

EUROPEAN FIRE CLASSIFICATION OF CONSTRUCTION PRODUCTS, NEW TEST METHOD "SBI", AND INTRODUCTION OF THE EUROPEAN CLASSIFICATION SYSTEM INTO GERMAN BUILDING REGULATIONS

DIE EUROPÄISCHEN BRANDKLASSEN FÜR BAUPRODUKTE, DIE NEUE PRÜFMETHODE "SBI" UND EINFÜHRUNG DES EUROPÄISCHEN KLASSIFIZIERUNGSSYSTEMS IN DAS DEUTSCHE BAURECHT

CLASSEMENT EUROPEENNE AU FEU DES PRODUIT DE CONSTRUCTION, NOUVEAU METHODE D'ESSAIS "SBI" ET INTRODUCTION DU SYSTEME CLASSIFICATION EUROPEENNE DANS LE SYSTEME DE REGULATION BATIMENT ALLEMANDE

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SUMMARY

A fire model ("reference fire scenario") is described on which the new european fire classification system for construction products is based upon. The adoption of this new classification system within the existing national classification system and its safety level requirements for the use of building construction products due to national regulations with and without reaction to fire testing is explained. Informations on the new introduced european central fire testing method "SBI", run at MPA fire testing department, are given in comparison to the existing national used Brandschacht test.

ZUSAMMENFASSUNG

Es wird das dem neuen europäischen Klassifizierungssystem des Brandverhaltens von Baustoffen zu Grunde liegende Brandmodell ("Referenz-Brandszenarien") beschrieben und die Umsetzung der europäischen Baustoffklassifizierung bei der Verwendbarkeit von Baustoffen unter Beachtung der bisherigen nationalen Schutzziele mit oder ohne Brandprüfung erläutert. Die dabei völlig neu eingeführte und in der Brandprüfstelle der MPA vorgehaltene europäische Zentralprüfmethode für das Brandverhalten "SBI" wird im Vergleich mit der seitherigen nationalen Brandschachtprüfung beschrieben.

RESUME

Nous décrivons ici d'une part le nouveau système de classement au feu européen des matériaux de construction basé sur le modèle de réaction au feu («scénario de référence de réaction au feu»), d'autre part la transcription de la classification européenne dans l'utilisation des matériaux de construction dans le cadre des objectifs de prévention nationaux – avec ou sans test au feu – actuellement en vigueur. Nous décrivons la méthode centrale européenne « SBI » de test au feu, nouvellement introduite et présentée au département de contrôle de réaction au feu de MPA, en comparaison avec la méthode de test «Brand-schacht» jusqu'à présent en vigueur au niveau national.

KEYWORDS: Approval, Bauregelliste, building product directive, classification, commission decision, CWFT, fire growth, fire scenario, fixing & mounting, flame spread, flashover, ignitability, non combustibility, SBI, smoke

1 INTRODUCTION

Protection against fire hazard and assessment of reaction to fire as well as fire resistance is a basic presumption when planning and erecting buildings and is therefore an imperative requirement from both, national and EC regulations, given e.g. in the construction products directive (CPD). Assessment of reaction to fire solely is possible on basis of a prescriptive fire model and resulting fire test methods. Reaction to fire for building products historically is given by classification within national standards such as DIN 4102. The new reaction to fire classification system for building products according to EN 13501-1, set up by the European Commission, now requires reaction to fire assessment on basis of new introduced fire test methods, especially the new “central” test method, “SBI”. These new european reaction to fire classes have to be set in relation to the existing national classification system and its legal requirements, thus rendering possible the use of the products due to national building regulations.

2 EUROPEAN FIRE CLASSIFICATION SYSTEM

2.1 Fire scenario – Fire model

European commission Construction Products Directive (CPD) 89/106 gives the basic provisions for limitation of the generation and spread of fire and smoke within the building, one of them being the limitation of the building products' contribution to a fully developed fire.

To render possible the estimation and limitation of the building products' contribution to a fire, the implementation of a fire classification system was recommended for the description of their reaction to fire. The classification system itself is not included in the Construction Products Directive but has been published first time within Commission Decision 94/611/EG [1] and finally was published with Commission Decision 2000/147/EG [2].

The 7 fire classes for building products laid down in the Commission Decision are specified in the standard EN 13501-1 "Fire classification of construction products and building elements" [3]. These european fire classes in principle as well cover the requirements of the as yet existing 5 national German reaction to fire classes according to DIN 4102 [4].

Classification is a means to consider the construction product's contribution to the generation and spread of fire and smoke within the room of origin or in a given area. A simplifying assumption is made to apply the same classification to different orientations and geometrics and to product types other than room surface products. Products are generally considered in relation to their end use application.

For all building products, this classification is based upon fire models ("reference scenarios"), the principal validity of which has been shown from various fire disasters or results from real large scale fire tests. The latter ones are based on the consideration of a fire, initiated in a room, which can grow and eventually reach flashover. This scenario includes three fire situations corresponding to three stages in the development of a fire (Fig. 1) :

- First stage includes initiation of the fire by ignition of a building product, with a small flame, within a limited area of the product.

- Second stage addresses fire growth eventually reaching final flashover situation with heat release $> 1 \text{ MW}$ to 2 MW and temperature levels of $800 - 1200^\circ\text{C}$.

This stage generally is simulated for building products by a single burning item in the corner of a room, creating a heat flux onto the adjacent surfaces within the room. For floorings, a fire is seen to grow in the room of its origin, creating a heat flux on the floorings in an adjacent room or corridor, through a door opening. Smoke development and smoke density have as well to be taken in account.

- In the post-flashover phase all combustible building products present finally are contributing to the fire load (fully developed fire).

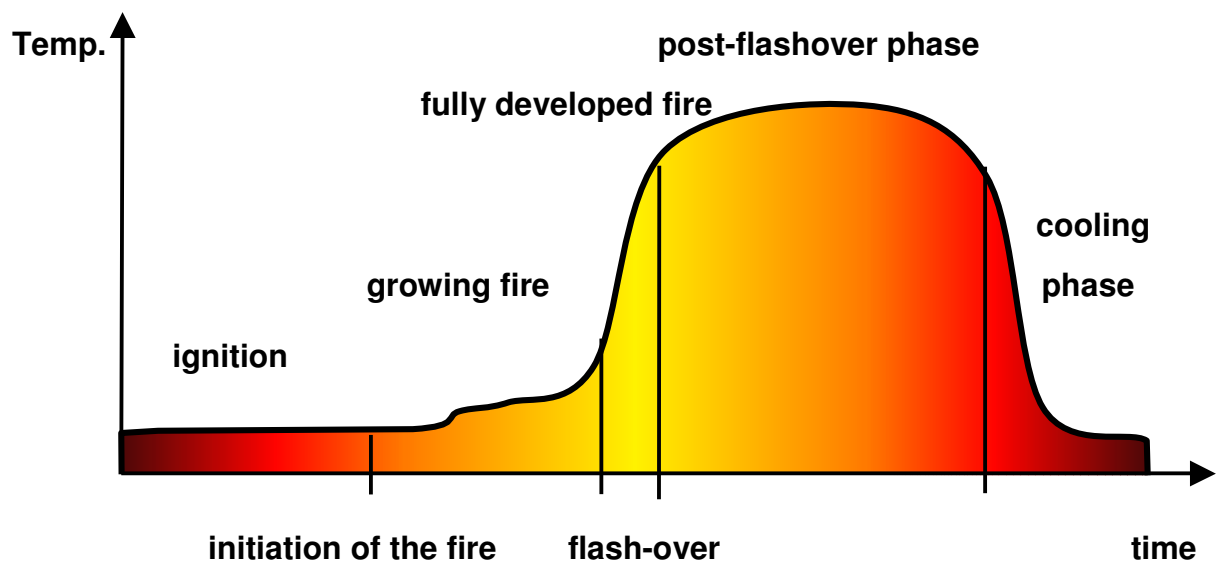


Fig. 1 : fire model (after Troitzsch [5], Beard [6] et.al.)

Different classes address exposure of the product to the fire at different stages of the fire development in the reference scenario.

According to EN 13501-1, the relation between fire classes for building products excluding floorings (Table 1), and for floorings ("fl", Table 2), and the above shown reference fire scenario generally is described as follows:

Table 1: Relationship between the classes and the reference fire scenarios for building products excluding floorings acc. to EN 13501-1

Euro-class	contribution to fire / aspired safety level	classification acc. to DIN 4102
F	Products for which no reaction to fire performances are determined or which cannot be classified in one of the classes A1, A2, B, C, D, E.	B3
E	Products capable of resisting, for a short period, a small flame attack without substantial flame spread.	B2
D	Products satisfying criteria for class E and capable of resisting, for a longer period, a small flame attack without substantial flame spread. In addition, they are also capable of undergoing thermal attack by a single burning item with sufficiently delayed and limited heat release.	
C	As class D but satisfying more stringent requirements. Additionally under the thermal attack by a single burning item they have limited lateral spread of flame.	
B	As class C but satisfying more stringent requirements.	B1
A2	Satisfying the same criteria as class B for the SBI-test according to EN 13823. In addition, under conditions of a fully developed fire these products will not significantly contribute to the fire load and fire growth.	A2
A1	Class A1 products will not contribute in any stage of the fire including the fully developed fire. For that reason they are assumed to be capable of satisfying automatically all requirements of all lower classes.	A1

Additional classifications for smoke production:

- s3: No limitation of smoke production required
- s2: The total smoke production as well as the ratio of increase in smoke production are limited
- s1: More stringent criteria than s2 are satisfied

Additional classifications for flaming droplets/particles:

- d2: No limitation
- d1: No flaming droplets/particles persisting longer than a given time allowed
- d0: No flaming droplets/particles are allowed

Table 2: Relationship between the classes and the reference fire scenarios for floorings acc. to EN 13501-1

Euro-class	contribution to fire / aspired safety level	classification acc. to DIN 4102
F _{fl}	Products for which no reaction to fire performances are determined or which cannot be classified in one of the classes A1 _{fl} , A2 _{fl} , B _{fl} , C _{fl} , D _{fl} , E _{fl} .	B3
E _{fl}	Products capable of resisting a small flame attack without substantial flame spread.	B2
D _{fl}	Products satisfying E _{fl} and in addition capable of resisting, for a certain period, a heat flux.	
C _{fl}	As class D _{fl} but satisfying more stringent requirements.	B1
B _{fl}	As class C _{fl} , but satisfying more stringent requirements.	
A2 _{fl}	Satisfying the same requirements as class B _{fl} relating to heat flux. In addition, under conditions of a fully developed fire these products will not significantly contribute to the fire load and fire growth.	A2
A1 _{fl}	Class A1 products will not contribute in any stage of the fire including the fully developed fire. For that reason they are assumed to be capable of satisfying automatically all requirements of all lower classes.	A1

Additional classifications for smoke production:

s2: No limit

s1: The total smoke production is limited

2.2 Testing and classification of reaction to fire of building products according to european standards (EN)

The 7 reaction to fire classes A1, A2, B, C, D, E, F for construction building products/floorings, published in the above noted commission decision, are given in standard EN 13501-1 "*Fire classification of construction products and building elements – Part 1: Classification using test data from reaction to fire tests*". These european fire classes principally as well cover the yet existing 5 German building product's classes (Baustoffklassen) A1, A2, B1, B2, B3 according to DIN 4102.

For assessment of reaction to fire, as far as possible test methods had been chosen based on already existing international standards (ISO) [7].

Some of the European fire testing methods are mainly comparable to the existing German fire tests in terms of testing and sample mounting procedures, thus giving sufficient equivalence in test results. A greater number of products is therefore assumed to meet at least the existing national safety levels when classified into Euro-class E (ignitability test/“Kleinbrennerprüfung“, EN ISO 11925-2 [8]) or classes A1/A2 (non-combustibility test EN ISO 1182 [9] and heat of combustion test EN ISO 1716 [10]). The test method for floorings (EN ISO 9239-1 [11]) substantially compares to DIN 4102-14 [12, 13], too.

Reaction to fire tests for classification purposes of building construction products according to EN 13501-1, are therefore generally possible to be performed, based on European standardized fire test methods, since all of the testing standards had already been published. Nevertheless, the problem still is existing, that for some of the fire tests according to European standard test methods, to a great extent still the rules are missing on how samples are to be prepared, or fixed and mounted for testing purposes, with regard to the general requirement of consideration the end use application as given in the Commission decisions and the classification standard (“**fixing & mounting**”). The same is true for the still wanting guidance on the validity of test results for variations in one or more of the product properties and/or intended end use applications (“**extended application**“). Another still unsolved problem addresses the yet completely missing European rules for testing the smouldering hazards in fires, which are fire safety classification demand in some member states, e.g. Germany. The introduction of these rules and guidances, into the corresponding technical product specifications such as harmonized product (EN) standards, European Technical Approval Guidelines (ETAG) etc. or additional test directions (recommendations, technical guidance papers etc.) are but unconditional presumptions beforehand the new Euroclass system can totally be adopted.

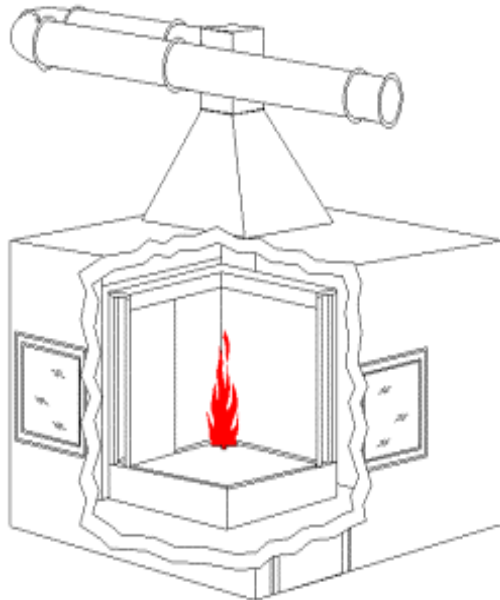
3 NEW EUROPEAN “CENTRAL” TEST METHOD

3.1 “SBI“ according to EN 13823

As was said before, for assessment of reaction to fire, as far as possible test methods had been chosen based on already existing international standards (ISO). Both, the national and the new european classification, are but partly based on different test methods, therefore a direct comparability between both systems is not given. Proof of correct relation of the classification limits, and comparability of european to national reaction to fire classification, solely can be given by direct comparison of test results on a product by product method.

Especially for assessment of the “central” european classes (B, C, D), a totally new test method had been established: the so called **SBI-Test** (*Single Burning Item acc. to EN 13823 : 2002-02 : Reaction to fire tests for building products. Building products excluding foerings exposed to the thermal attack by a single burning item* [14]). The original aim of this standard has been, comparable to the well known German Brandschacht-test according to DIN 4102-1/-15 [4, 15], to determine flame spread under the attack of a single burnig item such as e.g. a burning paper basket in a room corner. Conception, test arrangement, and test performance, however, are fundamenally different to the existing national Brandschacht test method. Thus, direct comparabilty definately is not given at all.

Figures 2 a through c show -somewhat simplified- main construction parts of the SBI test arrangement.



a : test room (housing) - schematic



b : fixed frame with hood, collector, exhaust duct with measurement section



c : trolley

(courtesy Fire Testing Technology Ltd., Charlwoods Road, East Grinstead, West Sussex, UK)

Fig. 2 a - c : SBI – test apparatus

3.2 Comparison between both “central” test methods

The comparison between the both “central” test methods, the existing national Brandschacht acc. to DIN 4102 and the new european testing method SBI acc. to EN 13823 (Table 3), shows the main parameter flame spread now is replaced by the measurement of heat release being the essential european classification criterion.

Table 3: Brandschacht compared to SBI test

	Brandschacht - DIN 4102	SBI - EN 13823
szenario/ fire model	single burning item in a room corner (Paperbasket)	single burning item in a room corner
requirement	flame spread not substantial outside primary area +	sufficient retarded and limited heat release +
additional:	heat release limited smoke - temperature - (density) flaming droplets/particles (smouldering)	limited lateral flame spread smoke - rate - development + release flaming droplets/particles -
test period	10 min	20 min
parameter	residual length smokegas-temperature smokegas-density flaming droplets/particles	FIGRA (heat release) SMOGRA (smoke rate) LFS (lateral flame spread) flaming droplets/particles

3.3 SBI testing facilities at MPA-Otto-Graf-Institute fire department

These differences require re-development of most of the common used building products in terms of fire safety performance. Thus, it could be foreseen, that most of the building products on the market would be subject to new-/re-testing.

MPA-Otto-Graf-Institute fire department was able to install an SBI-test apparatus and now is in a position to provide this central european fire test method for about 80% of the european approved building products. The SBI-test apparatus requires more room, extent, test period, and sample size etc. than the Brandschachtprüfung, and putting it into operation made necessary a new fire testing laboratory and the installation of an expensive smoke cleaning system which is required by legislation.

In combination with the whole of all the other european fire test methods available at MPA-Otto-Graf-Institute fire department, all of the fire tests for building products and floorings necessary for both, national and european testing, are now provided.

Figure 3a shows the SBI-test apparatus run at MPA-Otto-Graf-Institute fire department and Figure 3b shows a real SBI test on slab material.



Fig. 3a : MPA-Otto-Graf-Institute fire department test laboratory with SBI–test apparatus



Fig. 3b : SBI-test on slab material

4 REACTION TO FIRE CLASSIFICATION WITHOUT TESTING

In a further European Commission decision 96/603/EG [16], those building products are listed which are classified into categories A1/A1_{fl} -no contribution to a fire in any stage including the fully developed fire- without testing.

These products, classified A1 from their well known reaction to fire behaviour (“deemed to satisfy“), are listed in an annex to this decision. The list covers, amongst others: concrete, mineral fibres, foamglass, fibrecement, lime, metals (iron, steel, copper, zinc, aluminum, lead), gypsum, mortars with inorganic binders (rendering and plastering mortars and floor screeds with one or more inorganic binders, as are e.g. cement, lime, masonry mortar or gypsum), clay (bricks, slabs, chimney claddings), calcium-silicate materials, natural stone and slate materials, glass, ceramics (including glass-ceramics, and glazed or unglazed extruded products).

Nevertheless, none of the listed products may contain more than 1 % per weight or volume (whatever is the lower value has to be taken into account) of homogeneously dispersed organic content. Products, which are made by laminat-

ing one or more of the listed materials, are classified into class A1 without testing, if the laminating glue does not exceed 0.1 % per weight or volume.

Products with one or more **organic** layers or containing not homogeneously dispersed **organic material**, cannot be classified based on this commission decision. These products can only be classified with tests.

Products made with coating of one of the listed materials with an **inorganic** layer (e.g. coated metal products) can but classified in class A1 without testing.

Additional lists of classified building products (“CWFT“ - "classified without further testing") are intended to be issued for classes below class A1 [17], too. This corresponds to well known national practice in many of the european member countries (e.g. Germany: DIN 4102 Teil 4 [18]).

5 INTRODUCTION OF THE EUROPEAN CLASSIFICATION SYSTEM INTO GERMAN BUILDING REGULATIONS

As was explained both, the national and the new european classification are partly based on different test methods, therefore a direct relationship between both systems is not possible. For some of the hitherto German fire testing methods being comparable to the european fire tests, the safety level according to DIN 4102 as required in German building regulations “Landesbauordnungen”, for greater number of products is therefore also met when the products are classified into european fire classes. Building regulations consequently already accept application of euroclasses for reaction to fire of building construction products [19]. For this purpose, Deutsches Institut für Bautechnik (DIBt) published, in the “Bauregelliste” (building regulation list), a table of related requirements giving relations of classifications according to EN 13501-1 to the still, and within a foreseeable space of time, required legal fire classification nominations (e.g. “schwerentflammbar”) to the classifications (Baustoffklassen) according DIN 4102. The generally corresponding classes (without respect to additional smoke and flaming droplets/particles classification requirements) are shown in above tables 1 and 2, respectively.

By reason of still missing rules for sample preparation, fixing and mounting and extended application, as well as assessing the smouldering hazards in fires, which are fire safety classification presumptions when performig european fire tests (see 2.2), these rules have to be fixed nationally in any case to comply with the existing fire safety level requirements in national building regulations.

The current situation of generally accepted and applied technical rules for testing and assessment of reaction to fire of building products not yet being available, results in the necessity of proofing the usability of European tested and classified products by a national approval. Many of such approvals, covering European reaction to fire classification, have already been issued by Deutsches Institut für Bautechnik, mainly for floorings and thermal insulating products.

For a number of building products, however, rules for reaction to fire testing have already been laid down by the responsible European technical (e.g. group of notified bodies GNB FSG SH02, EOTA PT 04 etc.) or product standardisation committees after publication of the harmonized technical specifications such as mandated EN-product-standards, ETA-Guidelines, CUAPs etc. This more and more completes the European reaction to fire classification system and allows the implementation into national legislation step by step. As a consequence, Deutsches Institut für Bautechnik decides on a case by case procedure on if all relevant safety requirements are definitively regulated in these technical product specifications, and issues the list of “European usable” products within the “Bauregelliste”. Such products may then be used without the need of any additional approval.

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