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Fire tests — Guidance on the choice of substrates for building products

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

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Contents **Page**

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO members 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 in 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.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

— type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR14697, which is a Technical Report of type 3, was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 1, *Reaction to fire tests*.

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Fire tests — Guidance on the choice of substrates for building products

1 Scope

This Technical Report gives guidance on the choice of substrates for building products when carrying out reaction-to-fire tests.

Many building products are produced and used in combination with other materials; for example, wall-coverings are adhered to many different substrates, which vary in their thickness, density, thermal conductivity and flammability characteristics. When selecting a substrate on which to fix a sample of building product for reaction-to-fire testing, the guidelines given in this Technical Report should be followed.

2 Definitions

For the purpose of this Technical Report, the definitions given in ISO/IEC Guide 52 together with the following apply.

2.1
assembly
fabrication of materials and/or composites

NOTE — This may include an air gap.
EXAMPLE — Dry wall partition.

2.2
coating
product applied as a liquid or a powder to a substrate which will cure or dry into a continuous protective facing to the substrate

2.3
composite
combination of materials which are recognised in building construction as discrete entities

EXAMPLE — Coated, faced or laminated materials.

2.4
exposed surface
that surface of the product subjected to the heating conditions of the test or fire in end-use

2.5
facing
thin pre-produced sheet material which is applied to the substrate using an adhesive or the self-adhesive properties of the substrate or fixing

2.6
material
single basic substance or uniformly dispersed mixture

2.7
product
material, composite or assembly about which information is required

2.8
spacers
non-combustible material applied in the form of edge strips to a non-combustible substrate to provide an air gap behind a product for testing purposes

2.9
substrate
material which is used or is representative of that used immediately beneath a surface in end-use

EXAMPLE — Plasterboard beneath a wallcovering.

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 standard, the substrate should be chosen to represent the type of floor on which the textile or non-textile floor covering is placed.

3 Guidance rules

3.1 Rule 1: In all cases, end-use substrates are preferred

The term end-use substrate applies not only to the material immediately beneath the surface to be tested, but also to the method of attachment which must also be end-use in terms of the type and application, where appropriate.

If the product has both primary and secondary substrates in end-use practice, the test specimen should be prepared to incorporate both substrates (the second substrate may be an air gap); e.g. a paint coating to a steel plate which has an insulation substrate beneath as in a sandwich panel construction. The paint layer in this case should be tested together with the steel and the insulation.

NOTE 1 The test method will define the required specimen dimensions.

NOTE 2 In no test method should water or another highly conductive liquid be used as a secondary substrate.

This requirement for end-use testing is necessary since underlying layers of material 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 material 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 effect performance since partial delamination can create a significantly worse fire performance due to the insulatory air layer created between the material and the substrate.

In some actual uses, the substrate may be 'air' since an airgap is formed in the construction of the lining to wall, ceiling or floor surface, by the use of battens, etc. If an airgap is used in practice, then this should be simulated in the preparation and testing of the specimen.

3.2 Rule 2: As an alternative option, for non-combustible (i.e. PCS[1] = 0 when tested to ISO 1716) substrates or substrates of limited combustibility (i.e. PCS[1] < 1,0 MJ/kg when tested to ISO 1716), the following reference substrates may be used to represent end use substrates having a density which is equal to or more than the nominal value of the density of the reference substrate (see table 1)

Table 1 — Reference substrates

Reference substrate	Density (kg/m³)	Thickness (mm)	Thermal inertia ($W^2 \cdot s/m^4 K^2$)	Fire performance when assessed to ISO 1716 or ISO 5658-2
a) Fibre cement board	1800 ± 100	6 ± 1	about $9,0 \times 10^4$	PCS = 0 kJ/kg
b) Calcium silicate board	750 ± 100	11 ± 2	about $9,0 \times 10^4$	PCS = 0 kJ/kg
c) Gypsum plasterboard[1)]	800 ± 100	12 ± 1	$5,8 \times 10^5$	CFE[2)] ≥ 15,0 kW/m² Qsb[3)] ≥ 3,2 MJ/m²
d) Mineral wool rock slab[4)]	50 ± 10[5)]	20 ± 5	about 1×10^3	PCS < 1000 kJ/kg
e) Steel sheet	7850 ± 50	0,8 ± 0,1	$2,4 \times 10^8$	Inert
f) Aluminium sheet	2700 ± 50	3 ± 0,5	$4,7 \times 10^6$	Inert

1) With paper not exceeding 300 g/m² on either side. In some countries plasterboard is considered to be combustible.
2) CFE = Crucial flux at extinguishment
3) Qsb = Heat for sustained burning
4) Mass loss less than 3 % at 550 °C (ISO 1887).
5) Purchase density.

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

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.

1) PCS = gross calorific potential

Gypsum plasterboard due to its water content tends to yield a slightly worse fire performance when used as a substrate when compared to calcium silicate board; the water content increasing the probability of a reduction of adhesion between itself and the upper surface layer.

3.3 Rule 3: Reference substrates may 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 must be used (see clause 5)

A study on a number of reference substrates (see reference [1]) has been conducted which provides a theoretical and practical understanding of the problem of substrate selection. It concludes that the outcome of the test should reflect the fire behaviour of the real product in practical applications. Therefore, the substrate of the test specimens should 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:

a) the testing time is short;

b) the specimen is fairly thick.

3.4 Rule 4: Where the substrates used in practice are combustible, the material should preferably be tested together with its end-use substrate and method of attachment

The use of reference substrates should be avoided since it is not possible to predict how the underlying combustible substrate (and its method of attachment) will influence the fire behaviour of the surface product.

3.5 Rule 5: Where a standardized combustible substrate is required, then the recommended reference substrate may be used to represent end-use substrates which have a density which is equal to or more than the density of the reference substrate (see table 2)

Table 2 — Combustible reference substrates

Reference substrate	Density (kg/m^3)	Thickness (mm)	Fire performance
Particle board, not fire retardant treated, for internal use in accordance with ISO 820	680 ± 50	15 ± 5	CFE ≥ 5,5 kW/m^2 Qsb ≥ 2,35 MJ/m^2 when assessed to ISO 5658-2

4 Storage of reference substrates

Reference substrates should 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. The substrate should only be stored for a maximum of 3 years after which time it shall be discarded. The substrates should be discarded after test and not reused.

NOTE — When testing involves the assessment of mass loss, considerable error can be introduced due to the moisture content of the substrate. It is therefore recommended that the substrate be dried at a temperature of (105 ± 2) °C for 24 h prior to use on these tests. Alternatively, a control test using the substrate alone can be conducted to determine the effects of moisture content.

5 Methods of application to the substrate

5.1 Methods of attachment

Wherever possible, the method of attachment in end-use practice should 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 conducted is known, this should also be reproduced in the test specimen; e.g. if the adhesive is applied to the substrate and not to the surface product in practice, then it should be applied to the substrate during test specimen preparation. The same or greater time for curing and drying as used in end-use practice should also be allowed.

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

5.2 Joints

For intermediate-scale and for large-scale testing (e.g. ISO 9705), the influence of joints within the assembly on the burning behaviour of the product should be assessed by reproducing the end-use joint. For small-scale testing, the influence of joints cannot be accurately assessed and the relevance of test results obtained should be considered; usually a clear statement must be made in the test report whenever this situation occurs.

5.3 Edge covers

In some end-use assemblies, the edges of a product are covered by structural elements of the building (e.g. steel beams, concrete pillars) and it is difficult to reproduce end-use conditions in the laboratory. Some small-scale simulations (e.g. application of siliceous coatings to the edges of the substrate and its surface-covering) may be permitted provided the type of coating, its application procedure and conditioning treatment prior to reaction-to-fire testing are stated in the test report.

Where a product in its end-use form is always used with covered edges, the product should be tested with its edges covered by the method used in end-use, e.g. by sealing strips, etc. Where a product is used with a substrate and the edges of the product and its substrate are both covered, this should also be reproduced for the test.

5.4 Construction of air gaps

An air gap is normally constructed by placing the specimen over spacers mounted around the perimeter of a non-combustible board so that an enclosed air gap is provided between the unexposed surface of the specimen and the non-combustible board. The thickness of the spacers used should be representative of the end use air gap. The spacers should be constructed from non-combustible board.