Association of British Insurers

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TECHNICAL BRIEFING: FIRE PERFORMANCE OF SANDWICH PANEL SYSTEMS

Foreword

This Technical Briefing is one of a series that comes from the ABI research programme managed by BRE for the period 1999-2002.

This Technical Briefing provides a risk assessment approach to the fire performance of sandwich/composite panels and takes into account research funded by ABI since 1999, which has been particularly targeted at sandwich panels used internally in the food and cold storage industry. This complements approximately twenty years experience of testing external cladding systems.

Other applications present different degrees of risk of inception and fire spread. In interpreting the conclusions of this report for applications other than the above, due consideration must be given to these differences.

The Technical Briefing has been written specifically with the needs of insurance surveyors and under-writers in mind, but may also be of use to building occupiers and managers.

This report is the final version of the ABI Technical Bulletin on 'Fire Performance of Sandwich Panels'.
Any previous drafts in circulation are superseded and should be disregarded.

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Executive Summary

Over the last decade or so significant losses have occurred associated with large fires in which composite panels have been a feature. Many have related to risks within the food manufacturing sector.

ABI commissioned BRE to draw up this Technical Bulletin to assist commercial property insurers in understanding the features of composite panel systems, their use and management which either contribute to or mitigate the risk of such losses. The findings will also be of interest to construction professionals and facilities managers in minimising risks in both new and existing buildings. This document covers important issues such as fire safety management, compartmentation, panel system construction, combustibility and fire performance of panel core material and the choice of system for applications with differing inception and fire spread risks.

As with other types of risk, buildings containing sandwich panel systems should be considered on their own merits by underwriters and risk managers, taking account of application, choice of sandwich panel system and fire risk management measures in place. A three pronged approach is necessary, balancing negative factors in any one area with strengths elsewhere.

Sandwich panels do not start a fire on their own, and where these systems have been implicated in fire spread the fire has often started in high risk areas such as cooking areas, subsequently spreading as a result of poor fire risk management, prevention and containment measures. Prevention of ignition and containment of early fire spread are critical. Specific and detailed risk assessment is crucial. Where high levels of risk management are not achievable, due to the nature of the processes in the business in question and/or the quality of the management demonstrated, and the risk of ignition is high, the use of panel systems with high fire performance characteristics should be considered. Systems meeting accreditation schemes such as LPS 1181 demonstrate such characteristics.

Some applications, including stand-alone cold stores and panel systems used as external claddings in areas where arson risk is low, have experienced few fire losses. In low risk situations such as these there can be greater flexibility in choice of panel system, taking account of other business needs such as hygienic environments and insulation properties.

Inevitably many situations will fall between clear cut 'high' or 'low' risk scenarios. Here the degree of financial exposure is likely to drive insurers' decisions. Fire stop panels and other fire safety management measures have a significant role in such situations, and the importance of a demonstrated ability by facilities managers in ensuring that such systems are robust cannot be over-emphasised.

1 Introduction and background

1.1 Scope and purpose

This Technical Briefing is written specifically to assist insurance surveyors and under-writers in understanding the fire issues relating to sandwich panels. It may also be of use to building occupiers and risk managers. For the purposes of this guidance document, sandwich panels (also known as insulated panels and sometimes as composite panels) are defined as follows:

Sandwich panels are a building product consisting of two metal faces positioned on either side of a core of a thermally insulating material, which are firmly bonded together so that the three components act compositely when under load (wind-loading, access loads etc).

Sandwich panel systems comprise the panels, their jointing methods and the type of support provided.

The purpose of this Technical Briefing is to give a basis on which to assess the use of sandwich panels in respect to property protection. It recommends a risk-based approach to the various relevant parameters including amongst other things use of the building, location of panels, type of panel and standard of fire safety management.

This document deals with property protection issues and complements Appendix F of Approved Document B to the Building Regulations, 2000, which is limited to life safety aspects.

Composite panels with facings other than metal are not covered in this document. This definition also does not apply to built up external cladding systems assembled on site. These typically use lightweight non-combustible (Euroclass A1 or A2) mineral wool rolls (rock fibres or glass fibres).

1.2 Fire initiation and spread

The spread of fire is influenced by:

- fire safety management
- compartmentation
- sandwich panel system construction
- combustibility and fire performance of panel core material
- application of sandwich panel system

Not all sandwich panels contain a combustible core. Even sandwich panels containing a combustible core do not themselves create the fire risk; they require a significant size of ignition source to propagate the fire. Not all combustible materials used in the construction of sandwich panels have poor fire performance.

Good standards of fire safety management can substantially reduce the fire risk.

Building regulations do not necessarily provide sufficient fire protection for insurance purposes. For example, unlimited floor areas are a major contribution to losses because of the lack of fire resisting compartment walls.

1.3 Importance of fire safety management

Insurers should satisfy themselves that the building operator maintains a high standard of fire safety management as this can reduce the possibility of accidental ignition. A detailed risk assessment should be undertaken to establish the likelihood of ignition, before a decision is made on the suitability or otherwise of a particular sandwich panel system.

1.4 Lack of compartmentation

Many factory buildings do not incorporate fire resisting compartment walls which would make a significant contribution to reducing spread of fire since this is not required by Building Regulations and their supporting documents. Active intervention by fire fighters is less likely in the absence of compartmentation. The introduction of an adequate level of compartmentation may be a sensible alternative to replacing panels.

1.5 Importance of good joints and support systems

Poor joint detailing and inadequate support for the panels lead to rapid delamination of the facings, exposing any core directly to the fire condition. Depending on the type of core, premature collapse of such panels allows the ensuing fire to spread rapidly thus making effective fire fighting almost impossible and extremely hazardous. In such cases, the complete loss of the building is almost inevitable. Panel systems that prevent, or restrict delamination should be viewed as presenting less of a risk than those that do not.

1.6 Internal use of sandwich panels

The majority of fires where sandwich panels have been identified as being the main mechanism in fire spread have concerned their use internally in the food industry (see 5.1 for typical causes). The dominant panel type, used to enclose food production areas has been metal faced expanded polystyrene. Recent unpublished investigations by BRE have indicated that poor levels of fire safety management were also a major influence.

1.7 External claddings

Fire spread via the external envelope is not so common and therefore does not have the same level of risk. Fire statistics confirm this and replacement of such panels is probably not justified. Some reasonable control on fire performance may be needed, particularly for higher risks. It may not be necessary to replace all external envelopes (claddings) installed in existing buildings provided there are other compensatory risk improvements.

Sandwich panels systems used for external claddings typically have a polyurethane core and are supported inside the building by purlins and mid rails at frequent spacing. Polyurethane is a thermo-setting plastic which, whilst it burns, also forms a char layer. The end use requirements for external cladding panels make it important that they are assembled with weather-tight joints and this may also help to improve fire performance. In addition, the internal framework tends to act to some extent as a barrier to internal flame spread. External cladding may be the subject of an arson attack, so adequate precautions need to be taken to minimise this.

External cladding may be involved later in the fire when the contents of the building have become fully involved in the fire.

2 Definitions

2.1 Non combustible

A material that when tested to BS 476: Part 4:1970, non-combustibility test for materials, meets the requirements for non-combustibility.

2.2 Limited combustibility

Materials of limited combustibility

a any non-combustible material;

b any material of density 300kg/m^2 or more which, when tested to BS 476: Part 11:1982, method for assessing the heat emission from building products, does not flame and the rise in temperature on the furnace thermocouple is not more than 20°C;

c any material with a non-combustible core at least 8mm thick having combustible facings (on one or both sides) not more than 0.5mm thick (where a flame spread rating is specified, these materials should also meet the appropriate test requirements);

d any material of density less than 300kg/m^2 which, when tested to BS 476: Part 11, does not flame for more than 10s and the rise in temperature on the centre (specimen) thermocouple is not more than 35°C and on the furnace thermocouple is not more than 25°C.

3 General

3.1 Importance of risk assessment

In reaching a decision on the suitability of a sandwich panel system for a particular function or application, due regard should be taken of the likely chance of ignition as well as the nature of any inception risk, fire load in the building and the potential to involve the panels. Also the financial exposure needs to be considered. Experience from fires in food factories has indicated that fires start often because of poor standards of fire safety management. Whilst better performing sandwich panel systems will slow down or prevent the spread of fire, an adequate standard of fire safety management is still needed as discussed in the following section.

As the risk gets higher, due to a combination of these factors, there will be a need to put more emphasis on non-combustible sandwich panels. Conversely, for low risk applications (eg secure, stand-alone cold stores) it may be possible to accept sandwich panels that do not meet the LPS 1181 requirements.

This is illustrated in Appendix 1.

3.2 Fire Safety Management

The risk of combustible sandwich panels contributing to the spread of fire may be significantly reduced by the maintenance of a good standard of fire safety management.

With respect to combustible sandwich panels, the following factors are of particular importance in assessing the hazard that the panel(s) represent:

- Processes which are a potential fire hazard should be located well away from sandwich panels.
- Combustible materials should not be stacked near to the surface of panels. Timber or plastic pallets should not be stacked close to combustible sandwich panels, a 10m break being widely recommended.
- Forklift truck battery charging should be located well away from sandwich panels unless the sandwich panel system can be identified as having at least 60 minutes fire resistance.
- Automatic fire suppression systems, appropriate for the process, should be fitted to all heating and cooking equipment.
- Flues used to extract hot gases should not pass through combustible sandwich panels unless adequately protected.
- As far as possible, services penetrations through sandwich panels should be avoided. If this is not possible, any gaps should be adequately fire stopped.
- Electrical cables passing through sandwich panels should always be enclosed in a metal conduit.
- Electrical equipment located near sandwich panels should be examined and tested at least annually.
- Attaching items to sandwich panels should be avoided. Where this is not possible, care should be taken to ensure that the core is not left exposed or damaged.
- The building should be sub-divided into a number of fire resisting compartments wherever practical.
- The use of full sprinkler protection to the factory should be encouraged.
- Unauthorised access to the external cladding should be prevented to reduce the possibility of an arson attack.

3.3 What are sandwich panels used for?

Typical applications for sandwich panel systems are as follows:

3.3.1 External claddings

These are used for single and occasionally multi-storey buildings. Polyurethane is the most common core insulation used for this application. Sandwich panels used externally have to withstand wind-loads and also be weather-tight. There are far fewer instances of external envelopes being the cause of severe fire spread compared to insulated internal envelopes used for example to enclose food processing areas in food factories.

3.3.2 Insulated internal envelopes and partitions

These are used typically in food factories, cold stores, pharmaceutical industries, other temperature controlled envelopes and high tech clean rooms. Expanded Polystyrene (EPS) is by far the most common core insulation used for these applications.

3.3.3 Fire resisting compartment walls

Masonry is not the only solution for compartment walls. Some sandwich panel systems can be used very successfully in this application. High-density rock-fibre mineral wool is commonly used for this application as it can easily provide panels with 90 minutes and up to 240 minutes fire resistance. It is important to ensure that the panel system provides adequate insulation to ensure that combustible materials in direct contact with the unexposed panel side will not ignite. (That is the purpose of the insulation requirement in the fire resistance test)

It is also essential that the junction between the compartment wall and the building envelope be designed to prevent fire spread round the perimeter of the fire resisting compartment wall.

3.4 Which insulants are used in sandwich panels?

These are presented in approximate order of frequency of use

3.4.1 External roof and wall applications

- Polyurethane (PUR)[1]
- Polyisocyanurate (PIR)[1]
- LPCB approved Polyisocyanurate (PIR)(these can be regarded as having better quality and fire performance than the standard PIR)[1]
- Mineral wool (rock fibre) (MWRF)
- Expanded polystyrene EPS, supplied in standard duty (SD) and high duty (HD)[2] [Small historic usage, <0.5%, in architectural wall panels]
- Mineral wool (glass fibre) (MWGF) (Occasional historic use)

3.4.2 Internal wall, partition and ceiling applications

- Expanded polystyrene EPS, supplied in standard duty (SD) and high duty (HD)[2,3]
- Extruded polystyrene (XPS)[4] (behaves similarly to EPS in fire conditions)
- Polyurethane (PUR)
- Polyisocyanurate (PIR)
- Mineral wool (rock fibre) (MWRF)
- Modified Phenolic foam (MPHEN)
- Cellular glass insulation (CG) (Occasional historic use)

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1 Together PUR and PIR account for at least 90% of external applications
2 For many years only FR (Flame Retardant) grades of EPS have been used. (Reaction to Fire Classification Euroclass E)
3 New EN Standards have resulted in a change in nomenclature - SD becomes EPS 70 and HD becomes EPS 100
4 XPS is only supplied in Flame Retardant grades (Reaction to Fire Classification Euroclass E)

3.5 What are the problems associated with sandwich panel systems?

Not all sandwich panels present an undue fire risk. Panel systems based on combustible cores vary significantly in their fire performance.

Many of the thermal insulating products used in sandwich panel systems are combustible. (e.g. EPS,XPS, PUR, PIR) When openly exposed to a fire they will burn. The potential to ignite is dependant on the size of the ignition source/inception risk and also on the specific type of combustible core. EPS will tend to shrink away from a small ignition source but when exposed to a large heat source will burn and produce molten droplets which have the ability to re-ignite once the ignition source is removed if sufficient heat has been trapped in the panel (any combustible residuals in any material/product may continue to flame after removal of an ignition source for a period of time). PUR will burn before producing a char layer. LPCB approved PIR and Phenolic materials show less tendency to burn. Joint design and method of support can also have a significant effect on fire performance. Cores can become directly exposed to the fire if the facings become delaminated. This can be experienced particularly with self-supporting internal panels which are not secured and where early collapse is possible.

Where the ignition source is sufficiently large, or where the contents of the building are already burning, some panel systems may make a significant contribution to the fire. This is particularly true for combustible cored sandwich panels used internally (not part of the external envelope) where the fire load represented by the relatively thick panels may in some cases be higher than the contents of the building. It is important to take into account the fire load represented by the sandwich panels, with allowance being made for how much of the material is likely to be consumed in a fire.

Sandwich panel systems approved by LPCB to LPS 1181 will not make a significant contribution to a fire.

Unless it can be proven otherwise, it should be assumed that sandwich panels contain a combustible insulation. LPCB approved sandwich panels should be clearly marked (as should all panels to ease identification). Some LPCB approved products are marked with an UV (ultra-violet) identification mark.

3.6 Why are combustible products used in sandwich panels?

Combustible insulants are often specified in preference to non-combustible materials when taking into account other properties meeting design needs.

The use of roof and wall panels with polyurethane cores in the external envelope has quadrupled over the last ten years. The primary reasons are enhanced and consistent thermal performance, light weight (compared to rock-fibre mineral wool cores) build speed and installation cost. Building Regulations specify thermal insulation requirements.

For the internal partitions of food processing factories expanded (or extruded) polystyrene has been specified for the past 20 years as the dominant core insulant in food factories. This is because of low cost, resistance to moisture, hygiene considerations and its light weight, aiding demountability and re-use.

More discussion on this may be found in ABI Research Report Number 6, 'Appraisal of the performance and cost effectiveness of using factory produced metal faced sandwich panels in building applications.'

3.7 What is the difference between structurally supported external sandwich panel systems and internal panel systems?

Sandwich panels (typically with rigid polyurethane cores) used for external envelopes are used with the necessary supporting structure and are therefore less likely to become delaminated in a fire. Purlins and mid-rails may make some contribution in controlling flame spread across the surface. This can be confirmed by observations during numerous tests to LPS 1181. However, the fire performance of such panels is very dependent on the formulation and type of blowing agents used. Consequently, unless the products are certified by LPCB to LPS 1181, their actual fire performance cannot be quantified.

Sandwich panels installed inside the building to enclose food processing areas (typically EPS), in the form of partitions, ceilings and wall linings, are often inadequately supported and have inadequate joints. This leads to premature delamination of the metal face, rapid combustion of the cores and premature collapse of the panel. In these circumstances fire fighting becomes at best ineffective (as well as dangerous). In the IACSC guide, some guidance is given to designers to improve joint and support conditions. The majority of food factories probably do not yet incorporate the latest improvements, but many of the recommendations can be installed after the initial construction.

3.8 Which types of sandwich panels should be avoided?

This is really dependent on the assessed risk level of the occupancy/occupancy type, and whether the panels are used for the external envelope or inside the building.

Care is required when assessing panel specifications. Panels approved for external cladding should not be assumed to be approved for internal applications. Some approved manufacturers market both approved and non-approved sandwich panels. At least two manufacturers use the same reference for the approved panel as for the non-approved panel. Look for the addition of LPC/LPCB within the reference. If in doubt written proof should be obtained from the architect/contractor or panel manufacturer.

ABI sponsored research has clearly shown that fire performance can be improved by better joint design and how the sandwich panels are supported to any framework. It is suggested that unless the risk is considered low, sandwich panels that have not been approved are best avoided, particularly in respect to internal applications involving hot food processes.

Some improvement in fire performance can be obtained from EPS panels having mineral wool edges. Some manufacturers refer to these as fire stop panels. It is important that combustible materials are not stacked too close to the panel surface because of potential conduction of heat through the panel thickness if a fire occurs on one side, enabling fire to spread.

Research has shown that it is more difficult to get good fire performance from sandwich panels having flat surfaces, which are supported from outside (or freestanding), such as those typically used in the food industry.

3.9 Do sandwich panels create problems when fighting a fire?

There are concerns that combustible sandwich panels used inside the building (not part of the external fabric) may create an additional problem to fire fighters unless the building is fully sprinkler protected or is sub-divided by fire resisting compartment walls.

The Fire Services are in general less concerned where sandwich panels are used as external roof and wall claddings, securely fixed to the structural frame of the building, since these do not represent the same danger to life during fire-fighting.

Sandwich panels approved by LPCB to LPS 1181 should not create a problem for fire fighting if adequately supported, as any burning is considerably reduced. However, for the more combustible materials, fire-fighting experience has shown that problems do occur, particularly for sandwich panels used internally in the food industry. It is not easy to detect or get to a fire burning within a combustible panel. In such circumstances, not only do the burning building contents have to be dealt with, but the sandwich panels as well. Consequently there is a greater possibility of significant fire damage, as the fire load is greater.

In reality, the problems experienced by the fire brigade are as much due to lack of fire resisting compartmentation or fire suppression as the volatile nature of certain types of inadequately specified sandwich panel systems.

3.10 Fire growth and post-flashover

From initiation to decay, the two main stages of a fire of particular relevance to sandwich panels are fire growth (pre-flashover) and fully developed (post-flashover).

This is illustrated in Appendix 2.

Fire growth has always been at the forefront of LPC and BRE research and the evolution of the LPS 1181 test addresses one of the main factors that could differentiate between a controllable incident and a total loss.

Post flash-over in modern insulated buildings relates more to the developed stage of a fire and thus the requirement for fire resisting compartmentation. This is the basis for the LPS 1208 test.

3.11 What is LPS 1181?

In the context of this document, LPS 1181 is a test to evaluate the performance of sandwich panel systems to assess their contribution to fire growth. Panels satisfying the requirements of LPS 1181 will not make a significant contribution to fire growth.

Fire growth is explained in clause 2.2 of the LPC Design Guide for the Fire Protection of Buildings. This represents the earlier stage of a fire before the room or compartment is fully involved in the fire. Sandwich panels that have passed this test are currently given the grade B designation in the LPCB List of Approved Fire and Security Products and Services (grade B designation is explained in Section 4.4).

The test comprises building an open-ended enclosure (approximately the size of a large domestic garage) from the sandwich panels with a timber crib located in one corner. It tests not only the panels, but also the jointing methods and supporting system as well. This gives a more precise evaluation of true fire performance than the small-scale reaction to fire tests used by regulators, such as the surface spread of flame and fire propagation tests.

Recent developments have led to the standard being split into two parts. Part 1 deals with external claddings. Part 2 with internal enclosures and linings used typically in the food or cold store industry. BRE research has confirmed that if panels are supported from outside the enclosure (as has been the standard practice in the food industry), a worse fire performance is achieved. Consequently a clear differential between the two applications is necessary. In addition, because of the range of risks attributed to internal applications, a more intense heat exposure is specified for high risks such as cooking areas. The need to contain the fire is also important so, for higher risks in the food industry, fire resistance is also specified. (See LPS 1208).

The following summarises the criteria in LPS 1181 used as a basis for determining performance:

Flashover: There should be no flashover at the ceiling (based on a defined temperature limit not being exceeded).

Internal Surface Flaming: There should be no sustained surface flaming beyond 1.5m from the perimeter of the crib in both horizontal directions (e.g. outside crib fire area).

External Surface Flaming: There should be no flame spread at any location on the external surface of the test building.

Concealed Burning/Damage: Should be within defined limits, based on charred/damaged area of core, see LPS 1181 for more information

Burning Brands: There should be no fall of burning brands from the ceiling outside the vicinity of the crib fire area

Stability: (Internal applications only) This will be satisfied if no part of the test building collapses during the fire test. This will be deemed to have occurred if the deformation exceeds 1/30 of the distance between the ceiling support centres. Delamination of the exposed skin from the core should not be judged under this criterion

3.12 What is LPS 1208?

LPS 1208 is the standard for evaluating the fire resistance of an element of construction with specific application to compartment walls and floors. Fire resistance is related to the fully developed or post-flashover stage of a fire. This is the phase of the fire where all the contents in the room or in the vicinity of where the fire originates are fully involved and are burning. The basic objective is to maintain the structural integrity of the building and to prevent the spread of fire into other compartments. Furnaces are used to test elements of construction for fire resistance.

Criteria used for panel assessment are integrity (no gaps that allow fire and smoke to get through) and insulation (combustible materials on the non-fire side cannot become ignited).

LPS 1208 uses the methods of test described in BS 476:Part 20/22:1987 or EN equivalent.

Test reports express the result in terms of integrity and insulation. An example of which is given below:
Integrity: 240 minutes
Insulation: 15 minutes*

* The insulation value should be noted in particular as this is more indicative of real fire performance.

Some sandwich panels may have only been evaluated to LPS 1208 and listed by LPCB because of their specific application in the building. This is particularly true for panels used in compartment walls. However, as most systems having fire resistance above 60 minutes are non-combustible, they therefore meet the requirements without the need for testing to LPS 1181.

4 External claddings

4.1 Overview

Approved Document L supports Building Regulations in England and Wales and now requires a higher standard of thermal insulation and air-tightness for the external envelope. Published fire statistics tend to show that external claddings constructed from sandwich panels are not a major fire risk, particularly if the chances of an arson attack can be reduced and its effect minimised. It is important to ensure that no combustible materials such as pallets are located less than 10m from the external wall.

Over a five year period, total **reported** losses that were directly attributable to external claddings of all kinds was £8,688,875 of which £6,387,875 was due to Arson. These figures do not include business interruption claims, which may add a further 50-100% to costs in some cases. Typical causes of ignition in the above were:

Table 1 Fires in external claddings (based on FPA data)

Number	Cause
33	Arson/under investigation
6	Electrical/gas
4	Rubbish/smoking
1	Spontaneous
2	Unknown

Note: The above was recorded over a five-year period. See also a summary of the losses in the food industry over the same period (Table 2, Section 5.1).

The number of fires given in Table 1 do not take into account the contribution that claddings make when the goods in the building are fully involved in the fire. In such cases, the cladding will be severely damaged regardless of the type of core used (combustible or non-combustible). In order to avoid such potential losses attention should to be given to fire safety management, early suppression and fire resisting compartmentation.

4.2 New buildings

For new buildings serious consideration should be given to the use of the better performing LPCB approved sandwich panels to LPS 1181 for external claddings in any of the following circumstances, taking account of the other factors identified as critical in fire ignition risk and spread:

- High financial exposure
- Buildings containing hazardous processes
- High fire load
- Potential for arson attack
- Storage risks
- Buildings that are not sub-divided with fire resisting compartmentation and have a floor area in excess of 4000m^2

The value of products certified to have higher fire performance characteristics can often be demonstrated by undertaking a cost:benefit analysis taking account of build and running costs, including insurance, and the likelihood of loss (particularly where the policyholder would normally retain a significant proportion of the risk

or where significant deductibles would be applied) over the medium term. Insurance costs and terms, with and without certified products and other fire safety management measures, should be assessed in order to inform customer decisions, working with brokers and risk managers as appropriate.

4.3 Existing buildings

The importance of the risk assessment cannot be over emphasised for existing buildings. It may not be practical or necessary to replace existing claddings. In assessing the need for risk improvements key areas for consideration are:

- Improved levels of fire safety management
- Improvements to security to reduce the possibility of an arson attack
- Removal of all combustible materials stored outside the building to a safe distance (say 10m away)
- Segregation of high fire loads/high risks by using fire-resisting compartmentation.
- Fitting an automatic sprinkler system.
- Attention should be given to the design of eaves, especially where combustible materials are stored externally.

4.4 LPCB Grading of sandwich panels used as external claddings

External claddings that are LPCB approved to LPS 1181 can be regarded as satisfying the original grade 2 construction rules or be classed as a non-combustible building. (Note: This grading does not imply that the material is non-combustible). In the past, LPCB approved panels have been graded simply as grade A or B.

Grade A panels, in addition to meeting all the requirements of LPS 1181, also meet the fire resistance requirements of LPS 1208. Typically with a performance of 30 minutes integrity (formation of gaps do not develop that will allow fire to pass through) and 15 minutes insulation (combustible materials in direct contact will not ignite).

Grade B panels meet fully the requirements of LPS 1181 but do not have fire resistance to LPS 1208.

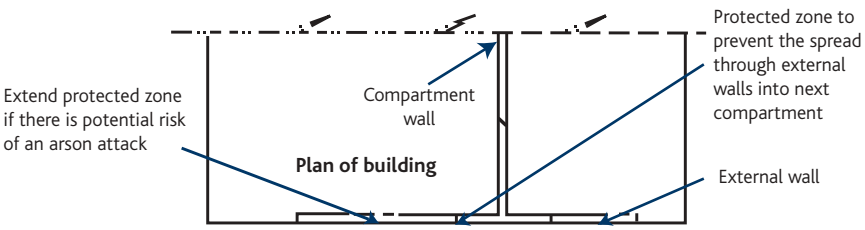
This simple grading method is no longer adequate, as it is important to differentiate between approved panels suitable for external applications and the designation EXT A and EXT B will be used (see Appendix 3). In addition, the LPC Design Guide for the Fire Protection of Buildings recommends higher levels of fire resistance in certain circumstances.

4.5 Protected zone

This relates to the sections of the roof, external walls and supporting frame of single-storey buildings adjacent to a compartment wall. For a suitable distance on each side of the wall these will have to have fire resistance. This is to prevent the fire breaking through via the external cladding. LPC recommended levels of fire resistance are given in Appendix 3.

When an arson attack is possible, and it is not practical to remove combustible materials stored close to the external surface, careful consideration should be given to the need to extend the proportion of the external wall to be made fire resisting.

Protected zone to reduce the risk of fire spread



5 *Sandwich panels used internally in food factories*

5.1 Overview

Fire statistics clearly show that it is the unsuitable use and management of sandwich panel systems in food factories that is the principal reason for rapid fire spread. The reasons for a fire starting vary and some causes of ignition in food processing areas from cases which have been reported as ultimately involving the sandwich panels, are listed below:

- Debris in the base of an oven
- Oil-heated to above its flash-point
- Discarded smoking material in a packaging store
- Oil deposits on filters ignited from a spark from an oven
- Badly maintained deep fat fryer
- Oil ignited in a bund surrounding an oil holding tank
- Sparks from a smoke box containing burning sawdust igniting tarry residue on pipework
- Arson
- Inappropriate specification for conveyor belting
- Badly maintained or used radio frequency defrosting ovens

Much of the above can probably be identified as being due to inadequate levels of fire safety management. This is clearly an important issue to consider in addition to the fire performance of the construction products. Estimated fire losses in food factories over the period 1991 to 2002 are shown below:

Table 2 Food factories

Property losses (Based on FPA data and other sources)[5]	
Year	Loss (millions of pounds)
1991	12
1992	24
1993	17
1994	8
1995	54
1996	36
1997	31
1998	91
1999	65
2000	9
2001	17
2002	61
Total	**425**

5 FPA statistics understate total market losses since returns are voluntary and are known to be incomplete. It is believed that figures for 2000 and 2001 are particularly affected due to significant numbers of loss reports not being reported during industry re-structuring, and due to a major insurer active in this market going into liquidation in June 2001.

This equates to an average loss per year of about £35,400,000. The above figures do not include business interruption costs that are typically about 50% to 100% or greater than the values recorded for property damage. They also exclude losses in the Republic of Ireland market, which are running in excess of 83,000,000 euros for the period 1999-2002.

It should be noted that the majority of the above cases relate to cooking risks or malfunction of equipment.

5.2 Relative fire growth performance

Comparative fire performance experiments, funded by ABI, on sandwich panels tested in food panel configuration, have been undertaken by LPC/BRE. Joint design was found to be very important on the rate of involvement of panels. Large-scale testing to LPS 1181 with the panels supported from an external frame has confirmed that adequate levels of support are of vital importance, particularly for ceilings.

5.3 LPC recommended performance for internal applications

5.3.1 LPCB Grading of sandwich panels used for internal applications

For internal enclosures, designations INT 1, 2 and 3 have been adopted in LPS 1181:Part 2 (see Appendix 4)

The purpose of the more complex grade system is to ensure that designers specify the right product for the specific application.

5.3.2 Food factory applications –new buildings

LPC recommended requirements are detailed in Appendix 4, which should be read in conjunction with the LPC Design Guide for the Fire Protection of Buildings. INT-1 can be regarded as meeting the high-risk classification and INT-2 the normal risk classification of Part 7.2, the only change being that both LPS 1181 and the LPS 1208 methods are used. Panels approved to LPS 1181 or 1208 may only be used up to the limits defined by their Field of Application.

5.3.3 Food factory applications-existing buildings

Due to the potentially higher risks associated with food processing at elevated temperatures some replacement of sandwich panels in designated high risk areas may be considered necessary, although the same options given for external claddings may be appropriate in certain circumstances (see Section 4.3.). Such a decision will depend on, for example:

- Presence of an automatic extinguishing system in cooking and other high risk areas such as packaging/storage or if the facility is fully sprinkler protected
- Standard of fire safety management, with particular reference to maintenance of equipment that presents an inception risk
- Presence of fire resisting compartmentation
- Attitude of building operator to fire risk management
- Presence of unprotected conveyors

6 *Sandwich panels used in cold store buildings*

6.1 Overview

Stand-alone cold stores may be considered as a lower risk and therefore may be rated separately, subject to the risk assessment, which would take into account the financial exposure, building size and other relevant parameters set out below. Few large fires have been reported in stand-alone cold-stores, which are not attached to a hot food processing plant.

Based on FPA data, the total loss in cold-stores between 1990 and 2000 was approximately £12,000,000, or an average of £1,200,000 per year. These figures do not include business interruption claims, which may add a further 50-100% to costs in some cases.

The risk assessment must consider the possibility of an arson attack and this can be minimised by ensuring the cold-store is on a secure site. A good standard of fire safety management should also be implemented to reduce the possibility of malfunction of equipment that might cause ignition.

6.2 Performance requirements

6.2.1 Stand-alone Cold store applications-new buildings

Particularly where the arson risk can be minimised, this should normally be regarded as a low risk but this will also depend, for example, on the financial exposure. For high financial exposures risk management measures may need to include the use of panels be certified to LPS 1181: Part 2. Any restrictions on height or maximum support centres imposed by LPCB on systems certified by them must be complied with.

For other cold store applications, fire-stop panels, as defined in the IACSC Design, Construction, Specification and Fire Management of Insulated Envelopes for Temperature Controlled Environments or panels approved to LPS 1181 should be considered.

6.2.2 Stand-alone Cold store applications-existing buildings

The risk assessment should take into account the standard of fire safety management, the potential for arson and the financial exposure. If the risk is not acceptable and it is not practical to replace existing panels then alternative fire protection strategies should be considered.

6.2.3 Cold stores attached to food processing plant

The preceding approaches may not be appropriate in cold stores attached to a hot food processing plant, due to the greater ignition risk. In such circumstances improvements in fire risk can be achieved by measures such as separating the cold store from the food processing area by a wall having a fire resistance not less than 90 minutes (integrity and insulation) with all openings protected to the same standard.

7 *Sandwich panels used as compartment walls*

7.1 Overview

Many sandwich panel systems provide some degree of fire resistance. As combustible materials may be in contact with the wall, it is important that the wall provides sufficient protection. The main applications for compartment walls in the LPC Design Guide for the Fire Protection of Buildings are from 90 to 240 minutes fire resistance (integrity and insulation). This tends to restrict the choice currently to high density (HD) Rock Fibre mineral wool cored sandwich panel systems with suitable jointing and supporting systems, that have been tested and shown to achieve the required fire resistance. Their suitability for greater heights and widths will need to be demonstrated by an appropriate field of application. However, these are a good substitute for more conventional masonry walls.

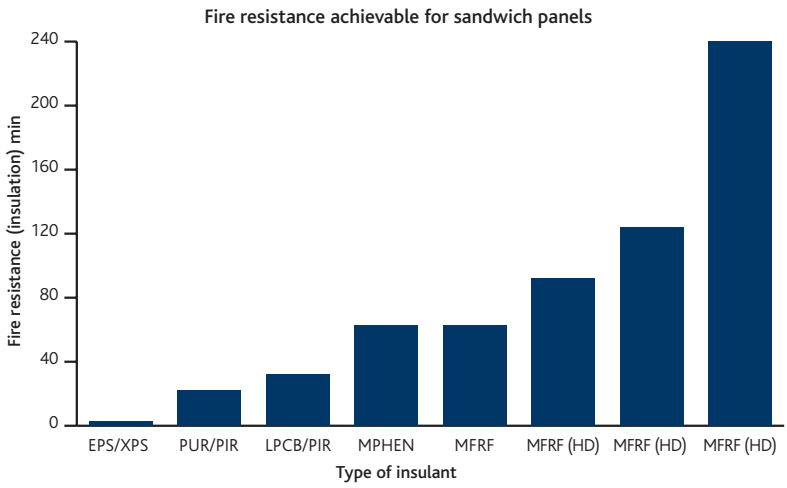
Where only 60 minutes fire resistance is specified, sandwich panel systems using either rock fibre mineral wool, cellular glass, or modified phenolic can also be used as compartment walls.

7.2 Typical fire resistance

Typical fire resistance performances are given below for the most common sandwich panel systems but some variation should be expected from one manufacturer to another depending on panel joint design and method and spacing/number of supports..

With cellular plastic core materials, fire resistance in general increases with panel thickness. In the case of rock-fibre mineral wool panels, fire resistance is primarily a function of increasing density as well as thickness.

LPS 1208 provides a basic standard for panel systems used in compartment walls.



8 Conclusion

Whilst experience suggests there are particular difficulties associated with buildings containing sandwich panel systems, the fundamentals of fire hazard assessment and insurability apply just as for other types of risk where significant fire loads are present. Each risk should be assessed on its merits. The importance of adequate and specific risk assessment cannot be over-emphasised, with particular importance placed on the standard of fire safety management as a key element in the fire risk strategy. Sandwich panels do not start a fire on their own.

Statistics show that the majority of fires where fire spread has involved combustible sandwich panels has occurred in food processing factories. A significant number of these fires have started in high risk areas, such as cooking areas. Poor fire safety management and prevention/containment measures have typified these losses. Reducing future losses requires all three contributory factors to be addressed with the prevention of ignition and early spread being critical. However this requires a significant improvement in the standard of fire safety management practiced by many businesses. This may not be achievable in all circumstances and where this is the case, avoidance (new build) or replacement (existing buildings) of low performance panel systems may be the most appropriate approach.

Few fires have occurred in stand-alone cold stores and these should normally be regarded as low risk, with a consequent reduction in the need for more demanding panel system performance or risk management requirements.

Fire statistics confirm that fire spread via the external envelope is not common and therefore does not in general represent a high level of risk. Replacement of such panels is probably not justified in many circumstances particularly where there are other compensatory risk control measures. Some reasonable control on fire performance may be needed, particularly for higher risks.

More generally, many factory buildings do not incorporate the fire resisting compartment walls which can make a significant contribution to reducing the spread of fire as well as providing conditions in which fire fighters assess it as safe to enter the building in order to actively fight, rather than contain, the fire. As a consequence sub-compartmentation should be considered, but if it is, then it must be carried through the roof spaces. Fire safety measures such as these are as vital a part of the risk management process as the presence or absence of sandwich panels and their relative fire performance.

9 *Useful references*

9.1 General

The LPC Design Guide for the Fire Protection of Buildings 2000, Fire Protection Association

ABI Research Report number 6, Appraisal of the performance and cost effectiveness of using factory produced metal faced sandwich panels in building applications, Association of British Insurers

Appendix F, Fire Behaviour of Insulating Core Panels used for Internal Structures, Approved Document B, 2000 edition, Office of the Deputy Prime Minister.

LPS 1181 Requirements and tests for LPCB approval of wall and ceiling lining products, Loss Prevention Certification Board, BRE Certification Ltd: (© BRE Certification Limited)

Part 1: External Claddings
Part 2: Internal Claddings

LPS 1208-2, LPCB Fire resistance requirements for elements of construction used to provide compartmentation (© BRE Certification Limited)

9.2 External claddings

EPIC (Engineered panels in construction) Insulated panels for external roof and wall cladding. (This is most relevant to rigid polyurethane products).

9.3 Insulated envelopes for temperature controlled environments

International Association of Cold Storage Construction (European Division), Design, Construction, Specification and Fire Management of Insulated Envelopes for Temperature Controlled Environments.

9.4 Fire Safety management

LPC Code of practice for Fire Protection in the Food and Drink Industry

Cold Storage and Distribution Federation, The RFIC (Refrigerated Food Industry Confederation) Guide to the Management and Control of Fire Risks in Temperature Controlled Structures of the Refrigerated Food Industry.

Fire Protection in the Food and Drink Industry, Fire Protection Association

Fire Risk Minimisation Guidance, Food Industry Panels Group

Guidance on Fire Safety at Work, Fire Protection Association

Business Fire Risk Assessment Guide for Small Businesses, Fire Protection Association

Arson Risk Assessment Checklist for Industry and Commerce, Fire Protection Association

9.5 Useful website addresses

A wide range of references are included for information but the views expressed or advice given is not necessarily endorsed by ABI or BRE.

Arson Prevention Bureau	**www.arsonpreventionbureau.org.uk**
Association of British Insurers	**www.abi.org.uk**
Association of Insurance and Risk Managers	**www.airmic.com**
BRE Certification Limited and Loss Prevention Certification Board	**www.brecertification.co.uk**
BRE/FRS	**www.bre.co.uk**
British Rigid Urethane Foam Manufacturers Association	**www.brufma.co.uk**
Engineered Panels in Construction	**ww.epic.uk.com**
European Extruded Polystyrene Insulation Board Association	**www.cefic.org**
European Manufacturers of Expanded Polystyrene	**www.eumeps.org**
European Phenolic Foam Association	**www.epfa.org.uk**
Fire Protection Association	**www.thefpa.co.uk**
Food Industry Panels Group	**www.infoatfipg.com**
International Association of Cold Storage Construction	**www.iacsc.org**
Office of the Deputy Prime Minister	**www.odpm.gov.uk/safety**
PANAMA INTERNATIONAL - International Association of Sandwich Panels Manufacturers	**www.panama-international.org**
UK Mineral Wool Association	**www.eurisol.com**

Appendix 1

– Risk Matrix

This diagram is intended to illustrate the importance of considering the risk of ignition together with the potential level of the inception risk or financial exposure. This is particularly important when considering the relative risks between a cooking area of a food processing factory and a low risk area. External panels rarely become involved at the inception stage, unless subjected to an arson attack. These are intended to be examples only and will depend on the judgement of the individual insurer.

Example 1
Food factory, good standard of fire safety management

Inception Risk	Possibility of Ignition			
	Little possibility of ignition	Some possibility of ignition	Reasonable possibility of ignition	High possibility of ignition
No inception risk	**Very low risk** Washing area, good standard of fire safety management, EPS/XPS/PUR panels may be acceptable			Medium risk
Small size inception risk		Fire stop panels	Fire stop panels	
Medium size inception risk		Fire stop panels	LPCB approved panels to LPS 1181:Part 2 for internal enclosures (INT-3)	LPCB approved panels to LPS 1181:Part 2 for internal enclosures (INT-2)
Large inception risk	**Medium risk**		LPCB approved panels to LPS 1181:Part 2 (INT-2)	High risk Cooking area Only LPCB approved panels (INT-1) to LPS 1181:Part 2 acceptable

Example 2
Secure Cold Store, good standard of fire safety management. As inception risks are lower, this example takes into account financial exposure.

Financial exposure	Possibility of Ignition			
	Little possibility of ignition	Some possibility of ignition	Reasonable possibility of ignition	High possibility of ignition
Low financial exposure	**Very low risk** Any Combustible panel(EPS/XPS/PUR) panels may be acceptable			**Medium risk** Fire stop panels
Medium financial exposure			Fire stop panels	
High financial exposure		Fire stop panels	LPCB approved panel to LPS 1181 INT-3	
Very high financial exposure	**Medium risk**			**High risk** LPCB approved panel to LPS 1181 INT-2

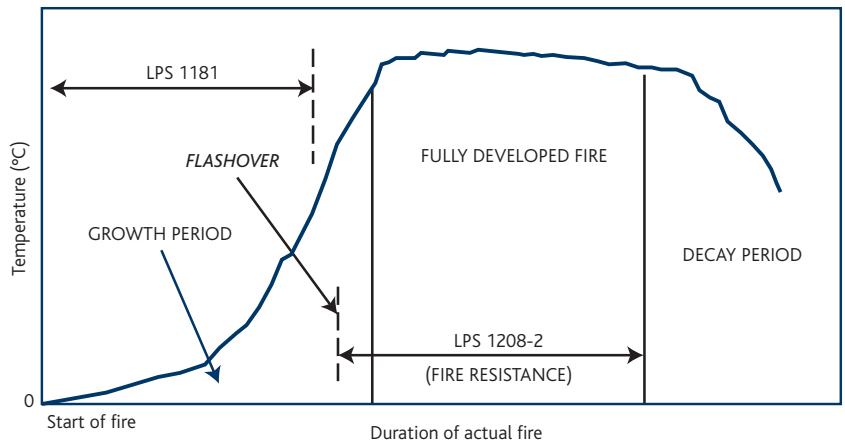
Appendix 2

– Fire curve

It is important for insurers to understand the fire curve, which is typical of any fire. Whilst the temperatures reached and the duration of the fire varies, the basic stages of the fire remain the same.

The importance of this diagram is that it clearly shows that LPS 1181 deals with the growth stage of a fire and LPS 1208 deals with the post-flashover stage when the whole area is fully involved with the fire. Test methods tend not to cover the decay period of a fire.

Typical compartment fire



Appendix 3

– Recommended fire resistance levels for the protected zone

This is for guidance only and is subject to the risk assessment carried out by the insurer.

GRADE (See LPS 1181:Part 1)	Integrity (minutes)	Insulation (minutes)	Typical application (see Table 2.2 of Design Guide)
EXT-A60	60	60	4b Retail warehouse and superstore 6b Industrial and 7a Storage
EXT-A30	30	30	4a Shop and Commercial and 6a Industrial
EXT-A15	30	15	Fully sprinklered buildings

It needs to be noted that for this application, the current grade A panels which only achieve 15 minutes insulation are only considered to be suitable when the building is fully sprinkler

Appendix 4

– Recommended performance levels for internal applications

protected.

The following will be inserted in the next issue of the LPC Design Guide for the Fire Protection of Buildings. This covers the use of sandwich panels used inside the building as partitions and ceilings. Typical applications are food industry.

Grade	Requirements for internal applications LPS 1181: Part 2			
	Fire resistance		Wall and ceiling lining test	
			Thermal exposure	
	Integrity	Insulation	Level	Source
	(minutes)	(minutes)		
INT-1	60	60	Enhanced	Gas burner
INT-2	30	30	Standard	Timber crib

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