1. SCOPE

This test method simulates a fire that under well ventilated conditions starts in a small room and spreads to a larger room.

2. FIELD OF APPLICATION

2.1 This test method is intended for products where the corresponding small scale test NT FIRE 004 is unsuitable, for example thermoplastic products and products having irregular surfaces.

2.2 National standards may specify the appropriate classification criteria based on this test method.

3. REFERENCES

1) ISO 3261 Fire tests - Vocabulary.

2) NT FIRE 004.

3) Coordinated Nordic Fire Technical Classes, Guidelines for Nordic building regulations, NKB - publication No 29.

4) CIE, "The basis of physical photometry", 2. rev.ed. of Publication CIE No 18.2. 1983.
4. DEFINITIONS

For the purposes of this test method, the definitions given in ISO 3261 apply together with the following:

4.1 Product

The material, composite or assembly about which information is required.

4.2 Material

A basic single substance or uniformly dispersed mixture, e.g. metal, stone, wood, concrete, mineral wool.

4.3 Composite

A combination of materials which are generally recognized in building constructions as discrete entities, e.g. coated or laminated materials.

4.4 Assembly

A fabrication of materials and/or composites, e.g. sandwich panels.

4.5 Exposed surface

That surface of the product which is subjected to the heating conditions of the test, such as wall paper, paint, varnish, board, wood panel, laminate, etc.

5. SAMPLING

The sample of the product to be tested shall be representative, particularly in the case of non-homogeneous products.

6. METHOD OF TEST

6.1 Principle

The product is mounted in the ceilings and on the walls in a fire
test house consisting of one larger and one smaller room connected with an opening.

The product is exposed to fire from a wooden crib positioned near the rear wall of the smaller room. The wooden crib is ignited with ethanol. In the rear wall of the smaller room there is an opening to ensure air supply for the combustion.

The time for flame spread from the smaller to the larger room and flames out the doorway is documented.

6.2 Equipment

All dimensions given in the following description are nominal, unless tolerances are specified.

6.2.1 Test house

6.2.1.1 The test house shall consist of two rooms: one smaller inner, and one larger outer room. The dimensions of the rooms shall be

<table>
<thead>
<tr>
<th></th>
<th>The smaller room</th>
<th>The larger room</th>
</tr>
</thead>
<tbody>
<tr>
<td>length</td>
<td>3.00 ± 0.05 m</td>
<td>6.00 ± 0.10 m</td>
</tr>
<tr>
<td>width</td>
<td>1.50 ± 0.05 m</td>
<td>3.00 ± 0.05 m</td>
</tr>
<tr>
<td>height</td>
<td>2.65 ± 0.05 m</td>
<td>2.65 ± 0.05 m</td>
</tr>
</tbody>
</table>

See also Fig. 1.

6.2.1.2 Between the two rooms there shall be an opening with a height of 2.05 ± 0.05 m and a width of 1.00 ± 0.02 m. In the front wall of the larger room there shall be an outer doorway of the same dimensions as the opening between the rooms. The rear wall of the smaller room shall have a ventilating opening, see Fig. 1. There shall be no other openings in the house. The outside openings shall be closeable.
6.2.1.3 The test house shall be constructed of non-combustible material with a density of 500 - 800 kg m\(^{-3}\). The thickness of the construction shall at least be 0.2 m.

6.2.1.4 The test house can be placed either indoors or outdoors. In the latter case it should be placed so that effects of wind are minimized.
6.2.2 Ignition source

6.2.2.1 The ignition source shall consist of a wooden crib with the external dimensions of 450 mm x 450 mm x 450 mm. The wooden crib shall be made of 34 pieces of sawn pine wood (Pinus silvestris) having dimensions 50 mm x 50 mm x 450 mm. The pieces shall be placed in nine layers with two pieces in the bottom layer and four pieces each in the remaining layers. The pieces in the bottom layer shall be placed length-wise in the house.

The wood shall be dried in 65 ± 5 °C during at least 24 h to achieve a moisture ratio of maximum 10%, see Annex, Clause A.4. The total weight of the dry wood shall be 19.0 ± 2.0 kg.

The position of the ignition source in the test house can be seen in Fig. 1.

6.2.2.2 The wooden crib shall be placed on a plate with the dimensions of 500 mm x 500 mm and with edges at least 20 mm high. The plate shall be placed on a stand with a height of 300 mm.

The plate on the stand shall be located in the smaller room, 250 mm from the rear wall.

6.2.2.3 Ethanol having a purity of 95% shall be used to ignite the wooden crib. The amount shall be 2 l.

6.2.3 Additional equipment

6.2.3.1 Oven

The oven should be used for the drying of the wooden crib. It shall be capable of maintaining a constant temperature of 65 ± 5 °C.

6.2.3.2 Balance

The balance should be used to weigh the wooden crib. It should have a nominal capacity of 20 kg.
6.2.3.3 Building dryer

The building dryer or similar should be used to dry and heat the interior of the test house before testing.

6.2.3.4 Thermometer

The thermometer should be used to measure the temperature outside and inside the test house.

6.2.3.5 Hygrometer

The hygrometer should be used to measure the relative humidity outside and inside the test house.

6.2.3.6 Anemometer

The anemometer should be used to measure the air velocity in the openings of the test house.

6.2.3.7 Photo equipment

The equipment should be used for photographing or/and video recording the product before, during and after testing. The test time with a resolution of 1 s should be visible on the picture.

6.2.3.8 Timing device

The stop watch should be used to register elapsed time to different events during test. It shall have an accuracy of ± 1 s per hour.

6.2.3.9 Photocell system

The photocell system (optional) could be used to measure the light absorption of the smoke gases, see Annex Clause A.2.

6.2.3.10 Thermocouples

The thermocouples (optional) could be used to facilitate detection of ignition of the ceiling surface in the larger room. They should
then be placed along the longitudinal centre line of the ceiling in the larger room, approximately 1 m from each of the openings and in the middle of the ceiling. The measuring point should be placed approximately 50 mm below the ceiling. A wire diameter of maximum 0.25 mm is recommended.

6.2.3.11 Millivolt meter

The millivolt measuring device should be used to record the output of the photocell and the thermocouples. It shall have an accuracy of ± 0.5% of actual millivolt value.

6.2.3.12 Fire extinguisher

An equipment for extinction of a fully developed fire should be available.

6.3 Preparation of test specimens

6.3.1 In cases where the product to be tested is of plate form, standard dimensions of the boards should be used as far as possible.

6.3.2 Thin surface materials, paints and varnishes shall, depending on their use in practise, be applied on one of the following substrates:

1) Non-combustible fiber reinforced silicate board with a dry density of 680 ± 50 kg m\(^{-3}\). A suitable thickness is 11 ± 2 mm, see also Annex, Clause A.3.1.

2) Ordinary particle board with a density of 680 ± 50 kg m\(^{-3}\) at normal conditioning atmosphere (a relative humidity of 50 ± 5% and a temperature of 23 ± 2 °C). A suitable thickness is 11 ± 2 mm.

3) Standard plaster board with a density of 725 ± 50 kg m\(^{-3}\) at normal conditioning atmosphere. A suitable thickness is 11 ± 2 mm.

The substrates described under points 1 and 2 can be considered comparable with light weight concrete (1) and wood products of comparable density (2).
In special cases other substrates can be applicable, for example steel and mineral wool, see also Annex, Clause A.3.2.

6.3.3 The product shall be attached to the underlay or directly to the interior of the test house (painting, varnishing, nailing, glueing, framing, support system, etc) according to the directions given by the client so that the mounting technique or the application rate, as far as possible, conforms to the practical use of the product.

6.3.4 If a special mounting technique is used in order to improve the fire technical properties of the product, this shall be clearly stated in the test report.

6.3.5 The walls (excluding the end wall containing the outer doorway), the ceiling and the edges of the door opening between the rooms shall normally be covered by the product, see also Annex, Clause A.5.

6.3.6 If the product is applied with a wet technique, e.g. glueing, painting, spraying, it shall be allowed to properly dry or polymerize before testing. Thin surface materials applied on wooden underlay (e.g. ordinary particle board) and exposed wooden products shall have a moisture ratio in the wood of maximum 12%, see Annex, Clause A.4.

Prior to testing, the temperature in the house shall be 20 ± 5 °C during at least 24 h.

6.4 Testing

Tests shall not be performed when weather conditions can influence the results.

6.4.1 Preparations prior to test

The preparations prior to a test shall be performed in the following order.

6.4.1.1 Measure the temperature and the relative humidity outside and inside the test house. The temperature inside shall be within the limits given in Clause 6.3.6. The temperature outside shall not be below ± 0 °C.
6.4.1.2 Open the outer door and the shutter in the rear wall of the smaller room.

6.4.1.3 Measure the air velocities in the outer openings of the test house. They shall not exceed 2 m s\(^{-1}\).

6.4.1.4 Photograph the mounted product before testing.

6.4.1.5 Prepare the photocell system device (where appropriate) as follows:

   The lamp shall be supplied with constant voltage to give the correct colour temperature, see Annex, Clause A.2. Cover the lamp to ensure that light from other sources is not affecting the measurements.

6.4.1.6 Pile the room tempered wood on the plate in the smaller room as described in Clause 6.2.2.1.

6.4.1.7 Pour the room tempered ethanol on the plate immediately before ignition. Make sure that only the bottom layer is in contact with the fluid.

6.4.2 Test procedure

6.4.2.1 Ignite the ethanol and start the timing simultaneously.

6.4.2.2 During the test, the following observations including the times when they occur shall be recorded:
   a) Flames reaching the ceiling in the small room.
   b) Ignition of the product in the small room.
   c) Flash over of the ceiling in the small room.
   d) Flames emerging through the doorway to the large room.
   e) Ignition of the product in the large room.
   f) Burning of half the area of the ceiling in the large room.
   g) Burning of the entire ceiling in the large room.
   h) Flames emerging through the outer doorway of the large room.
   i) Deformation of the product and the location where this occurs.
   j) Falling down of material and the location where this occurs.
k) The occurrence of falling drops from the product, if the drops are burning and the location where this occurs.

l) The amount of smoke production and any changes in the amount. Failure to see the fire source due to the smoke shall be noted.

6.4.2.3 The recorded events according to Clause 6.4.2.2 are photographed in order to, as clear as possible, illustrate the course of events.

6.4.2.4 The test is terminated by extinguishing the fire source and the burning test material
- 15 minutes after the ethanol was ignited, or
- when the flames emerge through the outer doorway.

6.4.2.5 After ventilation of the test house, the test material is examined. The fire damages, if any, are recorded and photographed.

6.5 **Expression of test results**

6.5.1 The fire development shall be described. The time observations should be expressed in minutes and seconds elapsed from the start of the test. The appropriate photographs should be included.

6.5.2 The production of the light obstructing smoke shall be described. When using a photocell system, the obstruction should be expressed as stated in the **Annex**, Clause A.2. Otherwise the smoke shall be described from the visual observation as
- light or
- moderate or
- heavy

6.5.3 The fire damages of the product shall be described.

6.6 **Test report**

The test report shall be as comprehensive as possible. Any observations made during and after the test and comments on any difficulties experienced during testing shall be reported. The following essential information shall also be included in the report:
a) Name and address of the testing laboratory
b) Date and identification number of the report
c) Name and address of the client
d) Purpose of the test
e) Method of sampling
f) Name of manufacturer or supplier of the product
g) Name or other identification marks of the product
h) Density or weight per square unit and thickness of the product
i) Date of the supply of the product
j) Description of the product
k) Description of the mounting technique
l) Date of the mounting
m) Date of the test
n) Reference to this test method
o) When not identified in the test method, equipment and instruments used
p) Deviations from the test method, if any
q) Test results
r) Designation of the product according to criteria expressed in official standards or regulations
A.0 Introduction

A.0.1 This Annex provides a commentary on the text and more explicit details of some of the requirements and procedures given in this test method.

A.0.2 This method is intended to describe the fire technical properties of a product under controlled laboratory conditions.

This test method may only be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire risk of a particular end use.

A.0.3 Users of this test method should observe the following warning:

SAFETY WARNING - To all concerned in fire tests - toxic or harmful gases may be evolved during combustion of the test specimens. Accordingly, suitable precautions should be taken to safeguard health.

A.1 Purpose

The method is not intended to evaluate the fire endurance of a product.

The method is neither intended to evaluate the technical fire properties of floorings, draperies or curtains, nor of the contribution to fire growth provided by objects placed in the room.

A.2 Optical density

The light absorption of the smoke is measured with a photocell system. The optical density is then calculated according to clause A.2.7. The essential parts of the system are a lamp, lenses, an aperture and a photocell, see Fig. A:1.
A.2.1 The lamp shall be of the incandescent filament type and operate at a colour temperature of 2 900 ± 100 K. The lamp shall be supplied with stabilized direct current stable within ± 0.2% (including temperature, shortterm and longterm stability). The filament length axis shall be perpendicular to the light beam.

A.2.2 The lens system shall align the light to a parallel beam with a diameter of at least 20 mm. The lens in front of the photocell shall focus the light beam to give an illuminated area corresponding to the active area of the photocell.

A.2.3 The aperture shall be placed in the focus of the lens L₂ according to Fig. A:1. It shall have a diameter as small as possible without decreasing the measuring range, see also Clause A.2.5.

A.2.4 The detector shall have a spectrally distributed responsivity according to the CIE V(λ)-function (the CIE photopic curve). The detector shall be linear within 5% over an output range of at least 5 decades.

Fig. A:1. A schematic illustration of the light absorption measuring device.
A.2.5 The photocell system shall be designed to give a resolution of at least 4 decades of transmission. This is achieved by optimizing the illumination, and depression of other light sources as well as choosing the appropriate measuring device. The use of neutral density filters may be feasible for extending the measuring range.

A.2.6 The parallel light beam shall follow the vertical line in the centre of the outer doorway. The lamp shall be mounted in a box above the doorway. The box shall be placed on the inside of the front wall and shall be insulated to protect the lamp housing. It shall be designed so that it does not affect the outflow of smoke. The lamp housing shall be constructed in such a way as to ensure that soot deposits during the test do not reduce the light transmission by more than 5%. This can be achieved by pressurizing the lamp housing and allowing a small air flow to pass the optics. The distance between the openings of the lamp housing and the photocell housing shall be 1.0 ± 0.05 m.

A.2.7 The optical density of the smoke shall be calculated by:

\[ D_L = 10 \times \frac{1}{L} \log_{10} \frac{I_0}{I} \]

where

\( D_L \) = the optical density expressed as the number of obscura.
\( L \) = the length of the light path through the smoke.
\( I_0 \) = the light intensity when no smoke is present.
\( I \) = the light intensity in the presence of smoke.

A.3 Underlay for testing

A.3.1 Suitable non-combustible boards of fibre reinforced silicate are "Navilite N" (Dansk Eternit-Fabrik A/S, Aalborg, Denmark) or "Monolux 40" (Cape Boards and Panels Ltd, U.K).

A.3.2 As fas as possible, the underlay is chosen to comply with the end use of the product. The flame spread velocity of a thin material is strongly dependent of the backing it is applied to. The lower the thermal inertia (the square root of the product of the density, the
heat transfer coefficient and the specific heat capacity) of the substrate is, the faster flame spread is obtained if other factors are kept unchanged. If there are several practical applications of the product, the worst technical fire case should be chosen for testing in order to achieve as broad an application as possible of the test results. When the tested combination is not of the worst technical fire case, this should be clearly stated in the report.

Thermoplastic products can be tested on a suitable substrate according to Clause 6.3.2 in the test method description to facilitate the demolishing of the tested product.

A.4 Moisture ratio

The moisture ratio is determined by drying specimens at 105 °C during at least 24 h. It is calculated by:

\[ x = \frac{a-b}{b} \times 100 \]

where

\( x \) = moisture ratio.
\( a \) = weight of specimen before drying.
\( b \) = weight of specimen after drying.

A.5 Special products

Special type of products such as suspended ceilings of flexible material and pipe insulations may be mounted only in the ceilings of the fire test house.

This is a deviation in the test procedure for a special purpose test. The deviation shall be clearly stated in the test report.