# External fire spread: new research

## In a two-part feature, BRE Global reports on the latest findings to come out of its work on the 'Investigation of Real Fires' for the Department for Communities and Local Government (DCLG)

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## Introduction

With the trend to use new types of more energy-efficient insulation in façade design, this new research into external fire spread addresses the intentions behind 'Part B4 Section 12 of Approved Document B – Volume 2' concerning the construction of external walls of buildings.

Part 1 of the work, discussed here, looked at previous and current guidance for external fire spread and reviewed several case studies of external fire spread since the introduction of the BS 8414 test series.

This was followed by a Part 2 experimental scoping study focusing on the issue of external fire spread, to be covered in next month's issue.

## Part 1: Background research & existing guidance

Part B4 Section 12 of Approved Document B – Volume 2 (AD B) [1] is concerned with the construction of external walls of buildings. The authors aim to clarify the background to these recommendations, their objectives and intended outcomes.

The requirement of Part B4, Schedule 1 of Building Regulations 2010 [2] regarding external fire spread is as follows:

1. *The external walls of the building shall* ***adequately resist the spread of fire over the walls*** *and from one building to another, having regard to the* ***height, use and position of the building****.*
2. *The roof of the building shall adequately resist the spread of fire over the roof and from one building to another, having regard to the use and position of the building.*

It must be noted that this article focuses on the Building Regulations requirements highlighted above, namely, fire spread across the face of a building. The article does not discuss building separation and fire spread from one building to another, although it must be acknowledged that the external wall construction should not only be considered in this regard but holistically since the differing requirements clearly interact.

## Background

As part of the research, previous guidance was reviewed to understand current guidance.

The Model Byelaws [3], of circa 1952, recommended that *"A reasonable degree of protection* [for buildings of fully protected construction] *could be obtained by providing at least 3 ft of construction (of which at least 2 ft should be above floor level) of the same grade of fire resistance as the walls, between the lintel of the lower window and the sill of the one above".*

In 1960, Ashton and Malhotra [4] carried out a series of large-scale experiments to assess the value of this recommendation which looked at the effect of fire on the external walls of buildings. They concluded that the recommendations for 3 ft vertical separation or 2 ft horizontal separation between windows in adjacent storeys were "*inadequate to prevent the entry of flames from a fire in the lower storey unless fire resisting* *glazing is used*". It was also observed that "*the fire resistance required of the spandrel wall could be substantially reduced even below ½ hour, without any significant reduction in fire safety to a building or its occupants*".

It was these findings that underpinned later recommendations intended to satisfy the Building Regulations.

However, the construction of buildings has changed since 1960, as have Building Regulations and supporting recommended guidance, AD B.

There have been a number of fires, both historical and more recent, which have raised concerns regarding fire spread over external walls, leading to the introduction of guidance documents and test procedures to assess the fire performance of external wall construction. Included among them was the first edition of the BRE report BR 135 (Fire performance of external insulation for walls of multi-storey buildings) [5], published in 1988.

One of the most significant of the historical fires is the 1991 fire in Knowsley Heights, a residential block of flats which had been refurbished with the addition of thermal insulation to the external walls of the block. The fire started externally to the block and ignited the combustible cladding system, resulting in extensive fire spread across the face of the building (mostly upwards).

Although this was not the first incident of its kind, it raised many concerns and resulted in a change to the test methods used for external cladding systems, namely the introduction of a full-scale fire test method (similar to the BS 8414 test series [6] and [7]). However, BS 8414-1 (for non-loadbearing external cladding systems) was not published until 2003 as an accompaniment to the second edition of BR 135 [9]. This was following a review of guidance in this area instigated by a fatal fire at Garnock Court, Irvine in June 1999.

In 2002, Crook [8] carried out a review of international practices related to external fire spread via windows (and ways to mitigate such spread), but concluded that *"very few people are killed or injured from fire who are elsewhere than on the fire floor"* and *"most deaths or injuries on floors other than the fire floor are as a result of smoke"*. The overall findings of this later study confirmed the findings of Ashton and Malhotra. It stated that "*The evidence acquired for this project leads to the conclusion that the measures currently called upon through Approved Document B are still commensurate with the risk."*

Fires can spread up buildings even without the involvement of the exterior materials of cladding system. There are numerous examples of fire spread from the flat of origin to the flat above via the windows, but most cause only property damage to the flat (or flats) above.

However, more innovative ways to insulate buildings to improve their sustainability and energy efficiency are changing the external surfaces of buildings with an increase in the volume of potentially combustible materials being applied.

## Existing guidance

AD B recommends restriction of the combustibility of external walls to reduce the danger from fire spread up a building's external face and also to reduce the susceptibility of the surface to ignition from an external source [1]. It is considered that the use of combustible materials and/or extensive cavities in cladding systems in tall buildings can pose a route for fire spread and thus a danger to life as shown by the case studies. Hence, the recommendation is to limit both the combustibility of materials used on the external face of the building and the extent of cavities in cladding systems.

Diagram 40 of AD B sets out the provisions for external surfaces (or walls) relative to the relevant boundary, height and use of the building. The classification of the external surface of a building depends upon the distance to the relevant boundary. Any external surface less than 1000 mm from the relevant boundary, regardless of its height, must be European Class B-s3,d2 or National Class O (as defined in AD B) or better. This increased level of protection for surfaces close to the relevant boundary is provided to mitigate building-to-building fire spread, rather than fire spread across the surface of one building.

However, when the external surface is 1000 mm or more from the relevant boundary, then the height and use of the building become relevant; a building less than 18 metres high has no restrictions unless it is an assembly or recreation building over one storey. The external surface of a building 18 metres or higher should have an index value (I; BS 476-6 [10] or Class C-s3, d2; BS EN 13501-1 [11]) not more than 20 up to 18 metres above ground, but over 18 metres (of any dimension) should be Class B – s3,d2 or O. This is in part due to the reach of fire appliances.

AD B makes further recommendations that, where the construction of external walls use combustible materials in the cladding system, then it should meet the performance criteria set out in BR 135 [9] using the full scale test methods BS 8414-1:2002 [6] or BS 8414-2:2005 [7]. This involves testing the entire cladding system including the insulation among other components.

## Fires since the introduction of BS 8414 test series

BRE Global has investigated several fires as part of its DCLG contract where external fire spread has had an implication. Some of those incidents are summarised here.

**Case study 1 – June 2008**

A fire occurred in a first floor flat of a 1960s nine-storey block of maisonettes. The external walls of the flats incorporated uPVC window and door units (Figure 1) and some of the lower window panels had been replaced with painted metal panels (comprising two sheets of painted metal, possibly aluminium, and a thin layer of adhesive holding the two together). The fire melted the frames of the window units, allowing flames to extend up the building exterior. These flames were sufficient to melt the frames and break the window panes of the floors/flats above the flat of fire origin, causing fire and smoke damage within the flats from the third to the sixth floors.

**Figure 1 – Block of flats showing undamaged window sets; the fire damage is behind the scaffolding**

**Case study 2 – July 2010**

A fire started on the balcony of a $12^{th}$ floor flat of a 16-storey residential block of flats constructed in the 1960s. As can be seen in Figure 2, the fire spread from the balcony of origin to the $15^{th}$ floor and the roof of the building. Several building features were attributed to the extent of fire spread including:

- combustible insulating panels clad onto the underside of all of the balconies;
- cladding panels installed on the outer surface of the exterior wall, comprising a mineral fibre board face supported on timber batons in front of a fibrous combustible insulation material;
- plastic drain pipes installed at each corner of the building, passing through the concrete floor slab on each floor.

There was no evidence of any fire stopping, proprietary seal or sleeve where the pipe passed through the floor slab, which should have been provided to maintain the level of fire resistance afforded by the concrete floor slab.

**Figure 2 – Block of flats showing extent of fire damage caused by holes in compartmentation on balconies**

While external fire spread has been an issue, the authors would also like to acknowledge that there have been successes as in Case study 3.

**Case study 3 – February 2008**

A fire occurred in a flat on the 11$^{th}$ floor of a 22-storey block of flats built during the 1960s and refurbished in 2006/7. This refurbishment included the fitting of a new cladding system to the exterior of the building comprising an insulated render containing mineral wool insulation, which had been tested to and passed BS 8414-1. The fire developed to fully involve the flat of origin and broke out of the windows. Façade damage was localised to the immediate vicinity of some of the windows, and beyond this, appeared to have been limited to surface charring and sooting (Figure 3).

**Figure 3 – Block of flats showing limited damage to the non-combustible cladding system after a fire**

## Common misconceptions

Fires involving the exterior of a building, in particular high-rise flats such as those described above, are visually impressive, high-profile and attract media attention. However, fire precautions for the external envelope of a building are intended to delay the spread of fire either across the façade of a building or from building to building but not necessarily to prevent it.

Any risks posed by inappropriate façades should be identified and assessed as part of the fire safety risk assessment carried out under the Regulatory Reform (Fire Safety) Order 2005 [12] and, if necessary, remedial work carried out.

A further confusion arises since many elements required for fire safety in buildings are recommended to be "fire resisting", i.e., to demonstrate that they satisfy performance criteria as determined by BS EN 13501-2 [13] or BS 476 fire resistance tests [14]. Fire resistance tests subject a test specimen to a fire exposure that is similar to a fully flashed-over compartment fire. Such an exposure is appropriate for interior elements of a building and load-bearing elements. However, it is not evident that such exposure conditions are appropriate for the exterior of a building. Furthermore, the Class B-s3,d2 or O recommendation and other recommendations mentioned above, are intended to limit the rate of fire growth and fire spread and there is no evidence to date to suggest that these recommendations are inadequate.

In any case, high-rise flats are homes and must provide light and ventilation. Flats must be provided with openable windows unless an (often expensive) alternative ventilation strategy can be provided (under Part F to the Building Regulations [2]). Additionally, once open, such windows may offer a route for fire spread, in either direction in or out of the flat, irrespective of the other materials forming the exterior of the building. To prevent vertical fire spread, it would be necessary to ensure that all windows in such buildings were both fire-resisting and sealed closed (fixed shut) - or were shut in an emergency, manually or automatically. A similar recommendation is given for windows that open onto external escape routes (AD B Section 5.25 and Diagram 25 [1]) but would almost certainly conflict with the needs of everyday life.

## Conclusions

With the exception of one or two unfortunate but rare cases, there is currently no evidence from BRE Global's fire investigations for DCLG to suggest that current Building Regulation recommendations, to limit vertical fire spread up the exterior of high-rise buildings, are failing in their purpose.

However, as the need to improve energy efficiency grows, more innovative ways to insulate buildings to improve their sustainability and energy efficiency are changing the external surfaces of buildings, with an increase in the volume of potentially combustible materials being applied. A number of significant fires, such as those discussed, have demonstrated the potential risks.

Following on, BRE Global carried out a three experiment scoping study for DCLG to assess the performance of different external façades when exposed to a fire from below, representative of the external face of some buildings. The findings will be published in Part 2 next issue.

## References

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