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Fire resistance tests for service installations - Part 9: Single compartment smoke extraction ducts

Feuerwiderstandsprüfungen für Installationen - Teil 9: Entrauchungsleitungen für eine Raumeinheit

Essais de résistance au feu des installations de service - Partie 9 : Conduits d'extraction de fummée relatifs a un seul compartiment

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Contents

Page

Foreword

This document (prEN 1366-9:2004) has been prepared by Technical Committee CEN/TC 127 "Fire safety in buildings", the secretariat of which is held by BSI.

This document is currently submitted to the CEN Enquiry.

Introduction

This part of this European standard has been prepared because a method of test for smoke extraction ducts used in single compartment applications has become necessary. This test exposes a smoke extraction duct to conditions intended to represent the pre-flashover stage of a fire.

Leakage is measured at both ambient temperature and exposure at 600 °C. During the tests, air/gases are drawn through the duct at a differential pressure between the inside and outside of the duct. Leakage is determined at ambient temperature by sealing the openings in the duct located in the furnace and taking flow measurements through a flow measuring device located just before the extraction fan. With respect to determining leakage at 600 °C, oxygen-measuring techniques are used.

CAUTION — The attention of all persons concerned with managing and carrying out this fire resistance test is drawn to the fact that fire testing may be hazardous and that there is a possibility that toxic and/or harmful smoke and gases may be evolved during the test. Mechanical and operational hazards may also arise during the construction of the test elements or structures, their testing and disposal of test 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 method of EN 1366 specifies a test method for determining the fire resistance of smoke extraction ducts that are used for single compartment applications only. In such applications, the smoke extraction system is only intended to function up to flashover (typically 600 °C). The smoke extraction duct is part of the smoke extraction system which also includes smoke control dampers and smoke extract fans.

This test method of part 9 is applicable only to smoke extraction ducts that do not pass through into other fire compartments. It represents fire exposure of a developing fire (pre-flashover).

For smoke extraction ducts that pass through into other compartments, the method of test described in EN 1366-8 should be used.

This test has been designed to cover horizontal smoke extraction ducts intended for single compartment applications only.

This method of test is only suitable for ducts constructed from non-combustible materials (euro class A1).

It is applicable only to four sided ducts and two and three sided ducts are not covered.

The method described in this test is complex and requires sophisticated instrumentation. It is not recommended therefore to try to test multiple assemblies in this test.

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.

EN 1363-1, *Fire resistance tests — Part 1: General principles*

EN 1366-1, *Fire resistance tests for service installations — Part 1: Fire resisting ducts*

EN 1366-8, *Fire resistance tests for service installations — Part 8: Smoke extraction ducts*

EN 1507, *Ventilation for buildings — Ductwork — Rectangular sheet metal air ducts strengthened leakage — requirements and testing*

ISO 516,7, *Measurement of fluid flow by means of orifice plates, nozzles and venturi tubes inserted in circular cross-section conduits running full*

ISO 5221, *Air distribution and air diffusion — Rules to methods of measuring air flow rate in an air handling duct*

3 Terms and definitions

For the purposes of this part of this European Standard, the terms and definitions given in EN 1363-1 and ISO 13943 and the following apply.

3.1
single compartment smoke extraction duct
a duct used for the extraction of smoke up to a temperature of 600 °C from a single compartment to outside a building without passing through another compartment.

3.2
smoke extraction duct for single compartments
a duct needed for the distribution or extraction of air or smoke

3.3
suspension devices
the components used for suspending and fixing a duct from a floor or supporting a duct from a wall

3.4
supporting construction
the wall or partition through which the duct passes in the test

3.5
fire zone
fire area of a single compartment building bounded by smoke curtains

3.6
smoke curtain
vertical barrier designed to contain hot gas layer to fire zone

4 Test equipment

4.1 General

In addition to the test equipment specified in EN 1363-1, the following is required.

4.2 Furnace

This shall be capable of subjecting fire resisting smoke extraction ducts to the heating and pressure conditions specified in this standard and be suitable for testing ducts in the horizontal orientation (Figure 1).

4.3 Perforated plate

The perforated plate controls the flow through the duct so that the required differential pressure, see Table 1, can be achieved. Depending on the end-use conditions, a pressure level from Table 1 shall be selected: These levels correspond to typical values used in smoke extraction design.

The plate shall be positioned 250 ± 50 mm from where the duct passes through the furnace wall (see Figures 1 and 2).

These plates shall be made from heat resisting steel, 19 % min. Cr content and 11 % min. Ni content. The number of holes and dimensions are given in Tables 2 and 3. The thickness of the plates shall be 2,5 mm.

NOTE 1 Table 2 gives details of perforated plates for standard rectangular ducts of size 1000 mm x 250 mm. For smaller sizes, the number of holes will be reduced proportional to the smaller cross-section.

NOTE 2 Table 3 gives details of perforated plates for standard circular ducts of diameter 560 mm. For smaller sizes, the number of holes will be reduced proportional to the cross-section (a change to larger sizes is not accepted; see 6.1.2 and Table 5).

Further details of the plate are shown in Figures 3, 4 and 5.

Table 1 — Differential pressures between inside and outside the duct for smoke extraction ductwork

Pressure Level*)	Operating differential pressure at ambient temperature Pa	Differential pressure for the fire test and pre-test calibration Pa
1	-500	-150
2	-1000	-300
3	-1500	-500

Table 2 — Details of perforated plates for testing rectangular ducts (see Figure 3)

Specification for perforations	Pressure level*)		
	1	2	3
Total number of holes	550	407	324
Number of holes - horizontally	50	37	36
Number of holes - vertically	11	11	9
Diameter of hole (mm)	10	10	10
Horizontal distance from rim e (mm)	15	15	20
Vertical distance from rim c (mm)	15	15	20
Mounting hole separation a (mm)	19,8	26,9	27,4
Mounting hole separation b (mm)	21,8	22	26,3

Table 3 — Details of perforated plate for testing circular ducts (see Figure 4)

Specification for perforations	Pressure level[a)]		
	1	2	3
Total number of holes	541	403	319
Diameter of hole (mm)	10	10	10
Horizontal distance from rim e (mm)	30	35	35
Mounting hole separation a (mm)	20,8	22,2	27,5
Mounting hole separation b (mm)	20,8	22,2	27,5
[a)] see clause 5			

4.4 Inlet nozzles (fire test)

Each nozzle shall have an internal dimension of 160 mm (see Figure 10, suitable for the standard size of duct specified in 6.1) in accordance with ISO 5167/ISO 5221 and shall be suitably mounted to the end of the duct with its piezometric ring connected to appropriate differential pressure measuring equipment. The measuring device shall be capable of measuring to an accuracy of ± 5 %.

4.5 Ambient leakage measuring device

These shall be in accordance with ISO 5167/ISO 5221 and suitably mounted to the end of the duct, connected to appropriate differential pressure measuring equipment. The measuring device shall be capable of measuring to an accuracy of ± 5 %.

4.6 Pressure sensors for differential pressure control

A tube sensor as specified in EN 1363-1 shall be located at the end of the duct, inside the duct, at the level of its centre line. A second sensor (e.g. an open end of a measuring tube) shall be located on the same level outside the duct differential pressure fine control device.

A flow control damper shall be provided for a fine control for maintaining the required differential pressure. Alternatively, another suitable device such as a variable speed fan may be used. Any flow control damper shall be attached to the extract fan connecting duct (see 4.8).

4.7 Welded connecting tube

A welded connecting tube is a tube designed to provide a suitable gas tight connection between the inlet nozzles and the oxygen measuring probes.

4.8 Extract fan connecting duct

An extract fan connecting duct is a duct designed to connect between the test specimen and the extraction fan. An inlet opening may be provided if a flow control damper is used for fine control of the differential pressure (see 4.6).

4.9 Extraction fan

An extraction fan is a fan for extracting gas under test with a suction capacity of at least 2 x V_n where V_n is the required capacity e.g. for a stated cross-section of 1 m x 0,25 m, V_n = 0,5 m^3/s.

The characteristic curves of the fan shall be horizontal for the actual airflow. The capacity of the fan shall not change by more than 10 % in the event of a drop in the pressure of up to 50 Pa.

4.10 Thermocouples

1,5 mm sheathed thermocouples shall be provided for measuring the gas temperature adjacent to the nozzles. An alternative thermocouple may be used, provided it can be shown to have equivalent response time.

4.11 Oxygen measuring equipment

Equipment for measuring the oxygen content of gases shall be provided. This system shall consist of paramagnetic cell oxygen analysers together with appropriate equipment for cooling, filtering and drying the gases. Appropriate connecting tubes and probes shall be provided. The 90 % response time of the complete system shall be 20 s maximum. The accuracy shall be better than ± 0,1 %.

4.12 Restraint equipment

Restraining equipment shall be applied as for duct B in EN 1366-1.

4.13 Observation window

An observation window shall be provided between the two nozzles and a suitable method of viewing from a safe distance be provided (a mirror arrangement may be found suitable).

5 Test conditions

5.1 Differential pressure conditions

Depending on the end-use conditions, a pressure selected from Table 4 shall be selected: These levels correspond to typical values used in smoke extraction design.

Table 4 — Differential pressures between inside and outside the duct for smoke extraction ductwork

Pressure Level	Operating differential pressure at ambient temperature Pa	Differential pressure for the fire test Pa
1	-500	-150
2	-1 000	-300
3	-1 500	-500

5.2 Heating conditions

The heating conditions and the furnace atmosphere shall conform to those specified in EN 1363-1 (or, if applicable, EN 1363-2) until 600 °C is reached. This mean temperature shall be reached between 5 to 10 minutes from igniting the first furnace burner. After 10 minutes this temperature shall be maintained between +70, -0 °C for the rest of the test.

The furnace pressure shall be controlled to (15 ± 3) Pa throughout the test at the mid-height position of the ducts in the furnace.

Details of test conditions within the duct during the test are given in clause 10.

6 Test specimen

6.1 Size

6.1.1 Length

The minimum lengths of the parts of the test specimen inside and outside the furnace shall be as given in Table 5 (see also Figure 1).

Table 5 — Minimum length of test specimen

Orientation	Minimum length (m)	
	Inside furnace	Outside furnace
Horizontal	3,0[a)]	4,2
[a)] see clause 7.4.		

6.1.2 Cross-section

The sizes of duct given in Table 6 shall be tested unless smaller cross-sections are required for specific applications.

Table 6 — Cross-section of test specimen

Rectangular		Circular
Width (mm)	Height (mm)	Diameter (mm)
1000	250	560

6.2 Number

One test specimen shall be tested for each type of installation to be evaluated.

6.3 Design

The test shall be made on a test specimen representative of the complete duct. Each type of duct requires a different approach and an attempt shall be made to reproduce the edge conditions and the method of fixing or support inside and outside the furnace representative of that used in practice. The distance between hangers or supports shall be representative. Where compensators are used in practice, than they shall be incorporated in the test specimen. In this case, the compensator shall be located outside the furnace, approximately 500 mm from the perforated plate.

7 Installation of test specimen

7.1 General

The test specimen shall be installed, as far as possible, in a manner representative of its use in practice.

The fire-stopping at the penetration through the supporting construction shall be sufficient to prevent leakage of furnace gases.

Parts of the ducts within the furnace shall be exposed to fire from all sides over their whole length.

7.2 Standard supporting construction

A standard supporting construction shall be selected from the specifications detailed in EN 1366-1.

Where the duct passes through an opening in the furnace wall, the opening shall be of sufficient dimensions to allow for the supporting construction to surround all faces of the duct by at least 200 mm.

To ensure that leaking furnace gas does not occur, it is important that the supporting construction and furnace roof is well sealed where it contacts the furnace wall.

7.3 Duct arrangement

7.3.1 A single duct may be tested in the furnace, or alternatively, two or more ducts may be tested in the same furnace, provided that there is sufficient space to do so, in accordance with the dimensions shown in Figure 1.

7.3.2 Ducts shall be arranged as shown in figure 1. The end of the ducts within the furnace shall be closed independently of any furnace enclosure by materials and construction similar to the remainder of the duct.

7.3.3 The test arrangement shall include at least one joint or flange connection inside the furnace and at least one joint or flange connection outside it. Any stiffeners used to maintain the cross-section of the duct shall be arranged at the positions and centres specified by the sponsor. The distance