ICDLI

International Committee of the Decorative Laminates Industry

Fire behavior of HPL

Preface

High-pressure laminate (HPL) in accordance with EN 438 has been used in the construction and furniture sector for decades. The European standard EN 438 defines the material, requirements and properties of HPL.

HPL is a resin and paper-based thermosetting composite material and features a unique, extremely robust, resistant, modern and very decorative surface. HPL is omnipresent in our day-to-day lives and is self-supporting or used in conjunction with substrates. The application and usage areas of HPL are extremely diverse and are constantly evolving. This requires knowledge management which provides regularly updated information and assistance with regard to different applications and processing, in the form of technical bulletins.

The technical leaflet “Fire behaviour of decorative high pressure laminates (HPL)” gives information.

For more than 50 years the ICDLI has been the international representative of the interests of European laminate manufacturers. Further information about the ICDLI and the data sheets published up to now can be found at www.icdli.com.

This application was compiled by the International Committee of the Decorative Laminates Industry.
It considers the conditions of application technology in the European countries. If you have further questions, please contact us:

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ICDLI aisbl - International Committee of the Decorative Laminates Industry
Rue de la presse 4, 1000 Bruxelles, Belgium
Head office:
Städelstraße 10, 60596 Frankfurt / Main, Germany, phone +49 69 2 71 05-31, fax +49 69 23 98 37,
E-Mail: info@pro-kunststoff.de

Table of Contents

1. General

The materials referred to are high pressure decorative laminates (HPL) according to the European Standard EN 438. This standard describes the various types of HPL:
S = Standard
P = Postforming
F = Fire Retardant (FR)

Laminates are used in a variety of applications. Their reaction to fire (a measure of material properties) is of great importance, for example, in wall lining, ceiling and floors in private, industrial and public buildings, and in the transport industry. Laminates contribution to fire resistance (a measure of the performance of a building element) is of less significance.
HPL can be used as self supporting compact panels or require bonding to a supporting substrate (wood based, mineral or metal substrates).

2. Description of the material / composition

HPL are typically made of organic materials. They consist of layers of cellulose fibrous material impregnated with thermosetting resins. During the high pressure process, defined as a simultaneous application of heat and pressure, the polymer chains are joined (or cross-linked) by intermolecular bonding (thermosets). This produces homogeneous panels that in a fire situation do not soften or drip. Where improved fire retardance is required, the laminate core may be treated with additives, which do not contain halogens, improving its reaction to fire.

3. Reaction to fire of HPL

In most countries authorities give much importance to four characteristics in terms of reaction to fire. These characteristics are also the basis for the European reaction to fire test in the construction products and transportation fields:

- flammability
- spread of flame
- heat release
- production of smoke and toxic gases

3.1 Flammability

Flammability is a measure of the ignition of a material in a fire situation. Most household materials, for example textiles and plastics, ignite at relatively low temperatures (150-250ºC). Due to its composition, high pressure laminates will ignite only at higher temperatures (≈400ºC).

3.2 Spread of Flame

The spread of flame is a measure to determine the risk of fire propagation. It determines the spread of flame at the surface of the product after ignition.
HPL show a favorable behavior by retarding the spread of flame in applications such as: wall panels, ceilings, etc., thus prolonging evacuation time. For this reason, HPL may be used in various application areas such as emergency corridors (Depending on national legislation).

3.3 Heat release

The heat released by a material during the burning process determines the contribution of that material to the fire situation.
Tests have shown that HPL, in comparison to other organic materials, have a significant retarded heat release.

3.4 Production of smoke and toxic gases

All organic materials produce smoke and toxic gases in a fire. Tests have shown that during the burning of HPL, as in the case of many organic materials, carbon dioxide is produced as the main component. Traces of toxic gases, such as carbon monoxide, nitrogen oxide, sulphur dioxide and hydrogen cyanide may be detected in the smoke. A person in a fire situation is endangered by the heat release, lack of oxygen, smoke density and carbon monoxide, rather than by other toxic gases. HPL produce a low volume of smoke and toxic gases. They receive the highest classification for organic materials, as described, for example, in the European and French railways standards.

3.5 Material behavior in fire

In a fire HPL do not soften, melt or produce burning droplets.

3.6 Conclusion

HPL panels are difficult to ignite and have properties that retard the spread of flame. For this reason, they produce a low release of heat and smoke, prolonging the evacuation time. Gases, produced during the burning of HPL, do not differ essentially from those of common organic materials such as wood, wool or cotton.

4. Resistance to fire

Resistance to fire is a performance characteristic expressed in time (minutes) that the building element such as a wall, floor or ceiling can resist heat and smoke penetration against standardized fire circumstances. HPL are not building elements and can only be tested as part of a building element.

5. National fire standards

Regarding reaction to fire, most countries still have their own test methods and classification systems even for similar application fields. HPL are classified according to the most important national fire standards (see following table).

Common name	Standard	Typical Classification	
		HPL according to EN 438, type F	HPL according to EN 438, type S, P
Spread of flame (UK)	BS 476-7	Class 1	Class 2
Brandschacht (DE)	DIN 4102-1	B1	B2
Epiradiateur (FR)	NFP 92 501	M1	M3 or better
SBI (AT)	ÖNORM EN 13501	Euroclass B/C	Euroclass D
Pannello radiante (IT)	UNI 8457 UNI 9174	Class 1	Class 3 or better
Reacciòn al fuego (ES)	UNE 23727	M1	M3 or better
Brandvoortplanting (NL)	NEN 6065	Class 1 = Euroclass B Class 2 = Euroclass B /C Class 3 = Euroclass C	Class 4 =Euroclass D
Smoke density, toxicity (FR)	NFF 16.101	Class F2 or better	Class F2 or better
Technical regulation on	123 –	KM2 or better	KM5

safety requirements (RU)	Federal Law		

The tables in appendix 2 provide an overall view of the test results and test ratings.

The results depend on the thickness and construction of the HPL, on the substrate and adhesives. For details regarding fire certification contact the manufacturer.

6. European Fire classification of construction products and building elements according to EN 13501

A new European fire classification system was developed in 2001 for construction products (defined as products to be installed permanently into or on buildings). This new fire classification system will replace the national fire classification systems for construction products. The definitions and classification for construction products in terms of fire performance are described in the European standard EN 13501. It consists of several parts. For HPL products part 1 and 2 are important. Part 1 describes the reaction to fire classification and test methods for construction products (table 2, 3, 4 and 5 of appendix 1). EN 13501 part 2 describes the resistance to fire classification for building elements. Interior standard grade HPL panels have a Classified Without Further Testing (CWFT) classification Euroclass D-s2, d0 (table 1 of appendix 1).
The CWFT classification is published in the Official Journal of the European Union (08.08.2003). This means that these products are classified as Euroclass D-s2, d0 and do not need an official test report to prove this.

7. Building Regulations

Building regulations determine where and how products with various reaction to fire classifications can be used. In Europe these exist only at the National level. The EU member states have transposed their national fire classification system to the European fire classification system. Each member state has set national fire requirements for construction products based upon the European fire classification system.

Appendix 1: European fire classification and test methods

Table 1. Classification without further testing for standard HPL[1]

Classes of reaction to fire of high pressure decorative laminate panels

High pressure decorative laminate panels ([1])	Product detail	Minimum density (kg/m^3)	Minimum overall thickness (mm)	Class ([2]) (excluding floorings)
Interior grade non-FR compact HPL panels ([3])	Compact HPL meeting EN 438-4 type CGS	1 350	6	D-s2, d0
Interior grade non-FR HPL composite panels with wood–based substrates ([3])	Composite panels comprising non FR grade HPL meeting the requirement of EN 438-3, adhesively bonded to both sides of non-FR grade wood-based core of minimum thickness 12 mm complying with EN 13986, using PVAc or thermosetting adhesive at an application rate of 60 to 120 g/m^2	Wood-based core minimum density 600 HPL minimum density 1 350	12 mm wood-based core with HPL≥ 0,5 mm bonded to both sides	D-s2, d0

([1]) Either directly fixed (i.e. with no air gap) to a material having a reaction to fire of A2-s1, d0 or better and a density of at least 600 kg/m^3, or mounted on a timber or metal batten support frame, with a non-ventilated (i.e. void open only at the top) air gap of at least 30 mm, the reverse face of the cavity so formed having a reaction to fire classification of A2-s1, d0 or better.
([2]) Classes as provided for in Table 1 of the Annex to Decision 2000/147/EC.
([3]) Complying with European Standard EN 438 –7.

[1] Table 1 is taken from the Official Journal of the European Union (L201/25 dated 08.08.2003)

Table 2: Construction products, reaction to fire classification according to EN 13501-1 excluding flooring

Class	Smoke	Droplets	Remark	Examples
A1			Incombustible, organic content ≤ 1 %	Concrete, stone, metals, gypsum
A2	s1 s2 s3	d0 d1 d2	incombustible, organic content ≤ 10 %	Gypsum plasterboard, t ≥ 9,5 mm
B	s1 s2 s3	d0 d1 d2	combustible	HPL FR compact, t ≥ 6 mm Composite panels comprising FR HPL bonded to FR wood-based substrates Cement bonded particle board, t ≥ 10 mm FR particle board, t ≥ 12 mm
C	s1 s2 s3	d0 d1 d2	combustible	HPL FR compact, t < 6 mm HPL standard compact, t ≥ 8 mm
D	s1 s2 s3	d0 d1 d2	combustible	HPL standard compact, t ≥ 6 mm Composite panels comprising standard HPL bonded to non-FR wood-based substrates Plywood, t ≥ 9 mm Solid wood, t ≥ 12
E			combustible	Low density fibre board
F			No fire performance determined	Some plastics

Table 3: Construction products, reaction to fire classification according to EN 13501-1 for flooring

Class	Smoke	Remark
$A1_{fl}$		Incombustible, organic content ≤ 1 %
$A2_{fl}$	s1 s2	incombustible, organic content ≤ 10 %
B_{fl}	s1 s2	combustible
C_{fl}	s1 s2	combustible
D_{fl}	s1 s2	combustible
E_{fl}		combustible
F_{fl}		No fire performance determined

Table 4: Test method for construction products according to EN 13501-1 excluding flooring

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

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 $t_f = 20$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 ISO 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 =30s	Fs ≤ 15 mm within 60s	

C	EN ISO 13823 (SBI) and	FIGRA ≤ 250 $W.s^{-1}$ and LFS< edge of specimen and THR_{600s} ≤7,5 MJ	Smoke Production ([5]) and flaming droplets/particles ([6])
	EN ISO 11925-2 ([8]) Exposure = 30s	Fs ≤ 15 mm within 60s	
D	EN ISO 13823 (SBI) and	FIGRA ≤ 750 $W.s^{-1}$	Smoke Production ([5]) and flaming droplets/particles ([6])
	EN ISO 11925-2 ([8]) Exposure = 30s	Fs ≤ 150 mm within 60s	
E	EN ISO 119525-2 (8) Exposure= 15s	Fs ≤ 150 mm within 20s	Flaming droplets/particles ([7])
No performance determined			

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

(1) For homogeneous products and substantial components of non-homogeneous products.

(2) For any external non–substantial components 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 (SBI): FIGRA≤ 20 $W.s^{-1}$, and LFS < edge of specimen and THR_{600} ≤ 4,0 MJ and s1 and d0.

(3) For any international non-substantial component of non-homogeneous products.

(4) For the product as a whole.

(5) s1=SMOGRA≤ 30m^2, s^{-2} and STP_{600s}≤ 50m^2; s2 = SMOGRA≤ 180$m^2.s^{-2}$ and TSP_{600s}≤ 200m^2, s3=not s1 or s2.

(6) d0= No flaming droplets/particles in EN 13823 (SBI) within 600s; d1= no flaming droplets/particles persisting longer than 10s in EN 13823 (SBI) within 600s, d2 = not d0 not 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.

Table 5: Test methods according to EN 13501-1 for floorings

Classes of reaction to fire performance for floorings

Class	Test method	Classification criteria	Additional classification
A1 $_{fl}$	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 ([3])	PCS ≤ 2,0 MJ.kg^{-1} ([1]) and PCS ≤ 2,0 MJ.kg^{-1} ([2]) and PCS ≤ 1,4 MJ.m^{-2} ([3]) and PCS ≤ 2,0 MJ.kg^{-1} ([4])	–
A2 $_{fl}$	EN ISO 1182 ([1]) Or	$\Delta T \leq 50$° C and $\Delta m \leq 50$ % and $t_f = 20$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 ISO 9239-1 [(5)]	Critical flux [(6)] ≥ 8,0 kW.m^{-2}	Smoke production ([7])
B $_{fl}$	EN ISO 9239-1 [(5)] and	Critical flux [(6)] ≥ 8,0 kW.m^{-2}	Smoke production ([7])
	EN ISO 11925-2 [(8)] Exposure = 15s	Fs ≤ 150 mm within 20s	
C $_{fl}$	EN ISO 9239-1 [(5)] and	Critical flux [(6)] ≥ 4,5 kW.m^{-2}	Smoke production ([7])
	EN ISO 11925-2 [(8)] Exposure = 15s	Fs ≤ 150 mm within 20s	

D_{fl}	EN ISO 9239-1 (5) and EN ISO 11925-2 (8) Exposure = 15s	Critical flux (6) ≥ 3,0 kW.m^{-2} Fs ≤ 150 mm within 60s	Smoke production (7)
E_{fl}	EN ISO 11925-2 (8) Exposure= 15s	Fs ≤ 150 mm within 20s	
F_{fl}	No performance determined		

(*) for homogeneous products and substantial components of non-homogeneous products.

(1) For any external non-substantial component non-homogeneous products.

(2) For any internal non-substantial component non-homogeneous products.

(3) For the product as a whole.

(4) Test duration = 30 minutes

(5) Critical flux is defined as the radiant flux at which the flame extinguishes or the radiant flux after a test period of 30 minutes, whichever is the lower (i.e. the flux corresponding with the furthest extent of spread of flame).

(6) s1 = Smoke ≤ 750% min; s2 = not s1.

(7) Under conditions of surface flame attack and, if appropriate to the end-use application of the product, edge flame attack.

Appendix 2: Typical results for HPL

The results depend on the thickness and construction of the HPL, on the substrate and adhesives.

Construction

Country	Authorities -societies-	Test method (characterization)	Reaction to fire HPL EN 438		Substrate	HPL thickness
			F	S, P		
European Union	Notified national test institutes	EN 13501-1	Euroclass B-s2, d0	Euroclass D-s2, d0	NC or FR for B-s2, d0 C for D-s2, d0	
Denmark	Bolihetsministeriet ETA	NT Fire 004 (B+C) ISO 5657 (F)	DS 1066 Class A Ut 1	DS 1066 Class B Ut 2	NC or K	
Germany	Deutsches Institut für Bautechnik	DIN 4102 Part 1 (G)	B1	B2	NC, FR or K* for B1, C for B2	
France	C.S.T.B.	NFP 92 501 (H)	M1	M3	K	
Great Britain	Building Regulations	BS 476 Part 7 (A) BS 476 Part 6 (B) and Part 7	Class 1 Class 0	Class 1 or 2 Class 2	NC or K C or K NC or K	
Italy	Ministerio del'Interno	UNI 8456, 8457 (A), 9174 (A), 9177	Class 1	Class 1 Class 3 or better	NC K or C	
Netherlands	TNO-Bouw	NEN 6065 (A, F) NEN 6066 (C)	Class 1 = Euroclass B Class 2 = Euroclass B /C Class 3 = Euroclass C	Class 4 =Euroclass D	NC	
Norway	Norges Standardiserings	NT Fire 004 (B+C) ISO 5657 (F)	in 1 Ut1	In 2 Ut 2		

	Förbund NSF					
Austria	OFI/IBS	ÖNORM EN 13501	Euroclass B/C	Euroclass D	NC or FR B-s2,d0 C for D-s2,d0	
Poland	Instytut Technikl Budowlanej	PN-90/B (A)	low flame spread	low flame spread	NC or K	
Russian Ferderation	Approved by National Duma	123 – Federal Law GOST – 12.1.044-89	KM2 or better	KM5	K	
Sweden	Boverket	NT Fire 004 (B+C)	Class 1 Class 2	Class 2 Class 3	NC K	
Switzerland	Vereinigung Kantonaler Feuerversicherung VKF	VKF method (flammability and smoke test)		4,3	K	0.5-1.9 mm
			5.3		K	0.5-1.9 mm
			5.3	5.3	K	≥ 2 mm

* refers to compact laminates

Transport Industry

Country	Authorities	Test method (characterization)	Reaction to fire HPL DIN EN 438		Substrate	HPL thickness
			F	S, P		
European Union	Notified national test institutes	EN 45545	HL2/HL3	HL1		
Germany	Deutsche Bahn AG und lokale Verkehrsbünde	DIN 54 837 (F) DIN 5510-2	S3-S4/SR2/ST2 S4/SR2/ST2	S3/SR2/ST2	C K	
France	S.N.C.F. (Laboratories CSTB or LNE)	NFP 92501(H) NFF 16.101 (C+D)	M1/F1 M1/F2	M3/F1 M3/F2	K	≥ 3 mm < 3 mm
	UTAC	UTAC ST 18-502/1	A1	A1	K	> 3 mm
Great Britain	British Rail etc. London Underground	BS 476 Part 7 (A) BS 6853 Appendix B (C) BS 6853 Appendix B (C)	Category 1 Category 1 Ao (on) < 1,4/ Ao (off) < 1,8		NC or K NC or K	
Italy	Ferrovie dello Stato S. P. A.	UNI 8466, UNI 9177, UNI 9174 (A), NFF 16.101 (C+D) NFF 16.101 (C+D)	Classe 1 F1 F2			> 3 mm < 3 mm
Sweden	Statens Järnvägar	NT Fire 004 (B+C)	Class 1 Class 2	Class 2 Class 3	K or FR C	
Spain	RENFE	UNE 23727/ UNE 23721 (A, B) NFF 16.101 (C+D)	M1/F1			> 3 mm
USA	NFPA 130	ASTM E - 162 (A)	< 36		K	
		ASTM E - 662 (C)	Ds 1 min < 100 Ds 4 min < 200			

Russian Federation	Research Institute of Railway Transport	GOST – 55183-2012 Gost - 12.1.004-89	Flame soread index ≤20 Smkoe release coefficient (m^2 /kg) ≤500 Toxity index (g/m^3)>40		K	

Ship building and offshore

Country	Authorities	Test methods (characterization)	Reaction to fire HPL DIN EN 438		Substrate	HPL thickness
			F	S, P		
European Union, China, Denmark, Germany. Great Britain, Italy, Korea. Poland, Netherlands Norway, France	Notified national test institutes	IMO Res. A 653 (16) (B)	Requirement fulfilled	Requirement fulfilled	NC	< 1,5 mm
		IMO Res. MSC 61 (67) C, D	Requirement fulfilled	Requirement fulfilled	NC, K	≤ 1,2 mm
Australia	Australian Maritime Safety Authority	BS 476 Part 7 (A)	Class 1	Class 1 or 2	NC	
Canada	Board of Steamship Inspection	BS 476 Part 7 (A)	Class 1	Class 1 or 2	NC	
USA	US Coast Guard	ASTM E 84/NFPA 256 (A+C)	Class 1	Class 1 or 2	NC	
	American Bureau of Shipping	BS 476 Parte 7 (A)	Class 1	Class 1 or 2	NC	
China	China Classification Society	BS 476 Part 7 (A) NT Fire 004 (B+C)	Class 1 Class 1	Class 1 or 2 Class 2	NC	
Japan	Nippon Kaiji Kyokai	BS 476 Part 7 (A)	Class 1	Class 1 or 2	NC	
Great Britain	Department of Transport Lloyd's Register	BS 476 Part 7 (A)	Class 1	Class 1 or 2 Class 2	NC	
Russian Federation	Russian Maritime Register of Shipping Russian River	GOST – 12.1.044 Gost – 12.1.044	Requirement fulfilled Requirement fulfilled	Requirement fulfilled Requirement fulfilled	K K	

	Register					

Key

Test method

(A) = flame propagation

(B) = heat release

(C) = smoke density

(D) = toxicity

(E) = calorific value

(F) = combustion

(G) = “Brandschacht”

(H) = “Epiradiateur”

Laminate

S = Standard

P = Postforming

F = Fire Retardant

Subtrate

C = combustible

NC = non combustible

K = no substrate

FR = flame retardant