The use of fire classification in the Nordic countries – Proposals for harmonisation

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Preface

This project is financed by NICe, Nordic Innovation Centre. The project is funded within a programme called “grenselös region”, with the general aim to harmonise rules and regulations in the Nordic countries.

Since the introduction of the Construction Products Directive the implementation of harmonised standards for fire testing and classification is an on-going process in the Nordic countries. This project aims to define the status of rules and regulations of today and propose further harmonisation of fire regulations for building products.

It is up to the regulators in each of the Nordic countries, if and when – and to which degree – they will follow the proposals given in this report.

Apart from research and test institutes also the building authorities in Sweden, Norway, Denmark and Iceland have taken part in the project. The authorities have sponsored the project by working hours, which forms 50% of the total project budget.

Several people have contributed to the report. Apart from the authors considerable efforts have been made by Vidar Stenstad (Statens Bygningstekniske etat), Ejner Jerking (Erhvers – og Byggestyrelsen), Henrik Bygbjerg and Ejnar Danö (Dansk Brand- og sikringsteknisk Institut), Anders Johansson and Michael Strömgren (Boverket), Lars Boström and Joakim Albrektsson (SP Fire Technology) and Gudmundur Gunnarsson, (Brunamalastofnun)

Summary

The implementation of the Construction Products Directive (CPD) has opened up the European market for building products. A CE-marked product can be put on the market anywhere within the EU. The system with harmonised standards for testing and classification has lead to a common language for the regulators in each member state. However this process is complicated and the speed of implementation in national building codes varies between countries. In the Nordic countries the process has progressed quite far and the harmonised classes have been implemented in the national building codes. This does however not mean that all countries use the same class for the same building type, the building codes differ to a certain extent in this matter.

This report has been written in cooperation between the fire research and testing institutes and the building authorities in the Nordic countries. The proposals given are a result from discussions within the project and aim to reduce obstacles from a regulation point of view for industry, authorities and other actors within the construction sector. The desired outcome of this process is that the development and movement of products over the borders will be more efficient and cost effective.

The report discusses and proposes a common use of the European harmonised fire classes, both within the field of fire resistance and reaction to fire. By a systematic review of different types of products the report gives the status as it is today and proposes what can be done to even more harmonise the building codes.

In the field of fire resistance there is still not many harmonised product standards available. Therefore the CE-marking process has not progressed so far for products in this area. In general terms the use of European harmonised classes are quite similar in the Nordic countries. A major difference is however that some countries apply reaction to fire requirements for materials used in a fire resistance building element, while other do not.

An important product with fire resistance properties is fire doors. A complete harmonisation of classes used on fire doors in the Nordic countries requires a substantial adaption of the Nordic regulations. A straight forward action is to harmonise the smoke classes. It is recommended that either S_a or S_m class is used.

Smoke ventilation systems are an example of a fire resistance product that can be CE-marked today. So far only Denmark requires CE-marked smoke ventilation systems. A proposal is given to use the same classes in all Nordic countries, even if all relevant properties can not be harmonised due to regional differences (snow-load, wind-load etc.).

In the field of reaction to fire, a big product group is internal and external surfaces. For internal surfaces it is proposed to exclude the use of the C class and only permit products which don't produce burning droplets. For external surfaces it is proposed to permit burning droplets (d2) and to require only the lowest class for smoke production (s2).

An area where there is still no published harmonised product standard is technical insulation products, which include pipe insulation. For pipe insulation however, the available reaction to fire classes have been published by a commission decision a couple of years ago and the proposal is to use five defined classes for the Nordic countries. Those classes will replace, for example, the PI, PII and PIII classes which have been used in Sweden and Norway.

For cables there are still too early to propose common classes. Even if a commission decision on cable classes is published there is still work going on how to implement

testing procedures for CE-marking of cables. Therefore it is proposed for cables to await the outcome of further research.

1 Nordic harmonisation of building regulations – earlier work

1.1 NKB

On a Nordic basis the "Nordiska Kommittén för byggbestämmelser" (NKB) (Nordic Committee for building regulations) had the task of harmonising the nordic building regulations concerning the rules for type approval of products and the factory product control systems of approved products. NKB issued recommendations, which could be incorporated voluntarily in the national regulations.

The guidelines, “product rules”, on testing and classification of product groups came into force from January 1985 until January 1990. They have played a significant role within the Nordic countries regarding the movement of building products over the borders. Since the Construction Products Directive came into practise use the NKB product rules have more and more been replaced by the new European system for testing and classification.

Below is a list of documents that have been issued through NKB.

- NKB Utskotts- och arbetsrapporter 1994:07 “Funktionsbestemte brandkrav og teknisk vejledning for beregningsmaessig eftervisning”.
- NKB report no 51, Nordic guidelines for mutual acceptance of centrally approved building products and official control measures
- NKB product rule no 1, fire doors, January 1985
- NKB product rule no 2, prefabricated steel chimneys, January 1986
- NKB product rule no 6, floorings, July 1988
- NKB product rule no 7, roofings, January 1989
- NKB product rule no 14, surface linings, January 1990
- NKB product rule no 15, fire protecting coverings, 1990
- NKB product rule no 16, non-loadbearing walls, 1990

2 Building regulations in the Nordic countries

2.1 Levels of regulatory tools

The general principles and levels of regulatory tools concerning fire safety are described in Figure 1. The highest level defines the objectives; safety in the case of fire. The next level includes two possible routes: Either pre-accepted design using fire classes and numerical values or performance based design utilising fire safety engineering (FSE). Finally, at the third level, either European test and classification methods or engineering methods are used to define required classes or performance of materials, products and building elements.

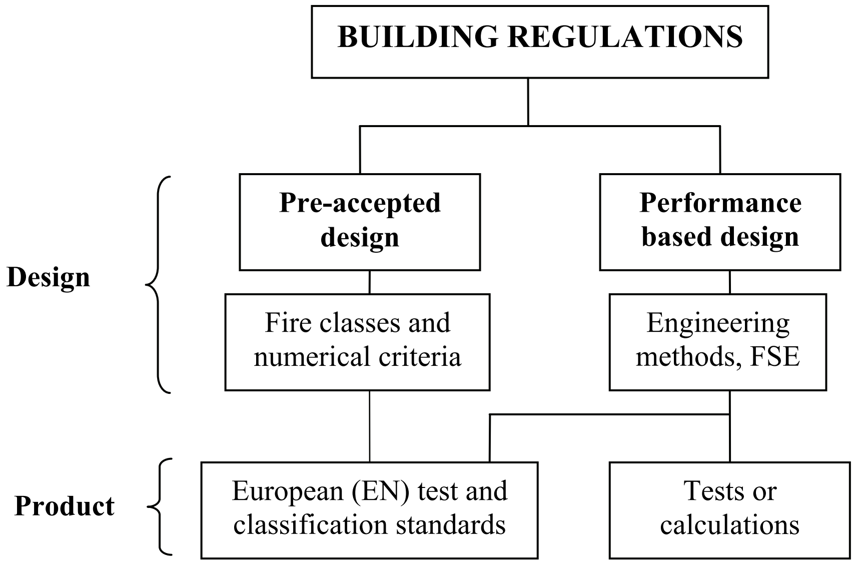

Figure 1. Schematic presentation of regulatory tools

In Table 2-1 below consequences, relevance and possible actions related to this project caused by differences in regulations and requirements are shortly described. Only the test and classification methods (bottom of the table) and essential requirements in case of fire (top of the table) are harmonised. In the design level there are a lot of differences between the Nordic countries.

The relevant national building regulations are:

- Denmark: Bygningsreglement 2008.
- Finland: Suomen Rakentamismääräyskokoelma. Finlands byggbestämmelsesamling. The National Building Code of Finland
- Iceland: Byggingerreglugerd nr 441/1998.
- Norway: Technical regulations under the planning and building Act 1997.
- Sweden: Boverkets byggregler, BBR.

Table 2-1. Building regulations and requirements – concerns related to this project

Buildings	Regulations and standards	Requirements	Consequences, relevance and possible actions in this project
Building design	Building regulations	Essential requirements	Objective statements. Safety levels not defined.
	(Pre-) accepted design solutions or "accepted examples" (former prescriptive regulations)	Performance criteria or requirements. Fire classes and numerical values	Defines the safety levels indirectly. Application dependent criteria or requirements; a lot of differences between countries. Long-term harmonisation by means of co-operation between regulators, industry and research. Comparisons and proposals for adjustments of requirement levels needed. Performance based reviews of requirements.
	Performance based design (FSE)	Absolute or comparative performance criteria	Fire safety engineering used on national basis; acceptable safety/risk levels are not defined. Need for international co-operation for agreeing basics: acceptable safety levels (acceptance criteria), methods for verification, competence and control of designers.
Building products	Product standards. Test and classification standards. End use applications.	Fire classes	Same methods used in Europe. Different classes applied to same end use applications quite often. New methods and procedures are being proposed, e.g.: - Large scale test methods for certain product groups with classification criteria belonging to them - Reaction to fire classes for materials - Glowing combustion test method with classification criteria belonging to it

See also the BENEFEU report "The potential benefits of fire safety engineering in the European Union" (dated 19 July 2002, EC contract EDT/01/503480).

2.2 Performance-based design and Fire Safety Engineering (FSE)

During the last decades, building codes have been shifting from prescriptive to performance-based, to comply with the evolution of modern building design. At the same time rapid progress has been made during the last decades in Fire Safety Engineering. Already in 1994 the Nordic Committee for Building Regulations (NKB) decided upon harmonised Nordic rules for performance-based fire codes /1/. Many other countries and regions in the world have agreed upon similar rules for performance-based fire safety design /2/. The purpose of this section is to briefly describe performance-based building codes and discuss how the principles of Fire Safety Engineering are used in the design of modern buildings.

2.2.1 Fire safety and performance-based building codes

Fire safety regulations can have a major impact on the overall design of a building with regard to layout, aesthetics, function and cost. During the last decades the rapid development within modern building technology has resulted in unconventional structures and design solutions; the physical size of buildings is continually increasing; there is a tendency to build large underground car parks, warehouses and shopping complexes. The interior design of many buildings with large light shafts, patios and covered atriums inside buildings, connected to horizontal corridors or malls, introduces new risk factors concerning spread of smoke and fire. Past experiences or historical precedents (which form the basis of current prescriptive building codes and regulations) rarely provide the guidance necessary to deal with fire hazards in new or unusual buildings.

At the same time there has been a rapid progress in the understanding of fire processes and their interaction with humans and buildings. Advancement has been particularly rapid where analytical fire modelling is concerned. Several different types of such models, with a varying degree of sophistication, have been developed in recent years and are used by engineers in the design process.

As a result, there is a worldwide movement to replace or to complement prescriptive building codes with ones based on performance. Instead of prescribing exactly which protective measures are required (such as prescribing a number of exits for evacuation purposes), the performance of the overall system is presented against a specified set of design objectives (such as stating that satisfactory escape should be effected in the event of fire). Fire modelling and evacuation modelling can often be used to assess the effectiveness of the protective measures proposed in the fire safety design of a building.

The need to take advantage of the new emerging technology, both with regards to design and regulatory purposes, is obvious. The increased complexity of the technological solutions, however, require higher levels of academic training for fire safety engineers and a higher level of continuing education during their careers. A number of textbooks /3/, /4/, handbooks /5/ and design guides /6/ have been produced for this purpose, the references are given as examples of such texts.

2.2.2 Verification

In spite of the progress made in Fire Safety Engineering as a result of performance based-codes being introduced, it must be mentioned that it can be problematic for designers and authorities to verify that performance-based requirements are fulfilled. Lundin /7/ carried out work where fire protection documentation from forty-six projects was studied, together with a detailed analysis of the Swedish building regulations and an extensive risk analysis of a class of buildings. The results showed that there is a lack of regulation and guidance on how to perform verification, which can lead to arbitrary design decisions. Lundin questioned whether the approach taken by many practitioners would be deemed sufficient to fulfil the requirement laid out in the building regulations. He stated that few tools were available to address these issues in a practical way, but presented a procedure for verification and suggested general quality demands for verification as a means of addressing these issues.

The following description in 2.2.2 is mainly based on /8/.

Verification methods
The verification process includes a systematic analysis and a comparison of the results with defined performance criteria. A method of verification therefore has to include both a method of analysis and predetermined acceptance criteria.

An analysis may be performed both qualitatively and quantitatively, except where only a qualitative analysis is possible or where a qualitative analysis is sufficient for the purpose of the analysis. This means that the qualitative analysis is always required. One of the main outcomes of the introductory parts of the qualitative analysis is the decision whether a quantitative analysis is necessary and/or possible.

A quantitative analysis may be probabilistic or deterministic, or a combination of the two (example: index methods).

Methods of analysis
Quantitative analysis - probabilistic
A probabilistic analysis usually includes the making of model in the form of an event tree for a large number of fire scenarios for the design object. In principle it should include an event tree for all scenarios, but a qualitative analysis may make it possible to exclude most scenarios except those that are among the most critical to occur in the building object. For each event in each scenario there is a favourable and a less favourable outcome/consequence that may be linked to a probability. By multiplying the probabilities for each sequence of events, you end up with the quantity of risk for individual scenarios for comparison.

This method of analysis is considered to require a lot of resources and is seldom performed in the Nordic countries. However, its use will increase especially in large and high risk applications.

Quantitative analysis - deterministic
In a deterministic analysis a detailed analysis is made of one or a small number of scenarios for the purpose to examine the consequences. This means that one or rather few of all the branches (string of events) that make out a complete tree of events for possible fires in a building will be analyzed. This is in contrast to the probabilistic analysis, which includes “all” the branches.

Calculation/simulation of the smoke development and spreading through the object of design using CFD (computational fluid dynamics) and the required time of egress for one or more fire scenarios, are examples of deterministic analysis.

This method of analyzing, which is limited to subsystems (or a part of a subsystem) is less demanding of resources and is often performed in the Nordic countries in support of qualitative analysis. Deterministic analysis has also been the main focus in the ISO/PDTR 13387-series developed by ISO/TC 92/SC 4. A brief overview of the main principles is given in section 2.2.3.

Quantitative analysis - combined methods
Index methods are semi-quantitative methods that are completely or partly based on qualitatively expert evaluations. These methods generally involve both evaluation of probabilities and consequences of events. The index method called FRIM-MAB (which is developed in a Nordic project related to the fire safety in multi-story timber frame apartment buildings) is sometimes used in the Nordic countries as a part of the verification.

Acceptance criteria
Acceptance criteria may be *comparative* as well as *absolute*.

Comparative criteria
The Nordic building regulations do not give any absolute quantitative requirement for the fire safety. The level of safety is, however, in some countries given indirectly by numerous principal solutions and sets of performance criteria (pre-accepted design solutions or “accepted examples”) based on former prescriptive regulations. By using methods of analysis comparative evaluations may be performed between the design object and the set of pre-accepted performance criteria. Required time of egress, risk index and FAR-values may be values to compare, which mean the parameters may be both deterministic and probabilistic.

Absolute criteria
As an example, the NKB stated and quantified a number of absolute deterministic acceptance criteria that must be fulfilled if humans are to be considered to survive a particular fire environment. These criteria are for example in the form of threshold values for maximum heat flux and maximum temperatures which humans could be exposed to, maximum levels of gas concentration of various gases, the minimum visibility distance, and a number of other such criteria. These criteria are very similar to those used in various other countries. It is essential in use of such criteria that realistic factors of safety or safety margins are used to include the uncertainties in data and methods used and consequences failure in the measures designed.
An example of a probabilistic and absolute criterion may be the expected number of people to die in a year. Even though this criterion in principle is absolute, it may in reality be comparative because usually it is based on history. Statistics and experiences are needed to determine the criterion.

2.2.3 Fundamental principles of deterministic Fire Safety Engineering

The rapid progress in the understanding of fire processes and their interaction with buildings and humans has resulted in the development of a wide variety of models that are used to simulate fires in compartments and to simulate the escape of humans from buildings.

The enclosure fire models can roughly be divided into three categories; CFD models; zone models; and hand-calculation models. Similarly, models for simulating the escape of humans from buildings range from being simple hand-calculation models to being relatively complex computer programs. A more detailed description of the various types of models is given in /9/. Such models can be used as tools in the design process and the results from the simulations can often be used in design reports as indications that various performance-based criteria are fulfilled.

The field of Fire Safety Engineering encompasses topics from a wide range of engineering disciplines as well as material of unique interest to fire safety engineering. The fundamental topics of interest have been divided into the following five modules /10/:

- **Fire fundamentals.** This module provides the basic chemistry and physics for the understanding of fire.
- **Enclosure fire dynamics.** This module gives an understanding of room fire growth and spread mechanisms. It is of particular interest in regards to fluid mechanics as it deals among others on vent flows, heat flow, ceiling flames and jets, smoke filling and evacuation and venting.
- **Active fire protection.** This module deals with the analysis and designs of active fire protection fires such as detection system, automatic and manual suppression system and smoke management system.
- **Passive fire protection.** This module develops an understanding of the traditional practices of the traditional code approach to the structural aspect of passive fire protection for building.
- **Interaction between fire and people.** People can interact with fire in many different ways, e.g. they can cause fire ignition. The movement of people and access of fire fighters are essential concerns to the fire safety engineer.

2.3 The Construction Products Directive – CPD

The Construction Products Directive (89/106/EC) was adopted in December 1988 and published in the Official Journal February 1989. The aim was to create a European Single Market by removal of regulatory barriers to trade.

When the Construction Products Directive came into force it was clear that harmonised methods for fire testing and classification of building products were required as a prerequisite for allowing building products to be CE-marked and to have access to a large market.

Reaction to fire as well as **resistance to fire** of building products and building elements were included. As there were no common tests in use in the different EU member states (apart from the Nordic countries where common tests partly have been used) it became necessary to develop or modify existing international standards in order to have a set of standards that would be common to all countries. This task was given to CEN, the European Committee for Standardization. A CEN standard is called EN, European Norm, and the CEN member countries must implement a CEN standard within a certain time. Considerable progress has been made by CEN in producing standards and a package for products reaction to fire has been in operation since some years. Many of the required standards for fire resistance are also operational.

Having the test standards available is not enough, as the classification criteria for the European fire classes must also be available. In order to make the European classification system a part of the legal system in EU the European Commission takes the formal decision and publishes that in the publication the Official Journal. The European fire classes according to the EN 13501-series are expressed in a completely different way compared to former national systems.

The **reaction to fire** system includes 40 classes for construction products, excluding floorings, linear pipe thermal insulation and cable products. The number of classes for floor coverings is 11. For linear pipe thermal insulation products there are 40 classes (the number of cable classes is not set for the time being).

A European reaction to fire class is declared as for example B-s1,d0. The reason for the many classes is that each member state wishes to identify its own fire safety level in its own building code. Considering the differences in testing and classification system between countries it is clear that a large number of European fire classes can be the result. However, each country uses only a very small fraction of the possible combinations.

Table 2-3 gives a summary on the situation of the implementation of the European reaction to fire classification system in the Nordic countries. The figure shows the national classes in each country and the corresponding European reaction to fire classes implemented in the building regulations.

Table 2-3. European classes for Reaction to Fire (except flooring) – National translations and implementation (the subclasses for smoke and droplets are excluded)

Euroclass	**Earlier national class**				
	Denmark	Finland	Iceland	Norway	Sweden
Officially implemented in building codes	2004	2002	2006	2003	2002
A1		NC	NC		
A2	NC	NC	NC	NC	NC
B	A	1/I, 1/II	A	In1/Ut1	I
C		1/-			II
D	B	2/-	B	In2/Ut2	III
E					
F		-/-			

NC = Non-combustible
A = low ignitability, low heat release, low smoke production
B = moderate ignitability, moderate heat release, moderate smoke production
1/I = low ignitability/low heat release, low smoke production
In1 = low heat release, low smoke production, indoor use
Ut1 = low heat release, low smoke production, outdoor use
I = surface finish class I (low heat release, low smoke production)

Annex B gives a summary of the situation of the implementation of the European reaction to fire classification system in 2006. The information was provided by the Fire Safe Use of Wood Network /11/.

The **resistance to fire** system is a combination of performance characteristics (loadbearing capacity R, integrity E, insulation I, radiation W, mechanical action M etc.) combined with the classification period in minutes, as for example REI 120-M.

The visible sign that a product conforms to the requirements of the Construction Products Directive is the CE-mark. To be able to CE-mark a product all the essential requirements of the directive must be declared. This includes also other properties than fire, for example insulation properties. The full set of requirements is covered by a product standard. For the case of fire the product standard makes reference to the relevant classification standard. At present approximately 350 product standards are published in the Official Journal, which is approximately two thirds of the total number of product standards planned.

3 Implementation of the CPD in the Nordic countries – present situation and proposals

In the following tables the column "Old class" refers to the national classes which have been in use or still are in use. The column "New class" refers to the harmonised European reaction to fire and fire resistance classes, which in some cases/countries are used in parallel with the old class.

3.1 Materials

Definitions distinguishing "materials" from "products" (in accordance with the Commission Decision 200/147/EC and the European Standard EN 13501-1 /12/):

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

Product: Material, element or component about which information is required.

Present situation

An overview of the reaction to fire classes for materials implemented in regulations in the Nordic countries is given in Table 3-1.

Table 3-1. Reaction to fire classes for materials in the Nordic countries

	New class	Old class
Denmark	Material class A2-s1,d0 Material class B-s1,d0 Material class D-s2,d2 Lower than material class D-s2,d2	Non-combustible material Class A material Class B material Unclassified material
Finland	A1 (fire wall) A2-s1,d0 B-s1,d0 C-s2,d1 D-s2,d2	Non-combustible Non-combustible, nearly non-combustible Non-combustible, nearly non-combustible 1/I 2/-
Iceland	A2-s1,d0 B-s1,d0 D-s2,d0 Lower than D-s2,d0	Non-combustible material Class A material Class B material Unclassified material
Norway	A2-s1,d0 Lower than A2-s1,d0	Non-combustible or limited combustible Combustible
Sweden	A2-s1,d0 E	Non-combustible Material difficult to ignite

The table shows that the Nordic countries express reaction to fire classes for materials in different ways.

Discussion

The reaction to fire classes A1 and A2-s1,d0 are used in all the Nordic countries, and are in most cases understood in the same way, i.e. on material related level. The reaction to fire properties on material related level can be characterized by the fact that the properties are seen as independent of the end use application for the product – contrary to the normal classification system in which the product is classified in its different end use applications.

Denmark has proposed a European solution for dealing with reaction to fire requirements on material related level /13/.

Supplementary to the statements given above the following explanations are added for each of the Nordic countries.

<u>Denmark</u>

DBI Method No. FIRE01:2007 /14/ give specifications for testing and classification for the reaction to fire properties on material related level in relation to the SBI test and the small flame test, i.e. by a characterization testing and classification procedure giving results, which are independent of the concept "end use application".

The Danish rules in "Collection of examples for fire protection of buildings" imply reaction to fire requirements on material related level for materials, coverings and building elements.

When the Danish rules prescribe
- material class A2-s1,d0
- material class B-s1,d0
- material class D-s2,d2
then this implies that each of the products in question shall fulfil the in pursuance of the stated class designation prevailing reaction to fire requirements on material related level.

When the Danish rules prescribe
- covering class K_1 10 B-s1,d0
- covering class K_1 10 D-s2,d2
- covering class K_2 30 A2-s1,d0
- covering class K_2 60 A2-s1,d0
then this implies that the covering shall give the prescribed fire protection ability (for 10 or 30 or 60 minutes) and that each of the products from which the covering consist shall fulfil the in pursuance of the stated class designation prevailing reaction to fire requirements on material related level.

When the Danish rules prescribe
- building element class REI 120 A2-s1,d0
- building element class R 120 A2-s1,d0
- building element class REI 60 A2-s1,d0
- building element class EI 60 A2-s1,d0
- building element class R 60 A2-s1,d0
- building element class REI 30 A2-s1,d0
- building element class EI 30 A2-s1,d0
- building element class R 30 A2-s1,d0
- building element class R 60 D-s2,d2
- building element class EI 60 D-s2,d2
- building element class R 30 D-s2,d2
- door class EI_2 60-C A2-s1,d0

then this implies that the building element/the door shall give the prescribed fire resistance (for 30 or 60 or 120 minutes) and that each of the products from which the building element/the door consist shall fulfil the in pursuance of the stated class designation prevailing reaction to fire requirements on material related level.

Finland

In Finland material type requirements are related to minimum performance levels in some applications or to certain conditions on materials used in building elements. Some examples are given in the following:

- There are some less strict requirements than usually demanded for load-bearing constructions, if the insulation materials of the uppermost floor are at least of class A2–s1,d0.
- The framework of external walls of buildings of class P2 with 3-4 storeys may be made of building materials of class D-s2,d2. The insulation material and other filling material shall in this case be of at least class A2-s1,d0.
- Building materials used in external walls in buildings of class P1 shall be mainly of at least class B–s1,d0.
- Thermal insulation which is inferior to class B–s1, d0 shall be protected and positioned in such a manner that the spread of fire into the insulation, from one fire compartment to another and from one building to another building is prevented.
- Internal wall and ceiling surfaces in buildings of class P2 shall be provided with a protective covering made of building materials of class A2–s1,d0 if the construction is made of materials of class C–s2,d1 or worse.

Iceland

In the Icelandic building regulation there is a collection of examples for fire protection of buildings which imply reaction to fire requirements on material related level for materials, coverings and building elements.

When the Icelandic rules prescribe
- material class A2-s1,d0
- material class B-s1,d0
- material class D-s2,d0

then this implies that each of the products in question shall fulfil the in pursuance of the stated class designation prevailing reaction to fire requirements on material related level.

When the Icelandic rules prescribe
- covering class K 10 B-s1,d0
- covering class K 10 D-s2,d0
then this implies that the covering shall give the prescribed fire protection ability for 10 minutes and that each of the products from which the covering consist shall fulfil the in pursuance of the stated class designation prevailing reaction to fire requirements on material related level.

When the Icelandic rules prescribe
- building element class REI 120 A2-s1,d0
- building element class R 120 A2-s1,d0
- building element class REI 60 A2-s1,d0
- building element class EI 60 A2-s1,d0
- building element class R 60 A2-s1,d0
- building element class REI 30 A2-s1,d0
- building element class EI 30 A2-s1,d0
- building element class R 30 A2-s1,d0
- building element class R 60 D-s2,d0
- building element class EI 60 D-s2,d0
- building element class R 30 D-s2,d0
- door class EI_2 60-C A2-s1,d0
then this implies that the building element/the door shall give the prescribed fire resistance (for 30 or 60 or 120 minutes) and that each of the products from which the building element/the door consist shall fulfil the in pursuance of the stated class designation prevailing reaction to fire requirements on material related level.

Norway

When performing pre-accepted design according to the Guideline to the Technical Regulations /15/, minimum performance on material related level is required in some applications. Examples: Load bearing elements and insulation of class A2-s1,d0.

Sweden

In Sweden material type requirements are related to minimum performance levels in some applications. Some examples are given in the following:
- Material in air ducting in one family houses shall fulfill reaction to fire class E or material difficult to ignite (SIS 650082 or NT FIRE 002).
- Insulation of smoke gas chimneys etc. shall be of at least class A2–s1,d0.

Proposal

There are fundamental differences in the Nordic countries in the way products are regulated from a material point of view. At present further harmonisation does not seem to be realistic.

3.2 Internal surfaces

Present situation

The reaction to fire performance of internal surfaces implies that all layers close to the surface affecting the fire performance shall be taken into consideration. The term “surface finish” refers to the outermost thin exposed layer of a wall or ceiling surface, including a coat of paint, laminate or similar. The attachment of a surface finish to its backing (by adhesive or some other means) is considered as part of the surface finish. /16/.

Table 3-2. Internal surfaces

	New class	Old class
Denmark	Term not used in DK fire regulations	Term not used in DK fire regulations
Finland	A2-s1,d0 B-s1,d0 C-s2,d1 D-s2,d2	Non-combustible, nearly non-combustible, 1/I (exists in P1 buildings) 1/I, 1/II 1/- 2/-
Iceland	B-s1,d0 D-s2,d0	Class 1 Class 2
Norway	B-s1,d0 D-s2,d0	In 1 In 2
Sweden	B-s1,d0 C-s2,d0 D-s2,d0	Class I Class II Class III

Discussion

Internal surfaces have been treated in a similar way in the Nordic countries due to the NKB regulations. The reference scenario for internal surfaces is a room fire scenario, the ISO 9705. Therefore the national internal surface classes from a technical point of view have been very similar, apart from minor differences in smoke criteria. Denmark has not used the term internal surfaces, instead they use covering classes, which imply reaction to fire requirements on material related level. However, their A and B material class (see 3.1) have the same technical basis as the internal surface classification in the other countries.

All countries refer today to European reaction to fire classes. One minor difference is that Finland, apart from the other nations, accepts droplet class d1 and d2 for certain applications. This means that a Finnish manufacturer of an internal surface product with, for example, class D-s2,d2 can not export the product for use in the other Nordic countries. A technical drawback incorporated with the use of d1 and d2 droplet class could be that it opens up for internal surface materials which may prevent safe escape from premises because of giving of burning droplets. Another difference is that only Sweden and Finland use the “middle class” C. The number of products stating this class is rather limited, why the use of only class B and D may be considered.

All together, the fire classes for the internal surfaces have already reached a rather harmonised stage.

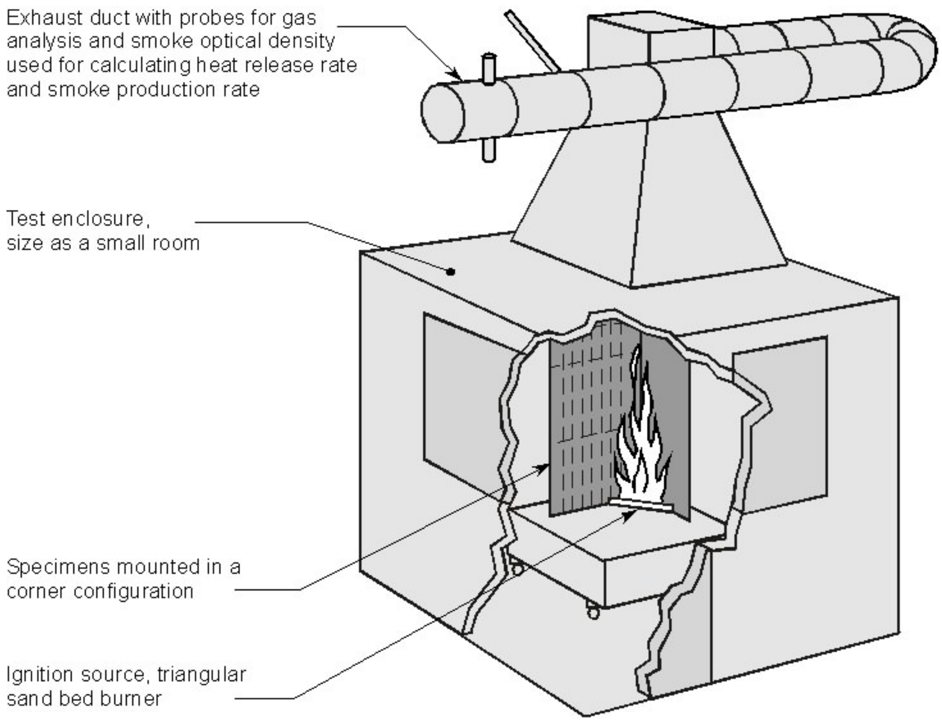

Figure 2. The harmonised European fire test method for building materials, such as internal surfaces, EN 13823, single burning item.

Proposal

A further step towards complete harmonisation would be to withdraw the use of class C and to avoid the use of droplet class d1 and d2 for internal surfaces, especially for ceilings and escape routes.

If the above proposal is implemented, then the situation for internal surfaces would be similar in Finland, Iceland, Norway and Sweden.

3.3 External surfaces

In this section the external surfaces of external walls are considered.

Present situation

The reaction to fire performance of external surfaces implies that all layers close to the surface affecting the fire performance shall be taken into consideration. The term “surface finish” refers to the outermost thin exposed layer of a wall surface, including a coat of paint, laminate or similar. The attachment of a surface finish to its backing (by adhesive or some other means) is considered as part of the surface finish.

Table 3-3. External surfaces of external walls

	New class	Old class
Denmark[1]	D-s2,d2	No equivalent old class
Finland[2,3]	B-s1,d0 D-s2,d2	1/I No requirement for 2/- smoke
Iceland	B-s1,d0 D-s2,d0	Class 1 Class 2
Norway	B-s3,d0 D-s3,d0	Ut 1 Ut 2
Sweden	D-s2,d0[4] A2-s1,d0	Class III Non-combustible, or SP Fire 105 /17/ (multi-storey buildings)

[1] Denmark use the term “exterior surface of outside walls”. In Denmark external wall surfaces shall fulfil the requirements for a covering class K_1 10 B-s1,d0 or for a covering class K_1 10 D-s2,d2 (primarily dependent on the height of the building). “Outside wall with exterior surface class D-s2,d2” (as indicated in the table) is a possible alternative to “covering class K_1 10 D-s2,d2”.
[2] In Finland external surfaces may be coated with ordinary layers of filler, putty and paint.
[3] Also applicable to surfaces adjacent to ventilation gap.
[4] Maximum two-storey building.

Discussion

There are major differences between the Nordic countries:

- Smoke class requirements: From s3 (=no requirement) in Norway to levels s2 and s1 in Denmark, Finland, Sweden and Iceland.
- Droplet class requirements: From d2 (=no requirement) in Denmark and Finland to d0 in Iceland, Sweden and Norway.
- Main class (heat release) requirements vary from D to B level depending on type of use.

From a fire risk point of view the smoke requirements could be harmonised because outside the building the smoke from the burning building products will rarely be a hazard to people. Thus less severe requirements can be applied to exterior surfaces than for interior surfaces.

The risks associated with burning droplets for low rise buildings are much smaller than those for high rise buildings. Thus, d2 linked with D class can be recommended, because D class is used in practice mainly for low rise buildings.

Proposal

The smoke class s2 is proposed as the main option for all external surfaces of external walls. The droplet class d2 is proposed when associated with D class.

If the above proposal is implemented, then the situation for external surfaces of low-rise buildings would be similar in all Nordic countries.

3.4 Facades

In this section fire spread along and penetration through facade structures are considered. Reaction to fire performance of external surfaces of external walls is dealt with in section 3.3.

A facade is an external wall assembly, e.g. the industrial type of wall consisting of internal and external skins of corrugated steel sheet with insulation in between, a twin skin masonry wall, or a composite masonry and timber construction type. A facade can also include the materials and constructions added to an inner facade structure. The inner structure can be of concrete, lightweight concrete, masonry, timber etc.

Present situation

Table 3-4. Fire spread along and penetration through facade structures.

	New class	Old class
Denmark	-	The term “facade” is not used in DK fire regulations
Finland	-	No requirements
Iceland	-	Non-combustible for multi storey buildings but class 2 for one storey building for external surfaces and surfaces in ventilated cavities. Non combustible insulation.
Norway	-	-[1)]
Sweden	- SP Fire 105[2)]	Non-combustible, or SP Fire 105 (multi-storey buildings)

[1)] Classes for external surfaces and surfaces in ventilated cavities according to Table 3-3 (External surfaces). Insulation systems with combustible insulation to be used on existing facades have to be tested as a unit.
[2)] Preliminary proposal until a large scale harmonised European test method is available.

Discussion

There is no large scale European fire test method for facades. A national large scale test method (SP FIRE 105) has been used in Sweden. As seen in Table 3-4 no other Nordic country requires large scale testing at present. Besides Sweden two more countries (Denmark and Norway) are considering to require large scale testing for facades in the future.

Sweden will continue to use SP FIRE 105 when there is a regulatory need to assess fire spread along facade systems in multi-storey buildings. For the time being, it could be an advantage for some of the facade system producers if facade systems that are approved according to SP FIRE 105 are accepted in all Nordic countries when large scale tests are required.

At the moment ETAG development concerning rendering systems for facades is on-going, but no fire testing or classification method for all products is available.

The Commission invited in 2002 the Member states to supply details of performance characteristics that were regulated in Member States for facades. After several discussions the Commission concluded the outcome as follows:

"Evaluation of the fire performance of facades (CONSTRUCT 05/716 Rev 1, November 2005):

With the exception of the UK representative, the SCC members present accepted the conclusion of the Commission not envisaging the need of standardisation work, for facades in general, regarding the generation and spread of fire and smoke within a facade as place of origin.

The issue is considered only relevant for products to be used for cladding systems which are placed on the market as kit.

It remains a task of EOTA to reach consensus on a test method to be included in ETAGs and ETAs covering the relevant kits, developing the most appropriate solution on the basis of test methods already developed in different countries for the specific issue of assessing the limitation of the generation and spread of fire and smoke within a facade as place of origin."

Proposal

It is proposed to await the outcome of standardisation within EOTA for facade system kits.

3.5 Floorings

Present situation

All the Nordic countries have implemented the European fire classes for floorings according to EN 13501-1. The former classification of floorings was based on the test method NT FIRE 007 (floorings in class G or L) and NT FIRE 001 (non-combustible floorings). In most areas in buildings there is no requirement on reaction to fire for floorings. The main exception is escape-ways and premises like conference halls etc. Table 3-5 gives the classes in the case requirements are defined.

Table 3-5. Reaction to fire classes for floorings

	New class	Old class
Denmark	Flooring class $A2_{fl}$-s1 Flooring class D_{fl}-s1	Non-combustible flooring Class G flooring
Finland	$A2_{fl}$-s1 D_{fl}-s1	Non-combustible L
Iceland	D_{fl}-s1	G
Norway	D_{fl}-s1	G
Sweden	$A1_{fl}$ C_{fl}-s1 D_{fl}-s1	Non-combustible flooring Class G Class G

Discussion

A simple correlation between the old classes (G and L) and the new European fire classes could not be found when the differences were investigated in a common Nordic project 1998 /18/. However, the general outlines of the ranking order according to the tests were similar. The criteria for class D_{fl}-s1 incorporates, for example, wood products which were former classified as G and L floorings.

Sweden has chosen to require the class C_{fl}-s1 for escape routes. This was done since several types of former class G floorings also meet the criteria of C_{fl}-s1 according to EN 13501-1.

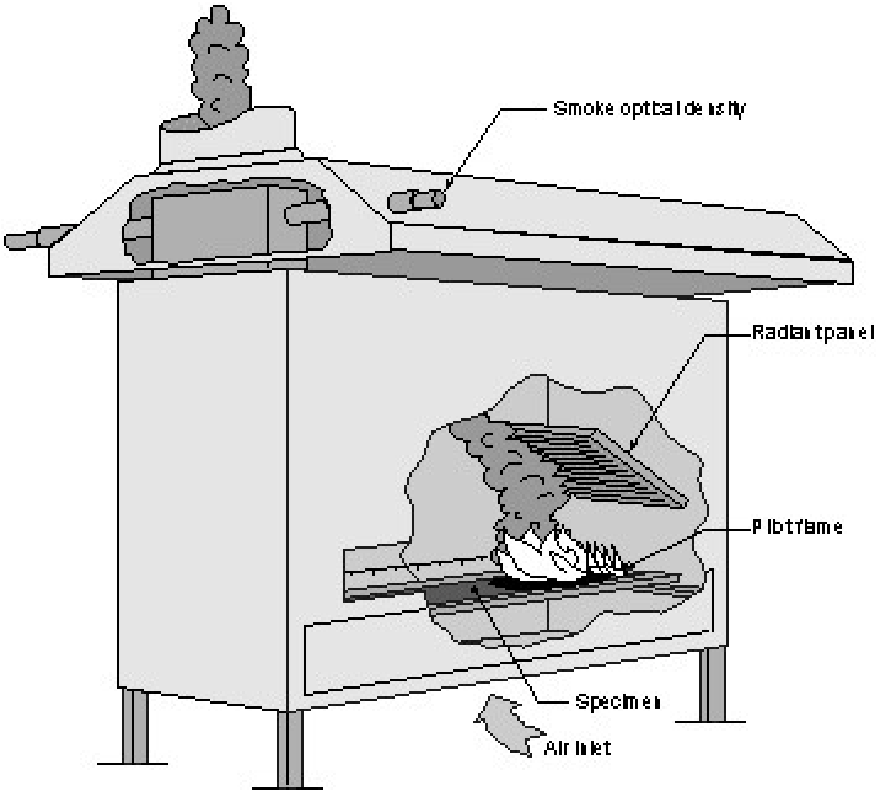

Figure 3. The harmonised European fire test method for floor coverings, EN ISO 9239-1, radiant panel test.

Proposal

The requirements on floorings in the Nordic countries do not represent a trade barrier since the majority of premises ask for the same classification. It is therefore proposed that the present regulations are maintained.

3.6 Insulation products

The following terminology is used:

Insulation product: A pre-fabricated product with a high thermal resistance which is intended to impart insulation properties.

Present situation

Table 3-6. Reaction to fire classes for insulation products

	New class	Old class
Denmark	Material class A2-s1,d0 Material class B-s1,d0 Material class D-s2,d2 Lower than material class D-s2,d2	Non-combustible material Class A material Class B material Unclassified material
Finland	A2-s1,d0 B-s1,d0 C-s2,d1 D-s2,d2	Non-combustible 1/I, 1/II 1/- 2/-
Iceland	Material class A2-s1,d0 Material class B-s1,d0 Material class D-s2,d0 Lower than material class D-s2,d0	Non-combustible material Class A material Class B material Unclassified material
Norway	A2-s1,d0	Non-combustible material
Sweden	A2-s1,d0	Non-combustible material

Discussion

<u>Denmark</u>

In Denmark there are requirements on material related level for insulation products incorporated within building elements, cf. the Danish “Collection of examples for fire protection of buildings”.

<u>Finland</u>

In Finland material type requirements for insulations are related to minimum performance levels in some applications. Some examples are given in the following:
- There are some less strict requirements than usually demanded for load-bearing constructions, if the insulation materials of the uppermost floor are at least of class A2–s1,d0.
- In external walls of buildings of class P2 with 3-4 storey’s the insulation material shall in this case be of at least class A2-s1,d0.
- Thermal insulation which is inferior to class B–s1,d0 shall be protected and positioned in such a manner that the spread of fire into the insulation, from one fire compartment to another and from one building to another building is prevented.

Iceland

In Iceland there are requirements on material related level for insulation products incorporated within building elements, All insulation must be non-combustible i.e. A2-s1,d0 except on ground under concrete floors and in concrete buildings if protected by K 10 B-s1,d0 cladding. Sandwich panels can have combustible insulation, see section 3.9

Norway

Combustible insulation, i.e. lower than A2-s1,d0, may be used in a building element (with some exceptions) if the building element fulfils the performance requirements (e.g. fire resistance). Besides, the combustible insulation must not contribute to fire spread. This means that combustible insulation must be completely built in or covered by other materials. Some acceptable solutions are given in the Guideline to the Technical Regulations.

Sweden

There are no general material requirements on insulation materials. Combustible insulation, i.e. lower than A2-s1,d0, may be used in a building element if the building element fulfils the performance requirements (e.g. fire resistance). Exhaust ducts etc. that may reach higher temperatures than 85 ºC shall be insulated with non-combustible insulation.

Smouldering combustion

Smouldering combustion requirements are generally not found in the Nordic countries. The exception is the Norwegian requirements for combustible insulation materials in attics.

In Norway combustible insulation based on cellulose/textile fibres and similar, meeting the requirements for material class E or the proposed criteria in NT FIRE 035, may be used in buildings in fire class 1 and residential buildings in three stories or less.

Proposal

There are fundamental differences in the Nordic countries in the way insulation products are regulated. Either from a performance based point of view or from a material related point of view. Note, however, that where non-combustible material is required the same European fire class is asked for (A2-s1,d0). At present no further harmonisation is proposed.

Smouldering combustion requirements are not needed in the Nordic countries with the possible exception of combustible insulation materials in attics.

In the future it will be possible to refer to a European harmonised fire classification for smouldering. Work to standardise a suitable test procedure is going on in CEN.

3.7 Linear pipe thermal insulation products

Present situation

Pipe insulations fall within the scope of technical insulation products. Though considerable work within CEN the harmonised standards for this group of products are still at the prEN stage, why CE-marking is not possible at present. The reaction to fire classification of pipe insulation is, however, decided by the European commission and published in EN 13501-1. Table 3-7 below gives the status in the Nordic countries as today.

Table 3-7. Reaction to fire classes for pipe insulation.

	New class	Old class
Denmark	To be decided	No requirements
Finland	$A2_L$-s1,d0 B_L-s1,d0 C_L-s2,d1 D_L-s2,d2	Non-combustible, nearly non-combustible, 1/I (exists in P1 buildings) 1/I, 1/II 1/- 2/-
Iceland	The insulation shall fulfil the same class as the surrounding surface finishes	Non combustible but B1 to DIN 4102 for few pipes
Norway	To be decided	PI, PII, PIII
Sweden	$A2_L$-s1,d0 B_L-s1,d0 C_L-s3,d0 D_L-s3,d0	 PI, PII PIII

Discussion

Pipe insulation has been treated in different ways in the Nordic countries. Denmark has no requirements at all while Sweden and Norway have had requirements based on large scale testing. Finland and Iceland have used requirements based on small scale testing. At present time only Finland and Sweden have adapted European fire classes as given in Table 3-7.

The new European reaction-to-fire classes for pipe insulation products, as defined in EN 13501-1 are based on fire performance in a large-scale reference test scenario. There is a strong correlation between the harmonised test procedure in the SBI test and results in the reference room scenario /19/. In contrast to surface finishes, the classification approach for pipe insulation does not use the concept of flashover.

There are several approaches to define pipe insulation regulations. One alternative is to use the parallelism that exists with the classes for surface linings. This would simply require the same European reaction to fire class for pipe insulation as the one required for linings in a given space. For example in a space where the fire behaviour of ordinary wood is acceptable the D_L -class can be used for products exposed in that space. This approach is now decided in the Swedish regulations.

In the present regulations the smoke production requirements have not been very severe and smoke is not a big problem for pipe insulation, since it is usually used in relatively small quantities. The s2 class is probably more severe than the present classes (PII, PIII). There are several ways to proceed here depending on the market implications. It is possible to declare no smoke requirements for C and D classes, and possibly B_L-s1, d0 could be a class for higher demands.

Proposal

The following classes for pipe insulation are proposed for the national regulations.

$A2_L$-s1,d0
B_L-s1,d0
C_L-s3,d0
D_L-s3,d0
E_L-d2

Below is an example of how the classes may be implemented.

If the pipe installation covers a major part of the enclosure the pipe insulation shall fulfil $A2_L$-s1,d0 or the same class as the surrounding surface finishes.

If the pipe installation covers a minor part of the enclosure the pipe insulation may fulfil the following classes.

– B_L-s1,d0 when the surrounding surface finishes fulfil B-s1,d0
– C_L-s3, d0 when the surrounding surface finishes fulfil C-s2,d0
– D_L-s3, d0 when the surrounding surface finishes fulfil D-s2,d0
or
-E_L-d2

The second part of the example is based on the philosophy of a parallel system to linings as discussed in section 3.8 cables.

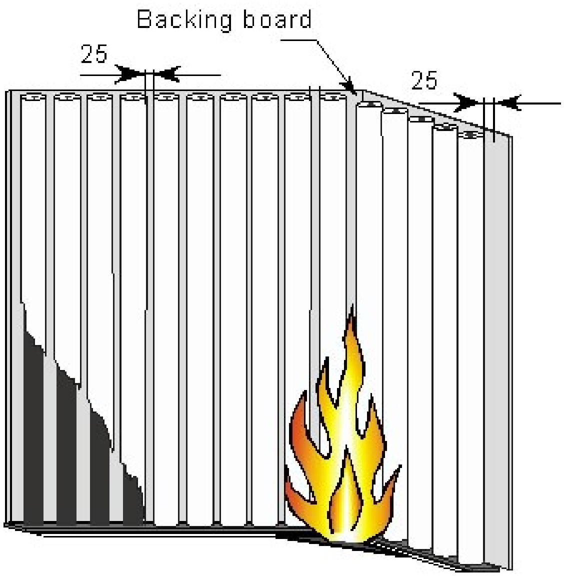

Figure 4. Pipe sections vertically mounted with 25 mm spacing to the backing board and between pipe sections in the SBI (EN 13823) test equipment.

3.8 Cables

Present situation

Present Nordic fire requirement are based on the directives for installation of cables. Fire tests used are IEC 60332 /20/ test series.

Table 3-8. Classes for reaction to fire for cables in the Nordic countries.

	Present class
Denmark	General requirement, EN 50265-1 and EN 50265-2-1. High risk areas, exit areas etc. may require stricter demands.
Finland	General requirement, EN 50265/IEC 60332-1. High risk areas, exit areas etc. may require EN 50266, EN 50267 and EN 50268
Iceland	No requirement.
Norway	Electrical code/NEK400: General requirement, EN 50265, escape routes EN 50266 and limitations on fire load, 50 MJ per m installation.
Sweden	F2[1] (general requirement) F4A F/R[2] F4A[3] F4B[4] F4C[5] F4D[6]

[1] SS-EN 50265-1, SS-EN 50265-2-1 / SS-EN 50265-2-2 (analogue to EN 60332-1-2)
[2] IEC 60332-3-21
[3] IEC 60332-3-22
[4] IEC 60332-3-23
[5] IEC 60332-3-24
[6] IEC 60332-3-25

Denmark

Denmark follows in general the directive for high power installation (starkstrømsbekendtgørelsen) with national additions written below:

-Cables fulfilling EN 50265-1[1] and EN 50265-2-1[2] and other products (cable conduits etc.) that fulfil EN 50085 /21/ and EN 50086 /22/ can be installed without any restrictions.

[1] Superseded by IEC 60332-1-1 and IEC 60332-2-1

Note 1: Cables in high-risk spaces can be required to fulfil stricter demands of bunched cables according to HD 405.3. [4]

Note 2 : The Danish Standard DS 2393 /23/ series are considered to be covered by the standards EN 50265-1 and EN 50265-2-1.

-Cables not fulfilling the requirements on flame spread in EN 50265-1 and EN 50265-2-1 can still be installed but only in short lengths for connection of equipment, and they may under no circumstances penetrate a fire cell partition.

For installations in exhibitions, concerts and similar where no fire alarm system is installed the following requirements apply:

-Either fire restricted according to (IEC 60332-13) HD 405-1[2] or HD 405-3[4] (IEC 60332-34) and with low smoke production according to IEC 61034 /24/.
- Or all unarmoured cables or wires shall be inside metallic or plastic pipes/conduits that give a fire protection according to IEC 60614 /25/ or IEC 61084 /26/ and has an enclosure class of at least IP4X.

For temporary electrical installations at construction sites, amusement parks, markets, circuses etc the following apply:

- All electrical cables shall comply with EN 50265-1 and EN 50265-2 (IEC 60332-1).

- In areas with high risk for fire spread the cables should comply with IEC 60332-3.
- Where there is need for low smoke production materials cables shall have smoke production properties as a minimum fulfilling IEC 61034.

Finland

In Finland the general requirements (according to installation standards) for cables indoors are according to, EN 50265 / IEC 60332-1.For special places, where there is a distinct element of danger (e.g. high risk for fire spread), it might be needed to use cables, which when bunched fulfil the requirements according to EN 50266 (IEC 60332-3).

At exit areas, cables should be covered by minimum EI 30 –fire proof construction, or if this is not possible, the cables have to meet the following fire tests: EN 50266, EN 50267 and EN 50268 (IEC 61034).

There are also certain extra requirements for fire-resistant cables.

Additional requirements apply for cables inside tunnels (route, railway and underground).

Norway

Norway has a general requirement that all cables in buildings shall fulfil EN 50265/IEC 60332-1 (CPD fire class Eca) and for escape routes there is a recommendation to use cables passing EN 50266 according to the Norwegian Electrical Code/NEK400. In

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[2] Superseded by IEC 60332-1-2
[3] Superseded by IEC 60332-1-1, IEC 60332-1-2
[4] Superseded by IEC 60332-3-10, IEC 60332-3-21, IEC 60332-3-22, IEC 60332-3-23, IEC 60332-3-24, IEC 60332-3-25

addition there is a requirement given in the Building Code Guidance for a max fire load per meter cable-ladder of 50 MJ/m.

Some users specify cables of low smoke- (according to IEC 61034/EN50268) and acidity (according to IEC 60754-1 and -2/EN50267-1 and -2), typically for tunnels/road and railroad, and in parts of some official buildings, like the new Opera house in Oslo.

Sweden

In Sweden the general requirement for cables indoors is F2 (EN 50265). Special environments where escape is difficult or where people density is high might require one of the F4 (EN50266, Category C and B) classes. Also cable shafts, tunnels and power plants have F4 requirements.

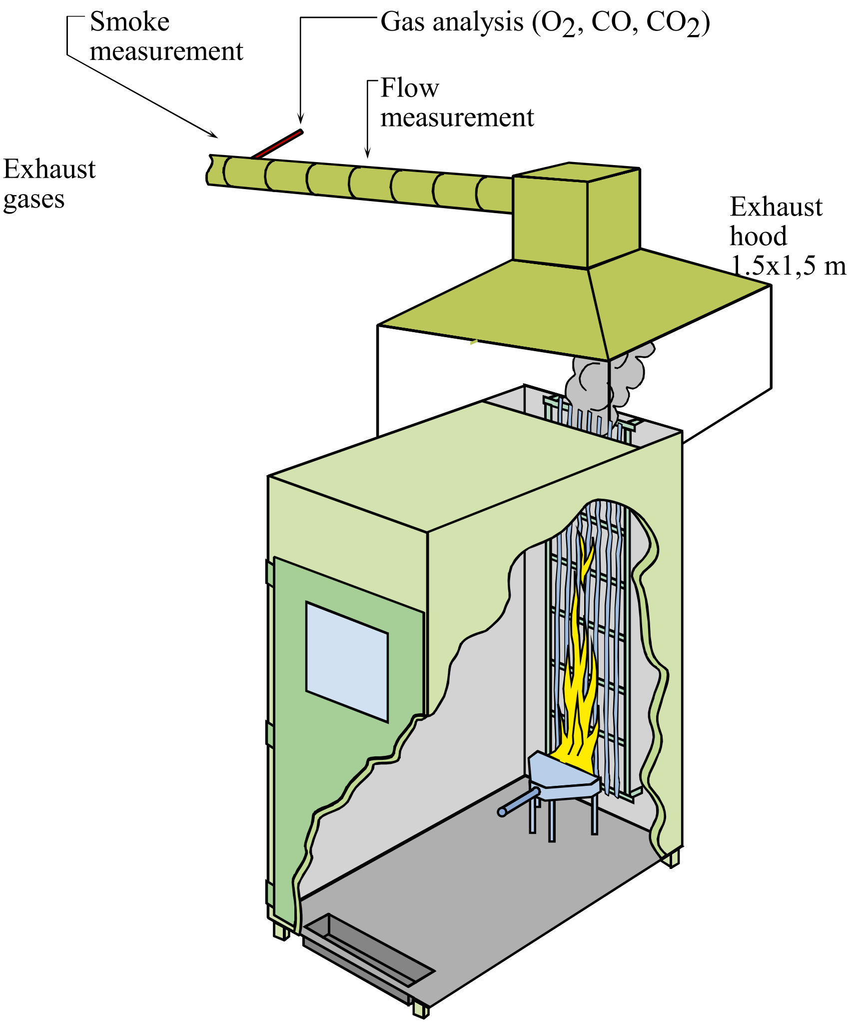

Figure 5. Cable test equipment according to EN 50266.

Discussion

The EU Commission decision defining the reaction to fire classes for electric cables was published in the official journal in November 2006, see Annex A. The classes are based on FIGRA, maximum heat release rate, total heat release rate and spread of flame. Additional classes are defined for smoke production and the production of burning droplets. In addition to these requirements, the acidity of the smoke gases may be voluntarily declared.

There are seven primary classes: A_{ca}, $B1_{ca}$, $B2_{ca}$, C_{ca}, D_{ca}, E_{ca}, and F_{ca}. Class A_{ca} is for non-combustible products, e.g. cables with ceramic insulation. Class $B1_{ca}$ is the best class of the combustible products, while $B2_{ca}$ and C_{ca} represent products capable of some degree of spreading a fire. D_{ca} has fire characteristics similar to that of ordinary wood, while E_{ca} consists of products that are difficult to ignite by a small flame, such as that from a cigarette-lighter. F_{ca} indicates that no fire performance class has been determined.

There are three main classes s1-s2-s3 for smoke production. These classes are determined according to prEN 50399-2-1. The highest smoke class, s1, can be divided up into two additional classes, s1a and s1b, having more severe requirements. These classes are determined in an additional test method, referred to as the ”3 m cube”, EN 61034-2. The additional smoke classes were introduced in order to meet requirements for cables for use in tunnels, e.g. metro rail tunnels and road tunnels.

The possibility to declare acidity of the smoke gases was included by request of European industry. Some countries have requirements for acidity content of smoke gases in high-risk applications, such as tunnels.

Cables are covered by the construction products directive following the same principles as for other building products for example linings. Therefore the European fire classes for cables are to a large extent parallel to the fire classes for linings. In both cases there are seven classes. These classes also reflect a burning behaviour that is quite similar. Euroclass A1/A2 for linings and Euroclass A_{ca} for cables represent non-combustible products. Euroclass D for linings and Euroclass D_{ca} for cables are selected to match the fire behaviour of wood. Euroclass E and E_{ca} refer to products that are difficult to ignite with a small flame. The intermediate classes then represent intermediate burning behaviour. Although the products themselves are very different the resulting fire performance from the classes bear similarity and this could be used for regulating purposes.

Presently (2008) the European cable industry through Europacable together with SP Fire Technology and other research labs are running a research project with the aim to assist the process of CE-marking of cables in the CPD. The project is called CEMAC II - CE-marking of cables /27/, and will through a comprehensive test programme create a technical background for extended application (EXAP) procedures for cables. This knowledge is fundamental to the creation of regulations for CE-marking of cables and it is therefore reasonable to await information from this project before writing concrete guidelines for classification of cables in the Nordic countries. However some possible ways forward are discussed below.

There are several approaches to define cable regulations and two possible alternatives are discussed here. One alternative is to use the parallelism that exists with the classes for internal surfaces. This would simply require the same cable Euroclass for cables as the one required for linings in a given space. For example in a space where the fire behaviour of ordinary wood is acceptable the D-class can be used for products exposed in that space. A similar approach is taken today in the Swedish regulations for pipe insulation in buildings.

Another alternative is to define classes using a risk based approach specific to certain high risk areas, which is to some extent the situation for cables today. Cable requirements would depend on the risk level in the space of installation, e.g. high-risk spaces as underground stations, elevator shafts and escape way stair-cases would have high demands. Smoke production and smoke gas acidity requirements could follow the same philosophy.

In addition, the way of installation will probably have to be considered in the regulations, e.g. if the cable is installed in a non-combustible conduit.

Finally there is the possibility to combine the regulatory philosophies discussed above.

Proposal

Definition of requirements should await the experience gained in the CEMAC II project. However, care should be taken to use the same set of classes in the Nordic countries. For example, the number of possibilities of selecting smoke and droplet classes can create trade barriers. A possibility to avoid that is to select the smoke and droplets classes that already appear for internal surfaces and make them parallel to that system.

3.9 Sandwich panels

Present situation

The following definition applies (in accordance with European Standard EN 14509):

Sandwich panel: Building product consisting of two metal faces positioned on either side of a core that is a thermally insulating material, which is firmly bonded to both faces so that the three components can act compositely under load.

Note: There are other types of sandwich panels than metal faced. Clause 3.9 deals with metal faced sandwich panels only.

An overview of the fire classes for sandwich panels in regulations in the Nordic countries is given in Table 3-9.

Table 3-9. Reaction to fire classes for sandwich panels in the Nordic countries.

	New class	Old class
Denmark*	No sandwich panel specific requirements	No sandwich panel specific requirements
Finland	No sandwich panel specific requirements	No sandwich panel specific requirements
Iceland	A2-s1,d0 B-s2,d0	D according to Eurefic /28/ or insulation being class A material or class B material
Norway*	B-s1,d0 D-s2,d0	A according to Eurefic E according to Eurefic
Sweden		Not used, but full scale test asked for in certain cases (see text below)

* in addition the covering requirements apply

<u>Norway</u>
Limitations on the use of sandwich panels meeting the classes given in the Table 3-9 are specified in the Guideline to the Technical Regulations. In addition to the classification of sandwich panels as products, the panels may also be subject to requirements related to fire resistance. In Norway testing of sandwich panels is made in full scale according to ISO 9705 (for the old class).

<u>Sweden</u>
Boverkets recommendation for national type approval (1993:2) (clause 1.3.1) contains the following text related also to sandwich panels (as an internal surface):

If testing to NT FIRE 004 (now replaced by SBI) gives doubtful results or results hard to interpret testing shall be made in full scale according to NT FIRE 030 or ISO 9705. Criteria according to Boverkets allmänna råd 1993:2, utgåva 2.

<u>Iceland</u>
Limitations on the use of sandwich panels meeting the classes given in table 3-9 are specified in the Building regulation and in a guideline from Iceland Fire Authority. In addition to the classification of sandwich panels as products, the panels may also be subject to requirements related to fire resistance.

Discussion

There are no specific requirements for sandwich panels expressed in the European classification system. Concerns on the suitability of the Single Burning Item (SBI) test (EN 13823) for testing of sandwich panels has been reported /29/. There are different solutions to this in the Nordic countries.

In Denmark, Finland and Sweden, sandwich panels are treated like any other building element used for walls and roof constructions and may be subject to requirements related to reaction to fire, fire protection ability, fire resistance and/or external fire exposure depending on their use in the building.

The European Standard for sandwich panels EN 14509 specifies that sandwich panels shall be fire tested in end use application as far as possible. This European standard does not prescribe the reaction to fire characteristics of the insulating core material to be determined.

During 2006 the Commission conducted an enquiry on the existence of regulatory provisions in force in Member States and directly or indirectly applicable to the fire behaviour of sandwich panels /30/.

The Danish answer to the enquiry shows, that a European solution for dealing with reaction to fire requirements on material related level (and where necessary covering requirements) would remove the obstacles for Denmark to apply the European classification system for sandwich panels (see 3.1).

ISO has standardised a large scale test, ISO 13784-1, specifically designed for testing of sandwich panels in end use conditions. This test gives more reliable information on the burning behaviour of sandwich panels than the SBI. The ISO 13784-1 test has been proposed as a complement or replacement of the SBI. However, the present proposal is to use the procedure according to EN 14509, i.e. the SBI, but with an additional paragraph that in certain cases allows for additional measurements on these products. The proposed paragraph says

“The reaction to fire classification derived from the provisions in this standard provides regulators and other users with an essential parameter concerning fire performance of sandwich panels. Exclusively based on fire safety needs and with explicit justification, regulators may, for specific intended uses, set additional requirements for ensuring the fire safety of the construction works, in accordance with EN 13501-1. Other classifications, such as fire resistance, may also be required to achieve the intended fire safety objectives. In addition, in exceptional cases, other instruments, such as fire safety engineering, specific to the building incorporating the products and associated assembly characteristics, may be used to assess the fire safety of the building”

Proposal

There is a need for survey on how these products are used on the Nordic market. Then a sustainable solution based on fire safety measures should be created.

3.10 Roofings

Present situation

All the Nordic countries have chosen the same requirement to roofings, i.e. B_{ROOF}(t2). This class is based on testing according to ENV 1187, test 2 with burning brands and wind /31/, which again is based on the Nordic method NT FIRE 006 /32/. Products are classified according to EN 13501-5 /33/. The choice of this test with the corresponding classification system is a direct continuance of the former agreed Nordic safety level regarding roofings.

Table 3-10. Reaction to fire classes for roofings.

	New class	Old class
Denmark	Roofing class B_{ROOF}(t2)	Class T roofing
Finland	B_{ROOF}(t2) and broken into parts of maximum 2400 m2 when substrate lower than A2-s1,d0 B_{ROOF}(t2)	K1 (on large areas of combustible substrates) K2
Iceland	B_{ROOF}(t2)	Class T roofing
Norway	B_{ROOF}(t2)	Ta
Sweden	B_{ROOF}(t2)	T

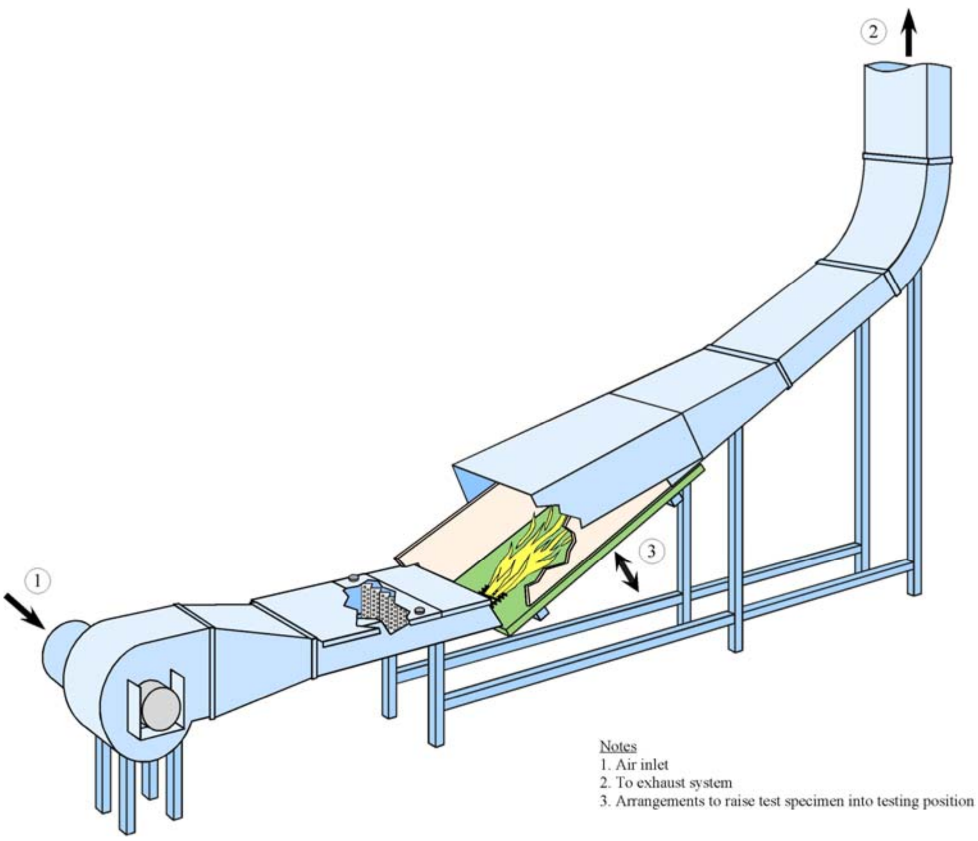

Figure 6. Test equipment for roofings according to ENV 1182, test 2.

Discussion

The fire safety requirements to roofings do not represent any trade barriers within the Nordic countries today. However, some problems may appear in relation to other countries as there are four test methods for roofings in ENV 1187. However, CEN has now started up the work to develop a single harmonised roofing test method for the European market. The final outcome of this work is most probably several years ahead. It is recommended that the Nordic countries support this work.

Proposal

For the time being, the requirement roofing class $B_{ROOF}(t2)$ should be maintained in the Nordic countries.

3.11 Repainting and redecoration of surfaces

Present situation

Redecoration, e.g. by application of new layers of paint or wallpaper on top of the existing ones, may change the reaction-to-fire behaviour of surfaces. This may be critical for fire safety in certain areas, for example in escape routes. A project carried out by SINTEF NBL showed that a glass fibre wall paper treated with two layers of water-based paint satisfied the criteria to class B-s1,d0. 2-4 additional layers of paint lead to a worsening of the fire behaviour, and when there were a total of 8 layers of paint, the class criteria were no longer fulfilled /34/. The products were tested according to ISO 5660 (cone calorimeter), EN 13823 (SBI) and ISO 9705 (room corner test).

Building codes set requirements to assessment of fire properties of products in building design, and are generally not concerned with change in properties caused by use, maintenance, or redecoration.

The Danish building codes, however, has a general requirement that the fire safety shall be maintained during the buildings' complete life time. The guidelines state that this implies a continuous maintenance of active and passive fire safety measures.

In Finland the general guideline states that surfaces may be coated with ordinary layers of filler, putty and paint or wallpaper.

The Norwegian building codes has a general requirement that the building and its technical installations shall fulfil the codes requirements during its economical lifetime. This will then also comprise all required fire safety measures. The fire safety in buildings in use are more regulated by the Directorate for Civil Protection and Emergency Planning (DSB) in more detail /35/. The regulations state that the owner is responsible for that the building is built, equipped and maintained according to existing regulations concerning fire prevention. The fire safety is assessed as satisfying when requirements according to existing building codes are fulfilled and maintained. Fire safety in buildings designed according to previous building codes should, as far as possible, be upgraded to the same level as new buildings. The interpretation of these regulations with regard to repainting and redecoration of surfaces must be that surface treatment that leads to worse reaction-to-fire behaviour than required by the existing building codes is not acceptable.

For the time being Norway, Denmark and Finland do not require approval of wall paper (or paintings) with regard to their fire properties, when they are used in normal buildings. The same position is maintained in case of repainting and redecoration of surfaces.

In Sweden the building code requires that internal surfaces within a building shall fulfil a specific surface finish class. A process of repainting or redecoration shall not lead to that the required surface finish class is not longer fulfilled.

Discussion

Surfaces in escape routes will be redecorated by applying additional layers of either by paint or wallpaper. This increases the amount of combustible material on the surface, and the reaction to fire behaviour of the surface is worsened. Old layers of paint under newer layers may loosen from the surface, thereby introducing pockets of air and a rougher surface that enhances flame spread. This means a lowering of the actual fire safety level.

Building regulations in the Nordic countries have general statements on maintenance of the fire safety level in a building, but no specific requirements to how to maintain the reaction to fire properties of surfaces.

Treatment of surfaces in e.g. escape routes should be a part of the fire documentation for the building, and would prevent that the total thickness of paint or wall paper is too large to fulfil the provided safety level. A possible reduction of fire properties of surfaces in critical areas should also be a point on the check list for the fire brigade's fire inspections. It would be useful to have guidelines on how the surfaces should be assessed – it is obviously not feasible to perform fire testing of the actual surface material. Such guidelines could give information on acceptable number of layers, total thicknesses of surface treatment, etc. based on different types of products.

Many layers of wallpaper or paint may compromise the fire safety level in escape routes by lowering the fire class. This problem should be addressed by the authorities.

Proposal

The maintenance of reaction to fire properties of surfaces in escape routes should be explicitly mentioned in building regulations, and should be a checkpoint on fire inspections.

3.12 Windows

Present situation

Openable windows shall be tested and classified as doors according to prEN 1634-1 /36/.
Not openable windows are tested and classified as partitions

Denmark

- **Openable windows** are tested and classified as doors
- **Not openable windows** are tested and classified as partitions
- No requirements are specifically related to windows
- Smaller openable windows in fire resistant walls may resist fire half of the fire resistance time as determined for the wall itself /37/.

Finland

- Windows in fire resistant partitions may resist fire at least half of the fire resistance time determined for the partition itself /38/.

Norway

- Windows in fire resistant partitions shall have the same fire resistance as the rest of the partition, and shall not be openable under normal conditions. For windows in corners and windows in parallel to opposite external walls there are, however, some exceptions to this requirement.

Sweden

- Windows in fire resistant partitions may in some situations have a lower fire resistance classification than the rest of the partition /39/.

Iceland:

- **Openable windows** are tested and classified as doors
- **Not openable windows** are tested and classified as partitions
- No requirements are specifically related to windows

Table 3-12. Openable windows

	New class	Old class
Denmark	See text under "present situation".	See text under "present situation".
Finland	EI_2 15 EI_2 30 EI_2 60 EI_2 90 EI_2 120 If I requirement not met (for > 0,1 m^2 area) then safety distance required (heat flux ≤ 10 kW/m^2)	 B 30, A 30 B 60, A 60 B 90, A90 B 120, A 120
Iceland	E 30 E 60 EI_2 30 EI_2 60	F 30 F 60
Norway	E 30 E 60 EI_2 15 EI_2 30 EI_2 60 EI_2 60	F 30 F 60 B 30 B 60 A 60
Sweden	E 15 E 30 EI_1 30 EI_1 60 EI_1 120 EI_1 240	F15 F30 B 30 B 60

None of the Nordic countries has requirements to reaction-to-fire properties for windows or window components.

Discussion

All the Nordic countries, except Finland, require that windows in general shall have the same fire resistance as the rest of the partition. Fire resistance based on assessments can be made in certain cases (small windows, corners, parallel opposite walls). How windows are treated in the regulations differs slightly between the countries, and also the different classes applied.

Finland and Sweden are the only Nordic countries requiring fire resisting classes longer than 60 minutes, which means that the market for openable windows satisfying these classifications is rather small..

Sweden uses EI_1 xx (index 1) instead of EI_2 xx (index 2). From a technical point of view this means that there is a more severe temperature requirement on openable windows on the Swedish market compared to the other Nordic countries.

Proposal

Sweden should consider the use of index 2 instead of 1 for openable windows. Beyond that no further changes are proposed.

3.13 Coverings

Present situation

Coverings are products which are intended to protect underlying products against ignition, charring and other damage during a specified fire exposure, normally a period of 10 minutes during the initial stage of a standard fire.

Table 3-13. Coverings

	New class	Old class
Denmark	Covering class $K_1$10 B-s1,d0 [D)] Covering class $K_1$10 D-s2,d2 [D)] Covering class $K_2$30 A2-s1,d0 [D)] Covering class $K_2$60 A2-s1,d0 [D)]	Class 1 covering Class 2 covering 30 minutes fire protection system 60 minutes fire protection system
Finland	K10 A2-s1,d0 [F)]	Protective covering (10 min) made of at least nearly non-combustible material
Iceland	$K_2$10 B-s1,d0 $K_2$10 D-s2,d0	Class 1 covering Class 2 covering
Norway	$K_2$10 A2-s1,d0 $K_2$10 B-s1,d0 $K_2$10 D-s2,d0	K1-A K1 K2
Sweden	$K_2$10/B-s1,d0	Tändskyddande beklädnad (fire protective cladding)

[D)] Each of the products from which the covering consist shall fulfil the in pursuance of the stated class designation prevailing reaction to fire requirements on material related level.
[F)] Use of K_1 or K_2 not formally implemented. The guidance text of the regulation *'The function of protective coverings is to protect the construction behind the covering from ignition, charring and other damage in the initial stage of fire for a period of 10 minutes'*, may correspond closer to K_1. However, in practise also K_2 may be accepted.

Coverings shall be tested according to EN 14135 /40/ and classified according to EN 13501-1 and EN 13501-2 /41/.

K_1 means that the covering is tested on one of the following substrates:
- a chipboard with a density of 680 kg/m^3, which represents all materials with a density not less than 300 kg/m^3 behind the covering or
- a material with a density of less than 300 kg/m^3 (a low density material), which represents a material of the same type and density behind the covering or
- any other specific substrate, which represents a material of the same composition behind the covering.

The fire protection ability period for a covering of class K_1 is 10 minutes.

K_2 means that the covering is tested on one of the following substrates:
- a chipboard with a density of 680 kg/m^3, which represents all materials behind the covering or
- any other specific substrate, which represents a material of the same composition behind the covering.

The fire protection ability period for a covering of class K_2 may be either 10, 30 or 60 minutes.

A K_2 covering can be used on all substrates, while a K_1 covering can be applied to substrates having a density according to the substrate used in the test. K_1 may therefore be regarded as a more restrictive requirement than K_2, because it requires documentation from testing on a substrate relevant for the backing material in the end-use application.

Discussion

Table 3-13 shows that there is some variation in required fire classification for coverings in the Nordic countries. The differences may to some degree affect the trade of this product group. An example is a covering made of wood, i.e. a class D-s2, d0 material. For use in Norway, the covering can be tested on a chipboard substrate, and the classification will cover all substrate materials behind the covering in the end-use situation. The same product will, however, not be approved in Denmark, if a low density material is to be used behind the covering. The product will also not be approved for use as covering in Sweden or in Finland, because the reaction-to-fire classification of the material does not fulfil the Swedish or Finnish criteria. The access to the Norwegian market will therefore be easier than to the Danish, Swedish or Finish markets for this product.

There are also differences in reaction to fire classification of the covering. In Finland, regulations cover only coverings of reaction to fire class A2-s1,d0, while coverings of reaction to fire class B-s1,d0, D-s2,d2 and D-s2,d0 are used in the other Nordic countries' regulations. The criteria to SBI test results for products of reaction to fire class B-s1,d0 and A2-s1,d0 are identical. It could therefore be assumed that the contribution to fire during the first 10 minutes would be the same for products of either of these classes. This could be implemented in that way, that a requirement of reaction to fire class B-s1,d0 would be sufficient. However, if there for some reason is a wish to limit the amount of combustible material in a certain application, reaction to fire class A2-s1,d0 will also cover this aspect.

What would the consequences of changing requirements from K_2 to K_1 for Sweden, Finland, Iceland and Norway be? Such a change would mean that more restrictions are applied on the use of coverings. Some existing products would have to be retested to document that they fulfil the K_1 requirements and others may be excluded from the market. If a change in requirements is planned, the practical and economical aspect should be assessed in more detail.

As the substrate often significantly affects the fire behaviour of a covering, testing for the K_1 class is more relevant regarding the product's fire performance in the end use condition. The effect of requiring K_1 instead of K_2 on fire safety level should also be assessed.

Proposal

The Nordic requirements to coverings are quite different and it is not straight forward to propose a harmonisation. Possible technical, practical and economical aspects of choosing either K_1 or K_2 and the effect of choosing different reaction to fire classes for the materials in coverings has to be assessed more into detail.

3.14 Loadbearing elements – not separating

Present situation

There are no major differences between the countries with respect to the fire resistance classification. All have the 30, 60 and 120 minute classes. Finland, Norway and Sweden have also more time classes available. As for some other products there are cases where some countries also have requirements on the reaction to fire for loadbearing elements.

Table 3-14. Loadbearing elements

	New class	Old class
Denmark	Building element class R30 A2-s1,d0 Building element class R60 A2-s1,d0 Building element class R120 A2-s1,d0 Building element class R30 Building element class R60	BS-building element 30 BS-building element 60 BS-building element 120 BD-building element 30 BD-building element 60
Finland	— (=no class requirement) R15 R30 R60 R90 R120 — A2-s1,d0 R60 A2-s1,d0 R90 A2-s1,d0 R120 A2-s1,d0 R180 A2-s1,d0 R240 A2-s1,d0	— B10 B30, A30 B60 B90 B120 A60 A90 A120 A180 A240
Iceland	R30 A2-s1,d0 R60 A2-s1,d0 R120 A2-s1,d0 R30 R60	A 30 A 60 A 120 B 30 B 60
Norway	R15, R30, R60 R30 (A2-s1,d0) R60 (A2-s1,d0) R90 (A2-s1,d0) R120 (A2-s1,d0) etc.	B15, B30, B60 A10, A30, A60, A90 etc.
Sweden	R15, R30, R60, R90, R120, R180, R240	R15, R30, R60, R90, R120, R180, R240

Discussion

There are no major differences between the classes used in the different countries. The main difference is that in some cases there are also requirements on reaction to fire. When there is a reaction to fire requirement it is in all cases class A2-s1,d0.

Proposal

No changes are proposed.

3.15 Separating elements

Present situation

The following covers separating elements such as walls and ceilings. Other separating elements such as doors and windows are dealt with in other chapters.

Separating elements can be classified by their integrity, insulation and loadbearing capability. In the following only walls and ceilings without loadbearing capacity are covered except in the case of fire walls where most countries also require that the loadbearing capacity is fulfilled.

Table 3-15a. Separating elements - integrity

	New class	Old class
Denmark	Building element class E30 Building element class E60	F-building element 30 F-building element 60
Finland	E15 E30 E60 E90 E120 + When I requirement not met (for > 0,1 m^2 area) then safety distance required (heat flux ≤ 10 kW/m^2)	B15 B30, A30 B60, A60 B90, A90 B120, A120
Iceland	E30 E60	F 30 F 60
Norway	E30, E60	F15, F30, F90
Sweden	E30, E60	E30, E60

Table 3-15b. Separating elements – integrity and insulation

	New class	Old class
Denmark	Building element class EI60-M A2-s1,d0 Building element class EI30 A2-s1,d0 Building element class EI60 A2-s1,d0 Building element class EI120 A2-s1,d0 Building element class EI30 Building element class EI60	Heavy BS-building element 60 BS-building element 30 BS-building element 60 BS-building element 120 BD-building element 30 BD-building element 60
Finland	E15 E30 E60 E90 E120	B15 B30, A30 B60, A60 B90, A90 B120, A120
Iceland	EI30 A2-s1,d0 EI60 A2-s1,d0 EI120 A2-s1,d0 EI30 EI60	A 30 A 60 A 120 B 30 B 60
Norway	EI15, EI30, EI60	B30, B60
Sweden	EI30, EI60, EI120, EI240	EI30, EI60, EI120, EI240

.

Table 3-15c. Separating elements, non-combustibility

	New class	Old class
Denmark	(See Table 3-15b)	(See Table 3-15b)
Finland	A2-s1,d0 requirement for walls of exits of P1 buildings with more than two storeys (EI60, EI90, EI120) and for basement spaces (EI30, EI60, EI90, EI120)	A30, A60, A90, A120 for buildings more than 8 storeys
Iceland	EI30 A2-s1,d0 EI60 A2-s1,d0 EI20 A2-s1,d0	A 30 A 60 A 120
Norway	EI60 (A2-s1,d0)	A30, A60, A120 etc.
Sweden		Not used in Sweden

Table 3-15d. Separating elements – fire walls

	New class	Old class
Denmark	Wall class REI 120 A2-s1,d0[1]	BS-wall 120[1]
Finland	EI60-M EI120-M, EI120-M A1 EI180-M A1 EI240-M A1	 A120 A180 A240
Iceland	REI120-M A2-s1,d0	A120 firewall
Norway	REI90-M A2-s1,d0 REI120-M A2-s1,d0 etc.	A90, A120 etc.
Sweden	REI60-M, REI90-M, REI120-M, REI240-M	REI60-M, REI90-M, REI120-M, REI240-M

[1] It is noted , that (according to the Danish terminology) a fire wall is a wall, which shall prevent that a fire can spread from a building to a building on the nearest neighbouring plot of land (with another number in the land registry).

Discussion

There are no major differences between the classes used in the different countries. The main difference is that in some cases there are also requirements on the reaction to fire. When there is a reaction to fire requirement it is in all cases Euroclass A2-s1,d0, with one exception for fire walls in Finland where an A1 class can be required.

Proposal

No changes are proposed.

3.16 Fire doors

Present situation

In the following text, fire doors are subdivided into the following groups:

- doors without self-closing device
- doors with self-closing device
- doors, hatches etc. with limited smoke leakage
- lift landing doors

An overview of the regulations for fire doors in the Nordic countries is given in Table 3-16a-d.

Insulation criteria with suffix 1 (I_1) means that no temperature measurements on the door leaf within 25 mm from the border line of the visible part of the door leaf are taken into account.

Insulation criteria with suffix 2 (I_2) means that no temperature measurements on the door leaf within 100 mm from the border line of the visible part of the door leaf are taken into account.

The temperature rise at any point of the frame is limited to 180 °C for I_1 and 360 °C for I_2, in both cases to be measured 100 mm from the visible edge of the door leaf.

A door that satisfies the criteria to I_1 will always satisfy the criteria to class I_2.

Table 3-16a. Doors without self-closing device

	New class	Old class
Denmark	Door class EI_2 30	BD-door 30-M
Finland	EI_2 15, EI_2 30 or nationally defined classes [F)] If I requirement not met (for > 0,1 m^2 area) then safety distance required (heat flux ≤ 10 kW/m^2). Rule: At least half of the fire resistance time required for the fire-separating element.	Fire resistance time of a door in a fire-separating building element shall in general be at least half of the fire resistance time required for the fire-separating element (B30, B60, A30, A60).
Iceland	EI_2 120 A2-s1,d0 EI_2 90 A2-s1,d0 EI_2 60 A2-s1,d0 EI_2 30 EI_2 60 E 30 E 60	A 120 A 90 A 60 B 30 B 60 F 30 F 60
Norway	EI_2 30	B 30
Sweden	EI_2 30, EI_2 60	EI 30/A30, EI 60/A60 [S)]

[F)] Old temperature limits (higher than EN) applied.
[s)] Higher temperature limits than in EN standards still accepted. See BBR 5:6214 where a general exception allows A-class during the coexistence period.

Table 3-16b. Doors with self-closing device

	New class	Old class
Denmark	Door class EI_2 60-C A2-s1,d0 Door class EI_2 30-C Door class EI_2 60-C Door class E 30-C Door class E 60-C Door class CS_a	BS-door 60 BD-door 30 BD-door 60 F-door 30 F-door 60 Self-closing, smoke tight door
Finland	EI_2 15, EI_2 30, EI_2 45, $EI_2$60[F1,F2] or nationally defined classes[F3] Fire wall doors: EI_2 120, EI_2 180, EI_2 240 and A2-s1,d0 in P1 buildings	B30, A30 B60, A60 B90, A90 B120, A120
Iceland	EI_2 120-C A2-s1,d0 EI_2 90-C A2-s1,d0 EI_2 60-C A2-s1,d0 EI_2 30-C EI_2 60-C E 30-C E 60-C	A 120 self closing A 90 self closing A 60 self closing B 30 B 60 self closing F 30 self closing F 60 self closing
Norway	E 30 - CS_a EI_2 30-CS_a EI_2 60-CS_a EI_2 60-C	F 30 S B 30 S B 60 S A 60 S B 60 S
Sweden	EI_2 30-C, $EI_2$60-C	EI 30-C, EI60-C

[F1)] C in the class designation has not been implemented in the regulation yet.
[F2)] If I requirement not met (for > 0,1 m^2 area) then safety distance required (heat flux ≤ 10 kW/m^2).
[F3)] Old temperature limits (higher than EN) applied.

Table 3-16c. Doors, hatches etc. with limited smoke leakage

	New class	Old class
Denmark	Door class CS_a	Self-closing, smoke tight door
Finland	Not applied	Not applied
Iceland	EI_2 120-CS_m A2-s1,d0 EI_2 90-CS_m A2-s1,d0 EI_2 60-CS_m A2-s1,d0 EI_2 30-CS_m EI_2 60-CS_m E 30-CS_m E 60-CS_m	A 120 not used A 90 not used A 60 not used B 30 not used B 60 not used F 30 smoke tight F 60 not used
Norway	E 30 - CS_a EI_2 30-CS_a EI_2 30-S_a EI_2 60-S_a EI_2 60-CS_a	F 30 S [N)] B 30 S B 30 B 60 B 60 S
Sweden	Ongoing work if S_a or S_m will be used.	Not used in Sweden.

[N)] In separating elements where smoke tightness is required, an alternative to class S_a is doors equipped with draught seals, threshold and rebate between door and frame on all 4 sides.

Table 3-16d. Lift landing doors

	New class	Old class
Denmark	E 30-C EI_2 30-C EI_2 60-C	F-door 30 BD-door 30 BD-door 60
Finland	EI 15, EI 30, EI 45, EI 60[F)] Rule: At least half of the fire resistance time required for the fire-separating element.	Fire resistance time of a door in a fire-separating building element shall in general be at least half of the fire resistance time required for the fire-separating element (B 30, B 60, B 90, B 120, A 30, A 60, A 90, A 120).
Iceland	EI 30-C	EI-C30
Norway	E 90[N)]	F 90
Sweden	-	-

[F),N)] Not stated if testing should be according to EN 81-58 or EN 1634-1

In the Danish guidelines (*Eksempelsamling)* it is stated that smaller openings, like openable windows, doors and hatches in fire resistant partitions often may be designed with a fire resistance equal to half of the fire resistance time as determined for the partition itself /37/.

Discussion

Various combinations of classification criteria are used in the Nordic countries. Denmark, Iceland and Norway require (for some applications) doors that only fulfil the integrity requirement E in specific applications. Finland and Sweden require that fire doors shall fulfil the insulation criterion I as well.

One factor that will be crucial for the trade of fire doors within the Nordic countries will be which requirements that are chosen for smoke leakage (i.e. either S_a or S_m). This requirement is not yet set in all Nordic countries.

The class requirement to self closing doors (i.e. C0-C5) will depend on the use of the door in the building in question, and must be determined for each special case. This is not a regulatory issue. Class C1-C5 should be prescribed for doors that shall be self-closing, whereas the classification C0 means “no door-closer” or “no performance determined”.

Currently a national class A can be used is Sweden where the temperature requirements are lower than for EI_2. A change to EI_2 class with the same time requirement would therefore make the demands on the fire doors higher. A possible solution could be to consider E- or EW-classes as a replacement for the A-class.

Fire resistance of lift landing doors are regulated by the lifts directive /42/, and a specific standard for testing this has been developed, EN 81-58 /43/. However, doors in fire divisions in general are regulated under the CPD /44/, and should be tested according to EN 1634-1 /36/. There are some major discrepancies between the two test standards, and between the way doors are classified based on test results. As an example, the integrity is designated E in both classification systems, but the criteria are not identical. This means that there is a potential conflict between the two directives, which again may lead to different requirements to fire resistance for lift landing doors, and may represent a trade barrier.

Proposal

A complete harmonisation of classes used on fire doors in the Nordic countries requires a substantial adaptation of the Nordic regulations. A straight forward action is to harmonise the smoke classes. It is recommended that the Nordic building authorities harmonise the use of either S_a or S_m class. The issue of lift landing doors should be resolved through CEN.

3.17 Smoke ventilation systems

Present situation

In most countries smoke ventilation systems have not been classified. A harmonised standard, EN 12101-2:2003, has been published which now makes it possible to classify and CE-mark smoke ventilation systems. In Denmark it is a requirement that smoke ventilation systems shall be CE-marked.

Table 3-17. Declared properties of smoke ventilation systems

	New class	Present class
Denmark	(no changes)	RE 50 + RE 10 000 SL 720 T(-05) WL 1500 B 300 E-d2
Finland	-	No requirements[1]
Iceland	-	No classification
Norway	-	No classification
Sweden	-	No classification

[1] In practical design the following classes are often used:
RE 1000 + 10 000
SL 500
T(-15)
WL 1500
B 300

Discussion

A harmonised standard EN 12101-2:2003 (Smoke and heat control systems. Part 2: Specification for natural smoke and heat exhaust ventilators) is already in use and thus the smoke ventilation systems can be CE-marked. This will most certainly lead to a situation where all producers will have CE-marked products.

It would not be possible to harmonise all classes of smoke ventilation systems because of variation of loading conditions between regions, such as snow, temperature and wind load. Although, some of the classes can be harmonised as according to the following proposal.

Proposal

Reliability if it is only fire ventilation: RE 50
Reliability if it is also comfort ventilation: RE 10 000
Heat exposure, fire class: B 300
Reaction to fire class: E-d2

3.18 Ventilation ducts

Present situation

Different methods have been used in the Nordic countries for classification and type approval of ventilation ducts. The new European test method EN 1366-1 (Fire resistance tests for service installations. Ducts) is quite different from the national methods used and thus it is not possible to directly translate the old national classes used to the new European classes.

Table 3-18. Fire resistance class of ventilation ducts

	New class	Old class
Denmark	Duct class E 60 (ve ho i ↔ o) A2-s1,d0 Duct class EI 30/E 60 (ve ho i ↔o) A2-s1,d0	F-duct 60 with only non-combustible materials BS-duct 30 with integrity as F-duct 60
Finland	-	EI 15 - EI 120[1)]
Iceland	E30 B-s1,d0	E-30 non-combustible
Norway	-	EI 15 – EI 120
Sweden	-	EI 15-EI 120[2)]

[1)] Present classes
[2)] SP Fire 124. In SP Fire 124 a fire is applied within the ventilation duct.

Discussion

The European method EN 1366-1 treats different fire conditions such as fire within the ventilation duct, fire outside the ventilation duct and the penetration system of the ventilation duct.

The new European classification and testing of ventilation ducts implies a major change compared to the situation today. The test method EN 1366-1 is very different from the ones used in the Nordic countries and it is difficult to say which classes according to EN 1366-1 that corresponds to the old classification. If the new method is fully adopted, i.e. all different tests and all scenario classes, it will lead to much more severe requirements and more expensive products.

Proposal

Testing and classification of ventilation ducts to all fire conditions stated in EN 1366-1 may lead to overqualified products in some applications. A proposal is therefore to only test and classify the ventilation ducts in accordance with EN 1366-1 with fire within the ventilation duct (or: clearly define applications were also outside fire is of concern). The following classes are appropriate: EI 15 – EI 120.

4 Summary of proposals

The harmonisation of construction products within Europe is an ongoing process. For many products, especially in the field of reaction to fire, product and classification standards are available today. Accordingly the building regulations in the Nordic countries have, to a large extent, adapted European fire classes. For some types of products the differences between the regulations are already quite small, i.e. flooring and roofing products. In other cases further harmonisation may lead to a more efficient market and a reduction in cost of product development for industry. This is the case for i.e. pipe insulation, internal and external surfaces.

Regarding fire resistance, the conclusion is that it is too early to propose a change in present regulations for many types of products. The reason for this is that there is still more harmonisation work needed in this field. However, also in this field, further harmonisation is possible for products like fire doors and smoke ventilation systems etc.

Below a summary of proposals for different product groups is given.

4.1 Materials

According to the European reaction to fire classification system it's only the A1 class which is not dependant of the end use application for the product. The reaction to fire properties on material related level can be characterized by the fact that the properties are seen as independent of the end use application for the product – contrary to the normal European classification system in which the product is classified in its different end use applications.

There are fundamental differences in the Nordic countries in the way products are regulated from a material point of view. At present further harmonisation does not seem to be realistic.

4.2 Internal surfaces

All countries refer today to European reaction to fire classes. One minor difference is that Finland, apart from the other nations, accepts droplet class d1 and d2 for certain applications. This means that a Finnish manufacturer of an internal surface product with, for example, class D-s2,d2 can not export the product for use in the other Nordic countries. A technical drawback incorporated with the use of d1 and d2 droplet class could be that it opens up for internal surface materials which may prevent safe escape from premises because of giving of burning droplets. Another difference is that only Sweden and Finland use the "middle class" C. The number of products stating this class is rather limited, why the use of only class B and D may be considered.

A further step towards complete harmonisation would be to withdraw the use of class C and to avoid the use of droplet class d1 and d2 for internal surfaces, especially for ceilings and escape routes.

If the above proposal is implemented, then the situation for internal surfaces would be similar in Finland, Iceland, Norway and Sweden.

4.3 External surfaces

There are major differences between the Nordic countries in the use of smoke and droplet class. From a fire risk point of view the smoke requirements could be harmonised because outside the building the smoke from the burning building products will rarely be a hazard to people. Thus less severe requirements can be applied to exterior surfaces than for interior surfaces.

The risks associated with burning droplets for low rise buildings are much smaller than those for high rise buildings. Thus, d2 linked with D class can be recommended, because D class is used in practice mainly for low rise buildings.

The smoke class s2 is proposed as the main option for all external surfaces of external walls. The droplet class d2 is proposed when associated with D class.

If the above proposal is implemented, then the situation for external surfaces of low-rise buildings would be similar in all Nordic countries.

4.4 Facades

There is no European fire test method for facades. Some types of facade kits, like rendered facades, can be CE-marked based on ETAGs.

A national large scale test method (SP FIRE 105) has been used in Sweden. As seen in Table 3-4 no other Nordic country requires large scale testing at present. Besides Sweden two more countries (Denmark and Norway) are considering to require large scale testing for facades in the future.

Sweden will continue to use SP FIRE 105 when there is a regulatory need to assess fire spread along facade systems in multi-storey buildings. For the time being, it could be an advantage for some of the facade system producers if façade systems that are approved according to SP FIRE 105 are accepted in all Nordic countries when large scale tests are required.

At the moment ETAG development concerning rendering systems for facades is on-going, but no fire testing or classification method for all products is available.

It is proposed to await the outcome of standardisation within EOTA for facade system kits.

4.5 Floorings

All the Nordic countries have implemented the European fire classes for floorings according to EN 13501-1. The former classification of floorings was based on the test method NT FIRE 007 (floorings in class G or L). ***The requirements on floorings in the Nordic countries do not represent a trade barrier since the majority of premises ask for the same classification. It is therefore proposed that the present regulations are maintained***.

4.6 Insulation products

There are fundamental differences in the Nordic countries in the way insulation products are regulated. Either from a performance based point of view or from a material related point of view. Note, however, that where non-combustible material is required the same European fire class is asked for (A2-s1,d0).

Smouldering combustion requirements are not needed in the Nordic countries with the possible exception of combustible insulation materials in attics.

At present no further harmonisation is proposed. In the future it will be possible to refer to a European harmonised fire classification for smouldering.
Work to standardise a suitable test procedure is going on in CEN.

4.7 Linear pipe thermal insulation products

Pipe insulations fall within the scope of technical insulation products. Though considerable work within CEN the harmonised standards for this group of products is still at the prEN stage, why CE-marking is not possible at present. The reaction to fire classification of pipe insulation is, however, decided by the European commission and published in EN 13501-1. The proposed implementation of the new smoke classes below is based on the assumption that the national requirements on smoke for the lower performing classes have been rather moderate (for some countries smoke has not been regulated at all).

The following classes for pipe insulation are proposed for the national regulations.

$A2_L$-s1,d0
B_L-s1,d0
C_L-s3,d0
D_L-s3,d0
E_L-d2

Below is an example of how the classes may be implemented.

If the pipe installation covers a major part of the enclosure the pipe insulation shall fulfil $A2_L$-s1,d0 or the same class as the surrounding surface finishes.

If the pipe installation covers a minor part of the enclosure the pipe insulation shall fulfil the following classes.

– B_L-s1,d0 when the surrounding surface finishes fulfil B-s1,d0
– C_L-s3, d0 when the surrounding surface finishes fulfil C-s2,d0
– D_L-s3, d0 when the surrounding surface finishes fulfil D-s2,d0
or
-E_L-d2

The second part of the example is based on the philosophy of a parallel system to linings as discussed in section 3.8 Cables.

4.8 Cables

Cables are covered by the construction products directive following the same principles as for other building products for example linings (see annex A). Therefore the European fire classes for cables are to a large extent parallel to the fire classes for linings. In both cases there are seven classes. These classes also reflect a burning behaviour that is quite similar. Although the products themselves are very different the resulting fire performance from the classes bear similarity and this could be used for regulating purposes.

Presently (2008) the European cable industry through Europacable together with SP Fire Technology and other research labs are running a research project with the aim to assist the process of CE-marking of cables in the CPD. The project is called CEMAC II - CE-marking of cables, and will through a comprehensive test programme create a technical background for extended application (EXAP) procedures for cables. ***This knowledge is fundamental to the creation of regulations for CE-marking of cables and it is therefore proposed to await information from this project before writing concrete guidelines for classification of cables.***

However, care should be taken to use the same set of classes in the Nordic countries. For example, the number of possibilities of selecting smoke and droplet classes can create trade barriers. A possibility to avoid that is to select the smoke and droplets classes that already appear for internal surfaces and make them parallel to that system.

4.9 Sandwich panels

During 2006 the Commission conducted an enquiry on the existence of regulatory provisions in force in Member States and directly or indirectly applicable to the fire behaviour of sandwich panels /30/. Based on the outcome of the enquiry, the Commission has expressed the point of view that for the time being there is no basis to develop a large scale test for sandwich panels. The present proposal is to use the procedure according to EN 14509, i.e. the SBI, but with an additional paragraph that in certain cases allows for additional measurements on these products.

There is a need for survey on how these products are used on the Nordic market. Then a sustainable solution based on fire safety measures should be created.

4.10 Roofings

In the area of roofings there is complete harmonisation. All countries use the same classification. The choice of ENV 1187, test 2 with the corresponding classification system is a direct continuance of the former agreed Nordic safety level regarding roofings. ***For the time being the requirement roofing class B_{ROOF}(t2) should be maintained in the Nordic countries***.

CEN has started up the work to develop a single fire test method for roofings. It is recommended that the Nordic countries support this work.

4.11 Repainting and redecoration of surfaces

Building regulations in the Nordic countries have general statements on maintenance of the fire safety level in a building, but no specific requirements on how to maintain the reaction to fire properties of repainted and redecorated surfaces.

Treatment of surfaces in e.g. escape routes should be a part of the fire documentation for the building, and would prevent that the total thickness of paint or wall paper is too large to fulfil the provided safety level. Many layers of wallpaper or paint may compromise the fire safety level in escape routes by lowering the fire class. This problem should be addressed by the authorities.

The maintenance of reaction to fire properties of surfaces in escape routes should be explicitly mentioned in building regulations, and should be a checkpoint on fire inspections.

4.12 Windows

All the Nordic countries, except Finland, require that windows in general shall have the same fire resistance as the rest of the partition. Fire resistance based on assessments can be made in certain cases (small windows, corners, parallel opposite walls). How windows are treated in the regulations differs slightly between the countries, and also the different classes applied.

Finland and Sweden are the only Nordic countries requiring fire resisting classes longer than 60 minutes, which means that the market for openable windows satisfying these classifications is rather small..

Sweden uses EI_1 xx (index 1) instead of EI_2 xx (index 2) for openable windows. From a technical point of view this means that there is a more severe temperature requirement on openable windows on the Swedish market compared to the other Nordic countries.

Sweden shall consider the use of index 2 instead of 1 for openable windows. Beyond that no further changes are proposed.

4.13 Coverings

The harmonised test standard for coverings EN 14135 allows the use of different substrate materials during test, leading to different designation, K_1 or K_2. The Nordic countries have chosen different designations. Also reaction to fire requirements on the covering materials are added by each country varying from A2-s1,d0 to D-s2,d2.

As the situation is today the Nordic requirements on coverings are quite different and it is not straight forward to propose a harmonisation. Possible technical, practical and economical aspects of choosing either K_1 or K_2 and the effect of choosing different reaction to fire classes for the materials in coverings has to be assessed more into detail.

4.14 Load bearing elements – not separating

There are no major differences between the fire resistance classes used in the different countries. The main difference is that in some cases there are also requirements on the reaction to fire properties of the materials in the element. When there is a reaction to fire requirement it is in all cases class A2-s1,d0 that is asked for.

At present further harmonisation does not seem to be realistic, why no changes are proposed.

4.15 Separating elements

There are no major differences between the fire resistance classes used in the different countries. The main difference is that in some cases there are also requirements on the reaction to fire properties of the materials in the element. When there is a reaction to fire requirement it is in all cases class A2-s1,d0, with one exception for fire walls in Finland where an A1 class can be required.

At present further harmonisation does not seem to be realistic, why no changes are proposed.

4.16 Fire doors

Currently a national class A can be used is Sweden where the temperature requirements are lower than for EI_2. A change to EI_2 class with the same time requirement would therefore make the demands on the fire doors higher. A possible solution could be to consider E- or EW-classes as a replacement for the A-class.

A complete harmonisation of classes used on fire doors in the Nordic countries requires a substantial adaptation of the Nordic regulations. A straight forward action is to harmonise the smoke classes. ***It is recommended that the Nordic authorities harmonise the use of either S_a or S_m class***. The issue of lift landing doors should be resolved through CEN.

4.17 Smoke ventilation systems

Smoke ventilation systems can be CE-marked based on EN 12101-2:2003. Because of variation of loading conditions between regions, such as snow, temperature and wind load, it would not be possible to harmonise all relevant properties of smoke ventilation systems. However, some of the properties can be harmonised as according to the following proposal.

Reliability if it is only fire ventilation: RE 50
Reliability if it is also comfort ventilation: RE 10 000
Heat exposure, fire class: B 300
Reaction to fire class: E-d2

4.18 Ventilation ducts

The new European classification and testing of ventilation ducts implies a major change compared to the situation today. The test method EN 1366-1 is very different from the ones used in the Nordic countries and it is difficult to say which classes according to EN 1366-1 that corresponds to the old classification. If the new method is fully adopted, i.e. all different tests and all scenario classes, it will lead to much more severe requirements and more expensive products.

Testing and classifying ventilation ducts to all fire conditions stated in EN 1366-1 may lead to overqualified products in some applications. A proposal is therefore to only test and classify the ventilation ducts in accordance with EN 1366-1 with fire within the ventilation duct (or: clearly define applications were also outside fire is of concern). The following classes are appropriate: EI 15 – EI 120.

References

/1/ "Funktionsbestemte brandkrav og teknisk vejledning for beregningsmæssig eftervisning", NKB Utskotts- och arbetsrapporter 1994:07, (Nordiska kommitten för byggbestämmelser, NKB, 1994.

/2/ Hadjisophocleous, G. V., Benichou, N., Tamim, A. S., "Literature Review of Performance-Based Fire Codes and Design Environment", Journal of Fire Protection Engineering, Vol. 9, No. 1, 1998.

/3/ Drysdale, D., "An Introduction to Fire Dynamics", Wiley-Interscience, 1992.

/4/ Karlsson, B., Quintiere, J., "Enclosure Fire Dynamics, CRC Press, 1999.

/5/ "The SFPE Handbook of Fire Protection Engineering", Second Edition, The National Fire Protection Association, 1995.

/6/ "Brandskyddshandboken", Rapport 3134, Brandteknik, Lunds Tekniska Högskola, Lund, 2005.

/7/ Lundin, J., "Safety in Case of Fire – The Effect of Changing Regulations", Report 1032, Brandteknik, Lunds Tekniska Högskola, Lund, 2005.

/8/ Stenstad, Vidar; Bjørkmann, Wiran: "Performance Based Design in Norway", paper presented at International Seminar on Fire Safety Engineering, Paris, France, April 2007,

/9/ Cox, G, Combustion fundamentals of fire, chapter six, Compartment fire modelling, Academic Press Limited, 1995.

/10/ Magnusson, S.E., Drysdale, D.D., Fitzgerald, R.W., Mowrer, F., Quintiere, J., Williamson, R.B., Zalosh, R.G., "A Proposal for a Model Curriculum in Fire Safety Engineering", Fire Safety Journal, Vol. 25, 1995.

/11/ Birgit Östman, Fire Safe Use of Wood Network, 2006.

/12/ EN 13501-1:2007 Fire classification of construction products and building elements –Part 1: Classification using data from reaction to fire tests. European Committee for Standardization (CEN), Brussels, Belgium, 2007.

/13/ Testing and classification for reaction to fire on material related level Note dated 9 September 2006. National Agency for Enterprise and Construction.

/14/ Testing and classification for reaction to fire properties on material related level, DBI Method No. FIRE01, Danish Institute of Fire and Security Technology, December 2007.

/15/ Guideline to the Technical Regulations, 4th edition, 2007 (only in Norwegian).

/16/ NKB Product rules for fire resistance surface finishes, NKB produktregler 14, January 1990.

/17/ SP FIRE 105 Large scale testing of facade systems.

/18/ Tuula Hakkarainen, Birgitte Messerschmidt, Anne Steen Hansen, Per Thureson, Comparison of Nordic classification System for surface Linings and Floor Coverings with the EU Euroclasses for Surface Linings and Floor Coverings, Nordtest project No 1349-97, SP REPORT 1998:20.

/19/ Björn Sundström, Jesper Axelsson, Development of a common European system for fire testing of pipe insulation based on EN 13823 (SBI) and ISO 9705 (Room/Corner test), SP REPORT 2002:21.

/20/ IEC 60332-1, Test on electric and optical fibre cables under fire conditions, Test for vertical flame propagation for a single insulated wire or cable. (3 parts), IEC.

IEC 60332-3, Test on electric and optical fibre cables under fire conditions, Test for vertical flame spread of vertically-mounted bunched cables or wires. (6 parts), IEC.

/21/ EN 50085 Cable trunking systems and cable ducting systems for electrical installations (3 parts), European committee for standardization (CEN), Brussels, Belgium.

/22/ EN 50086, Conduit systems for electrical installations (5 parts), European committee for standardization (CEN), Brussels, Belgium.

/23/ DS 2393, Polyvinyl chloride insulated sheathed cables of rated voltages up to and including 450/750 V.

/24/ IEC 61034:2006: Measurements of smoke density of cables burning under defined conditions, Part 1 and 2, IEC, 2005.

/25/ IEC 60614, Specification for conduits for electrical installations (7 parts), IEC.

/26/ IEC 61084, Cable trunking and ducting systems for electrical installations (4 parts), IEC.

/27/ CEMAC II, project financed by Europacable (an European organisation for cable producers) with the aim to propose extended application rules for fire properties in cables. Four European cable fire test laboratories are involved in the project. The project is planned to be finished during 2009.

/28/ Björn Sundström, Classification of wall and ceiling linings, proceedings of EUREFIC seminar September 1991.

/29/ Patrick Van Hees, The need for full scale fire testing of sandwich panels, Flame retardants conference 2006.

/30/ Outcome of the enquiry on national regulations applicable to sandwich panels (CONSTRUCT 06/763 REV. 1).

/31/ ENV 1187:2002: Test methods for external fire exposure to roofs. European committee for standardization (CEN), Brussels, Belgium, 2002.

/32/ NT FIRE 006: Roofings: Fire spread. Edition 2. approved 1985-11. NORDTEST, Esbo, Finland, 1985.

/33/ EN 13501-5:2005: Fire classification of construction products and building elements – Part 5: Classification using test data from external fire exposure to roof tests. European committee for standardization (CEN), Brussels, Belgium, 2005.

/34/ Bjarne Kristoffersen : Etterbehandling av overflater i rømningsvei (Redecoration of surfaces in escape routes). Report no. NBL10 A02113. SINTEF NBL as, Trondheim, Norway, 2002.

/35/ Forskrift av 26. juni 2002 om brannforebyggende tiltak og tilsyn. (Regulations of 26 June 2002 relating to fire-preventive measures and control. In Norwegian only). The Directorate for Civil Protection and Emergency Planning (DSB), Tønsberg, Norway.

/36/ EN 1634-1: 2008. Fire resistance and smoke control for door, shutter and openable window assemblies and elements of building hardware – Part 1. Fire resistance tests for doors, shutters and openable windows. European committee for standardization (CEN), Brussels, Belgium, 2008.

/37/ Eksempelsamling om brandsikring af byggeri. 5.2.7 Gennembrydninger og lignende i brandadskillende bygningsdele. Erhvervs og byggestyrelsen, Copenhagen, Denmark, 2006. www.ebst.dk/publikationer/eksempelsamling_om_brandsikring_af_byggeri/index.htm

/38/ E1, The national building code of Finland. Fire safety of buildings. Regulations and guidelines 2002. Ministry of the Environment. http://www.ymparisto.fi/download.asp?contentid=12754&lan=en
.

/39/ Regelsamling för byggande - Boverkets byggregler, BBR. BFS 1993:57 med ändringar t.o.m. 2006:22. 5 Brandskydd. Boverket, Karlskrona, Sweden, 2006.

/40/ EN 14135:2004: Coverings – Determination of fire protection ability. European committee for standardization (CEN), Brussels, Belgium, 2004.

/41/ EN 13501-2:2003: Fire classification of construction products and building elements – Part 2: Classification using data from fire resistance tests, excluding ventilation services. European committee for standardization (CEN), Brussels, Belgium, 2003.

/42/ European Parliament and Council Directive 95/16/EC of 29 June 1995 on the approximation of the laws of the Member States relating to lifts.

/43/ EN 81-58:2003. Safety rules for the construction and installation of lifts - Examination and tests - Part 58: Landing doors fire resistance test. European committee for standardization (CEN), Brussels, Belgium, 2003.

/44/ Council Directive of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products.

Annex A Classification of cables – EU commission decision

The reaction-to-fire classes are correlated to fire performance in real-scale reference scenarios (FIPEC ref) and can be described in general words as below:

Class A_{ca}
A simple selection of the criteria for class A1 linings is used.

Class $B1_{ca}$
Products that show a non-continuous flame spread and very limited HRR in the vertical and the horizontal reference scenario when exposed to the 40-100-300 kW ignition source. This also applies for the 30 kW test exposure in FIPEC20 Scenario 2.

Class $B2_{ca}$
Products that show a non-continuous flame spread when exposed to the 40 kW ignition source in the vertical reference scenario and the 40-100 kW ignition source in the horizontal reference scenario. They should also show a non-continuing flame spread, a limited fire growth rate, and a limited heat release when exposed to the 20 kW test procedure, FIPEC20 Scenario 1.

Class C_{ca}
Products that show a non-continuing flame spread when exposed to the 40-100 kW ignition source in the horizontal reference scenario and a non-continuing flame spread, a limited fire growth rate, and a limited heat release when exposed to the 20 kW test procedure, FIPEC20 Scenario 1.

Class D_{ca}
Products that show a fire performance better than ordinary not flame retardant treated polyethylene and a performance approximately like wood when tested in the reference scenarios. When tested in FIPEC20 Scenario 1 the products show a continuous flame spread, a moderate fire growth rate, and a moderate heat release rate.

Class E_{ca}
Products that show a continuous flame spread when exposed to the 40 kW ignition source in the horizontal reference scenario. Only the small flame test EN 60332-1-2 is used for assessment.

Table A1 below show the classes of reaction to fire performance for electric cables as given by the Commission decision 2000/147/EC.

Table A1. Classes of reaction to fire performance for electric cables.

Class	Test method(s)	Classification criteria	Additional classification
A_{ca}	EN ISO 1716	PCS ≤ 2.0 MJ/kg (1)	
$B1_{ca}$	FIPEC20 Scen 2 (5) *And*	FS ≤ 1.75 m *and* THR_{1200s} ≤ 10 MJ *and* Peak HRR ≤ 20 kW *and* FIGRA ≤ 120 Ws^{-1}	Smoke production (2, 6) and Flaming droplets/particles (3) and Acidity (4, 8)
	EN 60332-1-2	H ≤ 425 mm	
$B2_{ca}$	FIPEC20 Scen 1 (5) *And*	FS ≤ 1.5 m; *and* THR_{1200s} ≤ 15 MJ *and* Peak HRR ≤ 30 kW *and* FIGRA ≤ 150 Ws^{-1}	Smoke production (2, 7) and Flaming droplets/particles (3) and Acidity (4, 8)
	EN 60332-1-2	H ≤ 425 mm	
C_{ca}	FIPEC20 Scen 1 (5) *And*	FS ≤ 2.0 m; *and* THR_{1200s} ≤ 30 MJ *and* Peak HRR ≤ 60 kW *and* FIGRA ≤ 300 Ws^{-1}	Smoke production (2, 7) and Flaming droplets/particles (3) and Acidity (4, 8)
	EN 60332-1-2	H ≤ 425 mm	
D_{ca}	FIPEC20 Scen 1 (5) *And*	THR_{1200s} ≤ 70 MJ *and* Peak HRR ≤ 400 kW *and* FIGRA ≤ 1300 Ws^{-1}	Smoke production (2, 7) and Flaming droplets/particles (3) and Acidity (4, 8)
	EN 60332-1-2	H ≤ 425 mm	
E_{ca}	EN 60332-1-2	H ≤ 425 mm	
F_{ca}	No performance determined		

(1) For the product as a whole, excluding metallic materials, and for any external component (i.e. sheath) of the product.
(2) **s1** = TSP_{1200} ≤ 50 m^2 *and* Peak SPR ≤ 0.25 m^2/s
s1a = **s1** and transmittance in accordance with EN 61034-2 ≥ 80%
s1b = **s1** and transmittance in accordance with EN 61034-2 ≥ 60% < 80 %
s2 = TSP_{1200} ≤ 400 m^2 *and* Peak SPR ≤ 1.5 m^2/s
s3 = not s1 or s2
(3) For FIPEC20 Scenarios 1 and 2: **d0** = No flaming droplets/particles within 1200 s; **d1** = No flaming droplets/ particles persisting longer than 10 s within 1200 s; **d2** = not d0 or d1.
(4) EN 50267-2-3 : **a1** = conductivity < 2.5 μS/mm *and* pH > 4.3 ; **a2** = conductivity < 10 μS/mm *and* pH > 4.3;
a3 = not a1 or a2. No declaration = No Performance Determined.
(5) Air flow into chamber shall be set to 8000 ± 800 l/min.
FIPEC20 Scenario 1 = prEN 50399-2-1 with mounting and fixing as below
FIPEC20 Scenario 2 = prEN 50399-2-2 with mounting and fixing as below
(6) The smoke class declared for class $B1_{ca}$ cables must originate from the FIPEC20 Scen 2 test.
(7) The smoke class declared for class $B2_{ca}$, C_{ca}, D_{ca} cables must originate from the FIPEC20 Scen 1 test.
(8) Measuring the hazardous properties of gases developed in the event of fire, which comprise the ability of the persons exposed to them to take effective action to accomplish escape, and not describing the toxicity of these gases.

Symbols used : PCS – gross calorific potential; FS – flame spread (damaged length); THR – total heat release; HRR – heat release rate; FIGRA – fire growth rate; TSP – total smoke production; SPR – smoke production rate; H – flame spread.

Annex B Implementation of the European reaction to fire classification system

The tables below show the national classes in each country and the corresponding European reaction to fire classes implemented in the building regulations as the situation was in the year of 2006. The information was provided by the Fire Safe Use of Wood Network /11/.

Table B1. National translations and implementation of European reaction to fire classes for surface linings.

European classes for Reaction to Fire - National translations and implementation – Status 2006

Main Euroclasses (except floorings) – Excluding smoke and droplet sub classes

Euroclass	Earlier national class																								
	Austria	Belgium	Czech Republic	Denmark	Estonia	Finland	France	Germany	Greece	Hungary	Iceland	Ireland	Italy	Latvia	Nether-lands	Norway	Poland	Portugal	Slovakia	Slovenia	Spain	Sweden	Switzer-land	UK (Engl. Wales)	UK (Scotland)
Officially implemented in building codes (year)	No	No	No	-04	-05	-02	-03	No	No	-07	-06	-06	No	No	-03	-03	-07	No	-04	-05	-06	-02	No	-02	-06
A1	A		A		*NC*	*NC*	*NC*	A1			*NC*	*NC*	0	*NC*	*NC*		*NC*		A	*NC*	M0			*NC*	*NC*
A2	A	A0	A	*NC*	*NC*	*NC*	M0/ M1	A2					I/II	*HC*	1	*NC*	*NC/ NI*		B	*NC*	M0	*NC*		*LC*	*NC*
B	A/ B1	A1	B	A	1/I	1/I	M1	B1			A	0	I/II	*HC*	1/2	In1/ Ut1	*NI*		C1	1	M1	I		0	0
C	B1/ B2	A1/ A2	C1		1/II 1/-	1/II 1/-	M2	B1				1	II/I II	*Co*	2/3		*HI*		C2	1	M2	II		1	1
D	B1/ B2	A3	C2	B	2/-	2/-	M3/ M4	B2			B	3	III	*Co*	4	In2/ Ut2	*HI/ EI*		C2	3	M3	III		3	2/3
E	B1/ B2		C3				*UC*	B2						*Co*			*EI*		C3	3					
F	B3	A4	C3			-/-	*UC*	B3											C3	4					

Abbreviations *(in Italics)*:
Co = Combustible (Latvia)
NC = Non combustible
HC = Hardly combustible (Latvia)
LC = Limited combustible (UK, Ireland)
NI = Not ignitable (Poland)
HI = Hard ignitable (Poland)
EI = Easy ignitable (Poland)
UC = Unclassified

Table B2. National translations and implementation of European reaction to fire classes for floorings.

European classes for Reaction to Fire - National translations and implementation – Status 2006

2. Flooring classes

Euroclass	Earlier national class																								
	Austria	Belgium	Czech R.	Denmark	Estonia	Finland	France	Germany	Greece	Hungary	Iceland	Ireland	Italy	Latvia	Netherl	Norway	Poland	Portugal	Slovakia	Slovenia	Spain	Sweden	Switzerl	UK (Engl, Wales)	UK (Scotland)
Officially implemented in building regulations (year)	No	No	No	-04	-05	-02	-03	No	No		-06	No req	No	No	-03	-03	-07	-07	-04	-05	-06	-02	No	-02	-06
$A1_{fl}$	A		L_s=0		*NC*		*NC*	A1							*NC*		*NC*		A		M0				
$A2_{fl}$ (no smoke class)	A				*NC*														B						
$A2_{fl}$-s1		A0		*NC*	-	*NC*	M0	A2			*NC*		I				*NC*				M0	*NC*			
$A2_{fl}$-s2							M3						I				*NC*				M1				
B_{fl} (no smoke class)			0-50																C1						
B_{fl}-s1	B1				P		M3						I				*HI*								
B_{fl}-s2		A1/ A2					M3						I				*HI*				M2				
C_{fl} (no smoke class)			50-100																C2						
C_{fl}-s1	B1				P		M3	B1					II		T1		*HI*					G			
C_{fl}-s2		A3					M3						II				*HI*				M3				
D_{fl} (no smoke class)			>100																C2						
D_{fl}-s1	B2			G		L	M4				G		III			G	*EI*					G			
D_{fl}-s2				*UC*			M4						III		T3		*EI*								
E_{fl}	B3		>100	*UC*				B2									*EI*		C3						
F		A4	>100	*UC*				B3											C3						

Abbreviations *(in Italics)*:
Co = Combustible (Latvia)
NC = Non combustible
HC = Hardly combustible (Latvia)
LC = Limited combustible (UK, Ireland)
NI = Not ignitable (Poland)
HI = Hard ignitable (Poland)
EI = Easy ignitable (Poland)
UC = Unclassified

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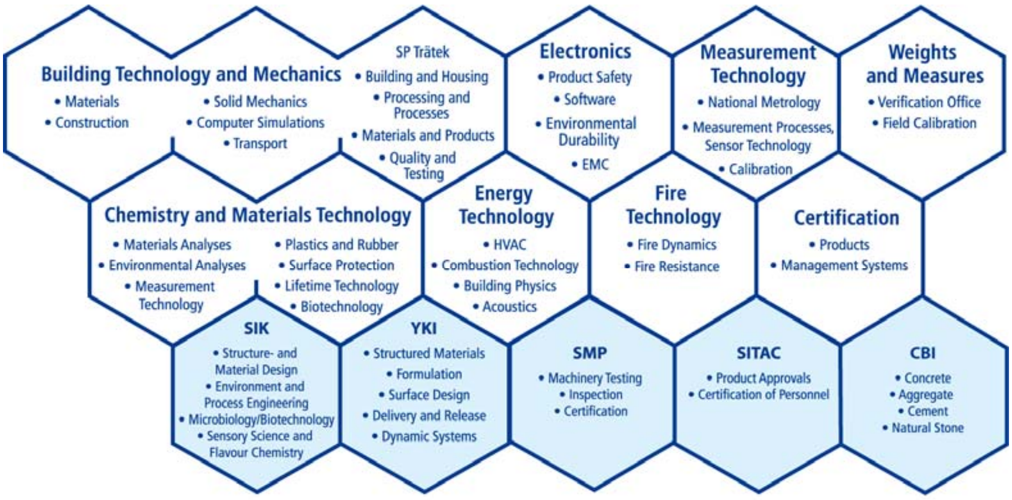

SP is organised into eight technology units and five subsidaries

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