PD CEN/TR 15276-1:2009

Fixed firefighting systems — Condensed aerosol extinguishing systems

Part 1: Requirements and test methods for components

ICS 13.220.20

British Standards

National foreword

This Published Document is the UK implementation of CEN/TR 15276-1:2009.

The UK participation in its preparation was entrusted to Technical Committee FSH/18/6, Gaseous extinguishing media and systems.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 30 April 2009.

ISBN 978 0 580 54126 1

Amendments/corrigenda issued since publication

Date	Comments

TECHNICAL REPORT

RAPPORT TECHNIQUE

TECHNISCHER BERICHT

CEN/TR 15276-1

January 2009

ICS 13.220.20

English Version

Fixed firefighting systems - Condensed aerosol extinguishing systems - Part 1: Requirements and test methods for components

Installations fixes de lutte contre l'incendie - Systèmes d'extinction à aérosol - Partie 1 : Exigences et méthodes d'essais pour les éléments constitutifs

Ortsfeste Brandbekämpfungsanlagen - Löschanlagen für kondensierte Aerosole - Teil 1: Anforderungen und Prüfverfahren für Bauteile

This Technical Report was approved by CEN on 9 September 2008. It has been drawn up by the Technical Committee CEN/TC 191.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. CEN/TR 15276-1:2009: E

Contents

Page

Foreword

This document (CEN/TR 15276-1:2009) has been prepared by Technical Committee CEN/TC 191 "Fixed firefighting systems", the secretariat of which is held by BSI.

This document has the general title *Fixed fire-fighting systems – Condensed aerosol extinguishing systems* and will consist of the following parts:

— Part 1: *Requirements and test methods for components;*

— Part 2: *Design, installation and maintenance*.

Introduction

It has been assumed in the preparation of this document that the execution of its provisions is entrusted to appropriately qualified and experienced people in the specification, design, installation, testing, approval, inspection, operation and maintenance of systems and equipment, for whose guidance it has been prepared, and who can be expected to exercise a duty of care to avoid unnecessary release of extinguishant.

Product certification: Users of this document are advised to consider the desirability of independent certification of product conformity with this document based on testing and continuing surveillance, which may be coupled with assessment of manufacturer quality systems against EN ISO 9001.

Fire-fighting systems covered in this document are designed to provide a supply of fixed condensed aerosol extinguishing medium to extinguish fire.

The requirements of this document are made in the light of the best technical data known to the working group at the time of writing but, since a wide field is covered, it has been impracticable to consider every possible factor or circumstance that might affect implementation of the requirements.

It is important that the fire protection of a building or plant be considered as a whole. Aerosol extinguishant systems form only a part, though an important part, of the available facilities, but it should not be assumed that their adoption necessarily removes the need to consider supplementary measures, such as the provision of portable fire extinguishers or other mobile appliances for first aid or emergency use, or to deal with special hazards.

Aerosol extinguishants have been recognized as effective media for the extinction of Class A fires (solid surface burning fires) and Class B and Class C fires according to EN 2, but it should not be forgotten, in the planning of comprehensive schemes, that there may be hazards for which these mediums are not suitable, or that in certain circumstances or situations there may be dangers in their use requiring special precautions.

Advice on these matters can be obtained from the appropriate manufacturer of the aerosol generators or the extinguishing system. Information may also be sought from the appropriate fire authority, the health and safety authorities and insurers. In addition, reference should be made as necessary to other national standards and statutory regulations.

It is essential that fire-fighting equipment be carefully maintained to ensure instant readiness when required. Routine maintenance is liable to be overlooked or given insufficient attention by the owner of the system. It is, however, neglected at peril to the lives of occupants of the premises and at the risk of crippling financial loss. The importance of maintenance cannot be too highly emphasised.

Condensed aerosol may contain traces of toxic substances like those produced by a fire, and will obscure vision like smoke from fire.

1 Scope

This document specifies requirements, describes test methods for condensed aerosol extinguishing components and covers solely condensed aerosols.

This document is not intended to indicate approval of the extinguishants listed herein by the appropriate authorities, as other extinguishants may be equally acceptable.

This document is intended as a standard covering solely condensed aerosol.

The condensed aerosol generator typically consists of the following main components:

a) solid aerosol-forming compound;

b) cooling mechanism;

c) ignition device(s);

d) end plate discharge outlet(s);

e) housing;

f) mounting bracket.

This document does not cover dispersed aerosols.

This document requires, as a precaution, that the room is evacuated and sealed off whenever a generator is activated. Precautions include evacuation of the proximity area, criteria for re-entering and other safeguards as stated in Clause 5 of CEN/TR 15276-2:2009.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 316, *Wood fibreboards – Definition, classification and symbols*

EN 622 (all parts*), Fibreboards – Specifications*

EN 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal) (IEC 60068-2-6:2007)*

EN 60068-2-30, *Environmental testing – Part 2-30: Tests – Test Db: Damp Heat, cyclic (12 h + 12 h cycle) (IEC 60068-2-30:2005)*

ISO 209, *Aluminium and aluminium alloys – Chemical composition*

ISO 5660-1, *Reaction-to-fire tests – Heat release, smoke production and mass loss rate – Part 1: Heat release rate (cone calorimeter method)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
authority
organisation, office or individual responsible for approving equipment, installations or procedures in determining acceptability

NOTE The authority may base acceptance on conformity to the appropriate standards.

3.2
clearance

3.2.1
electrical clearance
unobstructed air distance between extinguishing system equipment and unenclosed or uninsulated live electrical components not at ground potential

3.2.2
thermal clearance
air distance between a condensed aerosol generator and any structure or components sensitive to the temperature developed by the generator

3.3
condensed aerosol
extinguishing medium consisting of finely divided solid particles and gaseous matter, these being generated by a combustion process of a solid aerosol-forming compound

3.4
condensed aerosol generator
non-pressurised device which, when activated, generates an aerosol. It includes the mounting brackets

3.5
design factor
extinguishing factor multiplied by the safety factor, required for system design purposes

NOTE 1 The design factor is expressed in grams per cubic metre.

NOTE 2 Extinguishing factor and design factor have been introduced as an alternative to extinguishing concentration and design concentration respectively as concentration of the actual aerosol cannot be measured or even assessed in some cases (the discharged medium, apart from the condensed aerosol, may contain products of the thermal decomposition of a chemical coolant).

3.6
discharge time
time from the generator activation to the end of its discharge

3.7
extinguishing application density
minimum mass of a specific aerosol-forming compound per cubic metre of enclosure volume required to extinguish fire involving a specific fuel under defined experimental conditions, excluding any safety factors

NOTE The extinguishing factor is expressed in grams per cubic metre.

3.8
family
group of generators with same solid compound, same kind of cooling device, same kind of discharge outlet, same ignition device, same layout and same internal/external architecture

3.9
ignition device
any device which is able to ignite the solid aerosol-forming compound

3.10
listing authority
recognized fire protection testing and approval body (notified laboratory)

3.11
maintenance
thorough check to give maximum assurance that the extinguishing system will operate as intended

NOTE It includes a thorough examination and any necessary repair or replacement of system components.

3.12
manufacturer
legal person that is responsible for the design, manufacturing, packaging and quality assurance of a device before it is placed on the market

3.13
monitoring
supervision of the operating integrity of an electrical, mechanical, pneumatic or hydraulic control feature of a system

3.14
protected volume
volume enclosed by the building elements around the protected enclosure, minus the volume of any permanent impermeable building element within the enclosure

3.15
release
physical discharge or emission of an aerosol as a consequence of the generator actuation

3.16
safety factor
multiplier of the extinguishing factor to determine the design factor

3.17
solid aerosol-forming compound
mixture of oxidant, combustible component and technical admixtures producing fire extinguishing aerosol upon ignition

3.18
supplier
legal person that is responsible for the product and is able to ensure that its quality is ensured

3.19
thermal ignition device
device which automatically operates at a rated temperature and is arranged for the ignition of the solid aerosol-forming compound

3.20
test house
establishment having all relevant test equipment to carry out the required tests

4 Component requirements

4.1 Condensed aerosol generator

The condensed aerosol generator typically consists of the following main components:

a) solid aerosol-forming compound;

b) cooling mechanism;

c) ignition device(s);

d) end plate discharge outlet(s);

e) housing;

f) mounting bracket.

The generator is a non-pressurised canister, because aerosol is generated and distributed by the combustion process of the solid aerosol-forming compound.

4.2 Solid aerosol-forming compound

Upon actuation of the condensed aerosol generator, the solid aerosol-forming compound shall undergo the combustion reaction producing a fire extinguishing aerosol.

4.3 Cooling mechanism

The cooling mechanism shall provide an adequate cooling of the hot aerosol prior to its discharge into the enclosure.

4.4 Ignition device

4.4.1 General

The ignition device is arranged to initiate the aerosol-forming compound.

If the ignition device is a complex device incorporating several components, all such components shall be specified by the manufacturer.

4.4.2 Electrical ignition device

The electrical ignition device shall be capable of operating via an electrical input and arranged to initiate the aerosol-forming compound.

4.4.3 Thermal ignition device

The thermal ignition device shall be capable of operating at a rated temperature and arranged to initiate the aerosol-forming compound.

4.4.4 Other methods of ignition device

Methods capable to ignite the aerosol-forming compound, other than 4.4.2 and 4.4.3, shall be specified.

4.5 End plate and housing

The outer case and all parts inside the generator shall be made of corrosion-resistant material or shall be suitably treated to resist corrosion. The manufacturer shall ensure that the materials of construction are also compatible with the solid aerosol-forming compound and the cooling device so that corrosion or chemical action does not occur.

Materials for non-metallic components that are exposed to ultraviolet light shall be UV-stabilised.

4.6 Extinguishants

The extinguishants referred to in this document are electrically non-conductive media.

5 Condensed aerosol generators requirements

5.1 General

The test samples shall conform to the technical description (drawings, parts list, description of function, operating instructions) as stated by the manufacturer (see 5.16 and 7.3).

The manufacturer shall specify the minimum distance from the generator outlet to the first obstacle.

The manufacturer shall specify the minimum and maximum mass of aerosol compound discharged from the generator

5.2 Extinguishing factor

The extinguishing factor for specific fuels under different classes of fires shall be determined by test using the fire test protocol described in Annex A.

5.3 Agent distribution

The maximum area coverage and the related maximum and minimum height of the protected enclosure for each aerosol generator unit size shall be determined by test using the fire test protocol described in 7.5.

5.4 Discharge time

The discharge time required to achieve 95 % of the minimum design application density shall be specified by the manufacturer and shall not exceed 90 s when tested in accordance with 7.6.

5.5 Ambient temperature and humidity operation ranges

Condensed aerosol generators shall operate at ambient temperatures as specified by the manufacturer and as a minimum requirement from – 20 °C to + 50 °C.

Condensed aerosol generators shall operate at ambient humidity up to 95 %.

These operation ranges shall be verified by the temperature and humidity operation range tests as described in 7.7.

5.6 Service life

The service life of condensed aerosol generator under specific conditions, as described in 5.5, shall be specified by the manufacturer and as a minimum requirement shall not be less than 5 years.

The specified service life shall be verified by test using the accelerated ageing test as described in 7.8.

5.7 Shelf life and storage conditions

The shelf life and storage conditions shall be specified by the manufacturer.

5.8 Corrosion

The aerosol generator shall operate according to 7.16 and shall show no sign of damage which could alter the proper extinguishing action after being subjected to the corrosion test described in 7.9.

Any copper alloy part used in the component shall not crack, when tested in accordance with 7.10 (stress corrosion test).

5.9 Vibration

The aerosol generator shall operate according to 7.16 after being subjected to a vibration test described in 7.11.

5.10 Mechanical shock

The aerosol generator shall operate according to 7.16 after being subjected to an impact test as described in 7.12.

The aerosol generator shall operate according to 7.16 after being subjected to a drop test as described in 7.13.

5.11 Discharge temperature

5.11.1 General

The requirements of 5.11.2 and 5.11.3 shall be verified by test according to the procedure described in 7.14.

5.11.2 Casing temperature

The manufacturer shall specify the maximum developed temperature for aerosol casing that shall not exceed 400 °C.

5.11.3 Aerosol flow temperature

The manufacturer shall specify the distance from the aerosol generator discharge outlet to the point where the temperatures do not exceed 75 °C, 200 °C and 400 °C.

5.12 Ignition device

5.12.1 General

The characteristics of the ignition device shall be verified and the reliability of operation tested by using the test method as described in 7.15.

5.12.2 Electrical ignition device

The manufacturer shall specify at least the minimum activation current and its duration, form of the signal, maximum monitoring current, range of voltage and the type of connection for a multiple generators arrangement.

5.12.3 Thermal ignition device

The manufacturer shall specify at least the minimum rated temperature at which the device operates.

5.13 Function reliability

When activated, the aerosol generator shall operate satisfactorily when tested in accordance with the procedure described in 7.16 (Function test).

Any generator's family shall be actuated inside an explosive atmosphere. The actuation of the generator shall not initiate any explosion.

5.14 Open fire conditions

The aerosol generator, when intended for installation inside the protected enclosure, shall pass the function test after being subjected to the heat exposure test as described in 7.17.

5.15 Accessories

The mounting bracket shall be tested together with the generator for corrosion, vibration and mechanical shock impacts as described in 7.9, 7.11, 7.12 and 7.13.

5.16 Documentation

The manufacturer shall prepare and maintain documentation.

The manufacturer shall prepare installation and user documentation, which shall be submitted to the testing authority together with the sample(s). This documentation shall comprise at least the following:

a) a general description of the components;

b) a technical specification including:

   1) information mentioned in 5.1 and 7.16.6;

   2) sufficient information to permit an assessment of the compatibility with other components of the system (if applicable e.g. mechanical, electric or software compatibility);

c) installation instructions including mounting instructions;

d) operating instructions;

e) maintenance instructions.

The manufacturer shall prepare design documentation, which shall be submitted to the testing authority together with the sample(s). This documentation shall include drawings, parts lists, block diagrams (if applicable), circuit diagrams (if applicable) and a functional description to such an extent that conformity to this document may be checked and that a general assessment of the design is possible.

6 Marking

Each generator shall be marked with the following information:

a) name of the product;

b) manufacturer's or supplier's name or trade mark;

c) some mark(s) or code(s) (e.g. serial number or batch code), by which, at least, the date or batch and place of manufacture (if several places of manufacture) can be identified by the manufacturer;

d) mass of aerosol-forming compound;

e) date of manufacture;

f) temperature range;

g) storage humidity range;

h) service life;

i) distances as specified in 5.11.3.

The markings shall be non-detachable, non-flammable, permanent and legible.

7 Test methods

7.1 Conditions

The components shall be tested assembled as recommended for installation by the manufacturer. The tests shall be carried at a temperature of (25 ± 10) °C, except when otherwise stated.

The tolerance for all test parameters is ± 5 %, unless otherwise stated.

7.2 Samples

The manufacturer shall submit for tests 100 samples from the same batch. From this number, 20 samples shall be tested according to the function test in 7.16 only.

The order of tests (with the exception of the compliance test and the functional test) may be changed by the testing authority.

The sequence of tests is shown in Table 1 and is given by the numbers 1, 2, 3 etc. in the Table. A, B etc. are the different samples.

Table 1 — Test order for samples

Test method	Test order for sample							
	A	B	C	D	E	F	G	H
7.3 Conformity	1	1	1	1	1	1	1	1
7.6 Discharge time test	2	—	—	—	—	—	—	—
7.7.2 Temperature and humidity test	—	2	—	—	—	—	—	2
7.7.3 Low temperature test	—	—	—	—	—	—	—	3
7.8 Accelerated ageing test	—	—	—	—	2	—	—	—
7.9 Corrosion test	—	—	—	2	—	—	—	—
7.10 Stress corrosion test	—	—	—	—	—	—	2	—
7.11 Vibration test	—	—	2	—	—	—	—	—
7.12 Impact test	—	2	—	—	—	—	—	—
7.13 Drop test	—	—	—	—	—	—	—	2
7.14 Casing and aerosol flow temperatures tests	3	—	—	—	—	—	—	—
7.16 Function test	2	4	3	3	3	—	3	4
7.17 Heat exposure test	—	—	—	—	—	2	—	—

7.3 Conformity

A visual and measurement check shall be made to determine whether the condensed aerosol generator corresponds to the description in the technical literature (drawings, parts lists, description of functions, operating and installation instructions).

7.4 Extinguishing factor determination

NOTE This test relates to the requirements of 5.2.

The extinguishing factor for specific fuels under different classes of fires shall be determined by specific test using the fire test procedure described in Annex A.

Extinguishing factor tests should be conducted with generator(s) of the same family. Number of aerosol generator units shall be sufficient to provide needed extinguishing factor in the test enclosure. Mass of generators unit prior and after discharge shall be registered. Other generators unit sizes which belong to the same family shall be subjected to a cold discharge. Mass prior to and after discharge shall be registered. These data shall be compared to results from fire tests to get extinguishing factor for each generator unit type.

7.5 Coverage determination

NOTE This test relates to the requirements of 5.3.

The maximum coverage and maximum and minimum height of the protected enclosure for each aerosol generator unit size shall be determined by test using the fire test procedures as described in Annex A.

7.6 Discharge time test

NOTE This test relates to the requirements of 5.4.

Discharge time test is integral part of the function test. See 7.16.1 for the discharge time test procedure.

7.7 Temperature and humidity operation range tests

NOTE The tests relate to the requirements of 5.5.

7.7.1 Object of the test

The object of the test is to demonstrate the ability of the equipment to function correctly at high relative humidity (with condensation) which may occur for short periods in the anticipated service environment.

7.7.2 Test procedure

7.7.2.1 General

The test procedure as described in EN 60068-2-30, using the variant 1 test cycle and controlled recovery conditions shall be used.

7.7.2.2 Conditioning

Apply the following severity of conditioning:

a) lower temperature: (25 ± 3) °C

b) upper temperature: (55 ± 2) °C

c) relative humidity at lower temperature: (93 ± 3) %

d) relative humidity at upper temperature: (93 ± 3) %

e) number of cycles: 2

7.7.2.3 Final measurements

After the recovery period, the sample shall be visually checked for mechanical damage externally, and shall be subjected to the function test.

7.7.2.4 Requirements

When subjected to the function test, the sample shall respond correctly.

7.7.3 Low temperature Test

Condition the sample at – 20°C, or the service temperature recommended by the manufacturer whichever is the lower, for (2 ± 0,5) h.

Then carry out function test immediately. When subjected to the function test, the sample shall respond correctly.

7.8 Accelerated ageing test

NOTE This test relates to the requirements of 5.6.

7.8.1 Test time

The test time shall be calculated to fulfil requirements as follows:

$$\frac{t_2}{t_1} = 2^{\Delta T/10} \qquad (1)$$

where

t_1 test time, in days

t_2 expected service life, in days

$\Delta T = T_1 - T_2$

T_1 test temperature, in degrees Kelvin

T_2 equivalent storage temperature, in degrees Kelvin

Table 2 — Example for the calculation result of formula (1) at T_2 = 25 °C

Test temperature T_1	Test days for 10 years expected service life	Test days for 5 years expected service life
363,15K (90°C)	40 days	20 days
373,15K (100°C)	20 days	10 days

7.8.2 Test procedure

a) Tests are performed on three fully assembled condensed aerosol generators of the selected model size(s).

b) The manufacturer shall specify the maximum operation temperature and expected service life.

c) The generators shall be subjected to air-oven ageing at temperature T_1, which shall be at least 10 °C higher than the specified maximum operation temperature, for a period of t_1 days as calculated by Equation (1).

d) Following the ageing test the aerosol generators shall be subjected to and pass the function test.

7.9 Corrosion test

NOTE The tests relate to the requirements of 5.8.

The sample shall be exposed to a salt spray within a fog chamber.

The essential components and properties of the reagents and the test configuration are:

— Solution consisting of NaCl in distilled water;

— Concentration of the solution: (5 ± 1) %;

— pH Value: 6,5 to 7,5;

— Spray pressure: 0,6 bar to 1,5 bar;

— Spray volume: 1 ml/h to 2 ml/h on an area of 80 cm^2;

— Temperature in test cabinet: $(35\ ^{+1,0}_{-1,7})$ °C;

— Position of the sample: 15° to the vertical axis;

— Spray time: (240 ± 2) h;

— Drying time: (168 ± 5) h at a humidity of maximum 70 %.

The sample shall be inspected for external mechanical damage and shall be subjected to a function test in accordance with 7.16.

7.10 Stress corrosion test

The aqueous ammonia solution shall have a specific weight of (0,94 ± 0,02) kg/l. The sample shall be filled with (10 ± 0,5) ml of the solution for each litre of container volume.

The sample shall be degreased for the test and shall be exposed for 10 days to the moist atmosphere of ammonia and air, at a temperature of (34 ± 2) °C. The samples shall be positioned (40 ± 5) mm above the level of the liquid.

After testing, the samples shall be cleaned and dried and subjected to careful visual examination. To make cracking clearly visible, the liquid penetration method shall be used.

7.11 Vibration test

NOTE This test relates to the requirements of 5.9.

The drawings and the technical data shall be checked to determine whether vibration could have an adverse effect on the performance of the non-electrical disable device.

If necessary, vibration tests shall be carried out either in the standby position, loaded position or unlocked position.

The sample is attached to a vibration table using fixing materials provided by the manufacturer.

The test apparatus and procedure shall be as described in EN 60068-2-6, Test F_c:

— Frequency range: 10 Hz to 150 Hz

— Acceleration amplitude for components which are designed to be attached to machinery:

  — 10 Hz to 50 Hz: 9,81 m/s^2 (= 1,0 g_n)

  — 50 Hz to 150 Hz: 29,43 m/s^2 (= 3,0 g_n)

— Acceleration amplitude for components which are designed to be attached to walls:

  — 10 Hz to 50 Hz: 1,962 m/s^2 (= 0,2 g_n)

  — 50 Hz to 150 Hz: 4,905 m/s^2 (= 0,5 g_n)

— Sweep rate: 1 octave per 30 min

— Number of sweeps: 0,5 per axis

— Number of axes: 3 mutually perpendicular

The sample shall not operate during the test as a result of the vibrations.

No deterioration or detachment of parts shall occur. The sample shall be inspected for external mechanical damage and shall be subjected to a function test in accordance with 7.16.

7.12 Impact test

NOTE This test relates to the requirements of 5.10.

7.12.1 Test procedure

The test apparatus shall consist of a swinging hammer incorporating a rectangular-section aluminium alloy head (Aluminium alloy $AlCu_4SiMg$ conforming to ISO 209, solution treated and precipitation treated condition) with the plane impact face chamfered to an angle of (60 ± 1)° to the horizontal, when in the striking position. A suitable apparatus is described in Figure 1 – Impact test apparatus.

The specimen shall be rigidly mounted to the apparatus by its normal mounting means and shall be positioned so that it is struck by part of the upper half of the impact face of the hammer (i.e. above the centre line), when the hammer is in the vertical position (i.e. when the hammer-head is moving horizontally). The direction of impact relative to the specimen shall be chosen as the most likely to impair the normal functioning of the specimen.

A horizontal blow shall be delivered to the specimen at an impact energy level of (1,9 ± 0,1) J by a hammer velocity of (1,5 ± 0,125) m/s.

7.12.2 Test apparatus

The tolerance for all dimensions in this test apparatus shall be 0,5 mm, unless otherwise specified.

The test apparatus (see Figure 1) shall consist essentially of a swinging hammer comprising a rectangular section head (striker), with a chamfered impact face, mounted on a tubular steel shaft. The hammer shall be fixed into a steel boss, which runs on ball bearings on a fixed steel shaft mounted in a rigid steel frame, so that the hammer can rotate freely around the axis of the fixed shaft. The design of the rigid frame shall be such as to allow complete rotation of the hammer assembly when the specimen is not present.

The striker shall be of dimensions 76 mm wide, 50 mm deep and 94 mm long (overall dimensions) and shall be manufactured from aluminium alloy $AlCu_4SiMg$ according to ISO 209, solution treated and precipitation treated condition. It shall have a plane impact face chamfered at (60 ± 1)° to the long axis of the head. The tubular steel shaft shall have an outside diameter of (25 ± 0,1) mm with walls (1,6 ± 0,1) mm thick.

The striker shall be mounted on the shaft so that its long axis is at the radial distance of 305 mm from the axis of rotation of the assembly, the two axes being mutually perpendicular. The central boss shall be 102 mm in external diameter and 200 mm long and shall be mounted coaxially on the fixed steel pivot shaft, which is approximately 25 mm in diameter; however the precise diameter of the shaft will depend on the bearings used.

Diametrically opposite the hammer shaft are two steel counter-balanced arms, each 20 mm in external diameter and 185 mm long. These arms shall be screwed into the boss so that a length of 150 mm protrudes. A steel counter-balance weight shall be mounted on the arms so that its position can be adjusted to balance the mass of the striker and arms. On the end of the central boss shall be mounted a 12 mm wide and 150 mm diameter aluminium alloy pulley and round this an inextensible cable is wound, one end being fixed to the pulley. The other end of the cable shall support the operating weight.

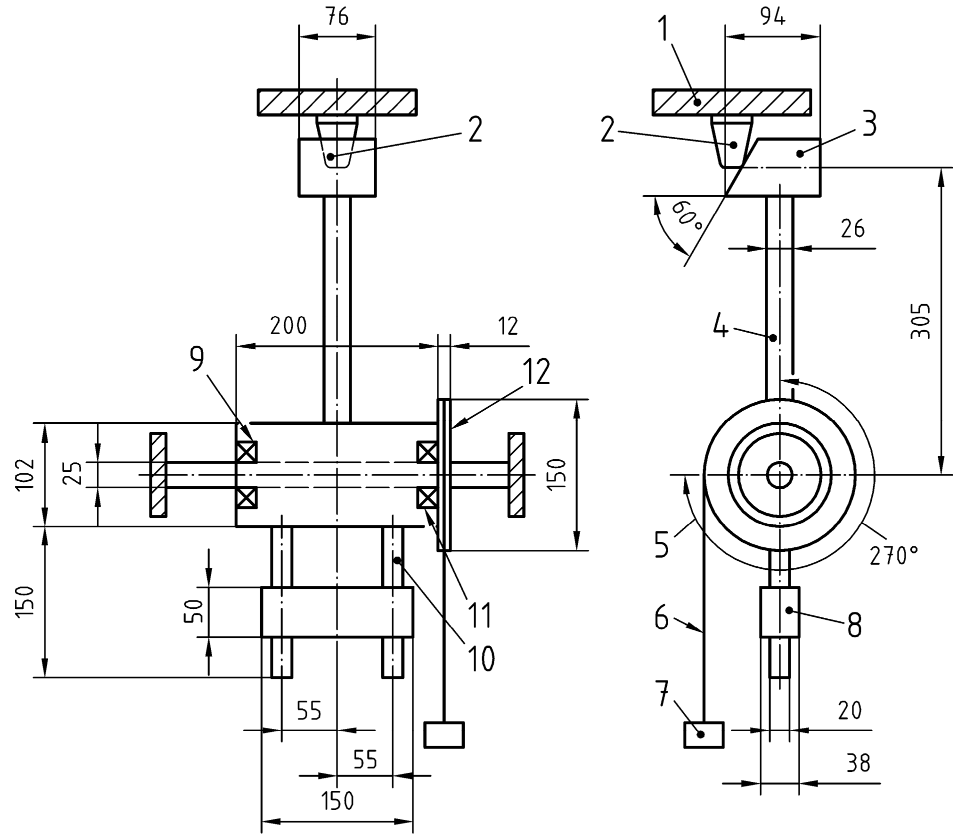
The rigid frame shall also support the mounting board on which the specimen is mounted by its normal fixings. The mounting board shall be adjustable vertically so that the upper half of the impact face of the hammer will strike the specimen when the hammer is moving horizontally, as shown in Figure 1.

To operate the apparatus the position of the specimen and the mounting board shall be first adjusted as shown in Figure 1 and the mounting board shall then be secured rigidly to the frame. The hammer assembly shall then be balanced carefully by adjustment of the counter-balance weight with the operating weight removed. The hammer arm shall then be drawn back to the horizontal position ready for release and the operating weight is reinstated. On release of the assembly the operating weight will spin the hammer and arm through an angle of $3\pi/2$ radians to strike the specimen. The mass of the operating weight to produce the required impact energy of 1,9 J equals $(0{,}388/3\pi r)$ kg where r is the effective radius of the pulley in metres. This equals approximately 0,55 kg for a pulley radius of 75 mm.

As a hammer velocity at impact of (1,5 ± 0,125) m/s is specified, the mass of the hammer head will need to be reduced by drilling the back face sufficiently to obtain this velocity. It is estimated that a head of mass of about 0,79 kg will be required to obtain the specified velocity, but this will have to be determined by trial and error.

The sample shall be inspected for external mechanical damage and shall be subjected to a Function test in accordance with 7.16.

Dimensions in mm



Key

1	mounting board	5	270° angle of movement	9	boss
2	specimen	6	cord	10	counter-balance arms
3	striker	7	operating weight	11	ball bearings
4	striker shaft	8	counter-balance weight	12	pulley

NOTE The sizes given to the dimensions are for guidance only.

Figure 1 — Impact test apparatus

7.13 Drop test

NOTE This test relates to the requirements of 5.10.

7.13.1 Impact surface

The impact surface is a solid base with a reasonably smooth surface. An example of such a surface is as follows:

— steel plate, with a minimum thickness of 75 mm and Brinell hardness of not less than 200, solidly supported by a concrete foundation having a minimum thickness of 600 mm.

The length and width of the surface should be not less than one and a half times the dimension of the unit being tested.

7.13.2 Procedure

The test unit without packaging is dropped from a height of 2 m as measured from the lowest point of the test unit to the impact surface. A safe waiting period following impact prescribed by the test laboratory should be observed, even if no visible initiation or ignition occurs at impact.

7.13.3 Requirements

The sample shall be subjected to a function test in accordance with 7.16.

7.14 Casing and aerosol flow temperatures test

NOTE This test relates to the requirements of 5.11.

7.14.1 Casing temperature test

Casing temperature test is an integral part of the function test. See 7.16 for casing temperature test procedure.

7.14.2 Aerosol flow temperature test

Aerosol flow temperature test is an integral part of the function test. See 7.16 for aerosol flow temperatures test procedure.

7.15 Ignition performance test

NOTE This test relates to the requirements of 5.12.

The ignition of the generator shall be tested in accordance with the manufacturer's specifications.

25 samples of the complete ignition devices shall operate as intended.

The power output of the ignition device shall be not less than that specified by the manufacturer at minimum power output sufficient to ignite the maximum designed mass of the aerosol-forming compound at the most disadvantageous operating conditions.

7.16 Function test

NOTE This test relates to the requirements of 5.13.

7.16.1 Discharge time

Discharge time shall be measured by using one or more of the following techniques:

— thermocouples recording temperature changes at the start and end of the discharge;

— infrared video recording.

NOTE The reference points identified as the start and the end of the aerosol generator discharge should be the same as taken during performance testing and as defined by the manufacturer.

7.16.2 Aerosol flow temperatures

Aerosol flow temperatures shall be measured by thermocouples.

The following thermocouples arrangement shall be used for measuring temperatures at the specified minimum distances for 75 °C, 200 °C and 400 °C.

— three cross-shaped poles are used as a support for the thermocouples and installed at the specified minimum clearances;

— centre of each cross shall be in line with a centre of a condensed aerosol generator's discharge outlet with the ends of the cross being within the cone-shaped discharge path;

— crosses may be rotated against each other (i.e. X, Y, Z axis) to minimize the impact of the aerosol flow on the temperature readings;

— five thermocouples may be used – one at the centre of the cross, and four at its ends;

— three highest readings out of five shall be taken for recording.

Any other than above described suitable measuring technique acceptable to and approved by a Listing Authority may be used for measuring discharge time, temperatures and enclosure pressure.

7.16.3 Test procedure

Condition a fully assembled condensed generator for 16 h at ambient temperature of 21 °C.

Discharge the generator in a test enclosure.

7.16.4 Casing temperature test

The following thermocouples arrangement may be used for measuring temperature of the outer generator's casing.

— Three thermocouples shall be attached to the outer casing of the aerosol generator in the locations with the highest expected temperature.

7.16.5 Discharged mass

The mass of aerosol generator shall be measured before and after the discharge. The difference of mass shall be recorded.

7.16.6 Explosive atmosphere actuation test

Any generator's family shall be actuated inside an explosive atmosphere. The actuation of the generator shall not initiate any explosion.

7.16.7 Requirements

Full function requirements apply to the discharge of a condensed aerosol generator prior to conducting any of the performance testing and to the discharge of condensed aerosol generators in the function tests shown in Table 1.

The conditions are described in Table 3.

Table 3 — Test conditions for function test

Parameter	Clause	Requirement	Tolerance
Visual examination	—	During discharge: no flame coming out from discharge outlet	—
Discharge time	7.16.1	As specified by manufacturer	10 %
Temperatures at the specified minimum clearances for 75°C, 200°C and 400°C	7.14.2	As specified by manufacturer	10 %
Temperature of the outer casing	7.14.1	—	10 %
Mass of aerosol compound discharged	7.16.5	—	5 %
Explosive atmosphere actuation test	7.16.6		0

7.17 Heat exposure test

NOTE This test relates to the requirements of 5.14.

7.17.1 Object of the test

The object of the fire exposure test is to demonstrate the safe operation of the condensed aerosol generator during and/or after its exposure to an external fire simulating a realistic accident.

7.17.2 Test procedure

Subject the sample to a temperature of (600 ± 30) °C in a furnace for a period of 10 min. The temperature inside the oven shall be recorded from the initial temperature up to the end of the test.

7.17.3 Requirements

a) Should the condensed aerosol generator actuate during the test, it shall discharge as intended.

b) Should the condensed aerosol generator fail to actuate during 10 min from the starting time, it shall be remotely electrically activated and shall discharge as intended.

c) There shall be no rupturing to the generator casing during the discharge.

The discharge time shall be in accordance with the function requirements as specified in the Function test.

7.18 Explosive atmosphere test

NOTE This test relates to the requirements of 7.16.6.

7.18.1 Object of the test.

The object of the explosive atmosphere test is to demonstrate the safe operation of the condensed aerosol generator inside a potentially explosive atmosphere.

7.18.2 Test procedure

Subject the sample of any generator's family to an actuation test inside a test volume (fitting the extinguishing factor of the specific generator) containing a proven explosive atmosphere i.e. propane or propane/butane (the explosive atmosphere shall be proven by testing it 3 times).

7.18.3 Requirements

a) Should the condensed aerosol generator actuate during the test, it shall discharge as intended.

b) There shall not be initiating any explosion.

c) The test shall be repeated 3 times.

Annex A
(normative)

Extinguishing factor/coverage test procedure

A.1 General

The tests shall be carried out in accordance with Table A.1.

Table A.1 — Tests

Test objective	Enclosure size	Test fires	Tests in accordance with
Aerosol generator distribution verification	To suit aerosol generator's unit size	heptane test pans	A.5.1
Min. Height/max protected volume and distance		heptane test pans	A.5.2
Max. Height/max protected volume and distance			
Extinguishing factor	≥ 100 m^3	(a) wood crib	A.6.1
	no side less than 4 m, height: not less than 3,5 m	(b) n-heptane pan	A.6.2
		(c) polymeric sheet (i) PMMA (ii) Polypropylene (iii) ABS	A.6.3
		(d) Composite wood	A.6.4

A.2 Principle

A.2.1 An engineered or pre-engineered extinguishing system unit shall mix and distribute its extinguishant and shall totally flood the enclosure when tested in accordance with this test method under the maximum design limitations and most severe installation instructions. (See also A.2.2)

A.2.2 When tested as described in A.5.1, A.5.2 and A.6.2 an extinguishing system unit shall extinguish all visible flaming within 30 s after the end of extinguishant discharge. When tested as described in A.6.1 an extinguishing system unit shall extinguish all visible flaming and prevent re-ignition of the fires after an 10 min soak period (also measured from the end of extinguishant discharge). When tested as described in A.6.3, and A.6.4 an extinguishing system unit shall extinguish all visible flaming within 60 s after the end of extinguishant discharge and also prevent re-ignition of the fires after an 10 min soak period (also measured from the end of extinguishant discharge).

A.2.3 The tests described herein consider the intended use and limitations of the extinguishing system unit, with specific reference to:

a) coverage for each aerosol generator unit size ;

b) maximum and minimum height of the protected enclosure for each aerosol generator units size;

c) location of aerosol generators in the protected area;

d) maximum pressure built up during discharge;

e) maximum discharge time;

f) extinguishing factor for specific fuels.

A.3 Extinguishing system

A.3.1 For the extinguishing tests described in A.6.1, A.6.2, A.6.3, and A.6.4, jet energy from the discharge outlets shall not influence the development of the fire. Therefore the discharge outlets shall be directed away from the fires.

A.3.2 Adequate pressure relief vents in forms of closeable flaps shall be provided during all tests. Calculations for the minimum vent area as well as location of the vents shall be in accordance with manufacturer's specifications.

A.4 Extinguishing factor

The extinguishing factor for each test is to be 76,9 % (see 5.2 of CEN/TR 15276-2:2009) of the intended end use design factor specified in the manufacturer's design and installation instructions at the ambient temperature of (20 ± 5) °C within the enclosure. In the tests described in A.5.1 and A.5.2, the same extinguishing factor shall be used as in the tests described in A.6.2.

A.5 Aerosol generator distribution verification tests

A.5.1 Minimum height/maximum coverage test

A.5.1.1 Test facility

A.5.1.1.1 Construction

The test enclosure shall meet the following requirements:

a) the area ($a \times b$) and height (H) of the enclosure (see Figure A.1) shall correspond to the maximum area coverage and minimum height specified by the manufacturer for a specific aerosol generator unit size, but not less than 100 cubic meter;

b) test room volume shall be determined from the result of heptane fire test (see A.6.2):

$$V_{Test} = \frac{M}{0.769 \cdot c} \quad \left[m^3\right] \qquad (A.1)$$

M is the generator’s unit mass in grams,

c is the design factor, in grams per cubic metre;

c) area sides a and b shall be calculated to fulfil following requirements:

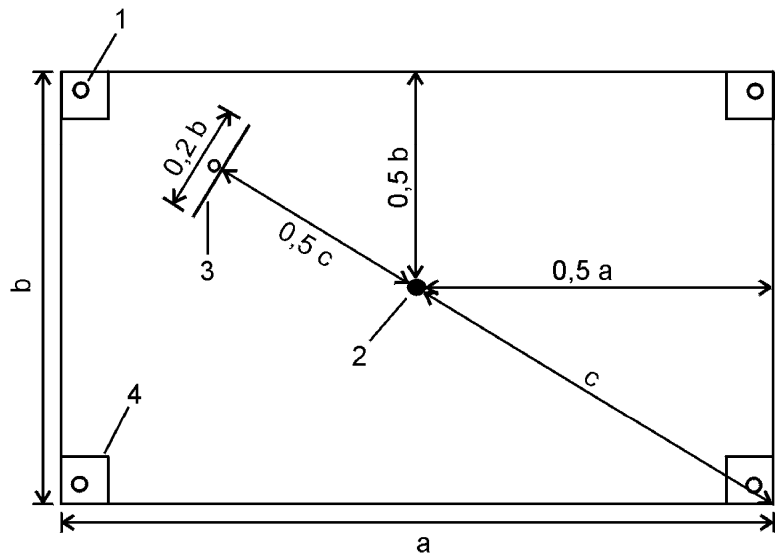
1) $$a\,b = \frac{V_{test}}{H} \qquad (A.2)$$

2) the distance c (see Figures A.1 and A.2) shall be equal to maximum coverage distance (R_{max}) specified by manufacturer;

d) means of pressure relief shall be provided;

e) closeable openings shall be provided directly above the test pans to allow for venting prior to system actuation;

f) one baffle is to be installed between the floor and ceiling with the height of the room. It is to be installed halfway between the discharge outlet location and the walls of the enclosure (see Figure A.1 for centre mounting generator and Figure A.2 for side mounting generator). The baffle is to be perpendicular to the direction between the discharge outlet location and walls of the enclosure (see Figures A.1 and A.2), and be 20 % of the length of the short wall of the enclosure.



Key

H minimum height and maximum height specified by manufacturer for the centre mounting generator

$a \times b$ maximum generator area coverage for a single generator

c maximum generator coverage distance (R_{max})

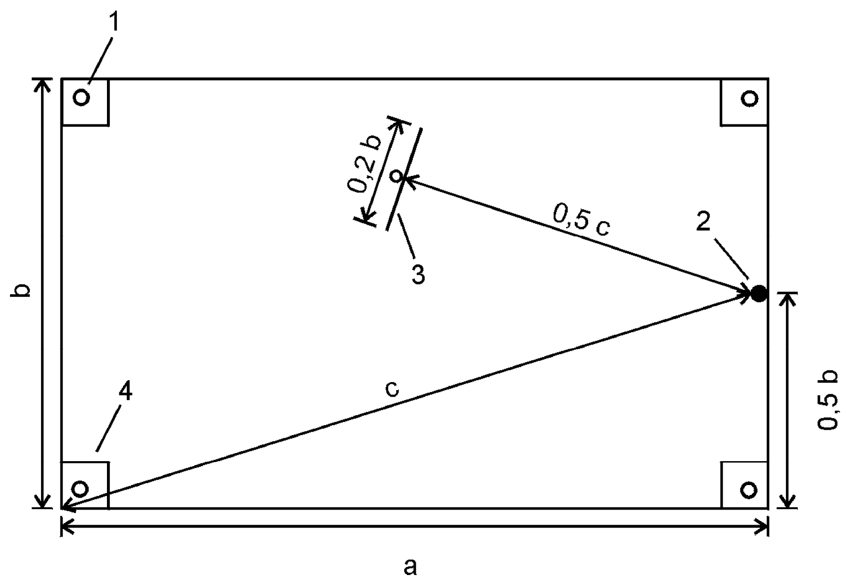
1 Test pans

2 Generator

3 Baffle

4 Vents

Figure A.1 — Example configuration for Generator minimum height/ maximum coverage test for centre mounting generator



Key

H	minimum height and maximum height specified by manufacturer for the side mounting generator
a × *b*	maximum generator area coverage for a single generator
c	maximum generator coverage distance (R_{max})

1 Test pans
2 Generator
3 Baffle
4 Vents

Figure A.2 — Example configuration for Generator minimum height/ maximum coverage test for side mounting generator

A.5.1.1.2 Instrumentation

Sampling and storage of data from the sensors described below shall occur at a rate of at least 4 Hz.

A.5.1.1.3 Oxygen concentrations

The oxygen level (minimal oxygen level as per 5.1.3.2.) shall be measured by a calibrated oxygen analyser capable of measuring the percentage oxygen to within at least one decimal place (0,1 %). The sensing equipment shall be capable of continuously monitoring and recording the oxygen level inside the enclosure throughout the duration of the test. The accuracy of the measuring devices shall not be influenced by any of the fire products.

At least three sensors shall be located within the enclosure (Figures A.3 and A.4). The three sensors shall be located in a horizontal distance from the centre of the room 850 mm to 1 250 mm and in the following heights: 0,1 × *H*, 0,5 × *H* and 0,9 × *H* (*H* = height of the enclosure) above the floor.

A.5.1.1.4 Discharge pressure

The pressure built up during system discharge shall be recorded by a pressure transducer at a distance not greater than 1 m from the generator.

A.5.1.1.5 Enclosure temperature

At least the temperature in a horizontal distance from the centre of the room of 850 mm to 1 250 mm and 0,5 × *H* (*H* = room height) above the floor shall be recorded (Figures A.3 and A.4).

NOTE It is recommended to use K type thermocouples (Ni-CrNi), diameter 1 mm.

A.5.1.1.6 Aerosol temperature and discharge times

A thermocouple shall be placed just outside the discharge outlet of the aerosol generator to record aerosol temperature at the outlet as well as commencement and end of the aerosol discharge. Additional thermocouples may be placed at the minimum thermal clearance from the discharge outlet as specified by the manufacturer for each unit size of the aerosol generators.

NOTE It is recommended to use K type thermocouples (Ni-CrNi), diameter 1 mm.

A.5.1.1.7 Flame out times

Cameras, e.g. infrared-cameras, or an alternative means of directly viewing the fire can be provided as an aid to determining flame out times.

A thermocouple can be located centrally 30 mm above each fire pot to provide additional information.

Dimensions in mm

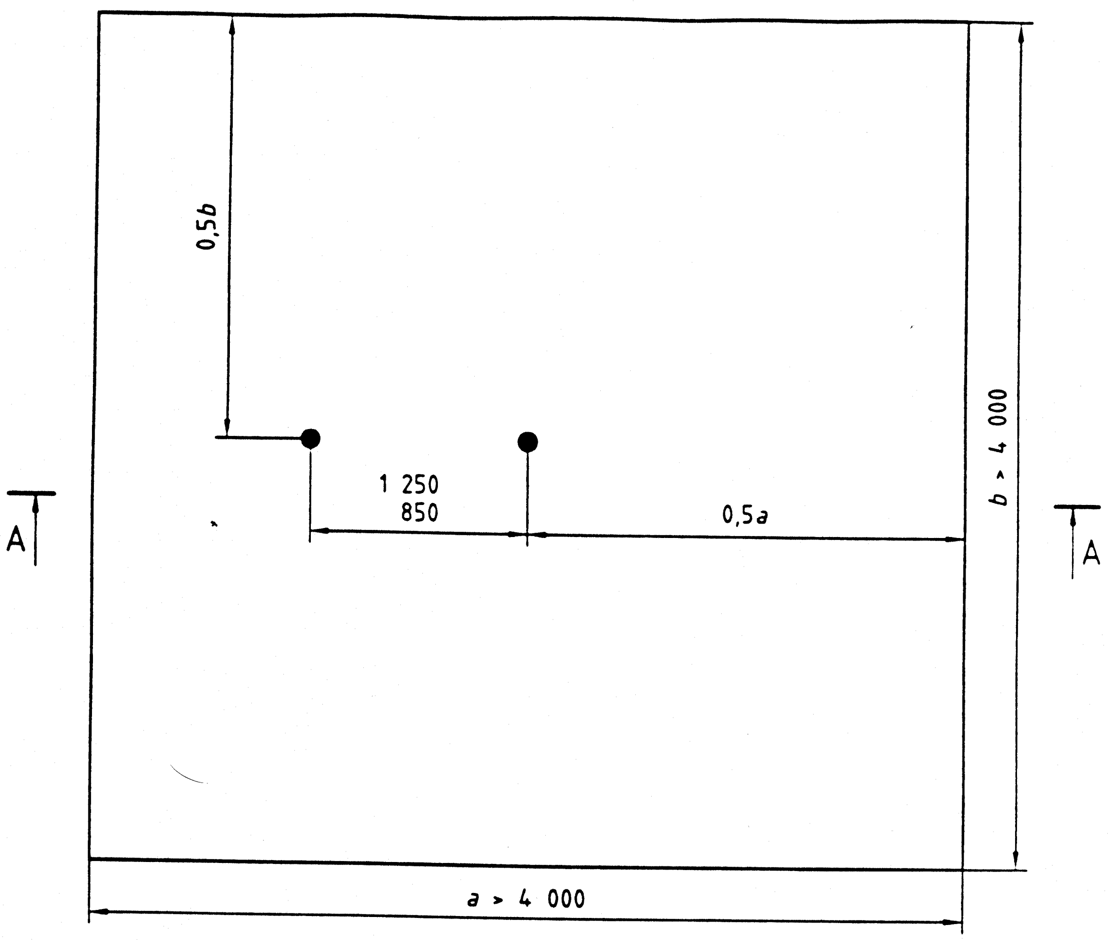


Figure A.3 — Plan view of instrumentation placement for generator minimum height/maximum area coverage and maximum height/maximum area coverage test

Dimensions in mm

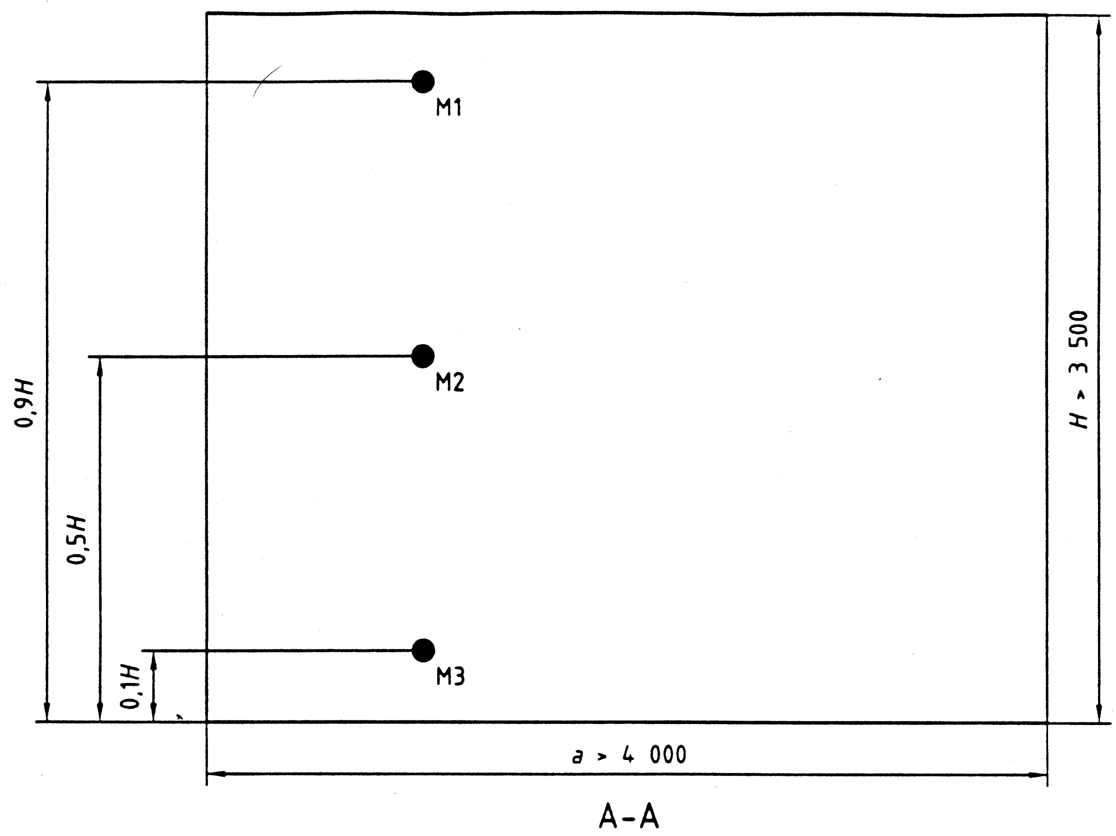


Figure A.4 — Side view of instrumentation placement for generator minimum height/maximum area coverage and maximum height/maximum area coverage test

A.5.1.2 Fuel specification

A.5.1.2.1 Test pans

The test pans shall be cylindrical (80 ± 5) mm in diameter and at least 100 mm high made of mild or stainless steel with a thickness of 5 mm to 6 mm.

A.5.1.2.2 n-Heptane

The heptane shall be:

— n-heptane; or

— commercial grade having the following characteristics:

a) distillation

1) Initial boiling point: 90°C minimum

2) Dry point: 100°C maximum

b) density (at 15,6°C) (700 ± 50) kg/m^3.

A.5.1.2.3 Fire configuration and placement

The test pans may contain either n-heptane or n-heptane and water. If they are to contain n-heptane and water, the n-heptane shall be at least 50 mm deep. The level of n-heptane in the pans shall be at least 50 mm below the top of the can.

The test pans are to be placed within 50 mm of the corners of the test enclosure and in addition directly behind the baffle (see Figures A.1 and A.2), and located vertically within 300 mm of the top or bottom of the enclosure, or both top and bottom if the enclosure permits such placement.

A.5.1.3 Test procedure

A.5.1.3.1 General

Prior to commencing tests, the composition of the extinguishing aerosol shall be analysed.

A.5.1.3.2 Operation

The heptane filled test pans are to be ignited and allowed to burn for 30 s with the closeable openings above in the open position.

After 30 s all openings are to be closed and the extinguishing system is to be manually actuated. At the time of actuation of the system, the amount of oxygen within the enclosure shall not be more than 0,5 vol% lower than the normal atmospheric oxygen concentration. During the test, the oxygen concentration shall not change more than 1,5 vol% due to fire products. This change shall be determined by comparing the oxygen concentration measured in the cold discharge test with the measured oxygen concentration in this test (averaged over the three sensors).

A.5.1.3.3 Results recording

After the required pre-burn period, record the following data for each test:

a) the discharge time of extinguishant, in seconds;

b) the time required to achieve extinguishment, in seconds. This time shall be determined by visual observation, thermocouples readings or other suitable means.

A.5.1.4 Determination of distribution performance of the generator

Using the extinguishing factor for n-heptane, determined according to A.5.2, all test pans have to be extinguished within 30 s after the end of agent discharge.

A.5.2 Maximum height test

A.5.2.1 Test facility

A.5.2.1.1 Construction

The test enclosure shall meet the following requirements:

a) area ($a \times b$) and height (H) of the enclosure (see Figure A.1) shall correspond to the maximum area coverage and maximum height specified by the manufacturer for a specific aerosol generator's unit size;

b) test room volume shall be determined from the result of heptane pan test (see A.6.2) (see A.6.2):

$$V_{Test} = \frac{M}{0.769 \cdot c} \quad \left[m^3\right] \tag{A.3}$$

M is the generator's unit mass in grams,

c is the design factor, in grams per cubic metre;

c) area sides a and b shall be calculated to fulfil following requirements:

1) $a\,b = \frac{V_{test}}{H}$

2) the distance *c* (see Figures A.1 and A.2) shall be equal to maximum coverage distance (R_{max}) specified by manufacturer and shall be the same specified for minimum height;

d) means of pressure relief shall be provided;

e) closeable openings shall be provided directly above the test pans to allow for venting prior to system actuation;

f) one baffle is to be installed between the floor and ceiling with the height of the room. It is to be installed halfway between the nozzle location and the walls of the enclosure (see Figure A.1 for centre mounting generator and Figure A.2 for side mounting generator). The baffle is to be perpendicular to the direction of nozzle discharge, and be 20 % of the length of the short wall of the enclosure.

A.5.2.1.2 Instrumentation

Instrumentation of the enclosure is as described in A.5.1.1.2.

A.5.2.2 Fuel specification

A.5.2.2.1 Test pans

Specification of test pans is as described in A.5.1.2.1.

A.5.2.2.2 n-Heptane

See A.5.1.2.2.

A.5.2.2.3 Fire construction and placement

The test can filling requirements and placement within the enclosure are as described in A.5.1.2.1.

A.5.2.3 Test procedure

A.5.2.3.1 General

Prior to commencing tests the composition of the extinguishing aerosol shall be analysed.

A.5.2.3.2 Operation

The n-heptane filled test pans are to be ignited and allowed to burn for 30 s with the closeable openings above in the open position.

After 30 s all openings are to be closed and the extinguishing system is to be manually actuated. At the time of actuation of the system, the amount of oxygen within the enclosure shall not be more than 0,5 vol% lower than the normal atmospheric oxygen concentration. During the test, the oxygen concentration shall not change more than 1,5 vol% due to fire products. This change shall be determined by comparing the oxygen concentration measured in the cold discharge test with the measured oxygen concentration in this test (averaged over the three sensors).

A.5.2.3.3 Results recording

Results are to be recorded as specified in A.5.1.3.3.

A.5.2.4 Determination of distribution performance of the generator

Using the extinguishing factor for heptane, determined according to A.6.2, all test pans have to be extinguished within 30 s after the end of agent discharge.

A.6 Extinguishing factor tests

A.6.1 Wood crib test

A.6.1.1 Test facility

A.6.1.1.1 Construction

The test enclosure shall meet the following requirements:

a) the test enclosure shall have a minimum volume of 100 m^3. The height shall be at least 3,5 m. The floor dimensions shall be at least 4 m wide by 4 m long;

b) means of pressure relief shall be provided;

c) the temperature in the test enclosure shall be (20 ± 5) °C at the beginning of each test and there shall be enough time between the tests so that the enclosure can adapt to this temperature.

A.6.1.1.2 Instrumentation

Sampling and storage of data from the sensors described below shall occur at a rate of at least 4 Hz.

A.6.1.1.3 Oxygen concentrations

The oxygen level shall be measured by a calibrated oxygen analyser capable of measuring the percentage oxygen to within at least one decimal place (0,1 %). The sensing equipment shall be capable of continuously monitoring and recording the oxygen level inside the enclosure throughout the duration of the test. The accuracy of the measuring devices shall not be influenced by any of the fire products.

At least three sensors shall be located within the enclosure (Figures A.5 and A.6). One sensor shall be located at the equivalent height of the top of the test object from the floor, 0,6 m to 1 m away from the test object. The other two sensors shall be located at $0,1 \times H$ and $0,9 \times H$ (with H = height of the enclosure (see Figures A.5 and A.6).

A.6.1.1.4 Discharge pressure

The pressure built up during system discharge shall be recorded by pressure transducer at a distance not greater than 1 m. from the discharge outlet.

A.6.1.1.5 Enclosure temperature

Temperature sensors shall be located centred 100 mm above the test object and 0,9 × *H* (*H* = room height), and a third sensor at the equivalent height of the top of the test object from the floor, horizontally 0,6 m to 1 m away from the test object (see Figures A.5 and A.6).

NOTE It is recommended to use K type thermocouples (Ni-CrNi), diameter 1 mm.

A.6.1.1.6 Aerosol temperature and discharge times

A thermocouple shall be placed just outside the discharge outlet of the aerosol generator to record aerosol temperature at the outlet as well as commencement and end of aerosol discharge. Additional thermocouples may be placed at the minimum thermal clearance from the discharge outlet as specified by the manufacturer for each unit size of the aerosol generators.

NOTE It is recommended to use K type thermocouples (Ni-CrNi), diameter 1 mm.

A.6.1.1.7 Flame out times

Cameras, e.g. infrared-cameras, or an alternative means of directly viewing the fire can be provided as an aid to determining flame out times.

Dimensions in mm

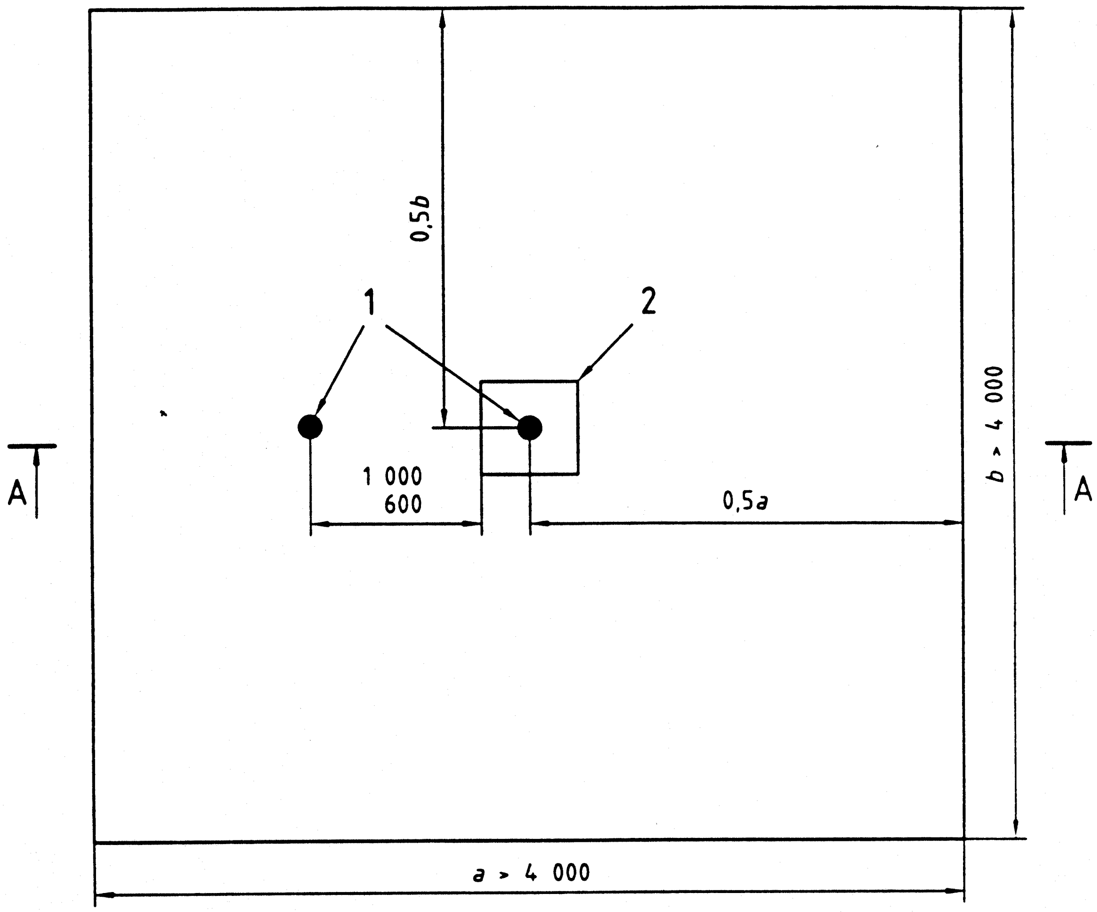


Figure A.5 — Plan view of instrumentation placement for the extinguishing factor test

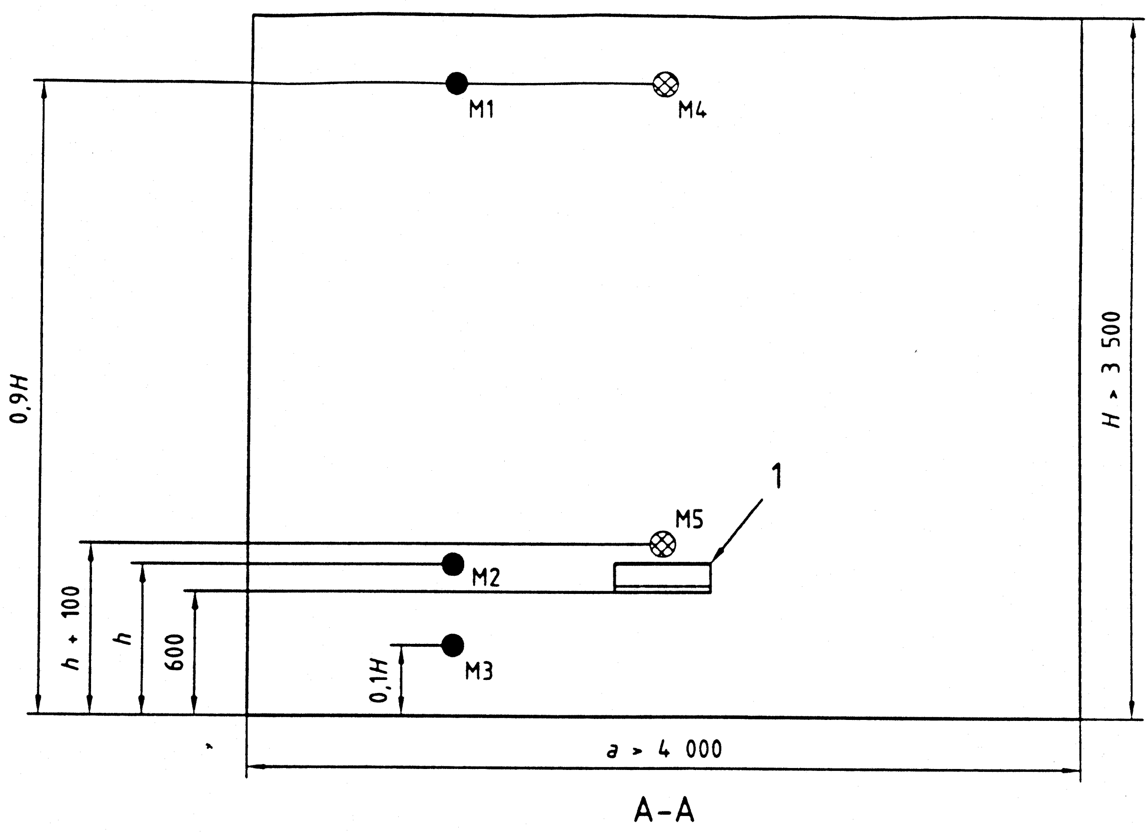


Figure A.6 – Side view of instrumentation placement for the extinguishing concentration test

A.6.1.2 Fuel specification

A.6.1.2.1 Crib igniter fuel

Ignition of the crib is achieved by burning 1,5 l of commercial grade n-heptane (specified in A.5.1.2.2) on a 12,5 l layer of water in a square steel pan 0,25 m^2 in area, 100 mm in height and with a wall thickness of 6 mm (see Figure A.7).

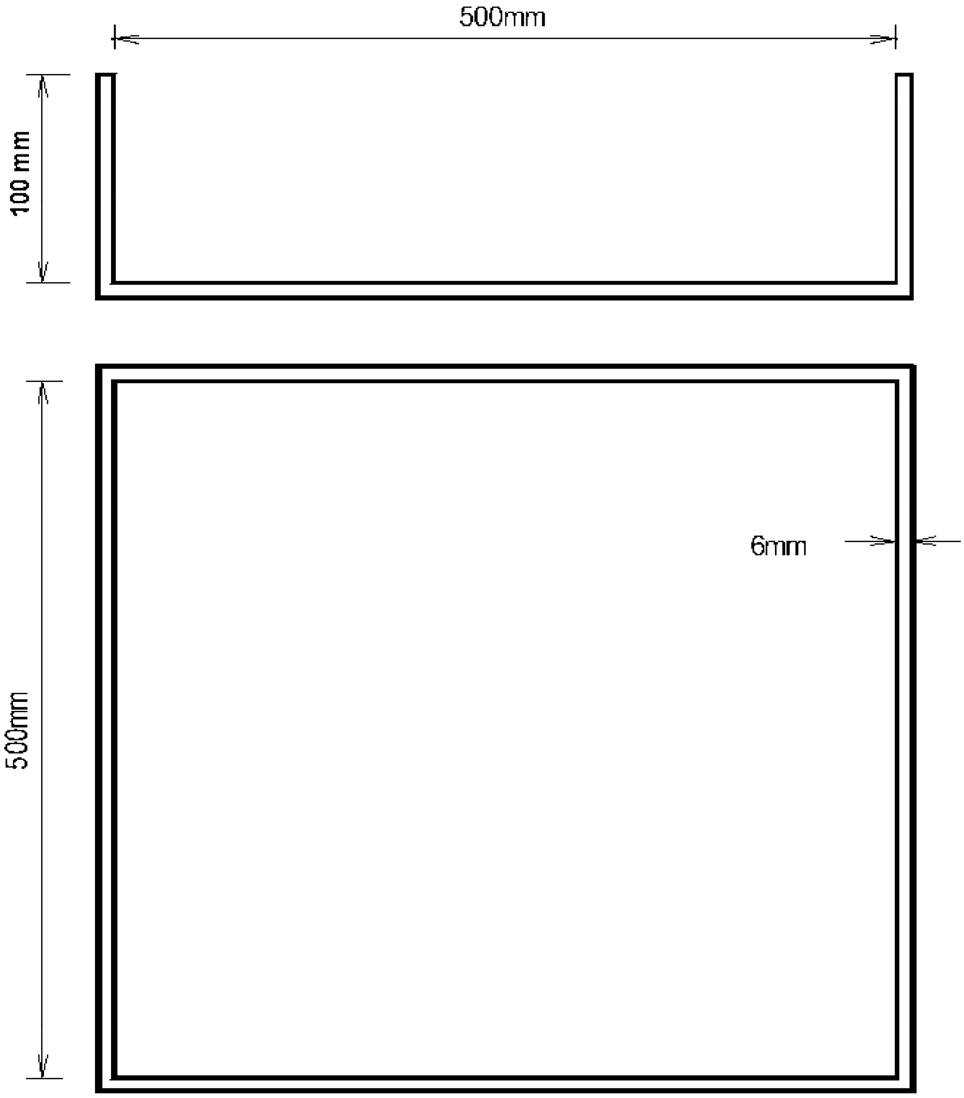


Figure A.7 — Pan geometry for wood crib and n-Heptane pan fire test

A.6.1.2.2 Fire configuration and placement

The wood crib is to consist of four layers of six, approximately 40 mm × 40 mm by (450 ± 50) mm long, kiln spruce or fir lumber having a moisture content between 9 % and 13 %. Place the alternate layers of wood members at right angles to one another. Evenly space the individual wood members in each layer forming a square determined by the specified length of the wood members. Staple or nail together the wood members forming the outside edges of the crib.

The crib shall be pre-burned outside the enclosure on a stand supporting the crib 300 mm above the pan holding the igniter fuel (specified in A.6.1.3.1).

After the pre-burn period the crib shall be moved into the enclosure and be located on a stand supporting the crib centrally within the enclosure with the base of the crib 600 mm above the floor (specified in A.6.1.3.1).

A.6.1.3 Test procedure

A.6.1.3.1 General

Prior to commencing tests, the composition of the extinguishing aerosol shall be analysed. Record the mass and the moisture of the crib prior to the test.

A.6.1.3.2 Operation

Centre the crib with the bottom of the crib approximately 300 mm above the top of the pan on a test stand constructed so as to allow for the bottom of the crib to be exposed to the atmosphere. The pre-burning shall take place outside the enclosure, if possible in a sufficiently dimensioned room (at least five times the volume of the test enclosure). In any case, the pre-burning shall not be influenced by weather conditions such as rain, wind, sun. The maximum wind speed in the proximity of the fire shall be 3 m/s. If necessary, adequate means for protection against wind etc. shall be used. Record the weather conditions including location of pre-burn, air temperature, humidity and wind speed.

Ignite the n-heptane and allow the crib to burn freely. The 1,5 l of n-heptane will provide a burn time of approximately 3 min. After the n-heptane is exhausted, the crib shall be allowed to burn freely for an additional time of 3 min resulting in a total pre-burn time of ($6\,^{+0,1}_{\;\;0}$) min outside the test enclosure.

Just prior to the end of the pre-burn period, move the crib into the test enclosure and place it on a stand such that the bottom of the crib is 600 mm above the floor. Seal the enclosure and actuate the system. The time required to position the burning crib in the enclosure and the actuation of the system discharge shall not exceed 15 s.

At the time of actuation of the system, the amount of oxygen within the enclosure at the level of the crib shall not be more than 0,5 vol% lower than the normal atmospheric oxygen concentration. During the test, the oxygen concentration shall not change more than 1,5 vol% due to fire products. This change shall be determined by comparing the oxygen concentration measured in the cold discharge test with the oxygen concentration measured in this fire test (averaged values).

From the end of system discharge, the enclosure is to remain sealed for a total of 10 min. After the soak period, remove the crib from the enclosure and observe to determine that sufficient fuel remains to sustain combustion and for signs of re-ignition.

The following shall be recorded:

a) presence and location of burning embers;

b) whether or not the glowing embers or crib re-ignites;

c) mass of the crib after the test.

If necessary, amend the aerosol extinguishing factor and repeat the experimental programme until three successive, successful extinguishments are achieved.

A.6.1.3.3 Results recording

After the required pre-burn period, record the following data for each test:

a) discharge time of extinguishant, in seconds;

b) time required to achieve extinguishment, in seconds. This time shall be determined by visual observation, thermocouples readings or other suitable means;

c) soaking time (time from the end of system discharge until the opening of the test enclosure);

d) recording the temperature profile of the wood crib, using the infrared camera, is recommended.

A.6.1.4 Determination of extinguishant design factor

The laboratory extinguishing factor is that which achieves satisfactory extinguishment of the fire over three successive tests (no re-ignition or existence of burning embers after 10 min after end of discharge). The design factor is the laboratory extinguishing factor multiplied by an appropriate 'safety factor' (1.3).

Extinguishing factor shall be calculated dividing the total mass of aerosol compound installed by the test room volume.

A.6.2 n-Heptane pan test

A.6.2.1 Test facility

A.6.2.1.1 Construction

Construction of the enclosure is as described in A.6.1.1.1.

A.6.2.1.2 Instrumentation

Instrumentation of the enclosure is as described in A.6.1.1.2.

A.6.2.2 Fuel specification

A.6.2.2.1 n-Heptane

See A.5.1.2.2.

A.6.2.2.2 Fire configuration and placement

The fire will be a square steel pan of 0,25 m^2, 100 mm high with a wall thickness of 6 mm as specified in A.6.1.2.1. The test pan is to contain 12,5 l of n-heptane. The resulting n-heptane surface is then 50 mm below the top of the pan.

The steel pan shall be located in the centre of the test enclosure with the bottom 600 mm above the floor of the test enclosure.

A.6.2.3 Test procedure

A.6.2.3.1 General

Prior to commencing tests, the composition of the extinguishing aerosol shall be analysed.

A.6.2.3.2 Operation

The n-heptane is to be ignited and allowed to burn for 30 s.

After 30 s all openings are to be closed and the extinguishing system is to be manually actuated. At the time of actuation of the system, the amount of oxygen within the enclosure shall not be more than 0,5 vol% lower than the normal atmospheric oxygen concentration. During the test, the oxygen concentration shall not change more than 1,5 vol% due to fire products. This change shall be determined by comparing the oxygen concentration measured in the cold discharge test with the oxygen concentration measured in this fire test (averaged values).

If necessary, amend the extinguishant extinguishing factor and repeat the experimental programme until three successive, successful extinguishments are achieved.

A.6.2.3.3 Results recording

Results are to be recorded as specified in A.6.1.3.3 with the exception of d).

A.6.2.4 Determination of extinguishant design factor

The laboratory extinguishing factor is that which achieves satisfactory extinguishment of the fire over three successive tests (no flaming 30 s after the end of extinguishant discharge). The design factor is the laboratory extinguishing factor multiplied by an appropriate safety factor.

Extinguishing factor shall be calculated dividing the total mass of aerosol compound installed by the test room volume.

A.6.3 Polymeric sheet fire test

A.6.3.1 Test facility

A.6.3.1.1 Construction

Construction of the enclosure is as described in A.6.1.1.1.

A.6.3.1.2 Instrumentation

Instrumentation of the enclosure is as described in A.6.1.1.2.

A.6.3.2 Fuel specification

A.6.3.2.1 Igniter fuel

The ignition source is a heptane pan (constructed of 2 mm thick mild or stainless steel) with inside to inside 51 mm × 112 mm and 21 mm deep centred 12 mm below the bottom of the plastic sheets of polymeric fuel (see Figure A.8). The 51 mm side of the pan is orientated parallel to the sheets of polymeric fuel. The pan is filled with 6,0 ml of commercial grade heptane (specified in A.6.1.2.2) on a water base of 40 ml.

A.6.3.2.2 Polymeric fuel

Tests are to be conducted with three plastic fuels:

— Polymethyl methacrylate (PMMA);

— Polypropylene,

— Acrylonitrile-butadiene-styrene polymer (ABS).

Plastic properties are given in Table A.2.

Table A.2 — Plastic properties
25 kW/m² Exposure in Cone Calorimeter - ISO 5660-1 Cone Calorimeter Test

Fuel	Colour	Density	Ignition Time		180 s average		effective	
					Heat Release Rate		Heat of Combustion	
		g/cm³	s	Tolerance	kW/m²	Tolerance	MJ/kg	Tolerance
PMMA	Black	1,19	77	30%	286	25%	23,3	25 %
Polypropylene	Natural (White)	0,905	91	30%	225	25%	39,6	25%
ABS	Natural (Cream)	1,04	115	30%	484	25%	29,1	25%

A.6.3.2.3 Polymeric fuel array

The polymeric fuel array shall consist of 4 sheets of polymer, which are cut to 405 mm ± 5 mm high by 200 mm ± 5 mm wide. The thickness of the sheets shall be as follows:

— Polymethyl methacrylate (PMMA) – (9,0 ± 0,5) mm;

— Polypropylene (PP) – (9,5 ± 0,5) mm;

— Acrylonitrile-butadiene-styrene polymer (ABS) – (10,0 ± 0,5) mm.

Sheets are spaced and located as per Figure A.8. The bottom of the fuel array is located 203 mm from the floor. The fuel sheets shall be mechanically fixed at the required spacing. The sheets of plastic shall not significantly bend during the test.

The fuel array shall be located centrally within the enclosure.

A.6.3.2.4 Fuel shield

A fuel shield consisting of a metal frame with sheet metal on the top and two sides shall be provided around the fuel array as indicated in Figure A.8. The fuel shield is 380 mm wide, 850 mm high and 610 mm deep. The 610 mm (wide) × 850 mm (high) sides and the 610 mm × 380 mm top are metal sheet. The two remaining sides and bottom are open.

The metal sheet shall be aluminium with a wall thickness of 2 mm to 3 mm.

The fuel array is oriented in the fuel shield such that the 200 mm dimensions of the fuel array is parallel to the 610 mm side of the fuel shield.

A.6.3.2.5 External baffles

External baffles are constructed as shown in Figure A.9 and are located around the exterior of the fuel shield. The baffles are placed 90 mm above the floor. The top baffle is rotated 45° with respect to the bottom baffle.

A.6.3.3 Test procedure

A.6.3.3.1 General

Prior to commencing tests the composition of the extinguishing aerosol shall be analysed. Record the mass of the plastic sheets prior to the test.

A.6.3.3.2 Operation

The n-heptane is ignited and allowed to burn completely. 210 s after ignition of the n-heptane, all openings are to be closed and the extinguishing system is to be manually actuated.

At the time of actuation of the system, the amount of oxygen within the enclosure at the level of the fuel shall not be more than 0,5 vol% lower than the normal atmospheric oxygen concentration. During the test, the oxygen concentration shall not change more than 1,5 vol% due to fire products. This change shall be determined by comparing the oxygen concentration measured in the cold discharge test with the oxygen concentration measured in this fire test (averaged values).

The enclosure is to remain sealed for a total of 10 min from end of discharge. After the soak period, ventilate the enclosure and observe to determine that sufficient fuel remains to sustain combustion and for signs of re-ignition. The following shall be recorded:

a) presence and location of burning fuel;

b) whether or not the fire re-ignites; and

c) mass of the fire structure after the test.

If necessary, amend the extinguishing factor and repeat the experimental programme until three successive, successful extinguishment are achieved.

A.6.3.3.3 Results recording

After the required pre-burn period, record the following data for each test:

a) discharge time of extinguishant, in seconds;

b) time required to achieve extinguishment, in seconds. This time shall be determined by visual observation, thermocouples readings or other suitable means;

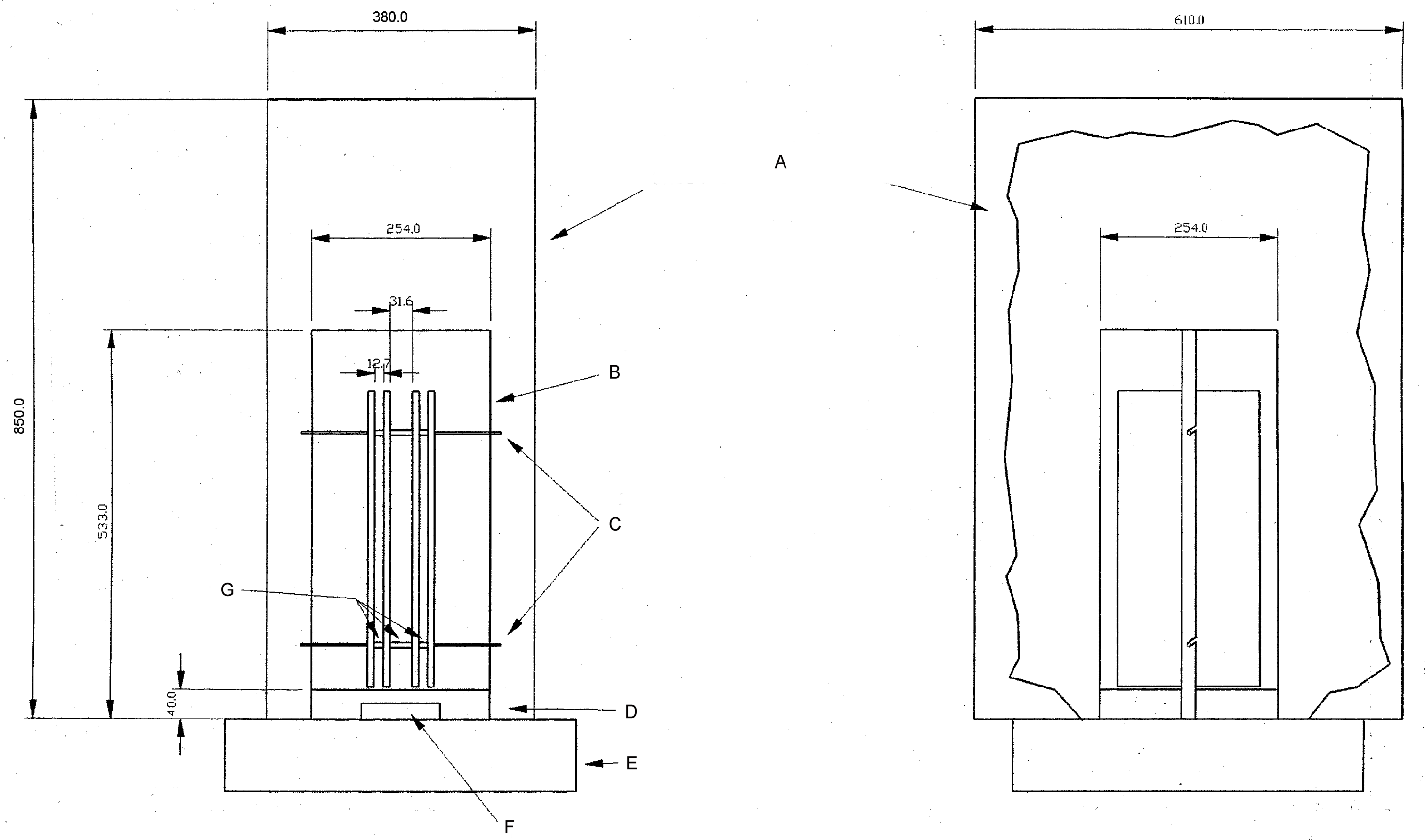
c) soaking time (time from the end of system discharge until the opening of the test enclosure).

A.6.3.4 Determination of design extinguishant factor

The laboratory extinguishing factor for each fuel is that which achieves satisfactory extinguishment of the fire over three successive tests (no flaming 60 s after end of discharge and no re-ignition after 10 min from end of discharge).

The design factor is the highest of the laboratory extinguishing factors for the three fuels (see A.6.3.2.2) multiplied by an appropriate safety factor.

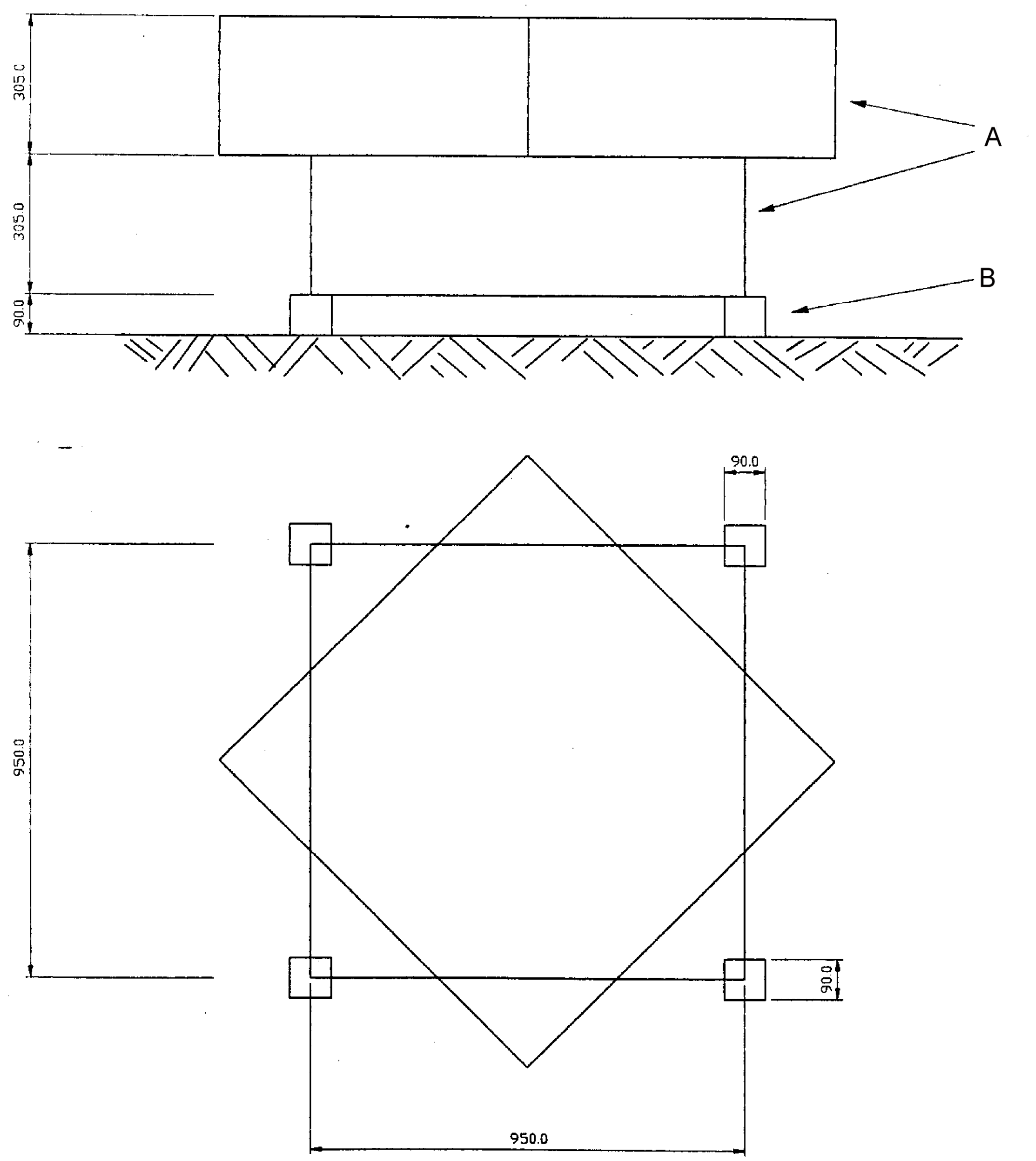
Extinguishing factor shall be calculated dividing the total mass of aerosol compound installed by the test room volume.



Key

A Channel metal frame covered with metal sheet on top and two sides
B Metal angle frame
C 1/8" All thread rod fuel support
D Drip tray
E Load cell
F Heptane pan
G Spacer

Figure A.8 — Polymeric sheet and composite wood panels fire



Key

A Polycarbonate or metal baffles
B Cinder block

Figure A.9 — Polymeric and composite wood panels fire baffle arrangement

A.6.4 Composite wood fire test

A.6.4.1 Test facility

A.6.4.1.1 Construction

Construction of the enclosure is as described in A.6.1.1.1.

A.6.4.1.2 Instrumentation

Instrumentation of the enclosure is as described in A.6.1.1.2.

A.6.4.2 Fuel specification

A.6.4.2.1 Igniter fuel

The ignition source is a n-heptane pan (constructed of 2 mm thick mild or stainless steel) 51mm × 112mm and 21 mm deep centred 12 mm below the bottom of the composite wood sheets (see Figure A.8). The 51 mm side of the pan is orientated parallel to the sheets of composite wood. The pan is filled with 12 ml of commercial grade n-heptane (specified in A.6.1.2.2), heptane will provide a burn time of approximately 3 min.

A.6.4.2.2 Composite wood

Tests are to be conducted with three composite woods:

- Reformed wood (chops) both sides plastic lined;
- MDF (Medium Density Fibreboards) according to EN 622 and EN 316 not lined;
- Multilayers plywood (kiln spruce or fir) not lined.

Composite wood properties are given in Table A.5.

Table A.5 — Composite wood properties
25 kW/m² Exposure in cone calorimeter – ISO 5660-1 cone calorimeter test

Fuel	Colour	Density	Ignition Time		180 s Average		Effective	
					Heat Release Rate		Heat of Combustion	
		g/cm3	s	Tolerance	kW/m^2	Tolerance	MJ/kg	Tolerance
Reformed wood (chops) both sides plastic lined	White	0,783	213	30 %	61,86	25 %	10	25 %
Reformed wood (chops) both sides unlined	Brown	0,882	109	30 %	65,56	25 %	8,76	25 %
MDF (Medium Density Fibre boards) according to EN 622 and EN 316 not lined	Brown	0,886	91	30 %	62,23	25 %	9,33	25 %
Multi-layers plywood (kiln spruce or fir) not lined	Brown	0,991	93	30 %	60,33	25 %	11,3	25 %

A.6.4.2.3 Composite wood fuel array

The Composite wood fuel array consists of four sheets of Composite wood, 18,0 mm thick, 405 mm high, and 200 mm wide. Sheets are spaced and located as per Figure A.8. The bottom of the fuel array is located 203 mm from the floor. The fuel sheets shall be mechanically fixed at the required spacing. The Composite wood panels shall not significantly bend during the test.

The fuel array shall be located centrally within the enclosure.

A.6.4.2.4 Fuel shield

A fuel shield consisting of a metal frame with sheet metal on the top and two sides shall be provided around the fuel array as indicated in Figure A.8. The fuel shield is 380 mm wide, 850 mm high and 610 mm deep. The 610 mm (wide) × 850 mm (high) sides and the 610 mm × 380 mm top are metal sheet. The two remaining sides and bottom are open.

The metal sheet shall be aluminium with a wall thickness of 2 mm to 3 mm.

The fuel array is oriented in the fuel shield such that the 200 mm dimensions of the fuel array is parallel to the 610 mm side of the fuel shield.

A.6.4.2.5 External baffles

External baffles are constructed as shown in Figure A.9 and are located around the exterior of the fuel shield. The baffles are placed 90 mm above the floor. The top baffle is rotated 45° with respect to the bottom baffle.

A.6.4.3 Test procedure

A.6.4.3.1 General

Prior to commencing tests the composition of the extinguishing aerosol shall be analysed. Record the mass of the Composite wood panels prior to the test.

A.6.4.3.2 Operation

The n-heptane is ignited and allowed to burn completely (heptane will provide a burn time of approximately 3 min.) after the n-heptane is exhausted, the crib shall be allowed to burn freely for an additional time of 3 min resulting in a total pre-burn time of ($6\ ^{+0,1}_{\ \ 0}$) min. At 6 min after the ignition of the n-heptane all openings are to be closed and the extinguishing system is to be manually actuated.

At the time of actuation of the system, the amount of oxygen within the enclosure at the level of the fuel shall not be more than 0,5 vol% lower than the normal atmospheric oxygen concentration. During the test, the oxygen concentration shall not change more than 1,5 vol% due to fire products. This change shall be determined by comparing the oxygen concentration measured in the cold discharge test with the oxygen concentration measured in this fire test (averaged values).

The enclosure is to remain sealed for a total of 10 min from end of discharge. After the soak period, ventilate the enclosure and observe to determine that sufficient fuel remains to sustain combustion and for signs of re-ignition. The following shall be recorded:

a) presence and location of burning fuel;

b) whether or not the fire re-ignites; and

c) mass of the fire structure after the test.

If necessary, amend the extinguishing factor and repeat the experimental programme until three successive, successful extinguishment are achieved.

A.6.4.3.3 Results recording

After the required pre-burn period, record the following data for each test:

a) discharge time of extinguishant, in seconds;

b) time required to achieve extinguishment, in seconds. This time shall be determined by visual observation, thermocouples readings or other suitable means;

c) soaking time (time from the end of system discharge until the opening of the test enclosure).

A.6.4.4 Determination of design extinguishant factor

The laboratory extinguishing factor for each fuel is that which achieves satisfactory extinguishment of the fire over three successive tests (no flaming 60 s after end of discharge and no re-ignition after 10 min from end of discharge).

The design concentration is the highest of the laboratory extinguishing factors for the four fuels (see A.6.4.2.2) multiplied by an appropriate safety factor.

Extinguishing factor shall be calculated dividing the total mass of aerosol compound installed by the test room volume.

A.7 Aerosol generator explosive atmosphere test

A.7.1 Actuation test inside an explosive atmosphere environment.

A.7.1.1 Test facility

A.7.1.1.1 Construction

The test enclosure shall meet the following requirements:

a) steel cabinet open on top having dimensions (volume) to fit the extinguishing factor of the specific generator to be tested;

b) the ceiling of the cabinet/volume shall be sealed by a plastic sheet to allow the explosion (if occurs) to be vented outside avoiding any potential damage;

c) 3 sample points shall be provided to measure the concentration of the explosive atmosphere inside the cabinet/volume:

   1) one on the bottom, close to the cabinet floor,

   2) one in the mid point of the test volume,

   3) one on top, close to the ceiling;

d) a fan driven by an electric motor (the electric motor shall be placed outside the cabinet/volume or use an explosion proof fan unit) shall be installed on the floor to mix and obtain an homogeneous explosive atmosphere;

e) an ignition automotive spark plug (or any suitable ignition device) shall be installed at about the middle of the cabinet/volume (close to the same position of the aerosol generator) to ignite the explosive mixture.

A.7.1.1.2 Instrumentation

The explosive mixture shall be measured utilizing a suitable explosive meter connected to the 3 sample points.

A.7.1.1.3 Explosive atmosphere

The explosive atmosphere shall be obtained metering inside the test cabinet/volume propane or mixture of propane/butane utilizing a bottle equipped with a pressure reducer, mixing the atmosphere using the fan and checking the percentage of the propane of propane/butane mixture with the explosive meter (the range shall be between the Lowest Explosion Level and the Highest Explosion Level. The explosive atmosphere shall be checked by repeating the explosion test 3 times actuating the spark plug, the explosion will prove the atmosphere inside the test cabinet/volume is really in the explosive range.

A.7.1.2 Test procedure

A.7.1.2.1 General

Prior to commencing tests, the composition of the explosive atmosphere shall be obtained and checked according the procedure described in A.7.1.1.3.

A.7.1.2.2 Operation

The aerosol generator shall be placed inside the test cabinet/volume about the middle of the volume and connected to the actuation device/wiring. The propane or propane/butane mixture will be administered to obtain the explosive atmosphere and the generator will be left inside the explosive atmosphere for 3 min to allow the explosive atmosphere to enter inside the generator casing.

After 3 min of immersion inside the explosive atmosphere the generator shall be actuated and shall discharge without initiating any explosion.

After the test, the test cabinet/volume shall be securely vented.

A.7.1.2.3 Results recording

Record the following data for each test:

a) the data from the explosive meter proving that the administered atmosphere has been in the explosive range;

b) the result of the test, by visual observation.

A.7.1.3 Pass fail criteria of the explosive atmosphere generator actuation test

All 3 tests shall not initiate any explosion.

Bibliography

[1] EN 2, Classification of fires

[2] EN ISO 9001, Quality management systems – Requirements (ISO 9001:2008)

[3] CEN/TR 15276-2, Fixed firefighting systems – Condensed aerosol extinguishing systems – Part 2: Design, installation and maintenance

BSI - British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: +44 (0)20 8996 9000. Fax: +44 (0)20 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: +44 (0)20 8996 9001. Fax: +44 (0)20 8996 7001 Email: orders@bsigroup.com You may also buy directly using a debit/credit card from the BSI Shop on the Website http://www.bsigroup.com/shop

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact Information Centre. Tel: +44 (0)20 8996 7111 Fax: +44 (0)20 8996 7048 Email: info@bsigroup.com

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: +44 (0)20 8996 7002 Fax: +44 (0)20 8996 7001 Email: membership@bsigroup.com

Information regarding online access to British Standards via British Standards Online can be found at http://www.bsigroup.com/BSOL

Further information about BSI is available on the BSI website at http://www.bsigroup.com.

Copyright

BSI Group Headquarters 389 Chiswick High Road, London, W4 4AL, UK
Tel +44 (0)20 8996 9001
Fax +44 (0)20 8996 7001
www.bsigroup.com/standards