

External Fire Spread – Part 1 Background research

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Introduction

BRE Global carries out fire investigation activities on behalf of the Department for Communities and Local Government (DCLG); the contract 'Investigation of Real Fires', for which this work was undertaken was completed in 2015 but has since been renewed until 2018.

BRE Global, through this contract with DCLG attend fires of special interest, investigate issues that may have implications for Building Regulations and the guidance that supports Building Regulations, such as the Approved Documents. Access to fire scenes is achieved through contacts with the Fire and Rescue Services and other agencies and their assistance is gratefully acknowledged.

An important element of this contract is to ensure that findings from fire investigations are made available to the fire community, and other stakeholders.

Scope

Part B4 Section 12 of Approved Document B – Volume 2 (AD B) [1] is concerned with the construction of external walls of buildings. The aim of this article is to clarify the background to these recommendations, their objectives and intended outcomes. The requirement of Part B4, Schedule 1 of Building Regulations 2010 [2] with regards to 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.*

This article focuses on the Building Regulations requirements in bold above, namely, fire spread across the face of a building. This article does not discuss building separation and fire spread from one building to another, although it needs to 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 this 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*” and “*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, when Ashton and Malhotra carried out their experiments and Building Regulations and supporting recommended guidance, AD B, have changed. There have been a number of fires, both historical and more recent, which have raised concerns regarding fire spread over external walls and have consequently resulted in the introduction of guidance documents and test procedures to assess the fire performance of external wall construction. The first edition of the BRE report BR 135 (Fire performance of external insulation for walls of multi-storey buildings) [6] was 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 [7] and [8]). 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 [5] 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

Approved Document 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 hence 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 further makes recommendations that should 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 [7] or BS 8414-2:2005 [8] which involves testing the entire cladding system including the insulation among other components.

Fires since the introduction of BS 8414 test series

There have been several fires that we have investigated as part of our DCLG contract where external fire spread has had an implication and 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 exterior of the building. These flames were sufficient to melt the frames and break the window panes of the floors/flats above the flat of fire origin and caused fire and smoke damage within the flats from the third to the sixth floors of the block.



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 12th floor flat of a 16-storey residential block of flats constructed in the 1960s. As can be seen from Figure 2, the fire spread from the balcony of origin to the 15th floor and the roof of the building. Several features of the building were attributed to the extent of fire spread including combustible insulating panels (which were clad onto the underside of all of the balconies), cladding panels (which had been installed onto the outer surface of the exterior wall and comprised a mineral fibre board face supported on timber batons, behind which there was a fibrous combustible insulation material) and plastic drain pipes (which were installed at each corner of the building and passed 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 and 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 as outlined by these case studies, the authors would also like to acknowledge that there have been successes as can be seen in Case study 3.

Case study 3 – February 2008

A fire occurred in a flat on the 11th 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 which comprised an insulated render, the insulation for which was mineral wool and 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. The damage to the façade was localised to the immediate vicinity of some of the windows but beyond this the damage 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. Any risks posed by inappropriate exterior or cladding materials 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. Further, as mentioned above the Class B-s3,d2 or O recommendation, and the other recommendations 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]) and, 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 spread of fire 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 such 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

As mentioned, BRE Global, through the contract with DCLG, investigate fires that may have implications for Building Regulations. With the exception of one or two unfortunate but rare cases, there is currently no evidence from these investigations to suggest that the current 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 becomes increasingly urgent, 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 previously, have demonstrated the potential risks.

It was agreed with DCLG to carry out three experiments, to assess the performance of different external façades including non-fire rated double glazing, when exposed to a fire from below, representative of the external face of some buildings. This work did not test the performance of specific products/systems and was not a comprehensive research study but rather a scoping study and as such, the results need to be considered within this context. The findings of this new research will be published as Part 2 of this article.



References

- [1] HM Government. The Building Regulations 2010 (For use in England). Fire safety. Approved Document B Volume 2 – Buildings other than dwellinghouses. London. DCLG, 2006 edition incorporating 2007, 2010 and 2013 amendments, Crown Copyright 2006.
- [2] HM Government. The Building Regulations 2010.
- [3] Ministry of Housing and Local Government, Model Byelaws, Series IV, .Buildings, Her Majesty's Stationery Office.
- [4] Ashton, L. A. and Malhotra, H. L., F.R. Note No.436. Department of Scientific And Industrial Research and Fire Offices' Committee, Joint Fire Research Organization. External Walls of Buildings - Part I. The Protection of Openings Against Spread of Fire from Storey to Storey. Fire Research Station, Boreham Wood, Herts, July 1960.
- [5] Crook, C., External fire spread via windows, BRE Client report for DETR, 2002.
- [6] Rogowski, B. F. W., Ramaprasad, R. and Southern, J. R., Fire performance of external thermal insulation for walls of multi-storey buildings. BRE Report BR 135. First Edition, Bracknell, BRE Bookshop, 1988. (Now superceded).
- [7] BS 8414-1:2002 Fire performance of external cladding systems. Test methods for non-loadbearing external cladding systems applied to the face of a building. British Standards Institution, 2002. Note Current version of this standard is dated 2015.
- [8] BS 8414-2:2005 Fire performance of external cladding systems. Test method for non-loadbearing external cladding systems fixed to and supported by a structural steel frame, British Standards Institution, 2005. Note Current version of this standard is dated 2015.
- [9] Colwell, S. and Baker, T., BRE Report BR 135 Fire performance of external thermal insulation for walls of multistorey buildings. Second edition, IHS BRE Press, 2003. Since superseded by Third Edition, 2013.
- [10] BS 476-6:1989+A1:2009 Fire tests on building materials and structures. Method of test for fire propagation for products, British Standards Institution, 1989.
- [11] BS EN 13501-1:2007+A1:2009 Fire classification of construction products and building elements. Classification using data from reaction to fire tests. British Standards Institution, 2009.
- [12] The Regulatory Reform (Fire Safety) Order 2005.
- [13] BS EN 13501-2:2007+A1:2009 Fire classification of construction products and building elements. Classification using data from fire resistance tests, excluding ventilation services. British Standards Institution, 2009.
- [14] BS 476-20:1987. Fire tests on building materials and structures. Method for determination of the fire resistance of elements of construction (general principles), British Standards Institution, 1987 [and others in the series].



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BRE staff have carried out fire investigations in support of the Building Regulations (and its precursors) on an ad hoc basis since 1948, and with a dedicated team since 1974. BRE has been wholly owned by the BRE Trust since its privatisation in 1997. BRE's fire investigation team is independent and provides world class fire investigation services to a wide range of clients, including insurers, legal firms, fire and rescue services, police and government departments.

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