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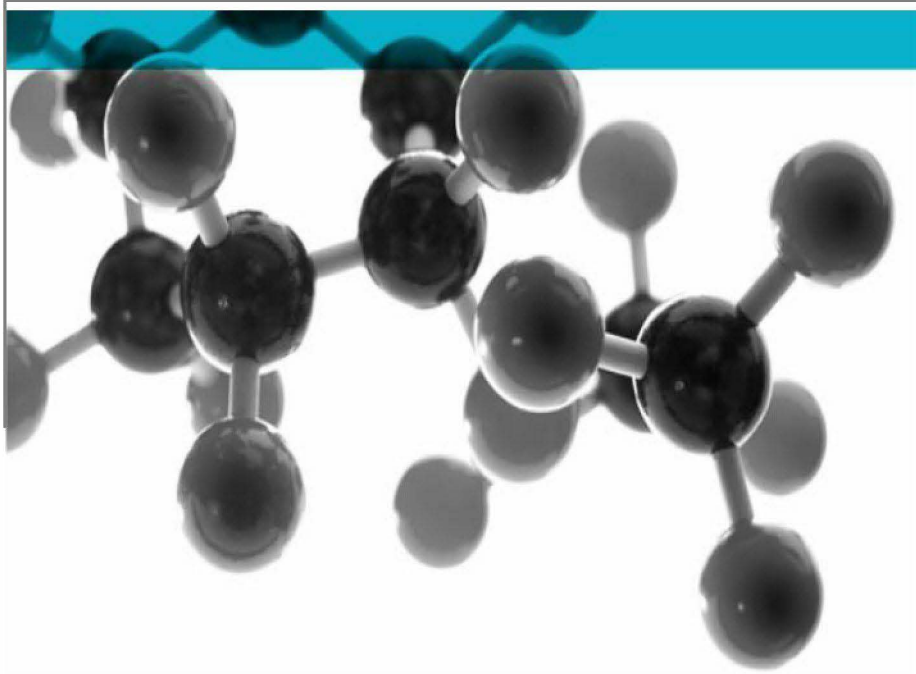
Testing. Advising. Assuring.

Assessment of the fire performance of an external wall system for use on high rise buildings as featured on Project Unite Portsmouth



A Report To: Kingspan Insulation Ltd.

Document Reference: 392416

Reference: Project Unite Portsmouth

Date: 6 February 2018

Issue No.: 2

Executive Summary

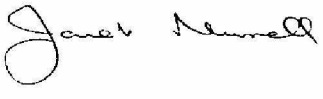
Objective To determine the compliance of a ventilated and insulated façade system and utilising K15 phenolic insulation for use on rainscreen cladding constructions with the requirements of the Building Regulations for England and Wales as defined in Approved Document B and the relevant warranty provider standards. The façade is faced with a Alpolic FR PE (type 2) aluminium composite panel rainscreen system.

Generic Description
The ACM rainscreen system build up comprises: • A double layer of 15mm acoustic Wallboard, tape and joint finish, fastened to the EOS frame • 100mm EOS frame steel frame system fully filled with 80mm thick mineral wool • 10mm Versaliner sheathing board • Tyvek Breather Membrane • 70mm thick foil faced phenolic insulation (Kingspan Kooltherm K15) • 55mm ventilated cavity fitted with AIM VRB Lite 60 minute mineral fibre horizontal fire barriers with an intumescent face and AIM 60 minute mineral fibre vertical fire barriers at full thickness. • 3mm aluminium helping hand brackets, top hats and rails • 4mm Alpolic FR aluminium faced composite panel filled with a mineral and polyethylene core (flat panels) and fixed to metal support frame. The panels have a separation distance of 10mm around their perimeter

Report Sponsor Kingspan Insulation Ltd., Pembridge, Leominster, Herefordshire, HR6 9LA, UK

Opinion We consider that the information reviewed in this document is sufficient to allow a conclusion to be drawn that the fire performance of the system described will be sufficient to meet the requirements of the Building Regulations for England and Wales for Ventilated Façade Systems on high rise buildings when effective cavity barriers are used within the construction.

Signatories

	
Responsible Officer Jennifer Lucas-Cox * Certification Engineer	Authorised Janet Murrell* Technical Manager

* For and on behalf of **Exova Warringtonfire**.

Report Issued:

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Introduction

Terms of Reference

Exova Warringtonfire have been instructed by Kingspan Insulation Ltd., to assess the compliance of an external wall system to be used in rainscreen cladding constructions (8 storeys high) on the Project Unite Portsmouth building to the requirements of the current Building Regulations for England and Wales following the guidance given in Approved Document B and the relevant warranty provider standards. The purpose of this report is to provide the assessment of performance requested in Option 3 of the BCA Technical Guidance Note 18 Issue 1 Jun 2015.

Introduction

The façade construction includes the use of an organic cellular foam, Kingspan Kooltherm K15 (referred to hereafter as K15), as the insulation in the external build-up of the ventilated system.

In buildings taller than 18m, insulation materials in external wall systems should be of limited combustibility to meet the contemporary design guidance to the Building Regulations. The general intent is that buildings with a storey at a height of more than 18 m above the external access level cannot be easily reached by fire and rescue service equipment and personnel. Therefore the materials in the build up of external walls in buildings over 18m should be provided with means of reducing fire spread risk.

For buildings in the Unite Portsmouth project, this restriction is applicable. The K15 insulation has been proposed to meet the thermal insulation performance within this construction. This insulation product is based on a thermoset material (phenolic foam), which is organic in nature and therefore classed as combustible. It therefore does not meet with the fire strategy requirement given in the Building Regulations and is therefore required to undergo either a fire test to BS 8414 (Option 2) or a desktop study (Option 3) or a full Fire safety engineering assessment (Option 4) in accordance with BCA Guidance Note 18 *Use of Combustible Cladding Materials on Residential Building*.

There is a need to assess the Kingspan K15 insulation for suitability in this external façade system and to look at the overall potential performance of the total system based on various fire test reports, including a BS 8414 test on the same foam and similar aluminium composite panels which are proposed to be used in the Unite Portsmouth project construction. For a combustible material to be used at heights of over 18m the guidance given in the Building Regulations for England and Wales is that it should have a fire performance of at least Class 0 when tested to BS 476 part 6 and 7 or B-s3,d2 when classified to BS EN 13501-1 and in addition should be tested against BS 8414-2 and assessed against the requirements of BR 135, which for this proposed combination of foam and facing is the case.

Supporting Documentation

The following reports and drawings have been used in this assessment of the ventilated external wall system which is proposed for use on high rise buildings in Unite Portsmouth project development.

Product (Component Part of External Wall System)	Reports and Other Information
Double layer of 15mm thick acoustic wallboard, tape and joint finish, fastened to the SFS frame	Classified without further testing as A2-s1, d0 Commission Decision 96/603/EC, as amended 2000/605/EC And in addition 2 layers of 15mm wallboard gives 30 minutes integrity
100mm EOS steel frame fully filled with 80mm mineral wool insulation	Classified as non combustible – deemed to satisfy A1
9mm Versaliner MgO sheathing board	Classified as of limited combustibility A2-s1, d0
Breather membrane -Tyvek	Light weight HDPE membrane – class E to EN 13501-1
70mm thick foil faced phenolic insulation (Kingspan Kooltherm K15)	BBA Certificate 08/4582 BRE Report 220876 to BS 8414-1 BRE Report 293940 to BS8414-2 BRE Report 297099 to BS8414-2 AFITI Report 8482/11 to EN 1363-1 BRE Report 218611 to BS EN 1364-1 EWF Report 323655 to BS EN 1365-1 BRE Report CC 301393 BRE Report P107017-1000/1 BRE Report P109939-1000/1
Cavity Barriers - AIM VRB Lite 60 minute mineral fibre horizontal fire barriers with an intumescent face and AIM 60 minute mineral fibre vertical fire barriers at full thickness.	Vertical firestop giving up to 60 minutes fire protection Horizontal fire barriers with intumescent face provide up to 60 minutes fire protection BS 476 Part 20 - WFRC C130775 EOTA TR31 – Chilt/IF12009 AR1
Fixings	Helping hands aluminium brackets, top hat profile fixed to EOS frame at every stud location and rails fixing cladding to insulation and SFS
4mm Alpolic aluminium faced composite panel filled with a FR PE mineral core	Classified to EN 13501-1 – Class B – s2, d0 WFRC 143612 (EN 13501-1)

1. BRE Test Report No P109939-1000

A fire test in accordance with BS8414 - 1 (where the façade system is mounted onto a masonry wall) was carried out on a Kingspan K15 insulated system with a ventilated ACM FR facing.

The system which consisted of 100mm K15 Kooltherm insulation board was fixed to the masonry wall (a blockwork structure) with screws and plastic washers. An aluminium railing system was also mechanically fixed to the blockwork wall. In the ventilated cavity, four intumescent strip faced mineral fibre horizontal ventilated cavity barriers were utilised, one directly above the hearth, one at the top to close the cavity in that location and two intermediate barriers. In addition, three vertical non - ventilated full thickness barriers were installed on the outer edges of the cladding together with a full thickness barrier around the fire source hearth and would have been used around a window. The cavity between the insulation and the façade facing panels was 50mm deep.

The façade facing was an aluminium composite panel (ACM) with a core consisting of a mixture of a mineral filler and polyethylene with a calorific value of 13-15MJ/kg. The flat panels were mounted using stainless steel rivets through the panels onto an aluminium railing system with a 10mm horizontal and vertical expansion gaps between the panels.

2. BRE Test Report No P107017-1000

A fire test in accordance with BS8414 - 1 (where the façade system is mounted onto a masonry wall) was carried out on a Kingspan K15 insulated system with a ventilated ACM FR facing.

The system which consisted of 100mm K15 Kooltherm insulation board was fixed to the masonry wall (a blockwork structure) with screws and plastic washers. An aluminium railing system was also mechanically fixed to the blockwork wall. In the ventilated cavity, four intumescent strip faced mineral fibre horizontal ventilated cavity barriers were utilised, one directly above the hearth, one at the top to close the cavity in that location and two intermediate barriers. In addition, three vertical non - ventilated full thickness barriers were installed on the outer edges of the cladding together with a full thickness barrier around the fire source hearth and would have been used around a window. The cavity between the insulation and the façade facing panels was 50mm deep.

The façade facing was an aluminium composite panel (ACM) with a core consisting of a mixture of a mineral filler and polyethylene with a calorific value of 13-15MJ/kg. The flat panels were mounted using stainless steel rivets through the panels onto an aluminium railing system with a 4mm horizontal and vertical expansion gaps between the panels.

3. BRE Test Report No 220876

A fire test in accordance with BS8414 - 1 (where the façade system is mounted onto a masonry wall) was carried out on a Kingspan K15 insulated system with a ventilated cement particle board facing. Panels were 1200mm x 900mm x 6mm thick.

The system which consisted of a single layer of 60mm K15 Kooltherm insulation board was fixed to the masonry wall (a blockwork structure) with screws and plastic washers. An aluminium railing system was also mechanically fixed to the blockwork wall to which was fixed to the 6mm thick cement particle boards at 600mm centres. The fire stopping was provided in the ventilated cavity and consisted of a graphite based intumescent strip bonded to nominal 0.6mm thick galvanised steel positioned horizontally above the fire chamber at a distance of 0.5m and 4m.

4. BRE Test Report No 297099

A fire test in accordance with BS8414-2 (where the façade system is mounted onto a steel structure rather than a masonry wall) was carried out on a Kingspan K15 insulated system with a ventilated Terracotta tile facing.

The system consisted of a double layer of wall board mounted onto a 150mm steel frame. The steel frame system (SFS) was installed between the floor slab hangers on the main wall with horizontal base and head trackers fixed to the steel substrate. On the face of the steel frame was mounted 15mm thick cement sheathing board. On this were mounted aluminium L and T rails. A single layer of 80mm K15 Kooltherm insulation board was fixed to the sheathing board with screws and plastic washers, the aluminium helping hand brackets protruding through precut slots in the K15 board.

The construction was faced with Taylor Maxwell (Argeton) Classico 30mm x 250mm x600mm tiles which were held in place using tile clips and Fixfast rivets which were fixed to the Taylor Maxwell Leg Tee support. The reaction to fire performance of these boards is A2-s1,d0. In the ventilated cavity, three horizontal fire breaks (Lamatherm CW-RHS ventilated cavity barrier) were fixed to the sheathing board and three vertical non- ventilated barriers were installed on the outer edges of the cladding and around the fire source hearth.

5. AFITI Test Report No 8482/11

An indicative fire test in accordance with EN 1363-1 on a Kooltherm K15 insulation without facing, to demonstrate integrity only.

6. EWF Test Report No 323655

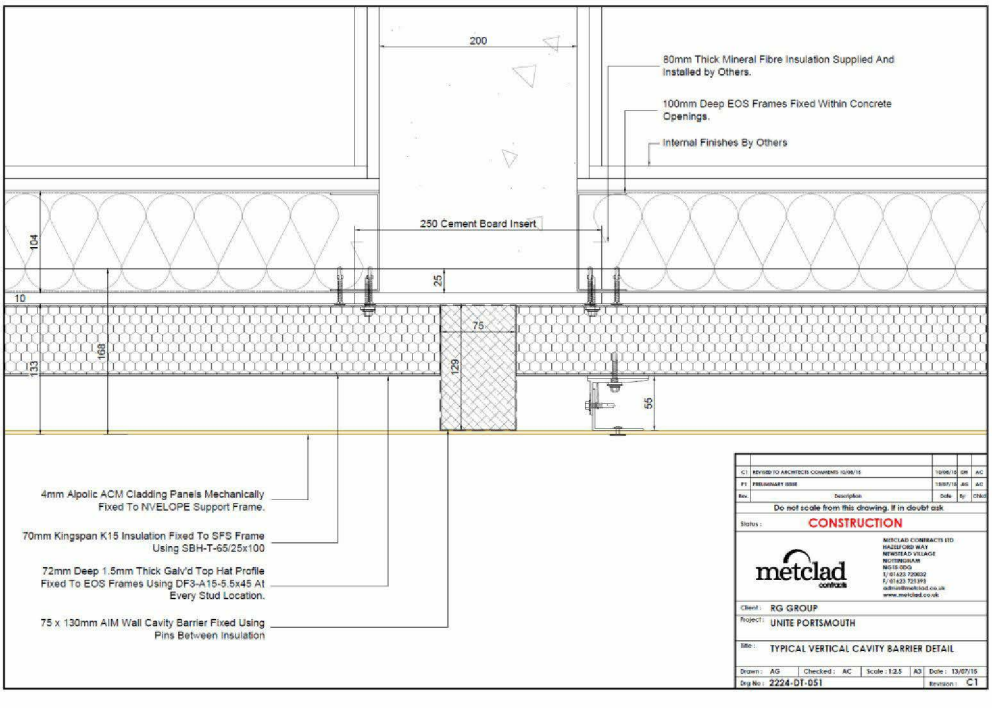
A fire test in accordance with EN 1365-1 on a load bearing wall assembly consisting of a stud partition wall with Kooltherm K15 insulation faced on the fire side with 9mm cement particleboard and on the non fire side with 2 layers of 12.5mm plasterboard.

Description of the Proposed System

The proposed system comprises:

Generic Description
The ACM rainscreen system build up comprises: • A double layer of 15mm acoustic Wallboard, tape and joint finish, fastened to the EOS frame • 100mm EOS frame steel frame system fully filled with 80mm thick mineral wool • 10mm Versaliner sheathing board • Tyvek Breather Membrane • 70mm thick foil faced phenolic insulation (Kingspan Kooltherm K15) • 55mm ventilated cavity fitted with AIM VRB Lite 60 minute mineral fibre horizontal fire barriers with an intumescent face and AIM 60 minute mineral fibre vertical fire barriers at full thickness. • 3mm aluminium helping hand brackets, top hats and rails • 4mm Alpolic FR aluminium faced composite panel filled with a mineral and polyethylene core (flat panels) and fixed to metal support frame

Elevation



Wall composition

Assessment

During the tests on the external wall systems in BRE reports nos P107017-1000, 297099 and 220876, the maximum external air temperature at level 2 remained below the limit of 600ºC within 15 minutes of the start time as did the temperature within the cavity between the external finish and the K15 insulation and the temperature at the mid depth of the insulation. The approximate maximum temperatures in each test at each location within the first 15 minutes of the test are tabulated below

	BRE Report No 297099 (SFS system)	BRE Report No 220876 (masonry system)	BRE Report No P107017-1000 (masonry system)	BRE Report No P107017-1000 (masonry system)
Air Temperature	420ºC	500ºC	390ºC	340ºC
Mid Point Cavity Temperature	100ºC	380ºC	195ºC	180ºC
Mid Point of Insulation	60ºC	190ºC	165ºC	135ºC

These tests determine the fire performance of the insulation within a cavity and illustrate which temperatures were recorded at the storey immediately above the fire source. The temperatures within the cavity are dependent on the nature of the fixing detail on the sill above the fire which should be that installed in practice as a window and also on the nature of the facing used.

There are a number of differences between the tested systems and the proposed system to be used in the Unite Portsmouth project, which can be summarized as follows:

- The internal lining in the tests with a SFS framework comprised a double layer of 12.5mm Gyproc wallboard to which the SFS frame was directly fixed. This is replaced by a double layer 12.5mm gypsum board which should provide a greater degree of fire protection to the building itself reducing burn through. A double layer of gypsum board of 12.5mm provides 30 minutes fire integrity and it would be expected that the double layer of 15mm would provide at least this time.

- The two tests conducted with the FR PE ACM facing were conducted with the façade system mounted on a masonry wall as opposed to the system being tested on a structural steel framework. There are also two tests with the Kingspan K15 foam mounted onto the sheathing board of a steel frame. Both tests were faced with non combustible facings, ie tile and cement particle board, however both facings were displaced or cracked and fell away to expose the insulation and the cavity to the fire especially at level 1. From these two tests and the tests with the ACM panels it can be seen that the fire source either melted or displaced the facing materials over a height of 4m and allowed flames to enter

the cavity and to directly impinge on the surface of the insulation. Due to this occurrence we can see the effects the the different underlying structures may have on the fire performance of the total façade system. Essentially the fire source in the BS8414 test affected all the components at the front face of the system up to the sheathing board for the SFS frame systems and the masonry wall for the part 1 system. The insulation at level 1 in both systems was destroyed to full thickness however the sheathing board was not mechanically damaged only charred/discoloured and the same effect was seen on the masonry wall. At level 2 the damage to the insulation was not to full thickness for insulation greater than 60mm and therefore the underlying materials were unaffected. It is therefore our opinion that the results of tests conducted on a masonry wall are equally applicable to those with an SFS frame, especially if that frame is also insulated.

- With the tested systems which were to BS 8414-2, there is no infill to the SFS frame. With the proposed system the frame incorporates 80mm mineral wool insulation which will significantly slow heat transfer to the gypsum board and hence the interior of the building and will act as a physical fire barrier in terms of integrity and penetration.

- The K15 insulation was tested at thicknesses of 60, 80, and 100mm and will be used in the proposed system at a thickness of 70mm. The 70mm foam would be expected to perform in a similar manner to the 60 and 80 mm foam.

  In this construction, the foam is behind the cavity which rests behind an aluminium composite panel facing with a B-s2,d0 performance and in front of a sheathing board attached to a structural EOS frame filled with mineral wool insulation. Due to the nature of the facings, the fire is expected to enter the cavity and to impinge directly onto the foam insulation. K15 insulation is a thermosetting phenolic foam which tends to char under the influence of heat before being eventually combusted due to prolonged direct flame exposure. There will be some spread of flame however this is very much a surface effect and the foam beneath will char. This however takes a period of time as can be demonstrated by the fire resistance test conducted on the Kingspan K15 insulation by AFITI where 100mm thick unfaced foam was exposed to the time temperature curve in EN1363-1. After 30 minutes exposure to temperatures up to 830ºC, the foam, although very charred to full thickness, was still intact. Direct flame impingement onto the insulation should failure occur of the window soffit should still provide 30 minutes protection into the Unite building. The SFS frame is also filled with mineral wool which will also serve as protection to the internal lining ie the two gypsum boards and building itself. It is however important that the cavity barriers used can act as breaks within the foam so that there is no continuous surface to spread flame. The 70mm thickness of foam will char through faster than the 100mm foam however the non-combustible sheathing board attached to the insulated SFS will stop any further involvement of the façade system at that level.
  From the photographs of the tests conducted with the FR PE ACM panels where these had melted away to a height of 4m this mechanism of charring can be seen; at level 1 the charring is to full depth and at level 2 is more of a surface effect with undamaged foam clearly visible behind the surface char.

- A breather membrane is proposed to be applied over the insulation. This type of membrane is typically 0.1 – 0.2 mm thick, 60 g/m^2, from High Density Polyethylene (HDPE). Such a membrane can provide an additional fuel source for potential fire growth, and can potentially increase the fire spread in the cavity. Considering the behaviour of the Phenolic insulation, and that of a thin thermoplastic film, a significant change in behaviour is not expected when the construction would be tested in accordance with BS 8414.

- The proposed system has ACM FR mineral filled polyethylene cored panels with a reaction to fire performance of B-s2,d0 which is similar to the panels tested in P107017-1000 and P109939-1000. The conducted tests indicate that in a flashover fire situation, the panels would

melt up to 4m above the position of the fire impinging on their surface, leaving the insulation exposed to direct flame impingment, due to the melting point of aluminium being 660°C. The flames would be within the cavity of the first storey within 10 minutes of fire breaking out onto the external part of the system. The results show that in this case the system will then rely on the performance of the cavity barrier above this storey to close the cavity and stop cavity fire spread in the early stages of the fire. This means that the mechanism of spread in this façade construction would be via the cavity and therefore the cavity barriers will need to be effective. The same area and location of opening of the cavity would be expected to occur with this system of ACM panels and therefore the results, would be expected to be similar to the performed test given that the fire stopping could act effectively. The cavity depth in the tests (P107017 and P109939) was 50mm and in the proposed construction will be 55mm. The similar cavity depth provides assurance that in a fire situation the cavity barriers would be able to effectively close the cavity in the event of fire. It should be noted that the small (55mm) cavity is suited to the use of cavity barriers which have intumescent strips used to close the cavity. The small distance will allow a solid dense char to form what will mold to any deformation of the facing due to heat and effectively close the gap. Solid cavity barriers are unable to move with the movement of the facing and therefore may not be as effective in closing the cavity. It should be noted that the size of the cavity can affect the performance of the cavity barriers since the lager the distance the intumescent has to close the less dense and more unstable the char may be.

From the fire test results, the aluminium panels melted away in the vicinity of the storey 1 to 2 cavity barrier within 20 minutes allowing flames to jump the barrier and enter the cavity above. The combustion of the foam insulation was only in the area of direct flame impingement and therefore stopped at around 4m, the extent of the flaming from the crib in the test. The cavity barrier at the 2nd to 3rd storey was effective in closing the cavity to stop fire spread. Once the external fire source was removed all flaming decayed within the following 5 minutes. It would be expected that the same behaviour would occur in a fire situation from the proposed buildup of the façade system on the Unite Portsmouth project.

The panels in the tested systems were flat panels which were drilled and riveted through their thickness onto the supporting helping hands which fix back to the framework to ensure that the panels remain in place in all areas where the flames were not impinging although the facing could potentially get distorted due to heat. The panels were also fixed to give either a 4mm or a 10mm expansion joint in both the horizontal and vertical plane. The panels for the Unite Portsmouth project are also flat. This means that the vertical joints are completely closed against the fixing rail system however there are horizontal joints which have a gapping of approximately 10mm as an expansion joint. This will allow air to be drawn into the cavity during any fire however the cavity barriers should close the cavity to stop the increased flame size caused by this upward draft. The joints in the panels should not be located close to any cavity barrier. The test reported in BRE Report No 109939-1000 also had a 10mm perimeter gap around the panels and has been shown to meet the requirements of BR135.

- The cavity barriers in the test conducted to BS8414 were, in the vertical orientation, mineral fibre batts fitted to the full thickness of the ventilated cavity and, in the horizontal orientation, were ventilated barriers incorporating an intumescent strip. The cavity barriers proposed for the vertical orientation in the Unite Portsmouth project are also mineral fibre batts. In the horizontal orientation the AIM VRB Lite 60 minute mineral fibre horizontal fire barriers with an intumescent face are proposed This allows a much greater freedom of movement of air in the cavity and in a fire situation, the intumescent strips expand to close the cavity to prevent passage of smoke and flame. In a fire situation it would be expected that this type of barrier would be equally as effective as those used in the tested system. The cavity is only 55 mm therefore this will provide a greater guarantee of the effectiveness

of the cavity barriers. It is however suggested that the construction company should check with the manufacturer of the cavity barriers to ensure that the cavity barriers to be used in this construction are appropriate for the type of façade facing to be used in this construction.

Note: Cavity barriers should be fitted in accordance with section 9 of Approved Document B, volume 2.

Conclusion

Opinion	**It is our opinion that the Alpolic FR aluminium composite panel rainscreen faced Kingspan K15 insulated façade system as proposed and as described for the Unite Portsmouth project would satisfy the performance criteria detailed in BR 135 third edition, if tested against BS8414:2005.**
Validity of Opinion	This opinion is based on the requirements of BR 135, third edition and against the requirements of the Building Regulations for England and Wales based on the guidance given in Approved Document B to those regulations. The opinion has been formulated on the assumption that the information provided by the client was correct and issued by independent third parties and that the client was not aware of any information that could have been provided which may adversely affect the conclusions drawn in the assessment. This assessment is issued on the basis of test data and information available at the time of issue and provided by Kingspan Insulation Ltd. The assessment is invalidated if the proposed construction is subsequently tested since test data takes precedence over an expressed opinion. Any changes in the proposed system described in this assessment will invalidate this assessment. This assessment relates only to the design as detailed in this report and as used at the Unite Portsmouth project. This assessment has been carried out in accordance with the Fire Test Study Group Resolution No 82. It relates to the fire performance of the product and does not cover aspects of quality, durability, maintenance or service requirements. This assessment relates only to the specimen(s) assessed and does not by itself infer that the product is approved under any certification scheme. This report may only be reproduced in full. Extracts or abridgements shall not be published without permission of **Exova Warringtonfire**.

Revision History

Issue No : 2	Issue Date: 6th February 2018
Revised By: Janet Murrell	Approved By: Mostafa Jafarian
Reason for Revision: new test evidence allowing closer comparison of the assessed wall build up	

Issue No :	Issue Date:
Revised By:	Approved By:
Reason for Revision:	