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# INTERNATIONAL FIRE PROTECTION


THE GLOBAL VOICE FOR PASSIVE & ACTIVE FIRE PROTECTION

# Progress with fire-resistant glass

## Limiting risk, reducing uncertainty

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Glass is such a common and familiar material in today's architecture that there is a risk that too much is taken for granted concerning its behaviour in fire. Glass architecture and design practice continue to advance by leaps and bounds; each new iconic building that goes up seems to lead with another structural innovation. Fire-resistant glass, and the understanding of glass in fire, have also advanced in parallel, influenced by the trend to open building design in the shadow of the threat from fire to an increasingly complex congested built environment. It is important that those advances are given full recognition.

### Myth and mystique

Some assumptions are simply not justified given the fundamental nature of glass. For example, higher impact strength (e.g. as toughened glass) is sometimes implicitly taken generically to mean strength in fire. Not so – the two are different and governed by entirely different factors. Equally, standard annealed glass and double glazed units are too often erroneously assumed to provide an acceptable degree of resilience. Single glazing easily cracks in fire and a double glazed unit shows consistent integrity failure in tests after only a few minutes exposure. A too literal interpretation of the terms "safety and security" applied to glass products may also lead to misconceptions. Products in this category, for example laminates based on plastic organic interlayers, fail catastrophically in fire after glass cracking followed by smoking, with dripping of the hot liquid interlayer and flaming.

Glass is not a material with inherent resilience against fire. To have any practical and significant fire resistance, especially against various fire scenarios, requires a special and robust fire-resistant technology.

### Regulations

Countries the world over recognise the importance of making provision for fire safety in their country regulations governing buildings, design, and construction. Some may have well established regulations over more than fifty years, others may

only just be developing up-to-date guidance. In all cases, the applicable regulations are influenced by local tradition, custom and practice, stimulated in particular by significant landmark fire events.

The ways of making fire safety provisions, and the recommended guidance, varies, but the underpinning principles remain the same. The first priority is safety of the occupants and sure protection for firefighters. Second comes protection of the property and assets, an increasing need since fire can have tremendous economic impact on local communities, through its affect on jobs, businesses and public buildings such as hospitals, residential homes for the elderly, and schools. Fire does not only have a human dimension. There are economic, social, and environmental aspects as well. There are good reasons for wanting good fire safety regulation, and especially appropriate enforcement.

### Specifying fire resistance

Given the complexities of fire and the various possible fire safety objectives, it is not sufficient to simply specify "fire resistance". Fire resistance has to be defined. Standards commonly recognise two basic classifications, which for any qualifying product must be checked by test in a specified fire-resistant system. These categories are a) integrity, i.e. acting merely as a physical barrier to simply hold back flames and hot gases, and b) insulation, which requires integrity plus the ability to prevent significant heat transfer from the fire and flames (by all mechanisms: radiation, conduction, convection). Similarly, the general term "fire protection" can also cause confusion and misconception, especially between fire resistance and fire retardancy. The fire retardant property applies entirely separately to spread of flame and the ability of a material to sustain burning.

Intermediate fire resistance options may also only serve to blur distinctions. An example is the European class EW which allows classification up to a measured radiant heat level of 15kW/sqm at 1 metre distance. Only one country in Europe uses this class in its regulations. In fact 15kW/sqm is a high level of radiant heat – readily understandable if it is remembered as being equivalent to around 15 times the maximum sun's intensity at mid summer on the earth's surface, capable of causing serious burns in a fraction of minutes. The limit to protect people is 2.5 kW/sqm, i.e. insulation performance.

One of the reasons for the 15 kW/sqm provision in the classification scheme is a presumption that this generally limits the risk of ignition on the non-fire side. This may be the case for some materials, but not necessarily all. But what the 15 kW/sqm level hardly limits is the risk of smouldering combustion on the non fire side (without flaming), generating smoke in the protected zone. And it is smoke and fumes which cause many deaths in fire.

### Critical importance of insulation

Because heat is one of the most dangerous aspects of fire, integrity with limited or no ability to attenuate heat has restricted application. That is, for example, before the fire conditions become untenable, i.e. in the early stages of escape within the first minutes of the fire alarm being sounded, or for smoke screens in the absence of flames.

In contrast, insulation plus integrity has the ability to provide far more robust fire protection over time, also providing excellent protection against heat which may otherwise cause serious life-threatening burns. Insulation performance may therefore offer particular advantages for enhanced life safety (especially for vulnerable groups) as well as benefits in limiting fire spread by secondary ignition on the protected side of the glazing.

## Confidence in performance

One of the most important questions facing specifiers and designers concerning fire is product reliability. Does the product performance in a test reflect likely performance in a fire? Does a pass in one test mean a pass should the test be repeated? Does an individual furnace test reflect routine production quality, or is it a special quality?

The main purpose of testing is to allow product classification. The test is formulised to represent a standard, fixed fire condition. Yet in practice there is no "standard" fire: fire is essentially unpredictable and variable with infinite capacity to surprise. Chance circumstance may determine outcome in a way that cannot be foreseen at design.

A single fire test, it should be remembered, only provides information on the system as provided and tested on the day of the test, as installed on that day. Installations should replicate the original tested specification. A single test simply allows classification, and only provides an indication of tendency. Important considerations that allow better judgment on risks in real fires are not recorded nor offered, for example a description of the change mechanism under fire exposure. If wider assurance and confidence in the level of performance is sought then the wider picture needs to be obtained. That evaluation should include the fundamental characteristics of the particular fire-resistant glass technology being used.

## Pointers to reliability

The first point of reference is the test record – not only the extent of testing and success rate, but also if test failures are experienced and why. The range and number of test approvals is a significant guide: different applications and situations, number of framing options, the complexity of the glazing arrays, and the size of the glazing panels tested are all useful indicators. It is valid to ask how many approvals have been gained, in how many different test laboratories under different testing regimes, as well as the number, range and variety of systems that have successfully gained official test approval. Additional product certification – e.g. international and national marks, such as CE marking, UL approval, and third party schemes – are also useful indicators.

It's the responsibility of manufacturers to take all measures that they can to check the fitness for purpose of their products. A basically sound and robust fire-resistant glass technology is needed, that can respond in real fire situations to the unpredictable challenges set by fire. Not all fire-resistant glass technologies may measure up to this criterion. Internal checks and control processes are also important.

The governing attitude should be "test, test and test again," not only in official tests but also by the discipline of internal furnace testing and product control. For example, Pilkington operates four full size furnace test facilities in regular use, with facility to evaluate both oil and gas firing, including the capability to test elements up to size 4m by 4m.

## Natural selection

One of the most important considerations in evaluating risk in a fire is to understand the mode and mechanism of failure under fire exposure. The necessary level of confidence in a product can only come from a good pedigree of furnace testing, as diverse and varied as possible, together with an open explanation of the mechanism of deterioration in fire together with explanation of the fundamental strengths of the technology that counterbalance that mechanism. For example, there is a world of difference between catastrophic, unpredictable failure (which is essentially an unreliable failure mode, e.g. as characteristic of toughened glass in fire), and one that is based on gradual and progressive deterioration, which is predictable and therefore controllable through product design (e.g. as applies to intumescent sodium silicate based laminated fire-resistant technology, as used and extensively tested over many years in the first of this type Pilkington **Pyrostop**® and Pilkington **Pyrodur**®).

All materials, sooner or later, fail in fire. The product that recognises that, and adjusts accordingly in its underlying technology and design, is the one that provides the natural choice for security and peace of mind.

## Range of application

The use of fire-resistant glass is now extensive, providing plenty of options. Interior applications include vision panels, full glass doors and doorsets, large area glazed partitions or separating walls, and privacy glazing with integral blind systems. Even some fire-resistant glazed sliding door systems are available. For the older heritage building, secondary fire-resistant glazing systems may be appropriate to provide the fire protection function whilst preserving the character of the original casements. The widespread use of atria in designs has also led to some interesting fire-resistant solutions, especially in the side glazing for major atria to prevent fire break out from the adjoining rooms looking out into the atrium. The latest innovation is integral load-bearing fire-resistant glass floors in one composite structure – which critically require insulation fire-resistant glass to limit heat transfer into the structure and preserve structural stability.

External applications include not only the vertical façade elements to minimise the risk of fire transfer to adjacent buildings or escape ways, but also composite overhead glazings for horizontal or inclined roof applications to allow the maximum light penetration into the building, also fulfilling the safety requirements for overhead. The designer now has many available options to realise innovative and open design without compromising fire safety (whilst providing other critical functions such as energy efficiency, security and acoustic comfort). One of the most important and growing applications is the use of external fire-resistant glazing to prevent fire movement outside the building, since break out followed by break in on adjacent levels is especially one of the most sensitive fire risks for the tall and complex buildings that now dominate city skylines.

## The future: risk and intelligent design

The risk-based approach to fire safety design is becoming more popular as an alternative to prescription. Complex and individual building designs call for fire safety design tailored to suit the building's occupancy profile, performance specification and layout. If prescriptive regulatory guidance is to be sidelined more and more by expert judgment and functional design then it is even more critical that products and technologies are clearly understood.

Fire-resistant glass cannot be treated generically. And relying just on a single fire test, or a limited range, is not enough. Each fire-resistant glass needs to be evaluated on its own merits. Risk can only be properly evaluated, and related to real fire conditions, if the failure mode is taken into account in specification decision making. That means using a robust and resilient fire-resistant glass technology, one that has an inherently reliable and repeatable function. If seeking to limit risk and minimise uncertainty in real fires is the way forward, then there needs to be a greater focus on behaviour under real fire conditions and less of a tendency to take products just at face value. IFP