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RAPPORT

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European Classes for the Reaction to Fire Performance of Wood Products

(except Floorings)

Trätek

INSTITUTET FÖR TRÄTEKNISK FORSKNING

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EUROPEAN CLASSES FOR THE REACTION TO FIRE PERFORMANCE OF WOOD PRODUCTS
(exeept Floorings)

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Summary

The European system for CWFT, Classification without further testing, has been applied to four types of wood products: Wood-based panels, Structural timber, Glulam and Solid wood panelling and cladding as being 'products with known and stable fire performance'.

In addition, the same procedure has been applied also to wood flooring products. These products have a separate classification system and are tested according to different methods. The results for wood floorings are presented separately.

The results presented clearly demonstrate the stable reaction to fire performance of wood based products. Class D-s2,d0 has been verified with the required safety limit of 20 %, which is generally required for CWFT. The main parameters influencing the reaction to fire characteristics of all wood products are product thickness, density and end use conditions such as substrates or air gaps behind the product.

The work has already resulted in Commission decisions published in the Official Journal of the European Communities for wood-based panels and structural timber products. Remaining results are in progress of being finally approved and published. The classes will also be included in the harmonised product specifications as soon as they become available from the product standard committees and used for CE-marking.

All wood products included obtain the European class D-s2,d0, but there are different conditions for the classification of the different products:

- *Wood based panels*:
  The classification is limited to end use applications without an air gap behind the panel. An extension of the classification is planned in order to be able to include other end use applications.
- *Structural timber products*:
  The classification applies to all species in the product standards
- *Glulam products*:
  The classification applies to all species and glues in the product standards
- *Solid wood panelling and cladding products*:
  The classification covers end use applications both with and without an air gap behind the panelling depending on the thickness of the products.
  Wood ribbon elements mounted on a support frame are also included in the classification with limitations on the total exposed area.

In addition to the CWFT decisions this knowledge can be utilized in predicting classifications also for wood products not covered by the CWFT cases or for new products being developed.

Wood products and end use applications not included in the CWFT classification tables have to be tested and classified in the ordinary way. Better classification may then be reached, since no safety margins have to be fulfilled.

Fire retardant treated wood products have always to be tested and classified separately, since the treatments may influence their reaction to fire performance.

Svensk sammanfattning - Swedish summary

Nya möjligheter till förenklad europeisk brandklassificering finns för produkter med s k 'känt och stabilt beteende vid brand'. Träprodukter är ett utmärkt exempel på sådana produkter. Brandklassningen avser det nya europeiska systemet med s k Euroklasser A1-F. Klassningen ingår i de harmoniserade produktstandarderna som behövs för att byggprodukter ska kunna CE-märkas.

Förenklad brandklassning för produkter med 'känt och stabilt brandbeteende' innebär att brandegenskaperna dokumenteras genom inledande provningar, som ligger till grund för generell brandklassning och godkänns av europeiska organ, först av en grupp med nationella myndighetspersoner *Fire Regulators' Group* (FRG)/ *European Commission Expert Group on Fire Issues* (EGF) och sedan av ständiga byggkommittén *Standing Committee on Construction* (SCC). Till sist publiceras brandklassningen i EUs officiella tidning *Official Journal*. Systemet kallas Klassificering utan ytterligare provning, eller på engelska CWFT som står för *Classification without further testing*. Alternativet är att varje enskild tillverkare provar sina produkter eller att produkten hamnar i den sämsta brandklassen F, som betyder att inga brandegenskaper är dokumenterade.

Kraven på dokumentation är hårda. Allt måste verifieras med provningar. Olika slutanvändning måste ingå, vilket lett till att många olika fall med bakomliggande material, luftspalter och hopfogningar har provats och redovisats. För samtliga träprodukter gäller dessutom att brandklassen beror av produkternas minimitjocklek och minimidensitet.

Fyra olika fall med träprodukter ingår: Träbaserade skivor, Konstruktionsvirke, Limträ och Träpaneler. Samtliga uppfyller klass D-s2,d0, men med olika förutsättningar:

- **Träbaserade skivor** var det allra första fallet med förenklad brandklassificering. Klass D-s2,d0 visades kunna uppfyllas med krav på bl a minimitjocklek och densitet. Klassificeringen begränsar sig till slutanvändning utan luftspalt bakom skivan. Beslutet publicerades i EUs tidning *Official Journal* i januari 2003. Träbaserade skivor började kunna CE-märkas i april 2003. Klassificeringen ska under 2005 utvidgas till att gälla fler typer av slutanvändning, bl a med luftspalt bakom skivan.
- **Konstruktionsvirke** var det andra fallet, där det slutgiltiga beslutet publicerades i *Official Journal* i augusti 2003. Konstruktionsvirke har en mycket enkel klassificering, som gäller för alla träslag enligt produktstandarden.
- **Limträ** har i likhet med konstruktionsvirke en mycket enkel klassificering, där alla träslag och limtyper enligt produktstandarden ingår.
- **Träpaneler** omfattar in- och utvändiga träpaneler med ett stort antal olika paneltyper och profiler. Klassificeringen täcker slutanvändning både med och utan luftspalt bakom panelen, beroende på paneltjocklek. Dessutom ingår fristående träribbor som används på liknande sätt som paneler både in- och utvändigt. De klassificeras med begränsningar på totalt exponerad träyta.

De träprodukter och slutanvändningar som inte finns med i tabellerna för europeisk klassificering måste brandprovas för att få en brandklass. Annars hamnar de automatiskt i den lägsta klassen F, som betyder att inga brandegenskaper har dokumenterats. Specialprodukter eller produkter med annan slutanvändning kan få högre brandklass om de brandprovas.

Resultaten sammanfattas på svenska i en Trätek kontenta /15/.

1. The new European system for reaction to fire performance

1.1 New European classes for the reaction to fire for building products

A new classification system for the reaction to fire properties of building construction products has recently been introduced in Europe /1/. It is often called the Euroclass system and consists of two sub systems, one for construction products excl. floorings, i.e. mainly wall and ceiling surface linings and one for floorings. Both sub systems have classes A to F of which classes A1 and A2 are non combustible products. The new system will replace the present national classification systems, which have formed obstacles to trade /7/.

The new classification system for reaction to fire performance was published in Official Journal in 2000 /1/ and is based on a set of EN standards for different test methods /2, 3 , 4/ and for classification systems /5/.

The new European system has to be used for all construction products in order to get the CE-mark. Products with known and stable performance may be classified as groups according to an initiative from the EC /6/. This is a possibility for wood products that have a fairly predictive fire performance. Properties like density, thickness, joints and type of end use application may influence the classification. If no common rules are available, each producer has to test their products in order to fulfil requirements in product standards and to get the CE-mark. A common European classification without need for further testing of main wood products on the market are then beneficial to the many producers in Europe.

1.2 CWFT - Classification without further testing

The procedure for CWFT is described in a document from DG Enterprise /6/. Main points are given below.

"Classified without further testing" (CWFT) corresponds to the definition "Products which have been proven to be stable in a given European class (on the basis of testing to the appropriate EN test method(s)) within the scope of their variability in manufacture allowed by the product specification (harmonised standard or ETA), and when evaluated for the influence of other possible variations, that may occur outside the scope of the specification, which may have an impact on their fire performance." CWFT is a list of generic products, not a list of proprietary products.

CWFT lists will be established by Commission Decision(s) in consultation with the Standing Committee on Construction (SCC). The Fire Regulators Group (FRG)/ European Commission Expert Group on Fire Issues (EGF), advised by its CWFT Working Group made up of representatives of regulators and experts on fire performance of building products, CEPMC (Council of European Producers of Materials for Construction), Notified Bodies Group, CEN TC127 WG4, and CEN/EOTA TC (invited for specific cases, as applicants), will consider all requests made and forward recommendations onto the SCC for final opinion.

CWFT lists will refer to products of known and stable performance for defined end use applications with respect to their reaction to fire performance, their external fire performance and/or their resistance to fire (the latter to be developed in due course). "Products" are product families, product sub-families and generic products as defined in Guidance Paper G and

specified by European Standards or European Technical Approvals. It may also be possible to extend the concept to kits and systems, if it is possible to define them with sufficient precision.

Products for which a clearly identifiable stage in the production process results in an improvement of the reaction to fire classification (e.g. a limiting of organic material) cannot normally be considered for CWFT status.

Products will only be considered for inclusion onto the lists where :

- their fire performance is demonstrated by test to be stable;
- they have been shown in tests to satisfy a given class;
- they have been defined with sufficient precision.

Requests to set up a new list, or to add products to existing lists, may come from any interested party, i.e. Member State, Technical Committee, CEN, CENELEC, EOTA, industry directly or European industry federations.

Requests should, however, wherever possible, come via CEN, CENELEC or EOTA. It is recommended that applications should not come from individual manufacturers, even though the results might apply to only one or a few manufacturers. Requests will be formally made to the European Commission, DG Enterprise G5 Construction unit.

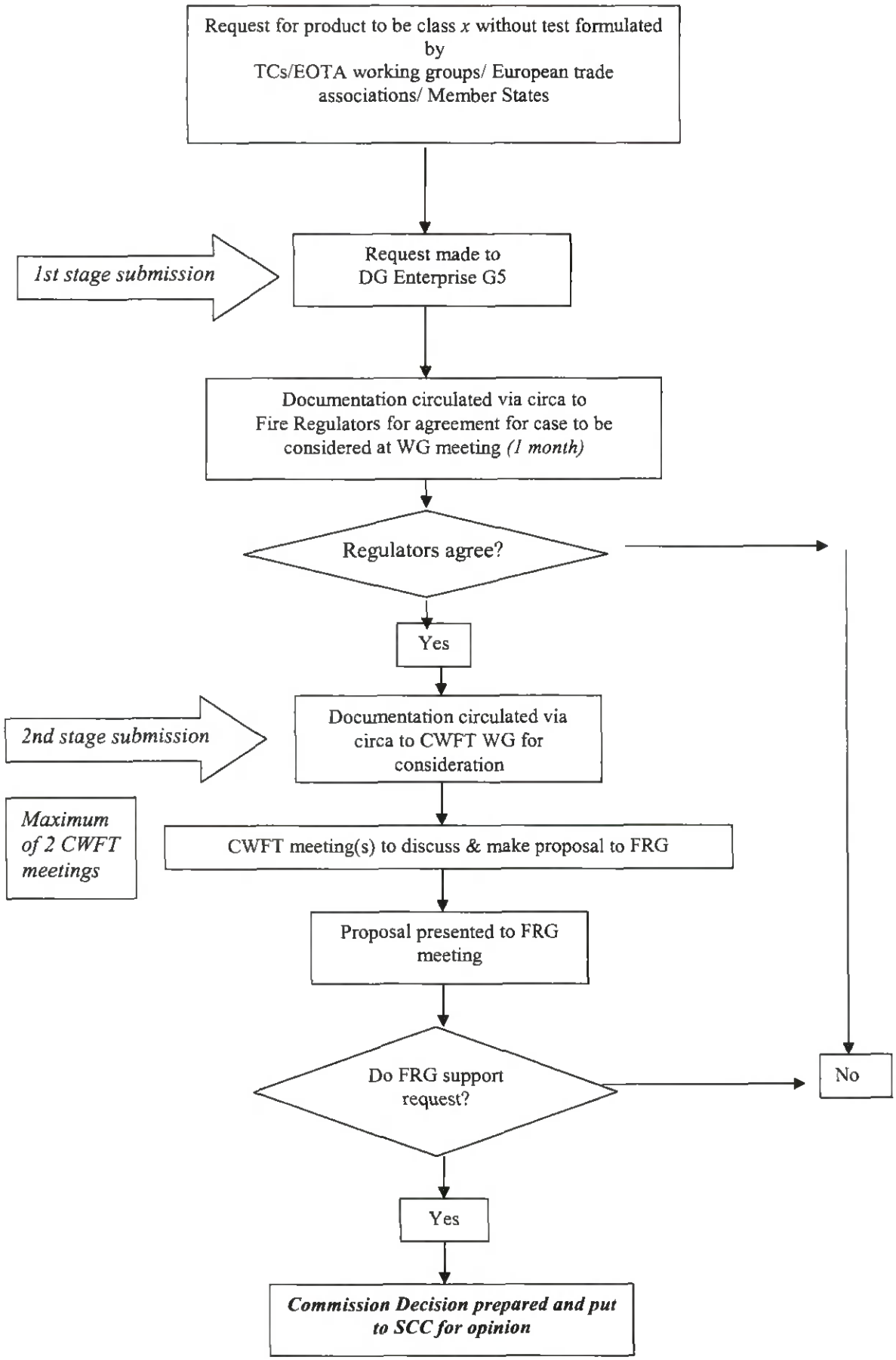
The stages of the application procedure are shown diagrammatically on next page. To avoid unnecessary work and expense for applicants, this is a two stage procedure.

- The first stage is to get approval from the FRG/EGF that the products in question are suitable to be on the CWFT list. It is recommended that, at this stage, the application does not give the intended class(es); this will be assessed in detail in the Working Group on the basis of data and test results supplied. If the approval of the FRG/EGF is obtained, the applicant then supplies all the necessary details (in electronic format) and the request is considered by the Working Group; otherwise the procedure stops at that point.

- The second stage is a detailed analysis of the case and follows once the FRG/EGF has approved the application in principle. The CWFT Working Group will examine all the documents submitted, will request further information if necessary, and when the case is considered to be complete, will make a recommendation to the FRG/EGF. It should take no more than two CWFT WG meetings for this recommendation to be agreed.

Products claiming CWFT must be clearly above the lower class limits, to provide a safety margin. This should be determined on a statistical basis in relation to the scattering of results. In general terms, each classification parameter (as defined in the relevant classification standard in the EN 13501 series) should be either 20 % above the class limit (although some relaxation of this may be possible), or shown by statistical means to have a satisfactory safety level, for a request to be accepted. Due account will be taken of the likely variability in the production process of products.

The SCC will make the final decision based upon the recommendations from the FRG/EGF. All requests and related data will be submitted to the FRG/EGF for discussion (using written as well as oral procedures). The advice of the FRG/EGF will largely determine whether the request is forwarded to the SCC for opinion.


Request for product to be class x without test formulated by TCs/EOTA working groups/ European trade associations/ Member States
1st stage submission
Request made to DG Enterprise G5
Documentation circulated via circa to Fire Regulators for agreement for case to be considered at WG meeting (1 month)
Regulators agree?
Yes
2nd stage submission
Documentation circulated via circa to CWFT WG for consideration
Maximum of 2 CWFT meetings
CWFT meeting(s) to discuss & make proposal to FRG
Proposal presented to FRG meeting
Do FRG support request?
No
Yes
Commission Decision prepared and put to SCC for opinion

1.3 European classification system for the reaction to fire performance

The new European system for the reaction to fire performance classes consists of two sub-systems, one for construction products, i.e. mainly wall and ceiling surface linings, see Tables 1.1 and 1.3, and another for floorings. This report deals only with products excluding floorings. A separate report on Euroclasses for wood floorings is available /9/.

Table 1.1. Overview of the reaction to fire classes for building products excl. floorings /1/.

Euro class	Smoke class	Burning droplets class	Requirements according to			FIGRA W/s	Typical products
			Non comb	SBI	Small flame		
A1	–	–	x	–	–	–	Stone, concrete
A2	s1, s2 or s3	d0, d1 or d2	x	x	–	≤ 120	Gypsum boards, mineral wool
B	s1, s2 or s3	d0, d1 or d2	–	x	x	≤ 120	Fire retardant wood
C	s1, s2 or s3	d0, d1 or d2	–	x	x	≤ 250	Paper covering on gypsum
D	s1, s2 or s3	d0, d1 or d2	–	x	x	≤ 750	Wood, wood-based panels
E	–	- or d2	–	–	x	–	Some synthetic polymers
F	–	–	–	–	–	–	No performance determined

SBI = Single Burning Item /2/, main test for the reaction to fire classes for building products;
FIGRA = Fire Growth Rate, main parameter for the fire class according to the SBI test /2/.

Three test methods are used for determining the classes of all combustible (classes B-E) building products (including floorings), see Table 1.2. For non combustible products also additional test methods are used, see Table 1.3.

Table 1.2. Test methods used for determining the European reaction to fire classes of combustible building products /1/.

Test method	Construction products excl. floorings, i. e. wall and ceiling linings	Floorings	Main fire properties measured and used for the classification
Small flame test EN ISO 11925-2	X	X	Flame spread within 60 or 20 s.
Single Burning Item test, SBI EN 13823	X	–	- FIGRA, FIre Growth RAte; - SMOGRA, SMOke Growth RAte; - Flaming droplets or particles
Radiant panel test EN ISO 9239-1	–	X	- Critical heat flux; - Smoke production

Table 1.3. European classes of reaction to fire performance for construction products excluding floorings /1, 5/

Class	Test method(s)	Classification criteria	Additional classification
A1	EN ISO 1182 (1); *and*	$\Delta T \leq 30°C$; *and* $\Delta m \leq 50$ %; *and* $t_f = 0$ (i.e. no sustained flaming)	-
	EN ISO 1716	PCS ≤ 2.0 MJ.kg^{-1} (1); *and* PCS ≤ 2.0 MJ.kg^{-1} (2) (2a); *and* PCS ≤ 1.4 MJ.m^{-2} (3); *and* PCS ≤ 2.0 MJ.kg^{-1} (4)	
A2	EN ISO 1182 (1); *or*	$\Delta T \leq 50°C$; *and* $\Delta m \leq 50$ %; *and* $t_f \leq 20$ s	
	EN ISO 1716; *and*	PCS ≤ 3.0 MJ.kg^{-1} (1); *and* PCS ≤ 4.0 MJ.m^{-2} (2); *and* PCS ≤ 4.0 MJ.m^{-2} (3); *and* PCS ≤ 3.0 MJ.kg^{-1} (4)	
	EN 13823 (SBI)	FIGRA ≤ 120 W.s^{-1}; *and* LFS < edge of specimen; *and* $THR_{600s} \leq 7.5$ MJ	Smoke production (5); *and* Flaming droplets/ particles (6)
B	EN 13823 (SBI); *and*	FIGRA ≤ 120 W.s^{-1}; *and* LFS < edge of specimen; *and* $THR_{600s} \leq 7.5$ MJ	Smoke production (5); *and* Flaming droplets/ particles (6)
	EN ISO 11925-2 (8): *Exposure = 30 s*	Fs ≤ 150 mm within 60 s	
C	EN 13823 (SBI); *and*	FIGRA ≤ 250 W.s^{-1}; *and* LFS < edge of specimen; *and* $THR_{600s} \leq 15$ MJ	Smoke production (5); *and* Flaming droplets/ particles (6)
	EN ISO 11925-2 (8): *Exposure = 30 s*	Fs ≤ 150 mm within 60 s	
D	EN 13823 (SBI); *and*	FIGRA ≤ 750 W.s^{-1}	Smoke production (5); *and* Flaming droplets/ particles (6)
	EN ISO 11925-2 (8): *Exposure = 30 s*	Fs ≤ 150 mm within 60 s	
E	EN ISO 11925-2 (8): *Exposure = 15 s*	Fs ≤ 150 mm within 20 s	Flaming droplets/ particles (7)
F	No performance determined		

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

1.4 European test methods for the reaction to fire performance

1.4.1 Small flame test, EN ISO 11925-2

The lowest fire exposure is measured by a small scale ignitability test method, called Small flame test, which is used for all building construction products i e incl. floorings /3/. The small flame test is based on the German test, 'Kleinbrenner', see Figure 1.1.

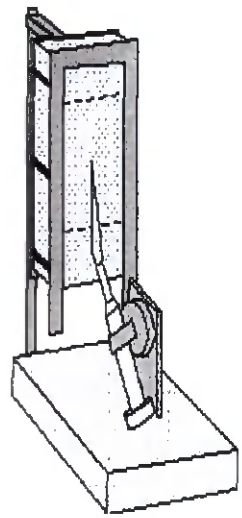


Figure 1.1.
Small flame test, EN ISO 11925-2.

A small sample, 250 mm high, is mounted vertically in a steel frame. A small flame, 20 mm high, is impinging on the surface or the edge of the sample for 15 or 30 seconds. The time for the flames to reach 150 mm height along the sample surface is observed. Burning droplets are noted.

The time for the flames to reach 150 mm height along the sample surface is observed. Burning droplets are noted by observing if a filter paper underneath the exposed sample is ignited or not. There are two exposure conditions, one with the flame impinging the surface and one with the flame impinging the edge of the sample. A third condition relates to multi-layer products ≥ 10 mm, e g plywood, for which the flames shall impinge also the vertical edge.

There are also two exposure times which relates to different Euroclasses, see Table 1.4.

Table 1.4. Criteria according to EN ISO 11925-2

Class	Exposure time	Criteria
B, C and D	30 s	Flame spread, $F_s \leq 150$ mm within 60 s
E	15 s	Flame spread, $F_s \leq 150$ mm within 20 s

1.4.2 SBI, Single Burning Item test, EN 13823

The main test method for non-flooring products is called Single Burning Item, SBI /2/. It is a completely new method for fire testing in medium scale. It has been developed within a group of fire laboratories with guidance by representatives of Fire regulators from EU countries.

The test samples are 1,5 m high and form a corner that is exposed to a triangular gas burner. The test rig is enclosed in a small room with an exhaust system, see Figure 1.2.

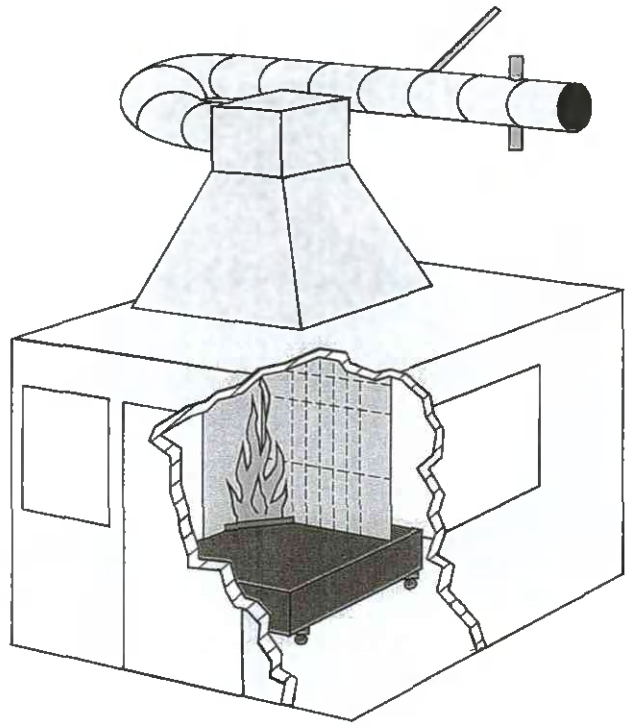


Figure 1.2.
SBI, Single Burning Item test, EN 13823

The building product to be tested is 1,5 m high, mounted in a corner and exposed to flames from a propane gas burner. Heat and smoke production is measured continuously. Burning droplets and flame spread are observed.

The following parameters are calculated from the SBI test data:

FIGRA	Fire Growth Rate
THR_{600s}	Total Heat Release during first 600 s
LFS	Lateral Flame Spread
SMOGRA	Smoke Growth Rate
TSP_{600s}	Total Smoke Production during first 600 s

2. Applications for different wood products

Four different types of wood products (excluding floorings) have been included:

- Wood-based panels
- Structural timber
- Glulam
- Solid wood panelling and claddings

The application of the new European system differs among the various wood products studied as described below. End use application of the products are essential for the reaction to fire classification, e g substrates or air gaps behind the wood product, joints and surface profiles. The classification is always related to harmonised product standards in which a CWFT reaction to fire classification table is included. Mounting and fixing conditions have to be specified.

2.1 Wood based panels - Applications

2.1.1 Harmonised standard

The harmonised product specification affected is:

- EN 13 986, Wood-based panels for use in construction - Characteristics, evaluation of conformity and marking.

2.1.2 End use applications

Wood-based panels are mainly used as wall and ceiling linings. It includes end-use conditions without air gap behind the panel. An extension to further end uses is planned to take place during 2005.

2.1.3 Mounting and fixing conditions

Wood-based panels may form major parts of the total surfaces of building elements.

For the purpose of testing and classification of wood-based panels, the whole area for exposure in the SBI apparatus, 1,5 x 1,5 m, has been covered with the panel pieces mounted with different specified joints and oriented horizontally or vertically. Different thicknesses and types of panels with insulation or other substrates behind the panel are included.

Details for mounting and fixing of product in the SBI includes the use of timber battens, mechanically fixed to the test backing boards at 600 mm centres horizontally or vertically. A vertical joint is provided 200 mm from the corner line between adjacent panels and a horizontal joint 500 mm from the bottom edge of the specimen, both joints in the larger 'wing' of the test specimen.

2.2 Structural timber - Applications

2.2.1 Harmonised standards

For structural timber the following harmonised product specifications are affected:

- prEN 14081 Timber structures – Strength graded structural timber with rectangular cross section
  - Part 1: General requirements
  - Part 2: Machine grading - Additional requirements for initial type testing
  - Part 3: Machine grading - Additional requirements for factory production control
  - Part 4: Machine grading – Grading machine settings for machine controlled systems
- EN 14250 Timber structures – Product requirements for prefabricated structural members assembled with punched metal plate fasteners
- prEN 14544 Timber structures – Strength graded structural timber with round cross-section – Requirements

A minimum thickness of 22 mm is specified in the product standards.

2.2.2 End use applications

Structural timber products are mainly used as parts of wall, roof or floor systems, that may be load bearing or not, i e as studs and beams in timber frame systems that are usually covered by wood-based or gypsum boards and as members of similar systems in solid wood that may not be covered, see Figure 2.1. End-use applications also include free standing structural elements as indicated in the figure.

2.2.3 Mounting and fixing conditions

Structural timber products are not generally used to form the major part of the total surfaces of a room and the number of possible applications is very large. Thus a material testing interpretation has been used.

For the purpose of the testing and classification of structural timber, therefore, the whole area for the exposure of the test specimen in the SBI apparatus, 1,5 m by 1,5 m, has been covered with timber pieces mounted edge to edge (butt jointed), without jointing or bonding and orientated horizontally or vertically. This includes the use of timber battens, minimum 40 mm by 40 mm, fixed to the test backing boards at 400-600 mm centres horizontally or vertically (perpendicular to the orientation of the timber pieces).

Different thicknesses of timber with and without air gaps behind the timber have been investigated, as well as with thermal insulation to ensure that the reaction to fire behaviour of the timber itself is fully independent of the underlying layers. However, the consequence of using a material based approach is that the effect of any underlying layers is not considered.

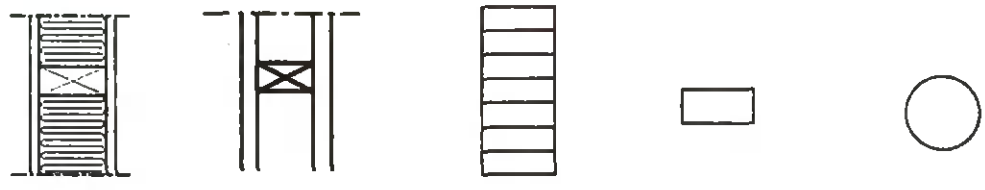


Figure 2.1. Examples of end uses for structural timber.

2.2 Structural timber - Applications

2.2.1 Harmonised standards

For structural timber the following harmonised product specifications are affected:

- prEN 14081 Timber structures – Strength graded structural timber with rectangular cross section
  - Part 1: General requirements
  - Part 2: Machine grading - Additional requirements for initial type testing
  - Part 3: Machine grading - Additional requirements for factory production control
  - Part 4: Machine grading – Grading machine settings for machine controlled systems
- EN 14250 Timber structures – Product requirements for prefabricated structural members assembled with punched metal plate fasteners
- prEN 14544 Timber structures – Strength graded structural timber with round cross-section – Requirements

A minimum thickness of 22 mm is specified in the product standards.

2.2.2 End use applications

Structural timber products are mainly used as parts of wall, roof or floor systems, that may be load bearing or not, i e as studs and beams in timber frame systems that are usually covered by wood-based or gypsum boards and as members of similar systems in solid wood that may not be covered, see Figure 2.1. End-use applications also include free standing structural elements as indicated in the figure.

2.2.3 Mounting and fixing conditions

Structural timber products are not generally used to form the major part of the total surfaces of a room and the number of possible applications is very large. Thus a material testing interpretation has been used.

For the purpose of the testing and classification of structural timber, therefore, the whole area for the exposure of the test specimen in the SBI apparatus, 1,5 m by 1,5 m, has been covered with timber pieces mounted edge to edge (butt jointed), without jointing or bonding and orientated horizontally or vertically. This includes the use of timber battens, minimum 40 mm by 40 mm, fixed to the test backing boards at 400-600 mm centres horizontally or vertically (perpendicular to the orientation of the timber pieces).

Different thicknesses of timber with and without air gaps behind the timber have been investigated, as well as with thermal insulation to ensure that the reaction to fire behaviour of the timber itself is fully independent of the underlying layers. However, the consequence of using a material based approach is that the effect of any underlying layers is not considered.

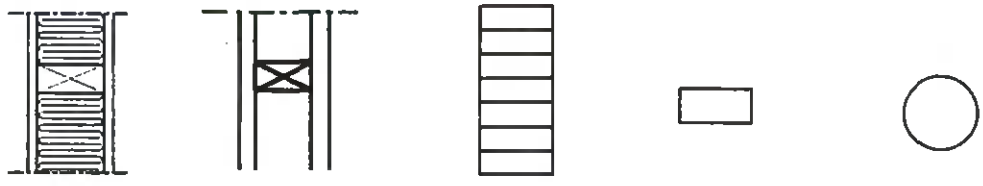


Figure 2.1. Examples of end uses for structural timber.

2.3 Glulam - Applications

2.3.1 Harmonised standards

The following harmonised product specification is affected:

- prEN 14080 Timber structures – Glued laminated timber – Requirements

The relevant product standards referred to are:

- EN 386 Glued laminated timber – Performance requirements and minimum production requirements.
- EN 387 Glued laminated timber – Large finger joints – Performance requirements and minimum production requirements.
- EN 390 Glued laminated timber – Sizes – Permissible deviations.
- EN 1194 Glued laminated timber – Strength classes and determination of characteristic values

A minimum mean density of 380 kg/m^3, a minimum thickness of 40 mm and a minimum lamella thickness of 18 mm are specified in prEN 14080.

2.3.2 End use applications

Glulam products are mainly used as parts of wall, roof or floor systems, that may be load bearing or not. End-use applications also include freestanding structural elements, see Figure 2.2.

2.3.3 Mounting and fixing conditions

Glulam products are not generally used to form the major part of the total surfaces of a room. Thus a material testing interpretation has been used.

For the purpose of the testing and classification of glulam, the whole area for the exposure of the test specimen in the SBI apparatus, 1,5 m by 1,5 m, has been covered with glulam pieces mounted edge to edge and tested free standing with an open air gap, 40-60 mm, behind the glulam pieces.

Minimum thickness of glulam, 40 mm, with an air gap behind has been investigated. However, the consequence of using a material based approach is that the effect of any underlying layers is not considered.

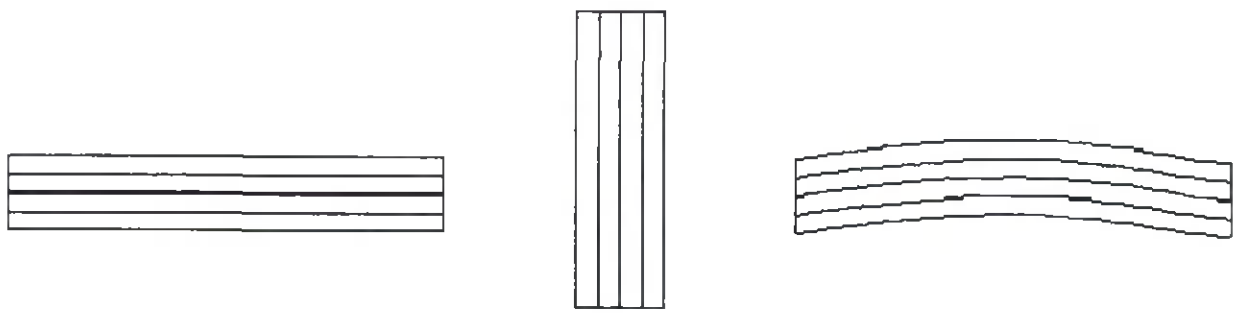


Figure 2.2. Examples of end uses for glulam, beams and columns.

2.4 Solid wood panelling and cladding - Applications

2.4.1 Harmonised standards

The following harmonised product specifications will be affected:

- prEN 14 915 Solid wood panelling and cladding – Characteristics, evaluation of conformity and marking
- prEN 175.098 Prefabricated timber stairs – Specifications and requirements (under development)

The relevant products standards referred to are:

- prEN 14 519 Solid wood panelling and cladding – softwood machined profiles with tongue and groove
- prEN (175.084) Solid wood panelling and cladding – softwood machined profiles without tongue and groove
- prEN 14 951 Solid hardwood panelling and cladding – Machined profiles elements
- prEN 13 912 Timber in stair – Specific timber requirements and specifications

2.4.2 End use applications

The end-use applications are as interior panelling and exterior claddings. It includes vapour barriers with or without an air gap behind the wood products and vertical parts of stairs. End use applications as free standing ribbon elements are also included.

Examples of end uses as interior panelling, exterior claddings and free standing ribbon elements are given in Figures 2.4, 2.5 and 2.6.

2.4.3 Mounting and fixing conditions

Solid wood panelling and cladding may form major parts of the total surfaces of building elements.

For the purpose of testing and classification of wood panelling and siding products, the whole area for exposure in the SBI apparatus, 1,5 x 1,5 m, has been covered with the wood pieces mounted with different specified joints and oriented horizontally or vertically. Different thickness of wood, air gaps, vapour barriers and substrates behind the wood products are included. Examples of joint profiles used are illustrated in Figure 2.3.

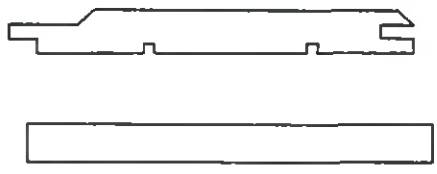


Figure 2.3.
Examples of profile joint types used.

For the purpose of testing and classification of free standing wood ribbon elements, rectangular wood pieces have been mounted on a wood batten frame and surrounded by air on all sides as illustrated in Figure 2.6.

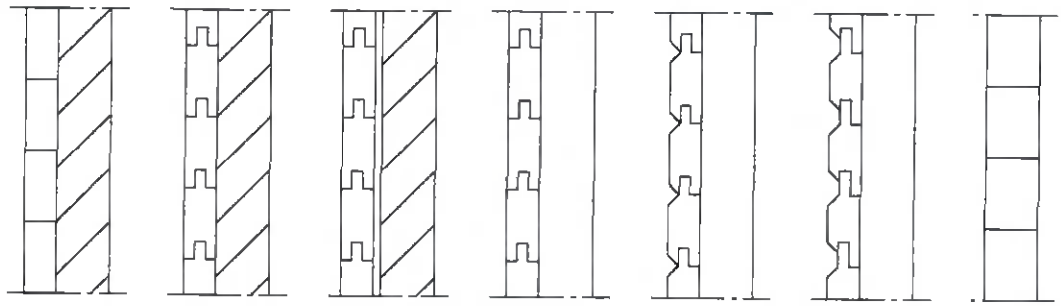


Figure 2.4. Examples of end uses for interior wood panelling.

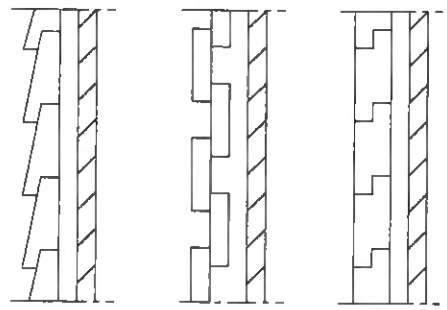


Figure 2.5. Examples of end uses for exterior wood claddings.

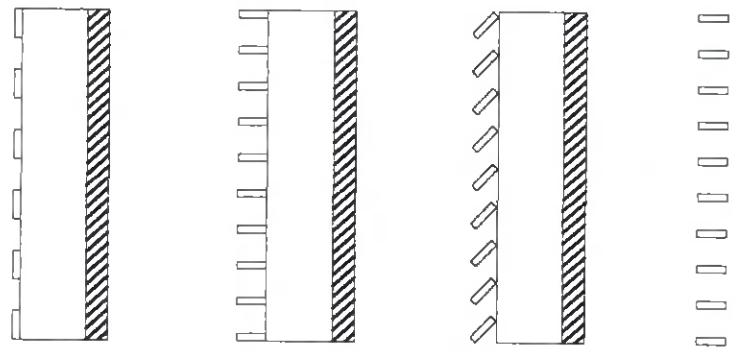


Figure 2.6. Examples of end uses as free standing wood ribbon elements.

3. Test results for different wood products

3.1 Wood based panels - Test results

Table 3.1.1. EN 11925-2 Small flame test data for wood-based panels.

Wood-based panel	Thick-ness mm	Density kg/m^3	Flame spread, Fs, within 60 or 20 s, mm						Ref. No
			Exposure 30 s (Fs within 60 s)			Exposure 15 s (Fs within 20 s)			
			Surface	Edge	Vertical edge	Surface	Edge	Vertical edge	
Particleboards:									
Particleboard	10	675		< 150	-		< 150	-	3.1.1
Particleboard	10	710	0	0	-	0	0	-	3.1.3
Ordinary particleboard	12	710	0	0	-	0	0	-	3.1.2
Particleboard	12	770	0	0	-	0	0	-	3.1.3
Melamine faced particleb.	12	700	0	< 150	0	0	< 150	0	3.1.2
FR chip board	12	780	0	0	-	0	0	-	3.1.2
MDF:									
MDF	3	880	0	< 150	-	0		-	3.1.3
MDF	4	760	0	< 150	-	0		-	3.1.3
MDF	5	800	0	< 150	-	0	0	-	3.1.3
MDF	9	765	0	< 150	-	0	< 150	-	3.1.4
MDF	10	760	< 150	< 150	-	< 150	< 150	-	3.1.1
MDF	10	830	0	< 150	-	0		-	3.1.3
MDF	12	850	0	0	-	0	0	-	3.1.2
MDF	19	565	0	< 150	-	0	< 150	-	3.1.4
MDF	19	820	0	0	-	0		-	3.1.3
MDF	28	800	0	0	-	0		-	3.1.3
MDF	50	700	0	0	-	0		-	3.1.3
Melamine faced MDF	12	770	0	< 150	0	0	< 150	0	3.1.2
Fibreboards, hard:									
Hardboard	2	1010	0	> 150	-	0		-	3.1.3
Hardboard	3	960	0	< 150	-	0	< 150	-	3.1.3
Hardboard	6	1050	0	< 150	-	0	< 150	-	3.1.4
Fibreboards, medium:									
Medium board	9	850	0	< 150	-	0	0	-	3.1.4
Fibreboard	12	450	< 150	< 150	-	< 150	< 150	-	3.1.3
Fibreboards, soft:									
Softboard	9	350	> 150		-	< 150	< 150	-	3.1.3
Low density fibreboard	12	250	< 150	< 150	-	0	< 150	-	3.1.2
Softboard	13	275	> 150		-	< 150	< 150	-	3.1.3
Bitumen board	13	310	> 150	< 150	-	< 150	< 150	-	3.1.3
Plywood:									
Plywood, oak	4	490	< 150	> 150	(0)	< 150	< 150	(0)	3.1.3
Plywood, pine	7	660	0	< 150	(0)	0	-	(0)	3.1.3
Plywood, poplar	9	360	0	< 150	-	0	< 150	-	3.1.4
Plywood, spruce	9	480	0	< 150	-	0	< 150	-	3.1.4
Plywood, birch	9	675	0	0	(0)	0	0	(0)	3.1.3
Plywood, spruce	11	510	0	< 150	0	0	< 150	0	3.1.3
Plywood, poplar	12	410	0	0	< 150	0	0	< 150	3.1.4
Ordinary plywood	12	720	0	0	0	0	0	0	3.1.4
Plywood, birch	12	740	0	0	0	0	0	0	3.1.1
Plywood, spruce	18	465	< 150	< 150	0	< 150	< 150	0	3.1.3
OSB:									
OSB	9	690	< 150	< 150	-	< 150	< 150	-	3.1.5

Note: No ignition of filter paper occurred, i. e. no flaming droplets in the small flame test.

References:

3.1.1 Results of Round Robin on Ignitability test. CEN TC 127 Doc N 1267, January 1998

3.1.2 Tsantaridis L, Östman B: CEN Ignitability test results for the SBI RR products. Trätek Report L 9808059, 1998.

3.1.3 Tsantaridis L: CEN Ignitability test results for wood building products. Trätek Report L 9702010, 1997.

3.1.4 Mollek V and Tsantaridis L.: Reaction to fire testing of wood-based panels - Ignitability by single-flame source. Trätek test report No A12164/2001-03-28, 2001.

3.1.5 Small flame test, BRE FRS, SI test reference number RTF/639, Test report number 204886, 2001.

Table 3.1.2. EN 13823 SBI test data for wood-based panels.

Wood-based panels	Thickness mm	Density kg/m³	Sub-strate[1]	Heat		Smoke		Droplets		Class EN 13501-1	Ref. No
				FIGRA W/s	THR_{600s} MJ	SMOGRA m^2/s^2	TSP_{600s} m^2	FDP_{600s}	FDP_{600s} >10s		
Particleboards:											
Particleboard	10	670	Ca sil.	495	27.1	3	27	no	no	D-s1, d0	3.1.13
Part. b. with str. vert. joint *	10	660	Ca sil.	515	26.7	4	57	no	no	D-s2, d0	3.1.14
Ordinary particleboard	12	710	Ca sil.	404	26.9	3	29	no	no	D-s1, d0	3.1.10
Particleboard, alcyd tr.	12	710	Ca sil.	496	23.8	7	69	no	no	D-s2, d0	3.1.12
Particleboard V313	12	710	Ca sil.	411	25.1	8	45	no	no	D-s1, d0	3.1.12
Melamine faced particleb.	12	700	Ca sil.	381	20.1	2	39	no	no	D-s1, d0	3.1.10
Paper wall cov. on part. b.	13	700	Ca sil.	479	26.7	2	18	no	no	D-s1, d0	3.1.10
Particleboard	22	690	Ca sil.	327	23.5	7	114	no	no	D-s2, d0	3.1.12
Flaxboard *	32	~400	Ca sil.	708	20.9	5	67	no	no	D-s2, d0	3.1.15
Particleboard, painted	18	550	Ca sil.	27	1.5	-	-	-	-	B	3.1.11
FR chip board	12	780	Ca sil.	25	2.3	12	101	no	no	B-s2, d0	3.1.10
MDF:											
MDF	9	740	Ca sil.	503	32.0	4	35	no	no	D-s1, d0	3.1.13
MDF	10	830	Ca sil.	456	38.8	11	30	no	no	D-s1, d0	3.1.12
MDF (1)	12	850	Ca sil.	436	33.4	1	21	no	no	D-s1, d0	3.1.10
MDF	19	570	Ca sil.	525	24.7	4	56	no	no	D-s2, d0	3.1.13
MDF (2)	19	800	Ca sil.	457	37.5	10	58	no	no	D-s2, d0	3.1.12
MDF	28	800	Ca sil.	410	34.7	11	79	no	no	D-s2, d0	3.1.12
Melamine faced MDF	12	770	Ca sil.	601	24,0	1	24	no	no	D-s1, d0	3.1.10
FR MDF (1)	12	820	Ca sil.	46	2.6	-	-	-	-	B	3.1.11
FR MDF (2)	12	820	Ca sil.	159	5.4	-	-	-	-	C	3.1.11
MDF	9	730	Rw [2,3]	606	45.7	13	113	no	no	D-s2, d0	3.1.13
MDF	9	730	Air [2,4]	>750 [5]	>15 [5]	>30 [5]	>200 [5]	no	no	E	3.1.13
Fibreboards, hard:											
Hardboard	5,5	900	Ca sil.	486	57.9	9	58	no	no	D-s2, d0	3.1.12
Hardboard	6	950	Ca sil.	407	56.8	3	37	no	no	D-s1, d0	3.1.13
Hardboard	6	950	Part.b.	439	68.2	15	156	no	no	D-s2, d0	3.1.13
Hardb., catalytic painted	3,3	970	Ca sil.	921	36.7	5	33			D-s1, d0	3.1.12
FR Hardboard	3,5	920	Ca sil.	137	8.1	-	-	-	-	C	3.1.11
Fibreboards, medium:											
Medium board	9	820	Ca sil.	527	40.0	2	20	no	no	D-s1, d0	3.1.13
Fibreboards, soft:											
Low density fibreboard	12	250	Ca sil.	1103	39.7	9	79	no	no	D-s2, d0	3.1.10
FR-painted LDF	12	350	Ca sil.	235	10.4	-	-	-	-	C	3.1.11
Plywood:											
Plywood, spruce	9	460	Ca sil.	570	23.1	6	61	no	no	D-s2, d0	3.1.13
Plywood, poplar *	9	410	Ca sil.	588	19.5	3	36	no	no	D-s1, d0	3.1.13
Plywood, spruce	12	480	Ca sil.	542	16.8	3	45	no	no	D-s1, d0	3.1.12
Plywood (pine surface)	12	540	Ca sil.	437	16.6	1	21	no	no	D-s1, d0	3.1.12
Plywood, phenol faced	12	660	Ca sil.	451	21.7	3	18	no	no	D-s1, d0	3.1.12
Ordinary plywood (birch)	12	720	Ca sil.	399	21.7	1	19	no	no	D-s1, d0	3.1.10
Plywood, poplar with multiple joints	12	420	Ca sil.	621	20.8	2	30	no	no	D-s1, d0	3.1.13
Plywood (2)	14	350	Ca sil.	682	16.2	-	-	-	-	D	3.1.11
Plywood	18	470	Ca sil.	434	15.8	2	28	no	no	D-s1, d0	3.1.12
Plywood, spruce	9	460	Rw [2,3]	463	30.4	7	71	no	no	D-s2, d0	3.1.13
Plywood, spruce	9	460	Air [2,4]	>750 [5]	>15 [5]	>30 [5]	>200 [5]	no	no	E	3.1.13
OSB:											
OSB	9	690	Ca sil.	374	26.5	2	37	no	no	D-s1, d0	3.1.16
OSB	9	690	Air [6]	647	69.6	12	82	yes	yes	D-s2, d2	3.1.17
OSB with T&G joints *	9	690	Ca sil.	384	29.0	2	26	no	no	D-s1, d0	3.1.18
Cement bonded particleb:											
Cement bonded particleb.	~10	~1000	Ca sil.	4.9	0.9	0	22	no	no	B-s1, d0	3.1.19

FIGRA Fire Growth Rate
THR_{600s} Total Heat Release during first 600 s
LFS Lateral Flame Spread to edge

SMOGRA Smoke Growth Rate
TSP_{600s} Total Smoke Production during first 600 s
FDP_{600s} Flaming Droplets or Particles during first 600 s

1) Panels screwed to standard substrate
2) Panels attached to wood studs (45x145 mm) cc 600 mm and open at the top
3) Gap filled with rockwool, Rw, 30 kg/m³
4) Gap empty
5) Tests terminated after 7-9 minutes due to high heat release
6) Free standing with 80 mm air gap
* Single test only (all others are duplicate tests)

References:
3.1.10 prEN 13823 Reaction to fire test for building products - Building products excluding floorings – exposed to the thermal attack by a single burning item (Table B.2 Statistical results), Final draft, 2000.
3.1.11 van Mierlo R, Janse E: Analysis of THR threshold values in the SBI draft test method. TNO-report 1999-CVB-R0904, 1999.
3.1.12 Hakkarainen T, Mikkola E: SBI test results of wood products, VTT Building Technology Internal report, Jan. 1998.
3.1.13 EPF, FEIC and FEROPA test program, SBI graphs and Summary, VTT Building and Transport, 2001.
3.1.14 SBI test report, BASF Fire Safety Department, Report-Nr.: 21.1-3343/12258, 2001.
3.1.15 SBI test report, BASF Fire Safety Department, Report-Nr.: 21.1-3343/12255, 2001.
3.1.16 SBI test, BRE FRS, SI test reference number RTF/480A-B, Test report number 204528 (a-b), 2001.
3.1.17 SBI test, BRE FRS, SI test reference number RTF/481A-B, Test report number 204530 (a-b), 2001.
3.1.18 SBI test, BRE FRS, SI test reference number RTF/482, Test report number 204532, 2001.
3.1.19 SBI test, Test Report WARRES No. 112089, 2000.

The safety margins for FIGRA to the class D limit are in the order of 20-60 % for most wood-based panels. Exceptions are only a few low density products and a rather thin free standing product tested with an air gap behind. Thin 9 mm panels on studs with an open air gap behind did not pass class D. Horizontal or vertical joints and different types of substrates did not influence the fire performance significantly. For the smoke, all products pass the SMOGRA limit with very high margins to class s1, > 60 %. However, for the TSP limit to class s1, some products have safety margins in the order of 30-60 %, while other products do not pass the s1 limit.

The FIGRA values have also been analysed in terms of density of the wood-based panels without any surface or other treatments. Data are presented in Figure 3.1. A trend of higher FIGRA values at lower density is obvious. The FIGRA limit to class E, 750 W/s, is approximately at a density of 350 kg/m^3. With a safety margin of 20 %, the density limit is about 400 kg/m^3.

No similar general trend has been observed for smoke parameters as TSP.

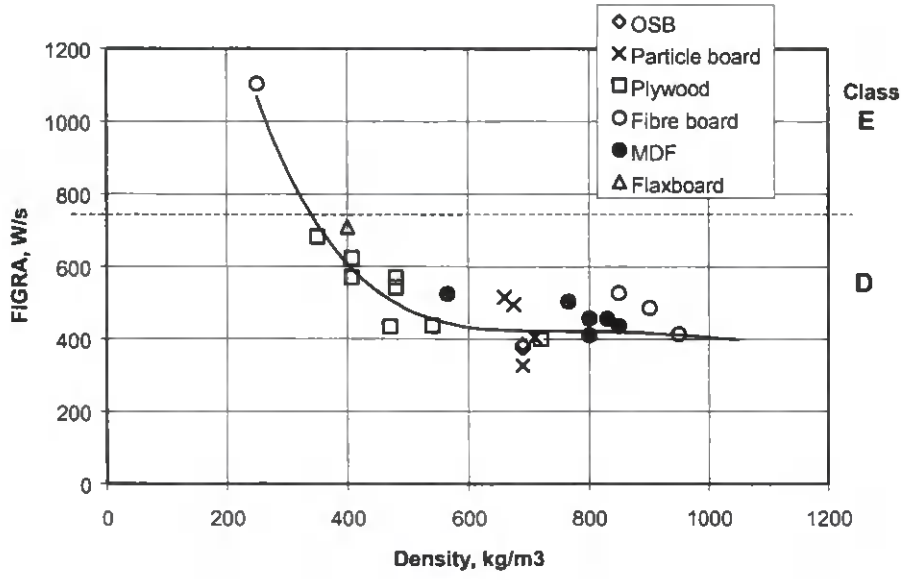


Figure 3.1. FIGRA value as a function of density (above) and basis weight (below) for wood-based panels attached to a calcium silicate substrate class D is obtained for all products except for a low density fibreboard.

3.2 Structural timber - Test results

Table 3.2.1. EN 11925-2 Small flame test results for structural timber (at 30 s exposure of flame)

Timber product	Thick-ness mm	Density kg/m^3	Flame spread within 60 s, mm		Ignition of filter paper	Class EN 13501-1	Ref. no
			Surface	Edge			
Spruce, planed	12	463	< 150	< 150	No	*	3.2.1
Spruce, planed, knot	12	430	< 150	< 150	No	*	3.2.1
Spruce, planed, joint	12	482	< 150	< 150	No	*	3.2.1
Spruce, planed, joint, knot	12	423	< 150	< 150	No	*	3.2.1
Spruce, unplaned	12	500	< 150	< 150	No	*	3.2.1
Spruce, unplaned, knot	12	488	< 150	< 150	No	*	3.2.1
Spruce, unplaned, joint	12	474	< 150	< 150	No	*	3.2.1
Spruce, unplaned, joint, knot	12	471	< 150	< 150	No	*	3.2.1
Spruce, planed	32	526	< 150	< 150	No	*	3.2.1
Spruce, planed, joint	32	477	< 150	< 150	No	*	3.2.1
Spruce, planed, joint, knot	32	482	< 150	< 150	No	*	3.2.1
Spruce, unplaned	38	494	< 150	< 150	No	*	3.2.1
Spruce, unplaned, knot	38	480	< 150	< 150	No	*	3.2.1
Spruce, unplaned, joint	38	495	< 150	< 150	No	*	3.2.1
Spruce, unplaned, joint, knot	38	482	< 150	< 150	No	*	3.2.1
Pine	20	515	< 150	< 150	No	*	3.2.1
Oak	22	700	< 150	< 150	No	*	3.2.2
Poplar	22	400	< 150	< 150	No	*	3.2.2
Sitka spruce	22	300	< 150	< 150	No	*	3.2.3

* Satisfies the small flame requirements for class D.

References

3.2.1 Tsantaridis L: CEN Ignitability test results for wood building products, Trätek report L 9702010, 1997.
3.2.2 Gaillard J-M: Reaction to fire test EN ISO 11925-2, CTBA Test Report N° 02/PC/PHY/277/3, 2002.
3.2.3 Tsantaridis L and Mollek V: Fire testing of Sitka spruce according to EN ISO 11925-2, Trätek Test Report A12323/2002-12-17, 2003.

FIGRA values for structural timber pieces, 21-22 mm thick of different wood species and with different densities, tested with an open air gap behind are illustrated in Figure 3.2. The FIGRA values decrease with increasing timber density and all values are well below the upper limit, 750 W/s, for class D.

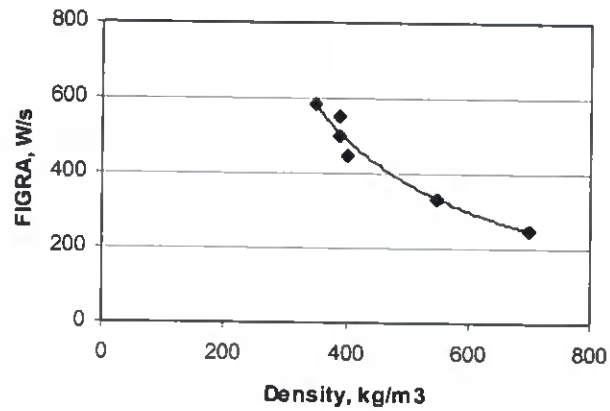


Figure 3.2
FIGRA value for structural timber as a function of density tested with an open air gap behind.
(Data from Table 3.2.2)

Table 3.2.2. EN 13823 SBI test results for structural timber

Timber product	Thick-ness mm	Density kg/m^3	Sub-strate	FIGRA (W/s)	THR 600 (MJ)	SMOGRA (m^2/s^2)	TSP (m^2)	Burning Particles	Class EN 13501-1	Ref. no
Spruce (M12)	10	410	Ca sil.	440	16	3	47	None	D-s1, d0	3.2.4
Spruce (P191)	18	490	Ca sil.	438	18	4	36	None	D-s1, d0	3.2.5
Norway spruce t&g vertical	15	490	Ca sil.	452	17	3	34	None	D-s1, d0	3.2.6
Norway spruce t&g horisontal	15	490	Ca sil.	494	18	4	50	None	D-s1, d0	3.2.6
Norway spruce	20	500	Ca sil.	545	19	2	38	None	D-s1, d0	3.2.7
Pine	45	550	Ca sil.	587	24	12	54	None	D-s2, d0	3.2.6
Pine	21	550	Ca sil.	321	23	3	15	None	D-s1, d0	3.2.6
Pine	21	550	Air gap [1]	329	22	4	36	None	D-s1, d0	3.2.6
Oak horisontal orientation	22	700	Air gap [2]	250	14,5	9	36	None	D-s1, d0	3.2.8
Poplar horisontal orientation	22	400	Air gap [2]	449	18,0	16	52	None	D-s2, d0	3.2.8
Sitka spruce horisontal orientation	22	390	Air gap [3]	551	42	19	122	None	D-s2, d0	3.2.9
Sitka spruce vertical orientation	22	390	Air gap [3]	501	16	16	127	None	D-s2, d0	3.2.9
Sitka spruce vertical orientation	22	350	Air gap [3]	586	14	11	105	None	D-s2, d0	3.2.10
Sitka spruce vertical orientation	22	390	Glass wool [4]	553	13	3	46	None	D-s1, d0	3.2.9
Sitka spruce vertical orientation	2x22	390	Glass wool [4]	524	15	1	27	None	D-s1, d0	3.2.9

1) 45 mm air gap, battens 45 x 45 mm at 600 mm center, perpendicular to the orientation of the timber pieces.
2) 40 mm air gap, battens 40 x 40 mm at 500 mm center, perpendicular to the orientation of the timber pieces.
3) 44 mm air gap, battens 44 x 44 mm at 500 mm center, perpendicular to the orientation of the timber pieces.
4) 44 mm gap, filled with glass wool, 50 mm and 19 kg/m^3, battens 44 x 44 mm at 500 mm center, perpendicular to the orientation of the timber pieces

References

3.2.4 prEN 13823 Reaction to fire test for building products - Building products excluding floorings – exposed to the thermal attack by a single burning item (Table B.2 Statistical results), Final draft, 2000.
3.2.5 van Mierlo R, Janse E: Analysis of THR threshold values in the SBI draft test method. TNO-report 1999-CVB-R0904, 1999.
3.2.6 Hakkarainen T, Mikkola E: SBI test results of wood products, VTT Building and transport, Int. report, 1998.
3.2.7 Östman B: Wooden facades in multi-storey buildings, Proc. Fire and Materials Conf, San Francisco, Jan 2001.
3.2.8 Gaillard J-M: Reaction to fire test EN 13823, CTBA Test Report N° 02/PC/PHY/277/1-2, 2002.
3.2.9 Hakkarainen T: Fire test of Sitka spruce according to EN 13823:2002 (SBI) test procedure, VTT Research Report No RTE 136/03, 2003.
3.2.10 Paloposki T: Fire test of Sitka spruce according to EN 13823:2002 (SBI) test procedure, VTT Research Report No RTE 432/03, 2003.

3.3 Glulam - Test results

Table 3.3.1. EN 11925-2 Small flame test results for Glulam (at 30 s exposure of flame)

Wood specie	Glue 3)	Thick-ness mm	Density kg/m^3	Lamella thickness mm	Flame spread within 60 s, mm		Ignition of filter paper	Class EN 13501-1	Ref. no
					Surface	Edge			
Spruce	Res.	40	384	18	< 150	< 150	No	*	3.3.1
-"-	PU	40	366	18	< 150	< 150	No	*	3.3.1
-"-	MUF	40	365	18	< 150	< 150	No	*	3.3.1
Douglas fir	MUF	40	482	18	< 150	< 150	No	*	3.3.1
Spruce, hor.	MUF	40	414	18	< 150	< 150	No	*	3.3.2
Spruce, vert.[1)]	MUF	40	414	18	< 150	< 150	No	*	3.3.2
Spruce, vert.[2)]	MUF	40	414	18	-	< 150	No	*	3.3.2
Larch, hor.	Res.	40	642	18	< 150	< 150	No	*	3.3.2
Larch, vert.[1)]	Res.	40	642	18	< 150	< 150	No	*	3.3.2
Larch, vert. [2)]	Res.	40	642	18	-	< 150	No	*	3.3.2

1) flame impignement on wood; 3) Res.= Resorcinol; PU= Polyurethane; MUF=Melamine Urea formaldehyde glue;
*2) flame impignement on glue line; * Satisfies the small flame requirements for class D.*

References

3.3.1 Prüfbericht Nr. PB III/B-03-227 vom 06/08/2003 1. Ausfertigung, MFPA Leipzig GmbH
3.3.2 Fire test according to EN 13823, 2002 (SBI method), Report P300091A, 2003-03-18, SP Fire technology.

Table 3.3.2. EN 13823 SBI test results for Glulam

Wood specie	Glue 1)	Thick ness mm	Density kg/m^3	Lam thick ness mm	Air gap mm	FIGRA (W/s)	THR 600 (MJ)	SMOGRA (m^2/s^2)	TSP (m^2)	Burn. Part.	Class EN 13501-1	Ref. no
Spruce	Res.	40	388	18	40	661	15,8	6	78	No	D-s2, d0	3.3.3
-"-	PU	40	362	18	40	616	15,5	4	71	No	D-s2, d0	3.3.3
-"-	MUF	40	360	18	40	674	18,2	7	67	No	D-s2, d0	3.3.3
Douglas fir	MUF	40	438	18	40	422	13,5	6	64	No	D-s2, d0	3.3.3
Spruce	MUF	40	405	18	60	414 ± 28	13,2 ± 1,0	2 ± 0,4	45 ± 6,5	No	D-s1, d0	3.3.4
Larch	Res.	40	640	18	60	251 ± 16	13,5 ± 0,4	2 ± 0,1	36 ± 3,1	No	D-s1, d0	3.3.4

1) Res. = Resorcinol; PU= Polyurethane; MUF=Melamine Urea formaldehyde glue.

References

3.3.3 Prüfbericht Nr. PB III/B-03-226 vom 06/08/2003 1. Ausfertigung, MFPA Leipzig GmbH
3.3.4 Fire test according to EN 13823, 2002 (SBI method), Report P300091, 2003-03-18, SP Fire Technology.

FIGRA values for glulam, 40 mm thick of different wood species and with different densities and different glues, tested with an open air gap behind are illustrated in Figure 3.3. The FIGRA values decrease with increasing timber density and all values are well below the upper limit, 750 W/s, for class D.

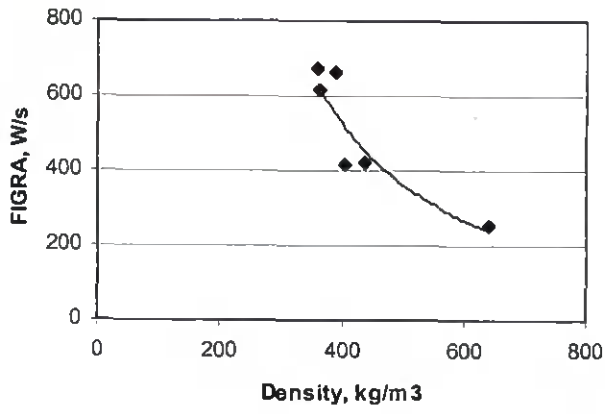


Figure 3.3.
FIGRA values as a function of density for glulam tested with an open air gap behind.
(Data from Table 3.3.2.)

3.4. Solid wood panelling and cladding - Test results

Table 3.4.1. EN 11925-2 Small flame test results for Solid wood panelling and cladding (at 30 s exposure of flame)

Wood product	Thick-ness mm	Density kg/m^3	Flame spread within 60 s, mm		Ignition of filter paper	Class EN 13501-1	Ref. no
			Surface	Edge			
Spruce, planed	12	463	< 150	< 150	No	*	3.4.1
Spruce, planed, knot	12	430	< 150	< 150	No	*	3.4.1
Spruce, planed, joint	12	482	< 150	< 150	No	*	3.4.1
Spruce, planed, joint, knot	12	423	< 150	< 150	No	*	3.4.1
Spruce, unplaned	12	500	< 150	< 150	No	*	3.4.1
Spruce, unplaned, knot	12	488	< 150	< 150	No	*	3.4.1
Spruce, unplaned, joint	12	474	< 150	< 150	No	*	3.4.1
Spruce, unplaned, joint, knot	12	471	< 150	< 150	No	*	3.4.1
Spruce, planed	32	526	< 150	< 150	No	*	3.4.1
Spruce, planed, joint	32	477	< 150	< 150	No	*	3.4.1
Spruce, planed, joint, knot	32	482	< 150	< 150	No	*	3.4.1
Spruce, unplaned	38	494	< 150	< 150	No	*	3.4.1
Spruce, unplaned, knot	38	480	< 150	< 150	No	*	3.4.1
Spruce, unplaned, joint	38	495	< 150	< 150	No	*	3.4.1
Spruce, unplaned, joint, knot	38	482	< 150	< 150	No	*	3.4.1
Pine	20	515	< 150	< 150	No	*	3.4.1
Oak	22	700	< 150	< 150	No	*	3.4.2
Poplar	22	400	< 150	< 150	No	*	3.4.2
Sitka spruce	22	300	< 150	< 150	No	*	3.4.3
Red ceder	18	350	< 150	< 150	No	*	3.4.4

* Satisfies the small flame requirements for class D.

References

3.4.1 Tsantaridis L: CEN Ignitability test results for wood building products, Trätek report L 9702010, 1997.

3.4.2 Gaillard J-M: Reaction to fire test EN ISO 11925-2, CTBA Test Report N° 02/PC/PHY/277/3, 2002.

3.4.3 Tsantaridis L and Mollek V: Fire testing of Sitka spruce according to EN ISO 11925-2, Trätek Test Report A12323/2002-12-17, 2003.

3.4.4 DANAK Prøvningsrapport, Dansk Brand- og sikringsteknisk Institut, Sag nr PF11326, Løbe nr 8775, Ref MPA/DB, 2002-11-13.

Table 3.4.2. EN 13823 SBI test results for Solid wood panelling and cladding

Wood product		Wood specie	Thick-ness mm	Profile min thickn mm	Density kg/m^3	Orien-tation	Vapour barrier	Substrate	No of tests	FIGRA W/s	THR 600 MJ	SMOGRA m^2/s^2	TSP m^2	Burning Particles	Class EN 13501-1	Ref. no
1	Panelling	Spruce	9	6	430	Vert	-	Closed air gap 40 mm	3	463±55	20±3	2	37±6	no	D-s1, d0	3.4.10
2	-"-	-"-	9	6	408	Vert	PE-Paper class F [3]	Min wool [5] class A2-s1,d0	3	547±63	32±2	2	33±9	yes/no	D-s1, d2	3.4.10
3	-"-	-"-	9	6	370	Vert	PE-LD class E/F [4]	-"-	1	657	36	3	37	yes	D-s1, d1	3.4.10
4	-"-	-"-	12	8	423	Vert	-	-"-	2	428±80	20±1	1	25±5	no	D-s1, d0	3.4.10
5	-"-	-"-	9	6	382	Vert	-	Insulation [7] class E/F	3	560±105	27±3	2	29±11	no	D-s1, d0	3.4.10
6	Cladding	-"-	21	12,5	399	Vert	-	Open air gap 21 mm	2	520±94	16±1	2	44±25	no	D-s1, d0	3.4.10
7	-"-	Sitka spruce	21	21 [1]	400	Vert	-	-"-	1	543	12	4	40	no	D-s1, d0	3.4.10
8	-"-	Spruce	21	12,5	430	Hor	-	-"-	3	454±57	15±1	8	49±10	no	D-s1, d0	3.4.10
9	-"-	Sitka spruce	21	21 [1]	397	Hor.	-	-"-	3	426±36	13±1	7	39±8	no	D-s1, d0	3.4.10
9a	Panelling	Spruce	9	6	399	Vert	-	Closed air gap 40 mm	1	481	18	3	45	no	D-s1, d0	3.4.10
9b	-"-	-"-	9	6	388	Vert	-	Min wool [5] class A2-s1,d0	3	503±18	27±2	0	24±10	no/yes	D-s1, d1	3.4.10
10a	-"-	-"-	10	10 [1]	404	Vert	-	Closed air gap 40 mm	3	460±37	15±1	2	39±8	no	D-s1, d0	3.4.10
10b	-"-	-"-	10	10	388	Vert	-	Min wool [5] class A2-s1,d0	2	452 ± 44	23±0,9	0	25±1	no	D-s1, d0	3.4.10
12	-"-	-"-	12	8	405	Vert	PE-Paper class F [3]	-"-	2	447±85	19±2	2	34±8	no	D-s1, d0	3.4.10
30	-"-	Pinus pinaster	10	5 [2]	545	Hor./Vert.	-	Min wool [6] class A2-s1,d0	4	458±98	46±9	2	47±14	no	D-s1, d0	3.4.5
31	-"-	-"-	10	5 [2]	545	Hor./Vert.	-	Closed air gap 20 mm	4	406±54	43±10	8	89±34	no	D-s2, d0	3.4.5
32	-"-	Oak	11	11	740	Hor.	-	-"-	3	240±18	25±2	0	17±2	no	D-s1, d0	3.4.6
33	Cladding	Larch	19,5	12	640	Vert	-	-"-	3	239±7	12±0	8	49±10	no	C-s1, d0	3.4.7
34	-"-	Oregon pine	19,5	9	510	Vert	-	Closed air gap 35 mm	3	315±33	17±6	10	87±11	no	D-s2, d0	3.4.8
35	-"-	Red cedar	17,6	12	350	Hor	-	Open air gap 25 mm	3	689±57	15±1	12	98±17	no	D-s2, d0	3.4.9

[1] No tougue and groove; [2] two profiles of type 'Grain d'Orge' and two profiles of type 'Mouchette';
[3] PE-Paper (paper with plastic facing), 160 g/m^2, F class fire performance; [4] Rani PE-LD (plastic foil), 185 g/m^2, F/E class fire performance.
[5] Thickness 100 mm, density about 11 kg/m^3; [6] Thickness 20 mm; [7] Cellulose insulation, thickness 45 mm, density about 60 kg/m^2, F/E class fire performance.

References

3.4.5 Gaillard J-M, Georges V: Reaction to fire test EN 13823, CTBA Test Report N° 03/PC/PHY/107, 2003.
3.4.6 Gaillard J-M, Georges V: Reaction to fire test EN 13823, CTBA Test Report N° 03/PC/PHY/107-2, 2003.
3.4.7 Gaillard J-M, Georges V: Reaction to fire test EN 13823, CTBA Test Report N° 03/PC/PHY/107-3, 2003.
3.4.8 Gaillard J-M, Georges V: Reaction to fire test EN 13823, CTBA Test Report N° 03/PC/PHY/107-4, 2003.
3.4.9 DANAK Prøvningsrapport, Dansk Brand- og sikringsteknisk Institut, Sag nr PF11326, Løbe nr 8775, Ref MPA/DB, 2002-11-13.
3.4.10 Paloposki T: Fire tests of wood panelling and cladding according to EN 13823:2002 (SBI) test procedure, VTT Research Report No RTE 2236 /03, 2003.

Table 3.4.3. Additional EN 13823 SBI test results for Solid wood panelling and cladding

Wood product		Wood specie	Thick-ness mm	Profile min thickn mm	Width mm	Spac-ing mm	Density kg/m³	Orien-tation	Vap. Barr.	Substrate	No of tests	FIGRA W/s	THR 600 MJ	SMOGRA m²/s²	TSP m²	Burn. Part.	Class EN 13501-1	Ref. no
10	Ribbons	Spruce	21	21 [1]	70	70	430	Hor. [4]	-	Open air gap [2] 46 mm	2	810±93	55±4	4	49±11	no	E	3.4.11
11	-"-	-"-	21	21 [1]	70	70	380	Hor. [5]	-	-"-	1 [9]	≈1130	> 45	≈29	> 87	no	E	3.4.11
13	-"-	-"-	21	21 [1]	70	100	430	Hor. [4]	-	-"-	1	679	36	2	27	no	D-s1, d0	3.4.11
14	-"-	-"-	10	10 [1]	75	120	440	Vert [3]	-	-"-	1	895	62	8	85	no	E	3.4.12
15	-"-	-"-	21	21 [1]	70	140	450	-"-	-	-"-	1	553	46	4	51	no	D-s1, d0	3.4.12
16	-"-	-"-	21	21 [1]	70	100	450	Hor. [4]	-	-"-	1	664	41	2	34	no	D-s1, d0	3.4.12
17	-"-	-"-	10	10 [1]	75	100	440	-"-	-	-"-	2	600±21	33±3	1	36±0	no	D-s1, d0	3.4.12
18	-"-	-"-	21	21 [1]	70	150	450	Hor. [5]	-	-"-	5	670±37	74±3	7	67±12	no/yes	D-s1, d1	3.4.12
19	Panelling	-"-	9	6	87	-	445	Hor.	Al foil	Open air gap [7] + min wool [6]	3	413±20	39±6	17	77±26	no	D-s2, d0	3.4.13
20	-"-	-"-	10	10 [1]	92	-	450	Vert	-	Closed air gap [7] + particleboard	1	462	17	2	21	no	D-s1, d0	3.4.13
21	-"-	-"-	10	10 [1]	92	-	450	-"-	-	-"- [8]	1	340	14	2	34	no	D-s1, d0	3.4.13
22	-"-	-"-	10	10 [1]	92	-	450	Hor.	-	-"- [7]	1	398	18	7	33	no	D-s1, d0	3.4.13
22b	-"-	-"-	9	6	89	-	440	-"-	-	-"- [7]	2 [9]	(460)	21±2	(6)	32±1	no	Undef.	3.4.13
23	-"-	-"-	10	10 [1]	92	-	450	-"-	-	-"- [8]	1 [9]	(371)	19	(9)	42	no	Undef.	3.4.13

[1] No tougue and groove; [2] Calcium silicate substrate behind the air gap; [3] with flat side at 45°; [4] with flat side vertical; [5] with flat side horizontal; [6] thickness 50 mm; [7] air gap 20-21 mm; [8] air gap 40 mm; [9] early termination of one test.

References

3.4.11 Paloposki T: Fire tests of wooden grating structures according to EN 13823:2002 (SBI) test procedure, VTT Research Report No RTE 3259 /03, 2003.
3.4.12 Hakkarainen T: Additional fire tests of wood grating structures according to EN 13823:2002 (SBI) test procedure, VTT Research Report No RTE 4148 /03, 2003.
3.4.13 Hakkarainen T: Additional fire tests of wood panelling and cladding according to EN 13823:2002 (SBI) test procedure, VTT Research Report No RTE 4212 /03, 2003.

Main product parameters influencing the reaction to fire characteristics of wood panelling and cladding are thickness, substrate and density. The main influence from density is illustrated in Figure 3.4. For wood densities of at least 390 kg/m^3, all FIGRA values are below 600 W/s, i e well below the limit to a lower main class, 750 W/s.

A similar influence of density and species has earlier been demonstrated for structural timber based on the data in Table 3.2.2.

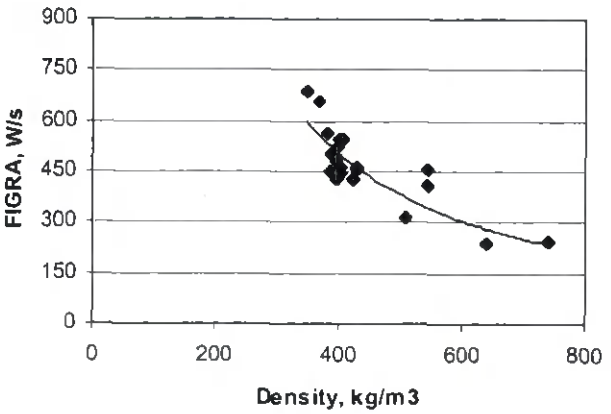


Figure 3.4.
FIGRA values as a function of density for all solid wood panels and claddings with thickness 9-21 mm and different profile types, tested with and without an air gap behind.
(Data from Table 3.4.2 and 3.4.3).

For the wood ribbon elements case in which all sides of the panel are exposed to fire, the fire performance is a function of the area exposed in relation to the nominal area in the SBI test method (2,25 m^2). This relationship is illustrated in Figure 3.5.

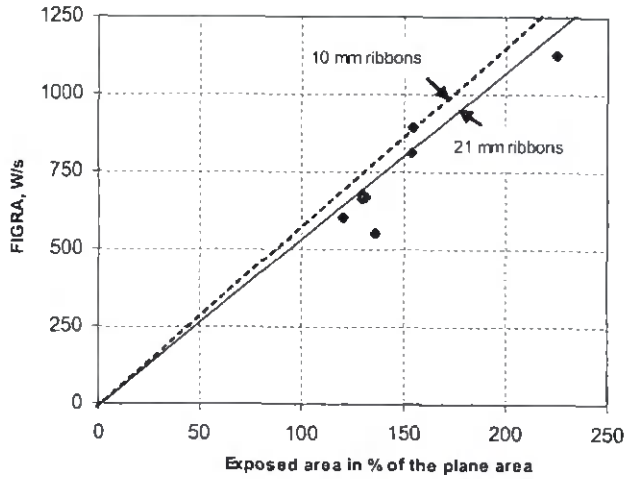


Figure 3.5.
FIGRA as a function of exposed area for wood ribbon elements (incl. the wood support frame) in percent of the plane area in the SBI test.
(Data from TABLE 3.4.3).

4. Conclusions on CWFT for different wood products

4.1 Wood-based panels - Classification

Main class D has been verified for most wood-based panels. Panel density and thickness are decisive for the FIGRA values, while panel joints and choice of standard substrates do not influence the class. Only low density products are class E.

Smoke class s2 should be used for all wood-based panels as surface linings in order to achieve a robust classification. However, as shown by test results many products do reach the s1 smoke class. Flaming droplets/particles class d0 has been verified for all wood-based panels in class D. The safety margins for these sub-classes are all very high, 20-90 %.

The final classification of wood-based panels published in Official Journal /11/ is given in Table 4.1. The table has been included in the harmonised product standard for wood-based panels, EN 13 986.

An extension of the classification for wood-based panels is planned in order to be able to include other panel types and further end use applications, e g with air gaps behind the wood-based panel.

Table 4.1. Final table in Commission decision /11/

Classes of reaction to fire performance for Wood-based panels [1]

Wood-based panel products [2]	**EN product grade reference**	**Minimum density (kg/m³)**	**Minimum thickness (mm)**	**Class** [3] **(excluding floorings)**	**Class** [4] **Floorings** *
Particleboards	EN 312	600	9	D-s2, d0	D_{FL}-s1
Fibreboards, Hard	EN 622-2	900	6	D-s2, d0	D_{FL}-s1
Fibreboards, Medium	EN 622-3	600	9	D-s2, d0	D_{FL}-s1
		400	9	E, pass	E_{FL}
Fibreboards, Soft	EN 622-4	250	9	E, pass	E_{FL}
Fibreboards, MDF [5]	EN 622-5	600	9	D-s2, d0	D_{FL}-s1
Cement-bonded particleboard [6]	EN 634-2	1000	10	B-s1, d0	B_{FL}-s1
OSB board [7]	EN 300	600	9	D-s2, d2	D_{FL}-s1
Plywood	EN 636	400	9	D-s2, d0	D_{FL}-s1
Solid wood panels	EN 13353	400	12	D-s2, d0	D_{FL}-s1

* *Verification for the flooring class is given in /9/.*

1) EN 13986
2) Wood-based panels mounted without an air gap directly against class A1 or A2-s1,d0 products with minimum density 10 kg/m³ or at least class D-s2,d0 products with minimum density 400 kg/m³
3) Class as provided for in Table 1 of the Annex to Commission Decision 2000/147/EC
4) Class as provided for in Table 2 of the Annex to Commission Decision 2000/147/EC
5) Dry process fibreboard
6) Cement content at least 75% by mass
7) Oriented strand board

4.2 Structural timber - Classification

Structural timber with thickness and width of 22 mm and above can, based on the evidence presented, be classified without further testing as class D-s2, d0.

The final classification of structural timber published in Official Journal /12/ is given in Table 4.2. The table will also be included in the harmonised product standards for structural timber, prEN 14081 parts 1-4, EN 14250 and prEN 14544.

Table 4.2. Final table included in Commission Decision for Structural timber /12/. Classes of reaction to fire performance of Structural timber

Material	Product detail	Minimum mean density [3] (kg/m^3)	Minimum overall thickness (mm)	Class [2] (excluding floorings)
Structural timber [1]	Visual and machine graded structural timber with rectangular cross-sections shaped by sawing, planing or other methods or with round cross-sections.	350	22	D-s2, d0

1) Applies to all species covered by the product standards.
2) Class as provided for in Table 1of the Annex to Decision 2000/147/EC.
3) Conditioned according to EN 13238.

4.3 Glulam - Classification

Glulam with thickness and width of 40 mm and above can, based on the evidence presented, be classified without further testing as class D-s2, d0.

The final classification of glulam approved by the Standing Committee on Construction /13/ is given in Table 4.3. The table will also be included in the harmonised product standard for glulam, prEN 14080.

Table 4.3. Proposed Table For Inclusion In Commission Decision for Glulam /13/. Classes of reaction to fire performance for Glulam

Material	Product detail	Minimum mean density [3] (kg/m^3)	Minimum overall thickness (mm)	Class [2]
Glulam [1]	Glued laminated timber products with a finished lamination thickness of not more than 45 mm.	380	40	D-s2, d0

1) Applies to all species and glues covered by the product standards.
2) Class as provided for in Commission Decision 2000/147/EC Annex Table 1.
3) At conditioning according to EN 13238.

4.4 Solid wood panelling and cladding - Classification

Solid wood panelling and cladding with total thickness of at least 9 mm and density of at least 390 kg/m^3 can, based on the evidence presented, be classified as class D-s2,d2, if mounted with a closed air gap behind or on a non combustible substrate with minimum density 10 kg/m^3 with or without a vapour barrier behind the wood product. Products with total thickness of at least 12 mm can be classified as class D-s2,d0 with the same conditions. A substrate of cellulose insulation of at least class E or an open air gap of maximum 20 mm behind the panel may be used.

Solid wood panelling and cladding with thickness of at least 18 mm and density of at least 390 kg/m^3 can, based on the evidence presented, be classified without further testing as class D-s2, d0 without any limitations in end use conditions

Wood ribbon elements are also included in the classification. They are defined as rectangular wood pieces, with or without rounded corners, mounted horizontally or vertically on a support frame and surrounded by air on all sides, mainly used close to other building elements, both in interior and exterior applications. They can be classified without further testing as class D-s2, d0, if the maximum exposed area (all sides of rectangular wood pieces and wood support frame) is not more than 110 % of the total plane area, see Figure a in Table 4.4.

A draft proposed Commission Decision /14/ is given in Table 4.4. The table will also be included in the harmonised product standards for solid wood panelling, prEN 14 915.

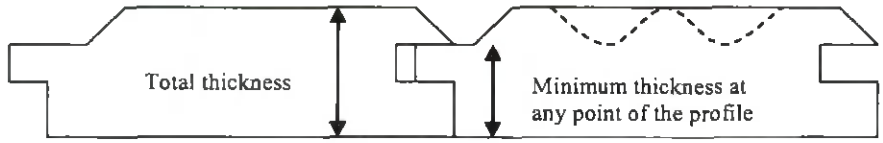
Table 4.4. Proposed Table For Inclusion In Commission Decision for Solid wood panelling and cladding /14/

Classes of reaction to fire performance for Solid wood panelling and cladding

Product [11]	**Product detail** [5]	**Minimum mean density** [6] **(kg/m³)**	**Minimum thicknesses, total / minimum** [7] **(mm)**	**End-use condition** [4]	**Class** [3]
Panelling and cladding [1]	Wood pieces with or without tongue and groove and with or without profiled surface	390	9 / 6	Without air gap or with closed air gap behind	D-s2, d2
-"-	-"-	390	12 / 8	-"-	D-s2, d0
Panelling and cladding [2]	-"-	390	9 / 6	With open air gap ≤20 mm behind	D-s2, d0
-"-	-"-	390	18 / 12	Without air gap or with open air gap behind	D-s2, d0
Wood ribbon elements [8]	Wood pieces mounted on a support frame [9]	390	18	Surrounded by open air on all sides [10]	D-s2, d0

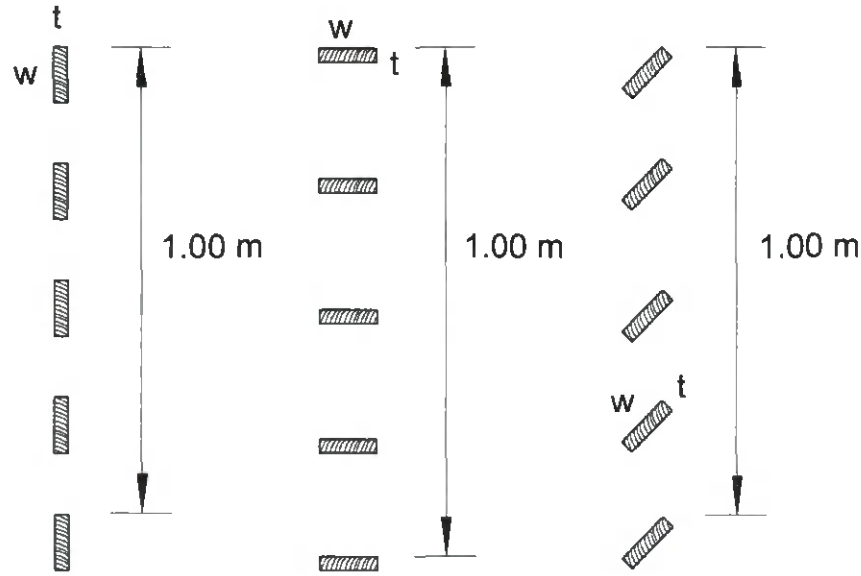
1) Mounted mechanically on a wood batten support frame, with the gap closed or filled with a substrate of at least class A2-s1,d0 with minimum density of 10 kg/m³ or filled with a substrate of cellulose insulation material of at least class E and with or without a vapour barrier behind. The wood product shall be designed to be mounted without open joints.
2) Mounted mechanically on a wood batten support frame, with or without an open air gap behind. The wood product shall be designed to be mounted without open joints.
3) Class as provided for in Commission Decision 2000/147/EC Annex Table 1. This decision is currently under review in respect to façade applications.
4) An open air gap may include possibility for ventilation behind the product, while a closed air gap will exclude such ventilation. The substrate behind the air gap must be of at least class A2-s1,d0 with a minimum density of 10 kg/m³. Behind a closed air gap of maximum 20 mm and with vertical wood pieces, the substrate may be of at least class D-s2,d0.
5) Joints include all types of joints, e g butt joints and tongue and groove joints.
6) Conditioned according to EN 13238.
7) As illustrated in Figure a below. Profiled area of the exposed side of the panel not more than 20 % of the plane area, or 25 % if measured at both exposed and unexposed side of the panel. For butt joints, the larger thickness applies at the joint interface.
8) Rectangular wood pieces, with or without rounded corners, mounted horizontally or vertically on a support frame and surrounded by air on all sides, mainly used close to other building elements, both in interior and exterior applications.
9) Maximum exposed area (all sides of rectangular wood pieces and wood support frame) not more than 110 % of the total plane area, see Figure b below.
10) Other building elements closer than 100 mm from the wood ribbon element (excluding its support frame) must be of at least class A2-s1,d0, at distances 100-300 mm of at least class B-s1,d0 and at distances more than 300 mm of at least class D-s2,d0.
11) Applies also to stairs.

Figure a



Profiles for solid wood panelling and cladding.

Figure b



Maximum exposed area of wood ribbon element: $2n\ (t+w) + a \leq 1{,}10$

n is number of wood pieces per meter
t is thickness of each wood piece, in meter
w is width of each wood piece, in meter
a is exposed area of wood support frame (if any), in m^2, per m^2 of wood ribbon element

4.5 Overall conclusions for wood products

The results presented clearly demonstrate the stable reaction to fire performance of wood based products. Class D-s2,d0 has been verified with the required safety limit of 20 %, which is generally required for Classification Without Further Testing, CWFT. The main parameters influencing the reaction to fire characteristics of all wood products are product thickness, density and end use conditions such as substrates or air gaps behind the product.

The work has already resulted in Commission decisions published in the Official Journal of the Commission for wood-based panels and structural timber products. Remaining results are in progress of being finally approved and published. The classes will also be included in the harmonised product specifications as soon as they become available from the product standard committees and used for CE-marking.

In addition to the CWFT decisions this knowledge can be utilized in predicting classifications also for wood products not covered by the decisions or for new products being developed.

Wood products and end use applications not included in the CWFT classification tables have to be tested and classified in the ordinary way. Better classification may then be reached, since no safety margins have to be fulfilled.

Treated wood products have always to be tested and classified separately, since the treatments may influence their reaction to fire performance.

Acknowledgements

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