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Fire tests for building elements and components — Fire testing of service installations —

Part 1: Penetration seals

Essais au feu pour les éléments et composants de bâtiment — Essai au feu des installations de service —

Partie 1: Joints d'étanchéité

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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 10295-1 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 2, *Fire containment*.

ISO 10295 consists of the following parts, under the general title *Fire tests for building elements and components — Fire testing of service installations*:

— *Part 1: Penetration seals*

A Part 2 dealing with linear joint (gap) seals and a Part 3 dealing with the methodology for establishing direct and indirect fields of application for single component penetration seals are under preparation.

Introduction

This part of ISO 10295 has been prepared to provide a method of test for assessing the contribution of a penetration sealing system to the fire resistance of separating elements when they have been penetrated by a service. It should be read in conjunction with ISO 834-1. This part of ISO 10295 contains specific requirements for fire resistance testing that are unique to the elements of building construction described as a penetration sealing system. The requirements for these penetration sealing systems are intended to be applied as appropriate in conjunction with the detailed and general requirements contained in ISO 834-1.

Fire tests for building elements and components — Fire testing of service installations —

Part 1:
Penetration seals

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

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

1 Scope

This part of ISO 10295 specifies the heating condition, method of test and criteria for the evaluation of the ability of a penetration sealing system to maintain the integrity and insulation of a fire separating element at the position at which it has been penetrated, for example by a service.

This part of ISO 10295 assesses

a) the effect of such penetrations on the integrity and insulation performance of the element concerned,

b) the integrity and insulation performance of the penetration sealing system,

c) the insulation performance of the penetrating service or services, and where appropriate, the integrity failure of a service.

This part of ISO 10295 does not provide information concerning the influence of the inclusion of such penetrations and sealing systems on the load-bearing capacity of the element.

It is possible that a penetration seal is a component of, or contributes to the performance of, a system to which special requirements apply. In such cases additional tests, relevant to the system and its function, can be necessary. Examples are chimneys and fire-rated ducts in air distribution systems.

This part of ISO 10295 is not intended 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 to be noted in describing the general behaviour of specimens during test.

This part of ISO 10295 does not provide information on the ability of the seal to withstand stresses that can be caused by the movement or displacement of the penetration services in practice.

NOTE Explanatory notes are included in Annex A.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 13943, *Fire safety — Vocabulary*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943 and ISO 834-1 and the following apply.

3.1
fire separating element
floors, walls and other separating elements of construction having a period of fire resistance determined in accordance with ISO 834-1

3.2
penetration
aperture within a fire separating element usually present to accommodate the passage of a service through that element

3.3
service
penetrating item for example a cable, conduit, pipe with or without any insulation, duct, chimney, or trunking, excluding air ventilation systems and fire-rated ventilation ducts, smoke extract ducts and fire-rated service ducts and shafts

3.4
penetration seal
single component or system used to maintain the fire resistance of the fire separating element at the position where services pass through the element

3.5
penetration sealing system
assembly for test consisting of the penetrating service or services and the penetration seal, materials or devices, together with any service support construction, designed to maintain the integrity and insulation performance of the separating element for the duration of the fire test

3.6
service support
mechanical support provided in the form of clips, ties, hangers, ladder racks of trays, or any device designed to carry the load imposed by the penetrating services

3.7
blank penetration seal
system where an aperture of specified size in the fire separating element is sealed or closed by the specified seal without incorporation of penetrating services

3.8
test construction
complete assembly, consisting of the separating element and penetration sealing system

4 Symbols and abbreviated terms

Symbols and designations appropriate to this test are given in ISO 834-1.

5 Test equipment

5.1 Equipment employed in the conduct of this test consists of a furnace, restraint and support frames and instrumentation as specified in ISO 834-1 and this part of ISO 10295.

5.2 The internal dimensions of the test furnace shall have a minimum size of 1 m $\times$ 1 m $\times$ 1 m and shall be such that a distance of at least 200 mm exists between any point of the periphery of any penetration seal and the wall of the furnace.

6 Test conditions

6.1 All test conditions, except those noted herein, shall conform to those given in ISO 834-1.

6.2 Where a penetration sealing system is intended for use in both floors and walls, then each orientation shall be tested.

6.3 A pressure of (20 ± 2) Pa shall be established at the bottom of the lowest penetration in a vertical assembly.

6.4 For horizontal elements a static pressure of (20 ± 2) Pa in the horizontal plane (100 ± 10) mm below the underside of the separating element shall exist.

7 Instrumentation

The control, monitoring and recording equipment necessary to carry out tests in accordance with this part of ISO 10295 shall be as described in ISO 834-1.

8 Test construction

8.1 Number of specimens

8.1.1 In the case of asymmetrical vertical elements, normally two tests shall be carried out; one from each direction of exposure. Where it can be established clearly in an asymmetrical vertical element that there is a weaker direction of exposure, it is required to test only the weaker. A full justification for the procedure adopted shall be included in the report. Where the penetration sealing system is fully symmetrical, only one specimen is required to be tested with either face exposed to the heating regime.

8.1.2 In the case of horizontal elements, the test specimen shall be exposed to heating from the underside.

8.2 Size of specimen

8.2.1 A penetration and the accompanying penetration seal shall be full size. In order to avoid boundary effects, the distance between the perimeter of the penetration sealing system and the outer perimeter of the heated part of the separating element shall be not less than 200 mm at any point.

8.2.2 In cases where multiple penetrations are included in a single test construction, the minimum distance between adjacent fire seals shall be not less than 200 mm. Each penetration with its associated service(s) and penetration sealing system(s) shall be the subject of a separate evaluation providing the specified conditions are maintained with respect to the penetration being evaluated.

8.3 Fire separating element

8.3.1 General

The fire separating elements shall be of known fire resistance and the construction details shall be representative of that used in practice. A rating obtained on such a specific separating element shall apply only to that particular type of separating element.

8.3.2 Standard fire separating elements

8.3.2.1 Wall constructions

The constructions depend on the period of fire resistance required. For concrete and masonry elements the wall shall be constructed from materials having a density of (650 ± 200) kg/m^3 and a thickness of not less than 70 mm.

8.3.2.2 Floor constructions

The floor constructions for concrete elements should have a density of (650 ± 200) kg/m^3 or $(2\,200 \pm 250)$ kg/m^3 and a thickness of not less than 100 mm.

8.4 Penetrating service

8.4.1 Selection of service(s)

8.4.1.1 The type of service or services passing through the penetration in the fire resisting element shall be selected so as to be representative of the service which the penetration seal is designed to accommodate. Standard service configurations for various applications are the subject of a separate document, which is in preparation.

8.4.1.2 When more than one penetration is incorporated into a test on a single separating element whilst remaining within the requirements of 6.3, 6.4 and 8.2, care shall be taken to ensure that there is no interaction between different penetrations. Examples are, for instance, where the early failure at one of the penetrations invalidates the time-temperature or pressure conditions specified or where one penetration sealing system directly influences another, e.g. by flaming or melting.

8.4.2 Installation of service(s)

8.4.2.1 For penetration systems that are uninsulated or partially insulated, the following distances shall be met. The exposed length of the uninsulated surface of the penetration system on the exposed face shall be a minimum of 300 mm. The unexposed length of the uninsulated surface of the penetration system on the unexposed face shall be a maximum of 500 mm. In this context the penetration sealing system shall include any coating, wrapping or other protection to the services.

8.4.2.2 At the start of the test, there shall be a minimum separation of 200 mm between adjacent penetrations and between any penetration and the internal surface of the furnace.

8.4.2.3 For the purpose of the test, the possibilities for support provided to the services are as follows:

a) unsupported condition;

b) notional support, agreed between the sponsor and the laboratory;

c) either full-scale simulation (representative of practical conditions); or

d) calculation and application of a load to simulate practical conditions. This will determine the field of direct application.

8.4.2.4 In each case, the procedure adopted and the validity of the test result shall be fully described in the report.

8.4.2.5 In the case of pipes, end options may be selected according to Table 1 and the conditions used shall be considered in the corresponding classification of the test result.

Table 1 — Pipe end situation

Pipe end options	
inside the furnace	**outside the furnace**
uncapped	uncapped
capped	uncapped
uncapped	capped
capped	capped

8.4.2.6 The capping of pipes shall be carried out by closing the pipe end with a mineral wool or ceramic fibre disc of a thickness of (50 ± 10) mm and a density of (150 ± 50) kg/m^3 fixed in place with an appropriate adhesive e.g. sodium silicate adhesive, ceramic adhesive. Alternatively, pipes may be sealed by welding a disc of the same material as the pipe to the end. In cases where vertical pipes are tested, the mineral wool or ceramic fibre discs shall be fixed additionally by mechanical means.

8.5 Penetration seal

8.5.1 Installation of penetration seal

The penetration sealing system shall be installed, together with services chosen to represent the field of application. Install these services in accordance with the manufacturer's instructions or in a manner representative of site practice. The installation procedures shall be described in the test report.

8.5.2 Addition of services

In the case where a penetration sealing system is designed to allow for the alteration of the service content after first installation, a representative penetration sealing system shall be prepared and fully conditioned. After this period, any required modifications shall be made to the service loading and a further conditioning period shall be allowed if necessary. Such procedures shall be fully described in the report.

8.5.3 Blank penetration seal

A blank penetration seal shall be tested in accordance with this part of ISO 10295. The test results of the blank penetration seal shall not be applied after the penetrating item is installed.

9 Test procedure

9.1 Pre-test conditioning

After completion of the test construction, it shall be subject to a conditioning procedure in accordance with ISO 834-1.

9.2 Setting up of test construction and apparatus

9.2.1 Installation of test construction

When the conditioning procedures are satisfied the test construction shall be mounted to form the vertical or horizontal face of the test furnace as appropriate. Measuring equipment and ancillary apparatus shall be provided in accordance with the provisions of this part of ISO 10295.

9.2.2 Furnace temperatures

Plate thermometers in accordance with ISO 834-1 for the measurement and control of furnace temperature shall be uniformly distributed so as to give a reliable indication of the average gas temperature in the vicinity of the heated face of the test construction. The hot junctions shall be located initially in a plane (100 ± 10) mm from the exposed face of the separating element. In addition, no junction shall be closer than 100 mm to any projecting part of the seal, a penetrating service or any part of the furnace at the start of the test. At least one plate thermometer shall be provided for every 1,5 m^2 of the heated area of the test construction, subject to a minimum number of four plate thermometers for each test construction.

9.2.3 Unexposed face temperature measurement

9.2.3.1 Generally, surface-temperature measurements shall be made using thermocouples in accordance with ISO 834-1. In the case of non-planar surfaces, the disc and pad shall be deformed to follow the surface profile. If there is difficulty in fixing the standard pad, the size of the pad shall be reduced in size subject to a minimum dimension of 12 mm.

9.2.3.2 Thermocouples in accordance with ISO 834-1 for the measurement of unexposed face surface temperatures shall be provided at the following locations; see also Figures 1 and 2.

a) Type A: On the surface of the service protruding from the unexposed face, at a position corresponding to a distance of 25 mm from the point where the service emerges from the penetration seal. 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.

   — 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 perimeters of the service. If the service passes through a vertical element, one of these thermocouples shall be attached to the uppermost surface of the service. Also, in the case of vertical elements, when similar services are included in the penetration, the service nearest the top of the penetration shall be chosen for temperature measurement.

   — Surface thermocouples shall also be placed on the service at a distance of 25 mm from the termination of any coating or insulation extending along the surface from the penetration.

b) Type B: On the surface of the penetration seal at the following locations:

   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.

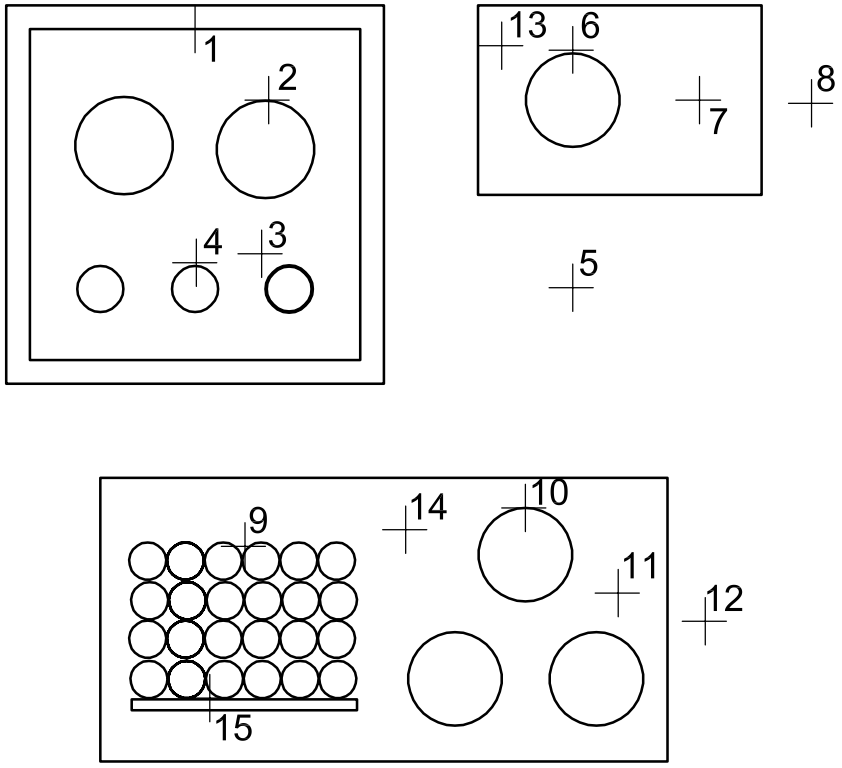
   2) If appropriate, equidistant from the perimeter of the service to the edge of the penetration where this distance is a maximum or, in the case where there is more than one penetrating service, at the nominal mid-position of what in the judgement of the tested is the largest uninterrupted area of seal.

c) Type C: At the mid-section of the unexposed surface on any supporting frame at the periphery of the penetration. In the case of vertical elements, this measurement shall be made at the top of the penetration.

d) Type D: On the surface of each rack, tray or any service support construction that passes through the fire seal at distances of 25 mm from the point of emergence from the seal.

e) Type E: On the surface of the separating element 25 mm from the edge of the penetration with a minimum of one thermocouple per penetration.

f) Type F: If, in the opinion of the laboratory, potential weak spots can be identified; additional fixed thermocouples shall be attached at those points.

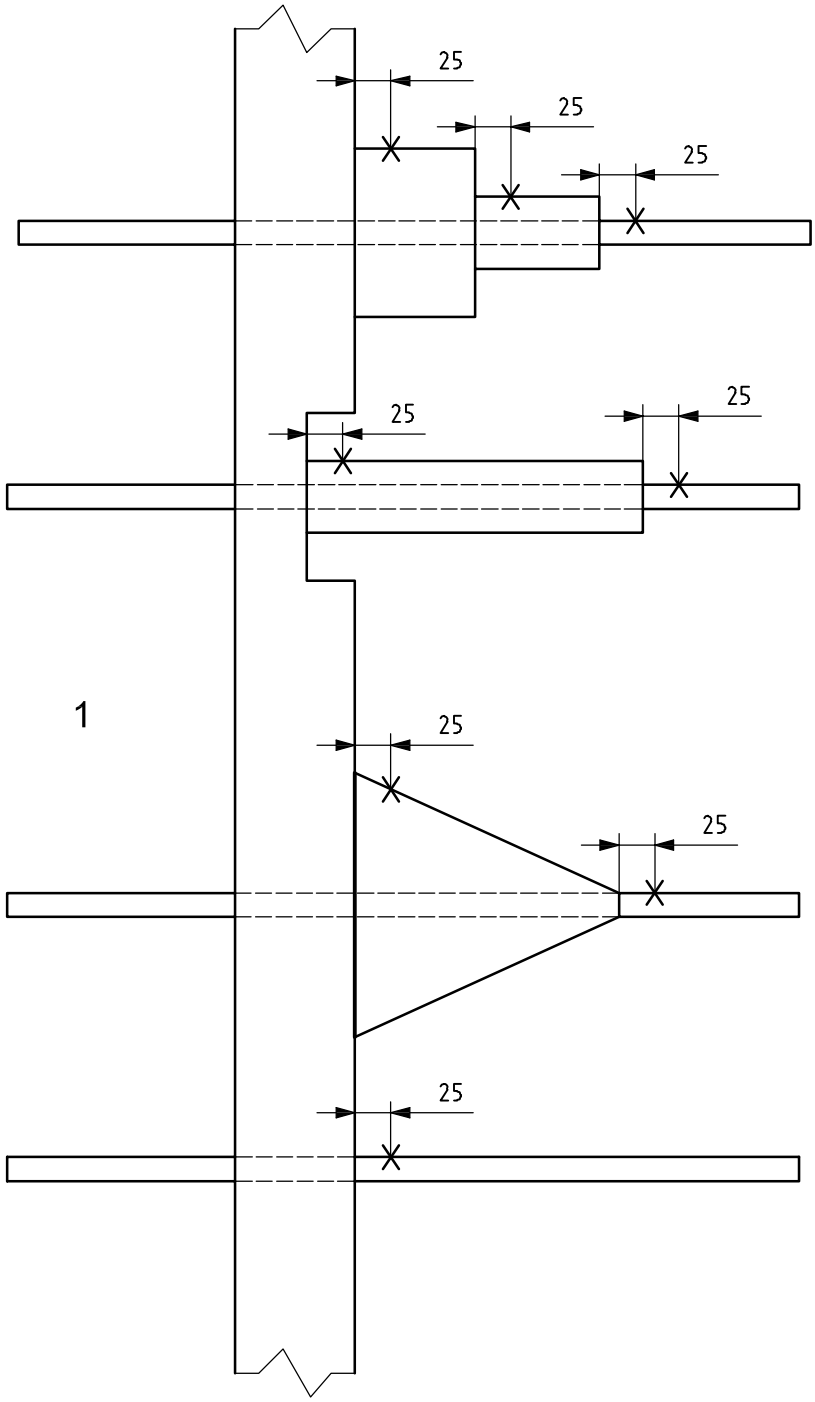


Key

Type A on service Nos. 2, 4, 6, 9 and 10
Type B 1) on seal Nos. 3, 13 and 14
Type B 2) on seal Nos. 7 and 11
Type C on frame No. 1
Type D on ladder No. 15
Type E on separating element Nos. 5, 8 and 12
Type F at discretion of laboratory

Figure 1 — Typical thermocouple locations

Dimensions in millimetres



Key

1 fire side

Figure 2 — Examples of separation of unexposed face thermocouples from supporting construction

9.2.3.3 On thermoplastic, fibrous, intumescent materials or paints, the pad and the thermocouple shall be fixed so that they remain in contact with the surface during the test without adversely affecting the performance of the penetration system.

9.2.4 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 ISO 834-1, applied to identify any local “hot spots” or where temperatures measured by the fixed thermocouples are not reliable.

9.2.5 Integrity measurements

Where difficulties arise in attempting to use the cotton pad for the assessment of loss of integrity in accordance with ISO 834-1 when the penetration carried a high density of services, the size of the cotton pad shall be reduced to 20 mm $\times$ 20 mm $\times$ 20 mm. The wire supporting frame described in ISO 834-1 shall be adapted to the small pad size but still maintain the 30 mm clearance required from adjacent surfaces. Gap gauges should not be used for the determination of integrity loss.

9.3 Performing the test

A test on the specimen shall be carried out in accordance with ISO 834-1.

9.4 Measurements and observations

Subject to the modifications referred to in the previous clauses, measurement and observations during the test shall be made in accordance with ISO 834-1.

10 Test criteria

10.1 General

10.1.1 After selecting the criteria for performance, it is necessary to consider the methods by which fire can be transmitted through such elements, including the following:

10.1.1.1 through a space formed between a service and the seal, or between the seal and the element it penetrates, or through an opening formed within the service itself, or in the fire seal material;

10.1.1.2 by a temperature rise on the unexposed surface of the element in the vicinity of the penetration;

10.1.1.3 by a rise in the surface temperature of that part of the service that is on the un-heated side of the separating element, or on the unexposed surface of the penetration sealing system.

10.1.2 The purpose of the test is to establish the effect of the inclusion of a sealed penetration in a fire resisting separating element, on the fire resistance of that element. In this respect the relevant criteria for integrity and insulation are based on those specified in ISO 834-1.

10.2 Integrity

Integrity shall be recorded as the time before the occurrence of flaming or other conditions on the unexposed face which ignite the cotton pad.

10.3 Insulation

10.3.1 Insulation shall be recorded as the time when the maximum unexposed face temperature rise, determined either by any of the thermocouples in specified positions, or by the roving thermocouple, exceeds 180 °C.

10.3.2 Temperatures recorded from thermocouples that become embedded in softening material or covered by intumescent material shall be disregarded.

11 Expression of results

11.1 The result shall be stated to the nearest completed minute of test in terms of elapsed time between the commencement of heating and the time at which the integrity and insulation criteria are no longer complied with in accordance with this part of ISO 10295. Any failure with respect to a single service incorporated in a penetration seal system shall constitute a failure of that system. If multiple penetrations are included in a single test, then the performance of each penetration seal system shall be judged separately subject to the constraints of 8.4.1.

11.2 Test results are valid only as long as the services do not receive additional support (e.g. from the floor of the furnace).

12 Direct field of application

12.1 The test results obtained using pipes are generally valid only for the material, the nominal outside diameter and the nominal wall thickness of the pipes that were tested.

12.1.1 Test results obtained from tests with pipes having both ends uncapped are valid for all other test conditions of Table 1.

12.1.2 Test results obtained from tests with cables apply if the diameter of a single cable is reduced or the number of cables in a bundle is reduced.

12.2 Test results obtained with penetration sealing systems tested in vertical separating elements cannot be used to assess performance in horizontal elements. Test results obtained with penetration sealing systems tested in horizontal separating elements can be used to assess performance in vertical elements.

12.3 Test results obtained with separating elements of concrete or masonry can be applied to concrete or masonry separating elements of a thickness and density equal to or greater than that of the element used in the test.

12.4 Results obtained with lightweight separating elements can be applied to concrete or masonry elements of a thickness equal to or greater than that of the element used in the tests.

12.5 The results obtained apply only to the number, size and type of cables (including insulation) tested. The results obtained apply only to the number, size and type of pipe tested.

13 Test report

The test report shall include the following information:

a) name of the testing laboratory;

b) date of the test;

c) names of the sponsor, the manufacturer and the product;

d) sufficient detail of the complete system tested to uniquely define and identify that system and the materials, where appropriate by reference to standards and/or approvals, including classification of fire behaviour;

e) description of the installation procedures, including the selection of service support system and details of work access (e.g. whether the penetration seal was installed from one or both faces, the pipe end situation, description of fixing);

f) description of the test procedure and a statement that the procedures of this part of ISO 10295 have been complied with;

g) records of measurement (e.g. temperatures) and observations (e.g. smoke on the unexposed side of the furnace) obtained during the test;

h) statement of the performance of the penetration sealing system with respect to integrity and insulation, determined in accordance with the provisions of this part of ISO 10295;

i) in the case of tests of pipes, a statement of the test condition according to Table 1;

j) maximum dimension of blank penetration seal.

Annex A
(informative)

Explanatory notes

A.1 General

The explanatory notes in this annex are intended to serve as guidance for the planning, performing and reporting of a fire resistance test carried out in accordance with this part of ISO 10295 and the interpreting and application of test results.

A fundamental requirement for fire resistance tests is that the test results be reproducible. This requirement necessitates very accurate preparation of the test specimen and the specification of the test conditions.

Detailed data from a fire-resistance test facilitates classification requirements. For extending the application and for quality control purposes, it can be necessary to complement a fire-resistance test by other tests for the determination of the relevant properties of materials, for example thermal conductivity, specific heat, and strength and deformation properties in the temperature range associated with fires.

A.2 Notes on scope and application of test results

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 has to be considered carefully. The fire hazard can be reduced by providing penetration sealing systems 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 part of ISO 10295 has, therefore, been designed with the intention of covering a wide range of fire situations in a minimum of tests corresponding to a “worst case” situation.

The worst case cannot be specified uniquely in every possible situation and it has, therefore, been necessary to accept some restrictions together with the lack of applicability of the method of test to all situations.

During discussions on test methods, it was shown that tests carried out in accordance with this part of ISO 10295 do not permit a final assessment of fire hazards. A number of particular hazards had to be excluded. Since the penetration seals, in practice, are attached to fixed building members (floors, walls, etc), the anticipated effects of the expansion, contraction or deflection of these elements should be considered in a complete evaluation of fire performance.

It can also be necessary to carry out additional tests on the load-bearing capacity and resistance to elongation or other deformation of supporting elements under fire conditions.

Other tests can be required in order to assess the reliability of services or the integrity of pipes and ducts against possible leakage of materials.

Heat conduction with respect to the media through pipes and ducts and mechanical stressing due to dimensional changes should be taken into account when preparing codes of practice for services. Experience gained from the test, carried out in accordance with this part of ISO 10295 is expected to be of use in the preparation of such codes.

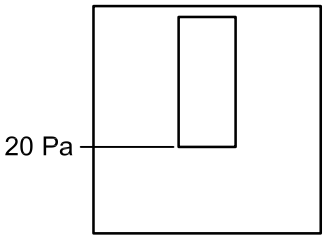
Electric cables used in practice differ widely in structure, particularly with regard to their insulation and according to their intended use. A document dealing with standard configurations for pipes and cables is in preparation.

A.3 Notes on test conditions

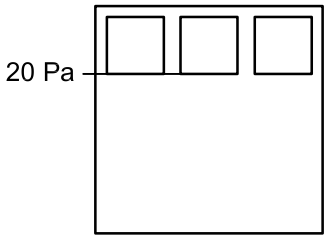
Often the penetrating service, together with its associated sealing system, forms only a minor percentage of a vertical separating element. In such cases, it is possible that the whole of the penetration sealing system can fall totally within the positive or negative pressure zone if the furnace is operated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

The pressure boundary conditions have been defined in 6.3 and 6.4. In large vertical furnaces that accommodate a number of penetration seals at different levels, all seals have a pressure of not less than 20 Pa. Seals positioned at higher levels are thus in areas of higher pressures.

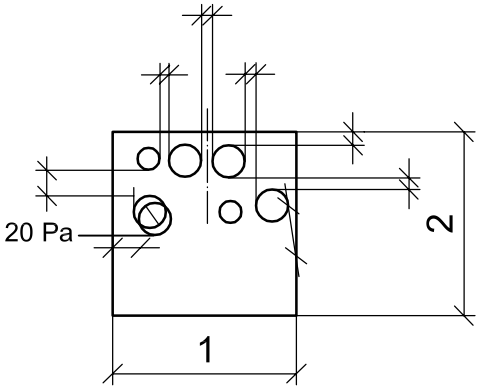
Examples are given in Figure A.1.



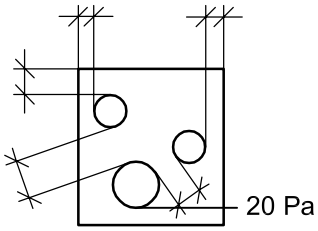
EXAMPLE 1 Single large penetration at top of the furnace.



EXAMPLE 2 Test with one penetration or more than one in the same height for cables.



EXAMPLE 3 Test of penetration seals with pipes.



EXAMPLE 4 Test situation for more than one service in a large penetration system.

Key

1 furnace width

2 furnace height

Figure A.1 — Examples for deciding on pressure conditions

A.4 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 sponsor, and due consideration is to be given to any additional safety precautions necessary.

A.5 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.

A.6 Notes on test report

The risk of fire propagation varies with the piping material used. In connection with metallic pipes, such aspects as heat conduction, strain, melting point (copper, brass, steel, aluminium) are decisive. In connection with mineral construction materials (e.g. glass, fibre reinforced concrete), it is the stability when exposed to raised temperatures that is important and, in connection with 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.

Proof of suitability should be provided for building materials whose suitability cannot be assessed adequately by the procedure laid down in this part of ISO 10295.

ICS 13.220.50; 91.140.01

Price based on 14 pages