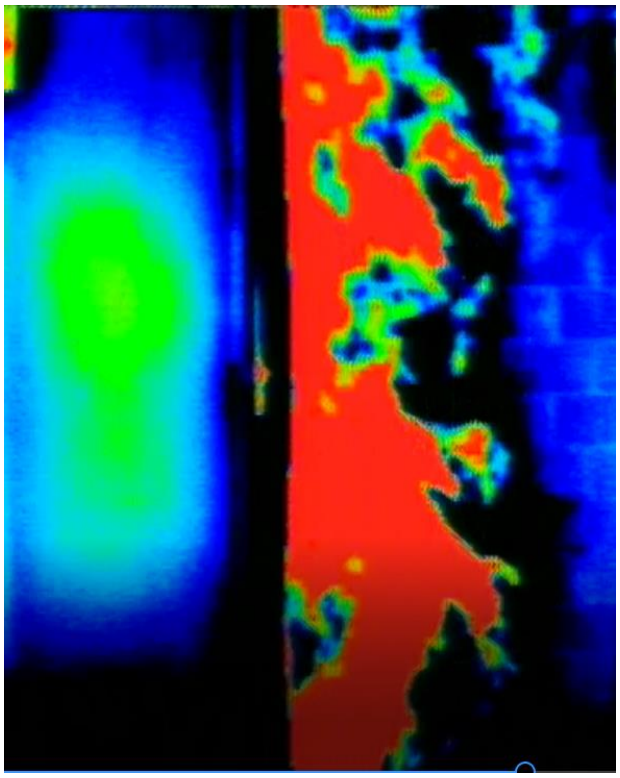
Fire Protection Association

RISCAuthority



CLADDING APPROVALS

A review and investigation of potential shortcomings of the BS8414 standard for the approval of cladding systems such as those commonly used on tall buildings

BRIEF

This work was commissioned by ABI to assist with the provision of insurer relevant information to Dame Judith Hackitt's Review of Building Regulations and the Grenfell Inquiry. The work was undertaken by the Fire Protection Association and technically supported by the RISCAuthority membership

22/2/2018

ABI

Executive Summary

The approval of cladding systems for use on high-rise buildings occurs by a number of methods, most of which referenced back to a large-scale British Standard test, BS8414. The requirement for a large-scale built-up-system test is due to the allowance of materials in the system's make-up that are combustible. In such systems, combustible materials are nominally protected from fire involvement through separation by higher performing materials for a period of time considered 'safe'. A pre-requisite of built-up-system testing is that the test specimen truly represents the situation into which the system will be installed but there may be doubt that this criterion is being met on a number of counts.

The objective of this study is to evidence a need to reconvene the BS 8414 committee, so that the findings can be considered by the panel and addressed where considered pertinent with a view to improving overall safety and resilience and providing better data to support future material selections and designs. This study does NOT investigate issues pertinent to specific cladding products, preferring only to address the challenges beset them under the BS8414 test protocol.

It is similarly important to note that in places there may be concern of how test data might be used to justify the use of material combinations on buildings – in this there is no criticism of those conducting and reporting test data who, it is appreciated, take great care to communicate that the data is relevant only to the precise materials and method of installation deployed within the test regime.

The fire-load for the test is a large wood-crib situated to model the condition where a compartment fire breaks through a window to allow ejected flames to threaten the exterior cladding surface. There are five key areas of concern in respect of the adequacy of the BS8414 test in describing product suitability for all components of a cladding system (brackets and framework, window detailing, insulation, rain-screen, and cavity barriers), namely:

1. Fuel load relevance to modern materials / lifestyle

   Issue: Historic work conducted on behalf of insurers on high-rise fires demonstrated that modern occupancy fuel loadings typically comprise 20% plastic-based fuels. The inclusion of plastics can both raise flame temperatures and elongate flame lengths exiting a building. Aluminium, a common external cladding material used, loses a great amount of its strength with temperature. There may be grounds to question whether the BS8414 fuel load is appropriate for determining cladding system performance if not representative of a modern-day fire source.

2. Breaching of the cladding system by un-fire-stopped vents and ducts

   Issue: Aside from the simulated window in which the fuel crib sits, the cladding system is installed in perfect form without any other breaches such as other windows, vents, ducts, or pipes. The external envelope of the building is not considered part of the design 'fire compartment' and as such 'weak' devices that include, for example, plastic duct tubing, may be installed through the cladding system without fire-stopping. Such inclusions can act to provide a simple path to communicate fire and toxic by-products of fire, into the cladding system's void, where combustible materials may be sited, from a fire originating from within the building, from outside the building, or travelling within the cladding void. There are grounds to question whether the BS8414 test, that is conducted with 'perfect encapsulation' of the combustible components, adequately addresses the impact of such common design features when seeking to confirm system safety.

3. Oxygen provision to materials and allowance of 'chimney effects' to manifest

   Issue: 'Chimney effect' describes a mode of burning where the rate of fire spread is significantly accelerated by the geometry of airflow delivery and smoke egress. Rain-screen cladding systems demand a void between the insulation and rear of the external

panel to allow the free passage of air and water drainage to prevent building fabric damp and pressurisation issues. There is a concern that the installation of test samples within the BS8414 test regime, in association with other features described in this investigation, may prevent a realistic flow of oxygen within the test specimen and as such normal burning and perhaps the allowance of chimney effects, which might exist in practice, may be inhibited. Specifically, the sealing of test piece edges which might be open in practice, the closeness of fire stopping, the omission of vents that might fail early in the fire event, and use of non-representative void depths, will all impact on the amount of air available to support fire spread and chimney-effect burning.

4. Performance of cavity barriers

   Issue: The aforementioned 'perfect-build' of the BS8414 test means that the only route for fire challenge is via the external cladding-material. In this situation, the cavity barriers might operate through 'pre-heating' in the period before the fire has broken through the external cladding material. If the inclusion of plastic vents allows direct flame passage from the fire into the void much earlier in the fire event, they will need to respond to a direct flame challenge. Since the intumescent material they are made of takes time to respond, flames may pass for a period of time before they activate and ignite material beyond the barrier. There is a concern that cavity barrier performance should be linked to the ignition properties of ALL materials they separate, but this is currently not the case and the configuration of the BS8414 test does not provide adequate challenge to confirm suitability.

5. System detailing differences between certification and in-use applications

   Issue: Built-up-system testing demands that the test piece under scrutiny is designed and installed to the exact same specification as it would be for the end building application. There is concern that some testing has allowed significant reinforcement of the system with features that may benefit its ability to pass the test but might not be design features of end-use applications.

Results headline points:

- Changing the fuel load so that 20% of its calorific value is sourced from plastic material has been demonstrated to; elongate the length of flame ejections, increase the intensity of the fire (peak heat release rate), and maximum temperatures achieved. It is believed that the changes identified could be significant in the survivability of materials such as aluminium.
- The inclusion of a standard kitchen / bathroom type vent into the BS8414 test allows access of flame, heat, and combustible material into the cladding void directly before failure of the external cladding panels. This by-passes the 'protection through encapsulation' of some of the cladding system components and might be sufficient to alter a test outcome. This also raises issues pertinent to the potential impact of materials not normally included in the test system (such as vapour barriers) and the communication of toxic by-products to other occupied areas of a building.
- The ability of 'chimney effects' in void geometries of a size used in cladding systems to promote fire spread, albeit on other materials has been demonstrated. BS8414 configurations with sealed edges might inhibit realistic oxygen provision and flow and not allow chimney-effects or full burning of materials to prevail where they might in reality.
- The operation of cavity barriers in a direct flaming regime has been demonstrated. Flames pass for the operation duration providing evidence that cavity barrier performance cannot be inferred by the BS8414 test regime. Cavity barrier performance should be determined by an alternative test that is made in association with the burning and ignition properties of all materials they will be separating in end-use, including lighter, more readily ignitable sheet materials, such as membranes and vapour barriers, which are not currently tested within the regime.

- The design differences between systems destined for BS8414 testing and on-building use can be many. Test specimens are often combinations of ‘specific’ materials assembled in a ‘generic configuration’ whereas in-use systems have a greater number of material components arranged to a very specific format. These tests have demonstrated that the cladding form and fixing method used generically in the MHCLG tests exhibit a very different failure and destruction mode than a real-life installation of the same materials. This must draw into question the suitability of the MHCLG tests to confirm the fire performance of systems already installed on buildings where the materials are the same but the installation methods, particularly the hanging system and window detailing, are different. The real-life system demonstrated enhanced lateral damage, and system collapse and fall-away of cladding components in comparison to the generic MHCLG installation with its much-enhanced panel support methods (number of support transoms and all-round panel riveting).

These findings suggest that the BS 8414 test may not give designers, specifiers or insurers confidence that cladding systems tested to it will ensure the level of building fire safety that is currently inferred by its use.

Our recommendation is that the findings of this report are provided to BSI to prompt a review of the BS8414 standard or to support the development of an insurer approved alternative.

Thanks for assistance are expressed to:

ABI & Membership	Research sponsors
ARUP Group Limited	For advice and guidance on as-installed cladding systems
PSP Architectural	For the sourcing and provision of test materials
MAF Associates	For technical input on cladding installation
RISCAuthority Membership	For technical guidance
FPA Special Projects Group	For conduct of the laboratory evaluations

This report, and the underlying work on which it is based, has been prepared and is submitted in accordance with the contract with the Client.

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Contents

1 Introduction

Following the Grenfell tragedy, the Fire Protection Association proposed fourteen potential research themes that it considered valid in addressing fire safety and resilience issues within the UK built environment as follows:

- Clarity and interpretation
- Scope
- Engagement
- Competency, Supervision, Control, and Authorisation
- Combustible Materials
- Imperfect World
- Standards
- Detection and Evacuation
- Engineered solutions
- Data
- Awareness
- Impact of other parts of Building Regulations
- Sprinklers
- Consequences of previous BR reviews and legislative changes

These themes were considered by ABI's and RISCAuthority's memberships and ABI funding was provided to deliver on three fronts in time to influence the inquiry:

- Cladding Standards: The adequacy of the current cladding testing regimes to deliver high levels of fire safety under real world conditions.
- Detection & Evacuation: The effectiveness of detection and associated evacuation procedures: furthering the 2014 FPA campaign for high-integrity detection systems in high hazard and commercial applications.
- Residential Sprinkler Systems: The standards and relative performance of sprinkler systems specified for residential applications with a view to ensuring quality in operation and function.

A fuller explanation of the research themes is given in Appendix A. This report details the research outputs of Workstream 1: Cladding systems.

2 Background

Historic experience from building methods and materials used in the food industry (insulated sandwich panels) inform us that the determination of building product suitability on the basis of non-representative standards tests can lead to very poor fire performance with immense financial and safety implications. The issues then, which might have shared relevance to the subject in hand, included problems of:

- Test regime scale – too small to determine real-life issues
- Product presentation – overly resilient in comparison to end-use installations
- Fire challenge – not representative in type or size

The solution in this case was the creation of a new insurer standard (LPS 1181) which tested the sandwich panel systems at maximum span with a more significant and realistic fire challenge, in association with risk assessed phased panel replacement programmes. The principle products causing the major problems are now no longer a feature of the UK food industry.

The primary test used for determining suitability of cladding systems for use on high-rise buildings is BS 8414 "*Test method for non-loadbearing external cladding systems applied to the masonry face of a building*". This test is appropriate for the evaluation of both vented rain-screen systems and non-vented external thermal insulation systems. This study focuses exclusively on methods for rain-screen systems.

The main components of these systems are:

- Rain-screen cladding – often a thin sandwich of aluminium sheets with plastic or fibre core (ACM – Aluminium Composite Material) but many other materials are also used
- Intumescing cavity barriers – with a requirement to allow free air flow in the normal condition and seal during fire
- Insulation – usually fibre or foam products
- Bracketry
- Vapour and breather membranes
- Window frame, door frame, and edge detailings

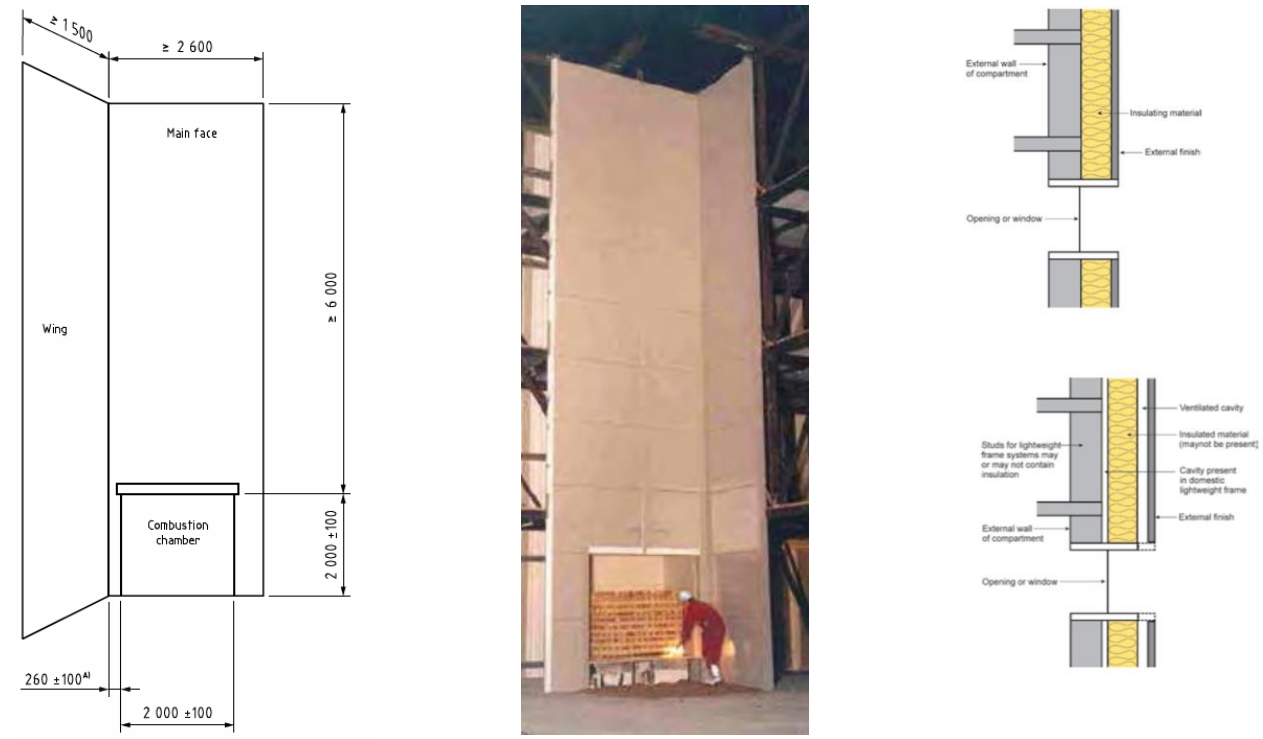


Figure 1 - BS 8414 Cladding test rig

The need for large-scale testing of this type is necessitated by the allowance of combustible materials within the built-up system. These combustible materials depend upon a degree of encapsulation behind higher performing materials to ensure their isolation from the fire event. This encapsulation may also allow the cavity barrier systems to respond under the action of 'heat' before direct flaming is experienced. In a study undertaken by BRE a range of fire test methods were compared for their ability to determine cladding system performance including:

- BS 476 Parts 6 and 7 (external finish and insulation only)
- European reaction to fire tests (EN 13501-1 – external finish and insulation only)
- ISO 9705 room test (the reference scenario for the European tests)
- The large-scale test method specified in BR135 (BS 8414-1)

The primary conclusion from this work was that '*the use of test methods and assessments which more closely reflect the end use application on a building should provide novel designs and materials with a method of demonstrating their overall fire performance, as part of a system'*.

As a one-stop test for assurance of a system's suitability in real-world applications it is therefore essential that the test encompasses all allowable features that might significantly alter its response to the presented fire challenge. Having considered BS 8414 and its associated

procedures in the context of real-life appropriateness, FPA have put forward a number of areas it considers are in need of investigation to assure the UK insurance industry, and the Grenfell Inquiry, of proper function as follows:

- Fire challenge
- Legitimate cladding system breaches
- Oxygen provision
- Cavity barrier challenge
- Installation detailing

Each of these is addressed in the following sections.

3 Fire Challenge investigation

3.1 Background

Just as it is essential that built up system testing uses an installed configuration that is coherent with end-use, it is similarly essential that the challenge set reflects the real-life challenges. The fire challenge presented to the cladding system in BS 8414 is in the form of a substantial yet traditional timber crib. Recent fire studies have noted that the materials deployed in modern homes and offices are substantially different from 20 years ago with the principal difference being the quantity of plastic based materials present and the impact that this may have upon:

- Fire development
- Flame temperatures
- Flames lengths

In the Loss Prevention Council's study on Fire spread in multi-storey buildings with glazed curtain wall facades the crib used in these tests, following office surveys, used a combined timber and polypropylene crib, where the plastic component accounted for 20% of the crib's total energy content. This feature altered significantly both the flame temperatures and flame lengths.

Figure 2 - LPC Multi-Storey fire spread test drib with 20% 'plastic energy'

It was proposed that the influence of plastic fuels should be evaluated in the context of relevance to assuring cladding system performance.

3.2 Test configuration

3.2.1 BS 8414 Wood crib test

The BS 8414 wood crib comprises 395kg of Pinus Sylvestris softwood of cross section 50mm x 50mm arranged in 20 layers to form a crib having a floor footprint of 1.5m x 1.0m. (100 sticks of length 1.5m and 150 sticks of length 1.0m). The crib was ignited using fibreboard batons soaked in white spirit.

3.2.2 Plastic modified crib test

The plastic modified crib test had a reduced wood composition of 80 sticks of length 1.5m, and 50 sticks of length 1.0m, arranged in 16 layers with 4 layers of 50 x 1.0m length sticks of polypropylene arranged over. The wood crib sticks had an unchanged cross section of 50mm x 50mm whilst the polypropylene was provided as batons of cross section 25mm x 25mm. The total energy content of the BS8414 wood crib, and plastic modified crib were designed to be equal.

Figure 3 - BS8414 Test crib

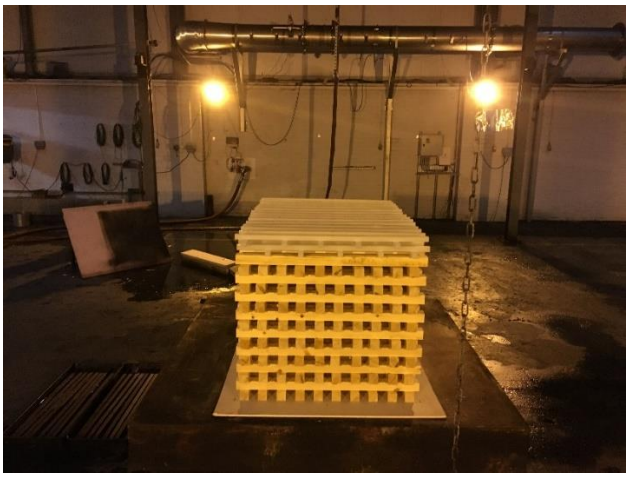


Figure 4 - Plastic modified test crib

3.3 Results

The test was instrumented to analyse:

- Fire plume length
- Fire plume and laboratory ceiling temperatures
- Fuel mass loss

Due to the increased severity of the fire that incorporated a plastic component the test was halted early as safe laboratory ceiling temperatures were exceeded after approximately 11 minutes in-spite of the water misting ceiling protection installed around the edges of the test ceiling (it should be noted that the ceiling is not specifically fire hardened in the test location).

3.3.1 Plume length

Flame lengths from the 2 cribs were comparable for the first 8 minutes of testing after which the plastic modified crib exceeded the wood crib as the plastic material was observed to burn, melt, and spread throughout the crib. At around 10 minutes 30 seconds the plastic modified crib was observed to have a consistent flame length of just over 6 metres; around 1 metre more than the wood crib.

The test was stopped soon after making further investigation impossible.

Figure 5 - Wood crib burning under 6.25m ceiling 10m 30s after ignition

Figure 6 - Plastic modified crib under 6.25m ceiling 10m 30s after ignition

3.3.2 Fire Plume temperatures

Graphs from 3 thermocouples located above the cribs are presented in Figure 7 and Figure 8 for the wood, and plastic modified cribs, respectively.

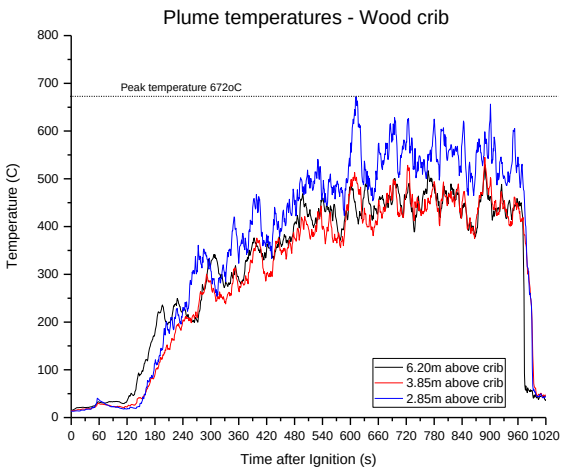


Figure 7 – Fire plume temperatures measured above wood crib

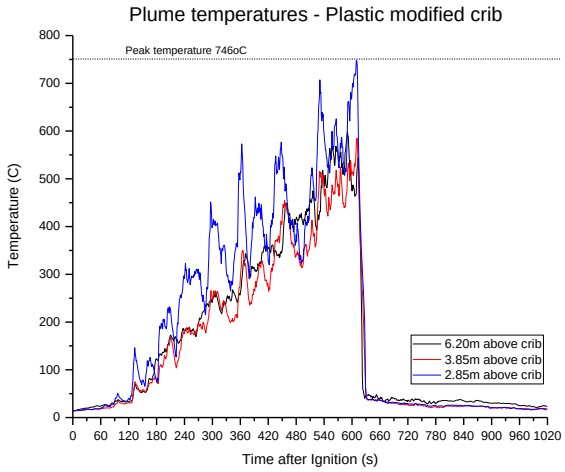


Figure 8 - Fire plume temperatures measured above plastic modified wood crib

The impact of the plastic component is observed to be:

- An increase in fire acceleration from ignition
- An increase of peak temperature of around 100ºC
- A likely increase in steady-state heat release rate for the duration after 11 minutes

3.3.3 Laboratory ceiling temperatures

Although not a precise measurement by any means, the monitoring of temperatures in the laboratory ceiling space, can indicate differences in overall heat release rates between the two fire configurations. It is important to note that the ceiling space was both doused with watermist and continuously extracted from as a means of keeping temperatures low but was done equally for the two tests.

Figure 9 and Figure 10 show the laboratory ceiling temperatures for tests conducted with the wood, and plastic modified cribs, respectively.

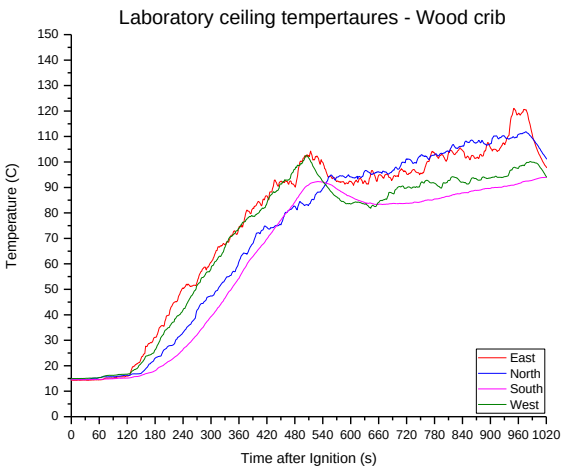


Figure 9 – Laboratory ceiling temperatures measured during wood crib test

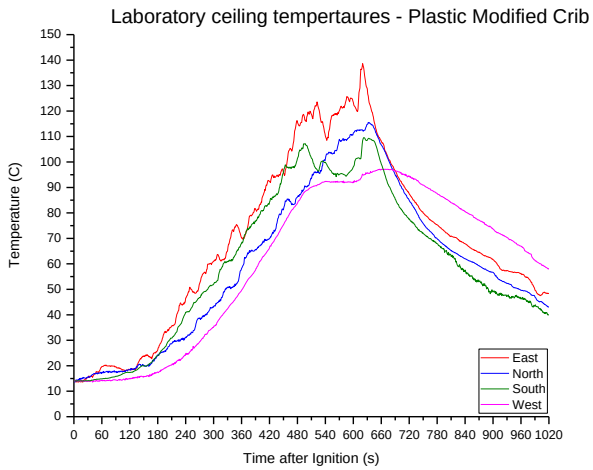


Figure 10 - Laboratory ceiling temperatures measured during plastic modified wood crib test

Although the plastic modified wood crib test was extinguished at 10m30s, it is clear that prior to this the gas temperatures were well above those of the wood crib which had reached a steady state value of around 100ºC – the gas temperatures from the plastic modified wood crib fire were still increasing at this time.

3.3.4 Fuel mass loss

The fuel cribs were mounted on a load cell so that their mass loss rate during burning could be determined. There is no inference that this rate would be indicative of what happens in the BS8414 test configuration since the combustion chamber geometry will influence many factors that would change how it burns. However, as a comparative study under similar conditions the results are valid.

Figure 11 and Figure 12 show the mass loss rates of the wood and plastic modified cribs, respectively.

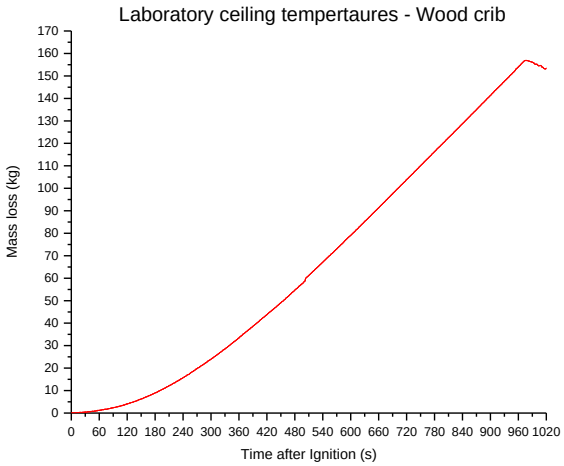


Figure 11 – Wood crib mass loss

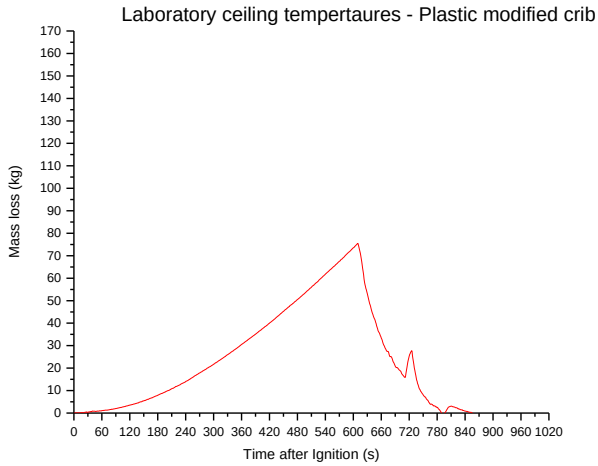


Figure 12 – Plastic modified wood crib mass loss

Whilst the plastic modified crib displays a lower mass loss, it is clear that the rate of burning of the plastic modified crib is still increasing at a time when the wood crib has reached steady state (at around 10 minutes after ignition).

3.4 Conclusions

It is clear that the inclusion of a plastic component in the fuel make-up of the BS8414 test crib, as is befitting modern day fuel loadings, changes the nature of the fire challenge by:

- Increasing plume flame lengths
- Increasing flame plume temperatures
- Increasing the rate of fire development
- Potentially delaying the onset of steady-state conditions
- Increasing the fire challenge (temperature, flame length, heat release rate, and intensity duration) presented to the cladding system.

Aluminium is noted for its rapid loss of integrity with temperature. At around 300°C it loses half of the strength it possesses at ambient, and at 500°C it has little or no physical strength at all.

It is simple to conclude from these tests that recognition of modern day fuel loadings into the BS8414 test regime might cause failure of the aluminium façade components earlier and set a more onerous challenge to other materials within the system but obviously, whether this would change the outcome of any given test is unknown.

4 Legitimate cladding system breaches

4.1 Background

As shown in Figure 1, BS8414 tests the cladding system in perfect form, unabridged by allowable penetrations such as pipes, ducts and vents which may:

- be of plastic construction
- be without fire stopping (there is no requirement under BR)
- vent to the void, behind the rain-screen (the duct may not be continuous from the inside of the room, to the external surface of the rain-screen cladding)

Almost without exception, vents will be a feature of every cladding system yet there is no specific evaluation made of whether their inclusion in any given system product combination is a safe and appropriate thing to do. Figure 13 shows examples of vents installed in rain-screen cladding systems on buildings having their cladding replaced.

Figure 13 - Vent apertures in rain-screen cladding systems

Such configurations could allow early ingress of flame into the void between the rear of the ACM and front surface of the insulation from fires originating both internally (i.e. a kitchen fire), or externally (such as a wheelie bin fire). Since the external envelop of the building is not treated as part of the fire compartment in building regulations, there is no requirement to fire-stop such devices. If the product combinations within the void did allow for spread of fire (from an internal or external ignition source), then there is potential to recommunicate that fire and potentially toxic fire gases to other locations of the building by the same penetrations.

In recognition of this, the Fire Protection Association in 2016, conducted a laboratory investigation of the influence of ducts and vents in buildings clad in external thermal insulation and render systems, and light timber frame. Plastic air bricks were demonstrated to provide a simple path for fire ingress into the structure of light timber frame buildings and accounts for a number of real building loss experiences. The addition of plastic vents into walls clad with ETICS was shown to significantly modify the propensity for fire spread up the outside of a building.

Figure 14 - Fire ingress study - light timber framed buildings

Figure 15 - ETICS cladding system study - Influence of vents

Whilst purporting to be a real-world test, the purpose of this phase of testing, was to investigate if the BS8414 test could be considered deficient in the non-inclusion of a common design feature that might detrimentally alter the outcome of the test.

4.2 Test configuration

Adopting the theoretical scenario of a fire starting in a kitchen and ‘breaking-out’ into the cladding system via an installed plastic extract vent, a BS8414 test was adapted for the purposes as follows:

- Rig height curtailed to 5 metres
- Combustion chamber extended internally to allow for a down-stand over the window into which the vent could be installed

- Instrumentation specifically placed to monitor vent impact

The cladding system was simulated by the use of non-combustible materials – fire resistant boarding to mimic the rain-screen panelling, and rock-fibre insulation, separated to create a void of appropriate width. In using entirely non-combustible components, this test is solely a demonstration of the ability of a fire to challenge the cladding system internals via a vent structure, not the impact of whether it would be able to progress within the cavity.

The standard BS8414 crib was used for this study.

In this configuration there is opportunity for the fire to enter the void from within the combustion chamber, or via an external route as issuing flames encounter the plastic vent grill.

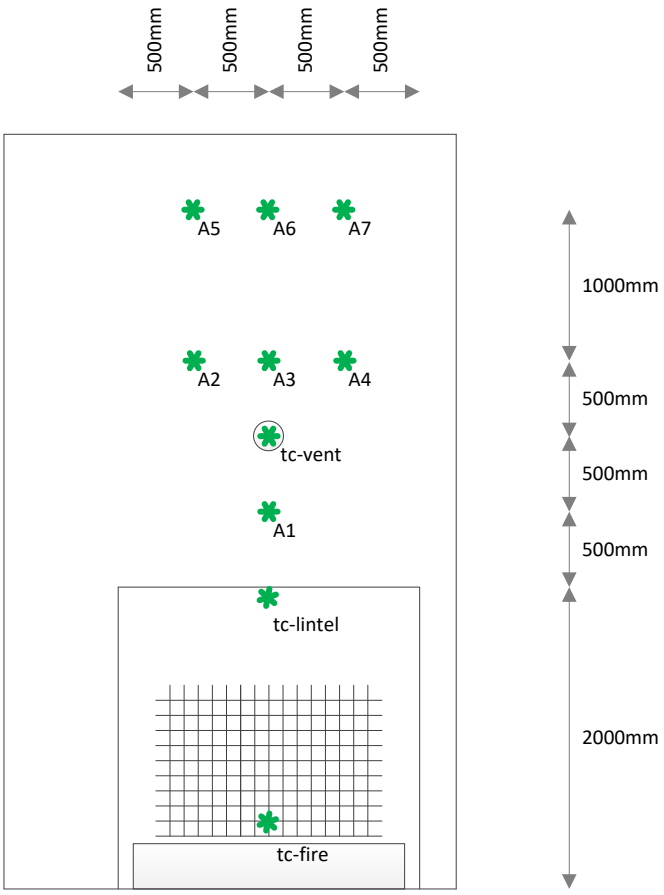


Figure 16 - Front face

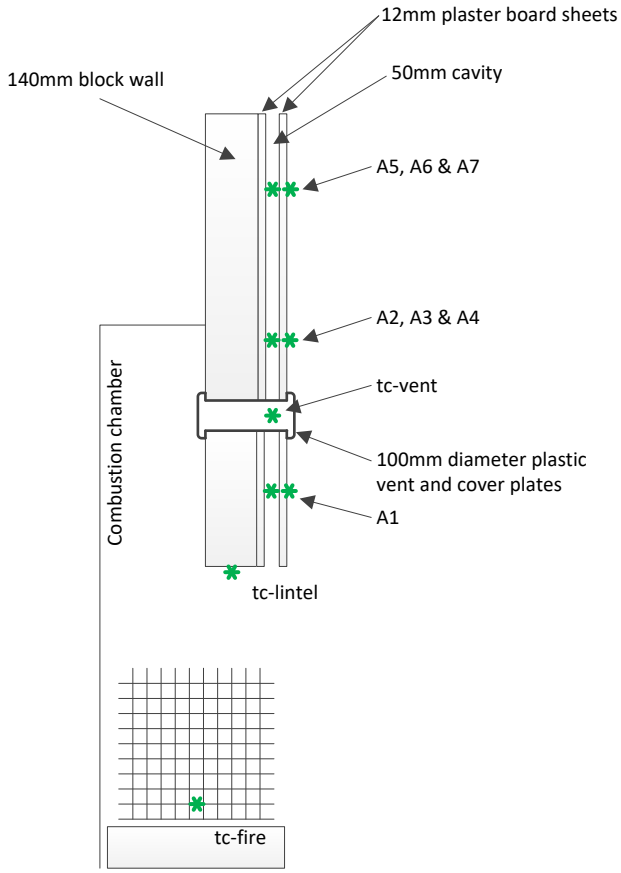


Figure 17 - Side elevation showing modified combustion chamber

Figure 18 - Front face

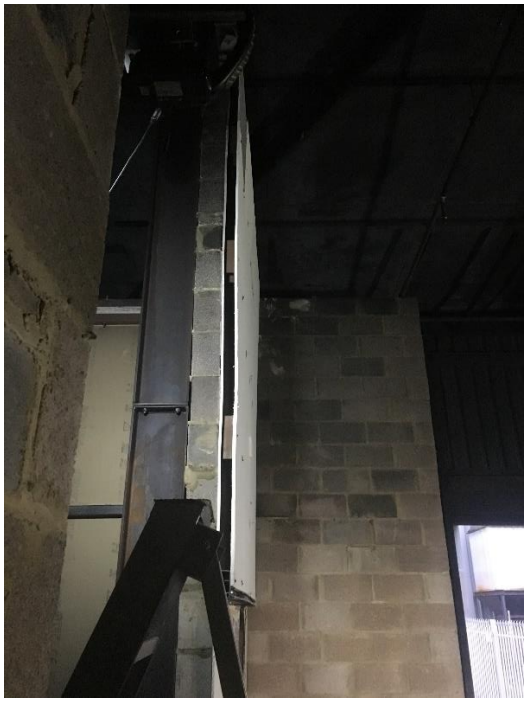
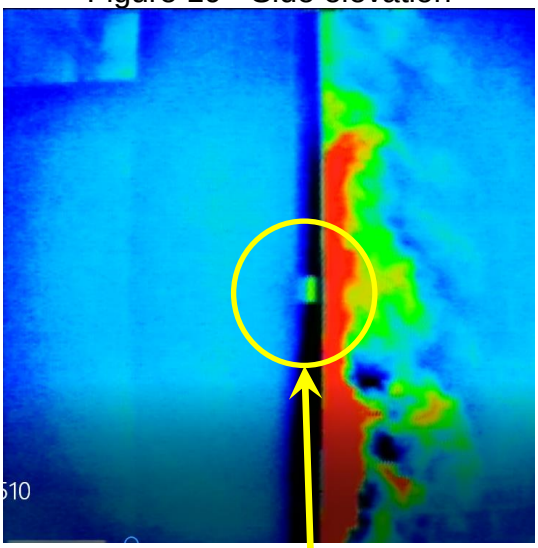
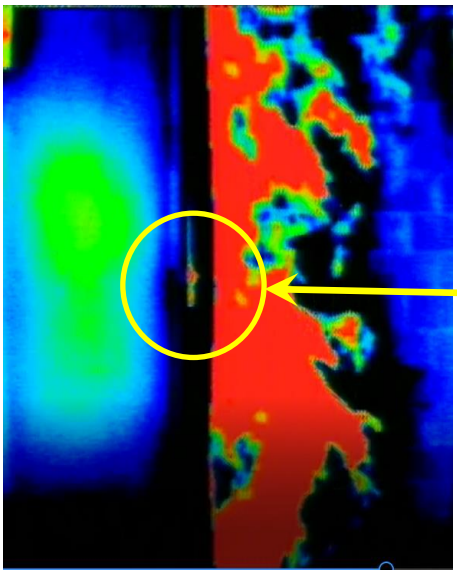


Figure 19 - Side elevation





Vent

Figure 20 - Side views of rig with vent detail clearly visible using thermal imaging allowing direct flaming within the void

4.3 Results

Temperatures from the thermocouples described in Figure 16 and Figure 17 are given in Figure 21 and Figure 22 for external and void temperatures, respectively.

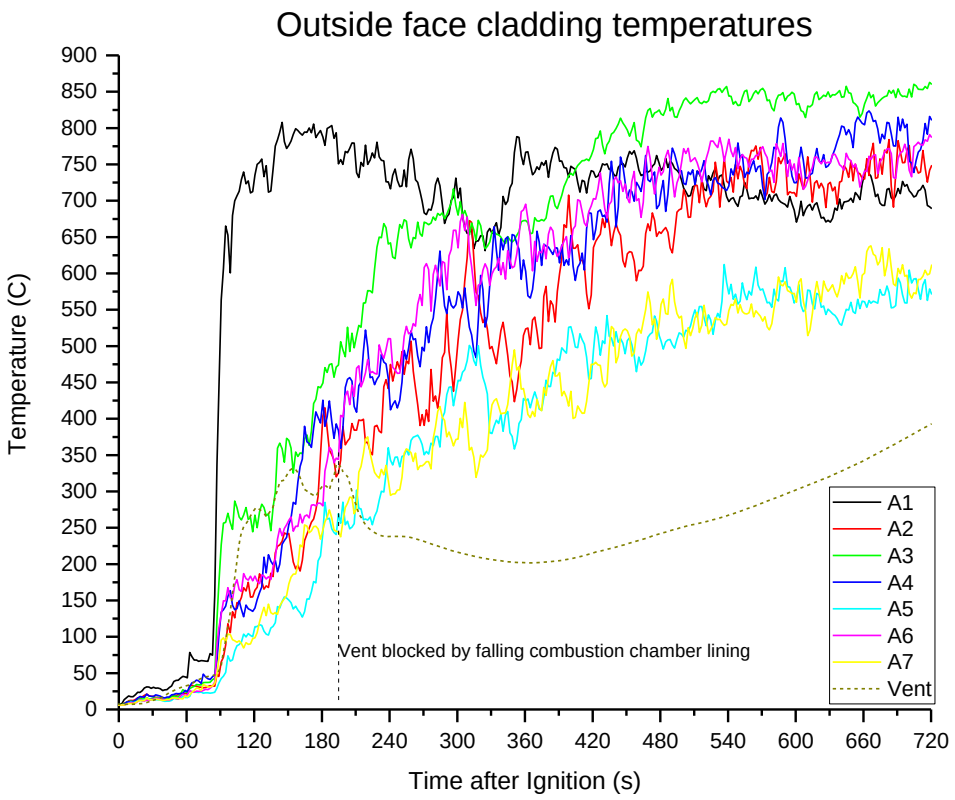


Figure 21 - External cladding face temperatures

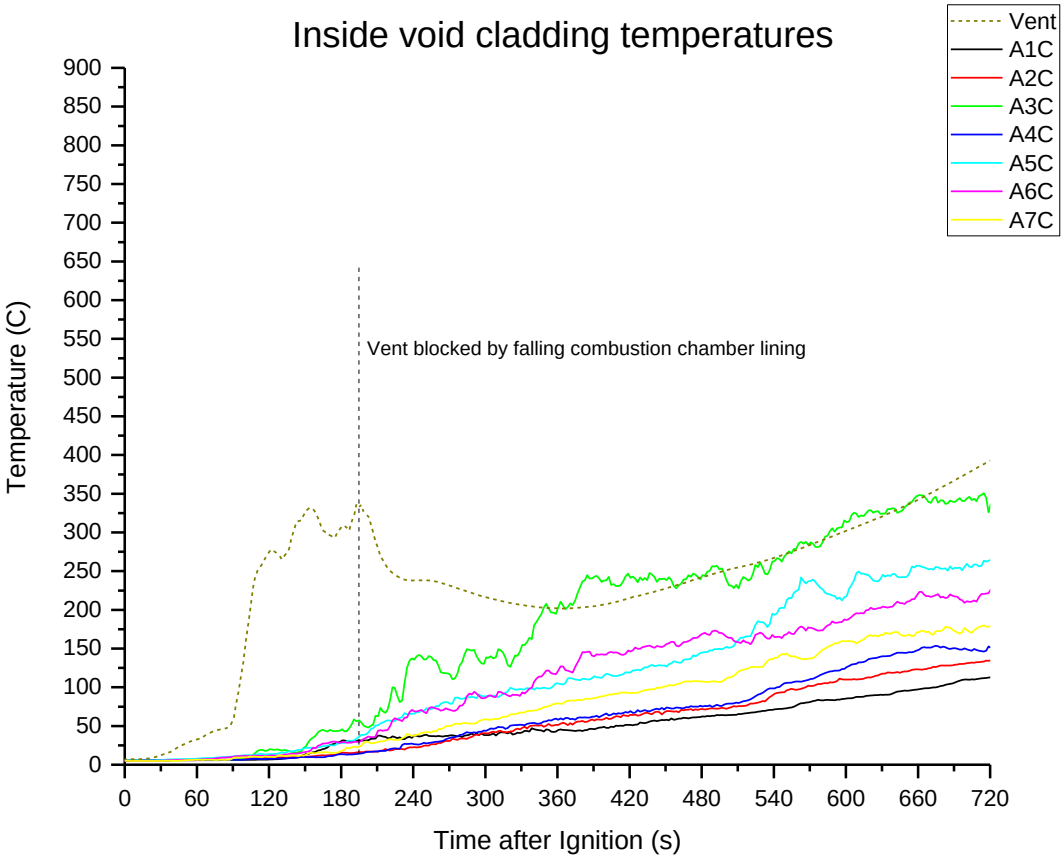


Figure 22 - Inside void cladding temperatures

The temperature measured within the vent clearly shows that for the first 3 ½ minutes of the test the internal void is subjected to the same temperatures as the external face of the cladding system due to flame and gas ingress from within the modified combustion chamber. This represents a much greater challenge within the void than the 'slow-heating' experienced at other locations through conduction of heat from the external flaming through the replicated panel system. After 3 minutes the vent aperture appears to have been mostly blocked by the detachment of some of the combustion chamber lining as shown in the post test photographs below.

Figure 23 – Cladding face showing vent

Figure 24 – Void face (external cladding removed) to reveal burning marks indicating direct flame protrusion into the void from the modified combustion chamber

Figure 25 - Partially blocked vent (remnants of vent structure and slipped combustion chamber lining behind)

4.4 Conclusions

The inclusion of a simple plastic vent within the BS8414 test configuration has demonstrated that very early on in the fire event the internal materials of the void may be subjected to a fire challenge of equal intensity to that experienced by the external rain-screen. Whilst this experiment was conducted in totally non-combustible form, it does raise the issue of whether such a simple and realistic feature could change the outcome of tests where materials of differing combustibility / ignitability are used.

Vents as a route for direct fire break-in will also change the way that cavity barriers will need to respond to prevent internal fire and toxic gas spread.

5 Oxygen provision

5.1 Background

Whilst the BS8414 test is significant in its vertical scale, its proportions are narrow in respect of the horizontal distances allowed for vertical cavity barrier placement. The relevance of this might not be immediately obvious but it could be speculated that should early flame exposure of the internal components (insulation, membranes, cavity barriers etc.) occur, i.e. as a result of the inclusion of vents and ducts (see Section 4) that:

- The challenge for the cavity barrier system may be different in that rather than being 'pre-activated' by heating through the rain-screen cladding before directly encountering flame, they may need to respond to the immediate challenge of flaming from a vent much earlier in the test scenario (see Section 4)
- The relevance of 'realistic' oxygen supply to the system on test must be considered as this, in association with the potential for void chimney-effect burning, has the potential to alter the overall response of materials that are combustible to some extent.

'Chimney effect' promoted fires demand oxygen at an ever-accelerating rate to fuel the growing fire. In an actual installation this oxygen will stem from the vented void volume itself and be replenished from the sundry openings from all directions around the fire. This phase of the study seeks simply to demonstrate the impact of oxygen provision impairment in void fire scenarios and ascertain whether edge-sealing, a feature of some BS8414 testing observed, undesirably prevents realistic system fire performance from being understood.

5.2 Test configuration

Using a simple 6 metre high, 3 sided chimney stack, as the support for a combustible wood face with glazed panel to create voids, tests were conducted to demonstrate how simple geometrical changes can significantly influence burning behaviour. Three tests were conducted as follows:

- Fire spread up a wood surface with no void (open burning face)
- Fire spread up a wood surface with a void but ventilation options limited by edge sealing (perhaps how BS8414 might be considered to be configured)
- Fire spread up a wood surface with a void with ventilation top and bottom and slightly leaky sides (perhaps more realistic of an installed cladding system where oxygen is available via the larger system volume and edge and 'between panel' ventilation paths.

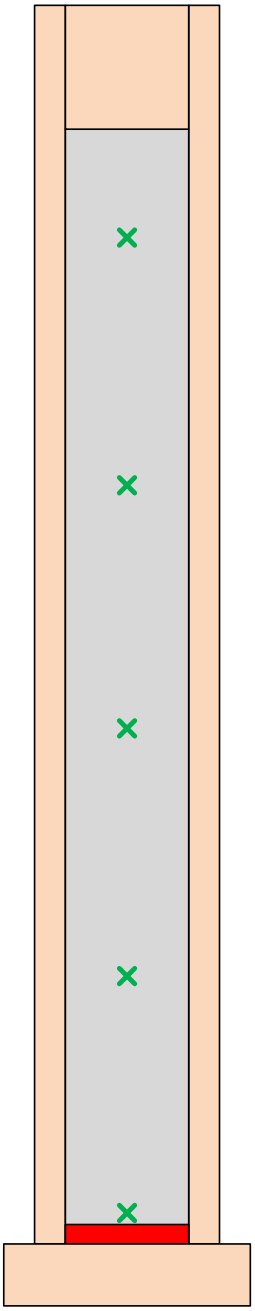


Figure 26 - Open burning wood face

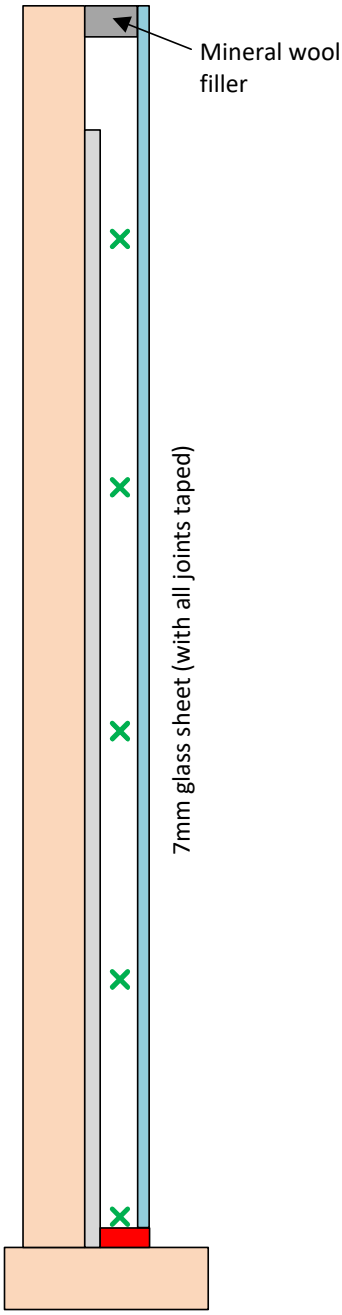


Figure 27 - Wood face with void and sealed edges and ends

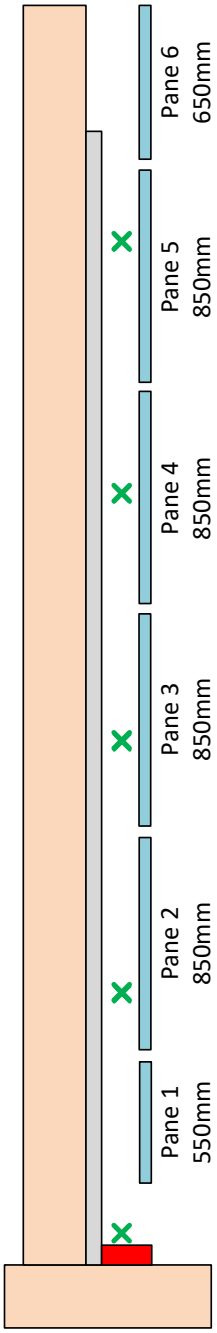
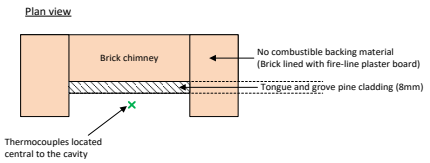


Figure 28 - Wood face with void, open ends, and leaky edges



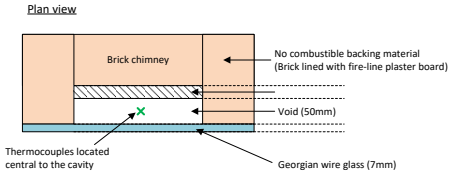


Figure 29 - Panel view without and with void formed with glazed front

5.3 Results

5.3.1 Fire spread up vertical wood face

In this geometry there was little inclination for the fire to climb and involve the open wood face surface and after the fuel source was exhausted the fire self-extinguished having impacted upon only the first 1½ metres of wood surface. Under these conditions vertical air flows are small and heat retention / preheating to involve further areas of fuel is limited to re-radiation from flames onto the wood surface above. An image taken at the time of peak involvement is shown in Figure 30.

5.3.2 Fire spread up vertical wood face with void and limited ventilation

In this geometry, after an initial small flare-up that consumed the available oxygen within the void the fire quickly died out to very low level burning and self-extinguished. An image showing it at the time of steady-state involvement is given in Figure 31.

5.3.3 Fire spread up vertical wood face with void with ventilation gaps

In this geometry fire spread up the wood face was immediate, rapid, and intense, involving the full height of the rig with burning characteristics associated with high velocity chimney effects. An image at the peak of the burning is given in Figure 32.

5.4 Conclusions

Although using non-representative materials, this phase of testing has demonstrated that, in void fire spread scenarios, the detailing of routes for oxygen provision can radically alter the burning behaviour of materials from non-involvement to total rapid consumption. It is therefore considered essential in any test regime that fire oxygen provision is accurately modelled to be realistic of end-use applications for cladding systems.

Figure 30 - Open burning wood face

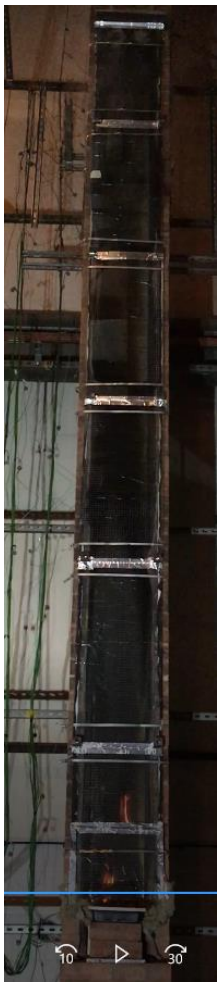


Figure 31 - Wood face with void and sealed edges

Figure 32 - Wood face with void and leaky edges

6 Cavity barrier challenge

6.1 Background

There are competing requirements placed upon rainscreen cladding system voids during normal use and under fire conditions. Voids must be open to allow air and water to flow freely to avoid moisture issues and be sealed during fire to prevent the spread of flame, heat and smoke. This inevitably means the use of reactive, or intumescent materials, that swell to close the void under the action of heat from the fire.

For the reasons described in Sections 4 and 5 there is potential for immediate flaming directly within the void of a rainscreen cladding system breached by vents in the event of a fire. The origins of the fire could be from within (the room from which the vent extracts air), or from the outside (fire ingress from i.e. a bin or car fire, at the building curtilage). This mode of fire spread is very different from the external-only challenge presented in BS8414 where the cavity barriers might be 'pre-heated' into position before failure of the perfect-form rainscreen protective layer. In this respect therefore, the current configuration of BS 8414 may not be appropriately testing one of the key principle components of any rain-screen cladding system.

The relationship between the cavity barrier and fire challenge is highly dynamic and it is not unreasonable to assume that there are barrier / combustible component combinations that will inherently fail to prevent vertical fire spread if the speed of operation is not correctly matched to the ignition properties of the materials they seek to separate. As such it does seem strange that cavity barrier suitability is not matched materially with other cladding components.

There are 3 basic cavity barrier types as shown in Figure 33, mineral wool pads with an intumescent front that expands to fill the gap; metal slot and hole type devices coated in intumescent that expands to close the slots or holes; and flame arrestor meshes that stop flame passage whilst an internal intumescent strip activates.

Figure 33 - Intumescing cavity barriers that satisfy the conflict venting / sealing requirements of rain-screen type cladding systems (indicative pictures only)

FPA speculate that there is a need to investigate the performance of reactive cavity barrier systems from fire sources originating in ducts and vents which are appropriately supplied with oxygen as may be befitting of a real-life system.

6.2 Test configuration

For the purposing of this phase of testing a bespoke rig was developed to simulate a flame source from a vent, entering the void, and challenging the range of cavity barriers presented. The void was open top and bottom, but the sides were sealed with glass – selected so the response of the cavity barriers could be viewed in real time. All components of the rig in this configuration were non-combustible so as to detail the response of the cavity barriers to the fire source alone. Obviously, material selections could be envisaged that would alter the challenge greatly. The test rig is shown in Figure 34

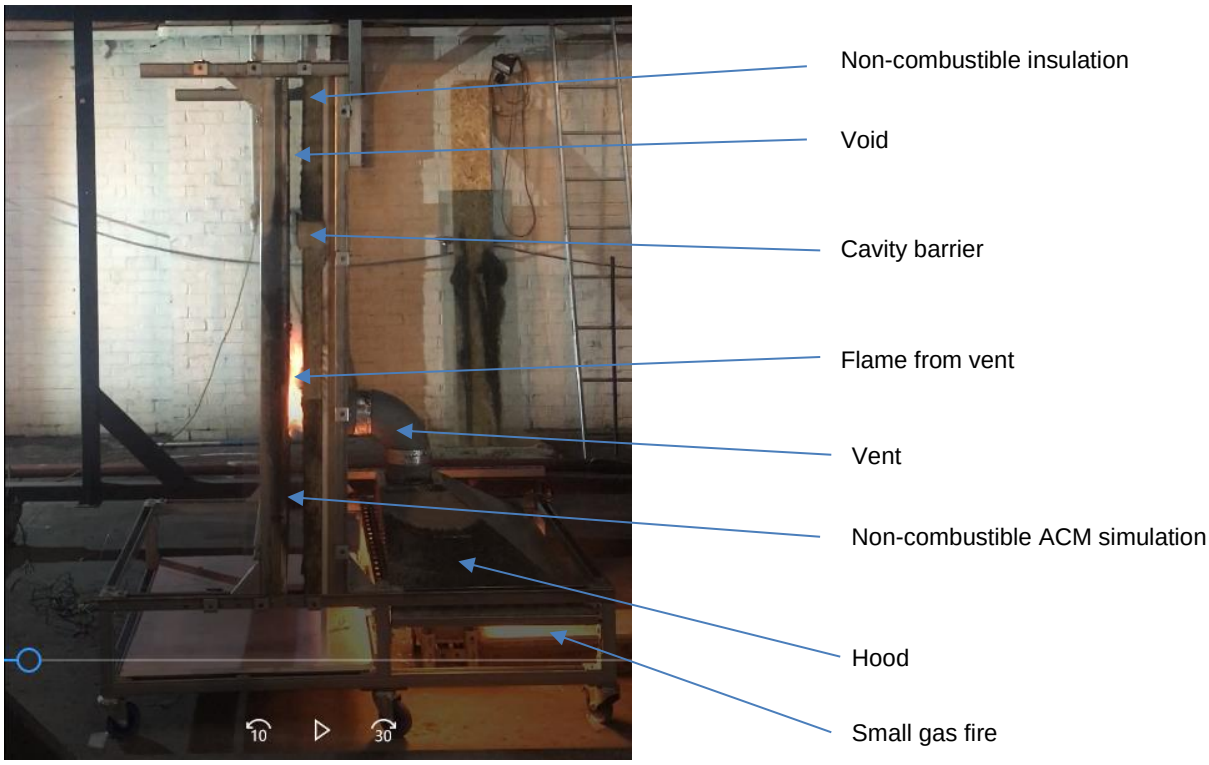


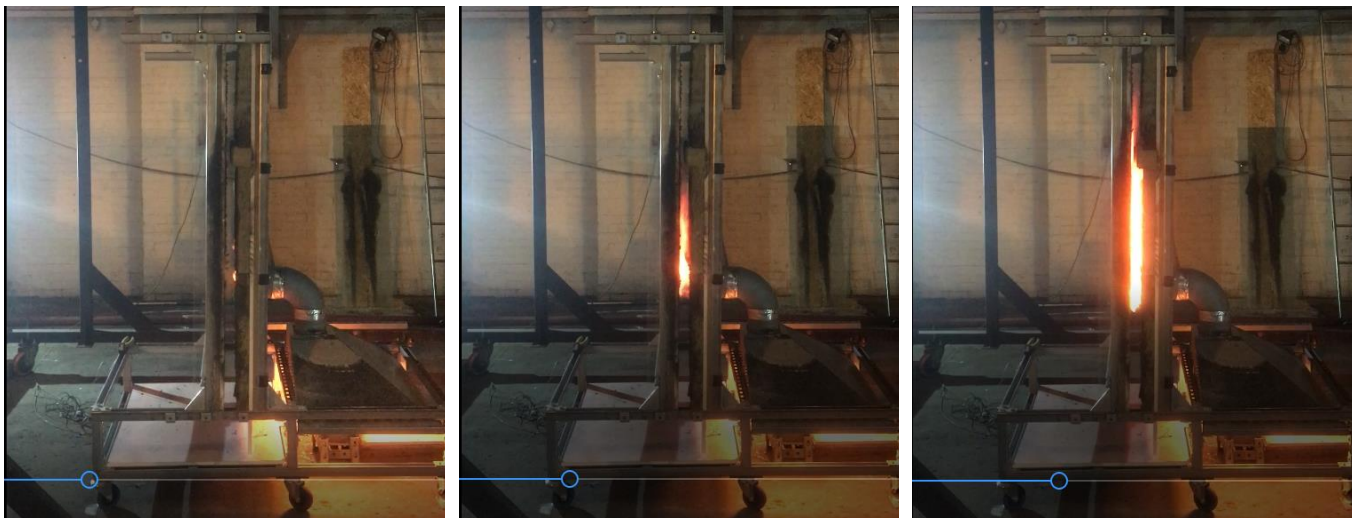
Figure 34 - Cavity barrier test rig

For each type of cavity barrier, tests were also conducted with the intumescing strip removed to ascertain how much of their function could be attributed to physical restriction of the void rather than reactive sealing.

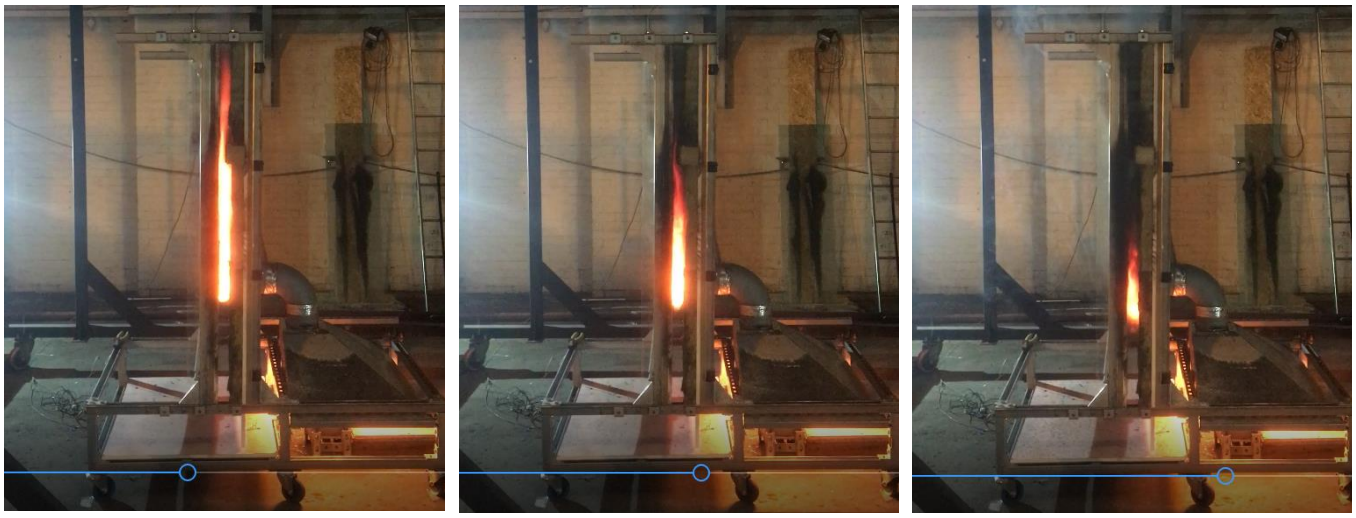
6.3 Test results

6.3.1 Intumescent mineral wool pad cavity barrier

The cavity barrier was installed in a void of 50mm leaving a 25mm gap in keeping with installation requirements that routes for air flow should not be inhibited by more than 50%. Figure 35 shows a series of time-lapse photographs of the response of the cavity barrier.



Flames 1st emerge from vent t=0s | Flames reach cavity barrier t=5s | Flames passing cavity barrier at t=13s



Flames passing cavity barrier t=21s | Flames passing cavity barrier t=33s | Cavity barrier closed t>36s+

Figure 35 - Time series photographs of response of intumescent mineral wool pad cavity barrier

Figure 36 shows the temperature profiles either side of the cavity barrier from the time of the fire starting with and without the intumescing strip.

In this non-combustible environment of limited width, the mineral wool cavity barrier system is able to form an effective seal against the transmission of temperatures over 200°C within 45 seconds, and against flame transit within 20 seconds. Comparison with the test data with the intumescent strip removed shows there to be a low dependency on void geometry restriction meaning air will flow freely during normal use.

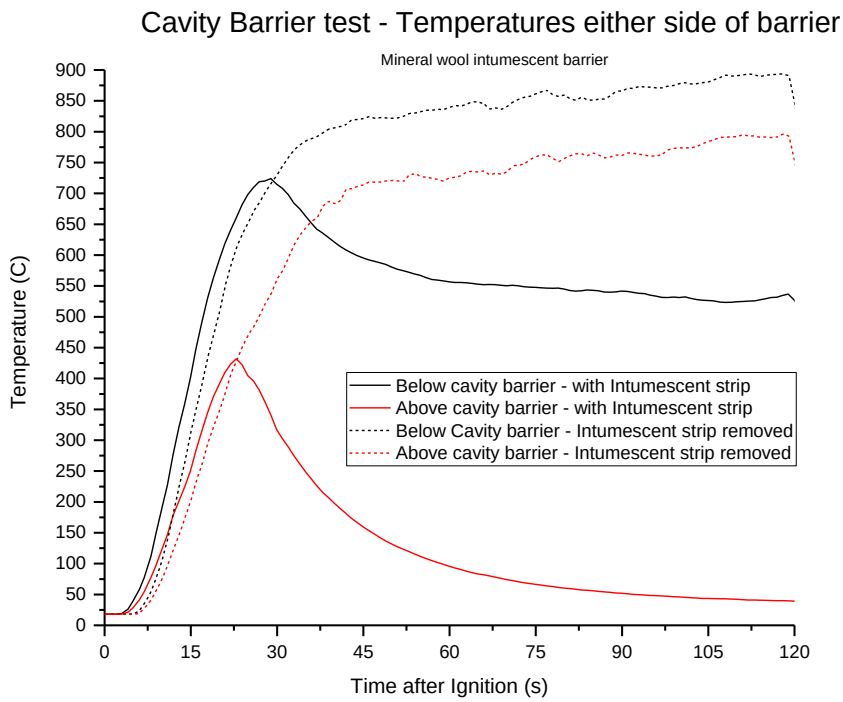


Figure 36 - Temperatures either side of mineral wool intumescent cavity barrier with and without intumescent strip

Figure 37 - Mineral wool cavity barrier post-test with front face removed, and in place

6.3.2 Slot type cavity barrier

The particular product used in this test had a very low porosity for free air passage. The Centre for Window and Cladding Technology guidance states that the “area of the path shall not be reduced by more than 50% at fire barriers or support rails” which clearly this system does not meet as shown in Figure 38. Product selection appropriateness to this study is being checked.

Figure 38 – Slot type intumescent cavity barrier in test rig

In this experimental configuration the physical barrier alone presented by this low-porosity system meant that a meaningful determination of the contribution of the intumescent component was not possible as shown in Figure 39.

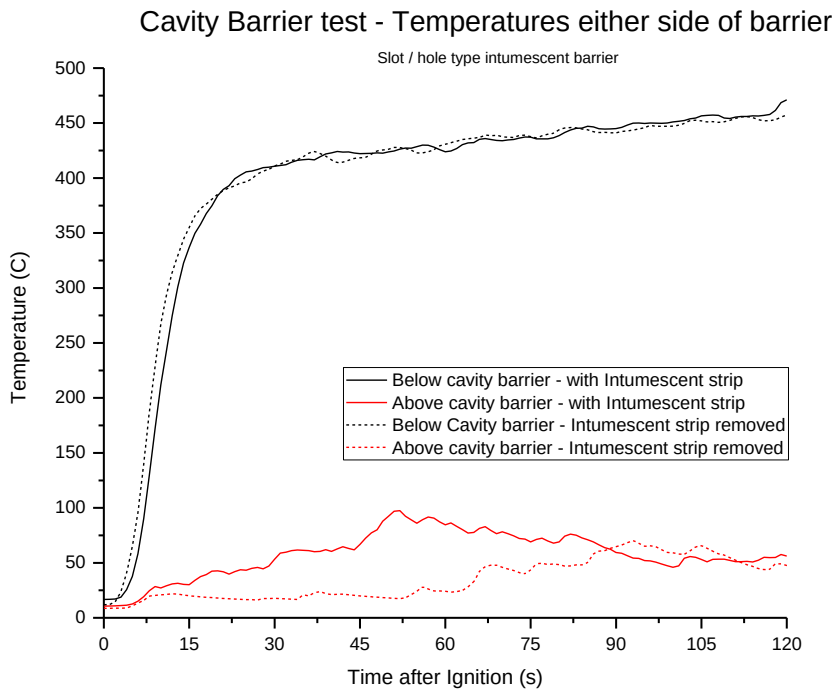
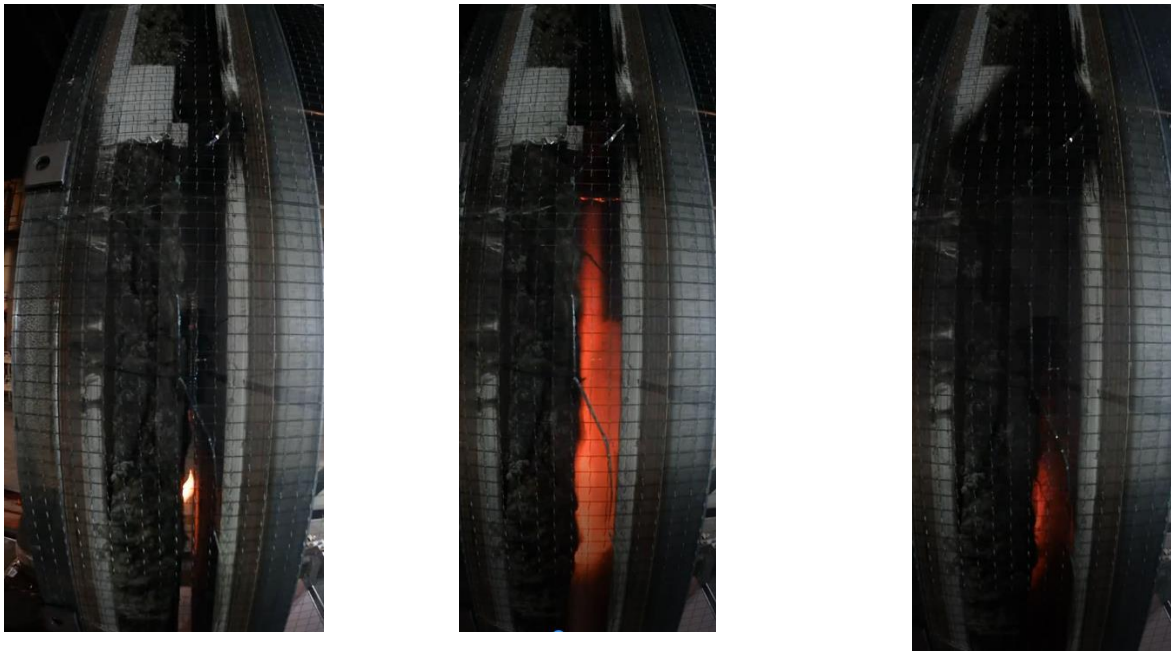


Figure 39 - Temperatures either side of slot type intumescent cavity barrier with and without intumescent strip

6.3.3 Flame arresting / intumescent type cavity barriers

The flame arresting / intumescing cavity barrier was installed in the 50mm void on a non-combustible beam with the mesh portion filling the 25mm ventilation gap. Figure 40 shows images of the cavity barrier under test.



Flames 1st emerge from vent t=0s | Flames reach cavity barrier t=60s | Flames do not pass barrier

Figure 40 - Time series photographs of response of flame arresting intumescent type cavity barrier

Figure 41shows the temperature profiles either side of the cavity barrier from the time of the fire starting with and without the intumescing strip.

In this non-combustible environment of limited width, the flame arresting intumescing type barrier system was able to keep transmitted temperatures to below 250°C and prevent any passage of flames past the cavity barrier device. Comparison with the test data with the intumescent strip removed shows there to be a low dependency on void geometry restriction meaning air will flow freely during normal use.

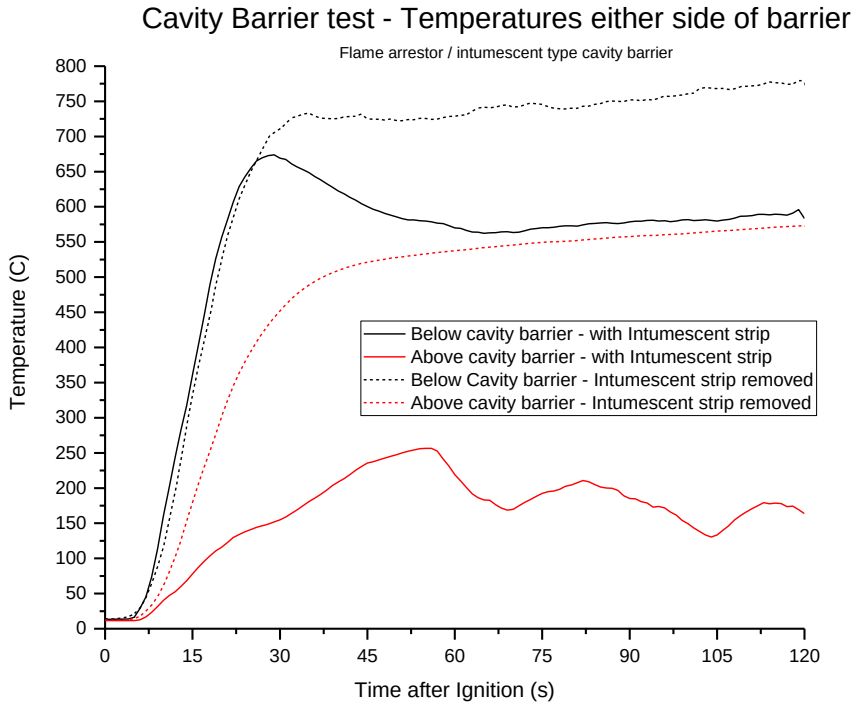


Figure 41 - Temperatures either side of flame arresting / intumescent type cavity barrier with and without intumescent strip

6.4 Conclusions

Cavity barriers are complex devices that have competing operational requirements under normal, and fire conditions. Even in the small and non-combustible environment of the test rig, flames and hot gases pass for a period of time whilst they operate. Whilst they can respond with impressive speed, it is easy to see that their prescription should be coherent with the ignition and fire properties of the materials they seek to separate. Materials that may promote the spread of fire faster than they might operate could include lighter materials such as breather members and vapour barriers which do not form part of the BS8414 test regime. Some insulating products might also have ignition times that would allow fire spread beyond a barrier.

7 Installation detailing – Influence of ACM support detailing of system performance

7.1 Background

BS8414 is a large-scale test of cladding systems purporting to represent real-world challenges. Aside from the arguments given in previous sections questioning whether the test regime really meets this ambition, it is similarly, if not more important, that the cladding systems presented for testing are truly representative of what goes on a building in end-use deployment (test houses quite correctly enforce this point along-side all data reporting).

The key components of the system are:

- Cladding panels
- Insulation
- Cavity barriers and fire stopping
- Window framing and lintel
- Vapour barriers and breather membranes
- Bracketry and fixings

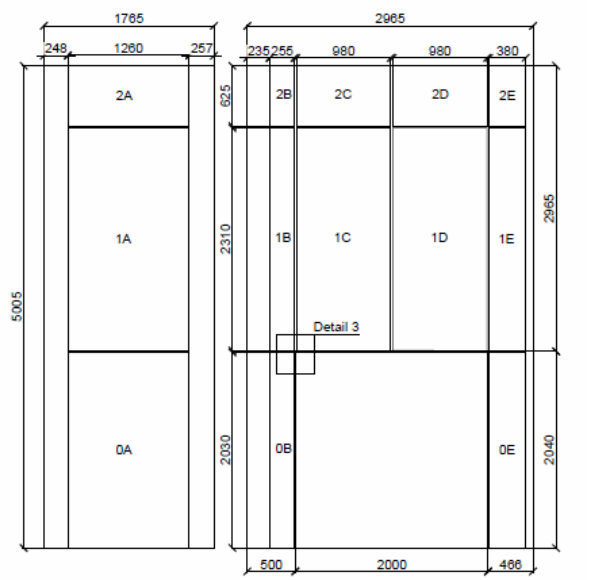
Not all of these items are tested within BS8414 and some that are, such as window lintel detail, cladding fixing method, and panel stiffeners, may not be recognised as tested features requiring comparison with end-use applications.

To expertly address this issue independent engineering firm ARUP Group Limited provided 2 system cladding designs that could be compared to ascertain whether differences between test specimen, and actual building installation, might perform differently when subjected to the same BS8414 fire challenge. The focus of these tests was to ascertain the role that ACM fixing method has on the integrity of the system when subjected to fire.

7.2 'Test specimen' versus 'Typical on-building design' detailing analysis

The basis of the comparison is Test 6 from the MHCLG post-Grenfell work programme (non-combustible ACM panel and non-combustible insulation) adapted to utilise the shorter 5m FPA test rigs. Brief (and not entirely complete) system differences are described below in a series of comparative drawings:

MHCLG Test 6 Replication



Typical on-building design

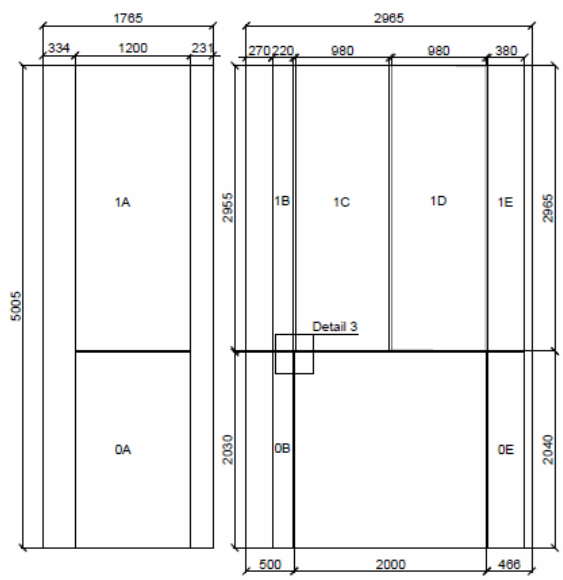


Figure 42 - ACM Panel size: Key differences:

- Greater length of ACM panels are generally used in practice meaning there would be no horizontal seam within the constraints of the shortened test rig
- Inclusion of the additional horizontal seam in the Test 6 replication means there is an additional horizontal cavity barrier at the panel join which might not be there in practice.

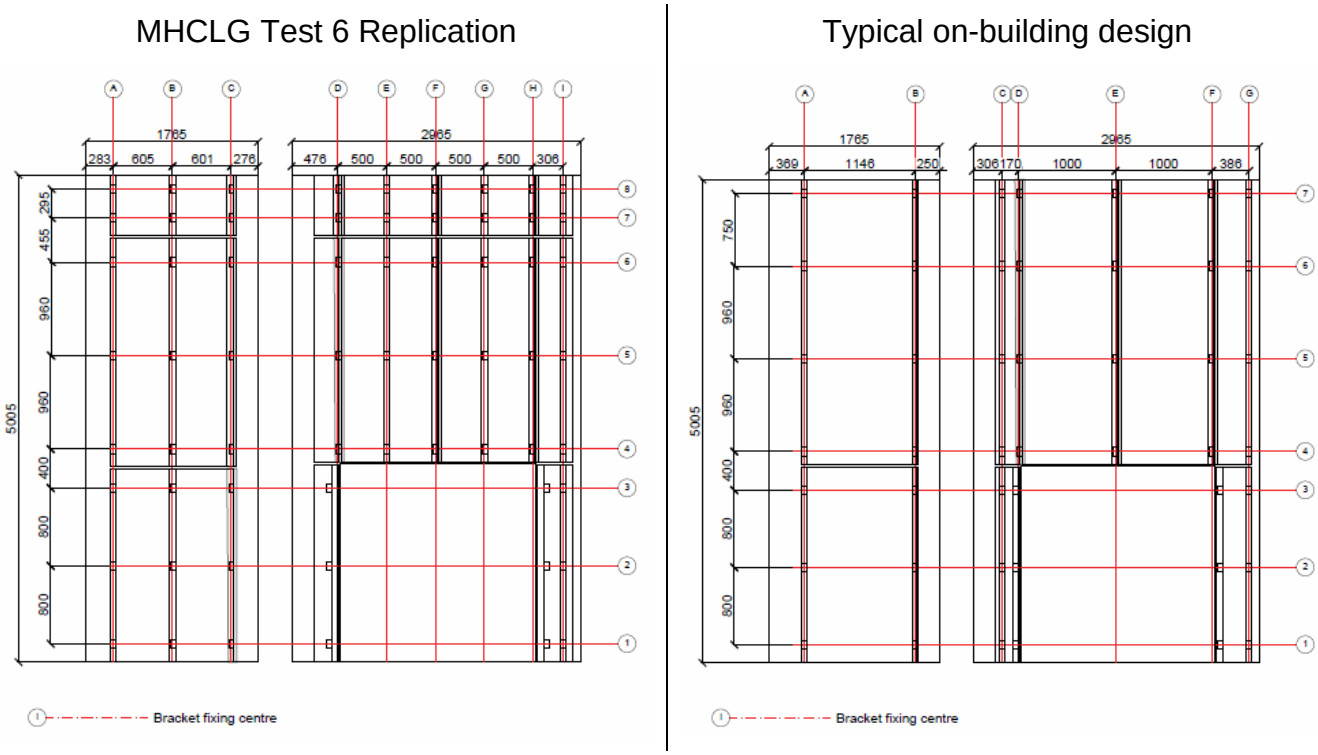


Figure 43 - ACM support: Key differences:

- Additional mid-panel bracketry rails included in MHCLG Test 6 replication that would not typically be used in practice
- Typical on-building design includes central ‘panel stiffeners’ – battens glued on to the mid-point of each panel but are not affixed to any bracketry.

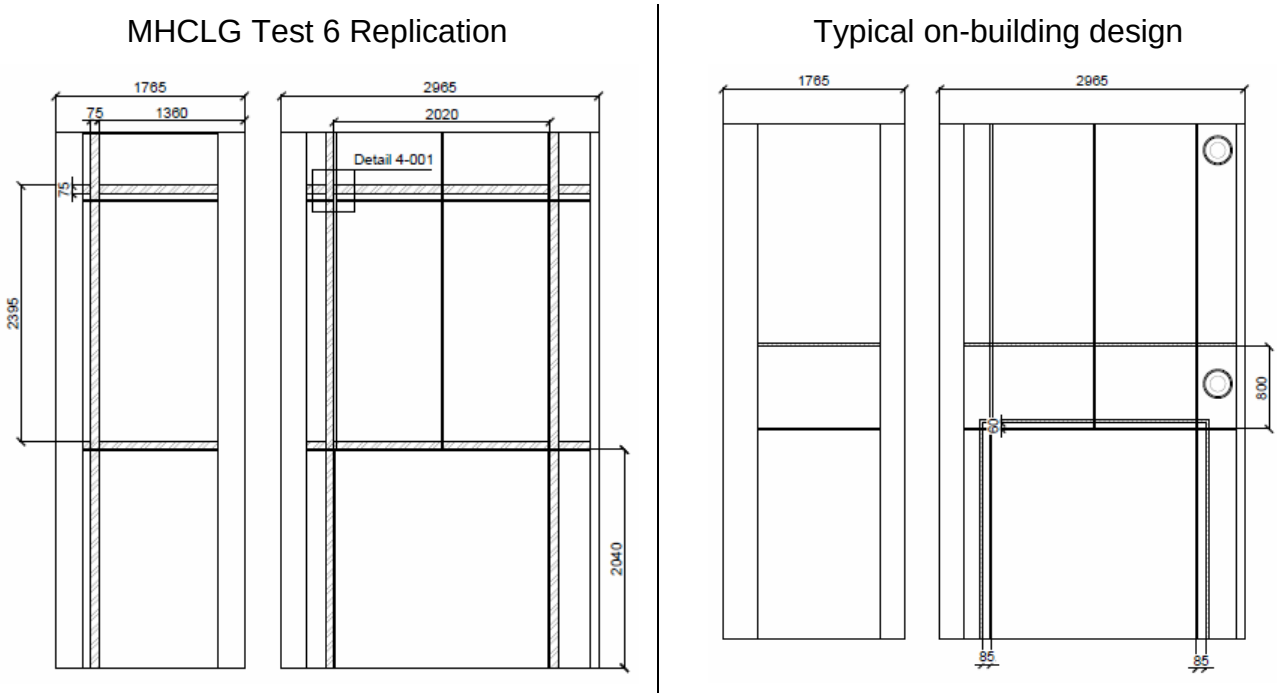


Figure 44 – Cavity barrier quantity and specification: Key differences:

- Reduced quantities of cavity barrier in Typical on-building design
- Reduced rating of cavity barrier in Typical on-building design (90/60 and 90/30 rated products used in MHCLG Test 6 Replication: EI 30/15 for TYPICAL specified system – minimum allowed)
- No vertical cavity barriers in Typical on-building design since only required at compartment walls (unlikely to coincide with a building's corner)
- Horizontal cavity barrier included at floor slab in Typical on-building design (located much higher up on MHCLG Test 6 Replication)

NB: circular penetrations on drawings not included in test.

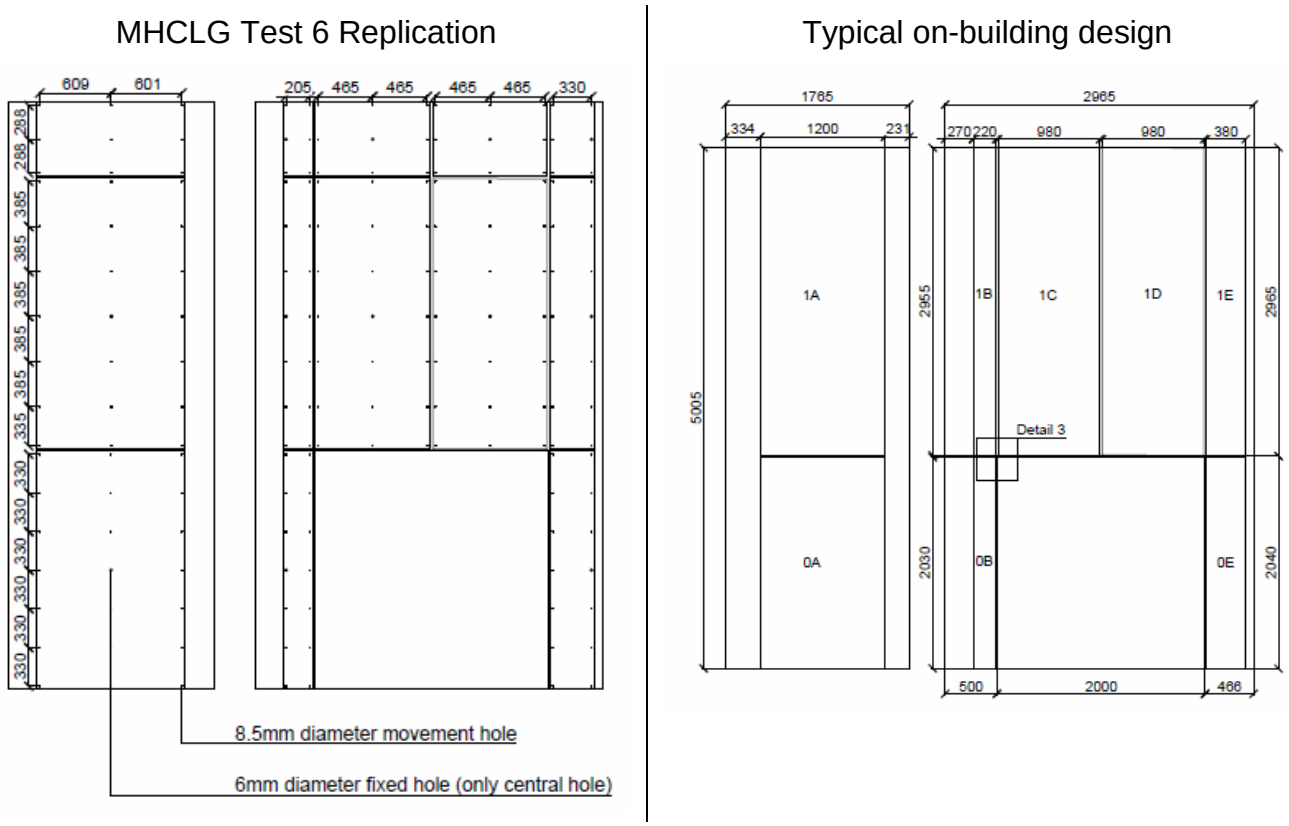
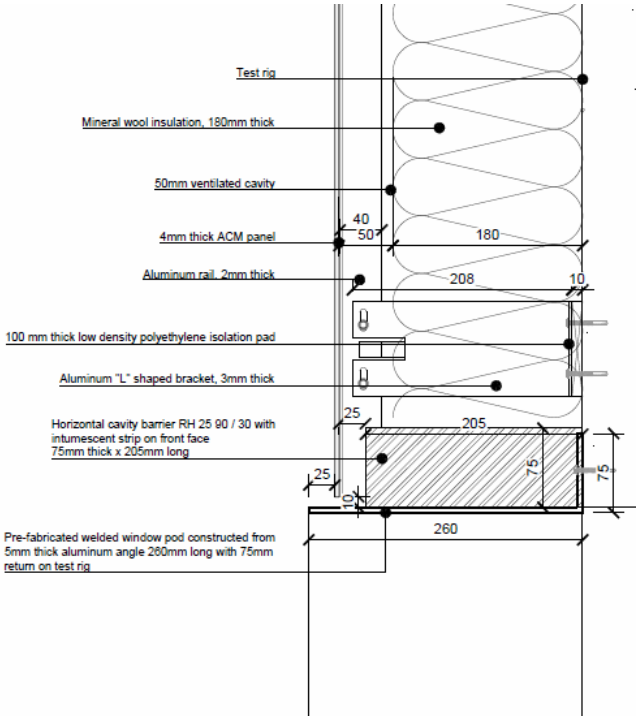


Figure 45 – ACM fixing method: Key differences:

- MHCLG Test 6 replication ACM panels riveted to all 3 supports around edges and to central support
- MHCLG Test 6 replication ACM panels are flat (unfolded)
- Typical on-building design uses a hook-on system of attachment
- Typical on-building design uses folded panels (depth of fold 40 mm making a void of 90mm – flat panels of MHCLG Test 6 replication has a void of 50mm)

MHCLG Test 6 Replication



Typical on-building design

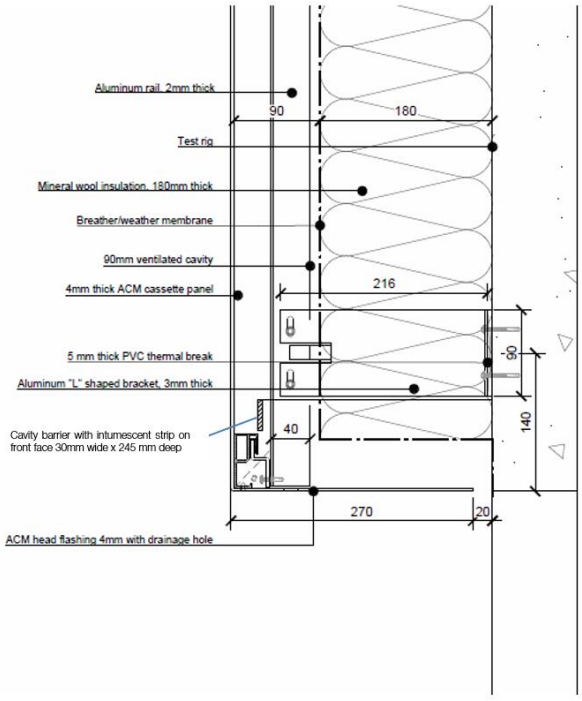


Figure 46 – Above window detailing: Key differences:

Feature	MHCLG Test 6 Replication	Typical on-building design
Window lintel position	Flush with cladding system	Recessed into cladding (countersunk)
Window lintel form	5mm aluminium angle full width	Folded under ACM panel – window recess
Void depth	50mm	90mm
Cavity barrier	90/30 75mm thick int. pad	30/15 30mm wide int. strip on front face
Drainage holes	None	4mm holes in folded ACM
Breather membrane	None	Present

7.3 Test configurations

The rigs were prepared as described in Section 7.2 with the exception of the cavity barrier detailing described for the Arup on-building system shown in Figure 46. To avoid any doubt about the influence that cavity barriers may exert on the stability of the ACM hanging system the same stonewool slab type products were used on both tests, positionally modified on the Typical on-building system test to provide 30/15 performance.

Photographs of rig detailing are given below:

Figure 47 – MHCLG 5mm thick ‘window pod’

Figure 48 - Typical on-building folded ACM window recess panel

Figure 49 - MHCLG window pod in position

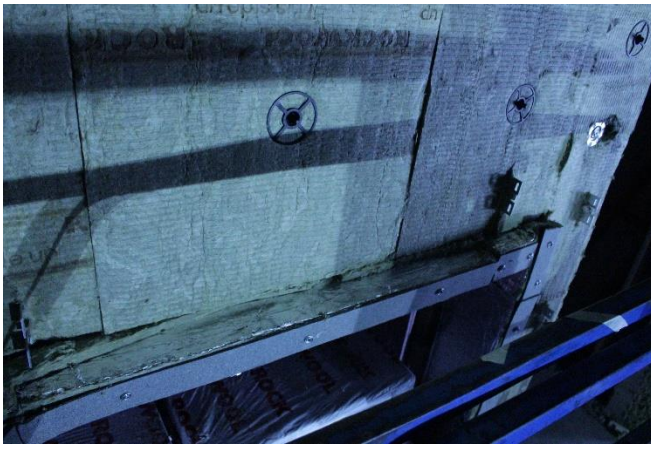


Figure 50 - Typical on-building design lintel detail

Figure 51 - MHCLG system bracketing

Figure 52 - Typical on-building design bracketing

Figure 53 - MHCLG Flat panel ACM

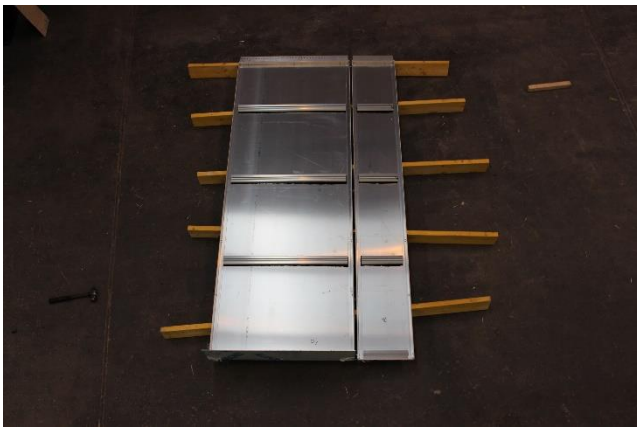


Figure 54 - Typical on-building design folder ACM showing strengthening batons on reverse

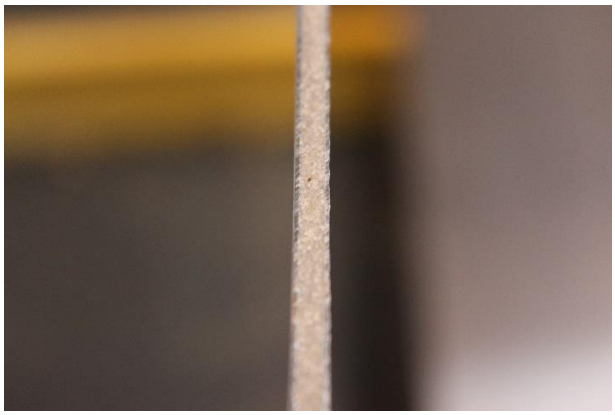


Figure 55 - Side view of ACM panel showing infill

Figure 56 - Flat and folder ACM panels

Figure 57 - MHCLG insulation and cavity barrier installed

Figure 58 - Typical on-building system insulation and cavity barrier installed

Figure 59 - MHCLG support rail system

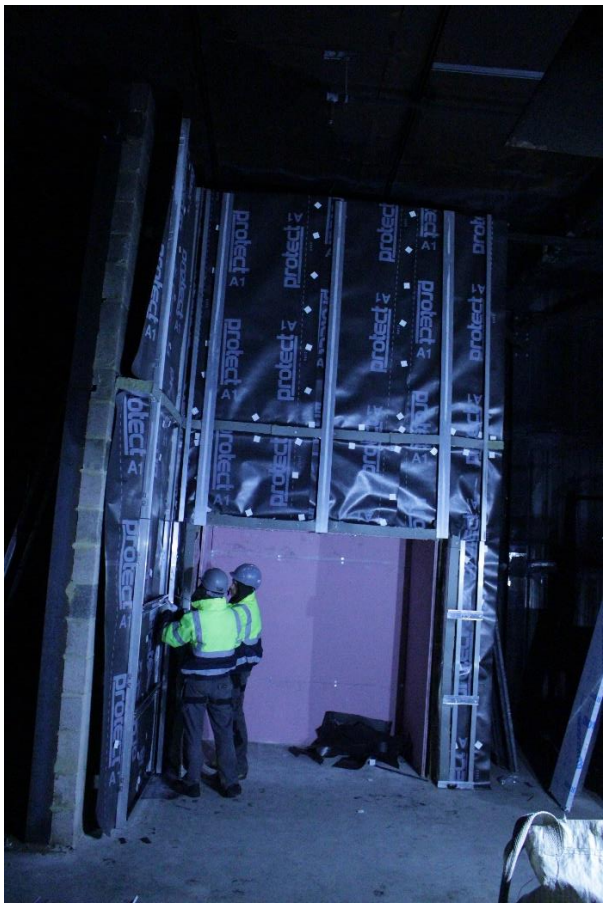


Figure 60 - Typical on-building support rail system

Figure 61 - MHCLG ACM rivet fixings to rails

Figure 62 - Typical on-building design rail-hung

Figure 63 - MHCLG near window detailing

Figure 64 - Typical on-building design near window detailing

Figure 65 - MHCLG rig edge detailing

Figure 66 - Typical on-building system edge detailing

Figure 67 - MHCLG over window detailing

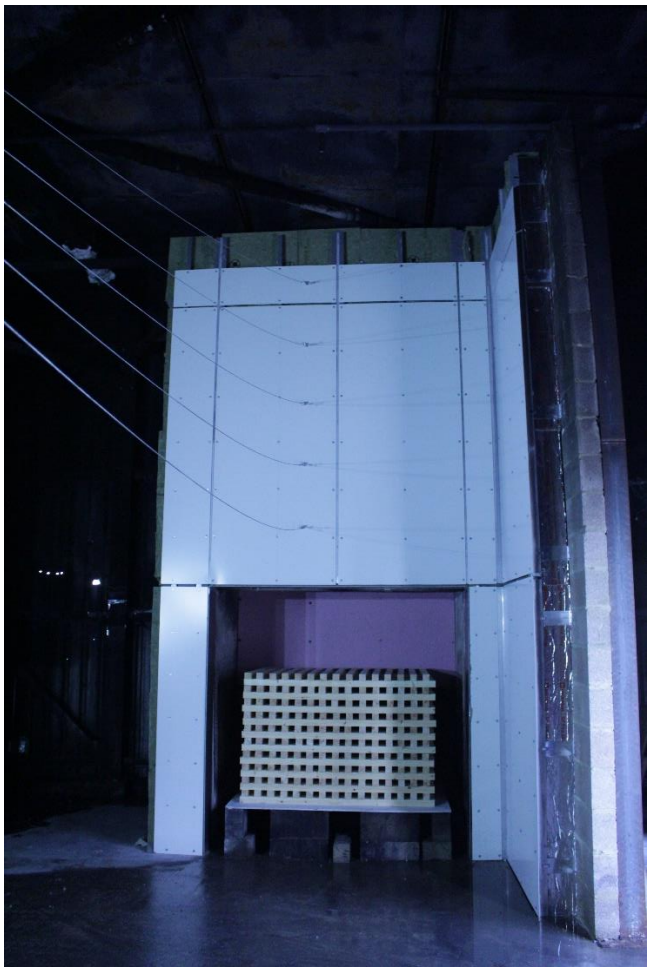


Figure 68 - MHCLG system completed with fire load

Figure 69 - Typical on-building design completed with fire load

The lightly weighted cables attached to the front face of the ACM panel were positioned to enable the timing of ACM destruction when smoke might prevent visual observation being effective.

7.4 Test Results

Both tests were run for a duration of 14 minutes with the crib being manually extinguished at that time. Figure 70 and Figure 71 show the extent of damage to MHCLG and Typical on-building systems, respectively.

Figure 70 - MHCLG system post-test damage

Figure 71 - Typical on-building system post-test damage

The headline differences between these comparative tests were:

- The more robust fixing of the MHCLG system (extra central support rail and all-round riveting) meant the ACM was ‘consumed by the fire leaving little debris below.
- The less robust hanger method of the Typical on-building system failed during the event to release panels to fall to the ground – partial consumption and structural failure
- The extra centre rails of the MHCLG system appeared to assist in the reduction of lateral damage to the ACM
- The less resilient window detailing of the Typical on-building system allowed the cavity barrier over the window to fall-away
- The top cavity barrier on the MHCLG test configuration reduced damage beyond
- The overall extent of damage was observed to be greater for the Typical on-building system

7.5 Conclusion

These tests have demonstrated that the fixing method, and overall system design can influence the extent of damage experienced under fire even when the suite of materials used is common. All BS8414 reporting seen to date correctly provide extensive warnings to the reader of the need to confirm system similarity between test sample and end-use systems, but without highly detailed knowledge of the both the testing regime and all architectural detailing this can present a huge challenge.

There is certainly scope to question whether the pass result achieved for the MHCLG test configurations provides adequate assurance of performance for systems using the same materials, but with potentially different mounting arrangements and window detailings – as may well be the case for many buildings.

8 Conclusions

Five specific areas of concern have been investigated in respect of the suitability of BS8414 as a means of ensuring cladding system performance. In brief it was found that:

- Changing the fuel load so that 20% of its calorific value is sourced from plastic material has been demonstrated to; elongate the length of flame ejections, increase the intensity of the fire (peak heat release rate), and maximum temperatures achieved. It is believed that the changes identified could be significant in the survivability of materials such as aluminium.
- The inclusion of a standard kitchen / bathroom type vent into the BS8414 test allows access of flame, heat, and combustible material into the cladding void directly before failure of the external cladding panels. This by-passes the ‘protection through encapsulation’ of some of the cladding system components and might be sufficient to alter a test outcome. This also raises issues pertinent to the potential impact of materials not normally included in the test system (such as vapour barriers) and the communication of toxic by-products to other occupied areas of a building.
- The ability of ‘chimney effects’ in void geometries of a size used in cladding systems to promote fire spread, albeit on other materials has been demonstrated. BS8414 configurations with sealed edges might inhibit realistic oxygen provision and flow and not allow chimney-effects or full burning of materials to prevail where they might in reality.
- The operation of cavity barriers in a direct flaming regime has been demonstrated. Flames pass for the operation duration providing evidence that cavity barrier performance cannot be inferred by the BS8414 test regime. Cavity barrier performance should be determined by an alternative test that is made in association with the fire properties of all materials they will be separating in end-use, including lighter, more readily ignitable sheet materials, such as membranes and vapour barriers, which are not currently tested within the regime.
- The design differences between systems destined for BS8414 testing and on-building use can be many. Test specimens are often combinations of ‘specific’ materials assembled in a ‘generic configuration’ whereas in-use systems have a greater number of material components arranged to a very specific format. These tests have demonstrated that the cladding form and fixing method used generically in the MHCLG tests exhibit a very different failure and destruction mode than a real-life installation of the same materials. This must draw into question the suitability of the MHCLG tests to confirm the fire performance of systems already installed on buildings where the materials are the same but the installation methods, particularly the hanging system and window detailing, are different. The real-life system demonstrated enhanced lateral damage, and system collapse and fall-away of cladding components in comparison to the generic MHCLG installation with its much-enhanced panel support methods (number of support transoms and all-round panel riveting).

These findings suggest that the BS 8414 test and the manner in which the data is used may not give designers, specifiers or insurers confidence that cladding systems tested to it will ensure the level of building fire safety that is currently inferred by its use.

9 Recommendations

- That the findings of this report should be provided to BSI to prompt a review of the BS8414 standard or to support the development of an insurer approved alternative.
- That the decisions made by MHCLG on the safety of the high-rise residential building population is re-evaluated giving greater consideration of the design relevance of the MHCLG tests to each of the buildings being evaluated.
- That a simple detailing check-list is required to assist the users of BS8414 data understand its relevance to supporting the safety case for proposed and installed cladding systems
- Findings should be shared with the Hackitt Review, the Public Inquiry, and BRAC
- RISCAuthority Passive Working Group to use this data in the next review of the Insurers' version of Approved Document 'B'
- That each of the challenges investigated be experimentally incorporated into the BS8414 test to evaluate their influence on overall test result for a range of common material collections to Typical on-building designs.

10 Further Work

On behalf of insurers, a recommended future work programme would involve full scale BS8414 testing with incorporation of each identified challenge (plastic fuel load, vent provision, no-edge sealing etc.) to assess how these real-life details might modify the results of the test. This information would be used to support the case for improvements in associated test standards and the specification of non-combustible materials in high hazard applications, including multi-storey buildings.

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APPENDIX A - ABI / FPA Tall Building Fire Safety: Research Themes

This note is a deliverable of the ABI / FPA Workshop 'Building Regulations Industry Asks' held jointly at ABI on 28th June 2017. FPA committed to specifying a series of logical research themes that would address all current and historic insurer concerns in respect of the UK's Building Regulations and the review framework they sit within. The list is not constrained to issues relevant to the Grenfell fire. The purpose of this note is to simply propose themes, providing limited supporting information, so that members of the workshop might add to the document, prioritise their instructions for effort placement, and develop detailed requirements in key areas going forward. Some of the themes might be 'fanciful' in that they would not be open for discussion in any Building Regulations review, but are included for completeness to present a fuller overall picture of insurance challenges in the built environment. The ambition is to have a well-focussed understanding of key insurer research requirements in time for the September GIC meeting accompanied by costed options which will enable insurers to develop well researched cases for change in a format, and with sufficient rigor, to influence those in a position to invoke change. Where prudent, collaboration with likeminded groups in some areas will be encouraged.

The research themes suggested, presented in no specific order, are as follows:

- Clarity and interpretation
- Scope
- Engagement
- Competency, Supervision, Control, and Authorisation
- Combustible Materials
- Imperfect World
- Standards
- Detection and Evacuation
- Engineered solutions
- Data
- Awareness
- Impact of other parts of Building Regulations
- Sprinklers
- Consequences of previous BR reviews and legislative changes

1. Clarity and Interpretation

Issue: Irrespective of the specifics of the Grenfell Tower fire many hundreds of other tower blocks (and other premises, hospitals for example) around the UK have been found to be clad in similar products. Product selection may be made by three specific routes; prescription, full-scale built-up system testing, or desktop study. Whilst the cladding product in question has been described as 'illegal', its use could have been legitimised via the second two of the three routes. If it transpires that the majority use is 'illegal' then consideration must be given to the apparently endemic misinterpretation / ignoring of the Building Regulations and/or Approved Documents (AD's) by those both designing and approving buildings. If it turns out that their use has been legitimised, then the soundness of the case made, methods used, and persons involved needs scrutiny.

2. Scope

Issue: Since the last review of building regulations, construction and refurbishment techniques and the associated materials have changed/altered substantially. The Grenfell Tower fire has also highlighted the social challenges associated with loss of accommodation. Current regulations are focussed only on life-safety with no cognisance of Property Protection objectives. Consideration must now be given to extending the scope of the regulations and associated AD's and associated guidance (HTM's; BB100) to address the changing risk environment and identified emerging trends. Key areas for attention (not limited to):

- To include a 'lowest bar' non-negotiable (prescriptive) property protection element around which the life-safety provision is formed.
- To address fire ingress – an emerging trend that has led to both significant property loss and near-miss life-safety issues.
- To address Arson (both internal and external) as a tangible threat – amendment of many other sections of AD's may contribute also.
- To review suitability, particularly in respect of the provision for some modern building methods of combustible structure and voids

3. Engagement

Issue: Whilst the UK insurance industry is in an admirable position to detect and comment upon emerging trends associated with fire loss our capability to both raise concerns and invoke change are greatly limited by the defences put in place within MHCLG. Our point-of-contact is a single person who seemingly operates outside of any quality assurance scheme. To this end, issues raised generally receive a short email response and we are left unclear as to whether our concerns have been raised with a panel of appropriate experts or get no further than the inbox of the individual. A typical response might read "…there are no plans to change Building Regulations for the foreseeable future". The lack of an established review period is unacceptable. It is interesting to note that the only time we have been granted access to BRAC has been when we have by-passed the MHCLG point of contact using unorthodox means.

4. Competency, Supervision, Control, and Authorisation

Issue: Within the Regulatory Framework the terms of 'Competency' and 'Responsible Person' are extensively used without any associated reference to qualifications or what makes a person 'competent' other than common phraseology in terms of 'training', 'experience' and 'other qualities'. A person's contribution may only be judged to have been 'competent' or 'incompetent' based on the outcome of a fire occurring and/or enforcement activity / prosecution – a reactive approach rather than predictive. Fire, is thankfully a rare event, and as such could mask many 'incompetent' decisions for many years. Should exposure of systemic 'incompetency' be revealed following an event by an individual or organisation, the legacy problems could have substantial life-safety, societal, and property / business loss implications.

It is clear too that a level of construction supervision is inferred that does not actually happen on today's building sites – the Clerk of Works is a historic and much missed role.

5. Combustible Materials

Issue: As defined in the RISCAuthority 'Essential Principles' guide, resilient fire prevention and protection starts with the selection of non-combustible materials. Non-combustible materials are known to be very forgiving of other key fire relevant challenges such as poor-quality workmanship, structural abuse and wear and tear over time. With a remit that extends no further than 'evacuation before collapse' the regulations allow for the deployment of materials that do burn, so long as they do so to a timeframe, or at a location, that will not impair escape. Whilst life-safety has traditionally been achieved using good performing materials, such as bricks and mortar or

reinforced concrete, modern methods of construction, in association with the drive for improved energy efficiency, has introduced large quantities of combustible material into the built environment by way of structure, cladding and insulation. The protection of this material very often demands encapsulation by better performing materials (such as plasterboard), to a precision that may be difficult to achieve on-site or whose capability may reduce during the life-span of the building.

6. Imperfect World

Issue: Evidence exists to demonstrate that key failings in the execution of Building Regulations generally pertain to in-exactness in construction (in both 'traditional' building methods and more modern approaches such as modular construction) and inappropriate (deliberate or accidental) adjustment of the materials/specification or the building during construction or occupation. If this is an accepted fact then there should be a duty on Building Regulations and guidance to not support construction method and material combinations that are so susceptible to minor deviation that they can only really be demonstrated to be safe and compliant 'on-plan'. Specific examples might include the fire stopping requirements of light timber frame construction, and cladding systems that encapsulate combustible insulation.

7. Standards

Issue: Seldom is it the case that test standards accurately represent real-life situations with any exactness but this is generally catered for by the application of safety factors inherent in the challenge of the test, or protection additions over and above the 'pass' threshold. For example, gaseous extinguishing systems are tasked with satisfying a series of tests to determine an 'extinguishing concentration' but the end use, or 'design concentration' is the extinguishing concentration uplifted by 30% to account for 'test to end-use' differences. Such a process does not seem to be common place within the product approvals process for building products. Specific to cladding systems, which are tested as 'perfect build' there might well be a need to introduce additional, reasonable-worst-case features known to impact upon performance. Some of these might be legitimate, such as the installation of plastic vents, grills and pipework that are not required to be fire-stopped; or illegitimate, such as imperfect construction or wear-and-tear features. This may also raise questions over the suitability of testing building components in isolation rather than as built up systems.

An additional area for consideration is in the interpretation of standards. A review of rainscreen cavity barrier tests demonstrate that whilst many products 'technically' fail the testing regimes (in the early stages of a fire they allow flames to pass), they can still be promoted as being fit-for-purpose through later desktop evaluation.

8. Detection & Evacuation

Issue: Building Regulations have traditionally been focussed on the requirement of 'evacuation before collapse'. However, for a range of reasons, stay-put evacuation policies are being used which, if not properly justified in terms of the building's compartmentation capability and resilience strategy to fire, could be more harmful than beneficial. A possible driver for the stay-put policy might additionally be the incredibly unreliable performance of automatic fire detection systems. Automatically generated fire alarm signals are over 95% likely to be false (not stemming from fire or smoke – shower steam etc.) or unwanted (smoke based, but not something requiring an FRS response (burnt toast or smoking)). A stay-put policy might reduce the inconvenience associated with false and unwanted alarms but does not alter the core issue of poor alarm performance. There are few areas of life-safety where there is such tolerance to poor supporting system performance.

9. Engineered Solutions

Issue: The discipline of fire engineering is a vital tool for the creation of modern complex buildings where the prescriptive elements of building regulations, AD's and the like (BB100; HTMs) are considered inadequate for meeting the design objective. However, experience does also show that, given the limited mandated objective of 'evacuation-before-collapse' that this allows for buildings (and their modification) to be 'value-engineered' down to a level that can significantly reduce the overall resilience of the built estate in the pursuit of cost savings. Clarification is required on the extent of the fire engineer's brief, and in particular, their ability to alter the requirement of established standards upon which their designs depend. An example might be where an engineered solution demands reliance upon sprinklers to meet the objective, but the fire-engineer determines that the full demands of the standard are not required; such as water supply duration. Linked in with the Competency Research Stream, questions must be asked of whether anyone is competent enough to have a standards-setting-level of competency in all of the key areas of fire prevention, protection, life-safety, and regulation, to make decisions of this type. The piecemeal use of fire-engineering must also be considered within this research stream. Fire Engineering by definition is meant to be holistic, and all encompassing, however we do see it applied to solve specific, limited scope problems that defeats the holistic ambition and can be the source of inconsistency in the overall design.

10. Data

Issue: All engagement on Building Regulations issues demand evidencing with appropriate data. One of the principle sources of data, the Incident Recording System (IRS), that records details of every FRS response, is kept a closely guarded secret by the Home Office (and MHCLG before them). For insurers to engage adequately there is a need to be able to marry up the information held within the insurers' large loss database with that held within IRS on a case-by-case basis. Extensive research capability pertaining to the analysis of building make-up and loss experience would quickly follow.

11. Awareness

Issue: The limited objective of 'evacuation before collapse' is not well understood by key industry sectors (Business, Public Services providers, homeowners and occupiers). This lack of understanding prevents those in a position to ask for more, from doing so, and leaves key resilience decisions to disengaged 3rd parties (such as the architect, specifier, supplier or contractor) who do not take benefit from improved decision making. This lack of awareness defeats market forces in that different build methods, with differing levels of inherent resilience, are considered equal on all counts. A scoring method for resilience, akin to the BREEAM sustainability scheme, would seem an appropriate method of redressing balance and supporting those who demand higher levels of protection over life-safety.

12. Impact of other parts of Building Regulations

Issue: Competing parts of Building Regulations can work against building fire protection endeavours. Such areas might include the provision of voids in building cladding to prevent moisture issues; these can act as flues in the event of fire if not controlled, and thermal performance demands that might promote poorer fire performing products over better performing ones.

13. Sprinkler Provision

Issue: The United Kingdom has one of the weakest policies in respect of Sprinkler provision in comparison to other European countries. Much like seat-belts and airbags are deemed essential

for making cars safe, the provision of sprinkler systems is considered an essential component to ensuring safety in large buildings and some modern methods of construction – particularly in light timber frame buildings in the US where it is the dominant residential construction method.

14. Consequences of previous BR reviews and legislative changes

Issue: Building Regulations, tightened up following the Great Fire of London, have undergone systematic erosion in recent history to bring us to this point in time where the built estate, whilst generally safe, is increasingly fragile to fire. The last mandated requirement for Property Protection, the Local Acts, was removed in April 2015 – it is possible, had they still been in place that they may have influenced the fire requirements of Grenfell Tower's refurbishment.

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