EPIC
ENGINEERED PANELS IN CONSTRUCTION

Insulated panels for external roof and wall cladding

A guide to fire safety, specification and installation

Foreword

Insulated panels are used extensively for the external roof and wall cladding of buildings in most construction sectors. They are selected for their thermal and energy saving properties and their construction and installation benefits. Insulated panels are single piece factory engineered units comprising two metal faces and a fully insulating core. The core is with few exceptions either polyurethane/polyisocyanurate or mineral fibre.

The performance in fire of insulated panels has only recently been analysed in depth. In particular studies have highlighted the differences in design, materials and method of fixing between external roof and wall panels and other sandwich type panels designed specifically for internal applications.

External roof and wall panels are uniquely designed for the external envelope and are securely fixed to the main building structure. They perform totally differently in fire compared to free standing internal systems. This is born out by large scale tests and real fire scenarios. Studies have also shown that rarely have external roof and wall panels been involved in the initial stages of a fire, only becoming involved as a result of a fully developed fire.

The Guide has been prepared to provide comprehensive information on the fire performance, specification and installation of external roof and wall panels.

New fire classifications

New European harmonised fire tests and classifications were agreed in 2001. These will be gradually adopted in England, Wales and Northern Ireland and in Scotland from 2002 replacing the current BS 476 requirements. There will be a transition period before the substitution of the relevant parts of BS 476 by the harmonised classes.

The Guide describes the new European classifications and illustrates their relationship to the current requirements.

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New thermal performance requirements

In addition to the requirements for fire performance, specifiers and designers must also take into account the new thermal transmission and airtightness regulations for the external roof and wall systems of buildings [Amendment to Building Regulations: Approved Document L2: 2002 [1]]; and in Scotland the new thermal transmission requirements in the 6th Amendment to the Technical Standards Part D.

The Guide illustrates that the latest junction details, which have been designed to meet these Regulations, can readily be combined with good fire engineering practice.

The guide

The guide is effectively divided into two parts.

Sections 1 to 8 review the history of insulated panels; their performance in fire; and the regulatory requirements for external cladding and roofing in England, Wales and Northern Ireland and also in Scotland. Additional fire precautions that may be desirable to minimise property damage and business interruption are also covered together with an overview of fire safety engineering techniques and how they may be applied to assess the impact of materials used in the external building envelope.

In the second part, Sections 10 to 13 consider the practical issues affecting panel specification, design and installation from a fire performance viewpoint. Checklists have also been added to assist designers and installers, including recommended information sheets for inclusion in the CDM health and safety file.

A substantial number of major fires can be attributed to the poor management of fire safety both during construction and maintenance operations and as part of the day-to-day operation of the building. An additional Appendix provides guidance on the fire safety procedures that are appropriate where construction work is involved or is carried out in the proximity of insulated panels. This Appendix refers equally to all forms of roof and wall cladding and not specifically to insulated panels.

Contents

General information and regulatory requirements

Practical design issues

Introduction

This guide is designed to give a clear understanding of how insulated panels work as the external envelope of a modern building by combining the requirements for fire performance with thermal performance.

1.1 Insulated panels

The guide covers the installation and fire performance of insulating panels used to clad the roofs and external walls of buildings. These have variously been called sandwich panels, composite panels, insulated panels, factory-engineered panels etc. The term insulated panel has been used throughout the guide as their primary function is as an energy saving construction element.

Nevertheless, it is the 'sandwich nature', in which two metal facings are bonded either side of a core insulating material, which gives the panels their excellent strength and mechanical properties and improves their fire performance.

1.2 External cladding

The term 'external' is emphasised throughout. This is to separate clearly external and internal systems and applications. Lack of differentiation between the two types of panel over the last decade has lead to some confusion regarding the very different performance in practice, particularly their fire performance.

External insulated panels have been specifically designed to fabricate the external envelope of buildings. They are required to absorb the considerable forces – wind, snow, static loads etc – to which the roofs and walls of buildings are subject and to transmit those forces to the supporting structure. They are also required to be weather tight and control energy loss through air tightness at the joints. As a result the method of fixing needs to be strong and the joint design robust and effective.

Internal sandwich panels on the other hand are generally structurally weaker systems designed for ease of installation / demountability and to satisfy the thermal insulation and hygiene demands of the cold store and food processing industries. There have been a number of high profile fires involving this internal type of system and the potential weaknesses and corrective design solutions are well documented.

1.3 Historical development of insulated panels

1.3.1. Early insulated cladding systems

The initial lightweight cladding systems that evolved in the 1950's and are still used for some applications, are constructed from a number of separate elements as a site-assembled system.

Built-up or site-assembled systems comprise an external profiled weather sheet, internal lining, spacers, fixings and an insulation layer of low-density glass-fibre quilt (9-12kg/m^3) Fig. 1.

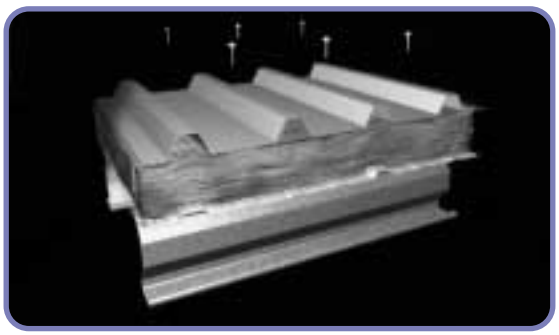

Figure 1. Site assembled built-up systems

Latterly higher density mineral fibre [MF] quilt (25kg/m^3) has been increasingly used especially with standing seam roof constructions to produce improved performance specifications. High density MF bats of up to 150kg/m^3 have been used for wall applications requiring a high degree of fire resistance.

In the mid 1980's site-assembled constructions made up approximately 90% of all metal cladding systems.

Fire performance – site assembled systems.

These systems have generally been regarded with minimal concern due to the relatively low organic content (limited combustibility) of the core insulants. However fire stopping in multi-storey applications can be of importance and is a specific requirement of Building Regulations.

1.3.2. Advent of insulated panel systems

Insulated panels have been used as the external roof and walls of buildings in increasing volumes since the early 1980's although their history in use dates back to the late 1960's.

Insulated panels are factory engineered and produced one-piece cladding panels consisting of two metal faces positioned either side of an insulating core which completely fills the space between. The facings are fully bonded to the core so that the panel acts compositely when under load. [Fig. 2].

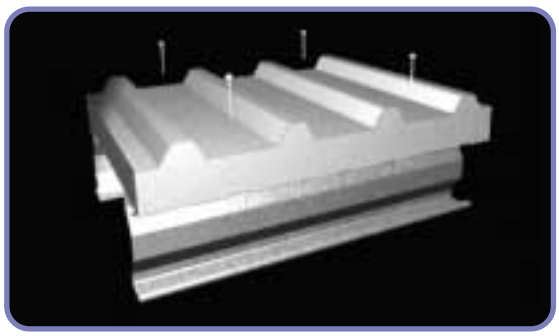

Figure 2. Factory engineered insulation panels

Facings used for insulated panels are predominantly of steel although aluminium can also be used for specific applications. The insulating core is bonded to the facings either auto-adhesively (urethanes) or by a conventional adhesive bond (mineral fibre and polystyrene). Initially all external panels were manufactured with rigid urethane insulating cores [PUR] whereas internal panels, following a separate parallel development, used polystyrene [PS]. The thickness of external panels at this time was 25-30mm compared to the 40-80mm typical of current urethane cored production.

PIR (polyisocyanurate) which is a variation of rigid urethane [section 9] was introduced in the early 1970's offering improved fire performance. These two forms of rigid urethane [PUR & PIR] still account for over 90% of insulated panels used externally and have followed parallel development paths and modifications in design to improve their fire performance.

Mineral fibre cored panels were introduced in the 1990's for applications where enhanced fire performance was required. In 2000, MF panels accounted for about 8% of the external insulated panel market.

Other core materials (polystyrene, phenolic foam and cellular glass) have been used from time to time in the production of insulated panels but their use has largely been restricted to internal applications. Polystyrene has been incorporated in some architectural wall panels but volumes with this insulation are very low. PUR and MF have now largely replaced this core material for external applications.

Introduction

1.4 History of fire performance – insulated panels

Insulated panels, the majority with rigid urethane cores, have been use for over 30 years with an exemplary record (in fire terms) as the external roof and wall cladding of buildings.

Analysis of the collated information indicates:

There are no recorded incidents where external insulated panels have caused or have been involved in the initial stages of a fire.

External roof and wall insulated panels have only become involved when an already established internal fire has reached a fully developed stage;

- During the development stage any involvement of the fire load from external insulated panels is gradual and does not provide an immediate and total contribution to the fire development.
- Due to the method of external fixing and engineered joint designs, insulated panels forming the external envelope retain their structural integrity until the structural support is compromised or fails.

Correctly engineered insulated panel systems with rigid urethane or mineral wool cores and designed for the external envelopes of buildings have performed well and should not be a major cause for concern in fires.

Further information on the performance in fire of external insulated panels and the results from large scale fire tests are given in section 9.

1.5 Specification

Buildings are becoming increasingly complex. The range of materials and components are more extensive, with greater opportunity for architectural expression using modern materials such as insulated panels. Latest designs often require a greater degree of flexibility to accommodate change of layout, information technology, product and system changes etc. Speed of installation is of particular importance in many applications.

Insulated panels and systems are required to be multifunctional. They need to satisfy a variety of factors including speed of construction, cost, ease of installation as well as meeting the new energy efficiency regulations and other technical requirements including fire.

The building designer is faced with a number of specification considerations encompassing a wide range of practical, commercial, technical and aesthetic factors of which fire is but one. These choices can be classified under the headings of 'regulatory' or 'general design/construction'.

The weightings given to different design issues will be influenced by many factors and will vary according to statutory requirements and the objectives of the client and the designer. Most of the specification choices directly influence cost, construction speed, and the cost in life/energy performance of the building.

Fire safety and fire performance may be subject to regulatory requirements. Generally the current range of commercially available insulated panels with rigid urethane or mineral fibre cores, when correctly designed and installed, should meet the present building regulations requirements [Section 2].

Insulated panels are suitable for a wide range of building applications. However like all cladding systems rarely will a single product provide the best performance for all design requirements and it is necessary to consider the optimum balance of properties for the particular building. In fire safety terms a cladding system that is more than adequate for a typical single storey storage building may be unsuitable for a high rise hospital where evacuation is impractical and staff and patients will need to remain in the building during a fire.

Specification factors for insulated panels used for external roof and wall cladding.

Energy: Regulatory requirement – Building Regulations – Approved Document L2: 2002 edition
~ Energy performance of fabric [new insulation levels]
~ Energy control of fabric [new recommended levels for air tightness – England & Wales]

Cost

Aesthetics

Buildability

Speed of installation

Durability and life cycle

Weight

Fire: Reaction to fire
Fire resistance
[see sections 3 and 4]

Acoustics

Environmental

Health and safety

Specific requirements from client; insurance industry etc.

2 Statutory Requirements

In the United Kingdom fire safety in buildings is controlled under various statutory instruments. The main requirements arise from:

a) Building Regulations:
   (i) England and Wales – The Building Regulations 2000 [2]
   (ii) Scotland – The Building Standards (Scotland) Regulations 1990 (as amended) [3]
   (iii) Northern Ireland – The Building Regulations (Northern Ireland) 1994 [4]

b) Fire precautions Act 1971 (as amended)

c) Fire Precautions (Workplace) Regulations 1997 (as amended 1999)

d) Construction (Design and Management) Regulations 1994

2.1 Building regulations

The Building Regulations apply to the design and construction of new buildings and also to existing buildings if a material alteration or material change of use is being made. It is the building regulations that are likely to have the main impact on the required fire performance of external cladding systems.

England and Wales, Scotland and Northern Ireland each have their own building regulations and each country has its own set of guidance documents for fire safety. It is important to recognise that the guidance applicable in Scotland can be significantly different to that applicable in England and Wales or Northern Ireland. Guidance on the building regulations applicable in England and Wales and Northern Ireland is given in section 3 and Scotland in section 4.

2.2 Fire precautions legislation

The Fire Precautions Act and Fire Precautions (Workplace) Regulations are primarily intended to ensure that an acceptable level of safety is achieved during occupation of the building. Generally this legislation will not have a direct effect upon the design of the structure or the specification of external cladding systems.

The Fire Precautions Act contains a statutory bar that prevents additional structural measures being required if the building has been previously approved under building regulations. Therefore this act is likely to have little impact on the specification of the external cladding.

The Fire Precautions (Workplace) Regulations (FPW) require that a risk assessment be carried out to identify any potential fire hazards in a workplace and to evaluate the risks to employees. Employers are required to take steps to reduce any unacceptable risks. Construction materials complying with current building regulations would normally be acceptable but there may be circumstances where additional fire precautions are appropriate (e.g. during maintenance procedures).

2.3 Construction (Design and Management) Regulations

The Construction (Design and Management) Regulations 1994 (CDM) relate to all aspects of construction and affect all those concerned in the construction process. The CDM regulations impose specific obligations on designers to consider matters relating to safety during construction and subsequent maintenance of the completed building.

The FPW and CDM regulations require that any foreseeable risks associated with the construction and the continuing operation of a building are identified and effectively managed and controlled. Guidance on appropriate management procedures, which is appropriate to all types of building systems not just buildings with sandwich panels, is given in the appendix.

3 Building Regulations for England, Wales and Northern Ireland

The fire safety aspects of building design and construction in England and Wales are controlled by the requirements of the Building Regulations, 2000 (requirements B1 to B5). The regulations are set out in functional form and set performance objectives rather than prescribing specific fire safety measures. These functional requirements can be met by;

a) following the recommendations set out in Approved Document B [2] or

b) adopting an alternative approach (e.g. using fire engineering).

Whilst there is no overriding requirement to adopt the recommendations given in the Approved Document this represents the most common approach, particularly for relatively small and straightforward buildings. However, fire engineering techniques are increasingly being applied in large or complex developments.

Northern Ireland

The design and construction for fire safety in buildings in Northern Ireland is controlled by the Building Regulations (Northern Ireland) 1994. Recommended fire safety measures are detailed in sections 1 to 5 of Technical Booklet E [4] for fire safety.

There are some minor differences between Technical Booklet E and Approved Document B that applies in England and Wales. In particular the critical height at which additional provisions regarding the external flame spread classification apply is 20m rather than the 18m stated in Approved Document B. However in other respects the guidance given in this section relating to Approved Document B will generally be applicable.

3.1 Functional requirements

The functional requirements of the Building Regulations require that 'reasonable', 'adequate' and 'appropriate' steps be taken to ensure health and safety of people in and around buildings. These requirements are summarised below.

3.1.1. Escape

Requirement B1 requires that adequate escape routes be provided to enable the occupants to reach a safe location outside of the building. Suitable means of giving warning of a fire are also required.

3.1.2. Fire spread across surfaces

Requirement B2 requires that materials used as wall and ceiling linings do not promote rapid fire spread or unduly contribute to the heat produced by a fire.

3.1.3. Building structure

Requirement B3 requires that appropriate measures be taken to ensure that:

- the structural stability of the building will be maintained;
- a wall between two buildings will resist fire spread between the buildings;
- buildings are subdivided into compartments to restrict the size of a fire;
- unseen voids are subdivided to inhibit hidden fire spread.

These objectives are generally achieved by providing fire resisting constructions (section 12).

3.1.4. External fire spread

Requirement B4 is primarily intended to prevent the spread of fire from one building to another as a result of heat radiation or airborne burning brands. This is generally achieved by:

a) controlling external surfaces of walls and roofs;

b) providing fire resisting external walls when appropriate.

3 Building regulations for England, Wales and Northern Ireland

3.1.5. Facilities for the fire service

Requirement B5 requires that reasonable facilities are available to enable fire appliances to gain access to the building and to enable fire fighters to protect life.

3.2 Approved Document B

Approved B provides guidance on how the functional requirements of the regulations may be met taking account of the use, occupancy, height (of top storey) and area of the building.

3.2.1. Building occupancy

The fire safety measures recommended in Approved Document B are specified in terms of the proposed use of the building. Table D1 of the Approved Document defines seven purpose groups, which provide a generic means of categorising the use of a building in context with the likely fire risk. The purpose groups covered in this design guide are summarised in table 1.

Table 1. Classification of purpose groups

Title	Group	Purpose for which the building or compartment of a building is intended to be used
Residential (Institutional)	2(a)	Hospital, home, school or other similar establishment used as living accommodation for, or for the treatment, care or maintenance of persons suffering from disabilities due to illness or old age or other physical or mental incapacity, or under the age of five years, or place of lawful detention, where such persons sleep on the premises.
(Other)	2(b)	Hotel, boarding house, residential college, hall of residence, hostel, and any other residential purpose not described above.
Office	3	Offices or premises used for the purpose of administration, clerical work (including writing, book keeping, sorting papers, filing, typing, duplicating, machine calculating, drawing and the editorial preparation of matter for publication, police and fire service work), handling money (including banking and building society work), and communications (including postal, telegraph and radio communications) or radio, television, film, audio or video recording, or performance {not open to the public} and their control.
Shop and Commercial	4	Shops or premises used for a retail trade or business (including the sale to members of the public of food or drink for immediate consumption and retail by auction, self-selection and over-the-counter wholesale trading, the business of lending books or periodicals for gain and the business of a barber or hairdresser) and premises to which the public is invited to deliver or collect goods in connection with their hire, repair or other treatment, or (except in the case of repair of motor vehicles) where they themselves may carry out such repairs or other treatments.
Assembly and Recreation	5	Place of assembly, entertainment or recreation; including bingo halls, broadcasting , recording and film studios open to the public, casinos, dance halls; entertainment, conference, exhibition and leisure centres; funfairs and amusement arcades; museums and art galleries; non-residential clubs, theatres, cinemas and concert halls; education establishments, dancing schools, gymnasia, swimming pool buildings, riding schools, skating rinks, sports pavilions, sports stadia; law courts; churches and other buildings of worship, crematoria; libraries open to the public, non-residential day centres, clinics, health centres and surgeries; passenger stations and termini for air, rail, road or sea travel; public toilets; zoos and menageries.
Industrial	6	Factories and other premises used for manufacturing, altering, repairing, cleaning, washing, breaking-up, adapting or processing any article; generating power or slaughtering livestock.
Storage and other non-residential	7(a)	Place for the storage or deposit of goods or materials [other than described under 7(b)] and any building not within any of the purpose groups 1 to 6.
	7(b)	Car parks designed to admit and accommodate only cars, motorcycles and passenger or light goods vehicles weighing no more then 2500 kg gross.

3.3 Approved Document B and the external envelope

The main recommendations of Approved Document B that impact on the specification of external cladding systems are summarised in the following sections. The two principle parts that affect the specification and use of insulated panels are requirement B2 – Fire spread across surfaces and B4 – External fire spread between buildings.

3.3.1. Fire spread across surfaces – Requirement B2

Approved Document B sets performance standards that are intended to ensure that internal lining materials do not promote rapid flame spread. In escape routes and general circulation areas it is also necessary to limit the rate at which materials release heat.

The surface spread of flame classification of materials is assessed in accordance with BS 476: Part 7 [5] and materials are designated Class 1 to 4 (where class 1 is the best). The heat release potential is determined in accordance with BS 476: Part 6 [6] [section 10].

Class 0 materials are specified for areas where both the flame spread and heat release rate is controlled (e.g. on escape routes). To achieve a Class 0 rating a product must achieve Class 1 in BS 476: Part 7 and also achieve a specified level of performance in BS 476: Part 6. It will also shortly be acceptable to demonstrate compliance with the fire spread requirements by performance classifications in designated European test standards.

The recommended performance levels for internal linings to walls and ceilings based on British Standards and European Standards is summarised in table 2. For the majority of buildings, the internal lining should exhibit a Class 1 surface spread of flame except where it forms part of a circulation or protected route in which case it should have a Class 0 rating.

Insulated panels with metal facings and standard pvc/pvdf protective coatings intended for use in the external envelope will generally achieve Class 0 and will therefore meet the most onerous guidance for internal linings.

Table 2. Classification of internal linings in accordance with British and European Standards

Location	British Standards	Euroclass
Internal walls and rooms	1	C*
Circulation spaces (corridors, lobbies, stairways)	0	B*

** The corresponding Euroclasses above are the proposed classes set out in the draft European Supplement to Approved Document – B which at the time of printing is out for public comment. They are given for informative guidance only.*

3 Building regulations for England, Wales and Northern Ireland

3.3.2. External fire spread between buildings – Regulation B4

Requirement B4 is intended to ensure that fire does not spread from one building to another as a result of heat radiation or airborne burning brands.

Figures 3a and 3b give an illustration of radiation and airborne burning brands spreading fire from one building to another.

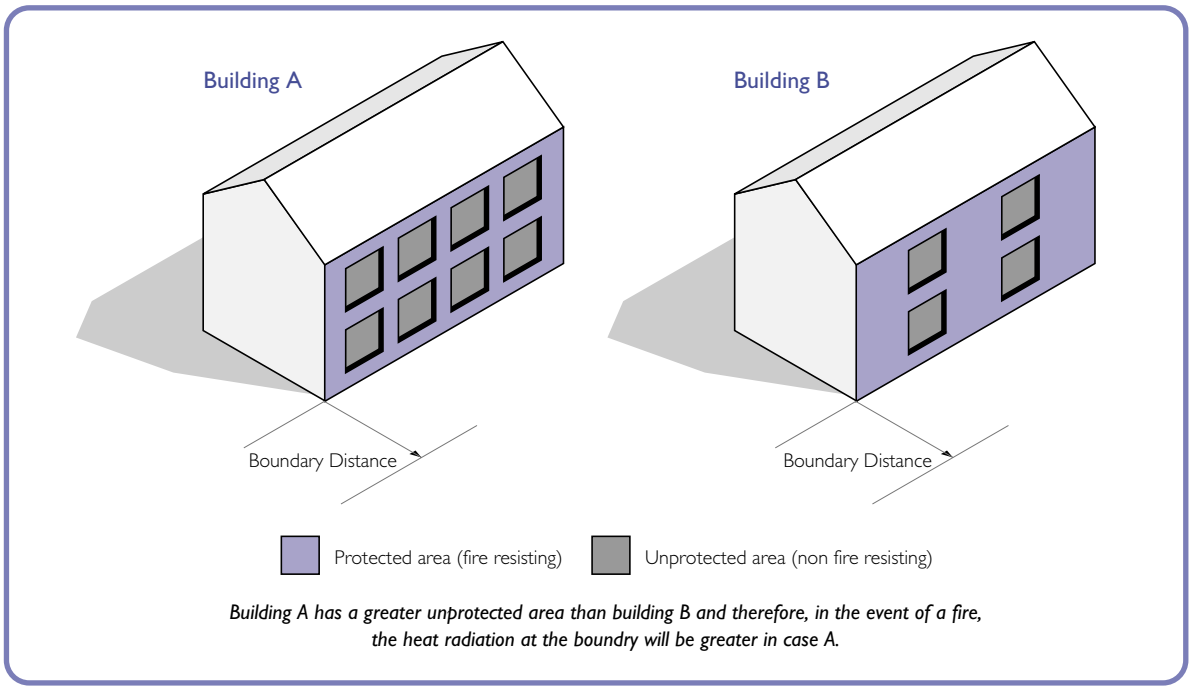

Figure 3a. External fire spread between buildings

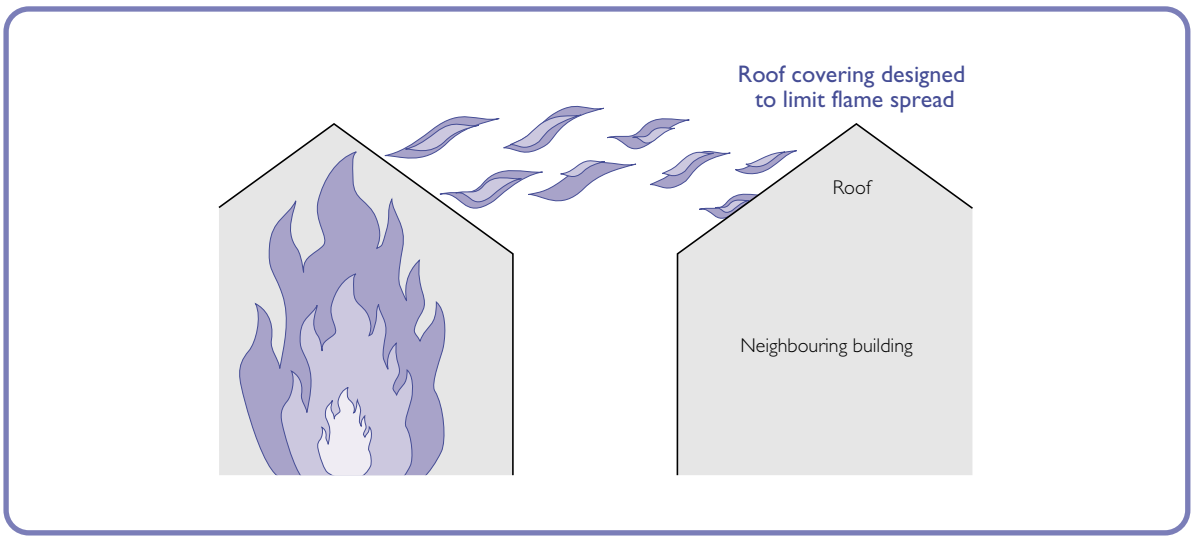

Figure 3b. Fire spread by airborne burning brands

Where there is the potential for fire spread from one building to another (e.g. when it is located close to a site boundary) the Approved Document may recommend restrictions on the flame spread characteristics of roof coverings and external wall surfaces. It may also be necessary to make all or part of an external wall fire resisting, to restrict the heat radiation to an adjacent building or boundary.

The extent to which any external wall of a building will require fire resistance and the extent to which the external surfaces need to be controlled depend on the distance of the wall from the boundary [see table 3, page 19].

The relevant boundary will normally be the site boundary and there is no statutory requirement to control external fire spread between two buildings in common ownership and occupation on the same site (provided that one of the buildings is not in the assembly or residential purpose groups). Where one (or both) of the adjacent buildings is in the residential purpose group it is necessary to draw a 'notional boundary' between the two buildings and the extent of allowable unprotected areas should be calculated accordingly.

The main recommendations of the Approved Document are summarised below.

The requirements will be met if the external walls are constructed so that the risk of ignition from an external source and the spread of fire over their surfaces are restricted by specifying their flame spread and heat release properties. This can be achieved by using materials with a Class 0 surface (see section 3.3.1).

Secondly, the amount of unprotected area in the side of a building is restricted to limit the amount of thermal radiation that can pass through the wall, taking the distance between the wall and boundary into account. This is can be achieved by having walls that resist fire according to BS476: Part 22 [7] except for the allowable unprotected areas (without fire resistance).

3.3.2.1. External walls within 1000mm of boundary

Any part of an external wall within 1000mm of a relevant boundary should have:

a) Class 0 external surface;

b) fire resistance (integrity and insulation) to the same standard as required for the building structure;

c) very restricted window openings (see diagram 44 of Approved Document B).

3.3.2.2. External walls more than 1000mm from boundary

If a wall is located more than 1m from the boundary it may still be necessary for all or part of it to be fire resisting. The area of window openings and other un-protected areas must therefore be restricted and the wall be constructed using a proven fire resisting construction (section 12).

Methods of calculating the required level of protected area are given in Approved Document B and BRE Report BR187 (1991) [8].

When the allowable extent of unprotected areas (i.e. the area that does not require fire resistance) has been determined the remaining protected areas of the wall should satisfy the following criteria:

a) external surface to be non-combustible; or any combustible surface more than 1mm thick to be Class 0;

b) fire resistance as regards integrity to the same standard as the other building elements and an insulation value of 15 minutes (when tested from the inside);

A special case is made for non-loadbearing external walls in single storey buildings up to 10m in height in that there may be no need for them to possess *any* fire resistance providing that:

– the wall does not form part of a compartment wall or a wall common to two or more buildings.

– it is more than 25m from the boundary for industrial, commercial, or storage buildings and more than 12.5m for office, assembly and recreation buildings.

– Where sprinklers are provided throughout the building in accordance with BS 5306: Part 2 (including the requirements for life safety) the values given above may be halved to 12.5m and 6.25m respectively.

If an external wall is located at a sufficient distance from the boundary (or adjacent residential or assembly building) that there is no restriction on unprotected areas then the provisions for surface classification only apply. The most onerous of these are satisfied by the Class 0 rating of most commercially available insulated panels.

3.3.2.3. Roof coverings

Approved Document B gives specifications for roof coverings where a building is located near to a boundary. These specifications vary according to the distance of the building from the boundary. No restriction is placed on the use of roof coverings designated AA, AB or AC to BS 476 Part 3: 1958 [9] but lower ratings are only acceptable if the building is at least 6m from the relevant boundary.

Insulated panels with metal facings and standard pvc/pvdf protective coatings intended for use in the external envelope generally have a test designation AA or AB and are suitable for all distances from any point or relevant boundary. However, if plastic roof lights are provided they should comply with the recommendations of Approved Document B.

Roof decking is not normally required to exhibit any fire resistance unless it is used as an escape route, or parking etc., as it is not normally considered to be an element of structure [Section 3.3.3].

3.3.3. Escape – Requirement B1

Section B1 of the Approved Document makes few recommendations that are directly relevant to the external building envelope. However, where external escape stairs are located within 1.8m of the external wall certain areas of the wall will need to provide a 30-minute standard of fire resistance (integrity only). The areas of wall that are required to be 30 minute fire resisting are illustrated in figure 4.

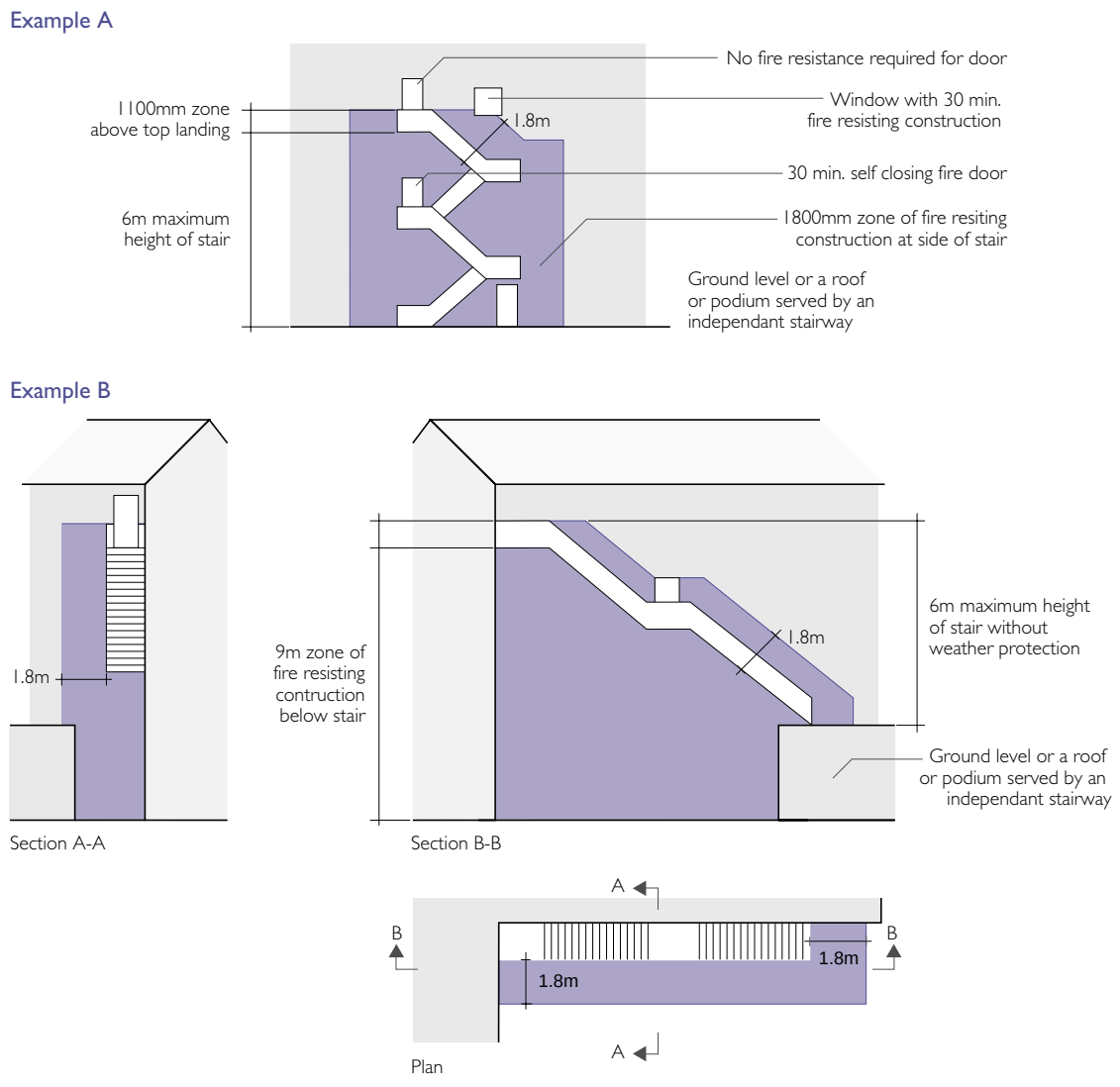

Figure 4. Fire resistance of areas adjacent to external stairs

3 Building regulations for England, Wales and Northern Ireland

Roofs used as escape routes

Any part of a roof that forms an escape route should provide a fire resistance of at least 30 minutes fire resistance with regard to load bearing capacity, integrity and insulation. Similarly if the roof performs the function of a floor it should have the same fire resistance as is required for other floors within the building. This requirement would generally preclude the use of insulated panels for sections of a roof that form part of an escape route.

3.3.4. Junctions with compartment walls and cavity barriers – Requirement B3

Section B3 of the Approved Document exempts non-loadbearing cladding (panels) from the provision of any fire resistance except where recommended to restrict the spread of fire between buildings [see 3.2 re B4 of AD-B]. However in some circumstances it is necessary to subdivide a building into separate fire resisting compartments to limit the potential extent of fire spread [Figure 5].

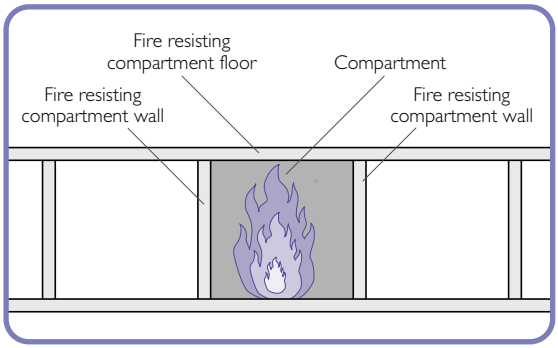

Figure 5. Illustration of the concept of compartmentation

Junctions with external walls

This guide does not deal with the construction of internal compartment walls but where a roof or external wall meets a compartment wall it is necessary to ensure that the junction does not compromise the fire resistance.

In relation to external walls, Paragraph 9.27 of the Approved Document states:

> Where a compartment wall or compartment floor meets an external wall the junction should maintain the fire resistance of the compartmentation.

This is usually achieved by fire stopping the junction with materials of limited combustibility to seal any gaps in the construction. There are a number of different techniques that may be used to fire stop such junctions but figure 6 shows an effective means of achieving a satisfactory junction detail.

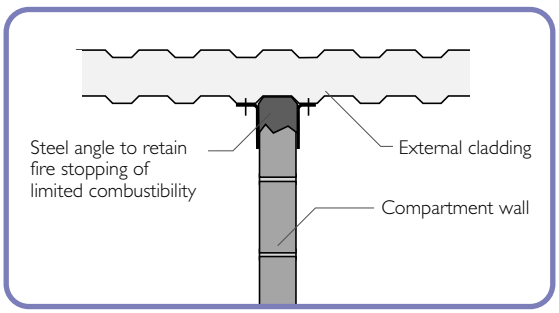

Figure 6. Illustration (on plan) of recommended fire stopping detail

Junctions with roofs

Where an insulated panel is used in roof construction and passes over a compartment wall the Approved Document recommends that a 300mm wide band of material of limited combustibility should be provided where a composite panel passes over the wall.

This implies the use of a mineral fibre core panel or removal of a 300mm wide strip of combustible core material and its replacement with an alternate material of limited combustibility (e.g. mineral fibre). This is difficult to achieve in practice. However some rigid urethane insulated panel systems, fully filled and auto-adhesively bonded, are acceptable without the 300mm strip if the performance of the specific product is proven by an appropriate fire resistance test.

At compartment wall junctions it is also recommended that the roof covering should be designated AA, AB or AC for a distance of 1500mm on each side of the compartment wall. This is satisfied by metal faced insulated panels intended for external roof applications, which in general have AA or AB classification.

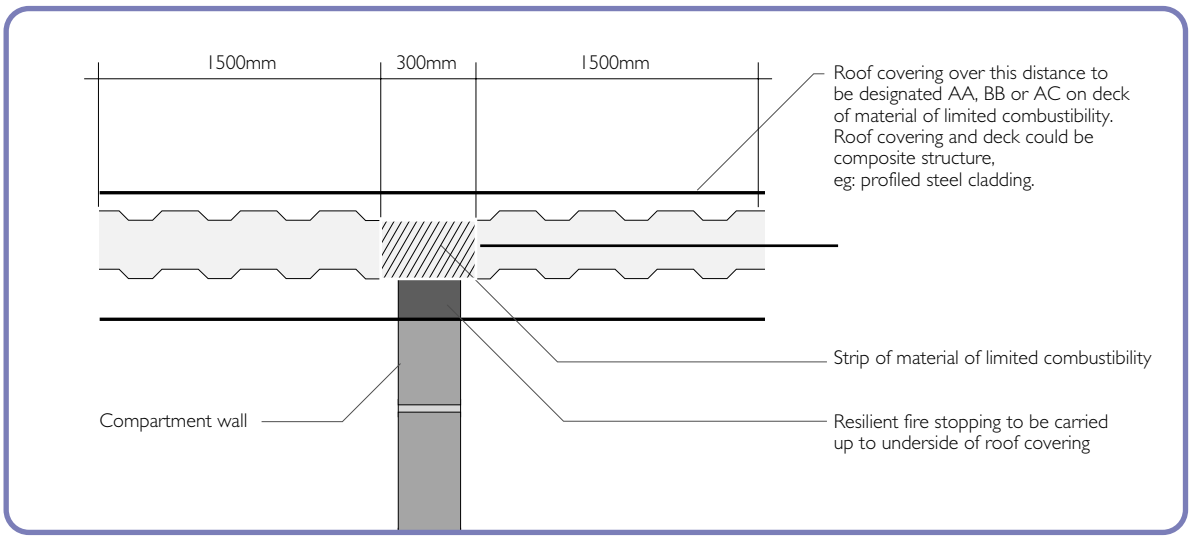

Figure 7. Illustration of the 1500 extent of AA, AB or AC material and the 300mm wide strip of material of limited combustibility

3 Building regulations for England, Wales and Northern Ireland

Cavity barriers in concealed spaces

An important part of requirement of B3 is the recommendation to close off the perimeter of hidden voids and provide protection where a void passes a compartment wall or floor.

Cavity barriers are also usually required to subdivide large concealed spaces such as the void behind a suspended ceiling at 20m intervals (This is reduced to 10m if the internal surfaces of the void are not Class 1 or Class 0).

There are no cavities associated with insulated panels because the insulating core completely fills the space between the two faces of the panel. However an area that is relevant to the external envelope, where the necessity to provide cavity barriers or continue a fire resisting wall is often forgotten, is at the eaves where a pitched roof meets an external wall [Figure 8].

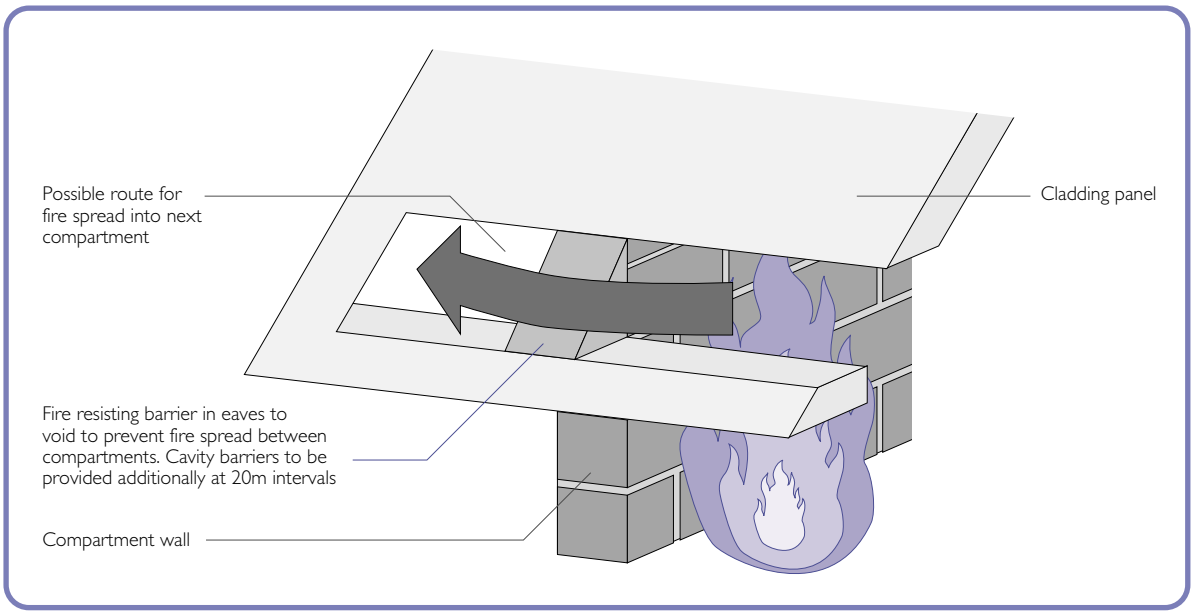

Figure 8. Illustration of required fire resisting barrier and cavity barrier at eaves

3.3.5. Access and facilities for the fire service – Regulation B5

Appendix F of the Approved Document provides guidance on the use of insulated panels *within* a building (e.g. internal panels used for cold store insulation) because of the difficulties these can present for fire fighting operations.

However no specific provisions are made regarding insulated panels used in the external building envelope that are securely fixed to the building framework, thereby preventing collapse with the result that the risk is not perceived to be significant.

3.4 Approved Document B – summary of recommendations relevant to external insulated panels

Table 3 summarises the main recommendations of Approved Document B that are relevant to the specification of insulated panels used in external walls and Table 4 summarises the recommendations applicable to their use in roof construction.

Table 3. Main recommendations of Approved Document B for external walls

Room size	Internal face*	External face*	Fire resistance	
			integrity	Insulation
Small rooms less than 30m^2 Other rooms Circulation spaces	Class 3 Class 1 Class 0			
Boundary distance				
Less than 1m Greater than 1m protected areas unprotected areas		Class 0 Class 0 N/A	Yes[1] Yes[1] N/A	Yes[1] 15mins N/A
Height of wall above ground				
Less than 18m Greater than 18m		N/A[2] Class 0[3]		
External escape stair				
Stair located within 1.8m of wall			30	N/A

Notes to table 3

** Most commercially available external insulated panels will achieve Class 0 and will therefore satisfy the most onerous flame spread requirements of the Approved Document.*

1. Fire resistance period as required for the building structure.

2. In assembly and recreation buildings (purpose group 5) the external face should have an index (I) = 20 when tested to BS 476: Part 6 to a height of 10m above any external level to which the public have access.

3. In any part of the wall below 18m this may me reduced to index (I) = 20 when tested to BS 476: Part 6. Panels with Class '0' meet this requirement.

3 Building regulations for England, Wales and Northern Ireland

Table 4. Main recommendations of Approved Document B for roofs

Room size	Internal face*	Roof covering	Material of limited combustibility
Small rooms less than 30m² Other rooms Circulation spaces	Class 3 Class 1 Class 0		
Compartment wall junction			
		AA, AB or AC² for 1500mm on each side of junction	300mm strip of non-combustible material over compartment wall¹
Boundary distance			
Less than 6m		AA, AB or AC²	
Greater than 6m		Lesser designations acceptable	

Notes to table 4

**Most commercially available external insulated panels will achieve Class 0 and will therefore satisfy the most onerous flame spread recommendations of the Approved Document.*

1. 300mm wide strip of material of limited combustibility to replace combustible core where roof passes over compartment wall unless demonstrated otherwise by suitable fire resistance test. [see 3.3.4 Junctions with roofs]

2. Insulated panels intended for external roof applications in general have AA or AB classification.

4 Building standards – Scotland

The design and construction for fire safety in buildings in Scotland is controlled by the Building Standards (Scotland) Regulations 1990 (as amended) [3]. These Regulations are supported by Technical Standards.

Structural fire protection measures are detailed in Part D of the Technical Standards and measures relating to means of escape, warning and fire fighting are given in Part E.

Whereas in England and Wales the regulations are set in functional form, in Scotland it is mandatory to comply with the measures detailed in the Technical Standards. Whilst some relaxation of these provisions is possible this is generally more difficult to achieve.

The 6th amendment to the Technical Standards are applicable from 4th March 2002 and the main provisions of these standards as they relate to the external building envelope are summarised below.

4.1 Fire spread across surfaces

In order to resist the spread of fire and smoke, the Technical Standards set out the minimum required performance standards for the surface properties of all wall and ceiling linings. The potential for the surface of a material to contribute to fire spread is defined in terms of a risk ranking. The risk classification of materials can be carried out in accordance with either British or European test standards as summarised below in table 5.

Table 5. Classification of materials in British Standard and European test regimes

Risk*	British Standards	European Standards*
Non-combustible	Non-combustible (BS 476: Part 4 [10] or BS 476: Part 11 [11]).	Classification A1 (BS EN ISO 1182 and BS EN ISO 1716) or Classification A2 (EN 13823 and BS EN ISO 1182 or BS EN ISO 1716).
Low	Class 0 (Class 1 in BS 476: Part 7 and an index of performance (I) not exceeding 12 and a sub-index (II) not exceeding 6 in BS 476: Part 6).	Class B or better (EN 13823 and BS EN ISO 11925-1)
Medium	Class 1 (BS 476: Part 7)	Class C or better (EN 13823 and BS EN ISO 11925-1)
High	Class 2 or Class 3 (BS 476: Part 7)	Class D or better (EN 13823 and BS EN ISO 11925-1)
Very High	Any material that does not meet the criteria for high risk	Any material that does not meet the criteria for high risk

Notes to table 5

** The required surface classification of wall and ceiling linings for various end use conditions is summarised in table 6.*

4 Building standards – Scotland

The Technical Standards set out minimum requirements for walls and ceiling linings in different locations. These are set out in table 6.

Table 6. Fire Spread on wall and ceiling surfaces

Purpose group	Highest permitted level of risk of a building component			
	Room 30m² or less	Room more than 30m²	Unprotected zone and protected enclosure	Protected zone and fire fighting shaft
2a Institutional	Medium	Low	Low	Low
2b Other residential	Medium	Medium	Medium	Low
3 Offices	High	Medium	Medium	Low
4 Shops and commercial	High	Medium	Low	Low
5 Assembly & recreational	High	Medium	Medium	Low
6 Industrial	High	Medium	Medium	Low
7a Storage – high risk	High	Low	Medium	Low
7b & C Storage – low risk & open sided car parks	High	Medium	Medium	Low

Notes to table 6

Most commercially available insulated panels designed for use in the external building envelope will be classified as low risk and will therefore satisfy the most onerous flame spread requirements of this table.

4.2 Insulated panels

Guidance given in part D7.3 of the Technical Standards requires that insulated panels used internally or as internal wall or ceiling linings in purpose groups other than residential must be suitably designed and installed. It is considered that the recommendations presented in sections 9 and 10 of this guide should satisfy this requirement for insulated panels that form both the external cladding and internal lining.

D7.3 requires insulated panels used for internal walls or linings in a building of purpose group 1 or 2 (Residential) must be fully filled with cores that consist of non-combustible material.

4.3 Fire spread on the external wall

In order to limit fire spread on external walls the Technical Standards (D10) require that any external cladding must either comply with the specifications given in Table 7 or meet the requirements of a suitable test for the fire performance of external cladding systems.

Table 7. Required level of performance for cladding to an external wall

Height of building above ground	Purpose group or sub-purpose group	Location	Highest permitted level of risk of product (see table 5, page 21)
18m or less	5 Assembly and recreational	Up to 10m above the ground (or above a roof or any part of the building to which the public have access)	Low
	5 Assembly and recreational	10m or more above the ground	Very high
	2A Institutional	Any	Low
	All others	Any	Very high
More than 18m	Any	Any	Low

Notes to table 7

Most commercially available insulated panels designed for use in the external building envelope will be classified as low risk and will therefore satisfy the most onerous flame spread requirements of this table.

In buildings of more than one storey that have a floor at a height of more than 18m above the ground any insulation material situated within cavities in the external wall construction must be non-combustible. This would preclude the use of insulated panels with combustible cores in buildings with a top storey at more than 18m above ground.

4.4 Junctions between fire resisting walls and the external envelope

4.4.1. Junction with external wall

The Technical Standards require that the junction between an external wall and a fire resisting wall or floor must not prejudice the fire resisting separation. This is usually achieved by fire stopping with non-combustible material to seal any gaps in the construction (see figure 6, page 16).

4.4.2. Junction with roof

Where a fire resisting wall is provided to separate adjoining buildings or parts of a building that are in separate occupation (separating wall) the Technical standards require that no combustible construction materials are carried across the top of the wall in such a way as to impair the fire resistance of the wall. This generally requires that a non-combustible break be provided within the core of an insulated panel with a combustible core. However, if proven by a suitable fire resistance test that a particular roof system does not impair the fire resistance of a wall omission of the non-combustible break may be acceptable.

Roof coverings should also be of a low vulnerability classification (AA, AB or AC to BS 476: Part 3) for a distance of at least 1.7m each side of the separating wall.

4 Building standards – Scotland

4.5 Fire Spread to adjoining buildings

To minimise the risk of fire spread between adjacent buildings all or part of the external wall may need to be fire resisting.

Prior to the 6th amendment to the Technical Standards it was generally only necessary to calculate the allowable extent of unprotected (non-fire-resisting) areas on the basis of the distance to the actual site boundary. Therefore if two adjacent buildings were located on the same site and in common occupation there was no requirement to consider fire spread between the two buildings (unless in purpose group 2A e.g. hospitals).

However, in the 6th amendment an additional requirement was introduced that involves assessing the allowable unprotected areas in terms of a 'notional boundary' drawn between two buildings in the same occupation on the same site. This requirement only applies when the combined floor area at any level exceeds the maximum compartment size specified in D3.1 of the Technical Standards.

4.5.1. Walls within 1m of boundary

Part D8.2 of the Standards require that every part of an external wall within 1m of the boundary must be of non-combustible materials except for any thermal insulation in a wall in a building with a storey height of less than 18m above ground.

The wall must (with very limited exceptions) also be fire resisting as regards both integrity and insulation. The required period of fire resistance will be either short or medium duration (30 minutes or 60 minutes) depending upon the purpose group and internal compartmentation of the building.

4.5.2. Walls more than 1m from the boundary

Where the external wall is more than 1m from the boundary, those offices, assembly, recreational and industrial buildings that are designated low risk and therefore 'short duration' are required to be fire resisting in terms of integrity but are not required to satisfy the insulation criterion of the fire resistance test.

If a sprinkler system (in accordance with BS 5306: Part 2) is provided in these lower risk buildings there is no limitation on the allowable extent of unprotected areas in walls more than 1m from the boundary.

For purpose group categories defined as 'medium risk' (e.g. storage, shops and commercial usage) there may still be restrictions on the extent of unprotected areas (window openings etc.) and the remaining (protected) areas are required to satisfy the following criteria:

a) provide a standard of fire resistance (integrity) appropriate to the building structure and a short duration (30 minutes) as regards insulation.

b) have a surface of non-combustible material except for a maximum 1mm thick external surface layer.

When the external walls are situated some distance from a site boundary or other buildings on the same site, then no fire resistance may be required but this must be checked in accordance with the requirements of the Technical Standards.

The assessment of allowable unprotected areas is beyond the scope of this guide but detailed guidance on the calculation of space separation and unprotected areas is given in the Technical Standards.

4.6. Fire Spread from adjoining buildings – roofs

In order to resist the penetration or ignition by fire from an external source and limit the vulnerability of its external surface, the roof covering, (including any roof lights) should meet the requirements set out in table 8.

Table 8. Fire Acceptable roof coverings

Maximum distance of roof to the boundary	Highest permitted vulnerability of roof covering	
	Building of purpose sub-group 2a	All other buildings
6m or less	Low	Low
more than 6m	Low	Medium
more than 12m	Low	Medium
more than 24 m	High	High

Notes to table 8

Most commercially available insulated panels designed for use in the external building envelope will be classified AA or AB in accordance with BS 476 Part 3 and will therefore satisfy the most onerous flame spread requirement in table 8 (i.e. low vulnerability).

4.7 Roofs used as escape routes

Any part of a roof that forms an escape route should be fire resisting as regards load bearing capacity, integrity and insulation. Similarly if the roof performs the function of a floor it should have the same fire resistance as is required for other floors within the building. This requirement would generally preclude the use of insulated panels for sections of roof that form part of a floor or escape route.

4.8 External walls adjacent to an external stair

If an external escape stair is located within 2m of an external wall every part of the wall below the stair and within 2m of the stair should be fire resisting for a short duration (i.e. 30 minutes) as regards integrity and insulation.

4.9 Cavity barriers in concealed spaces

An important part of the Technical Standards is the requirement to close off the perimeter of hidden voids and provide fire barriers where a void passes a compartment wall or floor.

Cavity barriers are also usually required to subdivide large concealed spaces such as the void behind a suspended ceiling at 20m intervals (This is reduced to 10m if the internal surfaces of the void are not medium or low risk (Class 1 or Class 0 or Euroclass B or C).

Because the insulating core completely fills the space between the two faces of an insulated panels extensive cavities are only likely to arise if separate internal linings or suspended ceilings are provided.

However, an area that is relevant to the external envelope where the necessity to provide fire resisting and cavity barriers is often forgotten is at the eaves where a pitched roof meets an external wall (see figure 8, page 18).

4 Building standards – Scotland

Summary of main recommendations of Scottish Technical standards

The main recommendation of the Technical Standards (6th amendment) as they apply to external wall panels are summarised below in table 9 and for roofs in table 10.

Table 9. Main recommendations of Technical Standards for external walls

Room size	Internal lining*	External lining	Fire resistance integrity	Insulation
Small rooms less than 30m² Rooms greater than 30m² Unprotected escape routes Protected escape routes	High / medium[1] High / low[1] Medium / low Low			
Boundary distance				
Less than 1m		Non- combustible	Yes[2]	Yes[2]
Greater than 1m: protected areas				
a) buildings classed as medium duration.		Non-combustible (up to 1mm coating on combustible external face).	Yes[2]	30mins
b) Buildings classed as short duration			Yes[2]	None
c) Buildings situated sufficient distance from boundary			None	None
d) Lower risk buildings provided with a sprinkler system		See table 7, page 23	None	None
Allowable unprotected areas	N/A	N/A	N/A	N/A
Height of wall above ground				
Less than 18m Greater than 18m		N/A[3] Low[4]		
External escape stair				
Stair located within 2m of external wall			30	30

Notes to table 9

1. Requirement varies according to purpose group.

2. Fire resistance period: short or medium depending upon purpose group and degree of internal compartmentation.

3. In assembly and recreation buildings (purpose group 5) the external face should be categorized as of low risk for 10m above any external level to which the public have access. In category 2A (hospitals etc.) all of the external face should be categorized as low risk.

4. If the floor of the top storey is greater than 18m only non-combustible core materials are acceptable.

** Most commercially available external insulated panels will comply with the most onerous requirements for internal linings.*

Table 10. Main recommendations of Technical Standards for roofs

Room size	Internal lining* risk category	Roof covering* permitted vulnerability	Non-combustible material
Small rooms less than 30m^2 Rooms greater than 30m^2 Unprotected escape routes Protected escape routes	High / medium High / low Medium / low Low		
Junction with fire resisting walls			
			Joints to be fire stopped and only non-combustible materials to be carried over separating walls.
Boundary distance			
Less than 6m		Low	
Greater than 6m		Low to high depending upon purpose group and distance.	

Notes to table 10

** Most commercially available insulated panels designed for use in the building envelope will meet the most onerous lining and roof covering requirements when tested in accordance with British Standards.*

5 Fire precautions in hospitals

Guidance on the design for fire safety in hospitals in England and Wales is given in the Health Technical Memorandum 'Fire precautions in new hospitals' (HTM 81 [12]) . In Scotland separate guidance for hospitals is given in the Technical Standards.

Because of the presence of bed patients special provisions must be made for escape and compartmentation. However, recommendations regarding external cladding are generally consistent with other guidance in support of building regulations. This section summarises some of the the main additional provisions that are applicable to the external envelope of hospitals. However, it is strongly recommend that reference be made to the relevant design guidance when specifying for hospital use.

5.1 The junction of compartment walls and floors with external walls

Where a fire resisting compartment wall, sub compartment wall or a protected shaft meets an external wall, HTM 81 recommends that a one metre-wide strip of fire resisting construction should be provided at the junction. The strip should have the same fire resistance as the compartment wall. This is done to reduce the potential for fire spread between compartments. In cases where sprinklers are installed on both sides of the compartment wall this requirement does not apply.

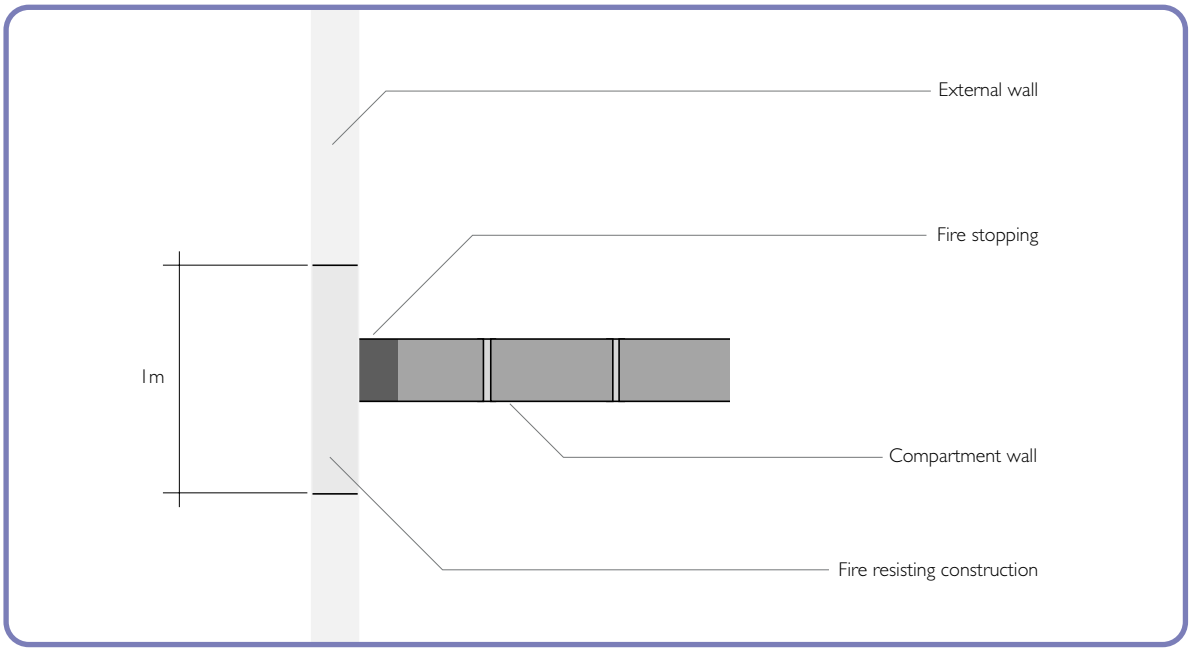

Figure 9. Plan of junction between compartment wall and external wall showing 1m strip of fire resisting construction

5.2 Fire spread across surfaces

To inhibit the spread of fire and smoke within the building provisions are made within HTM 81 to ensure that lining materials do not promote rapid flame spread. The main recommendation are summarised in Table 11.

Table 11. Surface classification for wall and ceiling linings

Location	Walls	Ceiling
Circulation spaces	Class 0	Class 0
Other rooms	Class 0	Class 1
Small rooms (max 4m^2)	Class 1	Class 1

Junction of walls and low level roofs

Where a low level roof abuts an external wall, the roof is required to provide a minimum period of fire resistance of 60 minutes (integrity and insulation) for a distance of 3 metres from the wall. This recommendation is designed to prevent fire spread through the lower roof and into the upper levels of the building. This requirement need not be applied when sprinklers are installed throughout the relevant areas.

5.2.1. Space separation

HTM 81 provides a method for calculating unprotected areas for buildings up to 12m high. Above this height the guidance given in BRE report BR 187 [8] should be adopted. In other respects the requirements for limiting unprotected areas are similar to building regulations guidance.

5.2.2. Surfaces of external walls

The surfaces of external walls of hospitals are required to provide a surface spread of flame classification of Class 0 as defined in building regulations.

5.2.3. Surfaces of roofs

All hospital roof coverings are required to have a designation of AA, AB or AC when tested in accordance with BS 476; Part 3: 1958.

6 Business and property protection

6.1 Introduction

Fire safety legislation is primarily concerned with the protection of people from death or injury in fire.

However, a fire that causes no physical injuries can still have potentially devastating effects on the viability of a business in terms of:

- loss of stock;
- loss of records;
- direct damage to building;
- lost production;
- lost customers;
- damage to public image;

etc.

Therefore, where a fire has the potential to have a substantial impact on the viability of a business or cause large financial losses consideration should be given to additional fire protection measures over and above those necessary to satisfy the minimum statutory requirements. Insurance premium discounts may be available where a high standard of fire protection is provided.

In some cases insurance cover may not be readily available unless fire protection measures exceed the minimum requirements of building regulations.

6.2 Risks associated with external insulated panels

Buildings have to comply with the statutory requirements for Energy Conservation. By definition this demands well insulated structures and the Amendments to the Building Regulations: L2: 2002 further extend these requirements.

The revised regulations mean thicker roof and wall systems and increasingly airtight building envelopes. The recommendations in this guide combine the requirements to achieve these regulations with the steps necessary for fire safety and performance through the securement of external insulated panels and the design detailing to provide good fire protection.

Fires involving insulated panels, which have increasingly been of concern within the insurance industry, have almost entirely been associated with polystyrene cored panels installed internally within the building. The external envelope has only become involved as a consequence of the fully developed internal fire.

Section 1 clearly identifies that insulated panels designed for use as the external roof and walls are totally different from products designed to build internal insulated boxes. The history of external panels in fire over 30 years indicates that the associated risk is relatively low. Nevertheless it is important that insulated panels are properly specified [section 10] to meet the regulations and that guidance is available on the design and installation of details especially at junctions [section 11] to ensure that any potential risk is kept to a minimum.

6.3 Insurance requirements

Sections 10 and 11 of this guide are designed to complement the published guidance and recommendations available to insurance companies and specialist fire professionals. It sets out the guidelines for design detailing of insulated panels at junctions and other points of potential vulnerability. Other published guides are briefly described below.

The Loss Prevention Council (LPC) have published a Design Guide for the Fire Protection of Buildings [13] for use by insurers when assessing the insurance premiums of premises that are considered to be of high value or risk.

The LPC Design Guide contains wide ranging recommendations for the fire protection of industrial and commercial buildings. These recommendations are aimed towards minimising the direct and indirect losses that may occur as a result of fire damage and business disruption.

As the LPC Design Guide for the Fire Protection of Buildings becomes more established, it is likely that its provisions will become more important. In some cases insurers may be unwilling to take on a specific risk. It is therefore important to establish, at an early stage, whether the insurers or the client have any specific requirements for property protection over and above building regulations requirements.

Some of the more significant recommendations of the LPC guide, relevant to the external building envelope, are summarised below. These recommendations would normally be in addition to the requirements of the relevant building regulations.

The LPC Design Guide recommends controls on the fire performance of materials used as the internal lining of a building. This includes the roofs and walls of the external envelope.

The use of insulated panels is considered acceptable if they are constructed of materials of limited combustibility. Wall and roof panels incorporating combustible materials are also deemed to be acceptable if they satisfy the requirements of the LPC test standard LPS 1181 (Requirements and tests for wall and ceiling lining materials and composite cladding materials [14]). Further information on the LPS 1181 test is given in section 8.1.2.

Compartment walls

Where a compartment wall meets with an external wall or roof it is recommended that a protected zone be formed such that the external wall or roof (and its supporting framework) has a fire resistance of at least 30 minutes integrity and 15 minutes insulation when tested from each side in accordance with BS 476: Part 22. The fire resisting section of the external cladding should extend for a minimum of 1m each side of the compartment wall or to the next structural bay whichever gives the greater distance.

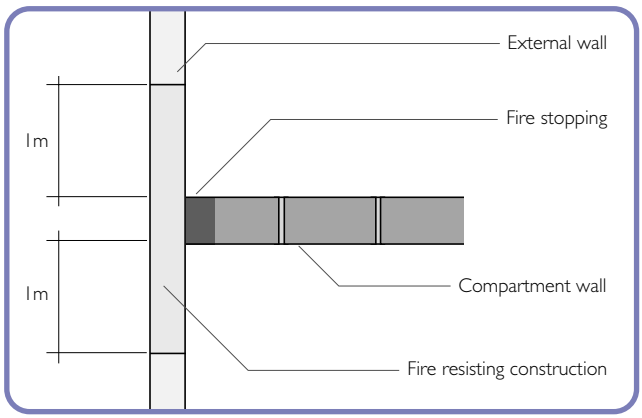

Figure 10. Illustration of protected zone on each side of fire resisting wall

In some circumstances where there is a potential threat of fire attack from the outside of a building (e.g. goods stored externally or an adjacent low roof) the external walls may be required to provide a minimum of 30 minutes fire resistance (15 minutes insulation). Dependent upon the magnitude of the potential loss this may be increased to 60 minutes for both insulation and integrity.

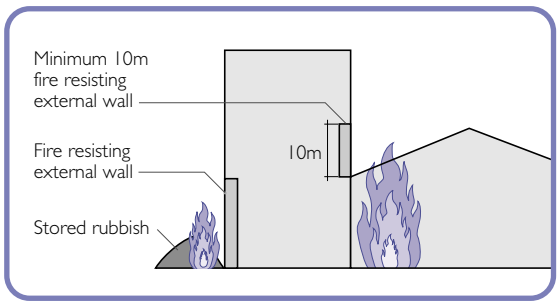

Figure 11. Illustration of fire resisting external wall to protect against effects of an external fire

6 Business and property protection

Roof coverings

The LPC guide recommends that roof coverings should be classified as AA, AB or AC when tested in accordance with BS 476: Part3: 1958 [9].

Exposure to fire from external accidental sources

The LPC Design Guide also provides guidance on the prevention of fire spread from accidental fires and specifically the creation of fire breaks, or clear areas, between buildings and storage as well as from adjacent sites.

Figure 12 [from Chapter 5 of the LPC Design Guide] illustrates that by planning at an early stage any imposed risks can be eliminated, controlled or reduced to acceptable levels capable of protection. A specific recommendation is that provision should be made to prevent the storage of combustible materials nearer than 10m from the building and at a suitable distance from surrounding property or boundary fences or walls. External cladding having a degree of fire resistance (section 8.2) may also be considered to combat threats to the buildings posed by external sources of fire.

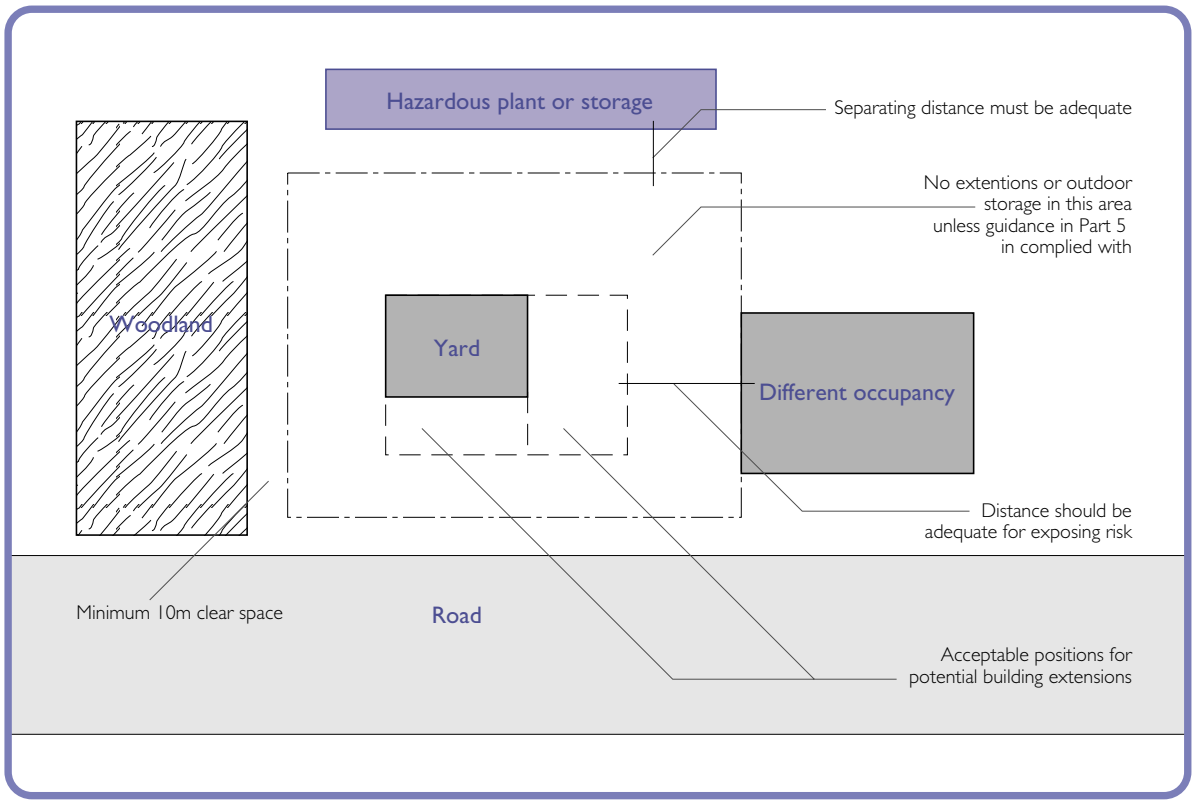

Figure 12. Outdoor exposure and arson risk – plan view

Factory Mutual

Factory Mutual like LPC is an insurance approval company which proactively supports good building design by means of a number of written documents and the approval testing of materials and services through the Factory Mutual Research Corporation.

FMRC approvals procedures encompass the testing of specific physical characteristics, e.g. wind uplift; foot traffic, in addition to fire characteristics.

In the case of insulated panels the principal test is the Room Fire test – UBC Standard No. 17-5 [FMRC 4880 / 4471 – Class1]. The list of fire issues tested as part of the approval procedure is:

- Room fire test – UBC Standard No 17-5
- Flammability characterisation
- Surface burning characteristic (ASTM E84-94)
- Heat of combustion (ASTM E711-87)
- Ignition properties (ASTM D1929-91)
- Ignition residue (ASTM D482-91)
- External fire resistance/spread of flame (ASTM E108).

Quality Management Systems

A key area of the LPC and FMRC approvals is the continued surveillance and audit checking of the Quality Management Systems for any approved insulated panel products to ensure that full compliance with product specification is maintained.

6.4 Loss prevention

The LPC design guide is essentially a prescriptive document that provides a series of standard solutions that may or may not be applied by insurers.

In many cases when considering property protection issues it may be more appropriate to utilise fire engineering and risk assessment techniques (see section 7) to determine appropriate fire protection measures and to establish the most cost effective means of reducing business risk.

For instance for a large manufacturing organisation it may prove to be more cost effective to divide operations between several dispersed locations rather than provide a very high level of fire protection to a single large operational centre.

7 Fire safety engineering

Historically an acceptable standard of fire safety in buildings has been achieved by reference to prescriptive codes that provide standard solutions for a given set of building parameters. For many buildings that are of simple and straightforward design, layout and use, prescriptive codes and standards will probably provide the designer with an acceptable solution.

The Technical Standards for Scotland and Approved Document B in England and Wales are examples of prescriptive guidance.

However, unlike the Technical Standards the recommendations of Approved Document B and Technical Booklet E (Northern Ireland) are not mandatory and designers are not required to adopt any particular solution contained in them providing that it is explicitly demonstrated that the functional requirements of the regulations can be met in some other way.

Fire safety engineering techniques can be adopted as a means of demonstrating compliance with functional requirements of the Building Regulations in England and Wales and specific relaxations of the Scottish Technical Standards can be achieved. In many large and complex buildings fire safety engineering may be the only practical way of achieving and demonstrating a satisfactory standard of fire safety.

As the traditional prescriptive codes have to account for an almost infinite range of building designs they will rarely provide the optimum solution in terms of:

- life safety;
- property protection;
- cost effective fire protection;
- operational requirements.

The prescriptive approach will often not meet the needs of building owners, designers or approvals bodies, particularly for more complex buildings or processes, or in instances where there is a potential for substantial financial loss arising from a relatively small fire.

A particular weakness in the prescriptive approach was recognised in the conclusions of the Cullen report into the Piper Alpha offshore platform disaster, which stated that:

> "Many regulations are unduly restrictive in that they are of a type that impose 'solutions' rather than 'objectives' and are out of date in relation to technological advances. There is a danger that compliance takes precedence over wider safety considerations..."

This conclusion is equally applicable to building design and BS 7974 (Application of fire safety engineering principles to the design of buildings [15])has been developed to provide an objectives based approach to the achievement of fire safety in buildings (Note. BS 7974 was originally issued as a draft for development BS DD 240).

The main objectives of BS 7974 are to:

a) provide a structured framework for assessing the interaction between buildings, people and fire.

b) enable an objective assessment of the fire safety measures required to achieve defined objectives.

c) assist in developing alternatives to prescriptive codes and enable the effect of these to be evaluated.

The British Standard divides the fire safety engineering design process into three main stages:

- Qualitative design review
- Quantitative analysis
- Assessment against criteria

The general approach adopted in the standard is illustrated in figure 13.

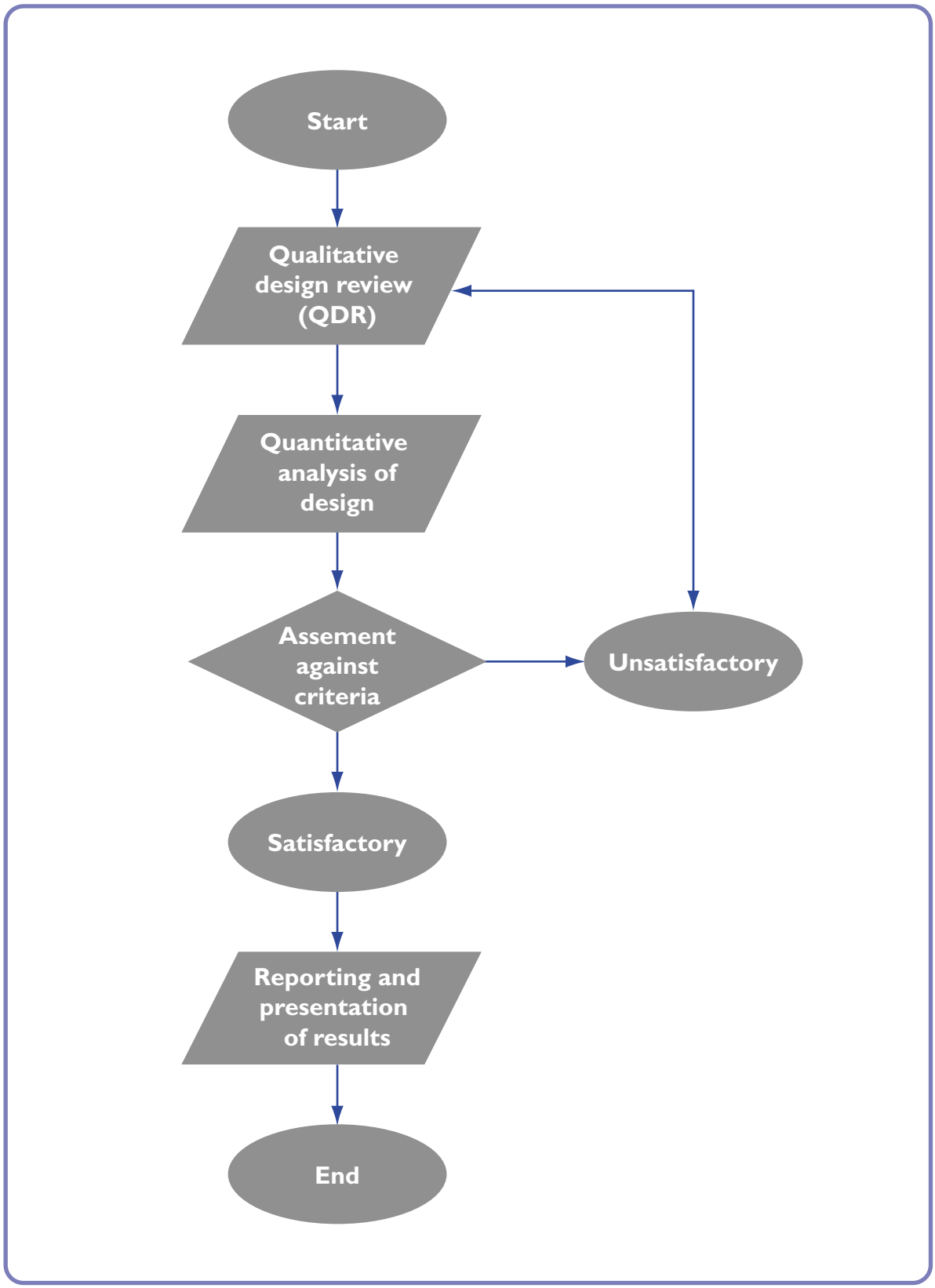

Figure 13. Structure of fire engineering methodology given in BS 7974

7 Fire safety engineering

7.1 Qualitative Design Review (QDR)

The first stage in a fire engineering design is to establish the basic parameters of the project. This process should include a review of the scheme, identification of any overriding constraints and definition of the design objectives. This initial stage should draw on the expertise and experience of the engineer and design team.

Any necessary calculations will normally only follow when the design parameters have been established. For the purposes of fire safety engineering (FSE) this preliminary stage is described in BS 7974 as the Qualitative Design Review (QDR).

During the QDR process the scope and objectives of the fire safety design are defined, performance criteria established and one or more potential design solutions (trial designs) proposed. Key information is also gathered to enable detailed evaluation of the possible design solutions in the quantitative analysis.

7.2 Quantitative analysis

Following the QDR a quantified analysis can be carried out if necessary. It has been found convenient to split information on various aspects of FSE into a number of separate parts, referred to as sub-systems in BS 7974. Guidance on each of the subsystems is published in the supporting series of Published Documents (PD's).

The PD's provide selected guidance on the underlying principles and the type of calculations that may form part of a fire engineering study. However, it should be noted that the use of data and calculation procedures from other sources is not precluded and may often be essential to reach a solution.

One or two of the sub-systems may be used when analysing a particular aspect of design or they may all be used in combination as part of an overall fire engineering evaluation of fire safety in a building.

The quantitative analysis may use probabilistic or deterministic calculation procedures or a combination of both.

The sub-systems are as follows:

sub-system 1: Initiation and development of fire within the enclosure of origin;

sub-system 2: Spread of smoke and toxic gases within and beyond the enclosure of origin;

sub-system 3: Fire spread beyond the enclosure of fire origin and structural response;

sub-system 4: Detection, activation and suppression;

sub-system 5: Fire service intervention;

sub-system 6: Human Factors;

sub-system 7: Probabilistic risk assessment.

7.3 Assessment against criteria

Following the fire engineering analysis the results need to be compared with the acceptance criteria identified during the QDR.

If none of the trial designs satisfies the specified acceptance criteria, the QDR and quantification process should be repeated until a fire safety strategy has been found that satisfies the design criteria.

7.4 Reporting and presentation

A fire safety engineering study will generally need to be reviewed and accepted by the relevant approval bodies and it is essential that full details of the study are documented in a clear and understandable form.

7.5 Qualifications of fire safety engineer

The detailed application fire safety engineering techniques is beyond the scope of this document and any fire engineering study should be carried out by a suitably qualified and experienced fire safety engineer. In assessing the suitability of fire safety engineering design personnel professional qualifications (e.g. Chartered Membership of the Institution of Fire Engineers) and experience of fire safety engineering on projects of similar scale and complexity should be taken into account.

7.6 Fire safety engineering and the external building envelope

At the start of the fire engineering process it is essential to clearly establish the fire safety design objectives. Typical fire safety objectives may include:

- protection of life (including firefighters);
- limitation of direct damage to property;
- minimisation of business disruption.

When the fire safety objectives have been agreed, specific performance criteria need to be established.

In the context of materials used in the external building envelope the achievement of these objectives may be influenced by:

a) flame spread characteristics of internal and external faces;

b) through fixing of cladding and detailing of panel joints;

c) detailing of the junction between construction elements (e.g. roof/wall)

d) material heat release rate and potential contribution to a developed fire;

e) smoke production and potential for smoke spread;

f) potential for fire spread around compartment walls or floors;

g) fire resistance of the cladding system and the supporting structure;

h) general building fire protection measures (e.g. sprinklers).

The extent to which the above factors may influence the specification in any particular building needs to be considered in the context of the specific case.

The detailed application of fire safety engineering techniques is beyond the scope of this design guide the general approach to fire safety engineering is illustrated by the following examples.

7.6.1. Single storey warehouse

Occupant safety

Experience suggests that fires in single storey warehouses and industrial buildings do not present a high risk to life. This is largely because the number of occupants in this type of building is relatively small and they are generally familiar with their surroundings and should participate in regular fire drills. Consequently once warning of fire is given evacuation can be quickly achieved.

The main life safety concern in this type of building is to ensure that early warning of a fire is provided and that the rate of fire and smoke spread in the early stages of fire does not impede escape.

In the context of external cladding the main aim is to ensure that exposed internal surfaces do not accelerate the rate of fire spread in such a manner that escape could be impeded. The smoke production, fire resistance and the ultimate rate of heat release are unlikely to be significant when compared to the effects of a fire involving combustible warehouse contents.

Therefore if the building is located well away from adjacent buildings (or site boundaries) it may only be necessary to consider the surface flame spread properties of the faces of an external cladding system.

In the early (evacuation) stages of a warehouse fire the combustible core of an insulated panel is unlikely to contribute to the rate of flame spread if:

a) steel facings are provided and these are fixed through to the structure using steel fixings;

b) inter-panel joints remain tight.

7 Fire safety engineering

Fire fighting

Whilst the occupants should be able to quickly escape fire fighters may be put at risk if fire spread or structural collapse occurs more quickly than might be expected in other buildings. It is therefore desirable to ensure that all facings of composite panels are well secured and jointed to avoid the falling of facings and exposure of any underlying combustible material. Additionally if a thermosetting core materials are utilised (e.g. PUR, PIR or Phenolic) the danger of molten flaming droplets being released is avoided.

Loss control

Where the objective is to protect the contents of the building and reduce the potential for business disruption the most effective fire protection measures are likely to be the sub-division of the building into fire resisting compartments and/or the provision of sprinklers.

In an unsprinklered warehouse building the main influence on the speed of development of a fire will be the stored combustible materials.

However, it is important to ensure that the internal linings do not accelerate the spread of fire and that combustible core materials do not enable fire to by-pass compartment boundaries.

At junctions with compartment walls or floors consideration should be given to the incorporation of non-combustible materials. In all cases and especially where combustible core materials are utilised the design of detailing and the use of metal closures should ensure that the core material does not promote fire spread around the edges of compartment walls, floors or penetrations.

7.6.2. Hospital

At the other extreme of the spectrum is the design for fire safety in multi storey hospitals. Hospitals pose particular evacuation problems because of the difficulties in evacuating patients who may be confined to bed.

Consequently the design for fire safety in hospital buildings is based upon the principle of progressive horizontal evacuation. This process involves the movement of patients away from the fire-affected area to separate fire compartments. Bed patients outside of the fire-affected compartment are expected to remain where they are and be safe from the effects of fire. It is therefore imperative to ensure that fire and smoke will not spread from one compartment to another.

In this situation it is essential to consider all of the factors affecting the fire performance of the external cladding (7.6a to 7.6g on previous page) including the potential for fire spread, smoke production and smoke spread between compartments.

8 Fire testing

Fire testing in relation to the regulations is relatively small scale and only gives an indication of the way a product may perform in fire and a comparison of the relative ranking of various products.

The fire performance of insulated panels is influenced by the nature of the protective facings, the design of the panel joints and the detailing at junctions. It is only possible to determine the likely practical performance by considering the insulated panel system under realistic large scale testing (see 8.1.2).

This section briefly describes the fire tests relevant to insulated panels and includes a summary table showing the relationship between the present British Standard tests and the new European Harmonised test methods.

In assessing the performance of panel systems various fire test procedures are available. These are generally divided into two main categories:

a) reaction to fire tests;

b) fire resistance tests.

Walls

For walls the level of performance recommended for external cladding systems in building regulations guidance documents varies depending on a number of factors (see sections 3 to 4) such as:

height of the building

purpose group (use) of the building

proximity of the external wall to an adjacent building or site boundary

In low-rise buildings that have historically presented a relatively low risk to the occupants (e.g. offices and storage) there are no specific fire performance requirements for an external wall if it is located well away from adjacent buildings or a site boundary.

However, where the overall fire risk to life is greater as a result of the height, use or location of a building it may become necessary for the external walls to satisfy specified fire test criteria.

Roofs

In the case of roofs, tests assess the required level of performance in terms of spread of flame and the potential penetration of an external fire through the roof.

8.1 Reaction to fire

Reaction to fire tests are intended to classify materials or insulated panel systems in terms of their contribution to flame spread and heat output in the early stages of fire development.

The main reaction to fire tests that are currently referred to in UK building regulations guidance documents include:

BS 476:

Part 3: 1958 External fire exposure roof tests [9]
Part 4: 1970 Non-combustibility test for materials [10]

Part 6: 1989 Fire propagation for products [6]

Part 7: 1987 Surface spread of flame test for materials [5]

Part 11: 1982 Assessment of the heat emission from building products [11]

8.1.1. Surface properties

In the early stages of fire development the main aim is to ensure that the exposed surfaces do not propagate flame or contribute sufficient heat to promote the rate of fire growth.

The flame spread and heat contribution properties of linings and other exposed surfaces is generally classified in terms of performance in tests to BS 476: Part 7 and BS 476: Part 6 respectively.

To achieve a Class 0 rating it is necessary to achieve both a Class 1 surface spread of flame to BS 476: Part 7 and a satisfactory result in BS 476 Part 6.

Except in small rooms internal linings are required to provide a Class 1 or Class 0 surface. The external surface of a wall may also require to be classified in accordance with BS 476: Part 7 and Part 6 depending upon the use, location and height of the building (see table 3, page 19 and table 9, page 26).

8 Fire testing

Insulated panels with metal facings and thin protective coatings [pvc/pvdf] generally achieve a Class 0 rating in accordance with the British Standard Tests.

8.1.2. Non combustible materials

BS 476: Part 4 and BS 476: Part 11 are designed to demonstrate that a material will contribute negligible heat when subject to the temperatures experienced in a fully developed fire. The tests involve placing a sample of material in a furnace at a temperature of 750°C. If no sustained flaming is observed and there is no significant increase in the furnace temperature the material is classified as non-combustible or of limited combustibility.

The tests are severe and assess the heat contribution of a material throughout its thickness. Materials that would be classified as non-combustible include steel, stone, concrete, brick etc. Materials consisting primarily of non-combustible constituents such as mineral or glass fibre products may not necessarily be categorised as non-combustible due to the presence of organic binders and, in the case of insulated panels, adhesives . In general a material containing more than 1% of organics is unlikely to be classified as non-combustible or of limited combustibility.

8.1.3. Large-scale tests

Whilst the reaction to fire tests in the BS 476 series have a proven track record for many traditional materials they rely on the testing of relatively small samples of less than 1m^2 in area. The tests are therefore ineffective in identifying the possible effects of failure of the joint or facings of the panel systems. These effects only become apparent in much larger scale tests.

For this reason the insurers (Loss Prevention Council and Factory Mutual) have developed their own test procedures which are intended to establish the large scale performance of insulated panel systems. For instance the LPC test (LPS 1181) utilises a room 10m long by 4.5m wide by 3m high, which is constructed with the particular panel system under investigation.

The typical ignition source is a timber crib that provides a relatively severe heat source with a maximum heat output of 1MW. The standards require that the extent of flame spread is limited and that flashover does not occur within the compartment.

8.2 Fire resistance

The fire resistance of a building element provides some measure of its ability to survive a fully developed fire. Fire resistance is measured in terms of the time a building element will survive the test conditions before specified failure criteria are reached.

The relevant British Standards for the fire resistance of insulated panel elements are:

BS 476: Part 20: 1987 General principles [16]

BS 476: Part 22: 1987 Fire resistance of non-load bearing elements [7]

Note: The majority of external wall applications are not subject to fire resistance requirements. Applications where fire resistance are required are set out in sections 3.3: 4.5: 4.7.

The fire resistance test assesses the integrity and insulation performance of insulated panels.

Integrity. Fire resisting separating elements (walls, floors, doors etc.) are required to satisfy the integrity criterion of the test. This requires that no through gaps or openings occur in the construction and that no sustained flaming occurs on the unexposed face of the structure.

Insulation. Where fire resistance is required, external wall elements may also be required to satisfy the insulation criterion for a specified time. This requires that the average temperature of the unexposed face of the separating element does not exceed 140°C and the maximum temperature at any one point does not exceed 180°C.

8.3 European fire tests – reaction to fire

As a result of efforts to harmonise fire test standards throughout the European Union, British Standard fire resistance and reaction to fire tests will gradually be replaced by harmonised European standards. Where a national standard is to be replaced by a European harmonised standard, there will be a co-existence period during which either standard may be used. At the end of the co-existence period the national standard will be withdrawn.

The Euroclass scheme will classify all roof and wall products into one of seven reaction to fire classes namely: A1, A2, B, C, D, E and F according to their performance in four harmonised tests. Because the British and European test methods are very different in nature there is no direct correlation between the performance of any particular material or system in the British and European tests.

The least combustible products will be classified A1 and A2 based upon the results of a furnace test (EN ISO 1182) and an oxygen bomb calorimeter (EN ISO 1716).

Products classified as A1 or A2 under the European system are broadly comparable to the British classification of non-combustible or material of limited combustibility respectively. Class A1 is not generally achievable with a panel with an insulating core due to the organic content of the adhesives and binders.

At the other end of the scale the classifications will involve a small burner test (EN ISO 11925-2), which will be used to assess the ignitability of products in categories B to E.

However, the main test used for discriminating between products in categories B, C and D will be EN 13823 also known as the Single Burning Item or SBI test. This test involves subjecting panels to a fire source with a heat output of 60kW and measuring the flame spread and contribution to heat output of the panel.

8.4 European fire tests – fire resistance

The harmonised fire resistance test (EN1363-1 and EN1364-1) is fundamentally the same as the equivalent BS 476: Part 20 and Part 22. The changes are unlikely to reduce the level of safety achieved in buildings. The classification procedure in terms of minutes of integrity and insulation is similar.

8.5 Comparison between British and European systems

Table 12 provides a comparison for insulated panels between the British Standard test requirements and the likely European equivalents.

Table 12. Comparison of equivalent British and European classifications

Performance criterion	Scotland	England, Wales and Northern Ireland	Euroclass*
Reaction to fire	Non-combustible Non Combustible Low risk Medium risk High risk	Non Combustible Material of limited combustibility Class 0 Class 1 Class 2	A1 A2 B C D
Fire resistance [insulation integrity]		15 minutes 30 minutes 60 minutes etc.	15 minutes 30 minutes 60 minutes etc.
Roof	Low vulnerability (see section 4.6)	Class AA: AB: AC	**

** For England and Wales the corresponding Euroclasses above are the proposed classes set out in the draft European Supplement to Approved Document – B which at the time of printing is out for public comment. They are given for informative guidance only.*

*** A harmonised procedure for the assessment of roofing systems is being developed but it is anticipated that this will not be available for some time.*

9 Fire performance and classification of insulated panels

9.1 9.1. Background

There have been a number of high profile fires involving insulated panels incorporating a polystyrene core. This type of panel has been widely used internally in the food processing industry to create insulated cold or freezer stores within the building enclosure.

As a result of these fires, guidance on the design of panel systems used internally in large cold storage areas has been published by the International Association of Cold Storage Contractors (European Division) [17].

This publication is referred to in Appendix F of Approved Document B which makes a distinction between the different fire risks associated with internal insulating structures and external cladding.

> "Insulating core panel systems are used for external cladding as well as for internal structures. However, whilst both types of panel system have unique fire behaviour characteristics, it is those used for internal structures that can present particular problems with regard to fire spread".

The external envelope

It is generally accepted that the fire risks associated with insulated panels with thermosetting cores (rigid polyurethanes) used in the external building envelope are much lower than those associated with internal partitioning applications of polystyrene panels, particularly within the food processing industry.

Whilst the informed consensus is that the use of cladding panels incorporating combustible cores does not represent a risk to the occupants of most buildings there is concern that fire fighting operations may be made more difficult. There may also be additional factors to be considered in certain types of buildings where a total evacuation is not feasible (e.g. hospitals and high rise buildings). In taking account of these concerns the recommendations of this design guide often go beyond the minimum requirements of building regulations.

By applying good design practice and the appropriate selection of products [section 10 & 11] the level of fire safety can be readily improved over and above that required by current building regulations guidance documents.

9.2 Factors affecting fire performance of insulated panel systems

The fire performance of different types of insulating panel system can vary considerably and will depend upon a number of factors including:

- facing material;
- security of joints between panels;
- the degree of restraint (fixings) provided to the facings;
- flammability of core material;
- flammability of other organic components – adhesives, binders etc.

9.2.1. Facing materials

The performance of any core material and in particular polymer cored panels is strongly influenced by the protection afforded to the core by the facings. If steel facings are firmly secured by through fixings and the inter-panel joints are designed to retain their integrity during a fire a substantial degree of protection can be provided to the underlying core. This form of construction will restrict flame spread and reduce the heat contribution to a fire.

External insulated panels have been specifically designed to absorb the considerable forces – wind, snow, static loads etc – to which the roofs and walls of buildings are subject and to transmit the forces to the supporting structure. They are also required to be weather tight and control energy loss through air tightness at the joints. As a result the panels are securely fixed to the supporting structure and the joint design is designed to be robust and effective.

9.2.2. Fixings and joints

To obtain the best fire performance the internal and external facings should be firmly secured to the structure with through fixings. The design and detailing of inter-panel joints and closure at the panel edges is also fundamental. The more effectively the joints are sealed the less the flames will impinge directly on the core material reducing flame spread and heat contribution. Detailed guidance regarding panel fixing and jointing is given in section 11.

9.2.3. Core materials

The fire properties of core materials can vary significantly according to the generic type of core and the specific formulation. The following paragraphs provide guidance on the performance of the four main generic types of core material when considered in isolation.

However, when the core material is incorporated into a steel faced insulated panel building system, the protection provided by the metal facings, joints, fixings and the support system may greatly modify the performance indicated for the core insulants in isolation. The practical performance of the complete insulated panel system should only be evaluated by a full-scale test and the following information should be viewed accordingly.

Rigid polyurethanes

Rigid polyurethane (PUR) materials are cellular thermosetting insulants that form a char when subject to heat and flame impingement. The char acts as an insulator which affords some protection to the underlying product. However, PUR will burn by charring and pyrolising producing significant quantities of smoke in the process.

When incorporated into panels however, large-scale tests [18] have shown that there is no hidden flame spread within the panel cores with external panel systems. Decomposition under these conditions is significantly different from testing the product in isolation.

Whilst the smoke level in large-scale tests has been deemed to be acceptable, the smoke production from rigid polyurethane is less than polystyrene but can still be very substantial.

Polyisocyanurate (PIR)

Rigid polyisocyanurate (PIR) core products are extensively modified polyurethanes by the incorporation of the much greater heat resistant isocyanurate ring structures created by the trimerisation of three molecules of the polymeric isocyanate used in their formulation.

As a result, when tested in isolation, the rate of pyrolysis is reduced, the strength of the char is increased, and the protection to the underlying insulation is enhanced. This results in the reduction of the amount of damage created by the incident of fire with a consequent reduction of smoke production. This is confirmed by large-scale tests [18].

Accordingly some steel faced PIR cored panel systems will give a fire resistance in excess of 2 hours integrity and 15 minutes insulation (BS 476 Part 22) as well as satisfying the large-scale test requirements of the LPC test LPS 1181-2 and FMRC 4880/4471.

Mineral fibre

Mineral fibre products are created by bonding the core product with organic binders. In isolation the fibre performance to BS 476 Part 4 may be non-combustible or of limited combustibility. When incorporated within insulated panels the mineral fibre core includes organic binders and the facings are bonded using an organic adhesive. Most mineral fibre panels will therefore not be rated non-combustible or of limited combustibility.

However, fire performance of panels with mineral fibre cores is generally very good and these panels will normally produce less heat and smoke than panels, incorporating polymeric cores.

Steel faced MF cored panels are capable of being classified in accordance with the LPC standard [LPS 1181] and of providing significant levels of fire resistance, both integrity and insulation, according to BS 476 Part 22.

9 Fire performance and classification of insulated panels

Phenolic foams

Phenolic foams contain a polymeric structure which offers a considerable resistance to degradation by heat. Accordingly, like PIR products they are thermosetting, forming a char in isolation which adds a high degree if protection to the underlying insulation. The characteristics are maintained when the product is incorporated into insulated panels. Smoke production is also low by comparison with most other polymeric materials.

Despite their good fire properties, Phenolic core materials have not been used for roofs and walls because of difficulties in achieving the additional mechanical resistance requirements for external envelope panels.

Expanded polystyrene

Expanded polystyrene is only rarely used in external cladding systems. Polystyrene is a thermoplastic that melts when heated. Chemical flame retardants can be added but when exposed to sustained flame impingement even flame retardant polystyrene materials will burn vigorously and produce large quantities of black smoke.

The softening temperature is approximately 100°C and melting temperature 180°C. As the temperature increases the polystyrene melts and recedes from the heated surface creating a void between the facing panels. Flames entering the void cause flaming droplets to flow on both the external and internal sides of the cladding and this can accelerate fire spread.

Fire tests in accordance with LPS 1181 indicate that once flames have entered the core, fire can spread unchecked between the facings consuming the core material as it progresses. If the facings are unsecured with no through fixings early collapse can occur and accelerate the speed of flame spread [18].

However, if the facings remain secured and the joints remain tight there should be no unexpectedly sudden spread of flame across a wall or ceiling.

The production of thick black oily smoke from burning polystyrene can be very substantial.

9.3 Fire test performance of panel systems

The building regulations and insurance recommendations require specified levels of performance in terms of reaction to fire, fire resistance and the integrity of junctions with fire resisting construction.

In the following paragraphs the fire performance of generic types of panel system are discussed in the context of these recommendations. However, in each case the specifier should ensure that test data is available from an accredited test laboratory to confirm the required level of fire performance.

9.3.1. Reaction to fire (flame spread)

In most cases either the external or internal face of an insulated panel will need to comply with specified reaction to fire (flame spread) criteria (commonly this will be Class 0, Class 1 or Euroclass B).

By virtue of the protection provided by the facing, commercially available, steel faced insulated panels will generally achieve a Class 1 surface spread of flame rating in accordance with BS 476: Part 7 irrespective of the type of core material.

The performance in BS 476: Part 6 (for a Class 0 designation) or the tests for designation in accordance with Euroclass B may also be influenced by the nature of the core material and the joint design. Insulated panels with rigid urethane or mineral wool cores will generally achieve Class 0 and Euroclass B.

With regard to insurance industry tests, currently only panels with certain PIR, Phenolic or mineral fibre (MF) cores have passed the LPS 1181-2 and the FMRC4480 / 4471- Class 1 large scale tests.

9.3.2. Fire resistance

The fire resistance of an insulated panel system is a function of the facing material, insulating core, joints between panels and the method of fixing.

Steel faced panels with a PIR core have achieved a fire resistance in excess of 2 hours in terms of integrity. PIR core panels can achieve approximately 15 minutes in terms of insulation. This generally meets the requirements for external walls located more than 1m from the boundary (note, however, that in some situations the Scottish Technical Standards require 30 minutes insulation).

Panels containing a mineral fibre (MF) core are able to provide a fire resistance in excess of 2 hours as regards both integrity and insulation.

To achieve the specified fire resistance the cladding system must be supported by a structure that will also provide the required fire resistance or has otherwise been designed to survive fire [19].

9.3.3. Junctions

The fire tests required by the regulations assess insulated panels as a product or system e.g. panel-to-panel joints. It is also essential that all the interfaces between panels on different planes, and panels with other construction elements – such as windows, doors, penetrations etc – are also designed and installed with maximum fire security in mind.

Sections 10 and 11 give good practice guidelines concerning the most common and important of these detailing areas together with recommendations for flashings and fixings.

9.3.4. Junctions with fire resisting constructions

At the junction between a roof, or an external wall with a compartment wall some guidance documents require that a strip of combustible core is removed and replaced with a strip of non-combustible or fire resisting material. This is to ensure that the core material does not provide a continuous path of combustible material that could allow fire to bypass the fire resisting construction.

However large-scale tests and analysis of actual fires have shown that some types of combustible core (particularly some types of PIR and Phenolic) will tend to char but may not promote the spread of fire spread beyond the fire resisting barrier.

Therefore if it can be demonstrated by suitable tests (e.g. following the principles of BS 476: Part 22 or a large scale ad-hoc test) that a particular insulated panel system will not promote fire spread past a compartment boundary it would, in many cases, be reasonable to omit a fire resisting or non-combustible break in the cladding.

9.3.5. Smoke production

When subject to sustained fire exposure insulated panels can produce considerable quantities of smoke as a result of degradation of a combustible core. However, the size of initiating fire necessary to cause significant degradation of the core and substantial smoke production is in itself likely to produce very large quantities of smoke. Therefore, the contribution of a insulated panel system designed and installed in accordance with the recommended good practice set out in this guide is unlikely to make a significant contribution to the risks to the occupants within buildings.

There are no statutory requirements covering the propagation of smoke by building materials. However, in certain cases where it is necessary for the occupants to remain within a separate compartment within the building for all or part of the duration of a fire the potential for smoke production and the impact of its spread on the occupants needs to be carefully assessed. This additional consideration would apply to buildings such as hospitals, high-rise buildings subject to phased evacuation or sensitive control installations (i.e. air traffic control) where immediate evacuation is not feasible.

9 Fire performance and classification of insulated panels

9.4 Recommended performance levels

Building Regulations are intended to set out the minimum standards necessary to achieve acceptable levels of safety.

The main use of insulated panels for the external roofs and walls of buildings has been in factories, warehouses and offices. In these types of buildings the risk to life from fire has historically been relatively low. More recently the use of insulated panels has extended to a wide range of applications within the commercial, retail and leisure sectors.

In other types of building, (e.g. hospitals, schools) the life safety consequences of fire can be much greater. It is therefore reasonable to specify more onerous fire safety performance standards for materials used in the construction of hospitals than in, for example, a warehouse or low-rise office building.

Based on the generic fire risk associated with the various building regulations purpose groups, this guide provides recommendations on the performance levels of external insulated panel systems that are considered appropriate for a range of generic situations. However, it should be noted that these recommendations are based on generic risk assessments and may go beyond the requirements of building regulations. Alternative specifications may be appropriate if shown to be acceptable by a risk assessment or fire safety engineering study (see section 7).

9.4.1. Insulated panel systems

The fire properties of cladding systems can vary considerably. The ultimate fire performance of insulated panels is determined by the facings, panel design, the panel-to-panel joint detail, the core insulant and to some extent the method of fixing.

To give guidance on panel selection relating to typical end uses, recommended performance levels are illustrated in Table 13. They combine the performance classifications from the current British Standard and Euroclass harmonised tests supplemented for certain Building Purpose Groups with additional information and certification from one or other of the larger scale tests [insurance industry tests – LPS 1181 / FMRC 4880/4471].

Whilst for many building group categories the requirements of the building regulations may be satisfied by reference to the British Standard tests or Euroclass levels, it is recommended that an enhanced level of performance be adopted particularly in higher risk building types [see table 13 opposite].

Note: Polystyrene as a core insulation in external cladding panels is rarely used, due to its poor performance in many major industrial fires [internal applications], and has in general been superseded by urethanes and mineral fibre cores. It is recommended that PS cored panels are only considered where their performance can be supported by relevant large-scale fire tests i.e. LPS 1181 or FMRC 4880/4471.

9.4.2. Recommendations for the choice of insulated panels

Table 13 presents recommended performance levels for insulated panels for use in roofs and external walls. These recommendations are based upon generic risk assessments. The performance specifications recommended in this table may exceed the minimum requirements of Building Regulations in England and Wales. In Scotland additional requirements for non-combustibility may apply to buildings in purpose group 2 (hospitals) or buildings with a floor at 18m or more above ground level.

The recommendations are based on the most commonly used steel faced insulated panels. Aluminium faced insulated panels may satisfy the reaction to fire requirements of the BS and corresponding Euroclass tests but are unlikely to meet the fire resistance or insurance industry test requirements.

Table 13. Recommended fire performance classifications for insulated panels for external wall and roof applications by purpose group*

Purpose group	Wall and ceiling facings	Roof performance	Fire resistance	Additional recommendation (EPIC)
2. Residential [Excl. dwellings] Schools; Hospitals etc.	Class 0	AA; AB; or AC	**For fire resistance requirements see Table 3 [Section 3, page 19]** **For Scotland – Section 4, page 21** **Walls** Fire resistance requirements depend upon: – boundary conditions **Roofs** There is generally no requirement for roofs to be fire resisting (but for exceptions see section 3.3.3; 3.3.4; 4.4.2 & 4.7)	LPS1181 Grade A or FMRC 4880 / 4771 – class 1 Limited combustibility core if more than single storey
	Euroclass B	N/A (see note 3)		Euroclass A2 if more than single storey
3. Offices	Class 0	AA; AB; or AC		LPS1181 Grade B or FMRC 4880 / 4771 – class 1
	Euroclass B	N/A (see note 3)		
4. Shops & commercial	Class 0	AA; AB; or AC		LPS1181 Grade A or FMRC 4880 / 4771 – class 1 Limited combustibility where top floor is more than 18m above ground
	Euroclass B	N/A (see note 3)		Euroclass A2 where top floor is more than 18m above ground
5. Assembly / Recreation	Class 0	AA; AB; or AC		LPS1181 Grade A or FMRC 4880 / 4771 – class 1 Limited combustibility where top floor is more than 18m above ground
	Euroclass B	N/A (see note 3)		Euroclass A2 where top floor is more than 18m above ground
6. Industrial	Class 0	AA; AB; or AC		Additional provisions may be specified for specific applications and insurance requirements
	Euroclass B	N/A (see note 3)		
7a. Storage & other non-residential	Class 0	AA; AB; or AC		Additional provisions may be specified for specific applications and insurance requirements
	Euroclass B	N/A (see note 3)		
7b. Car parks	Class 0	AA; AB; or AC		Additional provisions may be specified for specific applications and insurance requirements
	Euroclass B	N/A (see note 3)		

** The corresponding Euroclasses above are the proposed classes set out in the draft European Supplement to Approved Document – B which at the time of printing is out for public comment. They are given for informative guidance only.*

Notes

1. External insulated panels generally achieve Class 0
2. External insulated panels (roofs) generally achieve requirement AA or AB
3. External insulated panels (roofs) generally satisfy new requirement classification to prEN13501-5 for External Fire Performance

10 Designing for optimum fire performance

10.1 Introduction

This section consolidates the information given in the previous chapters into a single chapter covering 'good practice' in the design of insulated panel systems. Designers should also refer to the section 11 which provides guidance and recommendations relating to site installation, fixing and design detailing.

The following pages describe the way design and installation can affect the performance of insulated panels in the developing stages of a fire. The principle is to maintain structural integrity and prevent significant contribution from the building envelope during the early stages of a fire so that escape can be facilitated, damage to property minimised and the fire services can effectively treat the incident on arrival.

The fire resistance of insulated panel walls is considered separately in section 12.

10.2 Background

Insulated panels have been used to form the external roofs and walls of buildings for over 35 years. Historically their use was predominantly in the industrial and distribution construction sectors with some early use in housing. Insulated Panels can now be found in most areas of construction due to the primary regulatory requirements for thermal and energy efficiency and the practical issues of ease and speed of construction.

The predominant insulating material used in panels manufactured for the external envelope is rigid urethane, due to its superior thermal insulating properties. High density mineral fibre has been used more recently for certain applications and these products command about 10% of the market. Very little polystyrene, phenolic foam, or cellular glass have been used as the insulating core.

It is not normal for external envelope panels to be involved at the early stages of a fire. Occasionally they have become involved as the fire has become fully developed by which time the property is a potential loss. The security of panels and the protection afforded by the design and the use of metal facings is fully discussed in sections 8 and 9. The net result is that correctly specified and installed insulated panels used for the external envelope present little risk to the building occupants or contents.

Large scale tests have shown that protected joints, secure fixings and proper detailing of vulnerable areas such as penetrations and potential voids can further improve the reaction to fire performance of external insulated panels systems.

10.3 Regulations affecting design

Statutory requirements are described in Section 2. The following summarises the compliance of roof and wall insulated panels.

10.3.1. Surface spread of flame and prevention of penetration

Metal faced panels with the standard protective coatings – PVC plastisol [normally 200 microns] or PVDF [25-30 microns] generally satisfy the standard BS 476 tests (parts 3, 6 and 7) giving a Class 0 surface rating and a Class AA rating for roofs. These ratings are achieved irrespective of the choice of core material and in regulatory terms panels are deemed to satisfy the requirements.

Under the new European Tests, surface spread of flame and penetration are assessed by a combined reaction to fire test that results in a Euroclass designation. The class level is influenced by the type of core material and joint design. Insulated panels with mineral fibre cores generally obtain Class B and urethanes Class B, C or D dependent upon the specific formulation and design.

Roof panels are in addition subject to a separate External Fire Performance test (EFP). Insulated panels obtain the highest classification in accordance with the EFP test criteria.

10.3.2. Fire resistance

Fire resistance requirements apply only in certain circumstances to external wall panels. The requirements are detailed in sections 3, and 4 and cover integrity and insulation. Some urethane panels achieve 15 minutes insulation and in excess of 120 minutes integrity. Panels with mineral fibre cores can achieve insulation and integrity for times in excess of 120 minutes dependent upon the panel design and density of core material. Some of these panels can satisfy the requirements for internal compartmentation.

10.4 Assessment of fire risk

Observation of large-scale tests and real fires show that all types of insulated panel delaminate in a fire. Where the facings are securely fixed to the structural framework as in the case of external wall and roof panels, delamination is restricted and the facings remain in place [see 11.4 and Figure 16].

The core of current panels with factory engineered joint designs is protected from direct flame impingement and only gradually contributes to the fire. The core will not continue to contribute after the fire is controlled or the surface is cooled – by sprinklers or the actions of the Fire Service etc.

10.5 Panel selection

The various building regulations set out minimum standards for the fire performance of external cladding systems. However, it is recommended that the selection of insulated panels be based upon the recommendations given in Section 9, table 13. Whilst these recommendations are generally in excess of current building regulations requirements they represent industry best practice and will assist in reducing the risk to building occupants and fire fighters.

10.6 Structure and fixings

Insulated panels are factory engineered products designed for a long and durable life. The composite nature of the construction ensures good strength sufficient to withstand the forces of the elements, wind, snow loadings etc and movements of a typically lightweight framework structure. Panels designed for the external cladding of the envelope can sustain substantial movements of the supporting frame without compromising the weather tightness or joint integrity.

Throughout the 1990s there was a continual development of the panel-to-panel joint detailing together with improvements in fixing technology. Studies of panels involved in total loss fires have shown that the current standard fixings enable the structural integrity of the panels to be maintained until there is deformation and collapse of the supporting steelwork.

10.6.1. Structural steelwork and framework tolerances

Tolerances for structural steelwork are defined in BS 5950: The structural use of steelwork in building: Parts 2 & 7 1992. However no tolerances are defined for the position of purlins and cladding rails relative to the main frame and in particular no mention is made of the position of the surface of the purlins and rails to which the cladding will be fixed.

Excessive variation in this fixing plane can cause assembly problems for the cladding contractor and can affect the panel strength, weather tightness, fire performance, and the appearance of the finished building.

The guidance tolerance for insulated panels is based on BS 5950. The fixing surface of each purlin/rail should be within L/600 of the surface of the adjacent purlins/rails where L is the spacing between purlins. This equates to 3mm for a 1.8m rail spacing. The maximum variation from the theoretical cladding plane should be 20mm.

10 Designing for optimum fire performance

The joint design of typical insulated panel systems provides a degree of flexibility to accommodate variations in the supporting steel frame. However as with all cladding systems, tightening up the tolerances and alignment of the structural steelwork, purlins etc can significantly improve the joint efficiency in terms of air tightness and at the same time facilitate a tight joint that will give optimum fire performance.

Similarly junction details at the cill, head, corner etc should be able to accommodate the variation in the fixing planes. Typical details are shown in section 11.

> Structural tolerances should be kept to within the guidance tolerance for insulated panels to ensure tight fitting joints and optimum fire performance of the panel system.

10.6.2. Joint design and installation

Standard joint designs are described in section 11. The fire performance of well designed panel-to-panel joints has been proved in real fires and large-scale fire tests. Therefore when a suitable system has been specified there are no on-site measures or specific additional techniques necessary to improve the fire performance.

10.7 Detailing

The following good practice guidelines should be considered in conjunction with the mandatory requirements [1] for airtightness levels of 10m³/m²/h required from April 2002 and reducing to 5m³/m²/h by 2007. The techniques for design detailing and installation are common for both air tightness and optimum fire performance and cover all types of external insulated panel irrespective of the core material.

The chief principle behind good detailing is the correct use of metal closures and flashings. This is not necessarily new technology. The basic methods and recommendations for details have been employed for many years. To achieve air tightness standards and also best fire performance it is important that the detailing should be designed and carried out on site with both these factors in mind and without compromise.

10.7.1. General design points

The following procedures should be adopted to ensure optimum fire performance by ensuring that a combustible core material is not exposed to direct flame impingement.

- closures/flashings should be steel with a minimum thickness of 0.5mm and minimum girth of 50mm;
- stitching should be at a maximum of 400mm centres;
- closures should not be omitted, even if not visible behind columns etc.

Recommended standard typical details are shown in section 11 – Installation, fixing and detailing. The following details are illustrated:

- Drip detail – wall or floor
- Head detail – wall/ceiling/wall/roof
- Windows
- Doors
- Internal and external corners
- Penetrations
- Internal roof [ridge]
- Roof/wall – verge
- Roof/wall – eaves
- Roof/wall – parapet cladding
- Roof vents and penetrations
- Hot flues
- Internal valley gutter
- External soffit
- Break flashings – walls

Note: For 'scale' details and details not illustrated in section 11, reference should be made to manufacturer's detailed drawings, or advice obtained through their technical services.

10.7.2. Apertures and service penetrations

Whenever holes or apertures are cut on site through the insulated panels, all exposed cut edges should be finished off with the appropriate metal closure flashing.

Installation, fixing and detailing

11.1 Introduction

For the installer it is essential that the basic rules for good installation and detailing practice are followed if fire is to be prevented from bypassing the panel system at junctions, penetrations etc. There is no conflict between detailing required for energy conservation and detailing required for good fire performance as the recommended details developed for energy efficiency and air tightness also provide the optimum performance in fire.

The essential elements of fixing and detailing with fire in mind are covered in this section. Specific comments and recommended details for walls requiring fire resistance are covered separately in section 12.

11.2 Panel development

The fundamental difference between external insulated panels and panels designed specifically for internal use lies in the joint design and the method and security of fixing.

11.3 Joint design

Joints for external panels are required to be weather tight and energy efficient under 50-year wind forces and driven rain. Joints have developed under a complete re-engineering assessment and are now stronger with a substantial wrap-around of the steel together with an interlock. The addition of a return overlap nib on roof panels gives further added strength and accommodates additional sealing as required.

These developments have produced an effective panel-to-panel joint which is superior in terms of fire performance and which offers additional protection to the insulating core.

11.4 Fixings

Insulated panels used for the building envelope are in almost all cases firmly secured to the building framework using through panel fixing of both faces [Figure 14] or partial through fixing of one face in conjunction with a fully interlocking steel joint detail [Figure 15].

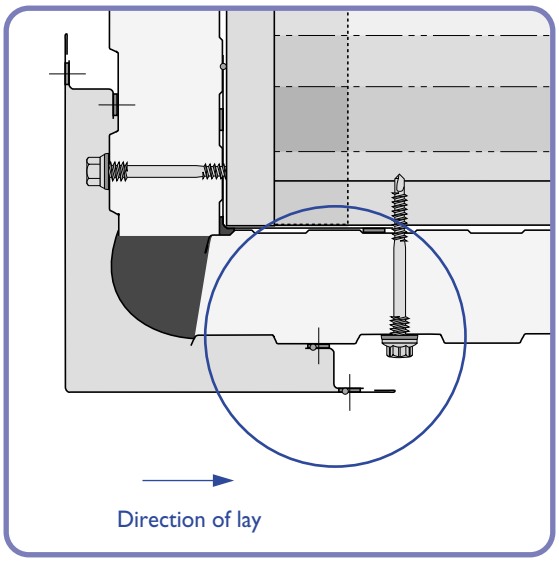

Figure 14. Illustration of through fixings

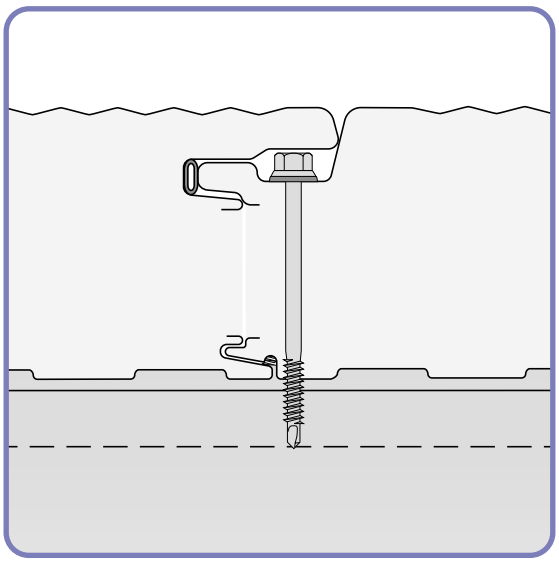

Figure 15. Illustration of secret/partial fixings

From the few fires in which insulated panels have become involved as a result of an internal fire, structural integrity has been maintained until the fire has reached fully developed proportions and the integrity of the framework has been affected.

Figure 16. The fire rated (PIR) insulated panel wall cladding remained intact in this major fire although the internal roof structure behind had totally collapsed

Steel fixings (at typical centres of 1.8m) that fulfil the required pullout strength to withstand the construction design forces for the building envelope will generally maintain the stability of the steel facings in fire without the need for change or special treatment.

Designers and specialist installers should refer to the manufacturer's recommendations for fixings according to the building application, location and the type of structural framework.

11.5 Detailing

11.5.1. Closures and flashings

Standard details usually comprise a variety of closures and flashings for application at corners, junctions, windows and doorways, penetrations etc. These play an important role in determining the fire performance of a system.

- To prevent transmission of flame and heat beyond the panel especially if there are cavities or hidden / inaccessible voids behind the cladding;
- To limit the transmission of smoke to the other side of the insulated panel;
- To protect the core and prevent direct flame impingement on the core at the ends of the panel and at penetrations or other places where the panel may have been cut;

The installer should ensure that:

– flashings are to the manufacturer's instructions in terms of material type and gauge, and girth

– flashings are installed to the recommended fixing centres

– the design of the fixings adequately accommodates differences in construction site tolerances without creating open gaps into which fire can pass.

– flashings are manufactured from steel

– seals and additional site applied insulation are to the correct specification and fire grade where required

– closures should not be omitted, even if not visible behind columns etc.

11 Installation, fixing and detailing

11.5.2. Recommended details

The following details illustrate the principles behind good detailing practice. They are designed to provide optimum fire performance and to take into account the improved standard required to meet the airtightness requirements of the Building Regulations: Approved Document L2: 2002 edition, which were introduced in August 2001 [1].

Where applicable the details have been designed with flexibility to take into account the difference in levels of tolerance between factory engineered insulated panels and the wider tolerance levels allowed under BS 5950 for site construction steelwork including the site installation of purlins and cladding rails.

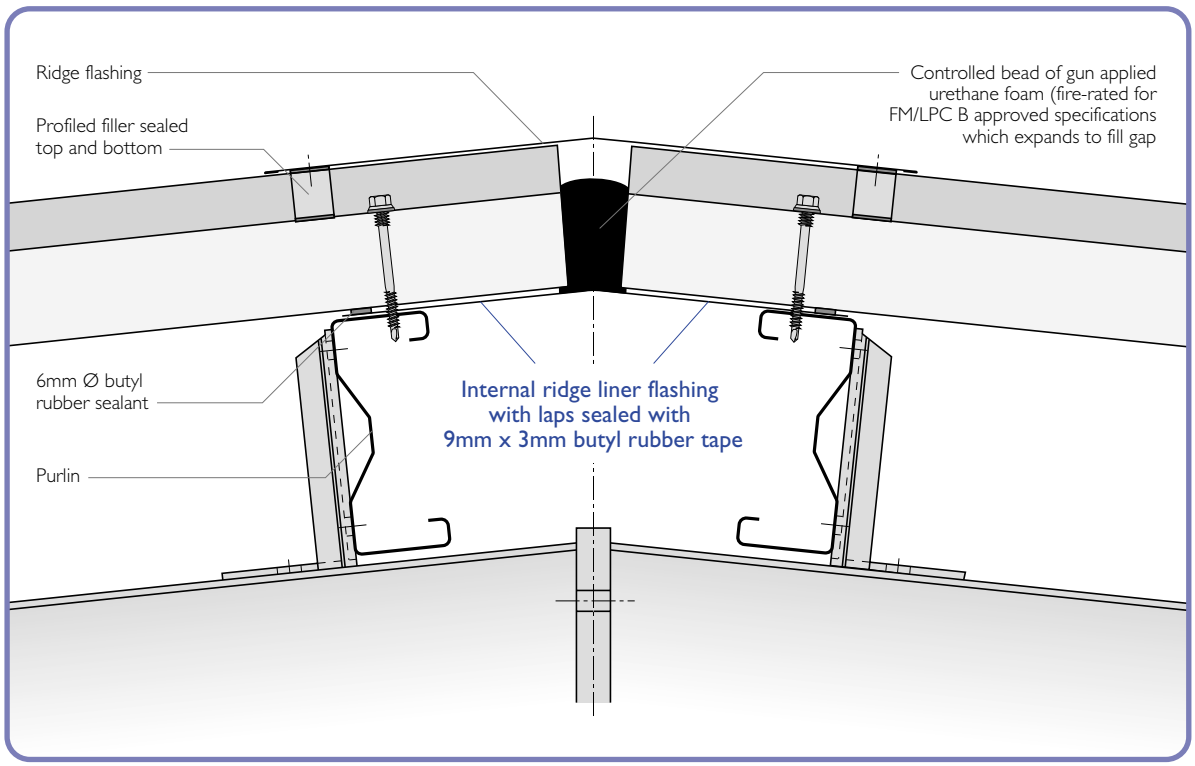

Figure 17. Standard ridge

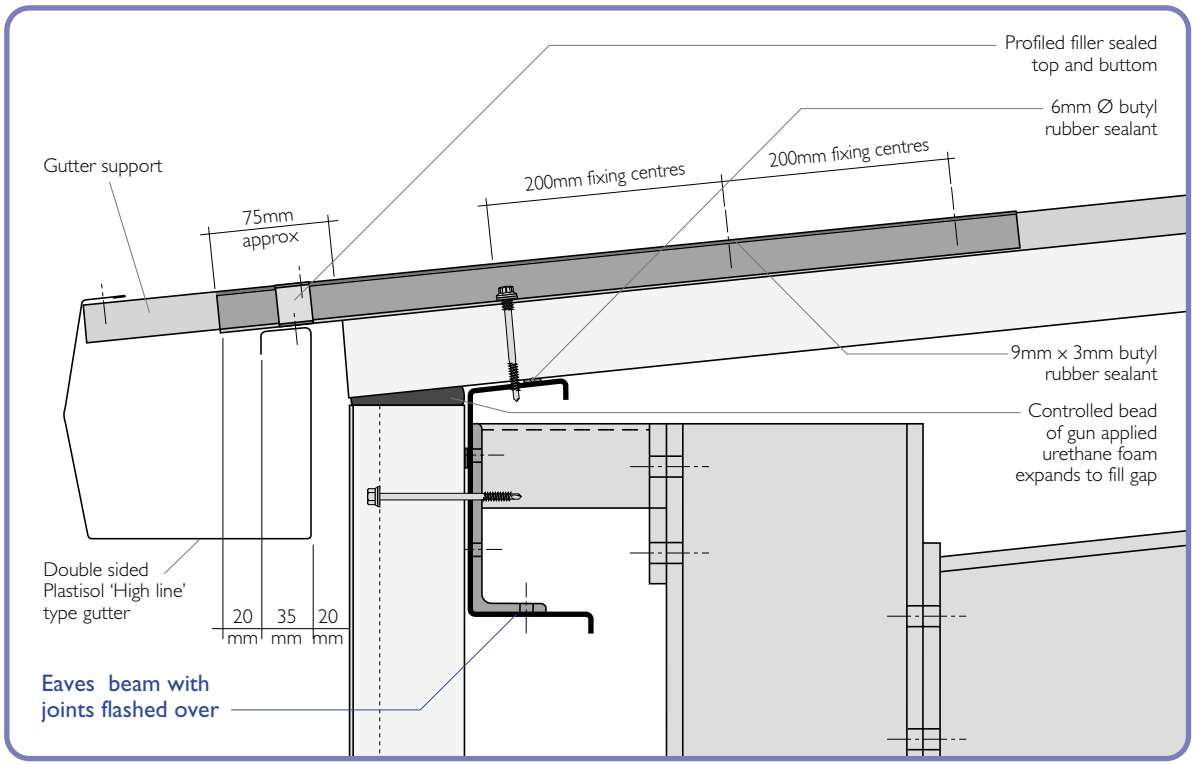

Figure 18. Eaves – external gutter

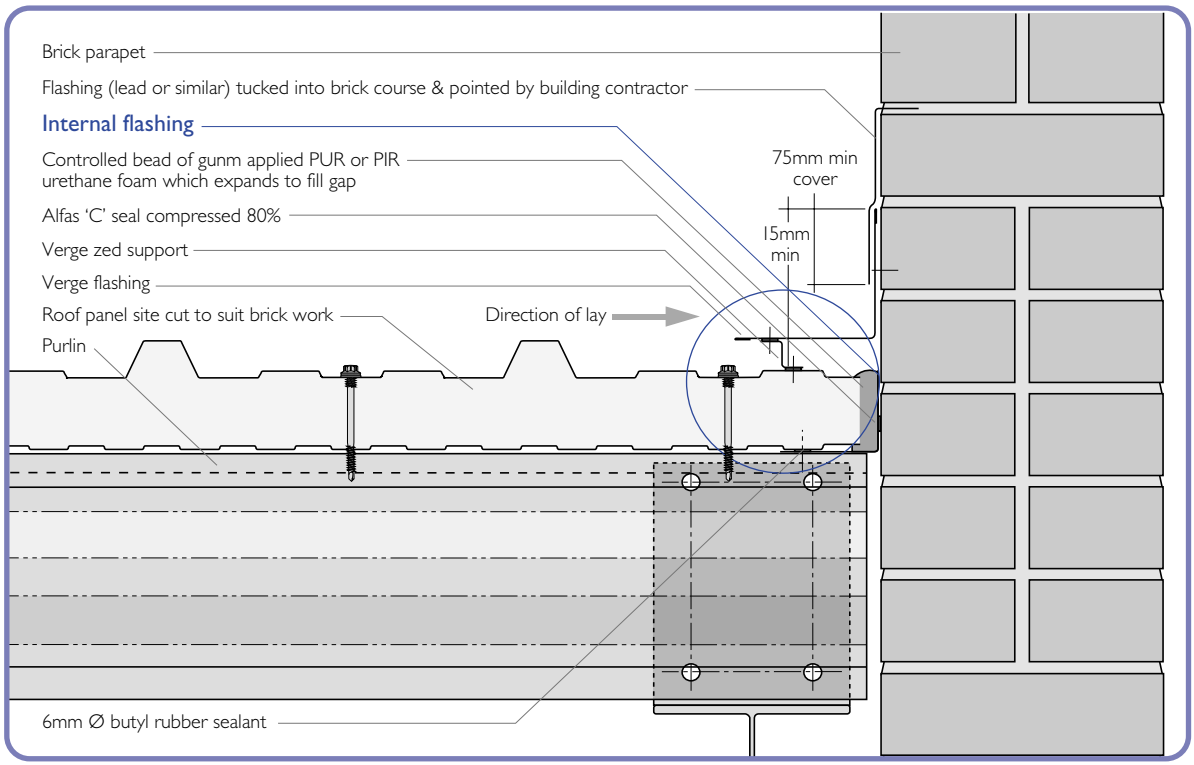

Figure 19. Verge – brick parapet

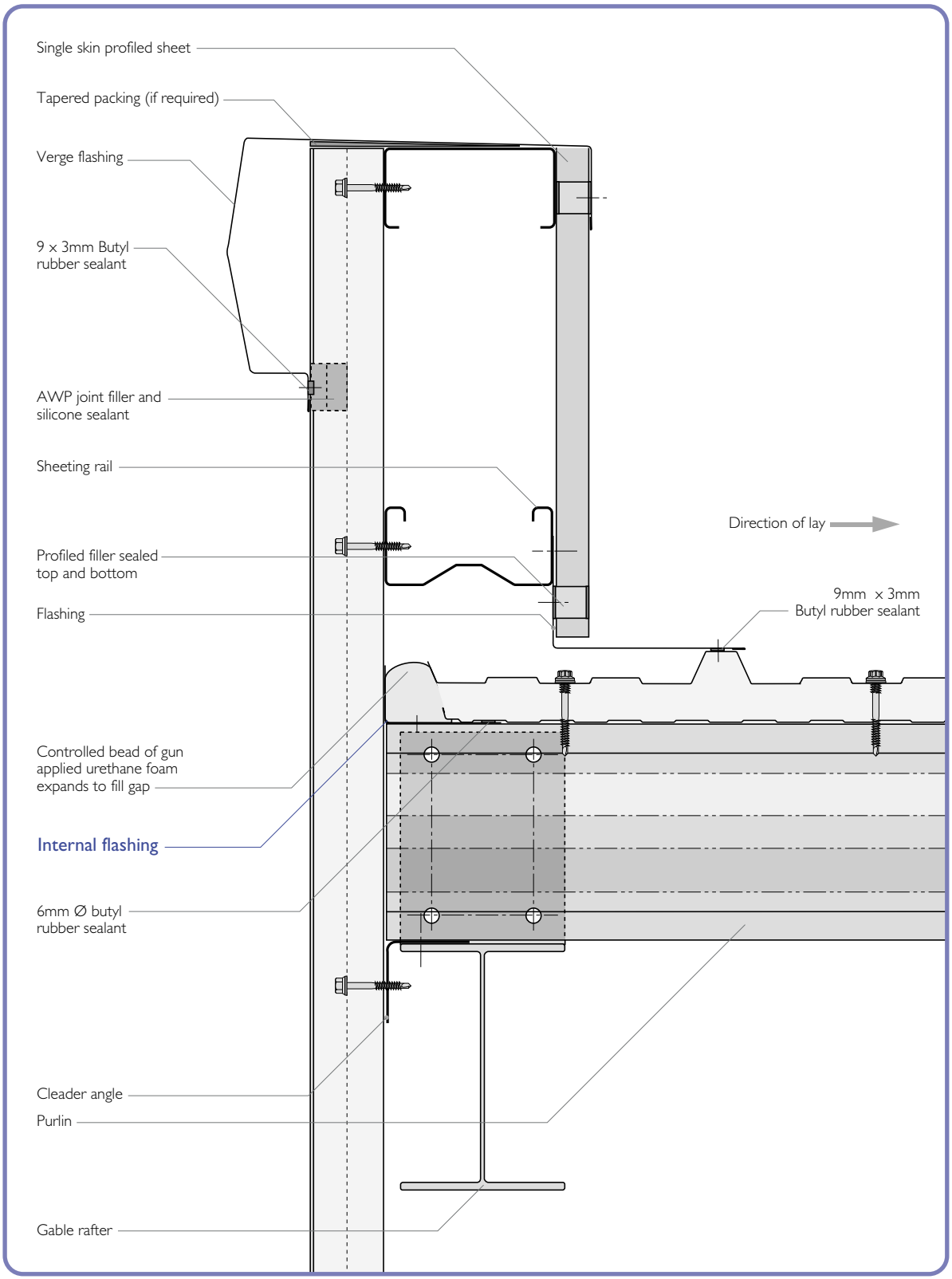

Figure 20. Verge – parapet cladding

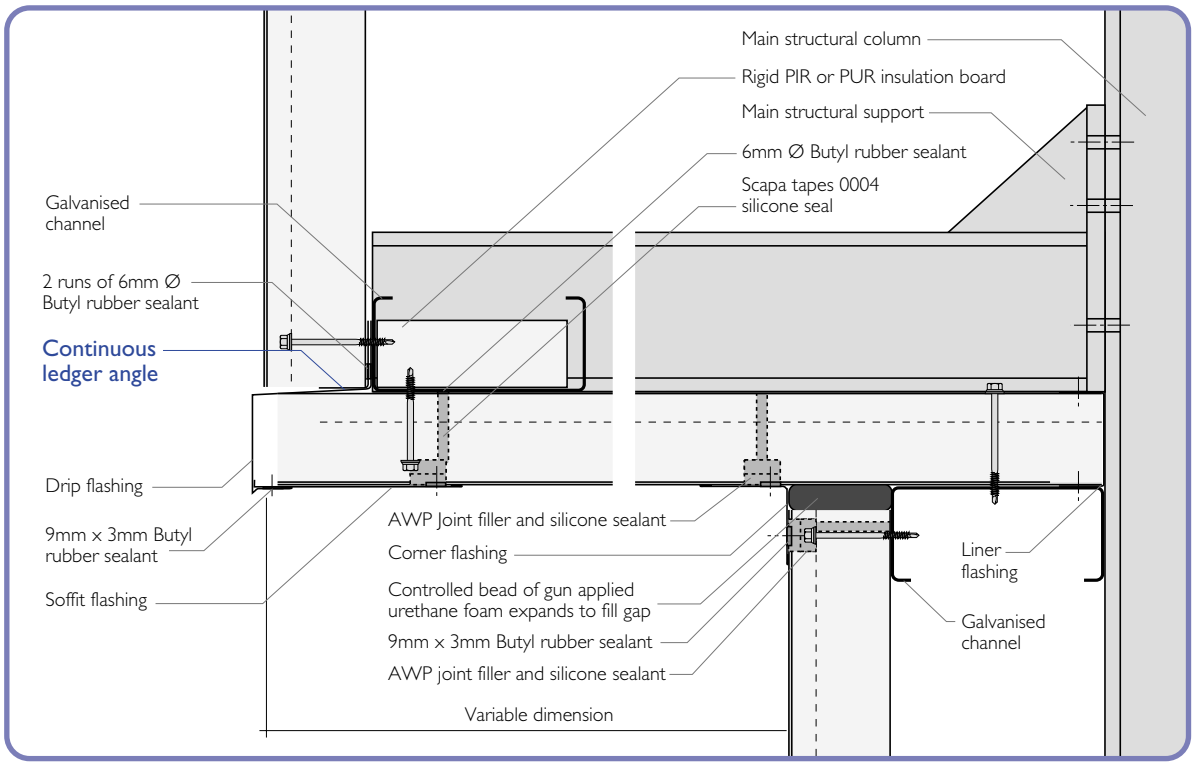

Figure 21. Soffit laid vertically

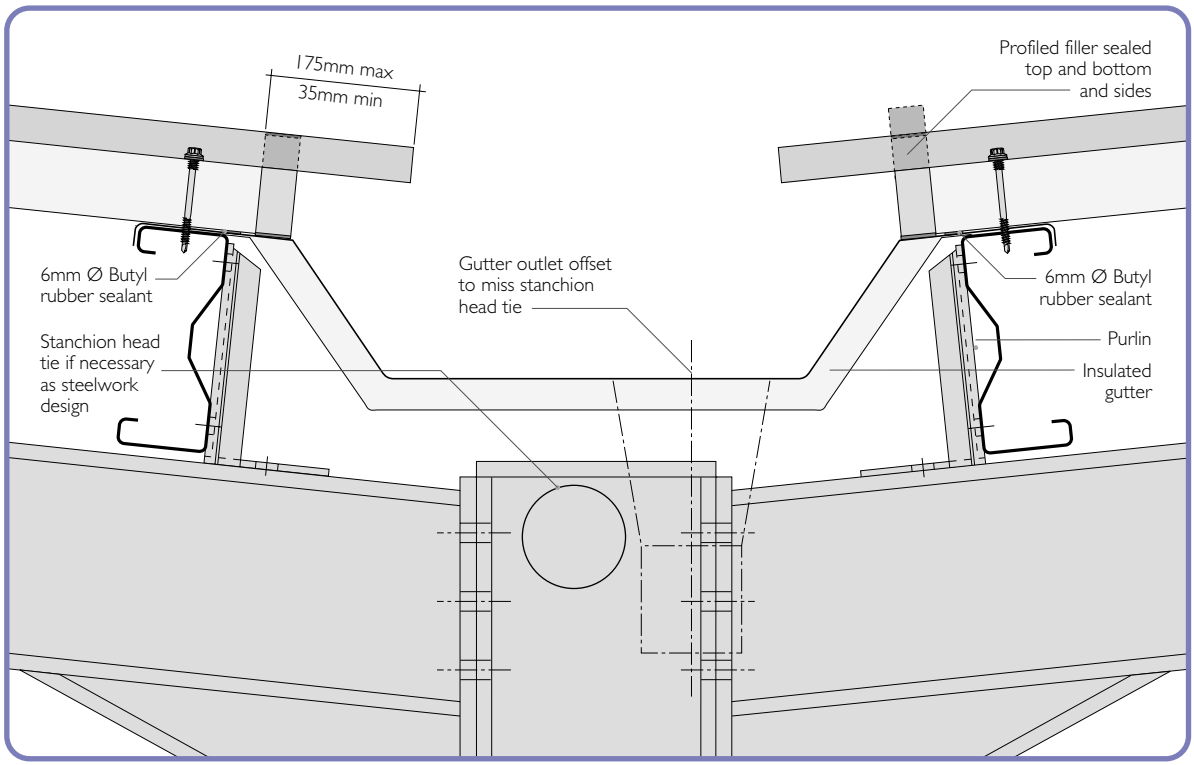

Figure 22. Valley

Installation, fixing and detailing

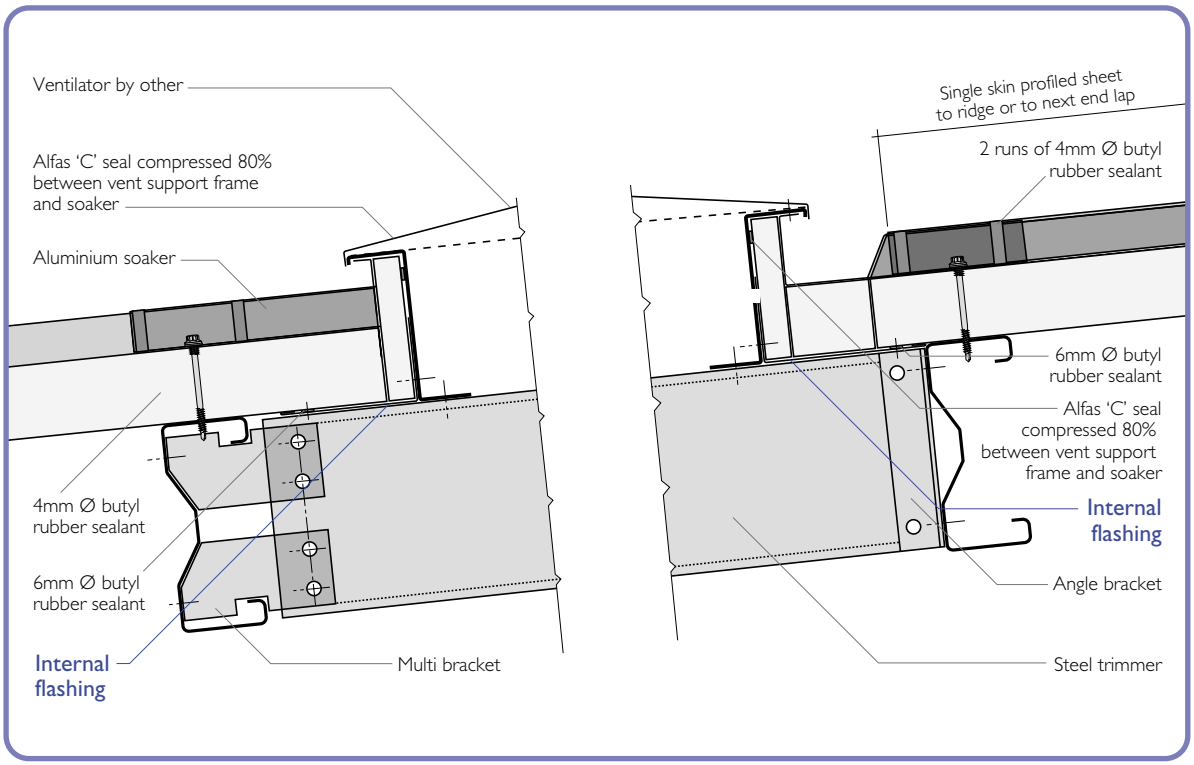

Figure 23. Roof ventilator

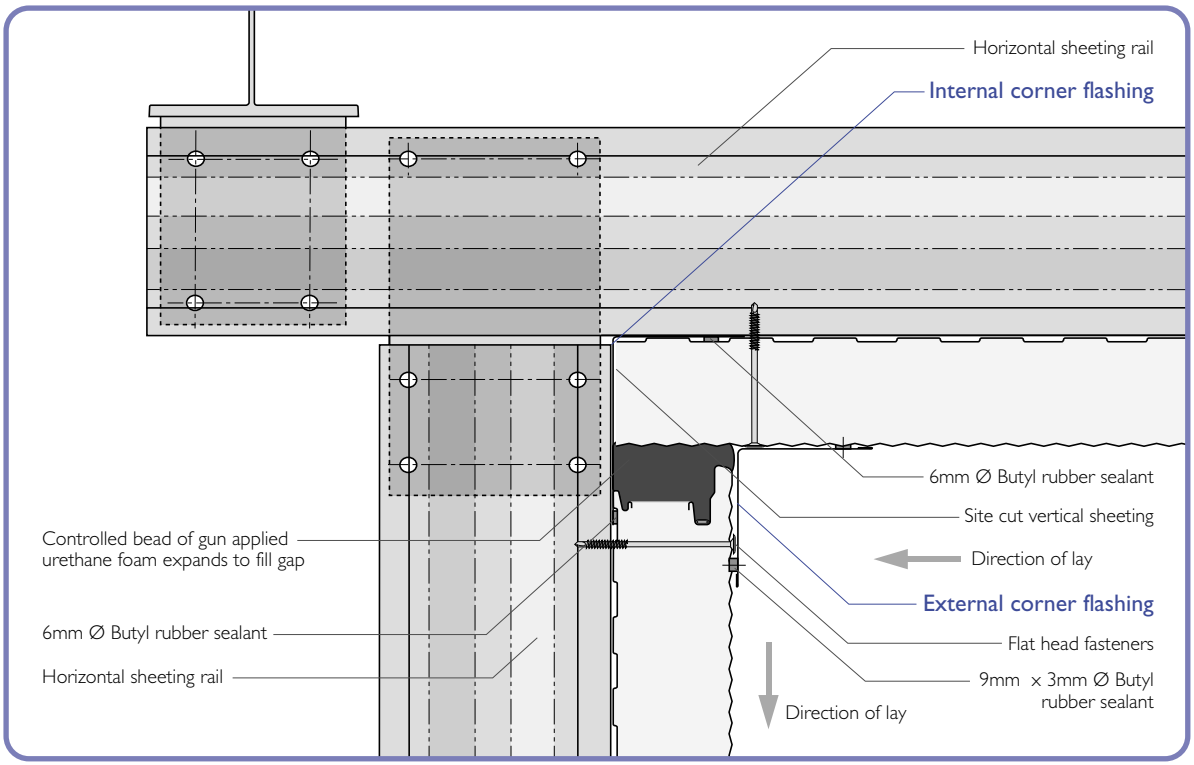

Figure 24. Internal corner

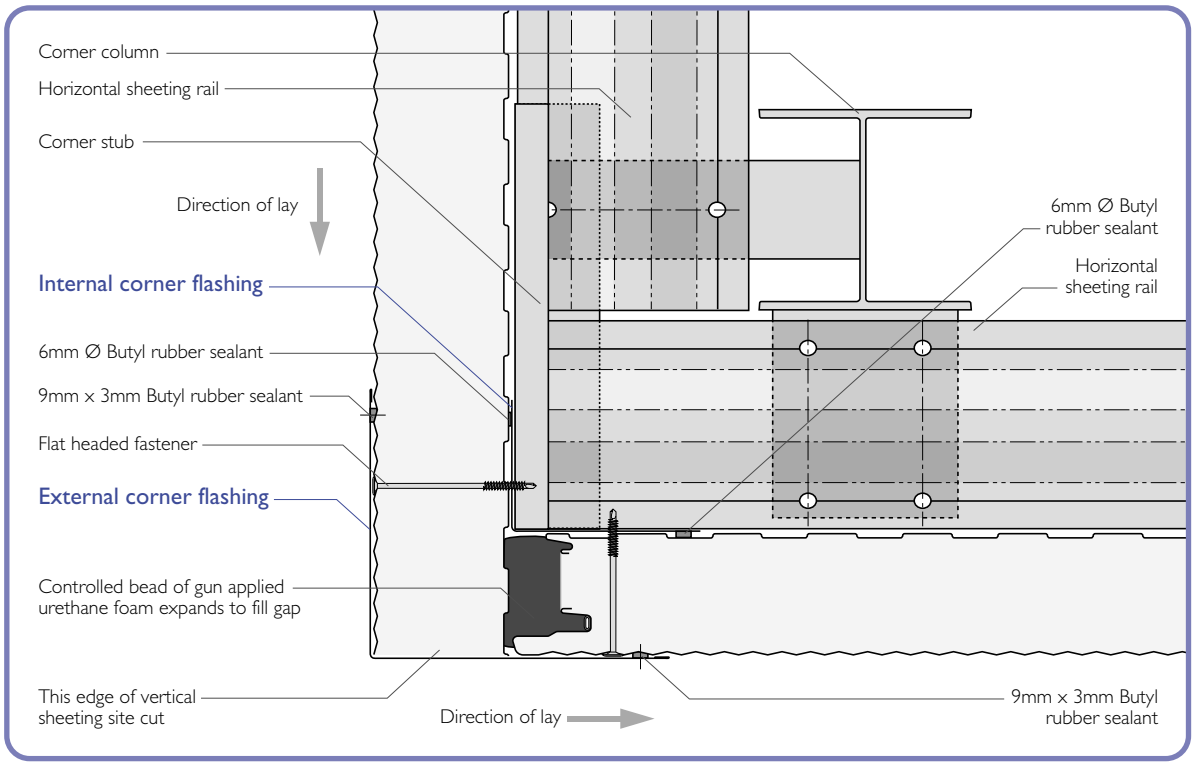

Figure 25. External corner

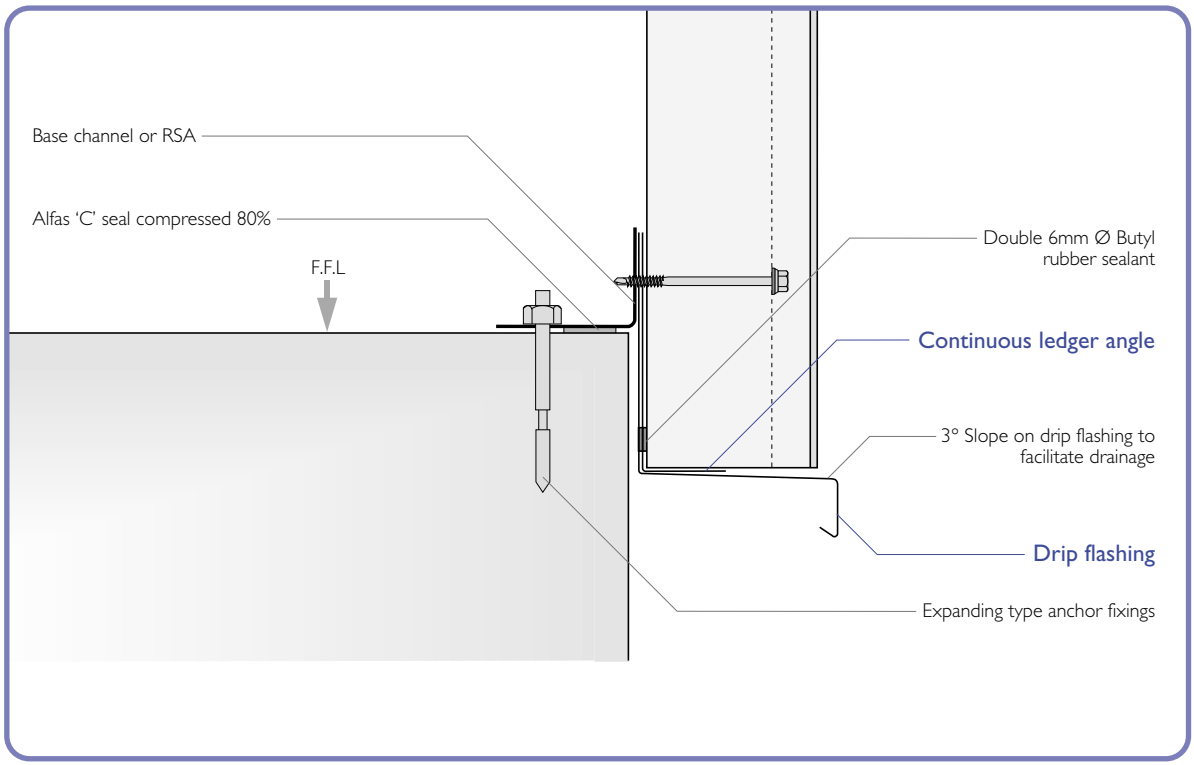

Figure 26. Drip – floor level

Installation, fixing and detailing

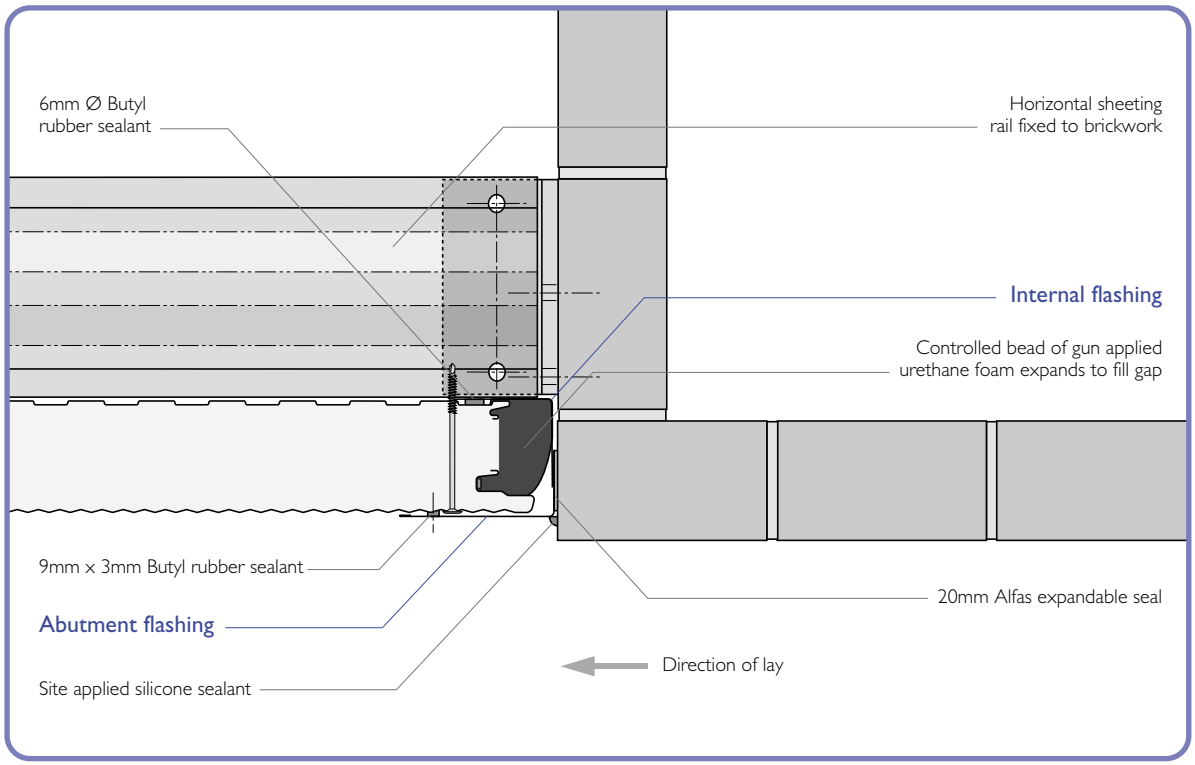

Figure 27. Abutment – brickwork

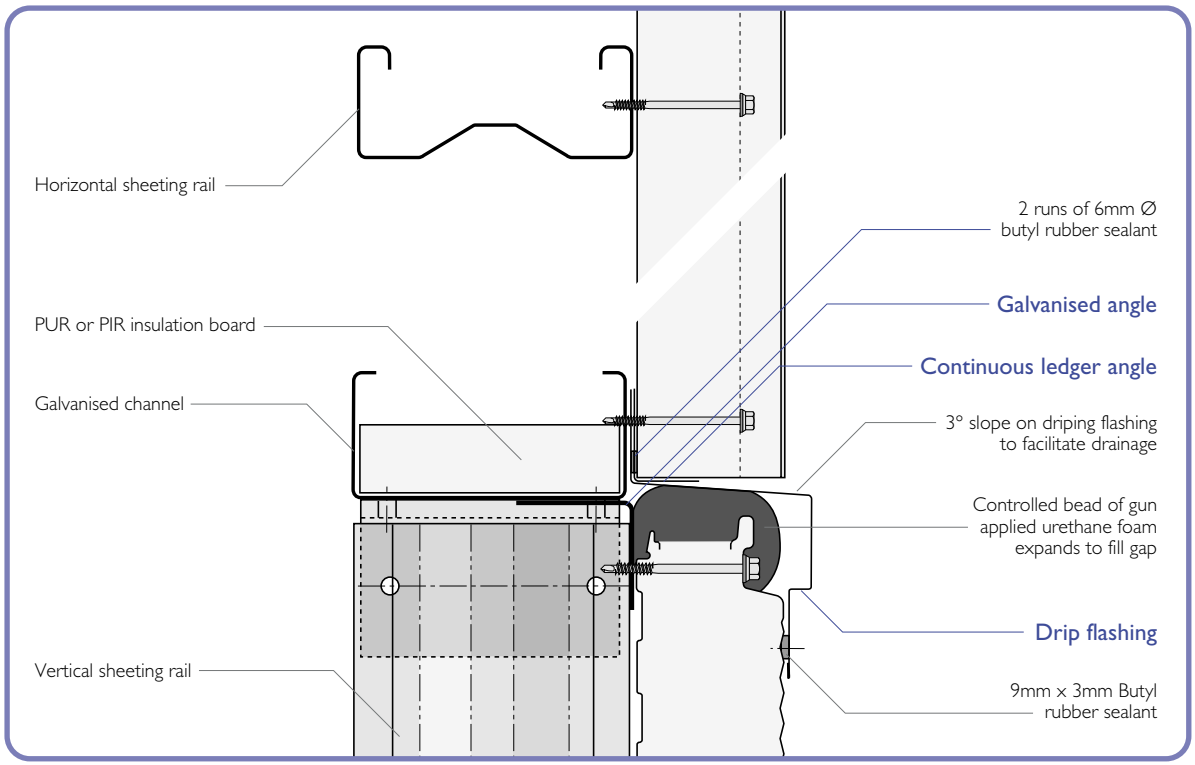

Figure 28. Stack joint

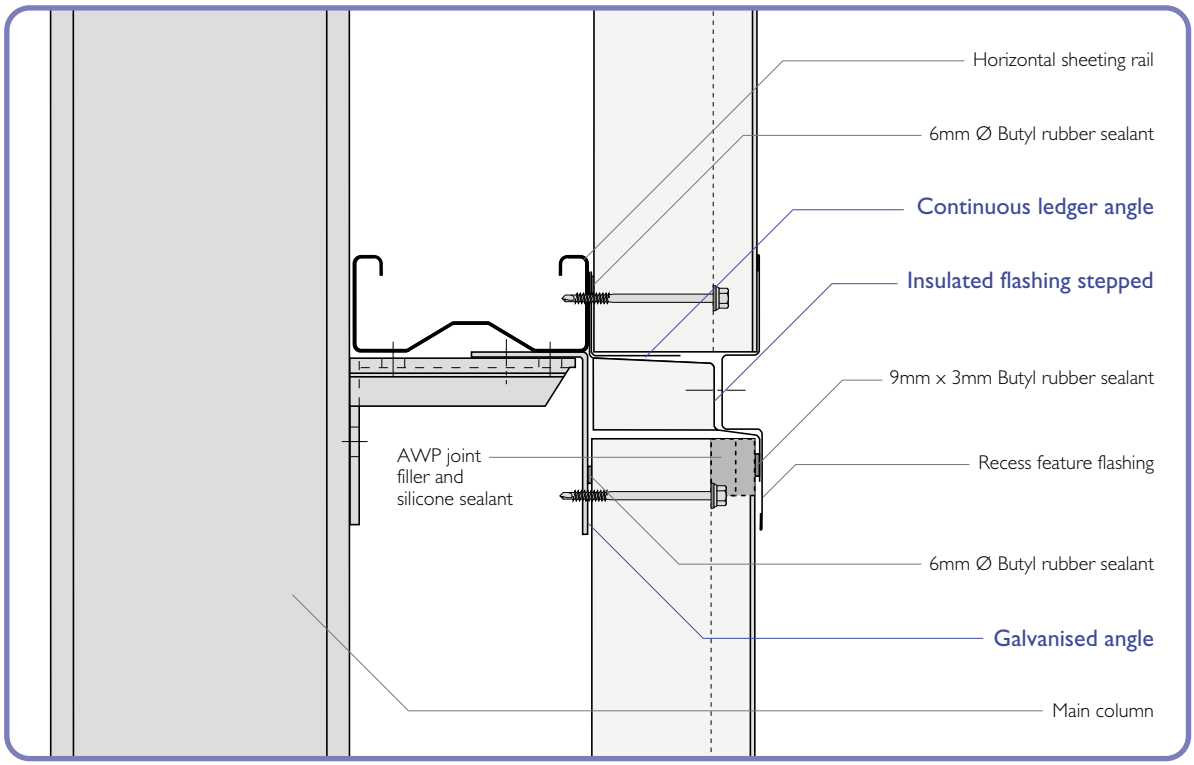

Figure 29. Panel break

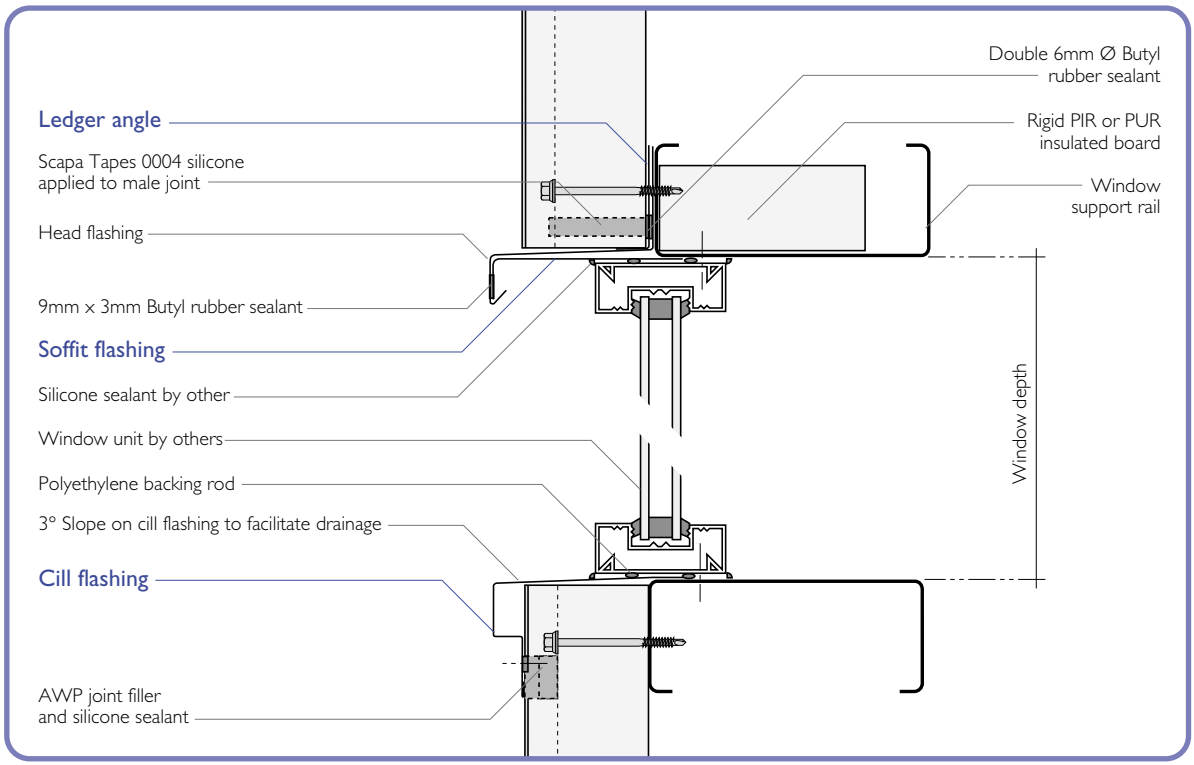

Figure 30. Window – head and cill

Installation, fixing and detailing

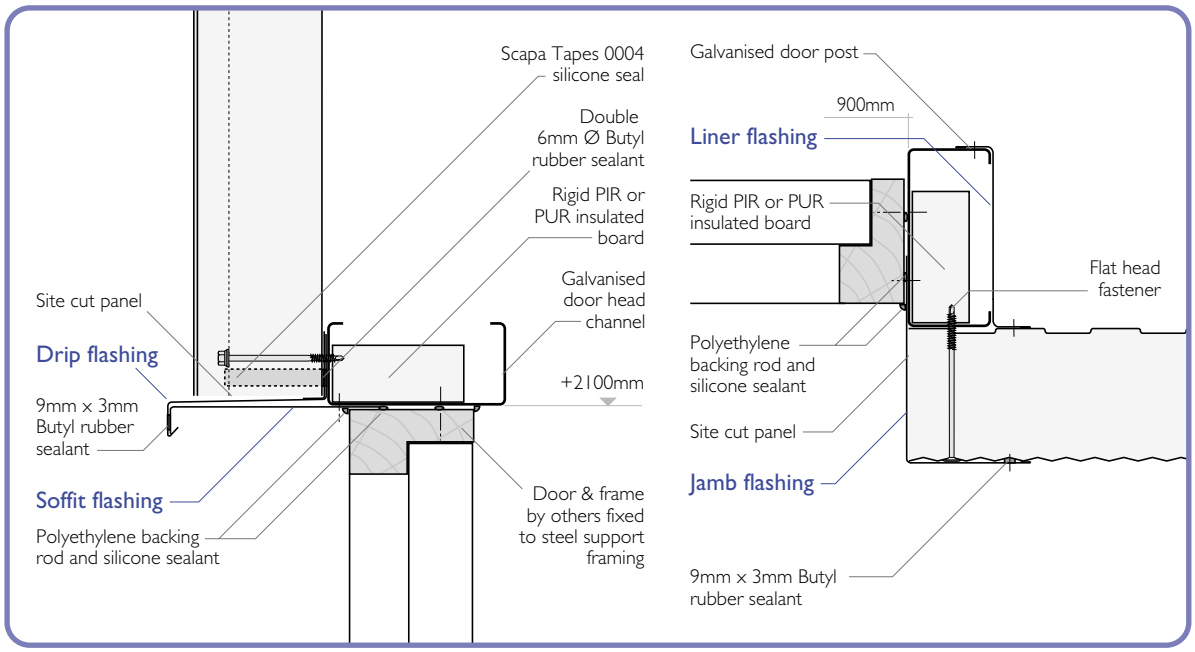

Figure 31. Door – head and jamb

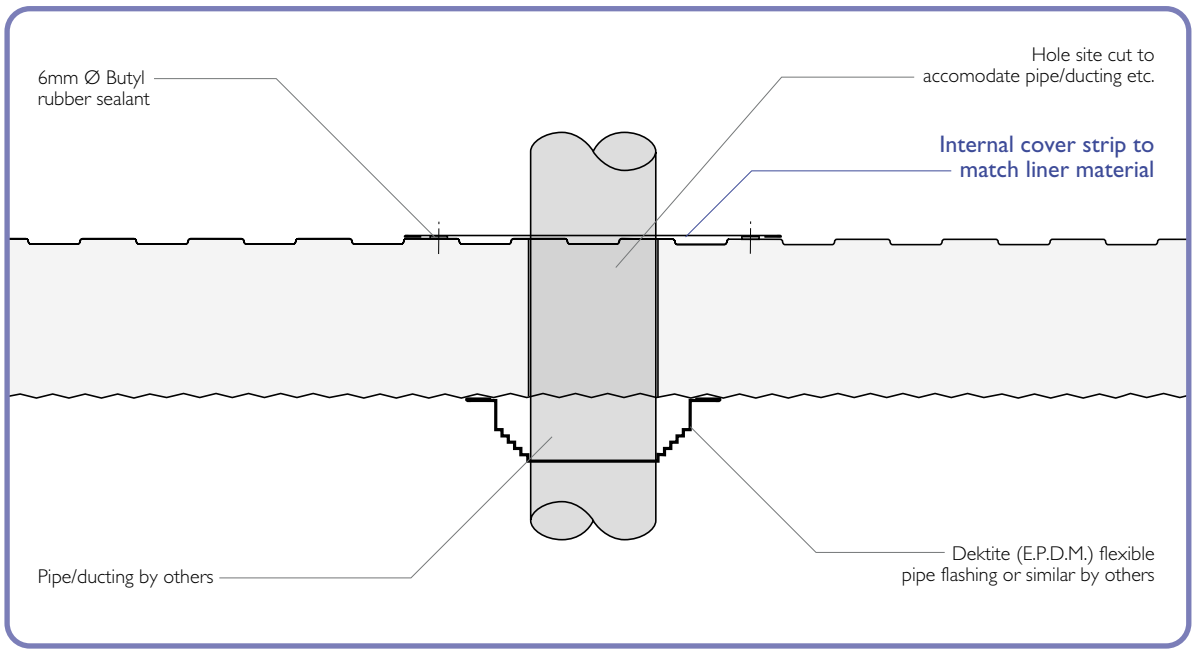

Figure 32. Wall penetration

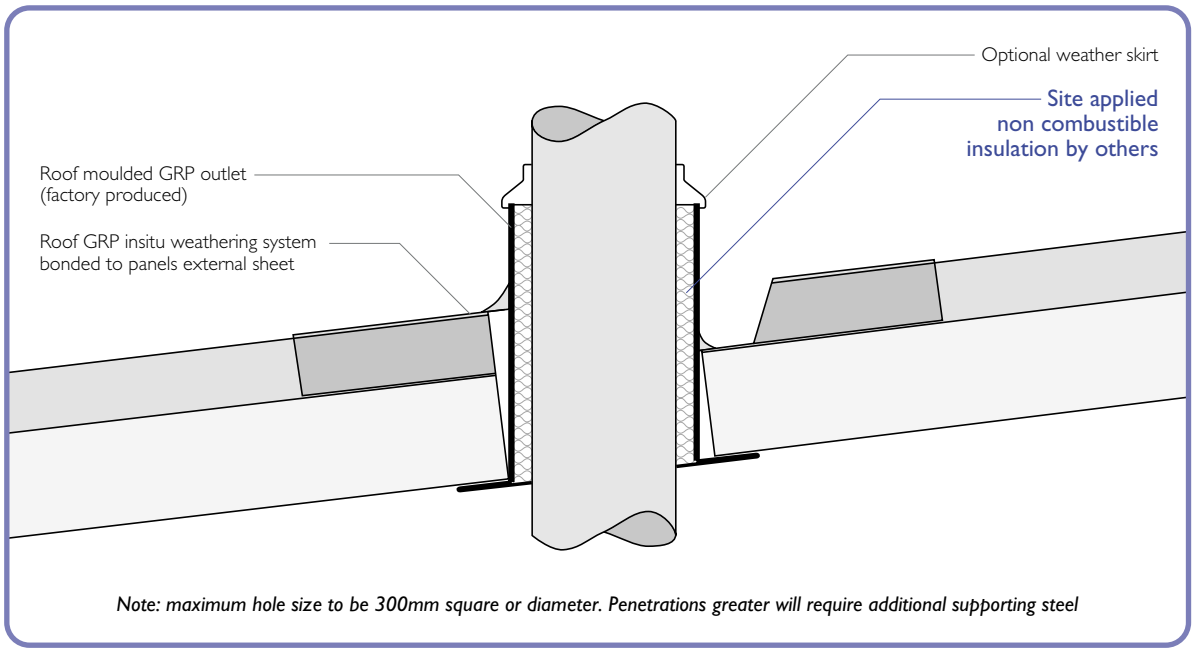

Figure 33. Hot flue – roof

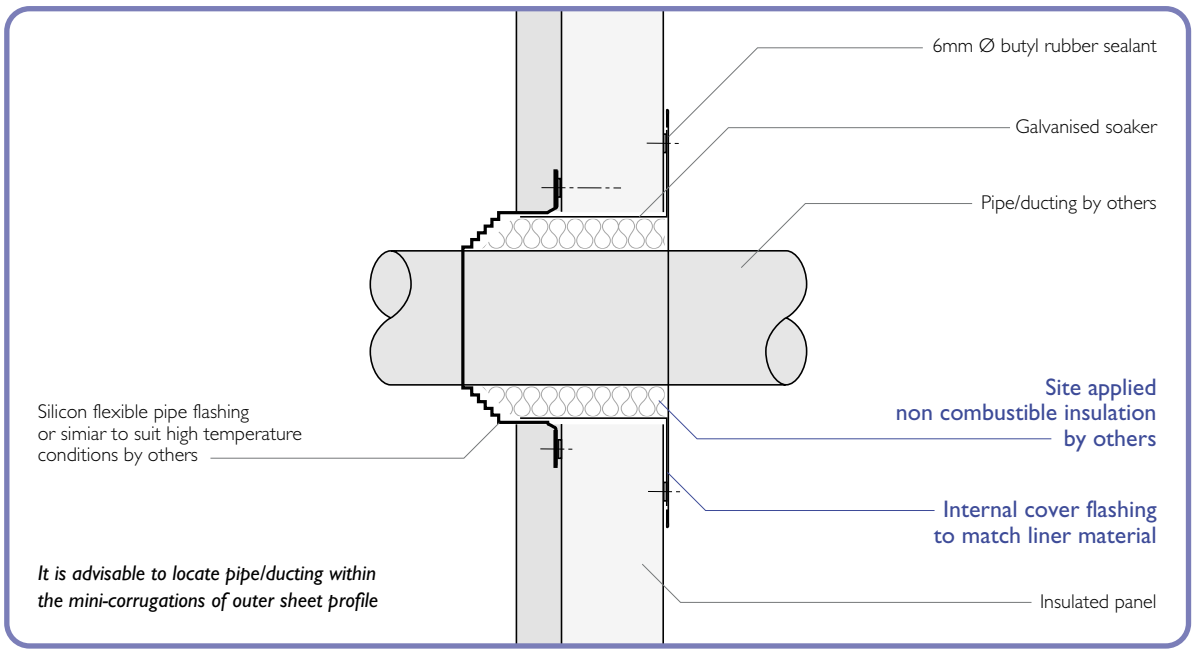

Figure 34. Hot flue – wall

For scale drawings and other details see manufacturer's detailed drawings or contact their technical services departments.

11 Installation, fixing and detailing

11.5.3. Apertures and service penetrations

Whenever panels are cut in-situ to create holes or apertures, the exposed cut edges should be finished off with the appropriate metal closure flashing to protect the core material from direct exposure to flames.

If the system is also required to be fire resisting the method of sealing the aperture around the penetrating services should be shown by test to satisfy the integrity and insulation criteria for the required fire resistance period.

11.5.4. Seals

Foam strip seals have been used as weather and air seals in conjunction with insulated panels for over 15 years.

With the introduction of a requirement for air tightness levels in the amendment to the Building Regulations – Approved Document L2: 2002 edition, increasing use is being made of polyurethane structural foam for the bulk filling of irregular voids and gaps between adjacent elements.

These seals are available in standard form and in flame retardant versions. It must be ensured that strip seals and infill foams do not degrade the fire performance of systems required to be fire resisting or which comply with LPC or FM standards.

12 Fire resisting construction

12.1 Introduction

For certain applications, external walls are required to provide a period of Fire Resistance – see Sections 3 to 6.

There is normally no requirement for roofs to provide a period of fire resistance, unless they form part of an escape route.

The fire resistance requirements are satisfied providing the cladding system:

- Resists the passage of flames and hot gasses [integrity];
- Provides resistance to heat transmission [insulation].

For insulated panels to maintain their integrity it is essential that the steel facings remain in place and the joints remain tight.

Standard fire resistance tests only assess the performance of the insulated panels themselves including the panel-to-panel joints. They do not incorporate junctions between walls or between walls and roofs or other elements. However it is of particular importance that the complete construction will maintain its integrity in fire and that the design follows this principle. [Certain insurance industry originated tests such as LPS 1208 assess a three dimensional structure].

12.2 Structure

Where an external wall is required to be fire resisting, (e.g. because of its proximity to a boundary) any elements of structure that are required to support the wall should also be provided with the same level of fire resistance. This can be achieved by providing structural fire protection to the relevant beams and columns to ensure they achieve the same standard of fire resistance.

Alternatively the Steel Construction Institute (SCI) have published a Guide [19] which provides a method of designing portal frame columns such that they are able to resist collapse without the application of applied fire protection to the portal rafters. Essentially the SCI guide requires that the columns and their bases have the capacity to resist the overturning moment induced by collapse of the portal rafters.

12.3 Insulated panels

Guidance in support of building regulations recommends a resistance to the passage of flames (integrity) and heat (insulation) for defined periods. Some mineral fibre cored panels are capable of providing 120 minutes integrity and insulation.

Certain types of system with a PIR core can achieve 120 minutes integrity and 15 minutes insulation. This will satisfy many applications for external walls located more than one metre from the boundary.

For requirements in excess of 15 minutes insulation and for all internal compartment walls it is necessary to use insulated panels with high density mineral fibre cores.

12.3 Detailing – external insulated panels

The recommended details shown in section 11 for normal panel installation apply equally where fire resistance is required. Steel flashings and closures should be used to ensure that the panel ends and any cut sections are fully protected.

Designers should confirm that site applied seals and cavity fill foams will not degrade the fire performance of the fire resisting system.

Where a fire resisting door is to be fitted into a fire resisting wall, the door and frame assembly should have been tested or assessed to BS 476 Part 22 or BS EN 13501 and in compliance with the integrity criterion for the required period. The performance should be achieved with the doors installed in a construction similar to that into which the assembly is to be fitted in practice. It is inappropriate to use a door that has only been tested in a masonry enclosure in a metal panel that may be subject to distortion under fire conditions.

13 Checklists

When specifying any external cladding system the designer should first establish the key factors that may affect the choice of system. This will be influenced by statutory, insurance and client requirements.

The specification will depend upon the applicable building regulations and any additional requirements of the insurer or client.

Table 14 highlights the main points to be considered before specifying a wall cladding system and Table 15 provides guidance on roof systems.

These summary tables can only provide a general guide and for more specific information reference should be made to the applicable sections of this guide and the relevant regulatory or insurance guidance documents.

13.1 Checklist – wall panels

Table 14. Checklist for the specification of external wall cladding panels

Check	Guidance	Comments	User notes
Building regulations:			
Purpose group	The building purpose group will define many fire safety requirements.	Additional requirements apply where a building is in purpose group 2A (hospitals) and purpose group 5 (assembly buildings).	
Height of top floor	In buildings where the height of the top storey exceeds 18m more onerous flame spread and flammability requirements may apply.	Most commercially available external cladding panels will comply with flame spread requirements*	
Junction with compartment or separating wall	Fire stopping is required at junctions between compartment walls and external wall.	In hospitals external walls should be fire resisting for 1m where they meet a compartment or separating wall.	
Internal lining	Surface spread of flame classification of internal lining will vary according to use and area of the internal spaces.	Most commercially available external cladding panels will comply with flame spread requirements*.	
Cavities	The classification of a surface exposed within a cavity will affect the required distance between cavity barriers.	Voids formed at the eaves of pitched roof should be provided with cavity barriers.	
Boundary location	If a wall is within 1m of a relevant boundary it should be fire resisting as regards both integrity and insulation. If the wall is more than 1m from the boundary, but the extent of unprotected areas is limited, the (protected areas of the) wall should be fire resisting with full integrity and 15 minutes insulation. Restrictions will also apply on the flammability of any external facings or coatings.	If external wall is required to be fire resisting the supporting steelwork should also be fire resisting*.	
Insurance requirements:			
Panel types	Insurers may require non-combustible panels or panels complying with LPS 1181.		
Fire resistance	Fire resistance may be required at junctions with compartment walls or floors or where there is a potential for external fire attack.		
Client requirements:			
Reduction in fire damage	Consideration should be given to additional measures to reduce the likelihood of extensive damage. e.g. sprinklers, additional protection at compartment boundaries or cladding with an enhanced fire performance (e.g. use panels of limited combustibility or conforming to LPS 1181) etc.	Sprinklers will reduce the overall fire risk. Care should be taken to ensure that fire will not bypass compartment boundaries	
General good practice			
Recommended performance enhancements	• through fixings to retain facing in position; • joints designed to remain sealed in fire; • closure of panel edges and penetrations to protect core from direct fire exposure.		

** Written confirmation should be obtained from the supplier confirming that the insulated panel system will comply with the necessary flame spread and fire resistance requirements.*

13 Checklists

13.2 Checklist – roof

Table 15. Checklist for the specification of external roof panels

Check	Guidance	Comments	User notes
Building regulations:			
Purpose group	The building purpose group will define many fire safety requirements.	Additional requirements apply where building is in purpose group 2A (hospitals).	
Junction with compartment wall	Fire stopping is required at junctions between compartment walls and external wall.	Combustible material should not be taken over top of compartment wall unless proven suitable by test.	
Internal lining	Surface spread of flame classification of internal lining will vary according to use of the internal spaces.	Most commercially available metal faced panels will provide a Class 0 surface.	
Cavities	The classification of a surface exposed within a cavity will affect the required distance between cavity barriers.	Voids formed at the eaves of pitched roof should be provided with cavity barriers or fire resisting barriers as appropriate.	
Boundary location	Where roof is located within 6m of boundary coverings should be rated AA, AB or AC.		
Roof used as escape route	Any part of a roof that forms part of an escape route should provide at least 30 minutes fire resistance as regards load bearing capacity, integrity and insulation.	Insulated panels are not generally suitable for fire resisting roof constructions.	
Insurance requirements:			
	Protected zones where the roof provides a degree of fire resistance and the roof coverings rated AA, AB or AC may be required at junctions with compartment walls.		
Client requirements:			
	If fire damage is likely to have a substantial impact on the viability of a business consideration should be given to additional measures to reduce the likelihood of extensive damage. e.g. sprinklers, additional protection at compartment boundaries or cladding with an enhanced fire performance (e.g. use panels of limited combustibility or conforming to LPS 1181) etc.	Sprinklers will reduce the overall fire risk. Care should be taken to ensure that fire will not bypass compartment boundaries.	
General good practice			
Recommended performance enhancements	• through fixings to retain facing in position; • joints designed to remain sealed in fire; • closure of panel edges and penetrations to protect core from direct fire exposure.		

13.3 Checklist – fire design issues

Project Name / identification ..... **Date** .....

Address .....

Regulatory and other fire requirements

Regulatory: **Roofs:** Classification BS476:Pt3 or Euroclass level — Class: (eg. AA or B_{ROOF})

Walls: Fire spread BS476:Pt6/7 or Euroclass level — Class: (eg. O or B)

Fire resistance BS476:22 or Euroclass level — Integrity (eg. 120) min; Integrity (eg. 15) min — None ☐

No specific requirements ☐ LPC certification ☐ Factory Mutual certification ☐ Other ☐

Certification details: .....

Panel Details

Manufacturer / product ref.: .....

Literature on file: ☐

Facings: Material external: steel ☐ aluminium ☐ internal: steel ☐ aluminium ☐ Thickness (mm) 0.4, 0.5, 0.6, 0.7, 0.9 / 0.4, 0.5, 0.6, 0.7, 0.9

Insulating core: Polyurethane [PUR] ☐ Polyisocyanurate [PIR] ☐ Mineral fibre [MF] ☐

Detailing	Type of detail	Drawing	N/A	Comments
Internal closures – Wall	Abutment to brickwork			
	External corner			
	Internal corner			
	Drip detail: to floor slab			
	Window detail: head			
	Window detail: cill			
	Door detail: head			
	Door detail: cill			
	Wall break joint / stack detail			
	Penetrations through panel			
Internal closures – Roof	Roof: Internal ridge			
	Roof / wall (verge – parapet)			
	Roof / wall (eaves)			
	Valley gutter			
	Roof ventilators			
	Soffit			
	Penetrations – hot flues			
Other				

Site applied seals and insulation

MF Type: Required ☐ M/f; reference; density .....

PUR / PIR: site applied foam Required ☐ M/f; reference; ..... standard or FR grade .....

13.4 Checklist – installation details

Project Name / identification ..... **Installation date** .....

Address .....

Roofs: Manufacturer ..... Type / ref .....

Core type: PUR ☐ PIR ☐ MF ☐ Other ☐

Certification: None ☐ LPC ☐ FM ☐

Walls: Manufacturer ..... Type / ref .....

Core type: PUR ☐ PIR ☐ MF ☐ Other ☐

Certification: None ☐ LPC ☐ FM ☐

Certification reference .....

Panel erection

Installed to manufacturer's requirements .....

Installed to LPC / FM requirements [where required] .....

Detailing

Type of detail	Metal closures		Site applied Insulation/Fire retardant foam*
	Thickness	Fixing centres	Type and location
Abutment to brickwork			
External corner			
Internal corner			
Drip detail: to floor slab			
Window detail: head			
Window detail: cill			
Door detail: head			
Door detail: cill			
Wall break joint / stack detail			
Penetrations through panel			
Roof: Internal ridge			
Roof / wall (verge – parapet)			
Roof / wall (eaves)			
Valley gutter			
Roof ventilators			
Soffit			
Penetrations – hot flues			
Other			

** Site applied seals and insulation. Refers to fire retardant foam used as an additional insulation or air seal measure between the insulated panels and the abutting element and closure.*

Appendix: Management of fire safety

This appendix refers equally to all forms of roof and wall cladding and not specifically to insulated panels. It covers the management of fire safety both during construction and maintenance operations and as part of the day-to-day operation of the building.

Statistics suggest that 70% of all major fires occur as a result of poor management and maintenance rather than as a result of inadequate design or the nature of the processes carried out within buildings.

Risk assessments may have been made at the planning stages of a building and if so will have covered its operation and use and also any foreseen maintenance activities relating to the equipment or fabric of the building. Against this background, this appendix highlights specific maintenance and construction issues that are known to have been the cause of a number of significant fires.

The subjects detailed in this section are part of a wider inspection programme recommended by the insurance companies and which is set out in full on the 'Self Inspection forms for Commercial / Industrial Premises' available from those companies.

Generally the nature of the external cladding, including insulated panels with the most commonly used polyurethane and mineral fibre cores, will not have a significant effect on the likelihood of a fire starting. However, the specific procedures highlighted in this section are advisable where combustible insulation is utilised.

The role of fire safety management

It is essential that any person who is responsible for the operation of a building should implement procedures to prevent a fire occurring and minimise its effects in the event that these procedures are not successful. Ideally such procedures, and details of the buildings construction and fire safety systems should be documented in a fire safety manual. This manual might typically include the following items:

a) fire safety policy statement;

b) safety management structure and responsibilities;

c) details of building construction relevant to fire safety;

e) actions to be taken in a fire emergency;

f) fire drills and staff training;

g) housekeeping (e.g. removal of combustible waste);

h) planned maintenance of fire safety measures;

i) safety procedures for hot works and other maintenance;

j) security (to combat arson);

k) contingency plans for salvage and damage control;

l) record keeping;

m) procedures for updating manual and auditing its implementation.

Good fire safety management can be a key factor in minimising the risk of fire in buildings. Detailed guidance on management procedures for fire safety will be given in a forthcoming part of BS 5588 [20], which is currently in the course of preparation.

Hot works

Hot work is work that involves open flames or sparks or any other activity that generates heat. Fires involving hot work have led to multi-million pound losses. Most frequently the cause is carelessness and ineffective supervision while hot work operations are being carried out.

The sources of heat most commonly involved which may be used in conjunction with or in close proximity to roof and wall cladding systems include:

– gas and electric welding and cutting equipment

– blowlamps and blowtorches

– grinding wheels and cutting discs

Hot working should be avoided whenever possible, but when making structural changes to a steel framed building or when installing or modifying steel pipe work, cutting, grinding and welding appropriate precautions should be taken.

During hot works and cutting operations it is recommended that any exposed combustible cores are protected by temporary coverings.

Appendix: Management of fire safety

Such coverings and screens need to be manufactured from non-combustible or non-flammable materials. Welding blankets are the preferred solution for protecting all exposed surfaces, including ends or edges of panels. Preferably no hot work should be carried out in the immediate vicinity of any exposed insulant of whatever type. Low flame spread plastic coverings, which are intended to prevent damage to finished items during construction do not provide the required levels of protection to resist welding or cutting sparks or splatter.

All works should be properly supervised and a full inspection carried out on completion. Personnel engaged to carry out this work should be competent and fire extinguishers should be on hand at all times.

Experience has shown that a satisfactory standard of care is far more likely to be achieved where a formalised permit to work – a 'Hot Works Permit' – is in force, issued under the supervision of an experienced person who has the authority to ensure compliance with the procedures.

A typical Hot Works Permit:

- specifies the particular job to be carried out
- lists any special conditions
- specifies the area where the work is to be done
- is issued for a set time period.

Follow-up checking:

A fire watch should continue for at least one hour after work is completed, to detect and extinguish any incipient burning in the work area and in all adjoining areas to which sparks and heat may spread. These could include floors above and below and areas on the other side of walls to where the work is being carried out.

Cutting panels

Neither hot cutting techniques nor grinding wheels should be used to cut any type of insulated panels and in particular panels incorporating combustible cores.

Panels should be cut with a powered reciprocating saw and all exposed site cut panels should be protected with a suitable edge protection lacquer.

Holes and apertures are frequently cut to take cabling and wiring through panels, particularly in the food processing and cold store industries, where polystyrene has been the common core insulation. It is essential that full inspection is carried out to ensure that:

- the work has been properly carried out and that the cabling / wiring is fully protected against chaffing and abrasion
- any holes or apertures are properly closed off according to the manufacturers instructions, including where necessary the use of fire stopping materials.

Exposed cores

Any core material of an insulated panel or any insulated cladding system that becomes exposed as a result of cutting penetrations, maintenance work or impact damage should always be protected with metal closure flashings, as soon as practical, following the panel manufacturers recommended procedures.

Rubbish/waste management

A common source of extensive fire damage is fires started, deliberately or accidentally, in skips and rubbish containers located adjacent to the external wall of a building.

Whenever practical skips and other rubbish should be kept well away from the external walls of a building. Waste in the open is particularly attractive to an arsonist and strict controls on the storage and disposal arrangements are essential.

– All waste stored in the open should be at least 10 metres from the building and a minimum of 2 metres from the perimeter fence. If this is not possible, lockable enclosed metal skips or a secure enclosed store or compound should be provided, located as far as practical from door and window openings.
– All waste should be deposited in appropriate containers or designated areas provided. These should be clearly marked and should not be under canopies or trees.
– Aerosol cans, containers of flammable liquids and gas cylinders (even if empty) should be kept separately and disposed of as directed by the local authority. They should not be placed in skips with other waste.

Internal self-inspection Reports

Self-inspection systems are recommended by insurance companies as part of an on-going programme to increase awareness of fire hazards and reduce risks. Internal Fire Inspection Reports are available which illustrate the areas that could be part of a self-inspection system.

The reports cover a much wider inspection programme than is directly relevant to the envelope cladding of a building. Examples from a typical list relating to panels and insulated cladding are:

Electrical equipment

– Is there any temporary wiring/cabling
– Is the wiring/cabling passing through panels correctly installed?

Gas cylinders

– Are gas cylinders stored in a secure fire safe compound outside the building?

Fork lift truck / electric vehicle charging area

– Is the charging area clean and tidy?
– Are the low voltage charging cable connectors undamaged?
– Has storage been allowed in the charging area?

Hot work

Have hot work permits been used as required?

Waste management / rubbish

– Are all idle pallets and waste skips at least 6 metres clear of buildings?

Appendix: Management of fire safety

Fire safety during construction

A large proportion of all fires occur when buildings are being constructed, modified or extended.

The Health and Safety at Work Act 1974 is applicable to all work carried out during the construction phase. Under this act the employer has a duty to keep the workplace in a safe condition without causing risk to health. The Act is enforceable by the Health and Safety Executive.

Guidance in respect of construction, including alterations and extensions is given in:
"Fire Prevention on Construction Sites" published by the Fire Protection Association [21]; and
"Fire Safety in Construction Work" pubished by the Health and Safety Executive [22].

Where temporary buildings are introduced within, or adjacent to the building envelope, only those site buildings that comply with the LPS 1195 standard should be used.

The procedures recommended for hot work above should be implemented.

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EPIC was set up in 1991 to promote quality roofing and cladding systems through the use of factory-engineered panels. Insulated panels maximise thermal efficiency whilst reducing the risk and effects of condensation and significant energy loss through air leakage.

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Download EPIC information from the website
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Acknowledgements
EPIC would like to thank the following organisations for their guidance, help and assistance in the production of this fire guide.

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Building Sciences Ltd
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