

Fire behaviour of building materials and elements

Part 1: Classification of building materials
Requirements and testing**DIN**
4102-1

ICS 13.220.50; 91.100.01

Supersedes
May 1981 edition.Descriptors: Fire behaviour, building materials, components,
elements, classification.Brandverhalten von Baustoffen und Bauteilen – Teil 1: Baustoffe –
Begriffe, Anforderungen und Prüfungen*In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.***Contents**

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Translation by DIN-Sprachendienst.

In case of doubt, the German-language original should be consulted as the authoritative text.

Foreword

This standard has been prepared by Technical Committee *Brandverhalten von Baustoffen* of the *Normenausschuß Bauwesen* (Building and Civil Engineering Standards Committee).

Amendments

The following amendments have been made to the May 1981 edition.

- a) Additional requirements are specified for material classes A2 and B1.
- b) Smoke generation tests and toxicity tests are now included.
- c) The fire test using the 'Brandschacht' apparatus is no longer included as it is now specified in DIN 4102-16.

Previous editions

DIN 4102-1: 1977-09, 1981-05.

Dimensions in mm

1 Scope

1.1 This standard defines fire behaviour classes for building materials and specifies requirements and test methods for each class. It applies to sheet materials (including plates and slabs), composite materials, material assemblies, coverings, insulation, coatings, pipes and fittings, decorative materials, curtains and other materials suspended from ceilings, fire retardants, and intumescent coatings, whether or not these materials are designated as construction products ('*Bauprodukte*') in the German *Länder* building regulations (cf. Explanatory notes).

1.2 The classification specified in this standard serves to assess the fire behaviour of materials alone or in combination. Fire behaviour not only depends on the nature of the material, but also on its shape, surface characteristics, density, processing, and its combination with other materials, including any bonding agents or fasteners used. These factors are to be taken into account when preparing tests, selecting specimens, evaluating test results and marking the materials.

2 Normative references

This standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate place in the text and the titles of the publications are listed below. For dated references, subsequent amendments to or revisions of any of these publications apply to this standard only when incorporated into it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

- | | |
|-------------|--|
| DIN 4102-2 | Fire behaviour of building materials and elements – Building components – Concepts, requirements and tests |
| DIN 4102-4 | Fire behaviour of building materials and elements – Overview and design of classified building materials, elements and components |
| DIN 4102-8 | Fire behaviour of building materials and elements – Small-scale test furnace |
| DIN 4102-14 | Fire behaviour of building materials and elements – Determination of the burning behaviour of floor covering systems using a radiant heat source |
| DIN 4102-15 | Fire behaviour of building materials and elements – 'Brandschacht' apparatus |
| DIN 4102-16 | Fire behaviour of building materials and elements – 'Brandschacht' tests |
| DIN 18180 | Gypsum plasterboard – Types, requirements and testing |
| DIN 50014 | Artificial climates in technical applications – Standard atmospheres |
| DIN 50050-1 | Small cabinets for testing the burning behaviour of materials |
| DIN 50051 | Burners for testing the burning behaviour of materials |
| DIN 50055 | Light measuring system for testing smoke development |
| DIN 51622 | Propane, propene, butane, butene and their mixtures – Requirements |
| DIN 51900-2 | Determination of gross calorific value of solid and liquid fuels using the bomb calorimeter, and calculation of calorific value – Method using the isothermal jacket |
| DIN 51900-3 | Determination of gross calorific value of solid and liquid fuels using the bomb calorimeter, and calculation of calorific value – Method using the adiabatic jacket |
| DIN 53436-1 | Toxicity testing of fire effluents – Combustion apparatus and determination of test temperature |
| DIN 53436-2 | Toxicity testing of fire effluents – Thermal decomposition method |

DIN 53436-3	Toxicity testing of fire effluents – Method of testing inhalation toxicity
DIN 53438-1	Determining the response of combustible materials to ignition by a small flame – General
DIN 66081	Classification of the burning behaviour of textile products – Textile floor coverings
ISO 1716 : 1973	Building materials – Determination of calorific potential
ISO 4783-2 : 1989	Industrial wire screens and woven wire cloth – Guide to the choice of aperture size and wire diameter combinations – Part 2: Preferred combinations for woven wire cloth

3 Building material classes

Building materials shall be classed according to their fire behaviour as shown in table 1.

Table 1: Building material classes

Building material class	Designation*)
A A1 A2	Non-combustible materials (<i>'nichtbrennbar'</i>)
B B1 B2 B3	Combustible materials (<i>'brennbar'</i>) Not easily flammable (<i>'schwerentflammbar'</i>) Flammable (<i>'normalentflammbar'</i>) Easily flammable (<i>'leichtentflammbar'</i>)
*) Translator's note. The German terms given are those used in German building regulations.	

These symbols and designations may only be used if the material's fire behaviour has been determined in accordance with this standard (cf. clause 4).

4 Classifying building materials

4.1 Materials requiring testing

The class of most building materials shall be determined on the basis of the fire tests specified in this standard. Materials which are designated as building products in the German *Länder* building regulations and which meet the general requirements of this standard for the relevant class still require additional proof¹⁾ when

- the results of testing as in this standard are not alone sufficient for classification (cf. subclauses 5.1.2.1, 5.2.2.1 and 6.1.2.1), or
- additional testing using other methods is required for classification.

4.2 Materials not requiring testing

The building materials covered by DIN 4102-4 shall be classed as specified therein without further testing.

5 Class A building materials

5.1 Class A1 materials

5.1.1 General requirements

The test specified in subclause 5.1.3 provides a fire model describing the growth and full development phases of a fire. During these phases, class A1 materials shall not release any ignitable gases or any considerable amount of heat.

5.1.2 Criteria for classification

5.1.2.1 Materials may be classed as A1 materials if they

- pass the test specified in subclause 5.1.3 and
- meet the requirements for class A2 materials (testing is not necessary here if it is evident beyond any doubt that these requirements are fulfilled).

¹⁾ According to German building regulations, such materials either require general approval by the building inspectorate in the form of an agrément, or their suitability is to be verified on a case-by-case basis.

The tests specified in this standard are not sufficient for assessing materials which are to meet additional requirements regarding the release of toxic gases; additional testing is required in this case.²⁾

5.1.2.2 The test specified in subclause 5.1.3 shall be deemed passed if

- no flaming occurs (cf. subclause 5.1.4);
- none of the specimens releases enough heat to cause the temperature in the furnace to rise by more than 50 °C above the initial temperature.

5.1.3 Furnace test

5.1.3.1 Number and size of specimens

Five 40 mm × 40 mm × 50 mm specimens shall be tested (see figure 2 for tolerances).

The specimens shall be representative of the material. Specimens of materials delivered with a thickness less than 40 mm shall consist of several layers; in this case, each layer shall be cut to a length of 40 mm and a height of 50 mm, and thinned down, if necessary, so that the total thickness is 40 mm.

The thickness of compressible materials shall be that obtained under a load of 0,1 kN/m² per unit area.

For materials containing varying quantities of combustible components (e.g. binders), the component with the highest combustibility shall be tested. For components with a lower combustibility, it is sufficient to determine their quantity only (e.g. by checking ignition loss).

5.1.3.2 Coated materials

Coatings applied at the works are to be tested along with the coated material.

If both the material and its coating are to meet the requirements for class A1, the coating thickness on test specimens shall be as in service.

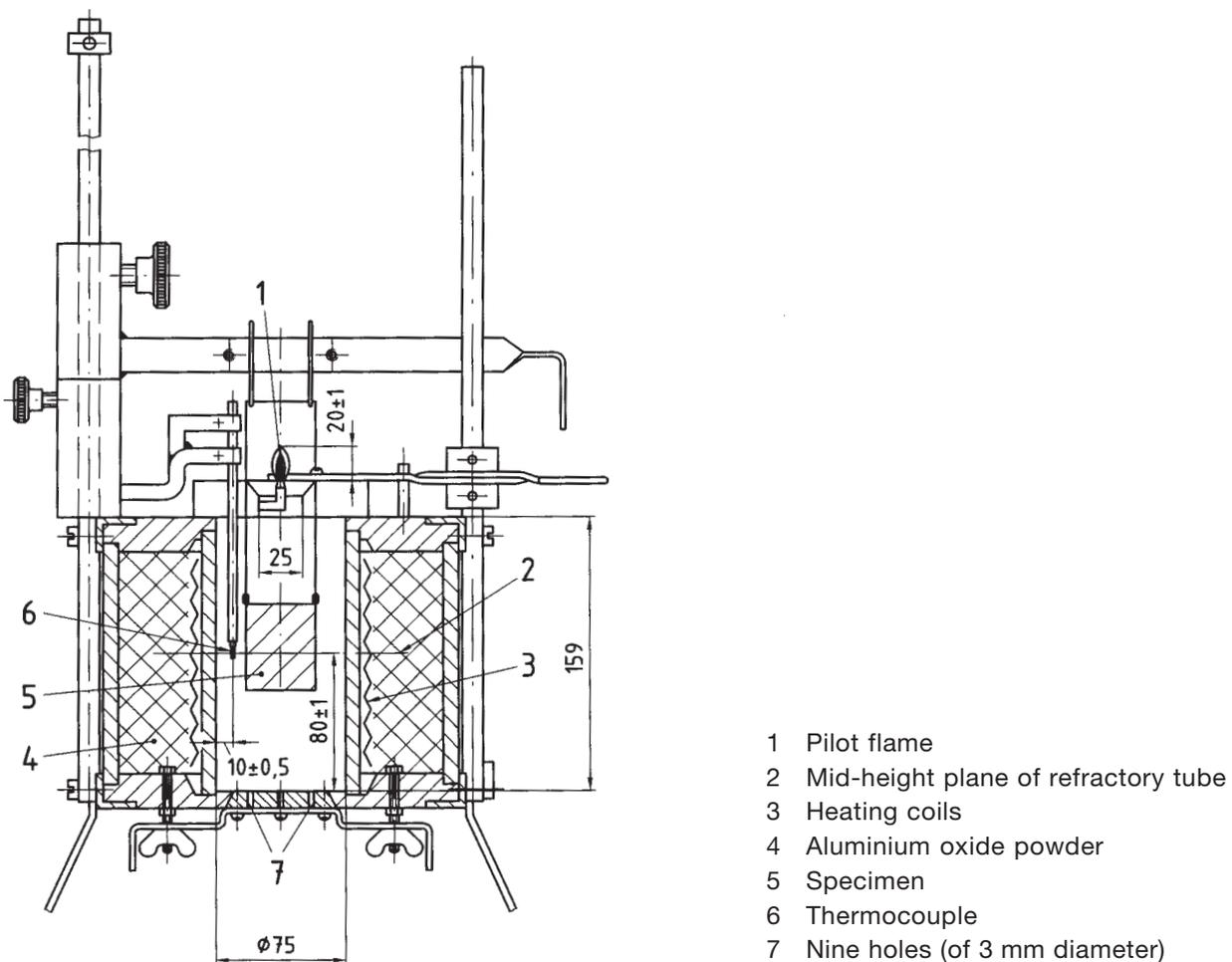


Figure 1: Electric furnace

²⁾ Appendix C specifies a toxicity test but not any requirements.

5.1.3.3 Specimen preparation

Dry specimens at 105 °C for six hours and store them in a desiccator above anhydrous calcium chloride or silica gel until they are required for testing.

For multi-layer specimens, place the least favourable surfaces in terms of fire behaviour facing outward, as shown in figure 2. Then, tie the specimen with a temperature-resistant wire (e.g. of NiCr) having a 0,2 mm diameter, binding the specimen in the middle so that the layers are held firmly together. Cut surfaces are not to face outwards (cf. figure 2).

Place tied specimens in a wire holder weighing $(5 \pm 0,5)$ g; this will help keep the specimen in the same position.

Place specimens which may disintegrate during testing or which are of loose material in a basket of stainless steel wire mesh having an aperture size of 1 mm and wire diameter of 0,5 mm as in ISO 4783-2.

Specimens which could run out of the wire basket during testing are to be placed in a container of nickel sheet that is 0,2 mm thick.

5.1.3.4 Apparatus and procedure

Apparatus

Testing is to be carried out in an electrically heated furnace³⁾ with heating coils arranged along the circumference of the refractory tube.

To minimize temperature fluctuations in the furnace, the supply voltage is to be kept constant to within $\pm 0,5\%$ by means of a voltage stabilizer.

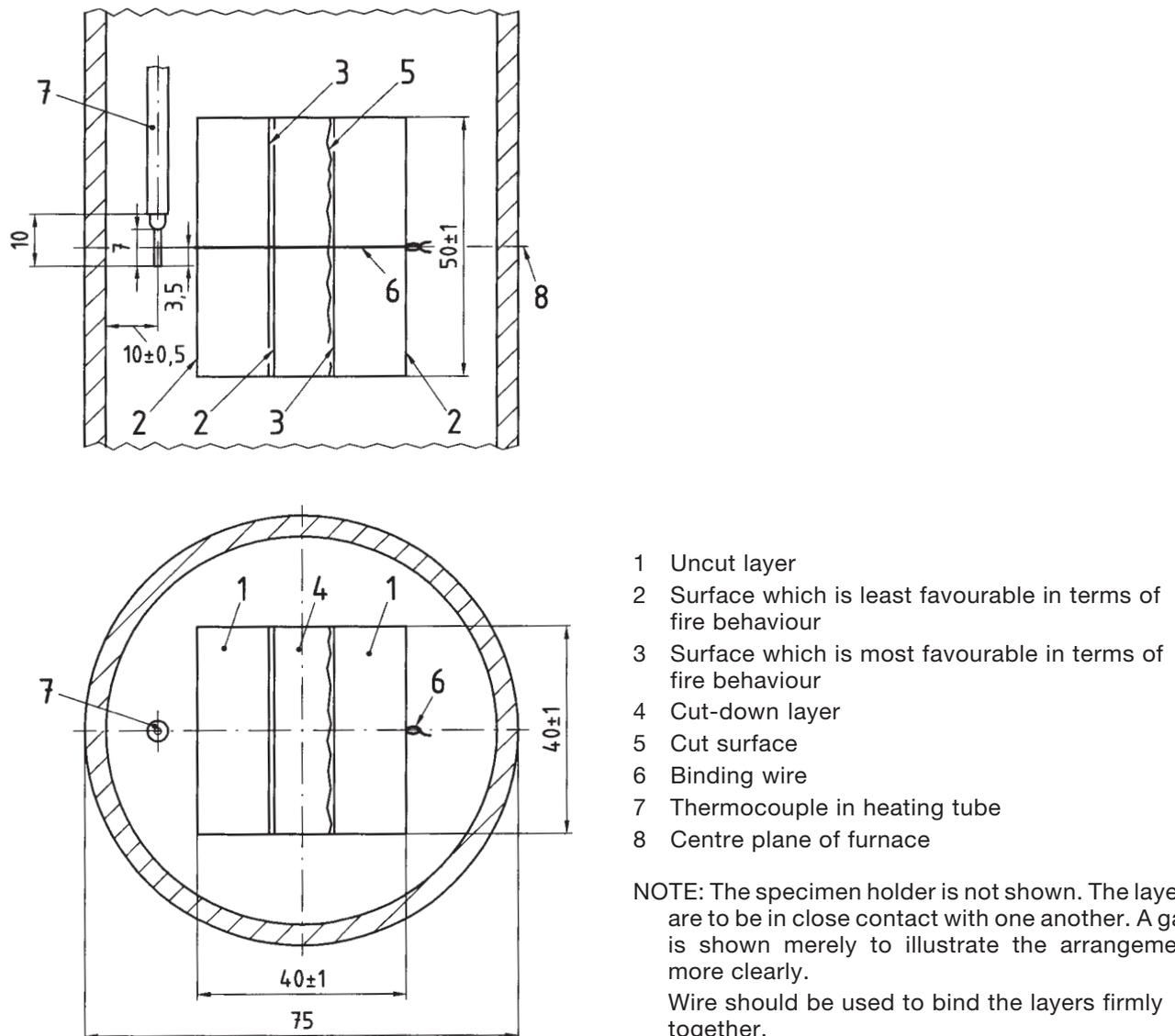


Figure 2: Placing multi-layer specimens in heating tube

³⁾ Information on sources of supply is available from the *Normenausschuß Bauwesen* of DIN, D-10772 Berlin.

To measure the temperature inside the furnace, insert a thermocouple reaching down to the centre of the heating tube (cf. figure 1) at a distance of $(10 \pm 0,5)$ mm from the tube wall. The thermocouple shall be made of a 0,5 mm thick wire with an open junction; sheathed thermocouples with an appropriate response characteristic may also be used.

The temperature indicator shall have a limit of error no greater than 5 °C.

A pilot flame of propane gas as in DIN 51622 is to be located (20 ± 1) mm above the centre of the heating tube's top opening.

To observe the specimen during testing, place a slanted mirror above the furnace.

Procedure

Pre-heat the furnace to (750 ± 10) °C; this temperature is to remain constant to within ± 1 °C without needing readjustment for at least ten minutes before testing. The energy input to the heating element is to remain constant throughout the test.

Suspend the specimen in the heating tube so that its centre is level with the junction of the thermocouple. The original specimen surface, or – in the case of asymmetrical specimens – the least favourable surface in terms of fire behaviour is to face the thermocouple, which shall be located midway across this surface's width (cf. figure 2).

Multi-layered specimens are to be suspended as shown in figure 2.

When suspending the specimen, do not open the furnace cover for more than five seconds.

The test period begins when the bottom edge of the specimen passes the top edge of the heating tube.

Leave the specimen in the furnace until the maximum furnace temperature has been reached, and for at least 15 minutes.

If the initial furnace temperature has still not risen after 30 minutes, only one specimen needs to be tested to the point where the maximum temperature is reached (but for no longer than 90 minutes), provided the other specimens behave in a similar manner during the first 30 minutes.

If the pilot flame is extinguished by gases released by the specimen, an immediate attempt shall be made to relight it with a burner that produces a gas flame about 20 mm long. If the first attempt fails, further attempts shall be made every 15 seconds.

The furnace cover shall not be opened during the test. The holes in the bottom plate are to be cleared before each test.

5.1.4 Evaluation of furnace test results

Flaming has occurred if

- flames can be observed in the furnace, or
- there is glowing combustion (incandescence does not necessarily indicate combustion), or
- the pilot flame enlarges to a height greater than 45 mm, or expands horizontally to fill the furnace cover opening (see figure 3).

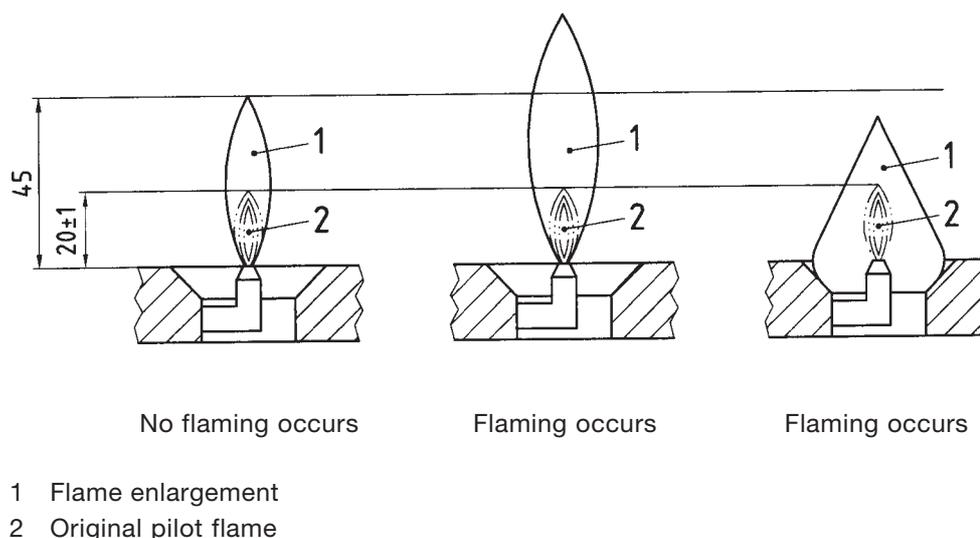


Figure 3: Examples for assessing pilot flame enlargement to determine whether flaming has occurred

5.1.5 Test certificate

If a building material can be classed as an A1 material on the basis of testing as in this standard, a test certificate⁴⁾ stating this shall be prepared which shall contain the following information:

- a) a full description of the building material, including its type (e.g. main constituents), appearance, design, dimensions, density or mass per unit area, and sampling method used;
- b) preparation and mounting of specimens, test procedure, number of tests;
- c) for each specimen, the duration of flaming;
- d) for each specimen, the results of furnace testing (expressed as the maximum increase in temperature);
- e) any observations made during testing (e.g. enlargement or extinction of pilot flame, appearance of specimen after the test);
- f) classification as a class A1 material;
- g) period of validity (no more than five years; extensions may be granted upon request).

For materials which cannot be classified solely on the basis of this standard (cf. subclause 4.1), a test report shall be prepared that does not include any information regarding classification.

5.2 Class A2 materials

5.2.1 General requirements

The fire tests specified in subclause 5.2.3 provide a fire model describing the growth and full development phases of a fire. During these phases, the heat release and spread of fire shall be minimal, the release of any ignitable gases limited, and any generation of smoke shall not be hazardous to health.

5.2.2 Criteria for classification

5.2.2.1 Materials may be classed as A2 materials if they withstand

- the test specified in subclause 5.1.3 or the tests specified in subclauses 5.2.3.2 and 5.2.3.3, and
- the test specified DIN 4102-16, and
- the test specified in subclause 5.2.3.5.

For composite materials with combustible layers making up more than 20 % either of the total mass or total volume (whichever is greater), the results of testing as in this standard are not sufficient for classification. For instance, a composite material containing a layer of combustible insulation cannot be classified as an A2 material if the requirements for the net calorific value are met only when a non-combustible cover layer is provided.

The test methods specified in this standard are not inadequate for assessing materials which are to meet additional requirements regarding the release of toxic gases; additional testing is required in this case.²⁾

5.2.2.2 The furnace test shall be deemed passed if, after 15 minutes of testing as in subclause 5.1.3, the requirements specified in subclause 5.1.2.2 are met, except that sustained flaming for a total period of 20 seconds is permitted as long as the flames on the specimen do not extend beyond the heating tube and the pilot flame is not enlarged to a height greater than 100 mm.

The sum of all periods of observed flaming of one second or longer shall be taken as the total period of sustained flaming. Where flaming occurs simultaneously at different places, any overlapping of periods shall be disregarded so that the total period is counted as one continuous length of time (cf. subclause 5.1.4).

5.2.2.3 The requirement for the net calorific value, H_u , shall be deemed to have been met if this value is no greater than $4\,200 \text{ kW} \cdot \text{s/kg}$ when testing as in subclause 5.2.3.2. If the gross calorific value, H_o , is less than $4\,200 \text{ kW} \cdot \text{s/kg}$, then H_u need not be determined.

5.2.2.4 The test specified in subclause 5.2.3.3 shall be deemed passed if the heat release calculated on the basis of H_u and the specimen's mass per unit area before and after the test is not greater than $16\,800 \text{ kW} \cdot \text{s/m}^2$. If the value calculated before testing for the material in its as-delivered condition is less than $16\,800 \text{ kW} \cdot \text{s/m}^2$, then testing as in 5.2.3.3 is not necessary.

5.2.2.5 The test using the 'Brandschacht' apparatus (cf. subclause 6.1.3) shall be deemed passed if

- the mean value for the residual length (portion of specimen that has not burned or charred; cf. subclause 9.1 of DIN 4102-16) of each specimen is at least 35 cm and no individual values are lower than 20 cm,

For ²⁾, see page 4.

⁴⁾ According to the German building regulations, this test certificate serves as a basis for the verification of conformity, 'Übereinstimmungsnachweis' (for regulated products) or as proof of suitability, 'Verwendbarkeitsnachweis' (for non-regulated products). See Explanatory notes.

- the mean effluent temperature does not exceed 125 °C in any test,
- there is no flaming on the back of any specimen,
- the requirement for the residual length of each specimen is met even where there is afterflame, afterglow, or smouldering,
- flames do not reach above the top surface of the specimen, and
- there is no molten dripping.

5.2.2.6 The test specified in subclause 5.2.3.5 shall be deemed passed if the effluents produced by decomposition (when testing as in Appendix A) and those produced by flame impingement (when testing as in Appendix B) are deemed to be harmless. This is the case if

- when testing as in Appendix A, the mean light absorptance does not exceed 30 % at any smoulder temperature, and
- when testing as in Appendix B, the maximum mean absorptance without a supply of air is not greater than 15 % (cf. table B.3). If this value is exceeded, additional testing may be required (cf. subclause 4.1).

5.2.3 Testing

5.2.3.1 Furnace test

The furnace test shall be carried out as specified in subclause 5.1.3.

5.2.3.2 Net calorific value determination

The net calorific value, H_u , shall be determined as in DIN 51900-2 or DIN 51900-3, although specimens shall be prepared as in ISO 1716.

5.2.3.3 Heat release test

At least two 500 mm × 500 mm specimens having a thickness as used in service shall be tested. Prior to testing, they shall be conditioned in a DIN 50014-23/50-2 standard atmosphere until they reach constant mass.

Testing shall be carried out using a small-scale test furnace as in DIN 4102-8. The specimens, which are to be backed with a 20 mm thick calcium silicate slab having an apparent density of (850 ± 50) kg/m³, shall be fixed in the side openings of the furnace so that one surface is facing the fire chamber. In the case of asymmetrical specimens, one test shall be performed on each side. The points at which the specimen is fixed to the furnace are to be carefully sealed.

The fire chamber is to be exposed to flame (i.e. heated) as specified in subclause 6.2.4 of DIN 4102-2 for a period of 30 minutes. At the end of this period, cut a piece (having an area of about 100 cm² and the same thickness as the rest of the specimen) from the centre of the specimen, and determine its mass per unit area and net calorific value as specified in DIN 51900-2 or DIN 51900-3.

5.2.3.4 'Brandschacht' testing

Testing shall be as in DIN 4102-16 using the 'Brandschacht' apparatus specified in DIN 4102-15 (except for floor coverings, which shall be tested as in subclause 6.1.3.2).

5.2.3.5 Smoke generation test

Testing shall be as specified in Appendices A and B, taking the following into consideration:

- a) Coatings shall be applied to a plate having a thickness of 0,88 mm when testing as in Appendix A.
- b) When performing the test described in Appendix A on multi-layered materials, the mean shall be taken for all values measured on the broad and narrow sides of the cover layer. This mean light absorptance shall not be greater than 30 %.
- c) When testing film, coated fabrics and other materials used for tent-like or diaphragm constructions, specimens shall have a single layer with a thickness as found in service, not several layers as specified in subclause A.6.3.6.
- d) Most materials break out in flames at temperatures above 550 °C. This case is covered by testing as in Appendix B, while testing as in Appendix A is normally carried out at temperatures up to 550 °C. Materials which only decompose at elevated temperatures and which will be exposed to such temperatures in service are also to be tested at 600 °C.

5.2.4 Additional requirements for specific materials

5.2.4.1 Effect of neighbouring materials in composite structures

The interaction of neighbouring materials in composite structures is to be tested as follows:

- a) Materials are to be tested in the condition in which they left the works, any protective sheeting being removed.

b) If a material will be used together with other materials, and if this combination can have an effect on fire behaviour, this shall be accounted for in the test. For instance, sheet materials that are in direct contact with each other or are separated by a distance less than 40 mm can have an effect on fire behaviour. For the purposes of this standard, materials are not considered to form a composite structure if there is only localized contact at a few places.

5.2.4.2 Coatings, film and adhesives

a) If a material is coated at the works, it shall be tested together with the coating.

In the case of coatings applied on site, if both the material and its coating are to meet the requirements for class A2, the coating thickness on test specimens shall be as in service.

b) Testing as in subclauses 5.1.3 and 5.2.3.2 is not required for A2 classification in the case of coatings and film with a thickness up to 1 mm and all paints when they are applied to a substrate of class A1 material as in DIN 4102-4.

c) For coatings and film with a thickness greater than 1 mm, any thin neighbouring materials may be included in the calculation of the net calorific value if classification is not determined by furnace testing as in subclause 5.1.3. In this case, the heat release (cf. subclause 5.2.2.4) is to be calculated without taking the substrate material into consideration.

d) For testing as in subclauses 5.2.3.4 and 5.2.3.5, the coating or film is to be applied to the substrate material for which it is intended, if this material is of class A1 or class A2. If steel plate is used as the substrate, test results for smoke testing also apply to all solid mineral backgrounds.

e) When testing adhesives as in subclauses 5.1.3 and 5.2.3.4, specimens shall be assemblies consisting of two plates joined by the adhesive under test. The adhesive joint is to have the maximum thickness specified by the client. The cover plates are to have the smallest commercially available thickness. In the furnace test (cf. subclause 5.1.3), adhesives intended for solid mineral, fibre cement or calcium silicate substrates shall be tested either using a specimen assembly of three 40 mm × 50 mm × 12 mm calcium silicate plates with two 2 mm thick adhesive joints, or taking a square block specimen of the adhesive alone. Assembled specimens are to be suspended in the furnace with the adhesive joints facing the thermocouple. Determinations of the net calorific value (cf. subclause 5.2.3.2) and heat release (cf. subclause 5.2.3.3) are to be carried out as specified for coatings and film.

f) If the suitability of wood intended as veneer for a class A2 material is to be determined, the following representative wood types – impregnated, if necessary – shall be used for testing:

for softwood veneer, use spruce, fir or pine (Oregon or European) specimens;

for hardwood veneer, use teak, oak or sipo specimens.

Classification applies only to veneers having a thickness equal to or less than the thickness tested. The thickness of veneer specimens is to be the same for each type of wood (softwood or hardwood).

The impregnation, application and glueing of veneer are to be as specified by the client.

g) Gypsum plasterboard shall be coated as specified in subclause 5.2.4.5.

5.2.4.3 Wall and ceiling coverings

The following tests are required for the classification of wall and ceiling coverings on solid mineral backgrounds:

a) Furnace testing as in subclause 5.1.3, using fibre reinforced concrete slabs;

b) 'Brandschacht' testing as in subclause 5.2.3.4, using fibre cement or fibre reinforced concrete slabs;

c) Smoke generation testing (by decomposition) as in Appendix A, using steel plate;

d) Smoke generation testing (by flame impingement) as in Appendix B, using fibre cement or fibre reinforced concrete slabs.

If wall and ceiling coverings are also to be classified for use on gypsum plasterboard backgrounds, then the tests listed under items b) and d) are to be performed using gypsum plasterboard, and the test listed under item c) is to be performed using steel plate.

5.2.4.4 Flexible ventilation ducts

Flexible ventilation ducts are to be tested as in subclause 7.17.1 of DIN 4102-16, May 1998 edition. Alternatively, the ducts can be cut up into sheet specimens. Any helical wires are to be removed, if possible. The edges of specimens are to be folded up by 20 mm.

When testing as in Appendix B, a piece of stainless steel woven wire cloth shall be laid on the specimen (but not on the folded edges) to prevent it from folding back up.

5.2.4.5 Gypsum plasterboard

The net calorific value of gypsum plasterboard as in DIN 18180 need not be determined. Where coatings on gypsum plasterboard are to be tested, a mass per unit area of 300 g/m² is to be assumed to account for the facing. To determine heat release, half of the mass per unit area of a gypsum plasterboard having a thickness of 12,5 mm is to be used for calculations, disregarding the negative calorific value of the gypsum core.

5.2.4.6 Composite panels of gypsum plasterboard or gypsum fibreboard and mineral fibreboard

For classification as A1 or A2 materials, composite panels of gypsum plasterboard or gypsum fibreboard and mineral fibreboard are to be tested as follows:

- a) Testing as in subclauses 5.1.3 (furnace test) and 5.2.3.4 ('Brandschacht' test) is not required if the individual boards are classified as A1 or A2 materials.
- b) For classification as regards smoke generation, testing as in Appendix B with the gypsum side facing the flame is sufficient. The thickness of gypsum specimens is to be reduced to 5 to 6 mm, and that of mineral fibreboard specimens is to be reduced to 9 to 10 mm, so that the total specimen thickness is 15 mm.

5.2.4.7 Aluminium

The net calorific value of aluminium (including foil) may be disregarded in calculations.

5.2.5 Test certificate

If a building material can be classed as an A2 material on the basis of this standard, a test certificate⁴⁾ stating this shall be prepared, which is to contain the following information:

- a) a full description of the building material, including its type (e.g. main constituents), appearance, design, dimensions, density or mass per unit area, and sampling method used;
- b) preparation and mounting of specimens, test procedure, number of tests.

When testing as in subclause 5.1.3 (furnace test), include:

- c) for each specimen, the duration of flaming and the time at which it occurs;
- d) for each specimen, the results of furnace testing (given as the maximum increase in temperature);
- e) any other observations made during testing (e.g. enlargement or extinction of pilot flame, appearance of specimen after the test).

When testing as in subclauses 5.2.3.2 and 5.2.3.3, include:

- f) the net calorific value, H_u , in kW · s/kg, and the heat released, in kW · s/m².

When testing as in subclause 6.1.3 ('Brandschacht' test), include:

- g) for each specimen, the single residual lengths and the mean of all residual lengths, in cm;
- h) for each specimen, the effluent temperature as a function of time (mean of five measurements), the maximum mean effluent temperature, and the time it takes for each specimen to reach this temperature;
- i) for each specimen, the greatest flame height (given to the nearest 10 cm), time to flaming, duration of flaming and description of any afterflame or afterglow;
- j) any other special observations, such as the time and duration of any combustion, nature of any flame spread, any flaming on the back of the specimen, appearance of specimen after testing (including the back);
- k) a statement as to whether or not there was molten dripping;
- l) any observations regarding smoke generation.

When testing as in Appendices A and B, include:

- m) the information specified in subclauses A.6.5 and B.7.

Also include:

- n) classification as class A2 material;
- o) period of validity (no more than five years; extensions may be granted upon request).

6 Class B building materials

6.1 Class B1 materials

6.1.1 General requirements

- a) For all materials except cladding and flooring:

The test using the 'Brandschacht' apparatus (cf. DIN 4102-15 and DIN 4102-16) provides a fire model describing an object on fire in a room (e.g. a wastebasket in a corner of the room). Under such circumstances, the extent of the combustion of class B1 materials shall not reach beyond the primary fire area, and the heat released shall be minimal.

- b) For cladding:

The test using the 'Brandschacht' apparatus provides a fire model describing flames penetrating a window opening. Under such circumstances, the extent of the combustion of class B1 materials shall not reach beyond the primary fire area.

For ⁴⁾, see page 7.

c) For flooring:

The test specified in DIN 4102-14 provides a fire model describing flames reaching into the next room through a door opening. Under such circumstances, there shall not be considerable flame spread or generation of smoke.

6.1.2 Criteria for classification

6.1.2.1 All materials, except flooring, may be classed as B1 materials if they

- withstand the test specified in DIN 4102-16 using the 'Brandschacht' apparatus specified in DIN 4102-15, and
- meet the requirements for class B2 materials.

Results of testing as in this standard are not sufficient for the classification of

- materials listed in clause 7 of DIN 4102-16, which require special test conditions, and
- materials which are to meet additional requirements regarding smoke generation.

6.1.2.2 The test using the 'Brandschacht' apparatus described in DIN 4102-15 (cf. subclause 6.1.3.1) shall be deemed passed if

- the mean value for the residual length (portion of specimen that has not burned or charred; cf. subclause 9.1 of DIN 4102-16) of each specimen is at least 15 cm and no individual values are lower than 0 cm,
- the mean effluent temperature does not exceed 200 °C in any test,
- the requirement for the residual length of each specimen is met even where there is afterflame, afterglow, or smouldering.

6.1.2.3 Materials used as flooring may be classified as B1 materials if they pass the fire test specified in DIN 4102-14 and meet the requirements for B2 materials.

The fire test in DIN 4102-14 shall be deemed passed if the mean critical irradiance, I , for three specimens is at least 0,45 W/cm², and the mean light absorptance obtained by integrating over 30 minutes for three specimens is no greater than 750 % · min.

6.1.3 Testing

6.1.3.1 All materials, except flooring, shall be subjected to testing as in DIN 4102-16 using the 'Brandschacht' apparatus specified in DIN 4102-15.

6.1.3.2 Flooring (including any finishes) shall be tested in accordance with DIN 4102-14, with the following exceptions:

a) Number of specimens

If the critical irradiance is greater than 1 W/cm² and the light absorptance obtained by integrating over 30 minutes is less than 300 % · min, then only two tests are required in each direction and thus only four specimens are required (cf. subclauses 6.2 and 7.2 of DIN 4102-14).

b) Preparation of textile specimens

If textile flooring is to be provided with a fire retardant after it has been laid, the specimens shall be taken from the treated flooring and then cleaned before testing as follows:

1. Vacuum clean the specimen 50 times, rolling it together after every fifth cleaning (this simulates mechanical loading).
2. Spray clean the specimen once.
3. Once the specimen has reached constant mass, repeat step 1.

6.1.4 Test certificate

If a building material can be classed as a B1 material on the basis of testing as in this standard, a test certificate⁴⁾ stating this shall be prepared which is to contain the following information:

- a) a full description of the building material, including its type (e.g. main constituents), appearance, design, dimensions, density or mass per unit area, and sampling method used;
- b) where fire retardants are used, the following information, determined after conditioning:
 1. For wood products:
 - the quantity of retardant applied (e.g. coating weight) or used for treatment, in g/m²;
 - the solids content of the retardant, as a percentage by mass;

For ⁴⁾, see page 7.

2. For textiles:

- quantity of retardant absorbed in the fabric, in g/kg;

c) preparation and mounting of specimens, number of tests.

When testing as in subclause 6.1.3 ('Brandschacht' test), include:

- d) for each specimen, the single residual lengths and the mean of all residual lengths, in cm;
- e) for each specimen, the effluent temperature as a function of time (mean of five measurements), the maximum mean effluent temperature, and the time it takes for each specimen to reach this temperature;
- f) for each specimen, the greatest flame height (given to the nearest 10 cm), time to flaming, duration of flaming and description of any afterflame, afterglow or smouldering;
- g) any other special observations, such as the nature of any flame spread on the front or back of the specimen, any flaming on its back, the time at which flaming ceases, appearance of specimens after testing (including any colouring on the back), and (in the case of intumescent coatings on wood products) the uncharred length of the coating;
- h) any observations made regarding molten dripping, including how long any drops continue to burn on the screen;
- i) a diagram describing the generation of smoke over time. The smoke density value (in terms of the integral of light absorptance over the test period) shall be given if it is greater than $400\% \cdot \text{min}$ at any time during flaming.

When testing flooring as in DIN 4102-14, include:

- j) the maximum distance burned to flame-out, critical irradiance, and integral of light absorptance over the test period (individual values and mean value for each specimen tested), any observations made during the test (e.g. afterflame, afterglow, whether flame was extinguished), and a description of the specimen after the test (e.g. a photograph) (cf. items c) and d) of clause 10 in DIN 4102-14).

Also include:

- k) a statement that the requirements for material class B2 have been met;
- l) classification as a class B1 material (taking into account any special conditions);
- m) period of validity (no more than five years; extensions may be granted upon request).

6.2 Class B2 materials

6.2.1 General requirements

The test specified in subclause 6.2.5 serves to determine the ignitibility of materials when subjected to direct impingement of a small, defined flame (about the size of a match flame). When tested as in subclause 6.2.5, the ignitibility of class B2 materials and the flame spread shall be limited over a defined time period.

6.2.2 Criteria for classification

Materials may be classed as B2 materials if they pass the ignitibility test specified in subclause 6.2.5. This test shall be deemed passed if, for any of the five specimens tested, flaming does not reach the gauge mark within 20 seconds after flame application, either with bottom edge ignition as in subclause 6.2.5.2 or surface ignition as in subclause 6.2.5.3.

Edge ignition tests are normally to be carried out on specimens without protected edges. Testing with protected edges shall only be performed if edges will not be exposed after installation. If there is a chance that edges may nevertheless become exposed in service, then a surface ignition test shall also be carried out, although this test may be dispensed with if no failure is expected.

Flooring materials may be assigned to material class B2 if they meet at least the requirements for class T-b as in DIN 66081.

6.2.3 Ignitibility test: Specimens

6.2.3.1 Number and size of specimens

Five specimens having the following dimensions are required for each test:

- for the edge ignition test: 90 mm × 190 mm;
- for the surface ignition test: 90 mm × 230 mm.

The specimen thickness shall be selected on the basis of the thickness used in service. For materials which come in varying thicknesses, fire behaviour shall be determined as a function of the material thickness. 60 mm thick specimens are representative of materials which come in greater thicknesses.

If a building material is only produced in widths smaller than 90 mm, its fire behaviour shall be determined for the maximum width available.

6.2.3.2 Conditioning of specimens

Specimens shall be conditioned in DIN 50014-23/50-2 standard atmosphere for at least two weeks before testing.

On specimens for the edge ignition test, a gauge mark shall be drawn across the width 150 mm above the bottom edge, and on specimens for the surface ignition test, two marks shall be drawn, one 40 mm and one 190 mm above the bottom edge. If necessary, a mark shall also be drawn on the back of specimens for the edge ignition test.

6.2.4 Ignitibility test: Apparatus

The following apparatus shall be used:

- a) A small cabinet as in DIN 50050-1, which shall be set up so that it is draught-free. A mirror is to be attached to the back wall inside the cabinet so that the back of the specimen can be observed during testing. As a departure from DIN 50050-1, the air speed – which shall be between 0,6 m/s and 0,8 m/s – is to be measured in the flue, 25 mm above the flange.
- b) A burner as in DIN 50051, operated with propane as in DIN 51622. A device shall also be provided that allows the burner to be adjusted both vertically (for setting the flame height) and horizontally (for bringing the burner into position) (see figure 4).
- c) Specimen holder and frame for vertically suspending specimens. For materials up to 60 mm thick and 90 mm wide, the frame shall be as in subclause 4.1.3, the specimen holder as in subclause 4.1.4, of DIN 53438-1, June 1984 edition. Specimens less than 90 mm wide shall be suspended accordingly.
- d) Gauge as in subclauses 4.4 and 4.5 of DIN 53438-1, June 1984 edition, for setting the distance of the burner to the specimen.

6.2.5 Ignitibility test: Procedure

6.2.5.1 The ambient temperature of the test room is to be about 20 °C.

Mount the specimen in the holder/frame and suspend the entire frame vertically in the cabinet. Position the burner vertically to set the flame height to 20 mm, then tilt the burner to a 45° angle (cf. figure 4) and place it in the cabinet.

6.2.5.2 For bottom edge ignition testing (cf. figure 6), position the burner so that flame is applied to the bottom edge of the specimen at the centre of its width and thickness (for specimens up to 3 mm thick only). For specimens with a thickness greater than 3 mm, apply the flame to the lower surface of the specimen at the least favourable point in terms of fire behaviour. The front edge of the burner's stabilizer is to be 16 mm away from the specimen's bottom edge, measured along the nozzle axis.

6.2.5.3 Where surface ignition testing is necessary, burner placement and flame impingement shall be as shown in figure 7. The flame shall be applied to the centre of the specimen's width.

6.2.5.4 Apply the flame for 15 seconds and then pull the burner back, taking care not to create any draught. Measure the time it takes for the flame tip to reach the gauge mark (unless the flame extinguishes beforehand).

6.2.5.5 Multi-layered materials are to be tested as shown in figure 5 and as specified in subclause 6.2.5.2, except that the flame is to be applied to the least favourable point on the specimen's front edge.

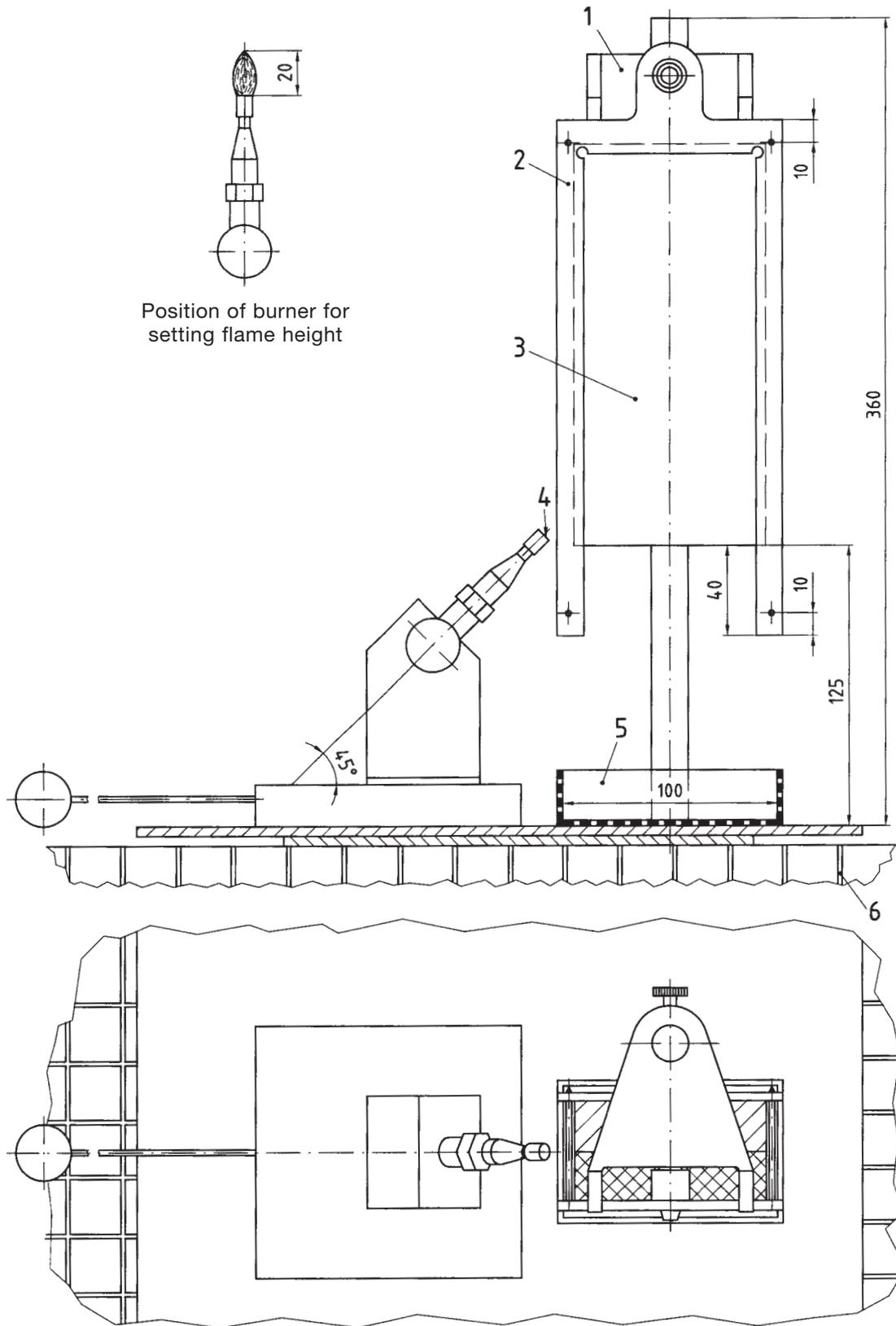
6.2.5.6 If materials are to be used in composite structures together with other materials, these shall be tested together.

6.2.6 Test for molten dripping

6.2.6.1 While testing as in subclause 6.2.5, class B2 materials are also to be tested for molten dripping. If within 20 seconds after flaming the filter paper as in subclause 6.2.6.2 ignites, or if drops that have fallen on the paper burn for more than two seconds, then molten dripping has occurred.

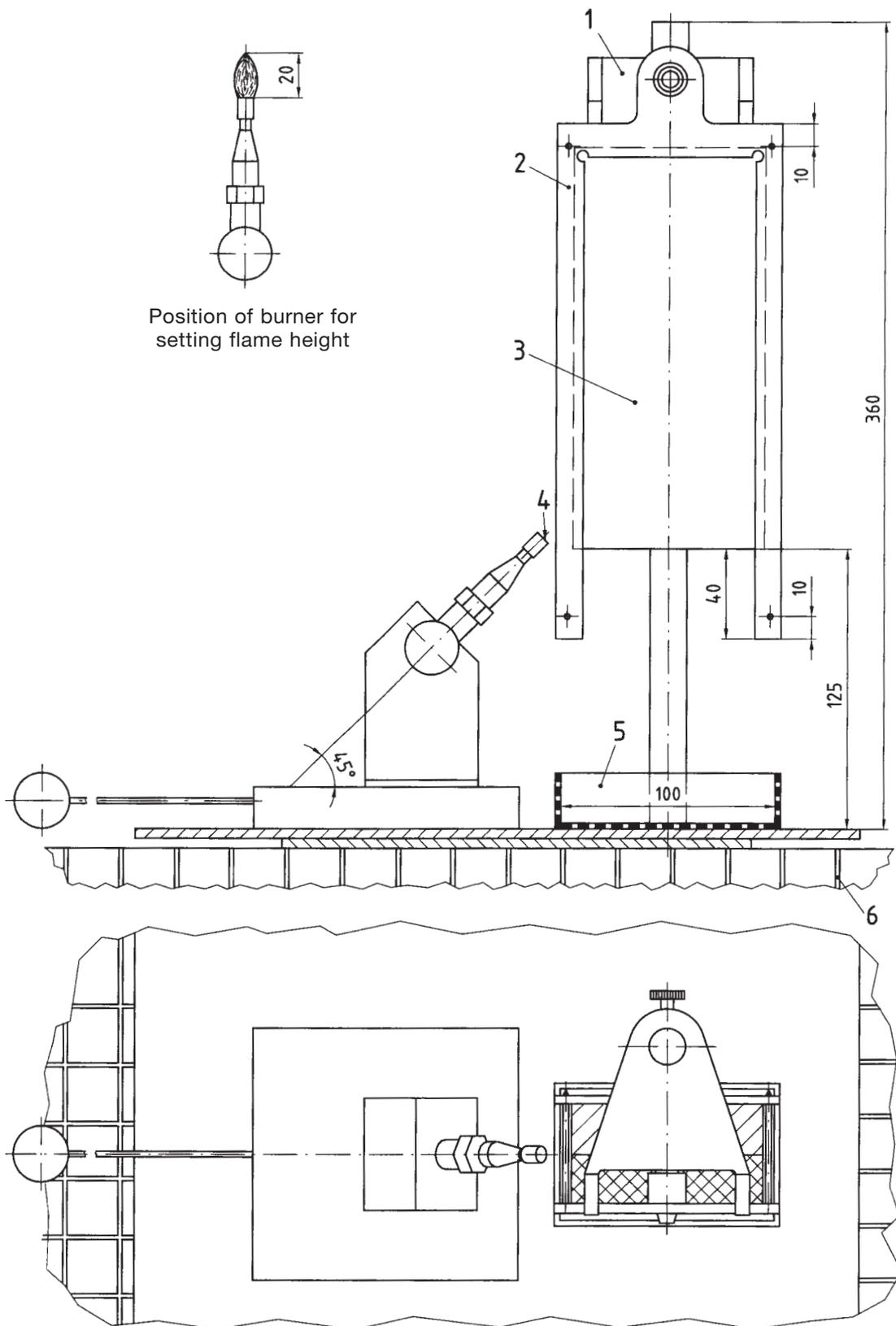
6.2.6.2 Before testing, condition two layers of filter paper in DIN 50014-23/50-2 standard atmosphere, and then place them in a 100 mm × 60 mm wire basket. Place the basket under the specimen on the floor of the cabinet.

For ⁴⁾, see page 7.



- | | |
|-------------------|----------------------------------|
| 1 Specimen holder | 4 Front edge of flame stabilizer |
| 2 Frame | 5 Wire basket, with filter paper |
| 3 Specimen | 6 Grating |

Figure 4: Apparatus for ignitibility testing as in subclauses 6.2.5.1 to 6.2.5.3 (schematic)



- | | |
|-------------------|----------------------------------|
| 1 Specimen holder | 4 Front edge of flame stabilizer |
| 2 Frame | 5 Wire basket, with filter paper |
| 3 Specimen | 6 Grating |

Figure 5: Apparatus for ignitability testing multi-layered materials as in subclause 6.2.5.5 (schematic)

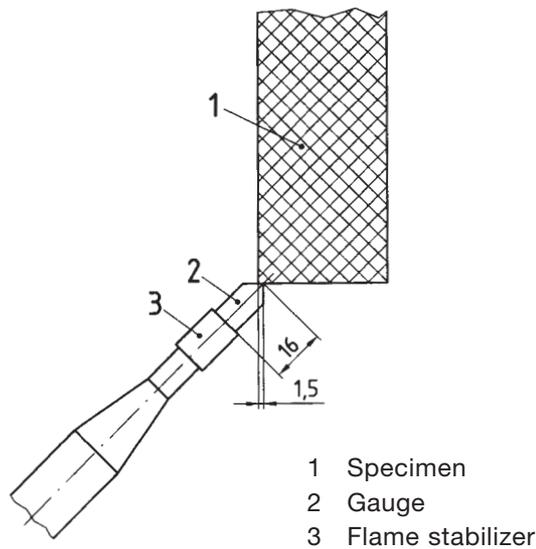


Figure 6: Burner position for edge ignition testing

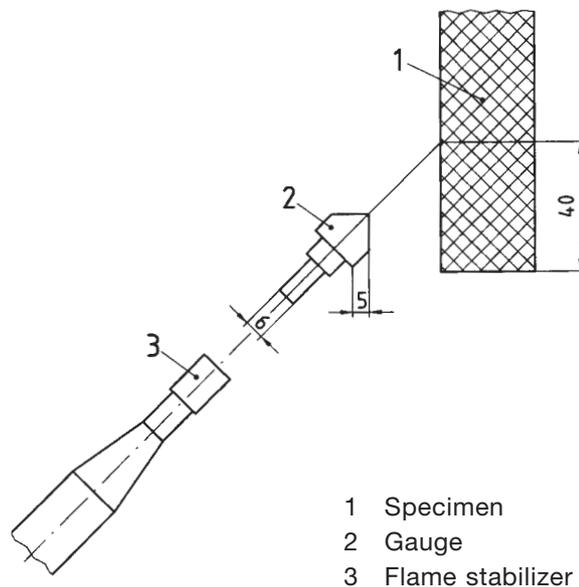


Figure 7: Burner position for surface ignition testing

6.2.7 Test certificate

If a building material can be classed as a B2 material on the basis of testing as in this standard, a test certificate⁴⁾ stating this shall be prepared, which is to contain the following information:

- a full description of the building material, including its type (e.g. main constituents), appearance, design, dimensions, density or mass per unit area, and sampling method used;
- details of specimen preparation;
- specimen thickness;
- details of test procedure, number of tests;
- any observations made during testing (e.g. time and duration of flaming, extinction of flame before the gauge mark is reached, generation of smoke, appearance of specimen after the test);
- classification as class B2 material (as a function of specimen thickness);
- statement as to whether molten dripping has occurred or not;
- period of validity (no more than five years; extensions may be granted upon request).

6.3 Class B3 materials

Combustible materials which cannot be classed as B1 or B2 materials shall be classed as B3 materials.

7 Marking

7.1 Building materials classed in accordance with this standard shall be marked with the appropriate class⁵⁾, for example: DIN 4102-A1, DIN 4102-A2, DIN 4102-B1 or DIN 4102-B2. Class B3 materials shall be marked with 'DIN 4102-B3 (*leichtentflammbar*)'.

7.2 Marking shall be applied to the material, packing slip, or packaging, or – if this is not practical – included on the delivery note or an attachment thereto.

7.3 The following materials are exempted from the marking requirement:

- a) all class A1 materials listed in DIN 4102-4;
- b) class B2 wood products with a density of 400 kg/m³ and a thickness greater than 2 mm.

Appendix A

Smoke generation test – Decomposition method

A.1 General

The method described in this appendix serves to determine the density of smoke produced by burning materials under defined conditions. Specimens are decomposed by exposure to radiant heat, and the optical density of the smoke thus produced is measured in terms of the light absorbance.

A.2 Decomposition apparatus

A.2.1 General

The decomposition apparatus shall consist of a quartz glass tube as in subclause A.2.2, a tube furnace as in subclause A.2.3, a flowmeter as in subclause A.2.4, and a specimen holder as in subclause A.2.5.

A.2.2 Quartz glass tube

The quartz glass tube shall be 1 000 to 1 300 mm long and shall have an external diameter of (40 ± 1) mm and a wall thickness of $(2 \pm 0,5)$ mm.

A.2.3 Tube furnace

The tube furnace shall be (100 ± 1) mm long, shall encompass the quartz glass tube, and be equipped with an automatic positioning device that is capable of moving the furnace along the glass tube at a continuous speed of $(10 \pm 0,5)$ mm/min. The heating element shall be capable of meeting the temperature requirements of subclause A.4.2 and of producing the required test temperatures up to 600 °C (cf. clause A.4 and subclause A.6.3.10). A thermocouple is to be incorporated in the heating element and is to be equipped with a controller capable of maintaining the temperatures specified in table A.1.

A.2.4 Flowmeter

The flowmeter shall be capable of measuring the air flow rate to an accuracy of 2 %.

A.2.5 Specimen holder (crucible)

The specimen holder shall be a quartz glass crucible having a wall thickness of $(1,7 \pm 0,2)$ mm, a length of (400 ± 10) mm and a semicircular cross section with an external radius of (15 ± 1) mm. It shall have a small bead with a height of $(2 \pm 0,5)$ mm at each end (cf. figure A.1).

A.3 Calibration body

The calibration body (cf. figure A.2) shall be a 200 mm × 5 mm × 2 mm steel strip. A NiCr-Ni thermocouple having a 0,5 mm wire diameter shall be brazed on the strip's centre. Before testing, the calibration body shall be preheated twice to (550 ± 50) °C.

A.4 Determining the test temperature

A.4.1 Procedure

Place the furnace in the initial position, as shown in figure A.3, and heat it to the desired temperature. The test temperature is determined by means of the calibration body temperature as follows.

⁵⁾ Building products are subject to the conformity marking regulations of the German *Länder*.

Place the calibration body in the crucible and insert both into the quartz glass tube. Then, attach the air supply to the tube inlet, set the air flow rate to (300 ± 10) l/h and start the furnace moving at a rate of 10 mm/min. Record the temperature of the measurement point on the calibration body continuously, taking the highest of these temperatures as the calibration body temperature. Carry out at least three measurements at the same furnace temperature, whereby single temperatures are not to deviate from the mean value by more than $\pm 3\%$. The mean calibration body temperature shall be taken as the test temperature.

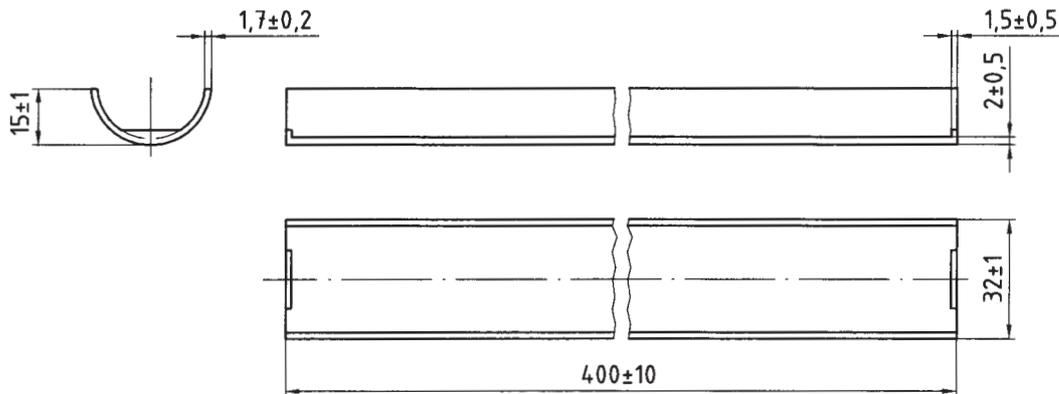
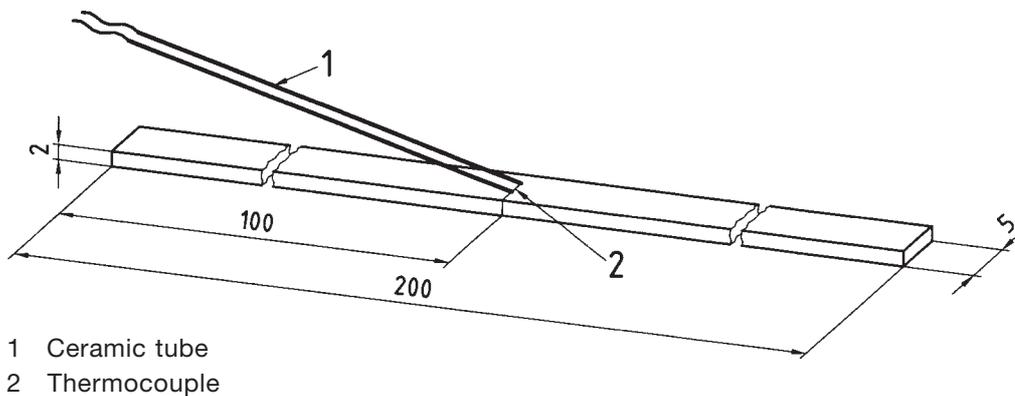
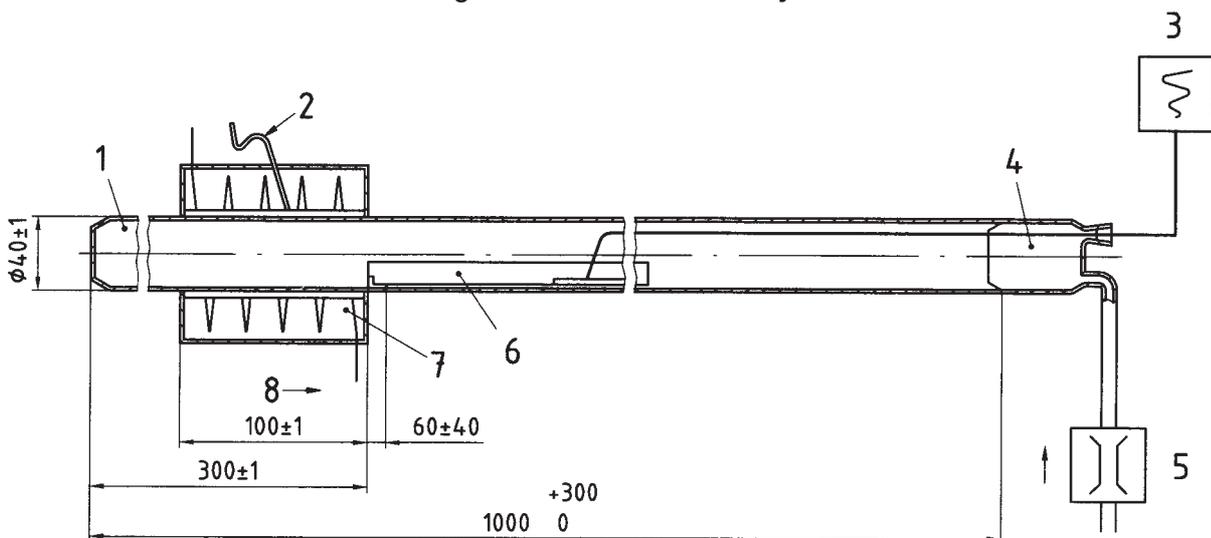


Figure A.1: Specimen holder (crucible)



- 1 Ceramic tube
- 2 Thermocouple

Figure A.2: Calibration body



- | | |
|---------------------|--------------------------------|
| 1 Quartz glass tube | 5 Flowmeter |
| 2 Thermocouple | 6 Calibration body in crucible |
| 3 Recorder | 7 Tube furnace |
| 4 Adaptor | 8 Positioning device |

Figure A.3: Decomposition apparatus

A.4.2 Calibration body temperatures

The calibration body temperature measured over time shall meet the requirements given in table A.1.

Table A.1: Calibration body temperatures

Time, t , in min	Measured temperature, as a percentage of the maximum temperature
$t_{\max} - 10$	(15 ± 10)
$t_{\max} - 5$	(65 ± 10)
t_{\max}	100
$t_{\max} + 5$	(70 ± 10)
$t_{\max} + 10$	(45 ± 10)

A.4.3 Calibration curve

To check the functioning of the test apparatus, draw a curve representing the calibration body temperatures at various furnace temperatures. The temperature control setting for the desired calibration body temperature (between 200 °C and 550 °C) at the given air flow rate can be taken from this curve.

A.5 Apparatus for measuring optical density of smoke

The apparatus for measuring the optical density of smoke shall consist of a metal tube as in A.5.1, a pressure-compensating vessel as in A.5.2 and a light measuring system as in A.5.3.

A.5.1 Smoke measuring tube

The smoke measuring tube shall be of corrosion-resistant metal and have two bends as shown in figure A.4. A glass tube for the air supply is to be placed at the inlet. The ends of the middle section shall be open so that the light beam can pass through. The light measuring system shall be attached to these ends by means of flanges (cf. figure A.4).

An adaptor as shown in figure A.5 shall be used to attach the tube to the decomposition apparatus.

A.5.2 Pressure compensating vessel

To compensate for pressure variations in the exhaust system, the fire effluents are to be drawn off through a pressure compensating vessel having a volume of at least 5 litres.

A.5.3 Light measuring system

The light measuring system shall be as in DIN 50055.

A.6 Test specimens and test procedure

A.6.1 Number of specimens

18 specimens are required for homogeneous material. For composite materials, 24 specimens are required, half of which shall be 5 mm wide \times 2 mm thick and the other half 2 mm wide \times 5 mm thick.

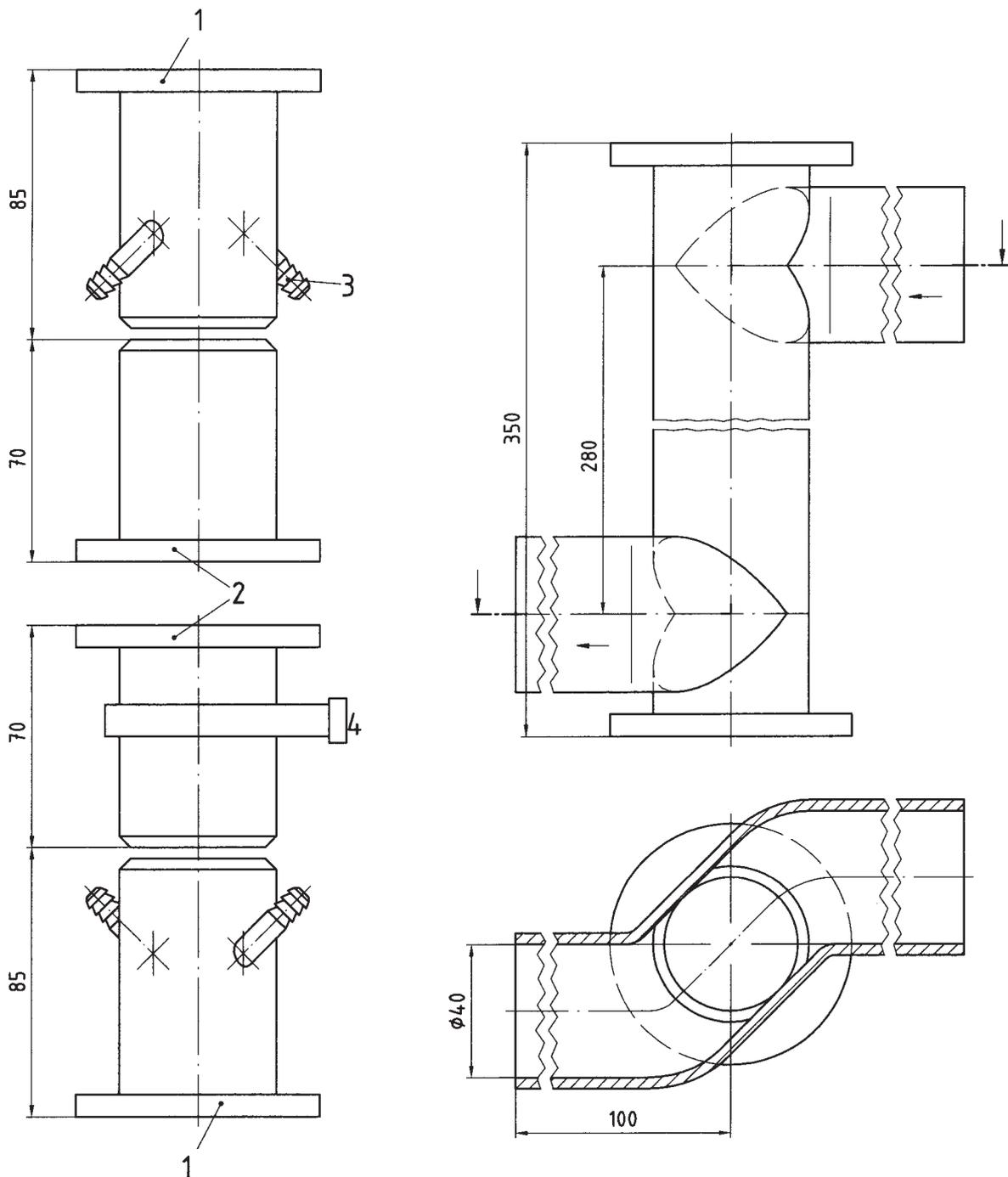
A.6.2 Preparation of specimens

A.6.2.1 All specimens shall be 270 mm \times 5 mm \times 2 mm (except the twelve composite specimens that are to be 270 mm \times 2 mm \times 5 mm as specified in subclause A.6.1).

A.6.2.2 Before testing, specimens shall be conditioned in DIN 50014-23/50-2 standard atmosphere until they reach constant mass.

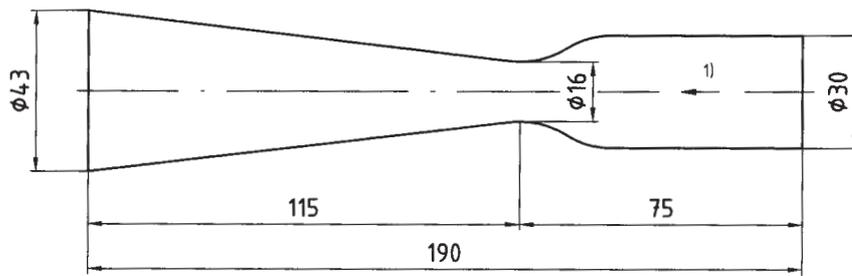
A.6.2.3 For composite materials, 12 specimens shall have the 2 mm side cut parallel to the surface and 12 shall have the 5 mm side cut parallel to the surface (cf. figure A.6).

A.6.2.4 Specimens of material thinner than 2 mm or of bulk material shall be as in A.6.3.6 and A.6.3.7, respectively.



- 1 Flange for connecting to light measuring device
- 2 Flange for connecting to smoke measuring tube
- 3 Connection to scavenging air system
- 4 Filter unit

Figure A.4: Smoke measuring tube



1) Direction of smoke flow

Figure A.5: Adaptor (for connecting decomposition and smoke measuring tubes)

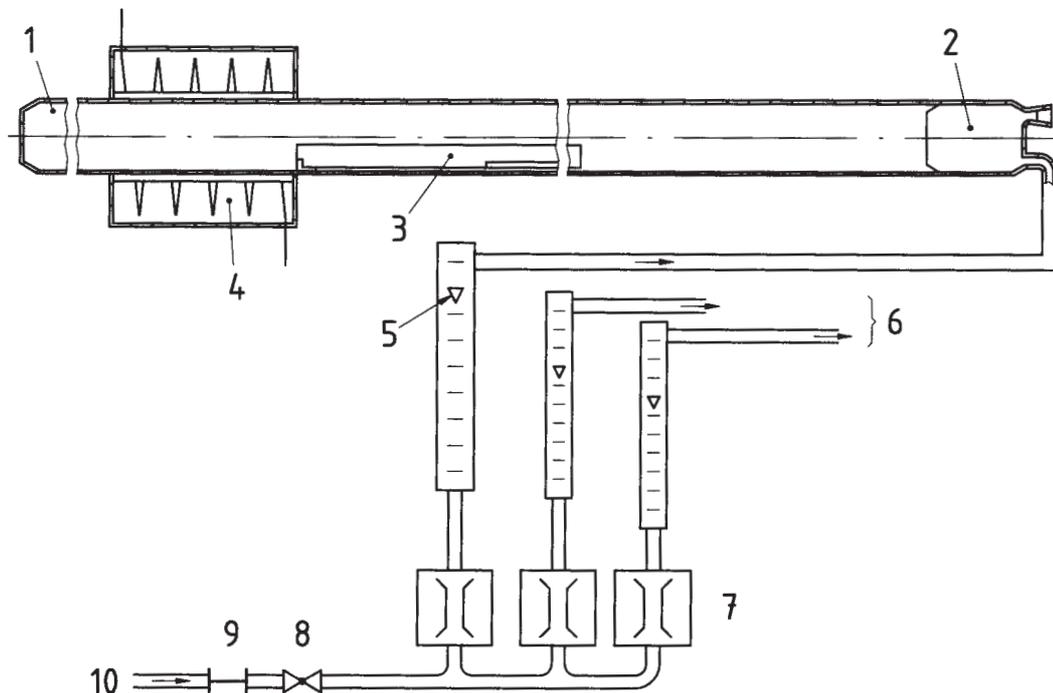


Figure A.6: Location of specimens of composite materials

A.6.3 Test procedure

A.6.3.1 Connect the quartz glass tube and smoke measuring tube using the adaptor shown in figure A.5 and a plastic hose. The distance between the two tubes shall be (230 ± 10) mm.

A.6.3.2 Place the tube furnace in its initial position and heat it to the test temperature. Set the air flow rate at (300 ± 10) l/h (cf. figure A.7).



- | | |
|---|---|
| 1 Quartz glass tube | 6 Scavenging air supplies for smoke measuring tube (flow rate for each: (15 ± 1) l/h) |
| 2 Adaptor | 7 Precision flowmeter |
| 3 Crucible, with specimen | 8 Pressure reducing valve |
| 4 Tube furnace | 9 Filter with water trap |
| 5 Air supply for decomposition tube (flow rate: (300 ± 10) l/h) | 10 Air inlet |

Figure A.7: Test assembly for smoke generation test

A.6.3.3 Set the inflow of the scavenging air into the smoke measuring tube at a rate of (15 ± 1) l/h per connection; this gives a total rate of 60 l/h (cf. figure A.7); this will prevent sooting of the optical lenses and valves.

A.6.3.4 Set the light receiver to full transmittance.

A.6.3.5 Place the specimen in the middle of the crucible so that it lies flat, with the surface to be tested facing up.

A.6.3.6 Lay specimens of sheet materials such as film or textiles in several layers.

A.6.3.7 For bulk materials or materials which fall apart when cut, the specimen shall have a mass that is equivalent to the specified specimen volume. This amount shall be evenly spread along a length of 270 mm in the crucible.

A.6.3.8 Place the crucible in the glass tube as shown in figure A.7 and close up the tube.

A.6.3.9 Turn on the automatic drive of the furnace, turn on the light beam, and begin recording the absorptance.

A.6.3.10 Carry out testing at test temperatures of 250, 300, 350, 400, 450, 550 and, if necessary, 600 °C.

A.6.3.11 For homogeneous materials, carry out three tests at each temperature. For composite materials, carry out four tests at each temperature, two on specimens with the 2 mm side parallel to the cut surface and two on specimens with the 5 mm side parallel to the cut surface. If the absorptance after the first test is less than 5 %, further testing is unnecessary.

A.6.4 Evaluation

A.6.4.1 The mean absorptance shall either be determined for the time from the start of the 16th minute of testing to the end of the 25th minute, on the basis of the integrated value (% · minute, i.e. the area below the curve) over ten minutes, or it shall be directly measured using an integrating device.

A.6.4.2 The mean absorptance at each temperature is the arithmetic mean taken from the three (or four, in the case of composite materials) single values measured at that temperature.

A.6.4.3 The maximum mean absorptance is the highest of the means obtained at all the test temperatures.

A.6.5 Test report

A.6.5.1 If the test results are not included in the test certificate specified in subclause 5.2.5, a separate test report shall be drawn up that comprises a cover sheet with the report number, name and address of client, designation of test material, sampling method used, and a second sheet with the table shown in subclause A.6.5.2.

A.6.5.2 Test results shall be presented as shown below.

Table A.2: Presentation of test results

Test temperature, in °C	Light absorptance, as a percentage				
	Test no. 1	Test no. 2	Test no. 3	Test no. 4	Mean
250					
300					
350					
400					
450					
550					
(600)					

Test results are for:

test nos. 1 to 3: Homogeneous specimens

or

test nos. 1 and 2: Composite specimens with the 2 mm side parallel to surface

test nos. 3 and 4: Composite specimens with the 5 mm side parallel to surface

Appendix B

Smoke generation test – Flame impingement method

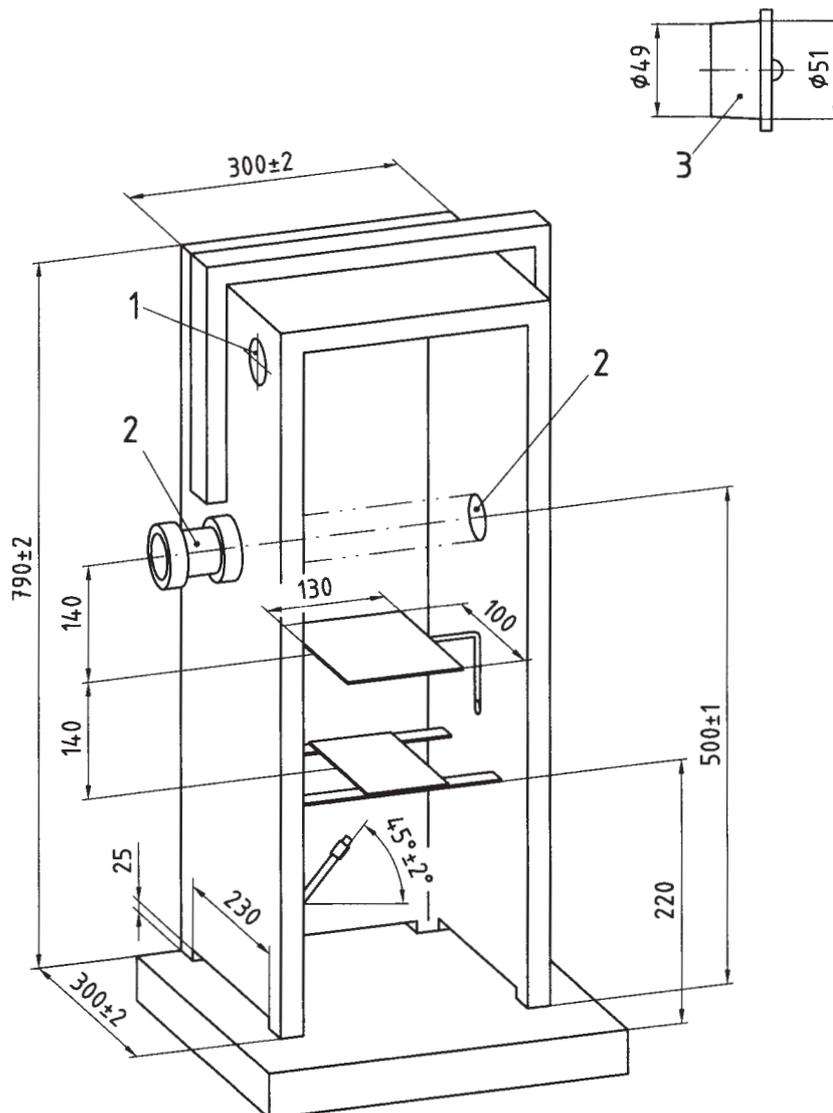
B.1 General

This method of determining the optical density of smoke generated by a material involves exposing specimens to impingement by a specified flame under reproducible conditions.

B.2 Apparatus

B.2.1 General requirements

The test apparatus shall comprise a chamber enclosing a burner, a specimen holder and a smoke density measuring system (cf. figure B.1).



- 1 Hole for air extraction device. When testing without air supply, this hole is to be closed using a 50 mm diameter metal plug.
- 2 UV filter, \varnothing 49 mm
- 3 Metal plug

Figure B.1: Test chamber

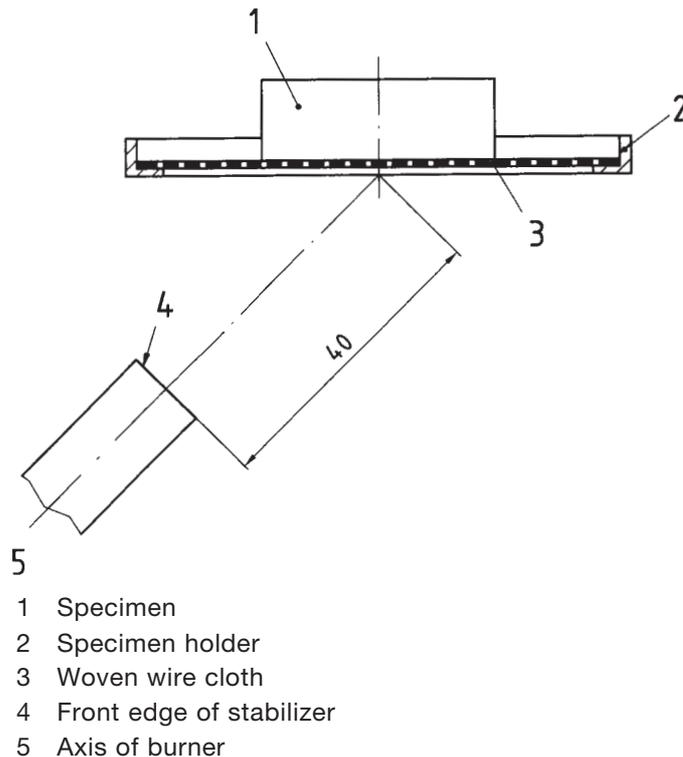


Figure B.2: Specimen holder and position of burner

B.2.2 Test chamber

The chamber shall measure (300 ± 2) mm \times (300 ± 2) mm \times (790 ± 2) mm, be of blackened steel plate and have a door of heat-resistant glass that closes tight on all sides. Small slits shall be provided at the bottom of the walls and the door. The slits in the walls shall be 230 mm wide and 25 mm high, while that in the door shall be 275 mm wide and 30 mm high (cf. figure B.1).

The specimen holder shall be placed 220 mm above the floor. The specimen itself shall be placed on a 64 mm square piece of stainless steel woven wire cloth with a 5 mm aperture size and a 0,9 mm wire diameter. Only completely flat wire cloth may be used. The frame of the holder shall be 67 mm square and be made of 1 mm angle sections with an L-profile (5 mm \times 5 mm \times 1 mm).

The front edge of the burner stabilizer shall be 40 mm from the centre of the specimen (cf. figure B.2). This distance shall be maintained by means of a distance gauge inserted in the stabilizer. A gauge shall also be used to check the precise axial position of the specimen at regular intervals throughout the test.

To prevent the flame from reaching the light beam, a 100 mm \times 130 mm \times 140 mm plate shall be placed above the specimen holder (cf. figure B.1). An air extraction device shall be placed on the upper left side of the chamber so that the air supply can be kept constant. It shall be possible to seal the opening for this device, when necessary. A 240 mm \times 240 mm \times 10 mm tray for catching molten drips shall be placed in the middle of the chamber floor.

B.2.3 Propane burner with propane and air supply

B.2.3.1 Propane burner

The burner shall have a ruby nozzle with a 0,17 mm bore³⁾ (cf. figure B.4).

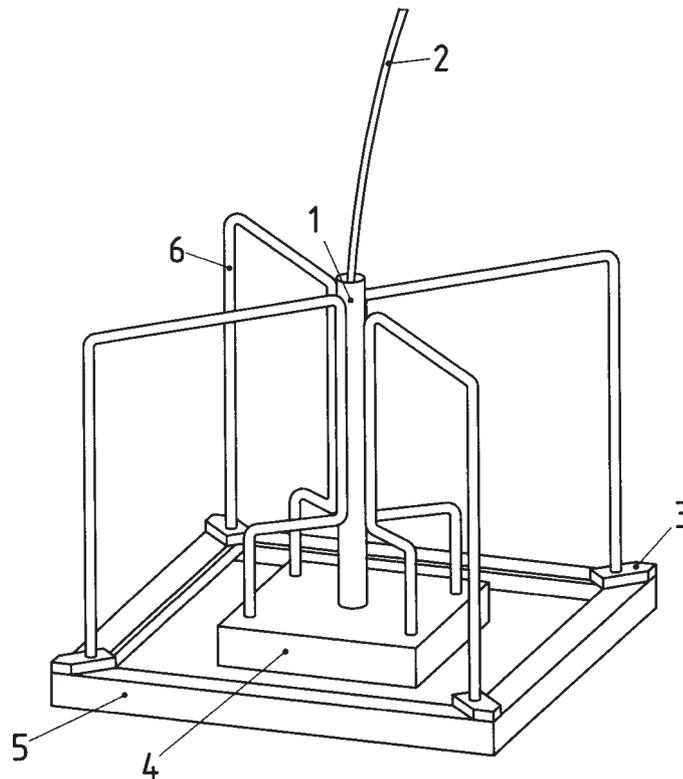
The propane and air supply shall be arranged as shown in figure B.5, taking care to place the control valves correctly.

B.2.3.2 Propane supply

The apparatus for the propane supply shall consist of the following (for item numbers, see figure B.5).

- Pressure regulator (no. 6) and pressure gauge (no. 7) having a scale range of 0 to 6 bar and 0,1 bar scale intervals.
- Stopvalve (no. 16).
- Variable-area flowmeter (no. 8) with float, adjusted to an absolute pressure of 3 100 mbar.
- Precision pressure gauge (no. 15), with 0,05 bar scale intervals. An absolute pressure gauge may be used instead, as long as it has the same limit of error.

³⁾ For ³⁾, see page 5.



- 1 Porcelain tube, 4 mm × 1 mm × 50 mm
- 2 Sheathed thermometer, 1 mm dia.
- 3 Foot
- 4 Steel plate, 30 mm × 30 mm × 6 mm, with hole for thermometer (1,2 mm diameter, 5 mm deep)
- 5 Specimen holder
- 6 Wire frame, 1,5 mm dia.

Figure B.3: Device for temperature adjustment

B.2.3.3 Air supply

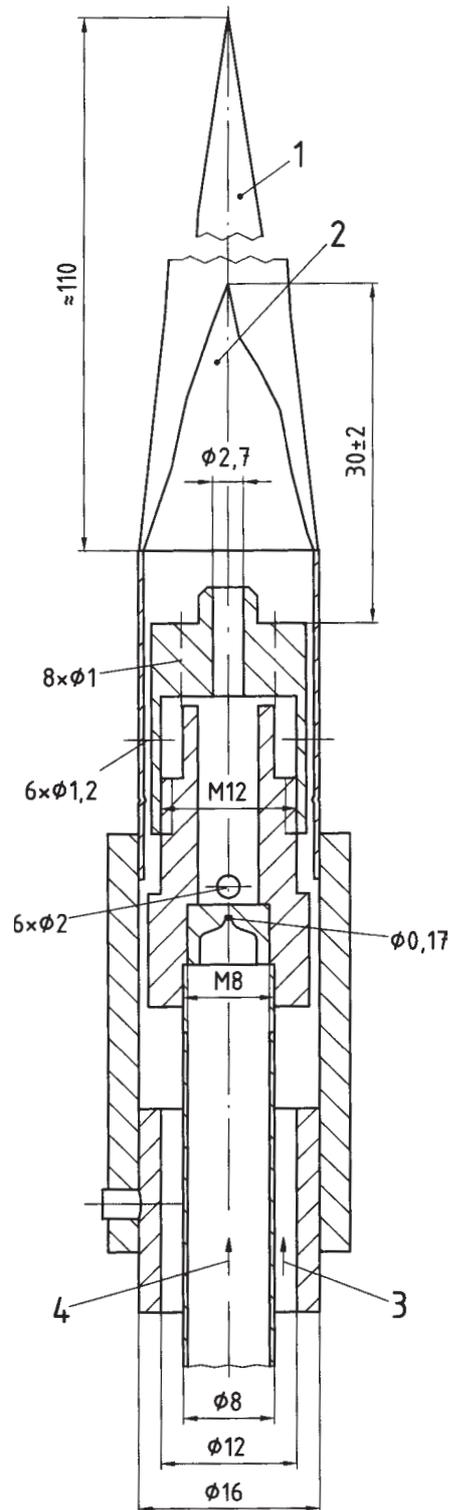
The apparatus for the air supply shall consist of the following (for item numbers, see figure B.5).

- a) Pressure regulator (no. 1) and pressure gauge (no. 2) with a scale range of 0 to 1,6 bar and 0,02 bar scale intervals.
- b) Stopvalve (no. 16).
- c) Flowmeter (no. 3) with float, adjusted to an absolute pressure of 1 013 mbar, with a scale range of 0 to 300 l/h and 10 l/h scale intervals. A flowmeter that is adjusted for higher absolute pressures may be used instead as long as it has the same limit of error.
- d) U-tube manometer (no. 4), with a scale range of 0 to 1,1 bar. An absolute pressure gauge may be used instead, as long as it has the same accuracy.
- e) Control valve (no. 5).
- f) Non-return valve (no. 14).

B.2.4 Light measuring system

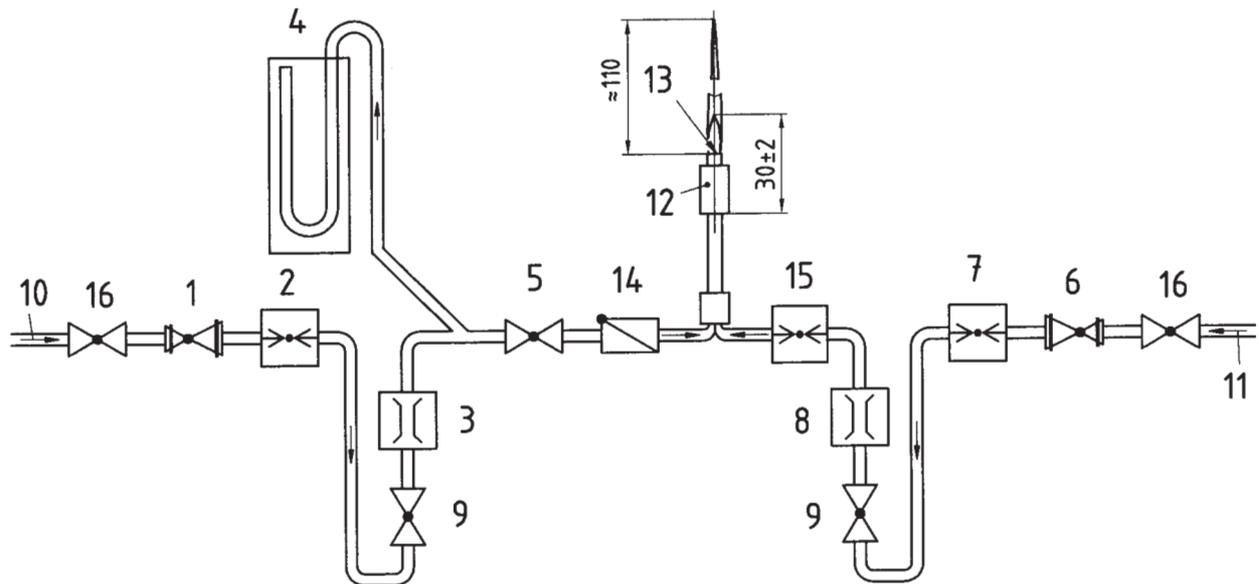
The light measuring system used to determine the optical density shall be as in DIN 50055. The light receiver and illumination unit shall be mounted outside the chamber on a channel-type frame which is to touch the chamber at no more than one spot to avoid deformation due to high temperatures.

The openings in the chamber for the light beam are to have UV filters. The light receiver and illumination unit are to be provided with flexible shields to protect them from light coming in from the side.



- 1 Outer cone, about 110 mm long
- 2 Inner (blue) cone, (30 ± 2) mm long
- 3 Air supply
- 4 Propane supply

Figure B.4: Propane burner



- | | |
|----------------------|-------------------------------------|
| 1 Pressure regulator | 9 Control valve |
| 2 Pressure gauge | 10 Air supply |
| 3 Flowmeter | 11 Propane supply (as in DIN 51622) |
| 4 U-tube manometer | 12 Burner |
| 5 Control valve | 13 Front end of stabilizer |
| 6 Pressure regulator | 14 Non-return valve |
| 7 Pressure gauge | 15 Precision pressure gauge |
| 8 Flowmeter | 16 Stopvalve |

Figure B.5: Burner with air and propane supplies

B.2.5 Additional equipment

B.2.5.1 Light filters for calibration.

B.2.5.2 Anemometer, with a range of 0 to 1 m/s.

B.2.5.3 Smoke density recording device.

B.2.5.4 Barometer, with a range of 800 to 1 100 mbar.

B.3 Specimens and number of tests

B.3.1 Specimen number and size

Five specimens are required for testing (in the special case mentioned in subclause B.3.3, ten specimens are required). Specimens shall measure 30 mm × 30 mm and have the same thickness as in service, as long as it is no greater than 15 mm (this applies to all materials, including single-layer materials, composite materials, film and fabrics). Specimens of thicker materials shall be cut down to 15 mm.

B.3.2 Position of specimens during test

The surface which will be exposed in use shall be placed face down on the wire cloth so that it is facing the burner. The centre of the specimen shall lie on the burner axis. Since the position of the specimen has a great effect on the test results, it shall be continually adjusted during testing by means of a setting gauge (see subclause B.2.2 and figure B.2).

B.3.3 Number of tests

Five tests shall be carried out with the air extraction device turned off and the openings in the chamber tightly closed.

If the mean smoke density is over 15 %, another series of five tests may be performed with the air extraction device turned on at a rate of 6,5 l/s (cf. subclause B.4.3). The volume of air extracted is to be set and monitored at regular intervals by means of a suitable orifice in front of the blower.

B.3.4 Conditioning specimens

Before testing, specimens are to be conditioned in DIN 50014-23/50-2 standard atmosphere until they reach constant mass.

B.4 Adjustment

The chamber door is to be kept closed during adjustment.

B.4.1 Burner (propane and air supply)

When setting up the burner and nozzle, check for leaks in the system (e.g. by using a leak indicating spray). Check the propane and air supply as follows:

- Using the device shown in figure B.3, check the temperature over time without air extraction. Plot a temperature-time diagram and compare it to the standard diagram⁷⁾; any deviations shall be no more than 3%. Carry out this check after every 100 hours of operation.
- Measure the volume flow of air and propane using a volumetric flask or test gas meter. The volume flow is to be 235 l/h for air and 16,2 l/h for propane (under normal conditions).
- Measure the flame height with the help of a gauge. The inner blue cone shall be (30 ± 2) mm long (cf. figure B.4).

B.4.2 Light measuring system

The light measuring system is to be checked regularly (e.g. daily) to see if the light beam is centred and falls in the middle of the light receiver opening. Taking the ageing of the light source and temperature fluctuations in the chamber into consideration, the photometer indication is to be checked using calibration light filters (e.g. with 20 %, 40 % and 80 % transmittance).

B.4.3 Air extraction

Set the air extraction rate at 6,5 l/s by taking measurements at an opening at the half-length of a 1 000 mm long straight pipe of 52 mm internal diameter.

B.5 Test procedure

B.5.1 Setting up the apparatus

Set up the apparatus in a draught-free area (i.e. the air speed at the bottom of the test chamber shall be 0,05 m/s or lower) so that no extraneous light falls on the photocells of the light measuring system. The ambient temperature in the test room shall be (23 ± 5) °C.

B.5.2 Set values

For item numbers, see figure B.5.

B.5.2.1 Propane

Using the pressure regulator (no. 6), set the pressure at the pressure gauge (no. 7) to p_{G0} , given by the following equation:

$$p_{G0} = p_{G1} - p_{G2} = 3100 - p_{G2}$$

where

p_{G1} is 3100 mbar (pressure for flowmeter in no. 8);

p_{G2} is the current barometric pressure, in mbar.

Set the flow rate at the flowmeter (no. 8) to 16,2 l/h.

If an absolute pressure gauge is used for no. 4 or 7, then the pressure of the relevant flowmeter is to be immediately adjusted using the control valve or pressure regulator.

B.5.2.2 Air

The indication of the U-tube manometer (no. 4) is to be set at p_{L0} , given by the following equation:

$$p_{L0} = 10 \times (p_{L1} - p_{L2}) / 13,6$$

where

p_{L1} is 1013 mbar (pressure for flowmeter no. 3);

p_{L2} is the current barometric pressure, in mbar.

⁷⁾ Standard diagram obtained using equipment at the *Institut für Holzforschung der Universität München* (Institute for Wood Research of the University of Munich).

Table B.2: Testing with air supply (additional test)

Time, in min.	0,2	0,4	0,6	0,8	1,0	1,2	1,4	1,6	1,8	2,0
Mean of five tests										
Time, in min.	2,2	2,4	2,6	2,8	3,0	3,2	3,4	3,6	3,8	4,0
Mean of five tests										

Table B.3: Results of smoke generation test

Results	Testing without air supply	Testing with air supply
Maximum mean, as a percentage		
Time maximum mean was determined, in min.		

Appendix C

Smoke toxicity testing of class A materials

C.1 General requirements

The tests specified in this appendix involve the analysis of toxic effluents released by class A materials when subjected to a continual supply of air during combustion under defined conditions.¹⁾

The biological test shall only be carried out if the results of the analytical test are not conclusive.

C.2 Specimens

C.2.1 Twelve specimens measuring 600 mm × 15 mm × d (where d is the thickness) are required. For uneven materials with different thicknesses, d shall be the maximum thickness of the material.

C.2.2 Specimens of homogeneous materials that are thinner than 20 mm in their as-delivered condition shall have the thickness used in service.

C.2.3 Specimens of homogeneous materials that are thicker than 20 mm as delivered shall be 20 mm thick.

C.2.4 Specimens taken from large panels or shells may have aluminium facing on their sides, if

- in service, joints between elements will be fully taped over (joints shall nevertheless be tested), or
- the joint area is no more than 10% of the total surface area of the material.

The aluminium facing shall comprise 2 mm thick strips which are folded around the edges of the specimen and held in place by means of aluminium clips.

C.2.5 Composite materials

C.2.5.1 Materials which are only used together with a background shall be tested on this background. If the specimen thickness is greater than 20 mm, then this thickness shall be reduced in such a manner that the specimen is still representative.

C.2.5.2 In place of the background used in service, one of the representative materials specified in sub-clause 4.3, items a), d) and e), of DIN 4102-16, May 1998 edition may be used. This background may either be used to back the specimen or the specimen may be applied to it.

C.2.6 Conditioning specimens

Specimens shall be conditioned in DIN 50014-23/50-2 standard atmosphere for at least two weeks before testing.

¹⁾ For ¹⁾, see page 3.

C.3 Generation of fire effluents

C.3.1 Decomposition apparatus

The apparatus specified in DIN 53436-1 shall be used to produce the fire effluents.

C.3.2 Test temperatures

Testing shall be carried out at 300 °C and 400 °C. If the test at 300 °C is passed, no further testing at 400 °C is required.

The test temperatures shall be determined as specified in DIN 53436-1 using a calibration body and checked in accordance with DIN 53436-2.

C.3.3 Supply of air and fire effluents, gas mixture

The air supply fed into the quartz glass tube of the decomposition apparatus shall have a flow rate of 300 l/h. The fire effluents generated in the apparatus shall be fed, undiluted, through a plastic tube, (90 ± 10) cm long, to the inhalation chamber as in subclause C.5.1.

C.3.4 Placement of specimens

Specimens shall be laid horizontally on the bottom of the glass tube. Spacers shall be used to keep the specimens 10 mm above the tube bottom, although in some cases the specimen will have to be laid directly on the bottom of the tube. At the start of each test, the front end of the specimen shall lie directly beneath the front end of the tube furnace.

C.3.5 Test duration

Testing shall be carried out for 60 minutes. This period begins as soon as the automatic positioning device of the furnace as in DIN 53436-2 reaches position 1 (i.e. immediately after the specimen has been inserted).

C.4 Analytical test

C.4.1 Before any bioassays are carried out, check the gas in the inhalation chamber for carbon and any other expected toxic substances. If the carbon content exceeds 0,1 % (V/V) after 30 minutes, or if it lies between 0,05 % and 0,1 % (V/V) and the concentrations of other toxicants lie around the LC₅₀ (median lethal dose) value, biological testing shall not be performed and the test results shall be deemed to be negative.

C.4.2 If biological testing is required, the analytical tests specified in clause 12 of DIN 53436-3, November 1989 edition, shall be performed throughout the assays.

C.5 Biological assay

C.5.1 Inhalation chamber

The whole body mode shall be used for testing.

The inhalation chamber shall be of 10 mm thick vitreous plastic, with internal dimensions of about 800 mm × 450 mm × 350 mm. A hole with a diameter of 40 mm shall be placed in the right wall 55 cm above the chamber floor (hole 1 in figure C.1); this shall be used to introduce the inhalation mixture. On the opposite side there shall be five outlet holes with a 20 mm diameter (holes 2 to 6). Hole no. 6 in the centre is the sampling port for measuring the CO content.

Hole no. 7 in the front wall shall have a 10 mm diameter and shall be used to take the gas samples.

The back wall shall have a lid hinged at the top through which the animals can be led.

C.5.2 Test animals

At least five female rats of the same weight and strain, kept in individual cages, shall be used for each test.

C.5.3 Number of tests

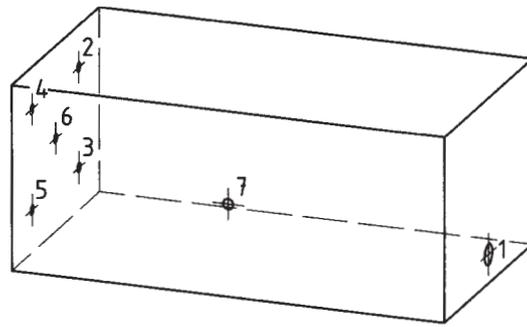
Two tests at each temperature (300 °C and 400 °C) shall be performed.

C.5.4 Test duration

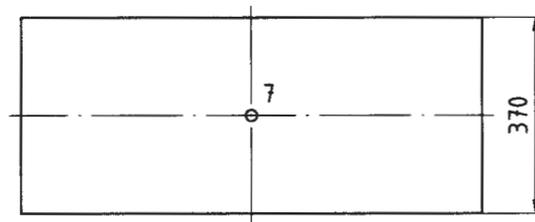
Testing shall be carried out for 60 minutes. This period begins as soon as the automatic positioning device of the tube furnace as in DIN 53436-2 reaches position 1 (i.e. immediately after the specimen has been inserted).

C.5.5 Post-exposure observation period

The post-exposure observation period shall be two weeks.



- | | |
|------------------------|-------------------------------|
| 1 Volume: | 125 dm ³ |
| 2 Internal dimensions: | 800 mm × 450 mm × 350 mm |
| 3 Material: | Vitreous plastic, 10 mm thick |
| 4 Hole 1: | ∅ 40 mm (inlet) |
| 5 Holes 2 to 5: | ∅ 20 mm (outlets) |
| 6 Hole 6: | ∅ 20 mm (CO sampling port) |
| 7 Hole 7: | ∅ 10 mm (sampling port) |



Front and back walls
(hole no. 7 in front,
hinged lid in back)

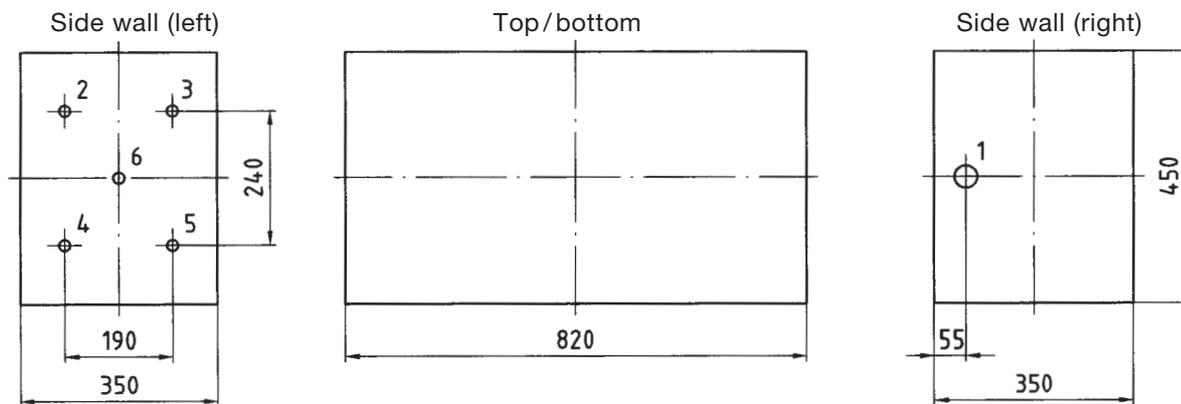


Figure C.1: Inhalation chamber

C.5.6 Biological assays

The biological assays shall be carried out as in clause 11 of DIN 53436-3, November 1989 edition.

C.6 Evaluation

The fire effluents produced by combustion of the specimen materials shall not be toxic. This is deemed to be the case if the following conditions are fulfilled:

- no test animal dies,
- the carboxyhaemoglobin (Hb-CO) value of the blood samples does not exceed 35 %,
- no other toxic concentrations of the relevant gas components are measured in the fire effluent, and
- no other toxicologic observations are made.

A single death shall be assessed in light of the behaviour of the other animals.

C.7 Test report

The test report shall include the following information:

- a) test method used;
- b) type, size and description of specimen;
- c) date of specimen delivery;
- d) date of test;
- e) species and strain of animal used;
- f) weight of animals;
- g) duration of bioassay;
- h) length of post-exposure observation period;
- i) time to death of animal(s);
- j) results of analytical testing as in subclause C.4;
- k) results of biological testing as in subclause C.5;
- l) number of tests;
- m) any deviations from this standard.

Explanatory notes

Test certificates are issued for the building materials and construction products (designated 'Bauprodukte' in German building regulations) which meet the relevant criteria when tested by the methods specified in this standard. For products subject to regulation or similar products (see *Bauregelliste**) A – Part 1⁸⁾), the test certificate is one of the criteria by which to verify conformity. Construction products that are not subject to regulation but which can be assessed on the basis of recognized test methods, including those described in this standard, require an 'Allgemeines bauaufsichtliches Prüfzeugnis' (General test certificate) as proof of their suitability (see *Bauregelliste* A – Part 2). If recognized test methods are not available, or if these are inadequate (see subclause 4.1, for example), proof of suitability shall be provided in the form of an 'Allgemeine bauaufsichtliche Zulassung' (agrément), or, alternatively, building inspectorate approval of the product shall be obtained on an ad-hoc basis.

Bauregelliste A – Part 2 also gives information on the means of verifying conformity with the general test certificate. This verification may take the following forms:

- a declaration of conformity by the manufacturer (ÜH);
- a declaration of conformity by the manufacturer following initial type approval testing of the product by an approved testing laboratory (ÜHP);
- a certificate of conformity issued by an approved certification body (ÜZ).

Manufacturers may make a declaration of conformity only where their factory production control has ensured that the product meets the requirements of the relevant technical rules or the general test certificate. See Annex 0.3 of *Bauregelliste* A – Part 1 for the nature of this factory production control.

In cases where a certificate of conformity is required, products must undergo both factory production control and third-party inspection (as stipulated in § 24c of the *Musterbauordnung* (Model Building Code), June 1996 edition). Third-party inspection shall be based on the *Richtlinien zum Übereinstimmungsnachweis nicht-brennbarer* (DIN 4102-A) *Baustoffe*⁹⁾ (Guidelines for verifying the conformity of non-combustible (DIN 4102-A) building materials) or the *Richtlinien zum Übereinstimmungsnachweis schwerentflammbarer* (DIN 4102-B 1) *Baustoffe*⁹⁾ (Guidelines for verifying the conformity of building materials that are not easily flammable (DIN 4102-B 1)), depending on the fire resistance class involved.

The German *Länder* building codes require verification of conformity for construction products only. It is, however, recommended that users also request that materials, etc. which are not officially classed as 'Bauprodukte' be provided with proof of conformity, as only those products that have undergone factory production control and, particularly in the case of classes A2 and B1, third party inspection, may be safely assumed to behave according to their fire resistance class.

*) Translator's note. The *Bauregellisten* (Lists A and B) are directories detailing ways of obtaining proof of suitability of construction products or product types. Products of minor importance and for which proof of suitability is not relevant are listed in List C of the *Bauregellisten*.

⁸⁾ *Bauregellisten* A, B and C are published in the *Mitteilungen des Deutschen Instituts für Bautechnik (DIBt)* (Proceedings of the German Institute of Building Technology), available from the *DIBt, Kolonnenstr. 30, D-10829 Berlin*.

⁹⁾ See *Mitteilungen Deutsches Institut für Bautechnik*, 1997: **28** (2).