

A summary of fire regulations, requirements and test methods for technical textiles used in buildings

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Abstract

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This report describes a summary of regulations and test methods which can be applicable for technical textiles when used in buildings. An overview and analysis is made for test methods and it can be seen they can be divided in small-scale tests, intermediate scale tests and even large scale tests.

The report contains also the results of a questionnaire inside the Contex-T consortium indicating the level of the requirements which will be used in different EU countries. It was difficult to get data from all countries but we obtained as much as possible.

Key words: technical textiles, fire test methods, regulations

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1 Introduction

1.1 Background

The EU project Contex-T aims at transforming the traditional resource-drive textile industry into knowledge based, sustainable and competitive industry by creating breakthrough innovation in a high tech area in technical textiles for construction. Following a holistic approach, this project aims at developing a breakthrough in textile architecture, lightweight textile reinforced structures and tension fabric structures industry. The approach does not only comprise the development of new materials but also addresses the intelligent use of the materials in the applications. The research will focus on the development of textile based lightweight walls and façade elements, lightweight but strong textile cables and belts, thick and thin wall textile materials which provide protection against rain, wind, provide thermal and noise insulation.

The materials and products developed will need to fulfil actual and future regulatory requirements e.g. fire. In this perspective a report is written to summarise the fire requirements for technical textiles used in buildings in different members states and consequently also the classification systems and corresponding test methods.

1.2 Description of a Technical Textile

A technical textile is often defined as a textile material and product manufactured primarily for their technical performance and functional properties rather than their aesthetic or decorative characteristics. A non-exhaustive list of end-uses includes aerospace, industrial, marine, military, safety and transport textiles and geotextiles¹. Another definition is given in Encyclopaedia Universalis: "Technical textiles are materials meeting high technical and quality requirements (mechanical, thermal, electrical, durability...) giving them the ability to offer technical functions².

In this report we will focus on the characterisation of one of the technical requirements namely fire requirements in buildings.

1.3 Typical fire phenomena related to fire safety of technical textiles

1.3.1 Reaction to fire

The reaction to fire of a product is covering characteristics such as ignition, flame spread, heat release rate, smoke and gas production, occurrence of burning droplets and parts.

1.3.2 Fire resistance

Fire resistance testing of technical textiles provides a measure of the ability of a construction element of separation element to guarantee the fire compartment concept when exposed to a fully developed fire for a specific time. Fire resistance testing assesses integrity, insulation and stability of the construction. Similar to reaction to fire the design of the joints and the fixing of the panels to the surrounding of the structure is extremely

important. The testing of a system built up with technical textiles should therefore reflect the end-use details of the whole structure. Testing is most often done by means of fire resistance tests such as refereed to in ISO 834 and EN 1363-1. Classification is regulated in the EN 13501 series of standards. The reader is referred to these procedures for further information.

1.3.3 Fire protection

Fire protection includes areas such as detection, extinguishment systems, smoke and heat control, etc. In work package 3 of Contex-T focus will be put on fire engineering and fire protections measures will be studied. Therefore this report will not focus on this issue and the reader is referred to the reports to be issued in WP 3.

2 Comparative analysis of International and European test methods for building applications

This chapter gives a summary of a number of test methods to which technical textiles can be subjected when placed in a building and used as wall lining. Both internationally within ISO but also regionally (Europe) and nationally world-wide test methods are applicable for building materials. Focus is put first on materials as wall and ceiling linings. The description is kept to a minimum for a number of tests but more information is available in the references³. Figures and text are taken from this reference.

2.1 International standardisation

2.1.1 Introduction

ISO's principal activity is to develop technical standards required by the market. The work is carried out by experts from the industrial, technical and business sectors which have asked for the standards and which will put them into use. Member bodies are standards organization from 132 countries (end of 1999). Of these, 90 member bodies are entitled to participate and exercise full voting rights within ISO. The most active ISO countries in terms of holding secretariats for technical committees and subcommittees are ANSI USA (140 secretariats), DIN Germany (130 secretariats) and BSI United Kingdom (113 secretariats). ISO activities in figures are shown in Table 1⁴.

Period	Production of international standards	Production of pages
1999	961	12 524
Total output	12 524	356 427

Table 1ISO standardization in figures.

Financially, the operational expenditure for ISO's work is estimated at 150 million Swiss Francs, of which about 30 million Swiss Francs finances the Central secretariat in Geneva (year 1999).

The structure of ISO is shown in Figure 1. The general assembly and the council have the final control of ISO. The technical management board, TMB, has the overall management of technical committee structure and subcommittee structure. TMB establishes and dissolves technical committees and provides outlines of their scopes. The central secretariat supports the work in the technical committees, publishes standards and publications etc.



Figure 1 ISO's structure.

A recent strategic initiative is to focus on increasing the ISO's market relevance. Important goals are a better understanding of market needs and increased involvement of industry, consumers and other stakeholders. Therefore business plans are seen as important tools in this process. Each technical committee will have a business plan which also covers the activities of its subcommittees. The business plans will analyse the conditions and trends in the market sector served by the technical committee and will be required explicitly to link work programmes and sector needs. Thus priorities for which standards are needed can be set.

The technical work in ISO is carried out via technical committees (TC). A TC may have assigned Sub-committees (SC) with working groups (WG) to cover certain areas of work. The actual standardisation work is taking place in the WGs and SCs. Further general information of ISO can be found in refs⁵ and⁶.

2.1.2 ISO/TC 92 covers fire related activities

Fire issues appear in more than one TC but only TC 92 is solely dedicated to the fire field. The scope of TC 92 is Fire Safety and therefore its activities are intended to cover a broad spectrum of standardisation issues in the fire area.

Liaison with other ISO TCs and IEC is maintained, namely with:

ISO/TC 21	Equipment for fire protection and fire fighting
ISO/TC 38	Textiles
ISO/TC 38/SC 19	Burning behaviour of textiles and textile products
ISO/TC 45	Rubber and rubber products
ISO/TC 59	Building construction
ISO/TC 61/SC 4	Burning behaviour
ISO/TC 77	Products in fibre reinforced cement
ISO/TC 85	Nuclear energy
ISO/TC 162	Doors and windows
IEC/TC 20	Electric cables
IEC/TC 89	Fire hazard testing

ISO/TC 92 also has liaison with organisations outside of ISO and is internally built up in a network. The structure is shown in Figure 2.



Figure 2 The structure of ISO/TC 927.

TC 92 has recently been reorganised. It has now an objective to produce standards in the field of fire safety engineering at the same time supporting the standards used for prescriptive purposes. The major activities of TC 92 are given in Table 2.

Unit	Chairman	Major activities
TC 92 Fire safety	B. Sundström, Sweden	General management of the TCs activities
SC1 Fire initiation and growth	K. Yoshida, Japan	Measurement of fire initiation and growth and standards relating to fire scenarios and characteristic fire growth of products.
SC 2 Fire containment	D N Priest, USA	Measurements of fire resistance and integration of fire resistance tests and fire safety engineering.
SC 3 Fire threat to people	D. Gann,	Effects on people from toxic gases, smoke
and environment	USA	and heat. Environmental effects of fires.
SC 4 Fire safety engineering	J Kruppa, France	Develop and maintain a set of ISO documents on the use of fire hazard and risk assessment models.

Table 2Major activities in ISO TC 92.

Test methods for reaction to fire as well as their application to fire safety engineering are covered by SC1.

2.1.3 TC 92/ SC1 Fire initiation and growth

The defined objectives of SC 1 are:

Fire safety engineering (FSE)

- a) Test protocols, measuring techniques and procedures for securing data of fundamental fire properties.
- b) Test protocols, measuring techniques and procedures for input data to FSE models.
- c) Standards relating to fire scenarios and characteristic fire growth of products.

Performance codes

- a) Test protocols for reference scenarios.
- b) Test protocols, measuring techniques and procedures for fire calorimetry.

Prescriptive codes

a) Updating tests already in use.

Test validation

- a) Protocols for determining the precision of fire test procedures.
- b) Test protocols for validation of fire growth predictions.

Instrumentation

a) Protocols for measurement technologies used in fire test procedures.

2.1.4 The present package of standards and technical reports from ISO TC 92/SC1

The activities of SC1 have lead to a number of different standards for different purposes. Some are intended for prescriptive codes. The use of ISO standards in the European harmonisation, see section 3.1.3, and the use of ISO standards in IMO are good examples. Other standards find a use for fire safety engineering like the cone calorimeter. Others are used as reference scenarios, for example the Room/Corner Test, ISO 9705.

The standards and technical reports issued by SC1 are in many cases accompanied by guidance documents. The intention is to provide the user of a certain standard with background information, technical details to support quality assurance in testing and scientific background to that test. In addition bibliographies are provided. Three standards are of a horizontal nature and give advice on how to use the test data from the SC1 package of standards for mathematical modelling and fire hazard analysis. The overall intention is not to leave the user of a SC1 standard only with a test procedure but a deeper understanding of underpinning technical work as well as how the test data can be used to mitigate hazard.

ISO/TR 3814 Tests for measuring reaction to fire of building materials – their **development and application**, and

ISO/CD TR 11696-1 Use of reaction to fire tests – Part 1: Application of results to predict performance of building products by mathematical modelling, and

ISO TR 11696-2 Use of reaction to fire tests – Part 2: Guide to the use of test results in fire hazard analysis of building products

This series of standards contains the principles of the SC1 tests for fire growth measurements, theoretical modelling of fire processes relating to growth and hazard analysis. Any user of the standards enumerated and described below should study this package. The benefit would be the maximum use of a given test standard for its purpose.

ISO/TR 14697 Reaction to fire tests – Guidance on the choice of substrates for building products

This standard recommends substrates on which the product sample can be attached before testing. The standard substrates represent various end use conditions. Thus the test results become more general and the amount of testing can be kept down.

EN ISO 1716 Reaction to fire tests for building products - Determination of the calorific value

EN ISO 1716 determines the potential maximum total heat release of a product when completely burning. The calorific potential of a material is measured in a bomb calorimeter. The powdered material is completely burned under high pressure in a pure oxygen atmosphere.

This standard is also used by CEN, see section 3.1 European Union.

EN ISO 1182 Reaction to fire tests for building products - Non-combustibility

EN ISO 1182 identifies products that will not, or significantly not, contribute to a fire, regardless of their end use.

EN ISO 1182 was first published by ISO during the 70's and is well known. It is used in various building codes and by IMO. This standard is also used by CEN, see section 3.1 European Union. The EN ISO version is shown in Figure 3 and the test specifications are given in Table 3.



Figure 3 EN ISO 1182 test for Non-combustibility.

Table 3EN ISO 1182 test specifications.

Specimens	5 cylindrical samples, diameter 45 mm, height 50 mm
Specimen position	Vertical in specimen holder in the centre of the furnace
Heat source	Electrical cylindrical furnace at 750 °C (measured by the furnace thermocouple)
Test duration	Depends on temperature stabilisation
Conclusions	Classification is based on temperature rise as measured by the furnace thermocouple, duration of flaming and mass loss of the sample

ISO 5657 Reaction to fire tests – Ignitability of building products using a radiant heat source

The ISO 5657 apparatus measures the time to ignition of a sample when exposed to different levels of radiation. The data can be used in fire modelling or for prescriptive purposes. The test apparatus is shown in Figure 4 and the test specifications are given in Table 4.



Figure 4	ISO 5657	Ignitability.
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Table 4	ISO 5657	test specifications.
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Specimens	5 specimen 165 mm square
Specimen position	Horizontal
Heat source	Electrical conical heater giving a heat flux to the specimen of 50 kW/m^2 or other levels as required
Test duration	Until ignition occurs or maximum 15 min
Conclusions	Time to ignition for actual heat flux

ISO/TR 5658 – 1 Reaction to fire tests – Spread of flame – Part 1: Guidance on flame spread, and

ISO 5658 – 2 Reaction to fire tests – Spread of flame – Part 2: Lateral spread on building products in vertical configuration

The spread of flame standard has two parts. Part 1 gives advice to the use of the test and its results. Part 2 contains the description of the hardware and the actual test procedure to be followed. The lateral flame spread as a function of time is measured on a vertical 800 mm long sample that is exposed to heat flux starting at 50 kW/m² and then decreasing to 1.5 kW/m^2 along the length axis. The ISO spread of flame test is similar to an IMO test procedure used for approval of marine products to be used on board ships. The IMO version is also equipped with a system for measuring heat release rate with a thermal method. The test apparatus is shown in Figure 5 and the test specifications are given in Table 5.



Figure 5 ISO 5658 - 2 Spread of flame.

Table 5	ISO 5658 -	2 test	specifications.
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Specimens	3 specimens 800mm x 155mm
Specimen position	Vertical in specimen holder
Heat source	Gas fired radiant panel
Test duration	30 min or earlier if flame front stops or if the flames spreads to the end of the specimen
Conclusions	Average heat for sustained burning*
	Critical heat flux at extinguishments

* Sustained burning = time from test start x nominal heat flux at actual flame front position. Units are MJ/m^2 .

ISO/CD 5658-4 Reaction to fire tests – Spread of flame – Part 4: Intermediate scale test of vertical spread of flame with vertically oriented specimen

A large vertical sample is exposed to heat flux from a gas fired radiant panel. Flame may spread in all vertical directions along the sample surface and the flame spread rate and distance is measured. Due to the size of the sample flame spread is easily observed and measured. This test may also be equipped with thermocouples for measurement of heat output from the fire.

ISO 5660-1 Fire tests – Reaction to fire- Part 1: Rate of heat release from building products (Cone calorimeter method)

The Cone Calorimeter, originally developed by Vytenis Babrauskas⁸, is widely used as a tool for fire safety engineering, by industry for product development and as a product classification tool (IMO). It has been proven to predict large-scale test results in the Room/Corner Test⁹, fire growth in upholstered furniture¹⁰, flame spread on cables¹¹ and in a number of other situations. The Cone Calorimeter is one of the most important tests developed by SC1 over its entire period of activity.

In the Cone Calorimeter, ISO 5660-1, specimens of 0.1 m by 0.1 m are exposed to controlled levels of radiant heating. The specimen surface is therefore heated up and an external spark ignitor ignites the pyrolysis gases from the specimen. The gases are collected by a hood and extracted by an exhaust fan. The heat release rate (HRR) is determined by measurements of the oxygen consumption derived from the oxygen concentration and the flow rate in the exhaust duct. The specimen is placed on a load cell during testing. The Cone Calorimeter standard is revised and a three-part edition is under publication. Part 1 is the traditional test for measurement of HRR, part 2 is intended for smoke measurements and part 3 is the guidance standard. In addition a very simple version of the Cone Calorimeter for measurement only of mass loss rate from the burning specimen will be published.

The test apparatus is shown in Figure 6 and the test specifications are given in Table 6.



Figure 6 ISO 5660-1 and ISO 5660-2 the Cone Calorimeter.

Specimens	3 specimens 100mm x 100mm
Specimen position	Horizontal in specimen holder
Heat source	Conical shaped electrical heater giving a heat flux in the range of 0-100 kW/m^2 . If no specifications are given tests at 25, 35 and 50 kW/m^2 are recommended.
Test duration	32 min unless the burning practically has stopped for 10 min. If there is no ignition test is stopped after 30 min.
Conclusions	HRR data: Time to sustained flaming, curve of HRR versus time, 180s and 300s average of the HRR, peak HRR and possibly other HRR data.
	Smoke data: Graph of smoke production rate per unit area of exposed specimen as well as discrete values for non-flaming and flaming phases. As supplementary information it is also possibly to report the yield of
	smoke per unit mass loss of the specimen, the specific extinction area, σ (units m ² /kg).

EN ISO 9239-1 Reaction to fire tests for floor coverings - Determination of the burning behaviour using a radiant heat source, and

ISO 9239-2 Reaction to fire tests - Horizontal surface spread of flame on floor covering systems - Part 2: Flame spread at higher heat flux levels

These standard tests evaluate the critical radiant flux below which flames no longer spread over a horizontal flooring surface. Flame spread on the floor surface of a corridor exposed to heat flux from a hot gas layer or from flames in a nearby room can be seen as the model case. EN ISO 9239-1 is used for classification in Europe. EN ISO 9239-1 is considered to model the case of wind aided flame spread on the surface of a floor covering. In the case of co-current airflow the heat flux levels used in EN ISO 9239-1 is considered too low¹². ISO 9239-2 exposes the sample to a higher heat flux and would be more versatile as it also covers the co-current airflow case. The test apparatus is shown in Figure 7 and the test specifications are given in Table 7.



Figure 7 EN ISO 9239-1 and ISO 9239-2 floor covering test.

Table 7	EN ISO 9239	-1 and ISO 9239-2 floor	r covering test specifications.
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Specimens	1050 mm long x 230 mm wide
Specimen position	Horizontal
Ignition source	A gas fired radiant panel that gives a heat flux to the specimen. A pilot flame is impinging on the surface of the hot end of the specimen to initiate any flame spread
	EN ISO 9239-1: The maximum heat flux is 11 kW/m ² that drops to 1 kW/m ² at the end of the specimen. ISO 9239-2: The maximum heat flux is 25 kW/m ² that drops to 2.6 kW/m ² at the end of the specimen.
Test duration	Until the flame extinguish or maximum 30 minutes
Conclusions	Classification is based on the critical heat flux below which flame spread is not occurring.

ISO 9705 Fire tests - Full scale room test for surface products, and

ISO/CD 9705-2 Reaction to fire tests - Full scale room tests - Part 2: Theory, and

ISO/CD 13784-1 Reaction to fire tests – Scale tests for industrial sandwich panels – Part1: Intermediate scale test

These standards all make use of the same test equipment, the so-called Room/Corner Test, see Figure 8.



Figure 8 The Room/Corner Test, ISO 9705.

The Room/Corner Test was first published by ASTM in 1982¹³ and then by NORDTEST in 1986¹⁴. The international standard, ISO 9705, was published in 1993.

The Room/Corner Test is a large-scale test method for measurement of the burning behaviour of building products (linings) in a room scenario. The principle output is the occurrence and time to flashover. Also a direct measure of fire growth (Heat Release Rate, HRR) and light obscuring smoke (Smoke Production Rate, SPR) are results from a test.

The product is mounted on three walls and on the ceiling of a small compartment. A door opening ventilates the room.

Experience on testing products has been gained during more than 10 years of work with the Room/Corner Test. A considerable amount of information on product burning behaviour in this method is available and the thermal conditions during a test fire has been carefully mapped^{15,9,16}.

ISO 9705-2 is a valuable source of background data and theory for the test. The complete heat balance of the test room is described. Equations for mass flow are given as well as a

mapping of the heat flux from the burner. ISO 9705-2 also contains a large biography of technical papers related to the Room/Corner Test.

ISO/CD 13784-1 is a variant where the Room/Corner Test is used for the testing of sandwich panels. These panels are generally well insulated and self-supporting. Therefore they are themselves used as construction materials for the test room. In all other aspects ISO/CD 13784-1 testing is performed in the same way as an ordinary ISO 9705 test, see Table 8.

Specimens	Sample material enough to cover three walls and the ceiling of the test room. The wall containing the doorway is not covered except for the ISO 13784-1 method.
Specimen position	Lined inside the room (ISO 9705) or forms the room structure itself (ISO 13784-1)
Ignition source	Gas burner placed in one of the room corners. The burner heat output is 100 kW for the first ten minutes and then 300 kW for another ten minutes.
Test duration	20 min or until flashover
Conclusions	A number of parameters relating to a room fire such as temperatures of the gas layers, flame spread and heat fluxes can be measured. However, the most important outputs are HRR, SPR and time to or occurrence of flashover.

Table 8The Room/Corner Test, ISO 9705 and ISO 13784, test specifications.

ISO/CD 13784-2 Reaction to fire tests – Scale test for industrial sandwich panels – Part 2 Large scale test

This test is typically for sandwich panels and will not be discussed here.

ISO/CD 13785 – 1 reaction to fire tests on facades – Part 1: Intermediate scale tests, and

ISO/CD 13785 - 2 reaction to fire tests on facades – Part 2: Large scale tests

These two standards are addressing the problem of fire spread along the surface of a facade. The reference fire for the large-scale test, part 2, is a flashover inside a compartment in a building followed by a large flame breaking through a window opening and subsequently impinging on the façade. The parameters measured are flame spread and breaking and falling pieces of the façade material. The intermediate scale test is smaller and intended to measure the flame spread only. The test methods will only be applicable for building with many floor levels.

ISO 5659 part 2 or ISO AWI 17471 Reaction to fire tests of building products – optical density of smoke – Determination by a single chamber test

A specimen is exposed to heat flux with or without an impinging pilot flame. Thus smoke is generated both under smouldering and flaming conditions. The smoke produced from the sample is accumulated in an airtight box. The optical density through the smoke is measured by using a lamp and a photocell. IMO is using this standard also for measurement of toxic gas species. There are classification criteria for products to be used on board ships. The apparatus is shown in Figure 9 and the test specifications in Table 9.



Figure 9 ISO 5659 part 2 smoke density chamber.

Table 9 I	SO 5659	part 2 te	st specifications.
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Specimens	9 specimen 75 mm square
Specimen position	Horizontal in a sample holder exposing 65 x 65 mm.
Ignition source	Electrical conical radiator giving the following exposure:
	3 specimen at 25 kW/m ² with impinging pilot flame
	3 specimen at 25 kW/m ² without impinging pilot flame
	3 specimen at 50 kW/m ² without impinging pilot flame
Test duration	Normally 10 minutes
Conclusions	IMO requirements are:
	Average maximum optical density, $D_m \le 200$, 400 or 500 depending on product type and use.
	Maximum measured gas concentrations of:
	CO 1450 ppm, HCl 600 ppm, HF 600 ppm, NO _x 350 ppm, HBr 600
	ppm, HCN 140 ppm and SO_2 120 ppm.

ISO/TR 11925 Reaction to fire tests – Ignitability of building products subjected to direct impingement of flame – Part 1: Guidance on ignitability, and

EN ISO 11925-2 Reaction to fire tests for building products - Ignitability, and

ISO 11925-3 Reaction to fire tests – Ignitability of building products subjected to direct impingement of flame – Part 3:Multi-source test

ISO 11925 series evaluates the ignitability of a product under exposure to a flame. This series of standards covers most cases where a flame test for ignitability determination would be required. Part 1 gives guidance on the theory and use of the ignitability tests. Part 2 is a small flame test, which also appears in the European regulations for Euroclass, see chapter 3.1.9. Part 3 is the multisource test where various flames sources from small flames to very large flames are covered. Each flame source is described in terms of the real case it intends to model, for example a fire in a sauce pan, a waste paper basket or a candle like flame.

ISO TR 14696 Reaction to fire tests – Determination of fire parameters of materials, products and assemblies using an intermediate-scale heat release calorimeter (ICAL)

A vertical sample is exposed to a constant precisely defined heat flux from a radiant panel. The heat release rate is measured by means of the oxygen consumption calorimetry. The test is similar in technology to the Cone Calorimeter. However, the sample in the ICAL test is larger and vertically oriented.

ISO/CD 14934 Reaction to fire tests – Calibration of heat flux meters

A world wide standard for the calibration of heat flux meters is urgently required. Theories of ignition and subsequent flame spread all rely on data for a certain heat flux. National calibration procedures all show small deviations in results compared to each other. The coming ISO standard is intended to solve this situation by creation a worldwide reference from which secondary national references can be deduced.

2.1.5 Future activities

ISO/TC 92 direction is now towards fire safety engineering. The work of SC1 is now emphasising the development of standards for fire safety engineering, reference scenarios and different tools describing the fire growth process. Details of the scope are given under section 2.1.3 "TC 92/ SC1 Fire initiation and growth".

2.2 Europe

The new Europeans system for testing of building materials is covered by the Euroclass system which is explained in detail in chapter 3. The European system is quite complex but the major route for CE marking is by means of a product standard which explains the type of testing etc to be done. For technical textiles no immediate product standard is applicable which means that no specific instruction for mounting, end-use condition, direct application and indirect application are available. The Contex-T project could develop such methods and even contribute to a draft product standard.

2.3 United States

Within the US the major test method for wall and ceiling linings is ASTM E 84 which is an intermediate scale test for interior finishes. In a number of cases also a full scale test is required such as NFPA 286 and UL 1715. These full-scale tests are rather similar, not identical with the ISO 13784 test. Besides this also requirements from the insurers are used, see chapter 3.2. Only the ASTM E84 is shortly discussed below.

2.3.1 ASTM E 84-00a Surface Burning Characteristics of Building Materials

ASTM E 84 is probably the most used or referenced fire test standard and the generally most important in the building codes to characterize flammability of plastics. The test fixture is known as the Steiner Tunnel and was developed by Underwriters Laboratories. The standard is used to assess the comparative surface burning behaviour of building materials and is applicable to exposed surfaces such as walls and ceilings, although building codes rely on data for most cellular product insulation materials, even if behind other barriers. The test is conducted with the specimen in the ceiling position with the surface to be evaluated exposed face down to the ignition source. The material, product, or assembly must be capable of being mounted in the proper test position during the test. Thus, the specimen must either be self-supporting by its own structural quality, held in place by added supports along the test surface, or secured from the back side. The purpose of this test method is to determine the relative burning behaviour of the material by observing the flame spread along the specimen. Flame spread and smoke developed indices are reported, however, there is not necessarily a relationship between the measurements. Table 10 gives test specifications.

Specimens	At least one sample, 0.51 m x 7.32 m x thickness of use up to a maximum
Specimen position	Horizontal
Ignition sources	Two gas burners, 5.3 MJ/min output located 190 mm below the specimen at a distance of 305 mm from and parallel to the fire end of the test chamber
Test duration	10 min
Conclusions	Flame spread index and smoke-developed index (smoke density)

Table 10	ASTM E 84-00a	Test specifications	for flame spread a	and smoke density.

Two preliminary tests are carried out after the apparatus is calibrated. A first run is made with a standard red oak specimen to obtain numerical values of 100 for flame spread and smoke density. In the second preliminary test, an inorganic reinforced cement board specimen is tested in order to obtain zero values for these same parameters.

In the actual main test, the contribution of the material under test to smoke development and flame spread is measured and the material classified on the basis of the results.

2.4 Japan

The Japanese system of test methods was recently changed and one of the major test methods is the cone calorimeter as described in ISO 5660, for a description the reader is referred to the ISO section, see chapter 2.1.3. In addition ISO DTS 17431, an intermediate test, and ISO 1182 are used.

2.5 Australia

The test methods in Australia are based on the cone calorimeter, ISO 5660 and the ISO 9705 room corner test which both can be found in chapter 2.1.3

2.6 China

For China the situation is not yet 100% clear. In the actual regulation methods such as ISO 1182, DIN 4102 and oxygen index are used. From the questionnaire review made within ISO TC92 SC1 WG7, it can be seen that there is a possibility that China will use the European methods and that means use of the SBI method, see chapter 3.1.8.

2.7 Germany

Compliance/conformity with building inspection regulations can be substantiated with the aid of the standards generally recognized as standard building practice, The DIN 4 102 Standard - Fire performance of building materials and components - defines in tangible terms the terminology of fire protection (e.g. combustible, non-combustible) employed in the rules and regulations covering building inspection and fire protection. The original version dates back to 1934. The complete version of this standard includes 20 parts of which now 19 have been issued, Part 20 is in preparation. The status is summarized in Table 11.

DIN 4102-	Fire behaviour of building materials and building components
	1. Building materials, terminology, requirements, and tests (1998-05)
	2. Buildings components (1977-09)
	3. Fire wall s and non-load-bearing external walls (1977-09)
	4. Synopsis' and application of classified building materials, components, and special components (1994-03)
	5. Fire barriers, barriers in lift wells and glazing resistant against fire (1977-09) 6, Ventilation ducts (1977 -09)
	7. Roofing (1998-07)
	8. Small-scale test furnace (1986-05)
	9. Seals for cable penetrations (1990-05)
	11. Pipe encasements, pipe bushings, service shafts and ducts, and barriers across inspection openings (1985-12)
	12. Circuit integrity maintenance of electric cable systems (1998- 11)

Table 11	DIN 4102	(Parts	1-20).
I GOIC II		(1	

13. Fire-resistant glazing (1990-05)
14. Determination of the burning behaviour of floor covering systems using a radiant heat source (1990-05)
15. "Brandschacht" (1990-05)
16. "Brandschacht" tests (1998-05)
17. Determination of melting point of mineral fibre insulating materials (1990-12)
 Fire barriers, verification of automatic closure (continuous performance test) (1991-03)
19. Surface products on walls and under floors inside rooms, test room for additional assessments) (1998-12)
20. Special proof of the burning behaviour outside wall facing)
a) Draft
b) Draft in preparation

For combustible materials the major method is the so called Brandschacht part 15 and 16 which is an intermediate test. A sketch of the test can be seen in Figure 10. The major parameters in the test are vertical flame spread and heat release rate. It should be noted that the German test methods will in the near future be replaced by the European test methods and system given in the next chapter.



Figure 10 Brandschacht test set-up.

2.8 France

In France there is a set of test methods at this moment but the major classification method used is the so called epiradiateur NFP 92-501. A sketch of the method is given in Figure 11. The method is a small scale test methods which measures parameters such as ignition and heat release rate. Similar to the other countries, France will change it methods to the European system (see Annex 2). For thin textiles quite often a specific method is used as the material is too thin for testing in the epiradiateur.



Figure 11 Epiradiateur test set-up

2.9 Nordic Countries

The major methods for testing building materials are ISO 1182, NT Fire 004 and ISO 9705 but several other methods are available as can be seen in the next paragraphs. The description of the methods is limited to NT FIRE 004 as ISO 1182 and ISO 9705 can be found in chapter 2.1.3.

2.9.1 Nordtest methods

Nordic building regulations make reference to common Nordic test methods to a very large extent. Nordtest¹⁷ has published about 50 fire test methods. They cover reaction to fire and resistance to fire in a variety of areas. Relevant Nordtest methods for reaction to fire in the building sector are listed below in Table 12.

Table 12Overview of Nordtest methods.

NT Fire 001/ISO 1182:1990 (1991-09)¹ Fire tests - Building materials - Non-combustibility test

NT Fire 002. (1985-11)1 Building products: Ignitability

NT Fire 003. (1985-11)1 Coverings: Fire protection ability

NT Fire 004. (1985-11)1 Building products: Heat release and smoke generation

NT Fire 006. (1985-11)1 Roofings: Fire spread

NT Fire 007. (1985-11)1 Floorings: Fire spread and smoke generation

NT Fire 012/ASTM E 662-97. (1999-02)1 Specific optical density of smoke generated by solid materials

NT Fire 013/ISO 4589-1, 2 and 3: 1996. (1998-02)1 Plastics – Determination of burning behaviour by oxygen index Parts 1, 2 and 3.

NT Fire 025/ISO 9705:1993. (1993-11)1 Fire tests – Full scale room tests for surface products

NT Fire 030. (1987-02)1 Buildings products: Fire spread and smoke production - full scale test

NT Fire 033/ISO 5657:1997. (1998-02)1 Fire tests - Reaction to fire - Ignitability of building products

NT Fire 035. (1988-02)1 Building products: Flammability and smouldering resistance of loose-fill thermal insulation

NT Fire 036. (1988-02)1 Pipe insulation: Fire spread and smoke production - full scale test

NT Fire 038. (1989-09)1 Building materials: Combustible content

NT FIRE 047. (1993-05)1 Combustible products: Smoke gas concentrations, continuous FTIR analysis

NT FIRE 048/ISO 5660-1:1993 (1993-05)1 Fire tests-Reaction to fire-Part 1: Rate of heat release from building products (Cone calorimeter method)

NT FIRE 050 (1995-05)1 Heat flux meters: Calibration

The procedures for testing the fire performance of building products are described below.

2.9.2 NT Fire 004. Heat release and smoke generation test

The tendency of exposed surfaces of building products to release heat and generate smoke is tested by Nordtest method NT Fire 004. A diagram of the apparatus and the test specifications are given in Figure 12 and Table 13 respectively.

¹ Date when adopted by Nordtest.



Figure 12 Apparatus for determining heat release and smoke generation.

Specimens	3 x 4 specimens, square with sides 228 ± 4 mm and a thickness of 12 ± 3 mm
Specimen position	4 specimens fixed to the rear wall, side walls and top of the fire chamber
Ignition source	Propane burner premixed with gas and air
Test duration	5 or 10 min
Conclusion	Classification is based on the time temperature curve from the fire inside the box as well as the smoke density

 Table 13
 Specifications for the heat release and smoke generation test.

The test specimens in principle form a room lining inside the box. The propane burner then acts as the ignitions source for the "model room fire". The time – temperature relation of the smoke gases leaving the box through the chimney reflects the fire growth and is used for classification. In addition the optical density of the smoke is included.

It is important to notice that in Sweden there is a specific small-scale flame test for tents (SIS 650082). There is also a large scale test described in SP Method 2205.

2.10 Italy

Testing of building materials in Italy is based on the small flame test, similar to ISO EN 11925-2 and a flame spread test, similar to ISO 5658 part 2. Similar to the other European countries, Italy will change its method to the European ones.

2.11 Belgium

In Belgium the actual test methods for building materials are the ISO 1182 test, the French epiradiateur test, see France, and the British surface spread of flame test. Similar to the other European countries, Belgium will change its method to the European ones.

2.12 United Kingdom



Figure 13 British Surface spread of flame test.

The major test method for building materials in the UK is the British surface spread of flame test, an intermediate scale test. A sketch is seen in Figure 13. Similar to the other European countries, the UK will change its method to the European ones.

2.13 Analysis of the different test methods for technical textiles

When analysing the different test method for technical textiles they can be divided in different type of tests:

- 1. Small scale tests which test ignitability, flame spread or heat release. Examples are the epiradiateur, Swedish box test, cone calorimeter, etc. In some case it is very questionable or difficult to mount technical textiles if air gaps are presents but for application as wall lining on a substrate these methods work well.
- 2. Intermediate scale tests which have larger samples and have sometimes the possibility to test the joints but not the whole mounting system. Examples are the ASTM tunnel test, Brandschacht test and the SBI EN 13823 test.
- 3. Full-scale test either in small room such as ISO 9705 or at larger level such as the insurance tests (e.g. FM test).

3

Code review of European countries, use, restriction, classification etc.

In many cases the building codes have different levels depending e.g. on the use of materials such as use of the building material in small or large rooms, evacuation routes, etc. The chapter gives a brief overview of the different regulation in the different countries or regions³. Where possible the situation for technical textiles is explained.

3.1 Europe

3.1.1 The building products directive

The European Commission published the building products directive (89/106/EEG) in 1989. A major reason was to promote free trade of building products. The directive contains six essential requirements that apply to the building itself. One of the requirements is safety in case of fire. Therefore building products must have a fire classification based on the same standards throughout Europe. A member state that regulates for a certain safety level will be able to identify the fire properties of a building product corresponding to that level. Products complying with the essential requirements of the directive are labelled $\zeta \in$.

The function of the building directive relies on a number of specifications. In the fire area a definition of European fire classes, harmonised test standards and rules for attestation of conformity are such important specifications. The European fire classes and the rules for attestation of conformity are published by the European Commission. The reactions to fire standards are published by CEN.

3.1.2 The role of regulators, notified bodies and standardisation bodies

The European standards for reaction to fire are published by the European Committee for Standardisation, CEN. CEN works out the test standards based on specifications given in a mandate from the European Commission. An expert group set up by the European Commission, the group of regulators, RG, worked out the basis for the European system of classification and the request for test methods. The representation in RG is one regulator and one technical expert per country. In addition liaison is maintained with industry and CEN. In particular the work of defining the European system was performed by RG.

Once the system is working there is a continuous need for quality assurance work. This can include interpretation of test procedures, extended application of test data, technical co-operation between test laboratories, agreements of praxis between certification bodies etc. A major role for keeping the system in work is expected to be held by the Fire Sector Group. This group consists of the notified bodies for testing and certification throughout Europe. A notified body is a body, for example a test laboratory or a certification organisation, which a member state has notified to the European Commission as suitable for performing testing/certification under the European system.

Technical work such as development of good technical practise in testing is expected to rely heavily on EGOLF, the European Group of Official Fire Laboratories, and European industrial organisations.

3.1.3 The Euroclasses

The European Commission published the Euroclasses on February 8, 2000. Reaction to fire testing will be done following a new concept compared to existing procedures in Europe. Seven main classes are introduced, the Euroclasses. These are A1, A2, B, C, D, E and F. A1 and A2 represent different degrees of limited combustibility. For linings, B-E represent products that may go to flashover in a room and at certain times. F means that no performance is determined. Thus there are 7 classes for linings and 7 classes for floor coverings. Additional classes of smoke and any occurrence of burning droplets are also given, see Table 14.

Class	Test method(s)	Classification criteria	Additional classification
A1	EN ISO 1182 (¹); And EN ISO 1716	$\Delta T \le 30^{\circ}C; and \\ \Delta m \le 50\%; and \\ t_{f} = 0 (i.e. no sustained flaming) \\ PCS \le 2.0 \text{ MJ.kg}^{-1} (^{1}); and \\ PCS \le 2.0 \text{ MJ.kg}^{-1} (^{2}) (^{2a}); and \\ PCS \le 1.4 \text{ MJ.m}^{-2} (^{3}); and \\ PCS \le 2.0 \text{ MJ.kg}^{-1} (^{4}) \\ \end{array}$	-
A2	EN ISO 1182 (¹); <i>Or</i> EN ISO 1716; <i>and</i>	$\begin{array}{c} \Delta T \leq 50^{\circ}C; \ and \\ \Delta m \leq 50\%; \ and \ t_{\rm f} \leq 20s \\ \end{array}$ $\begin{array}{c} {\rm PCS} \leq 3.0 \ {\rm MJ.kg^{-1}} \ (^1); \ and \\ {\rm PCS} \leq 4.0 \ {\rm MJ.m^{-2}} \ (^2); \ and \\ {\rm PCS} \leq 4.0 \ {\rm MJ.m^{-2}} \ (^3); \ and \\ {\rm PCS} \leq 3.0 \ {\rm MJ.kg^{-1}} \ (^4) \\ \end{array}$	- -
	EN 13823 (SBI)	FIGRA ≤ 120 W.s ⁻¹ ; and LFS < edge of specimen; and THR _{600s} ≤ 7.5 MJ	Smoke production(⁵); <i>and</i> Flaming droplets/ particles (⁶)
В	EN 13823 (SBI); <i>And</i> EN ISO 11925-2(8): <i>Exposure</i> = 30s	FIGRA ≤ 120 W.s ⁻¹ ; andLFS < edge of specimen; and	Smoke production(⁵); <i>and</i> Flaming droplets/ particles (⁶)
С	EN 13823 (SBI); <i>And</i> EN ISO 11925-2(⁸): Emogram = 30c	FIGRA ≤ 250 W.s ⁻¹ ; andLFS < edge of specimen; and	Smoke production(⁵); <i>and</i> Flaming droplets/ particles (⁶)
D	Exposure = 505 EN 13823 (SBI); And	$FIGRA \le 750 \text{ W.s}^{-1}$	Smoke production(⁵); <i>and</i> Flaming droplets/ particles (⁶)
	EN ISO 11925-2(8): Exposure = 30s	$Fs \le 150mm$ within 60s	
E	EN ISO 11925-2(8): Exposure = 15s	$Fs \le 150 mm$ within 20s	Flaming droplets/ particles (⁷)
F	No performance determined	1	

 Table 14
 Classes of reaction to fire performance for construction products excluding floorings (*).

(*) The treatment of some families of products, e.g. linear products (pipes, ducts, cables etc.), is still under review and may necessitate an amendment to this decision.

- (¹) For homogeneous products and substantial components of non-homogeneous products.
- (²) For any external non-substantial component of non-homogeneous products.
- $(^{2a})$ Alternatively, any external non-substantial component having a PCS $\leq 2.0 \text{ MJ.m}^2$ provided that the product satisfies the following criteria of EN 13823(SBI) : FIGRA $\leq 20 \text{ W.s}^{-1}$; and LFS < edge of specimen; and THR_{600s} $\leq 4.0 \text{ MJ}$; and s1; and d0.
- (³) For any internal non-substantial component of non-homogeneous products.
- $(^4)$ For the product as a whole.
- (⁵) $s1 = SMOGRA \le 30m^2 \cdot s^{-2}$ and $TSP_{600s} \le 50m^2$; $s2 = SMOGRA \le 180m^2 \cdot s^{-2}$ and $TSP_{600s} \le 200m^2$; s3 = not s1 or s2.
- (⁶) d0 = No flaming droplets/ particles in EN13823 (SBI) within 600s; d1 = No flaming droplets/ particles persisting longer than 10s in EN13823 (SBI) within 600s; d2 = not d0 or d1; Ignition of the paper in EN ISO 11925-2 results in a d2 classification.
- $(^{7})$ Pass = no ignition of the paper (no classification); Fail = ignition of the paper (**d2** classification).
- (⁸) Under conditions of surface flame attack and, if appropriate to end–use application of product, edge flame attack.

Symbols: The characteristics are defined with respect to the appropriate test method.

ΔT	temperature rise
Δm	mass loss
t _f	duration of flaming
PCS	gross calorific potential
FIGRA	fire growth rate
THR _{600s}	total heat release
LFS	lateral flame spread
SMOGRA	smoke growth rate
TSP _{600s}	total smoke production
Fs	flame spread

Definitions

Material: A single basic substance or uniformly dispersed mixture of substances, e.g. metal, stone, timber, concrete, mineral wool with uniformly dispersed binder, polymers.

Homogeneous product: A product consisting of a single material, of uniform density and composition throughout the product.

Non-homogeneous product: A product that does not satisfy the requirements of a homogeneous product. It is a product composed of one or more components, substantial and/or non-substantial.

Substantial component: A material that constitutes a significant part of a non-homogeneous product. A layer with a mass per unit area $\ge 1.0 \text{ kg/m}^2$ or a thickness $\ge 1.0 \text{ mm}$ is considered to be a substantial component.

Non-substantial component: A material that does not constitute a significant part of a non-homogeneous product. A layer with a mass per unit area $< 1.0 \text{ kg/m}^2$ and a thickness < 1.0 mm is considered to be a non-substantial component.

Two or more non-substantial layers that are adjacent to each other (i.e. with no substantial component(s) in-between the layers) are regarded as one non-substantial component and, therefore, must altogether comply with the requirements for a layer being a non-substantial component.

For non-substantial components, distinction is made between internal non-substantial components and external non-substantial components, as follows:

Internal non-substantial component: A non-substantial component that is covered on both sides by at least one substantial component.

External non-substantial component: A non-substantial component that is not covered on one side by a substantial component.

A Euroclass is intended to be declared as for example **Bd1s2**. **B** stands for the main class, **d1** stands for droplets/particles class no 1 and **s2** stands for smoke class no 2. This gives theoretically a total of about 40 classes of linings and 11 classes of floor coverings to choose from. However, each country is expected only to use a very small fraction of the possible combinations.

In many cases the test methods used are coming from ISO. They are well known and some of them have been in use in various countries throughout the world for many years. ISO/TC92/SC1 has in liaison with the CEN, actively been involved in development of European standards. These standards are called EN ISO to indicate that they are world wide as well as European.

3.1.4 EN 13501 Fire classification and EN 13238 standard substrates

EN 13501¹⁸ basically repeats the classification criteria given in Table 17 for wall and ceiling linings. It also gives general requirements, provides a model for reporting and gives background information of the testing and classification system. Classification reports on products will be given based on EN 13501.

Prior to all testing product samples shall be prepared, conditioned and mounted in accordance with the relevant test methods and product standards. If relevant, ageing and washing procedures are carried out in accordance with the actual product standard.

EN 13501 allows for two additional tests to increase accuracy of classification under certain circumstances. This rule applies to all of the tests described below.

EN 13238¹⁹ recommends standard substrates on which the product sample can be attached before testing. The standard substrates represent various end use conditions. Thus the test results become more general and the amount of testing can be kept down.

3.1.5 EN ISO 1716 Calorific potential

EN ISO 1716^{20} determines the potential maximum total heat release of a product when completely burning, regardless of its end use. The test is relevant for the classes A1, A2, A1_{fl} and A2_{fl}.

The calorific potential of a material is measured in a bomb calorimeter. The powdered material is completely burned under high pressure in a pure oxygen atmosphere.

3.1.6 EN ISO 1182 Non-combustibility

EN ISO 1182^{21} identifies products that will not, or significantly not, contribute to a fire, regardless of their end use. The test is relevant for the classes A1, A2, A1_{fl} and A2_{fl}.

EN ISO 1182 is a pure material test and a product cannot be tested in end use conditions. Therefore only homogenous building products or homogenous components of a product

are tested. The EN ISO version is shown in Figure 3 and the test specifications are given in Table 3.

3.1.7 ISO 9705 The Room/Corner Test

In order to find limit values for the Euroclasses a reference scenario, a room fire test, for the SBI was selected. Test data from the reference scenario could then be used to determine the Euroclass of the product and to "position" EN 13823, the SBI test procedure. The reference scenario chosen is the international standard Room/Corner Test, ISO 9705^{22} , see Figure 8.

The Room/Corner Test is a large scale test method for measurement of the burning behaviour of building products (linings) in a room scenario. The principle output is the occurrence and time to flashover. Also a direct measure of fire growth (Heat Release Rate, HRR) and light obscuring smoke (Smoke Production Rate, SPR) are results from a test.

The development of EN 13823, the SBI, included testing of 30 building products across Europe. The same products were tested according to the reference scenario, the Room/Corner Test. The subsequent analysis then resulted in a correlation between FIGRA (ISO 9705) and FIGRA (SBI)²³. The correlation between the tests is also relating flashover in ISO 9705 to certain Euroclasses, see Table 15.

EUROCLASS	LIMIT VALUE FIGRA(SBI) (W/S)	EXPECTED BURNING BEHAVIOUR IN THE ROOM/CORNER TEST
A2	120	No flashover
В	120	No flashover
С	250	No flashover at 100 kW
D	750	No flashover before 2 min at 100 kW
Е	>750	Flashover before 2 min

Table 15Description of the Euroclasses as the tendency of the actual product to reach
flashover in the Room/Corner Test, ISO 9705.

It is clear that a strict correlation in all cases between the SBI results and the occurrence of flashover in a room test will not be true. However, it is seen that a concept of safety was one of the reasons behind selecting the specific class limits.

3.1.8 EN 13823 SBI

EN 13823 SBI^{24} evaluates the potential contribution of a product to the development of a fire, under a fire situation simulating a single burning item in a room corner near to that product. The test is relevant for the classes A1, A2, B, C and D.

The SBI is the major test procedure for classification of linings, see Figure 14. Test specifications are summarised in Table 16.

The SBI is of intermediate scale size. Two test samples, $0.5 \text{ m} \times 1.5 \text{ m}$ and $1.0 \text{ m} \times 1.5 \text{ m}$ are mounted in a corner configuration where they are exposed to a gas flame ignition source. As for ISO 9705 a direct measure of fire growth (Heat Release Rate, HRR) and light obscuring smoke (Smoke Production Rate, SPR) are principal results from a test. Other properties such as the occurrence of burning droplets/particles and maximum flame spread are observed.



Figure 14 EN 13823, SBI, the Single Burning Item.

The index FIGRA, FIre Growth RAte, is used to determine the Euroclass. The concept is to classify the product based on its tendency to support fire growth. Thus FIGRA is a measure of the biggest growth rate of the fire during a SBI test as seen from the test start. FIGRA is calculated as the maximum value of the function (heat release rate)/(elapsed test time), units are W/s. A graphical presentation is shown in Figure 15.



Figure 15 Graphical representation of the FIGRA index.

To minimise noise the HRR data is calculated as a 30s running average. In addition certain threshold values of HRR and the total heat release rate must first be reached before FIGRA is calculated.

The additional classification for smoke is based on the index SMOGRA, SMOke Growth RAte. This index is based on similar principles as FIGRA is. SMOGRA is calculated as the maximum value of the function (smoke production rate)/(elapsed test time) multiplied by 10 000. The data on smoke production rate, SPR, is calculated as a 60s running average to minimise noise. In addition certain threshold values of SPR and integral values of SPR must first be reached before SMOGRA is calculated.

The detailed definitions of FIGRA and SMOGRA can be found in EN 13823 (SBI).

Table 16EN 13823 SBI test specifications.

Specimens	Samples for 3 tests. Each test requiring one sample of 0.5×1.5 m and one sample of 1.0×1.5 m
Specimen position	Forms a vertical corner
Ignition source	Gas burner of 30 kW heat output placed in corner
Test duration	20 min
Conclusions	Classification is based on FIGRA, THR_{600s} and maximum flame spread. Additional classification is based on SMOGRA, TSP_{600s} and droplets/particles. Details are given in Table 17.

3.1.9 EN ISO 11925-2 Small flame test

EN ISO 11925- 2^{25} evaluates the ignitability of a product under exposure to a small flame. The test is relevant for the classes B, C, D, E, B_{fl}, C_{fl}, D_{fl} and E_{fl}.

The small flame test is quite similar to the DIN test used for the German class B2. Variants of this procedure are also found in other EU member states regulations. The test rig is shown in Figure 16 and the test specifications in Table 17.



Figure 16 EN ISO 11925-2 Small flame test.

Specimens	250 mm long, 90 mm wide, thickness 60 mm
Specimen position	Vertical
Ignition source	Small burner. Flame inclined 45° and impinging either on the edge or the surface of the specimen
Flame application	30s for Euroclass B, C and D. 15s for Euroclass E
Conclusions	Classification is based on the time for flames to spread 150mm and occurrence of droplets/particles. Details are given in Table 17

Table 17EN ISO 11925-2 Small flame test, specifications.

3.1.10 Future developments

There is a footnote in Table 14 referring to linear products. These are cables, pipes and pipe insulation. They will have their own system of classification but no decisions are taken yet on how these products will be treated.

The role of the reference scenario, ISO 9705, is not yet decided. As it was used to identify the limit values in the SBI test for the Euroclasses, ISO 9705 could be used in special cases for direct classification. It was recognised by the RG that such needs may occur for products or product groups that for technical reasons cannot be tested in the SBI. Recently the European Commission has given a mandate to CEN to make ISO 9705 a European standard. Once an EN standard, the test can be used for reference tests for the European system also in the future. This is also the case for application within technical textiles.

3.2 United States

3.2.1 Summary of the actual situation

Building codes in the United States have developed over the years principally by locality and region. Local municipalities can choose to adopt their own building code version. Thousands of such jurisdictions across the country could make this potentially unworkable for material suppliers, designers, architects, and the construction industry. Even today there are virtually no nationally mandated building codes or regulations to cover fire protection and design.

Developing from the many locality-oriented building code interests were some 15 or so code making organizations in the early part of the last century. These organizations merged or reorganized over the years eventually to become the three Model Building Codes that have been in effect since about 1940. These codes, until recently, have been updated every 2 or 3 years. Their use has been preferred in the following regions:

• The West: The Uniform Building Code (CBC) issued by the International Conference of Building Officials (ICBO). The UBC was last updated in 1997. ICBO was founded in 1922.

- The Midwest and Northeast: The BOCA National Building Code issued by Building Officials and Code Administrators International, Inc. The BOCA code was last updated in 1998. BOCA was founded in 1915.
- The South: The Standard Building Code issued by the Southern Building Code Congress International, Inc. (SBCCI). The Standard Building Code was last updated in 1999. SBCCI was founded in 1940.

These model building codes are favoured in the areas where they originate and are adopted in full or in part in state or city building regulations, although this is not mandatory. Local or regional variations in building code acceptance allow for particular concerns of that area; for example, heavy wind resistance is needed along the Gulf Coast and Florida because of the hurricane threat and building codes and regulations have been altered in California because of the likelihood of earthquakes. Localities can adopt a model building code but with specific changes or provisions needed in their particular location. Fire precautions are dealt with comprehensively in these model building codes. Many of the fire standards referenced in the codes are issued by the American Society for Testing and Materials (ASTM).

Many building authorities also use the nationally available NFPA 101 Life Safety Code of the National Fire Protection Association (NFPA), which also covers fire precautions. In large part, NFPA 101 covers fire protection provisions of building construction by occupancy type, a different approach than the other model building codes.

In addition, certain building regulations issued by the federal agencies apply nationwide. One of these regulations is administered by the US Consumer Product Safety Commission (CPSC). The US CPSC is an independent federal regulatory agency, which protects the public's safety by reducing the risk of injury or death from consumer products. The one flammability standard for plastics enforced by CPSC concerns textile floor coverings, mentioned later. Minimum property standards have also been established by the Department of Housing and Urban Development (HUD) and the Department of Health and Human Services (HHS). To obtain federally sponsored mortgage insurance builders and developers would have to conform to these standards.

3.2.2 New Developments in Statutory regulations

3.2.2.1 International Building Code (IBC)

Even with most communities adopting one of the three main model building codes, there have been problems and challenges with material suppliers. In the past, it was difficult for building industry professionals to move into different regions within the United States, marketing their products on a national level. On December 9, 1994, the International Code Council (ICC) was established as a non-profit organization dedicated to developing a single set of comprehensive and coordinated national codes, including the BC and others such as the International Mechanical Code, to promote code uniformity throughout the country. The ICC founders BOCA, ICBO, and SBCCI created the ICC in response to technical disparities among the three sets of model codes in use within the United States.

This single family of codes has received widespread public support from leaders in the building community, including the American Institute of Architects, US Federal Emergency Management Agency, US General Services Administration, Building Owners and Managers Association International, National Association of Home Builders,

National Multi-Housing Council, National Apartment Association, Insurance Industry Building Code Coalition, and numerous other national and international stakeholders in the construction industry, citizens groups, and all levels of government in the United States.

The IBC was first issued in 2000. Because at this time it is relatively new, it may take several years for localities to adopt the new building code, although again, it is not mandatory for them to do so. For example, in October 2000, the California Building Standards Commission voted not to use the IBC as part of its codes process. The code, like the other three model codes has one primary chapter on plastics, which includes most of the flammability regulations. It was agreed that standards adopted by the code would be based on consensus processes, for example, ASTM or NFPA.

3.2.2.2 International Residential Code (IRC)

Since 1972, the Council of American Building Officials (CABO) had served as the umbrella organization for BOCA, ICBO, and SBCCr. In November 1997, it was agreed to incorporate CABO into the ICe. The 2000 International Residential Code replaces the International (formerly CABO) One- and Two-Family Dwelling Code. Designed as a companion to the International Building Code and other International Codes, the IRC concentrates on one- and two-family dwellings, as well as townhouses up to three stories high. Flammability resistance of plastics in residential housing is no more stringent than in other construction and generally must pass either ASTM E 84 for flame spread and smoke or the requirements of the federal standard for textile floor coverings.

All of the aforementioned building codes contain similar structural fire protection measures such as regulations on escape routes, fire resistance of building components, precautions against the spread of fire and smoke, the fire performance of combustible building materials and finished parts, fire alarms, extinguisher systems, and the classification of buildings into different categories of fire hazard (public buildings, cinemas, hospitals, etc.).

3.3 Japan

The Building Standards Law came into effect on November 16, 1950. The aim of this legislation is "to protect the lives, health, and wealth of citizens, and thus contribute to the prosperity of the community, by laying down guidelines and standards for plots of land, building design, furnishing and use."

In 1998, a revision of the main parts of the BSL (Building Standard Law), including the fire safety design systems, was published and came into effect on June I, 2000. This revision has started a process of changing from a specification-based to a performance-oriented design. The revision is defining:

Basic requirements - definition of categories of building parts and materials

- Fireproof, fire preventive construction, non-combustible materials, etc. (BSL Article 2),
- Quasi non-combustible materials, fire retardant materials, and so forth (Enforcement Order Article I).

Performance criteria required for defined building parts and materials

- Fireproof, quasi-fireproof, fire preventive construction (Enforcement Order Article 107,107-2,108),
- Noncombustible, quasi-noncombustible, fire retardant materials (Enforcement Order Article 1,108-2).

Approval of building parts and materials with the required performance

- Approval for "performance evaluation report" of tested materials (based on specific test methods and technical criteria) are submitted by designated examination bodies: (BSL Article 68-26),
- Among the specification-based materials listed in the previous notifications, those that proved to satisfy the new fire performance requirements are presented in the new regulation system.

Details are contained in the Notifications No. 1399 for fireproof, No. 1358 for quasifireproof, No. 1359 for fire preventive construction, No. 1400 for non-combustible, No. 1401 for quasi non-combustible and No. 1402 for fire retardant materials.

3.4 Australia

The Commonwealth of Australia consists of six states - New South Wales, Queensland, South Australia, Tasmania, Victoria, and Western Australia - and two Territories - the Australian Capital Territory where the capital, Canberra, is situated, and the Northern Territory.

Building regulations are the responsibility of the states and territories. All the State and Territory Building Regulations call up the Building Code of Australia (BCA). The individual building regulations are:

- Building Regulations (Australian Capital Territory)
- Building Regulations (Northern Territory)
- Building Regulations (Victoria)
- Local Government Approvals Regulation (New South Wales) . Building Regulations (Queensland)
- Building Regulations (Western Australia)
- Development Regulations (South Australia)
- Building Regulations (Tasmania)

The BCA is published by the Australian Building Codes Board (AB CB), a body formed by the Federal Government with representatives from the states and territories. The BCA is performance based. It contains Objectives, Functional Statements, and Performance Requirements. The Performance Requirement for materials is that they must resist the spread of fire and limit the generation of smoke, heat, and toxic gases to a degree appropriate to the building type. The BCA also contains Building Solutions that are deemed to satisfy the Performance Requirements.

3.5 China

The use of building materials in China basically conforms to the "Fire Law of the People's Republic of China" (issued and implemented in 1984). In practical applications, the performance requirements and the application fields for materials are specified more clearly in the relevant laws and regulations, such as the:

- Fire Protection Code for Building Design (GB 16-87),
- Fire Protection Code for Civil High Rise Building Design (GB 50045-95),
- Fire Protection Code for Building Internal Decorations (GB 50222-95) and others.

To define the fire performance of building materials, the China State Bureau of Quality and Technical Supervision has issued the standard "Classification of the Burning Behaviour for Building Materials" (GB 8624-1997), in which the classification of fire properties of building materials are definitely specified and the technical parameters and the test methods that determine whether the materials reach the relevant class are also described in detail.

3.6 Germany

The regulations relating to building inspection in Germany are derived from the Musterbauordnung (MBO, Mode! Building Code) which forms the basis of all the Landesbauordnungen (LBO, State Building Codes). The building inspectorate is responsible for averting hazards that threaten the life, health, and property of the individual. It is backed by a comprehensive range of legislation, directives, and standards. The MBO and also the LBO [latest version 1997] take into account the European Construction Products Directive CPD 89/1 06/EC (see Chapter 3.1). With respect to combustible technical textiles most of the time the Brandschacht is used on the system.

3.7 France

French building regulations for the public building sector differ from those for the private sector. French fire regulations relate mainly to high-rise buildings, buildings open to the public, residential buildings, workplaces, and classified installations. The regulations are contained in brochures entitled "Securité contre l'Incendie" (Fire Safety) as follows:

- Regulations for buildings open to the public [établissements reçevant du public (ERP)] laid down in Sections R.123-I-R.123-55 of the building and housing code (code de la construction et de l'habitation (No. 1477-1). The implementation of these safety regulations is covered in the Arrêté (decree) of 25. 6. 80 and several modifying and supplementing decrees (No. 1477-I-XI).
- Regulations for high rise buildings [immeubles de grande hauteur (IGH) contained in sections R.122-1 to 122-29 and R.152-1-52-3 of the building and housing code (No.1536) and in the decree of 18.10.1977 modified by the decree of 22. 10.82 regarding the construction of high rise buildings and anti fire and antipanic measures (No. 1536).
- The decree of 31.1.86 modified by the decree of 18.8.86, Official Journal of March 16 and September 20, 1986 regarding fire protection of residential buildings.

The test methods described in the previous chapter are used for technical textiles and requirements are given for the whole system. See Annex 2 for more details on the France system.

3.8 Nordic Countries

The Nordic countries, Denmark, Finland, Iceland, Norway and Sweden, have a long tradition of co-operation in the area of building regulations. The results are fire regulations, testing and classification procedures that are much the same in all of the Nordic countries. The relevant national building regulations are:

- Denmark: Bygningsreglement 1995²⁶ and for small houses, Bygningsreglement 1998²⁶.
- Finland: Suomen Rakentamismääräyskokoelma²⁷.
- Iceland: Byggingerreglugerd nr 441/1998 and Lög um brunvarnir og brunemål nr 41/1992²⁸.
- Norway: Plan og bygningslov av 14 juni 1985 nr. 77. Last update 1 June 1999²⁹.
- Sweden: Boverkets byggregler, BBR³⁰.

On a Nordic basis the "Nordiska Kommitten för byggbestämmelser" (NKB) (Nordic committee for building regulations) had the task of harmonising the Nordic building regulations including those relating to fire protection. NKB issued recommendations, which can be incorporated voluntarily in the national regulations. NKB has published guidelines, "product rules", on testing and classification of product groups that have had an influence on the Nordic regulations. For reaction to fire the relevant documents are given in the table below.

NKB report no 51 ³¹	Nordic guidelines for mutual acceptance of centrally approved building products and official control measures
NKB Product rules no 6 ³²	Floor coverings
NKB product rules no 7 ³³	Roof coverings
NKB Product rules no 14 ³⁴	Linings
NKB product rules no 15 ³⁵	Fire protecting coverings

Table 18Relevant documents for Nordic regulations.

Important to note is that at least in Sweden it is also possible to approve technical textiles by means of a fire performance based approach based on fire engineering.

3.9 Italy

The state building law (Legge Urbanistica) was enacted in 1942, brought up to date in 1967 by further legislation (Legge Ponte), and regulates the principles for the exploitation of building sites and the planning of buildings. Fire precautions must be supervised by the fire brigade.

In 1982 the decree of the President of the Republic No. 577 introduced the concept that all regulations on fire safety are governed by official laws and not just by instructions.

Subsequently a revision of all fire prevention regulations was carried out. The new regulations in the "Decretos" of the Ministry of the Interior apply to theaters, garages, hotels, and gymnasiums and will be completed by codes relating to schools, hospitals, high-rise buildings, and department stores. These regulations concern compartments, exits, safety routes, and all other measures for active and passive fire precautions. Existing buildings require a provisional approval (nullaosta provvisorio) according to Law 818/84.

The classification of the fire behaviour and the certification of materials for the purpose of fire prevention are regulated by the Decreto of the Ministry of the Interior issued on June 26, 1984.

3.10 Belgium

Subsequent to the third phase of state reform in 1988, there are now five different authority levels in Belgium with respect to fire safety regulations in buildings. The highest level of responsibility is the federal government, which has authority for general legislation concerning safety. With respect to fire safety, this means it establishes the minimum requirements that have to be applied generally for new buildings. The authorities at a lower level can add specific, additional requirements.

Reference	Application area	Confirmation by K.B.
NBN S21-204	Fire Safety of buildings - School buildings - General requirements for reaction-to-fire	K.B.of 06/12/1982 (B.S.08/03/1983)
NBN S21-205	Fire Safety of buildings - Hotels and similar buildings - General requirements	K.B. of 25/1 0/1993 (B.S.20/11/1993)
NBN S21-207	Fire Safety of buildings - High rise buildings - Heating and ventilation equipment	K.B.of 05/01/1988 (B.S.28/01/1988)
NBN S21-208-1	Fire Safety of buildings - Design and calculation of installation for smoke and heat extractions Part 1: Large non-divided internal spaces with one level of construction	K.B.of 25/04/1996 (B.S.19/06/1996)

Table 19Overview of Belgian standards.

Classification and testing of the fire performance of building materials are described in the Basic Standards (KB 7/7/1994), modified by KB 19/12/1997. Prescriptions about resistance to fire are given in these standards. In these references there is a link to NBN 713-020. The fire performance of a building material is defined as "the totality of the properties of a building material with regard to the initiation and development of a fire."

For technical textiles Belgium is using at this moment their standard test methods which are based on small scale test methods, but will move to the European system.

3.11 United Kingdom

The following building regulations apply in the various parts of the United Kingdom:

- England and Wales: The Building Regulations 1991.
- Scotland: The Building Standards (Scotland) Regulations 1990-1997.
- Northern Ireland: The Building Regulations (Northern Ireland) 1991.

Technical provisions for use and fire performance of building materials and components are given in the supporting documents to the Building Regulations, for example, under Approved Document B for England and Wales. The technical provisions for England and Wales, and Northern Ireland, are virtually identical. Those for Scotland differ in minor aspects only. All the technical provisions are based on the same test methods specified in British Standards.

The provisions given in Approved Document B are given as guidance and provide one method of showing compliance with the Regulations. There is no obligation to follow that method provided compliance with the Regulations can be satisfactorily demonstrated. For technical textiles the surface spread of flame test is used for the whole system but the regulations also add specific mounting and installation techniques.

4 Results of the questionnaire on requirements

4.1 **Purpose of the questionnaire**

A questionnaire on fire requirements on technical textiles was distributed to all partners within Contex-T. The purpose of the questionnaire was to get an impression of the national requirements for the technical textiles to be used in this project as to date and in the future. It was not the intention to get a complete picture. In Annex 1 the layout of the questionnaire is given.

4.2 **Results of the questionnaire**

In total 12 answers were received from the different partners in the Contex-T project.

Answers cover 6 countries including Belgium (3: BBRI, Centexbel, Sioen), France (2: IFTH and Porcher), Germany (4: Huntsman, Mattes and Amman KG, Polymade, Wagner Tragwerke), Italy (1: Cannobio), Spain (1: IASO) and Sweden (1: SP). In the next paragraph the results are summarised.

4.2.1 National Regulations/Requirements

Country	National regulation	National Requirement	Test method for membranes	National Product standards
Belgium	Regulations as building product	Only for buildings products, not specific for membranes	NBN EN 13501-1 and NBN EN 13501-1 French M classification methods	None
France	Decree of 21 November 2001	Building products: all Euroclasses and M0 to M4 Decorative products NFP92	Building products: Euroclass methods Decorative products NFP92-507 methods	None
Germany	Building regulations	DIN A2 and B1, B2	DIN 4102 methods	None
Italy	Building regulations	Normally Class 1, sometimes Class 2 (circus and sport facilities)	UNI 8456 UNI 9174 Criteria in UNI 9177 and UNI 9175	None
Spain	Building regulations	M2 outside application M1 and M2 for inside applications	UNE 23727 for classification UNE 23723 for testing	None
Sweden	BFS 1993:57 SRVFS 1995:1 (tent)	B s1-d0, C,s2-d0, D,s2-d0	SRVS 1995:1 SIS 650082 Euroclasses	None

 Table 20
 Summary of answers regarding national fire requirements.

4.2.2 Use of European system

Country	Awareness of Euroclasses	Classes required	Most used method for technical textiles	European Product standards
Belgium	3 out of 3	NA	Not yet possible, regulation not in line	None
France	1 out of 2	All classes	All methods	Not for technical textiles. Stretched ceiling EN 14716 Draft standards for wall coverings EN15102 and floorings EN 14041
Germany	1 out of 4	NA	Mainly reference to EN 13501-2 i.e. fire resistance	None
Italy	1	NA	Not yet applied in the regulations	None
Spain	1	NA	Not yet into the system	None
Sweden	1	All classes used mainly B, C or D	All methods	None

 Table 21
 Summary of answers regarding Euroclasses.

From the industrial partners only 2 had obtained results for the Euroclasses methods varying from no approval to E, B and A2.

4.2.3 Other information

Country	Other requirements	Full scale tests	Fire engineering possible
Belgium	No	No	No
France	NFPA701-89,96,99 California US title 19 ASTM D4372 AWTA AS 1530 Part 2 and 3 BS 476 part 6 class0	No	No
Germany	FMVSS302 for car applications FQR 258536 BS 6807 BS5852-1 DIN EN 1021-1 and 2 DIN 75200	In very specific cases it is possible	Yes through calculations but limited (1 out 4 answers)
Italy	No	No	For large structures
Spain	EN 14714 for tensed roofs EN 13859-1 for roof covering EN 13859-2 for outside facades	Products using SP method 2205 on market	No
Sweden	ISO 9705	Yes, SP method 2205	Yes

 Table 22
 Summary of additional information from the questionnaire.

4.3 Conclusions of the questionnaire

The major conclusions from the questionnaire are:

- Many countries still use their national methods and requirements.
- A very important conclusion is that the Euroclasses are only known by some of the responders. In many countries the Euroclasses will be adapted soon.
- Few industrial partners know the Euroclass of their product but all of them are well aware of their own national results.
- Very few countries have or know about the possibility of using fire safety engineering as an alternative to prescriptive regulations.
- In a few cases the industrial partners indicated other requirements from other countries which they need to fulfil.

5 Conclusions

This report gives an overview of the different fire test methods which are applicable for both national and international requirements and regulations. The new Euroclasses for building materials and the test methods associated with these classes are described in detail.

Not only is a descriptive overview given but information has also been collected through a questionnaire among the Contex-T partners. The major conclusions from the questionnaire are that there is still lack of information on the European system and also on the possibilities for using large scale tests in combination with fire engineering.

It is therefore recommended that a short study is made in the Contex-T project in order to characterise the most common type of textile building products (e.g. membranes) on the market according to the new Euroclasses. This will be important as a long term goal of this project should be to produce new products which are fulfilling and optimised for the European system. In a later stage of the Contex-T project use of fire engineering will be investigated for structures made of technical textiles (WP3).

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- ¹⁹ EN 13238 : 2001 Reaction to fire tests for building products Conditioning procedures and general rules for selection of substrates.
- ²⁰ EN ISO 1716 : 2002 Reaction to fire tests for building products Determination of the calorific value.
- ²¹ EN ISO 1182 : 2002 Reaction to fire tests for building products Non-combustibility.

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Annex 1 Layout of the questionnaire

Questionnaire on fire requirements

Within the Contex-T project we are conducting a questionnaire on fire regulations, standards and requirements for technical textiles/membranes in buildings. We would be grateful if you could spend 5 minutes filling in this questionnaire.

Name: _____ email:

Company: _____ RTD, university or industry:

Country:

- 1) What kind of fire regulation is applicable for membranes in your country? Please specify with reference.
- 2) What kinds of requirement are applicable (depending on application)?
- 3) What kind of fire test methods are mainly used, please give a good reference of the standard?
- 4) Are you or your company familiar with the Euroclasses proposed within the CPD (Construction Products Directive)? If no, go further to question 7.
- 5) Are the Euroclasses already used in your Country and if that is true what are the most used test methods (ISO EN 1182, ISO EN 1716, ISO EN 13823, ISO EN 11925) and what requirement (A1, A2, B, C, D or E)?
- 6) If you are an industrial partner, do you have information on the results of your material according to the new Euroclasses and if so are they available for this project?
- 7) Are there any specific requirements for the suspension structure (cables/columns)? If yes, please quote them.

- 8) Are you aware of any product standards for membranes at national or EU-level? If yes, please quote them.
- Are there requirements from non governmental organizations e.g. insurance companies? If yes, please quote them.
- 10) Are there possibilities to use large scale tests as an alternative to the national tests? If yes, please quote them.
- 11) Are there possibilities to use fire engineering based on performance based requirements (using e.g. modeling)?

Return the questionnaire to: SP Swedish National Testing and Research Institute, Fire Technology, Fax: +46 33 41 77 59, E-mail: per.blomqvist@sp.se



CONTEX-T WP1

"Synthesis on fire regulation in France in the building area"

Jean-Marc ORAISON / Pascal RUMEAU (IFTH)

Documentary source

In France, there is a **decree** of 21 November 2002 (JO of 31 December 2002) relating to the fire reaction of products for building construction and decoration. It abrogated the earlier decree of 30 June 1983 and introduced the "Euroclasses" in order to meet the fire safety requirements of the directive for building construction products (DPC) 89/106/CEE of 21/12/1998.

This French decree fixes the testing methods and the classification categories with regard to the fire performance.

General outline

One distinguishes 2 categories of materials:

1 "Building construction products"

2 "Decorative/furnishing materials" (or materials no concerned in the products^①)

One understands by **building construction products** any product which is manufactured with a view to being incorporated in a lasting manner in any work of construction, which covers both buildings as such but also civil engineering works. One can quote some examples of building construction products: floor coverings, stretched ceilings, thermal insulation products, etc.

This first type of products is the subject of a harmonized European standard. These standards are attached to the directive for building construction products (DPC) and make it possible for each product to lead to an EC marking. (There are about 150 harmonized standards).

In contrast, the **products**^② are decorative/furnishing materials, or not being the subject of a harmonized standard (those materials are



submitted to the "M" fire reaction classification). This concerns (among others) furniture, blinds, curtains, net curtains, hangings, wallpapers, etc.

The classification of the **products** ① **and** ② according to their fire reaction characteristics is carried out in accordance with the provisions, respectively of the **appendix 1** [classification A1, A2, B, C, D, E and F...] and **appendix 2** [classification M0, M1, M2, M3 and M4] of the **decree** (cf. Doc. JO of 31 December 2002).

Building Construction Products ①

The classification of the **products**^① is done with the title of EC marking, on the basis of the harmonized European standard of classification EN 13501-1 (Euroclass): it is a **fire classification standard** which describes the fire reaction tests to be carried out according to the product to test, and the classification obtained according to the test results.

Principal **testing standards** concerning the floor, the walls and the ceilings are:

- Thermal attack by a single burning item: **SBI EN 13823** (for walls and ceilings, floor coverings are not concerned)

- Radiant panel **9239-1** (for floor coverings)

And also

- Spread of Vertical Flame (SVF): Single flame source test EN ISO 11925-2

- Maximum calorific value (HCV): **Heat of combustion EN ISO 1716** (for non combustible materials (mainly mineral or with a very low organic part)

- Pyrolysis behaviour at 750°C: **Test of non-combustibility EN ISO 1182** (for fireproof materials)

To note: the A1 classification = EN ISO 17016 + EN ISO 1182

The only textile products concerned with the DPC are:

- Stretched ceilings: product standard EN 14716

- Wall coverings into lay (wallpapers, cork...): **draft product standard EN 15102** in project (not yet EC marking at the moment)

- Textile floor coverings (Pile carpets or moquette): **product standard 14041**

The **product standard** defines the tests (with the associated **testing standards**) to which must be subjected the product indicated as such.



Example: the product standard "stretched ceilings" provides that the product must be submitted to:

- Mechanical tests according to methods EN...

- Chemical tests according to EN...

- Test of fire resistance (EN 13501-2)

- Tests of fire reaction (EN 13823 / EN ISO 11925-2 / Classification according to the standard EN 13501-1)

Products^②

The classification of the **products**^② is done according to the **fire classification standard** [**NF P 92-507** / "M" Classification].

It is to some extent the equivalent of the European standard EN 13501-1. All products of category² are concerned with the "M" classification.

There is not **product standard** concerning these products. The principal **testing standards** are:

- **NF P 92-501**: **Radiation test** (Epiradiator) for rigid materials

- NF P 92-503: Electrical burner test for flexible materials

- NF P 92-506: Test for flooring for carpets, floor coverings

- NF P 92-504: Flame persistence and speed of the spread of flame for fusible materials

- **NF P 92-505: Dripping test** (test of drops for fusible materials)

To note:

The classification of **rigid materials**, or **flexible materials thicker than 5mm** is done from the results of the tests carried out according to the **testing standard NF P 92-501** (epiradiator) with complementary tests **NF P 92-504** and **NF P 92-505** for fusible materials [M1, M2, M3, M4 classification].

For **flexible materials with a thickness less than or equal to 5 mm**, the criteria of classification are defined starting from the results obtained according to the **testing standard NF P 92-503** (electric burner) with complementary tests **NF P 92-504** and **NF P 92-505** for fusible materials [M1, M2, M3, M4 classification].

A **MO classification** requires the determination of the HCV (Maximum calorific value) according to the **testing standard EN ISO 1716 (Heat of combustion)**.

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