

Fire performance

The performance and reaction of buildings in situations where fire breaks out is heavily dependent upon the way in which a building is designed, and the materials from which it is constructed. There are some key considerations that have to be taken into account; everything from restricting the way in which fire can propagate and spread, to providing safe access routes so that the occupants of the building can escape to safety. Consequently, the Building Regulations Approved Documents B, Volume 1 (Dwellinghouses) and Volume 2 (Buildings other than dwellinghouses), are very detailed and specific in their requirements.

Fire Classifications and Requirements for Rooflights

Approved Document B, Volume 2 of the Building Regulations 2010 (2006 edition, latest amendment 2013) sets out the requirements for fire safety of buildings that are other than dwelling houses as follows.

Requirement B2 covers internal fire spread, and the linings of both the roofs and walls of buildings - see pages 61 to 66.

Requirement B3 covers the requirements relating to internal fire spread and the structure of the building – see pages 68 to 90.

Section 8 covers compartmentation within a building and in particular, junctions of compartment walls and roofs - see pages 76 and 77.

Requirement B4 covers the requirements applicable to external fire spread. Section 12 applies to the external covering of walls – see pages 93 to 95, and Section 14 applies to the external roof covering - see pages 102 to 104.

Internal

Generally the fire safety requirements for linings are classified by surface spread of flame, specified in line with the performance classifications of BS 476-7:1997. Typically these will be Class 1 or Class 3. Where Class 0 performance is required, the classification is determined under BS 476-6: 1989+A1: 2009 in addition to BS 476-7:1997.

External

The requirements for external surfaces are generally fire resistance, specified in line with the classifications of BS 476-3:2004 - typically AA, AB or AC.



General Guidance

The following information is for guidance only, and whilst applicable for the majority of industrial buildings, it is the responsibility of the designer to ensure that compliance is achieved on each specific project.

From Approved Document B Vol2, The Building Regulations requirements can be summarised as follows:

- The lining of a roof or wall should normally be rated Class 1 to BS 476-7:1997, see B2 Section 6, clause 6.1 and Table 10 (page 63).
- The roof outer covering should normally be rated at least AC to BS 476-3:2004 for unrestricted use relating to distance of site boundary, see B4 Section 14 clause 14.5 and Table 16 (pages 102 & 103).
- There is no provision for any fire performance of **external wall** surfaces unless the building is within 1 metre of a boundary, is over 18 metres tall or 10 metres above an adjacent roof or is a building to which the public have access, see clause 12.6 and Diagram 40 (pages 93 to 95).
- The roof covering should be designated AA, AB or AC for 1.5 metres either side of a **compartment wall** and any built-up or composite panel cladding system should incorporate a band of limited combustibility 300mm wide centred over the wall. Fire protection for any roof support members that pass through the wall may also be required for a distance of 1.5 metres on either side.
- If the construction is of **single skin**, with no separate lining panel, then the single skin sheet or panel must meet the requirements for both the linings and the outer roof or wall sheet.



Limits on the use of Class 3 Linings

B2 Section 6, clause 6.7, Table 11 and Diagram 27 allows the linings of a rooflight to be rated Class 3 rather than Class 1, providing the rooflight area is less than 5m² in any 5m x 5m area, and there is a clear space of 3 metres in all directions between each group of rooflights in the 5m x 5m area. Rooflights may be spaced 1.8m apart provided that they are evenly distributed and do not exceed more than 20% of the floor area.

This is further detailed in B4 Section 14, clause 14.6, Diagram 47 and Table 17 covering limitations that apply to rooflights with a Class 3 rated lining. Note: these limitations do not apply to a rooflight lining that is rated Class 1.

Limits on the use of Thermoplastic (TP) Materials Rated TP(a) and TP(b)

Unlike GRP rooflights that are a thermoset material, there is difficulty testing thermoplastic materials to achieve classification under BS 476-3:2004, as the material melts during the test. Thermoplastic materials which are rated Class 1 to BS 476-7:1997 are given the rating TP(a) - other thermoplastic materials can be tested to BS 2782-1 and given ratings of TP(a) or TP(b).

There are concessions to allow the use of rooflight materials with an external fire classification of AD (or worse), and to allow the use of

Fire Rating Identification of Zenon Pro and Zenon Evolution GRP Sheets

The fire rating of all Hambleside Danelaw GRP rooflight sheets is printed on each rooflight; in addition a coloured thread is incorporated to identify the fire rating:

Red: identifies sheets which are rated AB to BS 476-3:2004 and Class 3 to BS 476-7:1997

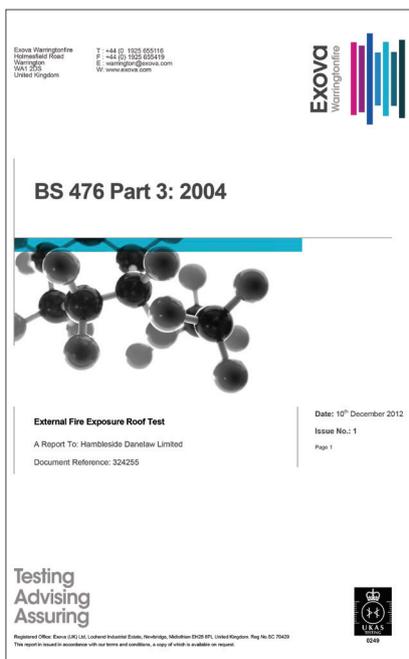
Green: identifies sheets which are rated AA to BS 476-3:2004, and Class 1 to BS 476-7:1997

Blue: identifies sheets that are rated Class 0 to BS 476-6:1989+A1:2009

materials with a TP(a) or TP(b) rating as the outer covering of a rooftop.

Clause 14.6 and Table 18 detail these concessions, and also show the restriction of use for these materials. These restrictions do not apply to materials which are rated AA, AB or AC to BS 476-3: 2004.

There is also a concession to allow the use of TP(a) or TP(b) rated materials as building linings, detailed in clauses 6.10 & 6.12 and Tables 11 and 18. Material rated TP(a) can be used in most applications where a Class 1 material is normally required; the only limitation being shown in Table 18. The use of TP(b) material as a lining has the same restrictions as the use of a Class 3 material in this application. Note that these restrictions do not apply to materials which are rated Class 1 to BS 476-7.



Fire Designation of Specimens to BS 476

The following is taken from Clause 4 of BS 476-3:2004

'The designation of specimens subject to conditions of external fire shall be according to both the time of penetration and the distance of spread of flame along their external surface. Each category designation consists of two letters, e.g. AA, AC, BB these being determined as follows:

First Letter (Penetration classifications)

- A - Those specimens which have not been penetrated within 1 hour
- B - Those specimens which are penetrated in not less than 30 minutes
- C - Those specimens which are penetrated in less than 30 minutes
- D - Those specimens which are penetrated in the preliminary test

Second Letter (Spread of flame classifications)

- A - Those specimens on which there is no spread of flame
- B - Those specimens on which there is not more than 533mm spread of flame
- C - Those specimens on which there is more than 533mm spread of flame
- D - Those specimens which continue to burn for 5 minutes after the withdrawal of the test flame or spread more than 381mm across the region of burning in the preliminary test

Attention shall be drawn to dripping from the underside of the specimen, any mechanical failure, and any development of holes, by adding a suffix 'X' to the designation to denote that one or more of these took place during the test.

The designation letters for penetration and spread of flame are preceded by the letters EXT.F (flat) or EXT.S (sloping) according to whether tested flat or inclined, e.g. EXT.S.AB.'

Internal Exposure Testing

The following is taken from Section 11 of BS 476-7:1997:

Exposed surfaces of materials used as linings for walls and ceilings are classified in the Standard according to the rate and distance of spread of flame across them as in Table 2 shown below.

Classification	Spread of flame (1.5 minutes)		Final spread of flame (10 minutes)	
	Limit (mm)	Limit for one specimen in sample (mm)	Limit (mm)	Limit for one specimen in sample (mm)
Class 0	Not a classification identified in any British Standard test			
Class 1	165	165 + 25	165	165 + 25
Class 2	215	215 + 25	455	455 + 25
Class 3	265	265 + 25	710	710 + 25
Class 4	Exceeding the limits of Class 3			

A suffix 'Y' shall be added to the classification if any softening and/or other behaviour that may affect the flame spread occurs e.g. Class 3Y.

Note: The highest product performance classification for lining materials is Class 0.

This is achieved if a material is either:

- a) composed throughout of materials of limited combustibility or*
- b) a Class 1 material that has a fire propagation index (I) of not more than 12 and sub-index (i1) of not more than 6 when tested to BS 476-6:1989.'*

Location of Rooflights Adjacent to Fire Compartment Walls

Hambleside Danelaw's interpretation of Building Regulations 2010 Part B, and Approved Document B (2006 Edition, 2013 amendment), clauses 8.28 to 8.31 and Diagram 30, with respect to the location of rooflights, is as follows:

Thermoplastic rooflights are not suitable for use within 1500mm of a fire compartment wall. GRP rooflights however are not a thermoplastic material, but a thermoset material, therefore this restriction will

not apply. The requirements are for the compartment wall to be constructed up to the underside of the roof covering with fire-stopping at the wall to roof junction, and for the outer surface to have a fire designation of AA, AB or AC. No specific reference is made to the fire designation of the liner of double skinned roof sheeting installation, however a metal liner would be designated Class 0.

The roof covering used with in-plane rooflights may be either a built-up metal cladding system using separate liner

and top sheets, or composite panels. In either case, the roof sheeting or cladding should incorporate a band of material of limited combustibility 300mm wide and centred over the wall. This would then maintain continuity of a fire break from the top of the compartment wall to the underside of the outer roof sheeting and negate the need for a liner panel to the roof sheeting or rooflight to have any specific level of fire resistance. Without this band of material, the fire resistance of the liner may be critical.

Hambleside Danelaw manufacture in-plane rooflights with fire designations of the outer sheet up to AA in accordance with BS 476-3 and liner panels up to Class 0 in accordance with BS 476-6 & BS 476-7.

Please note: It is the responsibility of the designer of the building to ensure that the requirements of the Building Regulations are implemented correctly. Should there be any doubt, we recommend that the guidance of the Local Authority Building Control Department be sought.

Combustion of GRP rooflight sheeting

GRP (Glass Reinforced Polyester) is a composite material comprising glass reinforcement encapsulated in polyester resin. This polyester resin is a ‘thermoset’ type of plastic and fundamentally different to ‘thermoplastic’ plastics materials that soften and eventually melt when exposed to increasing temperatures.

The thermoset material is inherently much more stable than a thermoplastic material and can withstand the application of heat up to around 400°C subject to composition, albeit the material will darken significantly and have a charred surface appearance. Above these temperatures, the material will burn, but only with the continued application of the heat source. When the heat source is removed, the GRP will self-extinguish.

Typical heat exposure behaviour

In tests conducted to identify the reaction of GRP to heat, a sample of translucent GRP sheeting manufactured using Class 1 resin with a high resin to glass ratio of 2.4:1 was supplied. Half the laminate was placed on a support in a muffle furnace with a temperature of 300°C for five minutes.

Within the first few minutes of placing the laminate sample in the furnace, smoke was observed. The smoke emission continued throughout the duration of the five minute exposure period.

The laminate was removed from the furnace and allowed to cool to an ambient temperature and the appearance was compared with the other half of the sample. The tested sample was opaque, charred orange/brown in appearance, with a rough, gritty texture to the surface.

To confirm the effects of this high temperature exposure the flexural strength, modulus and Barcol hardness properties were determined before and after exposure. The results were as follows:

Test	Unit	Standard	Heat aged
Flexural strength	MPa	378	294
Modulus	MPa	6870	5200
Barcol Hardness	934-1	30-40	42-55



By-products of combustion

There are, as with all plastics materials, toxic substances produced as a result of burning. It is not possible to manufacture any rooflight material for this type of application without this occurring.

The main by-products of combustion of the polyester resins used in the manufacture of GRP in-plane rooflights are carbon dioxide, water and carbon monoxide. In addition to these, there will also be some phosphorous halides given off from the halogens added to the material. These halogens are a necessary part of the composition of the material and are essential to improve the fire resistance.

The more halogens the product contains, the better the fire resistance will be.

It is not possible to be precise in stating exactly what substances will be produced and in what proportion as this will depend on the burning conditions of the material and the levels of oxygen present.

In selecting a product manufactured for high strength such as our Zenon Evolution range, and where the glass to resin ratio is much higher than traditional GRP laminates, there is a reduction in the noxious materials produced.

Zenon Pro and Zenon Evolution sheets are available in a range of internal fire grade classifications from Class 3 to Class 0 in accordance with BS476-6 and BS476-7, and external fire grade classifications up to S.AA in accordance with BS476-3 to accommodate all UK Building Regulation requirements for exposure to fire.

