INTERNATIONAL STANDARD

ISO 6944-2

First edition
2009-06-15

Fire containment — Elements of building construction —

Part 2: Kitchen extract ducts

Endiguement du feu — Éléments de construction —

Partie 2: Conduits de ventilation de la cuisine

Reference number
ISO 6944-2:2009(E)

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Published in Switzerland

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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 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 6944-2 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 2, *Fire containment*.

ISO 6944 consists of the following parts, under the general title *Fire containment — Elements of building construction*:

— *Part 1: Ventilation ducts*

— *Part 2: Kitchen extract ducts*

Introduction

The purpose of this part of ISO 6944 is to measure the ability of a representative duct or duct assembly that is part of a kitchen extract duct system to resist the spread of fire from one fire compartment to another with the fire attack being from either the inside of the duct or from the outside of the duct. This part of ISO 6944 is applicable to vertical and horizontal ducts, with or without branches, taking into account joints and exhaust openings, as well as suspension devices and penetration points.

The test method representing a fire attack from the inside of the duct first simulates temperatures within a kitchen extract duct during normal operation followed by simulating the temperatures during a fire within the duct. For kitchen extract ducts, the inevitable build-up of grease on the inside surfaces can lead to a severe fire exposure and this is represented in the test method described in this part of ISO 6944. A burner assembly, attached to a horizontal L-shaped combustion chamber, develops the heat required to obtain the temperatures. The combustion chamber is attached to the sample kitchen extract duct assembly. The kitchen extract duct is also L-shaped with both horizontal and vertical components.

The test method representing a fire attack from the outside of the duct exposes the kitchen extract duct to furnace conditions defined in ISO 834-1. The test method includes provisions for assessment of the penetration seal surrounding the kitchen extract as the duct passes through a fire resistive barrier. The test method evaluates the structural integrity of the kitchen extract duct by having the duct restrained within the furnace during the fire exposure.

Fire containment — Elements of building construction —

Part 2: Kitchen extract ducts

CAUTION — The attention of all persons concerned with managing and carrying out of this fire resistance test is drawn to the fact that fire testing can be hazardous and there is a possibility that toxic and/or harmful smoke and gases can be evolved during the test. Mechanical and operational hazards can also arise during the construction of the test elements or structures, their testing and disposal of test residues.

It is strongly recommended that the duct assembly be allowed to cool completely after the fire test before dismantling to minimize the possibility of the ignition of combustible residues.

An assessment of all potential hazards and risks to health shall be made and safety precautions shall be identified and provided. Written safety instructions shall be issued. Appropriate training shall be given to relevant personnel. Laboratory personnel shall ensure that they follow written safety instructions at all times.

1 Scope

This part of ISO 6944 establishes a method of test in which kitchen extract ducts are required to provide fire resistance. The requirements are intended to limit the spread of fire from the duct when a fire occurs within the duct and assesses the structural integrity of the duct when a fire occurs in the area surrounding the duct.

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.

ISO 834-1, *Fire-resistance tests — Elements of building construction — Part : General requirements*

ISO 6944–1:2008, *Fire containment — Elements of building construction — Part 1: Ventilation ducts*

ISO 13943, *Fire safety — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6944-1, ISO 13943 and the following apply.

3.1
kitchen extract duct
exhaust duct intended for use in commercial kitchens

3.2
fire-resisting kitchen extract ducts
kitchen extract ducts that have been tested to this part of ISO 6944 and meet the prescribed levels of fire resistance

4 Test equipment

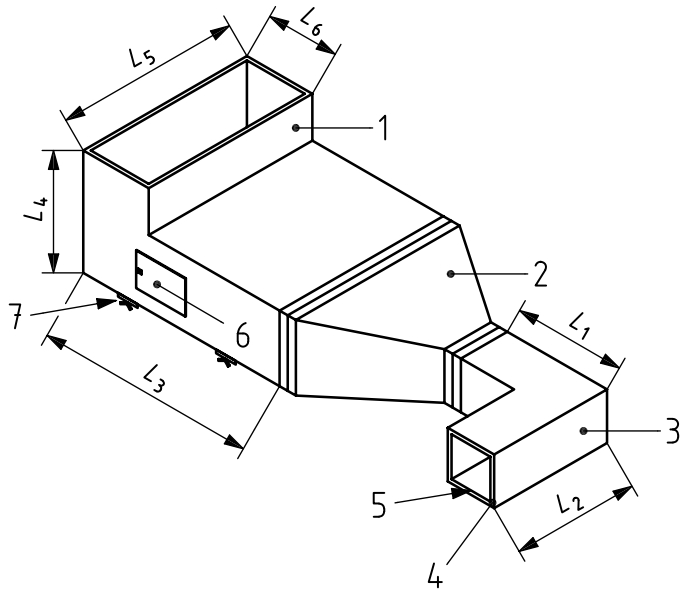
4.1 Fire outside duct

The test equipment specified in ISO 6944-1 for testing duct A shall be used, except that the fan, volume flow-measuring station and the condensing unit are not required.

4.2 Fire inside duct

4.2.1 A gas-fired premix burner assembly shall be used to supply flue gases to the test specimen.

4.2.2 The burner assembly shall be placed at the inlet of an insulated, L-shaped combustion chamber assembly, as illustrated in Figure 1.



Key

1	kitchen extract duct	5	location of burner assembly
2	transition section, where required	6	cleanout access cover
3	combustion chamber	7	supports
4	ceramic fibre insulation on combustion chamber	L_1 to L_6	various governing dimensions

Figure 1 — Test assembly

4.2.2.1 The minimum total length of the L-shaped insulated combustion chamber, $L_1 + L_2$, shall be 3 700 mm.

4.2.2.2 The minimum height and width of the steel duct for the combustion chamber shall be 700 mm by 700 mm.

4.2.2.3 The minimum thickness of the ceramic fibre insulation for the combustion chamber shall be 50 mm. The density of the insulation shall be 120 kg/m^3 ± 30 kg/m^3.

4.2.3 Combustion shall be complete within the combustion chamber assembly. The insulated combustion chamber assembly shall be connected to the kitchen extract duct by means of bolted or clamped flanges. The flanges shall be welded to the combustion chamber and to the kitchen extract duct.

4.2.4 For ducts whose orifice area exceeds 0,75 m^2, the use of flow restrictors at the exhaust end of the kitchen extract duct to adjust the rate of the flue gases to assist in obtaining the required temperatures within the kitchen extract duct is allowed, provided that the exhaust remains at least 75 % open.

5 Test conditions

5.1 Fire outside duct

The test conditions specified in ISO 6944-1 for testing duct A shall be used.

5.2 Fire inside duct

5.2.1 The specimen shall be tested within a laboratory having ventilation capable of maintaining the build-up of carbon monoxide to less than 50 µl/l[1)] throughout the period of any test. The area shall be free of extraneous drafts. The laboratory shall be constructed so that, during any one test, the room temperature in the laboratory does not increase by more than 23 °C above the temperature recorded at the beginning of the test.

5.2.2 The test specimen with respect to moisture content shall be representative of the condition that exists in similar construction in buildings. The condition shall be established by storage in air having 50 % relative humidity at 23 °C.

5.2.3 When conditioning to this level is not possible, the test shall be conducted when the dampest portion of the test specimen has achieved an equilibrium moisture content less than that corresponding to drying in air having 75 % relative humidity at 23 ± 3 °C.

5.2.4 Exception: The requirements of 5.2.3 are not mandatory when

— an equilibrium condition is not achieved within a 12 month conditioning period; or

— construction is such that drying of the interior of the test specimen is prevented by hermetic sealing of the construction materials.

6 Instrumentation

6.1 Fire outside duct

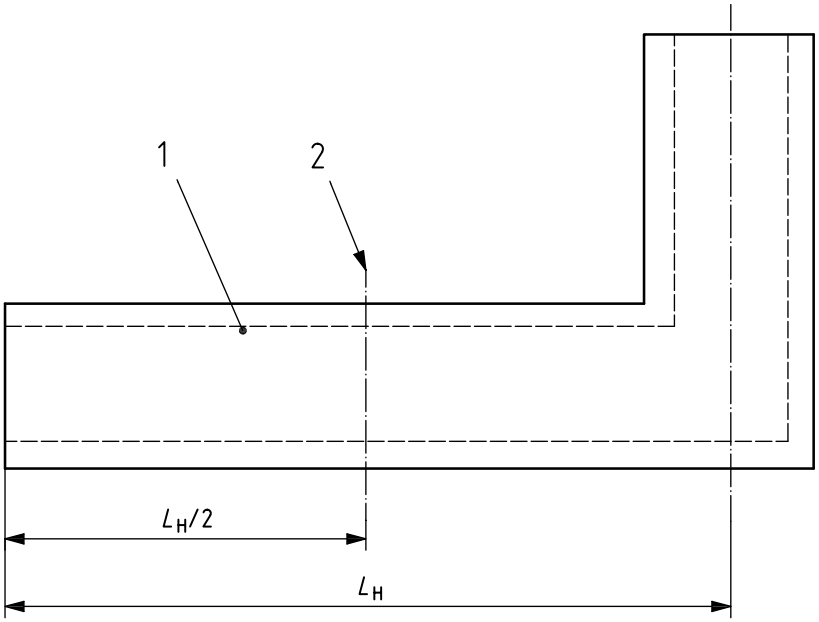
The instrumentation specified in ISO 6944-1 for testing duct A shall be used.

6.2 Fire inside duct

6.2.1 Flue gas temperatures

6.2.1.1 The thermocouples shall be located within the L-shaped kitchen extract duct as illustrated in Figures 2 and 3.

1) Microlitres per litre is the approximate conversion of the derogated unit “ppm.”



Key

1 kitchen extract duct (side view)

2 location of thermocouple grid for measuring flue-gas temperatures

Figure 2 — Thermocouple locations for measuring flue gas temperatures

6.2.1.2 Flue gas temperatures shall be determined by a thermocouple grid as illustrated in Figure 3. The grid shall consist of four thermocouples located inside the kitchen extract duct to measure the flue gas temperature at the mid-length of the horizontal section of the kitchen extract duct assembly; see Figure 2.

6.2.1.3 The thermocouples shall be maximum 1,0 mm, Type K or Type S Inconel-sheathed[2)] thermocouples with tips projecting 25 + 1,5 mm from the inner ends of the support tubes as illustrated in Figure 3.

6.2.1.4 The dimension a shall be equal to $D/4$ but not greater than 305 mm.

6.2.1.5 The dimension b shall be equal to $W/4$ but not greater than 305 mm.

6.2.2 Unexposed surface temperatures

6.2.2.1 Fixed locations

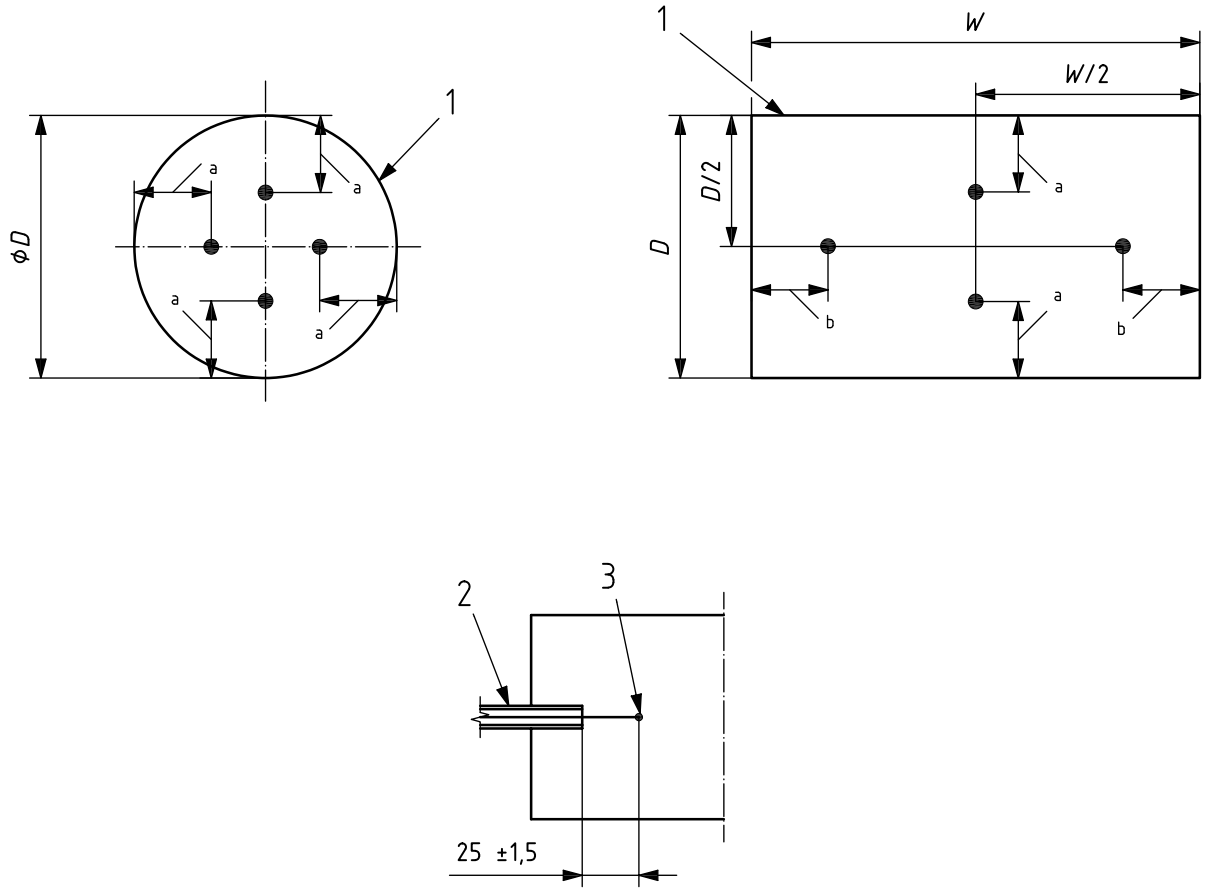
6.2.2.1.1 Temperatures on the unexposed surfaces shall be measured using thermocouples and pads in accordance with ISO 834-1.

6.2.2.1.2 A minimum of fourteen thermocouples shall be located on the horizontal section of the test specimen.

6.2.2.1.3 Eight thermocouples shall be symmetrically located around the perimeter of the specimen as shown in Figures 4 and 5. None of the eight thermocouples shall be located over joints in the insulation material. The insulation thickness shall be the minimum at these locations.

2) Inconel™ is an example of a suitable product available commercially. This information is given for the convenience of users of this part of ISO 6944 and does not constitute an endorsement by ISO of this product.

Dimensions in millimetres

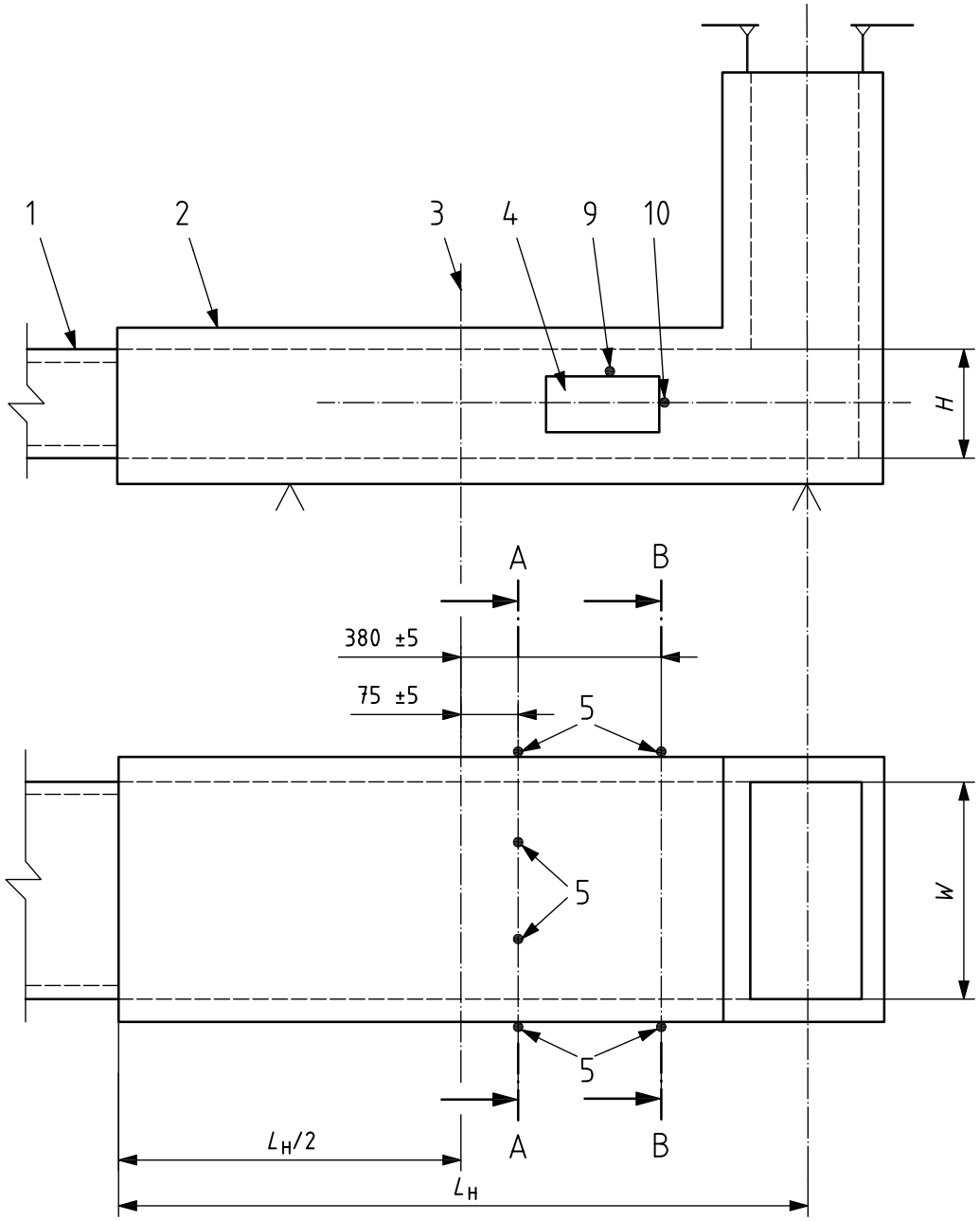


Key

1 kitchen extract duct
2 support tube for thermocouples
3 location of thermocouple tip, represented by "•"
a Dimension a shall be equal to D/4 but not greater than 305 mm.
b Dimension b shall be equal to W/4 but not greater than 305 mm.

Figure 3 — Thermocouple grid — Flue gas temperatures

Dimensions in millimetres

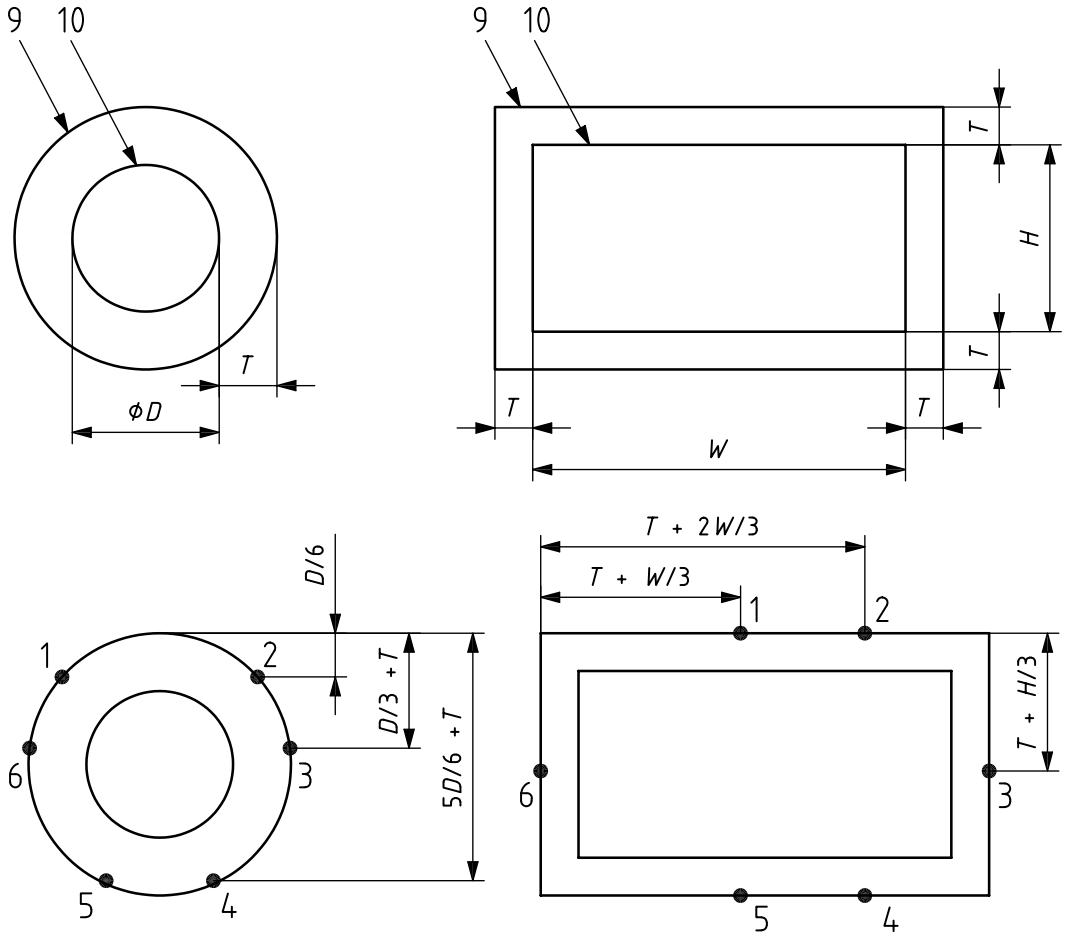


Key

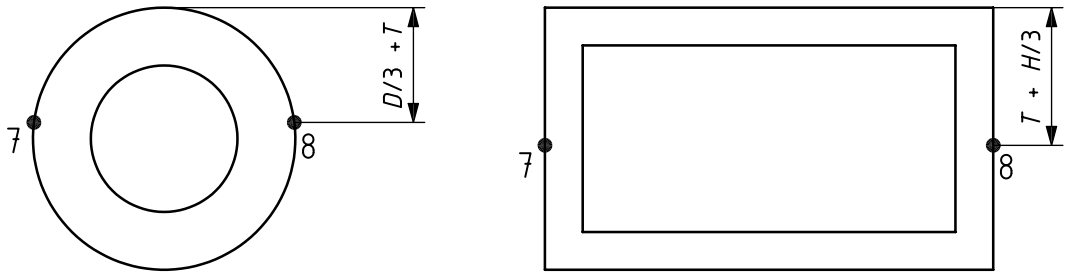
1 transition section
2 test specimen
3 thermocouple grid location measuring flue gas temperature
4 cleanout access cover
5 location of thermocouple tips, represented by "•"
9, 10 location of thermocouples 9 and 10, respectively

NOTE See Figure 5 for section A-A and section B-B.

Figure 4 — Thermocouple locations — Unexposed surface



a) Section A-A



b) Section B-B

Key

1 to 8 location, represented by "•", of thermocouples 1 to 8, respectively
9 insulating system
10 kitchen extract duct

Figure 5 — Thermocouple locations on sections A-A and B-B of Figure 4

6.2.2.1.4 Two thermocouples shall be placed around the edges of the cleanout access cover as shown in Figure 4.

6.2.2.1.5 Two thermocouples shall be located over horizontal joints in the insulation material and two thermocouples shall be located over vertical joints in the insulation material. These thermocouples shall be located between 75 mm and 380 mm from the mid-length of the horizontal section of the kitchen extract duct assembly; see Figure 4.

6.2.2.1.6 Other thermocouples shall be located at the discretion of the testing body where it is anticipated that maximum temperatures occur in order to obtain representative information on the performance of the test specimen.

6.2.2.1.7 Suggested placement of thermocouples on the support system and on the vertical section of the test specimen is described in Annex A.

6.2.2.2 Roving locations

Roving thermocouple shall be as shown in ISO 6944-1.

6.2.3 Interior surface temperatures of enclosure materials

Suggested placement of thermocouples to measure temperatures on the interior surface of the enclosure material is described in Annex A.

6.2.4 Integrity measurements

6.2.4.1 The integrity measurement of the enclosure system shall be made with cotton pads.

6.2.4.2 The cotton pad and its holder shall be as shown in ISO 834-1.

7 Test construction

7.1 Fire outside duct

7.1.1 The test construction as required in ISO 6944-1 for testing duct A shall be used except for the provision given in 7.1.2.

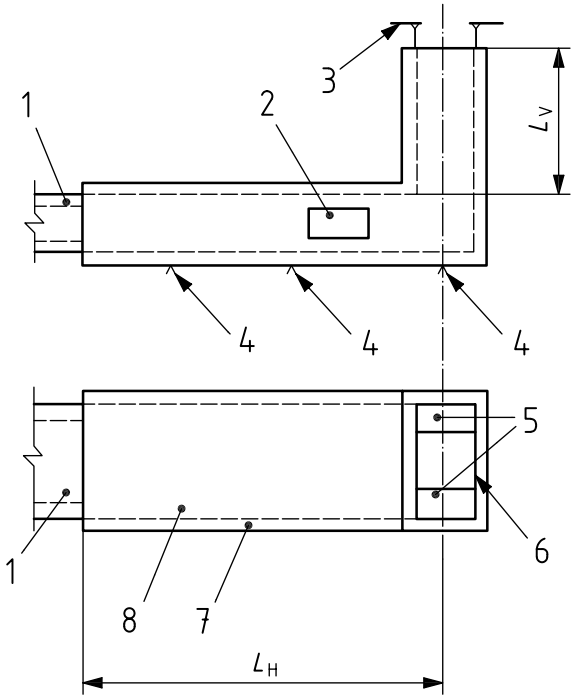
7.1.2 Exception: It is not required to restrain the duct within the furnace in all directions at the furnace wall when using the L-shaped test specimen as described in ISO 6944-1:2008, Figure 6.

7.2 Fire inside duct

7.2.1 The cross-sectional area of the kitchen extract duct used for the fire inside duct testing shall at least equal the cross-sectional area of the duct used for the fire outside duct testing.

7.2.2 The width-to-height ratio of the kitchen extract duct used for the fire inside duct testing shall not be less than the width-to-height ratio of the duct used for the fire outside duct testing.

7.2.3 The horizontal section of the kitchen extract duct shall be a minimum 2,75 m + L_6/2 long and the vertical section shall be a minimum 1,40 m + L_6/2 long for L_6 as shown in Figure 1. The horizontal section of the kitchen extract duct shall include supports at maximum spacing, and at least one access opening, as shown in Figure 6. The insulation within the horizontal section shall include a minimum of two joints. The weight of the kitchen extract duct on the supports shall represent the maximum load applied on the kitchen-extract-duct insulating materials. The kitchen extract duct shall include all fittings for which special methods of insulation are required.



Key

1 transition section
2 cleanout access cover
3 vertical supports
4 supports in accordance with installation instructions
5 flue gas restrictors
6 kitchen extract duct opening
7 insulating system
8 kitchen extract duct

Figure 6 — Test construction — Fire inside duct

7.2.4 The access opening and door construction shall represent the largest size, width-to-height ratio and construction for which evaluation is desired. The edge of the access opening closest to the combustion chamber shall be located on the side of the grease duct between the flue gas thermocouple grid and the vertical leg of the grease duct.

7.2.5 The test specimen shall be representative of the complete duct assembly, including installation. Insulation systems shall be installed in accordance with the manufacturer's installation instructions.

8 Test procedure

8.1 Fire outside duct

The test procedure specified in ISO 6944-1 for testing duct A shall be used.

8.2 Fire inside duct

8.2.1 The temperature of the test specimen shall be between 10 °C and 32 °C at the beginning of the test.

8.2.2 The gas-fired premix burner shall be regulated to produce a minimum flue gas temperature of 240°K above room temperature within 15 min as determined by the thermocouple grid shown in Figure 3.

8.2.3 If a flow restrictor as described in 4.2.4 is used, it shall be adjusted so that the heat input shall be a minimum of 420 kW/m^2 of the cross-sectional area of a circular grease duct.

8.2.4 The heat input provided by the burner shall be determined by the performance specifications of the burner and fuel usage.

8.2.5 The test shall be continued until equilibrium temperatures are attained on the unexposed surfaces of the test specimen as recorded by thermocouple numbers 1 through 8 as shown on Figure 5. Equilibrium is determined when, after a minimum 4 h exposure, two or more consecutive readings at 5 min intervals of the average temperature recorded by thermocouple numbers 1 through 8 show a temperature rise of no greater than 2 °C.

8.2.6 Temperature data shall be recorded at maximum 5 min intervals until temperature equilibrium is recorded on the unexposed surface. After equilibrium, the temperatures shall be recorded at intervals not exceeding 30 s.

8.2.7 After equilibrium temperatures are attained, the temperature of the flue gases entering the grease duct shall be increased to produce a minimum average flue gas temperature of 1 095°C within 15 min, as determined by the thermocouple grid shown in Figure 3.

8.2.8 If a flow restrictor is used, it shall be adjusted so that the heat input shall be a minimum of 1,83 Mw/m^2 of the cross-sectional area of a circular kitchen extract duct.

8.2.9 The minimum average flue gas temperature shall remain 1 095 °C for 30 min. After the 30 min period, the burner assembly shall be turned off.

8.2.10 For rectangular ducts, the cross-sectional area shall be modified when determining the minimum heat input specified in 8.2.3 and 8.2.8. The cross-sectional area, A, expressed in square millimetres, shall be determined as given in Equation (1); see Reference [1]:

$$A = \pi\left(0{,}5D_{\mathrm{e}}\right)^2 \tag{1}$$

where

D_{e} is the equivalent diameter, expressed in millimetres, in accordance with Equation (2):

$$D_{\mathrm{e}} = \frac{1{,}3\left(a \times b\right)^{0{,}625}}{\left(a + b\right)^{0{,}25}} \tag{2}$$

a is the length of one side of the duct, expressed in millimetres;

b is the length of the adjacent side of the duct, expressed in millimetres.

8.2.11 The integrity of the test specimen shall be checked for passage of flame and hot gases using a cotton pad in a wire frame provided with a handle.

8.2.12 The cotton pad shall be held directly over an observed crack or hole in the test specimen, 25 mm ± 6 mm from the breached surface, for a period of 30 s to 32 s. Small adjustments in the position of the cotton pad may be made when required to achieve the maximum effect from the hot gases.

8.2.13 The cotton pad shall not be applied within 450 mm ± 25 mm of the inlet and exhaust ends of the test specimen.

8.2.14 When no ignition (defined as sustained glowing or flaming) of the cotton pad occurs during the nominal 30 s application, a “screening test” involving a short-duration application of the cotton pad to areas of potential failure and/or the movement of a single pad over and around such areas shall be made. Charring of the pad provides an indication of imminent failure, and a previously unused cotton pad shall be employed in a prescribed manner for the confirmation of an integrity failure.

8.2.15 The roving thermocouple shall be applied until temperature equilibrium is reached but shall be removed if a temperature of 150 °C is not recorded within 20 s.

8.2.16 The roving thermocouple shall not be applied within 450 mm ± 25 mm of the inlet and exhaust ends of the test specimen.

8.2.17 After the burner is shut off, the test is concluded.

The temperatures shall be monitored at 5 min intervals until a decrease in temperatures of the entire assembly is recorded. These temperature data are recorded for informational purposes.

9 Performance criteria

9.1 Fire outside duct

9.1.1 Integrity

The requirements in accordance with ISO 6944-1 for duct A shall apply.

9.1.2 Insulation

The requirements in accordance with ISO 6944-1 for duct A shall apply.

9.2 Fire inside duct

9.2.1 At or before the equilibrium temperature is reached, any temperature measured on the unexposed surface of the test specimen shall not exceed 65 °C above the initial starting temperature during exposure in accordance with 8.2.2.

9.2.2 At no time during the exposure to the flue gases shall the average temperature on the unexposed surface of the test specimen, as determined by thermocouple numbers 1 through 6 as shown in Figure 5, exceed the initial starting temperature by 140°K or more.

9.2.3 At no time during the exposure to the flue gases shall any individual temperature measured on the unexposed surface, including temperature measured by the roving thermocouple, exceed the initial starting temperature by 180°K or more.

9.2.4 No flaming shall occur on the unexposed side of the test specimen during the classification period with the following exceptions. During the first 5 min of the test, flaming at any one location for a cumulative total of less than 10 s is permitted at overlaps or butt joints of the insulation material. Flaming at the inlet and outlet of the test specimen is also permitted.

9.2.5 During the exposure to the flue gases, the cotton pad on the unexposed surface shall not ignite.

9.2.6 During the exposure to the flue gases, there shall not be any openings in the kitchen extract duct.

10 Expression of results

When the kitchen extract duct meets the performance requirements for fire exposure inside the duct, the fire resistance rating of kitchen extract ducts shall be expressed in minutes equal to the lowest of the performance criteria for the integrity and insulation.

11 Test report

In addition to the items required by ISO 834-1 and ISO 6944-1, the following shall be included in the test report:

a) for fire outside duct:

- integrity and insulation ratings in minutes,
- description of the restraint provided to the duct and the condition of the duct end outside of the furnace;

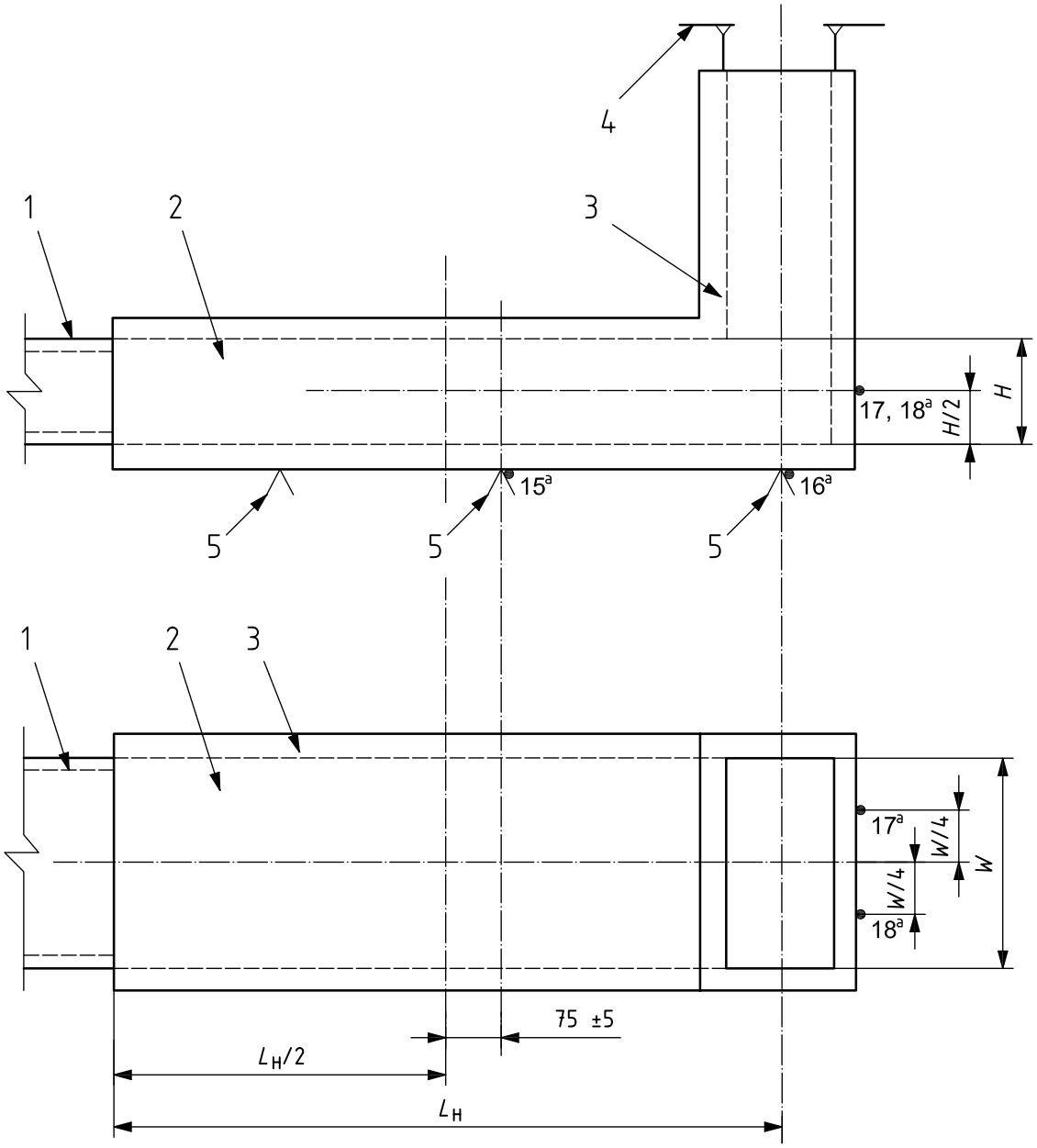
b) for fire inside duct:

- description of the materials and construction details of the test samples, including drawings depicting geometry of the test specimen including the length, width and thickness of the kitchen extract duct, the location and types of splices and access openings in the duct,
- temperatures, reported at intervals not exceeding 0,5 min from the time when equilibrium temperatures are reported and until the end of the test,
- time, expressed in minutes, equal to the lowest of the performance criteria for the integrity and insulation.

Annex A
(normative)

Optional test equipment and instrumentation — Fire inside duct

A.1 It is recommended that the thermocouples be placed on the support system adjacent to the insulation surrounding the kitchen extract duct (Figure A.1, thermocouples numbered 15 and 16) and on the vertical section of the test specimen (Figure A.1, thermocouples numbered 17 and 18).



Key

1 kitchen extract duct
2 insulation system
3 transition section
4 vertical supports
5 supports in accordance with installation instructions
[a] numbered locations for thermocouple tips, represented by "•"

Figure A.1 — Thermocouple locations — Unexposed surface

It is suggested that these locations can provide data to assist in an assessment of the ability of the kitchen extract duct enclosure to support the weight of the test specimen without significantly reducing the insulating performance of the enclosure during the test.

A.2 It is recommended that thermocouples numbered 19 to 22 be placed on the surface of the kitchen extract duct enclosure material nearest the duct beneath thermocouples numbered 1, 2, 3 and 4 shown in Figure 5. It is recommended these thermocouples be Type K with a maximum diameter of 0,21 mm.

It is suggested that these locations can provide data to assist in an assessment of the ability of the insulation material to retain it's insulating capacity during the normal operation of the kitchen extract duct.

Annex B
(informative)

Historical information

The fire performance of kitchen extract ducts presents unique challenges to commercial structures resulting from the build-up of cooking oil deposits. During routine use, flammable deposits accumulate on the interior surface of the duct. The characteristics of these deposits vary and include translucent-type creosote from deep-frying fat to a syrup-like grease.

Reports of fires originating in kitchen extract ducts are numerous. In November 1999, Fire Prevention [2] stated:

"In recent years there has been a dramatic increase in commercial kitchen fires in the UK. Blazes at Heathrow Airport, South Mimms Services and the Royal Albion Hotel in Brighton are examples of large-loss fires which have been traced back to the kitchen. All of these fires caused extensive damage to the whole building structure resulting in a major loss of revenue through business interruption, not to mention huge costs on rebuilding and re-equipping these premises to enable them to resume business."

According to National Fire Protection Association (NFPA) reports, fires related to kitchen extract ducts result in more than $100 million in direct property damage annually in the USA. In 2004, the NFPA Journal [3] reported on a fire in a supermarket located in Asuncion, Paraguay, where 400 persons died and 360 were injured. The reported cause was accidental. The fire was reported to have started in the kitchen in the horizontal transition of the charcoal-grill chimney where a large accumulation of grease served as the fuel load.

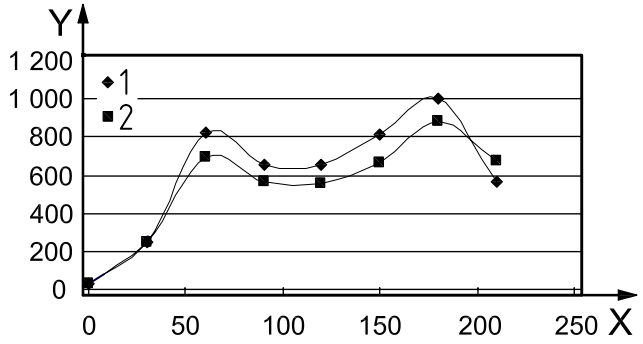
These flammable deposits, when ignited, create temperatures exceeding 980 ºC inside the duct. Temperatures at this level can result in the ignition of combustibles in contact with the outer surface of the duct. Further, during the combustion process, the flammable deposits liquefy and also present a potential to ignite combustibles by passing through openings that can occur in the duct assembly.

The test method in this part of ISO 6944 addresses these unique occurrences. The fire inside the duct (see 8.2) has two stages.

a) The first stage, which lasts a minimum of 4 h, represents normal operating conditions by stabilizing the temperature within the duct at 240 °C.

b) During the second stage, which represents a fire within the duct, the temperature within the duct is increased to 1 095 °C for 30 min.

This temperature approximates the conditions recorded when testing extinguishing systems for kitchen hoods. The test method for the extinguishing systems includes coating a kitchen extract duct with 1,5 kg/ m^2 of animal lard and establishing an air flow of 225 ± 75 m/min within the duct before ignition of the animal lard. Ignition of the animal lard is established by applying an external heat source of approximately 20,000 kJ/min. Typical temperatures recorded within the duct before the extinguishing system is activated are shown in Figure B.1. The initial decrease of the internal duct temperature reflects removal of the ignition source. The final decrease of internal duct temperature reflects the operation of the extinguishing system.



Key

X time, expressed in seconds

Y temperature, expressed in degrees Celsius

—♦— data from location A, located 3,65 m from the ignition source

—■— data from location B, located 6,09 m from the ignition source

Figure B.1 — Temperatures in kitchen extract duct

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