

Fire resistance tests for service installations

Part 3: Penetration seals

ICS 13.220.50

National foreword

This British Standard is the UK implementation of EN 1366-3:2009. It supersedes BS EN 1366-3:2004 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee FSH/22/3, Test procedures for fire penetration and seals.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Abschottungen

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Foreword

This document (EN 1366:2009) has been prepared by Technical Committee CEN/TC 127 “”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 2009, and conflicting national standards shall be withdrawn at the latest by August 2009.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 1366-3:2004.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

Annexes A to G are normative. Annex H is informative.

EN 1366, *Fire resistance tests for service installations* consists of the following:

Part 1: Ducts

Part 2: Fire dampers

Part 3: Penetration seals

Part 4: Linear joint seals

Part 5: Service ducts and shafts

Part 6: Raised access floors and hollow floors

Part 7: Conveyors systems and their closures

Part 8: Smoke extraction ducts

Part 9: Single compartment smoke extraction ducts

Part 10: Smoke control dampers (in course of preparation)

Part 11: Protective systems for essential services (in course of preparation)

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This part of this European Standard has been prepared to provide a method of test for assessing the contribution of a penetration seal to the fire resistance of separating elements when they have been penetrated by a service or services.

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 should be made and safety precautions should be identified and provided. Written safety instructions should be issued. Appropriate training should be given to relevant personnel. Laboratory personnel should ensure that they follow written safety instructions at all times.

1 Scope

This Part of EN 1366 specifies a method of test and criteria for the evaluation (including field of application rules) of the ability of a penetration seal to maintain the fire resistance of a separating element at the position at which it has been penetrated by a service. Penetration seals used to seal gaps around chimneys, air ventilation systems, fire rated ventilation ducts, fire rated service ducts, shafts and smoke extraction ducts are excluded from this standard except for mixed penetration seals. The fire resistance of those services itself cannot be assessed with the methods described in this standard.

Supporting constructions are used in this standard to represent separating elements such as walls or floors. These simulate the interaction between the test specimen and the separating element into which the sealing system is to be installed in practice.

This European Standard is used in conjunction with EN 1363-1.

The purpose of this test described in this standard is to assess:

- a) the effect of such penetrations on the integrity and insulation performance of the separating element concerned;
- b) the integrity and insulation performance of the penetration seal;
- c) the insulation performance of the penetrating service or services, and where necessary, the integrity failure of a service.

No information can be implied by the test concerning the influence of the inclusion of such penetrations and sealing systems on the loadbearing capacity of the separating element.

It is not the intention of this test to provide quantitative information on the rate of leakage of smoke and/or hot gases or on the transmission or generation of fumes. Such phenomena are only to be noted in describing the general behaviour of test specimens during the test.

This test is not intended to supply any information on the ability of the penetration seal to withstand stress caused by movements or displacements of the penetrating services.

The risk of spread of fire downwards caused by burning material, which drips through a pipe downwards to floors below, cannot be assessed with this test.

Explanatory notes to this test method are given in Annex H.

All dimensions given without tolerances are nominal ones unless otherwise stated.

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 520, *Gypsum plasterboards – Definitions, requirements and test methods*

EN 1329-1, *Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure – Unplasticized poly(vinyl chloride) (PVC-U) – Part 1: Specifications for pipes, fittings and the system*

EN 1363-1:1999, *Fire resistance tests – Part 1: General requirements*

EN 1363-2, *Fire resistance tests – Part 2: Alternative and additional procedures*

EN 1452-1, *Plastics piping systems for water supply – Unplasticized poly(vinyl chloride) (PVC-U) – Part 1: General*

EN 1453-1, *Plastics piping systems with structured wall-pipes for soil and waste discharge (low and high temperature) inside buildings – Unplasticized poly(vinyl chloride) (PVC-U) – Part 1: Specifications for pipes and the system*

EN 1455-1, *Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure – Acrylonitrile-butadiene-styrene (ABS) – Part 1: Requirements for pipes, fittings and the system*

EN 1519-1, *Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure – Polyethylene (PE) – Part 1: Specifications for pipes, fittings and the system*

EN 1565-1, *Plastics piping systems with structured-wall pipes for soil and waste discharge (low and high temperature) inside buildings – Styrene copolymer blends (SAN+PVC) – Part 1: Specifications for pipes, fittings and the system*

EN 1566-1, *Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure – Chlorinated poly(vinyl chloride) (PVC-C) – Part 1: Specifications for pipes, fittings and the system*

EN 1992-1-2, *Eurocode 2 – Design of concrete structures – Part 1-2: General rules – Structural fire design*

EN 1996-1-2, *Eurocode 6 – Design of masonry structures – Part 1-2: General rules – Structural fire design*

EN 10305-4, *Steel tubes for precision applications – Technical delivery conditions – Part 4: Seamless cold drawn tubes for hydraulic and pneumatic power systems*

EN 10305-6, *Steel tubes for precision applications – Technical delivery conditions – Part 6: Welded cold drawn tubes for hydraulic and pneumatic power systems*

EN 12201-2, *Plastics piping systems for water supply – Polyethylene (PE) - Part 2: Pipes*

EN 12449, *Copper and copper alloys – Seamless, round tubes for general purposes*

EN 12666-1, *Plastics piping systems for non-pressure underground drainage and sewerage – Polyethylene (PE) – Part 1: Specifications for pipes, fittings and the system*

EN 13501-1, *Fire classification of construction products and building elements – Part 1: Classification using test data from reaction to fire tests*

EN 13501-2, *Fire classification of construction products and building elements – Part 2: Classification using data from fire resistance tests, excluding ventilation services*

EN 13600, *Copper and copper alloys – Seamless copper tubes for electrical purposes*

EN ISO 13943:2000, *Fire safety – Vocabulary (ISO 13943:2000)*

EN 61386-21, *Conduit systems for cable management - Part 21: Particular requirements - Rigid conduit systems (IEC 61386-21:2002)*

HD 21.3, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 3: Non-sheathed cables for fixed wiring (IEC 60227-3:1993, modified)*

HD 22.4, *Cables of rated voltages up to and including 450/750V and having crosslinked insulation — Part 4: Cords and flexible cables*

HD 603.3, *Distribution cables of rated voltage 0.6/1 kV – Part 3: PVC insulated cables – unarmoured*

HD 604.5, *0.6/1 kV power cables with special fire performance for use in power stations – Part 5: Cables with copper or aluminium conductors with or without metallic covering or screen*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 1363-1:1999 and EN ISO 13943:2000 and the following apply.

3.1

blank penetration seal

aperture in the separating element which is sealed or closed by the specified seal without incorporation of penetrating services

3.2

cable box

housing with intumescent inlays that forms a channel which is normally fitted with a device to prevent the passage of cold smoke

3.3

combination frame

two or several single frames joined together to one unit

3.4

conduit

metal or plastic casing designed to accommodate cables

NOTE Normally a conduit is circular or oval in section. See also *trunking*.

3.5

flexible construction

horizontal or vertical supporting construction consisting of studs or joists, including linings and optional insulation

3.6

modular system

pre-sized frame into which are installed elastomeric insert blocks, compressed around the service

3.7

non-sheathed cable (wire)

normally a single core cable with only one layer of covering

3.8

penetration

aperture in a separating element for the passage of one or more services

3.9

penetration seal

system used to maintain the fire resistance of a separating element at the position where services pass through or where there is provision for services to pass through a separating element

3.10

penetration seal - large

penetration seal large enough to accommodate the standard configuration according to Figures A.1 or A.3B

3.11

penetration seal - small

penetration seal of an area of max 0,07 m², i.e. up to 300 mm diameter or equivalent rectangular up to a length to width ratio of 2,5:1

3.12

pipe closure device

reactive device in varying sizes, to seal pipe penetrations including associated pipe insulation

3.13

pipe insulation

Table 1 shows the terms used throughout the document for the various purposes of pipe insulation

3.14

service

system such as a cable, conduit, pipe (with or without insulation) or trunking

3.15

service support construction

mechanical support provided in the form of clips, ties, hangers, ladder racks or trays, or any device designed to carry the load of the penetrating services

3.16

sheathed cable

single or multi-core cable with individual covering of the cores and an additional protective covering of the assembly

3.17

single frame

square or rectangular frame, with predefined dimensions in different sizes, to accommodate a modular penetration seal (see Figure 1)

3.18

(single) module

single block, available in different sizes, to be used inside a single frame (opening)

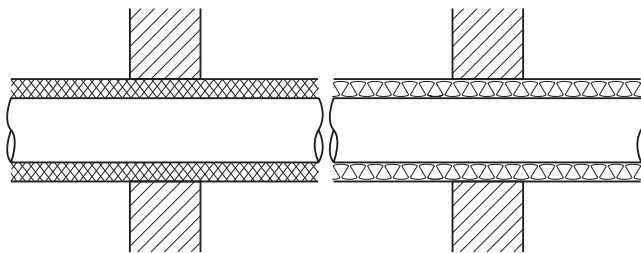
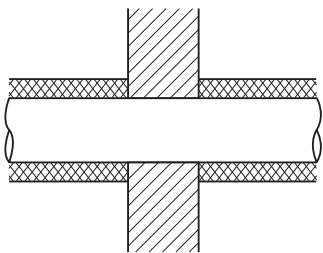
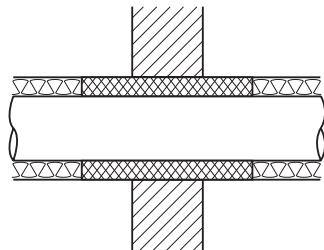
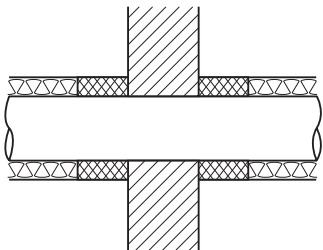
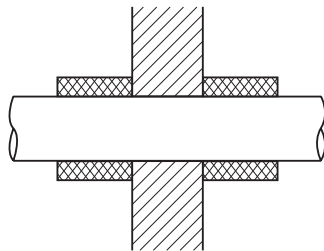
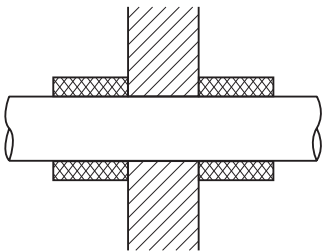
NOTE Adapted to seal around penetrating services in different sizes and shapes or as blanks (see Figure 1).

3.19

single opening

area of the modular system within a single frame or within each single frame of a combination frame which is available for the modules (see Figure 1)

Table 1 — Definition of pipe insulation (3.13)

	<i>Sustained</i>	<i>Interrupted</i>
Continued		
	 Case CS	 Case CI
Local	 Case LS	 Case LI
NOTE Depending on the reaction to fire classification of the insulation, the insulation may be the penetration seal / be part of the penetration seal or additional sealing means (which are not shown in the figures) may be necessary. For further explanation see Annex H.		
Key  Building element  Pipe  Thermal/acoustic/other pipe insulation  Insulation acting as penetration seal or forming part of the penetration seal		

3.20

standard supporting construction

form of construction of known fire resistance used to support the penetration seal being evaluated

3.21

test specimen

assembly for test consisting of the penetrating service or services and the penetration seal, materials or devices, together with any service supporting construction, designed to maintain the integrity and insulation performance of the separating element for the duration of the fire test

3.22

trunking

metal or plastic casing designed to accommodate cables

NOTE Normally trunking is square or rectangular in section. See also *conduit*.

3.23

waveguide

circular, elliptical or rectangular metal tube or pipe or a coaxial assembly of tubes/pipes through which electromagnetic waves are propagated in microwave and radio wave frequency communications

4 Test equipment

See EN 1363-1, and if applicable EN 1363-2.

5 Test conditions

5.1 Heating conditions

The heating conditions and the furnace atmosphere shall conform to those given in EN 1363-1 or, if applicable, EN 1363-2.

5.2 Pressure conditions

5.2.1 Pressure conditions including tolerances shall be as given in EN 1363-1 subject to the following:

5.2.2 A minimum pressure of 20 Pa shall be maintained at the top of the uppermost penetration seal in a vertical supporting construction. Services shall only be included in the zone where the positive pressure exceeds 10 Pa (a minimum pressure of 10 Pa shall be maintained at the lowest point of the lowest service, see Figure 2).

NOTE A pressure of 10 Pa is expected to be maintained ca. 1200 mm below the plane where a pressure of 20 Pa is maintained according to the pressure gradient given in EN 1363-1.

5.2.3 In case of a blank penetration seal in a vertical supporting construction a minimum pressure of 20 Pa shall be maintained at the top of the seal.

5.2.4 For horizontal supporting constructions a nominal pressure of 20 Pa shall be maintained in the horizontal plane (100 ± 10) mm below the underside of the supporting construction.

6 Test specimen

6.1 Size and distances

A penetration and the accompanying penetration seal shall be as in practice. In order to avoid boundary effects, the distance between the perimeter of the penetration seal and the internal surfaces of the furnace shall be not less than 200 mm at any point.

In cases where several test specimens are included in a single test construction, the minimum distance between adjacent penetration seals shall be not less than 200 mm unless it is the intention to demonstrate that a smaller distance does not have a negative effect on fire performance. Each penetration seal shall be the subject of a separate evaluation, provided the standard test conditions are maintained throughout the test with respect to the penetration being evaluated.

6.2 Number

See EN 1363-1.

For horizontal separating elements only one test specimen is required with fire exposure from the underside. Where a penetration seal is intended for use both in floors and walls, the systems shall be tested both vertically and horizontally.

6.3 Design

6.3.1 General

The test specimen shall be either:

- a) fully representative of the service and penetration seal used in practice, including any special features which are unique to that installation or
- b) a standard configuration which is deemed to cover a wide range of practical applications.

For standard configurations or advice for designing the specimen/test setup see the following:

- 1) Supporting construction: 7.2.2;
- 2) Large cable penetration seals: Annex A;
- 3) Small penetration seals: Annex B;
- 4) Modular systems and cable boxes: Annex C;
- 5) Bus bars: Annex D;
- 6) Pipe penetration seals: Annex E;
- 7) Mixed penetration seals: Annex F;
- 8) Critical pipe/cable approach: Annex G.

6.3.2 Penetrating services

For the purpose of this standard the following grouping applies:

- a) Pipes and conduits of class A1 according to EN 13501-1 with a melting or decomposition point greater than 1000°C (e.g. steel, cast iron, copper and copper alloys, nickel alloys) either insulated or non-insulated, hereafter referred to as "metal pipes". Included in this group are the above pipes with a coating provided the overall classification is minimum A2 according to EN 13501-1.
- b) Trunking of class A1 according to EN 13501-1 with a melting or decomposition point greater than 1000°C (e.g. steel, cast iron, copper and copper alloys, nickel alloys) either insulated or non-insulated, hereafter referred to as "metal trunking". Included in this group are the above trunkings with a coating provided the overall classification is minimum A2 according to EN 13501-1.
- c) Pipes, trunking and conduits of class A1 or A2 according to EN 13501-1 with a melting or decomposition point equal to or less than 1000°C (e.g. lead, aluminium and aluminium alloys) and/or the risk of fracture (glass, fibre cement) either insulated or non-insulated.
- d) Pipes not classified to A1 or A2 according to EN 13501-1 (e.g. made from thermoplastic or thermosetting material) including non-homogeneous materials (e.g. glass fibre reinforced plastic pipes or layered pipes), either insulated or non-insulated, hereafter referred to as "plastic pipes".
- e) Trunking and conduits not classified to A1 or A2 according to EN 13501-1 (e.g. made from thermoplastic or thermosetting material) including non-homogeneous materials, either insulated or non-insulated, hereafter referred to as "plastic trunkings" and "plastic conduits".

6.3.3 Support conditions for penetrating services

6.3.3.1 General

The support conditions for the service(s) shall be chosen from the following:

- a) without support;
- b) standard service support construction (see Figures A.2, A.3A, A.3B, A.4, A.5, A.6, A.8 and E.10);
- c) full-scale representation as in practice. A load may be applied to simulate practical conditions.

In each condition the method of support (if any) shall be fully described in the test report.

6.3.3.2 Standard service support construction

The standard support construction for cables shall comprise of steel H-studs, steel brackets, steel rod, steel ladders and trays as shown in Figure A.2, A.4 and A.6 for vertical test specimens, of steel angles, steel channels and steel ladders as shown in Figure A.3A, A.3B and A.5 for horizontal specimens. A single or a pair of horizontal supports (20 mm steel rod) may be used on each face.

Alternative constructions for the H-studs, steel brackets, steel angles and steel channels may be used (see Figure A.8 for cable supports and Figure E.10 for pipe supports).

When installing a steel ladder, positioning of a rung within the penetration seal should be avoided.

Alternative materials for cable ladders/trays, e.g. plastic, aluminium, steel with organic coatings resulting in an overall class of B to E according to EN 13501-1, shall be tested in addition to the standard ladders/trays as defined in Annex A with the cables from cable tray 1 as shown in Figure A.1.

The standard support for pipes shall consist of a strut / channel system with e.g. a steel band or pipe rings either standing on or hanging from the channel (see Figure E.10) to prevent movement in the plane of the supporting construction and perpendicular to the supporting construction.

In the case of flexible floor constructions the service support construction shall be independent of the supporting construction to allow differential movement of the services relative to the supporting construction.

6.3.4 Pipe end configuration

When pipes are to be tested, the pipe end configurations shall be chosen from Table 2 depending on the nature of the pipe material and the required field of application.

Table 2 — Pipe end configuration

Test condition	Pipe end configuration	
	Inside the furnace	Outside the furnace
U/U	Uncapped	Uncapped
C/U	Capped	Uncapped
U/C	Uncapped	Capped
C/C	Capped	Capped

Capping of pipes shall be carried out by closing the pipe end by inserting an appropriate mineral wool disc into the end of the pipe, fixed in place with an appropriate adhesive (e.g. sodium silicate adhesive). For further explanation see Annex H. In cases where vertical pipes are tested, the mineral wool shall be fixed additionally by mechanical means. For “metal pipes” the pipe may be capped by fixing a disc or cap (with a melting or decomposition point equal or greater than that of the pipe) onto the end of the pipe. For “plastic pipes”, “plastic conduits” and “plastic trunkings” the pipe may be capped using a plastic cap.

Where a flue gas recovery system is intended to be used the following rules shall be obeyed:

- 1) Maximum 4 pipes of a comparable diameter, i.e. mean value $\pm 20\%$ (for further explanation see H.4.2.3), at the same horizontal level shall be connected to one recovery pipe made from a metallic folded spiral-seam tube of 100 mm diameter. Appropriate bushings shall be used to connect the pipes to the recovery pipe;
- 2) The length of the recovery pipe outside the furnace shall be $1,5 \pm 0,1$ m (for further explanation see H.4.2.3).

For relation between the use of a flue gas recovery system and the pipe end configuration see Annex E.

6.3.5 Cable end configuration

The heated ends of cables shall be left uncapped. Cables projecting from the unheated face of the supporting construction shall be capped using an appropriate method, e.g. acrylic sealants, to prevent hot gases escaping.

6.3.6 Blank penetration seal

If a blank penetration seal is to be evaluated, this shall be incorporated into the supporting construction. To gain the maximum field of application the largest envisaged penetration seal shall be tested.

6.3.7 Subsequent addition/removal of services

If it is the intention of the test to represent the effect of adding extra services or altering the number and/or type of service running through the seal subsequent to installation, then the following procedure shall be followed.

After installation of the penetration seal into the appropriate supporting construction, the penetration seal shall be allowed to cure according to the manufacturer's installation instructions. After this period any required modifications shall be made to the service(s) and the penetration seal as required to be evaluated and the test construction shall be conditioned in accordance with Clause 8.

Any procedures involved in the addition or removal of services shall be fully described in the test report.

6.4 Construction

The test specimen shall be constructed as described in EN 1363-1.

6.5 Verification

Verification of the test specimen(s) shall be carried out as described in EN 1363-1.

7 Installation of test specimen

7.1 General

The test specimen(s) shall be installed, as far as possible, in a manner representative of their use in practice. Care shall be taken to avoid any artificial support which could be provided to the service e.g. if it sags during the test.

7.2 Supporting construction

7.2.1 General

The supporting construction may be either one of the standard constructions listed in 7.2.2 or a specific construction. In the latter case, however, the field of direct application is limited (see 13.2).

7.2.2 Standard supporting constructions

7.2.2.1 Wall constructions

7.2.2.1.1 Rigid wall constructions

The standard supporting constructions for rigid wall separating elements shall be made of aerated concrete slabs, lightweight concrete or high density concrete and a thickness appropriate to the required fire resistance classification according to the tables given in EN 1992-1-2 for lightweight concrete and high density concrete and EN 1996-1-2 for autoclaved aerated concrete.

7.2.2.1.2 Flexible wall constructions

The standard supporting construction shall be in accordance with the provisions given in EN 1363-1, subject to the following:

- 1) The size of the supporting construction shall be minimum 3 m in height and minimum 1,20 m in width. The flexible wall shall contain minimum 1 vertical joint between the boards;

- 2) The wall shall be restrained only on the top and bottom edge;
- 3) The number and thickness of the gypsum board(s) shall be as given in Table 3;
- 4) A construction including insulation shall be used. The insulation material shall be mineral wool with a classification of A1 or A2 according to EN 13501-1. The density of the insulation shall be $45 \pm 15 \text{ kg/m}^3$ for a desired fire resistance up to and including 60 min and $100 \pm 15 \text{ kg/m}^3$ for a fire resistance of more than 60 min. The thickness shall be such that the remaining gap between the board and the insulation is maximum 15 mm;
- 5) Demonstration of performance of a penetration seal that does not require an aperture framing may be shown by using an insulated flexible wall construction where the insulation is removed to a depth of 100 mm around the seal provided a minimum of 100 mm of insulation is left along the studs;
- 6) Steel studs of varying widths may be used to fit the flexible wall constructions defined in Table 3;
- 7) Provisions shall be made to ensure that the H-studs shown in Figure A.6 do not restrain movement of the flexible wall construction during the fire resistance test. A distance of 100 mm is considered to be appropriate. The fixing on the lower end shall be slotted to allow elongation and to avoid distortion;
- 8) Where the test sponsor's penetration seal system requires the cavity of the supporting wall around the penetration to be capped, this should be accomplished in accordance with the test sponsor's specification. The test result obtained is then only valid when used in conjunction with this capping detail.

Table 3 — Standard flexible wall constructions

Nominal minimum overall thickness ^a mm	Thickness of gypsum board EN 520 Type F mm	Number of layers each side	Indicative fire resistance min
69 - 75	12,5	1	30
94 - 100	12,5	2	60
94 - 100	12,5	2	90
122 - 130	15	2	120

^a The values given consider the different stud widths available within the European construction market.

7.2.2.2 Floor constructions

7.2.2.2.1 Rigid floor construction

The standard supporting constructions for rigid floor separating elements shall be made of aerated concrete slabs, lightweight concrete or high density concrete and a thickness appropriate to the required fire resistance classification according to the tables given in EN 1992-1-2 for lightweight concrete and high density concrete and EN 1996-1-2 for autoclaved aerated concrete.

7.2.2.2.2 Flexible floors

In the case of flexible floors, e.g. steel joisted floors, the minimum size of the supporting construction shall be at least 4 m in span and 2 m in width. In the case of timber joist floors the minimum size of the supporting construction shall be at least 3 m in span and 2 m in width.

7.3 Installation of service(s)

The service(s) shall be installed so that it projects a minimum of 500 mm on each side of the supporting construction, of which at least 150 mm shall extend beyond the extremities of the penetration seal. In the case of CS and CI pipe insulation (according to 3.13) the insulation shall extend to the end of the pipe.

Any coating, wrapping or other protection to the services (for instance the insulation of case LS and LI according to 3.13) shall be considered part of the penetration seal.

In the case of metallic services and metallic service supports that penetrate the seal the length of the unprotected part of the service/service support on the unexposed face shall not be greater than 500 mm.

In the case of plastic pipes the length of pipe on the unexposed side may be extended to allow for collection of the effluent gases.

7.4 Installation of penetration seal

The penetration seal shall be installed in accordance with the manufacturer's instructions.

7.5 Multiple penetration seals in one test specimen

When more than one penetration seal is incorporated into a single supporting construction in accordance with the requirements of Clause 6, care shall be taken to ensure that there is no interaction between different penetration seals.

8 Conditioning

The test construction shall be conditioned in accordance with EN 1363-1.

9 Application of instrumentation

9.1 Thermocouples

9.1.1 Furnace thermocouples (plate thermometers)

Plate thermometers shall be provided in accordance with EN 1363-1. There shall be at least one for every 1,5 m² of the exposed surface area of the test construction, subject to a minimum of 4. In vertical supporting constructions, the plate thermometers shall be orientated so that side 'A' faces towards the back wall of the furnace. In horizontal supporting constructions, the plate thermometers shall be orientated so that side 'A' faces the floor of the furnace.

No part of the plate thermometer shall be closer than 100 mm to any part of the seal, a penetrating service or any part of the furnace at the start of the test.

9.1.2 Unexposed face thermocouples

9.1.2.1 General

Unexposed surface temperature measurements shall be made using thermocouples in accordance with EN 1363-1 subject to the following:

The insulating pad shall be made from a silicate fibre based material ("mineral fibre paper") with an overall thickness of 2 mm. The nominal density shall range from 130 kg/m³ to 200 kg/m³, the

classification temperature shall be $> 1000^{\circ}\text{C}$ and the loss on ignition $< 12\%$. The thermal conductivity at 200°C shall be between $0,050\text{ W/(mK)}$ and $0,065\text{ W/(mK)}$. For further information see H.5.1.

In the case of non-planar surfaces the disc and/or pad shall be deformed to follow the surface profile. If there is difficulty in fixing the standard pad, the size of the pad may be reduced on two sides subject to covering the disc.

Thermocouples shall be provided in the following locations (see Figures 3 and 4):

9.1.2.2 Position A

On the surface of the service protruding from the unexposed face 25 mm from the point where the service emerges from the penetration seal and any applied insulation or coating (see Figure 4). At this location, a measurement shall be made on each different type and/or size of penetrating service included in the penetration. On each selected service one thermocouple as described above shall be provided per 500 mm perimeter of the service. See Figure 4 for the positions of the thermocouples if the penetration seal is a surface mounted device on the unexposed face.

In the case of tightly bunched or grouped services, the grouped assembly shall be treated as a single service. Thermocouples at the specified positions shall be evenly distributed around the perimeter of the service. If the service passes through a penetration seal in a vertical supporting construction, one of these thermocouples shall be attached to the uppermost surface of the service.

In the case of a penetration seal in a vertical supporting construction, when similar services are included in the penetration, the service nearest the top of the penetration shall be chosen for temperature measurement.

9.1.2.3 Position B

On the surface of the penetration seal at the following locations (see Figure 3):

- 1) If possible, 25 mm from each type of penetrating service (or group of services) with a minimum of one thermocouple provided for each 500 mm perimeter of the service;
- 2) If appropriate, equidistant from the perimeter of the service to the edge of the penetration where this distance is a maximum or, in the case where there is more than one penetrating service, at the nominal mid-position of what in the judgement of the laboratory is the largest uninterrupted area of the penetration seal;
- 3) In the case of penetration seals in a vertical supporting construction on the surface of the penetration seal at a distance of 25 mm from the top edge adjacent to the position E thermocouples;
- 4) In the case of a blank seal in the centre and at two of the quarter points (see Figure 3).

9.1.2.4 Position C

At the mid-point of the top member of any supporting frame at the periphery of the penetration on the unexposed surface (see Figure 3). In the case of a penetration seal in a vertical supporting construction this measurement shall be made at the top of the penetration.

9.1.2.5 Position D

On the surface of each ladder, tray or any service supporting construction that passes through the penetration seal, at a distance of 25 mm from the point of emergence from the penetration seal (see Figure 3).

9.1.2.6 Position E

On the surface of the supporting construction 25 mm from the top edge of the penetration with a minimum of one thermocouple per penetration (see Figure 3 for example).

9.1.2.7 Position F

If, in the opinion of the laboratory, potential weak spots can be identified, additional fixed thermocouples shall be attached at those points.

9.1.3 Roving thermocouple

The information obtained on unexposed face surface temperatures shall be supplemented by additional data derived from measurements obtained using a roving thermocouple as specified in EN 1363-1, applied to identify any local "hot spots" or where temperatures measured by the fixed thermocouples are not reliable.

9.2 Integrity measurement

In addition to the cotton pads specified in EN 1363-1, additional cotton pads shall be provided with a reduced size of 30 mm × 30 mm × 20 mm. An additional wire frame holder as described in EN 1363-1 modified to accommodate the smaller cotton pad shall also be provided. This modified holder shall still maintain the 30 mm clearance required from adjacent surfaces.

9.3 Pressure

Install pressure measuring devices in the furnace in accordance with EN 1363-1.

10 Test procedure

10.1 General

The test shall be carried out using the equipment and procedures in accordance with EN 1363-1, and if appropriate EN 1363-2, modified if necessary as described in this standard.

NOTE If the critical pipe/cable approach is to be used then a minimum of 5 additional minutes should be added to the test duration above the required classification period (see Annex G).

10.2 Integrity

Where difficulties arise in attempting to use the cotton pad for the assessment of loss of integrity in accordance with EN 1363-1 because the penetration carries a high density of services, the reduced size cotton pad specified in 9.2 shall be used.

10.3 Other observations

Observations as described in EN 1363-1:1999 clause 10.4.7 shall be recorded.

The test specimen in the furnace shall be monitored for the occurrence of artificial support to a service e.g. if it sags and is supported by the floor of the furnace or another test specimen.

11 Performance criteria

11.1 Integrity

The criteria by which the integrity performance of the test specimen is judged are given in EN 1363-1. The criteria are not applied to the uncapped pipe ends. Failure of any cable in a cable group as defined in Table A.1 fails the whole group.

11.2 Insulation

The criteria by which the insulation performance of the test specimen is judged are given in EN 1363-1 with the exception that the average temperature rise criterion is not used. Failure of any cable in a cable group as defined in Table A.1 fails the whole group.

11.3 Multiple penetrations

Any failure with respect to a single service incorporated in a penetration seal shall constitute a failure of that seal unless the field of application is restricted according to the field of application rules. If several penetration seals are included in a single test construction, then the performance of each penetration seal shall be judged separately subject to the constraints of 6.2.

12 Test report

In addition to the items required by EN 1363-1, the following shall also be included in the test report (if applicable):

- a) a reference that the test was carried out in accordance with EN 1366-3;
- b) identification of the services included in the test;
- c) the actual and nominal dimensions of services included in the test except for services listed in Tables A.1 and A.2;
- d) for tests on pipes, a statement of the pipe end configuration according to Table 2;
- e) for tests on cables, the dimensions of a_1 to a_5 according to Annex A (see Figure A.1);
- f) for “metal pipes” and “metal trunkings”, the dimensions a_1 to a_3 according to Annex E;
- g) the maximum size of a blank penetration seal;
- h) whether multiple penetrations have been tested in a single test construction;
- i) the result of gap gauge measurements if appropriate;
- j) any additional information as required in the annexes.

13 Field of direct application of test results

13.1 Orientation

Test results are only applicable to the orientation in which the penetration seals were tested, i.e. in a wall or floor.

13.2 Supporting construction

13.2.1 Rigid floor and wall constructions

Test results obtained with rigid standard supporting constructions may be applied to concrete or masonry separating elements of a thickness and density equal to or greater than that of the supporting construction used in the test. This rule does not apply to pipe closure devices positioned within the supporting construction in case of higher thickness of the supporting construction unless the length of the seal is increased by an equal amount and the distance from the surface of the supporting construction remains the same on both sides.

13.2.2 Flexible wall constructions

13.2.2.1 Test results obtained with the standard flexible wall constructions according to 7.2.2.1.2 cover all flexible wall constructions of the same fire resistance classification provided:

- 1) the construction is classified in accordance with EN 13501-2;
- 2) the construction has an overall thickness not less than the minimum thickness of the range given in Table 3 for the standard flexible wall used in the test. This rule does not apply to pipe closure devices positioned within the supporting construction unless the length of the seal is increased by an equal amount and the distance from the surface of the supporting construction remains the same on both sides;
- 3) in the case of penetration seals installed within the wall and where a flexible wall with insulation was used in the test an aperture framing shall be used in practice. The aperture frame and aperture lining shall be made from studs and boards of the same specification as those used in the wall in practice. The thickness of the aperture lining shall be minimum 12,5 mm. This rule does not apply in the case where the insulation was removed around the penetration seal(s) (see 7.2.2.1.2);
- 4) the number of board layers and the overall board layer thickness is equal or greater than that tested when no aperture framing is used;
- 5) flexible wall constructions with timber studs are constructed with at least the same number of layers as given in Table 3, no part of the penetration seal is closer than 100 mm to a stud, the cavity is closed between the penetration seal and the stud, and minimum 100 mm of insulation of class A1 or A2 according to EN 13501-1 is provided within the cavity between the penetration seal and the stud.

13.2.2.2 An aperture framing is considered as being part of the penetration seal. Tests without an aperture framing cover applications with aperture framing but not vice versa.

13.2.2.3 The standard flexible wall construction does not cover sandwich panel constructions and flexible walls where the lining does not cover the studs on both sides. Penetrations in such constructions shall be tested on a case by case basis.

13.2.2.4 Test results obtained with flexible supporting walls may be applied to concrete or masonry elements of an overall thickness equal to or greater than that of the element used in the tests. This rule does not apply to pipe closure devices positioned within the supporting construction unless the length of the seal is increased by an equal amount and the distance from the surface of the supporting construction remains the same on both sides.

13.3 Services

13.3.1 The direct field of application rules apply to the nominal dimensions of services.

13.3.2 For the field of direct application for cable penetration seals including small conduits see A.3, B.2, C.1.2 and C.2.3.

13.3.3 For field of direct application for bus bars see D.2.

13.3.4 For field of direct application for pipe penetration seals (including trunking / conduits) see E.1.5, E.2.7 and E.3.

13.3.5 For field of direct application for mixed penetration seals see F.5.

13.4 Service support construction

13.4.1 The standard cable ladders/trays as defined in Annex A cover metal trays with a melting point higher than the furnace temperature at the classification time, e.g. stainless steel, galvanised steel. For all other ladders/trays (e.g. plastic, aluminium) separate evidence is necessary.

13.4.2 Steel ladders/trays with organic coatings are covered by the standard ladders/trays if their overall classification is minimum A2 according to EN 13501-1.

13.4.3 The distance from the surface of the separating element to the nearest support position for services shall be as tested or less.

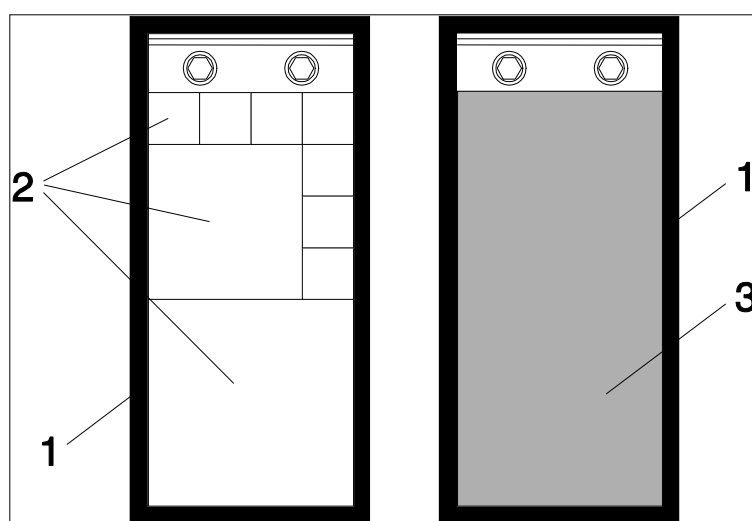
13.5 Seal size and distances

13.5.1 The test results obtained using standard wall and floor configurations for penetration seals are valid for any penetration seal size (in terms of linear dimensions) equal to or smaller than that tested, provided the total amount of cross sections of the services (including insulation) does not exceed 60 % of the penetration area, the working clearances are not smaller than the minimum working clearances (as defined in Annexes A, B, E and F) used in the test and a blank penetration seal of the maximum seal size desired was tested in addition.

A blank penetration seal test may be omitted for mortar seals, seals made from rigid boards and mineral wool boards of a density of minimum 150 kg/m³ and for single service penetration seals.

13.5.2 For floor constructions, results from tests with a penetration seal length of minimum 1 000 mm apply to any length as long as the perimeter length to seal area ratio is not smaller than that of the tested penetration seal.

13.5.3 The distance between a single service and the seal edge (annular space, e.g. a_1 according to Figures B.7 and E.2) shall remain within the tested range.

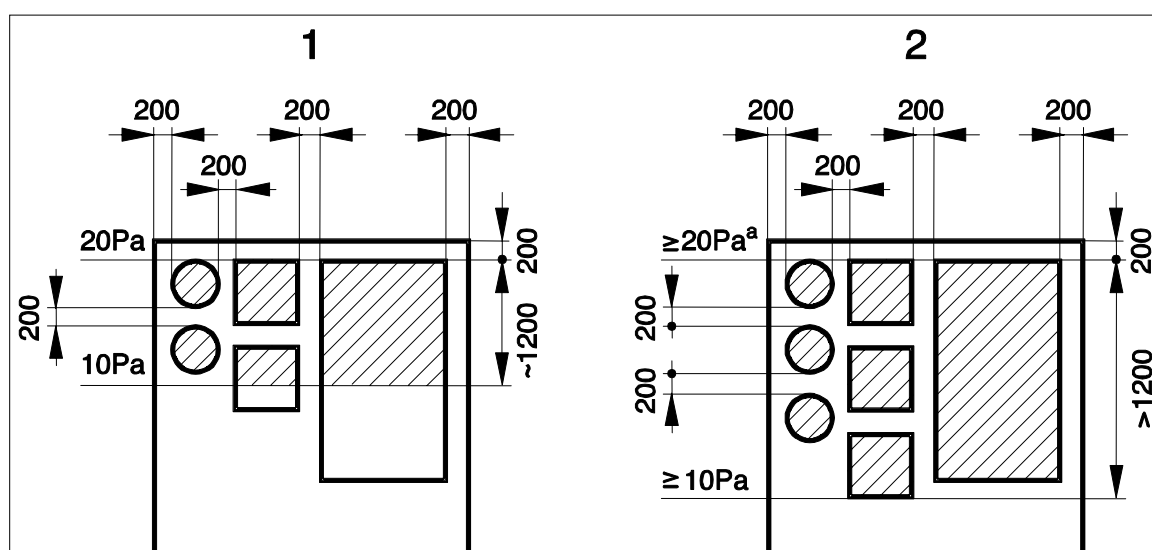


Key

- 1 Frame
- 2 Single modules
- 3 Single opening

Figure 1 — Illustration of the definition of single frame, single modules and single opening

Dimensions in millimetres



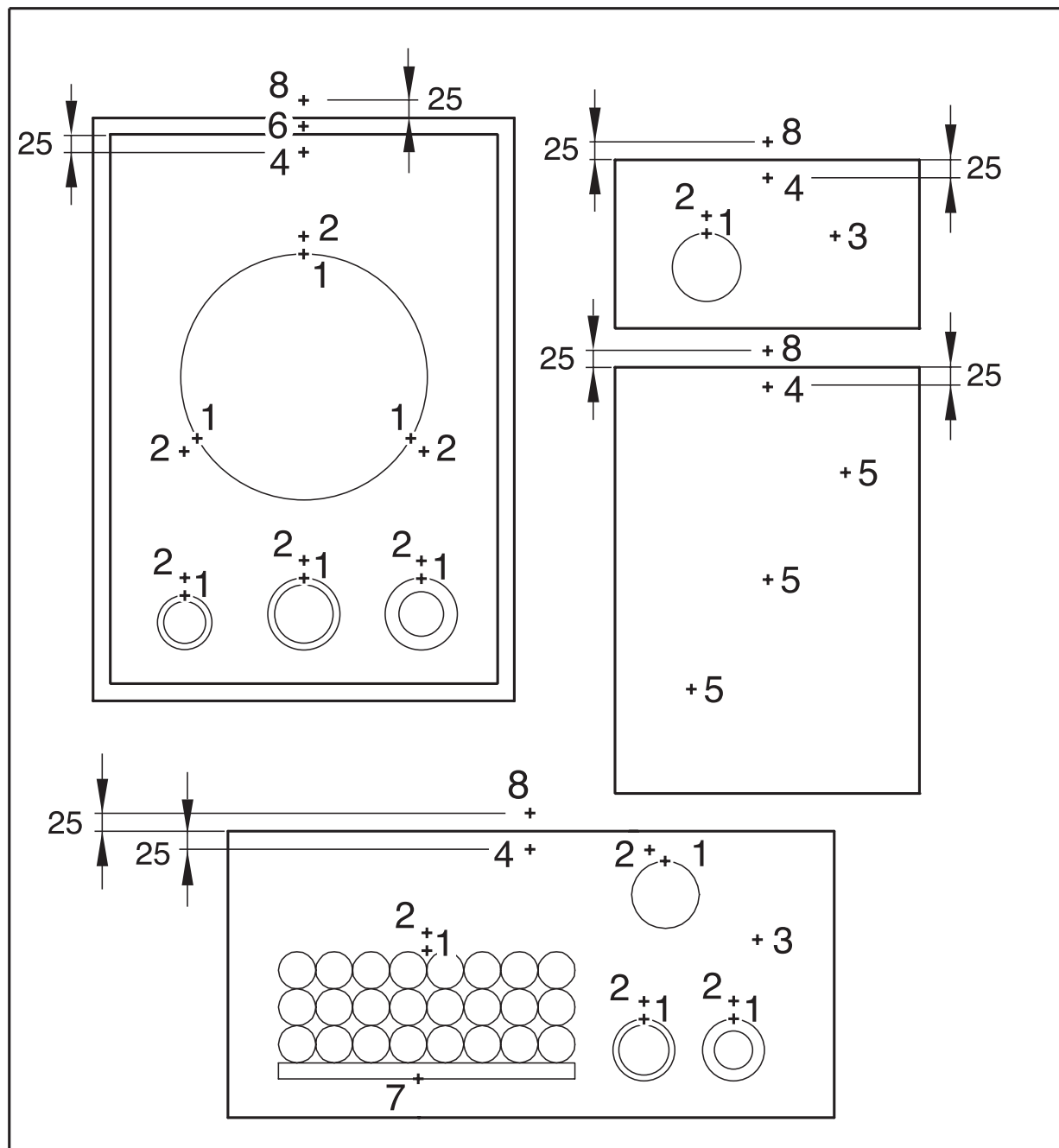
Key

- Area for services

- 1 Test with a pressure of 20 Pa at the top of the specimen
- 2 Test with a pressure exceeding 20 Pa at the top of the specimen ^a

^a The pressure at the top will depend on the height of the specimen used for services (ca. 8,5 Pa per meter according to EN 1363-1)

Figure 2 — Examples of location of test specimens in relation to pressure conditions

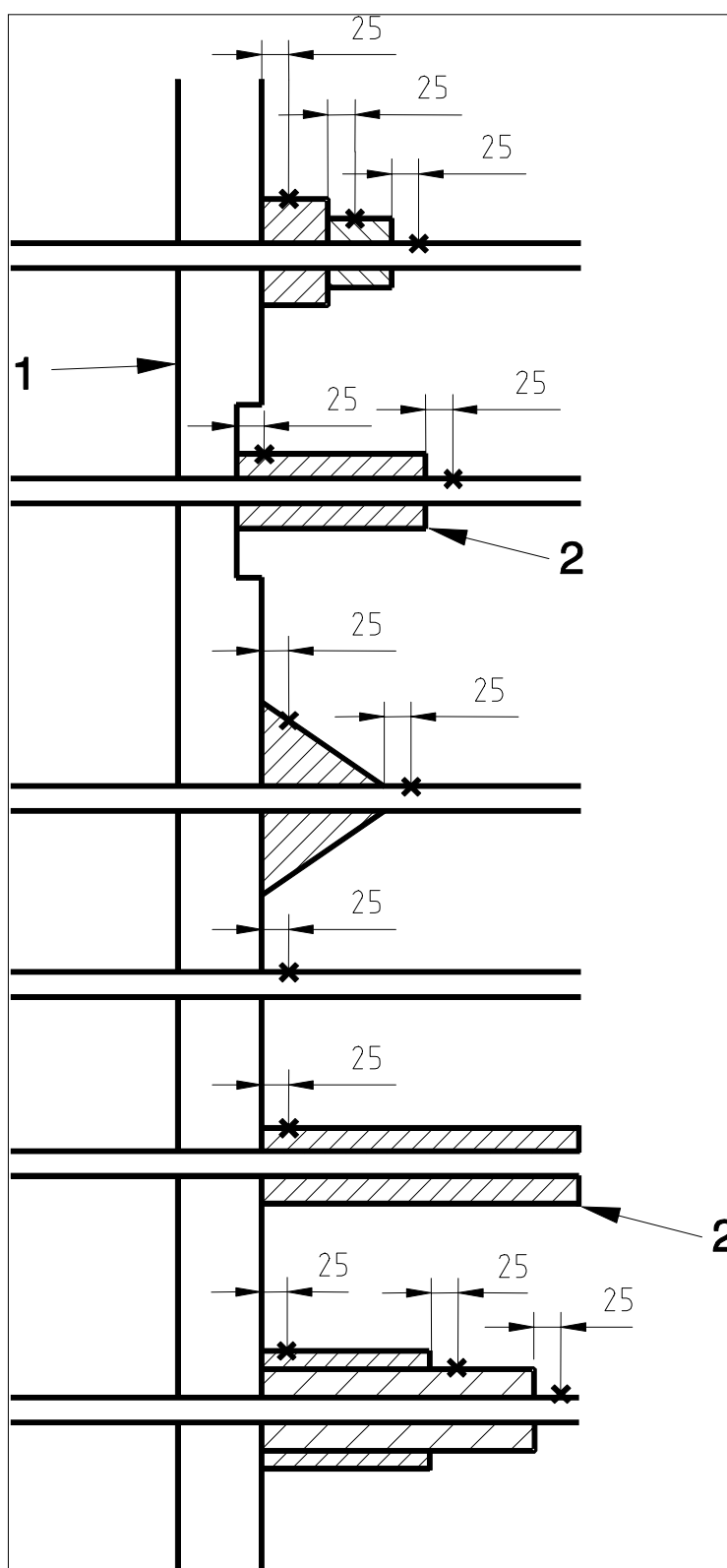


Key

- 1 Thermocouple Position A on service (see also Figure 4)
 - 2 Thermocouple Position B i) on seal
 - 3 Thermocouple Position B ii) on seal
 - 4 Thermocouple Position B iii) on seal
 - 5 Thermocouple Position B iv) on a blank seal
 - 6 Thermocouple Position C on frame
 - 7 Thermocouple Position D on ladder
 - 8 Thermocouple Position E on supporting construction
- Thermocouple Position F at the discretion of the laboratory

Figure 3 — Typical thermocouple locations (see 9.1.2.1 to 9.1.2.7)

Dimensions in millimetres



Key

- 1 Fire side
- 2 Part of the penetration seal, e.g. a coating or an insulation
- x Thermocouple position

Figure 4 — Examples of location of unexposed face thermocouples on the services

Annex A (normative)

Standard configuration for large cable penetration seals

A.1 Structure of specimens

A.1.1 Standard specimens of cable penetration seals in walls and floors shall have a minimum height of 600 mm and a minimum width of 600 mm unless the dimensions are smaller in practice. For small penetration seals according to 3.11 see Annex B, for modular systems and cable boxes see Annex C. For penetration seals smaller than 600 mm x 600 mm but larger than small seals according to 3.11 the rules of Annex A apply except that the services may be distributed between 2 specimens. Where cable trays or cable ladders are required to be included in penetration seals of such an intermediate seal size by the test sponsor an un-perforated steel tray with a maximum steel thickness of 1,5 mm shall be used to gain the maximum field of application as defined in A.3.3. For suitable steel grades see H 4.3.2.

A.1.2 The arrangements for cable penetration seals for the standard configuration are shown in Figures A.1 to A.3. When larger penetration seals are to be tested cable trays without cables are included in addition, see Figures A.4 and A.5. The dimensions given in Figures A.4 and A.5 are examples only. The cable types given in Table A.1 shall be used. There are several configuration options depending on the desired field of application:

- 1) "Small": all cables from cable group 1 shall be included (small sheathed cables);
- 2) "Medium": all cables from cable groups 1 and 2 shall be included (small and medium sheathed cables);
- 3) "Large": all cables from cable groups 1, 2 and 3 shall be included (small, medium and large sheathed cables);
- 4) Optionally, a tied bundle made from F-cables (cable group 4 according to Table A.1), cable G1 and/or G2 (cable group 5 according to Table A.1) and/or conduits / tubes (service group 6 according to Table A.2) may be tested together with one of the standard configuration options given above, either single or in combination, depending on the desired field of application. For location in the standard configuration see Figures A.1 and A.3B.

Cables shown in Figures A.1 and A.3B but not necessary for the chosen standard configuration are simply omitted leaving the configuration of the remaining cables and all cable trays unchanged.

A.1.3 The cables shall be secured as indicated in Figures A.2 and A.3A. This shall be done before installing the seal.

A.1.4 The cable supports (e.g. cable trays, ladders) may or may not pass through the penetration. The statement on the condition selected shall be included in the report.

A.1.5 The number of cables specified in the standard configuration is significantly lower than those which can be found in practice. To compensate for this, additional load with a tolerance of $\pm 0,5$ kg shall be applied to the fire side of each cable support, calculated using the formula:

$$f = (1000 - l) \times 0,03 \times \frac{w}{500} \quad (\text{A.1})$$

where

f is the load, in kg;

w is the width of service support construction, in mm;

l is the length of cable projecting into the furnace, in mm.

The loading shall be applied, by means of ballast, to these supports as shown in Figures A.2 and A.4. When there are no cables present, 50 % of the calculated load shall also be applied to the unexposed support as shown in Figure A.4. On the exposed face the calculated weight shall be provided by means of 2 rows of ballast weights.

An example for the ballast weights is given in Figure A.7.

This ballast shall be attached to the upper or underside of the service support on the position of the 20 mm steel rod.

A.1.6 Tests on seals for cable penetrations in a flexible supporting construction shall be carried out in accordance with the principles described and illustrated in Figures A.1 together with A.6 (walls) and A.3A (floors).

A.1.7 In Figures A.1 and A.3B the dimensions a_1 to a_5 are not specified. These dimensions shall be chosen by the test sponsor.

A.1.8 Any tied bundle of cables (consisting of a number of parallel cables tightly packed and tied firmly together) shall remain tied together when installed in the test construction.

A.1.9 When cables are orientated vertically, they shall be fixed to stop the cables moving downwards due to gravity. In order to prevent the cable core slipping out of its insulation during the test it is recommended that a steel wire is secured to the core via a hole drilled through it. This wire in turn is fixed solidly to the support construction (i.e. steel ladder or cable tray).

A.1.10 Service group 6 according to Table A.2:

Conduits shall have the following classification according to EN 61386-21.

- a) Steel conduits: 4 4 X X (1 X X X X X X X). The wall thickness shall be between 1,0 mm and 1,5 mm.
- b) Plastic conduits: 2 2 X 1 (1 X X X X X X X).

NOTE X = any class for this property may be chosen. The digits within the brackets are according to EN 61386-1 not mandatory for marking the product. The fifth digit (first within the brackets) set to 1 specifies the conduits as rigid ones. The classification system is outlined in H.4.1.3.

Where it is intended to simulate a continued conduit the rules given in 6.3.4 and 7.3 apply. Where it is intended to simulate a conduit of restricted length the conduit shall have a length so that it projects a minimum of 150 mm on each side of the supporting construction and the sealing method as in practice shall be used.

Conduits shall be tested without cable load.

Steel tubes for pneumatic or hydraulic power systems shall be in conformance with the requirements of EN 10305-4 or -6. Tubes with a wall thickness of 1,0 mm or 1,5 mm shall be used. Copper tubes shall be in conformance with EN 12449 or EN 13600. The wall thickness shall be 0,5 mm. The tube end may be capped inside the furnace.

A.2 Non-standard configuration

A.2.1 If the test is not conducted in accordance with A.1 each of the following shall be considered and the test specimen designed accordingly:

- 1) the largest envisaged sealed cable penetration in walls and floors;
- 2) the seal with the smallest envisaged thickness;
- 3) the type of cables included in the test;
- 4) the greatest possible cable density (in relation to the overall cross section of the cables per sealed penetration and in relation to the cross sections of the conductors per cable);
- 5) the cable supports, where appropriate;

A.2.2 The descriptions in A.2.1 also apply for penetrations through which bus bars pass.

A.2.3 If the use of the penetration seal with waveguides is required, then all variants of these devices as defined by the test sponsor shall be included in the test using pipe end configuration *U/C*. However, within a range of sizes of the same type of waveguide results of tests may be interpolated for diameters and wall thickness between those tested, based on the lowest result achieved.

A.3 Field of direct application

A.3.1 Cable type (construction characteristics)

A.3.1.1 The configuration options "Small", "Medium" and "Large" cover all cable types currently and commonly used in building practice in Europe subject to the rules in A.3.2, except tied bundles, waveguides according to 3.23 and non-sheathed cables (wires). Optical fibre cables are covered.

A.3.1.2 Test results achieved using cable group 5 according to Table A.1 are valid for all non-sheathed cables (wires) subject to the rules in A.3.2.

A.3.1.3 Test results achieved using a tied bundle made from F-cables according to Table A.1 are valid for all tied bundles of cables subject to the rules in A.3.2.

A.3.2 Cable size

A.3.2.1 Test results for the configuration option "Large" cover cables to a maximum diameter of 80 mm.

A.3.2.2 Test results for the configuration option "Medium" cover cables to a maximum diameter of 50 mm.

A.3.2.3 Test results for the configuration option "Small" cover cables to a maximum diameter of 21 mm.

A.3.2.4 Results of a tied bundle made from F-cables are valid for tied bundles with a diameter of less than or equal to the bundle tested made from cables of a diameter not greater than 21 mm.

A.3.2.5 Test results for cable G1 are valid for all non-sheathed cables with a diameter equal to or less than 17 mm, test results for cable G2 are valid for all non-sheathed cables with a diameter equal to or less than 24 mm.

A.3.3 Cable support

A.3.3.1 Results obtained from tests where the supports pass through the seal are applicable to those situations where the support does not. The reverse of this situation does not apply.

A.3.3.2 The test results obtained using standard configurations for cable penetration systems are not valid for lidded cable trays/trunkings where the lid passes through the penetration seal (see also E.3).

A.3.4 Service group 6 according to Table A.2

A.3.4.1 Test results achieved using service type H (conduit or tube) according to Table A.2 are valid for all steel conduits and steel tubes up to a diameter of 16 mm.

A.3.4.2 Test results for tubes made from copper cover tubes made from steel but not vice versa.

A.3.4.3 Test results achieved using service type I according to Table A.2 are valid for all plastic conduits and plastic tubes up to a diameter of 16 mm.

A.3.4.4 For rules regarding the pipe end condition see E.1.5.5 for metal conduits or tubes and E.2.7.3 for plastic conduits.

Table A.1 — Cables for the standard configuration

Cable	Cable type	Group	Number of cables	Dimensions	Designation	Standard	Insulation / sheath material	Diameter range (mm)	Nominal weight (kg/km) ^a
A1	small sheathed	1	10	5 mm × 1,5 mm ²	see Table A.3	HD 603.3	PVC / PVC ^b	14 ^{a,c}	300 ^c
A2	small sheathed	1	10	5 mm × 1,5 mm ²	H07RN-F 5G1,5	HD 22.4	EPR / PO ^d	11,2 – 14,4 ^{a,e}	186 ^c
A3	small sheathed	1	10	5 mm × 1,5 mm ²	see Table A.3	HD 604.5	XLPE / EVA ^f	13 ^{a,g} (≤ 14,0 ^h)	230 ^c
B	small sheathed	1	2	1 mm × 95 mm ²	see Table A.3	HD 603.3	PVC / PVC ^b	18 – 21 ^{a,i}	1150 ^c
C1	medium sheathed	2	1	4 mm × 95 mm ²	see Table A.3	HD 603.3	PVC / PVC ^b	40 – 47 ^{a,i}	5300 ^c
C2	medium sheathed	2	1	4 mm × 95 mm ²	H07RN-F 4G95	HD 22.4	EPR / PO ^d	48,4 – 61 ^{a,e}	5830 ^c
C3	medium sheathed	2	1	4 mm × 95 mm ²	see Table A.3	HD 604.5	XLPE / EVA ^f	42 ^{a,g} (≤ 45,5 ^h)	4050 ^c
D1	large sheathed	3	1	4 mm × 185 mm ²	see Table A.3	HD 603.3	PVC / PVC ^b	52 ^{a,j}	9900 ^c
D2	large sheathed	3	1	4 mm × 185 mm ²	H07RN-F 4G185	HD 22.4	EPR / PO ^d	64 – 80 ^{a,e}	9700 ^c
D3	large sheathed	3	1	4 mm × 185 mm ²	see Table A.3	HD 604.5	XLPE / EVA ^f	58 ^{a,g} (≤ 62,5 ^h)	7750 ^c
E	medium sheathed	2	2	1 mm × 185 mm ²	see Table A.3	HD 603.3	PVC / PVC ^b	23 – 27 ^{a,i}	2050 ^c
F	cable bundle (telecommunication cable)	4	1 tied bundle of 100 mm diameter ^k	20 mm × 2 mm × 0,6 mm screened ^l	see H.4.1.2 for examples	-	PE / PE ^m	15 to 17 ^{a,n,o}	275 to 320 _{c,o}
G1	non-sheathed (wire)	5	1	1 mm × 95 mm ²	H07V-R	HD 21.3	PVC / - ^b	14,1 – 17,1 ^{a,p}	980 ^c
G2	non-sheathed (wire)	5	1	1 mm × 185 mm ²	H07V-R	HD 21.3	PVC / - ^b	19,3 – 23,3 ^{a,p}	1890 ^c

a	For information only
b	PVC = Polyvinyl chloride
c	Average value from technical data sheets of manufacturers
d	EPR = Ethylene-propylene rubber compound, PO = Polyolefin, synthetic rubber compound
e	Values for minimum and maximum diameter from HD 22.4
f	XLPE = Cross-linked Polyethylene, EVA = Ethylene-vinyl-acetate copolymer compound
g	Nominal diameter from HD 604.5C
h	Maximum diameter from HD 604.5C
i	Values for minimum and maximum diameter from HD 603.3G
j	Nominal diameter from HD 603.3L
k	Depending on the actual diameter of the single cables 30 to 43 cables may be necessary to produce a tied bundle of 100 mm diameter
l	Construction: solid bare copper conductors of 0,6 mm diameter, core insulation of polyethylene, cores stranded to quads and the quads stranded to bundles, one layer of plastic foil, static screen of plastic-laminated aluminium tape, polyethylene outer sheath.
m	PE = Polyethylene, solid or cellular
n	Values from technical data sheets of manufacturers; actual values shall be used to calculate the number of cables necessary to form a tied bundle of 100 mm diameter
o	The given value relates to the single cable, not the cable bundle, and depends on the construction details of the cable (solid-PE or cellular-PE)
p	Values for minimum and maximum diameter from HD 21.3

Table A.2 — Optional services other than cables for the standard configuration

Service	Service type	Group	Number of services	Specification	Standard	Service material	Diameter (mm)	Wall thickness (mm)
H	conduit	6	3	see A.1.10	EN 61386-21	Steel	16	-
	tube				EN 10305-4 or -6			1 or 1,5
	tube				EN 12449 or EN 13600	Copper	16	0,5
I	conduit	6	3	see A.1.10	EN 61386-21	Plastics	16	-