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Reaction-to-fire tests — Guidance on the choice of substrates for building and transport products

Essais de réaction au feu — Lignes directrices sur le choix de subjectiles pour les produits du bâtiment et du transport

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Foreword

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

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

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

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

ISO 14697 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 1, *Fire initiation and growth*.

This first edition of ISO 14697 cancels and replaces ISO/TR 14697:1997, which has been technically revised.

Reaction-to-fire tests — Guidance on the choice of substrates for building and transport products

1 Scope

This International Standard gives guidance on the choice of substrates for building and transport products, when required, for use in reaction to fire tests.

This International Standard is applicable to those building and transport products that are produced and used in combination with other materials; for example, wall-coverings are adhered to many different substrates that vary in their thickness, density, thermal conductivity and flammability characteristics.

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 1716, *Reaction to fire tests for building products — Determination of the heat of combustion*

ISO 13943, *Fire safety — Vocabulary*

3 Terms and definitions

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

3.1
assembly
fabrication of materials, products and/or composites

NOTE This may include an air gap.

3.2
coating
product applied as a liquid or a powder to a substrate that cures or dries as an external layer on the substrate

3.3
composite
combination of materials, which is recognized in building and transport vehicle construction as a discrete entity

3.4
exposed surface
that surface of the product subjected to the heating conditions of the test or fire in end use

3.5
end use
method of application in an actual building or transport vehicle

3.6
facing
thin, pre-produced sheet or film product that is applied to the substrate using an adhesive or the self-adhesive properties of the substrate or facing

3.7
material
single basic substance or uniformly dispersed mixture of substances

EXAMPLES Metal, stone, timber, concrete, mineral wool with dispersed binder and polymers.

3.8
product
material, composite, component or assembly about which information is required

3.9
spacers
material with PCS equal to 0 (when tested in accordance with ISO 1716) applied in the form of strips to a substrate with PCS equal to 0 (also when tested in accordance with ISO 1716) to provide an air gap (open or closed) behind a product for testing purposes

NOTE Spacers fabricated from combustible materials may be used in specific test specimens if these are appropriate to the end-use application.

3.10
substrate
product that is used (or is representative of that used) immediately beneath the product about which information is required

EXAMPLE Plasterboard beneath a wall covering.

NOTE This definition of a substrate is different from that given in ISO 2424. For textile floor coverings, the substrate is considered to be part of the floor-covering assembly below the use surface. In the context of this fire-testing International Standard, the substrate should be chosen to represent the type of floor on which the textile or non-textile floor covering is placed.

3.11
standard substrate
product that is representative of the substrate used in end-use applications

3.12
test specimen
piece of the product that is tested with or without any substrate, including any air gap or treatment

4 Guidance on selection of substrates

4.1 In all cases, end-use substrates shall be used.

The term end-use substrate shall apply not only to the product immediately beneath the surface to be tested, but also to the method of attachment that shall also be end-use in terms of the type and application, where appropriate. The test method defines the required test-specimen dimensions.

If the product has both primary and secondary substrates in end-use practice, the test specimen shall be prepared to incorporate both substrates. The second substrate may be an air gap. For example, in the case of paint coating on a steel plate that has an insulation substrate beneath it (as in a sandwich panel construction), the paint layer shall be tested together with the steel and the insulation. Water or another highly conductive liquid should not be used as a secondary substrate in any test method.

This requirement for end-use testing is necessary since underlying layers of products and also various methods of attachment are known to have a profound effect on the fire performance of the surface product. The effects are more pronounced when assessing some parameters than others; for example, the choice of substrates when assessing the spread of flame performance of a product can make the difference between having the lowest or highest level of performance for the same surface material. Choice of the method of attachment can also affect performance, since partial delamination can create a significantly worse fire performance due to the insulatory air layer created between the product and the substrate.

In some actual uses, the substrate can be "air," since an air gap is formed in the construction of the lining to wall, ceiling or floor surfaces, by the use of battens, etc. If an air gap is used in practice, then this should be simulated in the preparation and testing of the specimen; see 6.2.

Table 1 — Standard substrates

Standard substrate	Density kg/m^3	Thickness mm	Typical values of thermal inertia W^2·s/m^4 K^2	PCS [a] MJ/kg	CFE [b] kW/m^2	Q_{sb} [c] MJ/m^2
Fibre cement board (see ISO 390)	1 800 ± 100	6 ± 1	$9{,}0 \times 10^4$	⩽ 2,0	—	—
Calcium silicate board	870 ± 50	11 ± 2	$9{,}0 \times 10^4$	⩽ 2,0	—	—
Gypsum plasterboard [d]	800 ± 100	12,5 ± 0,5	$5{,}8 \times 10^4$	—	⩾ 15,0	⩾ 3,2
Stone fibre mineral wool slab [e]	50 ± 20	25 ± 5	1×10^3	< 1,0	—	—
Steel sheet	7 850 ± 50	0,8 ± 0,1	$2{,}4 \times 10^8$	Inert	Inert	Inert
Aluminium sheet	2 700 ± 50	1,0 ± 0,2	$4{,}7 \times 10^6$	Inert	Inert	Inert
Particleboard [f]	680 ± 5,0	12 ± 2	$2{,}4 \times 10^5$	—	⩾ 5,5	⩾ 2,35

[a] PCS is the gross calorific potential (ISO 1716).

[b] CFE is the critical flux at extinguishment (ISO 5658-2).

[c] Q_{sb} is the heat for sustained burning (ISO 5658-2).

[d] With paper facing having a maximum weight of 220 g/m^2.

[e] Mass loss less than 3 % at 550 °C (see ISO 1887).

[f] Non-fire-retarded, for internal use (see ISO 820).

4.2 As an alternative option, for non-combustible (i.e. PCS equal to 0 when tested in accordance with ISO 1716) substrates or substrates of limited combustibility (i.e. PCS < 1,0 MJ/kg when tested in accordance with ISO 1716), the following standard substrates shall be used to represent end-use substrates having a density (or thickness) that is equal to or more than the nominal value of the density (or thickness) of the standard substrate; see Table 1.

NOTE The PCS criteria that are given in Clause 4 are those that are specified in EN 13501-1.

The substrates have very little contribution to the fire itself in terms of combustibility, but all affect the fire characteristics of the surface product due to their different thermal inertia.

Gypsum plasterboard has been included despite its similar density to calcium silicate board due to its different fire performance properties and the differences exhibited by various surfaces, particularly in terms of spread of flame when tested using the two different substrates.

The standard steel substrate is representative only of metal substrates in end use with a melting point equal to or greater than 1 000 °C, independent of thickness and density.

The standard aluminium substrate is representative only of metal substrates in end use of a greater thickness and density.

Where a standard combustible substrate is required, the recommended standard substrate shall be used to represent end-use substrates that have a density that is equal to or more than the density of the standard substrate.

4.3 Standard substrates shall be used to assess surface coatings (e.g. paint) but where a product in its end-use form provides a multilayer (i.e. surface, adhesive and substrate), end-use substrates and methods of attachment shall be used; see Clause 5).

A study[1] on a number of standard substrates has been conducted, which provides a theoretical and practical understanding of the problem of substrate selection. It concludes that the outcome of the test shall reflect the fire behaviour of the real product in practical applications. Therefore, the substrate of the test specimens shall be as representative of the common use as possible. The report goes on to identify areas where substrates have no effect on the results and these are mainly where the testing time is short or the specimen is relatively thick.

4.4 Where the substrates used in practice are combustible, the material shall be tested together with its end-use substrate and method of attachment.

5 Storage and conditioning of standard substrates

Standard substrates shall be stored in a conditioning atmosphere at a temperature of (23 ± 2) °C and a relative humidity of (50 ± 5) % (ISO 554) until constant mass is achieved, at which time they are ready for use. Constant mass is considered to be attained when two successive weighing operations, carried out at an interval of 24 h, do not differ by more than 0,1 % of the mass of the specimen or 0,1 g, whichever is the greater.

6 Methods of application to the substrate

6.1 Methods of attachment

Wherever possible, the method of attachment in end-use practice shall be reproduced in the preparation of the specimen for test; i.e. end-use adhesive and end-use quantities, etc. If the order in which the attachments are mounted is known, this shall also be reproduced in the test specimen. For example, if the adhesive is applied to the substrate and not to the surface product in practice, then it shall be applied to the substrate during test specimen preparation. The time for curing and drying shall be the same as or greater than that used in end-use practice.

In some instances, with certain methods of attachment or due to the size of the test specimen (e.g. for ISO 5660-1, where the specimen size is 100 mm × 100 mm square), it might not be possible to fix it as in practice, (e.g. if the product in this case is nailed). The test specimen shall, therefore, be attached in an appropriate and representative manner.

Where a product is used with a substrate and the edges of the product and its substrate are both covered, this shall also be reproduced for the test.

6.2 Construction of air gaps

An air gap is normally constructed by placing the specimen over spacers mounted around the perimeter of a standard substrate so that an enclosed air gap is provided between the unexposed surface of the specimen and a substrate selected from Table 1. The thickness of the spacers used shall be representative of the end-use air gap. The spacers shall be constructed from board with a PCS equal to 0 (when tested in accordance with ISO 1716).

7 Non-standard substrates

This International Standard has identified a variety of substrates that are commonly used in building and transport applications. These substrates have been defined as “standard” substrates and they have been specified in Table 1. However, there are other applications where it is necessary to determine the reaction-to-fire performance of substrates different from those covered by the standard substrates. Since these different substrates are subject to various design, geographical, climatic, societal etc., factors, local guidance and requirements similar to those outlined in this International Standard shall be adopted.