# Not All Insulation is the Same...

## Fire Test Certification & Real Fire Case Studies

Introducing our new hybrid insulation core for superior fire protection

POWERED BY QuadCore™ TECHNOLOGY

Kingspan®

"We have pushed the boundaries of building envelope technology for decades. Our insulation systems feature the world's most advanced closed-cell insulation cores, such as Kooltherm™ for insulation boards and ECO*safe* PIR for insulated panels. The recent introduction of QuadCore™ Technology takes the performance of insulated panel systems to an even higher level, delivering the best thermal efficiency, a 40 year thermal and structural guarantee, enhanced environmental credentials and superior fire protection performance."

Gene M. Murtagh, Chief Executive Officer, Kingspan Group.

### The Group comprises five divisions:

- **Insulated Panels;**
- **Insulation;**
- **Light + Air;**
- **Environmental; and**
- **Access Floors.**

Kingspan Insulated Panels is a global leader in the design, development and delivery of advanced building envelope products and solutions. It is widely recognised in the industry for the high quality and performance of its products as well as its commitment to excellent customer service and technical support.

Our product portfolio includes Insulated Roof & Wall Panels; Fabrications, Safety & Lighting Solutions; Controlled Environments; Rooftop Solar PV; BENCHMARK high-end Façade & Roof Systems; Standing Seam Systems; Structural Products & Systems; Steel Building Solutions and Insulated Door Components.

Our wide range of products allows developers, architects and contractors to meet and exceed today's construction challenges and create functional buildings that are aesthetically pleasing, energy efficient, safe, cost-effective and sustainable.

### Global Presence

Today the Group has over 100 manufacturing plants around the globe, sells in more than 90 countries and employs more than 10,000 people worldwide.

### Not All Insulation is the Same

QuadCore™ Technology is Kingspan's new hybrid insulation core technology. It takes the performance of ECO*safe* PIR - Kingspan's incumbent insulation core - to a new level. The purpose of this document is to review the extensive fire testing certification available for both QuadCore™ Technology and ECO*safe* PIR panel systems. In addition it contains independent fire investigation reports on incidents involving ECO*safe* PIR core to show how Kingspan panel systems perform in real fire situations. Whilst no fires have taken place in buildings with QuadCore™ panels as yet, it is clear that the superior performance of QuadCore™ Technology would be expected to provide equivalent or better performance than ECO*safe* PIR in real fire situations with less smoke damage anticipated.

### Fire Engineering and Insurance Industry Attitudes

Fire engineering to protect both lives and property is a crucial part of building design and assessment. This document has been created, in part, to provide resources for performance based design and for the assessment of potential risks associated with existing buildings. According to many global insurance companies, FM / LPCB approved sandwich panels carry the same level of risk as non-combustible products therefore helping reduce premiums for building owners / occupiers.

### Single component, off-site quality solutions

The panels consist of Kingspan's unique FIRE*safe* & FIBRE*free* PIR (Polyisocyanurate) insulation core which is sandwiched between two non-combustible solid steel sheet layers – one the external weather side, the other a pre-finished internal liner. The result is a single component solution that replaces multi-part construction.

**Single Component**
Accelerates build speed and project completion, thereby increases speed to market.

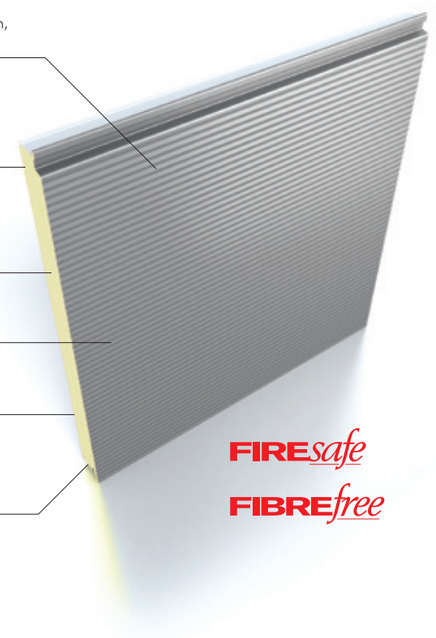
**Durability**
Robust and resilient with up to 40 year thermal and structural warranty. Whole lifetime performance.

**Enhanced Performance Insulation**
Low U-values, high R-values. Thermally efficient, continuous insulation can lower heating and cooling cost.

**Exterior Metal Skin**
All weather barrier.

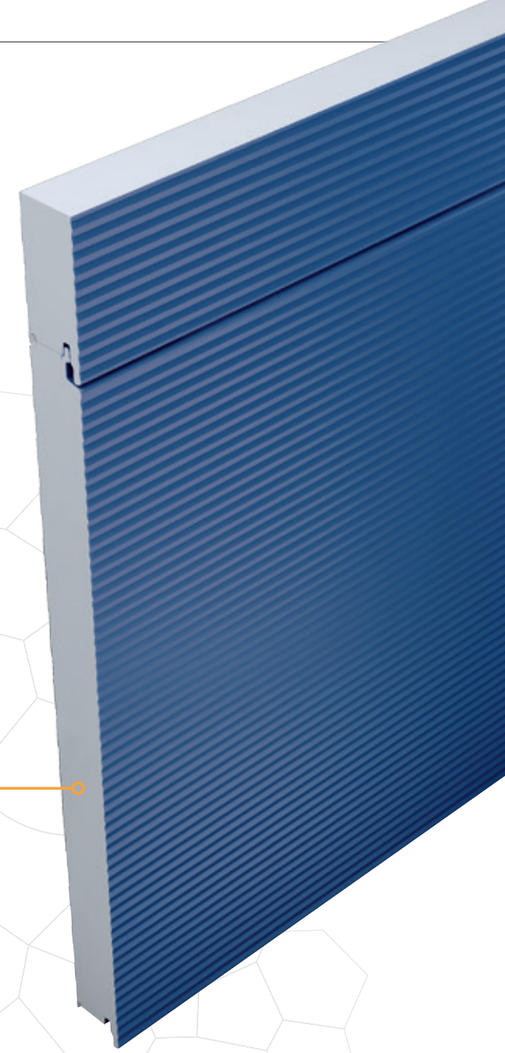
**Interior Metal Skin**
Vapour barrier.

**Airtight System**
Exceptionally airtight engineered joints.






# Introducing QuadCore™ Technology



### It's all in the grey cells...

QuadCore™ Technology is Kingspan's next generation, self-blended hybrid insulation core. Across the world of insulated panels, this innovation with its distinctive grey microcells powers the industry's highest combined performance, offering superior fire protection, up to 20% thermal enhancement and a higher environmental performance - all supported by an exceptional guarantee.

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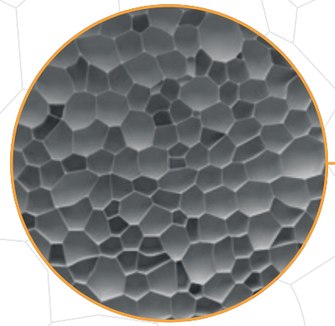


## 1 Superior FIRE Protection

QuadCore™ Technology is a high performance closed-cell solution offering a unique combination of fire performance certification including FM 4882 (the FM Global insurance standard for smoke sensitive occupancies), providing enhanced 'reaction to fire' and 'fire resistance' performance.

## 2 The Best THERMAL Efficiency

Class-leading aged lambda (thermal conductivity) value of 0.018 W/m.K.

## 3 Enhanced ENVIRONMENTAL Credentials

QuadCore™ Technology is 100% recyclable and is CFC, HCFC, HFC free while improved resource-efficiency means less truck movements to site.

## 4 Longest PERFORMANCE Guarantee

QuadCore™ Technology carries a unique 40 year thermal and structural performance guarantee.

This provides guaranteed 'built-in' continuous insulation, lowering building lifetime heating and cooling costs.



Kingspan

# Fire Engineered Panel Systems

## Extensive Fire Testing – Reaction to Fire Performance

Kingspan Insurer Certified sandwich panels can achieve high levels of reaction to fire performance in tests specified for regulatory purposes, large scale tests developed by the insurance industry and large scale tests developed by other organisations including ISO, British Standards Institute (BSI) and the National Fire Protection Agency (NFPA).
In summary:

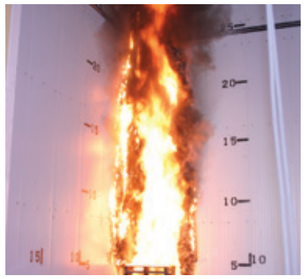
- Europe: EN 13501-1, particularly B-s1,d0. The 's1' rating, being the best (lowest emission) smoke rating.
- Global Insurance: FM 4880 – Class 1 Internal wall and ceiling panels without height restriction.
- Global Insurance: FM 4881 – Class 1 External wall panel systems without height restriction.
- Global Insurance: FM 4882 – Class 1 interior wall and ceiling panels for pharmaceutical manufacturing and storage areas, food preparation and storage areas or similar occupancies.
- Global Insurance: FM 4471 – Class 1 Roof panel systems.
- USA / Global: UBC 26-3 Room test.
- Global: ASTM E-84 Surface Burning Characteristics.
- Global: ISO 13784 Part 1 – Small room test for sandwich panels.
- UK / Ireland Insurance: LPS 1181 Part 1 Approval for external wall and roof panel systems.
- UK / Ireland Insurance: LPS 1181 Part 2 for internal wall and ceiling applications.
- UK: BS 8414 Part 2 – Façade testing.
- UK / Global: NFPA 285 Façade testing.
- Nordic countries – SP Fire 105 Façade testing.
- EN 11925 Part 3 Ignitability of Building Products.

The following examples, on pages 5 to 9, demonstrate a range of medium and large scale testing regimes where certain QuadCore™ and ECO*safe* PIR core panels have achieved a high standard of performance. Please check local market availability and performance levels achieved by specific tested / certified panel systems.

"According to many global insurance companies, FM / LPCB approved sandwich panels carry the same level of risk as non-combustible products thereby helping reduce premiums for building owners / occupiers."

**FM 4880 / FM 4881.** The 50ft corner test shown below forms part of assessment requirements for approval to Class 1 Internal wall and ceiling panels with no height restriction (FM 4880) and external walls with no height restriction (FM 4881).

Test set up



Fire development

End of test

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ECOsafe

FM APPROVED

**FM 4882.** The FM parallel panel test shown below is used to measure smoke emissions from the panels and delivers certification for smoke sensitive occupancies. QuadCore™ panel systems can achieve 'Class 1 interior wall and ceiling panels' and help deliver certification for pharmaceutical, manufacturing, food preparation and storage areas or similar occupancies.

Test set up

Fire development

End of test

*Only available with QuadCore™ Technology*

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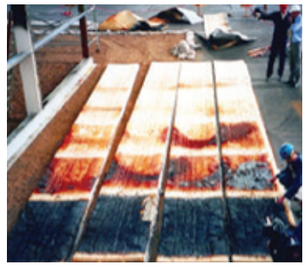
FM APPROVED



**LPS 1181: Part 1.** The test shown below forms part of the assessment requirements for EXT-B and EXT-A approval.

Test set up

During test



Inspection of protective char formation after test

POWERED BY QuadCore TECHNOLOGY

ECOsafe

LPCB

LPS 1181 : Part 1 : Issue 1.2
Cert No: 186, 260 & 279

**LPS 1181: Part 2.** The test shown below forms part of the assessment requirements for INT-1 and INT-2 approval for internal applications.

Test set up

During test

Inspection of protective char formation after test

*Only available with QuadCore™ Technology*

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LPCB

LPS 1181 Part 2: Issue 2
Cert No. 279

**EN 13823 SBI (Single Burning Item) Fire Test.** B-s1,d0 can be achieved to EN 13501-1.

Test set up

During test

End of test showing minimal panel damage

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ECOsafe



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# Fire Engineered Panel Systems

## Extensive Fire Testing – Reaction to Fire Performance

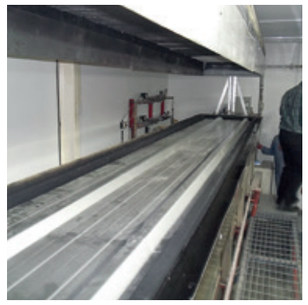
**UBC 26-3.** Room test.

Test enclosure

Wooden crib fire

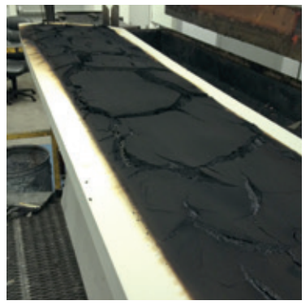
Panels at end of test with metal facings removed showing protective char formation on surface of insulation

**ASTM E84.** Surface burning characteristics. Class A can be achieved on panel and panel core.



Steiner tunnel test apparatus

Monitoring for fire spread during test



Panel core showing protective char formation after test

**ISO 13784 Part 1.** Small room test for sandwich panels.

Test room

Test in progress - note burner adjacent to vertical panel joints

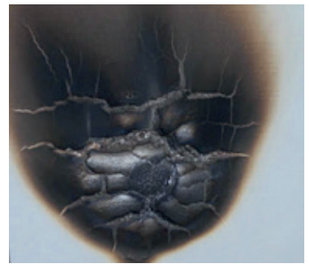
End of test showing limited internal damage and no evidence of flash-over conditions



**ISO 11925 Part 3.** Ignitability of building products subjected to direct impingement of flame, Part 3: Multi-source test. Test using roofer's torch.

Test set up

3 minute test in progress - note lack of surface burning and smoke emissions



End of test showing localised char formation with no evidence of fire spread

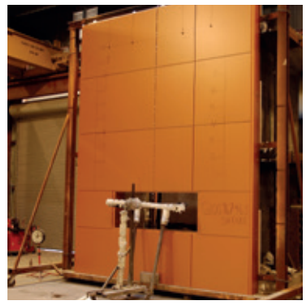
**BS 8414-2.** Fire performance of external cladding systems. Requirements of BR 135 for façades over 18m high can be achieved.

Test set up - Kingspan BENCHMARK façade panels with aluminium hook on cassette

Fire load

End of test showing aluminium cassette melted away to expose underlying Kingspan BENCHMARK Karrier panel in place

**NFPA 285.** Evaluation of fire propagation characteristics of exterior wall assemblies. Kingspan has successfully passed the NFPA 285 test for vertical and horizontal insulated panels, as well as panels with multiple façades attached utilising the Karrier panel system for all insulation thicknesses available in North America.

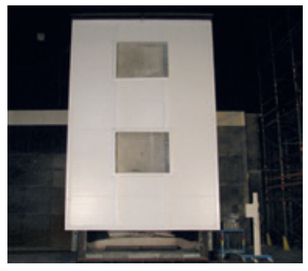


Testing of 4in (100mm) thick Kingspan insulated metal panels behind an ACM rainscreen façade

Fire exposure during test

End of test demonstrating damage to ACM rainscreen with Kingspan insulated metal panels remaining intact

**SP Fire 105.** Façade test.



Façade before test

Façade during test

Façade after test demonstrating minimal fire spread attributable to the cladding

*Test results pending for QuadCore™*

# Fire Engineered Panel Systems

## Extensive Fire Testing – Fire Resistance Performance

Fire resistance tests refer to testing of systems designed to contain or resist fire over a specified period of time. They are very different to reaction to fire tests but are sometimes confused. Fire resistance classifications are often expressed as a period of time such as '1 hour fire resistance' or two numbers such as 30/30 or a combination of letters and numbers such as EI30 or FR60. It is important to understand what each classification means.

When it comes to fire resistance for Kingspan panel systems the most common elements to consider are integrity (E), insulation (I), heat radiation (W) and load bearing capacity (R).

- 'Integrity' is the length of time that the insulated panel systems retains its integrity against flames or hot gases in a standard fire. For example, if flames were to break through the system after 100 minutes, the insulated panel system would achieve E90 or 90 minutes integrity.
- 'Insulation' is the time it takes to produce an average increase in temperature of 140°C (250°F in ASTM E119) above the initial temperature or an increase in temperature at one point of 180°C (325°F in ASTM E119) above the initial temperature on the unexposed (cold) side of the insulated panel system. This rise in temperature is measured with multiple thermocouples. Each thermocouple is monitored carefully during the fire resistance test.
- 'Heat Radiation' refers to the ability of the insulated panel system to reduce the transmission of fire as a result of radiated heat from the unexposed surface to adjacent materials. Heat radiation is limited to a maximum of 15kW/m$^2$.
- 'Load bearing capacity' refers to the structural ability of a floor or roof system to resist fire attack.

Kingspan panel systems are extensively tested for fire resistance in a variety of test methods that include ASTM E119, EN 1364 Parts 2 & 3, EN 1365 Part 2 and EN 1366 Part 3.

Kingspan panel systems can achieve:

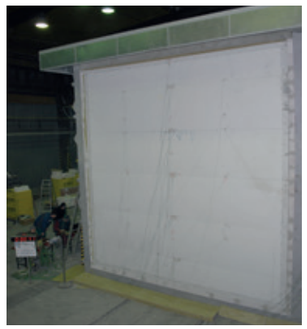
- up to 60 minutes fire insulation and integrity (EI60) according to EN 1364 Parts 2 & 3 and ASTM E119;
- up to FR60 according to UK Insurance Industry Standard LPS 1208;
- up to 180 minutes fire integrity and heat radiation (E180 and EW180) according to EN 1364 Part 2;
- up to 30 minutes insulation, integrity and load bearing capacity (REI30) according to EN 1365 Part 2 on X-Dek panel systems; and
- up to 90 minutes insulation, integrity and load bearing capacity (REI90) according to EN 1365 Part 2 on Op-Deck panel systems.

The use of QuadCore™ Technology can deliver improved fire resistance performance as a result of the increased stability of the insulation when exposed to fire. For specific situations this can result in improved performance, greater spans and / or a reduction in fixings.

**Fire resistance tests to EN 1364** (also applicable to LPS 1208). Up to EI60 on vertical walls and ceilings / roofs panel systems.

Vertical walls (3m x 3m furnace)

Ceilings / roofs (4m x 3m furnace)



Horizontal wall panels (5m x 6m furnace)

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ECOsafe

LPS 1208 : Issue 2
Cert No: 260

LPS 1181 : Part 1 : Issue 1.2
Cert No: 186, 260 & 279



# Fire Engineered Panel Systems

## Extensive Fire Testing – Fire Resistance Performance

**EN 1365 Part 2.** Fire resistance tests for loadbearing elements. Floors and roofs.

Op-Deck after 1 hour demonstrating no failure of insulation, integrity and load bearing capacity.

ECOsafe

**ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Materials.** Fire resistance test.

External face of QuadCore™ panel assembly after completion of 60 minute exposure.

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ECOsafe

**Fire resistance tests to EN 1366 Part 3 for service installations.**

Test for 1 hour penetration seals.

Test for 30 minute penetration seals.

*Only available with QuadCore™ Technology*

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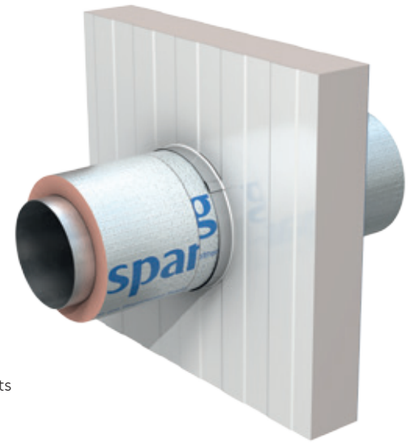


### Fire Penetration Seals

The principal driver for a better understanding of the impact of penetrations on fire specifications will always be the protection of life. Ensuring a fire is contained for an appropriate time is vital to allow for safe evacuation of a building. The best way to be certain on how a compartment wall will perform is to subject the entire system, walls and penetration seals, to a rigorous fire test.

Beyond ensuring the safety of building occupants, ensuring the integrity of compartments also helps with damage limitation. The further a fire spreads, the more the building and its contents will be damaged beyond repair. This in turn has a big impact on business continuation and thus costs to the insurer, the owner and / or the occupier.

The introduction of Kingspan's QuadCore™ Technology has enabled third party fire certification to EN 1366 Part 3 for a high performance closed-cell insulated panel fire compartment system that includes fire rated penetration seals. Addressing a well-known industry issue, this comprehensive testing takes a major step towards addressing inadequate fire safety specification in commercial and industrial buildings. It paves the way for safer, more reliable system fire performance through more robust specifications.



Kingspan

# Real Fire Case Studies

The following case studies involve insurance industry approved Kingspan ECO*safe* PIR panel systems.

The improved reaction to fire and fire resistance of QuadCore™ Technology means that insulated panels incorporating QuadCore™ Technology would be expected to provide equivalent or better performance in real fire situations with less smoke damage anticipated.

# Real Fire Case Studies

One of the most convincing arguments for the use of Kingspan Insurer Certified ECO*safe* PIR core sandwich panels is the way they react to fire in real building fire situations.

Independently researched real fire case studies have proven the performance of Insurer Certified PIR panel systems across the world.

We have been building up a library of real fire case studies over the years including, but not limited to, the following independent fire investigations by leading fire engineering consultancies and fire experts from around the world:

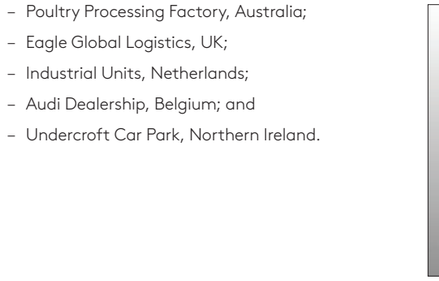
- Army Surplus Store, Netherlands;
- Wharfedale Hospital, UK;
- Spider Transport, Ireland;
- Crude Oil Pool Fire, Netherlands;
- Clifton Comprehensive School, UK;
- Food Preparation Facility, Heathrow Airport, UK;
- Suffolk Food Hall, UK;
- R A Wood Adhesives, UK;
- Furniture Retail Warehouse, Slovakia;
- Milk Powder Drying Tower, New Zealand;
- Poultry Processing Factory, Australia;
- Eagle Global Logistics, UK;
- Industrial Units, Netherlands;
- Audi Dealership, Belgium; and
- Undercroft Car Park, Northern Ireland.

Independently researched real fire case studies have proven the PIR panel systems in different applications including external arson attacks. We have published every single case study that we have had done on our panel systems with the exception of those that the client has asked to remain confidential. In every case,including the confidential studies, the PIR core panels have been found to have performed very well with no evidence of contribution to fire spread. For full reports, please contact the local Kingspan technical team.

**Overall Conclusions**

- PIR cores charred in the immediate vicinity of fire.
- Fires were not propagated within the PIR core.
- PIR panels did not char significantly outside of the area of the main fire.
- Dominant influence on fire severity was the contents of the building – fire severity not significantly influenced by the PIR panel.
- No evidence to indicate that PIR panels increased the risk of fire spread.

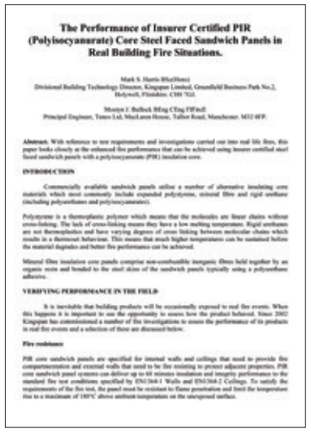
"Insulated panels incorporating QuadCore™ Technology are expected to provide equivalent or better performance than ECO*safe* PIR in real fire situations with less smoke damage anticipated."




Presentation at Fire Safety & Science' Conference, November 2014 - Roy Weghorst, Kingspan and Mostyn Bullock, Tenos.


Presentation of scientific paper at Interflam 2013.


Presentation at Façade Design & Engineering Conference, UAE - September 2016.


The Performance of Insurer Certified PIR (Polyisocyanurate) Core Steel Faced Sandwich Panels in Real Building Fire Situations.

# Real Fire Case Studies

## Army Surplus Store, Netherlands

A fire occurred at approximately 1am, Monday 18th April 2016, in an army surplus store located within a warehouse type building in Kootwijkerbroek in The Netherlands.

The warehouse is occupied by three businesses: the army surplus store, a metalworking / machine shop and a building materials supply warehouse. The three separate occupancies are separated by fire resistant walls.

The architectural wall panels that form the upper part of the external walls of the building are LPCB and FM Approved 80mm thick KS1000 AWP wall panels with ECO*safe* PIR insulation cores. The roof was constructed of a metal deck, polystyrene insulation and a bituminous membrane.

The fire in the army surplus store was extremely intense and lasted for over 4 hours. This was due, in part, to the storage of significant amounts of combustible materials in the building and the reported presence in appreciable quantities of accelerants such as cigarette lighter fluid and aerosol paint spray cans.

Aerial view of the damage showing structural collapse of the army surplus warehouse.

Panel at junction with internal compartment wall.

Panel at junction with steel stripped off demonstrating charring of PIR core but no evidence of fire spread.

### Conclusions

- The severity of the fire was at least equivalent to a two-hour standard fire resistance test, which is the notional fire resistance performance of the 300mm limestone blockwork wall.
- The Kingspan ECO*safe* PIR core wall panels bridged across the ends of the compartment wall between the building materials supply warehouse and the army surplus store and machine shop. Contrary to the architect's details, they had not been installed to provide fire resisting construction at the firewall/external wall locations.
- Notwithstanding this, the charring exhibited by the PIR insulation core to the panel at the point of intersection with the compartment wall indicated that a sufficiently stable char within the panel had formed to provide an effective fire stop and maintain the compartmentation within the building.
- The omission of a band of non-combustible material at the points of intersection with the compartment wall did not result in a break-down of fire compartmentation.
- The findings provide evidence that the PIR core of Kingspan LPCB and FM approved KS1000 AWP panels can provide sufficient resistance to fire propagation and erosion such that they meet the intent of reported local regulations where KS1000 AWP panels bridge across fire compartment walls.



# Real Fire Case Studies

## Wharfedale Hospital, UK

A fire occurred at a hospital under construction during the summer of 2003. The building was steel framed with concrete floors. The first and second floors were clad with Kingspan PIR insulated panels approved by LPCB to EXT-B of LPS 1181 Part 1.

At the date of the fire, the ground floor cladding had not yet been installed and the ground level was open sided.

It was thought that the fire was started deliberately by adhesive being poured over slabs of insulating material which were stored on the ground floor. *Photograph 1* shows the fire area.

The fire was discovered by on-site security staff and a call was made to the fire service who brought the fire under control within 40 minutes.

The heat generated by the fire was significant, as evidenced by cracking of the concrete floor above the fire and the distortion of steel beams that had been protected by a fire resisting intumescent coating.

The fire service found light smoke but no fire spread on the upper floors of the building. They also reported that although the joint between the floor and first floor walls had not been fire stopped there was no fire spread within the PIR core material. *Photograph 2* shows where the flame damaged outer skin of the bottom panel has been lifted to inspect the slight charring of PIR core beneath.

The main image above shows where the insulated cladding panels on the external face of the building had been attacked by flames.

Photograph 1

Photograph 2

### Conclusions

In spite of a very severe fire at ground level (sufficient to damage the concrete floors and distort fire protected steel beams) the cores of the insulated panels:

- did not ignite; and
- did not promote fire spread.

# Real Fire Case Studies
## Spider Transport, Ireland

This fire took place in the early hours of the morning on 17th September 2008, outside the Spider Transport building which was used as a warehouse and distribution point, in Wicklow, Ireland.

The fire, which was caught on CCTV, was started maliciously by two people pouring a flammable liquid over the interior of a vehicle parked across the front of the building. Flames impinged on the building and there was an 'explosion' of debris from the sides and top of the vehicle causing a fireball and burning debris to be projected onto the cladding, as captured by the CCTV image (*photograph 1*).

The main image above shows the aftermath of the fire. The upper parts of the external wall consisted of Kingspan Trapezoidal KS1000 RW insulated panels which complied with LPCB Grade EXT-B to LPS 1181 Part 1, whilst the lower parts were constructed of blockwork.

Although the bottom of the insulating core of the Kingspan insulated panels was directly exposed to flame impingement above the up and over door, there was no delamination of the skins of the panels and the insulation remained in place.

Photograph 1 shows a CCTV image of the truck fire. *Photograph 2* shows that the fire did not get into the building.

Photograph 1

Photograph 2

**Conclusions**

- The integrity of the Kingspan insulated panels was maintained, even immediately above the up and over door where the bottom of the insulating core was exposed to flame impingement and suffered severe charring.
- There were no signs of any spread of heat via the cores of the Kingspan insulated panels to any point within the building and no signs of spread within the cores of those panels.
- There is no indication that the Kingspan insulated panels contributed to the heat damage caused by the fire.




# Real Fire Case Studies
## Crude Oil Pool Fire, Netherlands

Photo: Ryland Heitink

The facility at Arnhem in the Netherlands is used for the testing of equipment for the oil industry. On the 18th January 2013 a fire involving crude oil occurred in an external equipment testing area.

The test site was located adjacent to the main test building which was clad with Kingspan Insurer Certified PIR insulated wall panels up to a parapet wall which was constructed from polyurethane core panels.

The fire started at about 5.00pm and continued to burn intensely for about 10 minutes with the flame plume, during this period, ranging from 10m to 30m high. After this initial period the fire died down significantly to form a number of smaller separate pool fires. The available video information ends after about 18 minutes of burning; at which time only small pools of flaming remained.

There appears to have been little or no direct flame impingement on the external cladding of the building. However, the building would have been subject to high levels of radiant heat flux from the fire plume and this has been estimated to be of the order of 24kW/m$^2$.

**Conclusions**

The intensity of radiation received by the panels caused some surface flaming but this ceased after approximately 30s (presumably after the surface coating had burned away). There was otherwise no evidence of self-sustaining flaming from the panel surface or at joints between panels.

As a result of the intensity of heat radiation the steel facing to the panels became rippled and delaminated from the foam core but there was only limited foam degradation at the core surface.

Despite the intensity of heat radiation being sufficient to cause ignition of the roofing system and being approximately double normal design values there was no evidence of any significant charring of the PIR panel cores or the promotion of fire spread via the panels.

# Real Fire Case Studies

## Clifton Comprehensive School, UK

Photograph 1

Photograph 2

At the time of the fire, the construction of Clifton Comprehensive School in Rotherham had just been completed. A significant quantity of equipment (computers and laboratory equipment, etc.) had been installed, but the building was not yet in use by the school.

The roof of the building was constructed of Kingspan Insurer Certified PIR insulated roof panels.

*Photograph 1* shows the area where the fire started, in an enclosed passageway linking two open air plant areas on the roof. There was scaffolding at the rear of the premises which gave access to the roof and the fire was thought to have been caused by the accidental or malicious ignition of roof sealant.

*Photograph 1* also shows the empty drum thought to have contained the roof sealant, and holes made in the partition system by the fire service to check that the fire had been completely extinguished. The plastic and glass components of the fire alarm and light fittings had shattered / melted and although delamination of the inner skin of the insulated panels occurred, the core and outer skin remained undistorted. The deformation of the purlins immediately above the seat of the fire indicated that this was a very hot fire.

The classrooms were separated from the passageway by compartment walls. The fire did not spread to the classrooms and fire fighters observed only light smoke in some of these rooms. There was no indication of any heat or smoke migration through the insulation of the roofing sheets and the fire service commented that the roofing panels did not contribute to the fire spread.

*Photograph 2* shows the apex of the roof, with some discolouration in the area subject to direct flame attack, but no evidence of fire spread.

### Conclusions

- The Kingspan insulated roof panels did not contribute to the cause of the fire.
- The Kingspan insulated roof panels did not contribute to fire spread to any other area of the building and assisted in containing the fire.
- Had the roof been of a more traditional construction (e.g. tiles on timber battens with a felt membrane), the fire may have been severe enough to ignite the roof construction and cause the fire to spread over the compartment walls.



# Real Fire Case Studies

## Food Preparation Facility, UK

The building provides in-flight food preparation facilities for airlines operating out of Heathrow. The fire occurred in a corner of the first floor men's changing room which contained rows of steel lockers fitted with clear plastic doors.

The room construction comprised of a timber floor incorporating ply-web engineered joists supported off a steel frame. The walls consisted of Kingspan Insurer Certified PIR core panels. The ceiling above the room was of timber joist construction which was under-drawn with two layers of fire resisting plasterboard.

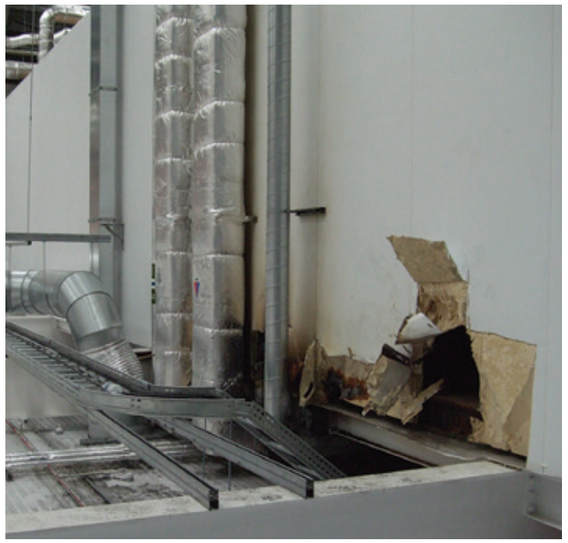
During their operations the fire service cut open the wall panels. This is standard practice to ensure that there is no continuing burning within the construction or voids. It was evident that where the fire service had opened up the panels there was only evidence of very limited charring of the PIR core with no suggestion of any fire propagation within the core material.

### Conclusions

The fire that occurred in the locker room of the food preparation facility was confined to a relatively small area but generated a localised severity equivalent to over 30 minutes exposure in a standard fire resistance test.

The sections of the Kingspan wall panels that were subject to direct contact with the fire suffered surface distortion and superficial charring of the PIR core material. However, there was no evidence of fire propagation within the core material.

Whilst there was some fire spread beyond the room of fire origin this was via the void in the timber floor. The Kingspan panels appear to have provided an effective barrier to fire spread, i.e. there was no fire spread through the panels into adjacent areas.



# Real Fire Case Studies
## Suffolk Food Hall, UK

A fire took place in Suffolk Food Hall in 2010. The fire occurred at about 5am in electrical equipment, located in a plant mezzanine area directly below the roof, that was constructed from large section timber portal beams, supporting PIR cored insulated panels.

The fire spread along the plant mezzanine involving all exposed combustible materials and including the timber supporting structure of the roof. The fire impacted on the main roof structure where the 15mm depth of charring of timbers was equivalent to what would be expected in a standard fire resistance test at approximately 23 minutes duration and at which time the furnace temperature would be approximately 800°C.

On locating the area of the fire the attending fire service cut a hole through the roof construction directly above the fire and in the location of the damage shown in the above image to ventilate the area. The images show the hole which was cut (which has been temporarily re-covered). The effect of the heat of the fire on the PIR core can be seen showing delamination of the exposed steel skin of the sandwich panel from the core, the formation of a carbon char layer and unaffected material at greater depth in the section which has been insulated from the fire.

Notably, the fire spread in the building was constrained to the mezzanine plant area and the combustible materials therein. Outside of this area, roof timbers were scorched, but not charred, indicating that temperatures were reduced to less than 450°C and PIR roof panels were not delaminated indicating clearly that the fire had not been propagated by the PIR core of the sandwich panel.

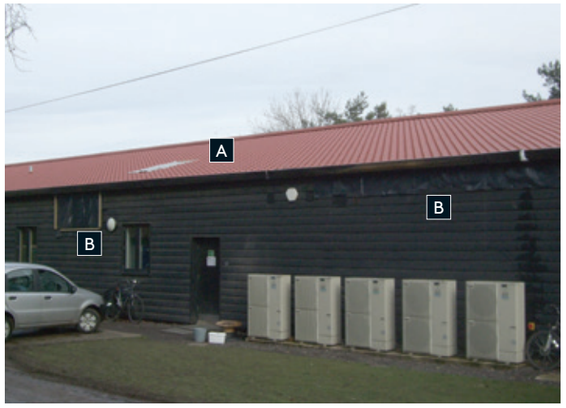
### Extract from East Anglian Daily Times

Firefighter Geoff Pyke, who is group manager and Ipswich district commander, described the blaze as severe, but praised the insulation in the roof for the fire not being able to spread. *"When we arrived the place was percolating smoke from all the openings on the roof. We tried to ventilate the building by opening all the apertures."*

Firefighters were concerned the fire could ignite the foam insulation in the roof, which was tightly sandwiched between two sheets of metal. However, Mr Pyke said that although they had to rip into the sheets of metal from the top and bottom, the quality of the foam meant the heat had not caused it to ignite. Had it done so the roof would probably have been destroyed and the building significantly damaged. Mr Pyke added, *"We can only assume the foam in the roof was of a fire retardant nature and withstood the fire."*

### Conclusions

- The fire was sufficiently intense to have subjected the roof membrane and wall separating the plant area from the retail space to a level of exposure equivalent to approximately 20-25 minutes in a standard fire resistance test.
- Fire spread did not occur from the mezzanine plant area to the rest of the building.
- The PIR core material of the roof sandwich panels did not transmit fire from one side of the walls enclosing the plant area to the other.




**A:** Vent cut in roof by fire service. **B:** Vents cut in wall by fire service.


**C:** Temporary roof covering over hole in roof. **D:** PIR core showing delaminated lower surface and extent of through-thickness charring. **E:** Cut edge of lower steel skin of sandwich panel.

Insurer Approved PIR core sample showing extent of through-thickness charring at Suffolk Food Hall.



# Real Fire Case Studies
## R A Wood Adhesives, UK

In 2009, a fire occurred at R A Wood Adhesives completely destroying the part of the building occupied by that business in Staffordshire.

The R A Wood Adhesives' facility was adjacent to another business where the two occupancies were separated by a compartment wall. The roof across both occupancies was constructed using Kingspan Insurer Certified PIR core panels.

The aftermath of the fire demonstrated that the fire compartment wall performed its intended function in preventing fire spread to the business next door, which was able to continue trading. In this case, the Insurer Certified PIR cored insulated panel insulation had been continuous over the top of the compartment wall.

An examination, carried out on the panel interface at the head of the wall, showed that the PIR core had charred to form a stable and effective seal between the steel skins of the sandwich panel to prevent fire transmission to the protected side of the wall. It should be noted that UK design guidance now recognises that an alternative approach might be to use a panel system which has been shown in a large scale test to resist internal and external surface flaming and concealed burning.

### Conclusions

The fire was sufficiently intense to have subjected the party wall between the adjacent tenancies to a level of exposure equivalent to at least 60 minutes in a standard fire resistance test.

The charring exhibited by the Kingspan Insurer Certified PIR core material indicated the formation of a sufficiently stable char within the panel to provide an effective fire stop between the steel skins of the cladding panels at the head of the compartment party wall.



The findings of the site inspection provide evidence that the Insurer Certified PIR core of the Kingspan Trapezoidal KS1000 RW panel can provide sufficient resistance to fire propagation and erosion to such an extent that the functional requirement of the UK Building Regulations (Regulation B3) can be satisfied without providing a 300mm wide band of limited combustibility material to replace the PIR core where the panel passes over a compartment wall.

# Real Fire Case Studies

## Furniture Retail Warehouse, Slovakia

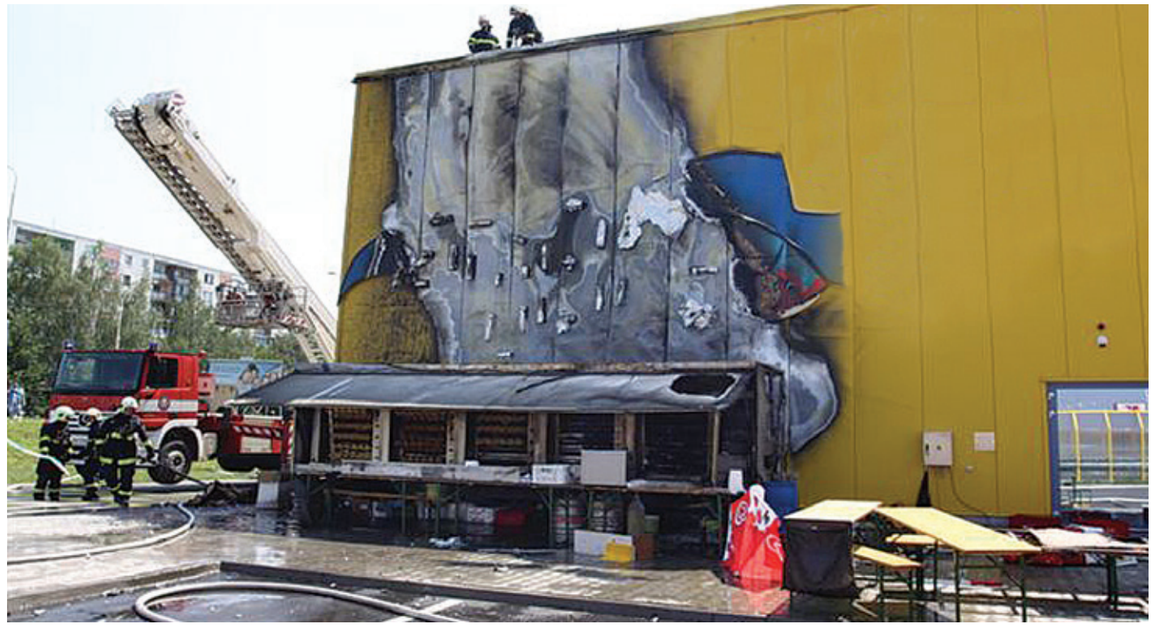
A large fire took place outside a furniture store in Presov, Slovakia – a large concrete framed, flat roofed retail building clad with Kingspan Insurer Certified PIR core wall panels. The building measures approximately 100 metres by 40 metres with a height to the roof parapet of approximately 8.5 metres.

The fire took place in a food cooking grill area located approximately 1.2m from an external wall. The fire involved the combustible contents of the grill and 5 propane gas cylinders – at the height of the blaze the flames were over 10m high and were impinging directly onto the surface of the panels.


### Conclusions

The fire in the grill trailer subjected the external façade of the furniture store to an intense fire plume for a duration of approximately 10 minutes.

- The intensity of this fire plume was such that is was capable of melting the aluminium composite panel used for the store's mascot sign within this short fire exposure period.
- There is clear evidence that combustible materials used in the construction of the store's mascot sign and parapet perimeter lighting strip contributed to the intensity of this fire plume and would have been instrumental in the fire-fighters' initial opinion that the external wall construction was also burning.
- The Kingspan Insurer Certified PIR core material of the external wall panels charred to a depth of about 10mm in the area directly impacted by the fire plume and the external skin of the panels delaminated from the core in these areas.
- Despite the intensity of the fire plume, the Kingspan Insurer Certified PIR core did not propagate the fire within the panel construction to areas within the core remote from the area of direct fire plume impingement.
- After extinguishing the fire on the outside of the wall panels, fire-fighters found no evidence of smouldering or flaming combustion inside the wall panels.
- The effects of fire in the store were limited to minor smoke ingress at joints between Kingspan Insurer Certified PIR panels in the area of direct fire plume impingement. There was no spread of fire into the store. ***The effects were minor enough that the store was able to re-open about 3.5 hours after the fire.***





# Real Fire Case Studies

## Milk Powder Drying Tower, New Zealand

Located on a business park, the milk processing facility houses a small spray drying dairy plant. The powder drying tower was constructed using an internal steel frame clad with Kingspan (FM approved) PIR insulated panels.

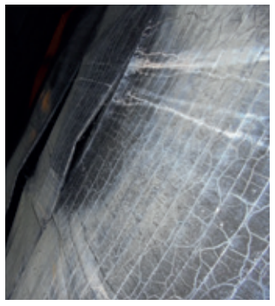
In April 2014, a fire occurred in the powder drying plant whilst the plant was processing infant formula milk powders.

On arrival of the first fire service appliances, it appeared that a major fire had engulfed the powder drying tower. A New Zealand Fire Service spokesperson said that the fire was notified as a third alarm with 20 appliances from the surrounding area responding to the blaze.

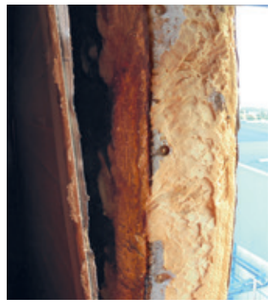
Findings concluded that a fire emanated in the region of the base of the milk powder drying cyclone and the fluid bed dryer. It is in this area, approximately mid-way up the tower, that there is extensive fire damage to the plant and structure and where the cladding had been exposed to direct flame impingement. Here the fire has penetrated into the PIR core causing the material to surface char.

Panels exposed to fire internally.

Milk powder drying tower showing external fire damage to panels explosion doors opened manually after fire).



Fire penetration into panel core, material charred but still in place, no void.



Window removed by Fire Service to ventilate the building to gain access – no fire penetration of core material.

### Conclusions

The fire within the milk powder drying tower was extensive and took the Fire Service at least 40 minutes to control. In conclusion, it can be seen that the Kingspan PIR panels reacted as designed and contained the fire to the original area within the building.

- The panels did not contribute to fire spread and there was no spread of fire within the panels.
- No panels failed structurally or fell off. Some panel areas that were subjected to direct flames did deform and split away from the inner core but the fixings held the skins together.
- In the one area on the top floor where the fixing had been torn out of the panel the proprietary jointing system retained the panels.
- There was no spread of fire to adjacent buildings (within 10m there are several polystyrene insulated clad buildings).

# Real Fire Case Studies

## Poultry Processing Factory, Australia

A fire occurred at an Australian poultry processing premises, late on an afternoon in January 2010. The area involved in the fire included the loading dock, finished product chiller, tunnelling chiller and plant room, all of which were contained within one building structure, approximately 10 metres in height and with 3,000m$^2$ floor area.

The walls and internal ceilings of the building were constructed from polystyrene (EPS) insulated panels, with Kingspan Insurer Certified PIR panels used to extend the building some years later as the plant volumes expanded. The roof and higher parts of the external walls above the ceiling level were constructed of sheet metal cladding material.

The fire started at one end of the building in a storage area, and quickly spread through the building (*photograph 1*). The core material (EPS) in the wall panels has been destroyed by the fire, and the remaining panel steel faces have collapsed.

The deformation of structural steelwork indicates significant heat was generated, probably due to the fuel load in the adjoining storeroom and the polystyrene panels, resulting in high flame temperatures. The fire quickly spread throughout the ceiling section of the chiller area until the fire reached the Kingspan panels, which effectively stopped the fire from spreading any further. *Photograph 2* shows some of the debris from the fire, including collapsed EPS walls and ceilings. The former ceiling level is evident from the line of steel support cables which were used to hold the EPS ceiling panels, which collapsed in the fire.

*Photograph 3* shows a control room which still remains standing – built at the end of the building where the fire started, using Kingspan Insurer Certified PIR panels.

**Conclusions**

- The Kingspan Insurer Certified PIR insulated panels suffered only minor damage from heat.
- The heat created by the fire in adjacent non-Kingspan EPS panels resulted in significant heat being generated, which caused distortion of steel structural building framework, and melting of plastic pipes and fittings.
- The Kingspan panels did not contribute to the fire in any way, and provided firewall type shielding to a significant portion of the building to stop spread of the fire, and protect specialised processing facilities from damage.

Photograph 1

Photograph 2

Photograph 3



# Real Fire Case Studies

## Eagle Global Logistics, Thurrock, UK

The fire originated in a large logistics warehouse occupied by Eagle Global Logistics (EGL) in Thurrock, which contained mixed goods stacked on the floor and on high bay racking.

Another warehouse was situated adjacent to EGL (approximately 9m away) and the walls and roof of both buildings were clad in Kingspan insulated panels (KS1000 MR) with PIR (Polyisocyanurate) cores.

The fire appeared to have started in the south end of the building which eventually collapsed. The fire burned for two days and two nights and it is clear from the photographs shown that the fire was very severe. Despite the duration and severity of the fire, significant areas of insulated cladding panels remained with only limited damage to core material indicating that the PIR core material did not promote fire spread.

The main image above shows north elevation of the adjacent building following the fire. The insulated cores of the panels did not ignite and did not transfer heat damage to the interior of the building.

**Conclusions**

- There was no evidence to indicate that the PIR insulated panel cores promoted fire spread or that fire spread through the panel cores beyond the region of severe burning of the building contents
- No significant damage occurred to the insulated panels on the adjacent building.

Collapsed south end of building.

Roof sheeting hanging from severely deformed steelwork.

No heat transfer damage to interior of adjacent property.

# Real Fire Case Studies

## Industrial Units, Heining, Netherlands


The site is on an industrial state outside of Amsterdam and all the buildings involved in the fire were used by businesses carrying out automotive works and storing vehicles with associated equipment, parts and consumable materials.

The buildings of interest are the building clad with Kingspan FM / LPCB approved PIR core panels (A) and the building immediately adjacent which was destroyed by the fire (B). The former building measures approximately 31m long by 14m wide, with height of 4.5m to eaves and 6.5m to the ridge of its pitched roof. The latter building which was destroyed by the fire measured approximately 37m long by 16m wide and was about 4.5m high to its eaves.

The adjacent building B that was destroyed by the fire appeared to be constructed using single skin profiled sheet cladding on a steel portal frame structure. The owner of this building explained that it contained a number of vehicles, tyres, equipment and fuels, including a high value racing car and associated spares and equipment towards the western end of the building. These spares included magnesium race wheels and tyres. As a security measure, two Transit type vans were parked externally along the south facing elevation of the building across the roller shutter door providing access to this part of the building.

### Conclusions

- The fire in building B would have subjected the external façade of building A to levels of radiative heat flux sufficient to cause delamination of the PIR panels and charring of the PIR core.
- The level of fire damage actually sustained by the PIR core panels on building A indicates that the actions taken by firefighters to cool the external façade of building A using water jets had a significant effect in reducing the temperatures achieved by the exposed surfaces of the PIR panels.
- The behaviour of the PIR wall panels in this fire was commensurate with that observed in previous fire case studies.

No heat transfer damage to interior of adjacent property (building A).



# Real Fire Case Studies

## Audi Dealership, Belgium

The fire occurred in the external compound of a large Audi dealership in Belgium in October 2014. It was a deliberate act of arson.

The building is of steel frame construction clad with 1m wide by 100mm thick Kingspan FM/ LPCB certified PIR cored sandwich panels and provides single storey showroom and workshop accommodation and an internal mezzanine floor for additional vehicles and back of house accommodation.

*Photograph 1* shows the aftermath of the fire and is a photograph taken (by others) shortly after the fire event. The car in the foreground is understood to be an Audi Q3 with other cars being of at least a similar make and model.

*Photograph 2* shows a sample of the PIR core material removed from the ECO*safe* PIR core panel at the location of predicted peak incident radiative heat flux of 31.8kW/m$^2$. The photograph indicates that the PIR core had pyrolysed to a carbon char to a depth of about 40mm at this location. At locations remote from the area of peak incident radiative heat flux, the charring of the PIR core was significantly reduced, demonstrating that combustion had not been propagated by the PIR core material.

The inside of the workshop showed no evidence of fire penetration in an area adjacent to the external fire attack.

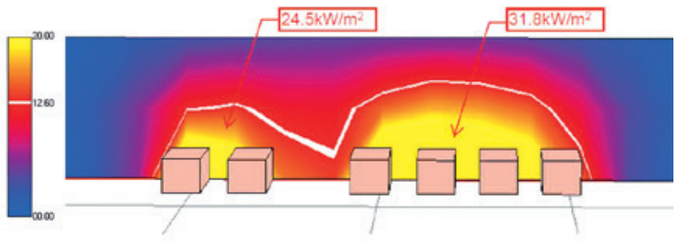
### Conclusions

- The PIR cored sandwich panels were subject to a fire likely to have lasted at least 15 minutes from ignition.
- It is likely that the cladding will have been subjected to peak incident radiative heat flux of at least 31.8kW/m$^2$ for a period of at least 10 minutes.
- The sandwich panels exposed to these conditions sustained damage in terms of delamination of the exposed steel skin of the panels away from the PIR core, removal of the paint coating and pyrolysis of the PIR core material to a depth of approximately 40mm.
- There was no evidence of fire propagation within the panels.

Photograph 1

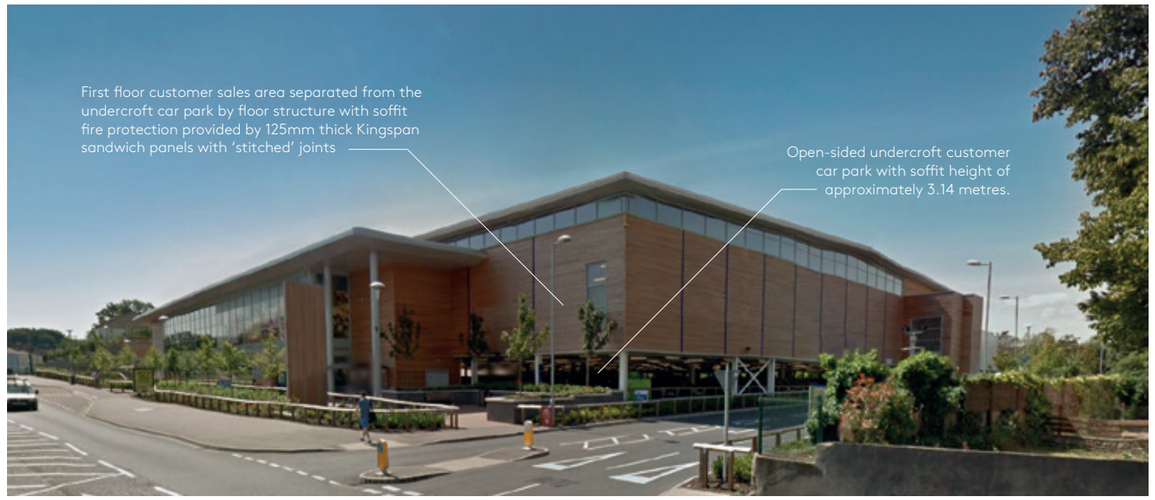
Photograph 2

No evidence of fire penetration to interior of the workshop



# Real Fire Case Studies

## Undercroft Car Park, Newry, Northern Ireland




Around 7.30am on 28th August 2014, an engine bay fire in a parked car occurred in a large ground level undercroft car park below the first floor retail level of a large supermarket.

The main image shows the front elevation of the building from the main road and the corner of the building that was closest to the fire location.

The overall footprint area of the building is approximately 11,500m$^2$ with the ground level undercroft car park occupying a slightly smaller footprint of approximately 11,200m$^2$ due to the ground level entrance foyer at the front of the building, which forms part of the same compartment as the sales area above. The majority of the car park possesses a flat soffit at 3.14m above floor level that has been created by the installation of 125mm thick Kingspan FM/LPCB approved PIR cored sandwich panels.

### Conclusions

- The PIR cored sandwich panels were subject to a period of fire exposure lasting at least 8 minutes and resulting in a period of sustained flame impingement directly above the fire and gas temperatures to a distance away from the fire sufficient to destroy plastic light fittings.
- The sandwich panels exposed to these conditions sustained damage in terms of removal of the paint coating together with distortion and delamination of the exposed steel skin of the panels away from the PIR core.
- There was no evidence of joints between panels opening up and no PIR core material had been exposed.
- There was no evidence of fire propagation within the panels.
- There were no reports from the attendant fire service relating to any measures needed or carried out in respect of the installed panels.

Evidence of direct flame impingment on soffit lining directly above the car.



# Market Sectors

Across the globe, Kingspan Insurer Certified panel systems are providing fire engineered solutions on a range of high risk buildings in all sectors, including:

- offices;
- education;
- logistics, distribution and storage
- healthcare / hospitals;
- cold storage and food processing;
- manufacturing;
- retail;
- hotels / leisure;
- student accommodation; and
- residential (apartments).


Friars Walk Shopping Centre, UK

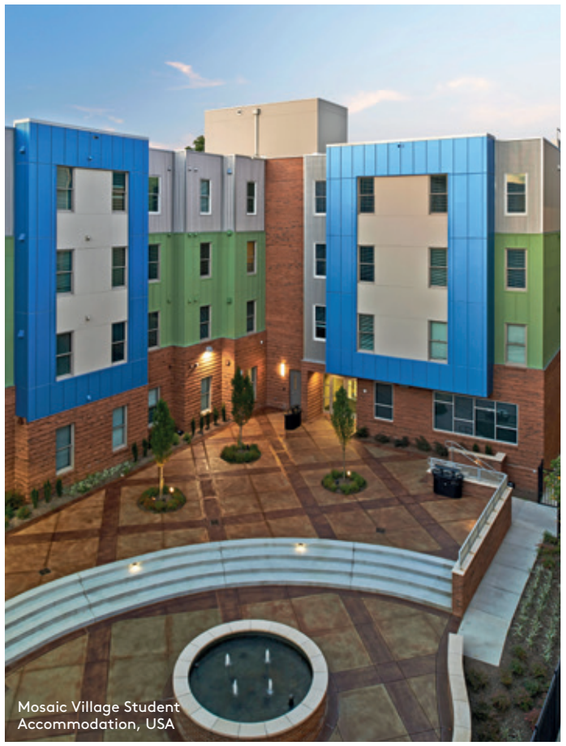
Hastings District Court House, New Zealand

Northeast Kingdom Human Services Office, USA


Hamad International Airport Maintenance Hangars,Qatar

# Market Sectors

Royal North Shore Hospital, Australia



Mosaic Village Student Accommodation, USA

Bale Breaker Brewery, USA

Australian National Maritime Museum Warships Pavilion

Gazeley Regional Distribution Centre for Waitrose, UK

Louis Blériot High School, France

# Market Sectors

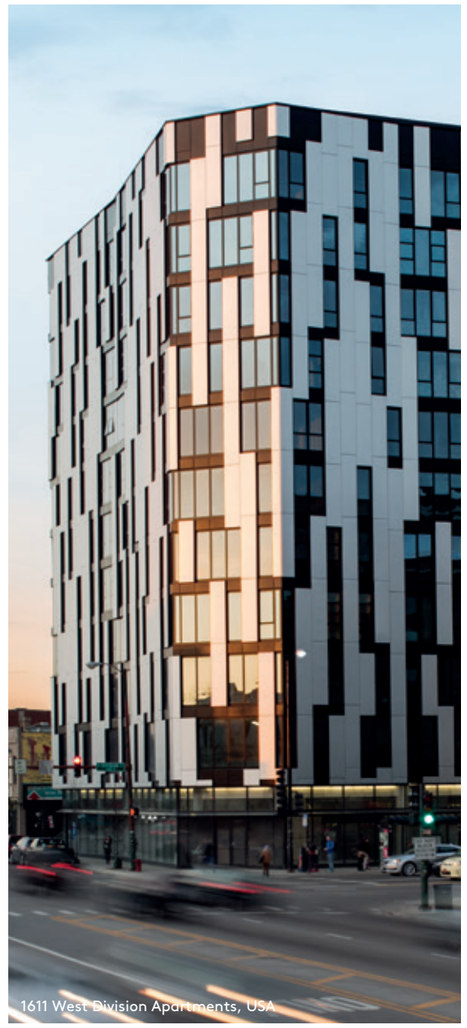

Plopsaqua Water Park, Belgium

Energy from Waste Facility, UK


Avon & Somerset Police Station, UK


The iHub at Infinity Park Derby, UK


Nostra Cement Manufacturing Plant, Hungary


1611 West Division Apartments, USA

# Further Information & Support


## Information Resources

Our global Fire Engineering Services Department carries out ongoing research through independent partners into the fire performance of Kingspan insulated panel systems.

We have recently produced a series of information videos featuring footage of the extensive testing regime that Kingspan insulated panel systems are subjected to, together with independent fire tests comparing some insulation cores (including QuadCore™ Technology) and steel faced panels to industry alternatives.

**To view these videos, please visit: quadcore.kingspan.net**

## Seminars & Training

Our Fire Engineering Services Department delivers seminars on request to a range of stakeholders including the insurance industry, fire engineers, architects, contractors and end users.

To enquire about a seminar for your business or association, please email: fireinfo@kingspan.com

## Project Support

Our Fire Engineering Services Department is on hand to support with technical advice on the fire performance of Kingspan insulated panel systems throughout the world, including practical guidance on the route to compliance in all markets in which we operate.

To be directed to project support in your location, please email: fireinfo@kingspan.com

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