CEN TC129: Glass in building

Essential Characteristic:-

"Safety in case of fire – Reaction to fire"

Proposal by TC129 to modify the manner in which this Essential Characteristic is dealt with when certain glass products are to be classified

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Executive Summary

TC 129: Glass in building believes that the application of EN 13501-1: *Fire classification of construction products and building elements – Part 1: Classification using test data from reaction to fire tests* to the classification of glass products for the Essential Characteristic – 'Safety in case of fire – Reaction to fire' is inappropriate for the following reasons:

- It does not allow a manufacturer to claim "No Performance Determined" (NPD)
- For inhomogeneous products such as laminated glass /laminated safety glass and insulating glass units the highest classification possible is Euroclass B and this does not meet the expectation of the member state regulators.

We propose the following solution:

- Change Class F given in EN 13501-1 so that it no longer covers 'no performance criteria'. This will then allow the use of NPD.

- For glass products such as laminated glass/laminated safety glass and insulating glass units their classification for 'Safety in case of fire – Reaction to fire' be given as Euroclass A1 by Commission Decision. The condition being that *both outer components be glass that is classified class A1 by existing commission decision.*

1) Background

TC129 has investigated the situation with regards to glass products and their involvement in situations where the essential characteristic "Safety in case of fire - Reaction to fire" is a legislated requirement.

We have been unable to find any evidence that glass products have contributed to the spread of flames and /or acted as an ignition source in applications where such requirements, i.e. "Safety in case of fire – Reaction to fire", are laid down in member state regulations.

In fact we have evidence that glass products per see are regarded as inorganic materials that are not involved in contributing to the spread of flames and /or acting as an ignition source. Many member states have drafted their national regulations based on this property expectation, i.e. that glass products are incombustible etc.

Unfortunately to comply with their mandate, i.e. M135, CEN TC129 have been required to classify all the glass products, that are to have harmonized standards written, to the essential characteristic 'safety in case of fire – reaction to fire'. This has meant that the TC 129 has had to comply by the incorporation of EN 13501-1[1] into the harmonized product standards.

However, there are a group of glass products, i.e. annealed glass[2], thermally toughened[3], heat[4] and chemically[5] strengthened and coated[6] glasses, that do not require to be tested as their classification has been given by Commission Decision[7].

This leaves two major groups of glass products, i.e. laminated glass/laminated safety glass[8] and insulating glass units[9], which would require to be classified. Their classification would have to be undertaken using EN 13501-1.

2) EN 13501-1

2.1 Relationship with the Construction Products Directive (CPD)

The CPD allows a construction product manufacturer to declare "No Performance Determined" (NPD) in the following situations:

a. When he does not want to make a claim, i.e. sees no potential.

b. When there is no regulatory requirement for the specific Essential Characteristic in the member state where he wishes to place the product on the market.

[1] EN 13501-1:Fire classification of construction products and building elements – Part 1: Classification using test data from reaction to fire tests

[2] Annealed glass – products complying with EN 572-9, EN 1748-1-2, EN 1748-2-2, EN 14178-2, prEN 15681-2

[3] Thermally toughened products complying with EN 12150-2, EN 13024-2, EN 14179-2, EN 14321-2, prEN 15682-2

[4] Heat strengthened glass – products complying with EN 1863-2

[5] Chemically strengthened – products complying with EN 12337-2

[6] Coated glasses- products complying with EN 1096-4

[7] 96/603/EC Commission decision establishing the list of products belonging to classes A 'no contribution to fire' provided for in Decision 94/611/EC implementing Article 20 of Council Directive 89/106/ECC on construction products

[8] Laminated/laminated safety glass – products complying with EN 14449

[9] Insulating glass units – products complying with EN 1279-5

EN 13501-1 Clause 10.2 states the following:

> **10.2 Class F**
>
> No performance criteria.
>
> Class F also applies if a product fails to obtain Class E when tested to prEN ISO 11925-2

This means that a manufacturer can not declare 'NPD' but must declare 'Class F'. This will imply that it is a very poorly performing product.

We have information from a Member State (Germany) who do not have a 'Safety in case of fire – Reaction to fire' regulation and thus do not require a product with a declared Euroclass; hence 'NPD' would be sufficient. That their building law will not allow *any Class F products* to be used in building. Therefore the imposition of 'Euroclass F' rather than allowing a declaration of 'NPD' is a barrier to trade

2.2 Fundamental problem

EN 13501-1 has the following definitions:

> **3.1.4**
> **non-homogeneous product**
> product that does not satisfy the requirements of a homogeneous product. It is a product composed of one or more components, substantial and/or non-substantial
>
> **3.1.5**
> **substantial component**
> material that constitutes a significant part of a non-homogeneous product. A layer with a mass/unit area $\geq$ 1,0 kg/m_2 or a thickness $\geq$ 1,0 mm is considered to be a substantial component

As both laminated glass/laminated safety glass and insulating glass units are by EN 13501-1 definition non-homogeneous material and their organic components can be defined as substantial components this influences how the products have to be dealt with.

The desire of the manufacturer's is to obtain a classification that will enable the product to be used in the same locations and subject to the same legislative requirement as existed before the publication of EN 13501-1. This means that a Euroclass of A1 and possibly A2 would be necessary to maintain the status quo. Clauses 10.7 and 10.8 deal with how to satisfy the requirements for class A2 and A1 respectively. For non-homogeneous materials there is an initial requirement that relates to the 'gross calorific potential' (PCS) of the components as well as the product itself.

As both product groups contain organic components, i.e. interlayers in the case of laminated glass/laminated safety glass and edge seals in the case of insulating glass units, they would fail due to their PCS. Even though the glass components will have a PCS of zero this still means the product as a whole would fall below the requirement given in clauses 10.7 and 10.8. *This would ensure that the products can not be classified Euroclass A1 or A2.*

3) Presentation of problems

In order to understand the true problem of applying EN 13501-1 to laminated glass/laminated safety glass and insulating glass units a series of experiments have been undertaken. Detailed results have been supplied previously. This work has shown up severe anomalies:

1. The classification of laminated glass/laminated safety glass products can never be better than Euroclass B whatever the real behavior might be.

2. The use of plastic sheet interlayer(s) within "Fire Resistant Laminated Glasses[10]", i.e. laminated glass where at least one interlayer reacts to the high temperature to give the product its fire resistance, means that they could never obtain a better class than a Euroclass B.

3. The classification of laminated glass/laminated safety glass is dependent both on the thickness of the glass panes and the type and thickness of the interlayer(s). This will mean that changing the make-up for increased performance, e.g. resistance to larger explosions, higher security performances, etc., will modify the 'reaction to fire classification' and possibly its ability to be used in buildings. This will produce a contradiction between regulations relating to 'Safety in use', i.e. protection against explosion, burglary, accidental human impact, etc., and 'Safety in case of fire – Reaction to fire'.

4. The classification of insulating glass units is highly dependent on the geometry of the product, i.e. dimensions, proportions, components, which makes the CE marking declarations for these products impracticable. For a given composition, the reaction to fire will vary with the ratio perimeter / surface, which is not manageable for CE-marking.

The National Regulations are the responsibility of the member states (MS). There is no harmonization between MS regulations on 'Safety in case of fire - Reaction to fire'. In order to avoid market distortion and allow CE-marking to take place, we propose a harmonized approach/solution.

4) Glass product types

4.1 General

Glass product types under harmonized European standards when related to 'Safety in case of fire - Reaction to Fire' may be considered as two kinds.

[10] EN 12543-1: Glass in building – Laminated glass and laminated safety glass – Part 1: Definitions and description of component parts, clause 3.3

- Glass products types covered by EC decision and classified A1 without further testing. Glass products containing only glass belong to this kind (basic flat glass, heat and chemically treated glass, coated glass).

- Glass product types which do not fulfill the criteria of annex A of the EC Decision, e.g. products containing more than 1% organic part, have to be classified following EN 13501-1. Two important kinds of glass products to be considered here are laminated glass and insulating glass units.

Laminated glass as defined by harmonized European standard is made of glass panes bonded by interlayer(s). Laminated glass used as safety/security products make use of organic interlayers.

For safety glass the minimum standard configuration (0.38 mm) of the interlayer component is over the maximum value required to satisfy an A2 classification following EN 13501-1. Therefore all safety laminated glass product could not be given a higher classification than Euroclass B.

Special laminated glasses offering burglar or bullet resistance are used in jewelries or bank offices, and embassies frequently make use of anti-bullet and anti-explosion laminated glass. These products are usually imposed by insurance companies. These establishments may be located on the ground floor of public building, for which some countries impose an "A2 class" for the entire facade. The two requirements will contradict each other.

Application	Laminated type	Number of interlayers[11]	Foreseen classification
Usual safety (shock and glass fragments retention)	2 glass panes	1 or 2	B
Anti-intrusion, anti-bandits	2 or more glass panes	4 to 6	C, D
Anti-explosion	2 or more glass panes	4 to 6	C, D
Anti-bullet	Multi-panes	6 to 10	D

Table 1 – Type and composition of laminated glass types

Insulating glass unit is composed by two or three glass panes assembled with a metallic or organic spacer and sealed with an organic sealant. The later is usually around the peripheral and is generally 15 mm wide and 3 to 6 mm minimum thick.

Depending on the insulating glass dimensions (perimeter to surface ratio) ordinary insulating glass units without laminated glass commonly used on the European market may be classified differently from A2 to B which makes the CE marking declarations for these products impracticable. For safety raison a laminated glass may be integrated, replacing one glass pane of the insulating glass unit. In this case, classification would be similar to the laminated component.

[11] As explained in SH02 document numbered ER44, only the number of interlayers in front of the product should be taken into account

4.2 Glass product market in façade

Glass products are extensively used in buildings (façade and roof) as they contribute by a well balanced combination of thermal, lighting, safety/security properties to satisfy customer.

Light properties ensure a free contribution to lighting of offices and health feeling of customers. Performing thermal properties satisfy national regulations. Safety and security properties in case of shock, breakage, burglary or criminal attempt are recognized by insurance companies. In some countries these properties are imposed by national regulations.

Insulating glass unit today constitutes 56% of the overall European building glazing type stock[12] (see figure 1). The rest is still single glazing. This proportion will increase in the future in the frame of the EPBD[13] when considering that member states target for 2020 will be all public building in a "zero-energy" scheme.

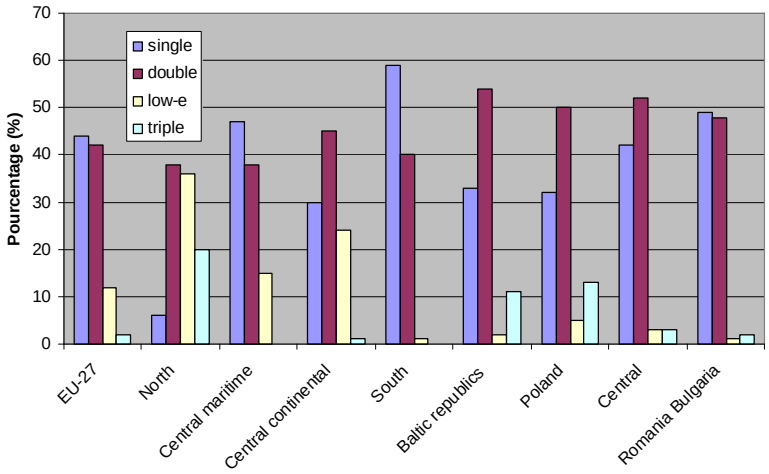

Figure 1 – Glazing type distribution in the European building stock.

Laminated glass represents around 20% of the glass products manufactured today[14]. About 20% of the manufactured insulating glass units contain a laminated glass. In commercial buildings, it may rise up to 30%. These values concern mainly the 2 glass component laminated products.

Laminated glass for security application (anti-intrusion, anti-bullet and anti-explosion), containing usually more than 2 glass panes and more PVB layers, represent less than 2%

[12] TNO report Glazing type distribution in the European building stock, TNO (Netherlands Organization for Applied Scientific Research), 2011
[13] EPBD – Energy performance of Buildings Directive
[14] See EUROSTAT at http://epp.eurostat.ec.europa.eu/portal/page/portal/prodcom/data/tables_excel Codes 23121270 (laminated glass) and 23111230 + 23111290 (float glass)

of the laminated glass market. Less than 1% is installed in façade, the remaining being installed inside the building (bank lockets, etc).

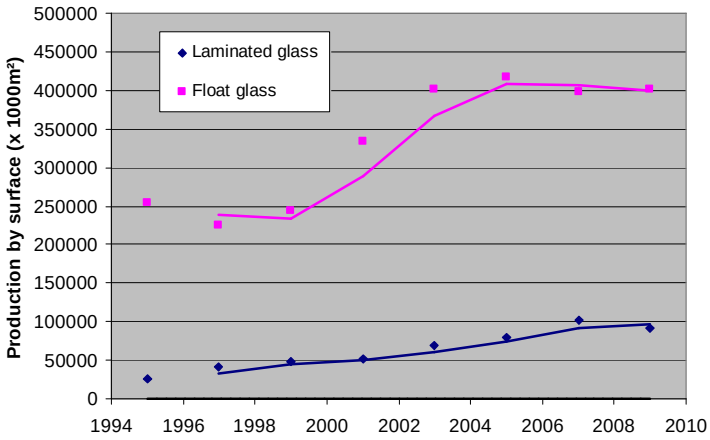

Figure 2 – European Production data for laminated and float glass (source: EUROSTAT)

4.3 Vertical windows and doors in facade

Glass product is usually mounted in façade using a framing system. In the harmonized standard for windows and doors, only roof windows need to declare the reaction to fire classification. It is tested with any kind of glass except laminated glass and the SBI mounting configuration has been modified by an amendment[15]. For vertical window and door no reaction to fire classification has to be declared. In this circumstance we question the requirement imposed to glass products. ***It seems meaningless to require a classification of glass products to be installed in windows framing systems if the product placed in the building (vertical window and door) is not classified itself.***

5. Fire behavior of Glass products

5.1 Description of a fire within a room

Fire in a room can be divided into various phases. The *incipient phase* or beginning of a fire is dependent on the size of the ignition source and the properties of the materials and objects that are directly affected.

During the *growth phase* the fire increases in size and other objects around the fire origin will begin to burn. Even the surface linings of the walls, floor and ceiling close to the fire can ignite. Increasing amounts of smoke and heat begin to develop and a layer of hot fire gases forms beneath the ceiling. In the growth phase the fire is local. The fire characteristics of the surface linings play an important part in the fire development.

[15] EN 14351-1:A1:2010

During the growth phase *flashover* can occur. This is when the intensity of the fire is so great that it ceases to remain local but involves all combustible material in the room. A large amount of heat is released and flames burst out through windows and door openings. Generally, flashover occurs once the fire gases in the room reach 500- 600°C. The heat radiation from the layer of fire gases is so great at this stage that it causes all combustible materials to ignite. Flashover can occur just a few minutes after ignition. However, it can also be delayed or avoided altogether. This could be the case in a room which has just a small amount of combustible furnishings and is equipped with surface linings that make just a negligible contribution to the fire development.

After flashover the fire reaches its *maximum level* and is fully developed. The length and intensity of the fire is now mainly determined by the supply of air and the fire load, i.e. the amount of combustible materials present. The decay phase is when the fire fades out. At the point of flashover the entire room is engulfed by the fire and large flames burst out from door and window openings. The fire can now spread to other parts of the building.

Insulating glass unit and the most popular laminated glass used in façade may probably obtain a Euroclass B. The reaction to fire of Euroclass A2 and B are the same as regards to fire growth rate, total heat release within 600 sec, smoke production and flaming droplets and lateral flame spread. ***These glass products have a 'Safety in case of fire – Reaction to fire' behavior similar to the class A2 incombustible materials.***

This explains why member states require high level of reaction to fire classification as glass products are known as being not contributive to Fire. United Kingdom considers possibility to "grand-father" a national deemed-to-satisfy status. Germany has already accepted such a decision for insulating glass units[16].

Laminated glass product and insulating glass unit are used on the European market for years. These products were never recorded as contributing to start or develop fire[17].

5.2 Fire scenario for facades

Fire façade testing[18] or calculation models[19] are intended to simulate the case of a large fire attack of façade from for example a flashover fire in an apartment (compartment) shooting out flames through windows.

Windows and doors in the walls of a compartment are the only way that oxygen may come up. Annealed glass will be broken by thermal breakage around 100-120°C,

[16] DIBT opinion expressed in a letter to Bundesverband Flachglas e. V. in March 2009

[17] *A profile of Fire in the United States 1995-2004*, FEMA 2008, 13th edition, U.S. Fire Administration / National Fire Data Center (see causes of fires and fire losses) and *Consumer fire safety: European statistics and potential fire safety measures*, Nibra, Netherlands Institute for Safety, 2009 (see p.16 to 26: causes of fires; p. 26: first material involved in domestic fire; p. 28: factor of fire speed; p.29: factor of smoke development)

[18] ISO 13785-2 large scale test

[19] For example Law and O'Brien model for steel structures. *Eurocode EN 1991-2-2: Eurocode 1. Basis of design and actions on structures. Part 2.2: Actions on structures. Actions on structures exposed to fire*

tempered glass around 250°C, allowing fire to grow without delay. When the temperature reaches 500-600°C the entire compartment will suddenly burst out in flames often causing shockwaves which cause the remaining glass to fall out of the window frame[20].

The amount of air getting in to the compartment depends on the area of the windows, type of glazing and the fire load. If the area of windows is small or the glazing partially broken (laminated glass) it is called a ventilation restricted fire. With ample ventilation it is called a free burning fire.

A restricted burning rate doesn't mean that the fire is easier to control or less dangerous. In this case combustible gas generated by pyrolyse of materials, because of the pressure in the compartment, will go out through broken windows and burn as soon as they reach the outside. These large flames can for instance cause fire spread to the next floor. Lack of oxygen means also that the burning rate will decrease, but the fire will last longer.

If the compartment is well ventilated a free burning fire occurs. In this case almost all combustible material burns and "in theory" no flames emerge from the windows, but only smoke does. In this case we should avoid the fire becoming large, which is more dangerous to occupants and fire service personnel, and we should also avoid the rapid spread of fire within the building (from one compartment to the others) which could trap occupants in the building.

The amount of ventilation of a fire compartment influences the extent of the flames coming out of the windows. Their geometry may be calculated from models and used in a "natural fire safety concept"[21]. Models make use of a compartment in post flashover conditions. In this case, windows are supposed to be open (all glazing broken) and a free fire or a ventilation controlled fire will occur. In fire engineering, windows with laminated glass are considered as semi-openings, as well as glazing with a height equal to the height of the wall. These models take also into account glazing with a fire rating (resistant to fire) where integrity of the glazing is insured during 30, 60 or 120 min.

In these models, it doesn't matter if the glass is annealed, tempered or laminated. The key point is that they assume all building glazings are the same. Those engineers should be aware of the type of glass used for implementation in the fire model of the building. Their only concern with glass is the fact that it breaks

[20] Koudijs J.T., van de Leur P.H.E., *Annealed, tempered or laminated? Your choice can influence fire safety!* GPD conference proceedings 2007

[21] *Rational Fire safety engineering approach to fire resistance of buildings*, CIB report 2001, n° 269, p.16; CIB is the International Council for Research and Innovation in Building and Construction.

6. Proposal

Our proposal is to cover all **glass products having two external glass surfaces** by an EC **"deemed to satisfy"** decision.

"Two external glass surfaces" means that laminated glass and IGU's containing organic components inside the composition or in the edges are included.

However, laminated glass where the last component is a plastics glazing sheet material (Polycarbonate, for instance) is excluded.

Such a European decision could be similar to the decision 96/603/EC, classifying the glass products containing less then 1% organic matter as class A1.

This procedure called "deemed to satisfy" could be decided when a product, or a family of products, is accepted by the European market without restriction but encounters problems to pass the pertinent EN tests/classification. **This harmonized solution should take the form of an extension of the EC decision 96/603/EC, amended by EC Decision 2000/605/EC, to all glass products used today in building**.

Bibliography

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EN 1096 – 4: *Glass in building – Coated glass – Part 4: Evaluation of conformity/Product standard*
EN 1279 – 5: *Glass in building – Insulating glass units – Part 5: Evaluation of conformity/Product standard*
EN 1748-1-2: *Glass in building – Special basic products – Borosilicate glass products - Part 2: Evaluation of conformity/Product standard*
EN 1748-2-1: *Glass in building – Special basic products – Glass ceramics - Part 2: Evaluation of conformity/Product standard*
EN 1863 - 2: *Glass in building – Heat strengthened soda lime silicate glass – Part 2: Evaluation of conformity/Product standard*
EN 12150 – 2: *Glass in building – Thermally toughened soda lime silicate safety glass – Part 2: Evaluation of conformity/Product standard*
EN 12337 – 2: *Glass in building – Chemically strengthened soda lime silicate glass – Part 2: Evaluation of conformity/Product standard*
EN 13024 – 2: *Glass in building – Basic soda lime silicate glass products – Part 9: Evaluation of conformity/Product standard*
EN 14178 – 2: *Glass in building – Basic alkaline earth silicate glass products – Part 2: Evaluation of conformity/Product standard*
EN 14179 - 2: *Glass in building – Heat soaked thermally toughened soda lime silicate safety glass – Part 2: Evaluation of conformity/Product standard*
EN 14321 – 2: *Glass in building – Thermally toughened alkaline earth silicate safety glass – Part 2: Evaluation of conformity/Product standard*
EN 14449: *Glass in building – Laminated glass and laminated safety glass – Evaluation of conformity/Product standard*
prEN 15681 – 2: *Glass in building – Basic alumino silicate glass products – Part2: Evaluation of conformity/Product standard*
prEN 15682 – 2: *Glass in building – Heat soaked thermally toughened alkaline earth silicate safety glass – Part 2: Evaluation of conformity/Product standard*

EN ISO 12543: Parts 1 to 6: *Glass in building – Laminated glass and laminated safety glass*

EN 13501-1: Fire classification of construction products and building elements – Part 1: Classification using test data from reaction to fire tests
EN 14351 – 1: Windows and doors – Product standard, performance characteristics – Part 1: Windows and external doorsets without resistance to fire and/or smoke leakage characteristics
ISO 13785 – 2: Reaction to fire tests for façades – Part 2: Large-scale tests