TECHNICAL REPORT

ISO/TR 9705-2

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Reaction-to-fire tests — Full-scale room tests for surface products —

Part 2: Technical background and guidance

Essais de réaction au feu — Essais dans une pièce en vraie grandeur pour les matériaux de revêtement intérieur —

Partie 2: Données techniques et lignes directrices

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.

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.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this part of ISO/TR 9705 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 9705-2 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 1, *Fire initiation and growth*.

ISO 9705 consists of the following parts, under the general title *Reaction-to-fire tests — Full-scale room tests for surface products*:

— *Part 1: Full-scale test for surface products* (currently published as ISO 9705:1993*, Fire tests — Full-scale room test for surface products*)

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

Introduction

ISO 9705:1993 specifies a test method simulating a fire that starts under well-ventilated conditions, in a corner of a small room with a single open doorway.

The method is intended to evaluate the contribution to fire growth provided by a surface product using a specified ignition source. The method provides data for a specified ignition source for the early stages of a fire from ignition up to flashover. ISO 9705:1993 also describes different measurement techniques inside and outside the room. This part of ISO 9705 gives background information and support to the potential users of the test. It gives the user of the test technical information on the ignition source, heat fluxes in the room from the burner, heat balance in the room during a fire, aspects of smoke production and toxic gas species production, as well as aspects of modelling the results of these tests. It gives the user the information necessary to select the testing procedure for specific projects or regulations.

Reaction-to-fire tests — Full-scale room tests for surface products —

Part 2: Technical background and guidance

1 Scope

This part of ISO 9705 provides guidance on ISO 9705:1993. It describes the technical background of the test and gives information which may be used for determining a testing procedure for a specific scenario, or how results can be utilized in a total hazard analysis for the specified scenario.

2 Characteristics of the ignition sources

2.1 Standard ignition source

The standard ignition source consists of a sandbox burner with dimensions of 0,17 m × 0,17 m. This source is used in reference [1] (see Bibliography). An important characteristic of the ignition source is its heat transfer towards the material. Figures 1 and 2 show a detailed mapped overview of the total heat flux towards the specimen and the gas temperatures. The measurements are performed in an open wall configuration, at an energy release rate level of 100 kW [2]. These values will slightly change when the burner is located in a room environment. Figures 3 and 4 give the contours of a constant heat flux of 10 kW/m^2 at different heat outputs of the burner and also where areas of total heat flux are higher than a given value.

2.2 Alternative ignition source

One of the alternative heat sources is a box burner, with dimensions of 0,3 m × 0,3 m. It is described in ASTM E603-98 [3]. Figures 5 and 6 give a detailed mapping of heat fluxes and gas temperatures for a burner energy release rate of 160 kW [2]. Other heat sources may be more appropriate (see annex B of ISO 9705:1993). Figure 7 gives results of heat fluxes towards the specimen for a heat source level of 40 kW and 160 kW, with different gases (natural gases and a mixture of natural gas and toluene) [4]. Figures 8 and 9 show a comparison of different burner sizes for contours of constant heat flux of 10 kW/m^2, at an energy release rate of 100 kW in an open corner and for areas exposed to a certain irradiant heat flux [4].

Finally, an example is given of the difference between the total heat flux produced by a burner in a corner and a wall position. Table 1 gives an overview of the total heat flux towards the floor and the total heat flux to the wall at 0,9 m and 1,5 m height for energy release rates of 40 kW and 160 kW using the alternative ignition source of ISO 9705:1993. Results show that, for the corner position, heat flux levels are higher in almost all cases.

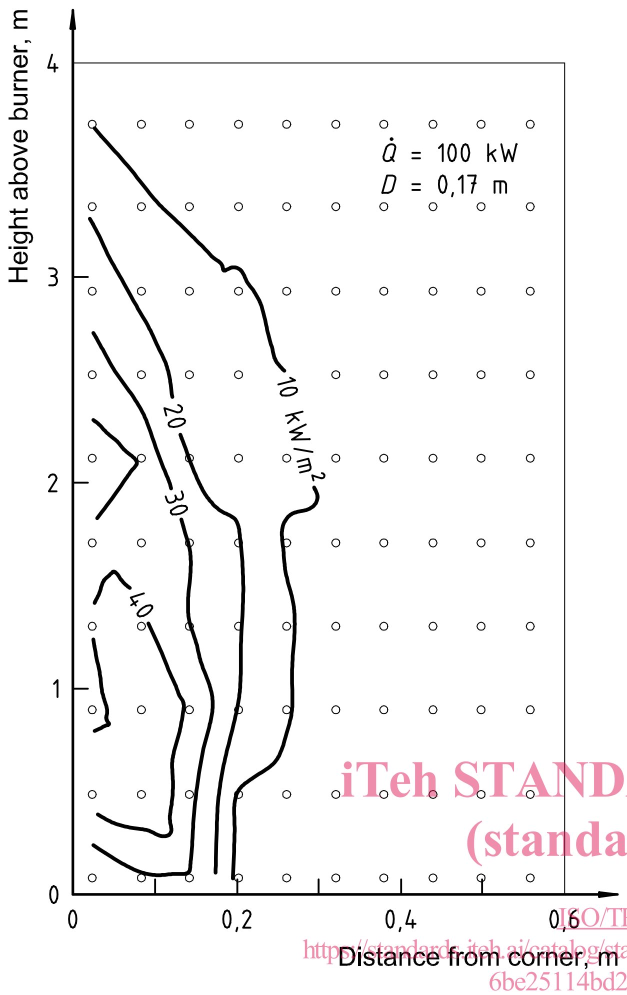


Figure 1 — Heat flux distribution at an energy release rate of 100 kW for the standard ignition source in an open corner

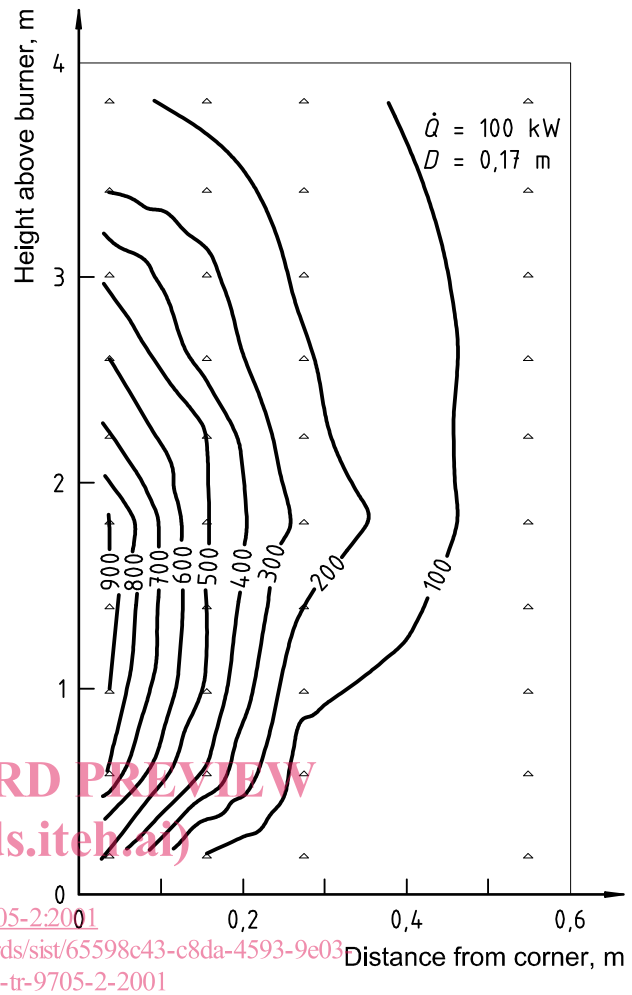
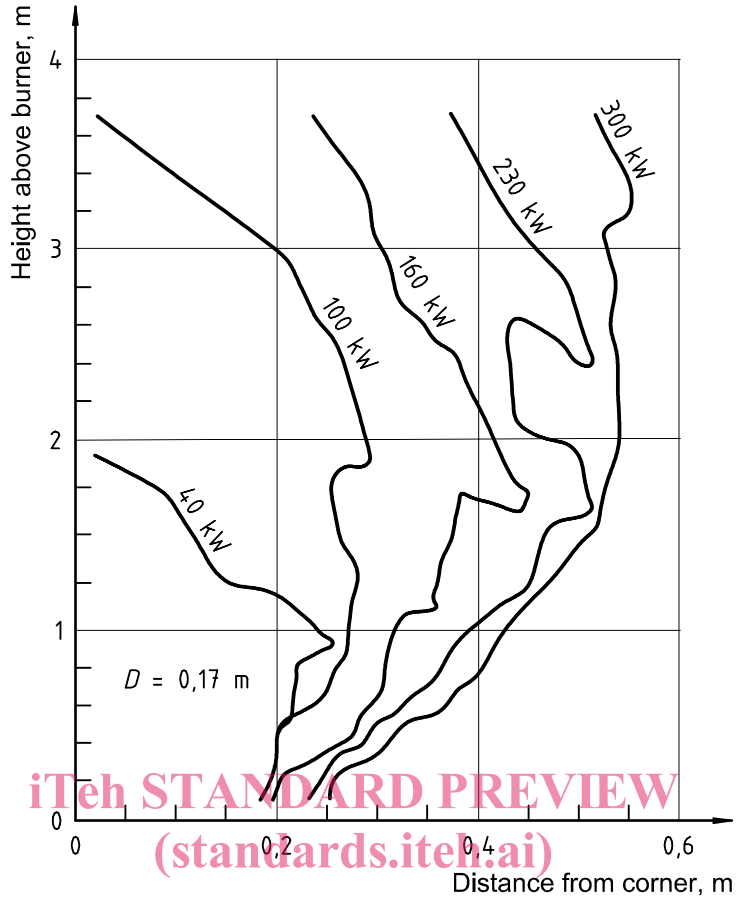


Figure 2 — Gas temperature distribution 30 mm from the wall at an energy release rate of 100 kW for the standard ignition source in an open corner



NOTE Contours of 10 kW/m^2.

Figure 3 — Contours of constant heat flux for the standard ignition source in an open corner at different irradiant heat flux levels

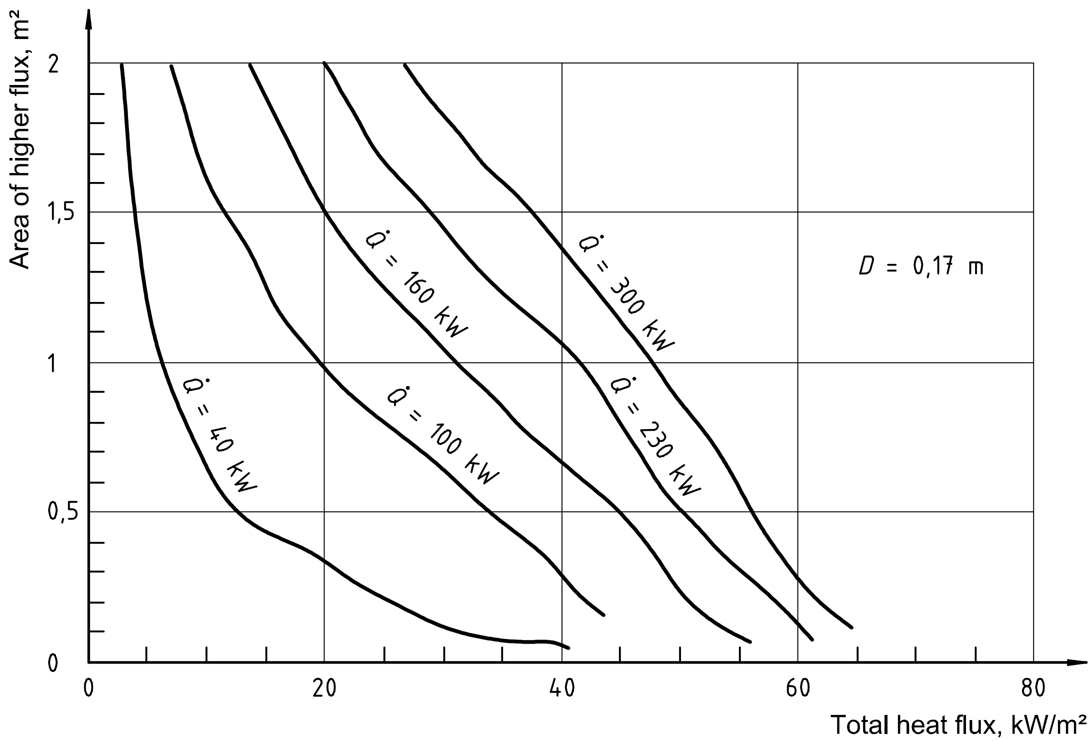


Figure 4 — Areas of total heat flux levels higher than a given value for the standard ignition source at different irradiant heat flux levels in an open corner

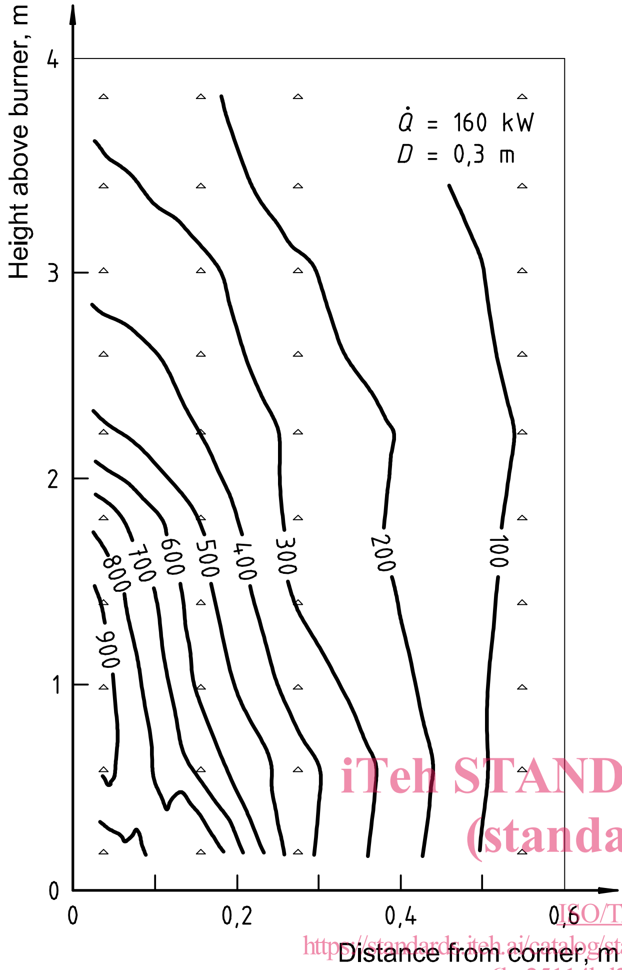


Figure 5 — Heat flux distribution at 160 kW for the alternative ignition source in an open corner

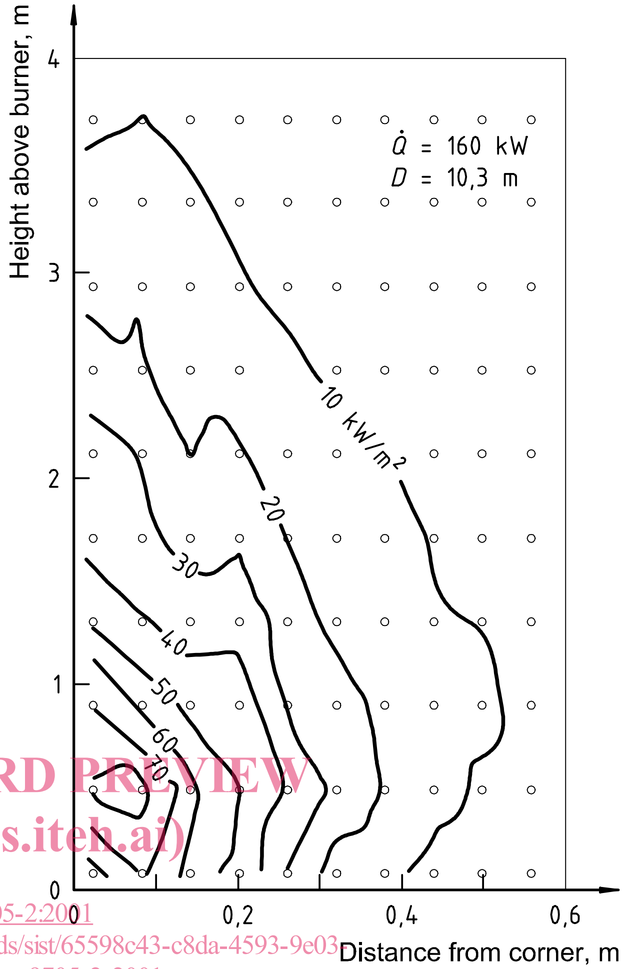


Figure 6 — Gas temperature distribution 30 mm from the wall at 160 kW for the alternative ignition source in an open corner

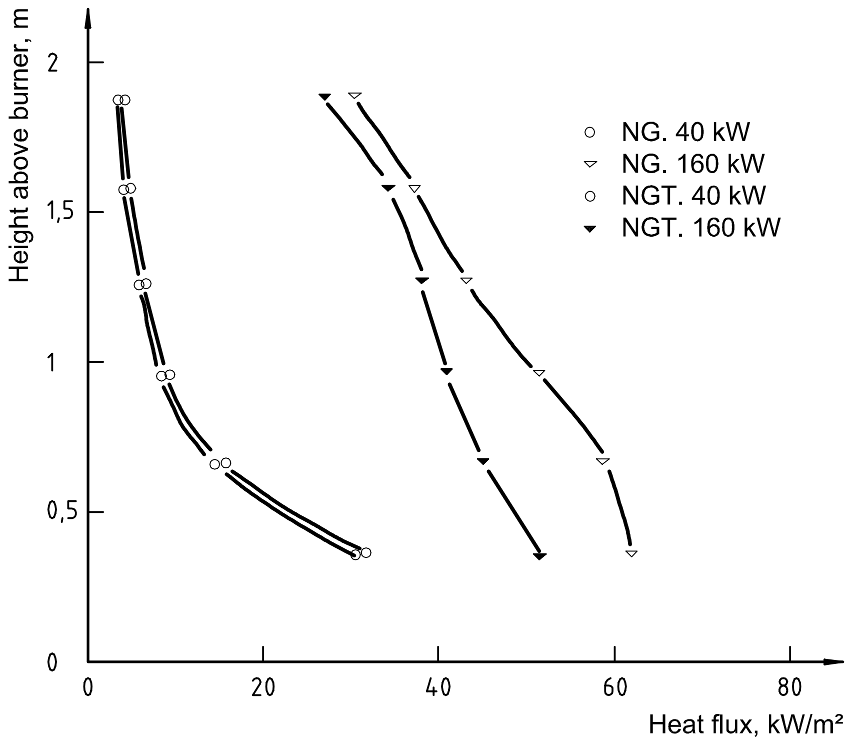
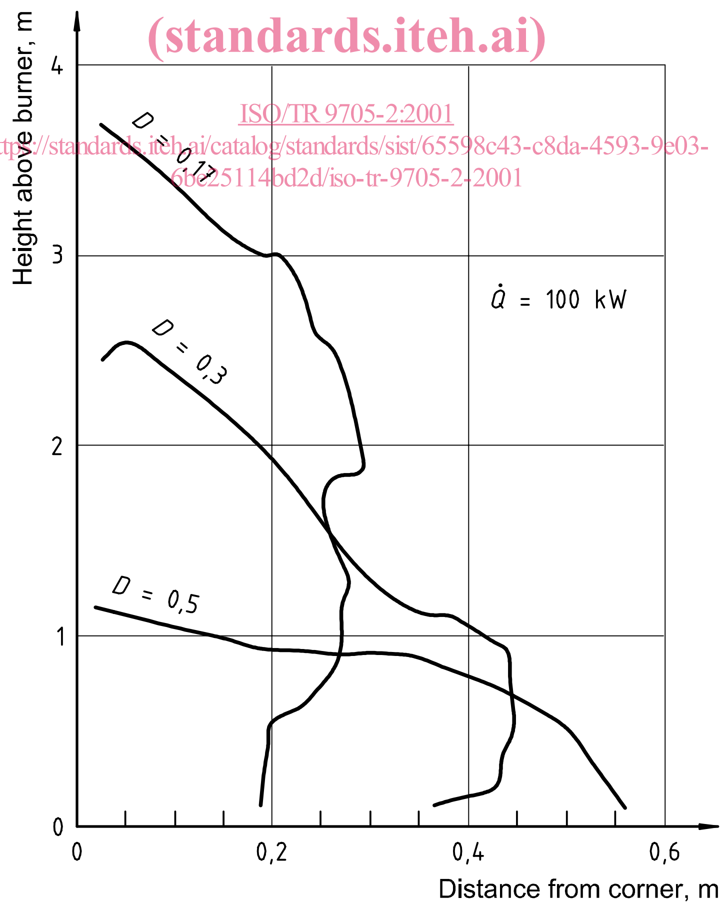


Figure 7 — Heat flux distribution for the alternative ignition source in an open corner at 40 kW and 160 kW with different types of gas



NOTE Contours of 10 kW/m^2.

Figure 8 — Contours of constant heat flux for the different sizes of box ignition sources in an open corner at a 100 kW heat source level

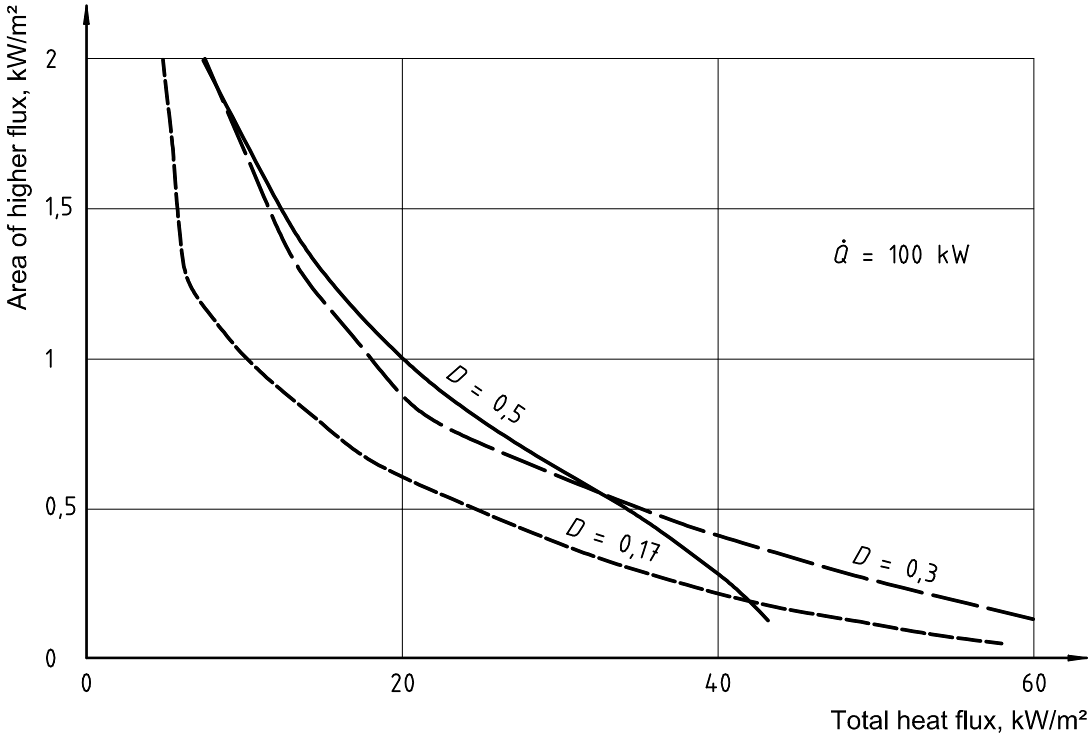


Figure 9 — Areas of total heat flux levels higher than a given value for different box ignition sources at 100 kW in an open corner

Table 1 — Comparison between corner and centre wall position

	Burner in the corner			Burner at centre of back wall		
Heat source level	**Heat flux to floor** kW/m²	**Heat flux to wall at 0,9 m** kW/m²	**Heat flux to wall at 1,5 m** kW/m²	**Heat flux to floor** kW/m²	**Heat flux to wall at 0,9 m** kW/m²	**Heat flux to wall at 1,5 m** kW/m²
40 kW	0,6	12,5	6,5	0,6	8,5	4
160 kW	5,4	56	60	4,2	62	33

3 Sensitivity analyses

3.1 General

Various sensitivity analyses have been performed over the last 25 years. All studies used the room described in ISO 9705:1993, but differed in the type of ignition source (the standard ignition source or the alternative ignition source of ISO 9705). These sensitivity analyses contained different specimen configurations and different ignition positions and levels. An overview is given below of some of the findings as guidance for testing in the ISO 9705 room.

3.2 Specimen configurations

Sensitivity analyses revealed that testing with linings on both ceiling and walls resulted in a more severe condition than tests with linings on the walls only [5]. When only the walls are covered with linings, a ceiling lined with ceramic wool is more severe than a ceiling lined with gypsum boards and will show less discrimination between the different materials [6].

In order to achieve comparable tests data between laboratories and high discrimination, it is recommended in ISO 9705 that the walls (excluding the wall containing the doorway) and the ceiling are covered with the product. When other specimen configurations are used, this should be clearly stated in the report.

3.3 Effect of the burner size

The effect of the burner size has been studied extensively within the Eurefic programme [7]. Results have been shown for heat flux distribution and gas temperatures. Moreover, tests were done in a room lined with particle board. Little effect was seen on the time to flashover at rates of heat release of 160 kW and 300 kW. At a lower heat release of about 40 kW, the time to flashover with a large burner (0,5 m by 0,5 m) was significantly longer than for the other burners (standard and alternative ignition source of ISO 9705). The reason for this was explained by the smaller area which is exposed to a given heat flux level (see Figure 9), hence producing a slower flame spread.

3.4 Effect of the stand-off distance of the burner

Experiments at lower heat source levels with the alternative ignition source of ISO 9705 showed that there was a considerable influence of the stand-off distance of the burner [8]. With the standard ignition source, the stand-off distance seems to be less critical. The influence can in most cases be predicted by heat flux measurements at the walls behind the burner flame.

4 Heat balance in the room

4.1 General

An energy balance calculation was carried out at the early stages on the development of the ISO 9705 room corner test [9]. The energy balance in the room can be given as follows:

$$\dot{Q}_c = \dot{Q}_{co} + \dot{Q}_w + \dot{Q}_r + \dot{Q}_b$$

where

$\dot{Q}_c$ is the heat released by combustion (kW);

$\dot{Q}_{co}$ is the heat loss by convection through the doorway (kW);

$\dot{Q}_w$ is the heat loss by conduction into the surrounding structure (kW);

$\dot{Q}_r$ is the heat loss by radiation throughout the doorway (kW);

$\dot{Q}_b$ is the heat stored in the gas volume (kW).

In most cases the heat stored in the gas volume is negligible. The other terms are calculated as given in the following paragraphs. The results of a heat balance calculation are also given below.

4.2 Heat release by combustion

Heat release by combustion might be the heat release measurement or, in the case of the calibration test, this can be calculated as

$$\dot{Q}_c = \Delta H_c \cdot \dot{m}_f$$