

NOT ALL INSULATION IS THE SAME...

Fire Performance of
Insurer Certified PIR Core
Sandwich Panels

Real Fire Case Studies

Kingspan Insulated Panels has been supplying fire resistant PIR insulated panels worldwide for more than 30 years. We have a fire testing philosophy that allows us to be certain that our PIR panels will perform as expected in real-life fire events - a safety aspect that sets us apart from the rest.

Fire resistant PIR insulated panels is Kingspan's core business. Life safety and building protection is important to us, because of this we are conservative with performance claims as there is no place for optimism in life safety.

Kingspan insulated panels use a unique high performance PIR (polyisocyanurate) core and have been tested as they would typically be installed; generally this means utilising Kingspan's standard details.

Typically we test the worst case scenarios, for example with joints orientated vertically, the thickest panel for reaction to fire tests and always with the joints exposed to the flame.

When dealing with fire it is important that every product is installed in accordance with the methods and details utilised to 'pass the test'.

Why choose an Insurer Approved Panel?

Over the last decade the New Zealand market has become increasingly aware of the potential fire risk using EPS panels in buildings. A number of companies who have previously used EPS panels and experienced extensive damage from fire (Fonterra Takaka 2005, Tegal Christchurch 2007 and Silver Fern Farms Te Aroha 2012) have moved to PIR panels for all their cold storage facilities.

Along with extensive proof of Kingspan's panel performance in real life fire situations, Kingspan have subjected their panels to numerous test regimes for both local regulatory purposes and large scale tests performed by FM Global for the insurance industry.

Kingspan insulated panels have achieved Class 1 without height restriction, the highest possible rating achievable in the FM Global 4880 test, making them 'insurer approved' panels.

EPS in panels tends to promote fire spread resulting in extensive fires and frequently total losses because the EPS vaporises, catches fire and then promotes the fire spread to the rest of the building. EPS panels are not 'approved panels'.

One of the most convincing arguments for the use of Kingspan Insurer Certified 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. We have been building up a library of real fire case studies over the years including the following independent fire investigations by Tenos, a leading fire engineering consultancy with global reach, based in the UK.

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.

Properties with EPS – lesson learned (extract from a claims example published by Zurich Australia Insurance)

In January 2010, a large fire occurred at the site of a major food processing factory, south of Melbourne. The fire started in a staging area for plastic packaging trays, and despite the area being attended and the presence of automatic smoke detection, the fire quickly spread to the EPS (expanded polystyrene) sandwich panel ceiling causing total loss.



An interesting footnote to this fire was the performance of approved PIR sandwich panels. A new extension to the existing EPS cold store had been constructed from PIR. The fire burnt up to the PIR wall but did not penetrate, the PIR section was left largely intact. This tends to confirm a number of insurer's and experts recommendations of approved alternative panels, be they PIR or Phenolic resin matrix.

New Zealand Tests

| Test | | Roof & Wall Panels KS1000 RW | Architectural Wall Panels KS1000 AWP | Coldstore Panels KS1100 CS |
|--|----------------------------------|---|---|---|
| Internal Spread of Flame ISO 13784-1 | | Group 1S* | Group 1S* | Group 1S |
| External Radiation ISO 5660 | THRR PHRR | 5 MJ/m ² 24 kW/m ² | 5 MJ/m ² 24 kW/m ² | 5 MJ/m ² 24 kW/m ² |
| FM Global Insurance: 4880 Insulated Panel Systems | | Class 1 Without height restriction | Class 1 Without height restriction | Class 1 Without height restriction |
| FM Global Insurance: 4471 Roof Panel Systems | | Class 1 | N/A | N/A |
| FM Global Insurance: 4881 Exterior Wall Systems | | Class 1 | Class 1 | Class 1 |
| Fire Resistance FRR*** | Unsprinklered** Sprinklered** | Up to FRR 30 Up to FRR 240 | Up to FRR 90 Up to FRR 120 | Up to FRR 60 Up to FRR 240 |

*Firewall details required. **Clause 2.3.13b, "insulation ratings are not required where sprinklers are installed throughout the building".

***Structural adequacy (structure /integrity/insulation) provided by an appropriately designed building structure.

At the time of publication, Kingspan Insulated Panels is the only company in New Zealand to have tested their panels to ISO 13784-1, which is a specialised test for Sandwich Panels as referenced in the NZBC. Kingspan believe this to be the most rigorous and severe test to expose their insulated panel products to. Kingspan is also the only company to have tested multiple panel profiles as the performance can vary between profiles.

With a comprehensive suite of products and experienced technical support Kingspan can provide a range of solutions to meet many project specific performance requirements.

For individual product specification and performance details please contact Kingspan.



International Tests

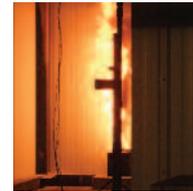
Following are some of the current international tests that Kingspan insulated panels have been exposed to and passed:

- Europe: EN 13501-1, particularly B-s1,d0. The 's1' rating, being the best (lowest) smoke rating.
- UK Insurance: LPS 1181 approval for external wall and roof panel systems.
- USA / Global: NFPA 285 façade testing.
- UK: BS 8414 – Façade testing.
- Nordic countries – SP Fire 105 façade testing.

ISO 13784-1. The test below forms part of the assessment requirements to achieve a Group 1S rating, the highest possible rating achievable for Internal Spread of Flame.



Set up: 300 kW fire load



During test



Completion of test

FM 4880. The 50ft test shown below forms part of assessment requirements for approval to Class 1 without height restriction.



Set up: 4000 kW fire load



Fire development



End of test

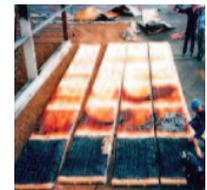
LPS 1181: Part 1. The test shown below forms part of the assessment requirements for EXT-B and EXT-A approval.



Test set up



During test



Inspection of char formation after test



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.



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.
- Business continued to trade the day after the fire.



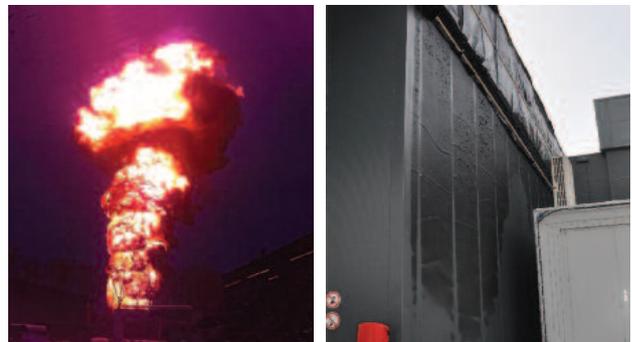
Photo: Roland Heitink

Crude Oil Pool Fire, Netherlands

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/m².



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.



Clifton Comprehensive School, UK

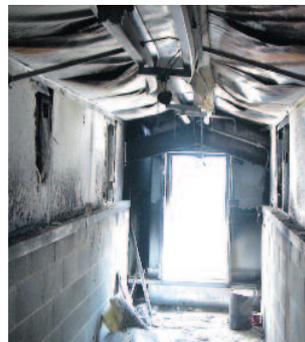
At the time of the fire, the construction of Clifton Comprehensive School in Rotherham had just been completed. A significant quantity of equipment (computers and laboratory equipment, etc.) had been installed, but the building was not yet in use by the school. The roof of the building was constructed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

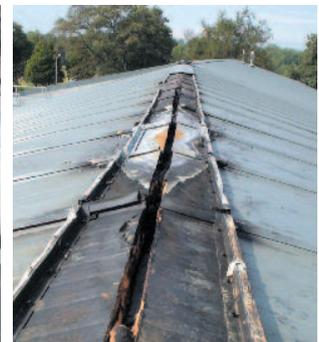
Photograph 1 also shows the empty drum thought to have contained the roof sealant, and holes made in the partition system by the fire service to check that the fire had been completely extinguished. The plastic and glass components of the fire alarm and light fittings had shattered / melted and although 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 1



Photograph 2

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



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



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.

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.



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



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.



Furniture Store, Slovakia

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

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 it 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.**

Fire Engineered PIR Panel Systems

Kingspan Insulated Panels in New Zealand

- Largest supplier of insurer approved PIR panels in New Zealand across a wide range of sectors.
- Leading the way in research and development using both local and global resources.
- Experienced in-house technical team have an integral understanding of the NZBC and provide qualified project based advice which saves time and money.
- Through rigorous testing, Kingspan stand behind their insulated panels to be FIREsafe, thermally efficient, sustainable and environmentally friendly.



Government – Hastings District Court House



Education – Eastern Institute of Technology



Manufacturing – Fisher & Paykel



Processing – Yealands Estate Winery



Industrial – Lion Nathan Brewery



Retail – Burger King



Recreation – Queenstown Aquatic Centre

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For the product offering in other markets please contact your local sales representative or visit www.kingspanpanels.com

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