HPL in facades

Considerations of fire properties

In cooperation with

Stadt Wien

Prüf-, Inspektions- und Zertifizierungsstelle

Preface

High-pressure laminate (HPL) manufactured 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. This position paper gives an overview about the exterior application of HPL-panels according to EN 438-6 as cladding material of rear-ventilated facade systems in terms of fire properties. The paper contains information about the performance of HPL-panels in case of a fire spreading onto a facade. It also summarizes the technical and legal requirements to fulfill the fire protection goals given by authorities.

All is based on the knowledge about the characteristics of HPL gathered by the two institutions that are responsible for this leaflet: ICDLI, experts on the product itself and the Testing Centre, Inspection and Certification Services of the City of Vienna, experts on fire protection. Because of the origin of these two the document emphasizes on the European Construction Product Directive, the European fire classification system and the European requirements in connection with rear-ventilated facades.

The present position paper was carried out on behalf of the ICDLI by the **Testing Center, Inspection and Certification Services of the City of Vienna**. Our special thanks go to the two authors

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About the Testing Centre, Inspection and Certification Services of the City of Vienna

Whether it's water quality, hospital hygiene or building material testing: Austria's most modern testing center ensures safety and is a constant partner in the development, testing and certification of innovative materials and processes. As a worldwide acting accredited testing centre, the building physics laboratory offers a comprehensive range of services relating to fire protection in the field of reaction-to-fire as well as in the field of fire resistance. In the fire testing hall in Vienna a large-scale test rig for testing facade systems is also available. Numerous fire tests (reaction-to-fire and large-scale facade test) carried out on different HPL-products prove the wide experience of the institute in this sector.
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The ICDLI

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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Table of contents

1 General Information

1.1 HPL as a facade cladding

HPL-panels 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.

Within this paper the scope of the application of such panels are facade constructions, in particular so-called rear-ventilated facades. This type of external wall cladding consists of an external cladding (HPL-panel), mechanically fastened to a subconstruction (usually metal or timber), which is fixed to the external wall of buildings. An insulation layer (mineral wool) is usually also mounted on the external wall.

Between the cladding elements and the insulation layer or the external wall accordingly, there is an air space (rear-ventilation) which shall always be drained and ventilated. The air space is connected to the outside air through supply air openings on the bottom and exhaust vents on the top of the facade or facade sections (e.g. only within one floor) and thus enables a constant exchange of air to transport moisture.

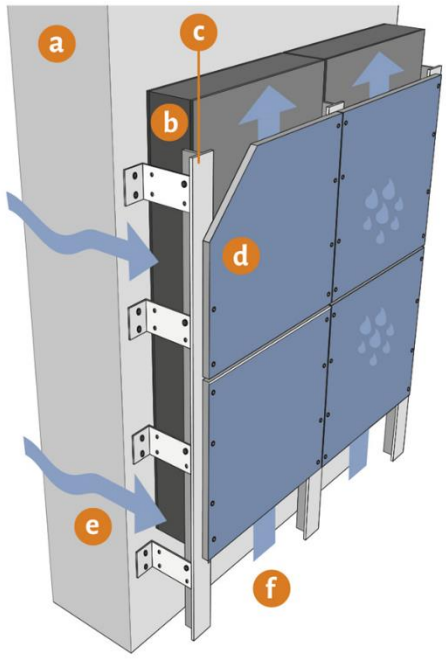

Figure 1: Rear-Ventilated System

a Facade b Insulation layer c Subconstruction d HPL–Compact

e Transportation moisture f Rear-ventilation

1.2 Fire scenarios on the facade

Actual fires as well as a great number of different lab fire tests prove that a fire spread over facades is a danger scenario authority have to deal with. A fire spread over facades may be caused by three types of fire events (see figure 2):

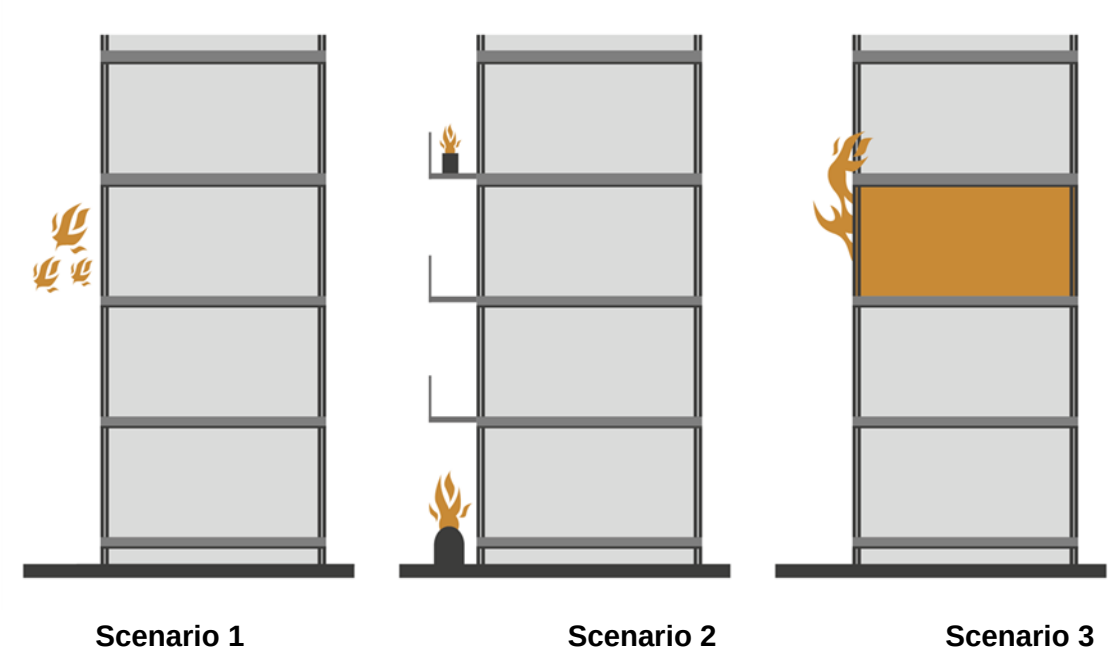

Figure 2: Fire scenarios in connections with facades (ÖFHF-Guideline)

Scenario 1: spread of an external fire onto facade by radiation from a neighbouring, separate building

Scenario 2: spread of an external fire onto facade from a source of fire located next to the facade (for example fire developed on a balcony or fire from a garbage can or a car parked near the facade)

Scenario 3: internal fire that has started in a room inside the building that spreads through openings in the facade (windows, doors, etc.) onto facade.

Considering the most common case, a room fire, it has been discovered that flames reaching the facade show lengths up to 5 metres above the edge of the opening (means two floors above the fire source), regardless of the facade system and the materials used. The flame length depends on the fire load, the size and the geometry of the windows. Subsequently, when the flames reach the outermost layer of the facade, the further propagation of the fire mainly depends on the properties and characteristics (material, geometry, etc.) of the facade itself. Therefore, among the main factors characterizing the fire spread over a facade, there are:

- reaction to fire class of the facade system materials
- presence of air spaces which are part of the facade system. If flames enter an air space, they may be extended from five to ten times its initial length, due to the chimney effect, regardless of

the properties of the materials. This effect can cause a fast vertical fire spread, “hidden” below the facade cladding;

Based on these general fire mechanisms certain requirements concerning fire protection of facades are defined.

2 Fire protection requirements

All over Europe the basic requirements concerning fire protection measures in facades follow the same general rules:

- requirements concerning the reaction-to-fire-classification of materials and/or systems
- requirements dealing with the effective restriction of fire spread over the facade
- requirements depend on the height of the building – the higher the building the stricter the requirements

Requirements are given in the national building codes of every single European country. No harmonized European building code exists!

2.1 Reaction-to-fire

More than 20 years ago, the fire classification standard EN 13501-1 for assessing the reaction-to-fire of construction products has been developed. It has been designed to test construction products in an easy and comparable way that also allows to test the product including mounting and fixing methods used in end use conditions.

Seven reaction-to-fire classes are defined (from best to worst): A1, A2, B, C, D, E and F. The classes characterize a products contribution to a fire, meaning that non-combustible materials of class A1 or A2 show no contribution, whereas products of class E deliver a significant contribution to a fire. Additional classifications for smoke production s1 to s3 and for flaming droplets/particles d0 to d2 are defined.

A classification report of an accredited testing institute is needed to prove the reaction-to-fire class of a construction product. Requirements differ a little bit all over Europe but one may come to the following common ground:

- Buildings up to 3 floors: minimum class D-d0
- Buildings from 3 to 6 floors: minimum class B-d0
- High-rise-buildings (definition also differs from 18 m to 25 m): minimum class A2

Due to the compact size of all the European reaction to fire-tests, the behaviour of full construction systems as well as the fire spread in facade fires may not be assessed which means that only requirements of reaction-to-fire-classes are not enough to ensure fire protection on facades fully.

2.2 Fire spread

To be able to evaluate this behaviour, national medium and large-scale facade fire tests are available. In these fire tests, the complete facade system including sub construction, insulation, air gap, cladding is tested. The test rigs all over Europe differ in the size of the fire load (wooden cribs 25 kg up to 600 kg or natural gas burners), the test period, the test specimen and the criteria (see figure 3).

Table 1a: Comparison of national facade fire test standards

Standard	**BS 8414-1**	**LEPIR II**	**M SZ 14800-6**	**SP FIRE 105**
Country	UK	F	H	S
Fire exposure	Wood crib, peak heat 3.5 MW, 4500 MJ	600 kg wood crib	380 kg wood crib / 10 kg Diesel oil	60 l heptane
Max. heat flux on surface	70 kW/m^2 at 1 m height	Not specified	Not specified	15 or 80 kW/m^2
Max. temperature on surface	600 °C / 20 min	Average 500 °C / peak 800 °C	600 °C 0,5 m high / 50 min	450 °C / 12 min
Test duration	30 min	min. 30 min	40 min	min. 12 min
Test specimen	Corner 2.5 m x 8.0 m + 1.5 m x 8.0 m	Flat Wall 3.0 m x 5.5 m	Flat Wall 6.0 m x 7.0 m	Flat Wall 4.0 m x 6.7 m
Substrate	Masonry or light frame	Any	Masonry	Aerated concrete
Criteria	Temp. limits	Flame on 2nd floor	Temp. rise, fire spread, falling parts	Flames 2 floor above, falling parts

Table 1b: Comparison of national facade fire test standards

Standard	**ÖNORM B 3800-5**	**DIN 4102-20**	**PN-90 / B-02867**	**ISO 13785-1**
Country	A	D	PL	CZ
Fire exposure	25 kg wood / 320 kW propane	25 kg wood / 320 kW propane	20 kg wood crib + wind towards the wall (2 m/s)	propane 100 kW
Max. heat flux on surface	Not specified	70-95 kW/m^2 in 1m Höhe	Not specified	Not specified
Max. temperature on surface	Not specified	Not specified	800 °C peak	max. 150 °C at 0.5 m height
Test duration	30 min	21 min gas, 30 min wood	30 min	30 min
Test specimen	Corner 3.0 m x 6.0 m + 1.5 m x 6.0 m	Corner 3.0 m x 5.2 m+ 2.0 m x 5.2 m	Flat Wall 2.3 m height	Corner 3.0 m x 5.7 m+ 1.2 m x 5.7 m
Substrate	Aerated concrete	Aerated concrete	Masonry	Any
Criteria	Temp. rise, fire spread, falling parts	Temp. rise, fire spread, falling parts	Temp. limits, burning particles	not included

Studying the national requirements for facade systems concerning the protection goal of an effective restriction of fire spread it becomes clear that all over Europe these national tests have to be positively completed to apply the system tested onto buildings with more than 3 floors.

3 Fire performance of HPL-products

3.1 Reaction-to-fire

HPL-panels with a minimum thickness of 6 mm usually reach class D-s2,d0 without any flame retardant. HPL-panels produced in a flame retardant version are usually classified B-s2,d0. This is the best class possible for this type of material. HPL-similar products with decorative surfaces and an anorganic, non-combustible core even reach class A2-s1,d0 according to the European classification scheme. Classification Reports for all three variants are known by the Testing Centre, Inspection and Certification Services of the City of Vienna.

3.2 Fire spread

Typical rear-ventilated systems consisting of:

- stone wool as insulation material
- a metal substructure
- a ventilation gap with no more than 60 mm width
- flame-retardant HPL-panels as cladding (minimum thickness 6 mm), mechanically fastened onto the substructure
- usually pass the medium and large scale tests given in table 1a-1b

Very often the system has to include additional structural fire protection measures such as horizontal fire barriers, non-combustible window reveals etc. to pass these tests.

4 Application of HPL-products in rear-ventilated facade systems

Merging chapter 3 and chapter 4 of this position paper leads to the following conclusions when applying HPL-panels as cladding of rear-ventilated facade systems.

4.1 Safe solutions

Yes, it is possible to construct safe (in terms of fire) rear-ventilated facade systems with claddings made of HPL-panels when considering the following conditions. The European harmonized reaction-to-fire-classification of flame retardant products gives the opportunity to apply the product on buildings up to

the high-rise limit. Special compositions that show an A2-classification may be used even in facades on high-rise-buildings.

Flame retardant HPL-boards are also able to withstand the fire scenarios given in national medium and large scale tests, often in connection with special fire protection measures like fire barriers. In all of the tests the authors have knowledge about no flaming droplets have been detected and no horizontal fire propagation has been observed. A fire spread from the cladding to surrounding objects or burning droplets causing secondary fires will not happen with a rear-ventilated facade made of HPL-panels as cladding.

Test reports of accredited testing institutes have to be submitted to prove the positive performance.

4.2 General conditions

A rear-ventilated facade made of fire retardant HPL-panels as cladding can therefore be considered as a safe facade solution in terms of fire properties described under the following conditions:

- strict observance of and adherence to the relevant European, national and local regulations
- the system built on the site has to correspond strictly to the products tested and classified which means for example the use of non-combustible mineral wool insulation.
- Further important parameters are the subconstruction, the dimension of the rear-ventilation air gap, the use of horizontal fire barriers, etc.

When designing and building facades these details have to be considered – built as tested! The person in charge of the building planning is responsible for the correct tender. HPL-panels have to be subjected to a continuous quality control according to EN 438 including the reaction-to-fire performance.