BRITISH STANDARD

BS EN
1366-3:2009

Fire resistance tests for service installations

Part 3: Penetration seals

ICS 13.220.50

BSI
British Standards

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 It supersedes BS EN 1366-3:2004 which is withdrawn.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.

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 March 2009

ISBN 978 0 580 57464 1

Amendments/corrigenda issued since publication

Date	Comments

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1366-3

February 2009

ICS 13.220.50

Supersedes EN 1366-3:2004

English Version

Fire resistance tests for service installations - Part 3: Penetration seals

Essais de résistance au feu des installations techniques - Partie 3 : Calfeutrements de trémies

Feuerwiderstandsprüfungen für Installationen - Teil 3: Abschottungen

This European Standard was approved by CEN on 3 January 2009.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 1366-3:2009: E

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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of an identical text or by endorsement, at the latest by August 2009, and conflicting national standards shall be withdrawn at the latest by August 2009.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 m^2, 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

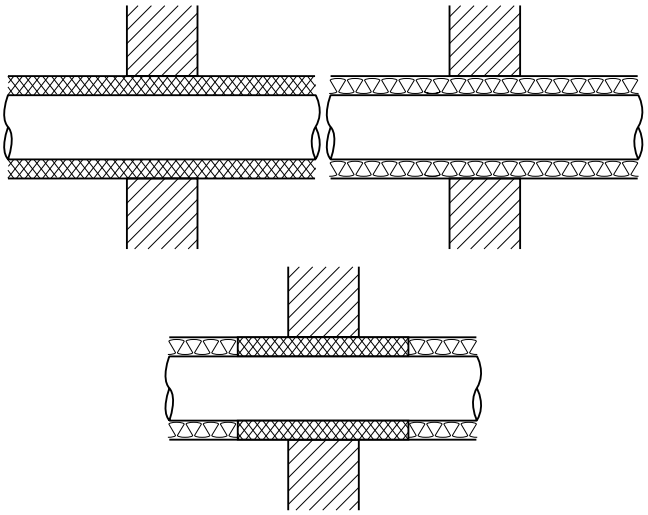
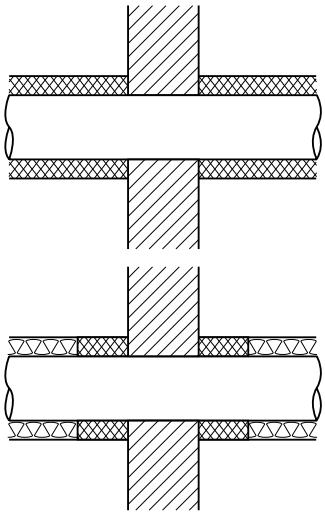
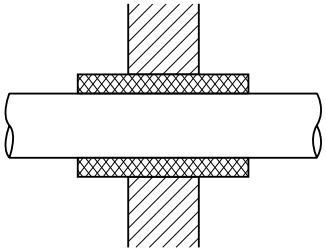
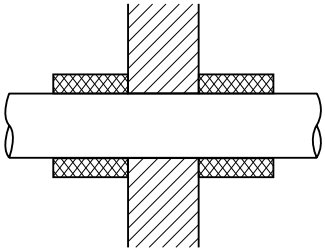
3.17
single frame
square or rectangular frame, with predefined dimensions in different sizes, to accommodate a modular penetration seal (see Figure 1)

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)

	Sustained	*Interrupted*
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 angels 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 ± 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 ± 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 ± 15 kg/m^3 for a desired fire resistance up to and including 60 min and 100 ± 15 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/m^3 to 200 kg/m^3, the

classification temperature shall be > 1000°C and the loss on ignition < 12 %. The thermal conductivity at 200°C shall be between 0,050 W/(mK) and 0,065 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 $\times$ 30 mm $\times$ 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.

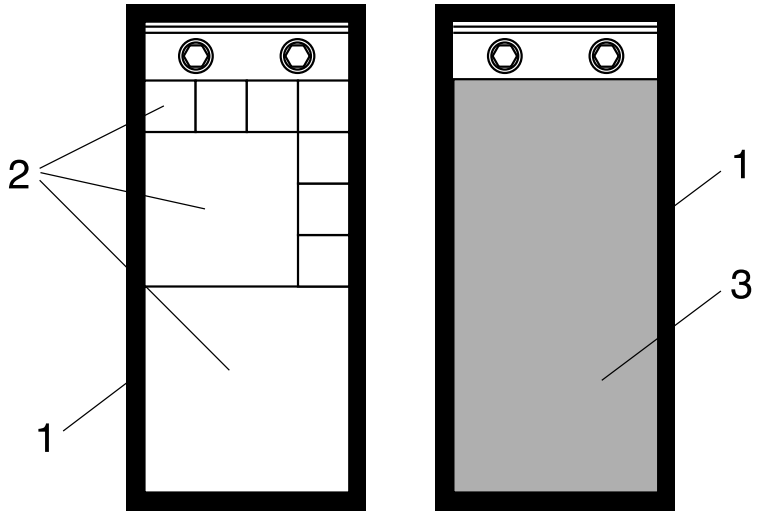
13.5 Seal size and distances

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/m^3 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.

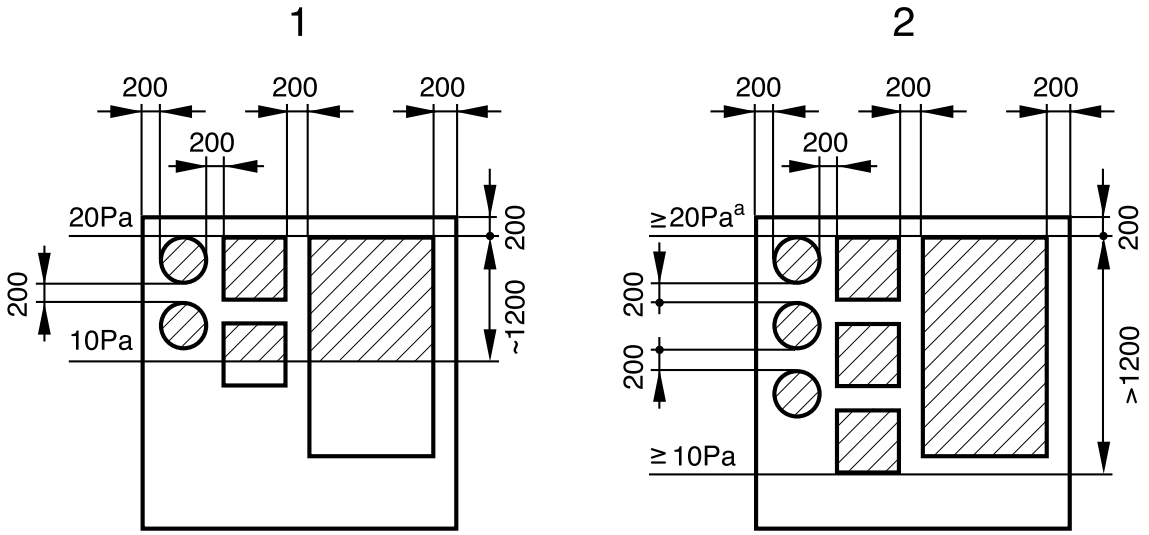


Key

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

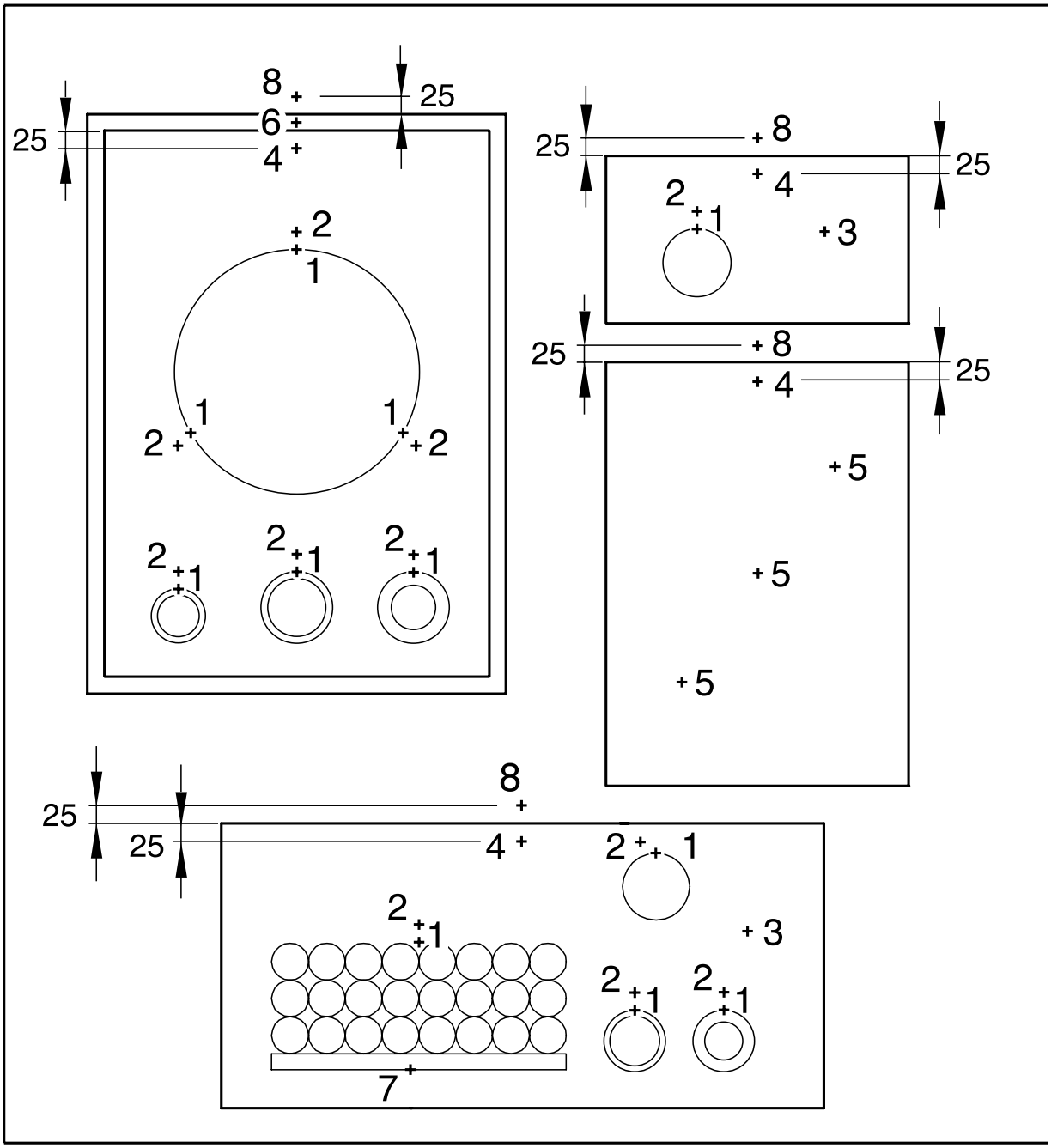
Area for services

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

Dimensions in millimetres

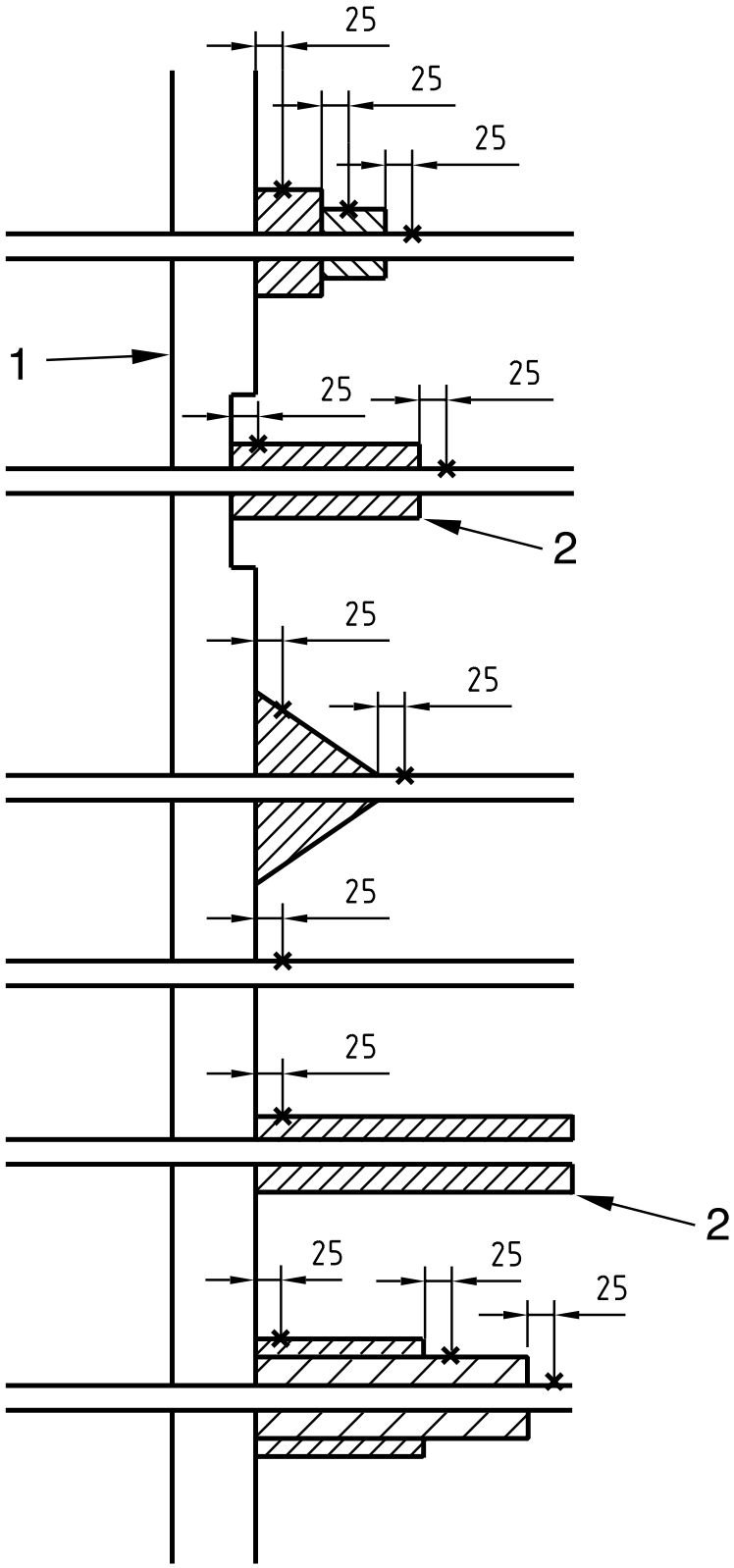


Key

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 ± 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

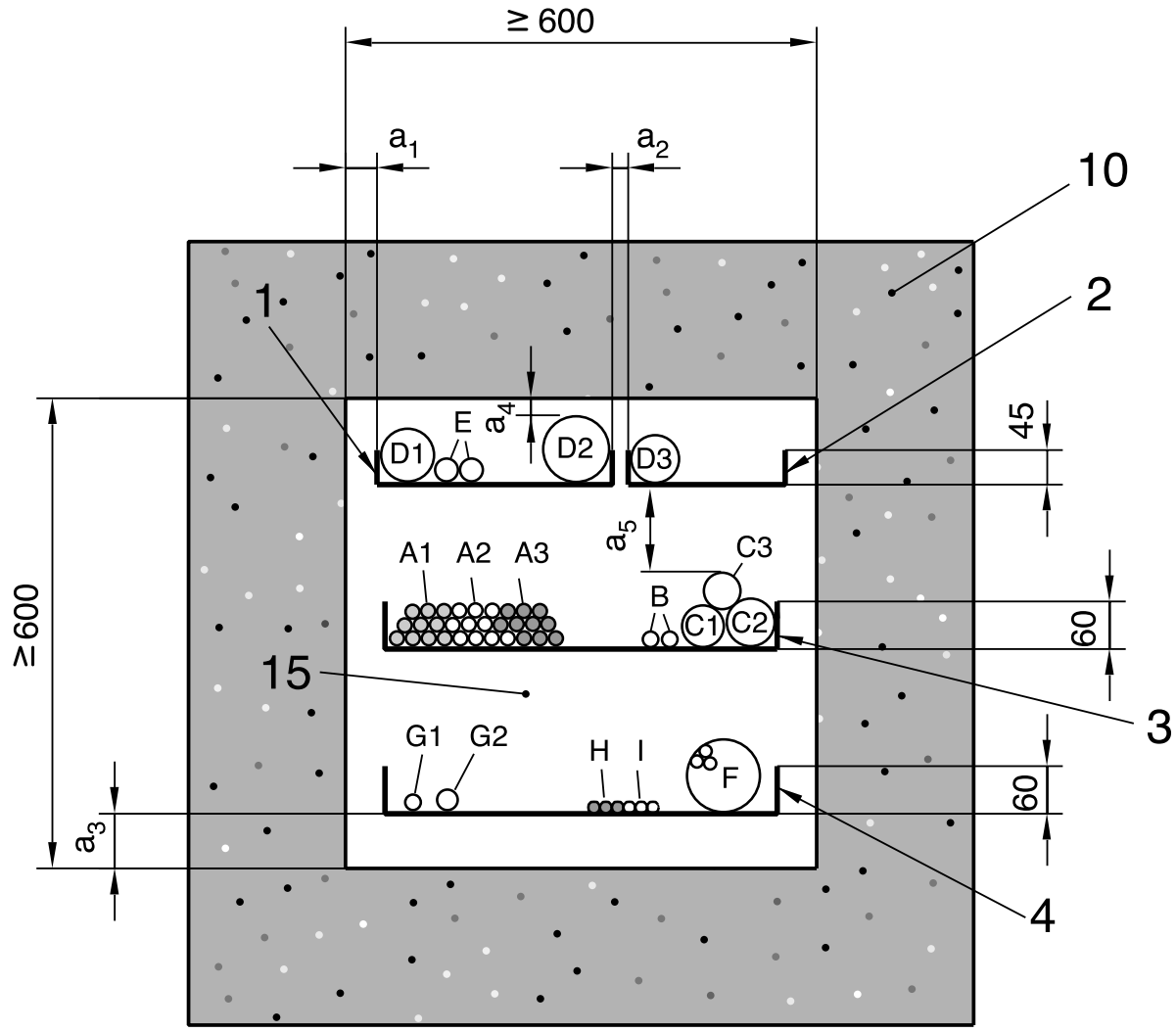
Table A.2 — Optional services other than cables for the standard configuration

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	-

Table A.3 — Designations of cables from Table A.1 according to HD 603.3 and HD 604.5

Cable according to Table A.1	Designation	Standard
A1	E-YY-J 5x1,5 RE NYY-J 5x1,5 RE VV 5x1,5	HD 603.3A HD 603.3G HD 603.3M
A3	YMz1Kmbzh 0,6/1 kV 5G1,5 RM PVIK-LS-HF 5x1,5 N2XH-J 5x1,5RE or N2XH-O 5x1,5RE n.n. E-NGNG-J 5x1,5RE or E-3G3G-J 5x1,5RE or E-NGNG-O 5x1,5RE or E-3G3G-O 5x1,5RE	HD 604.5C HD 604.5F HD 604.5G HD 604.5H HD 604.5K
B	E-YY-J 1x95RM or E-YY-O 1x95RM NYY-J 1x95RM or NYY-O 1x95RM VV 1x95 TT 1x95 RM 0,6/1 kV	HD 603.3A HD 603.3G HD 603.3M HD 603.3O
C1	E-YCWY 4x95SM/50 MCMK 4x95/50 NYCWY 4x95SM/50 PFSP CU 4x95/50 FKKJ 1 4x95/50 S	HD 603.3A HD 603.3F HD 603.3G HD 603.3J HD 603.3L
C3	YMz1Kmbzh 0,6/1 kV 4G95 PVIK-LS-HF 4x95 N2XH-J 4x95SM or N2XH-O 4x95SM n.n. E-NGNG-J 4x95SM or E-3G3G-J 4x95SM or E-NGNG-O 4x95SM or E-3G3G-O 4x95SM	HD 604.5C HD 604.5F HD 604.5G HD 604.5H HD 604.5K
D1	E-YCWY 4x185SM/95 MCMK 4x185/95 NYCWY 4x185SM/95 PFSP CU 4x185/95 FKKJ 4x185/95 S	HD 603.3A HD 603.3F HD 603.3G HD 603.3J HD 603.3L
D3	YMz1Kmbzh 0,6/1 kV 4G185 svs PVIK-LS-HF 4x185 N2XH-J 4x185SM or N2XH-O 4x185SM n.n. E-NGNG-J 4x185SM or E-3G3G-J 4x185SM or E-NGNG-O 4x185SM or E-3G3G-O 4x185SM	HD 604.5C HD 604.5F HD 604.5G HD 604.5H HD 604.5K
E	E-YY-J 1x185RM or E-YY-O 1x185RM NYY-J 1x185RM or NYY-O 1x185RM VV 1x185 TT 1x185 RM 0,6/1 kV	HD 603.3A HD 603.3G HD 603.3M HD 603.3O

Dimensions in millimetres



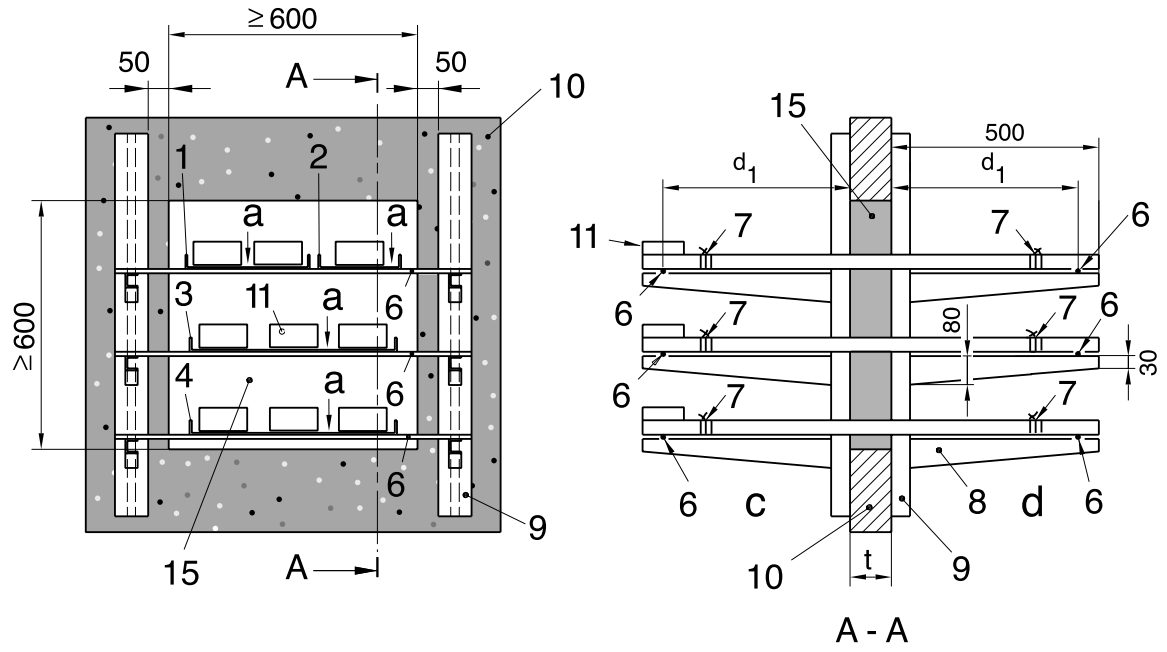
Key

For a recommendation on the steel grade for the steel parts see H.4.3.2.

1	Steel ladders 300 mm, thickness = 1,25 mm
2	Steel ladders 200 mm, thickness = 1,00 mm
3	Perforated steel tray 500 mm, thickness = 1,5 mm
4	Non-perforated steel tray 500 mm, thickness = 1,5 mm
10	Supporting construction
15	Penetration seal
A1 to G2	Cables according to Table A.1
H, I	Optional conduits / tubes according to A.1.10
a_1 to a_5	Minimum working spaces as specified by the test sponsor

Figure A.1 — Standard configuration for cable penetration systems

Dimensions in millimetres



Key

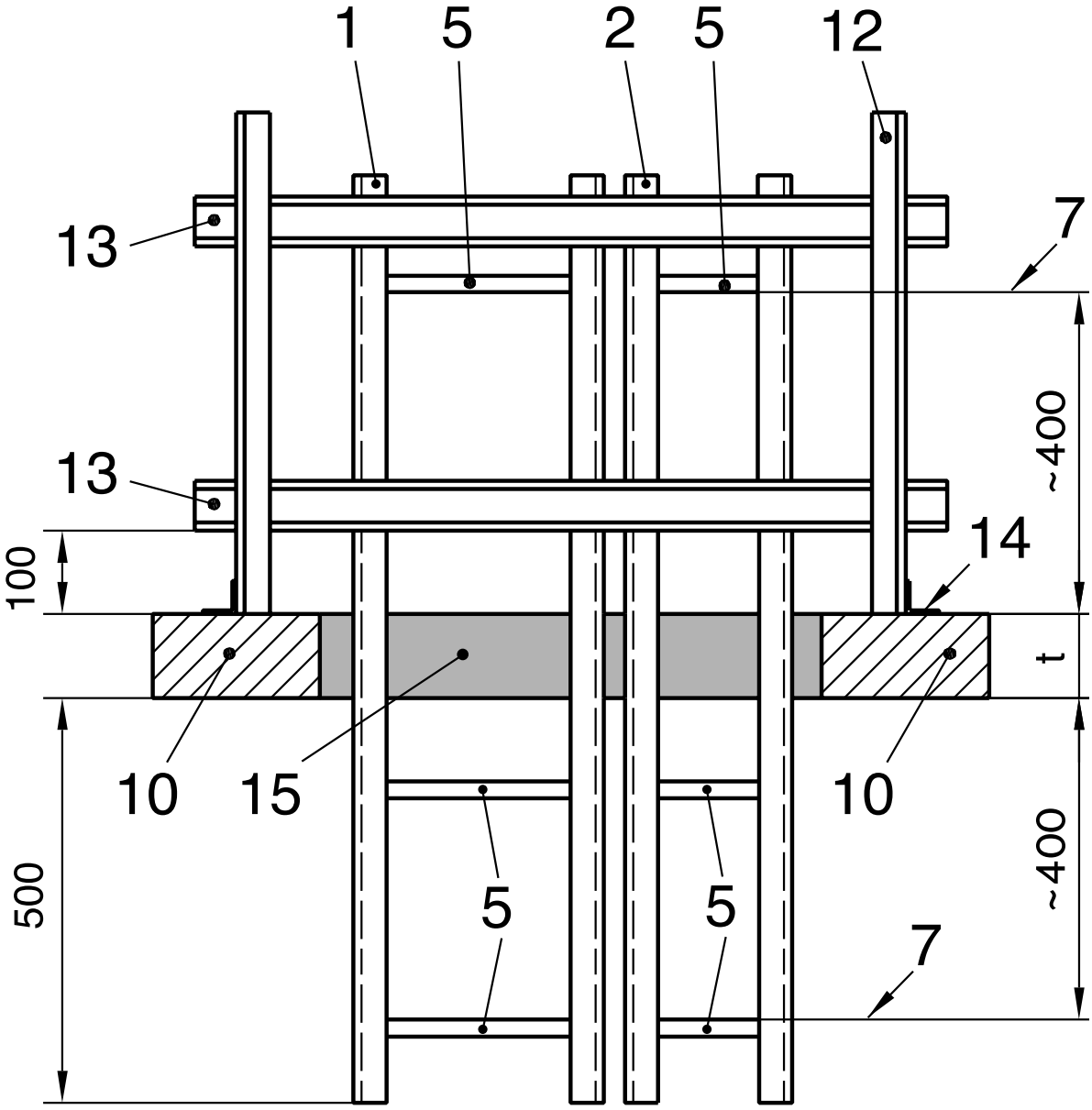
For a recommendation on the steel grade for the steel parts see H.4.3.2.

1 Steel ladders 300 mm, thickness = 1,25 mm
2 Steel ladders 200 mm, thickness = 1,00 mm
3 Perforated steel tray 500 mm, thickness = 1,5 mm
4 Non-perforated steel tray 500 mm, thickness = 1,5 mm
6 Steel rod Ø 20 mm fixed to bracket and tray on the unexposed face [a]
7 Fixing of cables with steel wire Ø 1 mm, ~ 400 mm from supporting construction
8 Steel bracket 500 mm length [b]
9 H-studs (80 mm × 40 mm × 5 mm)[b]
10 Supporting construction
11 Ballast (steel plate – see Figure A.7)
15 Penetration seal
a Ladders/trays supporting cables as in Figure A.1
c Exposed face
d Unexposed face
d_1 Distance from the surface of the supporting construction to the first support position, as specified by the test sponsor
t Thickness of the supporting construction

[a] A second support may be provided on the unexposed face
[b] Alternative constructions for the H-studs and steel brackets may be used – see 6.3.3.2.

Figure A.2 — Test arrangement for cable penetration systems in walls

Dimensions in millimetres



Key

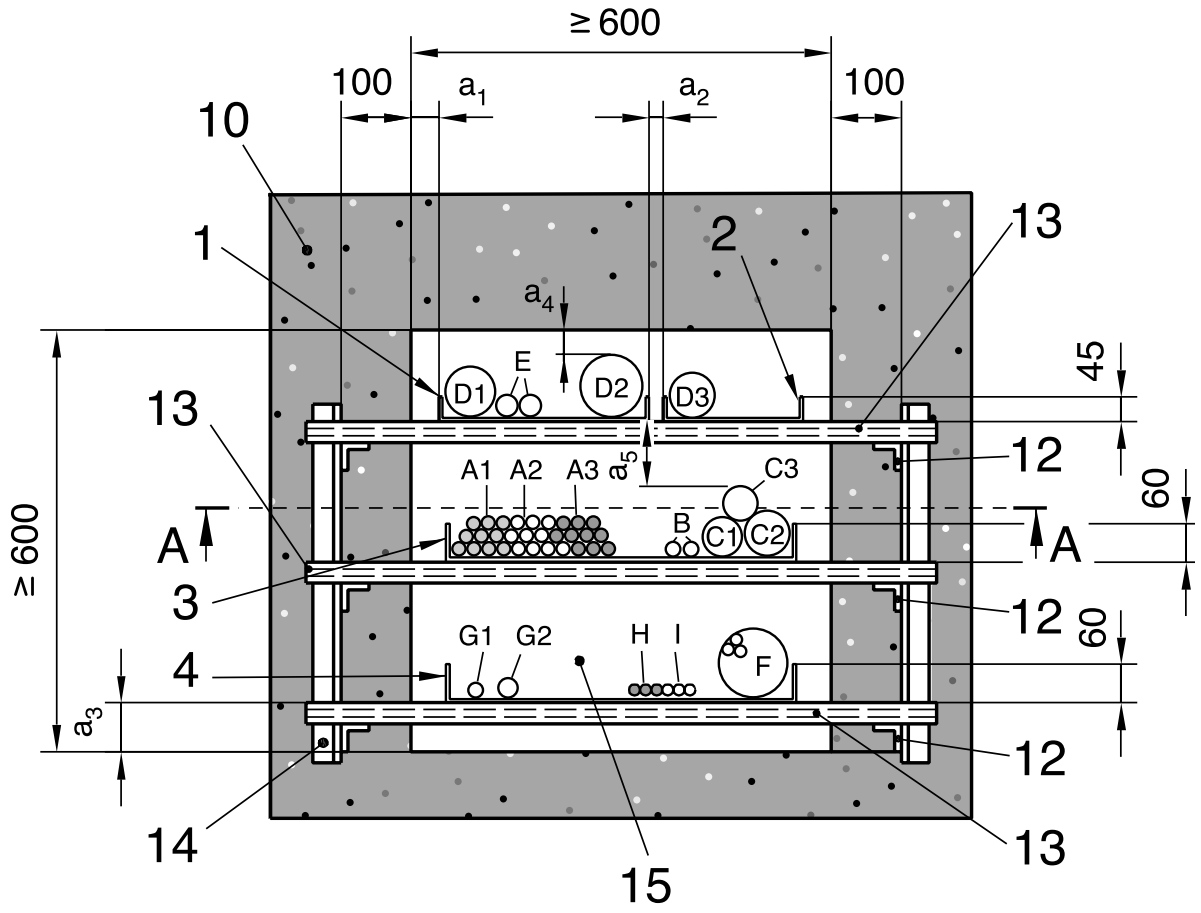
For a recommendation on the steel grade for the steel parts see H.4.3.2.

1 Steel ladders 300 mm, thickness = 1,25 mm
2 Steel ladders 200 mm, thickness = 1,00 mm
5 Rungs of the steel ladders
7 Position of fixing of cables with steel wire Ø 1 mm ~ 400 mm from supporting construction
10 Supporting construction
12 Steel angle (L 40 mm × 40 mm x 5 mm)[a]
13 Steel channel (U 30/60/30 mm x 5 mm)[b]
14 Steel angle (L 40 mm × 40 mm x 5 mm)[a]
15 Penetration seal
t Thickness of the supporting construction

[a] Alternative constructions for the steel angles and steel channels may be used – see 6.3.3.2.

Figure A.3A — Test arrangement showing service support construction for cable penetration systems in rigid floors – Section A-A

Dimensions in millimetres



Key

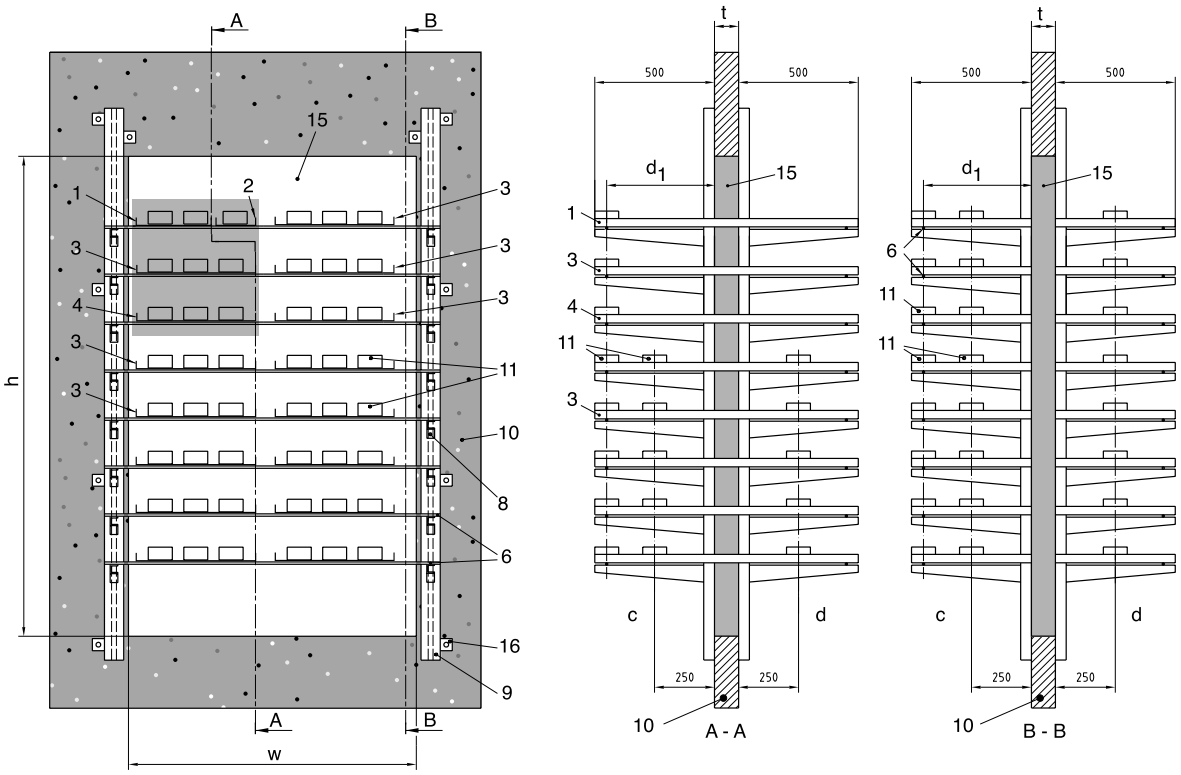
For a recommendation on the steel grade for the steel parts see H.4.3.2.

1	Steel ladders 300 mm, thickness = 1,25 mm
2	Steel ladders 200 mm, thickness = 1,00 mm
3	Perforated steel tray 500 mm, thickness = 1,5 mm
4	Non-perforated steel tray 500 mm, thickness = 1,5 mm
10	Supporting construction
12	Steel angle (L 40 mm × 40 mm x 5 mm)[a]
13	Steel channel (U 30/60/30 mm x 5 mm)[a]
14	Steel angle (L 40 mm × 40 mm x 5 mm)[a]
15	Penetration seal
A-A	Section shown in Figure A.3A
a_1 to a_5	Minimum working spaces as specified by the test sponsor
A1 to G2	Cables according to Table A.1
H, I	Optional conduits / tubes according to A.1.10

[a] Alternative constructions for the steel angles and steel channels may be used – see 6.3.3.2.

Figure A.3B — Test arrangement showing service support construction for cable penetration systems in rigid floors – elevation

Dimensions in millimetres



Key

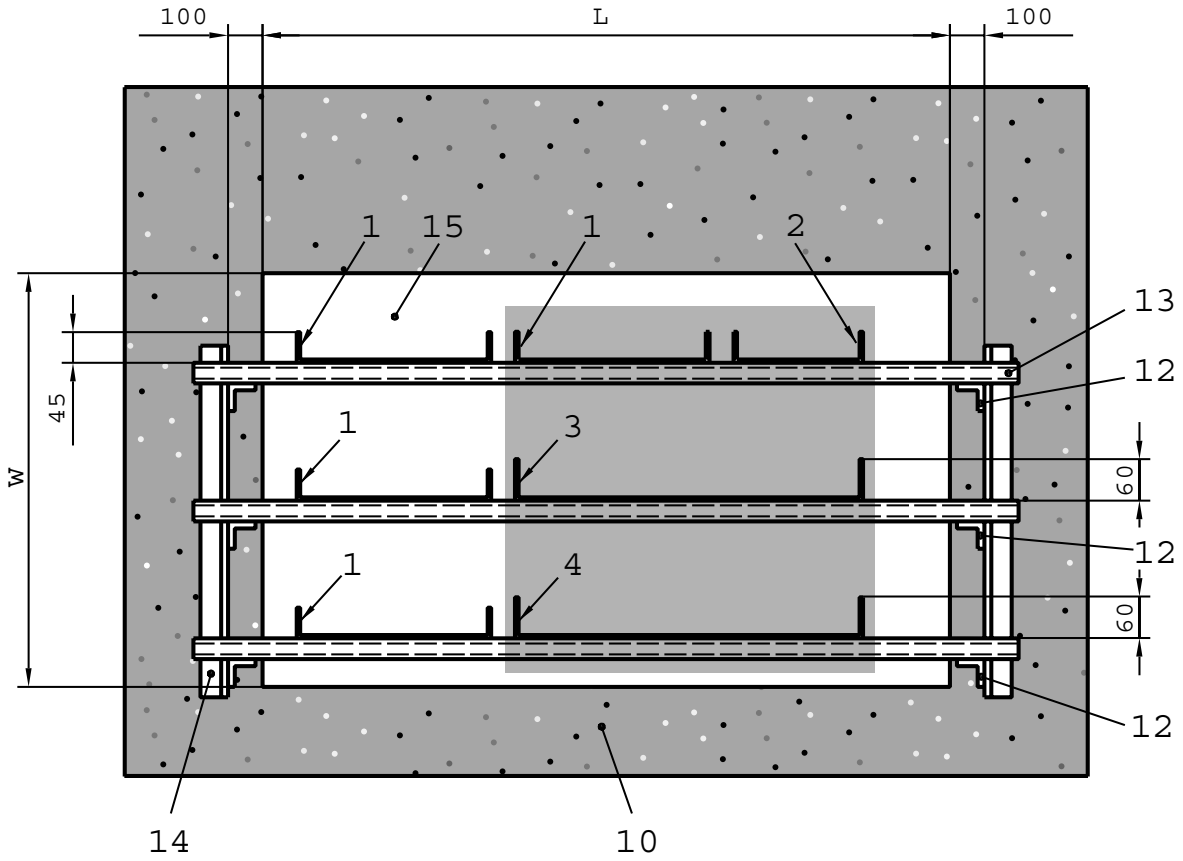
Area containing the cables as illustrated by detail in Figure A.1

For a recommendation on the steel grade for the steel parts see H.4.3.2.

1 Steel ladders 300 mm, thickness = 1,25 mm
2 Steel ladders 200 mm, thickness = 1,00 mm
3 Perforated steel tray 500 mm, thickness = 1,5 mm
4 Non-perforated steel tray 500 mm, thickness = 1,5 mm
6 Steel rod Ø 20 mm fixed to the bracket and tray on the unexposed face [a]
8 Steel bracket 500 mm length [b]
9 H-studs (80 mm × 40 mm × 5 mm)[b]
10 Supporting construction
11 Ballast (steel plate - see Figure A.7)
15 Penetration seal
16 Fixing points
c Exposed face
d Unexposed face
d_1 Distance from the surface of the supporting construction to the first support position, as specified by the test sponsor
h Height of the penetration seal
t Thickness of the supporting construction
w Width of the penetration seal
[a] A second support may be provided on the unexposed face
[b] Alternative constructions for the H-studs and steel brackets may be used – see 6.3.3.2.

Figure A.4 — Example of a test arrangement showing service support construction and the position of ballast weights for a large wall opening

Dimensions in millimetres



Key

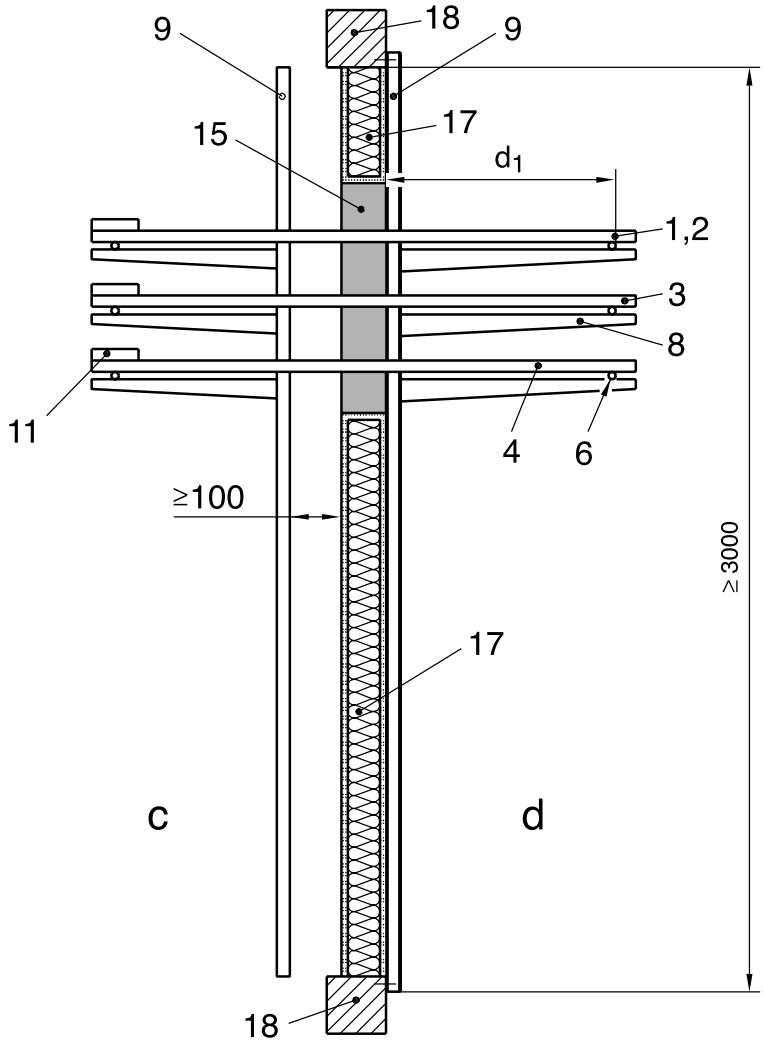
Area of the penetration seal containing the cables as illustrated by detail in Figure A.1

For a recommendation on the steel grade for the steel parts see H.4.3.2.

1 Steel ladders 300 mm, thickness = 1,25 mm
2 Steel ladders 200 mm, thickness = 1,00 mm
3 Perforated steel tray 500 mm, thickness = 1,5 mm
4 Non-perforated steel tray 500 mm, thickness = 1,5 mm
10 Supporting construction
12 Steel angle (L 40 mm × 40 mm x 5 mm)[a]
13 Steel channel (U 30/60/30 mm x 5 mm)[a]
14 Steel angle (L 40 mm × 40 mm x 5 mm)[a]
15 Penetration seal
L Length of the penetration seal
w Width of the penetration seal
[a] Alternative constructions for the steel angles and steel channels may be used – see 6.3.3.2.

Figure A.5 — Example of a test arrangement showing service support construction for cable penetration seals (large floor openings)

Dimensions in millimetres



Key
For a recommendation on the steel grade for the steel parts see H.4.3.2.

1 Steel ladders 300 mm, thickness = 1,25 mm
2 Steel ladders 200 mm, thickness = 1,00 mm
3 Perforated steel tray 500 mm, thickness = 1,5 mm
4 Non-perforated steel tray 500 mm, thickness = 1,5 mm
6 Steel rod Ø 20 mm fixed to bracket and tray on the unexposed face [a]
8 Steel bracket 500 mm length [b]
9 H-studs (80 mm × 40 mm × 5 mm)[b]
11 Ballast (steel plate - see Figure A.7)
15 Penetration seal
17 Lightweight partition (metal stud construction with no connection between supporting construction and H-studs)
18 Furnace frame
c Exposed face
d Unexposed face
d_1 Distance from the surface of the supporting construction to the first support position, as specified by the test sponsor

[a] A second support may be provided on the unexposed face
[b] Alternative constructions for the H-studs and steel brackets (see 6.3.3.2) may be used. Details of the fixing of the H-studs on the exposed face will depend on the furnace construction.

Figure A.6 — Test arrangement showing service support construction for flexible wall constructions

Dimensions in millimetres

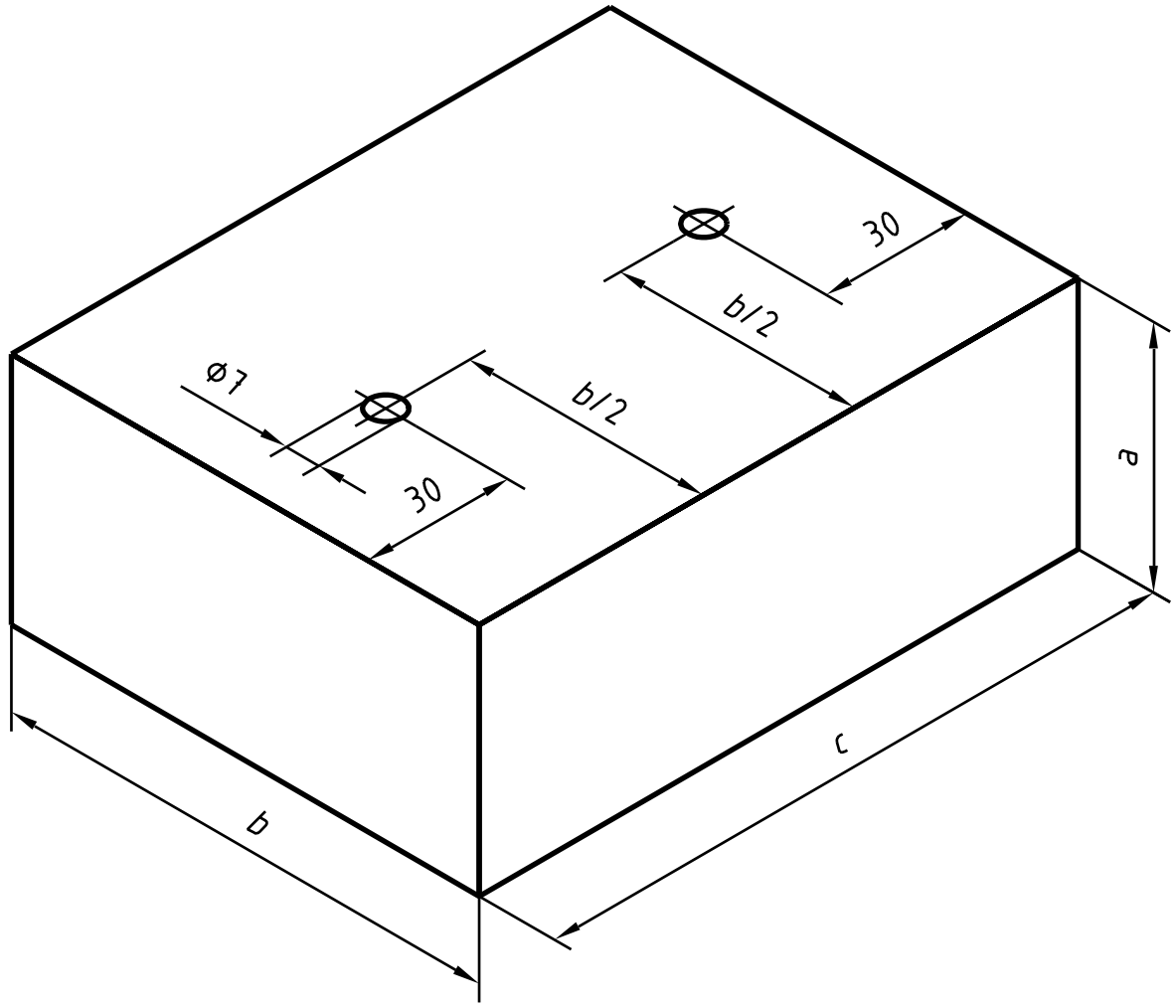
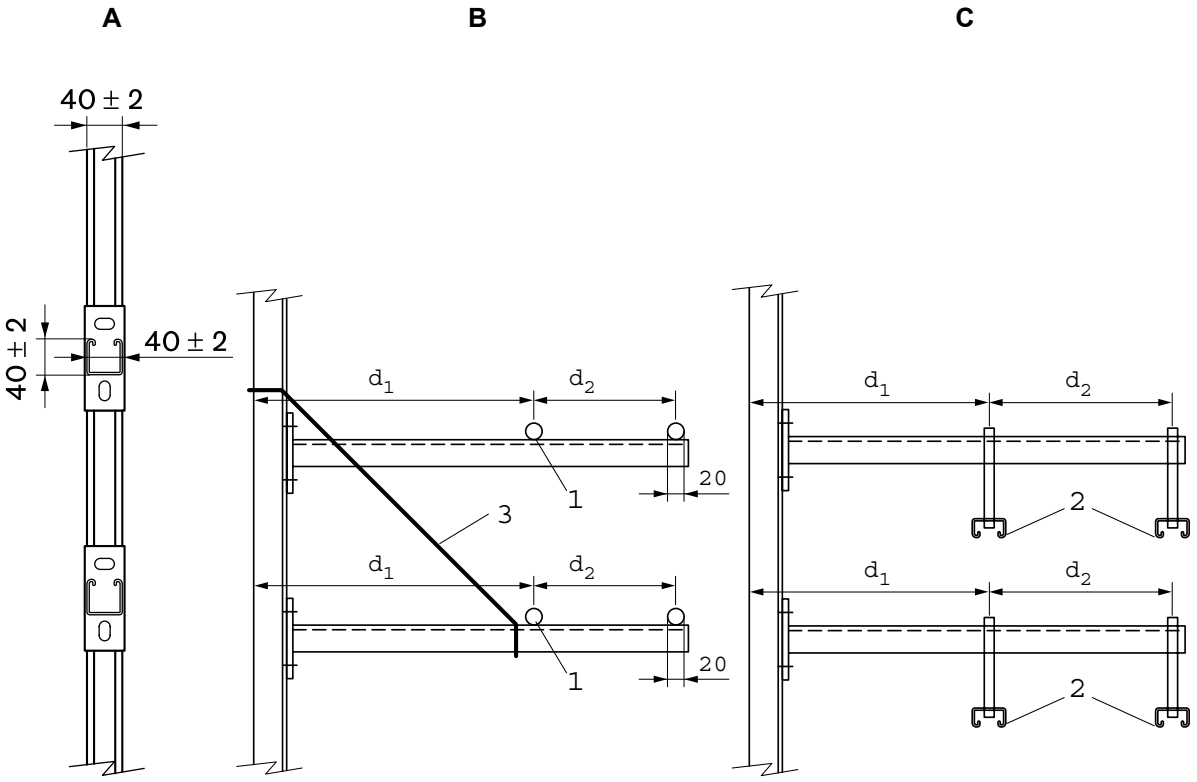


Figure A.7 — — Example for ballast weights in the form of steel plates

Steel weights

	6 kg		**5 kg**		**3 kg**		**1 kg**	
a	46	60	40	50	23	30	8	10
b	100	100	100	100	100	100	100	100
c	165	128	165	128	165	128	165	128

Dimensions in millimetres



Key

A Front view of the steel strut / channel with a wall thickness of 2 mm - 3 mm and the cantilever bracket, fixed by bolting or welding
B Option 1: 20 mm steel rod (1)
C Option 2: cable ladders / trays are hung below brackets on threaded rod; the channel (2) dimensions shall be (40 ± 2) mm x (40 ± 2) mm, wall thickness 2 mm - 3 mm
d_1 Distance from the surface of the supporting construction to the first support position, as specified by the test sponsor
d_2 Distance of the second support position (optional) from the first support position, as specified by the test sponsor
1 20 mm diameter steel rod
2 Steel struts (40 ± 2) mm x (20 ± 2) mm, wall thickness 2 mm - 3 mm
3 Steel rope or steel strap, if necessary, depending on the weight of the service

Figure A.8 — Alternative service support construction

Annex B
(normative)

Standard configuration for small cable penetration seals

B.1 Structure of specimens

B.1.1 For these small cable penetration seals the standard configuration defined in Tables B.1 and B.2 shall be used to gain the maximum field of application as defined in B.2. There are several configuration options:

1) “Small”: Specimens 1, 4 and 7 according to Tables B.1 and B.2 shall be included (small sheathed cables);

2) "Medium": Specimens 1, 2, 4 and 8 according to Tables B.1 and B.2 shall be included (small and medium sheathed cables);

3) “Large”: Specimens 1, 2, 3, 4 and 8 according to Tables B.1 and B.2 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 of the cables G1 and G2 see Figure B.5, for location of the tied bundle and conduits/tubes H and I see Figure B.6.

Where only one specific seal size is desired by the test sponsor, only Table B.1 or Table B.2 applies, depending on the seal size.

B.1.2 Where cable trays or cable ladders are required to be included by the test sponsor an un-perforated steel tray with a maximum steel thickness of 1,5 mm and a width of 100 mm to 150 mm, as indicated in the following clauses, shall be used in addition to the cables to gain the maximum field of application as defined in B.2. For a suitable steel grade see H.4.3.2.

B.1.3 There are 3 options regarding distances the test sponsor can choose depending on the field of application desired (the choice of options may be limited depending on the nature of the product/seal):

Option 1: Zero distance between the cables and between the cables and the aperture edge (the cables/cable trays are in contact with the lower edge of the aperture) for all specimens;

Option 2: Zero distance between the cables but a defined minimum distance between the cables and the aperture edge for all specimens;

Option 3: Defined minimum distance between the cables and between the cables and the aperture edge (the cables pass through the seal independent from each other) for all specimens.

To achieve the maximum field of application range the following combination shall be tested:

a) Specimen 2: option 2;

b) Specimen 3: option 1;

c) Specimen 4: option 1 or 2;

d) Specimen 5: option 1.

In all cases the cables/cable trays shall be supported/fixed to a support construction on both sides of the seal. The distance of the support from the penetration seal shall be recorded. Where an aperture framing or sleeve is foreseen as part of the assembled system it shall be included in the test.

Table B.1 — Specimens and standard configuration at the maximum seal size of the seal size range desired by the test sponsor

Specimen designation	No. of specimens	No. of services	Cable/service according to Tables A.1 and A.2	Width of optional cable tray
1	1	-	Blank penetration seal	-
2 (see Figure B.2)	1	1 1 1 1	C1 C2 C3 E	100 mm -150 mm[a] (see Figure B.1)
3 (see Figure B.3)	1	1 1 1	D1 D2 D3	100 mm - 150 mm[a]
4 (see Figure B.4)	1	1 3 3 3	B A1 A2 A3	100 mm - 150 mm[a]
5 (see Figure B.5)	1	1 1	G1 G2	100 mm - 150 mm[a]
6 (see Figure B.6)	1	1 2 2	tied bundle made from F-cables H (steel conduit / tube) [b] I (plastic conduit) [b]	
[a] See also B.1.4 [b] See Table A.2 and A.1.10				

Table B.2 — Specimens and standard configuration at the minimum seal size or minimum annular space of the seal size/annular space range desired by the test sponsor

Specimen designation	No. of specimens	No. of cables	Cable type according to Table A.1
7 (see Figure B.7)	1	1	B
8 (see Figure B.7)	1	1	E

B.1.4 When a cable tray is used ballast weights according to A.1.5 shall be used in addition to the cables.

B.2 Field of direct application

B.2.1 Tests of rectangular seals cover circular seals of the same area but not vice versa.

B.2.2 The field of direct application rules according to 13.5, A.3.1, A.3.2, A.3.3 and A.3.4 apply.

B.2.3 The test results obtained using standard configurations for cable penetration systems are valid for any penetration size equal to or smaller than that tested, provided the total amount of cross sections of the cables (core and insulation) does not exceed 60 % of the penetration and the working clearances are not smaller than the minimum working clearances (a_1, a_2, see Figures B.1 to B.7) used in the test.

B.2.4 Results from tests with the specimen combination given in B.1.3 are valid for all distance options and combinations. Results from tests according to option 1 or 2 are also valid for situations represented by option 3 but not vice versa.

B.3 Non-standard configuration

B.3.1 If the test is not conducted in accordance with B.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;

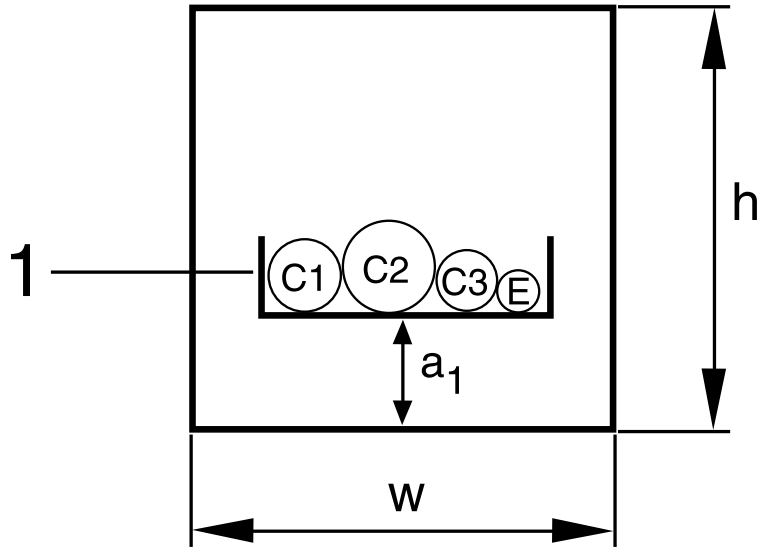
2) the seal with the smallest envisaged thickness;

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;

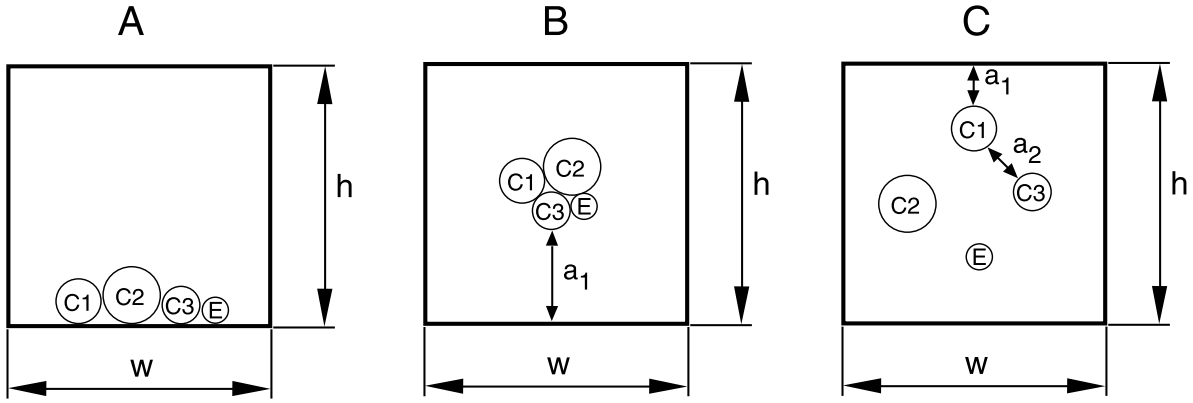
B.3.2 If the use of the penetration seal with waveguides is required, then all variants of these devices as defined by the test sponsor shall be included in the test using pipe end configuration *U/C*. However, within a range of sizes of the same type of waveguide results of tests may be interpolated for diameters and wall thickness between those tested, based on the lowest result achieved.



Key

1	Cable tray according to B.1.2 (if desired by the test sponsor)
a_1	Minimum distance between a cable/cable tray and the seal edge as chosen by the test sponsor
C1, C2, C3, E	Cables according to Table A.1
h	Maximum height desired by the test sponsor within the range defined in 3.11
w	Maximum width desired by the test sponsor, within the range defined in 3.11

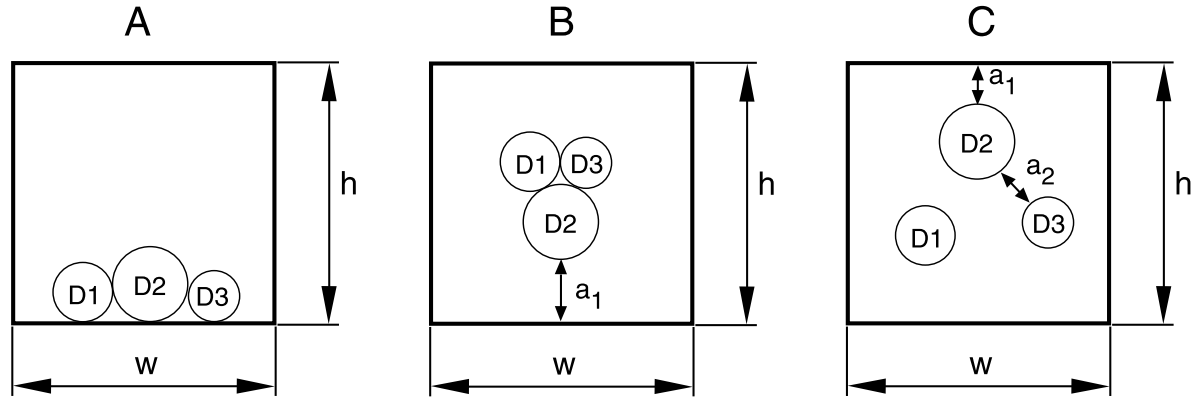
Figure B.1 — Example for a standard configuration for small cable penetration seals including a cable tray: specimen 2, option 2



Key

A	**Option1:** The positioning of the cables is arbitrary provided they are in contact with each other and the aperture edge
B	**Option 2:** The positioning of the cables is arbitrary provided they contact each other
C	**Option 3:** The positioning of the cables is arbitrary (no contact between any two cables)
a_1	Minimum distance between any cable and the seal edge as chosen by the test sponsor
a_2	Minimum distance between any two cables as chosen by the test sponsor
C1, C2, C3, E	Cables according to Table A.1
h	Maximum height desired by the test sponsor within the range defined in 3.11
w	Maximum width desired by the test sponsor within the range defined in 3.11

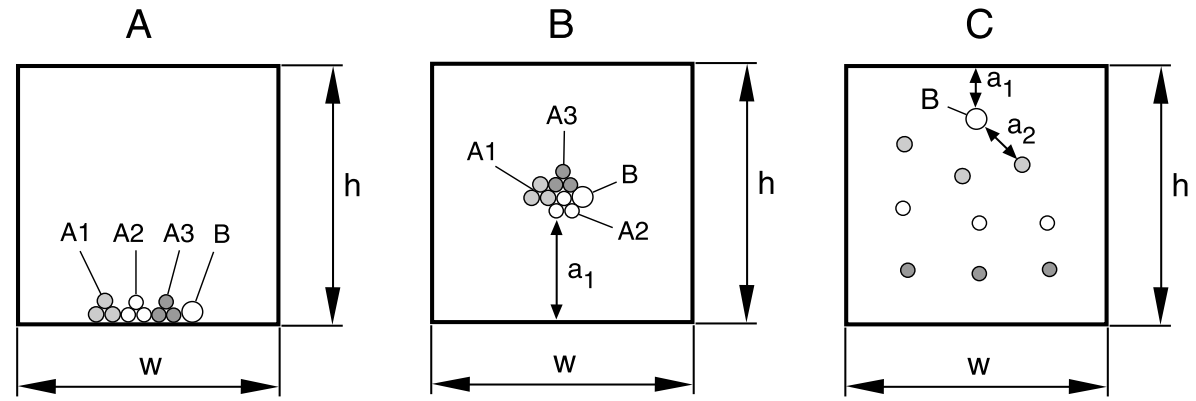
Figure B.2 — Specimen 2 according to Table B.1 – Example of square specimen



Key

A	**Option 1:** The positioning of the cables is arbitrary provided they are in contact with each other and the aperture edge
B	**Option 2:** The positioning of the cables is arbitrary provided they contact each other
C	**Option 3:** The positioning of the cables is arbitrary (no contact between any two cables)
a_1	Minimum distance between any cable and the seal edge as chosen by the test sponsor
a_2	Minimum distance between any two cables as chosen by the test sponsor
D1, D2, D3	Cables according to Table A.1
h	Maximum height desired by the test sponsor within the range defined in 3.11
w	Maximum width desired by the test sponsor within the range defined in 3.11

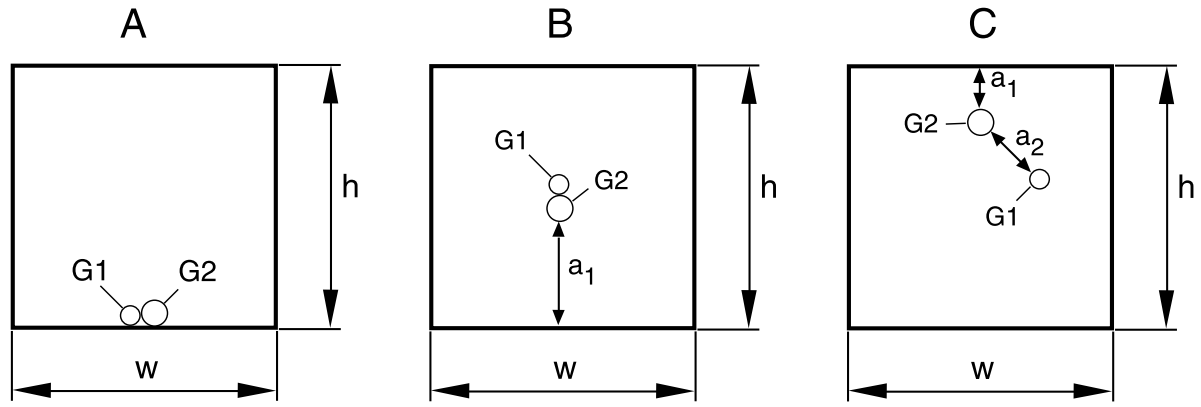
Figure B.3 — Specimen 3 according to Table B.1 – Example of square specimen



Key

○	Cables A1 according to Table A.1
○	Cables A2 according to Table A.1
●	Cables A3 according to Table A.1
A	**Option1:** The sequence of the trefoil arrangements is arbitrary provided they are in contact with each other and cable B
B	**Option 2:** The positioning of the cables is arbitrary provided they contact each other
C	**Option 3:** The positioning of the cables is arbitrary (no contact between any two cables)
a_1	Distance between cable B and the seal edge as chosen by the test sponsor; a_1 shall be the minimum distance between any cable and the seal edge
a_2	Distance between cable B and any one of the A-cables as chosen by the test sponsor; a_2 shall be the minimum distance between any two cables.
A1, A2, A3, B	Cables according to Table A.1
h	Maximum height desired by the test sponsor within the range defined in 3.11
w	Maximum width desired by the test sponsor within the range defined in 3.11

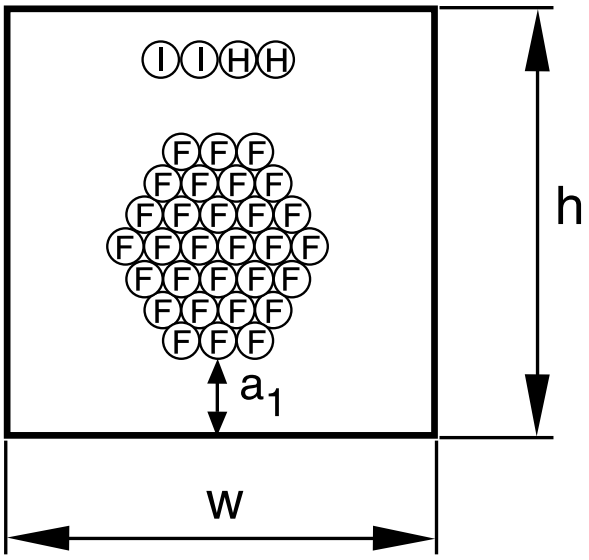
Figure B.4 — Specimen 4 according to Table B.1 – Example of square specimen



Key

A **Option1:** The positioning of the cables is arbitrary provided they are in contact with each other and the aperture edge
B **Option 2:** The positioning of the cables is arbitrary provided they contact each other
C **Option 3:** The positioning of the cables is arbitrary (no contact between the two cables)
a_1 Minimum distance between any cable and the seal edge as chosen by the test sponsor
a_2 Minimum distance between any two cables as chosen by the test sponsor
G1, G2 Cables according to Table A.1
h Maximum height desired by the test sponsor within the range defined in 3.11
w Maximum width desired by the test sponsor within the range defined in 3.11

Figure B.5 — Specimen 5 according to Table B.1 – Example of square specimen



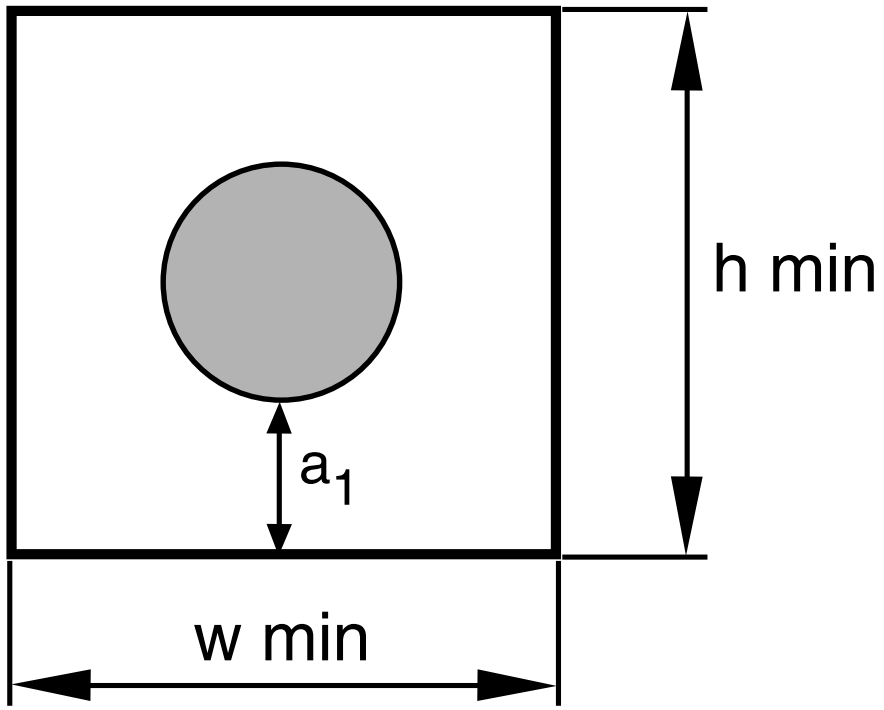
Key

a_1 Minimum distance between any cable and the seal edge as chosen by the test sponsor
F Cables according to Table A.1
H Metal conduit / tube according to A.1.10
I Plastic conduit according to A.1.10
h Maximum height desired by the test sponsor within the range defined in 3.11
w Maximum width desired by the test sponsor within the range defined in 3.11

NOTE The figure shows option 2 [a]. For option 1 [b] distance a_1 is zero.

[a] The positioning of the tied bundle and the conduits is arbitrary provided a plastic conduit touches a metal conduit / tube.
[b] The positioning of the tied bundle and the conduits is arbitrary provided they contact the seal edge and a plastic conduit touches a metal conduit / tube.

Figure B.6 — Specimen 6 according to Table B.1 – Example of square specimen



Key

●	Cable B (specimen 7) or E (specimen 8) according to Table A.1, see B.1.1
h min	Minimum height desired by the test sponsor within the range defined in 3.11
w min	Minimum width desired by the test sponsor within the range defined in 3.11
a_1	Distance between the cable and the seal edge

Figure B.7 — Specimen 7 and 8 according to Table B.2 – Example of square specimen

Annex C
(normative)

Standard configuration and field of direct application for modular systems and cable boxes

C.1 Modular Systems

C.1.1 Standard configuration

C.1.1.1 Frame and number of single openings

The maximum envisaged size of a single frame or a single opening in a combination frame shall be tested.

In case of a combination frame the maximum envisaged number of single openings shall be tested except in case of combination frames made from steel with a frame wall thickness equal to or greater than 6 mm. In this case a combination frame of 2x2 standard frame openings may be used.

C.1.1.2 Modules

C.1.1.2.1 Blank modules

The standard single or combination frames shall comprise the following modules:

All module sizes and geometries shall be represented as blank modules. One opening of the combination frame shall be filled completely with blank modules. If there is not enough space, a larger combination frame comprising more openings or additional single frames shall be used.

C.1.1.2.2 Modules containing services

There are 4 cases regarding services penetrating the seal:

Case 1: only cables

Case 2: only "metal pipes" (only interrupted insulation possible)

Case 3: only "plastic pipes"

Case 4: mixed

Standard configuration for Case 1:

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). For type, number and arrangement of the cables see Figure C.1A;

2) "Medium": all cables from cable groups 1 and 2 shall be included (small and medium sheathed cables). For type, number and arrangement of the cables see Figure C.1B;

3) "Large": all cables from cable groups 1, 2 and 3 shall be included (small, medium and large sheathed cables). For type, number and arrangement of the cables see Figure C.1C;

4) Optionally 1 x G1 and/or 1 x G2 may be included in addition to configuration option "Large" (see Figure C.1D);

5) When undividable multi cable modules for more than one cable are part of the system these modules shall be used in addition to the modules shown in Figure C.1, using the maximum cable loading. The module with the largest number of cables and the shortest distance between the cables shall be selected;

6) The minimum module size suitable for any particular cable shall be used;

7) In the case where more single openings are used than necessary as shown in Figures C.1A to C.1D they shall be filled with empty modules.

Standard configuration for Case 2:

8) Generally the same rules as in E.1 apply;

9) The pipes shall be included in a 2 x 2 combination frame. If there is not enough space in this frame, a larger combination frame comprising more openings or additional single frame openings may be used. In the latter case the minimum distance between the single frame openings and/or the combination frame and single frame openings shall be recorded.

Standard configuration for Case 3:

10) Additional provisions, e.g. a collar or wrap may be necessary;

11) Generally the same rules as in E.2 apply.

Standard configuration for Case 4:

12) Generally the same rules as in Annex F apply.

C.1.2 Field of direct application

13.5.1 Size

The maximum single opening size and maximum number of single openings in a combination frame shall be as tested except in the following case: Test results obtained on combination frames made from steel with a frame wall thickness not less than 6 mm cover combination frames with any number of single openings in rigid building elements and combination frames with 4 x 1 or 2 x 2 single openings in flexible constructions.

C.1.2.1 Services

Where the standard configuration described in C.1.1 Case 1 was used, the rules given in A.3.1 and A.3.2 apply.

Where the standard configuration described in C.1.1 Case 2 was used, the rules given in E.1.5 apply.

Where the standard configuration described in C.1.1 Case 3 was used, the rules given in E.2.7 apply.

Where the standard configuration described in C.1.1 Case 4 was used, the rules given in F.5 apply.

Results obtained with modules containing more than two services cover single modules with the same hole size, provided the distance between the services is equal or smaller compared to the equivalent single modules.

C.1.2.2 Separations

The minimum distance between single frames or combination frames shall be as tested or minimum 200 mm.

C.2 Cable boxes

C.2.1 General

The following rules are only applicable to cable boxes with a frame made from steel.

C.2.2 Structure of specimens

C.2.2.1 The specimens/standard configuration according to Table B.1 and B.2 shall be used to gain the maximum field of application as defined in C.2.3. The cables of specimens 2, 3, 4 and 5 may be combined in one specimen. A cable tray of appropriate width shall be used when a cable tray is included on request of the test sponsor (see Figure C.2B). There are several configuration options:

1) “Small”: Specimens 1 and 4 according to Table B.1 shall be included;

2) "Medium": Specimens 1, 2, 4 and 8 according to Tables B.1 and B.2 shall be included;

3) “Large”: Specimens 1, 2, 3, and 4 according to Table B.1 shall be included (see Figure C.2A);

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.

C.2.2.2 In case the ratio of the cross sectional area of the intumescent material to the opening size is different at the various sizes within the range desired by the test sponsor, a blank opening of the size with the minimum ratio shall be tested in addition.

C.2.2.3 When several cable boxes are intended to be used next to each other at least 2 boxes shall be arranged in orientation A or B (see Figure C.3). Orientation A covers orientation B but not vice versa.

C.2.2.4 Wall applications: When several cable boxes are intended to be used stacked above each other (orientation C according to Figure C.3) in a wall the maximum number of the boxes desired by the test sponsor shall be used in the test and a suitable load applied to simulate the load of the cables (e.g. steel ballast described in Annex A) unless precautions are being taken, such that these loads are carried by other means. If more than one box size is desired by the test sponsor to be stacked above each other, one assembly containing the maximum number of boxes made from the maximum box size and one assembly containing three different box sizes shall be tested (see Figure C.4)

C.2.2.5 In floor applications orientations A and C are equivalent.

C.2.2.6 Cable boxes with different length (dimension perpendicular to the wall / floor) shall be assessed separately.

C.2.3 Field of direct application

C.2.3.1 The rules given in A.3.1 to A.3.3 and A.3.4 apply.

C.2.3.2 Test results obtained are valid for all sizes between the maximum and minimum size tested provided a blank seal according to C.2.2.2 was tested with a positive result with respect to the intended classification period.

C.3 Non-standard configuration

C.3.1 If the test is not conducted in accordance with C.1 or C.2 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.

C.3.2 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.

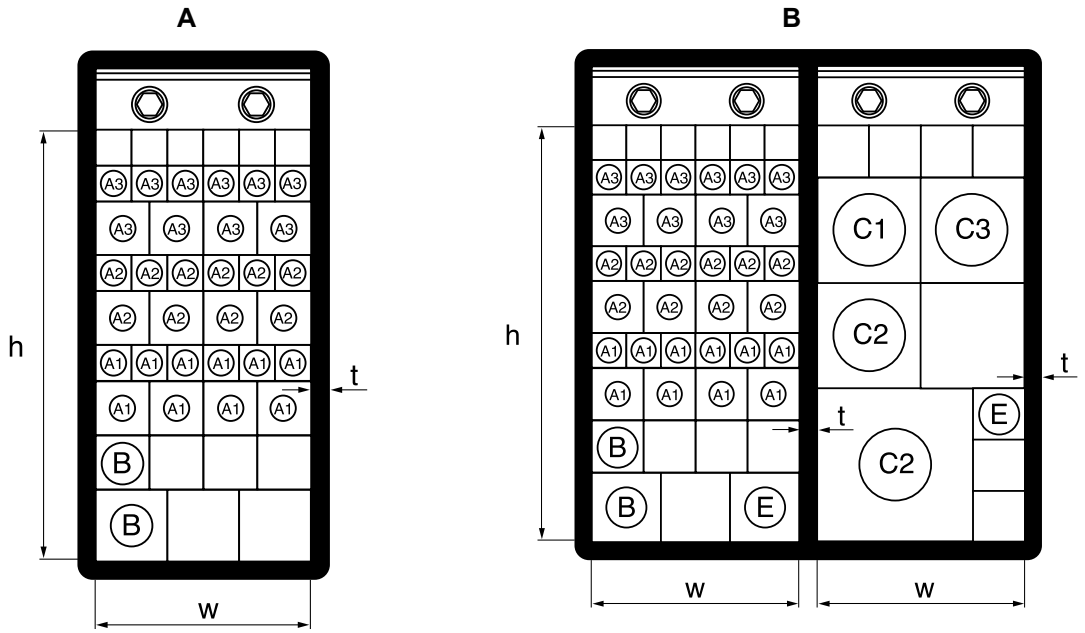
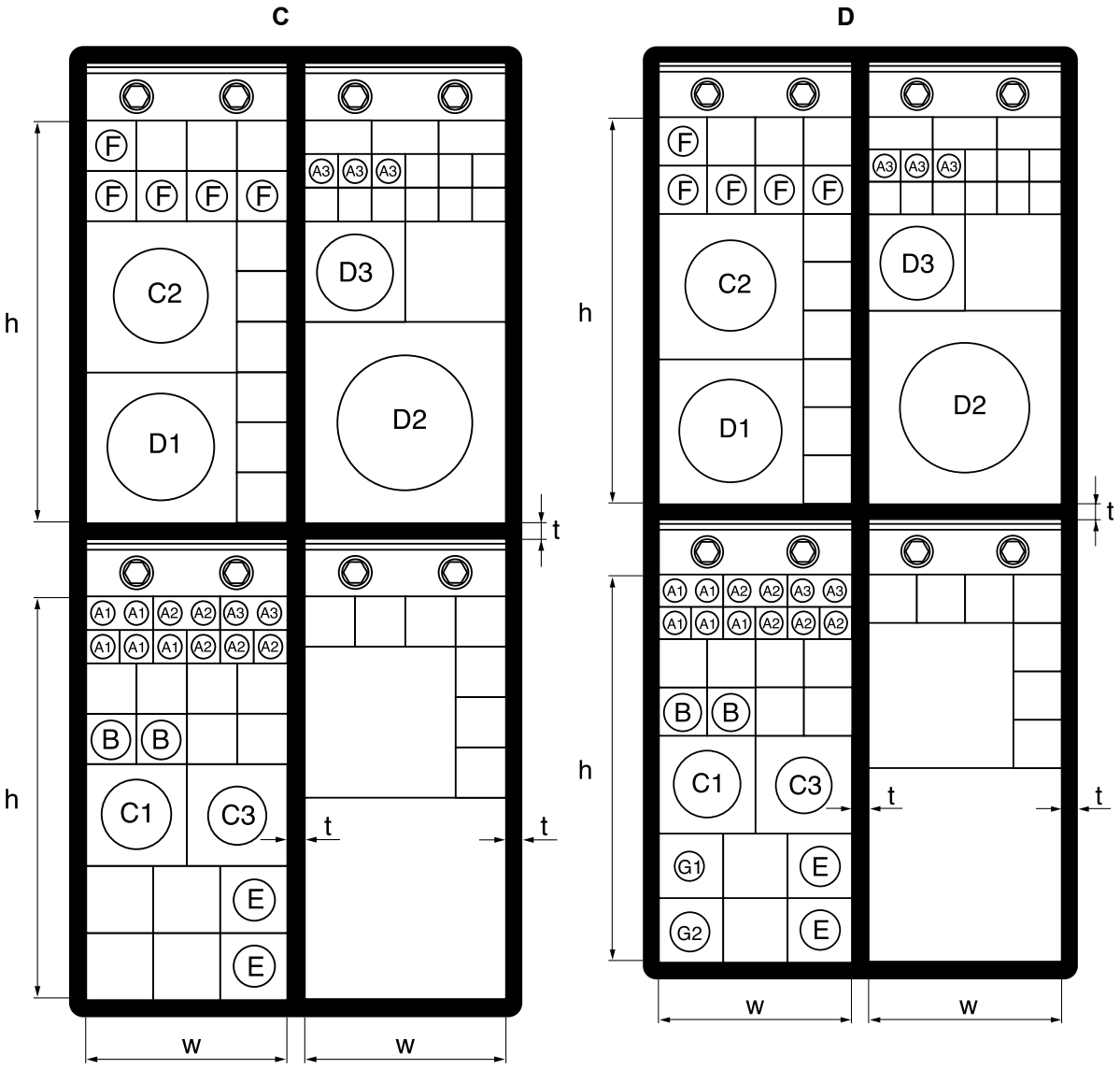


Figure (*continued*)

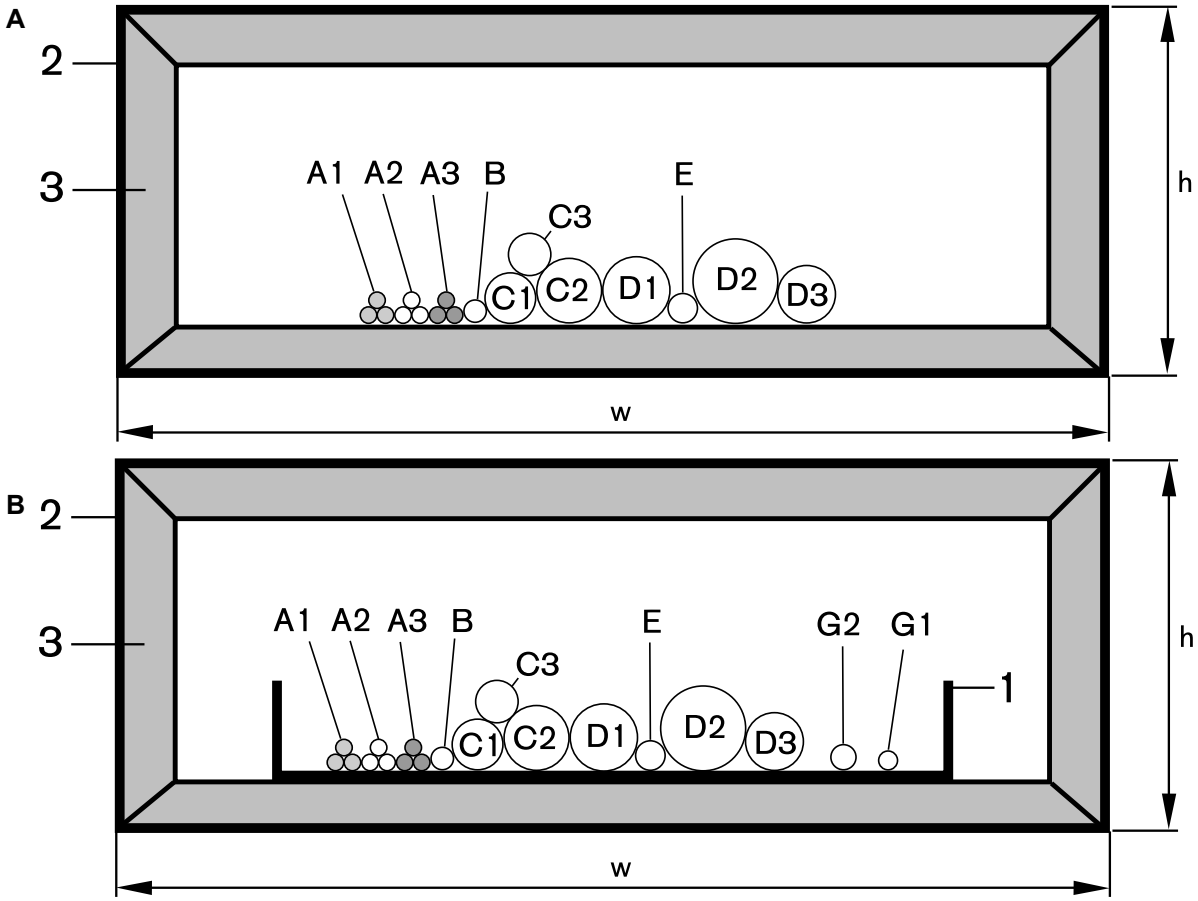


Key

2 x 2 Combination frame

A Configuration option "Small"
B Configuration option "Medium"
C Configuration option "Large"
D Configuration option "Large" including non-sheathed cables (wires) G1 and G2
A1 – G2 Cables according to Table A.1
h Maximum height of a single opening
t Thickness of the frame
w Maximum width of a single opening

Figure C.1 — Standard configuration for modular systems

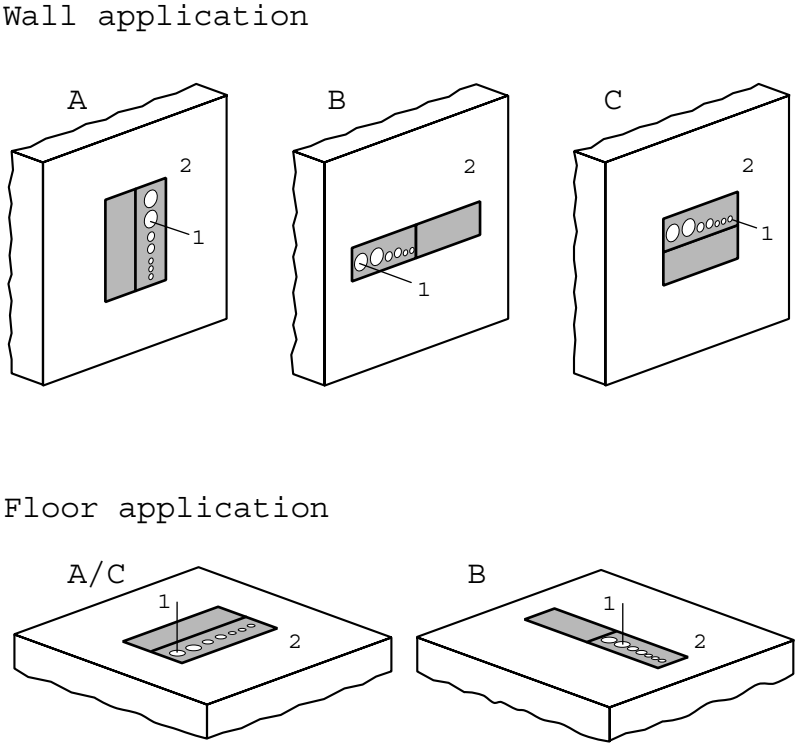


Key

A	Configuration option "Large" – specimens 2 to 4 according to Table B.1 combined
B	Configuration including specimens 2 to 5 according to Table B.1 and an optional cable tray
1	Optional cable tray according to B.1.2, width = 300 mm
2	Housing
3	Intumescent inlay
A1 to G2	Cables according to Table A.1
w	Maximum width desired by the test sponsor
h	Maximum height desired by the test sponsor

NOTE The sequence of the cables is arbitrary provided they contact each other and the formation of the A- and C-cables is as indicated (trefoil configuration).

Figure C.2 — Configuration for cable boxes when cables are combined in one specimen

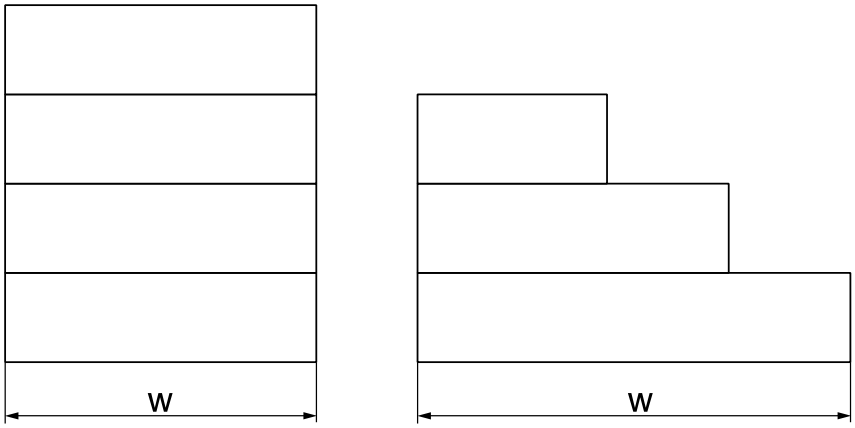


Key

1 Cables
2 Supporting construction
A Orientation A
B Orientation B
C Orientation C

NOTE The drawings show the front view of the cable boxes. The cables shown are indicative only.

Figure C.3 — Orientation of cable boxes in the test



Key

w Maximum width desired by the applicant

NOTE The drawings show the front view of the cable boxes.

Figure C.4 — Configuration of stacked cable boxes in the test

Annex D
(normative)

Specimen design and field of direct application for bus bars

D.1 Structure of specimens

D.1.1 For each shape of bus bar and each conductor material the maximum number of conductors and the maximum cross section area of the conductors shall be tested. Bus bars with two or more conductors for each phase shall be treated as a separate shape. If both orientations of the conductors (vertical and horizontal, see Figure D.1) are to be covered, both orientations shall be tested.

D.1.2 If, for different sizes of the bus bar, different seals (for example different types, length or thickness of the seal) are to be used, each seal type shall be tested with the maximum desired cross section area of the conductors.

D.1.3 Normally straight bus bars shall be tested. If it is required to include bus bars that change direction adjacent to the separating element (see Figure D.2) these shall be subject to additional tests.

D.2 Field of direct application

Results from the maximum sized bus bar are also valid for smaller bus bars (smaller cross section area of the conductors / less number of conductors) of the same type.

D.3 Non-standard configuration

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

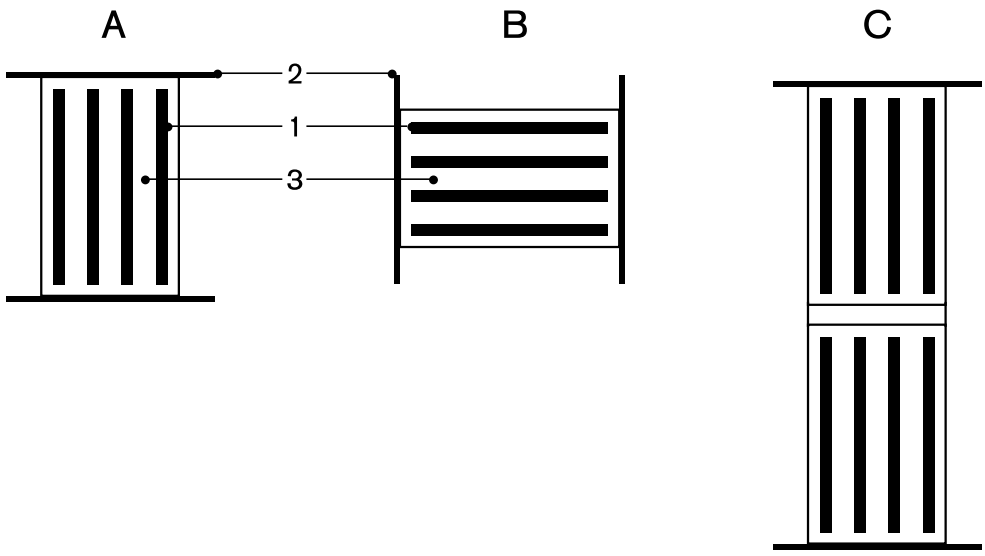
1) the largest envisaged penetration seal in walls and floors;

2) the seal with the smallest envisaged thickness;

3) the type of bus bars included in the test;

4) the greatest possible bus bar density (in relation to the overall cross section of the bus bars per sealed penetration and in relation to the cross sections of the conductors per bus bar);

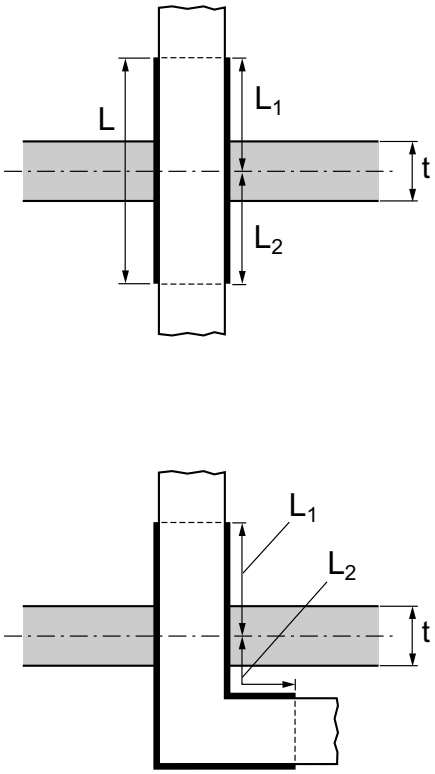
5) the bus bar supports, where appropriate.



Key

1 Conductor (normally copper or aluminium)
2 Metal casing
3 Air or insulation material
A Vertical orientation of the conductors
B Horizontal orientation of the conductors
C Type with two conductors for each phase

Figure D.1 — Bus bars – description/orientation



Key

t Thickness of the separating element
L Total length of the fire protected portion of the bus bar
L1, L2 Partial length of fire protected portion of the bus bar

Figure D.2 — Bus bars changing direction adjacent to the seal

Annex E
(normative)

Standard configuration and field of direct application for pipe penetration seals

E.1 Standard configuration for penetration seals for pipes according to 6.3.2 a) – "metal pipes"

E.1.1 General

All pipe diameters referred to in this document are the external diameters because this controls the space to be filled by the sealing medium.

E.1.2 Standard configuration for single and multiple penetration seals with pipes with linear separation

E.1.2.1 The configuration shall be as shown in Figure E.1 – Option 1 or Figure E.2 – Option 1. The distances a_1 to a_3, the dimensions and the material of pipes shall be selected by the test sponsor subject to the rules given in the subsequent clauses. The pipes shall be selected in order to demonstrate the 'corner points' of the required range, with respect to pipe diameter and pipe wall thickness (see Figure E.3, pipes A, B, C). Where the desired pipe wall thickness range is restricted to maximum 14,2 mm pipe A may be omitted. The diameters and wall thickness of the pipes shall be accurately recorded. For tests in flexible supporting constructions the pipes shall be restrained independently with respect to the supporting construction on the unexposed face in order to prevent movement. Pipe supports which are part of the sealing system shall be included in the test and shall be fixed either to or independent of the supporting construction, as appropriate.

E.1.2.2 The standard configuration shall comprise the following (see Figure E.1 – Option 1 and Figure E.2 – Option 1):

a) Pipe A: The largest pipe diameter at the maximum pipe wall thickness (only for the assessment of a pipe wall thickness range exceeding 14.2 mm);

b) Pipe B: The largest pipe diameter at the minimum pipe wall thickness;

c) Pipe C: The smallest pipe diameter at the minimum pipe wall thickness.

These pipes shall be equally spaced at a separation distance a_3 and spaced from the seal edge by distances a_1 and a_2. If alternative materials are required to be covered in the field of application, additional pipes made from these alternative materials shall be included.

E.1.3 Standard configuration for single and multiple penetration seals with pipes in clusters

The configuration shall be as shown in Figure E.1 – Option 2 or Figure E.2 – Option 2. All other details will be identical to that specified for single and multiple penetration seals with pipes with linear separation (E.1.2).

E.1.4 Standard configuration for pipes fitted with an insulation

E.1.4.1 For pipes with a local insulation (cases LI and LS according to 3.13) a minimum distance of 150 mm of exposed, non-insulated pipe shall be provided at each end.

E.1.4.2 Pipes with continued insulation (cases CI and CS according to 3.13) may be insulated to its full length. In case of a capped situation the capped end may also be insulated with insulation material of the same thickness and the same specification.

E.1.4.3 For pipes with insulation the insulation material/thickness and for local insulation in addition the length shall also be taken into account. If the insulation thickness/length remains consistent irrespective of pipe dimensions, then the configuration according to E.1.2 or E.1.3 will provide adequate information. However, if the insulation thickness/length varies depending upon the dimensions of the pipe, then additional pipes shall be added to the standard configuration at the maximum diameter and minimum wall thickness for each 'step' in insulation thickness/length for a given insulation material (see Figure E.4A – pipe C is necessary when the wall thickness is smaller than the wall thickness of pipe B).

Where a range of insulation thicknesses is offered for the same pipe dimensions a test shall be made with the maximum and minimum insulation thickness for cases LS and LI. For case CI a test with the minimum insulation thickness is sufficient. For case CS the maximum insulation thickness may be omitted in case of mineral wool insulation of classes A1 or A2 according to EN 13501-1.

Pipes A and E may be omitted when the pipe wall thickness is restricted to maximum 14,2 mm.

NOTE Insulation material is defined as the generic insulation material according to a particular product standard together with all components of the insulation system as used in practice.

E.1.5 Field of direct application for pipes according to 6.3.2 a) – "metal pipes"

E.1.5.1 Pipe diameter and pipe wall thickness

Results of tests conducted as specified in the standard configurations may be interpolated for pipes with diameters and wall thicknesses between those tested, based upon the lowest result achieved (see Figure E.3), provided the minimum pipe diameter is greater than or equal to 40 mm. If pipe A according to Figure E.3 was not included in the test the maximum wall thickness is restricted to 14,2 mm.

E.1.5.2 Type of pipe material

Results of tests conducted as specified in the standard configurations, on a particular pipe material covers pipe materials with a thermal conductivity lower than that tested, subject to the material having a melting point at least equal to that of the material tested or greater than the furnace temperature achieved at the required classification period.

E.1.5.3 Pipe arrangement

E.1.5.3.1 The results of a test conducted as specified in Option 1 of the standard configurations does not cover 'clusters' of pipes, unless the distances a_3 (Figure E.1) or a_2 (Figure E.2) are >100 mm in practice.

E.1.5.3.2 The results of a test conducted as specified in Option 2 of the standard configurations covers pipes with linear separation.

E.1.5.4 Number of pipes

Results from a multiple penetration seal may be extended to a single penetration seal of the same type but not vice versa.

E.1.5.5 Pipe end configuration

A test with pipe end configuration *U/C* covers all pipe end situations of Table 2.

E.1.5.6 Pipes fitted with an insulation material having class A1 or A2 according to EN 13501-1 made from glass wool or stone wool

E.1.5.6.1 A test conducted on insulated pipes does not cover non-insulated pipes.

E.1.5.6.2 A test conducted on non-insulated pipes covers the integrity criterion of pipes with interrupted insulation (cases LI and CI).

E.1.5.6.3 Thicknesses of insulation between tested dimensions (tests with a specific pipe dimension) for all arrangements of insulation according to 3.13 (cases CS, CI, LS and LI) may be used. Where E.1.4.3 allows testing only at minimum insulation thickness, there is no limit for the maximum thickness of the insulation.

E.1.5.6.4 In case of floor applications the thickness and the length of an asymmetrical local insulation as shown in Figure E.5 may be increased.

E.1.5.6.5 The length of a local insulation may be increased but may not be reduced.

E.1.5.6.6 The density of the insulation may be increased but may not be reduced.

E.1.5.6.7 A test conducted on pipes insulated with glass wool covers pipes insulated with stone wool but not vice versa.

E.1.5.6.8 If a single pipe was tested perpendicular to the supporting construction all angles between 90° and 45° are covered.

E.1.5.6.9 If a pipe was tested perpendicular to the supporting construction as well as oblique, the result is valid for each angle between a right-angle and the angle tested.

E.1.5.7 Pipes fitted with an insulation material having class B to F according to EN 13501-1

E.1.5.7.1 A test conducted on insulated pipes does not cover non-insulated pipes.

E.1.5.7.2 A test conducted on non-insulated pipes does not cover insulated pipes.

E.1.5.7.3 Thicknesses of insulation between tested dimensions (tests with a specific pipe dimension) for all arrangements of insulation according to 3.13 (cases CS, CI, LS and LI) may be used. Where E.1.4.3 allows testing only at minimum insulation thickness, there is no limit for the maximum thickness of the insulation.

E.1.5.7.4 The length of a local insulation may be increased but may not be reduced.

E.1.5.7.5 In the case where a pipe closure device is used, the maximum pipe closure device size within a design group determined according to E.2.2.1 covers smaller sizes. If the thickness of the active component of the pipe closure device is changed (length remains constant) the maximum pipe closure device sizes from the design groups comprising the smallest and the largest pipe closure device sizes cover the size range / design groups in between provided the thickness of their active components is higher than the calculated value from the straight line that connects the maximum and minimum size in a thickness - pipe diameter diagram (see Figure E.8). In this situation pipe diameter includes the insulation.

E.1.5.7.6 No extension to the range of pipe insulation materials is permissible beyond that tested.

E.1.5.7.7 If a pipe was tested perpendicular to the supporting construction as well as oblique, the result is valid for each angle between a right-angle and the angle tested.

E.2 Standard configuration for penetration seals for pipes according to 6.3.2 d) – "plastic pipes"

E.2.1 General

The configuration for single and multiple penetration seals with linear separation shall be as shown in Figure E.1 – Option 1 or Figure E.2 – Option 1. The configuration for single and multiple penetration seals with pipes in clusters shall be as shown in Figure E.1 – Option 2 or Figure E.2 – Option 2. Additional pipes may be added as required. The distances a_1 to a_3, the dimensions and the material of pipes shall be selected by the test sponsor subject to the rules given in the subsequent clauses.

For tests in flexible supporting constructions the pipes shall be restrained independently with respect to the supporting construction on the unexposed face in order to prevent movement. Pipe supports which are part of the sealing system shall be included in the test and shall be fixed either to or independent of the supporting construction, as appropriate.

E.2.2 Pipe closure devices

E.2.2.1 General

The sizes of the pipe closure devices to be included in the test are determined as follows:

1) Identify the "design groups" of the pipe closure device. A "design group" consists of all sizes of the pipe closure device with the same material, thickness and length of the active component (e.g. the inlay of a collar or a wrap). Guidance on methods how to determine the design groups are given in H.4.7.2. A "length group" contains one or more "design groups" which have all the same length of the active component.

2) The maximum size of each design group shall be selected for the test.

3) The maximum size of any design group between the design groups comprising the overall smallest and biggest sizes within a length group may be eliminated from the selected list provided it is above a line drawn between the minimum and maximum size selected from a length group (see Figure E.8) and the material of the active component is the same.

4) The remaining pipe closure device sizes are tested at both the maximum and minimum wall thickness of the related pipe (see Figure E.9).

5) The number and type of fixing tabs and of latches shall be considered.

E.2.2.2 Pipes with insulation

The sizes of the pipe closure devices to be included in the test are determined using the principles of E.2.2.1. In a second step the pipe sizes fitting into the selected pipe closure devices considering the maximum and minimum insulation thickness are determined. The maximum wall thickness of the pipe shall be combined with the maximum and minimum thickness of the insulation. The minimum wall thickness of the pipe shall be combined with the minimum insulation thickness. The combination of maximum wall thickness with minimum insulation thickness may be omitted in the case where non-insulated pipes have been tested with the selected pipe closure device size.

Each combination of pipe and insulation material shall be tested. The critical pipe approach may be used (see G.3). See also E.2.7.4.

E.2.2.3 Pipe closure devices for several pipe dimensions

Where a particular pipe closure device is designed to be used for several pipe diameters (different annular space between pipe closure device and pipe, see Figure E.6), the maximum and minimum pipe diameter envisaged shall be tested. The maximum and minimum pipe diameters shall be tested with both the maximum and minimum wall thickness of the pipe. These rules are valid for tests with a specific pipe material.

Where more than one pipe closure device size is to be tested the rules for selecting the sizes to be included in the test as given in E.2.2.1 apply. Intermediate sizes may only be omitted if the maximum annular space is equal to or smaller compared to the sizes included in the test.

E.2.2.4 Pipe closure devices for multiple pipes in one device

If a pipe closure device is to be used for more than one pipe (see Figure E.7), the number and dimensions envisaged shall be tested individually. The critical pipe approach according to Annex G may be used regarding the pipe material. In this case a minimum of 3 pipe closure devices containing multiple pipes shall be selected.

E.2.3 Seals other than pipe closure devices

E.2.3.1 General

The rules given in E.1 apply except the option for omitting pipe A (see Figure E.3) according to E.1.2.1.

E.2.3.2 Pipes with insulation

The selection of the specimens to be included in the test shall be done according to Figure E.4. Specimen A shall always be included.

The maximum wall thickness of the pipe shall be combined with the maximum and minimum thickness of the insulation. The minimum wall thickness of the pipe shall be combined with the minimum insulation thickness. The combination of maximum wall thickness with minimum insulation thickness may be omitted in the case where non-insulated pipes have been tested with the same product under the same assembly conditions, e.g. seal depth. In the case where the insulation is intended to fulfil the function of the penetration seal the minimum pipe wall thickness combined with the maximum insulation thickness shall be included in addition.

Each combination of pipe and insulation material shall be tested. The critical pipe approach may be used (see G.3). See also E.2.7.4.

E.2.4 Pipe-in-pipe systems (e.g. leakage indicator systems)

Each pipe material combination envisaged shall be tested.

E.2.5 Special installations

Special installations include but are not limited to

1) curved pipes;

2) pipes which are not fixed perpendicular to the seal;

3) pipe sockets in the area of the seal;

4) additional installation of cables for pneumatic dispatch systems.

They shall be tested individually installed as in practice. The critical pipe approach according to Annex G may be used regarding pipe dimensions and material. In this case a minimum of 3 pipes shall be selected.

E.2.6 Combination with other seal materials/products

See Annex F.

E.2.7 Field of direct application for pipes according to 6.3.2 d) – "plastic pipes"

E.2.7.1 General

Results from a multiple penetration seal may be extended to a single penetration seal of the same type but not vice versa.

E.2.7.2 Seal size

E.2.7.2.1 Pipe closure devices

E.2.7.2.1.1 The maximum pipe closure device size within a design group determined according to E.2.2.1 covers smaller sizes of this design group.

E.2.7.2.1.2 If the thickness of the active component of the pipe closure device is changed (length remains constant) the maximum pipe closure device sizes from the design groups comprising the smallest and the largest pipe closure device sizes cover the size range/design groups in between provided the thickness of their active components is higher than the calculated value from the straight line that connects the maximum and minimum size in a thickness - pipe diameter diagram (see Figure E.8). This interpolation is only permissible if the inner diameter of the smallest pipe closure device included in the test is greater than or equal to 40 mm.

NOTE For further details see H.4.7.2.

E.2.7.2.2 Seals other than pipe closure devices

See 13.5.

E.2.7.3 Pipe end configuration

Test results obtained from tests with "plastic pipes" having both ends uncapped (see Table 2, test condition "*U/U*") are valid for all other test conditions of Table 2. Test results obtained from tests where a flue gas recovery system was used are valid for pipe end conditions *U/C* and *C/C*.

Table E.1 — Field of application rules for pipe end configuration

	Tested				
		U/U	*C/U*	*U/C*	*C/C*
Covered	*U/U*	Y	N	N	N
	C/U	Y	Y	N	N
	U/C	Y	Y	Y	N
	C/C	Y	Y	Y	Y
Y = acceptable, N = not acceptable					

E.2.7.4 Pipe and insulation material

The pipe and/or insulation material range permitted is the range covered by the test including the critical pipe approach results where applicable.

Test results on pipes made from PVC-U according to EN 1329-1, EN 1453-1 or EN 1452-1 are valid for pipes made from PVC-U according to EN 1329-1, EN 1453-1 and EN 1452-1 as well as pipes made from PVC-C according to EN 1566-1.

Test results on pipes made from PE-HD according to EN 1519-1 or EN 12666-1 are valid for pipes made from PE according to EN 12201-2, EN 1519-1 and EN 12666-1, for pipes made from ABS according to EN 1455-1 and pipes made from SAN+PVC according to EN 1565-1.

E.2.7.5 Pipe wall thickness

E.2.7.5.1 Pipe closure devices for pipes without insulation

The range between that tested is covered for a particular size of the pipe closure device. The maximum thickness tested with the maximum size within a design group (see E.2.2.1) of pipe closure device sizes is valid for smaller sizes within the design group. For a design group not included in the test, either a linear interpolation between the corner points tested or a step approach as illustrated in Figure E.9 may be used. Where the minimum wall thickness remains the same over several design groups, the design groups representing the maximum and minimum sizes cover the intermediate ones.

E.2.7.5.2 Seals other than pipe closure devices

Results of tests conducted as specified in the standard configurations may be interpolated for pipes with diameters between those tested and wall thicknesses between those tested.

E.2.7.6 Pipe orientation

If a pipe was tested perpendicular to the seal as well as oblique, the result is valid for each angle between a right-angle and the angle tested.

E.2.7.7 Separations

For multiple penetrations the separations a_1 to a_3 from a test conducted as specified in the standard configurations may be increased without limitation (see Figure E.1).

Where single pipes penetrate directly through the structural associated construction (masonry walls, flexible walls, concrete floors, etc.) the annular space between the pipe and the supporting construction shall remain within the tested range. Separation a_2 may be increased.

For seals other than pipe closure devices the results of a test conducted as specified in Option 1 of the standard configurations does not cover 'clusters' of pipes, unless the distances a_3 (Figure E.1) or a_2 (Figure E.2) are > 100 mm in practice. The results of a test conducted as specified in Option 2 of the standard configurations covers pipes with linear separation.

E.2.7.8 Additional rules for pipes fitted with an insulation

E.2.7.8.1 Pipe closure devices

In the case where a pipe closure device is used, the maximum pipe closure device size within a design group determined according to E.2.2.1 covers smaller sizes. If the thickness of the active component of the pipe closure device is changed (length remains constant), the maximum pipe closure device sizes from the design groups comprising the smallest and the largest pipe closure device sizes cover the size range/design groups in between provided the thickness of their active components is higher than the calculated value from the straight line that connects the maximum and minimum size in a thickness - pipe diameter diagram (see Figure E.8). In this situation, pipe diameter as shown in Figure E.9 equals the sum of the actual pipe diameter and twice the thickness of the insulation.

Tests on non-insulated pipes do not cover insulated pipes.

Tests with sustained insulation cover interrupted insulation but not vice versa. Tests with sustained insulation do not cover interrupted insulation where the pipe closure device is in direct contact with the pipe.

E.2.7.8.2 Seals other than pipe closure devices

The thickness of the insulation may be interpolated between tested dimensions.

E.3 Trunking and conduits

E.3.1 General

Apart from the rules given in the subsequent paragraphs, the standard configuration shall always comprise minimum two specimens, one of which shall be an empty trunking/conduit, the second one shall contain either the maximum diameter cable or the maximum number of A-cables taken from Table A.1 that fit(s) into the trunking/conduit.

E.3.2 Conduits according to 6.3.2 a) and Trunking according to 6.3.2 b)

See E.1.

E.3.3 Trunking and conduits according to 6.3.2 e)

See E.2.

E.4 Standard configuration for floor penetrations ending at floor level (e.g. floor drain)

Generally the rules for "metal" or "plastic" pipes apply subject to the following:

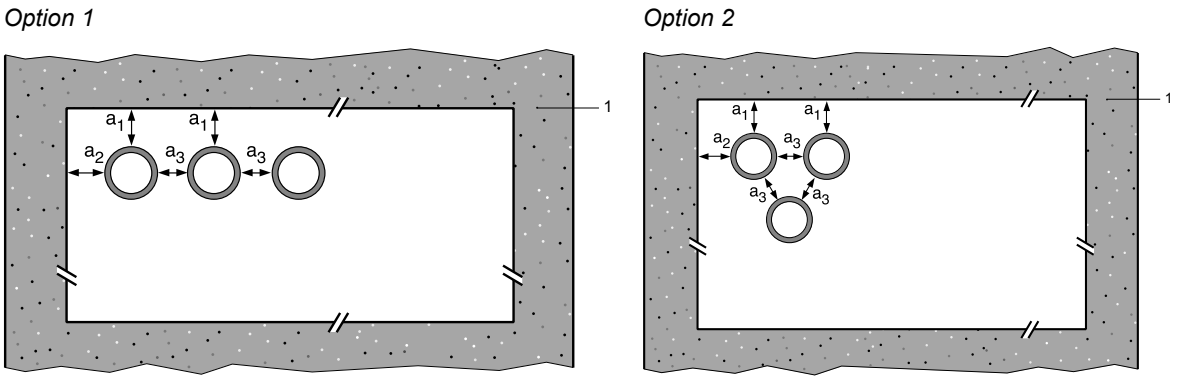
1) A straight plastic pipe with uncapped pipe end or a straight metal pipe with capped pipe end with a minimum length according to 7.3 may be used.

2) A filled water trap is equivalent to a capped situation at the unexposed face.

3) Differing from 9.1.2 thermocouples shall be provided at locations according to Table E.2 (see also Figure E.11).

Table E.2 — Thermocouple location for floor penetration seals ending at floor level

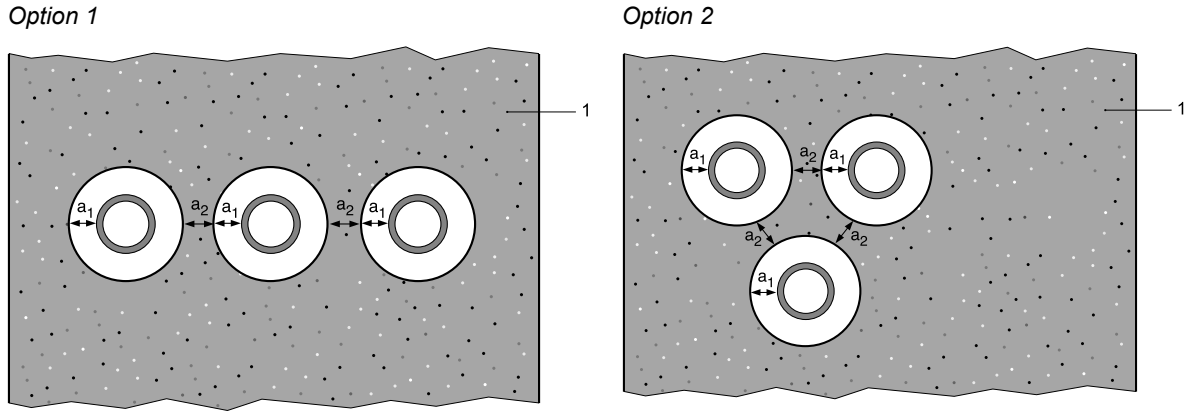
No.	Location on the service
1	on the side of the floor drain
2	on the frame of the floor drain
3	on the grating of the floor drain



Key

1 Supporting construction
a_1 Pipe / top edge of seal separation
a_2 Pipe / side edge of seal separation
a_3 Pipe / pipe separation

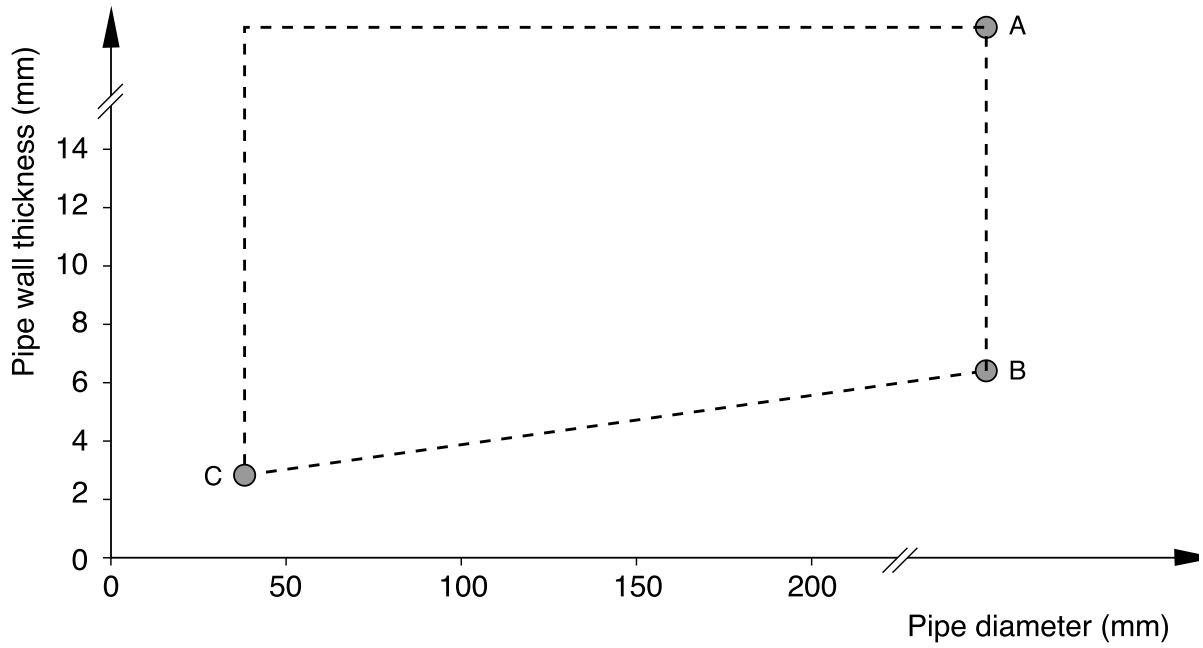
Figure E.1 — Standard configuration for multiple pipe penetration seals



Key

1	Supporting construction
a_1	Pipe / edge of seal separation (annular space)
a_2	Separation between penetration seals

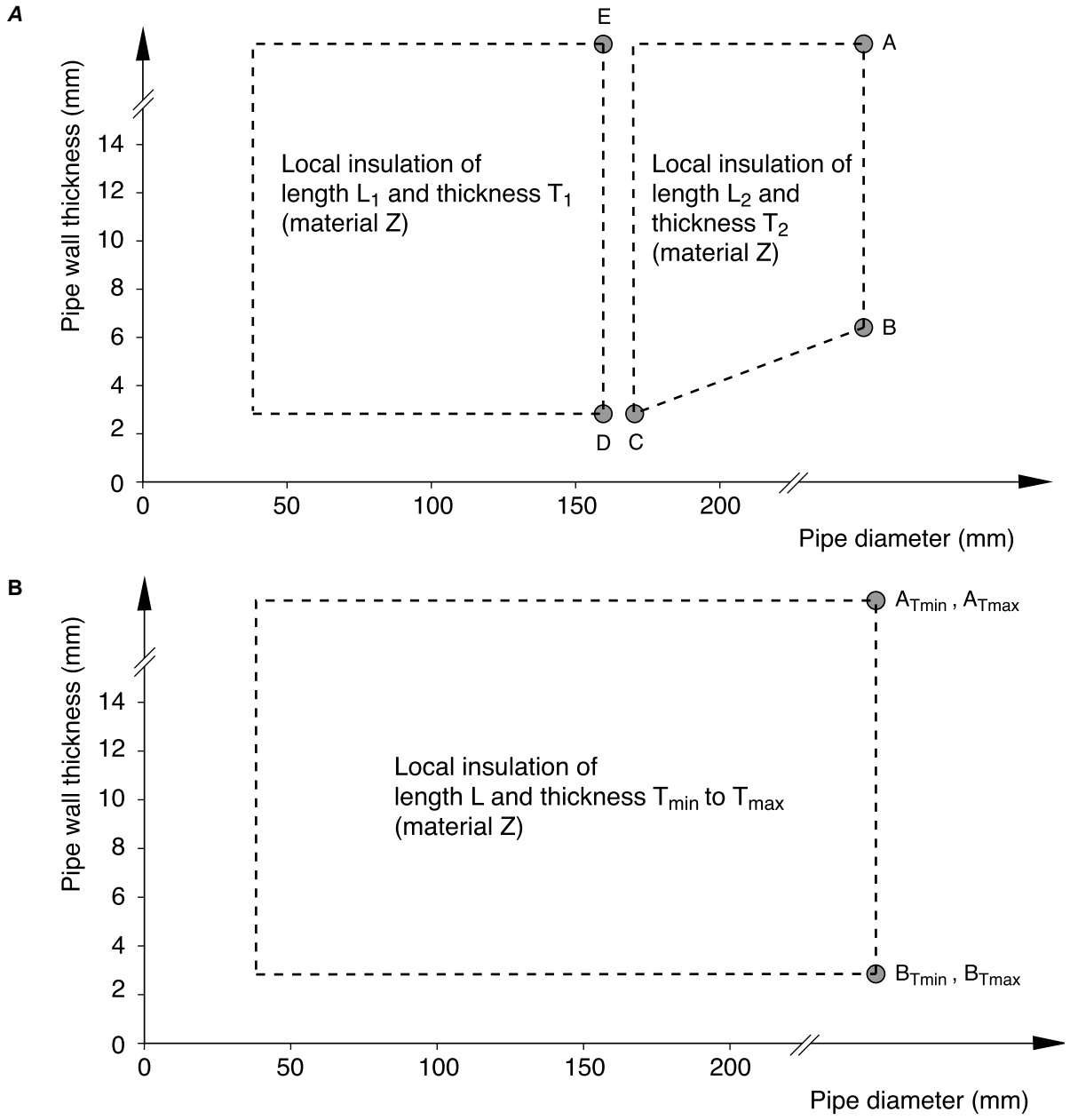
Figure E.2 — Standard configuration for single pipe penetration seals



Key

A-C Specimen reference

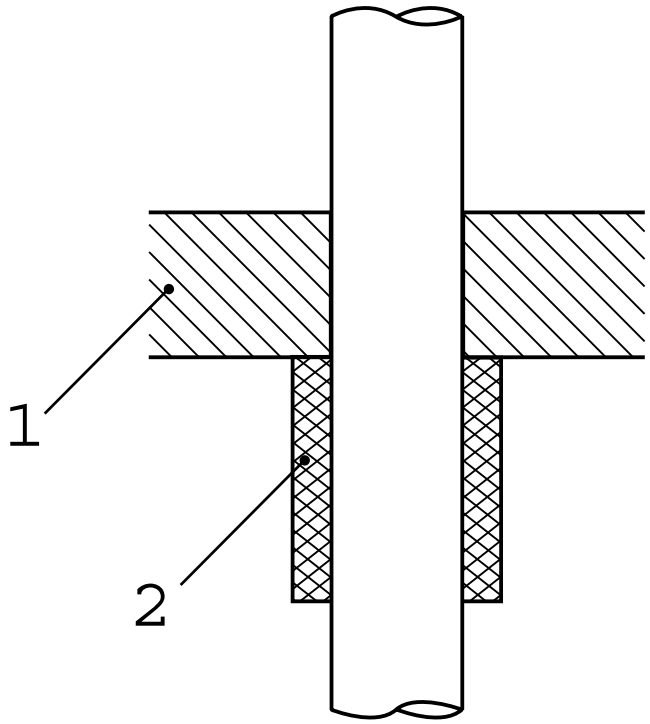
Figure E.3 — Schematic representation illustrating the selection of the pipe diameter / pipe wall thickness combinations to be included in the test for metal pipes



Key

A	Pipes with local insulation of particular length and thickness for particular pipe diameter ranges
B	Pipes with local insulation of particular length but varying thickness
A-E	Specimen reference

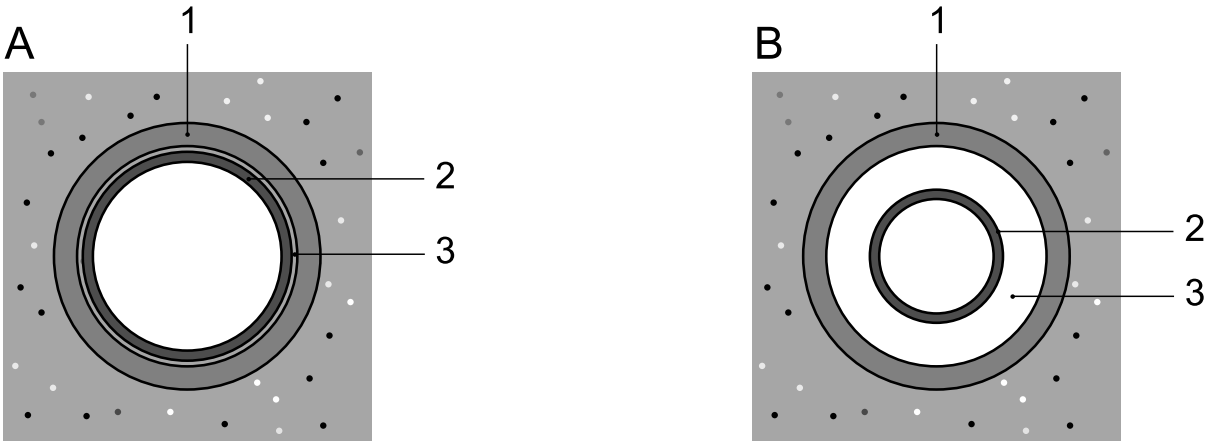
Figure E.4 — Schematic representation illustrating the selection of the pipe diameter / pipe wall thickness combinations to be included in the test for insulated pipes



Key

1 Building element
2 Insulation as part of the firestopping system

Figure E.5 — Asymmetrical local insulation in a floor application

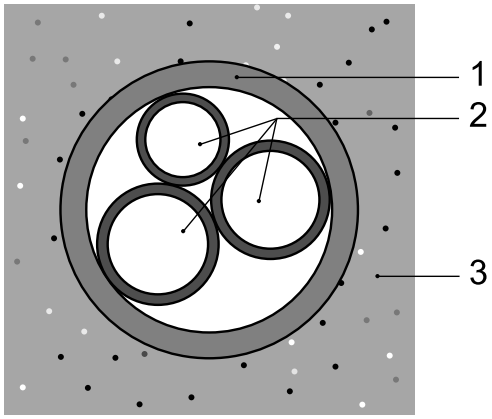


Key

Supporting construction

A Situation with maximum pipe diameter envisaged
B Situation with minimum pipe diameter envisaged
1 Pipe closure device of a particular size
2 Pipe
3 Annular space between pipe closure device and pipe / supporting construction (wall / floor)

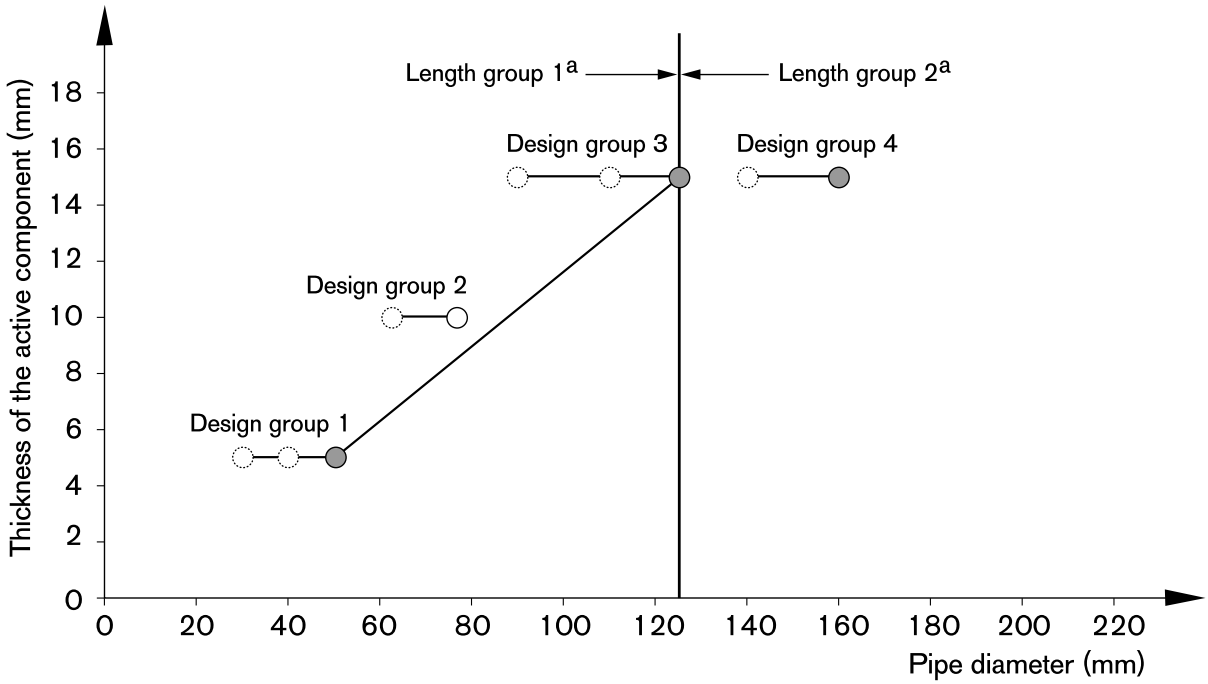
Figure E.6 — Pipe closure device for several pipe dimensions



Key

1 Pipe closure device
2 Pipes (2 or more pipes)
3 Supporting construction (wall / floor)

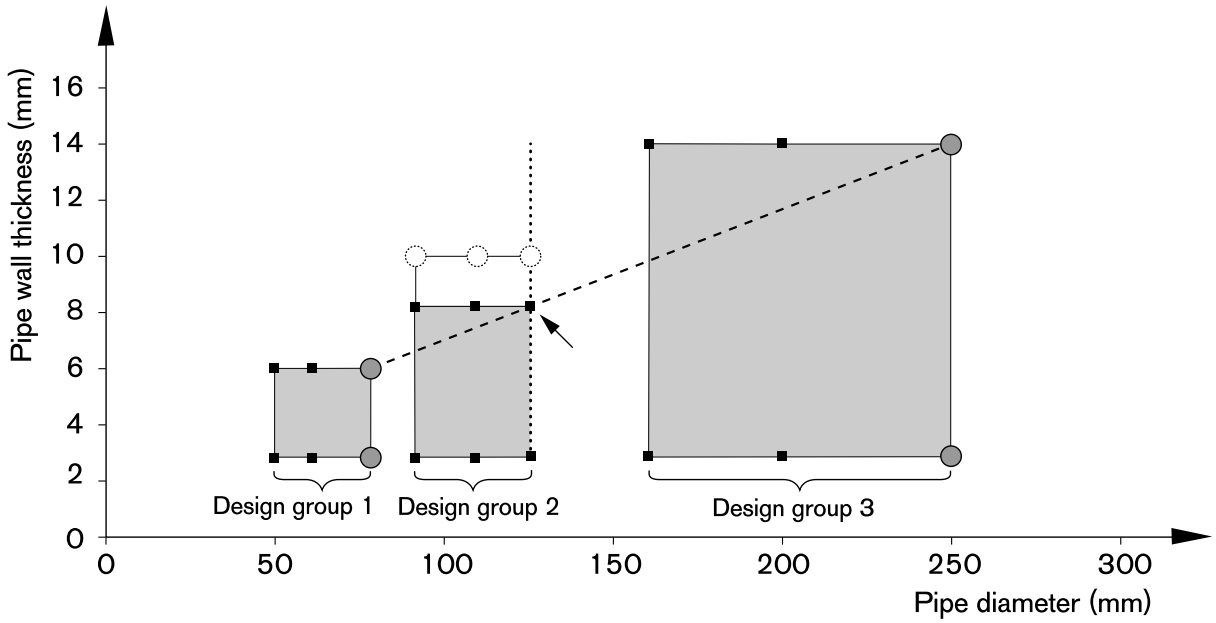
Figure E.7 — Example for a pipe closure device for multiple pipes in one device



Key

● Pipe closure device sizes included in the test
○ Sizes covered without test according to E.2.7.2.1.2
◌ Sizes covered without test according to E.2.7.2.1.1
[a] "Length" refers to the length of the active component of the pipe closure device

Figure E.8 — Diagram illustrating the selection of sizes of pipe closure devices for plastic pipes to be included in the test



Key

Pipe diameter / wall thickness range of a design group

Pipe closure device sizes included in the test

Wall thickness not covered without an additional test

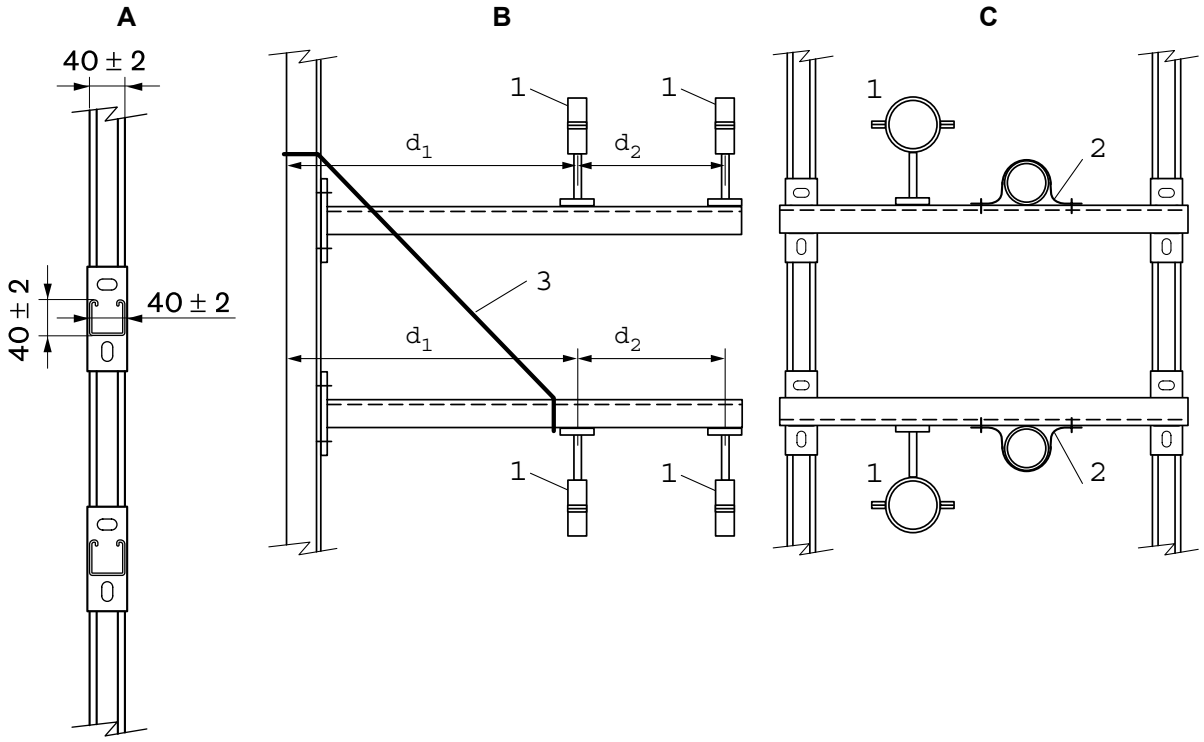
Pipe diameter / wall thickness combinations covered by a test of pipes / pipe closure devices indicated by:

- - - - Line connecting the minimum and maximum pipe closure device sizes included in the test at the maximum pipe wall thickness.

..... Line marking the largest pipe diameter of a design group between design groups included in the test. The crossing point with the connection line defines the maximum pipe wall thickness of a design group not represented in the test which is covered.

Figure E.9 — Diagram illustrating the field of application rules for the pipe wall thickness for pipe closure devices of a particular length group for plastic pipes

Dimensions in millimetres

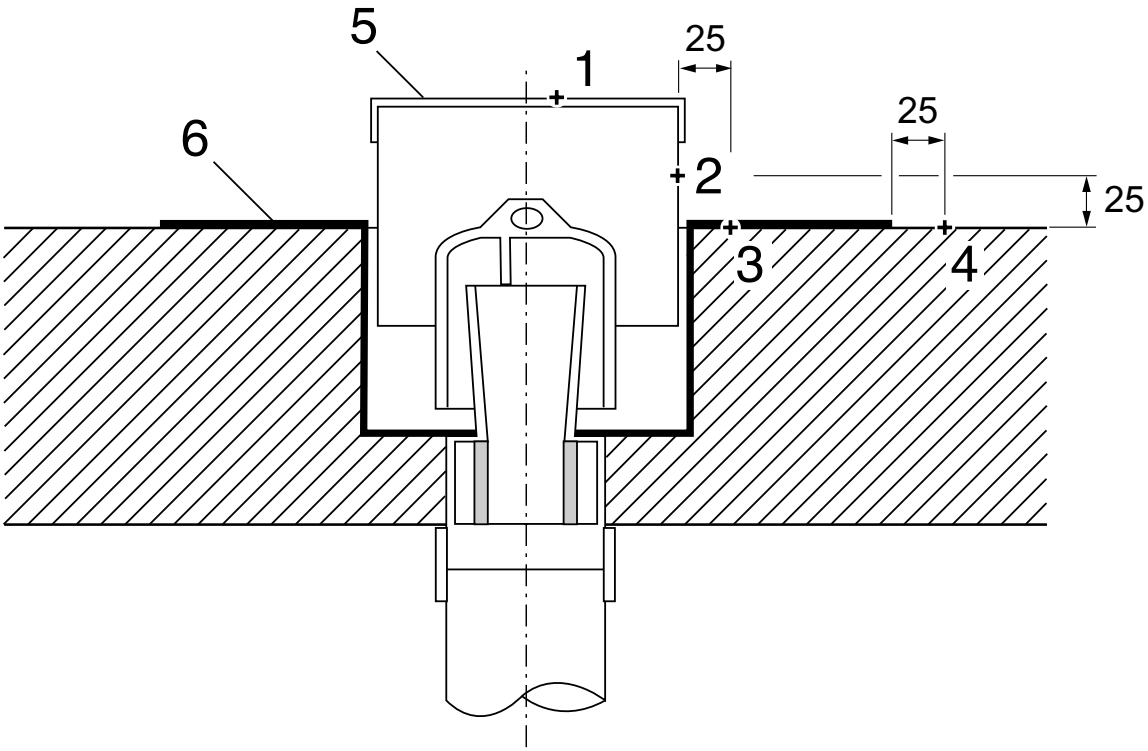


Key

A Front view of the steel strut / channel with a wall thickness of 2 mm to 3 mm and the cantilever bracket, fixed by bolting or welding
B Side view of the pipe support construction
C Front view of the pipe support construction
d_1 Distance from the surface of the supporting construction to the first support position, as specified by the test sponsor
d_2 Distance of the second support position (optional) from the first support position, as specified by the test sponsor
1 Pipe ring
2 Steel band
3 Steel rope or steel strap, if necessary, depending on the weight of the services

Figure E.10 — Service support construction for pipe seals

Dimensions in millimetres



Key

1 Thermocouple on the grating of the floor drain
2 Thermocouple on the side of the floor drain
3 Thermocouple on the frame of the floor drain
4 Thermocouple on the supporting construction (floor)
5 Grating of the floor drain
6 Frame of the floor drain

Figure E.11 — Thermocouple position for floor penetrations ending at floor level – floor drain as example

Annex F
(normative)

Standard configuration and field of direct application for large mixed penetration seals

F.1 General

F.1.1 A mixed penetration in the sense of this Annex may consist of cables, "metal pipes" and "plastic pipes". Depending on the desired field of application a combination of tests shall be performed to allow possible interactions between the various services and the seal to be determined.

F.1.2 The following combinations of services can occur:

a) "metal pipes" + "plastic pipes": see F.3;

b) cables + "metal pipes": see F.4;

c) cables + "plastic pipes" : see F.4;

d) cables + "metal pipes" + "plastic pipes": see F.4;

the pipes being non-insulated or insulated, with materials of various reaction to fire classification: A1 or A2 or B to E according to EN 13501-1.

F.1.3 To allow an assessment of any interaction between the services in the standard configuration a “Standard Mixed Module” (see F.2) shall be used as part of the specimen which contains all types of services foreseen.

F.1.4 If no test evidence for the seal is available, the standard configuration according to option 1 according to F.3 or F.4 shall be used. If results of previous tests on one or more types of services are available, option 2 according to F.3 or F.4 may be used. Option 2 allows the number of services to be reduced. With option 2 the “critical pipe/cable approach” may be used (see Annex G).

F.2 Standard Mixed Module

F.2.1 The size of the Standard Mixed Module shall be 600 mm x 600 mm.

F.2.2 For combinations of type a) according to F.1.2 only ”metal pipes” and “plastic pipes” but no cables are included. In case of a vertical test (wall application) the pipes shall be located in the upper area of the seal.

For combinations of type b) according to F.1.2 only "metal pipes" and cables are included in the test. All pipes in Figure F.1 are taken to be "metal pipes".

For combinations of type c) according to F.1.2 only "plastic pipes" and cables are included in the test. All pipes in Figure F.1 are taken to be "plastic pipes".

For combinations of type d) according to F.1.2 cables, ”metal pipes” and "plastic pipes" are included in the test. See Figure F.1.

All other services desired by the test sponsor, e.g. aluminium pipes and glass pipes, which are not covered by the definition of “metals pipes” and “plastic pipes” shall be included in the fire test additionally.

F.2.3 Rules for the services included

F.2.3.1 Cables

For number, type and arrangement of cables / cable trays see Figure F.1. In case of option 2 according to F.3 or F.4 the cables representing A-, C- and D-cables are selected using the “critical cable approach” (see Annex G). In case of option 1 cables A1, C1, D3 and G2 shall be used, if relevant (see Figure F.2 and F.3).

F.2.3.2 "Metal pipes"

At least three pipes shall be included in the standard mixed module. One of these pipes shall be

a) the largest pipe when option 1 according to F.3.1 or F.4.2 is used;

b) the most critical pipe when option 2 according to F.3.2 or F.4.3 is used.

When this is impossible because of the available space in the standard mixed module, the largest or most critical pipe may be installed in the seal area adjacent to the standard mixed module (area “3” in Figures F.2 to F.5) considering the distances between pipes and pipes and cables / cable trays.

F.2.3.3 "Plastic pipes"

For each pipe closure device/sealing system planned to be used in the mixed penetration seal at least three pipes shall be included. One of these pipes shall be

a) the largest pipe when option 1 according to F.3.1 or F.4.2 is used;

b) the most critical pipe when option 2 according to F.3.2 or F.4.3 is used. For surface mounted pipe closure devices the maximum size of the desired size range shall be included in addition. This is not relevant for mortar seals.

NOTE As pipe closure devices used in conjunction with a mixed penetration seal cannot be fixed rigidly in most of the mixed penetration seals the weight of the pipe closure device is expected to have an influence on the test result.

When this is impossible because of the available space in the standard mixed module, the largest or most critical pipe may be installed in the seal area adjacent to the standard mixed module (area “3” in Figures F.2 to F.5) considering the distances between pipes and pipes and cables / cable trays.

F.2.4 Layout of the Standard Mixed Module

The layout of the Standard Mixed Module is shown in Figure F.1.

The cables / cable trays and ladders shall be arranged as indicated in Figure F.1A or F.1B. At least one pipe of every pipe type ("metal pipes" and/or "plastic pipes") included in the test shall be located between the cable trays / ladders. The remaining space may be used for additional pipes or other services. Number and type of pipes in Figure F.1 are examples only.

F.3 Standard configuration for combinations of type a) according to F.1.2

F.3.1 Option 1

The test setup is created according to the rules given in Annex E using one or more seals of minimum 600 mm x 600 mm including all types of pipes that are desired to be covered in the field of application. All parameters that may influence the result shall be considered, e.g. pipe material, pipe diameter and pipe wall thickness.

F.3.2 Option 2

The number of pipes included in the test may be reduced by using the “critical pipe approach” as described in Annex G.

F.4 Standard configuration for combinations of type b), c) and d) according to F.1.2

F.4.1 General

The layout of the standard configuration for large openings is shown in Figures

a) F.2 for option 1 in walls;

b) F.3 for option 1 in floors;

c) F.4 for option 2 in walls;

d) F.5 for option 2 in floors.

To ensure the interaction of cables and pipes can be simulated properly, at least one Standard Mixed Module according to Figure F.1A (floor) or F.1B (wall) shall be included and in case of a wall test positioned in the upper left or right corner.

The remaining space outside the Standard Mixed Module and – in case of option 1 – the standard cable module (area “1” in Figure F.2 and F.3) may be used for additional pipes or other services (area “3” in Figures F.2 to F.5). If there is insufficient space in one specimen for all pipes or other services that are to be included, more specimens with the same basic layout shall be used. A Standard Mixed Module shall always be included, but in case of option 1 the standard cable module may be omitted in the additional specimen(s). The pipes in the Standard Mixed Module of the additional specimen(s) may be different from the first one.

F.4.2 Option 1

The specimen(s) shall comprise the following (see Figure F.2 and F.3):

1) the standard configuration for cable penetration seals as shown in Figure A.1 (wall) or Figure A.3 (floor) – area “1” and

2) a Standard Mixed Module according to F.2 – area” 2” and

3) space to accommodate the required additional pipes or other services – area “3”. All pipes intended to be covered in the field of application shall be included subject to the rules given in E.1 and/or E.2. All other services intended to be covered by the field of application shall be included subject to the rules given in the relevant sections of this standard (for bus bars see Annex D, for trunkings and conduits according to 6.3.2 a), b) and e) see E.3).

F.4.3 Option 2

F.4.3.1 A mixed penetration seal may be tested with reduced number of service items compared to option 1 if tests

a) according to Annex A with the standard configuration for cables and/or

b) according to Annex E with pipes according 6.3.2 a) and/or

c) according to Annex E with pipes according 6.3.2 d)

have been performed before and the results have allowed an equal or higher classification period than the one intended for the mixed penetration seal.

F.4.3.2 The following rules for the use for the selection of results from previous tests apply:

F.4.3.2.1 "Metal pipes"

1) non-insulated or with interrupted insulation (cases CI and LI according to 3.13): Only results from the same seal type shall be used;

2) with sustained insulation (cases CS and LS according to 3.13): Results from any tests on these pipes may be used as the insulation acts as the seal.

F.4.3.2.2 "Plastic pipes"

Results from tests may be used where:

1) Surface mounted pipe closure devices were used in single openings with an annular space that is covered / protected by the housing of the device;

2) Surface mounted pipe closure devices in conjunction with the same basic seal type were used;

3) Integrated (recessed) pipe closure devices: only results from the same seal type the device is used in conjunction with shall be used.

F.4.3.2.3 Others:

— only results from the same seal type shall be used.

F.4.3.3 The specimen(s) shall comprise the following (see Figure F.4 and F.5):

1) a Standard Mixed Module according to F.2 – area ”2” and

2) space to accommodate the required additional pipes – area “3”. All pipes that are desired to be covered in the field of application shall be included subject to the rules given in E.1 and/or E.2. The “critical pipe approach” (see Annex G) may be used. Pipes with materials / dimensions outside the range covered by the basic test may also be included. All other services intended to be covered by the field of application shall be included subject to the rules given in the relevant sections of this standard (for bus bars see Annex D, for trunkings and conduits according to 6.3.2 a), b) and e) see E.3).

F.5 Field of direct application

F.5.1 Combination a) according to F.1.2

The rules given in E.1.5 and E.2.7 apply.

F.5.2 Combinations b), c) and d) according to F.1.2

F.5.2.1 General

If the standard configuration, described in this document, is not used the field of application is restricted to that which was tested.

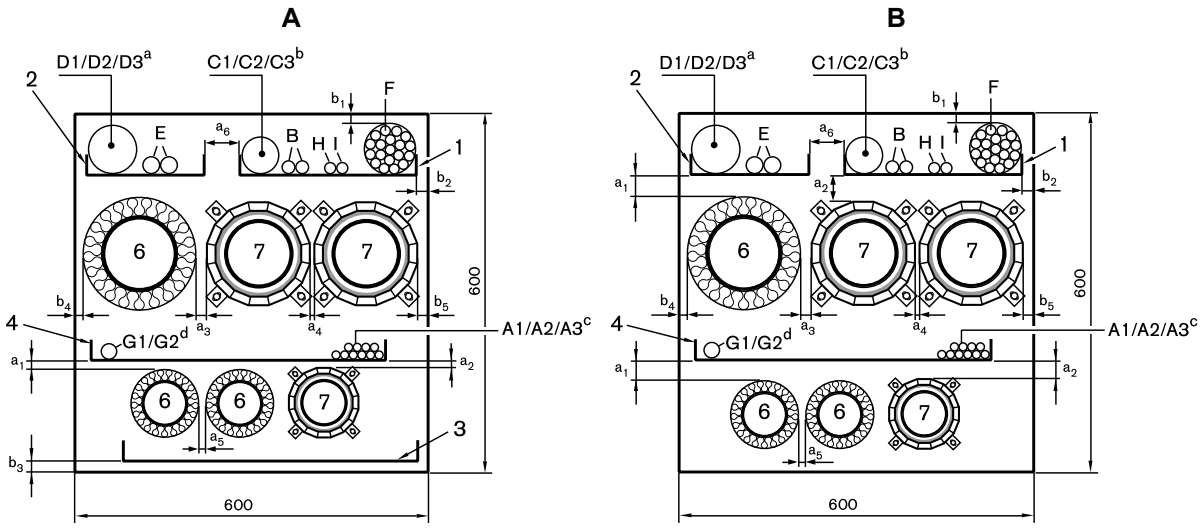
F.5.2.2 Services

For cables the rules given in Annex A apply, for "metal pipes" the rules given in E.1.5 and for "plastic pipes" the rules given in E.2.7 apply.

F.5.2.3 Separations

In practice, the minimum working clearances between the different service types (a_1 to a_6) and/or the services and the seal edge (b_1 to b_5) used in the test shall be applied.

Dimensions in millimetres



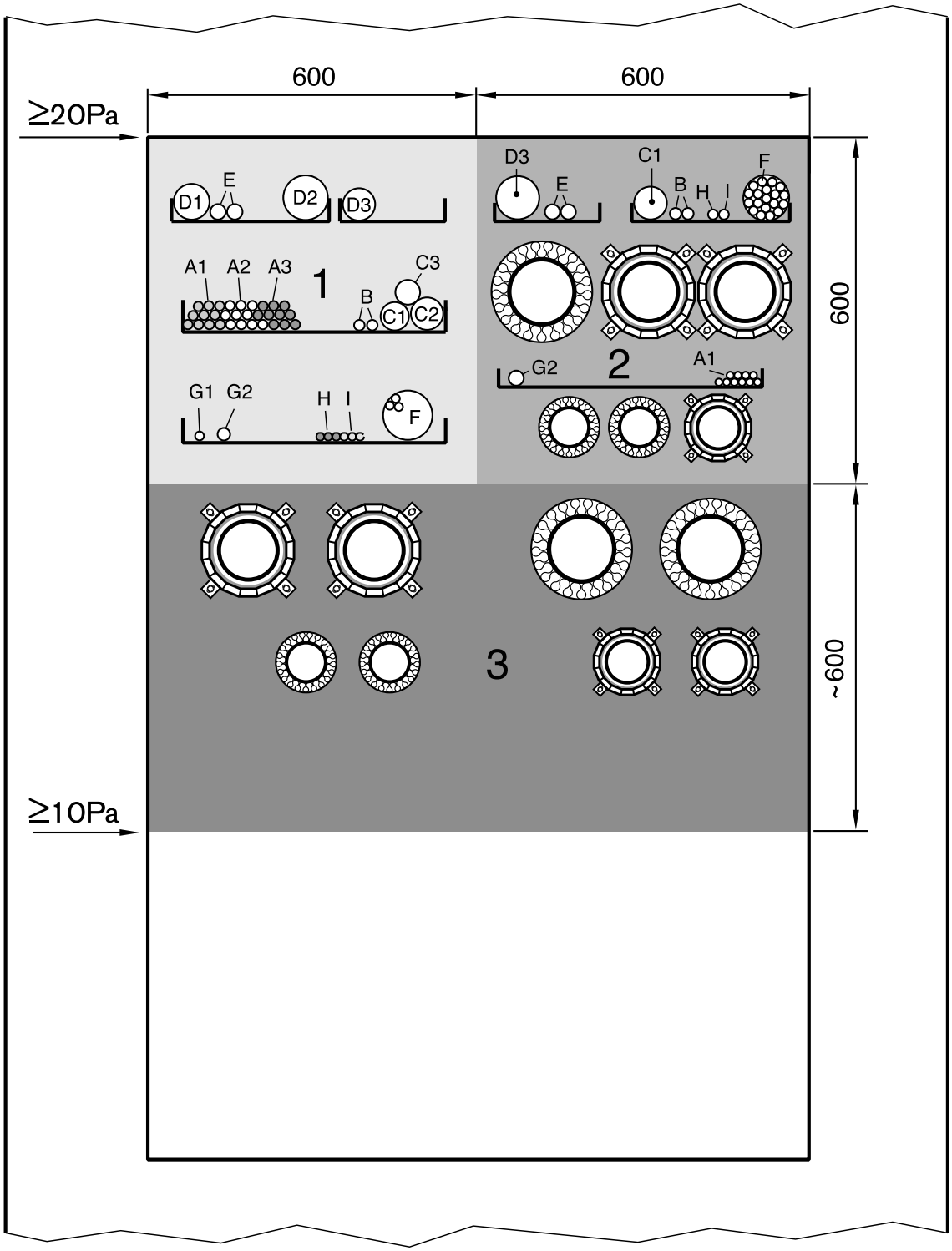
Key

A	Version A (including a cable tray at the bottom of the seal)
B	Version B (without a cable tray at the bottom of the seal)
1	Steel ladders 300 mm, thickness = 1,25 mm
2	Steel ladders 200 mm, thickness = 1,00 mm
3	Perforated steel tray 500 mm, thickness = 1,5 mm with ballast weights according to A.1.5
4	Non-perforated steel tray 500 mm, thickness = 1,5 mm
6	"Metal pipes" (examples with insulation) [e, f]
7	"Plastic pipes" with pipe closure device [f]
A1 to G2	Cables according to Table A.1; the bundle made from F-cables and the G-cable are optional
a_1	Distance between cables or cable ladders / trays and "metal pipes"
a_2	Distance between cables or cable ladders / trays and "plastic pipes" / pipe closure devices for "plastic pipes"
a_3	Distance between "metal pipes" and "plastic pipes" / pipe closure devices for "plastic pipes"
a_4	Distance between "plastic pipes" / pipe closure devices for "plastic pipes"
a_5	Distance between "metal pipes"
a_6	Distance between cable ladders / trays
b_1	Distance between cables and the upper seal edge
b_2	Distance between cables / cable trays and the side seal edge
b_3	Distance between a cable tray and the lower seal edge
b_4	Distance between "metal pipes" and the seal edge
b_5	Distance between "plastic pipes" / pipe closure devices for "plastic pipes" and the seal edge
H, I	Optional conduits / tubes according to A.1.10

a	Option 1: 1 cable D3 according to Table A.1; Option 2: For selection of one cable representing the D-cables the critical cable approach (Annex G) is used (see also F.2.3.1).
b	Option 1: 1 cable C1 according to Table A.1; Option 2: For selection of one cable representing the C-cables the critical cable approach (Annex G) is used (see also F.2.3.1).
c	Option 1: 10 cables A1 according to Table A.1; Option 2: For selection of 10 cables representing one type of the A-cables the critical cable approach (Annex G) is used (see also F.2.3.1).
d	Option 1: 1 cable G2 according to Table A.1; Option 2: For selection of one cable representing the G-cables the critical cable approach (Annex G) is used (see also F.2.3.1).
e	"Metal pipes" may be non-insulated or insulated (cases CS, CI, LS or LI according to 3.13).
f	Number and type of pipes shown in the figure are examples only to illustrate the position of pipes in the Standard Mixed Module. The selection of the type of pipe will depend on the option taken (see F.4) and on the type of service combination required by the test sponsor. The distances may vary with the type of pipe and must be reported individually. For details see text body.

Figure F.1 — Standard Mixed Module

Dimensions in millimetres

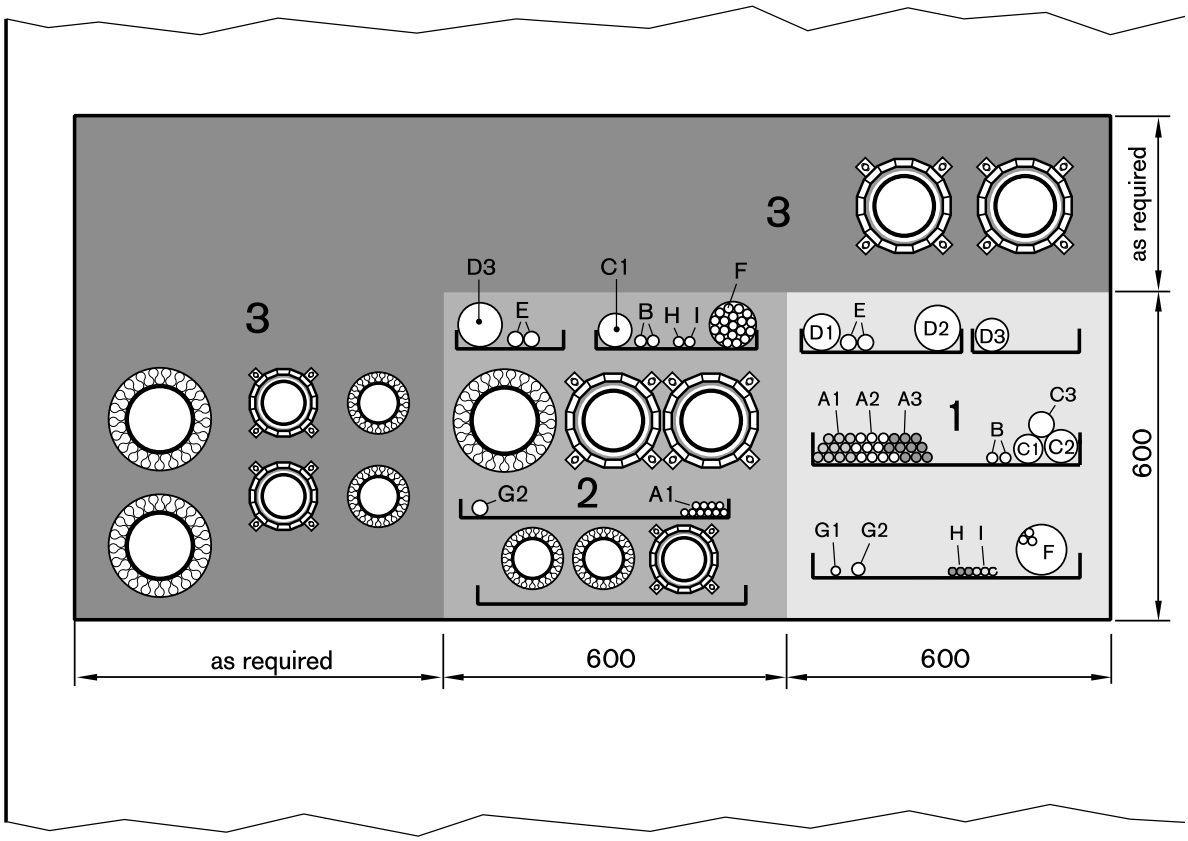


Key

1	600 mm x 600 mm standard cable module according to Figure A.1 with full number of cables
2	Standard Mixed Module version B according to Figure F.1B
3	Space for pipes and other services
A1 to G2	Cables according to Table A.1; the bundle made from F-cables and the G-cables are optional.
H, I	Optional conduits / tubes according to A.1.10

Figure F.2 — Standard configuration for mixed penetration seals in a wall – Option 1

Dimensions in millimetres

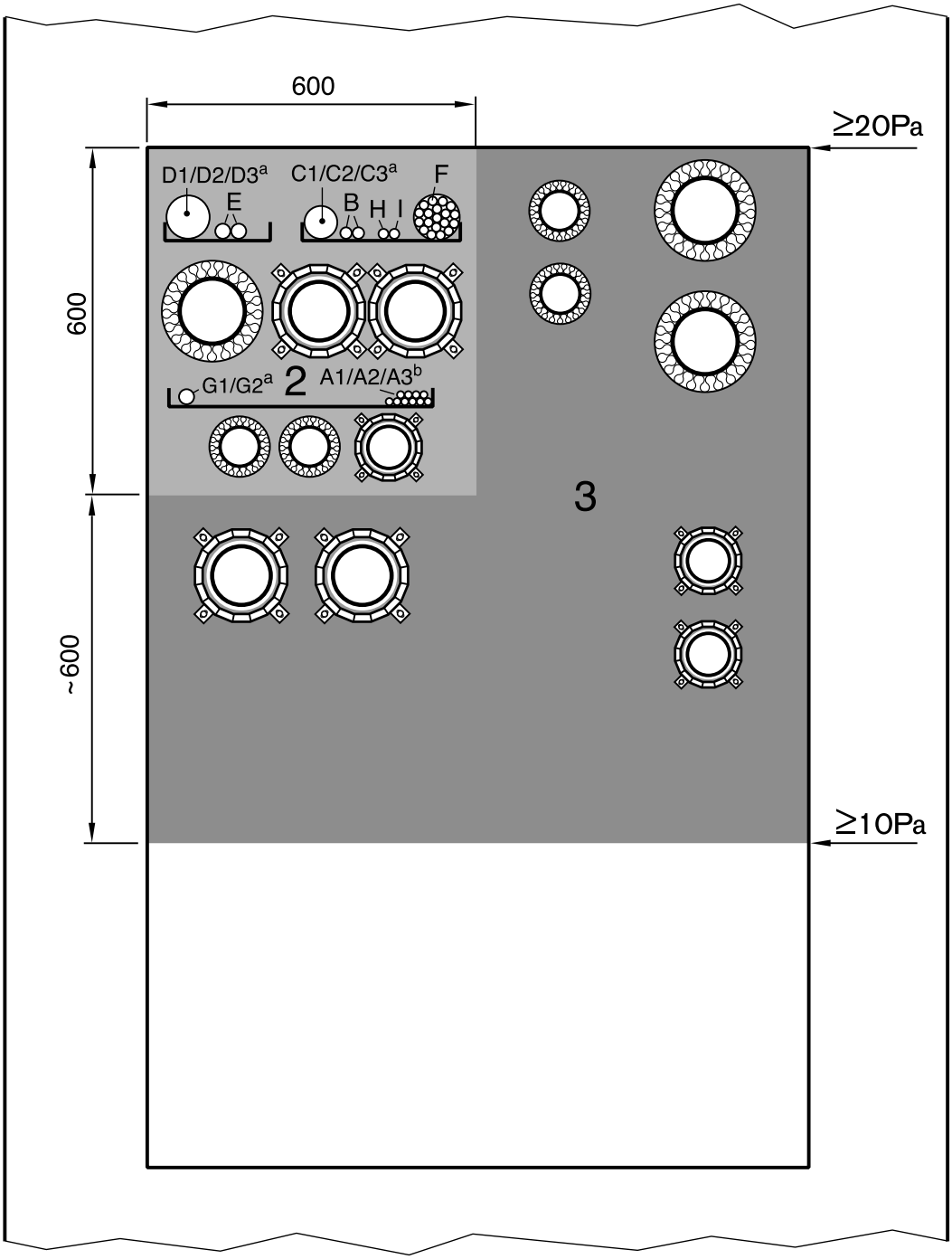


Key

1	600 mm x 600 mm standard module according to Figure A.1 with full number of cables
2	Standard Mixed Module version A according to Figure F.1A
3	Space for pipes and other services
A1 to G2	Cables according to Table A.1; the bundle made from F-cables and the G-cables are optional.
H, I	Optional conduits / tubes according to A.1.10

Figure F.3 — Standard configuration for mixed penetration seals in a floor – Option 1

Dimensions in millimetres

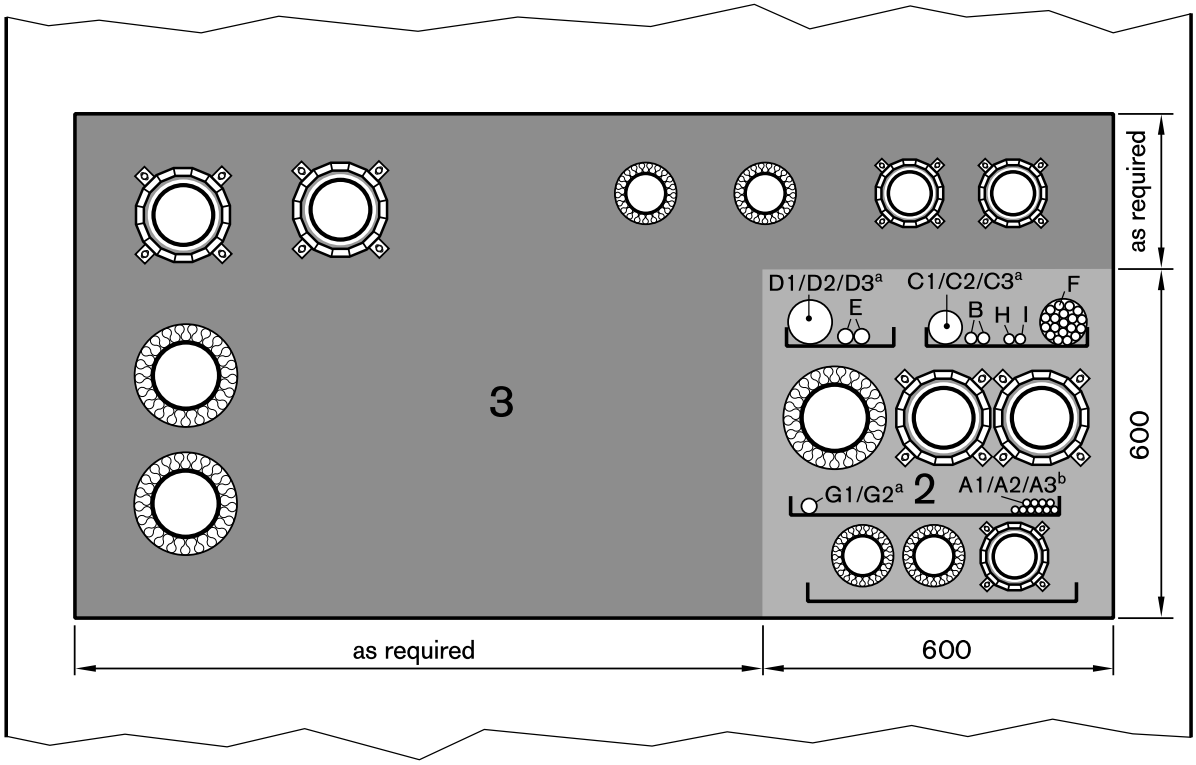


Key

2	Standard Mixed Module version B according to Figure F.1B
3	Space for pipes and other services
A1 to G2	Cables according to Table A.1; the bundle made from F-cables and the G-cables are optional.
H, I	Optional conduits / tubes according to A.1.10
a	For selection of one cable each representing the C-, D- and G-cables the critical cable approach is used.
b	For selection of 10 cables representing one type of the A-cables the critical cable approach is used.

Figure F.4 — Standard configuration for mixed penetration seals in a wall with reduced number of services – Option 2

Dimensions in millimetres



Key

2	Standard Mixed Module version A according to Figure F.1A
3	Space for pipes and other services
A1 to G2	Cables according to Table A.1; the bundle made from F-cables and the G-cables are optional.
H, I	Optional conduits / tubes according to A.1.10

[a] For selection of one cable each representing the C-, D- and G-cables the critical cable approach is used.

[b] For selection of 10 cables representing one type of the A-cables the critical cable approach is used.

Figure F.5 — Standard configuration for mixed penetration seals in a floor with reduced number of services – Option 2

Annex G
(normative)

Critical pipe/cable approach

G.1 General

“Critical pipe / cable approach” means that only the most “critical” pipes (regarding dimensions and/or material) or “critical” cables from the standard configuration of tests carried out before are included in a test according to E.2.2.2, E.2.2.4, E.2.3.2, E.2.5 or Annex F.

G.2 Definition of "critical"

There are two considerations in determination of "critical" pipe material / dimensions and combinations thereof. For cables only the insulation related criterion is used.

a) integrity related criterion:

   Any pipe material/dimension for which seal integrity failure was observed within the time period between the desired class and an additional 5 min is a "critical" pipe material/dimension.

b) insulation related criterion:

The pipe material/dimension or cable for which the temperature rise on the unexposed surface was closest to the threshold of 180 K at any time of the test (whatever the shape of the temperature/time curve – see Figure G.1. for example; case A only relevant for pipes) is the most "critical" pipe material/dimension or cable.

G.3 Procedure selecting critical pipes from previous test data

G.3.1 A minimum of 3 pipes up to 50% of the number tested before shall be selected.

G.3.2 Only results from previous tests on the same type of penetration seal which resulted in equal or higher classification than that sought may be used.

G.3.3 "Metal pipes"

The critical combinations of pipe material (e.g. copper, steel, cast iron), pipe diameter, wall thickness, insulation material and type (cases CS, CI, LS or LI according to 3.13) obtained from previous tests shall be used. All pipes meeting the absolute criteria for "criticality" or in the absence of such pipes at least the three most critical ones from a series of previous tests shall be included in the test.

G.3.4 "Plastic pipes"

The critical combinations of pipe material, pipe diameter and wall thickness for the pipe end configuration required by the test sponsor obtained from previous tests shall be used. All pipes meeting the integrity related criterion for "criticality" or, in the absence of such pipes, at least the three most critical for the insulation related criterion, from a series of previous tests, shall be included in the test. If the pipes identified as the most critical ones represent both types of critical temperature behaviour – maximum temperature at the beginning and maximum temperature at the end of the test

period (see Figure G.1) - pipes shall be selected in a way that both types are represented in the selection.

The maximum size of the desired size range shall be included for collar type pipe closure devices in addition. This is not relevant for mortar seals.

NOTE Because it is not always possible to rigidly fix a pipe closure device to the mixed penetration seal it is likely that the weight of the pipe closure device will have an influence on the test result.

G.3.5 All rules are valid only for a specific pipe end condition.

G.3.6 A flow diagram illustrating the pipe selection procedure is given in Figure G.2.

G.4 Procedure selecting critical cables from previous test data

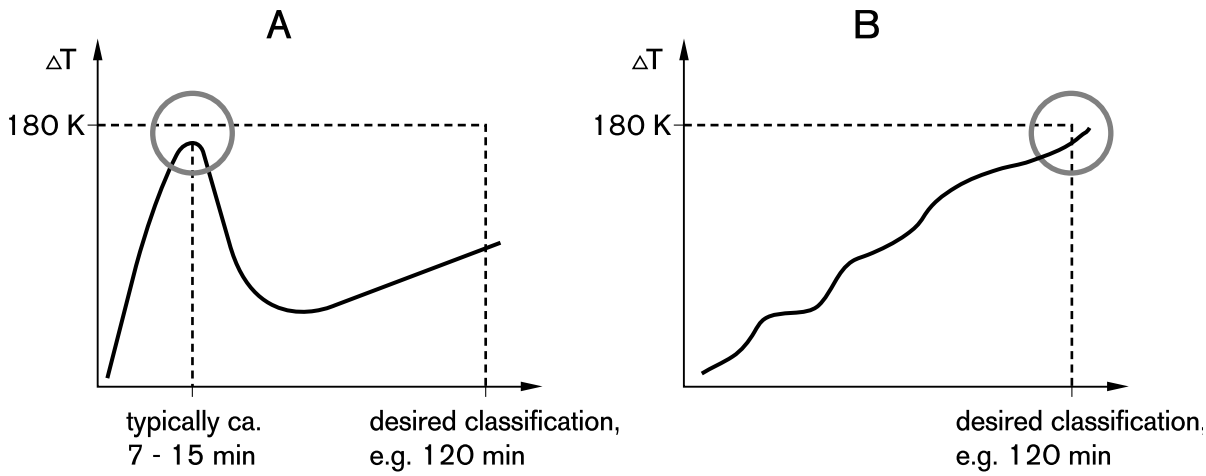
G.4.1 The most critical from cables A1, A2 and A3 tested before shall be selected.

G.4.2 The most critical from cables C1, C2 and C3 tested before shall be selected.

G.4.3 The most critical from cables D1, D2 and D3 tested before shall be selected.

G.4.4 The most critical from cables G1 and G2 tested before shall be selected.

G.4.5 Only results from previous tests which resulted in equal or higher classification than that sought may be used.



Key

A Shape type 1
B Shape type 2
ΔT Temperature increase on the unexposed face

Figure G.1 — Explanation of the "critical" behaviour regarding temperature rise on the unexposed face

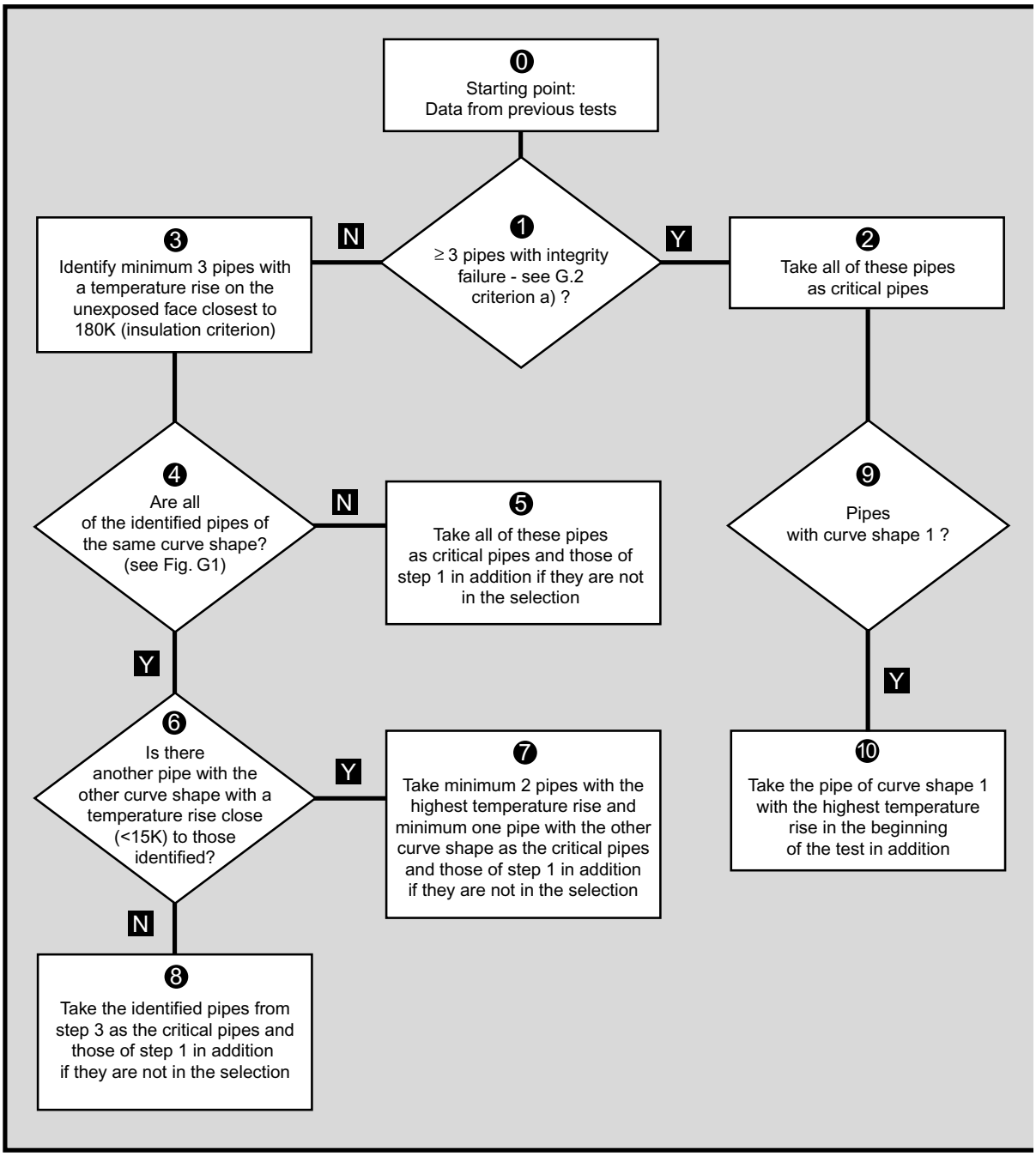


Figure G.2 — Flow diagram for the selection of critical pipes

Annex H
(informative)

Explanatory notes

H.1 General

These explanatory notes are intended to serve as guidance for the planning, performing and reporting of a fire resistance test carried out in accordance with this standard and interpreting and applying of test results.

H.2 Notes on the scope and application of test results

H.2.1 General

Service systems are well known for creating hazards facilitating the spread of smoke and hot gases in the case of fire. Systems of this type are often complicated and extensive in modern buildings and their influence on the fire hazard should be considered carefully. The fire hazard can be reduced by providing penetration seals at the points where the services pass through fire separations.

It is obvious that the impact of fire on a service system can vary considerably. A strict scientific approach to the problem of adequate testing of a sealing system would, therefore, be to design a series of tests each of which corresponds to a specified fire situation and arrangement. However, such an approach would probably fail due to its economic consequences, as tests of this type are very time-consuming and costly. The method of test described in this standard has therefore been designed with the intention of covering a wide range of fire situations in a minimum of tests. For most parts of the standard the principle applies that the field of application is restricted to what was included in the test. To allow a wider field of application standard configurations were defined on the basis of general experience and historic data wherever possible. As frequently a number of influencing parameters was considered when defining the standard configurations not all of which may be addressed explicitly in the field of application rules (e.g. metal-screen of cables) it is normally not permissible to omit a part or component of the standard configuration. To allow nevertheless flexibility a modular approach was taken as far as possible so that various combinations of standard configuration elements can be used to fit the needs of the test sponsor.

H.2.2 Guide through the document

Define the desired field of application				***> Find the relevant section for selection / preparation of specimen(s) in***	***> Find the relevant field of application rules in***
➢ Heat regime(s) to be covered				> 5.1	
➢ Services to be covered					
> Cables (Table A.1)	> Small sheathed cables: Configuration option "Small"	> Large penetrations		> A.1.2	> A.3.1 and A.3.2
		> Small penetrations		> B.1.1	> B.2.2
		> Modular systems		> C.1.1.2.2	> C.1.2.2
		> Cable boxes		> C.2.2.1	> C.2.3.1
	> Medium sheathed cables: Configuration option "Medium"	> Large penetrations		> A.1.2	> A.3.1 and A.3.2
		> Small penetrations		> B.1.1	> B.2.2
		> Modular systems		> C.1.1.2.2	> C.1.2.2
		> Cable boxes		> C.2.2.1	> C.2.3.1
	> Large sheathed cables: Configuration option "Large"	> Large penetrations		> A.1.2	> A.3.1 and A.3.2
		> Small penetrations		> B.1.1	> B.2.2
		> Modular systems		> C.1.1.2.2	> C.1.2.2
		> Cable boxes		> C.2.2.1	> C.2.3.1
	> Non-sheathed cables (wires)	> Large penetrations		> A.1.2 4th indent	> A.3.1.2 and A.3.2.5
		> Small penetrations		> B.1.1	> B.2.2
		> Modular systems		> C.1.1.2.2	> C.1.2.2
		> Cable boxes		> C.2.2.1	> C.2.3.1
	> Cable bundles	> Large penetrations		> A.1.2 4th indent	> A.3.1.3 and A.3.2.4
		> Small penetrations		> B.1.1	> B.2.2
		> Modular systems		> not relevant	

Define the desired field of application				> ***Find the relevant section for selection / preparation of specimen(s) in***	> ***Find the relevant field of application rules in***
			> Cable boxes	> C.2.2.1	> C.2.3.1
	> Small conduits / tubes (A.1.10 and Table A.2)		> Large penetrations	> A.1.2 4th indent	> A.3.5
			> Small penetrations	> B.1.1	> B.2.2
			> Modular systems	> not relevant	
			> Cable boxes	> not relevant	
> "Metal pipes" 6.3.2 a)	> Linear separation			> E.1.2	> 13.5 and E.1.5.3
	> Cluster of pipes			> E.1.3	> 13.5 and E.1.5.3
	> Pipe insulation	> "non-combustible"		> E.1.4	> E.1.5.6
		> "combustible"		> E.1.4	> E.1.5.7
	> Pipe diameter / wall thickness			> E.1.2, E.1.4, Figure E.3	> E.1.5.1
	> Pipe end configuration			> 6.3.4	> E.1.5.5
	> Pipe material				> E.1.5.2
> "Plastic pipes" 6.3.2 d)	> Pipe closure devices			> E.2.2	> E.2.7
	> Other seals			> E.2.3	> E.2.7
	> Pipes with insulation			> E.2.2.2 and E.2.3.2	> E.2.7.4 and E.2.7.8
	> Pipe-in pipe systems			> E.2.4	-
	> Special installations			> E.2.5	-
	> Pipe end configuration			> 6.3.4	> E.2.7.3
	> Pipe material			> E.2.2.2	> E.2.7.4
	> Combination with other seals /products			> F.2.3.3, F.4.3.2.2	> E.2.7
> Trunking and conduits: 6.3.2 b) and e)				> E.3	> E.3

Define the desired field of application				***> Find the relevant section for selection / preparation of specimen(s) in***	***> Find the relevant field of application rules in***
	> Other pipes: 6.3.2 c)			> No standard configuration	> WYTIWYG [1]
	> Bus bars			> D.1	> D.2
	> Combination (mixed penetration seals)	> "metal" + "plastic" pipes	> Start from scratch > option 1	> F.3.1	> F.5.1
			> Former test results available > option 2	> F.3.2	> F.5.1
		> Cables + "metal pipes" Cables + "plastic pipes" Cables + "metal pipes" + "plastic pipes"	> Start from scratch > option 1	> F.4.2	> F.5.2
			> Former test results available > option 2	> F.4.3	> F.5.2
➢ Service support constructions to be covered				> 6.3.3.2, Figures A.8, and E.10	> 13.4, A.3.3
➢ Blank penetration seal				> 6.3.6, Table B.1	> 6.3.6, 13.5
➢ Size and distances / separations to be covered				> 6.1	> 13.5, B.2.3, C.1.2.1, C.2.3.2, E.2.7.2, E.2.7.7, F.5.2.3
➢ Supporting constructions to be covered			> Rigid wall	> 7.2.2.1.1	> 13.2.1
			> Rigid floor	> 7.2.2.2.1	> 13.2.1
			> Flexible wall	> 7.2.2.1.2	> 13.2.2
			> Flexible floor	> 7.2.2.2.2	-
➢ Orientations to be covered			> Vertical elements	> 6.2 > EN 1363-1	> 13.1

[1] WYTIWYG = what you test is what you get

Define the desired field of application	> *Find the relevant section for selection / preparation of specimen(s) in*	> *Find the relevant field of application rules in*
> Horizontal elements	> 6.2 > EN 1363-1	> 13.1

NOTE The referenced sections represent a major or entry position relevant to the topic addressed. This must not prevent a user from carefully considering all other text of the standard that may be relevant in addition.

H.3 Notes on test conditions

H.3.1 Size of furnace

The minimum size of a furnace (1 x 1 x 1 m in the previous version of this standard) has been deleted as a number of large wall furnaces have a depth of less than 1 m and would therefore have been excluded from use for tests of penetration seals. Now only a minimum size of the specimen is defined where felt necessary. Where possible in terms of the seal size requirements a small furnace (minimum 1 x 1 x 1 m) may be used.

H.3.2 Furnace pressure

Often the penetrating service, together with its associated sealing system, will only form a minor percentage of a vertical separating element. In such cases, it is possible that the whole of the penetration seal could fall totally within the positive or negative pressure zone if the furnace is operated under standard conditions.

The pressure boundary conditions have, therefore, been defined in 5.2 such that the pressure at the top of the test construction is normally 20 Pa as defined for horizontal tests. Where a large furnace accommodates a number of penetration seals at different levels, services may only included in a position where the pressure exceeds 10 Pa. Where the 10 Pa pressure level is lowered to accommodate more services in the test construction the consequence will be a higher pressure at the top.

H.4 Notes on test construction

H.4.1 Services

H.4.1.1 General

The reason for suggesting that the cable or pipe length on both sides of the penetration seal should be ≥ 500 mm is that it will simulate the vertical load acting on the penetration seal, which results from the failure of the service supporting structure on the fire-exposed face. Past research work has revealed that a length of 1000 mm is the minimum for simulation of realistic penetration seal loads in the event of a fire.

As metal services or components of services may act as heat sink on the unexposed face the length of the unprotected part of the service or service support was limited to maximum 500 mm. For non-metallic services an exemption was made to allow a distance of the first service support of more than 500 mm.

It has been established that long cable routes and pipe suspension systems exposed to fire can produce major displacement or constraining forces acting in a direction perpendicular to the plane of the penetration seal and can result in premature failure.

In the case of standard configurations proposed for cables, a higher loading has been proposed to the fire side to take this into account (see Figures A.2 and A.4).

H.4.1.2 Cables

Electric cables used in practice differ widely in structure – in particular, with regard to their insulation and according to their intended use. In the tests described in this standard only a small selection of the great number of different types of electric cables has been used in the test specimens in order to keep the effort and expense involved in testing to a minimum. The cable arrangement is chosen on the basis of practical experience in testing. It is assumed that all parameters that are expected to

influence the test result are covered by the selection of the cables, i.e. diameter, cross sectional area ratio of metal core to insulation/sheath, insulation/sheath material, metallic screens/concentric conductors, number of cores. A variation of the conductor material (inclusion of Aluminium) was thought not to be necessary as normally only copper conductors are used in building installation. Aluminium conductors are normally used for utility cables.

The test results will apply to any of the arrangements of electric cables in sealed penetrations which were known at the time this standard was in preparation. For the purposes of this standard, fibre optic cables are also treated as electric cables.

The cables are grouped into several configurations to allow a tailored testing depending on the intended field of application. The configuration “Small” which covers all sheathed cables up to a diameter of 21 mm - equivalent to the maximum diameter of the 1x95 cable – will be useful for residential and other buildings with low energy demand. Configuration "Medium" covers cables up to 50 mm diameter. This value was chosen to be on the safe side as the diameter of 4 $\times$ 95 cables varies considerably depending on the insulation/sheath used. Most practical applications will be covered when configuration “Large” is used which also includes big multi-core cables up to 4 $\times$ 185 and a diameter of up to 80 mm. Cables with even bigger diameter will have to be treated as special cases.

A special group of cables are the non-sheathed cables, sometimes simply called “wires”, as they behave rather like metal pipes because of the very thin insulation and may need special measures to meet the insulation criterion. They are normally not used in installation with the exception of the UK with its grounding system that differs from other Member States. In the UK such cables are still used as grounding. Consequently they were treated as an optional separate group.

The cables selected are preferably cables standardised at European level and used for installation in buildings. As the CENELEC standards HD 603.3 and HD 604.5 are rather a compendium of national standards than a real harmonised standard there are several slightly different national versions of cables in accordance with these standards available on the market. To make the purchase of these cables simpler and to make sure, the intended cables are used, the designations used for cables according to the relevant sections of HD 603.3 and HD 604.5 the committee could identify, are given in Table A.3. Some of the cables may not be covered by every section of HD 603 and HD 604 as they do not cover the same cable size range. Nevertheless all cables are available throughout Europe according to the European Cable Association.

National standards / designations for the F-cable (examples):

Germany (cable according to DIN VDE 0816):

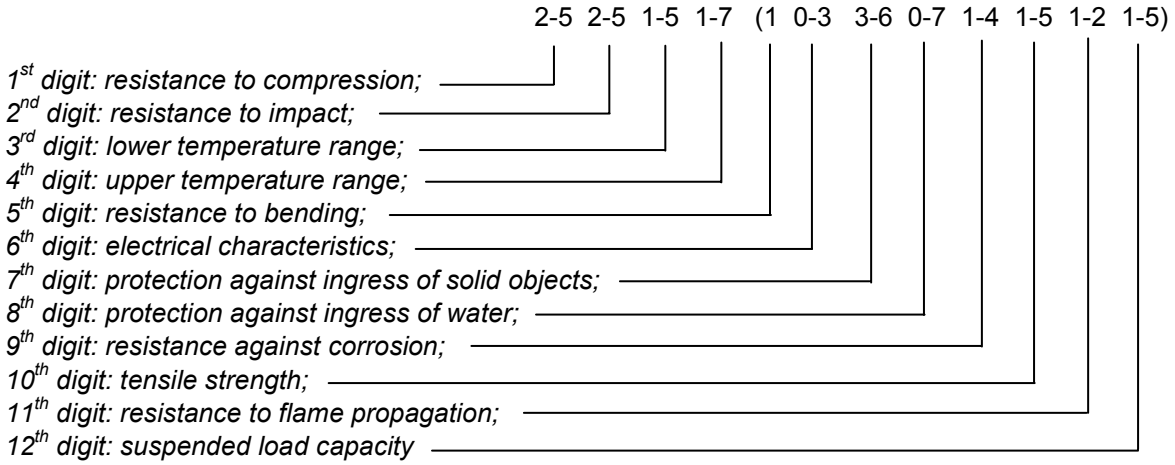
1) A-2Y(L)2Y St III Bd: solid PE

2) A-02Y(L)2Y St III Bd: cellular PE

United Kingdom: e.g. British Telecom specifications CW 1128/1179/1198

H.4.1.3 Small diameter conduits (service group 6 according to Table A.2)

Small diameter conduits for signal cables with a diameter ≤ 16 mm are occasionally laid alongside electric cables. These may be tested together with the standard configuration for cables. The classification according to EN 61386-21 is outlined below. The numbers show the possible classification. The brackets indicate that according to EN 61386-21 only the first 4 digits are required to mark the product. This is the reason that in A.1.10 only the first 4 digits are defined as classification requirements except the fifth digit which specifies the conduits as rigid ones. The specification values defined specify conduits which are expected to represent the "worst case" (lowest available resistance to compression and impact, lowest performance regarding upper temperature range).



H.4.1.4 Ballast plates

If there is not enough space between the cables and the cable tray above, the ballast weights may also be suspended from the cable tray.

H.4.1.5 Pipe insulation

Where pipes are insulated for thermal or other reasons it will depend on the insulation material whether additional firestopping measures are necessary. In case of insulation made from materials of class A1 or A2 according to EN 13501-1 and a melting point higher than the furnace temperature at classification time (E.1.5.6) no further measures may be necessary, except it does not fit the opening so that the remaining annular space has to be sealed by additional means. In case of other insulation materials (E.1.5.7) additional measures will always be necessary, e.g. a pipe closure device or by substituting a sufficient length of insulation by one of the first group.

Non-insulated pipes will normally need a local insulation where the insulation criterion in the fire test has to be passed.

H.4.1.6 Subsequent addition / removal of services

A clear distinction should be made in the test report between adding and removing services as the procedures/materials involved may be different.

H.4.2 Pipe end configuration

H.4.2.1 Capping

A mineral wool disc of a thickness of (75 ± 10) mm, a density of (150 ± 50) kg/m^3 and a melting point of minimum 1000 °C is recommended.

H.4.2.2 Suggested pipe end configurations for different end-uses

Different intended uses of pipes can lead to the need for different requirements for the pipe end configuration within a test.

In a fire situation the conditions the pipe and sealing system are exposed to depend on whether both or either ends of the pipe are sealed in practice. The pressure conditions and flow of hot gases will be different in a pipe which is ventilated to the atmosphere when compared to a pipe which is closed.

It is important to ensure that sealing systems have been tested with appropriate pipe end conditions.

The following table outlines some examples of intended uses where the pipe end conditions can be defined. However, in the case where a national regulation is in conflict with the content of Table H.1 the regulation should be followed. Not all applications are defined and consideration of whether a system is pressurised, ventilated or unventilated is the basis for deciding pipe-end condition. When considering which pipe-end condition to test it is appropriate to consider the intended use.

Table H.1 — Plastic pipe end configuration versus intended use

Intended use of pipe		Pipe-end condition	
		inside the furnace	outside the furnace
Rainwater pipe		uncapped	uncapped
Sewage pipe	Ventilated	uncapped	uncapped
	Unventilated	uncapped	capped
Gas, drinking water, heating water pipe		uncapped	capped

Metal pipes would normally be capped inside the furnace as they would not be expected to result in an open end situation in a fire scenario due to their high melting point. However, this depends on the supporting system staying in place. If this is a possibility, consideration can be given to an open ended scenario as shown in Table H.2.

Table H.2 — Metal pipe end configuration versus intended use

Use of pipe	Pipe-end condition	
	inside the furnace	outside the furnace
Supported by fire rated [a] suspension system	capped	uncapped
Supported by non fire rated suspension system	uncapped	capped
Waste disposal shafts made from pipes	uncapped	capped
[a] Shown by test or calculation (e.g. Eurocodes).		

H.4.2.3 Flue gas recovery system

H.4.2.3.1 General

The intention to use a flue gas recovery system is to avoid excessive smoke emission to the test laboratory when plastic pipes are to be tested. In case of pipe closure devices a gas flow through the recovery pipe can only be expected during the first minutes until the test pipe is closed by the pipe closure device. Therefore the situation is expected to be comparable to a pipe end configuration *U/C* (capped outside) in this case.

H.4.2.3.2 Rule regarding pipe diameters

$d_{max} = (d_1 + d_2 + \ldots d_n)/n + 0{,}2*(d_1 + d_2 + \ldots d_n)/n$

$d_{min} = (d_1 + d_2 + \ldots d_n)/n - 0{,}2*(d_1 + d_2 + \ldots d_n)/n$

Examples:

Pipes with a diameter of 140 and 180 mm may be combined: d_{max} = (140+180)/2 + 0,2*(140+180)/2 = 192, d_{min} = (140+180)/2 - 0,2*(140+180)/2 = 128.

Pipes with a diameter of 110 mm and 180 mm must not be combined: d_{max} = (110+180)/2 + 0,2*(110+180)/2 = 174, d_{min} = (110+180)/2 - 0,2*(110+180)/2 = 116.

H.4.2.3.3 Length of the recovery pipe outside the furnace

The situation for vertical specimens is illustrated in Figure H.1. For horizontal specimens the same principles regarding the length of the recovery pipe outside the furnace apply. Within the furnace the recovery pipe should have a length of approximately 1 m. If no rigid seal around the recovery pipe in the furnace floor is used (e.g. mineral wool) it is recommended to use a longer pipe and support it at the bottom of the furnace to avoid movement and strain on the pipes to be tested.

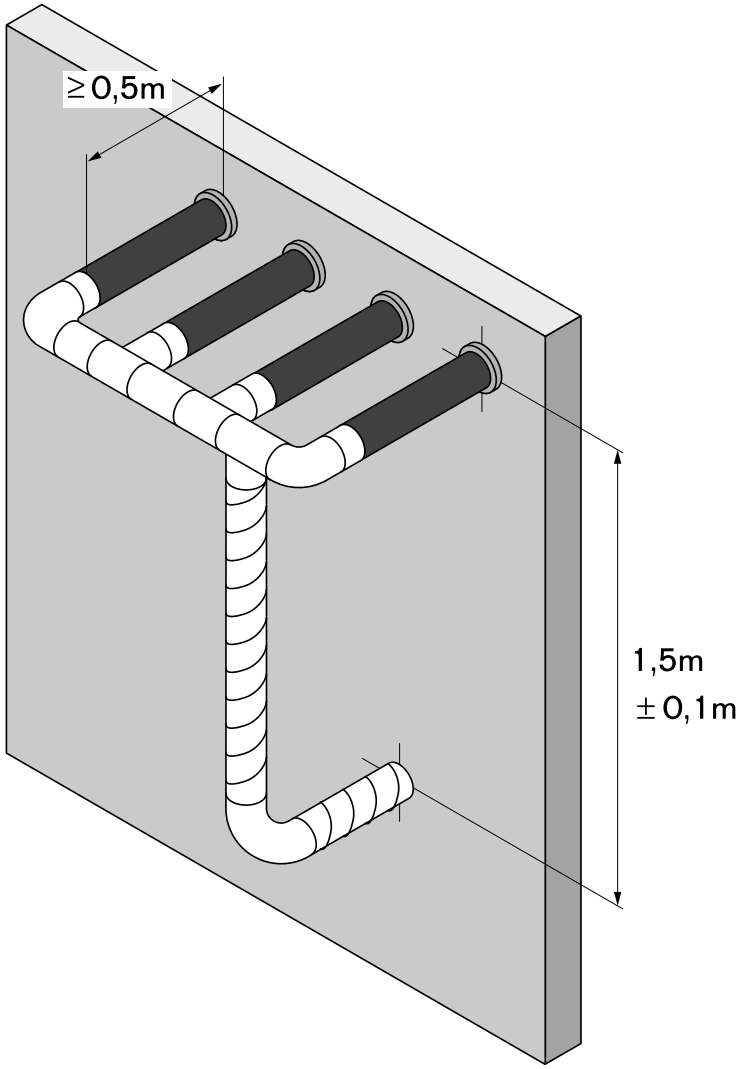


Figure H.1 — Example for a flue gas recovery system

H.4.3 Service support

H.4.3.1 Alternative service support constructions

More modern service support systems than described originally in Annex A were included with this revision. The dimensions given cover all commonly available strut systems and make sure that the stiffness is comparable. An alternative that allows hanging the services from the support system was also included as this is the case in practice with most of the pipes.

H.4.3.2 Service support material

Steel grade S235JR (1.0038) according to EN 10025-2 is recommended for steel parts that form a service support construction. EN 10056-1 is recommended for steel angles. EN 10162 (cold-rolled) or EN 10279 (hot rolled) is recommended for steel channels.

When other materials than steel are intended to be used for cable trays / ladders a separate assessment is necessary. To make sure test conditions in terms of load are comparable to the standard configuration situation the cables of tray 1 of the standard configuration were chosen as they comprise most of the big cables.

H.4.3.3 Cable support – field of application

The rule given in A.3.3.1 is not only applicable for a situation where a cable support, e.g. cable tray, is interrupted in front of the seal but also for a situation where no cable support is used at all.

H.4.4 Supporting construction

H.4.4.1 General

The selection of the supporting construction will depend on the period of fire resistance required for the penetration seal. It should have at least the fire resistance anticipated for the penetration seal but the test sponsor is free to select construction details that influence the fire resistance of the supporting construction, e.g. thickness, at a higher level of failure risk to gain the widest possible field of application.

H.4.4.2 Rigid constructions

As the Eurocodes define the properties for a series of construction materials and the necessary dimensions for rigid constructions to achieve a desired fire resistance when using these materials it was sensible not to create new and probably conflicting rules but to use this information. Attention should be given to the fact that some of the values given may be so-called "boxed values" which may vary from Member State to Member State.

H.4.4.3 Flexible wall constructions

The approach to define all influencing parameters and allow combinations to make bespoke flexible wall standard constructions proved to be too complex. Therefore an approach was taken to define a standard configuration assumed to be representative for similar other constructions (provided they are classified according to EN 13501-2 and some other restrictions are obeyed). The basis is the standard configuration defined in EN 1363-1 but with some amendments, e.g. the use of an insulated wall.

One important influence on the penetration seal and the fire resistance of the assembly is the deflection of the flexible wall during the test. To allow simulation of this interaction a minimum size of the supporting construction / furnace aperture was defined. The restraint only on the top and bottom edge of the wall allows a symmetrical deflection of the wall (no difference between the right and the left part of the wall) and hence the same influence on a penetration seal independent of its location.

The overall thickness of a flexible wall construction with a given number and thickness of boards and a given thickness of insulation will be different from Member State to Member State because of traditionally varying widths of studs. As test experience shows that no major difference in fire behaviour is to be expected when varying stud widths result in an overall wall thickness within the range given in Table 3 the field of application rule related to the overall thickness allows a variation of the overall wall thickness to the minimum thickness of the range given in Table 3.

The minimum width for the flexible wall in a test where both, rigid and flexible construction are used in one test construction was defined as 1,20 m because this is a standard gypsum board width.

To assure the stability of the test construction and simulate practical conditions an aperture framing may be necessary when a stud is cut due to an opening for a penetration seal depending on the size of the seal, for example 600 mm x 600 mm.

H.4.5 Distance between seals

Interactions between different penetration seals can occur where, for instance, the early failure at one of the penetrations invalidates the time-temperature or pressure conditions specified, or where one penetration seal directly influences another, e.g. by flaming or melting. Where it is the intention of the test to show that the penetration seal works at lower distances (e.g. single pipe penetrations) the distance may be freely chosen.

H.4.6 Non-standard cable configuration

In A.2.1 the parameters that are expected to influence the test result are listed and the frame conditions defining the worst case are given. To cover the entire cable range as with the standard configuration all types of cables listed in Table A.1 are to be included.

H.4.7 Pipe penetration seals

H.4.7.1 Metal pipes

In practice pipes are installed in a linear manner in many cases which is reflected in option 1 of the standard configuration. When intended to be installed in clusters option 2 has to be chosen as the heat input into the seal may be considerably different from a linear arrangement.

An arrangement as shown in Figure H.2 is taken as linear arrangement.

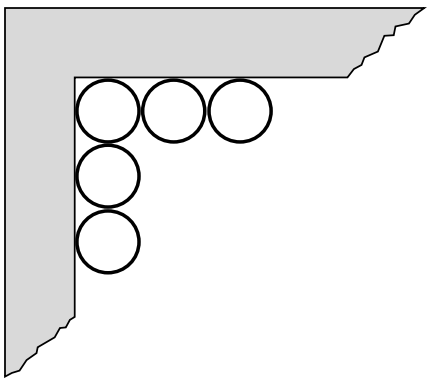


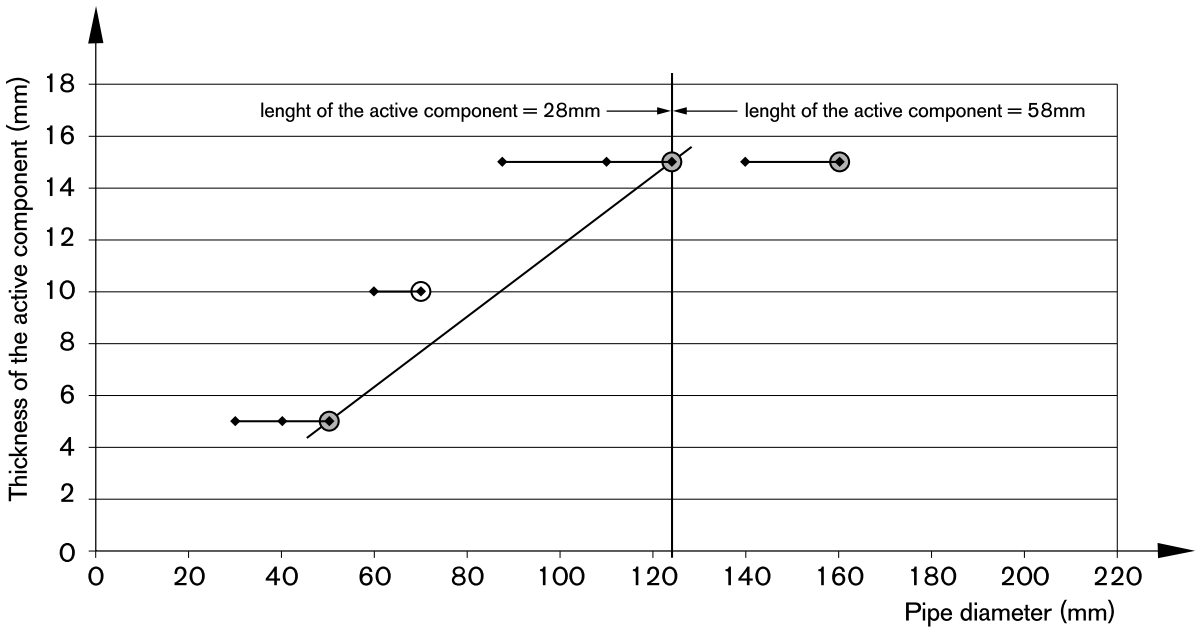
Figure H.2 — Example of linear arrangement of pipes

Two different diameters at the minimum wall thickness are to be included only if the minimum wall thickness of the smallest and the largest diameter intended to be covered is different (as shown in Figure E.3). If the wall thickness is the same only the larger pipe is to be included (e.g. pipe D in Figure E.4A).

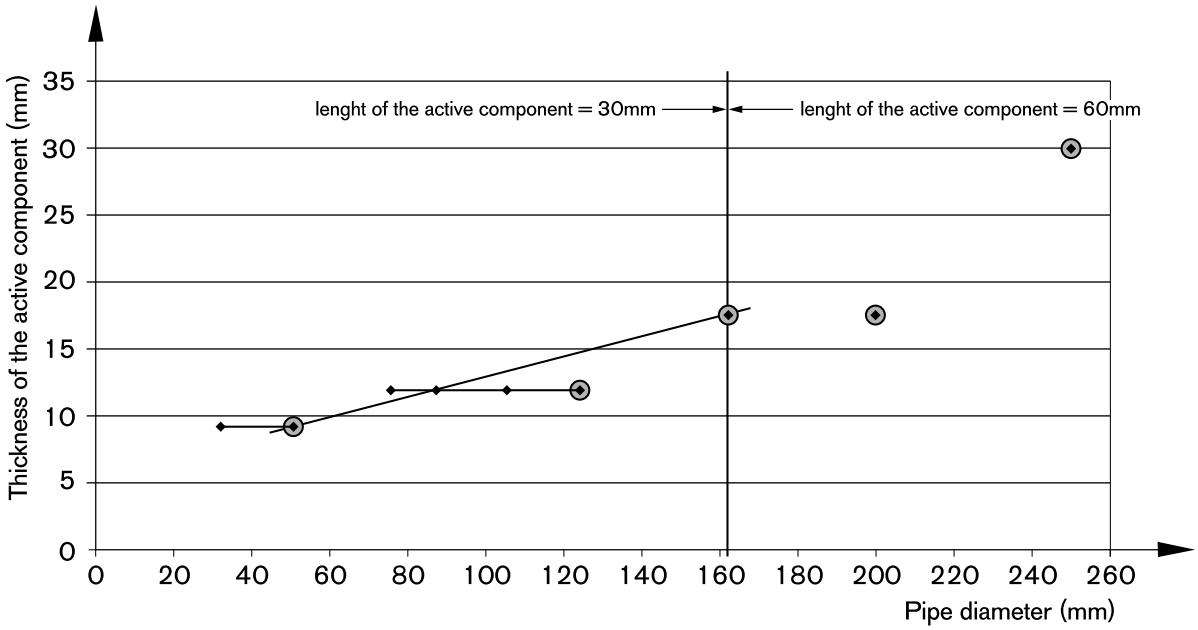
H.4.7.2 Plastic pipes sealed with pipe closure devices

Pipe closure devices, e.g. collars and wraps, are normally manufactured in sizes that fit to the dimensions of the pipes to be sealed off. For economic reasons the active component in many cases is manufactured in a “modular” way, e.g. the thickness is kept the same for several sizes of the pipe closure device. It cannot be assumed therefore that all sizes behave the same in the test. To avoid unnecessary testing of all sizes rules were developed to identify and select the worst cases. For this purpose the “design group” was defined, i.e. all sizes where neither the thickness nor the length (dimension along the pipe) of the active component are changed (only the circumference will change with the pipe diameter to fit into the pipe closure device). The maximum size within a design group is expected to be the worst case and has therefore to be selected for the test as the volume of the active component is a minimum related to the opening to be closed.

Example 1



Example 2



Key

- Sizes to be included in the test at maximum and minimum wall thickness
- Sizes not necessary to be included in the test
- Design group

Figure H.3 — Examples for the selection of sizes of pipe closure devices for the test

Where several design groups have the same length of the active component the selected size of intermediate design groups may be omitted if the volume ratio of the active component in relation to the opening volume is higher than the ratio of the other design groups. This can simply be determined by connecting the maximum and minimum size within a length group selected. If the intermediate size is above the line it can be omitted (Figure H.3 Example 1), if it is below it has to be included (Figure H.3, Example 2). If a design group consists of only one size this has to be included.

There are two main failure principles for pipe closure devices, which are related to the wall thickness of the pipe and to the intumescent material (reaction time, amount of material,…). For pipes with thin walls there is a risk that the pipe burns on the cold side before the pipe closure device is closed. For pipes with thick walls there is a risk that the pipe closure device is not able to crush the pipe or that the intumescent material drips down before the pipe melts or burns on the fire side and there is not enough material left to seal the remaining gap. Therefore the maximum and the minimum wall thickness of each selected pipe diameter have to be tested.

H.4.8 Small penetration seals

Special standard configurations for small penetration seals, i.e. products from which a seal of the size of the standard configuration according to Annex A cannot be made, were introduced to allow the use of the field of application rules regarding cables or other services. This offers the opportunity to get a wider field of application with less testing. Without a standard configuration taking into account the rationale behind the cable selection for the standard configuration in Annex A, considering rules for separations etc. the field of application would be restricted to exactly what was tested.

The number of cables represents a similar cable infill rate as the standard configuration in Annex A. To have all types of cables represented it was necessary to split it to several specimens.

The rules for the field of application regarding separation/arrangement of the cables are based on broad test experience over several years.

H.4.9 Modular systems

Depending on the manufacturing process blank modules may have cavities. In this case a module containing a service may not be the worst case. Consequently, the standard configuration was defined containing blank modules of all sizes.

Compared to the standard configuration described in Annex A all types of cables are included but the number of cables is reduced. This was thought to be acceptable as every single module acts comparably to an independent penetration seal.

A combination frame was selected as standard configuration because normally combination frames and not a group of single frames are used in practice where more services are to be sealed off than can be accommodated in a single frame.

H.4.10 Cable boxes

The selection of type and number of cables follows basically the principle used for the small penetration seals. A split into several specimens was not considered necessary normally.

The rules for the orientation to be used when several boxes are used next to each other are based on considering the influence of the weight of the boxes/cables.

H.4.11 Mixed penetration seals

Mixed penetration seals are common in practice. To allow a classification as a basis for CE marking (written rules necessary to define the field of application!) a standard configuration was developed based on intensive test experience in some tests laboratories. The basic principle of the standard configuration is to include all services intended to be grouped together. To simplify the test design a so-called “Standard Mixed Module” was defined. This module contains a selection of the cables from Table A.1 and the biggest or most critical pipes.

H.5 Notes on test procedure

If the service is a supply service, it will in practice be conveying a medium, e.g. gases, fluids or electricity. The standard test should be carried out using inactive service conditions.

When a test on a 'live' or active service is carried out, the exact procedures are a matter of negotiation between the testing laboratory and the test sponsor, and should take account of any relevant safety requirements and the specific nature of the service(s).

H.5.1 Thermocouple pad

An adhesive quantity of 0,2 g for smooth surfaces and 0,5 g for rough surfaces is recommended.

H.5.2 Blank seal

For some types of products/seals it can be assumed from the failure mode observed in tests that a blank opening may be the worst case as in this case services supporting the seal mechanically are missing. This is especially true for floor applications. In such a case the maximal seal size has to be defined from a test of a blank penetration seal.

H.5.3 Critical pipe/cable approach

This approach offers the opportunity to the test sponsor to cut the number of specimens necessary to cover the desired field of application considerably, especially if a wide range of services, special situations, e.g. inclined pipes, or mixed penetration seals are to be covered.

H.6 Notes on test criteria

Because of the non-uniform geometry of a system containing penetrating services, the average unexposed face temperature is not relevant in assessing insulation compliance.

H.7 Notes on validity of test results (field of application)

H.7.1 Flexible wall constructions

An insulation in the wall is assumed to increase the heat input into the penetration seal and hence to represent the worst case. Because of the support effect the insulation may have on the edge of the seal an aperture framing is required when the penetration seal is to be installed in other constructions. To avoid the necessity to test two walls when a seal without aperture framing is intended to be tested the standard configuration allows removing the insulation around the penetrations seal to a depth of 100 mm to eliminate a possible support effect. To ensure bending of the studs takes place as assumed for the worst case by using an insulated wall the studs must remain insulated over their length even where several seals are included in a test construction.

H.7.2 Cables

A failure of any cable out of a group (as defined in the standard configuration and Table A.1) fails the whole group because not only the size but also other influencing parameters were considered when selecting the cables to form a group. Not all influencing parameters may be covered any more if one cable fails.

If there is a reason to believe, from the properties of the cables used in practice, that the performance would be worse than those selected for the standard configuration, then additional tests may need to be carried out.

H.7.3 Plastic pipes

The rules given in E.2.7.4 are based on the list of pipe materials for which test results on PVC-U and PE-HD are valid, as used in Germany on a national basis. Included are only pipes made according to EN standards equivalent to the DIN standards referenced in this list. As there is not for all DIN standards an EN equivalent available and as all composite pipes are specified via a national approval the list in this standard is very much restricted compared to current German practise. Further test experience may allow extension of the list.

H.7.4 Seal size

See H.5.2.

H.8 Notes on test report

The risk of fire propagation varies with the piping material used. For metallic pipes such aspects as heat conduction, strain, melting point (copper, brass, steel, and aluminium) are decisive. For mineral construction materials (e.g. glass, fibre reinforced concrete) it is the stability when exposed to elevated temperatures that is important and for plastics melting characteristics and flame propagation can be significant.

Restrictions on the application of the test result can be derived from such descriptions included in the test report, e.g. in respect of the materials used for the services or in respect of the suitability of the sealing system for a particular application such as behaviour of intumescent materials:

1) under lower temperatures than the standard time temperature;

2) influenced by hot water pipes;

3) influenced by different gases etc.

Bibliography

[1] EN 10025-2, *Hot rolled products of structural steels – Part 2: Technical delivery conditions for non-alloy structural steels*

[2] EN 10056-1, *Structural steel equal and unequal leg angles – Part 1: Dimensions*

[3] EN 61386-1*, Conduit systems for electrical installations - Part 1: General requirements (IEC 61386 1:1996 + A1:2000)*

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