# INTERNATIONAL STANDARD

# ISO 9705-1

First edition
2016-02-15

# Reaction to fire tests — Room corner test for wall and ceiling lining products —

## Part 1:
## Test method for a small room configuration



*Essais de réaction au feu — Essai dans le coin d'une pièce pour les produits de revêtement pour murs et plafonds —*

*Partie 1: Méthode d'essai pour une configuration de petite pièce*



Reference number
ISO 9705-1:2016(E)

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

# Contents

Page





# 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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword — Supplementary information.



The committee responsible for this document is ISO/TC 92, *Fire safety*, Subcommittee SC 1, *Fire initiation and growth*.



This first edition of ISO 9705-1 cancels and replaces ISO 9705:1993, which has been technically revised. It also incorporates the Corrigendum ISO 9705:1993/Cor 1:1993.

ISO 9705 consists of the following parts, under the general title *Reaction to fire tests — Room corner test for wall and ceiling lining products*:

— *Part 1: Test method for a small room configuration*

— *Part 2: Technical background and guidance* [Technical Report]

## Introduction

This part of ISO 9705 is intended to describe the fire behaviour of a product under controlled laboratory conditions.

The test method may be used as part of a fire hazard assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.



# Reaction to fire tests — Room corner test for wall and ceiling lining products —

# Part 1: Test method for a small room configuration

**WARNING — So that suitable precautions can be taken to safeguard health, the attention of all concerned in fire tests is drawn to the possibility that toxic or harmful gases can be evolved during combustion of test specimens. The test procedures involve high temperatures and combustion processes from ignition to a fully developed room fire. Therefore, hazards can exist for burns, ignition of extraneous objects or clothing. The operators should use protective clothing, helmet, face-shield and equipment for avoiding exposure to toxic gases. Means of extinguishing a fully developed fire should be available.**

## 1 Scope

This part of ISO 9705 specifies the test method to evaluate the reaction of wall and ceiling products to fire when installed at the surface of a small room and exposed directly to a specified ignition source. The test represents a fire scenario, which starts under well-ventilated conditions in a corner of a specified room with a single open doorway.



Tests performed in accordance with the method specified in this part of ISO 9705 provide data for the early stages of a fire from ignition up to flashover. The method does not evaluate the fire resistance of products.



The method is not intended to evaluate floor coverings. This method is not suitable for sandwich panel building systems, pipe insulation and façades for which specific ISO standards (i.e. ISO 13784, ISO 20632 and ISO 13785, respectively) are available.

## 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*

EN 13238, *Reaction to fire tests for building products — Conditioning procedures and general rules for selection of substrates*

## 3 Terms and definitions

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

**3.1**
**exposed surface**
surface of the product subjected to the heating conditions of the test

**3.2**
**material**
single substance or uniformly dispersed mixture

EXAMPLE This includes metal, stone, timber, concrete, mineral fibre, and polymers.

**3.3**
**product**
material, composite or assembly about which information is required

**3.4**
**specimen**
representative piece of the product which is to be tested together with any substrate or treatment

Note 1 to entry: The specimen may include an air gap.

**3.5**
**wall and ceiling lining product**
wall and ceiling products, installed at the surface of a room and exposed directly to a specified ignition source

**3.6**
**flashover**
point in the fire history when the sum of the heat release rate from the ignition source and the product reaches 1 000 kW

Note 1 to entry: Heat release rate calculated as a 30-second sliding average, $HRR_{smooth}$, as given in Annex E.

**3.7**
**Fire Growth Rate**
**FIGRA**
growth rate of the fire during a specified time period



**3.8**
**Smoke Growth Rate**
**SMOGRA**
growth rate of the smoke during a specified time period



**3.9**
**burning droplets**
continuous occurrence of flaming droplets/particles from the specimen for at least 10 s or until a pool fire forms on the floor

## 4 Principle

The hazard of fire growth is evaluated by the measurement of the rate of heat release of the fire based on calculation of oxygen consumption.

The hazard of reduced visibility is estimated by the measurement of production of light-obscuring smoke.

Phenomena attributed to the fire growth, for example flame spread and emission of burning droplets, are visually documented by photographic and/or video recording.

NOTE If further information is required, measurements, for example of heat flux to the floor, toxic gas species, the gas temperature in the room and the mass flow in and out the doorway, can be performed. See also ISO/TR 9705-2.

## 5 Fire test room

### 5.1 Dimensions

The room (see Figure 1) shall consist of four walls at right angles, a floor and a ceiling and shall have the following inner dimensions:

a) length: 3,6 m ± 0,05 m;

b) width: 2,4 m ± 0,05 m;

c) height: 2,4 m ± 0,05 m.

The room shall be placed indoors in an essentially draught free, heated space, large enough to ensure that there is no influence on the test fire. In order to facilitate the mounting of the instruments of the ignition source, the test room may be placed so that the floor can be reached from beneath.

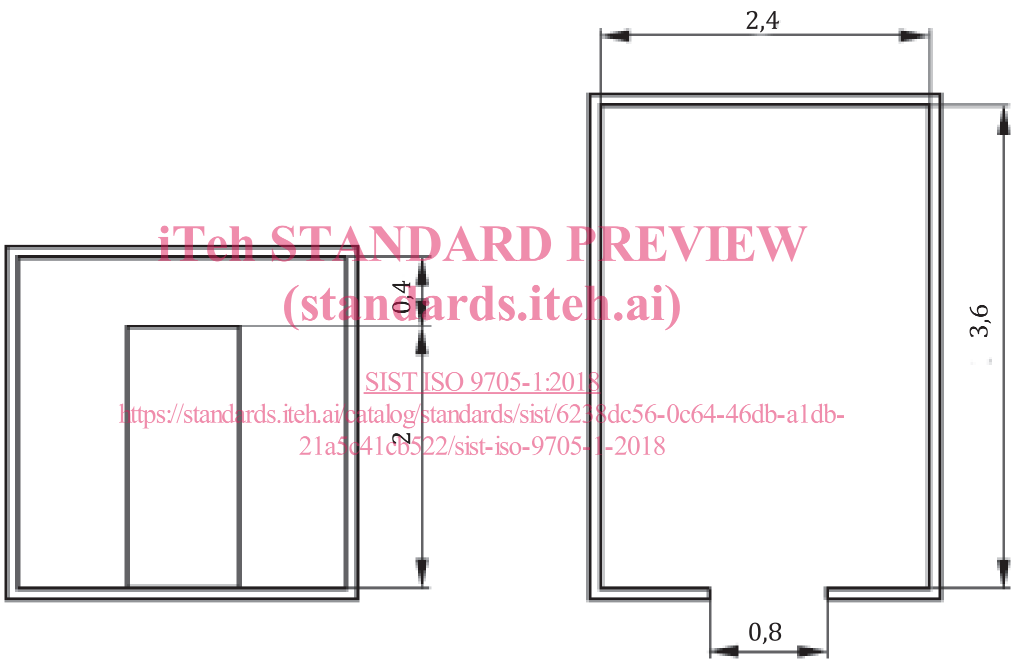
### 5.2 Doorway

There shall be a doorway in the centre of one of the 2,4 m × 2,4 m walls and no other wall, floor or ceiling shall have any openings that allow ventilation. The doorway shall have the following dimensions:

a) width: 0,8 m ± 0,01 m;

b) height: 2,0 m ± 0,01 m.

Dimensions in metres






**a) Front view** **b) Top view**

**Figure 1 — Fire test room**

### 5.3 Construction material

The test room shall be constructed of non-combustible material with a density of (600 ± 200) kg/m$^3$. The minimum thickness of the construction shall be 20 mm.

## 6 Ignition source

### 6.1 General

The ignition source design is specified in Annex A.

The ignition source shall be a propane gas burner having a nominal 170 mm × 170 mm square top surface layer of a porous, inert material. The top portion of the porous material shall be a minimum 45 mm of sand. The construction shall be such that an even gas flow is achieved over the entire opening area.

The burner shall be ignited with a remote-controlled ignition device, for example a pilot burner or a spark igniter. The burner shall be provided with controls for gas supply shut-off if flameout occurs or if there is a gas leak.

Because the propane gas burner consumes relatively large amounts of gas, the attention is therefore drawn to the following warning.

**WARNING — All equipment such as tubes, couplings, flowmeters, etc. shall be approved for propane. The installations shall be performed in accordance with existing regulations.**

### 6.2 Location

The burner shall be placed on the floor in a corner opposite to the doorway wall. The top surface of the burner through which the gas is supplied shall be located horizontally, (146 ± 3) mm off the floor, and the burner enclosure shall be in contact with both walls in the corner.

### 6.3 Gas

The burner shall be supplied with natural grade propane (95 % purity). The gas flow to the burner shall be measured throughout the test with an accuracy of at least ±3 %. The heat output to the burner shall be controlled within ±5 % of the prescribed value. Flow rates of gas shall be calculated using a net heat of combustion of propane of 46,4 MJ/kg.



### 6.4 Heat output

The net heat output shall be 100 kW during the first 10 min after ignition and then shall be increased to 300 kW for a further 10 min.



## 7 Hood and exhaust duct

The system for collecting the combustion products shall have a capacity and be designed in such a way that all of the combustion products leaving the fire room through the doorway during a test are collected. The system shall not disturb the fire-induced flow in the doorway. The maximum exhaust capacity shall be at least 3,5 $m^3s^{-1}$ at normal pressure and a temperature of 25 °C.

NOTE An example of one design of hood and an exhaust duct is given in Annex C.

## 8 Instrumentation in the exhaust duct

### 8.1 General

This Clause specifies minimum requirements for instrumentation in the exhaust duct. Additional information and designs can be found in Annex D.

### 8.2 Volume flow rate

The volume flow rate in the exhaust duct shall be measured to an accuracy of at least ±5 %.

The response time of the measurement system to a stepwise change of the duct flow rate shall be a maximum of 3 s at 90 % of the final value.

## 8.3 Gas analysis

### 8.3.1 Sampling line

The gas samples shall be taken in the exhaust duct at a position where the combustion products are uniformly mixed. The sampling line shall be made from an inert material which will not influence the concentration of the gas species to be analysed (see Annex D).

### 8.3.2 Oxygen

The $O_2$ analyser shall be of the paramagnetic type or equivalent in performance and capable of measuring a range of at least 0 Vol % to 21 Vol % oxygen ($Volume_{O2}/Volume_{air}$). The uncertainty of measurement shall be ≤ 0,1 Vol % $O_2$ or better. The stability of the analyser shall be within 0,01 Vol % $O_2$ over a period of 30 min (measured as recommended in accordance with D.3.2). The output from the analyser and also the data acquisition system shall have a resolution of 0,01 Vol % $O_2$ or better.

### 8.3.3 Carbon dioxide

The $CO_2$ analyser shall be of the IR type or equivalent in performance and capable of measuring a range of at least 0 Vol % to 10 Vol % carbon dioxide. The uncertainty of measurement shall be ≤ 0,1 Vol % $CO_2$ up to 5 Vol % $CO_2$ and ≤ 0,2 Vol % $CO_2$ from 5 to 10 Vol % $CO_2$. The linearity of the analyser shall be 1 % of full scale or better. The output from the analyser and also the data acquisition system shall have a resolution of 0,01 Vol % $CO_2$ or better.

## 8.4 Optical density



### 8.4.1 General



The optical density of the smoke is determined by measuring the light obscuration with a system consisting of a lamp, lenses, an aperture and a photocell (see Figure 2) or with a laser system as given in Annex H.

### 8.4.2 Lamp

The lamp shall be of the incandescent filament type and shall operate at a colour temperature of (2 900 ± 100) K. The lamp shall be supplied with stabilized direct current, stable within ±0,5 % (including temperature, short-term and long-term stability).

### 8.4.3 Lenses

The lens system shall align the light to a parallel beam with a diameter, *D*, of at least 20 mm.

### 8.4.4 Aperture

The aperture shall be placed at the focus of the lens $L_2$ as shown in Figure 2 and it shall have a diameter, *d*, chosen with regard to the focal length, *f*, of $L_2$ so that *d/f is* less than 0,04. Other solutions to avoid light scattering are allowed.

### 8.4.5 Detector

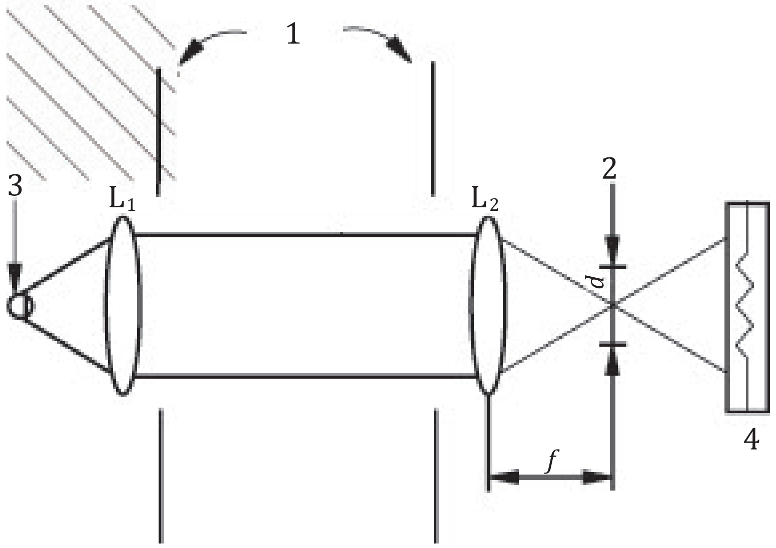
The detector shall have a spectrally distributed response agreeing with the CIE[1)], V(λ)-function (the CIE photopic curves) to an accuracy of at least ±5 %.

The detector output shall be linear within 5 % or 0,01 of the measured optical density value, over an output range of at least two decades. A routine to check this requirement is given in D.4.2.3.

1) Commission Internationale d'Eclairage.

### 8.4.6 Location

The light beam shall cross the exhaust duct along its diameter at a position where the smoke is homogenous.




**Key**

1 wall of exhaust duct

2 aperture

3 lamp

4 detector



**Figure 2 — Optical system**



## 9 System performance

### 9.1 System response

#### 9.1.1 Procedure

The delay times and response times of the gas analysis system shall be checked for a stepwise change of the heat output from the burner according to Table 1. The burner shall be placed centrally 3,5 m below the centre line of the duct. Measurements shall be taken every 3 s. The volume flow rate of the exhaust system shall be set to (2,5 ± 0,5) $m^3s^{-1}$.

**Table 1 — Burner heat output profile**

| Step Number | Time<br>min | Heat output<br>kW |
|---|---|---|
| 1 | 0 to 2 | 0 |
| 2 | 2 to 7 | 100 |
| 3 | 7 to 12 | 300 |
| 4 | 12 to 17 | 100 |
| 5 | 17 to 19 | 0 |

### 9.1.2 Delay times

The delay time of the oxygen analyser is found as the time difference between a 3 K change in the duct temperature and a 0,05 % change in the oxygen concentration. The delay time of the carbon dioxide analyser is found as the time difference between a 3 K change in the duct temperature and a 0,02 % change in the carbon dioxide concentration. Neither delay time shall exceed 30 s. The data shall be corrected on the basis of these delay times before calculating the heat release rate.

### 9.1.3 Response times

The response times are found as the time between a 10 % and 90 % change in the measured oxygen or carbon dioxide level. The response times shall not exceed 18 s.

### 9.1.4 Calculations

Based on the unshifted data, calculate:

a) for each step:

1) $t_{gas}$, the start time of the step as the time of the first data point at which the propane flow has changed by 100 mg/s in comparison with the mean value in the last 2 min of the previous step;

2) $t_T$, the time of the first data point at which the temperature $T_s$ has changed 3,0 K in comparison with the mean value in the last 2 min of the previous step;

3) $t_{O2}$, the time of the first data point at which the oxygen concentration has changed 0,05 % in comparison with the mean value in the last 2 min of the previous step;

4) $t_{CO2}$, the time of the first data point at which the carbon dioxide concentration has changed 0,02 % in comparison with the mean value in the last 2 min of the previous step;

5) $t_{O2,10\,\%}$, the time of the first data point at which the oxygen concentration has reached 10 % of its deflection using the mean values in the last 2 min of the previous and the current step;

6) $t_{O2,90\,\%}$, analogous to $t_{O2,10\,\%}$, however for 90 % instead of 10 % deflection;

7) $t_{CO2,10\,\%}$, the time of the first data point at which the carbon dioxide concentration has reached 10 % of its deflection using the mean values in the last 2 min of the previous and the current step;

8) $t_{CO2,90\,\%}$, analogous to $t_{CO2,10\,\%}$, however for 90 % instead of 10 % deflection;

b) the delay time of the oxygen analyser as the mean of $t_{O2} - t_T$ found for steps 2, 3, 4 and 5;

c) the delay time of the carbon dioxide analyser as the mean of $t_{CO2} - t_T$ found for steps 2, 3, 4 and 5;

d) the response time of the oxygen analyser as the mean of $t_{O2,90\,\%} - t_{O2,10\,\%}$ found for steps 2, 3, 4 and 5;

e) the response time of the carbon dioxide analyser as the mean of $t_{CO2,90\,\%} - t_{CO2,10\,\%}$ found for steps 2, 3, 4 and 5;

## 9.2 Daily Check

A calibration test shall be performed prior to each test or continuous test series.

NOTE Formulae for calculations are given in Annex E.

The calibration shall be performed with the burner heat outputs given in Table 1, with the burner placed centrally 3,5 m below the centre line of the duct . Measurements shall be taken every 3 s and shall be started 2 min prior to ignition of the burner. At steady-state conditions, the difference between the mean heat release rate ($HRR_{total}$) over 1 min (during the time interval between 180 s and 240 s after the start of steps 2, 3 and 4) calculated from the measured oxygen consumption and that calculated from the metered gas input ( $\dot{q}_b$ ) shall not exceed 5 % for each level of heat output in steps 2, 3 and 4.

## 9.3 Precision

The precision of the system at various volume flow rates shall be checked by increasing the volume flow in the exhaust duct in four equal steps, starting from 2 $m^3s^{-1}$ (at 0,1 MPa and 25 °C) up to the maximum. The heat output from the burner shall be 300 kW. The error in the mean heat release rate, calculated over 1 min shall be not more than 10 % of the actual heat output from the burner.

## 9.4 Methanol calibration

### 9.4.1 Frequency of calibration

At least once a year, or more often if needed, a calibration check using methanol shall be performed.

### 9.4.2 Container

The container for burning the methanol shall be of circular geometry and made of steel. The diameter of the container shall be (720 ± 10) mm and the height shall be (150 ± 10) mm. The thickness of the steel sheets shall be 2,0 mm. This gives a fuel area of (0,41 ± 0,01) $m^2$.

### 9.4.3 Methanol



The methanol shall have a purity of at least 98 %. The volume of methanol should be 10 l (approximately 7 920 g). The fire from the pool will release about 140 kW. One litre of methanol may be collected and stored in a separate container, so in case any doubt should arise about the purity of the liquid it can be chemically analysed at a later stage.



### 9.4.4 Procedure for methanol calibration

#### 9.4.4.1 Initial conditions

The fuel container shall be placed on a weighing platform consisting of a slab placed on top of a weight measuring device. The slab shall have the dimensions 1,2 m × 1,2 m and be of calcium silicate boards according to EN 13238.

The weight measuring device, e.g. load cells, shall measure the specimen mass with an accuracy of at least ±100 g up to at least 90 kg of specimen mass. It shall be installed in such a way that the heat from the burning sample and any eccentricity of the load does not affect the accuracy. Care should be taken to avoid range shifts during measurements. All parts of the weight-measuring device, e.g. load cells, shall be below the top level of the slab.

The distance from the upper surface of the slab to floor level shall not exceed 0,5 m. The area between the slab and the floor level shall be shielded in order to avoid lifting forces due to fire induced air flow that could influence the measurement.

The container shall be centred under the hood and be in the horizontal plane.

The temperature of the fuel, the container and ambient shall be (20 ± 5) °C. The fuel container shall be allowed to cool between tests. The amount of fuel dispensed into the container shall be weighed with an accuracy of ±10 g.

The horizontal wind draught measured at a distance of 0,5 m from the boundary of the weighing platform in level with the slab shall not exceed 0,5 m/s.

#### 9.4.4.2 Volume flow

The volume flow rate of the exhaust system shall be set to (2,5 ± 0,5) $m^3s^{-1}$.

#### 9.4.4.3 Base line recording

A baseline of at least 2 min shall be recorded prior to the ignition of the fuel.

#### 9.4.4.4 Ignition sequence

The fuel shall be ignited in such way that the weighing of the sample is not disturbed, for instance a burning match thrown into the fuel.

#### 9.4.4.5 End of calibration test

After the fuel has burnt out, the measurements shall continue for another 2 min.

### 9.4.5 Requirements for methanol calibration

The effective heat of combustion, $\Delta H_{c,eff}$, calculated as the total heat released/total mass lost shall not deviate from the theoretical value of 19,83 kJ/g by more than 10 %. The value 17,3 MJ/$m^3$ at 25 °C for E (see E.2.2) shall be used.

NOTE Precision of calibration from an exercise amongst International laboratories is given in Annex G.



## 10 Preparation of test specimens

### 10.1 Specimen configuration



The product to be tested shall, as far as possible, be mounted in the same way as in the end use application. Configurations for mounting the specimen in the test room are given in Annex F.

### 10.2 Boards

In cases where the product to be tested is in board form, the normal width, length and thickness of the boards shall be used as far as possible.

### 10.3 Mounting

The product shall be attached either to a substrate or directly to the interior of the fire room. The mounting technique (for example, nailing, gluing, using a support system) shall, as far as possible, conform to that used for the product in its end use application. The thickness of the specimen including air gap shall be a maximum of 100 mm. The mounting technique shall be clearly stated in the report (see Clause 12), particularly if the mounting technique used improves the physical behaviour of the specimen during the test.

### 10.4 Substrates

Products shall be applied to a substrate according to EN 13238.

### 10.5 Paints and varnishes

Paints and varnishes shall be applied to the substrates at the application rate specified by the sponsor.