

**SLOVENSKI STANDARD**  
**oSIST prEN ISO 5659-2:2016**  
**01-april-2016**

---

**Polimerni materiali - Nastajanje dima - 2. del: Določanje optične gostote s preskusom v eni preskusni komori (ISO/DIS 5659-2:2016)**

Plastics - Smoke generation - Part 2: Determination of optical density by a single-chamber test (ISO/DIS 5659-2:2016)

Kunststoffe - Rauchentwicklung - Teil 2: Bestimmung der optischen Dichte durch Einkammerprüfung (ISO/DIS 5659-2:2016)

Plastiques - Production de fumée - Partie 2: Détermination de la densité optique par un essai en enceinte unique (ISO/DIS 5659-2:2016)

**Ta slovenski standard je istoveten z: prEN ISO 5659-2**

---

**ICS:**

13.220.40	Sposobnost vžiga in obnašanje materialov in proizvodov pri gorenju	Ignitability and burning behaviour of materials and products
83.080.01	Polimerni materiali na splošno	Plastics in general

**oSIST prEN ISO 5659-2:2016**

**en,fr,de**



# DRAFT INTERNATIONAL STANDARD

## ISO/DIS 5659-2

ISO/TC 61/SC 4

Secretariat: BSI

Voting begins on:  
2016-01-28Voting terminates on:  
2016-04-28

### Plastics — Smoke generation —

## Part 2: Determination of optical density by a single-chamber test

*Plastiques — Production de fumée —*

*Partie 2: Détermination de la densité optique par un essai en enceinte unique*

ICS: 83.080.01; 13.220.40

iTeh STANDARD PREVIEW  
(standards.iteh.ai)

SIST EN ISO 5659-2:2017

<https://standards.iteh.ai/catalog/standards/sist/d9257a2a-f01b-49ae-9361-a546362495a1/sist-en-iso-5659-2-2017>

THIS DOCUMENT IS A DRAFT CIRCULATED FOR COMMENT AND APPROVAL. IT IS THEREFORE SUBJECT TO CHANGE AND MAY NOT BE REFERRED TO AS AN INTERNATIONAL STANDARD UNTIL PUBLISHED AS SUCH.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

### ISO/CEN PARALLEL PROCESSING

This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.



Reference number  
ISO/DIS 5659-2:2015(E)

© ISO 2015

# iTeh STANDARD PREVIEW (standards.iteh.ai)

SIST EN ISO 5659-2:2017

<https://standards.iteh.ai/catalog/standards/sist/d9257a2a-f01b-49ae-9361-a546362495a1/sist-en-iso-5659-2-2017>



## **COPYRIGHT PROTECTED DOCUMENT**

© ISO 2015, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
Ch. de Blandonnet 8 • CP 401  
CH-1214 Vernier, Geneva, Switzerland  
Tel. +41 22 749 01 11  
Fax +41 22 749 09 47  
copyright@iso.org  
www.iso.org

<b>Contents</b>	<b>Page</b>
1 Scope .....	1
2 Normative references .....	1
3 Terms and definitions .....	1
4 Principles of the test .....	3
5 Suitability of a material or product for testing .....	3
5.1 Material or product geometry .....	3
5.2 Surface characteristics .....	3
5.3 Asymmetrical products .....	4
6 Specimen construction and preparation .....	4
6.1 Number of specimens .....	4
6.2 Size of specimens .....	4
6.3 Specimen preparation .....	4
6.4 Conditioning .....	5
6.5 Wrapping of specimens .....	5
7 Apparatus and ancillary equipment .....	6
7.1 General .....	6
7.2 Test chamber .....	6
7.2.1 Construction .....	6
7.2.2 Chamber pressure control facilities .....	7
7.2.3 Chamber wall temperature .....	10
7.3 Specimen support and heating arrangements .....	11
7.3.1 Radiator cone .....	11
7.3.2 Framework for support of the radiator cone, specimen holder and heat flux meter ....	11
7.3.3 Radiator shield .....	14
7.3.4 Heat flux meter .....	14
7.3.5 Specimen holder .....	15
7.3.6 Pilot burner .....	15
7.4 Gas supply .....	16
7.5 Photometric system .....	16
7.5.1 General .....	16
7.5.2 Light source .....	16
7.5.3 Photo detector .....	16
7.5.4 Additional equipment .....	18
7.6 Chamber leakage .....	18
7.7 Cleaning materials .....	18
7.8 Ancillary equipment .....	19
7.8.1 Balance .....	19
7.8.2 Timing device .....	19
7.8.3 Linear measuring devices .....	19
7.8.4 Auxiliary heater .....	19
7.8.5 Protective equipment .....	19
7.8.6 Recorder .....	19
7.8.7 Water-circulating device .....	19
8 Test environment .....	19
9 Setting-up and calibration procedures .....	20
9.1 General .....	20
9.2 Alignment of photometric system .....	20

## ISO/DIS 5659-2:201X(E)

9.2.1	General .....	20
9.2.2	Beam collimation .....	20
9.2.3	Beam focusing .....	20
9.3	Selection of compensating filter(s) .....	21
9.4	Linearity check .....	21
9.5	Calibration of range-extension filter.....	21
9.6	Chamber leakage rate test .....	22
9.7	Burner calibration.....	22
9.8	Radiator cone calibration .....	22
9.9	Cleaning .....	23
9.10	Frequency of checking and calibrating procedure .....	23
10	Test procedure.....	23
10.1	General .....	23
10.2	Preparation of test chamber .....	24
10.3	Tests with pilot flame .....	24
10.4	Preparation of the photometric system.....	24
10.5	Loading the specimen .....	24
10.6	Recording of light transmission .....	24
10.7	Observations.....	25
10.8	Termination of test .....	25
10.9	Testing in different modes .....	26
11	Expression of results .....	27
11.1	Specific optical density $D_s$ .....	27
11.2	Clear-beam correction factor $D_c$ .....	27
12	Precision .....	28
13	Test report.....	28
<b>Annex A (normative) Calibration of heat flux meter .....</b>		<b>29</b>
<b>Annex B (informative) Variability in the specific optical density of smoke measured in the single-chamber test.....</b>		<b>30</b>
<b>Annex C (informative) Determination of mass optical density .....</b>		<b>32</b>
C.1	Scope.....	32
C.2	Principles of the test .....	32
C.3	Test specimens.....	32
C.4	Ancillary equipment .....	32
C.5	Calibration procedure.....	35
C.6	Test procedure.....	35
C.6.1	Preparation of test chamber .....	35
C.6.2	Loading the specimen .....	35
C.6.3	Recording of light transmission and mass loss.....	36
C.6.4	Termination of test .....	36
C.6.5	Repeat tests .....	36
C.7	Expression of results .....	36
C.8	Test report.....	37
<b>Annex D (informative) Precision data from tests on intumescent materials .....</b>		<b>38</b>
D.1	Background.....	38
D.2	Specimens.....	38
D.3	Participating laboratories.....	38
D.4	Test method .....	38
D.5	Test results .....	39
<b>Annex E (informative) Guidance on optical density testing .....</b>		<b>40</b>

E.1	Introduction .....	40
E.2	Objective.....	42
E.3	Optical density measurements .....	43
E.3.1	Principles.....	43
E.3.2	Calculation methods.....	43
E.4	Factors affecting smoke production.....	46
E.4.1	General .....	46
E.4.2	Mode of decomposition.....	46
E.4.3	Ventilation and burning environment.....	46
E.4.4	Time and temperature.....	47
E.4.5	Removal mechanisms for smoke particles .....	47
E.5	Applicability of results.....	47
Annex F (Informative)	Specific sample preparation .....	48
F.1	General .....	48
F.2	Composite specimens .....	48
F.3	Paint / coating .....	48
F.4	Curved-shaped products.....	49
F.4.1	Flexible materials.....	49
F.4.2	Rigid materials .....	49
F.5	Materials that require testing under compression.....	49
F.6	Liquids.....	50

**iTeh STANDARD PREVIEW**  
(standards.iteh.ai)

SIST EN ISO 5659-2:2017

<https://standards.iteh.ai/catalog/standards/sist/d9257a2a-f01b-49ae-9361-a546362495a1/sist-en-iso-5659-2-2017>

**ISO/DIS 5659-2:201X(E)****Foreword**

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

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 5659-2 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 4, *Burning behaviour*.

This fourth edition cancels and replaces the third edition (ISO 5659-2:2012), which has been technically revised.

STANDARD PREVIEW  
(standards.iteh.ai)

SIST EN ISO 5659-2:2017

<https://standards.iteh.ai/catalog/standards/sist/d9257a2a-f01b-49ae-9361-a546362495a1/sist-en-iso-5659-2-2017>



## Introduction

Fire is a complex phenomenon: its development and effects depend upon a number of interrelated factors. The behaviour of materials and products depends upon the characteristics of the fire, the method of use of the materials and the environment in which they are exposed (see also ISO/TR 3814<sup>[1]</sup> and ISO 13943).

A test such as is specified in this part of ISO 5659 deals only with a simple representation of a particular aspect of the potential fire situation, typified by a radiant heat source, and it cannot alone provide any direct guidance on behaviour or safety in fire. A test of this type may, however, be used for comparative purposes or to ensure the existence of a certain quality of performance (in this case, smoke production) considered to have a bearing on fire behaviour generally. It would be wrong to attach any other meaning to results from this test.

The term “smoke” is defined in ISO 13943 as a visible suspension of solid and/or liquid particles in gases resulting from incomplete combustion. It is one of the first response characteristics to be manifested and should almost always be taken into account in any assessment of fire hazard as it represents one of the greatest threats to occupants of a building or other enclosure, such as a ship or train, on fire.

The responsibility for the preparation of ISO 5659 was transferred during 1987 from ISO/TC 92 to ISO/TC 61 on the understanding that the scope and applicability of the standard for the testing of materials should not be restricted to plastics but should also be relevant to other materials where possible, including building materials.

iTeh STANDARD PREVIEW  
(standards.iteh.ai)

[SIST EN ISO 5659-2:2017](https://standards.iteh.ai/catalog/standards/sist/d9257a2a-f01b-49ae-9361-a546362495a1/sist-en-iso-5659-2-2017)

<https://standards.iteh.ai/catalog/standards/sist/d9257a2a-f01b-49ae-9361-a546362495a1/sist-en-iso-5659-2-2017>

# Plastics — Smoke generation — Part 2: Determination of optical density by a single-chamber test

## 1 Scope

**1.1** This part of ISO 5659 specifies a method of measuring smoke production from the exposed surface of specimens of materials or composites. It is applicable to specimens that have an essentially flat surface and do not exceed 25 mm in thickness when placed in a horizontal orientation and subjected to specified levels of thermal irradiance in a closed cabinet with or without the application of a pilot flame. This method of test is applicable to all plastics.

**1.2** It is intended that the values of optical density determined by this test be taken as specific to the specimen or assembly material in the form and thickness tested, and are not to be considered inherent, fundamental properties.

**1.3** The test is intended primarily for use in research and development and fire safety engineering in buildings, trains, ships, etc. and not as a basis for ratings for building codes or other purposes. No basis is provided for predicting the density of smoke that might be generated by the materials upon exposure to heat and flame under other (actual) exposure conditions. This test procedure excludes the effect of irritants on the eye.

**NOTE** This test procedure addresses the loss of visibility due to smoke density, which generally is not related to irritancy potency (see Annex E).

**1.4** It is emphasized that smoke production from a material varies according to the irradiance level to which the specimen is exposed. The results yielded from the method specified in this part of ISO 5659 are based on exposure to the specific irradiance levels of 25 kW/m<sup>2</sup> and 50 kW/m<sup>2</sup>.

## 2 Normative references

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

ISO 13943, *Fire safety — Vocabulary*

ISO 14934-3, *Fire tests — Calibration and use of heat flux meters — Part 3: Secondary calibration method*

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943 and the following apply.

**ISO/DIS 5659-2:201X(E)****3.1****assembly**

fabrication of materials and/or composites

NOTE 1 Sandwich panels are an example of an assembly.

NOTE 2 The assembly may include an air gap.

**3.2****composite**

combination of materials which are generally recognized in building construction as discrete entities

NOTE Coated or laminated materials are examples of composites.

**3.3****essentially flat surface**

surface which does not deviate from a plane by more than 1 mm

**3.4****exposed surface**

surface of the product subjected to the heating conditions of the test

**3.5****irradiance**

radiant flux incident on an infinitesimal element of the surface containing the point divided by the area of that element

**3.6****material**

basic single substance or uniformly dispersed mixture

NOTE Metal, stone, timber, concrete, mineral fibre and polymers are examples.

**3.7****mass optical density****MOD**

measure of the degree of opacity of smoke in terms of the mass loss of the material

**3.8****optical density of smoke** **$D$** 

measure of the degree of opacity of smoke, taken as the negative common logarithm of the relative transmission of light

**3.9****product**

material, composite or assembly about which information is required

**3.10****specific optical density** **$D_s$** 

optical density multiplied by a factor which is calculated by dividing the volume of the test chamber by the product of the exposed area of the specimen and the path length of the light beam

NOTE See 11.1.1.

### 3.11

#### **specimen**

representative piece of the product to be tested together with any substrate or surface coating.

NOTE The specimen may include an air gap.

### 3.12

#### **intumescent material**

dimensionally unstable material, developing a carbonaceous expanded structure of thickness > 10 mm during the test, with the cone heater 25 mm from the specimen

## 4 Principles of the test

Specimens of the product are mounted horizontally within a chamber and exposed to thermal radiation on their upper surfaces at selected levels of constant irradiance up to 50 kW/m<sup>2</sup>.

The smoke evolved is collected in the chamber, which also contains photometric equipment. The attenuation of a light beam passing through the smoke is measured. The results are reported in terms of specific optical density.

## 5 Suitability of a material or product for testing

### 5.1 Material or product geometry

5.1.1 The method is applicable to essentially flat materials, products, composites or assemblies not exceeding 25 mm in thickness.

5.1.2 The method is sensitive to small variations in geometry, surface orientation, thickness (either overall or of the individual layers), mass and composition of the material, and so the results obtained by this method only apply to the thickness of the material or product as tested.

5.1.3 It is not possible to calculate the specific optical density of one thickness of a material or product from the specific optical density of another thickness of the material or product.

### 5.2 Surface characteristics

A material or product having one of the following properties is suitable for testing:

- a) an essentially flat exposed surface;
- b) a surface irregularity which is evenly distributed over the exposed surface provided that
  - 1) at least 50 % of the surface of a representative 100 mm<sup>2</sup> area lies within a depth of 10 mm from a plane taken across the highest points on the exposed surface or
  - 2) for surfaces containing cracks, fissures, or holes not exceeding 8 mm in width or 10 mm in depth, the total area of such cracks, fissures, or holes at the surface does not exceed 30 % of a representative 100 mm<sup>2</sup> area of the exposed surface.

When an exposed surface does not meet the requirements of either 5.2 a) or 5.2 b), the material or product shall be tested in a modified form complying as close as possible with the requirements given in 5.2. The test report shall state that the material or product has been tested in a modified form and clearly describe the modification.

## ISO/DIS 5659-2:201X(E)

### 5.3 Asymmetrical products

It is possible that a product submitted to this test will have faces which differ or contain laminations of different materials arranged in a different order in relation to the two faces. If either of the faces can be exposed in use within a room, cavity, or void, both faces shall be tested.

## 6 Specimen construction and preparation

### 6.1 Number of specimens

**6.1.1** The test sample shall comprise a minimum of 12 specimens if all four modes are to be tested: six specimens shall be tested at 25 kW/m<sup>2</sup> (three specimens with a pilot flame and three specimens without a pilot flame) and six specimens shall be tested at 50 kW/m<sup>2</sup> (three specimens with a pilot flame and three specimens without a pilot flame).

If fewer than four modes are to be tested, a minimum of three specimens per mode shall be tested.

**6.1.2** An additional number of specimens as specified in 6.1.1 shall be used for each face, in accordance with the requirements of 5.2.

**6.1.3** An additional 12 specimens (i.e. three specimens per test mode) shall be held in reserve if required by the modes specified in 10.9.

**6.1.4** In case of intumescent materials, it is necessary to make a preliminary test with the cone heater at 50 mm from the specimen, so at least two additional specimens are required.

### 6.2 Size of specimens

**6.2.1** The specimens shall be square, with sides measuring 75 mm ± 1 mm.

**6.2.2** Materials of 25 mm nominal thickness or less shall be evaluated at their full thickness. For comparative testing, materials shall be evaluated at a thickness of 1,0 mm ± 0,1 mm. All materials consume oxygen when they burn in the chamber, and the smoke generation of some materials (especially rapid-burning or thick specimens) is influenced by the reduced oxygen concentration in the chamber. As far as possible, materials shall be tested in their end-use thickness.

**6.2.3** Materials with a thickness greater than 25 mm shall be cut to give a specimen thickness of 25 mm ± 0,1 mm, in such a way that the original (uncut) face can be evaluated.

**6.2.4** Specimens of multi-layer materials with a thickness greater than 25 mm, consisting of core material(s) with facings of different materials, shall be prepared as specified in 6.2.3 (see also 6.3.2).

### 6.3 Specimen preparation

**6.3.1** The specimen shall be representative of the material and shall be prepared in accordance with the procedures described in 6.3.2 and 6.3.3. The specimens shall be cut, sawn, moulded or stamped from identical sample areas of the material, and records shall be kept of their thicknesses and, if required, their masses.

**6.3.2** If flat sections of the same thickness and composition are tested in place of curved, moulded or speciality parts, this shall be stated in the test report. Any substrate or core materials for the specimens shall be the same as those used in practice.

**6.3.3** When coating materials, including paints and adhesives, are tested with the substrate or core as used in practice, specimens shall be prepared following normal practice, and in such cases the method of application of the coating, the number of coats and the type of substrate shall be included in the test report.

**6.3.4** This test method has been found suitable for applications outside the field of plastics, or to transformed products in their end-use shape. Such specific sampling conditions are proposed in Annex F.

## 6.4 Conditioning

**6.4.1** Before the test, specimens shall be conditioned to constant mass at a temperature of  $(23 \pm 2)$  °C and a relative humidity of  $(50 \pm 5)$  % in accordance with ISO 291.

NOTE Constant mass is considered to be reached when two successive weighing operations, carried out at an interval of 24 h, do not differ by more than 0,1 % of the mass of the test piece or 0,1 g, whichever is the greater. Materials, such as polyamides, which require more than one week of conditioning to reach equilibrium, may be tested after conditioning for a period specified by the sponsor. This period shall not be less than one week and shall be described in the test report.

**6.4.2** While in the conditioning chamber, specimens shall be supported in racks so that air has access to all surfaces.

Forced-air movement in the conditioning chamber may be used to assist in accelerating the conditioning process.

The results obtained from this method are sensitive to small differences in specimen conditioning. It is important therefore to ensure that the requirements of 6.5 are followed carefully.

## 6.5 Wrapping of specimens

**6.5.1** All specimens shall be covered across the back, along the edges and over the front surface periphery, leaving a central exposed specimen area of 65 mm × 65 mm, using a single sheet of aluminium foil (approximately 0,04 mm thick) with the dull side in contact with the specimen. Care shall be taken not to puncture the foil or to introduce unnecessary wrinkles during the wrapping operation. The foil shall be folded in such a way as to minimize losses of any melted specimen material at the bottom of the specimen holder. After mounting the specimen in its holder, any excess foil along the front edges shall be trimmed off.

### 6.5.2

1. Wrapped specimens of thickness up to 12,5 mm shall be backed with a sheet of non-combustible insulating board of oven-dry density  $850 \text{ kg/m}^3 \pm 100 \text{ kg/m}^3$  and nominal thickness 12,5 mm and a layer of low-density (nominal  $65 \text{ kg/m}^3$ ) refractory fibre blanket under the non-combustible board.
2. Wrapped specimens of thickness greater than 12,5 mm but less than 25 mm shall be backed with a layer of low-density (nominal  $65 \text{ kg/m}^3$ ) refractory fibre blanket
3. Wrapped specimens of a thickness of 25 mm shall be tested without any backing board or refractory fibre blanket.

## ISO/DIS 5659-2:201X(E)

**6.5.3** For resilient materials, each specimen in its aluminium foil wrapper shall be installed in the holder in such a way that the exposed surface lies flush with the inside face of the opening of the specimen holder. Materials with uneven exposed surfaces shall not protrude beyond the plane of the opening in the specimen holder.

**6.5.4** When thin impermeable specimens, such as thermoplastic films, become inflated during the test owing to gases trapped between the film and backing, they shall be maintained essentially flat by making two or three cuts (20 mm to 40 mm long) in the film to act as vents.

## 7 Apparatus and ancillary equipment

### 7.1 General

The apparatus (see Figure 1) shall consist of an air-tight test chamber with provision for containing a specimen holder, radiation cone, pilot burner, light transmission and measuring system and other, ancillary facilities for controlling the conditions of operation during a test.

### 7.2 Test chamber

#### 7.2.1 Construction

**7.2.1.1** The test chamber (see Figure 1 and Figure 2) shall be fabricated from laminated panels, the inner surfaces of which shall consist of either a porcelain enamelled metal not more than 1 mm thick or an equivalent coated metal which is resistant to chemical attack and corrosion and capable of easy cleaning. The internal dimensions of the chamber shall be 914 mm  $\pm$  3 mm long, 914 mm  $\pm$  3 mm high and 610 mm  $\pm$  3 mm deep. It shall be provided with a hinged front-mounted door with an observation window and a removable opaque door cover to the window to prevent light entering the chamber. The door of the chamber shall occupy a complete side of the smoke chamber. A safety blow-out panel, consisting of a sheet of aluminium foil of thickness not greater than 0,04 mm and having a minimum area of 80 600 mm<sup>2</sup>, shall be provided in the chamber, fastened in such a way as to provide an airtight seal.

The blow-out panel may be protected by a stainless-steel wire mesh. It is important that any such mesh is spaced at least 50 mm from the blow-out panel to prevent any obstruction in the event of an explosion.

**7.2.1.2** Two optical windows, each with a diameter of 75 mm, shall be mounted, one each in the top and bottom of the cabinet, at the position shown in Figure 2, with their interior faces flush with the outside of the chamber lining. The underside of the window in the floor shall be provided with an electric heater of approximately 9 W capacity in the form of a ring, which shall be capable of maintaining the upper surface of the window at a temperature just sufficient to minimize smoke condensation on that face (a temperature of 50 °C to 55 °C has been found suitable) and which shall be mounted around its edge so as not to interrupt the light path. Optical platforms 8 mm thick shall be mounted around the windows on the outside of the chamber and shall be held rigidly in position relative to each other by three metal rods, with a diameter of at least 12,5 mm, extending through the chamber and fastened securely to the platforms.

**7.2.1.3** Other openings in the chamber shall be provided for services as specified and where appropriate. They shall be capable of being closed so that a positive pressure up to 1,5 kPa (150 mm water gauge) above atmospheric pressure can be developed inside the chamber (see 7.2.2) and maintained when checked in accordance with 7.6 and 9.6. All components of the chamber shall be capable of withstanding a greater positive internal pressure than the safety blow-out panel.