

INTRODUCTION

Experience of fire, large scale fire tests and laboratory fire tests demonstrate the enormity of fire once it has developed and the power of a fire to search out weaknesses in the construction.

Any new building must comply with the fire protection requirements of the relevant Building Regulations, Building Standards and Local Authority Bye Laws.

In essence, these performance requirements are concerned with the preservation of life, rather than the preservation of property or goods. The material loss of the building and its contents is the concern of insurance companies, and certain insurance bodies have adopted approved roof constructions based on their own tests and experience. In addition, some industrial concerns have themselves adopted standards which may be in excess of the statutory requirements, and it is therefore important to establish whether there are any special fire performance requirements, and consult with the relevant insurance body for advice and approval at the planning stage.

Opinions on the subject of fire are divided and little authoritative guidance has been issued. It is easy for designers to make decisions that are misguided or at least controversial and may be at the expense of overall roof performance. The best approach will be to consult with and take advice from the fire authorities who will have the task of attending the fire if one arises.

The various statutory regulations consider the performance of a flat roof in respect of external and internal fire conditions, and are based on performance tests set out in British Standard 476 'Fire Tests on Building Materials and Structures'.

EXTERNAL FIRE

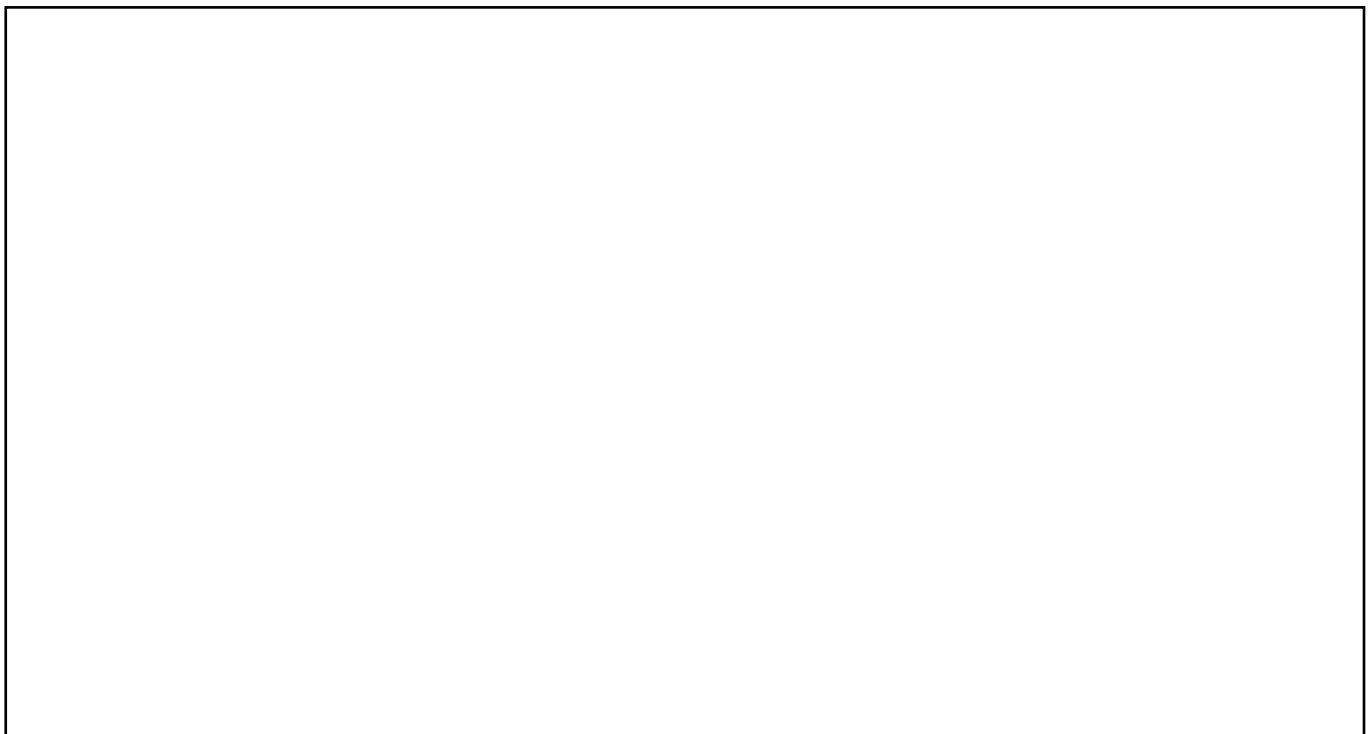
A fire may create a hazard to neighbouring property and the chief danger to a nearby roof arises from radiant heat, combined with burning embers thrown off from the fire.

The performance requirements for a roof construction exposed to external fire conditions relate to the ability of the roof to act as a protective barrier against penetration by fire and the spread of flame over the roof surface, both of which are tested in Part 3 of BS 476.

BS 476:PART 3:1958.

EXTERNAL FIRE EXPOSURE ROOF TEST

In the test procedures, samples of the roof construction are subjected to radiant heat on the upper surface and measurements are made of the possibility of fire penetration during a 60 minute heating period. A test flame is applied after 5 minutes to simulate the fall of a burning brand and the spread of flame is observed. A preliminary test is also made in which the specimen is subjected to a flame in the absence of radiant heat to identify highly flammable coverings. The two criteria of performance are penetration time and distance of spread of flame along the external surface, and the performance of the total roof construction is represented by the following letter system, with an AA designation indicating the best performance that can be obtained.



Roof fire test

First letter - Penetration classifications

- A Specimens not penetrated within 1 hour
- B Specimens penetrated in not less than 1/2 hour
- C Specimens penetrated in less than 1/2 hour
- D Specimens penetrated in the preliminary flame test.

Second letter - Spread of flame classifications

- A Specimens with no spread of flame
- B Specimens with not more than 533mm spread of flame
- C Specimens with more than 533mm spread of flame
- D Specimens which continue to burn for 5 minutes after the withdrawal of the test flame or spread more than 381mm in the preliminary test.

Attention is also drawn to dripping from the underside of the specimen, any mechanical failure or the development of any hole, by the addition of a suffix 'X' to the designation. This suffix, however, carries no restriction in Building Regulations. A typical roof designation would be presented as:

EXT.F.AA, where

EXT = external; F = flat; AA = achieved designation.

An A classification for spread of flame is most desirable as it is only too easy for flames fanned by a steady wind to spread across the roof and enter the building through openings such as ventilators and rooflights. The potential spread of flame on the roof is therefore important. It is regrettable that some roof treatments do not perform well in this respect and that the original spread of flame requirement is often ignored during re-roofing or maintenance.

BS 476:Part 3 was revised in 1975 with slight variations in the testing procedure and with the results expressed by a new method. The Building Regulations do not make reference to the new standard however and it is likely that the 1958 version will remain in general use until a suitable European Standard, has been issued.

In BS 476:Part 3:1975 the surface spread of flame element of the test has been dropped and replaced by a measurement of surface ignition, made at the same time as the penetration test and using the same level of radiation intensity.

The previous method required a test flame to be applied only once during the early part of exposure. With the 1975 test, the flame is applied at intervals throughout the test. Designations in the revised standard are expressed by the letters 'X' and 'P' followed by the time in minutes for the sample to be penetrated by fire.

X indicates that in the preliminary ignition test, the duration of flaming of the specimen exceeded 5 minutes or that the maximum distance of flaming exceeded 370mm.

P indicates that the above conditions were not exceeded.

The table 1.25 shows the basic relationship between the old and new designations.

TABLE 1.25

BS 476:Part 3:1958	BS 476:Part 3:1975
AA, AB, AC	P60
BA, BB, BC	P30
AD, BD, CA, CB, CC, CD	P15
Unclassifiable	P5

The standard allows the test period to be extended to 90 minutes if required so that the highest designation obtainable would be P90. The incidence of dripping from the underside, hole formation or mechanical breakdown (which were previously referred to by the suffix X) are now considered within the new overall classification.

BOUNDARY DISTANCE

The designations achieved in BS 476:Part 3:1958 are used in Building Regulations to define acceptable roof constructions in relation to their distance from a possible external fire source.

As the distance of the roof from the boundary increases, a relaxation is made for the ability of the roof to resist ignition and penetration as shown in table 1.27.

TABLE 1.26

Designation	Minimum distance from boundary*
AA, AB, AC	No restriction
BA, BB, BC	6m
CA, CB, CC	20m

* A boundary is defined in the Building Regulations as the boundary of land belonging to the building up to and including the centre line of any abutting street, canal or river.

Although designations AA, AB and AC are accepted by Building Regulations for most roofs, certain authorities may insist on the designation AA.

NOTIONAL DESIGNATIONS OF ROOF COVERINGS

Table A5, Approved Document B of the Building Regulations, England and Wales and Northern Ireland, and Schedule 9, Table 7 of the Scottish Building Standard Regulations give notional designations for roof coverings to BS 476:Part 3:1958. Mastic asphalt is deemed to provide an AA designation over deckings of timber, woodwool, plywood, particle board, concrete, steel, aluminium or asbestos cement and this designation is achieved without a surface dressing of chippings. A flat roof covering of bitumen felt on these decks (irrespective of the felt specification) is also deemed to be of AA designation, provided that the roofing has a surface finish of bitumen bedded stone chippings covering the whole surface to a depth of not less than 12.5mm, or non-combustible tiles.

INTERNAL FIRE

If the roof is required to support or stabilise the load bearing walls, or if the roof surface forms part of a fire escape route, there may be a requirement for the roof to provide fire resistance as defined in BS 476:Part 21 or 22 Test methods and criteria for the fire resistance of elements of building construction. Building Regulations Approved Document B3 section 8 gives requirements for the treatment of the top of compartment walls.

Fire on the underside of a concrete deck is unlikely to lead to structural collapse or cause ignition of the overlying roofing materials, or cause them to give off combustible gases which might enter the building.

Metal decking and woodwool decks would generally maintain their structural integrity with some distortion and deflections, although the steel frame could collapse or distort to the extent that the structural deck is no longer supported and may tilt or fall towards the fire. At this stage the combustible components may add fuel to the main fire but that section of the building will be a total loss and the additional fuel may not prove significant.

Aluminium deck is an exception as this will usually fail before the supporting steel frame. Typically a hole will burn through the roof above the fire and opinions have sometimes been expressed after such fires that the ventilation effect of the penetration of the roof by fire has proved beneficial and has helped to avoid the spread of fire further into the building.

As the development of the fire increases, roof temperatures may be reached which support a heat transfer through the deck to generate combustible gases from the insulation or roofing materials above. These gases will not burn until in contact with air containing normal proportions of oxygen to support the combustion, but the gases may pass down through the joints in the roof deck to burn on the underside of the deck if a suitable air supply is available.

The channels of metal decking will conduct the gases along them but it would be unusual for flame to travel along the channels as there is not usually a sufficient supply of air to support the combustion. The detailing of the roof usually closes off the ends of the channel at the edges of the building.

FIRE IN CAVITIES

Experience of fire and fire tests indicates that the greatest danger is the spread of fire through cavities, particularly the space between the ceiling or lining and the underside of the roof deck. It was with the object of restricting this unseen spread of fire that the Building Regulation requiring cavity barriers and fire stops was introduced. See Approved Document B3 section 9.