BRITISH STANDARD

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1984
EN 54-9

Components of automatic fire detection systems —

Part 9: Methods of test of sensitivity to fire

UDC 614.842.435:654.924.5:620.1

Cooperating organizations

The European Committee for Standardization, under whose supervision this European Standard was prepared, comprises the national standards organizations of the following Western European countries:

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United Kingdom	British Standards Institution

This British Standard, having been prepared under the direction of the Fire Standards Committee, was published under the authority of the Board of BSI and comes into effect on 31 May 1984

The following BSI references relate to the work on this standard:
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Contents

	Page
Co-operating organizations	Inside front cover
National foreword	ii
Brief history	2
1 Object and field of application	3
2 Aims	3
3 Methods of measurement	3
4 Measuring instruments	3
5 Test laboratory	3
6 Test fires	3
7 Test conditions	4
8 Recording the measured values and response values	4
9 Fire sensitivity table	4
10 Fire sensitivity classification	5
Annex A Test fire TF 1: Open cellulosic fire (wood)	7
Annex B Test fire TF 2: Smouldering pyrolysis fire (wood)	7
Annex C Test fire TF 3: Glowing smouldering fire (cotton)	9
Annex D Test fire TF 4: Open plastics fire (polyurethane)	11
Annex E Test fire TF 5: Liquid fire (n-heptane)	11
Annex F Test fire TF 6: Liquid fire (methylated spirits)	11
Figure 1 — Plan view of detectors, fireplace and measuring instruments	4
Figure 2 — Coordinates of the rectangular boxes that define classes A, B and C of the suitability table (see example in Table 4)	6
Figure 3 — Arrangement of beechwood sticks for test fire TF 1	7
Figure 4 — Arrangement of beechwood sticks for test fire TF 2	8
Figure 5 — Arrangement of wicks for test fire TF 3	10
Table 1 — Fire parameters	3
Table 2 — List of test fires	5
Table 3 — Fire sensitivity table	5
Table 4 — Example of a suitability table for a type of detector	6
National appendix Z	Inside back cover

National foreword

This Part of BS 5445 has been prepared under the direction of the Fire Standards Committee and is the English language version of European Standard EN 54 *"Components of automatic fire detection systems" Part* 9:1982 "*Fire sensitivity test"* of the European Committee for Standardization (CEN).

This Part of BS 5445 describes a method of test consisting of six test fires for testing the sensitivity of fire detectors; it will always be used in conjunction with other Parts which will specify performance requirements. The test fires are typical of certain categories of fire and together cover the majority of fires which occur.

It should be noted that the comma has been used as a decimal marker. In British Standards it is current practice to use a full point on the baseline as a decimal marker.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 12, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

EUROPEAN STANDARD

NORME EUROPEENNE

EUROPAISCHE NORM

EN 54

Part 9
July 1982

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English version

Components of automatic fire detection systems Part 9: Fire sensitivity test

Organes constitutifs des systemes de detection automatique d'incendie.
Partie 9. Essais de sensibilite sur foyers types

Bestandteile automatischer Brandmeldeanlagen.
Teil 9. Erprobungstest

This European Standard was accepted by CEN on 1982-07-30. CEN members are bound to comply with the requirements of CEN Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to CEN Central Secretariat has the same status as the official versions.

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CEN

European Committee for Standardization
Comite Europeen de Normalisation
Europaisches Komitee fur Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 54-9:1982 E

Brief history

This European Standard was drawn up by the Technical Committee CEN/TC 72 *"Automatic fire detection systems"* the Secretariat of which is held by BSI.

The titles of the Parts of this European Standard are listed in Part 1.

This Part of the European Standard was adopted by CEN on the strength of its acceptance by the following Member countries:

Austria, Denmark, Finland, Germany, Greece, Italy, Netherlands, Portugal, Spain, Sweden, Switzerland and United Kingdom.

1 Object and field of application

This standard describes test fires to which fire detectors are to be subjected in order to satisfy the conditions specified in other Parts of EN 54.

2 Aims

The fire sensitivity tests are intended to supply information as to the response behaviour to be expected from fire detectors under genuine fire conditions.

For this purpose, the detectors to be tested are subjected to test fires, which are typical of certain categories of fire and, viewed as a whole, cover the majority of the fires which occur in practice.

On the basis of the test results, the sensitivity of a type of detector is assessed with regard to its response behaviour under specific fire conditions.

The test fires are so arranged that characteristic fire size curves are produced in the desired manner. The fuel used serves this purpose both qualitatively and quantitatively.

3 Methods of measurement

The methods of measurement used to determine the temporal course of the fire parameters shown in Table 1 shall be the same as in other Parts of EN 54.

The smoke density is measured both by the obscuration method and by the ionization current method.

Furthermore, the temporal course of the loss in weight of the fuel shall also be indicated.

Use the following units.

Table 1 — Fire parameters

Parameter	Symbol	Unit
Temperature	T	°C
Smoke density (optical)	m	dB/m
Smoke density (ionization)	f	dimensionless
Initial weight	G_0	g
Weight loss	AG	g
Time	t	s
[a] $y = \frac{I_0}{I} - L$		
I_0 = ionization current without smoke		
I = ionization current without smoke		

4 Measuring instruments

The same measuring instruments as in other Parts of EN 54 shall be used.

The total measuring accuracy of the balance shall be better than ± (2 ± 0,01 G_0) g, where G_0 is the initial weight.

5 Test laboratory

The dimensions of the test room shall be:

Length	9 m to 11 m
Width	6 m to 8 m
Height	3,8 m to 4,2 m

The arrangement of the detectors and measuring instruments is given in Figure 1.

The ceiling shall be horizontal and flat. Limits on the thermal parameters of the ceiling are under discussion.

6 Test fires

Six test fires are described and designated TF 1 to TF 6. Their characteristic features are shown in Table 2.

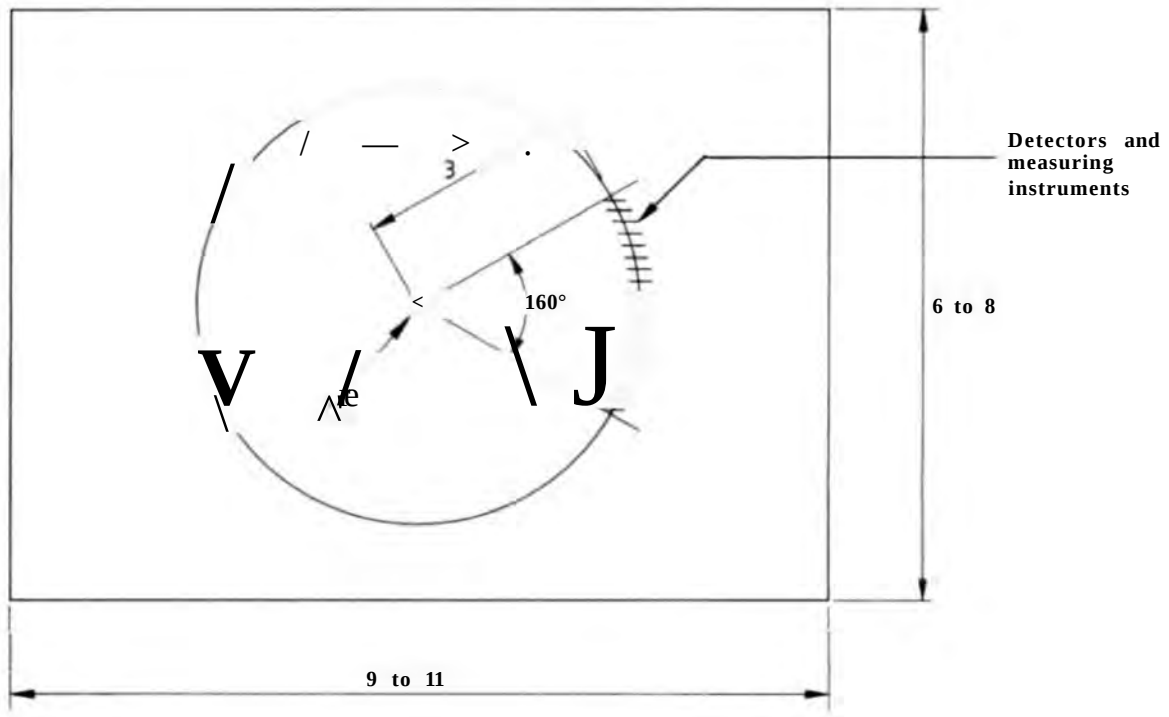
Annex A to Annex F describe how to carry out the test fires. They specify the type, quantity and arrangement of the fuel and the type of ignition or heat source.

The values of the fire parameters at the end of the test (ΔT_E, m_E, y_E,) [are] used as the controls of the validity and reproducibility of the test fires. It is permissible to vary slightly the quantities of fuel used, if necessary to produce the required values of fire parameters.

During each test at least one of the parameter values AT_3 or m_3 or specified in clause **10** shall be exceeded. The test fires shall be carried out in accordance with Annex A to Annex F.

During each test one of the fire parameters is dominant, i.e. it reaches first the maximum value specified in clause **10.** At that time the test shall be considered to be finished.

The ratios j and j the end of the test as specified in the annex shall be used as a control of the validity and reproducibility of the test fires. The response of a detector at a later time is ignored.



All dimensions are in m

Figure 1 — Plan view of detectors, fireplace and measuring instruments

7 Test conditions

Four detectors of the same type are required for carrying out the fire sensitivity test.

The detectors shall be installed in accordance with the manufacturer's instructions and connected to a suitable supply and monitoring device. Before each fire test the detectors shall be energized in the quiescent condition for at least 15 min.

Before each fire test, the test room shall be ventilated until the temperature and smoke measuring instruments show the following starting values:

$T = 23 \pm 5\ °C$

$y < 0{,}05$

$m < 0{,}05\ dB/m$

The personnel entrusted with the performance of the test shall leave the test room immediately after igniting the fuel, taking care to prevent air movements which might affect the development of the fire. All doors, windows or other openings shall be kept closed during the test.

8 Recording the measured values and response values

During the test, the fire parameters *AT, m, y, t* and the weight loss AG shall be measured and recorded. The alarm signal given at the control centre shall be taken as the indication that a detector has responded. At the moment of the alarm signal from a detector, the response values AT_a, ra_a, Y'_a shall be recorded. If a detector responds after the specified end of test fire parameters has been reached, this test fire shall be considered as undetected and this shall be recorded under "Remarks" in the table according to Table 3. If the requirements set out in the relevant annex are not fulfilled the fire test shall be repeated.

9 Fire sensitivity table

To make it easier to assess and classify the detectors according to their response behaviour, the response values AT_a, ra_a, y_a are set down in a table according to Table 3.

If a detector has failed to respond, this shall be noted under "Remarks".

Table 2 — List of test fires

Designation (TF = test fire)	Type of fire	Characteristic features				
		Development of heat	Upcurrent	Smoke	Aerosol spectrum	Visible portion
TF 1	open cellulosic fire (wood)	strong	strong	yes	predominantly invisible	dark
TF 2	smouldering pyrolysis fire (wood)	can be neglected	weak	yes	predominantly visible	light, high scattering
TF 3	glowing smouldering fire (cotton)	can be neglected	very weak	yes	predominantly invisible	light, high scattering
TF 4	open plastics fire (polyurethane)	strong	strong	yes	partially invisible	very dark
TF 5	liquid fire (n-heptane)	strong	strong	yes	predominantly invisible	very dark
TF 6	liquid fire (methylated spirits)	strong	strong	no	none	none

Table 3 — Fire sensitivity table

Test fire	Detector No.	A T_a (°C)	m_a (dB/m)	y_a	Remarks
TF 1	1 2 3 4				
TF 2	1 2 3 4				
TF 3	1 2 3 4				
TF 4	1 2 3 4				
TF 5	1 2 3 4				
TF 6	1 2 3 4				

10 Fire sensitivity classification

The purpose of the fire sensitivity classification is to give the user an indication of the suitability of a detector type in a particular potential fire situation by providing a suitability table (see the example in Table 4).

This classification applies only to applications for which the test conditions can be regarded as representative.

The ranges of the fire parameters are divided into three sections, thus defining a total of nine limiting values.

$$\begin{matrix} \mathbf{A}T_x & \mathbf{A}T_2 & \mathbf{a}r_3 \\ \wedge 1 & y^* & y^* \\ m_1 & m_2 & m_3 \end{matrix}$$

In a three-dimensional system of coordinates with the axes AT, m and y, these values define three rectangular boxes (see Figure 2). The response values AT_a, m_a, j_a, also termed alarm coordinates, constitute points in this system.

If the alarm points of all four detectors are within the smallest rectangular box, the detector for this type of fire shall be classified under class A of the suitability table (see the example in Table 4), i.e. if

$$\begin{matrix} \mathbf{AT_a} & < & AT,_1 & \text{and} \\ m_a & < & mi & \text{and} \\ \wedge a & < & y^* & \end{matrix}$$

If the alarm points of all four detectors are inside the middle rectangular box, but not all inside the smallest one, the detector shall be classified under class B of the suitability table (see the example in Table 4) for this type of fire, i.e. the following necessary conditions shall be followed:

$$\begin{matrix} \mathbf{AT_a} & < & \mathbf{A}T_2 & \text{and} \\ {}^{m}SL & < & m_2 & \text{and} \\ y^* & < & y2 & \end{matrix}$$

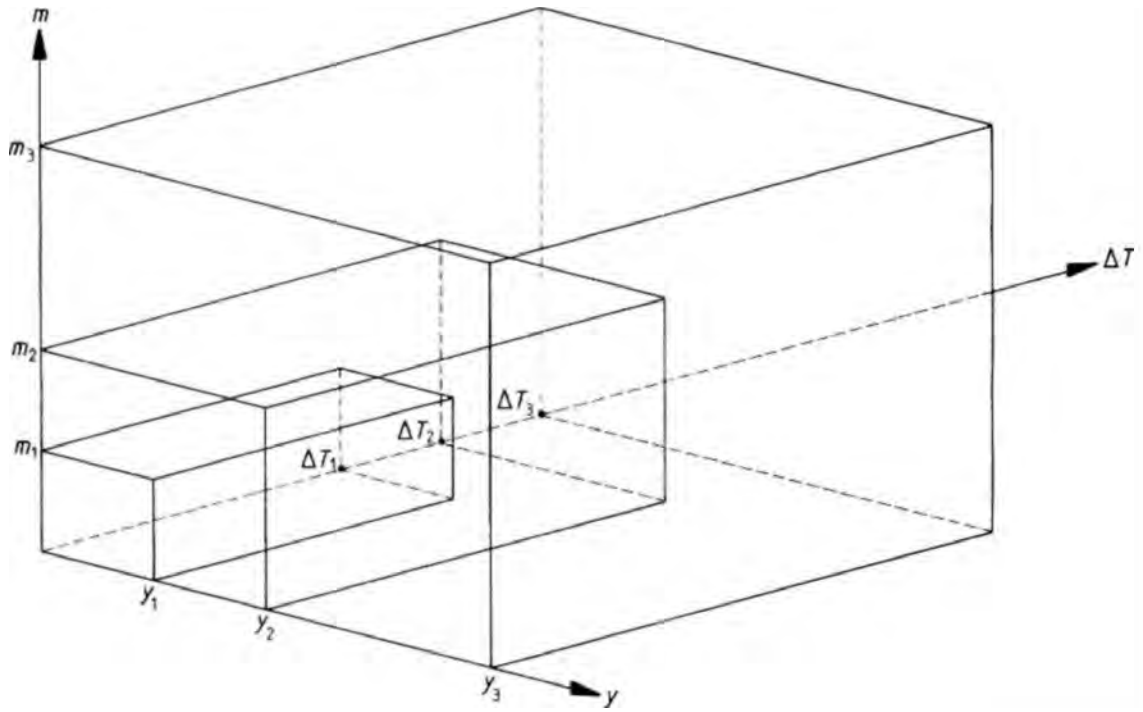


Figure 2 — Coordinates of the rectangular boxes that define classes A, B and C of the suitability table (see example **in** Table 4)

If the alarm points of all four detectors are inside the biggest rectangular box, but not all inside the middle one, the detector shall be classified under class C of the suitability table (see the example in Table 4) for this type of fire, i.e. the following necessary conditions shall be fulfilled.

$$\begin{aligned} \Delta T_a &< \Delta T_s \quad \text{and} \\ m_a &< m_3 \quad \text{and} \\ y^* &< y^* \end{aligned}$$

If the alarm point of one or more of the four detectors is outside the biggest rectangular box, for this type of fire, this type of detector shall not be classified. This shall be recorded under column N of the suitability table (see the example in Table **4).**

Table 4 — Example of a suitability table for a type of detector

Test fire	Class A	Class B	Class C	N
TF 1	x			
TF 2			x	
TF 3			x	
TF 4	x			
TF 5		x		
TF 6				x

NOTE "X" indicates that the detector type is classified under class A, B, or C, or is not classified.

The following limiting values shall apply:

ATi = 15 °C

$\wedge T_2$ = 30 °C

$\wedge T_3$ = 60 °C

m_i = 0,5 dB/m

m_2 = 1,0 dB/m

m_3 = 2,0 dB/m

y_i = 1,5

y_2 = 3

^3 = 6

Annex A Test fire TF 1: Open cellulosic fire (wood) (specified in clause 6)

a) *Fuel:*

Approximately 70 dried beechwood sticks (moisture content < 3 %) dimensions (1 × 2 × 25) cm^3

b) *Arrangement:*

At least 7 layers shall be superimposed on a base surface measuring (50 × 50) cm^2 as shown in Figure 3

c) *Ignition:*

5 cm^3 of methylated spirits in a bowl 5 cm in diameter

d) *Place of ignition:*

Centre of the base surface

e) *End of test:*

$y_E = 6$

f) *Fire parameters at end of test:*

$\left(\frac{m}{y}\right)_E = 0{,}10$ dB/m ± 25 %

$\left(\frac{\Delta G}{G_o}\right)_E \leqslant 0{,}5$

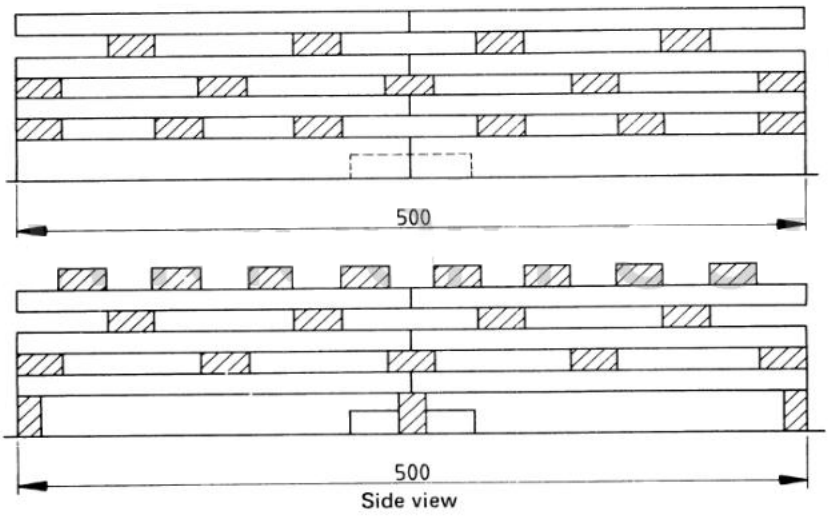


Figure 3 — Arrangement of beechwood sticks for test fire TF 1

Annex B Test fire TF 2: Smouldering pyrolysis fire (wood) (specified in clause 6)

a) *Fuel:*

Approximately 24 dried beechwood sticks (moisture content < 3 %) dimensions (1 × 2 × 3,5) cm^3

b) *Arrangement:*

The sticks shall be arranged in a star shape on a hotplate 220 mm in diameter with a grooved surface and then made to smoulder. The hotplate shall have 8 concentric grooves, 2 mm deep and 5 mm wide. The outer groove shall be 4 mm from the edge of the hotplate, and the distance between two grooves shall be 3 mm (see Figure 4). The hotplate shall be powered in such a way that the temperature of 600 °C is reached within 11 min. Flaming shall not occur before m_E is reached.

c) *Temperature measurement:*

The temperature measurement shall be performed with a sensor attached to the 5th groove, counted from the edge of the hotplate, with a good thermal contact.

d) *End of test:*

mg = 2 dB/m

e) *Fire parameters at end of test:*

$\left(2^{\wedge}_{YJE}\right.$ = 1,30 dB/m ± 25 %

$\left[4^{*}T\right)_{E}$ ^ o.6

Figure 4 — Arrangement of beechwood sticks for test fire TF 2

Annex C Test fire TF 3: Glowing smouldering fire (cotton) (specified in clause 6)

a) *Fuel:*

Approximately 90 pieces of cotton wick, about 3 g each, and having a total length of about 80 cm shall be washed and dried to constant weight before use.

b) *Arrangement:*

The wicks shall be fastened to a wire ring 10 cm in diameter (see Figure 5).

c) *Ignition:*

The ends shall be lit and the flame immediately blown out so that the wicks continue to glow.

d) *End of test:*

raj? = 2 dB/m

e) *Fire parameters at end of test:*

f^{m}1 = 0.50 dB/m ± 25 %
yyJe

$\left(\frac{\Delta G}{G_o}\right)_K \leq 0.8$

NOTE The reproducibility of this test is under consideration.

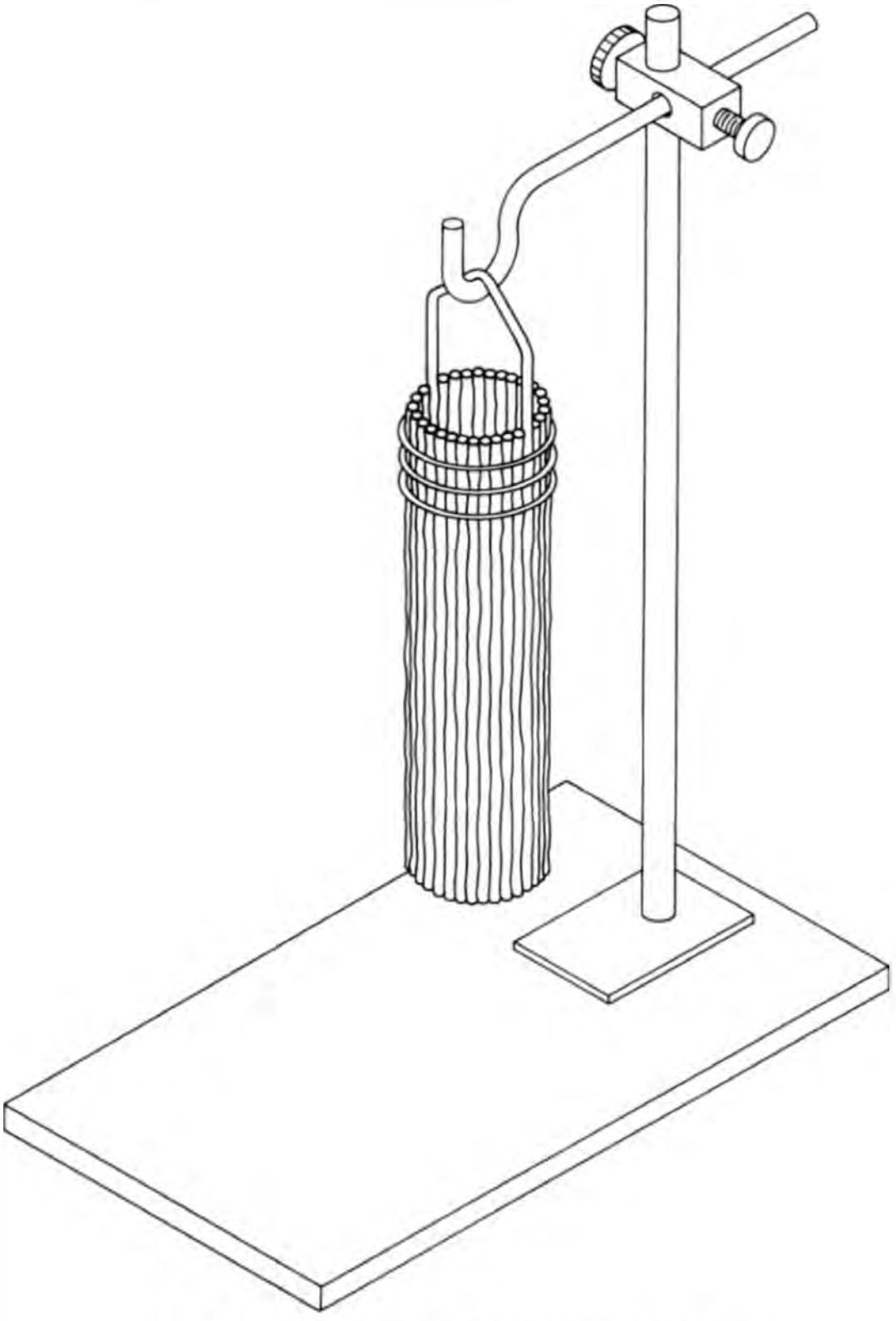


Figure 5 — Arrangement of wicks for test fire TF 3

Annex D Test fire TF 4: Open plastics fire (polyurethane) (specified in clause 6)

a) *Fuel:*

3 mats (50 x 50 x 2) cm^3 of soft polyurethane foam, without flame retarding additives, density about 20 kg/m^3, foamed on the basis of ether — polyolene.

b) *Arrangement:*

The mats shall be placed on top of one another on a base made of aluminium foil with the edges folded up.

c) *Ignition:*

5 cm^3 of methylated spirits in a bowl 5 cm in diameter.

d) *Place of ignition:*

A corner of the lowest mat.

e) *End of test:*

$3^rE = {}^6$

0 Fire parameters at end of test:

$\left(\frac{m}{y}\right)_E$ = 0.25 dB/m ± 15 %

$\left(\frac{\Delta G}{G_0}\right)_E \leqslant 0.8$

Annex E Test fire TF 5: Liquid fire (ra-heptane) (specified in clause 6)

a) *Fuel*

n-heptane (pure) + 3 % toluene (by volume).

b) *Arrangement:*

Container made from 2 mm thick sheet steel, base surface: 1 100 cm^2 (33 x 33) cm^2, height: 5 cm.

c) *Weight:*

G_0 ^ 650 g

d) *Ignition:*

Flame or spark.

e) *End of test:*

$yE = {}^6$

f) *Fire parameters at end of test:*

$\left(\frac{m}{y}\right)_E$ = 0,18 dB/m ± 15%

$\left(\frac{\Delta G}{G_0}\right)_E \leqslant 0.8$

Annex F Test fire TF 6: Liquid fire (methylated spirits) (specified in clause 6)

a) *Fuel:*

Methylated spirits at least 90 % ethyl alcohol C2H5OH

b) *Arrangement:*

Container made from 2 mm thick sheet steel base surface: 1 900 cm^2 (43,5 x 43,5) cm^2, height: 5 cm.

c) *Weight:*

G_0 ^ 2 000 g

d) *Ignition:*

Flame or spark.

e) *End of test:*

AT_E = 60 °C

f) *Fire parameters at end of test:*

$$\left(\frac{\Delta G}{G_n}\right)_E \leq 0{,}8$$

National appendix Z National committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Fire Standard Committee (FSM/-) to Technical Committee FSM/12 upon which the following bodies were represented:

Association of Manufacturers Allied to the Electrical and Electronic Industry (Beama Ltd)
British Fire Protection Systems Association Ltd
British Telecommunications
Chartered Institution of Building Services
Chief and Assistant Chief Fire Officers Association
Department of Health and Social Security
Department of the Environment. Building Research Establishment (Fire Research Station)
Department of the Environment. Property Services Agency
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Electrical Installation Equipment Manufacturers Association (Beama Ltd)
Fire Insurers Research and Testing Organization (FIRTO)
Fire Offices Committee
Fire Protection Association
Greater London Council
Home Office
Institution of Electrical Engineers
Institution of Fire Engineers
Ministry of Defence
Royal Institute of British Architects
Telecommunication Engineering & Manufacturing Association (TEMA)

The following body was also represented in the drafting of the standard:

Electricity Supply Industry in England and Wales

BS 5445-9: 1984
EN 54-9

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