INTERNATIONAL STANDARD

ISO 13784-2

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Reaction-to-fire tests for sandwich panel building systems —

Part 2: Test method for large rooms

Essais de réaction au feu des systèmes de fabrication de panneaux de type sandwich —

Partie 2: Méthode d'essai pour des chambres de grande taille

Reference number
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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 3.

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 part of ISO 13784 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 13784-2 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 1, *Fire initiation and growth*.

ISO 13784 consists of the following parts, under the general title *Reaction-to-fire tests for sandwich panel building systems*:

— *Part 1: Test method for small rooms*

— *Part 2: Test method for large rooms*

Introduction

Fire is a complex phenomenon, its behaviour and effects dependent 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 (for the philosophy of reaction-to-fire tests, see ISO/TR 3814).

The need for improved insulation of buildings has led to the increased use of insulating sandwich panel systems in different parts of the building industry. Sandwich panel systems are applied as external cladding on factory buildings, in internal envelopes with controlled atmospheres and in cold stores — varying from small rooms to large, cool houses. Other applications are in modular building rooms and, sometimes, retail premises. These systems can also be used for roof applications in traditional constructions. Multi-layered panels with other facings (e.g. plasterboard) or sandwich panel systems can also be applied to walls as internal linings or insulation; however, this is not within the scope of ISO 13784.

There exist three primary fire-related threats to the walls and ceilings or roofs of a building insulated with freestanding or frame-supported types of sandwich panel systems:

a) an interior compartment fire impinging directly onto the joints of the wall, typical ignition sources being welding torches, burning items near the wall and fire in an adjacent room;

b) an external fire or combustibles (rubbish, vegetation, vehicles, etc.) accumulated near the wall;

c) fire spread to outside spaces.

Moreover, such a fire can spread in several ways:

— over a combustible exterior surface;

— by travelling vertically and horizontally through the combustible cores of cavities within the external wall or ceiling/roof;

— through combustible gases which have developed due to the pyrolysis of the combustible components and which will ignite on the surface;

— as burning debris or flaming droplets.

This part of ISO 13784 deals with a simple representation of a fire scenario involving a sandwich panel system — such as that typified by a local fire impinging directly on the internal face of a sandwich panel building construction. The test method specified can be used to provide a large-room scale, end-use evaluation of all aspects of sandwich panel systems, including constructional techniques (supporting frameworks, jointing detail, etc.)

The test method is intended for evaluating products which, by their nature, are not normally used as internal linings and are unsuitable for assessment using ISO 9705[1], which evaluates fire growth from a surface product. Nevertheless, this part of ISO 13784 provides a means by which a freestanding or frame-supported sandwich panel building construction can be built and evaluated.

Testing of this type can be used for comparative purposes or to ensure the existence of a certain quality of performance considered to have a bearing on fire performance generally; it does not rely on the use of asbestos-based materials.

Reaction-to-fire tests for sandwich panel building systems —

Part 2:
Test method for large rooms

SAFETY PRECAUTIONS — In order 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 concerned 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. Operators should use protective clothing, helmet, face-shield and equipment for avoiding exposure to toxic gases.

Laboratory safety procedures shall be set up which ensure the safe termination of tests on sandwich panel products. Specimens with combustible content burning inside metallic facings can be difficult to extinguish with standard laboratory fire fighting equipment. Adequate means of extinguishing such a fire shall be provided.

When tests are conducted using the freestanding or frame-supported constructions, specimens could emit combustion products from their external faces, especially if joints open up. Specimen collapse can also occur. Laboratory safety procedures shall be set up to ensure the safety of personnel with due consideration to such situations.

For construction of the test enclosure using a freestanding structure without structural framework, because of the size and weight of the individual panels it is strongly recommended that construction be accomplished within an additional external support framework (e.g. scaffolding). If the test enclosure is erected in an outside environment, it is further recommended that the external framework remain in place during the test. The task of this framework is only to avoid collapse of the test room caused by wind action. This additional framework shall not be used to fix and support the sandwich panels.

1 Scope

This part of ISO 13784 specifies a test method for evaluating the reaction-to-fire performance of sandwich panel building systems for large rooms and the resulting flame spread on or within the sandwich panel building construction when it is exposed to heat from a simulated internal fire with flames impinging directly on its internal corner. The test method is not intended for evaluating a product's fire resistance.

This part of ISO 13784 is applicable to both freestanding and self-supporting, and frame-supported, sandwich panel systems, but only to wall and ceiling or roof constructions.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 13784. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 13784 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO/TR 9705-2, *Reaction-to-fire tests — Full-scale room tests for surface products — Part 2: Technical background and guidance*

ISO 13784-1, *Reaction-to-fire tests for sandwich panel building systems — Part 1: Test method for small rooms*

ISO 13943, *Fire safety — Vocabulary*

IEC 60584-2, *Thermocouples — Part 2: Tolerances*

3 Terms and definitions

For the purposes of this part of ISO 13784, the terms and definitions given in ISO 13943 and the following apply.

3.1
composite
combination of materials generally recognized in building construction as discrete entities

EXAMPLE Coated or laminated materials.

3.2
exposed surface
surface of the product subjected to the heating conditions of the test

3.3
product
material, composite or assembly

3.4
constant mass
state of a test specimen when two successive weighing apparatus operations carried out at an interval of 24 h do not differ by more than 0,1 % of the mass of the specimen or by 0,1 g, whichever is greater

3.5
surface product
any part of a building constituting an exposed surface on the walls or ceiling/roof, or on both

EXAMPLE Panel or board.

3.6
insulating sandwich panel
multi-layered product consisting of three or more layers bonded together

NOTE One layer is an insulating material, such as mineral or glass wool, cellular plastics or a natural material (e.g. corkboard), protected by facings on both sides. Facings can be selected from a variety of materials and can be either flat or profiled. The most widely used facing is coated steel. The composite can vary from a simple construction to a complex composite system with specific fixing joints and supports, depending on the application and on the performance requirements.

3.7
specimen
assembly representing the end-use construction

4 Principle

The reaction to fire performance of a sandwich panel assembly is assessed when it is exposed to flames impinging directly on the internal corner of a sandwich panel assembly. The different kinds of flame spread that can occur are flame spread within the internal core, on the surface or through joints, by ignited combustible gases and by falling

debris or melting droplets of the sandwich panel assembly. The assessment allows determination of the following possible fire hazards:

— the contribution of the system to fire development up to flashover;

— the potential for transmitting an interior fire to outside spaces or other compartments or adjacent buildings;

— the possibility of the structure's collapse;

— the development of smoke and fire gases inside the test room.

5 Types of structure

The test method is applicable to the following two types of structure, representative of those used in practice both in respect of construction and materials.

a) **Frame-supported structures**

Sandwich panel systems are mechanically fixed to the outside or the inside of a structural framework — normally steel — through the thickness of the panel. The ceiling/roof can be built traditionally or using sandwich panel systems. A widespread example is the external cladding of industrial buildings. In most cases, this kind of sandwich panel system is used on a building's exterior wall, roof or both.

Deformation of the frame can influence the fire behaviour of the sandwich panels. Where the frame is protected in practice because of fire resistance requirements, this should also be the case for the frame under test. Protection can be obtained by means of insulating boards or coatings.

b) **Freestanding structures**

Sandwich panel systems are assembled together to provide a room or enclosure that does not depend for its stability on any other structural framework (e.g. cold stores, food or clean rooms, generally constructed within a weatherproof shell). Normally situated inside a building, the ceilings of these constructions may be supported from above.

6 Test specimen

The test specimen shall consist of the requisite number of panels required for the test to be performed. In all cases, the test specimen shall be representative of that used in practice, both in construction and materials. All constructional details of joints, fixings, etc., shall be reproduced and positioned in the test specimen as in practice. If the type of sandwich panel under test is used in practice with an inside or outside structural framework, this shall be included in the test.

The test specimen should be built by those suitably qualified in the construction of this type of structure.

If, in practice, ceiling panels are different from wall panels, a test may be performed with the correct combination of wall and ceiling panels.

If the sandwich panel building system is intended for use with decorative paint or film facings, these shall be present on the test specimen.

7 Test room design and construction

7.1 The test method consists of a procedure by which sandwich panel assemblies are assessed in their end-use scale and with the constructional details incorporated in their end use. Products are evaluated with end-use joints and fixings; where a supporting steel framework is part of the construction, testing is done with this framework also in place. Where the panels are self-supporting, for safety reasons an unconnected external framework should be used.

7.2 Perform the test on a sandwich panel specimen in accordance with clause 6, erected as in end-use practice to form a large room configuration (see Figure 1). The room shall consist of four walls at right angles and a ceiling, and shall be located on a rigid, non-combustible floor surface. The room shall have the following inner dimensions.

Length: $(4{,}8 \pm 0{,}05)$ m

Width: $(4{,}8 \pm 0{,}05)$ m

Height: $(4 \pm 0{,}05)$ m

7.3 Provide a doorway in the front wall of the room; no other wall shall have any openings allowing ventilation. The doorway shall have the following dimensions.

Width: $(4{,}8 \pm 0{,}05)$ m

Height: $(2{,}8 \pm 0{,}05)$ m

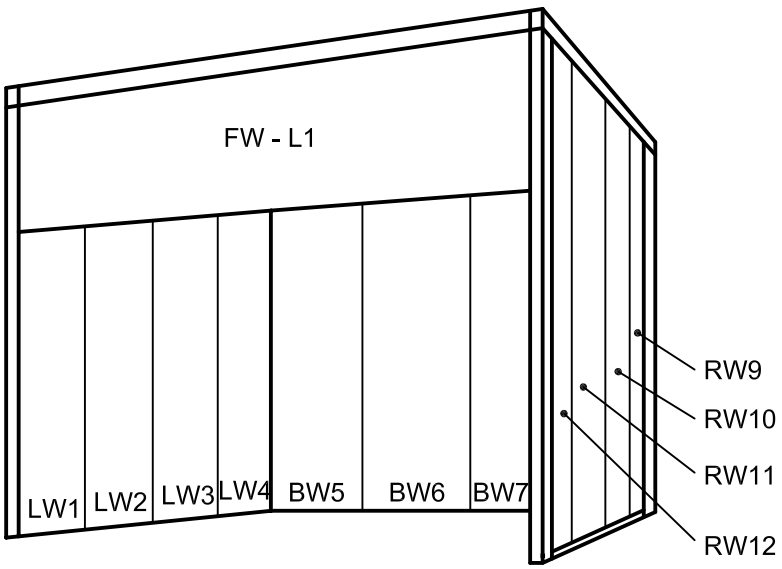
7.4 The room may be located indoors or outdoors.

7.5 Full and detailed drawings of the various elements of construction, including all jointing details and any framework required with attachment details, shall be provided by the panel system manufacturer prior to the test.

See Figures 2 and 3 for an example of an inside support framework for structural fixed sandwich panels.

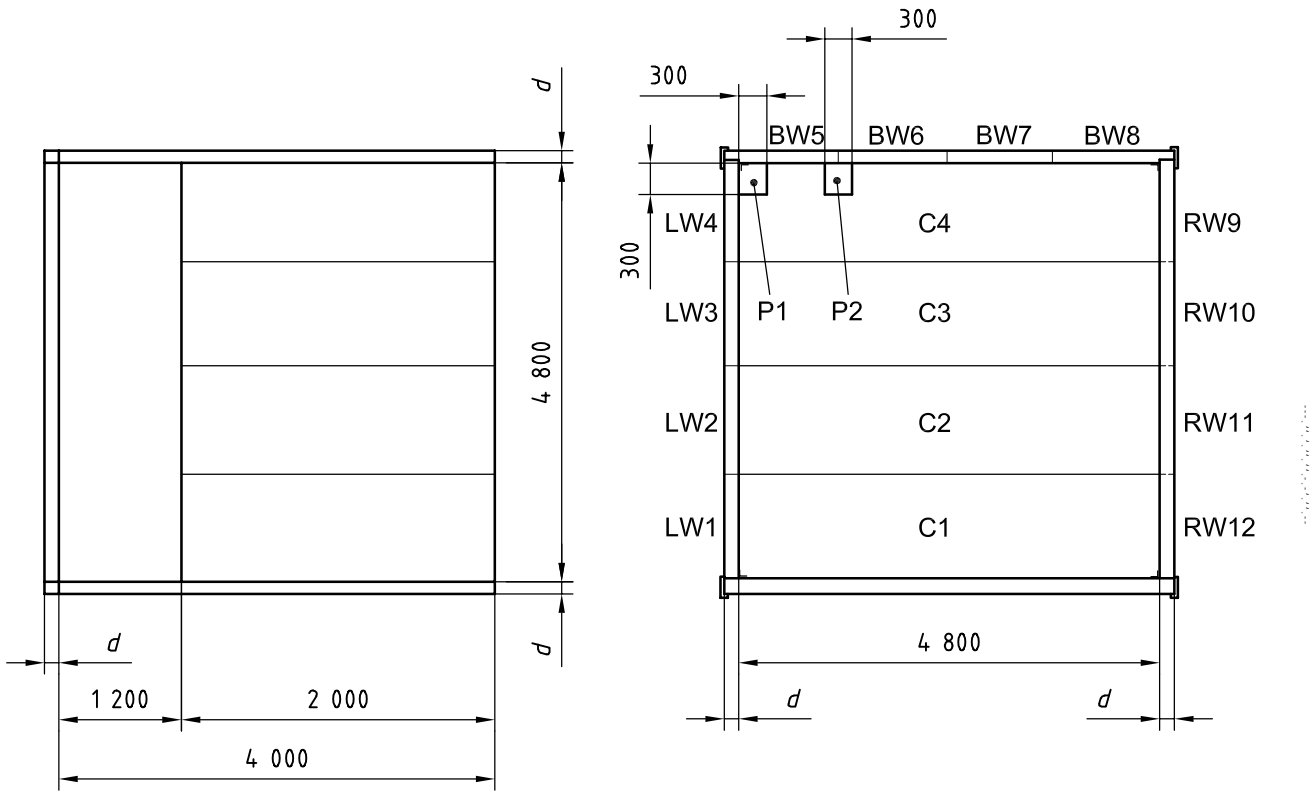
NOTE The number of panels and their thickness can of course be different from those shown in the examples, depending on the type of panels tested. In addition, the type of supporting frame will depend on the practical end-use mounting.

Dimensions in millimetres



a) Isometric elevation

Figure 1 — Example of test specimen



b) Plan showing alternative burner positions

Key

C	Ceiling panel
d	Thickness of panel
P1	Burner position 1, at corner
P2	Burner position 2, at joint
LW	Left wall panel
BW	Back wall panel
RW	Right wall panel
FW-L	Front wall lintel panel

Figure 1 — Example of test specimen

Dimensions in millimetres

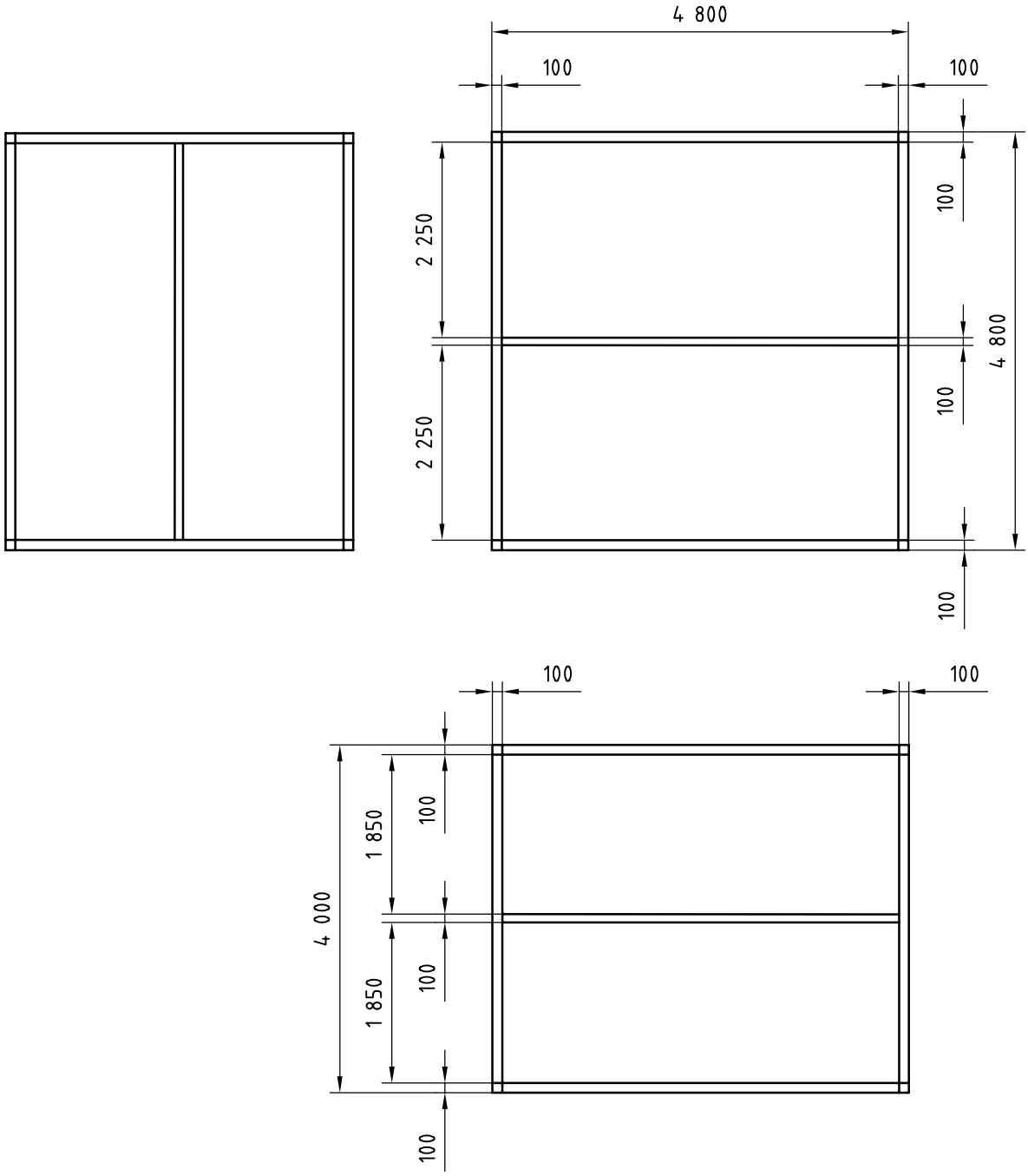


Figure 2 — Example of internal structural framework

Dimensions in millimetres

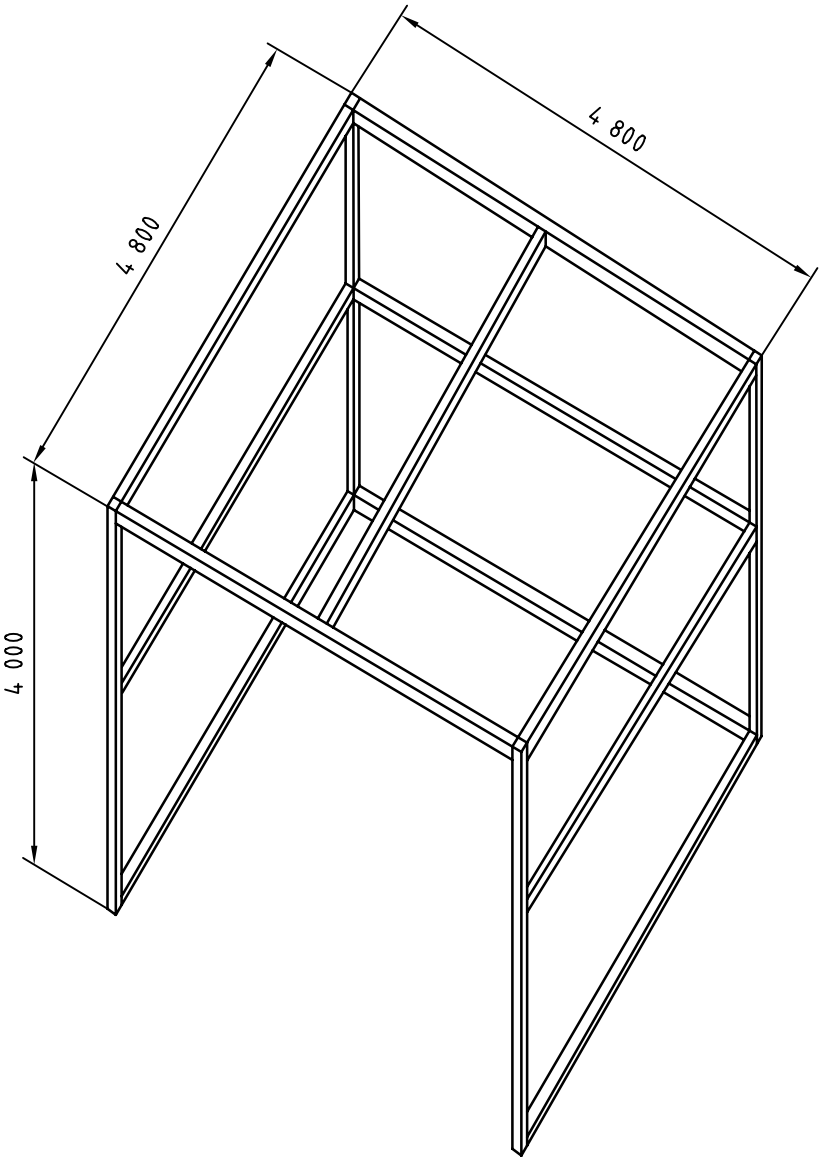


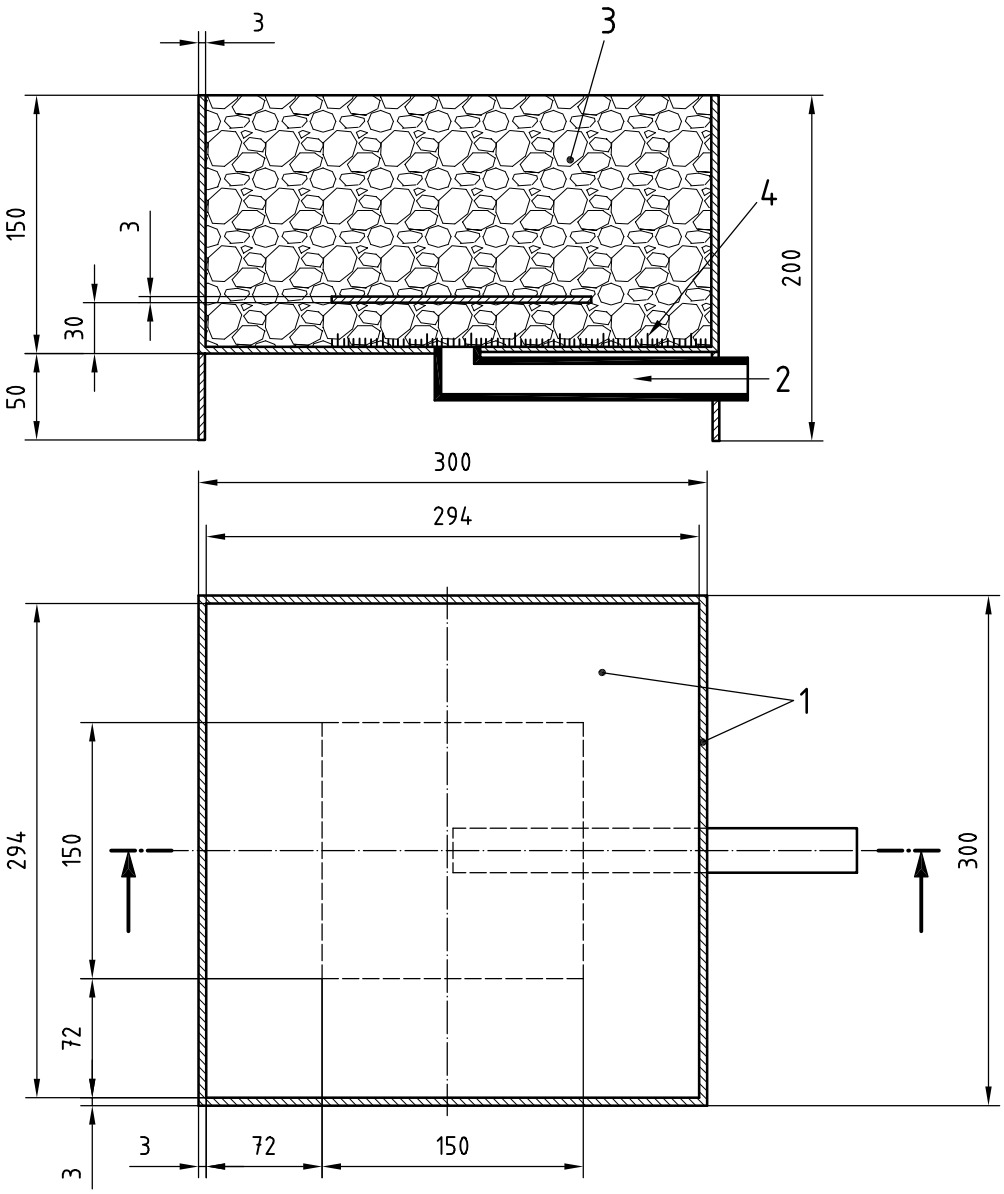
Figure 3 — Example of internal structural framework — Isometric elevation

8 Ignition source

WARNING — The ignition source is a propane gas burner that consumes relatively large amounts of gas. All equipment (tubes, couplings, flow meters, etc.) should be approved for propane. The installations shall be performed in accordance with existing regulations. For reasons of safety, the burner should be equipped with a remote-controlled ignition device, for example, a pilot flame or glow wire. There should be a warning system for leaking gas and a valve for immediate and automatic cut-off of the gas supply in case of extinction of the ignition flame.

8.1 The ignition source shall be a propane gas burner made from mild steel and having a square top surface layer of porous inert material (e.g. sand). The burner shall have face dimensions of 300 mm × 300 mm and a height of 200 mm above the floor. The construction shall be such that an even gas flow is achieved over the entire open area. See Figure 4.

Dimensions in millimetres



Key

1 Steel sheet
2 Gas inlet
3 Sand (5 mm to 12 mm)
4 Brass wire gauze (2,8 mm)

Figure 4 — Burner

8.2 The burner shall be mounted on a small trolley so that it is capable of being removed from the test facility during the test if necessary. An additional cut-off valve for the gas is recommended.

8.3 The burner shall be placed on the floor in a corner directly opposite the wall with the doorway, and shall be in contact with the specimen. If there is a structural framework member such as a column directly in the corner, the burner shall be placed at the joint nearest the corner on the back wall. This joint shall be not less than 300 mm from the corner column. See Figure 1.

If the structural member prevents contact, the burner shall be raised and adjusted such that it is in contact with the specimen.

8.4 The burner shall be supplied with natural grade propane (95 % purity). The gas flow to the burner shall be measured with an accuracy of at least $\pm$ 3 %. The heat output to the burner shall be controlled within $\pm$ 5 % of the prescribed value.

8.5 The burner heat output shall be 100 kW for the first 5 min of the test, 300 kW for the subsequent 5 min, and shall be increased again to 600 kW for a further 5 min if ignition and sustained burning of the test specimen has not already occurred. The burner heat release rate is calculated by multiplying the gas flow with the heat of combustion of propane. A value of 46,4 kJ/g shall be used.

NOTE The ignition source reflects the burning of, for example, a waste fire or liquid pool fire, which can occur in a storage room or in industrial buildings.

9 Apparatus

9.1 Thermocouples, positioned on the external surface of each of the panels and within their core, installed from the rear of the panel in such a way that flame spread within the core can be monitored.

One thermocouple shall be installed on the external surface of each panel and another in the core, both of them at 2,7 m above the floor and on the centreline. See Figure 5. Only thermocouples O1, O2 and O3 in the door opening are mandatory; all others are optional.

The thermocouples shall be either of the sheathed or welded types. The former shall be type K chromel/alumel stainless-steel sheathed thermocouples with a wire diameter of 0,3 mm and an outer diameter of $(1{,}5 \pm 0{,}1)$ mm. The hot junction shall be insulated and not earthed. Welded thermocouples shall have a maximum diameter of 0,3 mm. Thermocouples on the external surface of the panels shall have their hot junctions in contact with the surface of the panel. Surface thermocouples with copper disk for surface temperature measurements, sheathed thermocouples for core measurements and welded non-sheathed thermocouples for gas temperature measurements should be used. The thermocouples shall be of tolerance class 1 in accordance with IEC 60584-2.

The flow out of the door opening can be calculated by means of the thermocouples in the door opening and using additional pressure transducers. For additional guidance, see ISO/TR 9705-2.

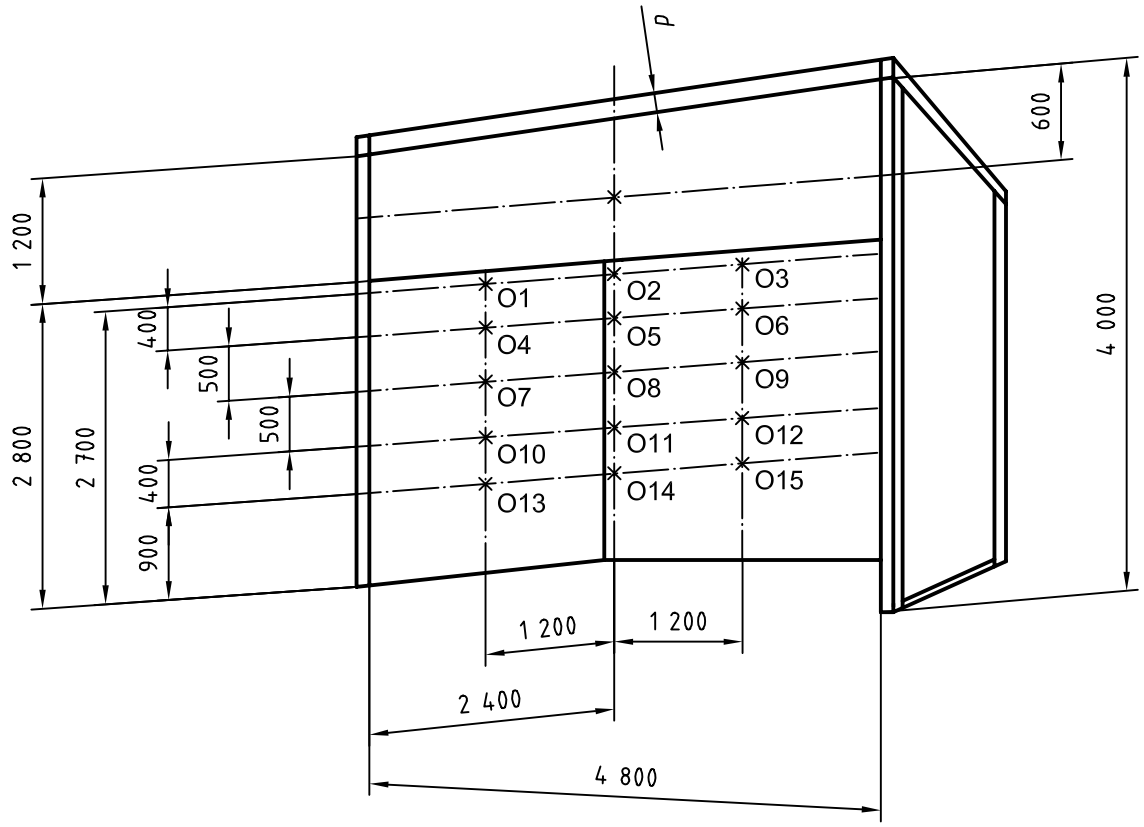
When installing thermocouples inside the core, a check should be made to ensure that the openings through which the thermocouples are inserted are well sealed, otherwise these openings can influence the fire behaviour of the panels.

9.2 Additional equipment

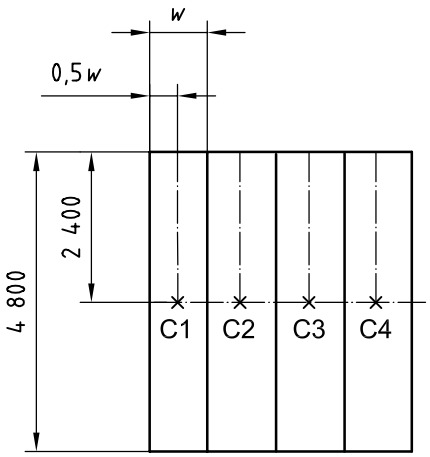
9.2.1 Data recorder — either a chart recorder or data logger capable of recording and storing input data from the thermocouples at intervals not exceeding 10 s, and able to provide a hard copy of the data.

9.2.2 Timing device — a clock with 1 s divisions or equivalent device.

Dimensions in millimetres

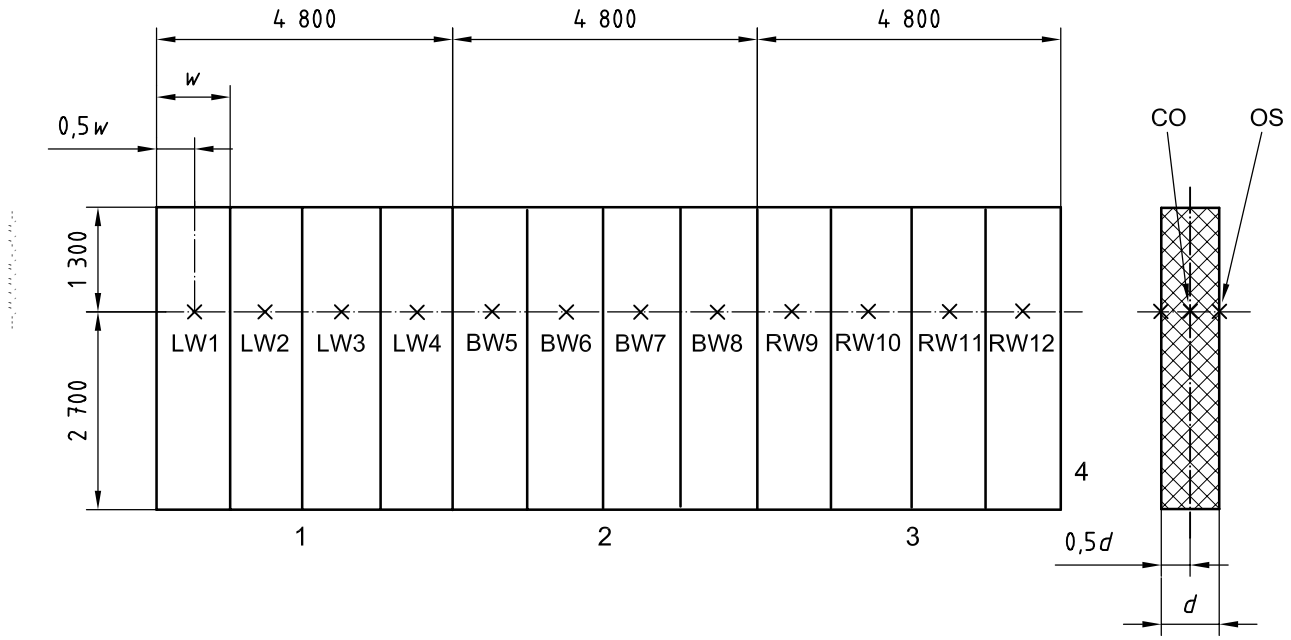


a) Door opening



b) Ceiling

Figure 5 — Thermocouple distribution



c) Walls

Key

1	left
2	back
3	right
4	wall
O	Opening (1 to 15)
C	Ceiling panel (core outside)
w	Width of panel
LW	Left wall panel (core outside)
RW	Right wall panel (core outside)
BW	Back wall panel (core outside)
CO	Core
OS	Outside surface of panel
d	Thickness of panel

Figure 5 — Thermocouple distribution

10 Procedure

10.1 Initial conditions

10.1.1 The temperature in the test facility at the start of the test shall be between 10 °C and 30 °C.

10.1.2 The horizontal wind speed measured at a horizontal distance of 1 m from the centre of the opening to the room shall not exceed 1,75 $m \cdot s^{-1}$.

10.1.3 The burner shall be in contact with the corner wall. The surface area of the burner opening shall be clean. If there is a structural framework such as a column directly in the corner, the burner shall be placed at the nearest joint from the corner on the back wall but not less than 300 mm away (see Figure 1).

10.1.4 The test set-up shall be photographed or video-recorded prior to testing.

10.2 Test

10.2.1 Start all recording and measuring devices and record data for at least 2 min prior to igniting the burner.

10.2.2 Adjust the burner to the required output levels within 10 s of ignition (see Figure 6). Adjust the exhaust capacity so that all combustion products are collected.

Dimensions in millimetres

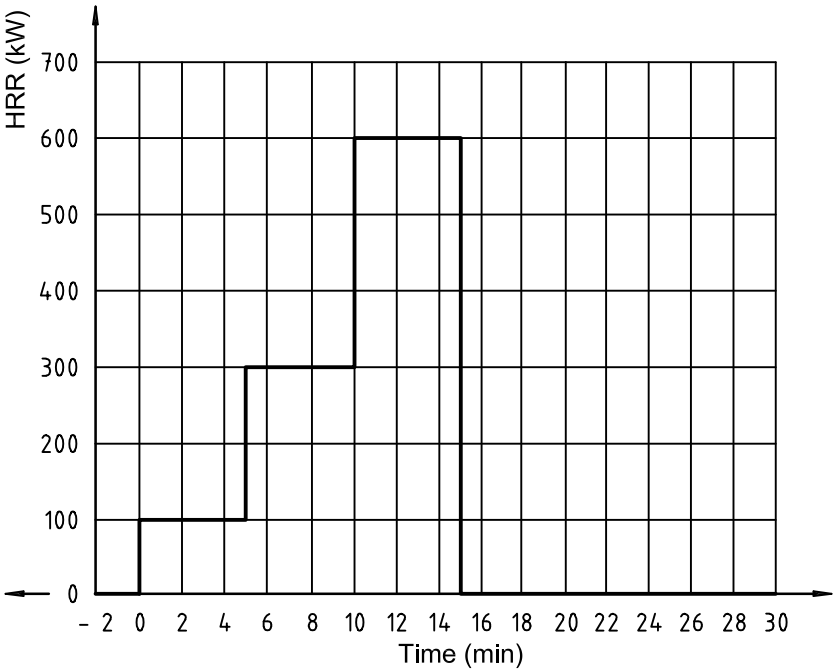


Figure 6 — Burner heat output programme

10.2.3 Make a photographic or videotape record of the test or both of these. A clock shall appear in all photographic records, giving time to the nearest second.

10.2.4 During the test, record the following observations and the time at which each occurs:

a) ignition of the specimen;

b) spread of flame on surface — internal or external — of panels (if any);

c) openings, cracks, damage or gaps appearing in specimen;

d) opening joints and flaming from joints;

e) delamination, falling debris, flaming droplets;

f) smoke or flames outside room through joints;

g) smoke intensity and colour (visual);

h) indications of flame spread through core of specimen (i.e. discoloration of facing panels);

i) flames emerging through doorway;

j) flashover;

k) collapse of structure.

10.2.5 End the test if flashover occurs, or after 30 min, whichever is first. The test shall be terminated earlier if structural collapse or other conditions potentially dangerous to the laboratory staff develop.

10.2.6 Report the results of the test in respect of temperatures recorded with time, observations of burning behaviour, extent of fire involvement, mechanical behaviour, etc. Note the extent of damage to the product after testing. Damage shall be clearly reported (extent of delamination or joint openings or both, extent and depth of char and possibly scorching, cracking, shrinkage, etc.).

10.2.7 Record any other unusual behaviour.

11 Precision

The precision of this test method has yet to be determined. Results of a planned inter-laboratory test series will be included in a future revision of this part of ISO 13784 when these become available.

12 Test report

The test report shall include the following information:

a) name and address of testing laboratory;

b) date and identification number of report;

c) name and address of sponsor;

d) purpose of test;

e) method of sampling;

f) name and address of manufacturer or supplier of product;

g) name or other identification marks and description of product;

h) construction and installation details of product, including

   1) drawings,

   2) descriptions,

   3) assembly instructions,

   4) specification of included materials, and

   5) details of the joints and fixings;

i) date of supply of product;

j) date of test;

k) whether freestanding or frame-supported room construction was used, and reference to this part of ISO 13784;

l) conditioning of test specimen, environmental data during the test (temperature, atmospheric pressure, relative humidity, etc.);

m) deviations from test method (if any);

n) test results, comprising

   1) temperatures of mandatory thermocouples O1, O2, O3 as a function of time in a graph,

   2) temperatures on panel surfaces, within the core of the sandwich panel and additional gas temperature as a function of time in a graph, where appropriate (optional),

   3) maximum temperature,

   4) illustration (e.g. by pictures) and description of fire damage, and

   5) observations during and after test;

o) designation of product according to criteria expressed in official standards or regulations, where appropriate.

Bibliography

[1] ISO 9705:1993, *Fire tests — Full-scale room test for surface products*

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