant heat ignition source.*

[3] IEC 60707:1981, *Methods of test for the determination of the flammability of solid electrical insulating materials when exposed to an igniting source.*

ICS 13.220.40; 83.080.01

Descriptors: plastics, tests, fire tests, test equipment, ignition, ignition sources (fire).

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