At the sharp end of fire resistant glazing

Specifying fire resistant glazing systems can be an opaque process, Ann-Marie Knegt learned. A long list of requirements have to be fulfilled before achieving safety and fire resistance.

The specification and installation of fire resistant glazing systems can potentially bring up a whole load of pitfalls. One of the most common mistakes made in practice is that people choose the wrong performance specification for the application. Fire resistant glass can be classified into two groups: integrity glass and insulation glass.

Integrity glass is solely tested on its barrier performance to physically hold back flames and hot gases usually for classification times of 30, 60, or 90 minutes.

Insulation glass should offer increased protection against transmitted heat (including radiation, conduction and convection) as well as creating an integrity fire barrier.

In the same way as integrity glass, insulation glass performance is classified by testing for a number of standard time periods – eg 30, 60 90, 120, and even 180 minutes.

While basic integrity glass stays clear during fire, enhanced integrity glass and insulation glass consists of layers which cut down transmitted heat levels, such as an intumescent substance (which foams and expands when exposed to fire) sandwiched between layers of glass. Generally speaking, the more layers the manufacturer puts in the glass, the higher the fire resistant performance will be.

Mike Wood, Global Consultant for Pilkington and Chair of the Fire Resistant Glazing Group of the Glass and Glazing Federation explains that fire resistance may not be specified at all, or that integrity glass is specified where protection of the building really requires insulation glass.

Avoiding assumptions

"There tends to be a lack of knowledge about fire resistant glazing with designers and specifiers – not surprisingly as the subject does tend to be quite complicated. But assumptions may be made that could cost lives and money. Building users, designers and specifiers need to understand that you cannot tie fire down in a neatly defined package," says Wood.

He points out that there is not necessarily a direct correlation between fire test performance and the duration of resistance in a real fire. According to Wood the test provides classification of the product and gives an indication of the direction of performance but cannot match completely what will happen to the glass in the building because there is uncertainty about events and the intensity of the fire exposure.

The third issue he points out is that building regulations around the world substantially focus on life safety and tend to neglect the needs of property protection and the wider economic impact of fire.

Wood continues, "The fundamental fact is people can leave the building within 30 minutes before the conditions become untenable, but the building itself cannot run away. It may be exposed to fire for hours. In many cases designing for life safety does not necessarily give a full level of property protection. Designers need to be aware of both these objectives and to what degree additional provision needs to be made for protection of the property."

Designing for fire safety should not only include easy movement, rapid response and prevention of smoke movement, but also measures for protecting the building from a fully developed fire.

In high-risk and high-value applications the protection of property is becoming more prevalent, calling for additional measures beyond life safety.

With this issue in mind, Wood adds that fire resistant glass does not work on its own, but only as part of an engineered glazed system which includes frame, seal, beads, the fixing of the beads into the frame and the fixing of the frame into the surrounding structure.

"A system should always be installed as tested," he continues. "The specifier should try to keep the installation process under strict control. There is such a wide range of performances out there, that no two glazings are the same, and further down the line the temptation exists to use cheaper uncertified and unapproved elements . Pilkington sees it as a concern for the industry that the design cannot exert sufficient control down the specify-and-build chain."

Wood emphasizes the need to understand at specification level what the required fire glazed system performance is, given the application. Fire resistant glazing systems are all different and fulfil different functions. "Fitness for purpose is key. People ought to

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More than 3,000 m2 of Pyrodur and Pyrostop are installed in the internal facade of Dusseldorf Airport's main hall.

ask the manufacturer more about the product in order to understand the mode of failure," he explains, "as this determines to a major degree the level of endurance that may apply in practice under fire conditions."

Pilkington's most popular fire resistant glazing systems include the clear glass types Pyrostop, Pyrodur and the wired glass Pyroshield. The Pilkington clear fire resistant range is based on special laminated glass. Because of the fundamental robustness of the technology, it can respond consistently to a variety of fire conditions. According to Wood there are potential disadvantages in using modified toughened glazing systems for fire protection applications, unless special precautions are taken.

"Modified toughened glass can break catastrophically when the conditions are unfavourable, destroying the glass pane in an instant."

This mode of failure, which carries a risk of exposure to fire, means that the system can be more unpredictable and uncontrollable under some conditions than others. "On the other hand, Pilkington's products have a gradual, progressive mode of deterioration in a fire which means that the performance in real fires is more predictable without the risk of such catastrophic exposure."

Integrity glass types are not designed primarily to stop heat, although some will attenuate radiation and others may actually achieve 15 minutes insulation. In the case of clear glass, some of the incident radiation goes straight through, and part is absorbed by the glass causing a hot surface on the protected side. This heat is re-radiated, which when combined with the directly transmitted component can cause relatively high heat levels for people and light materials. The other effect is that the air in the protected corridor is heated by convection, creating a hot atmosphere in addition to the potentially high levels of radiation which are present. This means that when certain types of integrity glass are used in the wrong place or situation then life safety may be endangered.

The way to stop this process is to create an opaque barrier. In insulating glass the intumescent barrier turns into foam, which reduces conduction, convection and radiation, meaning that the surface temperature of the glass will be lower.

By changing from transparent to opaque, radiant heat is blocked out and the foamed interlayer offers a high degree of insulation.

Pyroshield is a wired, transparent integrity-only glass, which is very effective as an integrity barrier, says Wood. "It stays effective up to temperatures when the glass starts to soften. The wire makes it a very robust product, for example even successfully resisting the US hose stream test. Pyrodur and Pyrostop are based on special proprietary insulation technology and both are based on the same interlayer system, which is over 30-years old. The intumescent interlayer we use is not liquid but made from hard material," he explains.

Wood believes that both systems have good optical stability while offering the best of intumescent (expanding) technology.

The main differences between the two products is that Pyrodur (integrity with certain degree of insulation) is thinner and uses only one or two intumescent interlayers (30 min, 60 min certification) whilst Pyrostop (insulation) has three or more interlayers and can be manufactured – by duplicating the sandwich structure – for applications that require even a 180-minute rating. Pyrostop has also been used in high performing loadbearing fire resistant glass floors and high specification applications requiring special test approval such as for the Reichstag building in Berlin.

Pyrostop could also be used in the type of applications where a higher performance level is required, such as in industrial control rooms or in other high-risk applications (eg petrochemical and oil applications).

Wood explains that the gap between life safety and protection of an industrial facility could be said to be much smaller because of the higher risk environments and the high strategic value of main industrial processes where the requirements of property protection may be high. "The basic requirements of building regulations will not even nearly satisfy the requirements for high risk applications. I think it is an important message to bring across to designers that understanding the way glass performs becomes even more critical in demanding applications and that there is always scope for increased understanding and dialogue," concludes Wood.

"Modified toughened glass can withstand heat better as well as being stronger than laminated glass. In most cases nickel sulphide is seen as the cause of exploding glass in hot conditions, therefore we put the glass through a heat soaking process, which helps in the removal of nickel sulphide inclusions."

Andy Lake

UK Sales Manager Vetrotech Saint Gobain

Table of the European classification scheme for fire resistant glazing systems.

CEN product classification scheme for fire-resistance(ref. BS EN 13501-2:2003)

E	*15 t*	*20 T*	*30*	*45 t*	*60*	*90*	*120*	*180 t*	*240 t*
EW		*20*	*30*		*60*	*90 T*	*120 T*		
EI	*15*	*20*	*30*	*45*	*60*	*90*	*120*	*180*	*240*

t = only for doors T = only for partitions

E = *integrity*
(No hot gases and sustained flaming on the protected side)

W = *limited transmittance of radiant heat*
(Measured radiant heat for the tested size < 15 kWm^{-2})

I = *thermal insulation*
($T_{surface}$ -$T_{ambient}$ < 140°C average or 180°C individual maximum)

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Vetrotech products are an excellent example of the materials expertise Saint-Gobain brings to the architectural glass market.

Photo: Skuespilhuset Copenhagen. Architects: Lundgaard & Tranberg

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Size matters

According to Andy Lake, UK Sales Manager for fire resistant glazing manufacturer Vetrotech Saint Gobain, the most common mistake made by designers is that they tend to assume that fire-rated glass can be specified in the same sizes as normal glass.

"This is unfortunately not true. Fire resistant glazing systems can only be specified to the sizes that have been fire tested, usually meaning that fire resistant glass panes are smaller. We test the largest pane sizes possible but in many cases architects over specify. This can make things difficult as often the exact fire rating required is not known," he explains.

Lake agrees with Wood that there is a lack of knowledge in the industry and therefore Vetrotech Saint-Gobain offers detailed product guides and organises training sessions, explaining the differences between integrity-only and insulating glass.

Lake explains that a 30 minute fire rating is the most common. However, a common mistake made is the assumption that a 30 minute glass can be used for any application.

"In addition a glass product is only as good as the system it is glazed into. We therefore supply our glass with strong recommendations about framing and fixings, because without being glazed into a suitable framing system the glass is worthless."

Like Wood, Lake wants his to clients to choose the right glass product.

"As integrity-only glass allows the passage of radiated heat through to the non-fire side, anything on the other side will spontaneously combust, or occupants trying to escape a building could suffer serious burns. It is up to us to educate customers and specifiers about making the right choices, and in many cases this choice involves the use of insulating glass because it will not only prevent the spread of fire and keep it contained, but dramatically reduces the transfer of radiated heat and therefore saves lives."

Vetrotech developed Contraflam specifically for high-risk applications. It is glazed into a fully framed system available in various fire ratings from EI30 to EI120. It consists of layers of modified toughened glass and intumescent gel.

Responding to Wood's argument that toughened glazing systems explode in unfavourable conditions, his answer is straight. "Modified toughened glass can withstand heat better as well as being stronger than laminated glass. In most cases nickel sulphide is seen as the cause of exploding glass in hot conditions, therefore we put the glass through a heat soaking process, which helps in the removal of nickel sulphide inclusions."

Vetrotech chooses to work with this product because it is much stronger and because laminated glass breaks and cracks easily. He adds that Contraflam is Vetrotech's top seller and that most of his customers prefer modified toughened glass because it can be used in more applications as it is so robust.

Regardless of this, Lake points out, it is the intumescent gel between the layers of modified toughened glass that affects the fire rating. When the Contraflam is exposed to four or five minutes of fire, the exposed glass layer breaks, therefore allowing the gel to be activated. As the inside pane falls away the gel starts to foam, but because there is significantly reduced transfer of heat through to the non-exposed pane it does not break.

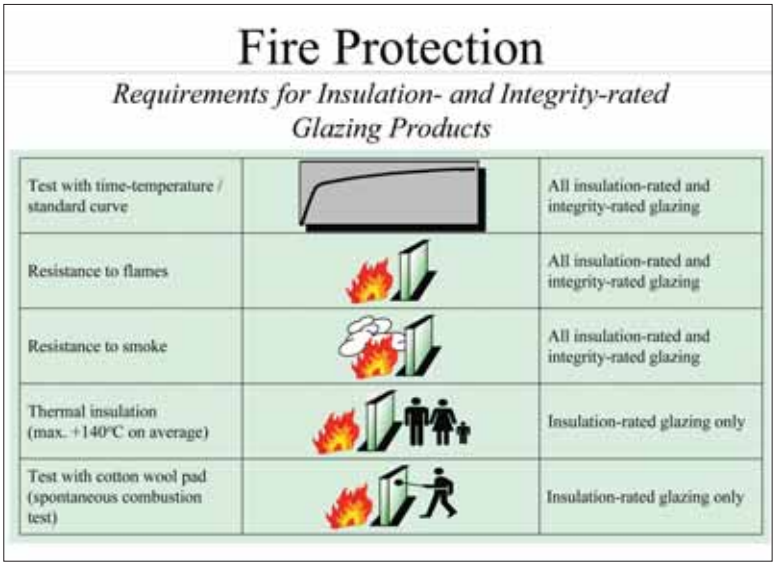
Lake explains that the glass will remain in place for the number of minutes the glass is certified to, and quite often more. In Vetrotech's case, this means that every layer of gel in the Contraflam product will offer protection equivalent to 30 minutes of insulation.

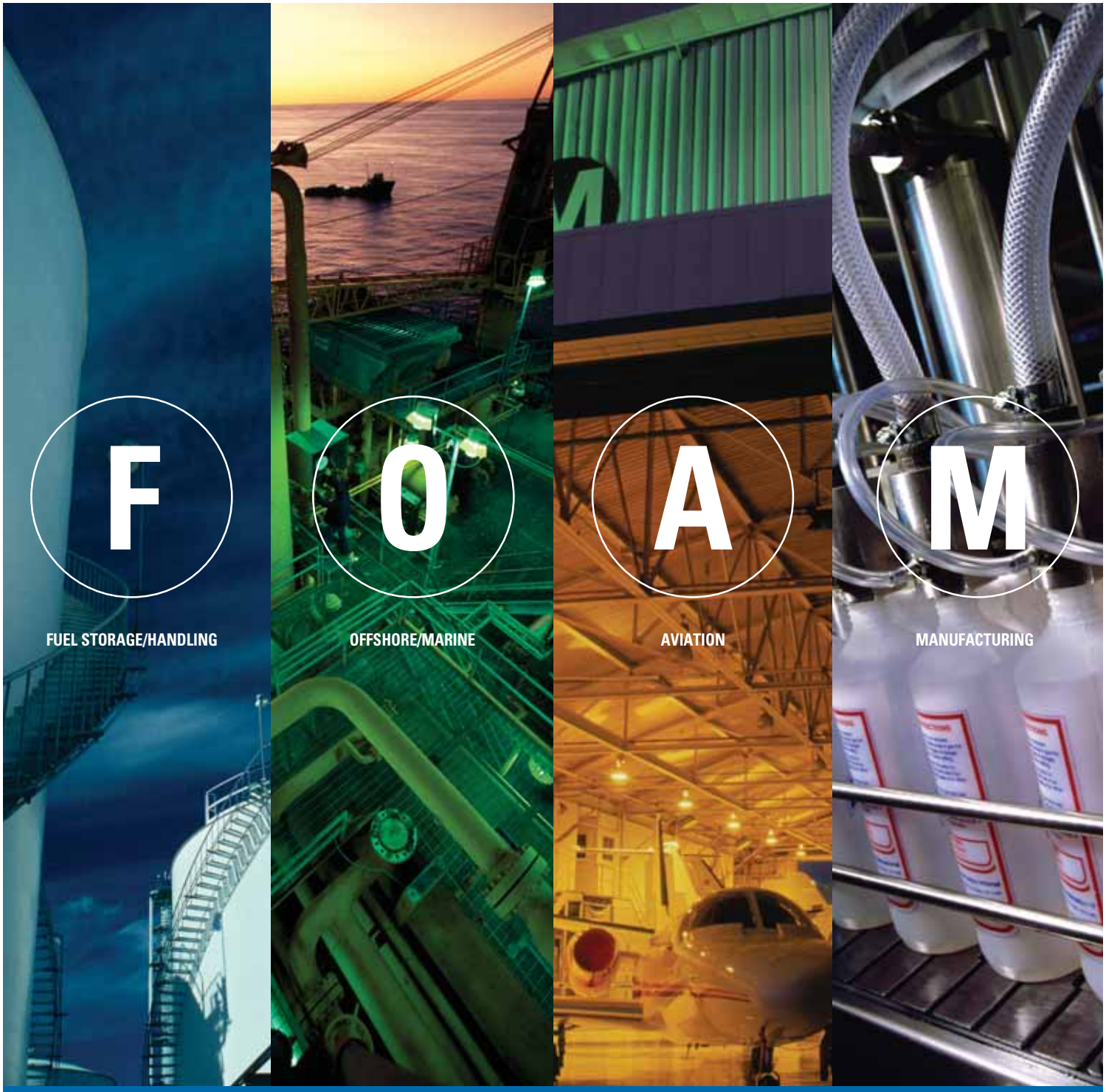
Vetrotech manufactures an extensive range of fire resistant glass products and all are certified according to British and European safety standards. The latest product launched by the company is Contraflam Structure, which is set within a perimeter frame and allows the architect to create large expanses of glass by joining panes with silicone joints.

Lake explains that using this butt jointed system gives the architect the "feel good factor" in specifying a glass that allows a light an airy feel in a building. Contraflam Structure has been tested to large pane sizes 1.8 metre wide x 3.5 metres high. Also, fire ratings EW30, EI30, EI60 & EI120 can all be achieved using this butt jointed system.

Vetrotech's Contraflam was used in the prestigious 'Le Centorial' project in Paris, designed by Jean-Jacques Ory.

European test requirements for fire resistant glazing systems.





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