SECTION 4

FAILURES OF STATUTORY COMPLIANCE

Contents

4.1 Introduction

4.1.1 In this section I examine how the design and specification work of Studio E, and then subsequently of Harley, developed over 3 key stages: early design development, tender, and then construction information. I refer to these as Snap-Shot stages 1, 2 and 3. Thereafter, under Snap-Shot Stage 4, I consider the '*As Built*' record information produced by Studio E.

4.1.2 In terms of stage and dates the Snap-Shot stages that I refer to in paragraph 4.1.1 above can be defined as follows:

Pre-Novation '*Snap-Shots*':

Snap-Shot 1: Studio E Stage D Design Report: August 2013

Snap-Shot 2: Studio E Tender Documentation: August 2013 to January 2014

Post-Novation '*Snap-Shots*':

Snap-Shot 3: Harley Construction Documentation: April 2014-2016

Snap-Shot 4: Studio E 'As Built' Documentation: May 2016

4.1.3 I will provide within this section a total of four separate Snap-Shot reviews against the criterion of statutory *compliance* of the design, specification and construction work as carried out.

Appointment arrangements

Pre-novation

4.1.4 Before conducting that review of the Snap-Shots, I will make some observations about the appointment terms pre and post novation, and about a significant issue that affected the appointment: that of the insolvency of SELLP. It is important to note that the architect originally appointed by KCTMO was the firm SELLP (Studio E Limited Liability Partnership). Despite the fact that the project was ultimately delivered as a Design and Build service, SELLP were appointed for a full architectural service under a standard appointment document {SEA00004571}. That appointment did not appear to anticipate any switch to Design and Build appointment terms. According to Mr Sounes' statement at paragraph 21.1 that appointment covered the period *'from around December 2011 until around April 2014'* (Pre-Contract) {SEA00014273}.

4.1.5 Two notable issues arose with respect to that appointment: firstly, SELLP were novated to work for the appointed Design and Build Contractor after tenders had been invited and Rydon had been selected as the preferred builder; secondly, SELLP was placed in receivership shortly after starting work for Rydon. In that circumstance SEAL (Studio E Architects Limited - a company created following the demise of SELLP) were ultimately appointed by Rydon to continue the provision of architectural services and see the project through to completion.

4.1.6 In terms of the initial appointment (SELLP to KCTMO) I understand that SELLP were appointed under the '*RIBA Standard Conditions of Appointment for a Consultant 2010*'. {SEA00004571}. The appointment was amended under the '*RIBA Standard Conditions of Appointment Amendment 1 - Oct 2011*' {SEA00009822}. This document states it is an amendment to the '*Standard Conditions of Appointment for an ARCHITECT*' (my capitals) - note the substitution of '*architect*' for '*consultant*'. A third document, Appendix B, entitled '*RIBA Services 2010*' {SEA00009824} records the services duly filled in. The e-mail which accompanied the appointment documentation was dated 12 June 2012 {SEA00004561}.

4.1.7 Notable in this latter document ('*RIBA Services 2010*') is the fact that SELLP were appointed as '*Lead Consultant*', '*Lead Designer*', '*Architect as Designer*' and '*Landscape Designer*'. In the first three instances the appointment was for Work Stages A-L which is all the RIBA work stages – this constitutes a complete service from inception to handover.

4.1.8 Of particular note the services are defined as follows:

*'**The Services** shall be performed in the specified Stages (as defined in the 'RIBA Outline Plan of Work 2007 as amended November 2008') and include performance of any specified roles in the list below'*

Figure 4.1: Extract from '*RIBA Services 2010*' {SEA00009824}

4.1.9 I exhibit below two extracts from the '*RIBA Services 2010*' document duly annotated to record the scope of SELLP's appointment to KCTMO. The first confirms the services to be provided. The second defines those services as set out in the '*RIBA Outline Plan of Work 2007 as amended November 2008*'.

Services 2010

Part 1: Role Specifications

The Services are set out in the parts of this schedule identified below

Role Specifications

Design Services

Other Services

and additional schedule(s)

The Services shall be performed in the specified Stages [as defined in the RIBA Outline Plan of Work 2007 as amended November 2008] and include performance of any specified roles in the list below

		Stages
Specified Roles	Project Manager	
	If no Project Manager is appointed then the Client or Client's Representative performs the role.	
	Lead Consultant	A-L
	Lead Consultant services are always required, whether or not other consultants are appointed.	
	~~CDM Co-ordinator~~	
	~~Cost Consultant~~	
	~~Contract Administrator/Employer's Agent~~	
	Lead Designer	A-L
	Architect as Designer	A-L
	Landscape Designer	A-E
	~~Civil and Structural Engineer as Designer~~	
	~~Building Services Engineer as Designer~~	

Figure 4.2: Extract from '*RIBA Services 2010*' {SEA00009824}

Services 2010

RIBA Outline Plan of Work 2007 as amended November 2008

The Outline Plan of Work divides the process of managing and designing building projects and administering building contracts into a number of Work Stages. The sequence or content of Work Stages may vary or they may overlap to suit the procurement method.

PREPARATION	**A Appraisal**	Identification of client's needs and objectives, business case and possible constraints on development. Preparation of feasibility studies and assessment of options to enable the client to decide whether to proceed.	**OGC Gateways** 1 Business justification
	B Design Brief	Development of Client's initial statement of requirements into the Design Brief by or on behalf of the client confirming key requirements and constraints. Identification of procurement method, procedures, organisational structure and range of consultants and others to be engaged for the project.	2 Procurement strategy
DESIGN	**C Concept**	Implementation of Design Brief and input to Project Brief. Preparation of Concept Design including outline proposals for structural and building services systems, outline specifications and preliminary cost plan. Review of procurement route.	3A Design brief and concept approval
	D Design Development	Preparation of Developed Design to include structural and building services systems, updated outline specifications and cost plan. Completion of Project Brief. *Application for detailed planning permission.*	
	E Technical Design	Preparation of technical design(s) and specifications, sufficient to co-ordinate components and elements of the project and information for statutory standards and construction safety.	3B Detailed design approval
PRE-CONSTRUCTION	**F Production Information**	F1 Preparation of production information in sufficient detail to enable a tender or tenders to be obtained. *Application for statutory approvals.* F2 *Preparation of further information for construction required under the building contract.*	
	G Tender Documentation	*Preparation and/or collation of tender documentation in sufficient detail to enable a tender or tenders to be obtained for the project.*	
	H Tender Action	*Identification and evaluation of potential contractors and/or specialists for the project.* *Obtaining and appraising tenders; submission of recommendations to the client.*	3C Investment decision
CONSTRUCTION	**J Mobilisation**	Letting the building contract, appointing the contractor. Issuing of information to the contractor. Arranging site hand over to the contractor.	
	K Construction to Practical Completion	Administration of the building contract to Practical Completion. Provision to the contractor of further Information as and when reasonably required. Review of information provided by contractors and specialists.	4 Readiness for service
USE	**L Post Practical Completion**	L1 Administration of the building contract after Practical Completion and making final inspections. L2 Assisting building user during initial occupation period. L3 Post-occupation evaluation – review of project performance in use.	5 Benefits evaluation

The activities in italics may be moved to suit project requirements, ie:
D Application for detailed planning approval;
E Information for statutory standards and construction safety;
F1 Application for statutory approvals;
F2 Further information for construction;
G+H Invitation and appraisal of tenders.

3

Figure 4.3: Extract from '*RIBA Services 2010*' {SEA00009824}

4.1.10 The above two exhibits were included within an electronic Zip folder that included the following further information: (i) a covering letter from Studio E dated 12 June 2012 (ii) an amendments schedule listing amendments to the clauses as contained within the standard form of appointment (iii) a memorandum of agreement and (iv) a series of appendices A to E. It is notable that the Memorandum of Agreement was not signed and also that although the attachments were in many parts duly 'filled in' the annotations were not initialled as is normal practice.

4.1.11 On this basis the range of the appointment(s) pre novation stage ('*Lead Consultant*', '*Lead Designer*', '*Architect as Designer*' and '*Landscape Designer*') were clearly established; the scope of services under each of those appointments was defined at Appendix B page 2 (respectively A-L, A-L, A-L and A-E) {SEA00009824/2}; and the key tasks that constitute those services were in each case determined by reference to the second exhibit: the '*RIBA Outline Plan of Work 2007 as amended November 2008*'. In this respect, however, it is important to note that on page 2 of Appendix A (Project Data) {SEA00009823/2} it is clearly indicated that the procurement route was anticipated to be through a 'Design and build contract' and that at Appendix D (Project Brief) {SEA00009826}, it was clear that novation of the architect to the selected Design and Build contractor was anticipated to take place at the commencement of RIBA Work Stage F2. I deal with these matters in greater detail in Part 1 of my Supplemental Report.

4.1.12 It is accordingly my opinion that until the novation of SELLP to Rydon the services that SELLP had contracted to provide, both in terms of scope and standard, were as would be expected of an architect providing full architectural services as Lead Consultant, Lead Designer, Architect as Designer and Landscape Designer. These roles are defined in the document titled '*RIBA Services 2010*' which formed Appendix B (which incorporates the '*RIBA Outline Plan of Work 2007 as amended November 2008*') of the SELLP appointment to KCTMO.

4.1.13 On that basis, it seems to me that SELLP had a contractual duty to provide a service in compliance with The RIBA Plan of Work up to at least Work Stage H, albeit with the exception of Work Stage F2, as shown in Figure 4.3 above. The importance of this point is that it defines the quantity and standard of information and documentation that SELLP should have provided at the point at which the project was issued to tender. This work should therefore have been available to Rydon at the point (following novation) that SELLP commenced services under the Design and Build arrangement. In terms of design and production information the drawings and specification should therefore, under the KCTMO appointment, (as had originally been set out in the attachments to the email from Mr Sounes to Mark Anderson of KCTMO dated 12 June 2012 {SEA00004561}) have reached the Stage of F1 which I quote for convenience as follows:

'F1 Preparation of production information in sufficient detail to enable a tender or tenders to be obtained'.

Application for statutory approvals.

4.1.14 My interpretation as set out above appears to be largely endorsed by Mr Sounes' witness statement wherein he states at paragraph 26:

'I cannot specifically recall Studio E signing the documents and nor do we have a completed copy on file. That said I consider that the services Studio E provided in the Pre-Contract phase were consistent with those services identified in the KCTMO Appointment.'

4.1.15 In the previous paragraph of his statement (paragraph 25) Mr Sounes seems to suggest that the services provided to KCTMO extended only to Stage E. In my experience, it is not unusual for an architect to enter into an appointment whereby even though the stipulated scope of service is effectively for all work stages to completion, it is anticipated that the scope might in due course be reduced – as happened in this instance. Sometimes the terms of the agreement are merely transferred at novation to the new employer; or, as happened in this instance with Rydon, the post-novation appointment might be established under a completely different set of conditions.

4.1.16 However, whilst Mr Sounes implies in paragraph 25 that Studio E's work did not proceed beyond Stage E, he later affirms in paragraph 241 of his statement (as noted in Section 5 of this report) that:

'Whilst Studio E had undertaken to prepare a RIBA Stage E tender package I believe what we produced was closer to RIBA Stage F1, albeit many aspects of the specification were expressly envisaged to be subject to the successful contractor proposing alternatives. The full NBS, (sic) schedules and details of internal areas meant that the contractor had clarity on the scope of work they were being asked to price.'

4.1.17 Either way, the above interpretation is all in direct conflict with '*Grenfell Tower Procurement Process Map*' as produced by Artelia dated 10 November 2013 {ART00006240}. According to this document the intention was to tender the project on the basis of RIBA Stage D information.

4.1.18 It seems to me that the form of appointment under which SELLP were engaged by KCTMO - which effectively amounts more closely to a traditional procurement process as opposed to a Design and Build arrangement - was a) inappropriate for a project where tenders are obtained earlier in the process than on a traditional contract basis and b) in conflict with the Artelia procurement process as set out on their '*map*'.

Post-novation

4.1.19 I note that Rydon, post novation, required significant design changes, but the point here is that whilst such design changes may have necessitated a re-working of information already carried out up to the end of RIBA Work Stage F1, and a revised application to Building Control with respect to *'statutory approvals'*, under the terms of SELLP's appointment to KCTMO, that work should have already been completed against the original design brief. I further note from paragraph 21.2 of Mr Sounes' statement {SEA00014273} that *'from around April 2014'* SELLP worked for Rydon. In this respect Mr Crawford {SEA00014275} suggests in both paragraphs 14 and 27 of his statement, that the actual appointment date was 30 October 2014 which suggests that Studio E worked for a period without terms of their appointment having been confirmed.

4.1.20 Mr Sounes at paragraph 30 of his witness statement states that *'Initially Rydon engaged SELLP under the same terms as the KCTMO Appointment (but for only those services that related to the construction stage) for a short period of time in June and July 2014'*.

4.1.21 I further understand that SELLP was put into receivership shortly after being appointed by Rydon and that thereafter, through to the completion of the project in 2016, Rydon engaged SEAL (Studio E Architects Limited) to continue the project under a Deed of Appointment the terms of which Studio E accepted as the basis for the firm's entire post-novation appointment, albeit that the Deed was only executed on 3 February 2016.

4.1.22 I have not investigated the details of the transfer arrangements in terms of the project passing from SELLP to SEAL, but I understand that the leadership team and staff from SELLP were transferred to SEAL, and that in that process they had access to the information previously in the possession of SELLP as required to continue the provision of architectural services to the project.

4.1.23 I note that Mr Sounes also states at paragraph 30 of his witness statement that *'after SELLP became insolvent, Rydon engaged SEAL to continue on the project'*

4.1.24 At paragraph 31 of his witness statement, Mr Sounes states that *'essentially SELLP's obligations transferred from KCTMO to Rydon'*. It should be noted in this respect that Rydon introduced a new appointment document in the form of a Deed with attached Schedules. It seems to me that the terms of appointment that prevailed under the KCTMO appointment were set aside and Rydon's Deed became the new contractual basis {RYD00094228}. I refer to the Rydon appointment during my commentary upon the post novation work.

4.1.25 That Deed of Appointment {RYD00094228} required that SEAL would provide the Architectural Services as set out in the Schedule to the Appointment.

4.1.26 Of particular importance I note that those Services as contained within that Schedule included (but were not limited to) advising Rydon where there were shortfalls within the Employer's Requirements (paragraph 5); responsibility for coordinating Building Regulation approval (paragraph 7); seeking to ensure that all designs complied with the Statutory Requirements (paragraph 8); providing a Design Risk Assessment under the CDM Regulations and providing as-built drawings for the CDM file (paragraph 9); co-operation in the consideration and selection of alternative materials (paragraph 11); developing the scheme designs and agreeing the type of construction and quality selection of materials (paragraph 12); co-ordinating any design work done by consultants, specialist contractors; subcontractors and suppliers (paragraph 13) and the provision of supplementary notes to drawings and further drawings to show sufficient information to construct the project (including 1:20, 1:10 and 1:5 details) (paragraph 31).

4.1.27 I also note that under the main Deed of Appointment, the following clauses were included under the headings as listed below:

SERVICES ...

2.3 The Consultant warrants it has exercised and will continue to exercise reasonable skill care and diligence in the discharge of the Services to the standard reasonably to be expected of a competent professional experienced in the provision of professional services for works similar to the size scope complexity quality and nature of the Development...

DELETERIOUS MATERIALS

5 The Consultant warrants to the Contractor that in carrying out the Services it has not and that it will not specify for use or knowingly permit to be used in relation to the design of the Development any materials or substances which the Consultant knows or exercising reasonable skill and care ought to know at the time of specification (save where the Consultant has an ongoing involvement in the Development including without limitation supervision or inspection of the Development in which case at the time of use) are not in accordance with British or European Standards and Codes of Practice (or their equivalent) or which are generally know (sic) within the Consultant's profession to be deleterious to health or safety or to the durability or integrity of the Development.

4.1.28 Notwithstanding my references at the outset of this section to SELLP, when referring to the architects throughout the remainder of this section, and within all other sections, I use the acronym SEAL for all stages of the project even though pre-novation SELLP were the entity employed for the majority of that period.

Reporting Technique

4.1.29 In order to report and summarise my findings for these Snap-Shot reviews, I have created a matrix which is progressively filled in as I proceed. This matrix is shown below:

Design Element	Studio E Stage D Design Report	Studio E Tender Documentation	Novation	Harley Construction Documentation	Studio E As Built Documentation
Envelope Insulation					
Rainscreen Cladding					
Cavity Barriers (Window Openings)					
Vertical Cavity Barriers (Compartment Walls)					
Horizontal Cavity Barriers (Compartment Floors)					
Cavity Barriers (The Crown)					
Window Unit Infill Panels					
Window Head, Jamb, Sill Interface					

Legend:
- ✓ Documentation Considered Compliant with ADB2
- ✗ Documentation Considered not to Comply with ADB2
- ○ Documentation Not Provided but Not Expected
- ● Documentation Unclear/ Not Provided But Expected

Figure 4.4: Reporting Matrix Template

4.1.30 The 4 Snap-Shot stages to which I have referred are listed along the top of the matrix.

4.1.31 Down the left-side margin of the matrix I have listed, generally in the order in which an architect should consider them, the principal components/ products/ materials/ systems that make up the over-cladding to Grenfell Tower. These are respectively:

a) the envelope insulation

b) the rainscreen cladding

c) cavity barriers: (window openings/ compartment walls/ compartment floors/ Crown

d) window unit infill panels

e) window head, jamb, sill interface

It should be noted that I use the term '*generally in the order*' because the design work of an architect involves an '*iterative*' process by which I mean it is based on a cyclical process of proposing (prototyping), testing, analysing, and refining. I show a diagram below that illustrates this.

4.1.32 It will be noted that the '*legend*' describes several categories. These are self-explanatory denoting variously:

- Green Tick: work complies with ADB2 guidance.

- Red '*X*': work does NOT comply with guidance given within ADB2.

- Blank Circle: indicates that although it appears that no documentation was provided at that stage, there is no criticism. (This is because project design and documentation are both iterative and progressive processes and it is reasonable and normal for some categories of information to be left to a later stage)

- Red Spot: indicates criticism because the documentation was, for reasons that I describe, seriously inadequate in terms of its quality, clarity or completeness, or because it was not provided at all at a time when it certainly should have been available.

4.1.33 It is very important to note that the principal components/ products/ materials that make up the over-cladding cannot be considered in isolation. For instance, the type and thickness of the insulation must be proposed and then tested (e.g. against legislation, cost, buildability, durability and dimensional constraint and consequences) along with other components and products as they are considered and incorporated into the design. That is why I refer to the design process as an iterative process – a commonly used term for designers. The diagram below illustrates this widely understood working process.

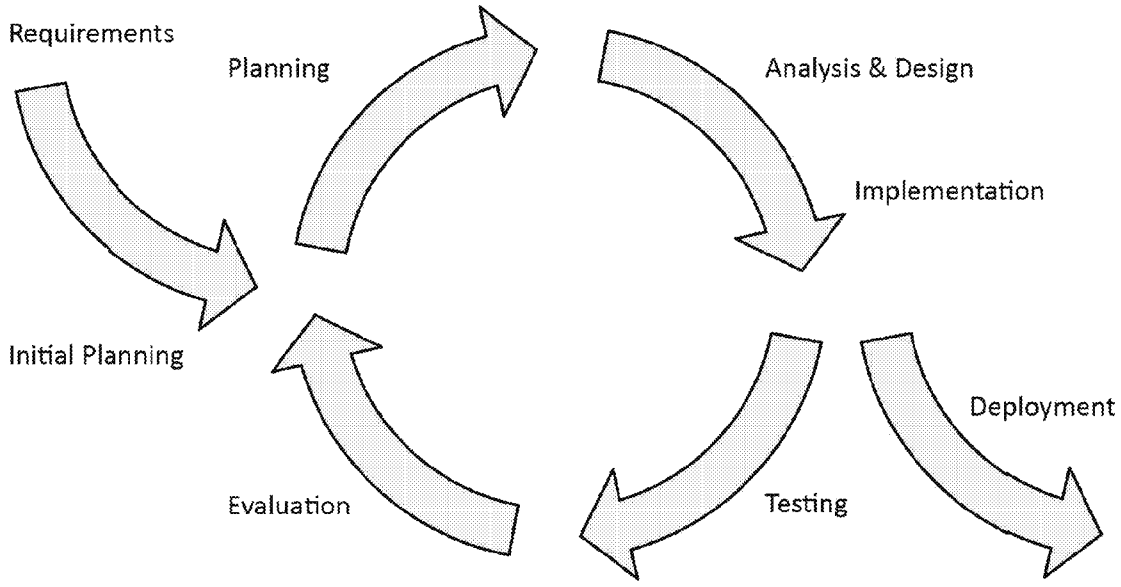


Figure 4.5: The Iterative Design Process illustrated

4.1.34 The RIBA have provided a helpful description of this process and the basis of its importance. I quote as follows:

'It is not very likely that the first drawn idea is going to meet universal approval. In fact, it is impractical to work in a collaborative environment in which iterative design processes are avoidable. The nature of iteration has to be planned and controlled, and should be seen as incremental steps towards the agreed design. There will be self-imposed design increments, information from design team members that informs process, client commentary and external advice on criteria like design constraints or planning policy – all of which will drive iterations of the design process. The skill of the architect is to see clearly the purpose of each iteration, acknowledging that incremental improvements in design and the fulfilment of briefing criteria increase the qualitative outputs of Stage 2 and that this has long term benefits for the project as it moves into future stages'

(Extract from 'RIBA Stage Guides – Design, A Practical Guide to RIBA Plan of Work 2013 Stages 2 and 3 to the question 'What is iterative design?')

4.1.35 That is also why I do not, for example, criticise Studio E for not developing a strategy with respect to cavity barrier positioning, or for not specifying the insulation/packing behind window reveals at the Stage D Design Report Stage. I only make criticisms within a Snap-Shot stage when I consider that such work is inadequate/unfit for purpose at a stage when it should have been resolved.

4.1.36 Before carrying out the Snap-Shot review I will make some comments about three of the products/systems that Studio E and Harley incorporated into their respective design and specifications.

Rainscreen Cladding

4.1.37 The rainscreen cladding (as ultimately adopted and applied) comprised two thin aluminium sheets bonded to either side of a core of low-density polyethylene (LDPE). This is variously known within the construction industry as '*ACM*' (Aluminium Composite Material) or '*ACP*' (Aluminium Composite Product). I refer to it throughout this report (as does Dr Lane) as '*ACP*' because I think '*material*' in this context is a misleading term: it is a product that comprises different materials (aluminium and polyethylene). Its edges are uncovered thus leaving the polyethylene exposed. I make the following further comments with respect to the ACP rainscreen cladding:

a) The ACP product used at Grenfell Tower was a version that is classified as '*cassette*': that is, it was folded at all four edges to form a '*tray*'. Slots were cut in two sides during manufacture to receive supporting brackets.

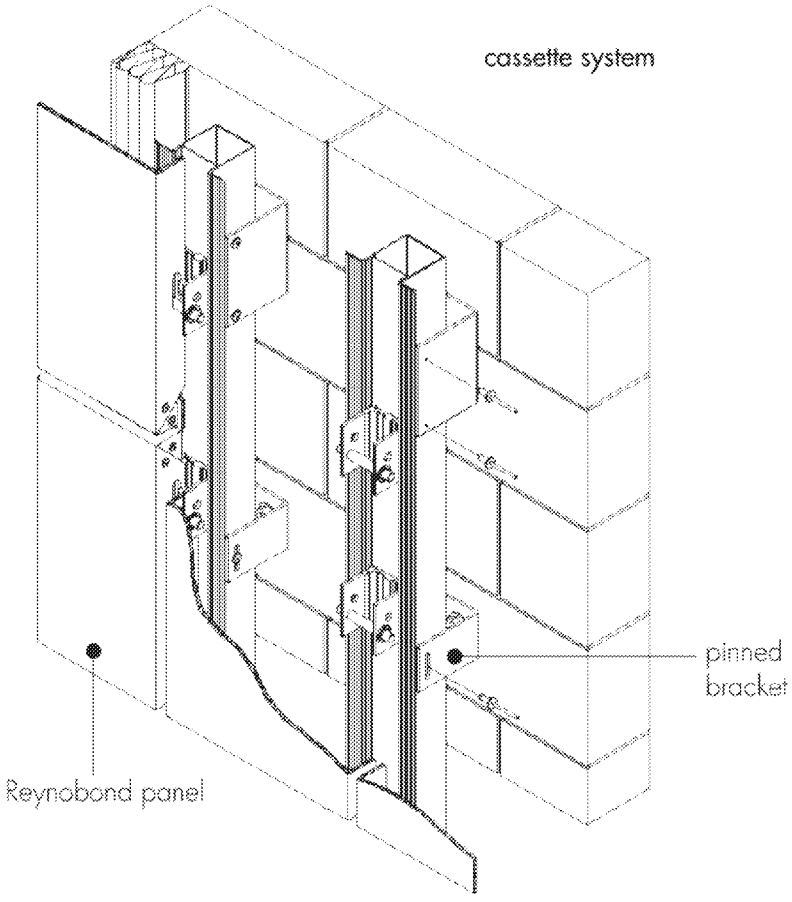


Figure 4.6: Extract from the Alcoa Architectural Products BBA Certificate 08/4510 {BBA00000047}

b) Harley procured a variety of brackets, rails, and fixings screws/ bolts etc. in order to affix the ACP to the existing structure. I therefore consider the combination of the ACP and these fixing arrangements to be a '*system*'. This is for ease of description and I do not think anything turns on this point.

c) The ACP can be supplied with a fire-retardant additive to the polyethylene. A '*standard*' ACP panel was specified at Grenfell Tower – that is without fire retardant additive.

Cavity Barriers

4.1.38 Two types of cavity barriers were supposed to be used for the over-cladding at Grenfell Tower: Horizontal Cavity Barriers and Vertical Cavity Barriers. I make the following further comments with respect to the cavity barriers:

a) Horizontal Cavity Barriers appropriate for ventilated cladding systems have an intumescent strip to the outer face. They are intended to only partially fill the cavity - that is they should not abut the inside face of the cladding. This allows any rainwater and other moisture that collects within the cavity to drain downwards. In the event of fire heating the horizontal cavity barrier, the intumescent strip is

intended to expand and form a seal with the inside face of the cladding. This seal should impede the spread of fire vertically – either up or down – within the cavity.

b) Vertical Cavity Barriers have no intumescent strip. They are intended to fill the cavity and fit tightly against the inside face of the cladding. This seal is designed to impede the spread of fire horizontally.

c) It will be noted that in each case I have variously referred to the intention of the cavity barriers (horizontal and vertical) being to impede and inhibit the spread of fire. I use these terms because such components cannot ultimately stop or prevent the spread of fire if it is of an intensity that will burn through the cavity barrier or pass around its sides. The Building Regulations clearly recognise this fact by stating that *'the unseen spread of fire and smoke within concealed spaces should be inhibited'* (as opposed to 'stopped').

4.1.39 Two points are worthy of note in this respect. Where cavity barriers are effective, they may either:

a) impede the spread of fire until firefighters arrive to put it out, or

b) alternatively, they may impede its spread whilst it self-extinguishes due to lack of fuel.

4.1.40 I note that whilst cavity barriers have been extensively used in connection with various lightweight cladding systems of metal and/or composite construction, Dr Lane has (at paragraph 10.3.39 / Figure 10.19 of her report) advised that the effectiveness of cavity barriers can be compromised in circumstances where the rainscreen panel distorts due to heat. That is a matter that I will leave other experts to comment on: I was not aware of such potential problems before reading Dr Lane's report and would not think it appropriate to criticise Studio E or any other architects who were also so unaware.

4.1.41 I also note that at paragraphs 11.20.30 through to 11.20.58 {BLAS0000011} Dr Lane provides further commentary on the testing conditions pertaining to the SideRise barriers. She draws attention to the fact that the tests were based on the product inserted between aerated concrete lintels which is clearly a very different performance context to that where a cavity barrier is inserted between a masonry or concrete inner leaf (as at Grenfell Tower, 2012 – 16 Works) and a metal outer rainscreen barrier. I would not have considered that by implication the limited context of such testing (the SideRise web site refers to testing between aerated concrete lintels) might suggest that the cavity barriers were not appropriate for use within metal rainscreen systems. I would have believed, based on the marketing literature and the way it described the testing, that cavity barriers with intumescent strips were fit for purpose within all ventilated rainscreen cladding systems as per the current (10 October 2019) web site of SideRise exhibited below:

'OPEN STATE' CAVITY BARRIERS - EXTERNAL ENVELOPE

KEY FEATURES

- Allow continuous ventilation and drainage behind cladding
- Up to 120 minutes fire integrity
- Tested to ASFP 'Fire Resistance Test of Open State Cavity Barriers' utilising BS EN 1363-1 and Principles of BS EN 1366-4
- Suitable for horizontal (open void) and vertical (full seal) applications
- Third-party approved (EWCL5)
- All horizontal cavity barriers are colour-coded for ease of identification

SIDERISE 'Open State' cavity barriers represent the default choice for market leading, high performance, 'Rainscreen Cladding Cavity Barrier' applications.

Used in the external envelope or fabric of buildings, they ensure the system will drain freely, whilst maintaining airflow and providing an effective hot smoke and fire seal.

Figure 4.7: Extract from current SideRise Web site

4.1.42 From the above it is evident that SideRise imply that their cavity barriers are designed for ventilated systems: see Bullet Point 4 reference to '*open void*' for horizontal use. The exhibit below from the same web site whilst also making it clear that the product is for use with drained and ventilated facades, shows what appears to be a metal rainscreen cladding adjoining glazed curtain walling and makes no suggestion that the product is not compatible with metal rainscreen cladding.

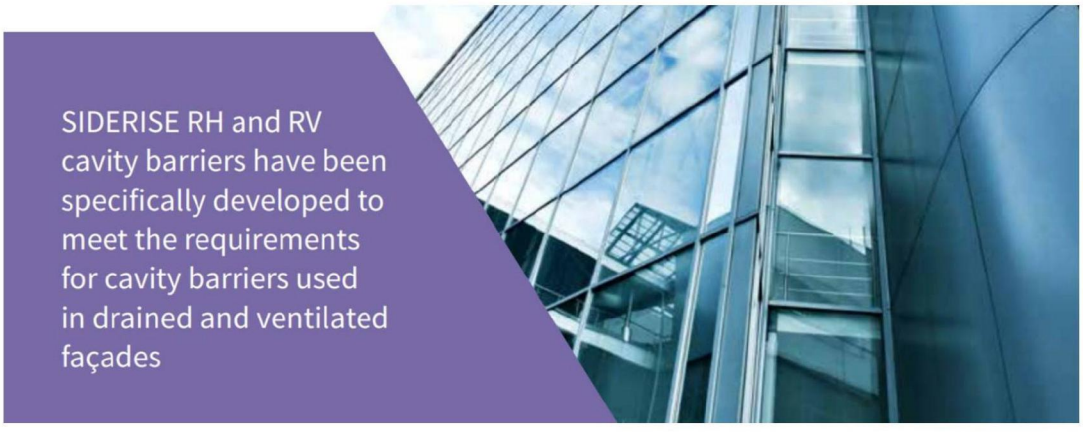


Figure 4.8 Extract from current SideRise Data Sheet Version 4 (March 2019)

4.1.43 The exhibit below offers further suggestion that the product is fit for purpose with rainscreen ventilated systems with no qualification suggesting that the product would not be suitable for metal rainscreen. Based on this information I had presumed that cavity barriers of the type manufactured by SideRise were suitable for use with metal rainscreen systems. I would not think it appropriate to criticise Studio E or any other architects who took the same view.

SIDERISE RH 'Open State' horizontal cavity barriers

STANDARDS AND APPROVALS

SIDERISE 'Open State' horizontal cavity barriers satisfy the requirements of:

- England and Wales – the Building Regulations 2000, Approved Document B (2006 edition), Appendix A, Table A1, item 10 (Volume 1) & item 15 (Volume 2) and diagram 33 (Provision for cavity barriers requires 30 minutes Integrity and 15 minutes Insulation).
- Northern Ireland – Technical Document E. (Provision for cavity barriers requires 30 minutes Integrity and 15 minutes Insulation).
- Ireland – Technical Guidance Document B. (Provision for cavity barriers requires 30 minutes Integrity and 15 minutes Insulation).
- Scotland – Technical Handbook 2. (Provision for cavity barriers requires 30 minutes Integrity only).

They also meet the higher minimum fire resistance standard for cavity barriers outlined in the LPC Design Guide for the Fire Protection of Buildings. (Provision for cavity barriers requires 30 minutes Integrity and 30 minutes Insulation).

FIRE TESTING – PRODUCTS

SIDERISE 'Open State' horizontal cavity barriers have been tested in accordance with ASFP TGD19: 'Open State' Cavity Barrier used in External Envelope or Fabric of Buildings. This test method specifies a procedure for determining the fire resistance of 'open state' cavity barriers when subjected to the standard fire exposure conditions and performance criteria stipulated in EN 1363 Part 1: 2012.

The tests have been undertaken to assess the ability of the horizontal 'open state' cavity barrier products to reinstate the fire resistance of a pre-cast, aerated concrete supporting construction. This is the standard assembly for testing such cavity barrier products as it allows the performance of the individual barrier to be classified.

THIRD-PARTY CERTIFICATION – TESTING

For details of testing carried out on those SIDERISE RH products subject to Third-Party Certification please refer to to Warringtonfire ewcl[5] Certificate Number ME 5101.

This Certificate is available on **www.siderise.com** or by contacting our Technical Support department: **technical@siderise.com**

Figure 4.9: Extract from current SideRise Data Sheet Version 4 (March 2019)

4.1.44 I have included 4 categories of cavity barrier to the left-hand margin of the matrix because each of these conditions warrants careful analysis in terms of the design, specification, construction, inspection and documentation work carried as out at Grenfell Tower. These categories are:

a) Window Openings (horizontal and vertical type barriers as appropriate).

b) Vertical barriers (to align with compartment walls)

c) Horizontal barriers (to align with compartment floors)

d) The Crown

4.1.45 As will be clear from earlier commentary herein, window cavity barriers are intended to surround window openings in order to inhibit the passage of fire *into* cavities. Vertical and horizontal cavity barriers that align with compartment walls and floors are intended to inhibit the passage of fire *within* cavities.

Window Infill Panels

4.1.46 The Window Infill Panels comprised an aluminium polyester coated outer face, an aluminium inner sheet (untreated/painted) with an insulating core. It is notable that the concrete spandrel walls that formed part of the original building below the glazed window openings extend up to the ceilings behind these window infill panels thus creating a cavity between the original construction and this part of the new window system that formed part of the over-cladding. This is illustrated in the diagram below. With respect to the incorporation and location of the Window Infill Panels the arrangements for the 2012-16 Works seem to replicate the previous window arrangement that was replaced by the 2012-16 Works.

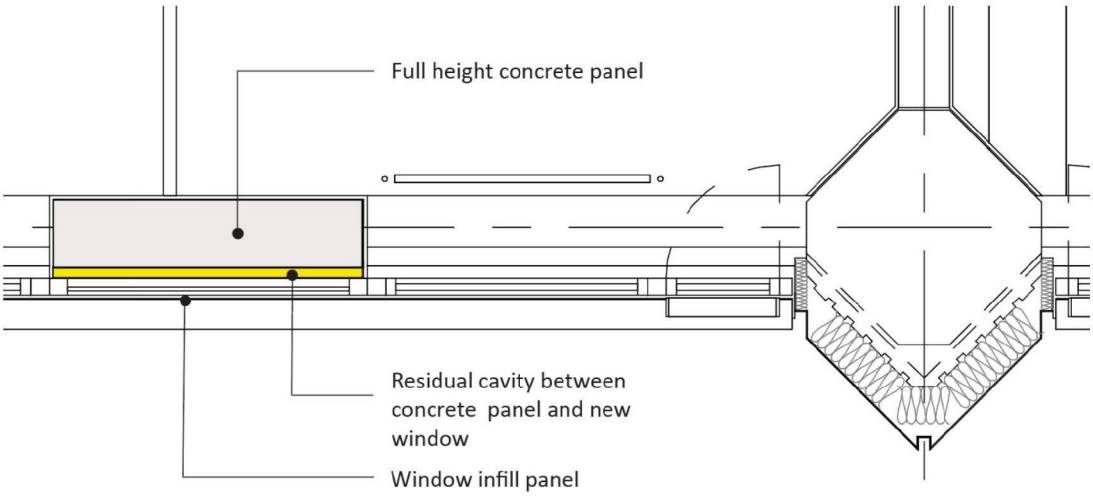


Figure 4.10: Diagram produced using Studio E drawing 1279 (04) 105 '*Proposed Residential Plan*' {SEA00010474}

4.1.47 Both PIR insulation and phenolic materials (Celotex and Kingspan) were used to form vertical insulation at the edges to the voids behind the window infill panels as shown in the photograph below taken on my second visit.

Figures 4.11 & 4.12 Photos taken by HKS at Grenfell Tower on 15 May 2019

4.1.48 I now offer some guidance on the way I have organised information and some explanation to help the reader in using the '*Snap-Shots*'.

4.1.49 I have for each item within each Snap-Shot (insulation/ rainscreen/ cavity barriers etc.) provided an account of the requirements under Building Regulations and the guidance under the relevant Approved Document specific and exclusive to that item. This will enable the reader to understand what had to be achieved in order to ensure compliance with the same. In order to minimise repetition I set out the account of the requirements under Building Regulations and the guidance under the relevant Approved Document only once. I do this at the first instance that an item features within the design development process (e.g. this occurs at Snap-Shot 1 for the Envelope Insulation as work started on this item very early. Code requirements/guidance for cavity barriers is, however, not provided until Snap-Shot 2 as this work only commenced during that stage.)

4.1.50 I will now present each of the four Snap-Shots in order with respect to my findings in relation to statutory compliance: that is compliance with the requirements of the Building Regulations, and with the guidance provided within ADB2.

4.2 Snap-Shot 1 - Studio E: Stage D Design Report (August 2013)

(Please see Appendix 2 for explanation of RIBA Work Stages)

4.2.1 I show below the Matrix with Snap-Shot 1 duly filled in to record my conclusions in terms of the compliance of each item of the work at this stage with the Building Regulations:

a)	envelope insulation:	NOT COMPLIANT
b)	rainscreen cladding:	COMPLIANT
c)	cavity barriers - window openings:	NO CRITICISM
d)	cavity barriers - vertical compartment walls:	NO CRITICISM
e)	cavity barriers -horizontal compartment floors:	NO CRITICISM
f)	cavity barriers – the Crown:	NO CRITICISM
g)	window infill panels:	NO CRITICISM
h)	internal window head, jamb, sill voids:	NO CRITICISM

Design Element	Studio E Stage D Design Report	Studio E Tender Documentation	Novation	Harley Construction Documentation	Studio E As Built Documentation
Envelope Insulation	✗				
Rainscreen Cladding	✓				
Cavity Barriers (Window Openings)	○				
Vertical Cavity Barriers (Compartment Walls)	○				
Horizontal Cavity Barriers (Compartment Floors)	○				
Cavity Barriers (The Crown)	○				
Window Unit Infill Panels	○				
Window Head, Jamb, Sill Interface	○				

Legend:
- ✓ Documentation Considered Compliant with ADB2
- ✗ Documentation Considered not to Comply with ADB2
- ○ Documentation Not Provided but Not Expected
- ● Documentation Unclear/ Not Provided But Expected

Figure: 4.13 Reporting Matrix Snap-Shot 1

4.2.2 I comment below on each of the items in sequence after, where appropriate, summarising the requirements of the Building Regulations and the guidance set out in the relevant Approved Document.

The Envelope Insulation

Building Regulations and Approved Document Guidance:

4.2.3 In terms of the scope of this report two key parts of the Building Regulations required particularly careful attention:

- PART L: CONSERVATION OF FUEL AND POWER
- PART B: FIRE SAFETY

With respect to Part L: (paragraphs 3.3.3 to 3.3.6 as incorporated within Section 3 are repeated below for the convenience of the reader as paragraphs 4.2.4 to 4.2.7):

4.2.4 Regulation 23 of the Building Regulations states:

'Requirements for the renovation or replacement of thermal elements...

(1) Where the renovation of an individual thermal element –

(a) constitutes a major renovation; or

(b) amounts to the renovation of more than 50% of the element's surface area;

the renovation must be carried out so as to ensure that the whole of the element complies with paragraph L1(a) (i) of Schedule 1, in so far that it is ***technically, functionally and economically feasible'*** (my emboldening).

4.2.5 Paragraph L1 of Schedule 1 of the Building Regulations (under PART L CONSERVATION OF FUEL AND POWER) states that:

'Reasonable provision shall be made for the conservation of fuel and power in buildings by:

(a) limiting heat gain and losses –
(i) through thermal elements and other parts of the building fabric;'

4.2.6 ADL1B provides guidance with respect to over-cladding work to existing buildings (as was the case at Grenfell Tower) under Section 5: '*Guidance on thermal elements*' (sub-heading: 'THE PROVISION OF THERMAL ELEMENTS') wherein paragraph 5.6A states:

'***Major renovation*** *means the renovation of a building where more than 25% of the surface area of the* ***building envelope*** *undergoes renovation'.*

On this basis the over-cladding of Grenfell Tower clearly constitutes a '*major renovation*'.

4.2.7 ADL1B Paragraph 5.7 under the sub-heading '*RENOVATION OF THERMAL ELEMENTS*' states that:

*'...For the purposes of this Approved Document **renovation** of a **thermal element** through:*

a. The provision of a new layer means either of the following activities:

*i) Cladding or rendering the external surface of the **thermal element**; or*
*ii) Dry-lining the internal surface of a **thermal element**.'*

4.2.8 ADL1B Paragraph 5.8 provides further guidance as follows:

*'Where the **thermal element** is subject to a **renovation** through undertaking an activity listed in 5.7a or 5.7b, the performance of the whole of the **thermal element** should be improved to achieve or better the relevant U-value set out in column (b) of Table 3...'*

In this context I interpret '*...the whole of the thermal element...*' to mean the combined performance of the original (retained) external wall together with the newly added over-cladding.

4.2.9 Table 3, as referred to in paragraph 5.8, ultimately provides the guidance required for this project under column (b) where it states that the external walls should be upgraded under the over-cladding work to achieve a U-value performance of 0.30 Wm2K *or better* (my italics).

With respect to Part B

4.2.10 The Building Regulations state under Schedule 1 B3-(4) that:

'The building shall be designed and constructed so that the unseen spread of fire and smoke within concealed spaces within its structure and fabric is inhibited'.

and under Schedule 1 B4(1) that:

The external walls of the building shall adequately resist the spread of fire over the walls... having regard to the height, use and position of the building'.

4.2.11 ADB2 guidance under '*External wall construction*' at paragraph 12.5 states:

'The external envelope of a building should not provide a medium for fire spread if it is likely to be a risk to health or safety. The use of combustible materials in the cladding system and extensive cavities may present such a risk in tall buildings.'

4.2.12 Further ADB2 guidance under *'Insulation Materials/Products'* states at Paragraph 12.7 that:

'In a building with a storey 18 m or more above ground level any insulation product.... used in the external wall construction should be of limited combustibility (see Appendix A)'

When a building has a storey with a floor level over 18 metres in height, I interpret paragraph 12.7 to apply to the whole of the external wall of such a building – not just those parts above 18 metres.

4.2.13 At Appendix A under '*Materials of limited combustibility*' paragraph 9 states:

'Materials of limited combustibility are defined in Table A7:'

Sub-paragraphs 9a. and 9b. then explain the methods of classification for '*National classes*' (which I assume to be British) and '*European classes*'.

4.2.14 Table A7 provides a list of definitions of materials of limited combustibility as shown below. The left-hand column of this table provides guidance (as) to '*where such materials should be used*' with respect to '*References in AD B guidance*'.

4.2.15 Item 8 of the left column to Table A7 refers to *'insulation material in external wall construction referred to in paragraph 12.7'* and stipulates that any materials listed under '*National class*' a, b, c or d; and any materials listed under '*European class*' a or b in Table A7, will be deemed compliant. The following two extracts from Table A7 define, respectively, those classes.

Definitions of materials of limited combustibility	
National class	**European class**
a. Any non-combustible material listed in Table A6. b. Any material of density 300/kg/m³ or more, which when tested to BS 476-11:1982, does not flame and the rise in temperature on the furnace thermocouple is not more than 20°C. c. Any material with a non-combustible core at least 8mm thick having combustible facings (on one or both sides) not more than 0.5mm thick. (Where a flame spread rating is specified, these materials must also meet the appropriate test requirements).	a. Any material listed in Table A6. b. Any material/product classified as Class A2-s3, d2 or better in accordance with BS EN 13501-1:2007 *Fire classification of construction products and building elements*, Part 1 – *Classification using data from reaction to fire tests*.
Any of the materials (a), (b) or (c) above, or: d. Any material of density less than 300kg/m³, which when tested to BS 476-11:1982, does not flame for more than 10 seconds and the rise in temperature on the centre (specimen) thermocouple is not more than 35°C and on the furnace thermocouple is not more than 25°C.	Any of the materials/products (a) or (b) above.

Figure 4.14: Extract from Approved Document B Volume 2, Appendix A, Table A7 *'Use and definitions of materials of limited combustibility'*

4.2.16 An architect should conclude therefore that in order to be fit for purpose in terms of the guidance in paragraph 12.7 the insulation *'used in the external wall construction'* would require proof of compliance with such testing in order to be deemed to be of *'limited combustibility'*.

Commentary Snap-Shot 1: Envelope Insulation:

4.2.17 The following extract from Studio E's Stage D Report (August 2013) {SEA00008054} shows that they specified Celotex FR5000 (100mm thickness) to the existing columns. This material (160mm thickness) was also specified for the slab edge/spandrel panels

P10 Sundry Insulation / Proofing Work
- Celotex FR5000 (100mm) to existing columns

Figure 4.15: Extract from the Studio E Stage D Outline Specification {SEA00008054}

4.2.18 Celotex '*5000*' is a polyisocyanurate product known as PIR. (I note that the prefix FR as well as RS are used in connection with the Celotex 5000 product. These both refer to the same product as I understand the distinction was purely for marketing purposes and in those circumstances I have used RS (rainscreen) and FR (flat roof) interchangeably throughout this report). It did not meet any of the definitions for materials of limited combustibility as set out in Table A7 of ADB2. Studio E should not have specified an insulation product that did not carry proper certification as evidence of its suitability in meeting the guidelines of ADB2 and the requirements of the Building Regulations.

4.2.19 I show below an extract {CEL00000013} from Celotex product information from 2014 – produced after Studio E had prepared the Outline Specification. It describes a system fire test (to BS 8414-2:2005) carried out on a completely different walling system. It also states that Celotex RS5000 is '*acceptable for use in buildings above 18m height*'. I believe that this is an erroneous claim. I am critical of Celotex for making such a misleading claim. However, it is unlikely that Studio E were aware of this document as found in Celotex product information during 2014 at the time of producing its Stage D Report in August 2013.

Fire Performance

Rainscreen Insulation

Celotex RS5000 is Class O fire rated as described by the national Building Regulations having achieved both:

- A pass to BS 476 Part 6: 1989 (fire tests on building materials and structures-method of test for fire propagation for products)
- Classification as Class 1 in accordance BS 476 Part 7: 1997 (fire tests on building materials and structures-method of test to determine the classification of the surface spread of flame of products)

Building above 18 metres

Celotex RS5000 has been successfully tested to BS 8414-2:2005 (Fire performance of external cladding systems: Test method for non-loadbearing external cladding systems fixed to and supported by a structural steel frame), meets the criteria set out in BR 135 and is therefore acceptable for use in buildings above 18 metres in height.

The system tested to BS 8414-2:2005 was as follows:

- 12mm fibre cement panels
- Supporting aluminium brackets and vertical rails
- 100mm Celotex RS5000
- 12mm non-combustible sheathing board
- 100mm SFS system
- 2 x 12.5mm plasterboard

Figure 4.16: Extract from Celotex RS5000 Rainscreen Cladding Specification Guide {CEL00000013}

4.2.20 Studio E's Stage D Report {SEA00008054} includes, at Appendix D, Revision 1 of the Exova fire strategy document an extract of which I exhibit below. This states under *'Compliance with B4 (external fire spread)'* that the design proposal *'will have no adverse effect on the building in relation to fire spread'*. The importance of the last phrase *'but this will be confirmed in an analysis in a future issue of this report'* cannot be overstated: it seems that no such analysis was ever carried out, thereby rendering the fire strategy for this project seriously deficient throughout all subsequent design stages and upon completion of the project and thereafter.

> 3.1.4 Compliance with B4 (external fire spread)
>
> It is considered that the proposed changes will have no adverse effect on the building in relation to external fire spread but this will be confirmed by an analysis in a future issue of this report.

Figure 4.17: Extract from the Exova *'Outline Fire Safety Strategy'* within the Studio E Stage D Report {SEA00008054}

4.2.21 I do not know whether Exova approved the incorporation of their report into Studio E's Stage D Report but if they did, and if Exova saw that Stage D report, this would constitute a serious error on their part as the Studio E Stage D Report confirmed the use of Celotex FR5000 which, because Exova are specialist Fire Engineering Consultants, should have been well known to them as being non-compliant with the guidance given under ADB2 Paragraph 12.7. I am however aware that Exova were sent a link to the Studio E Stage C report {SEA00006429} on 31 October 2012 {EXO00001575} and that this Stage C report contained details about the specification of FR5000. Those details were contained on page 12 of the Max Fordham Stage C report, which was included within the Studio E Stage C report from page 70. By virtue of Exova having received the Studio E Stage C report, it is therefore clear that Exova had indeed received confirmation of the proposed use of FR5000 from 31 October 2012 regardless of whether they then later received the Studio E Stage D report. On this basis I am of the opinion that Exova should have realised that the design team were intending to incorporate an insulation material within the external wall that was not compliant with the guidance in 12.7 of ADB, and in such circumstances, should have advised that the product was non-compliant and should not be specified.

4.2.22 Furthermore, despite stating that at paragraph 3.1.4 of the Exova report that compliance with the B4 requirement *'will be confirmed by analysis in a future issue of this report'* I do not believe that Exova ever did follow up on this matter in a written report. I believe that both Studio E and Exova should be criticised for not subsequently ensuring that such analysis was ultimately carried out. I also believe that Rydon should have identified this issue as not 'closed out' during their progress reviews.

4.2.23 I note from Mr Sounes' statement {SEA00014273} at paragraph 43.9 that it was the Max Fordham office that initially proposed Celotex RS5000 in order to achieve the 0.15 W/m2K level of thermal performance that they suggested should be targeted for the external walls.

4.2.24 I will put that recommendation into context for the reader. There has been an increased awareness in recent years about the importance of reducing carbon emissions from buildings both by conserving energy and by using '*clean*' forms of energy (e.g. photo-voltaic cells and solar panels). In response, the Building Regulations have progressively required improvements to the thermal performance of the external envelope of buildings, and this has been reflected in the guidance given under ADL1B. (For a fuller explanation of this issue see Section 3 above). Whilst the high-performance target in terms of '*U*' value as suggested by Max Fordham was laudable, it set a performance that was well beyond that required under the guidance in ADL1B, and effectively '*future-proofed*' the building which means that its thermal performance would meet future anticipated upgrading recommendations.

4.2.25 However laudable the intent, such performance had to be achieved in a manner compliant with the guidance in ADB2. The PIR range of products (including Celotex RS5000 and Kingspan Kooltherm K15 which is a phenolic insulation) did not achieve that compliance.

4.2.26 As services engineers Max Fordham should have known the importance, in principle, of compliance with Building Regulations and should have been sufficiently familiar with both the Building Regulations and the Approved Documents with respect to all aspects of their particular discipline. In those circumstances they ought not to have proposed a PIR product in this situation. I think that Max Fordham can therefore be criticised for proposing a material that was clearly non-compliant with the guidance in ADB2 and which did not meet the requirements of the Building Regulations.

4.2.27 I am nevertheless of the opinion that ultimate responsibility for ensuring compliance of the insulation material with the requirements of the Building Regulations lay with Studio E. I take this view because a) the insulation was a major '*stand-alone*' component of the building construction which Studio E specified at tender stage and b) because the Rydon appointment placed responsibility for compliance of construction with building codes squarely with Studio E under paragraph 8 of the Schedule of Architectural Services {RYD00094228}:

'Seek to ensure that all designs comply with the relevant Statutory Requirements, including Scheme Development Standards'.

I am therefore extremely critical of Studio E for their failure to ensure that an insulation of '*limited combustibility*' was specified and incorporated into the construction as per the guidance of ADB2 and the requirements of the Building Regulations.

4.2.28 Given that Exova had sight of the Celotex FR5000 specification when they were sent the Studio E Stage C report in October 2012, I am also extremely critical of their performance as a specialist fire consultant.

4.2.29 In my opinion, Celotex should also be severely criticised for stating in its product literature as of summer 2014 that their RS5000 product was suitable for buildings over 18 metres high. I exhibit below an extract from Celotex product data *'Issue 1 August 2014'* {CEL00007961}:

Figure 4.18: Extract from Celotex product literature of August 2014 {CEL00007961}

4.2.30 Routine Design Reviews, in line with RIBA recommended practice, and in compliance with the Quality Management Plan that Studio E (and Rydon) should have operated under their ISO 9001 registration should have identified this problem both during and at the conclusion of the Studio E Stage C and Stage D Design reports. This did not happen either because those reviews were not carried out, or because they were not carried out properly. The problem was thus carried into the next stage of the work on Envelope Insulation which I will review later herein under Snap-Shot 2 / Studio E Tender Documentation. It is notable that Studio E (and Rydon) were ISO 9001 registered. That obliged both firms to establish their own Quality Management System which is independently assessed. Such a system would routinely establish quality bench-marking and review and checking protocols. Section 6 to this report provides a fuller description of ISO 9001 protocols and offers an example of a Studio 1 technical review with a description of its short-comings.

Conclusion Snap-Shot 1: Envelope Insulation

4.2.31 The insulation as specified within Studio E's Stage D Report failed to comply with the guidance given under ADB2 and it also failed to meet the requirements of the Building Regulations.

4.2.32 As a result, this problem was carried over into the next stage which will be reviewed under Snap-Shot 2.

Rainscreen Cladding

Building Regulations and Approved Document Guidance:

(For the convenience of the reader I will repeat some of my Section 3 commentary on fire safety requirements of the Building Regulations and the guidance given in this respect within ADB2 as I expand herewith on those issues.)

4.2.33 The Building Regulations 2010 state under Schedule 1 External Fire Spread paragraph B4 (1) that:

'The external walls of the building shall adequately resist the spread of fire over the walls... having regard to the height, use and position of the building.'

4.2.34 Under the introduction to ADB2 Section 12 (page 92): *'Construction of external walls'* paragraph B4.ii states:

'Provisions are made in Section 12 for the fire resistance of external walls and to limit the susceptibility of the external surface of walls to ignition and to fire spread'

The use of the words *'susceptibility of the external surface of the walls'* seems to be a clear reinforcement of the requirement to *'adequately resist the spread of fire over the walls'.*

4.2.35 ADB2 clause 12.5 under *'External wall construction'* states:

'The external envelope of a building should not provide a medium for fire spread if it is likely to be a risk to health or safety. The use of combustible materials in the cladding system.... may present such a risk in tall buildings.'

4.2.36 This quote suggests 3 quite separate things:

a) That the *'envelope'* – that is the external wall in its entirety – should not provide a *'medium for fire spread'*.

b) That the *'cladding system'* – which I take to mean any series of products and components that would make up a proprietary system - such as rainscreen cladding - should not provide a *'medium for fire spread'*. This again goes to the heart of the requirement under the Building Regulations that *'The external walls of the building shall adequately resist the spread of fire over the walls'.*

c) That special regard is given to tall buildings. This is because tall buildings provide additional challenges to the Fire Brigade in terms of access to high positions on an

external wall and the limited reach of ladders and hoses. Tall buildings also produce challenges in terms of escape, and this is particularly true in relation to single staircase buildings, such as Grenfell tower.

4.2.37 ADB2 clause 12.6 under *'External surfaces'* states:

'The external surfaces of walls should meet the provisions in Diagram 40'

4.2.38 I show below Illustration *'e'* within Diagram 40 which applied to Grenfell Tower, together with the *'Key'* that sets out the detailed guidance as applicable to buildings that fell into the category of *''e' / ANY BUILDING'*:

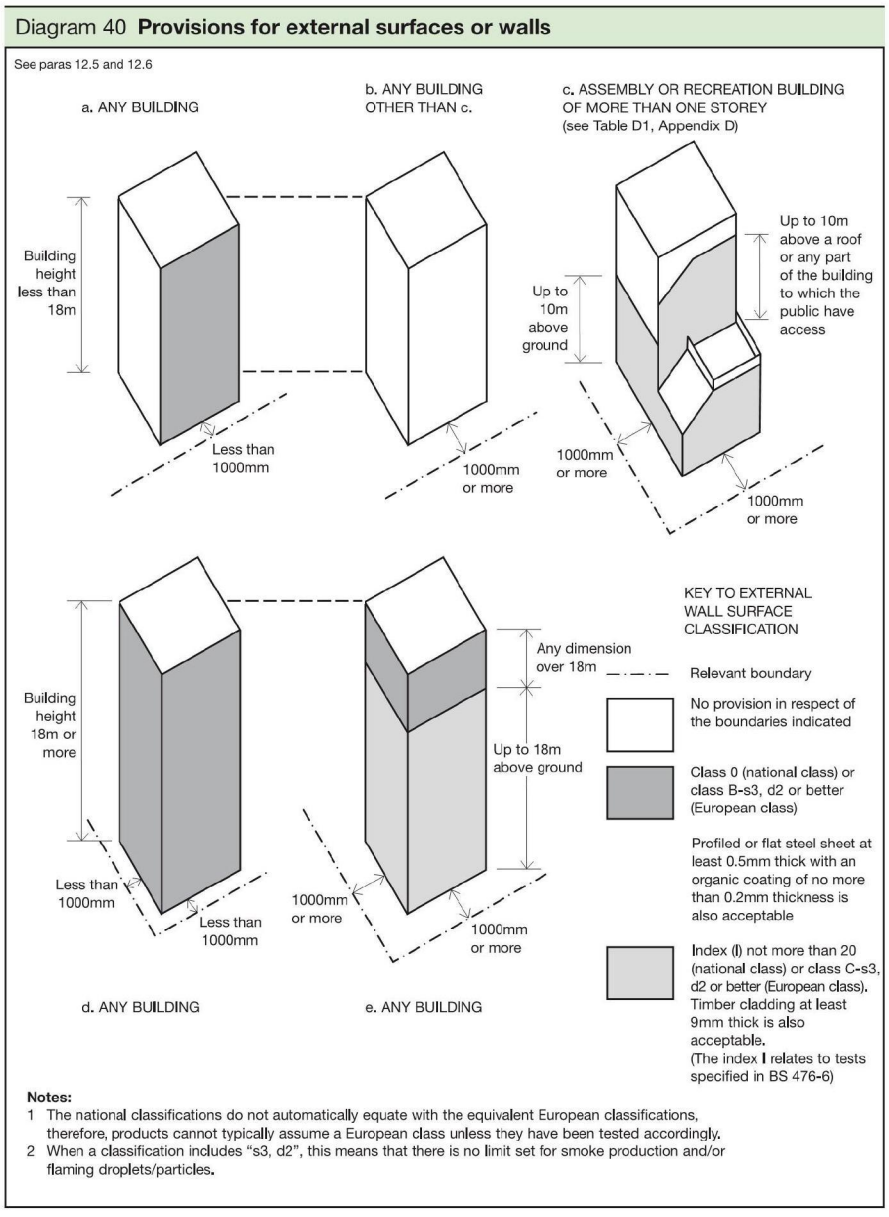


Figure 4.19: Extract from Approved Document B Volume 2, Diagram 40 '*Provision for external surfaces or walls*'

4.2.39 Class O is defined in ADB2 Appendix E as:

> **Class 0** A product performance classification for wall and ceiling linings. The relevant test criteria are set out in Appendix A, paragraph 13.

Figure 4.20: Extract from Approved Document B Volume 2, Appendix E, '*Definitions*'

4.2.40 Appendix A paragraph 13 (albeit bizarrely in this context under the heading '*Internal Linings*') states:

> **13** The highest National product performance classification for lining materials is Class 0. This is achieved if a material or the surface of a composite product is either:
>
> a. composed throughout of materials of limited combustibility; or
>
> b. a Class 1 material which has a fire propagation index (I) of not more than 12 and sub-index (i1) of not more than 6.
>
> **Note:** Class 0 is not a classification identified in any British Standard test.

Figure 4.21: Extract from Approved Document B Volume 2, Appendix A, '*Performance of materials, products and structures*'

4.2.41 As stated under Section 3, I believe that an architect should conclude from illustration '*e*' within Diagram 40 that the guidance in terms of fire safety for the performance of rainscreen panels for those parts of any building over 18 metres high (that is above the 18 meter point) would be: '*Class 0 (national class), or B-s3, d2* ***or*** *better (European class)*'. This is clearly stipulated under the heading: '*KEY TO THE EXTERNAL WALL SURFACE CLASSIFICATION*'.

4.2.42 As previously stated in Section 3, it is my view that possible confusion and ambiguity about these requirements are a consequence of what I consider to be poor drafting within the title to Diagram 40: '*...external surfaces or walls*'. These have quite different meanings and I do not understand how a diagram that purports to offer under its KEY a guide to '*EXTERNAL WALL SURFACE CLASSIFICATION*' can have any relevance beyond the wall's actual external surface or at most the material or product that makes up the external-most part of the wall – for example the outer brick leaf/ skin, or a rainscreen cladding product. (That is, any relevance to the make-up of the wall itself.)

4.2.43 On the basis of the guidance given within Diagram 40 it is therefore my opinion that an architect could quite reasonably decide not to look at establishing the requirements of the European classification, but instead simply ensure that there was compliance of the external wall surface with the National classification. Or, indeed, vice versa. That is the basis upon which I will assess the work of Studio E and subsequently (under Snap-Shot 3) of Harley.

4.2.44 Finally, I note that paragraph 12.7 of ADB2 refers to *'filler material'* amongst the components and substances that must be of *'limited combustibility'* where and when *'used in the external wall construction'*. Poor drafting has this paragraph under the sub-heading *'External surfaces'* when it would clearly be better placed under the previous heading of *'External wall construction'*. That point aside it is my view that the term *'filler material'* in this sense relates to a product or material such as mineral wool, or PIR insulation – that is something consisting of the same material – or at least largely the same material - throughout its make-up. I do not think that the authors of ADB2 intended the term *'filler'* or *'filler material'* to mean any part of a composite material (e.g. aluminium composite panel) that is factory manufactured and delivered to site as a finished product. Rather, it is something (either solid (e.g. polystyrene), granular (e.g. sand) or fluid (e.g. mastic)) that is put into, squeezed into, or poured into a host environment. It will be for the Inquiry to determine the meaning of *'filler material'* in the context of paragraph 12.7 of ADB2, but I can affirm with confidence that as an architect I would never have interpreted the polyethylene core of an ACP panel to be a *'filler material'* in the sense of the term as used in ADB2. That is a material or component in its own right. Therefore, I would have looked, in terms of considering the BBA Test Certificate in relation to the performance of the Reynobond ACP panel, only at the rating given to the product as a whole. I would not have made any enquiry of the elements of the product.

Commentary Snap-Shot 1: Rainscreen Cladding:

4.2.45 In their Stage D Report, Studio E applied paragraph H92 of the NBS Specification as the following extract shows {SEA00008054}:

H92 Rain-screen Cladding: Pre-patinated zinc rainscreen cladding on aluminium cladding rails with insulation fixed directly to existing concrete.

- 1mm folded metal shingles on steel substrate: Rheinzink Blue
- Pre-formed window surrounds (cill/jamb/head). Cills angled to prevent roosting.
- Spandrel panels U-value 0.15 W/m²K (=150mm PIR)
- Columns U-value 0.18 W/m²K (=100mm PIR)
- Decorative strips to Strips to

Figure 4.22: Extract from the Studio E Outline Specification {SEA00008054}

4.2.46 On examination of the Rheinzink product range only one product seems to fit this description. I provide further details in that respect as follows:

4.2.47 The Rheinzink website is to be found at:

https://www.rheinzink.co.uk.

Based on the description above of *'1mm folded metal shingles on steel substrate'* it appears that the '*Flat-Lock Tiles*' are possibly the product considered at this stage. Below is a typical detail extracted from the Rheinzink website with a product description of the zinc tile using the profiled steel deck tile that matches the '*shingle*' and '*steel substrate*' terms within H92. The following diagrams are extracts from the company website:

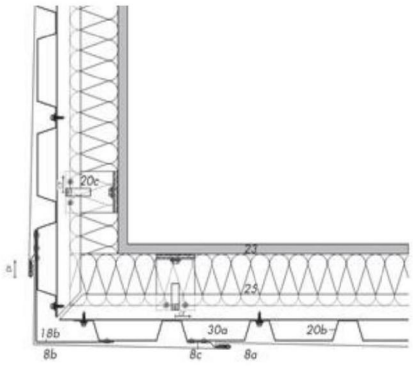


Figure 4.23

RHEINZINK-Flat-Lock Tile
Horizontal installation, window profiles and outside corner – matched to fit the face width.

Figure 4.24

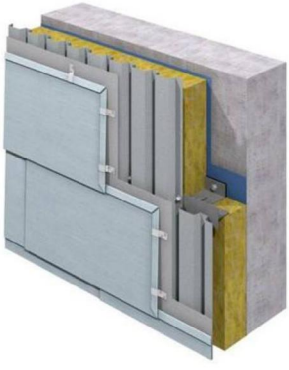


Figure 4.25

Figures 4.23, 4.24, and 4.25: Image extracts from the Rheinzink Product Literature Guide for '*Flat Lock Tiles*'

4.2.48 Under 1.13 of the literature it suggests that with a metal substrate and appropriate fasteners a '*non-combustible*' Building Material Class A1 to DIN 4102 could be achieved. Whilst there isn't a direct reference to the BS EN13015-1 standard in the brochure, the declaration of performance does indicate an A1 (untested) rating.

1.13 Fire Protection

Metal facades with a metal substructure and appropriate fasteners meet the highest requirements for non-combustibility (Building Material Class A1, DIN 4102). In the case of bracket-mounted, rear-ventilated facades, it may be necessary to install firestops.

Figure 4.26: Extract from the Rheinzink Product Literature Guide for '*Flat Lock Tiles*'

> DIN 4102-1 fire test to building material - Classification

When the material's fire behaviour has been determined in accordance with the standard, it divides into:

Building material class		Designation
Class A	A1	Non-combustible materials
	A2	
Class B	B1	Not easily flammable
	B2	Flammable
	B3	Easily flammable

Figure 4.27: Extract from the Rheinzink '*Declaration of Performance flat lock-tile EN 14783*'

6. Declared performances:

Essential characteristics	Performance
Water permeability	Impermeable
Vapour diffusion- and air tightness	Water vapour impermeable
Reaction to fire (EN 13501-1)	A1 (without testing, 96/603/EG)
Dimensional change	$22 \cdot 10^{-6} \cdot K^{-1}$
Durability	Titanium zinc according to EN 501 + EN 988, RHEINZINK-CLASSIC & RHEINZINK-prePATINA: patina forming material The following coatings are available: Top side: transparent polyester-coating Button side: papyrus white polyester-coating RHEINZINK-artCOLOR: Top side: PVDF-color-coating Button side: papyrus white polyester-coating
External fire performance (only for roof coverings, EN 13501-5)	Definitions fulfilled according to 2000/553/EG,

Figure 4.28: Extract from the Rheinzink '*Declaration of Performance flat lock-tile EN 14783*'

4.2.49 As the above extracts from the '*Rheinzink Flat Tile Product Guide*' show, when the zinc rainscreen panel is supported on a metal support system a DIN 4102 A1 rating can be achieved. This surpasses the minimum requirement as set out under ADB2 Diagram 40 which stipulates B-s3, d2. I note that the '*Declared performance*' diagram refers under '*Reaction to fire*' (EN 13501-1)' to '*A1 (**without testing** 96/603/EG)*' – my emboldment. Upon inquiry Rheinzink advised that testing is deemed unnecessary under a European Commission decision – as described within the referenced document 96/603/EG entitled '*Commission Decision of 4 October 1996*' establishing the list of products belonging to Classes A '*no contribution to fire provided for in Decision 94/611/ EC implementing Article 20 of Council Directive 89/106/EEC on construction products*'.

4.2.50 To conclude the Rheinzink Flat Tile product as specified at this stage by Studio E therefore met the standard '*class B-s3, d2 or better*' as set out in ADB Diagram 40 '*Provisions for External Surfaces or Walls*' as per the illustration at '*e*': '*ANY BUILDING*'.

4.2.51 On the basis of the above I believe that in specifying the Rheinzink Flat Tile product Studio E were complying with the guidance given under Diagram 40.

Conclusion Snap-Shot 1: Rainscreen Cladding

4.2.52 The zinc rainscreen cladding as specified within Studio E's Stage D Report complied with the guidance given under ADB2 and also met the requirements of the Building Regulations.

Cavity Barriers

(Building Regulations and Approved Document Guidance will be provided under Snap-Shot 2)

Commentary Snap-Shot 1: Cavity Barriers

4.2.53 I have found no evidence that the requirements with respect to cavity barriers were addressed by the architect or any other consultant during this stage of the project/work.

4.2.54 This is neither a surprise nor a concern to me. A competent architect would know that the issue has to be addressed at an appropriate time and it would be perfectly normal to leave consideration of the matter for a later stage in the project when detailed design development begins in earnest.

Conclusion Snap-Shot 1: Cavity Barriers

4.2.55 I therefore see no basis for criticising the architect, or any other party, with respect to their performance in relation to the issue of cavity barriers at this stage of the project.

Window Infill Panels

(Building Regulations and Approved Document Guidance will be provided under Snap-Shot 2)

Commentary Snap-Shot 1: Window Infill Panels:

4.2.56 I exhibit below an extract from Studio E Stage D Outline Specification (August 2013) {SEA00008054}.

L10 PPC Aluminium thermally broken windows.
- openable windows PPC Aluminium doubled glazed
- Inward opening casement windows (purge panels)
- External louvers to purge panel windows 100mm max openings
- Large tilt and turn casements. Lockable restrictors to prevent casual opening.
- Obscure panels below 1100mm from FFL
- Opaque white insulated blanking panels between windows

Figure 4.29: Extract from Studio E Stage D Outline Specification {SEA00008054}

4.2.57 The Studio E Stage D Report specification {SEA00008054} references '*opaque blanking panels*' (referred to herein as '*window infill panels*') but there is no further indication of what these are made of. Beyond this reference there is no product identification or further detail provided with respect to this item.

4.2.58 I have found no evidence of any detailed specification with respect to the window infill panels was proffered by the architect or any other consultant during this stage of the project/work.

4.2.59 Again, this is neither a surprise nor a concern to me for the reasons stated above under my commentary on Cavity Barriers. At the early stages of a project – that is up to the end of RIBA Stage D, which is submission of planning application, this level of detail is unexpected and unnecessary.

Conclusion Snap-Shot 1: Window Infill Panels:

4.2.60 I therefore see no basis for criticising the architect, or any other party, with respect to their performance in relation to the issue of window infill panels at this stage of the project.

Internal Window Head, Jamb, Sill Voids

(Building Regulations and Approved Document Guidance will be provided under Snap-Shot 2)

Commentary Snap-Shot 1: Internal Window Head, Jamb, Sill Voids

4.2.61 I have found no evidence that the requirements with respect to the internal window head, jamb, sill voids were addressed by the architect or any other consultant during this stage of the project/work.

4.2.62 There is no specification reference to the internal window head, jamb or sill interfaces, or their linings within the Studio E Stage D Report {SEA00008054}.

4.2.63 Again, this is neither a surprise nor a concern to me for the reasons stated above under my commentary on Cavity Barriers and Window Infill Panels. There are two reasons why such work is not necessary at this early stage (Snap-Shot 1):

a) Few clients are ever prepared to commit either time or fees to such advanced work in terms of detail.

b) The RIBA Plan of Work describes such activity as taking place during '*Technical Design*', which is RIBA stage E onwards.

4.2.64 Within my Section 3 Indicative Approach I have shown some exploratory detailing that is typical of work that would be carried out at RIBA Stage D in preparation for later work that would be more thoroughly carried through at RIBA Stage E onwards. The point here is that an architect tests early concept work in this way to ensure, as far as is reasonably possible, that his proposals can be effectively worked through at later stage in terms of spatial provision and cost within the parameters of the design. Such early work as I have alluded to within Section 3 is effectively '*prep*' work to ensure that the concept is robust and can be worked through to completion without significant change to the essential principles. An experienced architect knows how far to take this process in terms of any particular project in the context of its complexity and novelty.

Conclusion Snap-Shot 1: Internal Window Head, Jamb Voids

4.2.65 I therefore see no basis for criticising the architect, or any other party, with respect to their performance in relation to the issue of internal window head, jamb, sill voids at this stage of the project.

4.3 Snap-Shot 2 – Studio E: Tender Documentation (August 2013 - January 2014)

4.3.1 I show below the Matrix with Snap-Shot 2 duly filled in to record my conclusions in terms of the compliance of each item of the work at this stage with the Building Regulations:

a)	envelope insulation:	NOT COMPLIANT
b)	rainscreen cladding:	COMPLIANT
c)	cavity barriers – window openings:	NOT COMPLIANT
d)	cavity barriers - vertical compartment walls:	NOT COMPLIANT
e)	cavity barriers – horizontal compartment floors:	COMPLIANT
f)	cavity barriers – the Crown	NOT COMPLIANT
g)	window infill panels:	INADEQUATE DOCS
h)	internal window head, jamb, sill voids:	INADEQUATE DOCS

Design Element	Studio E Stage D Design Report	Studio E Tender Documentation		Harley Construction Documentation	Studio E As Built Documentation
Envelope Insulation	✗	✗	Novation		
Rainscreen Cladding	✓	✓			
Cavity Barriers (Window Openings)	○	✗			
Vertical Cavity Barriers (Compartment Walls)	○	✗			
Horizontal Cavity Barriers (Compartment Floors)	○	✓			
Cavity Barriers (The Crown)	○	✗			
Window Unit Infill Panels	○	●			
Window Head, Jamb, Sill Interface	○	●			

Legend:
- ✓ Documentation Considered Compliant with ADB2
- ✗ Documentation Considered not to Comply with ADB2
- ○ Documentation Not Provided but Not Expected
- ● Documentation Unclear/ Not Provided But Expected

Figure: 4.30 Reporting Matrix Snap-Shot 2

4.3.2 I comment below on each of the items in sequence and where I have not done so earlier in this section I summarise the requirements of the Building Regulations and the guidance set out in the relevant Approved Document.

Envelope Insulation

(For the convenience of the reader I will repeat some of my Section 3 commentary on fire safety requirements of the Building Regulations and the guidance given in this respect within ADB2 as I expand herewith on those issues.)

Commentary Snap-Shot 2: Envelope Insulation

4.3.3 Problems with the envelope insulation specification at Stage D Design Report Stage (Snap-Shot 1) were carried into the Tender Documentation stage of Studio E's work.

4.3.4 Routine design reviews in line with RIBA recommended practice and compliance with ISO 9001 should have identified these problems at the outset of this stage of the work. They did not do so, either because such reviews were not carried out at all, or because they were not carried out properly.

4.3.5 An insulation material that complied with the guidance under ADB2 in terms of *'limited combustibility'* criteria and met the target U-value would have been thicker, and this would have required design modifications: the rainscreen would have to be positioned further away from the façade of the original building, all as shown in the indicative design within Section 3 of this report. Accordingly, all Studio E work, and the work of other consultants, relating to the tender documentation was based on false assumptions in relation the required cavity size.

4.3.6 I exhibit below {SEA00000169} a copy of Clause 776 which is an extract from Studio E's full NBS H92 as incorporated into the Employer's Requirements Document January 30th, 2014 Revision. (NBS is the acronym for National Building Specification which is widely used within the construction industry and offers a template and guidance for specifications. H92 is the section that deals with rainscreen cladding.) Celotex, described as a rigid polyisocyanurate board (PIR), is listed as the insulation.

776 THERMAL INSULATION

- Material: Zero ODP rigid polyisocyanurate insulation board. BRE Green Guide rating A+.
- Manufacturer: Celotex Ltd, Lady Lane Industrial Estate, Hadleigh Ipswich Suffolk IP7 6BA
  T: 0901 996 0100,
  Web: celotex.co.uk, Email: technical@celotex.co.uk.
  - Product reference: FR5000 aluminium foil faced both sides.
    - Conductivity: 0.021W/mk.
- Thickness: Not less than 150mm for spandrel panels and 80mm for columns.
  - Required performance: Refer to clause 430.
- Recycled content: Manufacturer to confirm.
- Fixing: Attached to the outer face or supported within the backing wall so as not to bulge, sag, delaminate or detach during installation or in situ during the life of the rainscreen cladding.

Figure 4.31: Extract from NBS section H92 '*Rainscreen cladding*' {SEA00000169}

4.3.7 This represents a serious compounding of the error made under Snap-Shot 1. The design work had continued over some five months and had been substantially developed during that period. This fundamental error should have been spotted during that time by the design team on multiple occasions: for example, during formal internal design reviews, technical reviews and at design team workshops. I consider Studio E to be ultimately responsible for this failure.

4.3.8 I exhibit once more part of the extract from product information for Celotex RS5000 which the company made available from the summer of 2014 {CEL00000013}.

The system tested to BS 8414-2:2005 was as follows:

- 12mm fibre cement panels
- Supporting aluminium brackets and vertical rails
- 100mm Celotex RS5000
- 12mm non-combustible sheathing board
- 100mm SFS system
- 2 x 12.5mm plasterboard

Figure 4.32: Extract from Celotex RS5000 '*Rainscreen Cladding Specification Guide*' {CEL00000013}

4.3.9 As stated under Snap-Shot 1 it is unlikely that Studio E had been shown this at the time of issuing their tender documents. However, I quote from the Celotex data sheet {CEL00001240} as follows as an illustration of what Celotex were prepared to claim on behalf of their product, and what, in effect, offered subsequent affirmation that the RS5000 product was suitable for the Grenfell Tower project:

'RS5000 represents an ongoing commitment to product innovation and is the first PIR insulation board to meet the performance criteria in BR 135 for insulated rainscreen cladding systems and is therefore acceptable for use in buildings above 18 metres in height…

Celotex RS5000 is a premium performance solution and is the first PIR board to successfully meet the performance criteria set out in BR 135 for rainscreen cladding systems. The system tested was as follows: 12mm Fiber Cement Panels supporting aluminium brackets and vertical rails, 100 mm Celotex RS5000 12mm non-compressible sheathing boards, 100mm SFS System 2 x 12,5mm plasterboard. The fire performance and classification report issued ***only relates to the components detailed above. Any changes to the components listed will need to be considered by the building designer.'*** (My emboldening).

4.3.10 BR 135 is a publication issued by the BRE (Building Research Establishment). The third edition was published in 2013. It was first published in 1988. It states:

'....in response to the increasing use of thermal insulation in the refurbishment of multi-storey buildings. This third edition and has been revised to reflect the growing market for external cladding systems and the increasingly demanding requirements for thermal performance requirements. It also provides updated guidance on the performance of current materials and technologies.

It describes and illustrates scenarios based on typical examples of current practice, allowing designers to understand the parameters relating to fire safety design and the construction of external cladding. It also consolidates the fire performance classification systems for full-scale fire tests in BS 8414 Fire performance of external cladding systems.'

4.3.11 I do not know how Celotex draw the conclusion from BR 135 that their PIR product was suitable for buildings over 18 metres high. I understand that these issues are being separately investigated by the Inquiry.

4.3.12 But against that background, the internal email 1 November 2013 from Jonathan Roper to Paul Evans (both Celotex employees) is disturbing {CEL00000716}. It reveals an attitude that reflects an irresponsible corporate culture on the part of Celotex. I exhibit the email in full below with key parts highlighted.

From: Roper, Jonathan [/O=CELOTEX LTD/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=JROPER]
Sent: 01/11/2013 09:57:49
To: Evans, Paul [pevans@celotex.co.uk]
Subject: RE: RE:

Well... I think we have two possible solutions for testing in which both David @ IFC and I have confidence in. Will explain more on Monday but essentially since the beginning of the project, we have been looking at testing worst case scenario with an improved fire barrier to be then supported by an assessment report which broadens the scope of potential systems that we are applicable for.

After much research, I don't think this is possible and I don't believe K'span have a similar report. We cannot seem to find or design a suitable barrier in which we have enough confidence that it can be used behind a standard ACM panel which we know will melt and allow fire into the cavity. Speaking to SIMCO on Wednesday in B'ham with IL, he confirmed that architects will specify K15 with a standard fire barrier and panel. When the work is contracted and then sub-contracted to cladding contractors such as Simco, H A Marks, Stanmore etc, they value engineer that system to be competitive at tender. This means changing fire barriers, changing panels. The architect's only guarantee is that K15 will be used because there is no other alternative available.

An architect will be told that K15 is applicable for above 18m in accordance with ADB and that suffices from their perspective. Kingspan have done a great job at the spec end and according to Simco are specified much more than Rockwool Duo Slab for thermal performance. As discussed above, contractors opt for more cost effective solutions and although they are liable for what goes into that building, they do not know enough about the fire test to challenge. The only figure who might possibly challenge a product's eligibility for use in buildings above 18m is the building control officer. Kingspan I would suggest do not have a piece of paper that states they can specifically be used behind any cladding panel. What they have done is got BBA certification stating the fire test method and taken that to LABC to get a registered document detail which states that K15 can be used in a variety of cladding systems and complies with ADB through passing BR 135. A building control officer is unlikely to challenge a document that is approved from the head of building control.

What does all of this mean for us ? System approval limits us hugely as the market is so fragmented and its extremely difficult to grasp who is being most commonly used. The likes of Marley, Alucobond & Trespa are spec'd a lot but value engineered out for standard aluminium panels. Trying to do the right thing requires a complete re-education of the mkt and this would require a huge campaign and probably a lawsuit. Two options proposed below :

1. Test a standard A2 limited combustible panel of which there are a few (Alucobond A2, Marley Eternit) with a standard fire barrier system. If challenged on what system to use, we can happily state that our test used an A2 panel with a particular commonly used fire barrier. Still not 100% confident in passing as A2 is a euroclass classification derived from test data on reaction to fire testing.

2. Opt for the K'span route and put a cement particle board as the cladding. Use a standard fire barrier. Good chance of passing knowing they have and cp board is good in terms of resistance to fire.

However, what we do need to consider is if we have two potential systems that could pass, how do these dictate route to market. What does an ASM/CTC state to somebody who enquires ? If we simply have the test report, we don't want to have to provide this as evidence. Do we in fact need to spend £25k/£30k for a BBA to be able to gain this document from LABC which in my mind gives us very little chance of being challenged from building control. Do we partner with a few fire barrier manufacturers who have tested with K15 currently to gain confidence in the mkt that way ? Or do we take the view that our product realistically shouldn't be used behind most cladding panels because in the event of a fire it would burn ?

What K'span have done extremely well is say very little but build confidence if challenged by having fire barrier manufacturers showing tests with K15, achieve BBA validation and subsequently gain LABC approval. There is always the chance they do have the piece of paper in the top drawer from somebody that states for use with any system but I doubt it. !

Jon

Jonathan Roper
Product Manager

Figure 4.33: Internal Celotex Email Correspondence {CEL00000716}

4.3.13 Essentially, as the high-lighting shows, Mr Roper was addressing a problem posed, as he saw it, by the fact that his company were being outsold in the rainscreen over 18 metre market by competitors with a product that did not meet ADB2 guidance with respect to performance in fire. He lamented the fact that this was because there was, in his opinion, unjustified industry confidence in their competitor's brand and confusion in terms of testing classifications and codes.

4.3.14 He suggested two possible options: the first essentially involved issuing incorrect information that would imply that Celotex products did meet code requirements. The second involved restricting the claims on their product to uses that were known to be code compliant. This is revealed in the following quote from that email:

'Or do we take view that our product realistically ***shouldn't be used behind most cladding panels because in the event of fire it would burn****?'* (my emboldening)

4.3.15 Given that this question was being posed on 1 November 2013 I don't know how, by summer of 2014, Celotex was claiming in their Data Sheet {CEL00001240} that *'RS5000… is the first PIR insulation board to meet the performance criteria in BR 135 for insulated rainscreen cladding systems and therefore is acceptable for use in buildings above 18 metres in height'.*

4.3.16 It seems to me that this demonstrates that it is probable that Celotex were marketing a product for use in the external walls of buildings over 18 meters high that they knew at the time was not compliant with the guidance given in ADB2. It also seems, from the same email, that this was widespread practice for this type of product within the market.

4.3.17 In my view two things are clear:

a) A manufacturer should provide reliable and truthful information on their product's performance, especially in important areas such as fire testing and certification.

b) An architect should study manufacturer's literature carefully to ensure as far as reasonably possible that the claims made meet standards stipulated in Approved Document guidance.

4.3.18 In the absence of a certificate confirming that the Celotex product met the standard of '*limited combustibility*' as defined in ADB2 (and none was available), Studio E should have redesigned the envelope to provide a deeper cavity to accommodate a code compliant insulation before issuing tender documents. All other consultants should have been requested to amend their own work, where appropriate, accordingly.

4.3.19 I exhibit below an extract from Exova Fire Strategy Rev. 03 {EXO00001106} that was issued on 7 November 2013. It is identical to the text that Exova incorporated into their Revision 1 issue as incorporated into the Studio E Stage D Report.

3.1.4 Compliance with B4 (external fire spread)

It is considered that the proposed changes will have no adverse effect on the building in relation to external fire spread but this will be confirmed by an analysis in a future issue of this report.

Figure 4.34: Extract from Exova Fire Strategy Document Issue 03 {EXO00001106}

4.3.20 I cannot understand how a fire consultant could possibly issue a note headed '*Compliance with B4 (external fire spread)*' such as that quoted above which states that the proposed over-cladding work will have '*no adverse effect*' without taking care to properly study the information to which the note applies, as developed at that time, for the external wall construction. If Exova did carry out such a study they would have seen insulation referenced in Studio E drawings, drawing no. 1279 (06) 120, {SEA00002551} which clearly shows insulation referenced to spec clause H92/776, which states the product to be Celotex RS5000 {SEA00000169}. They would also have seen FR5000 identified in the Studio E Stage C Report of October 2012 {SEA00006429}. As a fire consultant Exova should have realised that this product was non-compliant with the guidance in ADB2. Accordingly, they should have a) raised alarm bells within the design team and b) refused to offer such endorsement within their note. In the alternative, if Exova did not secure access to information that was current and which described the over-cladding arrangements and products as proposed, the company should not have written a note that endorsed the proposal by stating under the heading 'Compliance with B4 (external fire spread)' that *'It is considered that the proposed changes will have no adverse effect on the building in relation to external fire spread…'*

4.3.21 Routine Design Reviews in line with RIBA recommended practice and compliance with ISO 9001 should have identified this problem both during and at the conclusion of this stage of the work (Tender Documentation). This did not happen either because those reviews were not carried out, or because they were not carried out properly. The problem was thus carried into the next stage of the work on Envelope Insulation which I will review later herein under Snap-Shot 3 / Harley Construction Documentation.

Conclusion Snap-Shot 2: Envelope Insulation

4.3.22 The insulation as specified within Studio E's Tender Documentation failed to comply with the guidance given under ADB2 and it also failed to meet the requirements of the Building Regulations.

4.3.23 As a result, this problem was carried over into the next stage which will be reviewed under Snap-Shot 3.

4.3.24 Studio E's continued confidence in the Celotex RS5000 product, and the use of PIR insulation within the cladding system, represents an ongoing major failure on their part to understand both the requirements of the Building Regulations and the guidance given within ADB2.

4.3.25 Celotex was promoting a product for use in buildings over 18 metres in height that they appear to have known did not meet the requirements of the Building Regulations.

Rainscreen Cladding

Building Regulations and Approved Document Guidance:

(Requirements of Building Regulations and guidance of ADB2 already provided under Snap-Shot 1)

Commentary Snap-Shot 2: Rainscreen Cladding

4.3.26 With the exception of the dimensional error (cavity too narrow to accommodate the thickness of mineral wool required in lieu of Celotex RS5000) the work brought forward from the previous stage (Studio E Stage D Design Report) provided a satisfactory basis for Studio E to commence work on their tender documentation.

4.3.27 Clause 11 in Studio E's full NBS H92 Employer's Requirement Document of 30 January 2014, exhibited below {SEA00000169} included a provision for tenderers to provide a cost comparison for alternative cladding systems from the list exhibited below (Reynobond/Alucobond/Zinc). I am critical of this listing as it refers in one instance to a product name (Reynobond), in a second to a manufacturer (Alucobond) and in the third to a material. It seems that the references are to:

a) Alcoa Architectural Products / Reynobond (respectively supplier and product name)

b) Alucobond / Spectra (respectively supplier and product name)

c) VM Zinc / Quartz Zinc (respectively supplier and product name)

The above listed alternatives were to be priced alongside a Proteus HR honeycomb rainscreen panel (product) supplied by KME Architectural Solutions Ltd. This product/system was listed in Clause 120 of the NBS Specification H92. It comprised a preformed panel made of a sheet of zinc each side of a honeycomb core to which the sheets were bonded. The core was aluminium.

11 INFORMATION TO BE PROVIDED WITH TENDER

- In addition to the cladding spcified in the below clauses 120 & 123 submit comparetive supply and install costs per m2 of the whole cladding system for the following alternative materials:

  Reynobond - Duragloss 5000:
  - o Metallic std & non-std (Satin gloss)
  - o Chameleon
  - o Anodised Look (Satin gloss)

  Alucobond:
  - o Spectra, Sakura 917.

  Zinc:
  - o QUARTZ ZINC composite polymer panel by VM Zinc

  Note: Face fastened solutions permitted.

Figure 4.35: Extract from Studio E NBS section H92 '*Rainscreen cladding*' {SEA00000169}

120 RAINSCREEN CLADDING TO COLUMNS & EXTERNAL ENVELOPE OF MAIN ENTRANCE CANOPY

- Primary support structure: Reinforced concrete half column with precast concrete cladding.
- Rainscreen cladding system:
  - Manufacturer: Submit proposals.
  - Type: Drained and back ventilated.
- Rainscreen panel:
  - Manufacturer:
    KME Architectural Solutions
    C/O KME Yorkshire Limited
    East Lancashire Road
    Kirkby
    http://www.kmearchitectural.com.
    Product reference: PROTEUS HR honeycomb rainscreen panel.
  - Material: aluminium honeycomb core structurally bonded between two lightweight zinc skins.
    zinc sheets manufacturer:
    NedZink B.V., Postbus 2135, 6020 AC Budel, Hoofdstraat 1, 6024 AA Budel-Dorplein, Netherland
    Tel:[redacted]
    web: nedzink.com

    zinc sheets supplier:
    SIG Zinc & Copper, Warnell, Welton, Carlisle, Cumbria, CA5 7HH
    Contact:
    Simon Walker
    Category Manager
    simonwalker@sigdandt.co.uk
    [redacted]
  - Thickness: To be confirmed by manufacturer. Provide backing panels to easy-to-reach locations if required to pass Category A under BS8200: 1985.
  - Finish/ Colour: NedZink NOVA, pre-weathered.
  - Fasteners: Concealed as recommended by panel manufacturer.
    Number and location: As recommended by panel manufacturer to suite location and panel layout.
  - Joint type: TBC.
  - Joint width: 20mm.
- Air gap: min 25 mm.
- Secondary support/framing system: Vertical rails with fixing brackets on thermal break spacers.
  - Manufacturer: Submit proposals.
    Product reference: As recommended by panel manufacturer to suit location and panel layout.
  - Material: Aluminium.
  - Fasteners: As recommended by panel manufacturer.
    Number and location: As recommended by panel manufacturer to suite location and panel layout.
- Backing wall: Existing diamond shaped reinforced concrete half column with precast concrete cladding.
  - Vapour control layer: As clause 780.
  - Thermal insulation: As clause 776.
  - Breather membrane: As clause 785.
- Accessories: Include products, fixings and interfaces necessary to complete the fabrication and installation.
- Incorporated components: Flashings, insect mesh.
- Other requirements: None.

Figure 4.36: Extract from Studio E NBS section H92 '*Rainscreen cladding*' {SEA00000169}

123 RAINSCREEN CLADDING TO SPANDREL PANELS

- Primary support structure: Precast structural reinforced concrete spandrel panel.
- Rainscreen cladding system:
  - Manufacturer: Submit proposals.
  - Type: Drained and back ventilated.
- Rainscreen panel:
  - Manufacturer:
    KME Architectural Solutions
    C/O KME Yorkshire Limited
    East Lancashire Road
    Kirkby
    http://www.kmearchitectural.com.
    Product reference: PROTEUS HR honeycomb rainscreen panel.
  - Material: aluminium honeycomb core structurally bonded between two lightweight zinc skins.
    zinc sheets manufacturer:
    NedZink B.V., Postbus 2135, 6020 AC Budel, Hoofdstraat 1, 6024 AA Budel-Dorplein, Netherland
    Tel: [redacted]
    web: nedzink.com

    zinc sheets supplier:
    SIG Zinc & Copper, Warnell, Welton, Carlisle, Cumbria, CA5 7HH
    Contact:
    Simon Walker
    Category Manager
    simonwalker@sigdandt.co.uk
    [redacted]
  - Thickness: To be confirmed by manufacturer.
  - Finish/ Colour: NedZink NOVA, pre-weathered.
  - Fasteners: Concealed as recommended by panel manufacturer.
    Number and location: As recommended by panel manufacturer to suite location and panel layout.
  - Joint type: TBC.
  - Joint width: 20mm.
- Air gap: min 25 mm.
- Secondary support/framing system: Vertical rails with fixing brackets on thermal break spacers.
  - Manufacturer: Submit proposals.
    Product reference: As recommended by panel manufacturer to suite location and panel layout.
  - Material: Aluminium.
  - Fasteners: As recommended by panel manufacturer.
    Number and location: As recommended by panel manufacturer to suite location and panel layout.
- Backing wall: Structural RC spandrel panel.
  - Vapour control layer: As clause 780.
  - Thermal insulation: As clause 776.
  - Breather membrane: As clause 785.
- Accessories: Include products, fixings and interfaces necessary to complete the fabrication and installation.
- Incorporated components: Copings, cill pressings, window head drip pressings, other flashings, insect mesh.
- Other requirements: None.

Figure 4.37: Extract from Studio E NBS section H92 '*Rainscreen cladding*' {SEA00000169}

4.3.28 I comment below on each of these products in turn with respect to their compliance with ADB2 guidance and the requirements of the Building Regulations:

Alcoa Architectural Products / Reynobond

Behaviour in relation to fire — in relation to the Building Regulations for reaction to fire, the panels may be regarded as having a Class 0 surface in England and Wales, and a 'low risk' material in Scotland (see section 6).

6 Behaviour in relation to fire

6.1 A standard sample of the product, with a grey/green Duragloss 5000 coating, when tested for reaction to fire, achieved a classification of B-s2, d0 in accordance with EN 13501-1 : 2002. A fire retardant sample of the product, with a gold-coloured Duragloss finish, when tested for reaction to fire, achieved a classification B-s1, d0 in accordance with EN 13501 : 2002.

6.2 A fire retardant sample of the product, with a metallic grey PVDF finish, when tested in accordance with BS 476-6 : 1989, achieved a fire propagation index (I) of 0 and, when tested in accordance with BS 476-7 : 1997, achieved a Class 1 surface spread of flame.

6.3 As a consequence of sections 6.1 and 6.2, the products may be regarded as having a Class 0 surface in relation to the Approved Document B of The Building Regulations 2000 (as amended) (England and Wales) and Technical Booklet E of The Building Regulations (Northern Ireland) 2000 (as amended) and a 'low risk' material as defined in Annex 2C[1] and Annex 2E[2] of The Building (Scotland) Regulations 2004 (as amended). The unexposed side of the products may also be regarded as having a class 0 surface.

6.4 These performances may not be achieved by other colours of the product and the designations of a particular colour should be confirmed by:

England and Wales — Test or assessment in accordance with Approved Document B, Appendix A, Clause 1

Scotland — Test to conform with the Table to Annex 2C[1] or Annex 2E[2] of Regulation 9

(1) Technical Handbook (Domestic).
(2) Technical Handbook (Non-Domestic).

Northern Ireland — Test or assessment by a UKAS accredited laboratory or an independent consultant with appropriate experience.

Figure 4.38: Extract from the Alcoa Architectural Products 2008 BBA Certificate No. 08/4510 {BBA00000047}

4.3.29 Assessment: At para 6.1 a standard (non-fire retardant) sample was certified as compliant with European Standard Class B as set out in ADB2 Diagram 40.

Alucobond / Spectra

FIRE CLASSIFICATION.

	ALUCOBOND®	
Country	**Tested according to...**	**Classification**
EU	EN 13501-1	Class D
Germany	DIN 4102-1 DIN 4102-7	Class B2 fulfilled
France	NF P 92-501 NF F 16-101	Class M1 Class F0
Italy	UNI 9177	Class 1
Great Britain England / Wales / Scotland	 BS 476-6/7 BS 476-6/7	 Class 0 Class 0

Figure 4.39: Extract from the 3M Alucobond Product Literature Guide dated 2012 {SEA00002713}

4.3.30 Assessment: This manufacturer's classification confirms compliance with Class 0 National Standard so achieves ADB Diagram 40 requirements but note it only meets Class D European Standard whereas diagram 40 requires Class B or better.

VM Zinc / Quartz Zinc

Fire resistance VMZ Composite in QUARTZ-ZINC® and ANTHRA-ZINC® is certified $B\text{-}s_1\text{-}d_0$ according to the European fire resistance standard EN 13501-1.

Figure 4.40: Extract from the VMZinc Composite, Composite zinc panels for ventilated cladding and curtain walls '*Specification and Installation Guide*'

4.3.31 Assessment: This manufacturer's classification confirms compliance with European Standard Class B as set out in ADB2 Diagram 40.

KME Architectural Solutions Ltd/ Proteus HR

Performance

Fire performance

The Proteus HR system meets the requirements of BS476: Parts 6 and 7, therefore achieving a Class O rating as classified by Building Regulations. Any specified firebreaks would be installed by a Proteus approved contractor. A non-standard A2 System is also available, which meets the requirements of the London Underground Code of Practice; the product is listed on the London Underground Register of approved products as 'Proteus HR LU'. For further information, please contact our technical department.

Figure 4.41: Extract from the Proteus HR Brochure (date unknown)

Figure 4.42: Deleted

4.3.32 Assessment: This manufacturer's classification confirms compliance with ADB2 Diagram 40 and with Class 0 National Standard.

4.3.33 The following '*Typical Bay*' elevation and 1:20 intermediate column plan was also issued with the tender documentation. I am critical of Studio E for not having developed 1:5 details at this stage. If they had done so they should have realised that there were fundamental problems that had to be resolved with respect to the ventilated rainscreen system's vertical joints as they passed the horizontal cavity barriers that aligned with the compartment floors. These provided a weakness that would have enabled fire within the cavities to bi-pass those cavity barriers. I show those drawings below:

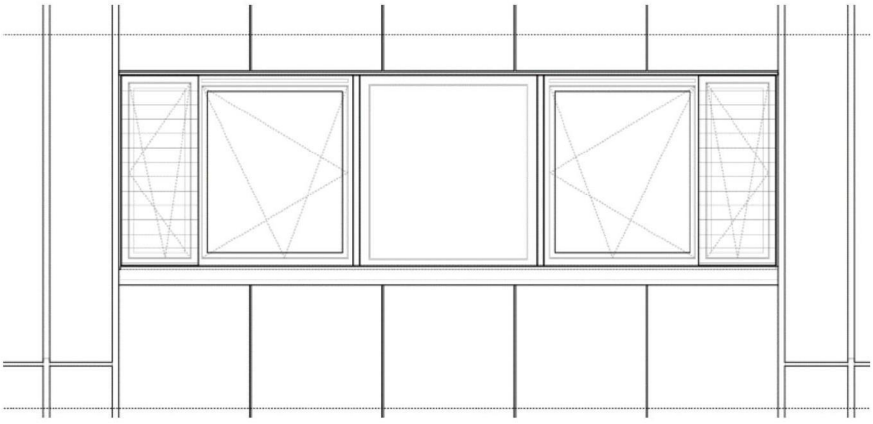


Figure 4.43: Extract from Studio E Drawing 1279 (06) 110 00 *'Proposed Typical Bay Plans, Section & Elevation'* {SEA00002499}

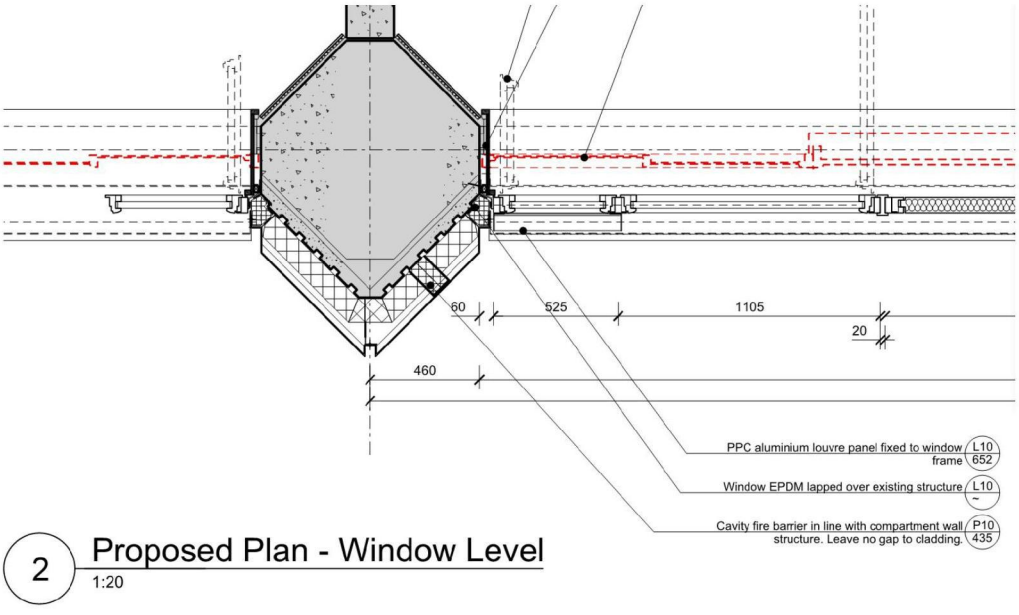


Figure 4.44: Extract from Studio E Drawing 1279 (06) 110 00 *'Proposed Typical Bay Plans, Section & Elevation'* {SEA00002499}

4.3.34 Routine Design Reviews in line with RIBA recommended practice and compliance with ISO 9001 should have identified the above listed fundamental inadequacies of this work during its progress and at completion of the Studio E Tender Documentation process in terms of its flawed concepts and inadequate scope. This did not happen either because those reviews were not carried out, or because they were not carried out properly. The problem was thus carried into the next stage of the work on rainscreen cladding which I will review later herein under Snap-Shot 3 under Harley Production and Construction Documentation.

Conclusion Snap-Shot 2: Rainscreen Cladding

4.3.35 Each of the four rainscreen cladding options as specified within Studio E's tender documentation appeared on the basis of their product literature and supporting information to comply with the guidance given under ADB2.

a) It is notable that whilst Reynobond offered a test certificate that confirmed their '*standard*' product achieved a European standard of compliance with respect to ADB Diagram 40 (i.e. non fire-retardant core as ultimately used for the 2012-16 Works). That endorsement was however qualified in that it related to only one colour sample and warned that other colours may not have met the stipulated European Standard.

b) The Alucobond failed to meet European Standard but nevertheless met National Class O Standard so also complied with ADB2 Diagram 40 guidance.

c) VM Zinc met European Standard Class B and thus complied with ADB2 Diagram 40.

d) Proteus Facades met the National Standard Class O and thus met ADB2 Diagram 40 guidance.

4.3.36 I cannot comment on whether the Alucobond, VM Zinc or Proteus Façade products would also meet the requirements of the Building Regulations at paragraph B4 (1) as I have no evidence as to how they would have performed in severe fire conditions. However, it is evident from the events of the 14 June 2017 at Grenfell Tower that the Reynobond cassette system installed did not meet the requirements of the Building Regulations (despite test certification that it complied with European Standard Class B and national Class 0) as the façade clearly, from the evidence of video footage, and the records of the speed of fire spread, failed to meet the requirement that *'The externals walls of the building shall adequately resist the spread of fire over the walls....'* This brings into question the testing and certification methods used for fire performance assessments with respect to cladding products. I deal with this issue in greater detail elsewhere in this report. It is also notable that the Alucobond product, as with the Reynobond product, contains a polyethylene core and on that basis, I would expect that it would perform in similar fashion to the Reynobond product in conditions of severe fire.

4.3.37 The Studio E drawings developed at this stage lacked adequate detailed information and failed to anticipate the need for provision at vertical joints to mitigate against fire crossing the horizontal cavity barriers. Whilst I believe that an architect should have *'got to grips'* with this issue and identified it as a problem requiring attention, I acknowledge that this could have been left for later resolution with the specialist sub-contractor. It is on this basis that I indicate within the matrix above that the rainscreen proposal - in terms of specification - was compliant with the Building Regulations and ADB guidance at Studio E Tender Documentation stage.

Cavity Barriers

Building Regulations and Approved Document Guidance:

(This explanation expands substantially on my Section 3 commentary on fire safety requirements of the Building Regulations and the guidance given in this respect within ADB2.)

4.3.38 The Building Regulations 2010 states under SCHEDULE 1 PART B FIRE SAFETY: Internal Fire Spread (structure) paragraph B3 (3) that:

'Where reasonably necessary to inhibit the spread of fire within the building, measures shall be taken, to an extent appropriate to the size and intended use of the building, comprising either or both of the following –

a) Subdivision of the building with fire resisting construction;

This is a clear reference to the process known by architects as '*compartmentation*' which I will explain further below and to which ADB2 Section 8 is dedicated.

4.3.39 Paragraph B4 (1) states:

'The external walls of the building shall adequately resist the spread of fire ***over*** *the walls....'* (my emphasis).

I take this to mean over the outside surface as opposed to any requirements under this paragraph with respect to the construction <u>within</u> the walls.

4.3.40 I understand the term '*within the building*' under paragraph B3 (3) to mean all parts of a building that lie within its external surfaces. That means that any voids or cavities contained within external walls themselves are also governed by the requirements of B (3); that is, they too are required to be sub-divided.

4.3.41 Paragraph B3 (4) of the Building Regulations states that:

'The building shall be designed and constructed so that the unseen spread of fire and smoke within concealed spaces in its structure and fabric is inhibited.'

4.3.42 An architect will understand that these clauses are referring to '*compartmentation*' within the building. That is a process by which a building is divided into zones called compartments. Such compartments should all connect directly to a safe route of escape.

4.3.43 For a building like Grenfell Tower each flat is thus considered as a compartment.

4.3.44 It is implicitly clear from the above that special care should be taken to inhibit any fire that has broken out within a compartment from getting into any concealed space or cavity within an external wall. Special care should also be taken to inhibit any fire within a cavity from spreading further into the cavity. This includes cavities within the external wall structure and fabric.

4.3.45 In order to achieve this:

a) The inner part of any external walls that contain cavities (often known as the '*inner leaf*') should act as an impediment to the passage of fire into those cavities.

b) The gaps around the frames of any '*openings*' (e.g. door and window frames) should be sealed with material that will also act as an impediment to the passage of fire.

c) The cavities should be sub-divided to inhibit the spread of fire.

4.3.46 It is my opinion that the Building Regulations are extremely clear insofar as they relate to Fire Safety. In contrast I am critical of ADB2 which I consider to be poorly drafted.

4.3.47 Below, I set out the guidance given by ADB2 in relation to concealed spaces and cavity barriers.

4.3.48 ADB2 Section 8 '*Compartmentation*' and Section 9: '*Concealed spaces (cavities*') gives guidance on meeting the requirements of B3 (3) (a) and B3 (4) of the Building Regulations.

4.3.49 ADB2 Section 8 does not make specific reference to sub-dividing any cavities within external walls, but states at paragraph 8.25 under '*Junction of compartment wall or compartment floor with other walls*' that:

'Where a compartment wall or compartment floor meet... an external wall, the junction should maintain the fire resistance of the compartmentation.'

4.3.50 This is a reference to fire-stopping which should not be confused with cavity barriers, but the principle is clear and immediately relevant to further guidance given under ADB2 '*Provision of cavity barriers*' paragraph 9.2 (which refers to Diagram 33 on the same page) where it is stated that:

'The provisions necessary to restrict the spread of smoke and flames through cavities are broadly for the purpose of sub-dividing;

a) Cavities, which could otherwise form a pathway a fire-separating element and closing the edges of cavities; therefore reducing the potential for unseen fire spread and

b) Extensive cavities

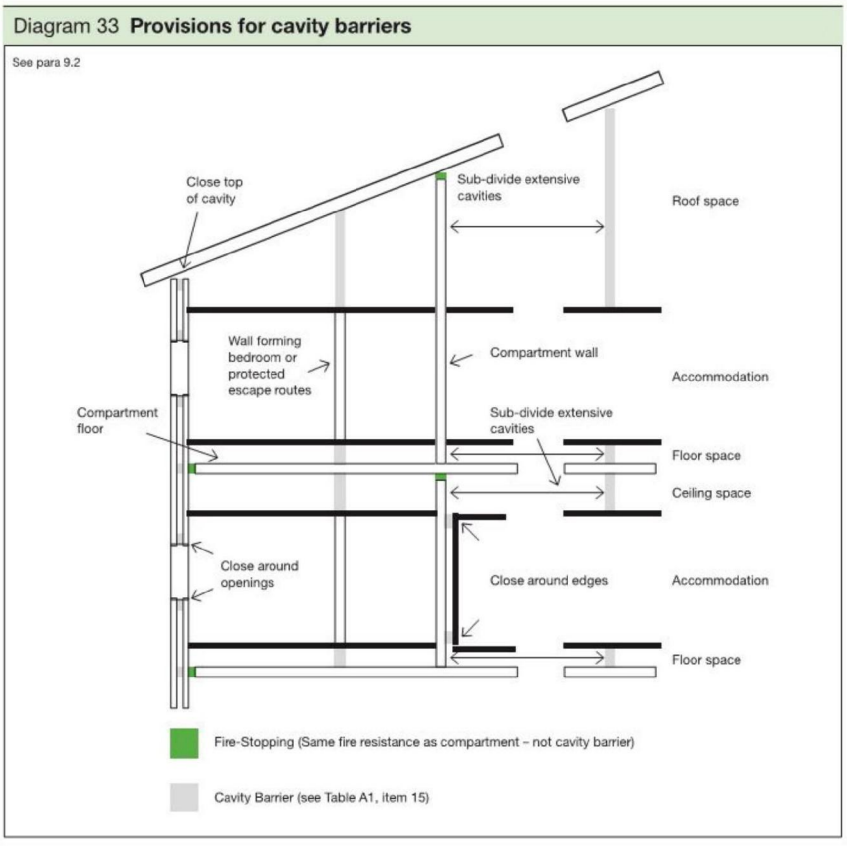


Figure 4.45: Extract from Approved Document B Volume 2, Diagram 33 '*Provision for cavity barriers*'

4.3.51 It is notable that, although not mentioned in its title, fire-stopping is shown prominently within Diagram 33. It is also notable that Diagram 33 comprises only a section. It would be helpful if it also incorporated a plan arrangement showing vertical cavity barriers. From this diagram fire-stopping can be understood as the sealing of any gaps/ imperfections occurring but '*unwanted*' between elements of fire-resting structure or construction. Cavity barriers relate to circumstances where a gap in the form of a cavity is intended but should be protected at its edges and sub-divided for purposes of inhibiting the passage of fire into and thereafter through that cavity.

4.3.52 ADB2 paragraph 9.3 states:

'Cavity barriers should be provided to close the edges of cavities, including around openings. Cavity barriers should also be provided:

a. at the junction between an external cavity wall… and every compartment floor and compartment wall;

4.3.53 Paragraph 9.3a is badly drafted as it implies that cavity barriers should be positioned between compartment walls/floors and the inner face of external walls which is not the case: that is the location for fire-stopping as is clearly shown with green high-lighting in Diagram 33.

4.3.54 Paragraph 9.3a is in fact a reference to the positions within the cavity that align with the compartment floors and walls at their junction with the external walls. However, and despite poor drafting and illustration, I believe that an architect should understand this, and therefore understand that it is within the external wall cavity at positions that align with compartment walls and floors that cavity barriers are required in order to comply with the guidance of ADB2 Diagram 33.

4.3.55 ADB2 paragraph 9.8, under the heading '*Extensive Cavities*', states:

'Cavity barriers should be used to sub-divide any cavity... so that the distance between cavity barriers does not exceed the dimensions given in Table 13.

4.3.56 Table 13 refers to *'...non-domestic buildings (Purpose Groups 2-7)'*

Table 13 **Maximum dimensions of cavities in non-domestic buildings (Purpose Groups 2–7)**

Location of cavity	Class of surface/product exposed in cavity (excluding the surface of any pipe, cable or conduit, or any insulation to any pipe)		Maximum dimensions in any direction (m)
	National class	European class	
Between roof and a ceiling	Any	Any	20
Any other cavity	Class 0 or Class 1	Class A1 or Class A2-s3, d2 or Class B-s3, d2 or Class C-s3, d2	20
	Not Class 0 or Class 1	Not any of the above classes	10

Notes:
1 Exceptions to these provisions are given in paragraphs 9.10 to 9.12.
2 The national classifications do not automatically equate with the equivalent classifications in the European column, therefore, products cannot typically assume a European class unless they have been tested accordingly.
3 When a classification includes "s3, d2", this means that there is no limit set for smoke production and/or flaming droplets/particles.

Figure 4.46: Extract from Approved Document B Volume 2, Table 13 '*Maximum dimensions of cavities in non-domestic buildings (Purpose Groups 2-7)*'

4.3.57 I note that Dr Lane does not believe that the 20 metre maximum requirement between cavities in Table 13 of ADB2 applies to flats as they are purpose group 1a as defined in ADB2 Appendix D Table D1 and Table 13 only applies to purpose groups 2-7 (see 11.20.9 of her report). I discuss this point in detail below under '*Commentary*'.

4.3.58 ADB2 paragraph 9.13 states:

'Every cavity barrier should be constructed to provide at least 30 minutes fire resistance. It may be formed by any construction provided for another purpose if it meets the provisions for cavity barriers (see Appendix A, Table A1, item 15)

4.3.59 Table A1 is shown below:

Table A1 **Specific provisions of test for fire resistance of elements of structure etc**

15. **Cavity barrier**	Not applicable	30	15	E 30 and EI 15	Each side separately

Figure 4.47: Extract from Approved Document B Volume 2, Appendix A Table A1 *'Specific provisions of test for fire resistance of elements of structure etc.'*

4.3.60 ADB2 paragraph 9.13 states:

'Cavity barriers in a stud wall or partition, or provided around openings may be formed of:

a. steel at least 0.5mm thick;
b. timber at least 38mm thick;
c. polythene-sleeved mineral wool, or mineral wool slab, in either case under compression when installed in the cavity; or
d. calcium silicate, cement-based or gypsum-based boards at least 12mm thick.

Note: Cavity barriers provided around openings may be formed by the window or door frame if the frame is constructed of steel or timber of the minimum thickness in a) or b) above as appropriate.'

This is essentially providing guidance to the effect that where a continuous element of construction – for example a window or door frame, or a supporting or fixing angle, provides protection, it may in certain circumstances be considered to be an adequate substitute for a proprietary, purpose made cavity barrier.

4.3.61 ADB2 paragraph 9.15 states:

'Cavity barriers should also be fixed so that their performance is unlikely to be made ineffective by:

a. movement of the building due to subsidence, shrinkage or temperature change and movement of the external envelope due to wind;

b. collapse in a fire of any services penetrating them;

c. failure in a fire of their fixings (but see note below); and

d. failure in a fire of any material or construction which they abut....

Item d) is important in relation to comments that Dr Lane has made about the performance of cavity barriers with metal cladding systems which, as I have stated above, she questions at paragraph 10.3.39 / Figure 10.19 of her report {BLAS0000010}.

4.3.62 The above outline has been kept as brief as possible but is necessarily detailed in order to prepare the reader for the analysis of the work with respect to cavity barriers that follows.

Commentary Snap-Shot 2 Studio E Tender Documentation /Cavity Barriers

4.3.63 When commencing Tender Documentation work Studio E had apparently done no earlier work on cavity barriers which, as stated under Snap-Shot 1, is neither a surprise nor concern to me. Before commenting on the work of Studio E at Tender Documentation stage, I will comment on the challenge that they faced in this respect.

4.3.64 The condition at the perimeter of the window frames was made particularly difficult by the requirement that, in order to maintain the new thermal barrier line, the replacement windows should be positioned further out, and away from the surrounding concrete at each side (jamb) and to the head and sill. The sealing of the gap around the window frame outer edge was necessary to impede the passage of fire into the cavities behind the new rainscreen cladding. Consequently, it would be a challenging detail.

4.3.65 It is my view that a competent architect should identify this problem early on in the design development stage. It should certainly be identified before the completion of tender documentation. It should be addressed with great care when developing, in sketch form, early details, as are normally prepared to '*test*' proposals and solve key problems that the project brief generates. Studio E does not appear to have done this as explained below.

4.3.66 The NBS specification prepared by Studio E (January 2014 revision) {SEA00000169} includes provision for cavity barriers and section P10/435 includes product references for ventilated cavity barriers as follows:

490 CAVITY FIRE BARRIERS TO BS 476-20
- Requirement: To resist the passage of flame and smoke for not less than 30 min. integrity, 30 min. insulation .

435 VENTILATED CAVITY BARRIERS
- Manufacturer: Downer Cladding Systems Ltd, Oaksmere Business Park, Yaxley, Eye, Suffolk IP23 8BW
  Tel: [redacted], Fax: [redacted]
  Web: http://www.downercladding.com.
  - Product reference: Lamatherm CW-RSH60 (horizontal), Lamatherm CW-RSV60 (vertical).
- Material:
  - Horizontal: Mineral wool lamella faced with reinforced aluminium foil and intumescent edge strip.
  - Vertical: Mineral wool lamella faced with reinforced aluminium foil on all sides .
- Size: Width to suit cavity, length cut to fit.
- Thickness: 90mm.
- Fire resistance rating: 30/30 to BS 476, Part 20:1987 and BS EN 1366-4:2006.
- Free air provision: To leave 25mm ventilation gap horizontally; vertically tightly packed.
- Installation requirements: Continuous, with minimum joints.
  - Fasteners: Lamatherm angle brackets fixed in accordance with manufacturer's recommendations.
- Other requirements: C.

Figure 4.48: Extracts from Studio E NBS section P10 '*Sundry insulation/ proofing work/ fire stops*' {SEA00000169}

4.3.67 These products complied with the guidance of ADB2.

4.3.68 Studio E Employer's Requirements drawing 1279 (06) 110 00 '*Proposed Typical Bay Plans, Section & Elevation*' {SEA00002499} indicates, as shown below, cavity barriers to the line of compartment floor only. The cavity barrier at the window head (which carries no specification note) could possibly have functioned as both the barrier to inhibit the passage of fire into the cavity, and as the horizontal barrier that aligned with the compartment floor to inhibit the passage of fire through the cavity, if that had been agreed with the Consultant Specialist Fire Engineer (Exova) and the Building Control Officer. However, there is no cavity barrier indicated to the window sill. This was a very serious omission.

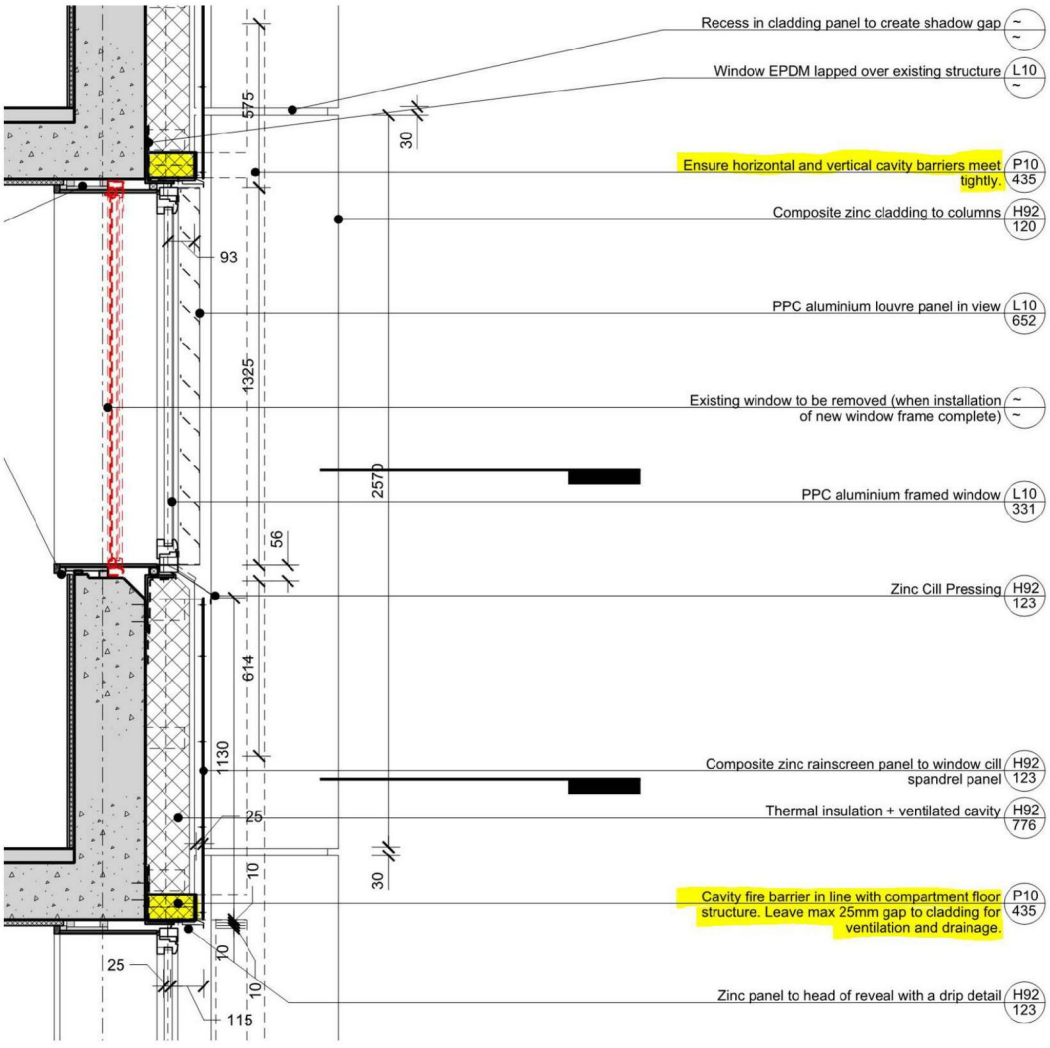


Figure 4.49: Extract from Studio E Employer's Requirements drawing 1279 (06) 110 00 'Proposed Typical Bay Plans, Section & Elevation' {SEA00002499}

4.3.69 The same drawing 1279 (06) 110 00 {SEA00002499} also shows a typical bay elevation together with three plans and one section. No cavity barriers are shown to the bay elevation and no elevations of the complete facade are marked up to show cavity barriers (as shown within Section 3 of this report in relation to the indicative approach). This suggests that no clear thought had been given by Studio E in their preparation of tender documentation to the overall strategy in terms of '*compartmenting*' or zoning the cavity behind the rainscreen.

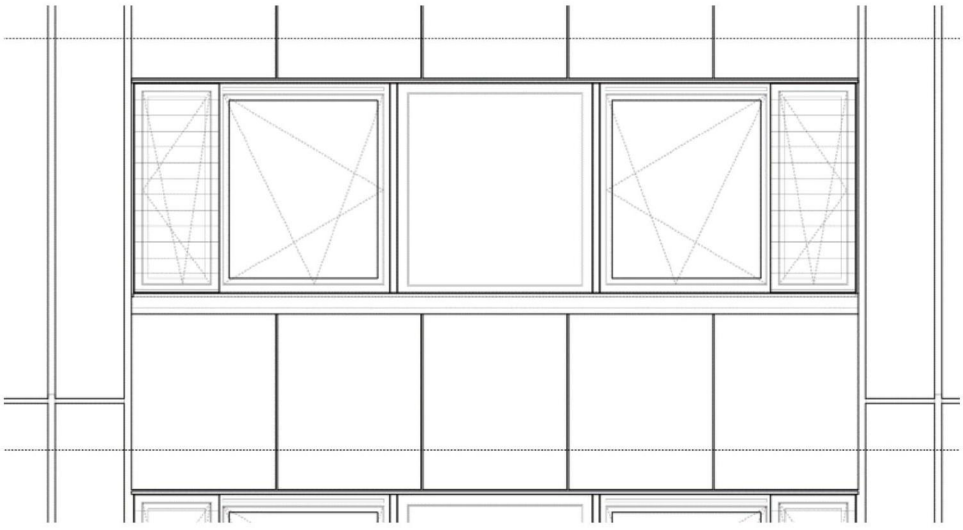


Figure 4.50: Extract from Studio E Employer's Requirements drawing 1279 (06) 110 00 *'Proposed Typical Bay Plans, Section & Elevation'* {SEA00002499}

4.3.70 The same drawing 1279 (06) 110 00 {SEA00002499} also includes a typical 1:20 plan detail that references and shows a vertical cavity barrier along the line of a compartment wall in the area of a column. There is a suggestion of a change of material at the window jambs which appears to be coded with the same '*hatch*' as the vertical cavity barrier, but the jamb components have no note or specification reference. This suggests that inadequate thought had been given to the window jamb conditions with respect to both fire stopping at the window frame /concrete column junction and inhibiting the passage of fire into the cavity at the window frame's edge condition.

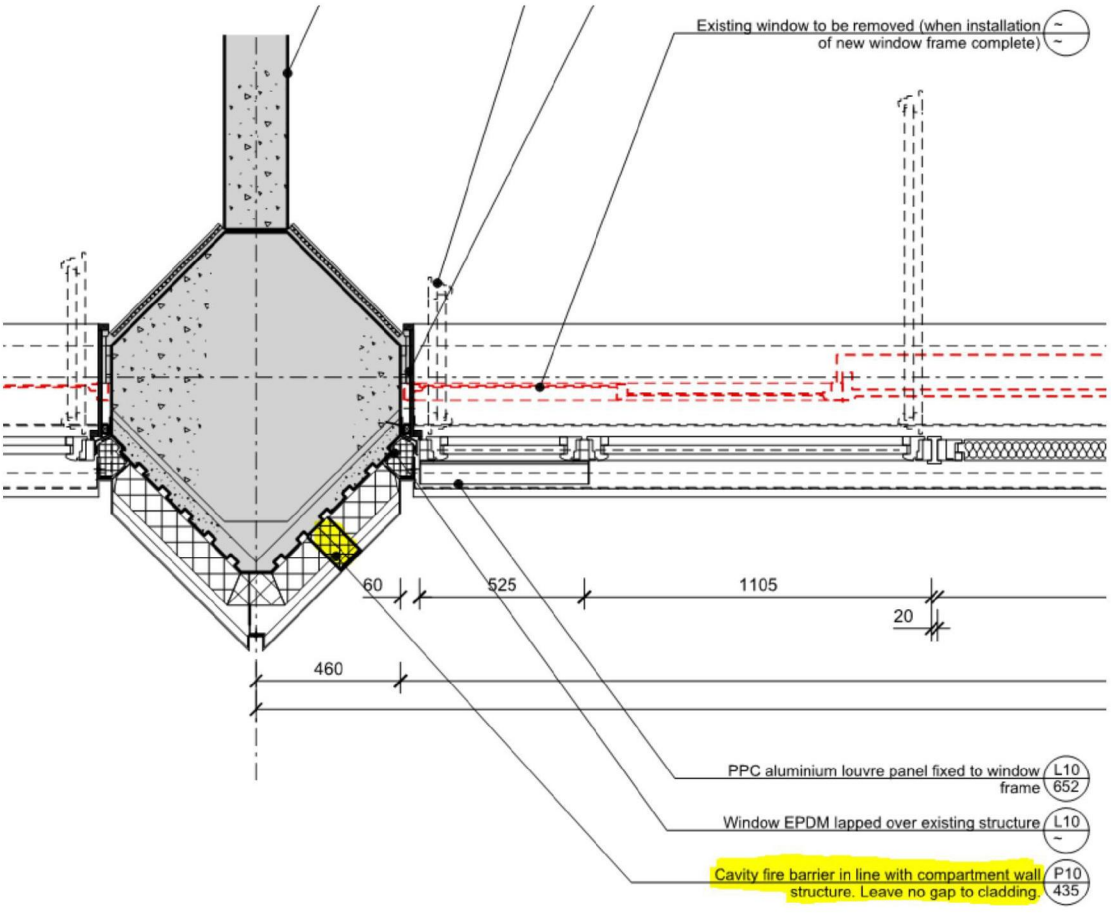


Figure 4.51: Extract from Studio E Employer's Requirements drawing 1279 (06) 110 00 *'Proposed Typical Bay Plans, Section & Elevation'* {SEA00002499}

4.3.71 Studio E Tender drawing 1279 (04) 105 00 {SEA00010474} entitled '*Proposed Residential Plan*' dated 9 November 2013 shows, at 1:50 scale, the cladding arrangement and typical bay reference. There is no indication on that drawing of the positioning of cavity barriers that are required at compartment wall/column junctions: that is at columns A3/B1/B5/C1/C5 and D3. Whilst this is not strictly necessary on the 1:50 plans, as the 1:20 column plan shown above clearly indicates vertical cavity barriers are required at all '*compartment column*' positions, it is my opinion that this again indicates a lack of care and attention in terms of the development of a strategy in relation to the positioning of cavity barriers.

4.3.72 An architect acting with due diligence and care would, in my view, show all vertical and horizontal cavity barriers carefully at an appropriate scale for all four complete façade elevations, then at 1:20 scale for all bay and all column conditions, then at 1:5 scale for details at head, sill column at window level and column at spandrel panel level, as demonstrated in Section 3 indicative scheme.

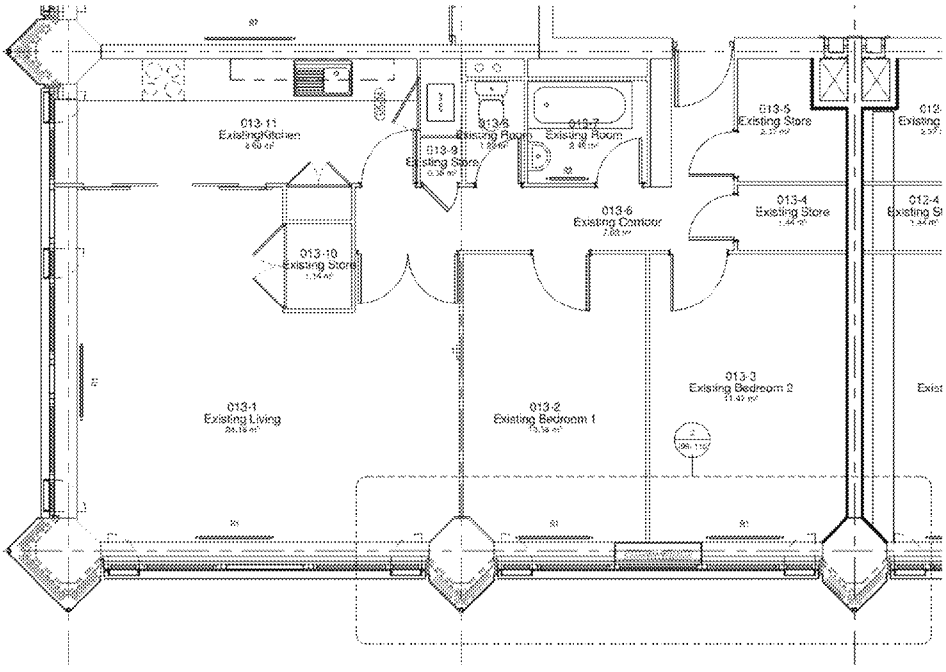


Figure 4.52: Extract from Studio E drawing 1279 (04) 105 '*Proposed Residential Plan*' {SEA00010474}

4.3.73 It is notable against the two drawings as illustrated above that Studio E have not shown vertical cavity barriers to the non-compartment columns – that is all four corner columns (A1/A5/D1/D5) and intermediate columns (A2/A4/D2 and D4). As Dr Lane correctly identifies, Table 13 of ADB2 does not apply to flats as they are exempt from the purpose groups as listed under ADB2 Appendix D (see her Phase 1 report at 11.20.9 {BLAS0000011}. Consequently, the design would not have to meet the cavity barrier spacing provisions in Table 13 (which provide for a maximum dimension of cavity of 20 metres). In this respect the Studio E work does comply with the guidance in ADB2 as regards the distance between vertical cavity barriers, which at maximum equate to the distance between B1 and A3, A3 and B5, C5 and D3 and D3 to C1. However, although I do not criticise Studio E in this respect, it is my view that the ADB2 guidance is wanting and that cavity barriers should be incorporated at more frequent intervals even though not called for under the guidance of ADB2 under the 20 metre maximum rule. However, I am very critical of Studio E for not showing in their general arrangement 1:50 scale drawings (part of which is exhibited above) those cavity barriers which were required under ADB2 guidance to align with the compartment walls at A3, B1, B5, C1, C5 and D3.

4.3.74 Clause P10/435 from the Studio E Employer's Requirements Full NBS (30 January 2014 Revision) includes product references for ventilated cavity barriers that state the use of a fixing bracket installed in accordance with the manufacturer's requirements (see below). The performance of the product reference meets the minimum performance set out in ADB Appendix A, Table A1, Item 15 (i.e. 30mins insulation and 15mins integrity) {SEA00000169}.

435 VENTILATED CAVITY BARRIERS

- Manufacturer: Downer Cladding Systems Ltd, Oaksmere Business Park, Yaxley, Eye, Suffolk IP23 8BW
  Tel: [redacted] Fax: [redacted]
  Web: http://www.downercladding.com.
  - Product reference: Lamatherm CW-RSH60 (horizontal), Lamatherm CW-RSV60 (vertical).
- Material:
  - Horizontal: Mineral wool lamella faced with reinforced aluminium foil and intumescent edge strip.
  - Vertical: Mineral wool lamella faced with reinforced aluminium foil on all sides .
- Size: Width to suit cavity, length cut to fit.
- Thickness: 90mm.
- Fire resistance rating: 30/30 to BS 476, Part 20:1987 and BS EN 1366-4:2006.
- Free air provision: To leave 25mm ventilation gap horizontally; vertically tightly packed .
- Installation requirements: Continuous, with minimum joints.
  - Fasteners: Lamatherm angle brackets fixed in accordance with manufacturer's recommendations.
- Other requirements: C.

Figure 4.53: Extract from Studio E NBS section P10 Sundry insulation/ proofing work/ fire stops {SEA00000169}

4.3.75 The window systems specified in the Studio E Full NBS H92 Extract Employer's Requirements dated 30 January 2014 Revision L10/331 {SEA00002499} {SEA00000169} indicates aluminum window units so would not meet the provisions of ADB paragraph 9.13 (see below). The point here is that under paragraph 9.13 of ADB the window frame itself (as well as any continuous supporting angle/arrangement as mentioned above) may form the cavity barrier, provided it is of the appropriate specification as per the stipulations under 9.13 a, b, c, or d of ADB (e.g. which provide for steel, timber of appropriate thickness or mineral wool). But neither the aluminium framed windows nor the continuous aluminium supporting angles meet those stipulations so cannot be deemed to perform as cavity barriers under the guidance in ADB2.

331 ALUMINIUM WINDOWS SIDE & BOTTOM HUNG - TILT & TURN OPENING
Manufacturer: Wicona - UK. www: http://www.wicona.co.uk
Contact: Stuart Pollard (Specification Manager London)
HBS Centre, Silkwood Park, Wakefield WF5 9TG
M: [redacted]
T:
F:
E: stuart.pollard@hydro.com.

- Product reference: Wicline 65 evo
  window assembly to achieve minimum U-value 1.6W/m²K.
- Finish as delivered: Polyester powder coating.
- Glazing details: Argon filled insulating glass units .
  - Inner pane: 6mm low E clear toughened glass.
  - Outer pane:
    Generally: 6mm clear toughened glass
    GF/Mezzanine: min 8mm clear laminated glass. Transluscent where indicated on the drawings to provide privacy .
- Glazing system: Mechanical corner cleats and stainless steel corner braces; EPDM gaskets .
  - Beading: Internal snap on aluminium box beads .
- Ironmongery/ Accessories:
  As determined by the sub-contractor to fully complete the installation and interfaces with other installations. Including but not limited to: colour coordinated hinges and locking handles OR concealed hinges - TBC with Architects and Client, multipoint locking, releasable restrictors, couplings, sill/head/abutment flashings, vapour barriers and air seals .
- Fixing: Aluminium extrusion angles fixed to the existing concrete structure, fixing the window top and bottom. Manufacturer: Harley Curtain Wall UK Ltd, Harley House, Brooklands Park, Farningham Road, Crowborough, East Sussex, TN6 2JD, Contact: MARK HARRIS
  Commercial Manager Tel: [redacted] Galvanised steel frame cramps to concrete reveal as clause 782 if required. .

Figure 4.54: Extract from Studio E NBS section L10 '*Windows/ Rooflights/ Screens/ Louvres*' {SEA00000169}

4.3.76 The bracket fixings for the window units at the head and sill are indicated as aluminum cramps but in fact they are continuous angles. For the same reason as above they would also not be deemed to perform as cavity barriers under the guidance in ADB2 paragraphs 9.13 a-d.

4.3.77 Clause P10/435 in the Studio E Employers Requirements Full NBS 30 January 2014 Revision {SEA00000169} includes product references for ventilated cavity barriers (see figure 4.55 below) that stipulate the use of a fixing bracket installed in accordance with the manufacturer's requirements.

4.3.78 Normally that would suffice as a specification for such fixings, but there is an inevitable '*clash*' between these brackets supporting the cavity barriers and the continuous aluminium angle support system for the window system. Ideally that clash should have been resolved at this stage. The clash prevents the cavity barrier bracket from being affixed directly to the structure, which is what should be achieved through a robust fixing. ADB2 states at paragraph 9.13 under '*Construction and fixings for cavity barriers*' that:

'cavity barriers should also be fixed so that their performance is unlikely to be made ineffective by… failure in a fire of their fixings (but see note below); and d) failure in a fire of any material or construction which they abut'.

In my opinion this clearly gives guidance to the effect that no fixing should be made through an independent component whose conduct or failure in fire might compromise the fixing of the cavity barrier.

However, there do not appear to be any details drawn to a sufficient scale that would indicate how the rainscreen cavity barriers are fixed and how they interface with the existing building and cladding rails/ brackets to maintain continuity of the barrier. Because they appear not to have investigated the design problems in sufficient detail Studio E have not addressed this issue in their tender documentation.

435 VENTILATED CAVITY BARRIERS

- Manufacturer: Downer Cladding Systems Ltd, Oaksmere Business Park, Yaxley, Eye, Suffolk IP23 8BW
  Tel: [redacted] Fax: [redacted]
  Web: http://www.downercladding.com.
  - Product reference: Lamatherm CW-RSH60 (horizontal), Lamatherm CW-RSV60 (vertical).
- Material:
  - Horizontal: Mineral wool lamella faced with reinforced aluminium foil and intumescent edge strip.
  - Vertical: Mineral wool lamella faced with reinforced aluminium foil on all sides .
- Size: Width to suit cavity, length cut to fit.
- Thickness: 90mm.
- Fire resistance rating: 30/30 to BS 476, Part 20:1987 and BS EN 1366-4:2006.
- Free air provision: To leave 25mm ventilation gap horizontally; vertically tightly packed.
- Installation requirements: Continuous, with minimum joints.
  - Fasteners: Lamatherm angle brackets fixed in accordance with manufacturer's recommendations.
- Other requirements: C.

Figure 4.55: Extract from Studio E NBS section P10 '*Sundry insulation/ proofing work/ fire stops*' {SEA00000169}

4.3.79 Finally, under this Snap-Shot I attach an email from Terry Ashton of Exova dated 4 November 2013 which confirms that the cavity barriers need only have a 30 minute standard of fire resistance. This responds to a Studio E query of 1 November as to whether the rainscreen cavity barriers should have been specified at 60min fire resistance to match the compartmentation. That clip of correspondence is at {EXO00000586}. Some professionals would expect Mr Ashton to have been more precise in his language in this response as cavity barrier performance is expressed in terms of both integrity and insulation. However, it should be noted that he is responding to an architect who should be familiar with the broader principles of performance. I am of the opinion that as a Fire Specialist Mr Ashton should be very precise in such a response and should have stipulated the fire rating for both integrity and insulation.

From: Terry Ashton [mailto:Terry.Ashton@Exova.com]
Sent: 04 November 2013 09:05
To: Tomas Rek
Subject: RE: Grenfell - Drawings in progress

Tomas

Cavity barriers need only have a 30 minute standard of fire resistance

Kind regards

Terry

Terry Ashton: *Associate*, **Fire Engineering (Europe)**
Exova Warringtonfire
T: [redacted] M: [redacted]
Exova
FIRE

Figure 4.56: Email Correspondence between Exova and Studio E {EXO00000586}

4.3.80 I understand that whilst SideRise product literature did clearly show the cavity barriers being used in construction arrangements that included rainscreen ventilated cladding systems, thereby implying that the products were fit for that purpose, they offered no test certification in support of that use: that is for use in cavities formed one side with metal cladding. However, whilst I am aware that Dr Lane has expressed concern in this respect such concern was not widely publicised at the time of preparing tender documents for the 2012-16 Works. Cavity barriers were widely used in such circumstances and I would not wish to criticise Studio E in this respect. The exhibit below from SideRise current website clearly implies that the products are suitable for use with rainscreen cladding systems and there is no qualification to the effect that the products are not suitable for use with metal rainscreen systems.

SIDERISE RH and RV cavity barriers for use in the external envelope or fabric of buildings

The SIDERISE RH 'Open State' horizontal and RV vertical cavity barrier range represents the default choice for market leading, high performance Rainscreen Cavity Barrier applications.

Figure 4.57: Extract from SideRise product literature

Compartmentation: Approved Document B, 2006 edition, Volume 2. England and Wales

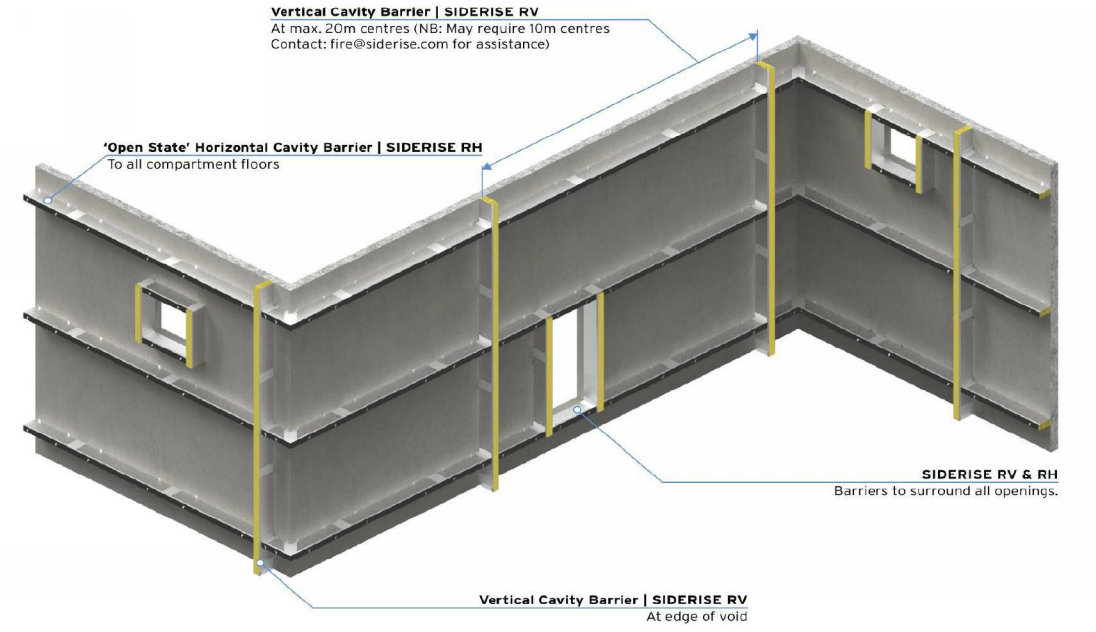


Figure 4.58: 2015 Version 1.6 contains diagram of cavity barriers

(I do not have earlier versions but expect that the principles have not changed)

4.3.81 With respect to the Crown Studio E seem to have provided little in the way of information at Tender Stage. However, the following exhibit provides some (albeit scant) indication of intent. There are no elevations to show the overall strategy for achieving compliance with the guidance in ADB2. The section implies that although the horizontal cavity barrier to the window head runs horizontally onto the column face to connect with a vertical cavity barrier, that is not shown on the 1:50 general arrangement plans, and there is no horizontal barrier indicated to close either the top of columns or the parapet at roof level. This information is, in my opinion, inadequate and insufficiently thought through. I do note that the drawing states that the '*design of the Crown detail TBC by Architect*' – i.e. that it is to be confirmed by the architect at a later stage. Whilst this is arguably sufficient for tender purposes, it leaves an unresolved area which Studio E appear never again to have addressed.

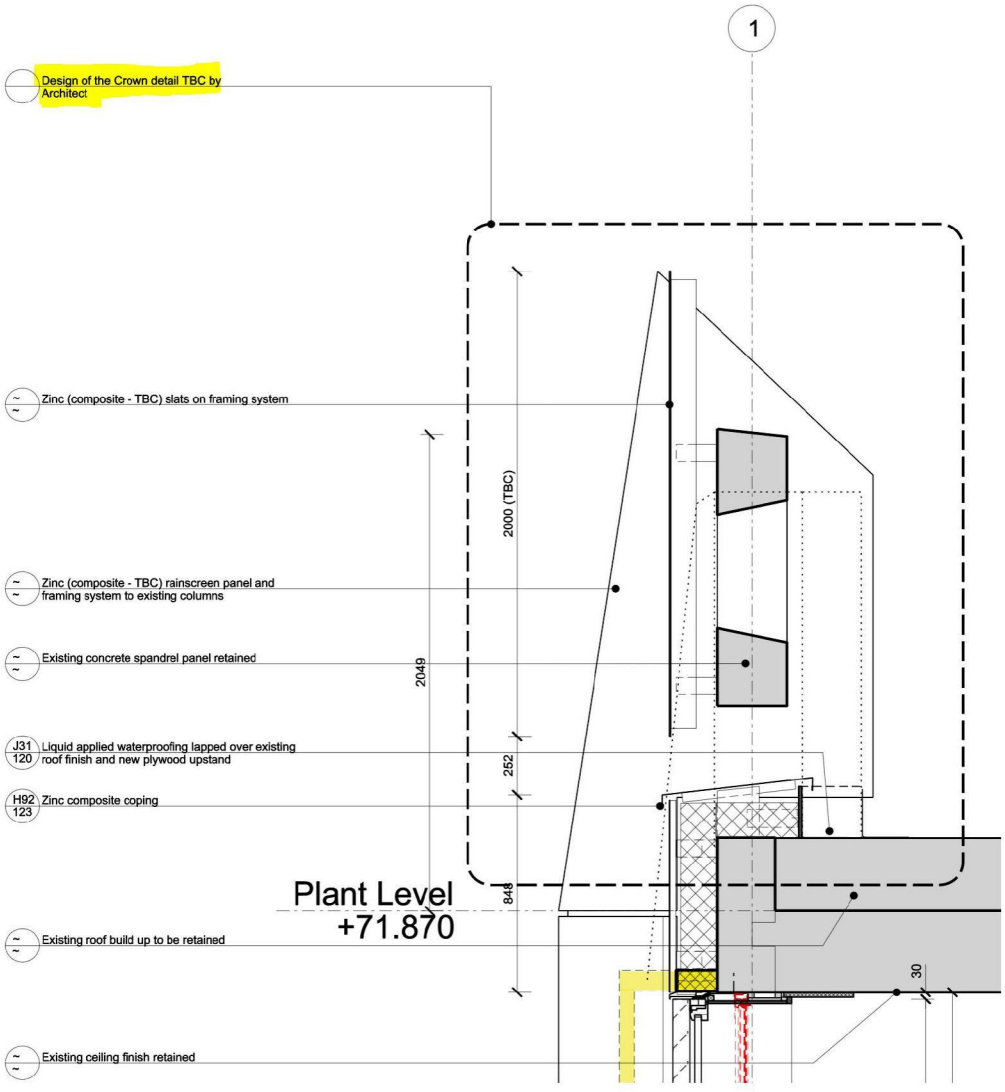


Figure 4.59: Extract from Studio E drawing 1279 (06) 120 00 '*Detailed Section - Sheet 1*' {SEA00002551}

4.3.82 Routine Design Reviews in line with RIBA recommended practice and compliance with ISO 9001 should have identified the above listed fundamental inadequacies of this work during its progress and at completion of the Studio E Tender Documentation process in terms of its flawed concepts and inadequate scope. This did not happen either because those reviews were not carried out, or because they were not carried out properly. The problem was thus carried into the next stage of the work on Cavity Barriers which I will review later herein under Snap-Shot 3 under Harley Production and Construction Documentation.

Conclusion Snap-Shot 2 Studio E Tender Documentation /Cavity Barriers

4.3.83 Studio E Tender Stage Documentation did not meet the guidance of ADB2 because although the cavity barriers as specified met the requirements for compliance with ADB2 guidance, they were not shown within the design in positions that were required to comply with ADB2 guidance. They were not shown clearly or specified at window jambs of any of the window column positions or at the sill positions.

4.3.84 No overall strategy for the positioning of cavity barriers appears to have been developed: I have found no evidence of such in the drawings that I have seen for this stage.

4.3.85 There appears to have been a lack of detailed investigation (that is through 1:5 drawings) regarding the conditions at head, sill, jambs and Crown. The 1:20 scale drawings incorporated within the tender documentation do not adequately show the arrangements or resolve the details in compliance with the guidance in ADB2.

4.3.86 As a result, clashes between cavity barrier fixings and the rainscreen support systems were implicit but unresolved in the documentation. Whilst not critical at this stage I believe such issues should have been properly resolved by the time of going to tender.

Window Infill Panels

Building Regulations and Approved Document Guidance

4.3.87 I have set out the Building Regulation requirements and the relevant guidance within ADB2 with respect to insulation at the outset of Envelope Insulation under Snap-Shot 1. For the appropriate statutory compliance briefing for this item, I therefore refer the reader to that section of my report.

4.3.88 I consider the material within the Window Infill Panels is an insulation product and that as such it was required to comply with ADB2 paragraph 12.7.

Commentary Snap-Shot 2: Studio E Tender Documentation / Window Infill Panels

4.3.89 Clause 332 Studio E Employer's Requirements Full NBS L10 section 30 January, 2014 issue, as exhibited below, indicates an insulated core but with no specific material or performance in relation to fire {SEA00000169}:

ALUMINIUM WINDOWS FIXED UNIT - ALUMINIUM
Manufacturer: Wicona - UK. www: http://www.wicona.co.uk
Contact: Stuart Pollard (Specification Manager London)
HBS Centre, Silkwood Park, Wakefield WF5 9TG
M: 07802 889332
T: 01924 232323
F: 01924 232300
E: stuart.pollard@hydro.com.

- Product reference: Wiciine 65 evo
  window assembly to achieve minimum U-value 1.6W/m²K.
- Finish as delivered: Polyester powder coating.
- Panel/ facing type: Aluminium faced insulated panel comprising core insulation, aluminium lining panel and integrated channel profile around perimeter, fully air-sealed at edges to achieve minimum U-value 0.15W/m²K.
  - External material: Aluminium panel.
  - External finish: Polyester powdercoated. Colour TBC.
  - Internal material: Aluminium sheet.
  - Internal finish: Polyester powder coated, colour TBC
- Panel retention system: Mechanical corner cleats and stainless steel corner braces; EPDM gaskets.
  - Beading: Internal snap on aluminium box beads.
- Ironmongery/ Accessories:
  As determined by the sub-contractor to fully complete the installation and interfaces with other installations.
  Including but not limited to: couplings, sill/head/abutment flashings, vapour barriers and air seals. Allow for M&E penetration (for ventilation ducts) where required.
- Fixing: Galvanised steel frame cramps to masonry/concrete reveal as clause 782.

Figure 4.60: Extract from Studio E NBS section L10 '*Windows/ Rooflights/ Screens/ Louvres*' {SEA00000169}

4.3.90 Studio E Employer's Requirements drawing 1279 (06) 110 00 *'Proposed Typical Bay Plans, Section & Elevation'* {SEA00002499} includes a typical 1:20 plan detail that references the insulated panel between windows. However, there is no product or insulation type reference. The specification reference that is included does not identify the core material and only states the external and internal face finishes.

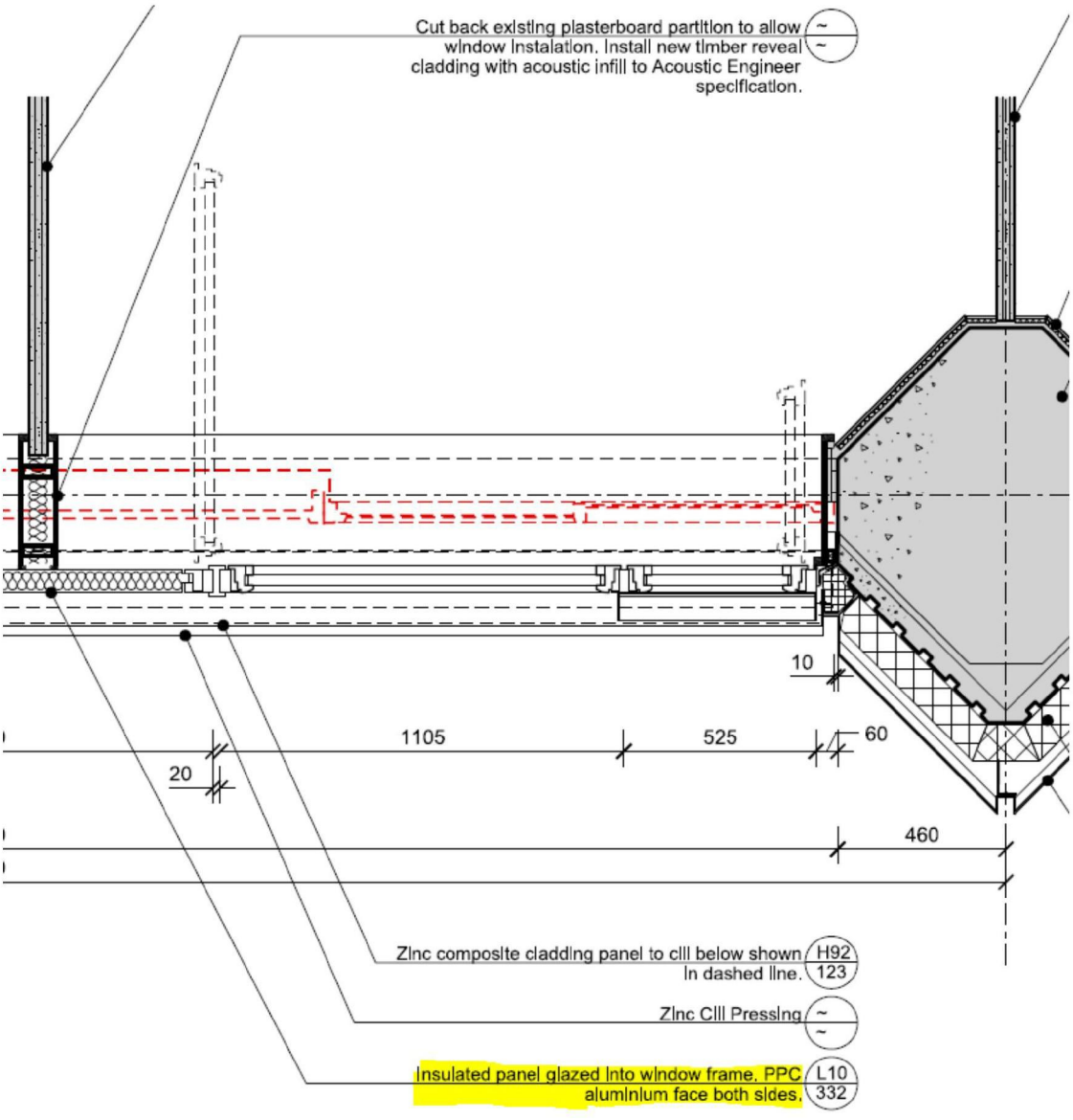


Figure 4.61: Extract of '*Proposed Plan at Window Level*' from drawing 1279 (06) 110 00 '*Proposed Typical Bay, Plans, Section & Elevation*' {SEA00002499}

4.3.91 In my opinion, although not critical, it would have been preferable for this item to have been properly specified in a manner compliant with the requirements of the Building Regulations and the guidelines of ADB paragraph 12.7 at the point of tender. That is, Studio E should at least have stated that the insulation should be of '*limited combustibility*' in accordance with the guidance in paragraph 12.7 of ADB2 even if the product type was not named. I take this view because the matter is principally one of product specification and not design arrangement so the '*in principle*' viability of a suitable window infill panel to meet Building Regulations would not be in question and there is no design work involved in resolving its instruction. However, in the pressure to get tender information out to strict deadlines (often under abbreviated fee conditions) architects frequently leave such items for later specification in the knowledge that there is sufficient information for tender pricing. I would not therefore criticise Studio E in this respect at this stage.

Conclusion Snap-Shot 2: Studio E Tender Documentation / Window Infill Panels

4.3.92 The tender documents did not carry a specification for the insulation to the window infill panels that met the requirements of the Building Regulations or the guidance within ADB2. The documents were silent on this issue when they should at least have specified that the tender should be based on an insulation of limited combustibility in accordance with paragraph 12.7 of ADB2. Despite this criticism I have marked the matrix at this Snap-Shot as a green circle.

Infill Behind Internal Linings to Windows

Building Regulations and Approved Document Guidance:

4.3.93 I have set out the Building Regulation requirements and the relevant guidance within ADB2 with respect to insulation in detail in the notes under Building Regulations and Approved Document Guidance at the outset of Envelope Insulation under Snap-Shot 1. For that appropriate statutory compliance briefing for this item I refer the reader to that section of my report. The requirements with respect to the insulation contained within the voids behind the head, jambs and sills of the windows is essentially the same and is covered under ADB2 paragraph 12.7.

Commentary Snap-Shot 2: Studio E Tender Documentation / Infill Behind Internal Linings to Windows

4.3.94 The Studio E Employer's Requirements Full NBS 30 January, 2014 issue contains a specification for the window linings P20/240A. This is a standard NBS template specification clause for window reveals which Studio E duly filled in to stipulate *'PLYWOOD WINDOW REVEALS AND SILLS'*. Studio E also stipulated that the fire-rating should be *'fire-rating Class 1 or Class C-s3, d2'*. This would have complied with ADB2 Classification of linings paragraph 6.1 Table 10. The Studio E document also includes a provision within P10/235 which is an NBS template specification clause for insulations which the architect would duly complete. Studio E adopted this clause and stipulated *'compressible insulation in gaps'* and referred to Rockwool which is the proprietary name for a mineral wool product. Although the specification was silent on where those gaps were to be found and neither mineral wool nor Rockwool were shown on the drawings, it is reasonable to assume that Studio E intended that such application would have included locations such as the gaps behind inner window reveals. Both are exhibited below and both are compliant with the guidance in ADB2 {SEA00000169}:

240A PLYWOOD WINDOW REVEALS AND CILLS
- Manufacturer: Specialised Panel Products Ltd
  contact: Bruce Inker Tel:[redacted] Mobile:[redacted]
  - Product reference: Birch faced ply 15mm.
- ply species: Birch throughout.
- Appearance class to BS EN 635: Class I/II.
- Bond quality to BS EN 314-2: Class 1.
- Fire rating: Class 1 (using the UK testing methods) or Class C-s3, d2 (using the European testing methods).
- Thickness: 15mm.
- Edges: birch lipping, pinned and glued. Size to cover edge of new and existing cladding.
- Finish: Prepared and primed as section M60 .
- Support/ Fixing: Pinned and glued to softwood grounds and existing window surround..

Figure 4.62: Extract from Studio E NBS section P20 *'Unframed isolated trims/ skirtings/ sundry items'* {SEA00000169}

235 COMPRESSIBLE INSULATION IN GAPS
- Manufacturer: Rockwool Limited, Pencoed, Bridgend, CF35 6NY
  Tel: [redacted] Email: customer.support@rockwool.co.uk, Web: www.rockwool.co.uk.
  - Product reference: Flexible Slabs RWA45.
  - Density: Not less than 45kg/m³
- Material: Mineral wool to BS EN 13162.
  - Facing: Not required.
- Recycled content: Submit proposals.
- Thickness: To suite application available in 30/ 40/ 50/ 60/ 75/ /100mm.
- Installation requirements:
  - Joints: Butted, no gaps. Cut and fit tightly between/around cladding supports.
  - Fasteners: Use where necessary to retain insulation and/ or prevent slumping.

Figure 4.63: Extract from Studio E NBS section P10 '*Sundry insulation/ proofing work*' {SEA00000169}

4.3.95 Studio E Employer's Requirements drawing 1279 (06) 110 00 *'Proposed Typical Bay Plans, Section & Elevation'* indicates a typical 1:20 section through the window opening. However, there is no indication of any packing material to the internal window lining to reduce the thermal bridging at either the head or sill interface. {SEA00002499}. As stated under Section 3 this is necessary in order to maintain the continuity of the new thermal insulation and avoid situations of '*cold bridging*'. (This occurs when the insulation is interrupted, or its performance is compromised and can lead to condensation, mould and damage to decorations).

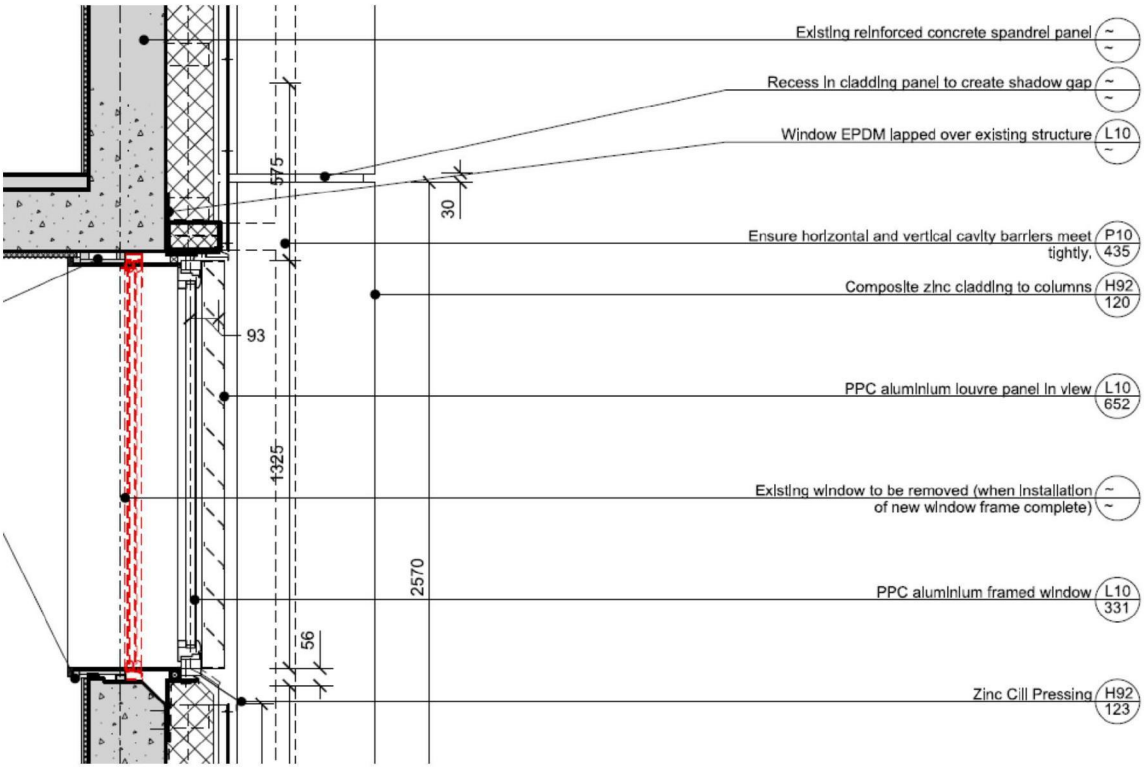


Figure 4.64: Extract of '*Proposed Section – Typical Bay*' from drawing 1279 (06) 110 00 '*Proposed Typical Bay, Plans, Section & Elevation*' {SEA00002499}

4.3.96 I am critical of Studio E for not providing 1:5 details which showed, in adequate detail, how the voids around the window linings at head, jambs and sill would be packed with insulation that prevented thermal bridging and thus complied with the guidance of ADL1B, whilst also meeting the requirements of ADB2 with respect to insulation within the external wall construction.

4.3.97 As previously stated, routine Design Reviews in line with RIBA recommended practice and compliance with ISO 9001 should have identified this problem both during and at the conclusion of the Studio E Tender Documentation. This did not happen either because those reviews were not carried out, or because they were not carried out properly. The problem was thus carried into the next stage of the work on insulation and filling of voids behind internal window linings, which I will review later herein under Snap-Shot 3 under Harley Production and Construction Documentation.

Conclusion Snap-Shot 2: Studio E Tender Documentation / Infill Behind Internal Linings to Windows

4.3.98 The insulation/infill as specified within Studio E's Tender Documentation did comply with the guidance given under ADB2 but the 1:20 section did not show how this work was to be carried out in sufficient detail to meet the guidance of ADB2 and therefore it failed to meet the requirements of the Building Regulations.

4.4 Snap-Shot 3 – Harley: Construction Documentation (April 2014 - 2016)

4.4.1 I show below the Matrix with Snap-Shot 3 duly filled in to record my conclusions in terms of the compliance of each item of the work at this stage with the Building Regulations.

a)	envelope insulation:	INADEQUATE DOCUMENTS
b)	rainscreen cladding:	NOT COMPLIANT
c)	cavity barriers – window openings:	NOT COMPLIANT
d)	cavity barriers- vertical compartment walls:	COMPLIANT
e)	cavity barriers – horizontal compartment floors:	NOT COMPLIANT
f)	cavity barrier – the Crown:	NOT COMPLIANT
g)	window infill panels:	NOT COMPLIANT
h)	internal window head, jamb, sill voids:	INADEQUATE DOCUMENTS

Design Element	Studio E Stage D Design Report	Studio E Tender Documentation	Novation	Harley Construction Documentation	Studio E As Built Documentation
Envelope Insulation	✗	✗		●	
Rainscreen Cladding	✓	✓		✗	
Cavity Barriers (Window Openings)	○	✗		✗	
Vertical Cavity Barriers (Compartment Walls)	○	✗		✓	
Horizontal Cavity Barriers (Compartment Floors)	○	✓		✗	
Cavity Barriers (The Crown)	○	✗		✗	
Window Unit Infill Panels	○	●		✗	
Window Head, Jamb, Sill Interface	○	●		○	

Legend:
✓ Documentation Considered Compliant with ADB2
○ Documentation Not Provided but Not Expected
✗ Documentation Considered not to Comply with ADB2
● Documentation Unclear/ Not Provided But Expected

Figure: 4.65: Reporting Matrix Snap-Shot 3

4.4.2 I comment below on each of the items in sequence and where I have not done so earlier in this section I summarise the requirements of the Building Regulations and the guidance set out in the relevant Approved Document.

4.4.3 Prior to that I offer some comments to place this Snap-Shot stage into proper context.

Introductory comments to this Snap-Shot

4.4.4 Snap-Shot 3 addresses a longer period of time and reflects a complete change in relationships as this was a Design and Build contract and Studio E had been novated to Rydon who had won the tender process and been appointed by TMO as Design and Build Contractor. Studio E who, as I have noted earlier in this section, were re-structured during this time following the company's receivership – were thus novated and were employed by Rydon. Their appointment with TMO ceased.

4.4.5 As I have explained at the outset of this section of my report, the Rydon appointment (albeit only signed on 3 February 2016) establishes the duties that Studio E assumed under their novation to Rydon {RYD00094228}. Of particular note is that it makes clear that Studio E was required to provide detailed drawings for the project. I quote below from the Deed of Appointment:

'SCHEDULE OF ARCHITECTURAL SERVICES

(Generally:)... 31. Provide supplementary notes to drawings and provide further drawings to show sufficient information to construct the project to completion consisting (but not limited to) the following:

Item a) External wall / internal wall and partition construction details (1:20 / 1:10 / 1:5)

Item c) Window jamb / head / sill details (1:20 / 1:10 / 1:5)'

4.4.6 I note in this respect that the Deed was not signed until near to the construction completion, but it was apparently signed by two Studio E Directors who presumably accepted that it represented a mutually agreed record of the duties that they had assumed.

4.4.7 I note that a variety of drawing scales are called for. For a project like this, 1:20 and 1:5 details would probably suffice and the 1:10, which is a rarely used scale, would be less relevant.

4.4.8 In my view, many of these details should have been routinely prepared by Studio E as part of the tender documentation issued at Snap-Shot 2 and therefore should have been available at the time of novation, albeit some modifications and amendments may well have been required as a part of the Production Information Stage – that is as outlined under RIBA Work Stage F. Essentially this provides information at sufficient detail for a builder to be able to order all materials and components and assemble the work in a timely manner.

4.4.9 It is a notable feature of this case that Design and Build tenders had been obtained on what I would consider to be less than satisfactory information in terms of both its quality – fundamental errors such as the PIR specification – but also lack of scope and detail for example an apparent lack of drawings at 1:5 showing in principle details.

4.4.10 Of particular importance is the fact that a contractor should have information upon which he can place orders, inform and brief sub-contractors such as Harley to enable them to commence their design development service, enable in timely fashion all necessary manufacturing to commence for products that will be manufactured / fabricated off-site, and direct labour and trades on site.

4.4.11 On most projects contractors are extremely *'hungry'* for information on groundworks, foundations, drainage and concrete and/or steel frame arrangements. However, on a project such as Grenfell, where the largest part of the work was the over-cladding, and there was little in the way of groundworks etc. because the building was already there, the demands for information to allow the cladding system – rainscreen and all supporting secondary structure, brackets, fixings' etc. – that is: the complete *'system'* – would have been intense.

4.4.12 In such circumstances, the poor state of information at the outset of the production information stage, RIBA Stage F, would have been a serious problem. Whether recognised or not.

4.4.13 In short, too much design development was required at a stage when it should have available: in particular, issues such as the strategy for cavity barriers in terms of their position and extent had simply not been addressed. My indicative approach as shown under section 3 demonstrates what should have been available at tender stage and therefore at the beginning of Snap-Shot 3.

4.4.14 It is another notable feature of this contract that neither Max Fordham nor Exova were appointed to Rydon. I understand that Rydon chose not to retain Exova under their contract. I further understand that in the circumstances TMO therefore retained Exova '*client side*' and that Exova remained available to assist Studio E on an '*as and when required*' basis. I think that this basis for their retention was wholly inappropriate for a project of this scale and complexity, and with work outstanding on the part of Exova from the pre-novation phase: Exova Fire Strategy Report of 7 November 2013 (Issue No. 3) titled '*Outline Fire Safety Strategy*' {EXO00001106} states at paragraph 3.1.4 '*Compliance with B4 (external fire spread)*':

'it is considered that the proposed changes will have no adverse effect on the building in relation to external fire spread but this will be confirmed by an analysis in a future issue of this report'.

4.4.15 That analysis was never carried out. Rydon, Studio E and Artelia should each be criticised for failing to ensure that this issue (effectively a '*loose-end*' of great importance) was addressed post novation by either Exova or another suitably qualified specialist fire consultant.

4.4.16 I am particularly critical of Rydon for deciding against the engagement of a specialist fire consultant. In my experience Design and Build contractors usually prefer, and sometimes even insist on, such appointments. Where they do not, my own firm makes very strong recommendations in favour of such appointment for most of our projects. I base my opinion that a specialist fire consultant should have been appointed under the contract for the 2012-16 Works on a number of considerations:

a) Studio E had never carried out a project of this kind before (high-rise residential up-grading plus over-cladding). Rydon and Studio E should both have recognised the importance of such specialist support in such circumstances: this was a large and reasonably complex project with respect to both Means of Escape and over-cladding design and detailing (respectively Building Regulations B1, B3 and B4).

b) The project was one to which the Regulatory Reform (Fire Safety) Order 2005 applied and as such would involve potentially complex dialogue with the local fire authority about a building that was considered to be of sufficient scale, complexity and risk in terms of function that it should fall under the Order.

c) At the outset of the Studio E novation it was – or should have been – clear to both Rydon and Studio E, and indeed Artelia as the Employer's Agent representing KCTMO, that much design and specification work remained to be carried out, both with respect to work that should have been done under the appointment of consultants to KCTMO, and with respect to variations that Rydon would be instructing, especially with reference to the over-cladding work. In such circumstances it should have been clear that the design and specification work as available at the outset of the novation would need significant further development and that the work of the specialist fire consultant as carried out under the KCTMO appointment had not been brought to a stage of completion that formed a satisfactory basis on which to proceed with the post-novation design and specification further development.

4.4.17 It seems to me that another fundamental problem with this project was that a matrix of responsibilities under the Design and Build contractor were never properly established or monitored. I have not seen evidence of any such matrix at any stage of the project.

4.4.18 Whilst such a matrix is important at the earlier stages, it is critically important under any Design and Build appointment.

4.4.19 Against that background Studio E seem to have assumed that Harley would carry out work that was clearly stipulated under the Rydon appointment terms to be within Studio E's province. As Exova were not fully integrated into the Rydon Design and Build team, their role was ambiguous. They appear to have been involved on an '*as and when needed*' basis.

4.4.20 In this respect I quote from the RIBA Job Book Ninth edition (published 2013) as follows from Stage 1 '*Preparation and Brief Supplementary Material*':

'It is good practice to table the Design Responsibilities Matrix at the earliest opportunity. This identifies all the main project activities and specifies which consultant will have prime responsibility for which activity. It can also identify whether there are any secondary roles. Its prime objective is to clearly set out who is doing what, which may then lead to any gaps or overlaps in devices being identified. This matrix needs to be shared with the client and agreed and signed off by the whole team'.

4.4.21 This resulted in a less than satisfactory level of commitment during Snap-Shot 3 on the part of Studio E: they simply didn't do enough work after novation (and they had not done enough work pre-novation, as stated earlier, during Snap-Shot 2).

4.4.22 In the circumstances, with respect to specialist fire advice, I think that Studio E should have either insisted on a *'fuller'* service from Exova, as part of the Design and Build team or alternatively ensured that they themselves, as architects, got properly to grips with the requirements of ADB2 and applied them diligently through the construction documentation stage. They did not do this instead leaving such work to Harley which, when presented, Studio E failed to adequately check. I am critical of Rydon for presiding over this wholly inadequate situation, and of Artelia, as Employer's Agent, for permitting this state of affairs to go unchallenged.

4.4.23 Max Fordham appears to have been retained by the TMO. However, nothing much turns on this with respect to the over-cladding works because their in-principle design work regarding U-value calculations had been completed.

4.4.24 I am very much of the view that Rydon's decision not to appoint Exova, or in the alternative, another specialist fire consultant, suggests a combination of a cavalier attitude to the issue of fire safety or a fundamental lack of understanding of the complexity of the task of complying with the requirements of the Building Regulations in relation to over-cladding works.

The Envelope Insulation

(Requirements of Building Regulations and guidance of ADL1B and ADB2 provided under Snap-Shot 1)

Commentary Snap-Shot 3: Envelope Insulation

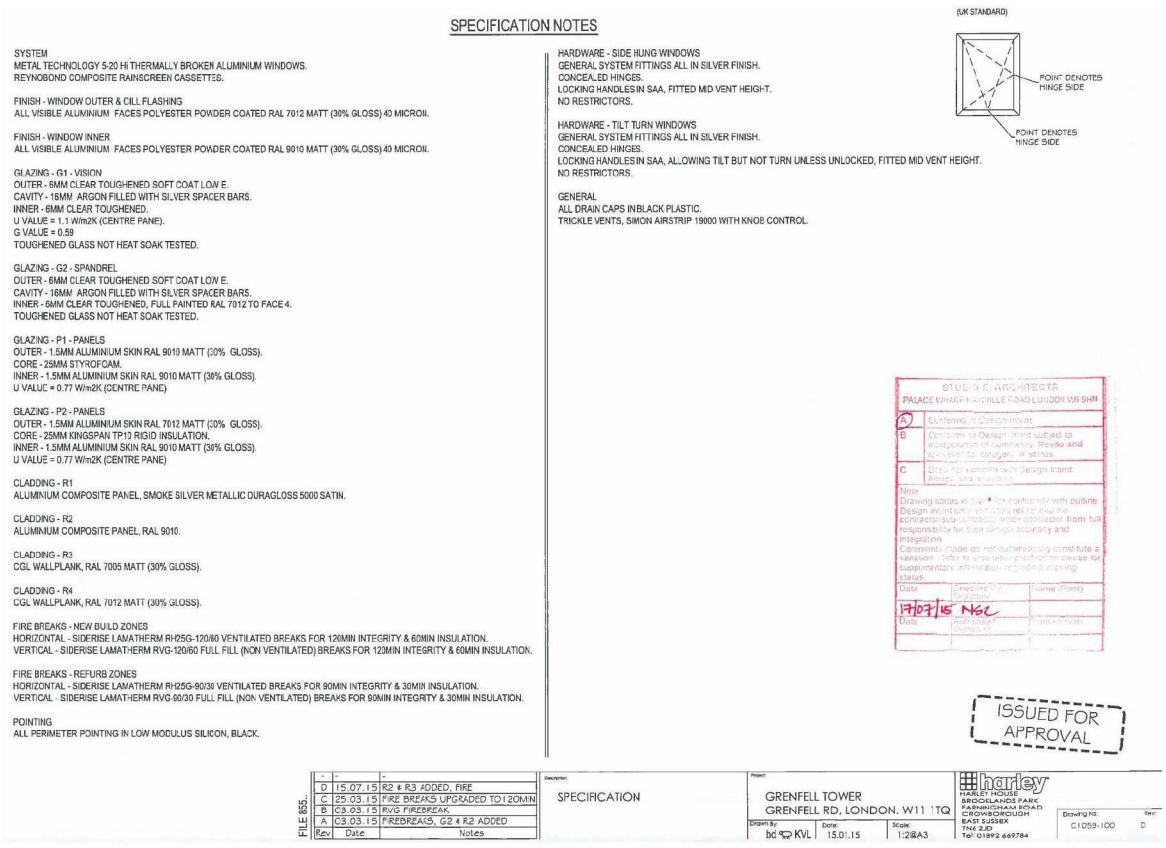
4.4.25 Problems with the failure of the envelope insulation specification to meet both the requirements of the Building Regulations and the guidance contained within ADB2 were carried into the work of Harley in their preparation of construction documentation.

4.4.26 Again, routine design reviews in line with RIBA recommended practice and compliance with ISO 9001 which should have identified this problem at the outset of this stage of the work. They did not do so, either because they were not carried out, or because they were not carried out properly.

4.4.27 A compliant insulation material would have been thicker, and this would have required design modifications: the rainscreen would have to be positioned further away from the façade of the original building, all as shown in the Indicative Design in section 3 of this report. Accordingly, all Harley work was based on false assumptions in relation to the required cavity size.

4.4.28 The failure to meet the requirements of the Building Regulations and the guidance given within ADB2 with respect to insulation continued throughout this stage of the project (Snap-Shot 3).

4.4.29 In due course Harley issued their specification – C1059-100 Rev D for approval. It was dated 15 July 2015 {RYD00046822}. The document did not include any specification notes for the insulation. It is also notable that the Harley drawings, whilst showing insulation, did not include any product reference, insulation type, or note of any kind. The specification was subsequently stamped by Studio E as Status A '*Conforms to Design Intent*'.



SPECIFICATION NOTES

SYSTEM
METAL TECHNOLOGY 5-20 Hi THERMALLY BROKEN ALUMINIUM WINDOWS.
REYNOBOND COMPOSITE RAINSCREEN CASSETTES.

FINISH - WINDOW OUTER & CILL FLASHING
ALL VISIBLE ALUMINIUM FACES POLYESTER POWDER COATED RAL 7012 MATT (30% GLOSS) 40 MICRON.

FINISH - WINDOW INNER
ALL VISIBLE ALUMINIUM FACES POLYESTER POWDER COATED RAL 9010 MATT (30% GLOSS) 40 MICRON.

GLAZING - G1 - VISION
OUTER - 6MM CLEAR TOUGHENED SOFT COAT LOW E.
CAVITY - 16MM ARGON FILLED WITH SILVER SPACER BARS.
INNER - 6MM CLEAR TOUGHENED.
U VALUE = 1.1 W/m2K (CENTRE PANE).
G VALUE = 0.59
TOUGHENED GLASS NOT HEAT SOAK TESTED.

GLAZING - G2 - SPANDREL
OUTER - 6MM CLEAR TOUGHENED SOFT COAT LOW E.
CAVITY - 16MM ARGON FILLED WITH SILVER SPACER BARS.
INNER - 6MM CLEAR TOUGHENED, FULL PAINTED RAL 7012 TO FACE 4.
TOUGHENED GLASS NOT HEAT SOAK TESTED.

GLAZING - P1 - PANELS
OUTER - 1.5MM ALUMINIUM SKIN RAL 9010 MATT (30% GLOSS).
CORE - 25MM STYROFOAM.
INNER - 1.5MM ALUMINIUM SKIN RAL 9010 MATT (30% GLOSS).
U VALUE = 0.77 W/m2K (CENTRE PANE)

GLAZING - P2 - PANELS
OUTER - 1.5MM ALUMINIUM SKIN RAL 7012 MATT (30% GLOSS).
CORE - 25MM KINGSPAN TP10 RIGID INSULATION.
INNER - 1.5MM ALUMINIUM SKIN RAL 9010 MATT (30% GLOSS).
U VALUE = 0.77 W/m2K (CENTRE PANE)

CLADDING - R1
ALUMINIUM COMPOSITE PANEL, SMOKE SILVER METALLIC DURAGLOSS 5000 SATIN.

CLADDING - R2
ALUMINIUM COMPOSITE PANEL, RAL 9010.

CLADDING - R3
CGL WALLPLANK, RAL 7005 MATT (30% GLOSS).

CLADDING - R4
CGL WALLPLANK, RAL 7012 MATT (30% GLOSS).

FIRE BREAKS - NEW BUILD ZONES
HORIZONTAL - SIDERISE LAMATHERM RH25G-120/60 VENTILATED BREAKS FOR 120MIN INTEGRITY & 60MIN INSULATION.
VERTICAL - SIDERISE LAMATHERM RVG-120/60 FULL FILL (NON VENTILATED) BREAKS FOR 120MIN INTEGRITY & 60MIN INSULATION.

FIRE BREAKS - REFURB ZONES
HORIZONTAL - SIDERISE LAMATHERM RH25G-90/30 VENTILATED BREAKS FOR 90MIN INTEGRITY & 30MIN INSULATION.
VERTICAL - SIDERISE LAMATHERM RVG-90/30 FULL FILL (NON VENTILATED) BREAKS FOR 90MIN INTEGRITY & 30MIN INSULATION.

POINTING
ALL PERIMETER POINTING IN LOW MODULUS SILICON, BLACK.

HARDWARE - SIDE HUNG WINDOWS
GENERAL SYSTEM FITTINGS ALL IN SILVER FINISH.
CONCEALED HINGES.
LOCKING HANDLES IN SAA, FITTED MID VENT HEIGHT.
NO RESTRICTORS.

HARDWARE - TILT TURN WINDOWS
GENERAL SYSTEM FITTINGS ALL IN SILVER FINISH.
CONCEALED HINGES.
LOCKING HANDLES IN SAA, ALLOWING TILT BUT NOT TURN UNLESS UNLOCKED, FITTED MID VENT HEIGHT.
NO RESTRICTORS.

GENERAL
ALL DRAIN CAPS IN BLACK PLASTIC.
TRICKLE VENTS, SIMON AIRSTRIP 19000 WITH KNOB CONTROL.

Figure: 4.66: Specification Sheet with Studio E Status Stamp {RYD00046822}

4.4.30 The importance of the insulation is self-evident. It is required to be in place before the rainscreen can be installed. The assembly sequence for principal elements would most likely be:

1. Rainscreen support structure
2. Windows
3. Vertical cavity Barriers
4. Horizontal cavity barriers
5. Cavity barriers around windows
6. Envelope insulation
7. Rainscreen cladding

4.4.31 It is against that background (i.e. given the importance of having reliable well thought out information at this stage of the project for ordering / manufacturing / fabrication and code consent purposes), that the following 17th/18th September 2014 exchange of emails is very disturbing ({EXO00000708} and {EXO00000714}). Whilst the emails are principally about cavity barriers, they also make key reference to the envelope insulation.

4.4.32 Advice requested of Mr Ashton at Exova:

Mr Crawford (Studio E):

"I am working on the Grenfell Tower regeneration project from the Studio E end. The following RFI has come in relating to horizontal fire breaks within the cladding areas. Can you comment on the RFI attached..."

Mr Aston:

*"**I've never seen details of what you're doing to the external walls**. Do you have any cross sections/elevations?"* (my emboldening)

Mr Crawford:

'Please see attached our sections and the initial drawings set we have had from Harleys. The initial drawings from Harleys are fairly limited but they attempt to establish the basic approach.'

4.4.33 What is notable about this exchange is that Mr Ashton, on behalf of Exova, claims never to have seen the details of the external walls.

4.4.34 Mr Ashton nevertheless replies:

*"**If the insulation in the cavities behind the rainscreen cladding is combustible** you will need to provide cavity barrier as shown on your drawing (number 1279 (06) 120) in order to prevent fire from spreading from one flat to the one above even if there isn't a continuous cavity from the top to the bottom of the building."* (my emboldening)

4.4.35 I cannot understand how a fire specialist could be asking if the insulation is combustible when he should well know that under paragraph 12.7 of ADB2 it should be of *'limited combustibility'*.

4.4.36 Courtesy of Studio E (Mr Crawford) various emails then follow (on 18.09.14 {EXO00000714} between Exova (Mr Ashton), and Harley's Design Manager (Mr D Anketell-Jones):

Mr D Anketell-Jones:

"The insulation is class 0. Therefore after reading the correspondence below; I believe that the fire barrier in these locations, will not be necessary. Can you confirm that this is acceptable?

Mr Ashton:

"A material which has a Class 0 rating is not necessarily non-combustible although the reverse is invariably true. Some Class 0 products will burn when exposed to a fully developed fire. In any case, you need to prevent fire spread from on flat to the flat above as I stated in my earlier email. What isn't clear from the information to hand is whether or not there is a continuous cavity from top to bottom in any part of the cladding (apart from around the column casings) irrespective of the type of insulation."

4.4.37 The extraordinary and disturbing point here is that even at this late date there seems to be a fundamental lack of clarity about what the essential principles of the design should be with respect to compliance of the insulation with ABD2 guidance and the requirements of the Building Regulations. Furthermore, it is extraordinary that Mr Ashton, as a specialist fire consultant, should have implied (in questioning whether there was *'a continuous cavity from top to bottom'*) that such a continuous cavity might be permissible.

4.4.38 Throughout all this, Studio E and Harley continued to develop work through the construction information stage that was founded on the major error manifest in the incorporation of an insulation product that failed to comply with the guidance given in ADB2 and failed to meet the requirements of the Building Regulations. I am very critical of Studio E in this respect: their ongoing design reviews should have afforded them multiple opportunities to identify and resolve this problem.

4.4.39 The project was by now running into very serious problems: aside from the code breach, all production information and therefore rainscreen system manufacturing was being based on dimensional planning that assumed a 160mm insulation to the slab edge / spandrel panel and 100mm to the columns derived against a product – Celotex RS5000 – that was unfit for purpose. The longer this situation prevailed, the greater would be the impact in terms of abortive work and materials, delay in completion, costs and claims. In the event, the problem was never identified, and the production information was never corrected.

Conclusion Snap-Shot 3 / Envelope Insulation

4.4.40 The insulation type was not specified by Harley, and their Construction Documentation failed to define the generic type to be used, or a particular product type. Accordingly, Harley's information failed to comply with the guidance given under ADB2 and it also failed to meet the requirements of the Building Regulations.

4.4.41 Studio E's continued confidence in the Celotex RS5000 product, and the use of PIR insulation within the cladding system, represents an ongoing major failure on their part to understand both the requirements of the Building Regulations and the guidance given within ADB2 with respect to insulation in external walls. That failure of understanding appears to have extended to both Harley (Mr D Anketell-Jones) and, surprisingly, Exova (Mr Ashton).

4.4.42 Routine Design Reviews in line with RIBA recommended practice and compliance with ISO 9001 should have identified this ongoing and serious problem both during and at the conclusion of the Production/Construction Information Documentation. This did not happen either because those reviews were not carried out, or because they were not carried out properly. The problem was thus carried into the construction stage work the conclusion of which I which I will later herein review for Snap-Shot 4.

The Rainscreen Cladding

Building Regulations and Approved Document Guidance:

(Requirements of Building Regulations and guidance of ADB2 provided under Snap-Shot 1)

Commentary Snap-Shot 3: Rainscreen Cladding

4.4.43 With the exception of the following two issues, the work brought forward from the previous stage (Studio E Stage D Tender Documentation) provided a satisfactory basis for Studio E to commence work on the construction documentation:

a) the dimensional error (cavity too narrow to accommodate the thickness of mineral wool required in lieu of Celotex RS5000).

b) The failure to provide detailed drawings that should have identified the need for provision at the vertical joints to mitigate against fire crossing the horizontal cavity barriers.

4.4.44 However, following Rydon's appointment as the rainscreen contractor a decision was evidently taken to incorporate a cassette rainscreen ACP panel system called Reynobond supplied by Alcoa Architectural Products. Harley would be responsible for producing construction drawings and in so doing would further develop the work so far produced by Studio E.

4.4.45 As stated earlier, it is my opinion that Studio E had not developed their work as far as it should have been developed at the point of tendering the project. Against that background, a routine Design Review in line with RIBA recommended practice and compliance with ISO 9001 would have identified at the outset of the construction documentation stage of the work that due to the decision to fundamentally change the rainscreen cladding system a major investigation of the Reynobond system would be urgently required to test its compliance with the requirements of the Building Regulations, and the relevant guidance within the Approved Documents, most notably ADB2. Such a review appears either never to have been carried out, or if so, not to have been carried out properly. I am critical of both Studio E and Rydon in this respect.

4.4.46 Despite their obligations to Rydon to produce more detailed information, as outlined in the introduction to this Snap-Shot, Studio E appear to have left Harley to develop the rainscreen cladding construction information with no further drawn information being issued on their part.

4.4.47 I do not know what level of scrutiny Studio E applied to checking the suitability of the Reynobond cladding panel system in terms of its compliance with Building Regulations and the guidance in ADB2, and I do not know what trade or technical literature on the product Studio E examined.

4.4.48 However, as stated in Section 3 above I believe that because page 1 of the BBA Certificate (No. 08/4510 dated 14 January 2008) {BBA00000047} for '*Reynobond Architecture Wall Cladding Panels*' stated that the panels '*may be regarded as having a Class 0 surface in England....*' they appeared to have met the guidance given under ADB2 Diagram 40. I also consider this to be a satisfactory basis upon which Studio E could, in principle, have accepted the product to which this '*Certificate of Confirmation*' related, that is: '*Reynobond Architecture Wall Cladding Panels, aluminium /polyethylene composite panels used to provide a decorative/protective façade over the external walls of buildings*' (see top of page 1 of certificate).

4.4.49 The Harley Specification C1059-100 Rev D Issue for Approval dated 15.07.15 includes a product reference of '*Reynobond Composite Rainscreen Cassettes*' {HAR00004309}. C1059-100-D of the specification was subsequently stamped by Studio E as '*Status A 'Conforms to Design Intent*' {RYD00046822}.

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Figure: 4.67: Extract from Harley Specification Sheet C1059-100 Rev D {HAR00004309}

4.4.50 I do however make some criticisms below, based on the following extracts from the BBA Certificate {BBA00000047}:

1 Description

1.1 The Reynobond Architecture Wall Cladding Panels comprise two 0.5 mm thick aluminium alloy sheets (EN AW-3005, H46) bonded to either side of a core of low-density polyethylene (LDPE). The panels are available either plain edged (riveted system) or flanged (cassette system) to suit architectural requirements (see Figure 1). A Duragloss or PVDF coating available in various colours protects the exposed face. A polyester primer protects the unexposed face. The products are also available in a fire-retardant grade (FR).

6 Behaviour in relation to fire

6.1 A standard sample of the product, with a grey/green Duragloss 5000 coating, when tested for reaction to fire, achieved a classification of B-s2, d0 in accordance with EN 13501-1 : 2002. A fire retardant sample of the product, with a gold-coloured Duragloss finish, when tested for reaction to fire, achieved a classification B-s1, d0 in accordance with EN 13501 : 2002.

6.2 A fire retardant sample of the product, with a metallic grey PVDF finish, when tested in accordance with BS 476-6 : 1989, achieved a fire propagation index (I) of 0 and, when tested in accordance with BS 476-7 : 1997, achieved a Class 1 surface spread of flame.

6.3 As a consequence of sections 6.1 and 6.2, the products may be regarded as having a Class 0 surface in relation to the Approved Document B of The Building Regulations 2000 (as amended) (England and Wales) and Technical Booklet E of The Building Regulations (Northern Ireland) 2000 (as amended) and a 'low risk' material as defined in Annex 2C[1] and Annex 2E[2] of The Building (Scotland) Regulations 2004 (as amended). The unexposed side of the products may also be regarded as having a class 0 surface.

6.4 These performances may not be achieved by other colours of the product and the designations of a particular colour should be confirmed by:

England and Wales — Test or assessment in accordance with Approved Document B, Appendix A, Clause 1

Scotland — Test to conform with the Table to Annex 2C[1] or Annex 2E[2] of Regulation 9

(1) Technical Handbook (Domestic).
(2) Technical Handbook (Non-Domestic).

Northern Ireland — Test or assessment by a UKAS accredited laboratory or an independent consultant with appropriate experience.

6.5 For resistance to fire, the performance of a wall incorporating the product, can only be determined by tests from a suitably accredited laboratory, and is not covered by this Certificate.

6.6 Cavity barriers should be incorporated behind the cladding, as required by the national Building Regulations, but should not block essential ventilation pathways. Particular attention should be paid to preventing the spread of fire from within a building breaching the cladding system through window and door openings.

Figure: 4.68: Extracts from the Alcoa Architectural Products BBA Certificate No 08/4510 {BBA00000047}

4.4.51 I particularly draw attention to the following: The BBA certificate states under *'6.1 Behaviour in relation to fire'* that it was *'a standard sample of the product with a green/gloss Duragloss 5000 coating, when tested for reaction to fire'*, that had *'achieved a classification of B-s2, d0 in accordance with EN 13501-01:2002'*.

4.4.52 Paragraph 6.2 refers to a fire-retardant sample of the product.

4.4.53 Paragraph 6.3 states that *'As a consequence of paragraphs 6.1 and 6.2 the products may be regarded as having a Class 0 surface in relation to the Approved Document B of the Building Regulations 2000'*. This appears to me to be sloppy drafting as only the fire-retardant sample under paragraph 6.2 appears to have met the class 0 test.

4.4.54 But critically, paragraph 6.4 of the BBA certificate states that:

'these performances may not be achieved by other colours of the product and the designations of a particular colour should be confirmed by… a Test or assessment'.

4.4.55 As I have stated above, I believe that because page 1 of the BBA Certificate (No. 08/4510 dated 14 January 2008) {BBA00000047} for '*Reynobond Architecture Wall Cladding Panels*' stated that the panels *'may be regarded as having a Class 0 surface in England...(see section 6)'* it was reasonable for an architect to conclude, on that basis alone, that the product met the guidance given under ADB2 Diagram 40. I say this because the statement was not qualified in any way. I accept that there is, as included in my quotation, an advice '*see section 6*' but I do not think it right to unduly criticise an architect who simply took the Class 0 endorsement on page 1 of the BBA Certificate at face value and proceeded to specify the product on the basis that it met the guidance in ADB2 Diagram 40 without further reference to '*section 6*'. That aside, *if* an architect did refer to section 6 which is exhibited above, I believe that he should, upon reading paragraph 6.2, have become alert to the availability of a '*fire-retardant*' option and upon reading paragraph 6.4 to the fact that the performance under fire may vary with colour. In this context:

a) I do know that Studio E received the BBA Certificate for Reynobond. (Mr Sounes' statement, paragraph 377 {SEA00014273}).

b) I do not know whether Studio E ever read the BBA Certificate for Reynobond beyond page 1: if they did not, as stated above, I would not be critical. If they did however choose to examine the Certificate in greater detail and in that process saw and read Section 6 '*Behaviour in relation to fire*', then I think that Studio E should have deemed it appropriate to seek further guidance (for example from Exova) on issues such as whether they should specify a product with a fire retardant core, and whether the colour they were proposing would meet either national class 0 or European class B-s3, d2 or better.

4.4.56 I believe that architects should be able to place reliance on a BBA certificate. In support of this view I quote from the BBA's web site and add some exhibit slogans as follows: (https://www.bbacerts.co.uk/BBA/about-us):

'Product Approval & Certification

BBA certification is recognised throughout the construction industry as a symbol of quality and reassurance. It's the vital ingredient in the provision of assurance, quality and integrity to a plethora of stakeholders in the construction industry'.

'Certification is an achievement that delivers the power of product confidence, industry satisfaction and market leadership'.

'Recognised, respected and sought after by specifiers, architects and contractors, reassures all parties that you are an expert in your speciality who stays on top of the latest advances and best practices, so you can deliver the safest, most efficient and highest quality product

possible'.

About Us

The BBA sets the standard for excellence in construction products and systems. We offer technical expertise, are independent with an unrivalled track record and offer more than certification through our audit and inspection and test services.

Figure: 4.69: Extract from the BBA Website https://www.bbacerts.co.uk

Product Approval & Certification

We are the leading authority on building product certification; a position we've held for more than 50 years. With a technical integrity founded on our independent approach and delivered by the industry's recognised experts, we can also leverage our unrivalled track record to accredit building systems using the same trusted, non-partisan approach.

Figure: 4.70: Extract from the BBA Website https://www.bbacerts.co.uk

BBA Agrément Certificate

BBA Agrément Certificate is a mark of excellence based on rigorous national and European standards that validate a construction product's specialist formulation, capability and uniqueness. Apply now to become Certified with us.

Figure: 4.71: Extract from the BBA Website https://www.bbacerts.co.uk

4.4.57 Against these comments I do not know whether the colour of Reynobond cladding as specified by Studio E would, if tested, have achieved a European standard rating B-s3, d2 or national class 0 as necessary to achieve compliance with ADB2 Diagram 40.

4.4.58 It is notable that the so called *'standard'* ACP (that is without fire retardant), was said to meet the classification of B-s2, d0 of EN 13501 -1: 2002 which complied with the guidance in Diagram 40 of ADB2. However, the product description states *'two 0.5mm thick aluminum alloy sheets (EN AW-3005, H46) bonded to either side of a core of low-density polyethylene (LDPE)'* – see BBA Agrement Certificate No. 08/4510 page 3 item 1 under '*Description*'. For the reasons explained in detail in Snap-Shot 1 of this section , I would not consider the polyethylene core of ACP panels to be *'filler'* as that term is used within ADB2, albeit I recognise that it is not listed in the definitions set out in ADB2 Appendix E.

4.4.59 It therefore appears that the BBA Certificate did not necessarily apply to the colour of panel that was specified for the Grenfell Tower over-cladding product. I do not know whether anything turns on this point: the colour specified may have been capable of meeting the BBA test requirements as required for their certification.

4.4.60 In such circumstances however, I think that if Studio E had examined the BBA certificate in sufficient detail to cause them to read Section 6 of that document then Studio E should have reverted to the manufacturer in pursuit of an assurance that the panel colour selected for Grenfell would meet the test requirement necessary for BBA certification. In the absence of any such satisfactory assurance, I think that Studio E should have insisted on a dedicated test being carried out on the preferred panel colour and refused to specify it without satisfactory certification.

4.4.61 Finally, it is of particular note that under paragraph 6.5 the BBA certificate states that:

> 6.5 *'For resistance to fire, the performance of a wall incorporating the product, can only be determined by tests from a suitably accredited laboratory, and is not covered by this Certificate'.*

4.4.62 Whilst this would seem to suggest that it should be routine for an architect to arrange for, or at least request permission for, a full fire test for any wall into which the product covered by the BBA Certificate is to be used, I would not expect an architect to interpret this as meaning that prior to specifying the product in question a full fire test of the proposed wall in its entity should be undertaken. I take this view because a full fire test is required to determine the performance of the entire wall. Such a test is neither practical nor possible in terms of the time available and costs involved for projects such as the 2012-16 Works. It is for this reason that it has always been my understanding that provided an architect is careful to select materials, products and components that *individually* comply with the Building Regulation requirements as set out in the guidance under the ADB suite of documents, the overall arrangement can be regarded as satisfying the statutory requirements. To test every wall in terms of fire performance would bring the industry to a grinding halt.

4.4.63 I also wish to make reference to paragraph 6.6 of the BBA certificate for the Reynobond product which clearly emphasises the importance of incorporating cavity barriers, as required by the Building Regulations. In this respect I make particular reference to the following extract from that clause:

'... Particular attention should be paid to preventing the spread of fire from within a building breaching the cladding system through the window and door openings'.

In this respect the BBA could hardly be clearer. I deal with cavity barriers at greater length at various places elsewhere in this report. Suffice it for me to state here that if Studio E had referred to Section 6 of the BBA certificate, they should have noted the emphasis placed on the use of cavity barriers. This should have prompted their own review of their work in this respect which was, as shown elsewhere in this section, fundamentally flawed at every stage of its consideration – as indeed they should already have realised.

4.4.64 I am aware of an internal email exchange within Harley {HAR00006585} in which Mr D Anketell-Jones (Technical and Engineering Manager) advises Mr R Bailey as Managing Director that the ACP panels would not withstand fire for long:

'There is no point in 'fire stopping', as we all know the ACM will be gone rather quickly in a fire. The whole point is to stop 'unseen' fire spreading in the cavity and moving to other parts of the building'.

It is notable that as self-professed experts in cladding application, the Technical Director of Harley appears to have muddled cavity barriers with fire stopping. It is also of note in this respect that despite an apparent misapplication of the correct terminology in relation to cavity barriers, Harley were at that time already well aware of the characteristics of '*ACM*' in fire conditions. I am surprised in these circumstances that Harley were (if either recommending the use of ACM, or accepting its use) a) not recommending the adoption of fire-retardant cores and b) not seeking to ensure absolutely strict compliance with the BBA advice that *'Particular attention should be paid to preventing the spread of fire from within a building breaching the cladding system through* ***window .... openings'*** {BBA00000047} (my emphasis).

4.4.65 It seems to me that serious criticisms can be made of all manufacturers who continued to supply polyethylene cored ACP products without warning their purchasers (both directly and through their product literature) of their product's characteristics in fire, and therefore the potential inappropriateness of such products for use in buildings over 18 metres high, particularly those used for residential purposes (flats) and those where people would be sleeping (hotels, hospitals and residential institutions such as hostels and halls of residence).

4.4.66 I am also aware that there have been a number of recent significant façade fires involving ACP/ACM products, a notable example of which has been the Torch in Dubai which has caught fire 3 times: in February 2015, August 2017, and January 2019, albeit the latter occasion relating to a fire of relatively small scale. Whist I would have expected architects, especially those regularly involved with tall buildings, at the time of the first of those fires (February 2015) to be aware of the possible dangers of façade fires, I would not have expected them to be alert to the particular dangers arising from the use of ACP rainscreen cladding incorporating polyethylene cores. In this respect I am not aware of any circular that for example the RIBA released, or of general coverage in the technical sections of specialist architectural journals, that would have particularly alerted architects to the specific dangers of polyethylene cores within ACP panels. Such dangers are now abundantly clear and have been evident due to the contribution that the ACP panels appear to have made to the fire at Grenfell Tower.

4.4.67 However, whilst conducting research in the preparation of this report I have noted that the NBS (National Building Specification) upon which architects routinely rely very heavily, does contain extensive guidance under Work Section H92 (Rainscreen Cladding) with respect to the specification of rainscreen cladding systems. That section also carries a series of valuable references to further information sources. In terms of relevant standards for such installations the NBS current guidance (October 2019) states:

'There are no specific British or European standards for ventilated rainscreen walls. The generally accepted industry standard for rainscreen cladding in the UK is the "Standard for systemised building envelopes" published in 2006 by the Centre for Window and Cladding Technology (CWCT). This document, together with various technical notes published by the CWCT, and insurers' publications (eg. NHBC Standards; LABC Warranty's publications 'Technical manual version 8' and 'Cladding technical memorandum', both of which can be downloaded from the LABC Warrant website; and LPCB's 'Loss Prevention Standards') should therefore form the basis for the design , specification and testing of rainscreen cladding in the UK'.

4.4.68 The Studio E specification section H92 '*Rainscreen cladding*' under '*DESIGN/PERFORMANCE REQUIREMENTS*' included for the CWCT Standard for Systemised Building Envelopes including '*Part 6 – Fire Performance*'.

4.4.69 I note that Harley is listed as a member of the Centre for Window and Cladding Technology (CWCT) although I do not know whether Harley was a member at the time of their appointment to Rydon. The CWCT membership includes a number of architects who appear to have significant involvement with rainscreen systems and a number of sub-contractors who specialise in such installations. As a member, Harley would have had access to benefits which include receiving updates on technical, training, publications and certification work.

4.4.70 Assuming that Harley was a member of CWCT at the time of their appointment by Rydon, it should have availed itself of the benefits of such membership and should have been aware of such circulars as Technical Note No. 73 published in 2011 titled '*Fire performance of curtain walls and rainscreens*' which provides specific advice in terms of designing in relation to fire.

4.4.71 Such information should have, in my opinion, informed Harley's work at production stage. They should, for example, have been properly informed about cavity barriers which, as I explain elsewhere, they were not. CWCT Technical Note No. 73 also refers to the importance of cavity barriers around openings and the requirement for thermal insulation to be of limited combustibility in buildings of over 18 metres height. (The full text of Technical Note No. 73 is included as Appendix 3)

4.4.72 It therefore seems to me that as rainscreen cladding was identified in Studio E's specification as a *'contractor designed element'* then Harley should have been better informed in their work. I particularly note in this respect that under Studio E's specification clause 342 *'CONTRACTOR'S DESIGN OF RAINSCREEN GENERALLY'* under design responsibility Harley were required comply with the stipulations of the following exhibit:

342 CONTRACTOR'S DESIGN OF RAINSCREEN GENERALLY

- Design responsibility: Determine sizes and thickness of panels and types, sizes and numbers of fixings to suit backing wall and the layout and details of supporting steelwork.
- Design standard: To CWCT 'Standard for systemised building envelopes'.
- Structural and fire requirements:
  - Generally: As section B50.
  - Modifications: None.
  - Design: Complete the design in accordance with the designated code of practice to satisfy specified performance criteria.
- Functional requirements: As specified in this section, with fire stopping to the requirements of the Building Regulations.
- Additional requirements: As specified in this section.

Figure 4.72: Extract from the Studio E Tender Specification Section H92 *'Rainscreen Cladding'* {SEA00000169}

4.4.73 I note in this exhibit which I believe was authored by Studio E, the apparent mis-use of the term *'fire-stopping'*, and the failure to reference cavity barriers. However, that aside, I think that the Studio E specification makes it abundantly clear that in terms of both design and and installation (that package such as the cavity barriers and insulation) Harley's work should be:

a) To the standard expected of a firm following all relevant guidance contained in information routinely provided by or available from CWCT.

b) To the standard as required to conform to the Building Regulations.

4.4.74 In this respect I think it reasonable to expect a firm that both holds membership of CWCT and holds itself out, as described elsewhere in this report, as an expert in cladding work, to fully avail itself of all necessary resource and information as required to fully meet the performance standards set out above.

4.4.75 In the course of preparing this report I have also become aware of several guidance documents produced by the Building Control Alliance ('BCA'). These include the BCA Technical Guidance Note 18.

4.4.76 I note from its website that the BCA is an industry group made up of representatives from *'clients, stakeholders and all the organisations directly involved in building control in England and Wales'*. The website also states that amongst its representative groups are:

- The Association of Consultant Approved Inspectors (ACAI)

- Local Authority Building Control (LABC)
- Chartered Association of Building Engineers (CABE) and
- Royal Institution of Chartered Surveyors (RICS)

4.4.77 As with the CWCT, I note that BCA issues regular bulletins and papers on construction related issues. It also produces 'practical guidance for designers and those working in Building Control to assist in understanding and applying the Building Regulations' amongst which was BCA Technical Guidance Note 18 which, although its title suggests otherwise ('Use of Combustible Cladding Materials on Buildings Exceeding 18 m in Height'), deals expressly with ADB2 paragraph 12.7 in terms of 'all the elements' of the cladding system including insulation. The June 2015 version (Issue 1) expressly states that PIR boards (polyisocyanurate) do not 'usually meet the limited combustibility requirements of ADB2 Table A7 and should not therefore be accepted as meeting ADB2 paragraph 12.7'.

4.4.78 I would not expect an architect, a specialist cladding contractor or rainscreen contractor to be aware of the advices and circulars as issued by the BCA, but I would certainly expect a Building Control Department, either through direct membership of the BCA, or indirectly through their membership of the LABC, to be properly informed of such advice.

4.4.79 I also take the view that if a Building Control Department, or officer within such a department, becomes responsible for such a cladding system on a project, in circumstances where previous experience is lacking, then it/that person should make full use of the information available at the BCA so as to be able to, in a properly informed manner, discharge its statutory duties effectively.

4.4.80 It is clear to me that such information as was required to properly assess the Full Plans application with respect to the 2012-16 over-cladding was *'out there'* and readily available, but regrettably the Building Control department were simply not *'up to speed'* and as such were woefully lacking in the knowledge and experience required for overseeing this application and construction programme.

Conclusion Snap-Shot 3 / Rainscreen Cladding

4.4.81 Routine Design Reviews in line with RIBA recommended practice and compliance with ISO 9001 should have identified serious problems both during and at the conclusion of the Production/Construction Information Documentation in terms of the specification of the rainscreen cladding (fire-retardant / assembly) and the detailing of the open vertical joint as it bi-passed every horizontal cavity barrier. This did not happen either because those reviews were not carried out, or because they were not carried out properly. The problem was thus carried into the construction stage work the conclusion of which I which I will later herein review for Snap-Shot 4.

4.4.82 I have denoted the rainscreen as a '*x*' within the matrix as shown at the outset of this Snap-Shot. That is '*documentation considered not to comply with ADB*'. This conclusion was reached on the basis of the Harley detailing to the rainscreen cladding: that is, the panel configurations and joint conditions. In particular the open nosing of the panels at their vertical joints at column locations and at the vertical joints where panels meet over windows. In both cases fire can '*travel*' within the joint bi-passing the cavity barriers. This is shown at Figures 4.84, 4.85 and 4.94. in Snap Shot 4 to this section. Comparison of that arrangement with the Indicative Approach shown in Section 3 reveals the concern.

4.4.83 The actual panel colour specified did not apparently carry a BBA certificate confirming that it met either '*Class 0 (National standard)*' or '*class B-s3, d2 or better (European Standard)*'.

4.4.84 Whilst Studio E may therefore be criticised in this respect (if they chose to read beyond the first page of the BBA Certificate), I do not know whether the panel colour specified had passed the tests necessary for such certification, nor I am in a position to say how the manufacturer would have responded if this query had been raised with them. I therefore cannot know whether anything turns on this point.

4.4.85 I am critical of the BBA for what I consider to be sloppy drafting on page 1 of the certificate for the Reynobond panels {BBA00000047} where it is stated that:

'Reynobond Architecture Wall Cladding Panels'...

This Certificate of Confirmation relates to Reynobond Architecture Wall Cladding Panels, aluminium/polyethylene composite panels used to provide a decorative / protective façade over the external walls of buildings.'...

'Behaviour in relation to fire - in relation to the Building Regulations for reaction to fire, the panels may be regarded as having a class O surface in England and Wales'...

4.4.86 There is no suggestion on the BBA certificate page 1 that the failure to specify a polyethylene core with fire retardant additive, or the failure to use only one or a few amongst the designated colours, would render any panels within the range described in the italics above as non-compliant with the requirements of Class O and Approved Document B.

4.4.87 I note that the statement on page 1 of the certificate refers to further information contained within the document (*'see section 6'*) but I do not see this as an indication that the Class O certification is in any way qualified. I rather see it as an invitation to peruse supplementary information.

4.4.88 It is my opinion that whilst many architects would insist on studying the entire BBA certificate – that is all 8 pages - an architect could reasonably rely on the page 1 statement as a satisfactory and complete endorsement of the product in terms of compliance with the requirements of Class O, and could also conclude that in so doing it meets the guidance of ADB2 Diagram 40.

4.4.89 As stated in Section 3, it is my opinion that the guidance within ADB2 (at that time) endorsed, in principle, the use of the Reynobond Aluminium Composite Panels for use on a project such as Grenfell Tower. It is my further opinion that most architects would have considered that such endorsement indicated that, in principle, panels complying with the guidance set out in ADB Diagram 40 would also meet the requirements of the Building Regulations. That would certainly have been my conclusion. It is clear that the simply stated requirements of the Building Regulations at B4 (1) of Schedule 1 were not met. However, I would not criticise Studio E in this respect as I believe that an architect should be able to rely on the Approved Document guidance as being adequate to meet the requirements of the Building Regulations.

4.4.90 Finally, I do not think that an architect should be expected to interrogate the performance of the core of a composite material in circumstances where the BBA certificate has endorsed that product as compliant with the standards set within the ADB2 guidance; in this case that standard being *'Class 0 (national class) B-s3, d2 or better (European Class)'*.

Cavity Barriers

Building Regulations and Approved Document Guidance:

(Requirements of Building Regulations and guidance of ADB2 provided under Snap-Shot 2)

Commentary Snap-Shot 3 / Cavity Barriers

Harley arrangements with respect to cavity barriers

4.4.91 Problems with the failure of the cavity barrier arrangements to meet both the requirements of the Building Regulations and the guidance contained within ADB2 were carried into the work of Harley in their preparation of construction documentation.

4.4.92 Again, routine design reviews by Studio E in line with RIBA recommended practice and compliance with ISO 9001 should have identified these problems at the outset of this stage of the work. They did not do so, either because they were not carried out, or because they were not carried out properly.

4.4.93 On assuming responsibility under their Design and Build contract Rydon should also have carried out reviews in compliance with their ISO 9001 obligations which should have identified gaps in the information available at the start of construction documentation. Again, such reviews were either not carried out properly or not carried out at all.

4.4.94 The Harley Specification C1059-100 Rev D *'Issue for Approval'* dated 15.07.15 includes a product reference of SideRise Cavity Barriers {RYD00046822}.

FIRE BREAKS - NEW BUILD ZONES
HORIZONTAL - SIDERISE LAMATHERM RH25G-120/60 VENTILATED BREAKS FOR 120MIN INTEGRITY & 60MIN INSULATION.
VERTICAL - SIDERISE LAMATHERM RVG-120/60 FULL FILL (NON VENTILATED) BREAKS FOR 120MIN INTEGRITY & 60MIN INSULATION.

Figure 4.73: Extract from Harley Specification Sheet C1059-100 Rev D {HAR00004309}

4.4.95 The products referenced within the Harley specification notes are suitable as cavity barriers and meet the performance requirements of Item 15, Table A1 of Appendix A of ADB2.

4.4.96 Harley produced elevations of the three typical bay conditions shown below and numbered C1059-200-I, C1050-202-C, C1059-201-D {HAR00008581} {HAR00009729} {HAR00008886}. I show those drawings below - in each case I have highlighted the positions of the cavity barriers as proposed by Harley, albeit in each case (as with their specification note as illustrated under figure 4.73) Harley has applied the term *'firebreak'* in lieu of *'cavity barrier'*.

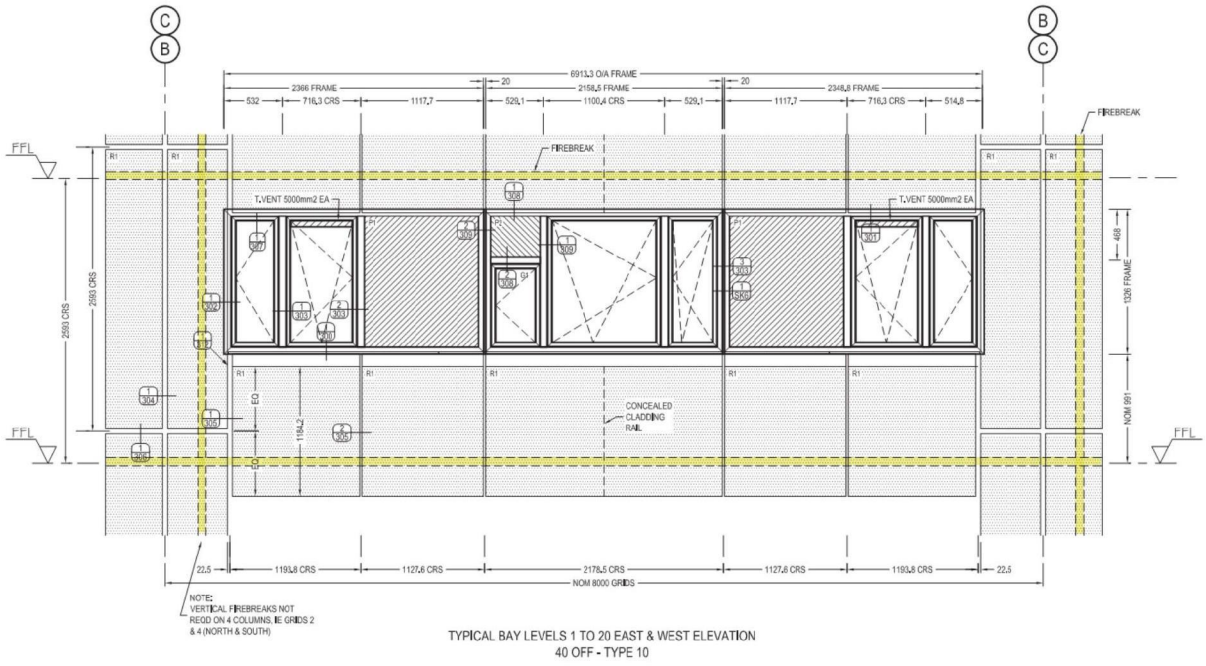


Figure 4.74: Harley Drawing C1059-200-I with Cavity Barriers highlighted - '*Bay A*' {HAR00008581}

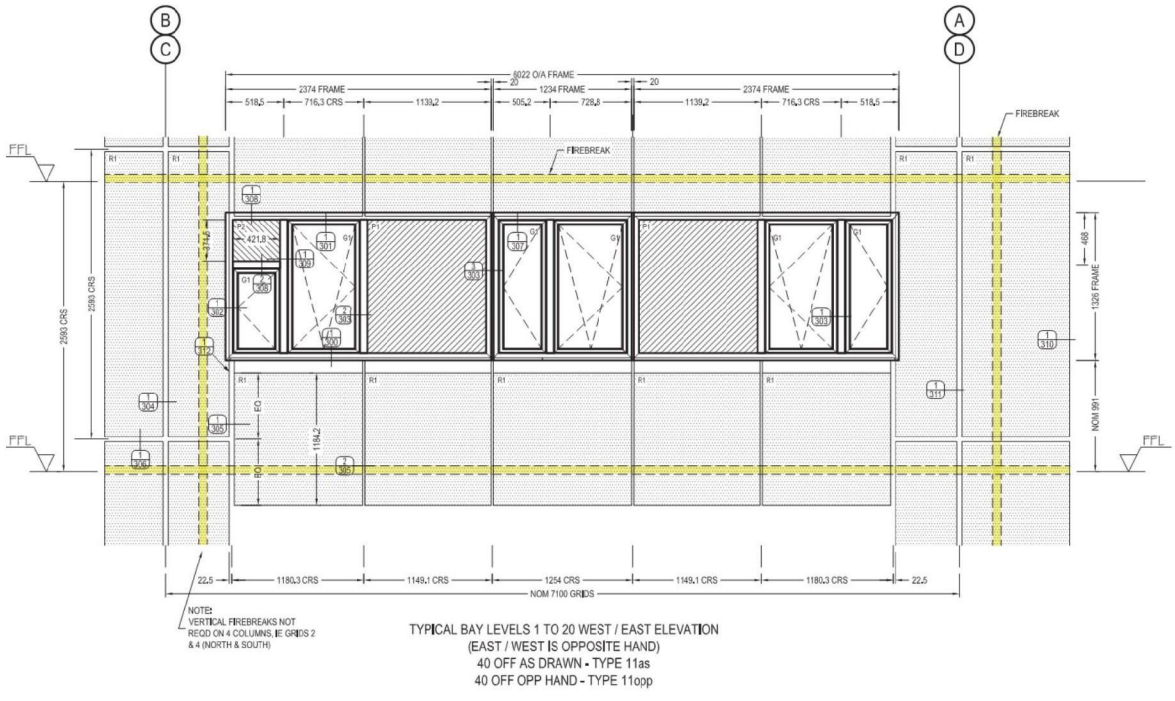


Figure 4.75: Harley Drawing C1059-201-D with Cavity Barriers highlighted - '*Bay B*' {HAR00008886}

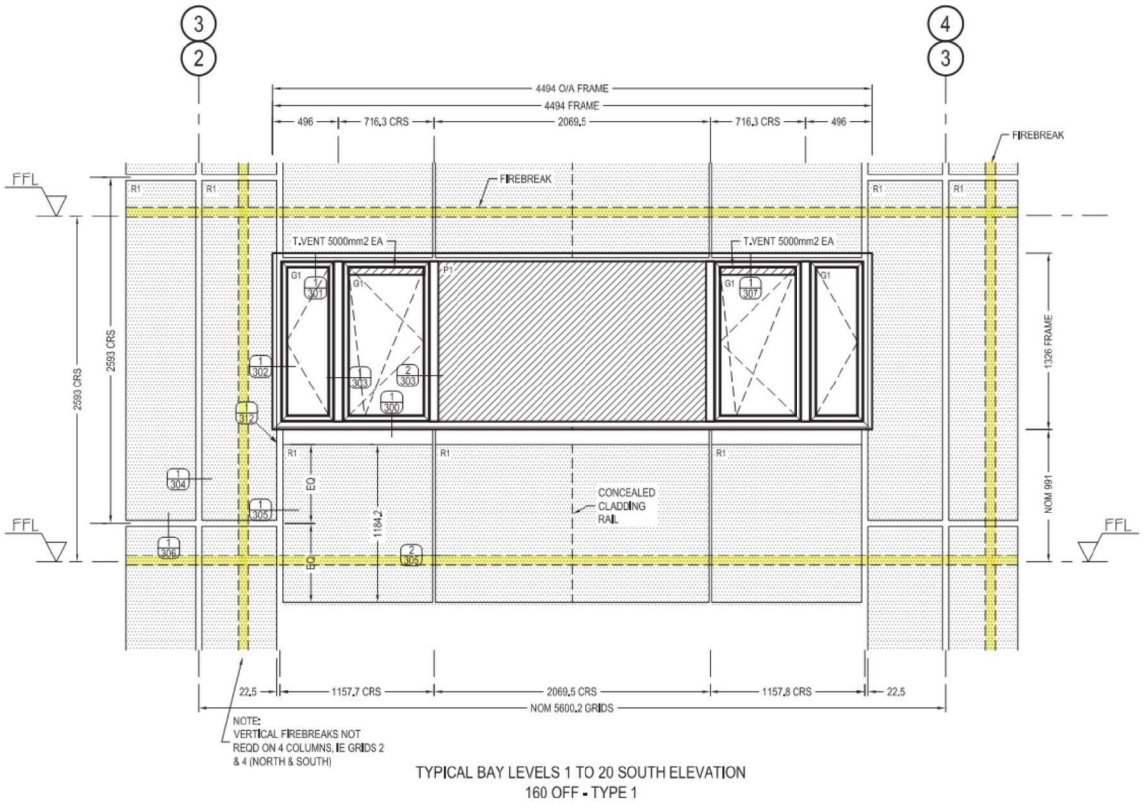


Figure 4.76: Harley Drawing C1050-202-C with Cavity Barriers highlighted - '*Bay C*' {HAR00009729}

4.4.97 To assist the reader, I have prepared the diagram below of a typical floor plan which identifies the location of the various bays which I refer to as Bay A, Bay B and Bay C Note: Harley do not show the arrangements to bays at A1/A2; A4/A5; D1/D2 or D4/D5 which I have identified as Bay D in the Indicative Scheme.

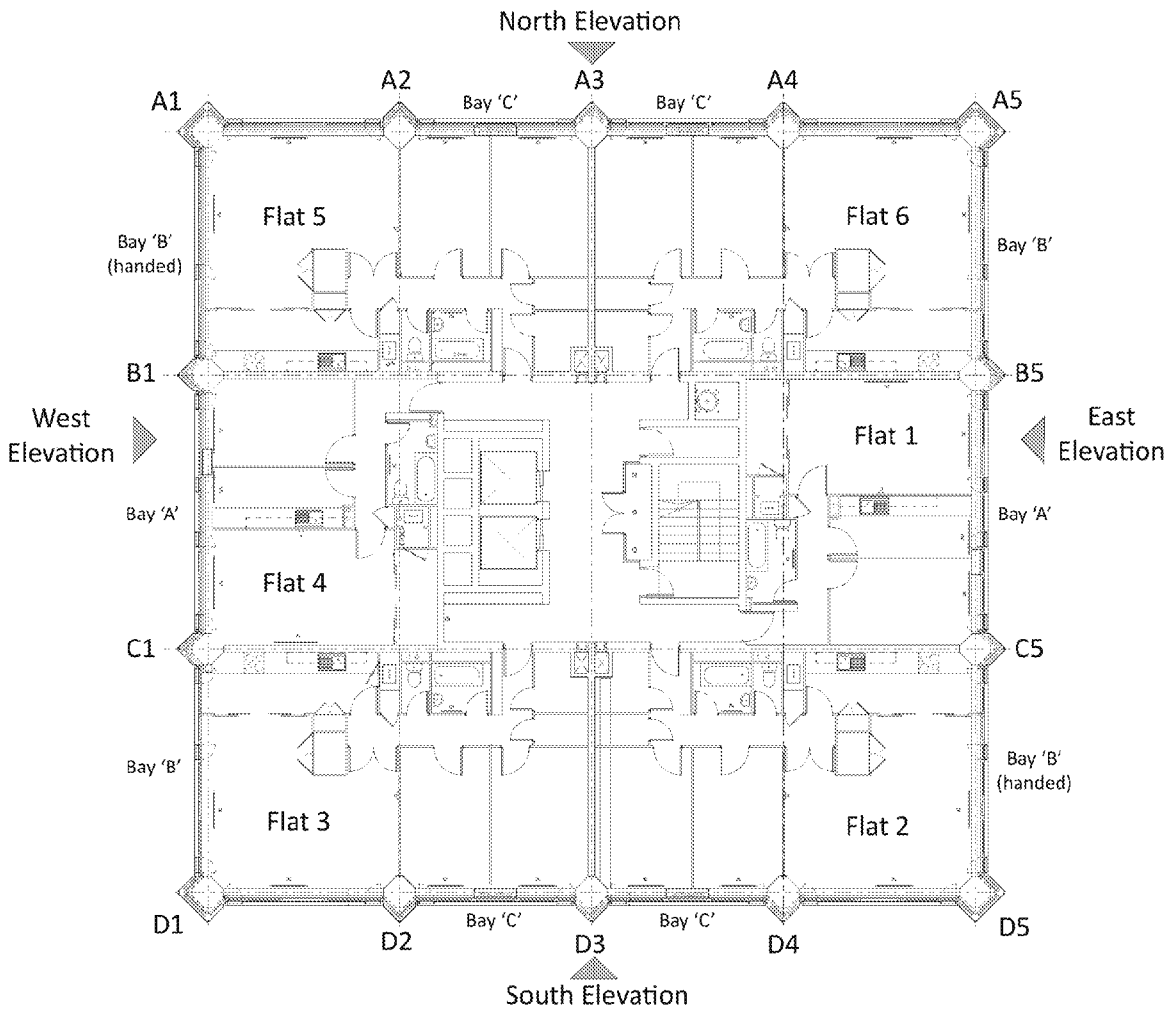


Figure 4.77: Diagram produced using Studio E drawing 1279 (04) 105 00 {SEA00010474}

4.4.98 The Harley drawings (i.e. Figures 4.74, 4.75 and 4.76) refer to '*Firebreaks*' by which I assume they mean '*cavity barriers*'. '*Firebreaks*' is not a word that is used within the Building Regulations or Approved Documents. I would not expect a competent firm to be using incorrect terminology for such a critically important component, particularly as the word could so easily be muddled with '*Fire-Stopping*' which is used within ADB2 albeit for a different purpose. I would expect both Studio E as architects, and Rydon as the Design and Build contractor, to have insisted on the terminology being corrected during their review process. This appears not to have happened.

4.4.99 As shown in the exhibit below the horizontal '*Firebreaks*' that are indicated on the elevations are not shown within the depth of the compartment floor as they are projecting (in part at least) above the FFL (finished floor level) dashed line. I have marked up the exhibit to show this clearly. These should align with the compartment floors, that is, they should be set to fit entirely between the underside of the concrete floor and its topside, albeit within the cavity in order to comply with ADB2 Diagram 33. But they do not so align and therefore do not comply with that guidance. That stated, I do not believe anything material turns on this as the spandrel panel is effectively a continuation of the concrete slab and therefore may simply be considered as an extension to the thickness of the slab at its edge. I do however believe that Harley/Studio E should have cleared such positioning with Building Control.

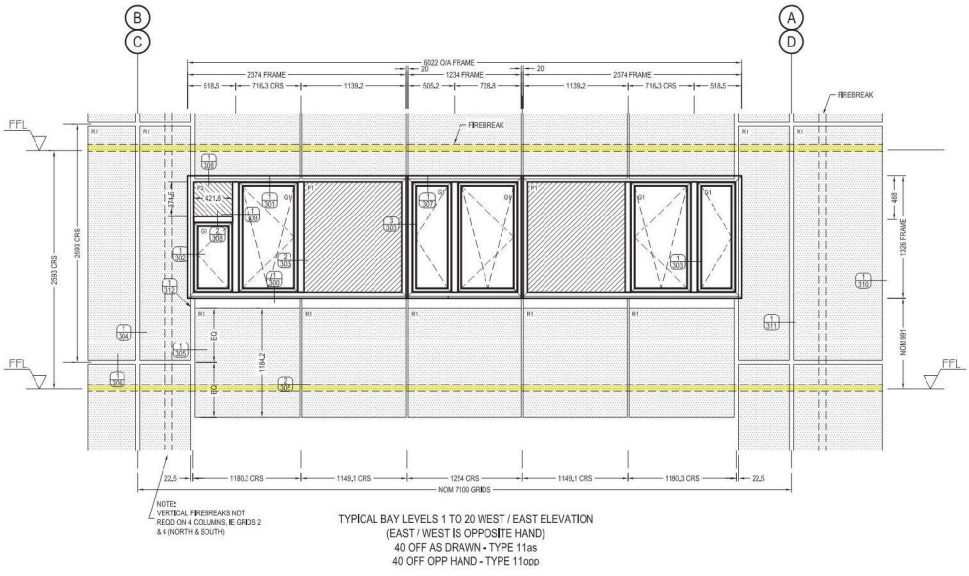


Figure 4.78: Mark up of Harley Elevation C1059-201-D {HAR00008886}

4.4.100 In addition, they do not correspond with the position shown on the Studio E drawings at tender stage– for example drawing 1279 (06) 110 00 {SEA00002499} shown at Figure 4.49 herein, as referred to within my Snap-Shot 2 analysis, showed horizontal cavity barriers immediately at the head of the window and in line with the compartment floor.

4.4.101 There is no reference on the three Harley typical bay drawings to any cavity barriers around the window openings. I have shown within the indicative approach under Section 3 where these should be located (for example at Figure 3.16). This omission on the part of both Harley and Studio E represents a fundamental failure to comply with the guidance in ADB2. It also represents a serious worsening of the non-ADB2 compliant arrangements shown within the Studio E tender information, whereby although there was no proper reference to cavity barriers at the jambs there was at least an indication of possible intent in that respect. The exhibit below shows this clearly highlighted.

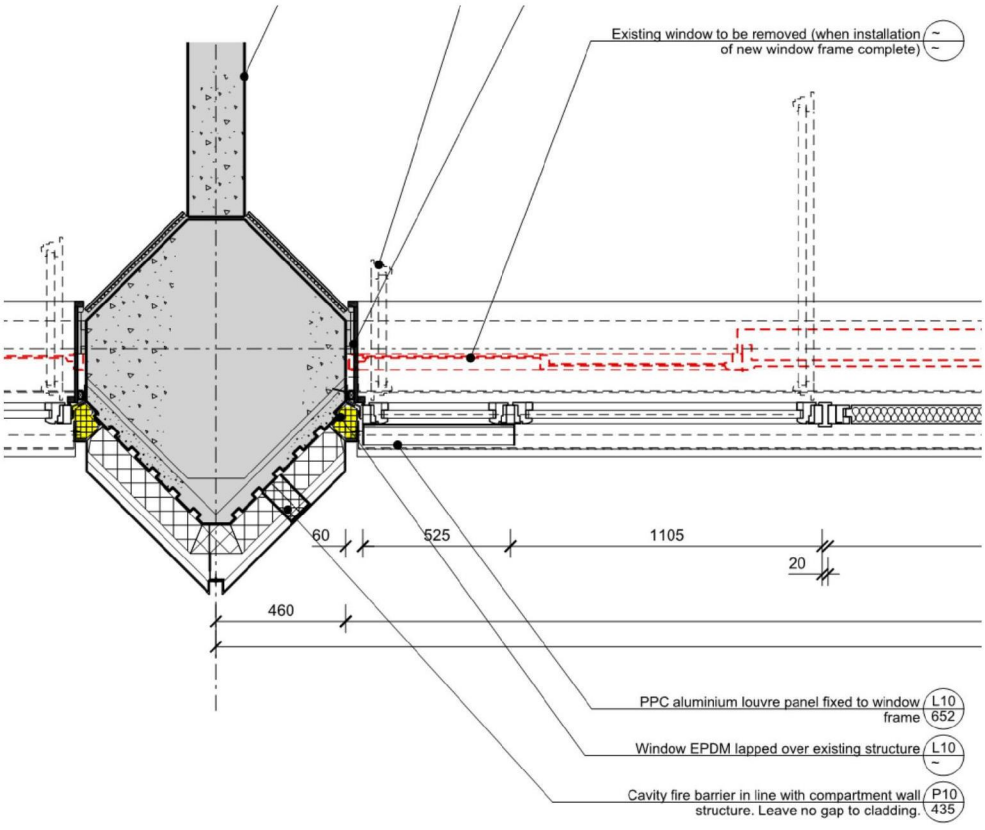


Figure 4.79: Extract of Studio E '*Proposed Plan at Window Level*' from drawing 1279 (06) 110 - 00 {SEA00002499}

4.4.102 Whilst the cavity barrier to the head of the window was shown by Studio E at tender stage, albeit unresolved in terms of detailing, the Harley design as shown above abandons any semblance of cavity barrier protection at the window head. Finally, and consistent with Studio E's failure at tender stage to incorporate a cavity barrier at sill level, likewise Harley's design omits this provision and therefore fails to meet the guidance in ADB2.

4.4.103 The Harley design shows a vertical cavity barrier at every column position albeit a note on each bay states that cavity barriers are not required at columns A2, A4, D2 or D4. These are not aligned with compartment walls, so this interpretation is correct. However, and inconsistent with the decision not to incorporate cavity barriers at columns A2, A4. D2 or D4, Harley does incorporate vertical barriers at each of the corner columns which, by virtue of not aligning with compartment walls, do not require them under the guidance in ADB2. I am not critical of Harley for improving on the guidance of ADB2 in this respect albeit I understand that this decision was based on the advice of SideRise as contained in their email of 22 June 2015 {HAR00020026}.

4.4.104 Extracts from Harley's Specification Notes C1059-100-D {HAR00004309} and drawings that were *'Approved for Construction'* C1059-300-E, C1059-301-D, & C1059-302-D {HAR00008469} {HAR00008470} {HAR00008880} do not indicate the material which is to be used for the window supports. However, the Witness Statement of Mr D Anketell Jones {HAR00010149} states that these are continuous aluminum angles at the head and the sill positions. As stated under Snap-Shot 2, these brackets, despite being continuous, would not constitute a cavity barrier at the openings in either the head or sill, because they do not comply with the permissible materials as listed under ADB clause 9.13. I show below the head and sill details produced by Harley with the continuous angles high-lighted in each case.

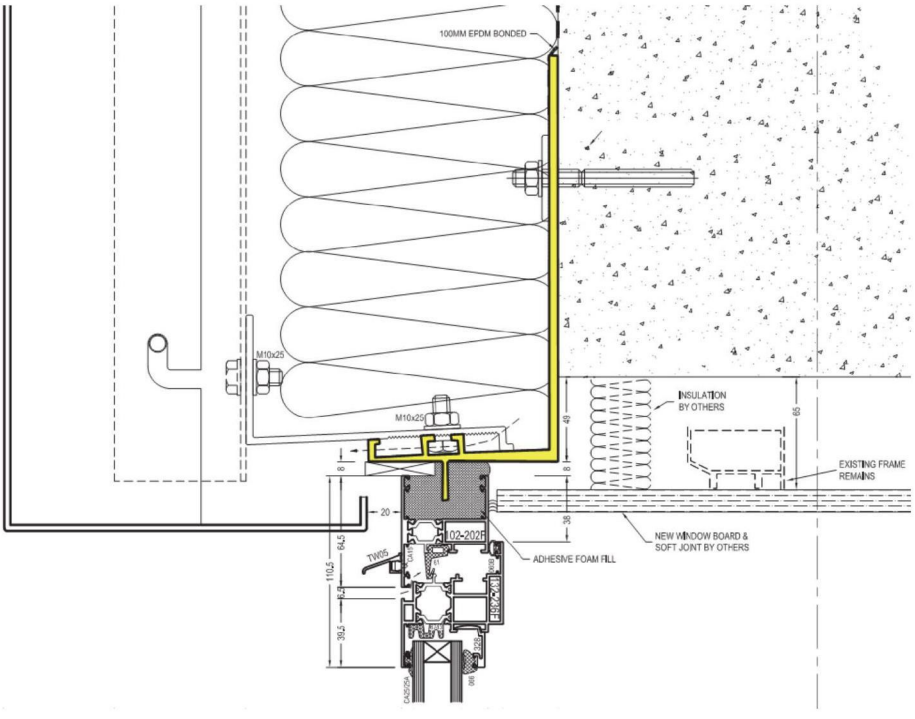


Figure 4.80: Harley Head Detail C1059-301-D with Aluminium Angle highlighted {HAR00008470}

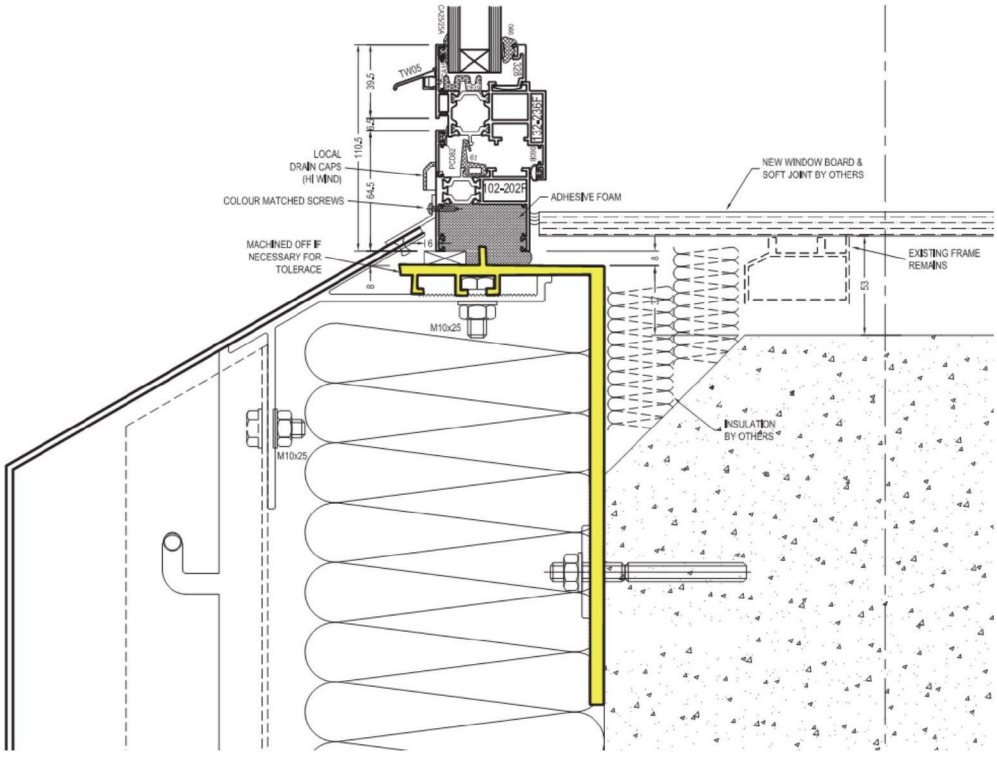


Figure 4.81: Harley Sill Detail C1059-300-E with Aluminium Angle highlighted {HAR00008469}

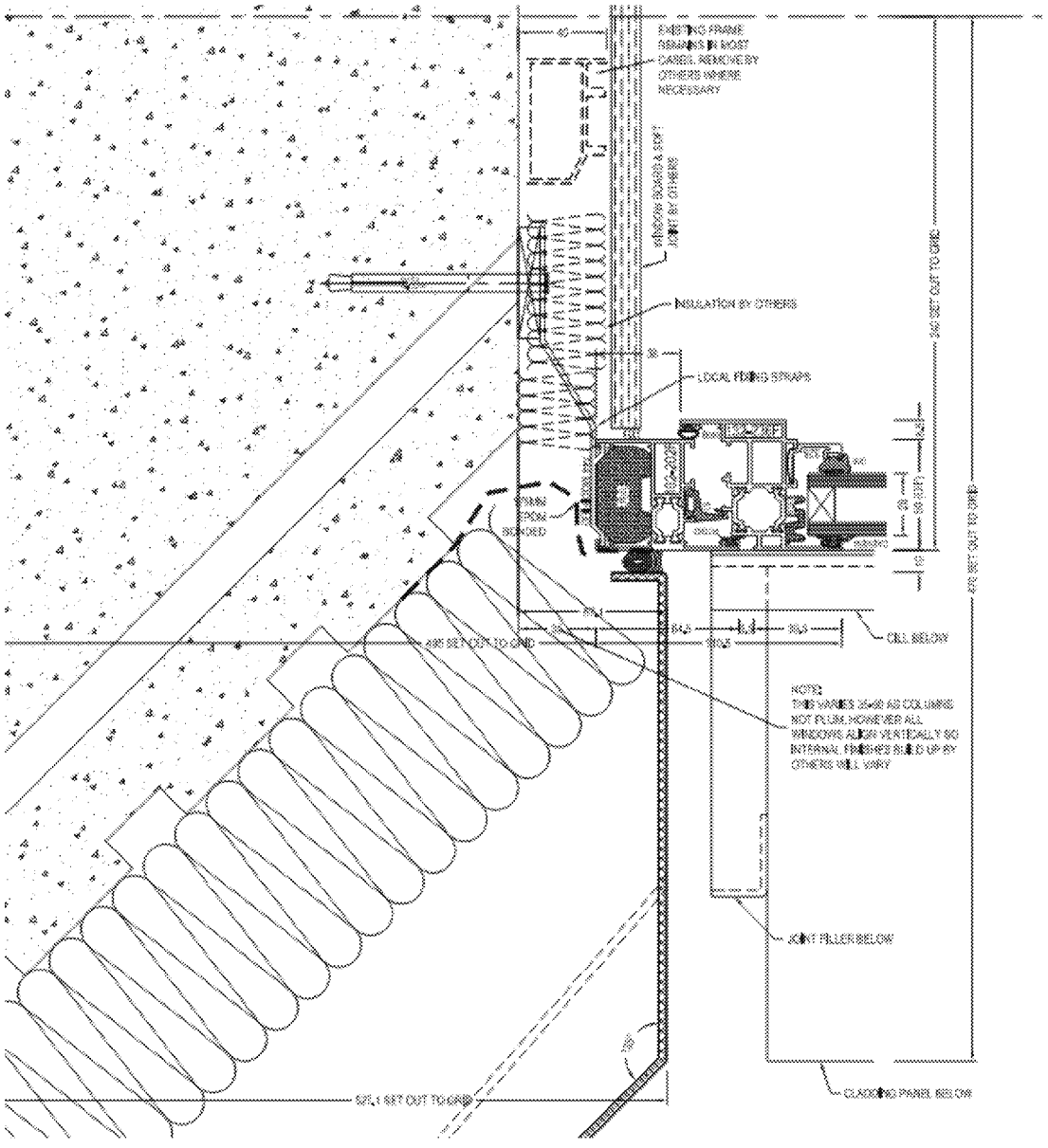


Figure 4.82: Harley Jamb detail C1059-302-D {HAR00008880}

4.4.105 The head, jamb and sill details above are drawn at 1:2 scale. It is clearly noticeable from these three drawings that there is no provision for cavity barriers at head, sill or jamb positions within these construction drawings and therefore no form of inhibition to the passage of fire either around the window frames (that is between frame and concrete slab above, column to the side or spandrel panel below) that complies with the guidance in ADB2.

4.4.106 Harley Detail C1059-301-E {HAR00003958} which is a detail section at the window head indicates (as shown in Figure 4.83 below) that the Open State Cavity barrier is mechanically fixed back to the structure. The detail indicates the SideRise product with the RH25 reference (see highlight on exhibit), which is designed for air gaps up to 25mm +/-3mm between outer face of the barrier and the back of the cladding. Its outer edge comprises an intumescent strip. The barrier therefore extends into the cladding cassette (as shown) in order to provide and maintain a maximum air gap of 25mm. It is not clear how the integrity of the barrier is maintained as the cavity barrier is expressly noted as being *'cut around cladding rail'*.

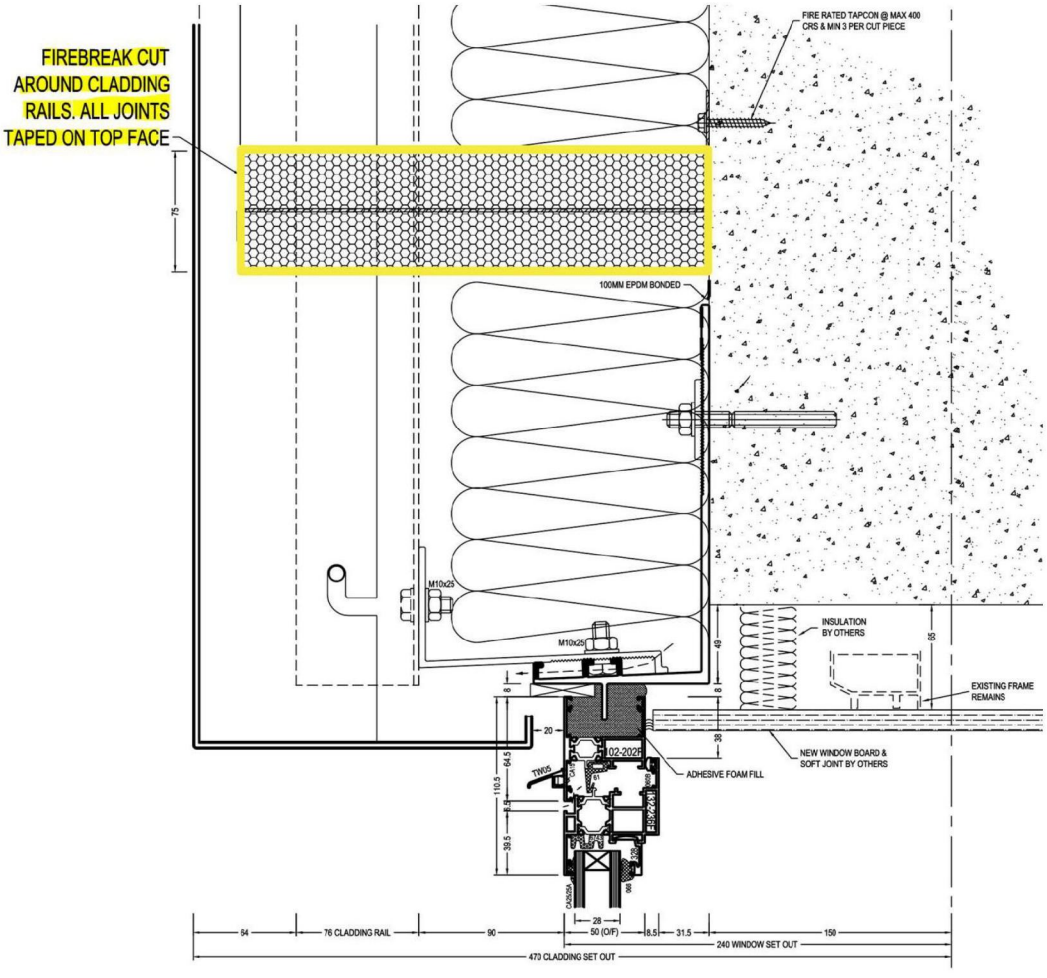


Figure 4.83: '*Open State*' Cavity Barrier Highlighted in Yellow on Harley Detail C1059-301-E {HAR00003958}

4.4.107 The Harley drawing below (drawing C1059-305-C) {HAR00009737} is a detail in plan showing the vertical channels that support the ACP cassette panels. It illustrates this point further. Whilst the SideRise horizontal cavity barriers can be cut fairly tight around the vertical rail support rail, it is inevitable that a gap is left at the point that the cassettes '*hook*' over the support pin.

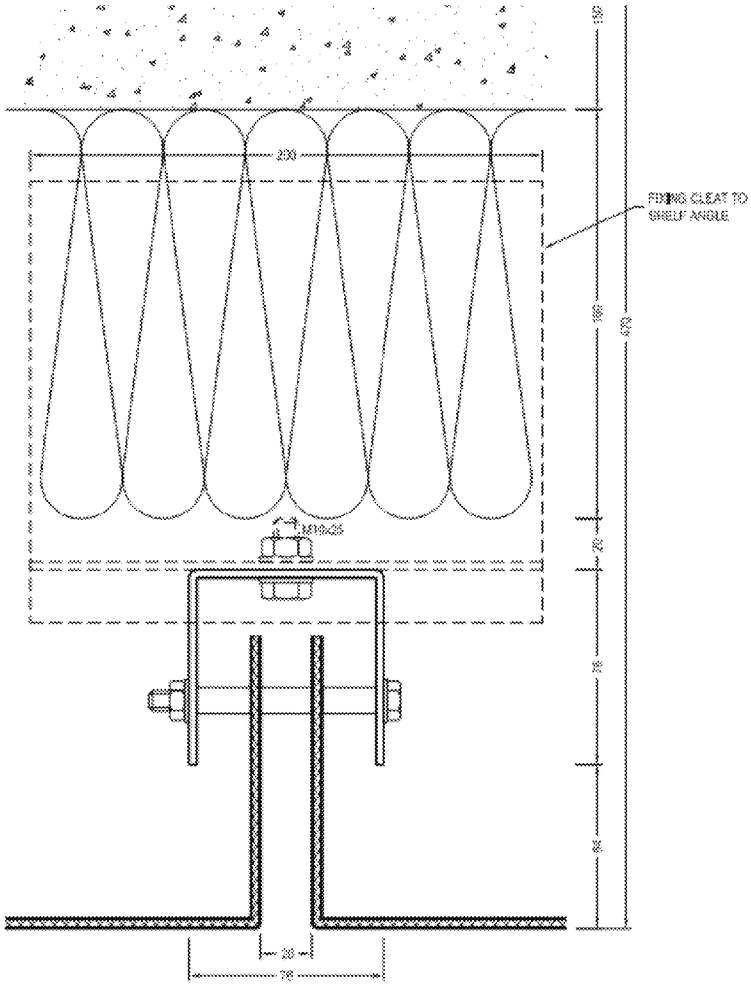


Figure 4.84: Extract from Harley Drawing C1059-305-D '*Typical Joint Upper Levels*' {HAR00008903}

4.4.108 I have created two diagrams which I show below which further illustrate this point. They show the cavity barrier, respectively in normal mode and during fire with the intumescent strip expanded to the inside face of the ACP cassette. I have annotated the diagrams by shading in yellow the gap within the channel that provides a vertical path through which fire can bi-pass the cavity barrier and travel upwards, bi-passing the cavity barrier and entering into the '*compartment*' above. This clearly demonstrates that the integrity of the cavity barrier at the joint is not maintained and requires further attention. I showed how this issue might be addressed within Section 3 as part of my indicative approach.

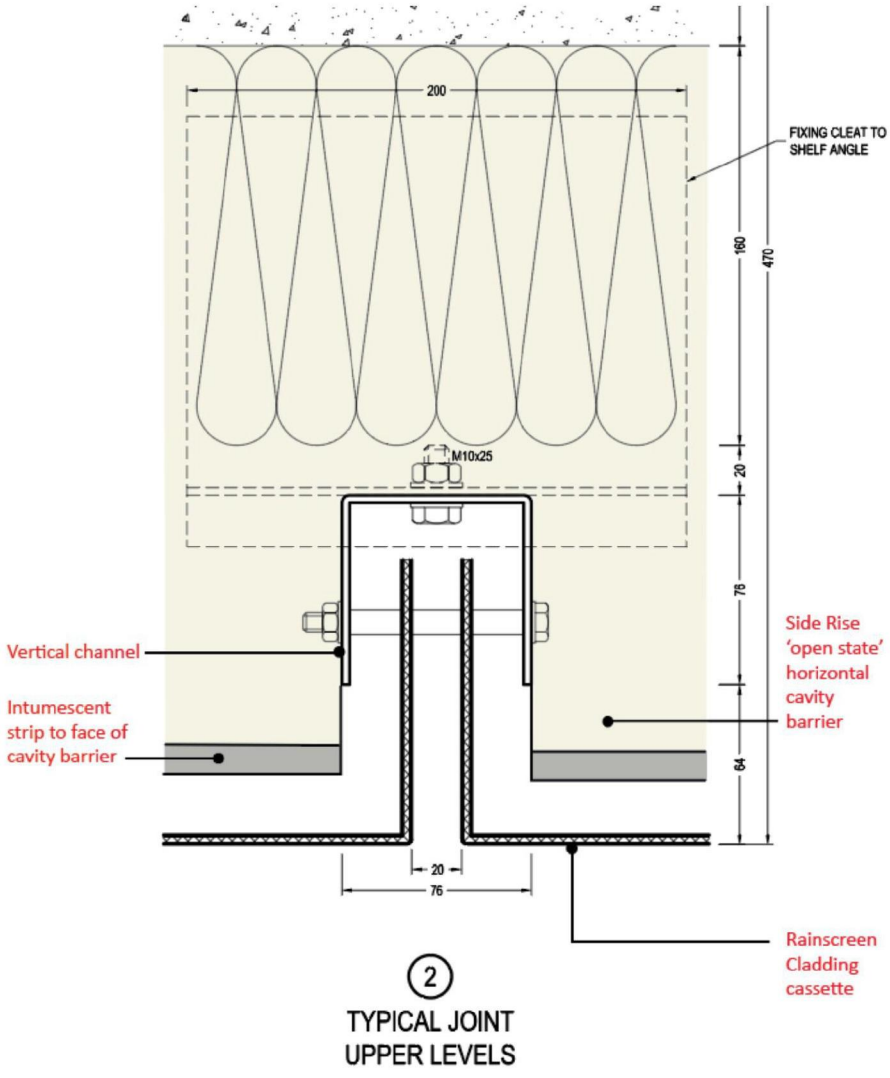


Figure 4.85: Diagram created on Harley Drawing C1059-305-D (Additional notes added in red) {HAR00008903}

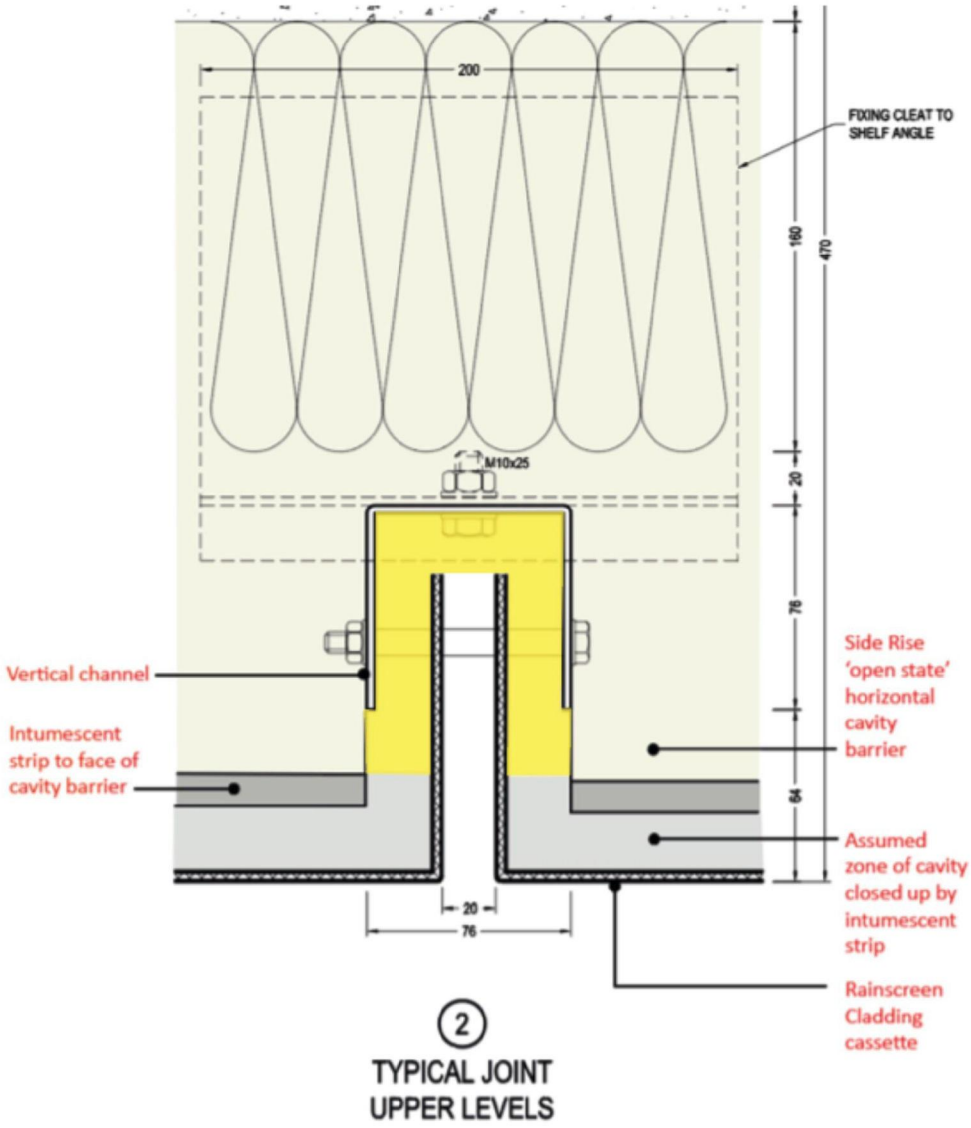


Figure 4.86: Diagram created on Harley Drawing C1059-305-D (Additional notes added in red) {HAR00008903}

4.4.109 As I have stated above, there seems to have been widespread confusion about the appropriate provision of cavity barriers for this project. No overall strategy emerged during the Harley construction documentation stage (either produced by Harley or Studio E) to compensate for the lack of strategy in this respect that had existed within the tender Stage work of Studio E. This confusion, by now at a very late, indeed critically late, stage of the project is evident within the chain of emails from which I quote below:

4.4.110 17/18 Sept 2014 email chain regarding cavity fire barriers and drawings produced by Harley {EXO00000708}:

Mr Crawford (Studio E) to Mr Ashton at Exova:

'I am working on the Grenfell Tower regeneration project from the Studio E end. The following RFI has come in relating to horizontal fire breaks within the cladding areas. Can you comment on the RFI attached and whether you believe this interpretation in relation to stack effect is correct?'

Mr Ashton:

'I've never seen details of what you're doing to the external walls. Do you have any cross sections/elevations?'

Mr Crawford:

'Please see attached our sections and the initial drawings set we have had from Harleys. The initial drawings from Harleys are fairly limited but they attempt to establish the basic approach'.

Mr Ashton:

'If the insulation in the cavities behind the rainscreen cladding is combustible you will need to provide cavity barrier as shown on your drawing (number 1279 (06) 120) in order to prevent fire from spreading from one flat to the one above even if there isn't a continuous cavity from the top to the bottom of the building.'

harley

Request for Information Form

To:	Simon Lawrence	**From:**	Daniel Anketell-Jones
Company:	Rydons	**Company:**	Harley
Project Name:	Grenfell Tower	**Date/Time:**	17th September 2014
Job No:	C1059	**Rydon Query No:**	**Harley Query No:**
			001
Date Answer is Required:	26th September 2014	**Date Answer was Received:**	

Query:

Please may you confirm the required extent of the horizontal firebreaks within the cladding areas?

Suggested Solution:

We believe that they will be required at every floor level on the vertical columns, but not in the area of cladding between windows. This is because there is no 'chimney' effect here, and therefore the cladding will not add to the spread of fire.

Distribution for Response	

Answer:	**Copy to**	**Company**
	Signature	**Date:**

Figure 4.87: RFI 001 as referred to in the email correspondence above {RYD00018043}

4.4.111 The above chain is surprising for several reasons:

a) Construction work, which had started on 2 June 2014 {ART00006734} was by now well underway on site and questions of this kind should have long ago been resolved. Studio E should certainly not be seeking clarification on an issue that they should long ago have resolved.

b) Mr Ashton states that he has never seen Studio E drawings in relation to external walls {EXO00000708}. This is despite comments given in Exova's Outline Fire Safety Strategy reports in August and November 2013 to the effect that *'the proposed changes will have no adverse effect on the building in relation to external fire spread…'* (I show an extract under Snap-Shots 1 and 2 under Envelope Insulation of a comment by Exova from the Stage D Report produced by Studio E {SEA00008054} which was further repeated in Exova's Outline Fire Safety Strategy report dated 7 November 2013 report {EXO00001106}. It is repeated below).

> 3.1.4 Compliance with B4 (external fire spread)
>
> It is considered that the proposed changes will have no adverse effect on the building in relation to external fire spread but this will be confirmed by an analysis in a future issue of this report.

Figure 4.88: Extract from the Exova Fire Strategy Report {EXO00001106}

c) Mr Crawford then suggests that Harley *'attempt to establish the basic approach'*, {EXO00000708} from which it may be inferred as a clear admission that, even at this late stage, no basic approach has yet been established in relation to cavity barriers.

d) Mr Ashton's reply is astonishing, coming from an alleged expert in fire safety within construction. By stating *'If the insulation…is combustible'* he appears to be condoning an outright breach of ADB2 guidance under paragraph 12.7 {EXO00000708}.

4.4.112 An email chain dated 18 September 2014 between Exova (Mr Ashton), Studio E (Mr Crawford) and Harley (Mr D Anketell-Jones, Design Manager) demonstrates further confusion {EXO00000714}:

Mr Crawford:

'Please see correspondence relating to RFI 001/ Cavity Barrier requirement below.'

Mr D Anketell-Jones:

'The insulation is class 0. Therefore after reading the correspondence below; I believe that the fire barrier in these locations, will not be necessary. Can you confirm that this is acceptable?'

Mr Ashton:

'A material which has a Class 0 rating is not necessarily non-combustible although the reverse is invariably true. Some Class 0 products will burn when exposed to a fully developed fire. In any case, you need to prevent fire spread from on flat to the flat above as I stated in my earlier email. What isn't clear from the information to hand is whether or not there is a continuous cavity from top to bottom in any part of the cladding (apart from around the column casings) irrespective of the type of insulation.'

4.4.113 The above chain is very disturbing for the following reasons:

a) Mr Crawford, by abrogating responsibility for answering implies a lack of understanding of the issues.

b) Mr D Anketell-Jones demonstrates a clear lack of grasp of the ADB2 guidance by suggesting that the insulation '*is class 0*' when it was required to be of limited combustibility and that 'fire barriers' may not be required at compartment floors.

c) Mr Ashton refers to '*non-combustible*' when the ADB2 guidance for the insulation was that it be of 'limited combustibility'.

d) Mr Ashton queries '*whether or not there is a continuous cavity from top to bottom in any part of the cladding (apart from around the column casings)*' which implies to me that such a '*top to bottom*' cavity would be acceptable within the cavities to the columns {EXO00000714}. Such a 'top to bottom' cavity would not have been acceptable under ADB2.

4.4.114 Several months later further discussions take place when on 3 March 2015 Mr Crawford forwarded Mr Ashton a Harley e-mail of the same date which stated:

'Please find attached drawings now showing the fire breaks, both horizontal and vertical. We assume a requirement of 90 min integrity and 30 min insulation is sufficient, if not please advise. The vertical breaks are not on all columns, just party walls' {EXO00001315}.

This is a mistake because, as stated above, whilst the Harley drawings do not call for vertical cavity barriers to columns A2/A4/D2 and D4 (which are columns that are not aligned with compartment walls) they do call for cavity barriers to each of the four corner columns which are not aligned with compartment walls.

4.4.115 Under cover of his email dated 3 March 2015, as referred to above, Mr Crawford asked Mr Ashton the following question:

'Just a quick question relating to Grenfell Tower. As part of the re-clad we are we have (sic) added fire breaks around the apartments as per the email below. Can you comment on the level of protection (90+ 30) as to whether this is suitable. My only query might be that we have different levels of party wall at the lower levels- see attached fire plan with some 60 some 120 walls' {EXO00001315}.

4.4.116 It does not appear that Mr Crawford received a response from Exova to his email dated 3 March 2015. On 6 March 2015, Mr Crawford responded to Harley's e-mail dated 3 March 2015 at {EXO00001315} as follows:

'As per telephone conversation I have asked the question of Exova on the fire break but not had anything back. To me the fire breaks would have to follow the ratings of the party walls which are shown on the fire plan attached. You can see some of the low level apartments are separated by 120mins and others by 60 mins'. {HAR00004014}

Mr Crawford again displays a lack of understanding of these matters which are clearly outlined within the guidance in ADB2 at Table A1 of Appendix A.

4.4.117 Some weeks later between 20 and 31 March 2015, there follows an extraordinary sequence of e-mails from a variety of parties, including Building Control, about cavity fire barrier requirements {EXO00000715}. I quote as follows:

SideRise (Mr Kay) to Mr B Bailey of Harley on 26 March 2015:

'Please find below extract from the Approved Document B of the Building Regulations. Here you can see that it clearly states that 30 minutes fire integrity and 15 minutes insulation is all that is required from a cavity fire barrier. This is reference to rainscreen cladding applications where the cavity barrier is deemed to be on the outside of the building. Our RH25-90/30 will offer 90 minutes fire integrity and 30 minutes fire insulation, therefore exceeds minimum requirements. 120 minute fire rating is generally the industry standard for curtain wall to concrete slab edge firestopping where the firestop is located on the inside of a building and is considered to be a continuation of the floor slab. Please get in touch if you need anything else from us to enable you to progress with your order, many thanks'.

Mr Crawford to Mr Hoban (RBKC) copying in Mr Ashton on 27 March 2015:

'There has been a lot of conversation on site about the cavity fire barrier requirements to be fitted between the existing concrete external wall panels and the new external rainscreen aluminum cassettes. Can you please see the proposal by the cladding contractor below and confirm if this is acceptable to you'.

Mr Hoban responds to Mr Crawford at 13.22, copying in Rydon and Harley, with the following apparently sensible advice:

'The Building Regulations 2010 (as amended) Grenfell Tower, Grenfell Road, Refurbishment... Further to my conversation with you today, I would confirm that the fire time for the new Elements of Structure [new columns, beams, sections of compartment floor etc.] in Grenfell Tower is 120 minutes, as specified in section 1a of Table A2, Appendix A of Approved Document B. I would also draw your attention to diagram 33 of Approved Document B and highlight the detail between compartment floors and external cladding'.

4.4.118 In an e-mail to Rydon, Harley, Siderise and Exova on 30 March 2015 later that day at 14.22, {EXO00000715} Mr Hoban states:

'...Please find detailed below a copy of an email sent to various persons on the 20th of March 2015, concerning the topic relating fire stopping of the compartment floors to the building. I would advise you that it is my interpretation of diagram 33 of Approved Document B is that the detail between compartment floors and external cladding is not a cavity barrier, therefore it must be fire stopped to at least the standard of the existing compartment floor [120 minutes]. Therefore the methods described in clause 9.13 would not be appropriate in this particular case...'.

This appears to represent an apparent muddling of the issues of Fire-Stopping and cavity barriers and a complete misinterpretation of Diagram 33.

4.4.119 On 31 March 2015 at 12.00 Mr Crawford writes to Mr Hoban, copying in Rydon, {EXO00000715}:

'Unfortunately this problem is not going away. The subject of fire barriers is raising a lot of concern on site not least because of program and cost. I have forwarded a copy of diagram 33 and the typical floor detail and we are all miffed as to why this detail is not a cavity barrier in this location- please see attached. (presumably this reference is to the Hoban email of the previous day) *...The relationship between the back of slab and cladding remains the same as the original cladding (concrete) is retained and therefore the integrity of this relationship at floor level has not been affected. The new cladding constitutes an additional layer applied on top not a new floor slab interface and therefore the interpretation is that this constitutes a cavity barrier and not a fire stop. This has now become something of an issue on site due to program bottle neck and so your earliest response to this would be appreciated...'*

I am sympathetic to Mr Crawford's predicament in receiving such erroneous advice from the Building Control Officer, albeit I remain firmly of the opinion that Studio E should have resolved all this pre-tender stage some 14 months earlier.

4.4.120 By way of an email shortly after that day, 12.05 on 31 March 2015 {EXO00000715}, Mr Crawford requests that Mr Ashton comment on the history of this item:

'... please see correspondence below as it is not clear to me why this item is causing such a difference in interpretation- can't see anything that seems to reference it in the fire strategy'.

4.4.121 Mr Ashton replied to Mr Crawford on 31 March 2015 at 13.32 {EXO00000715} as follows:

"This isn't something that would necessarily form part of a fire safety strategy for a building. Therefore, it would not have been dealt with in the fire safety strategy for this building. I agree with Ben Kay. I believe that a cavity barrier is all that is required in this application. Even if we were to agree with RBKC, it is difficult to see how a fire-stop would stay in place in the event of a fire where external flaming occurred as this would cause the zinc cladding to fail."

This response brings the earlier Exova statements into question as I cannot understand how the statement below can be reconciled with Mr Ashton's comment above. It seems to me that a statement confirming that the proposed changes '*will have no adverse effect on the building in relation to external fire spread*' could not be made without having given due consideration to the external wall's construction .

3.1.4 Compliance with B4 (external fire spread)

It is considered that the proposed changes will have no adverse effect on the building in relation to external fire spread but this will be confirmed by an analysis in a future issue of this report.

Figure 4.89: Extract from the Exova Fire Strategy Report {EXO00001106}

4.4.122 The following email from Mr Kay at SideRise dated 30 March 2015 to Mr Hoban (RBKC), Mr B Bailey (Harley), Mr Crawford (Studio E), Mr Ashton (Exova) and Rydon is helpful in tone but indicative of the kind of exchanges that I would expect between architect and product manufacturer pre-tender stage or at latest very early in the construction documentation stage as opposed to this very late stage when construction was already well underway having started under the pre-contract agreement on 2 June 2014 {EXO00001433}:

'Please can somebody forward over a drawing of the build-up of the cladding so that my Technical Officer can evaluate and forward an official response with a Siderise product specification. Many thanks. Kind regards Ricky Kay National Façades Manager'.

4.4.123 On 31 March 2015 Mr Crawford emails the following comment to Mr Ashton {EXO00001434}:

'Thanks this was my point as well - metal cladding always burns and falls off, hence fire stopping is usually just to the back of the cladding line. Thanks for this confirmation anyway'.

Again, this shows a lack of understanding of the principles of cavity barrier installations and a repeated mis-use of the terminology through reference to 'fire stopping'.

4.4.124 On 31 March 2015 Mr Pearson of Exova emailed Mr Ashton {EXO00001347} as follows:

'We note that the barrier against fire spread between floors is provided through the connection of the structural floors to the existing external walls. The existing external walls are expected to provide sufficient fire resistance to prevent fire from entering the cavities at or near floor or ceiling level.

We would not rule out that fire could enter the cavity if there is flaming through the windows. However, if significant flames are ejected from the windows, this would lead to failure of the cladding system, with the external surface falling away and exposing the cavity, eliminating the potential for unseen fire spread. A standard cavity barrier should be sufficient to prevent fire spread between floors while there remains a cavity.

In view of the above, we do not feel that there should be a need for a 2-hour rated fire break in the cavities along the lines of the compartment floors or walls'.

Again, this demonstrates to me a fundamental lack of understanding of the principles involved in ADB2 guidance with respect to inhibiting the passage of fire into the cavity behind the rainscreen cladding, and thereafter onwards through it.

4.4.125 I have quoted the above correspondence in detail because I believe it is important in terms of illustrating the general and sustained confusion amongst all parties involved, about how the work relating to the cavity barriers, in all its aspects, should be carried through.

4.4.126 Routine Design Reviews in line with RIBA recommended practice and compliance with ISO 9001 should have identified serious problems both during and at the conclusion of the Construction Information Documentation in terms of the cavity barrier strategy with respect to compartmentation and the detail design arrangements. This did not happen either because those reviews were not carried out, or because they were not carried out properly. The problem was thus carried into the construction stage work the conclusion of which I which I will later herein review for Snap-Shot 4.

Conclusion Snap-Shot 3 / Cavity Barriers

4.4.127 As indicated within Section 3, I place great emphasis on an architect's design and specification work with respect to cavity barriers being well resolved by tender stage.

4.4.128 The fact that this did not happen on the Grenfell Tower meant that the construction stage documentation work was more challenging as the basic principles of a cavity barrier strategy in terms of positioning and detailing had still to be resolved.

4.4.129 The documentation produced by Harley, and apparently accepted by Studio E and passed to Building Control, was seriously flawed in terms of its failure to comply with the guidance of ADB2.

4.4.130 Amongst the most serious failures in Harley's work, which Studio E failed to comment on under their checking role, were the lack of vertical cavity barriers to the window jambs, horizontal cavity barriers to the window head and sill, or indeed at the top of the cavity within the rainscreen system where it adjoined the Crown. Also serious were the imperfections to fit and continuity of the horizontal cavity barriers at, respectively, (1) their junction with columns where the grooves provided a vertical fire path '*behind*' the cavity barriers, (2) their junction with the vertical rainscreen support system, where the outer support channels provided a vertical fire path at the top corners of the ACP cassettes, and (3) particularly at the open vertical joint to the rainscreen panels at the leading edge of the intermediate columns.

4.4.131 All of the above failings are serious, including the Crown where there is not only no horizontal barrier at the top of the cladding shown on Harley drawings, but the vertical barrier to columns simply stops before reaching the top or any point of suitable termination thus allowing uninhibited horizontal fire passage around the perimeter/parapet of the building. As per the exhibit below stamped with Studio E's status B (conforms to design intent) Studio E failed in their commenting role to draw any attention to this failure.

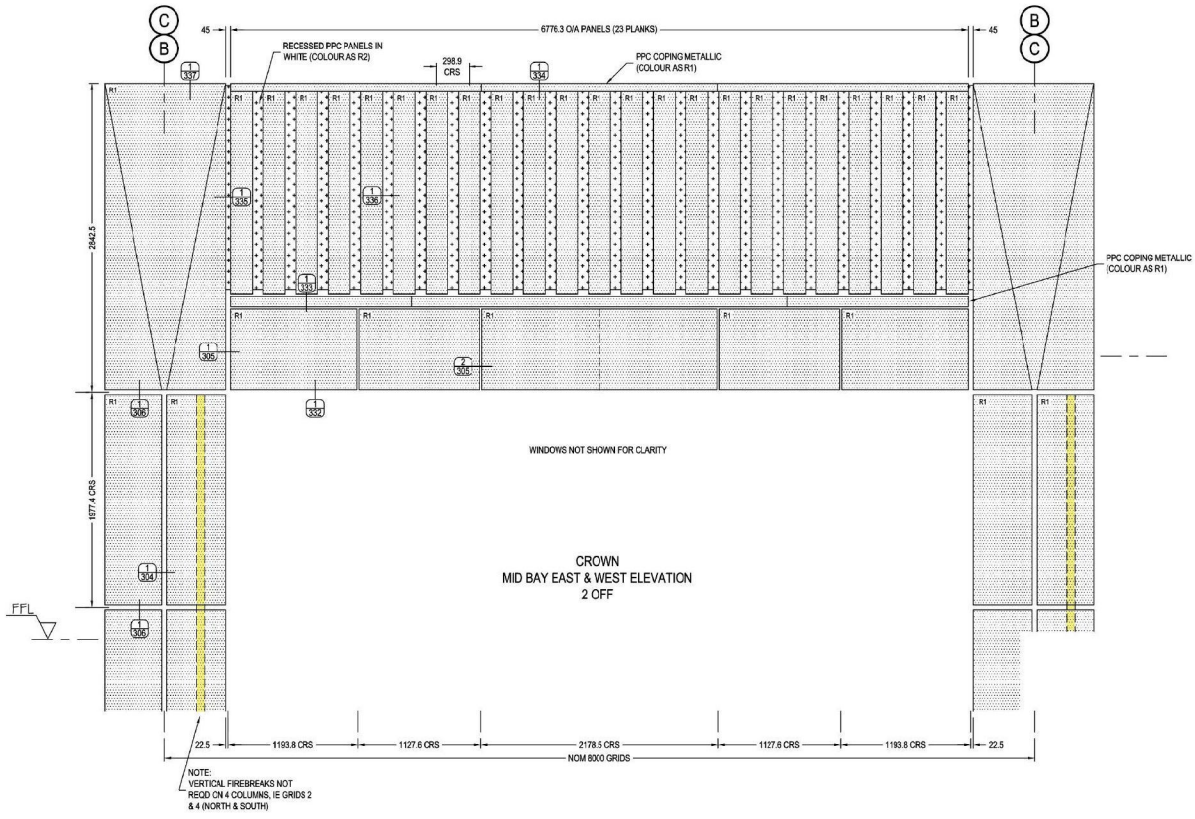


Figure 4.90: Harley Drawing C1059-216 Rev - with Vertical Cavity Barriers Highlighted {HAR00008910}

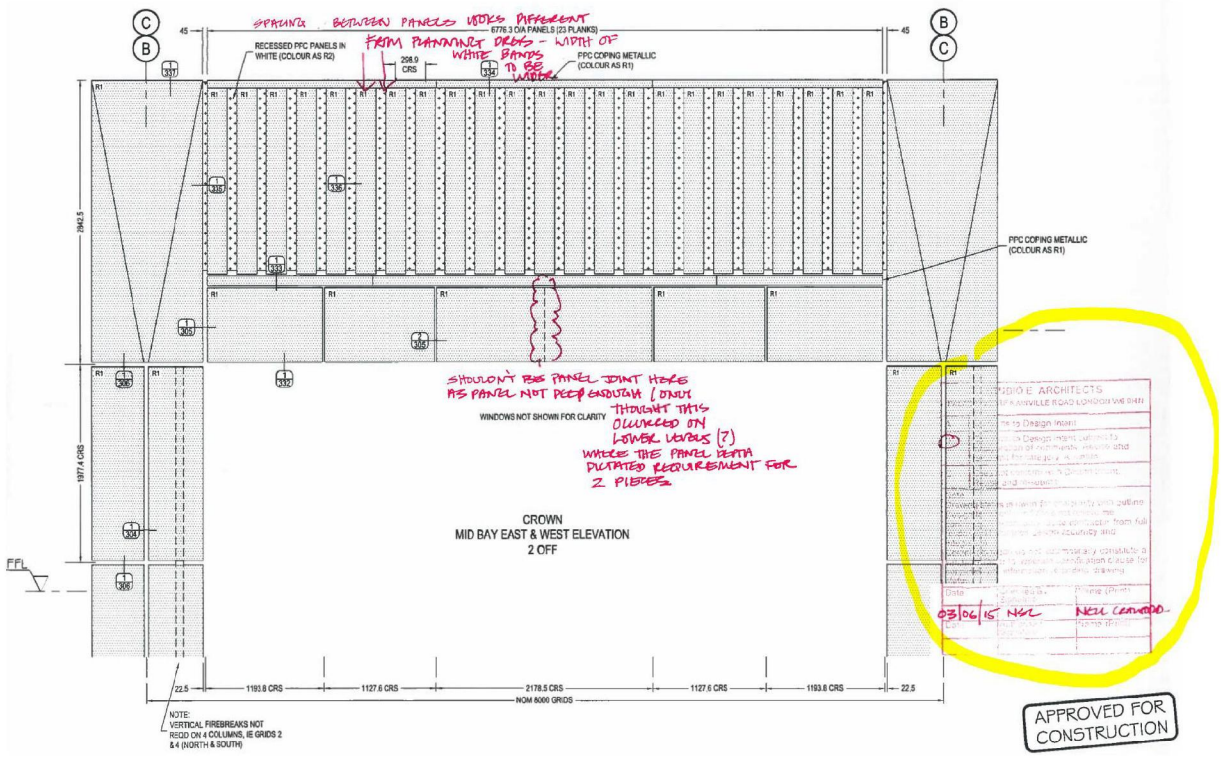
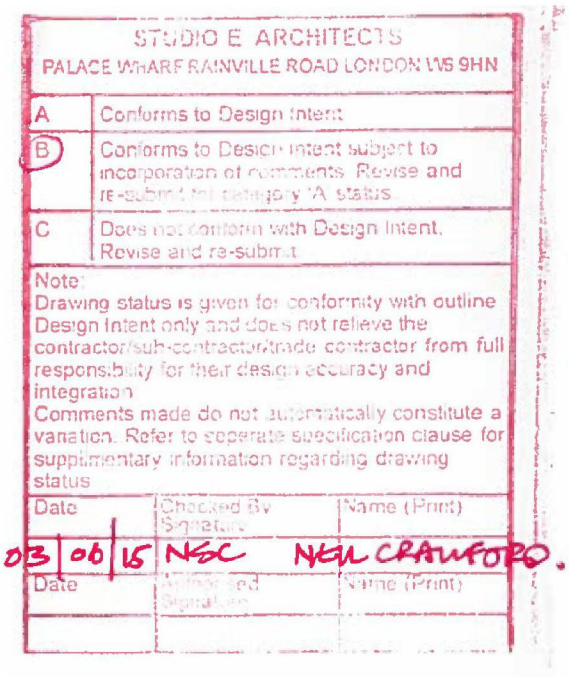


Figure 4.91: Studio E Comments on Harley Drawing C1059-216 {SEA00003240}



STUDIO E ARCHITECTS
PALACE WHARF RAINVILLE ROAD LONDON W6 9HN

A	Conforms to Design Intent
B	Conforms to Design Intent subject to incorporation of comments. Revise and re-submit for category 'A' status
C	Does not conform with Design Intent. Revise and re-submit

Note:
Drawing status is given for conformity with outline Design Intent only and does not relieve the contractor/sub-contractor/trade contractor from full responsibility for their design accuracy and integration
Comments made do not automatically constitute a variation. Refer to seperate specification clause for supplimentary information regarding drawing status

Date	Checked By Signature	Name (Print)
03/06/15	NSC	NEIL CRAWFORD.
Date	Approved Signature	Name (Print)

Figure 4.92: Studio E Drawing review stamp example from pack of Harley Drawings including C1059-216 {SEA00003240} '*B – Conforms to Design Intent subject to incorporation of comments. Revise and re-submit for category A status*'

4.4.132 Other Experts have provided analysis in terms of the consequences of these failures. In Figure 4.93 below I show, in the form of an elevation of a typical bay, where those weaknesses lay in terms of:

a) The omission of cavity barriers failing to inhibit the passage of fire into the cavities.

b) The poor fit of cavity barriers failing to adequately inhibit the passage of fire within the cavity zone across at compartment floor positions.

4.4.133 The marked up Harley drawing can be usefully read with Dr Lane's report and diagrams, wherein she shows the weaknesses in the arrangements that facilitated the passage of fire within the inner reveal areas of the windows at head sill and jamb positions and thereafter on out into the cavities. For example see her Figures: 9.11, 9.12, 9.14, 9.15 and 9.16 {BLAS0000009}. My mark-up below essentially shows what I believe are the weaknesses in the Studio E/Harley design expressed in elevational form.

4.4.134 As the marked up drawings below demonstrate, once within a cavity zone – any cavity zone - the fire could move freely vertically up the sides of windows within that cavity zone and within the adjoining column zones – particularly at the open joint at the '*nose*' of the column and within the '*grooves*' to the concrete columns that ran vertically to the columns, thus bi-passing the horizontal barriers at each floor level.(Dr Lane has covered this in great detail within sections 9 and 10 of her report). In this respect construction / installation errors are always a risk in building work but these fundamental errors in design meant that the Harley construction documentation, which Studio E endorsed, was deeply flawed in concept.

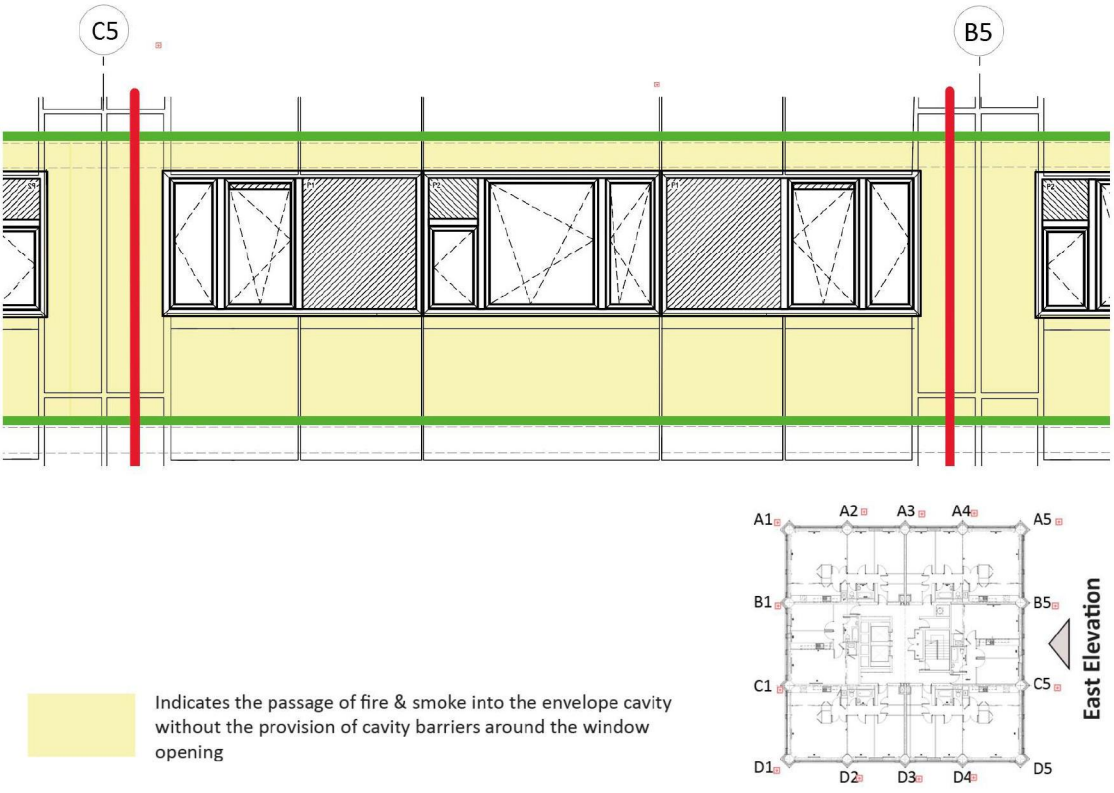


Figure 4.93: Diagram produced using Harley Drawing C1059-200-I {HAR00008581} and Studio drawing 1279 (04) 105 '*Proposed Residential Plan*' {SEA00010474}

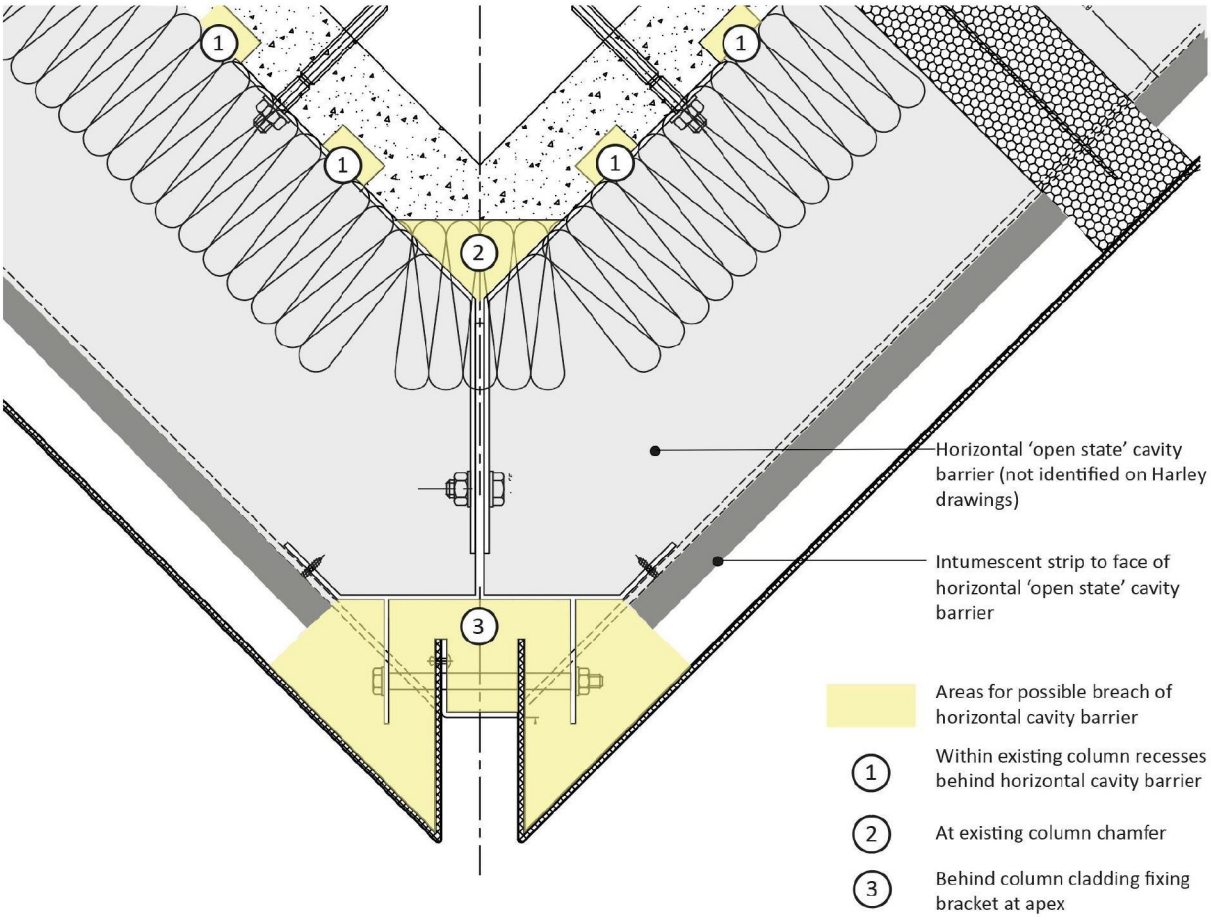


Figure 4.94: Diagram at Typical Column '*Nose*' produced using Harley Drawing C1059-304-D {HAR00008902}

4.4.135 It is a serious indictment of process that at the very time that the design and detailing should have been '*tying up any loose ends*' to achieve absolute clarity and compliance with ADB2 guidance, the design work produced by Harley with respect to the positioning and detailed arrangement of cavity barriers was progressively moving in the opposite direction.

4.4.136 With these multiple failures on the part of Harley's design, and Studio E's failure to correct these errors within their sub-contractor drawing checking process, the construction documentation was released in a form that provided no meaningful or ADB2 compliant protection against the passage of fire anywhere around the window opening directly into the cavity zone behind the rainscreen.

Window Infill Panels

Building Regulations and Approved Document Guidance:

(Requirements of Building Regulations and guidance of ADB2 provided under Snap-Shot 2)

Commentary Snap-Shot 3: Window Infill Panels

4.4.137 The Harley Specification C1059-100 Rev D *'Issue for Approval'* dated 15 July 2015 includes a product reference which indicates that the insulated panel which '*housed*' the kitchen extract fan contained a core of Kingspan TP10. The window infill panels that align with the existing partition between the bedrooms is noted with a core of Styrofoam Insulation but without a product reference. These specification references are exhibited below. {RYD00046822}

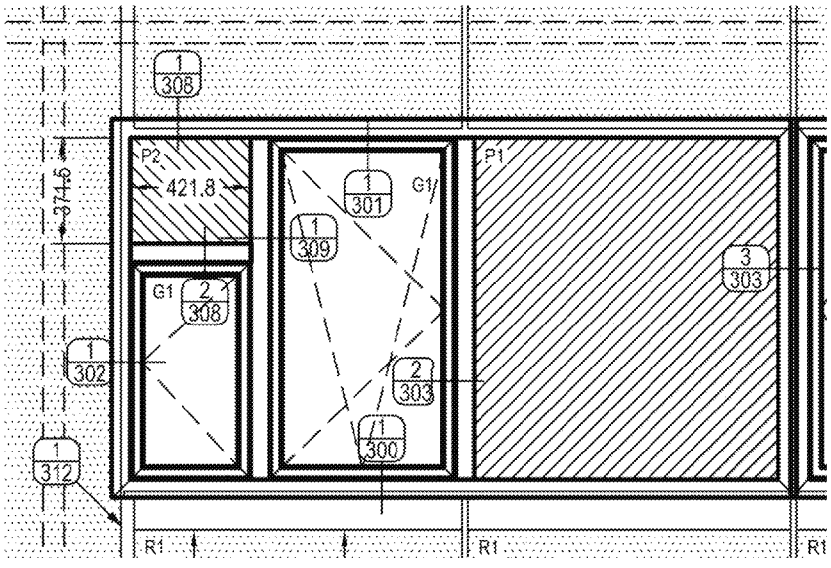


Figure 4.95: Window Infill Panels identified on Harley Drawing C1059-201-D '*Bay B*' {HAR00008886}

GLAZING - P1 - PANELS
OUTER - 1.5MM ALUMINIUM SKIN RAL 9010 MATT (30% GLOSS).
CORE - 25MM STYROFOAM.
INNER - 1.5MM ALUMINIUM SKIN RAL 9010 MATT (30% GLOSS).
U VALUE = 0.77 W/m2K (CENTRE PANE)

GLAZING - P2 - PANELS
OUTER - 1.5MM ALUMINIUM SKIN RAL 7012 MATT (30% GLOSS).
CORE - 25MM KINGSPAN TP10 RIGID INSULATION.
INNER - 1.5MM ALUMINIUM SKIN RAL 9010 MATT (30% GLOSS).
U VALUE = 0.77 W/m2K (CENTRE PANE)

Figure 4.96: Extract from Harley Specification Sheet C1059-100 Rev D Stamped by Studio E '*A – Conforms to Design Intent*' {RYD00046822}

4.4.138 With respect to panel P2 (i.e. the kitchen extract fan panel) this suggests that the insulation as specified was the Kingspan Thermapitch TP10 PIR insulation, typically used for warm roof application. The 2017 BBA certificate for this product, 15/5133 {BBA00000044} (an extract of which is exhibited below) indicates that the product is classified as Class E in accordance with BS EN 13501. This is the lowest classification aside for F (which means the product is not documented, the product does not meet the criteria for any class, or the manufacturer has not provided the fire properties for the product).

8 Behaviour in relation to fire

8.1 The product has a reaction to fire classification* of Class E to BS EN 13501-1 : 2007.

8.2 The product must not be carried over junctions between roofs and walls that are required to provide a minimum period of fire resistance. The continuity of fire resistance must be maintained, as described in the documents supporting the relevant national Building Regulations.

8.2 When installed between, under or over rafters the product will be contained between the roof and internal lining board until one is destroyed. Therefore, the insulation will not contribute to the development stages of a fire or present a smoke or toxic hazard.

Figure 4.97: Extract from the Kingspan Thermapitch TP10 BBA Certificate 14/5133 {BBA00000044}

4.4.139 As such the insulation specified for P2 did not comply with the requirements of the Building Regulations or with the guidance of paragraph 12.7 of ADB2 which stipulates that insulation within external wall construction should be of '*limited combustibility*'.

4.4.140 The larger window infill panels that align with the existing partition between the bedrooms are noted with a core of Styrofoam Insulation but without a product reference. Styrofoam is a Dow Tradename for their Extruded Polystyrene Insulation (XPS), which is typically used for basements and inverted roofs due to its high compressive strength. If the product selection was XPS, I think that any reasonably competent architect would know, or otherwise routinely establish, that such a product would not be suitable in any situation where a material of '*limited combustibility*' is required.

4.4.141 Routine Design Reviews in line with RIBA recommended practice and compliance with ISO 9001 should have identified problems both during and at the conclusion of the Construction Information Documentation in terms of the failure of the insulation products specified for the insulated windows to comply with the Building Regulations or the guidance of paragraph 12.7 of ADB2. This did not happen either because those reviews were not carried out, or because they were not carried out properly. The problem was thus carried into the construction stage work the conclusion of which I which I will later herein review for Snap-Shot 4.

Conclusion Snap-Shot 3 Window Infill Panels:

4.4.142 The insulated window infill panels did not meet the requirements of the Building Regulations or the guidance of ADB2.

Infill Behind Internal Linings to Windows

Building Regulations and Approved Document Guidance:

(Requirements of Building Regulations and guidance of ADB2 provided under Snap-Shot 2)

Commentary Snap-Shot 3: Infill Behind Internal Linings to Windows:

4.4.143 The Harley drawings that were issued as *'Approved for Construction'* following checking by Studio E) (for example C1059-300-E, C1059-301-D, & C1059-302-D as exhibited below) {HAR00008469} {HAR00008470} and {HAR00008880} indicate that the insulation to the head, jamb and sill behind the window reveal linings were to be supplied and installed *'by others'* ({HAR00008469}, {HAR00008470} & {HAR00008880}).

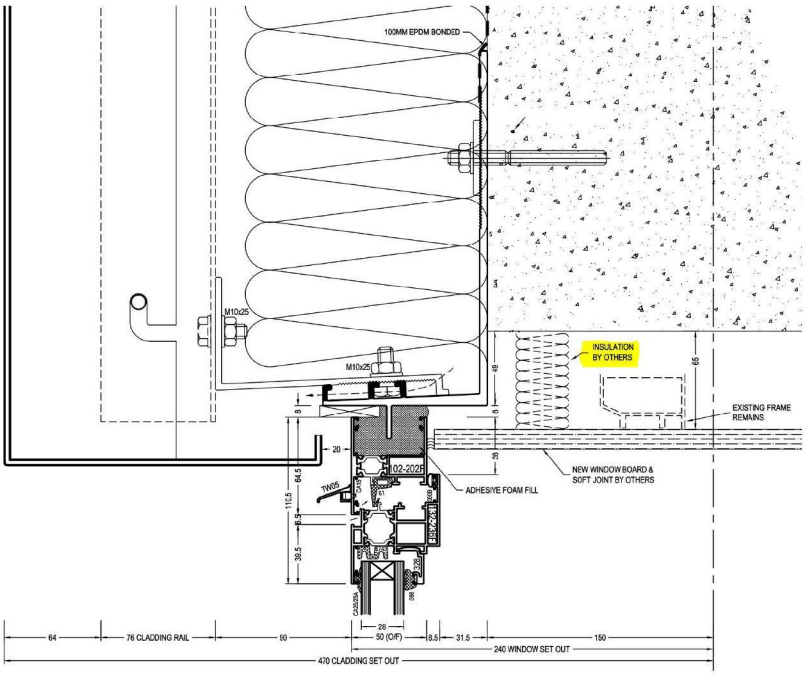


Figure 4.98: Extract from Harley drawing C1059-301-D indicating '*insulation by others*' {HAR00008470}

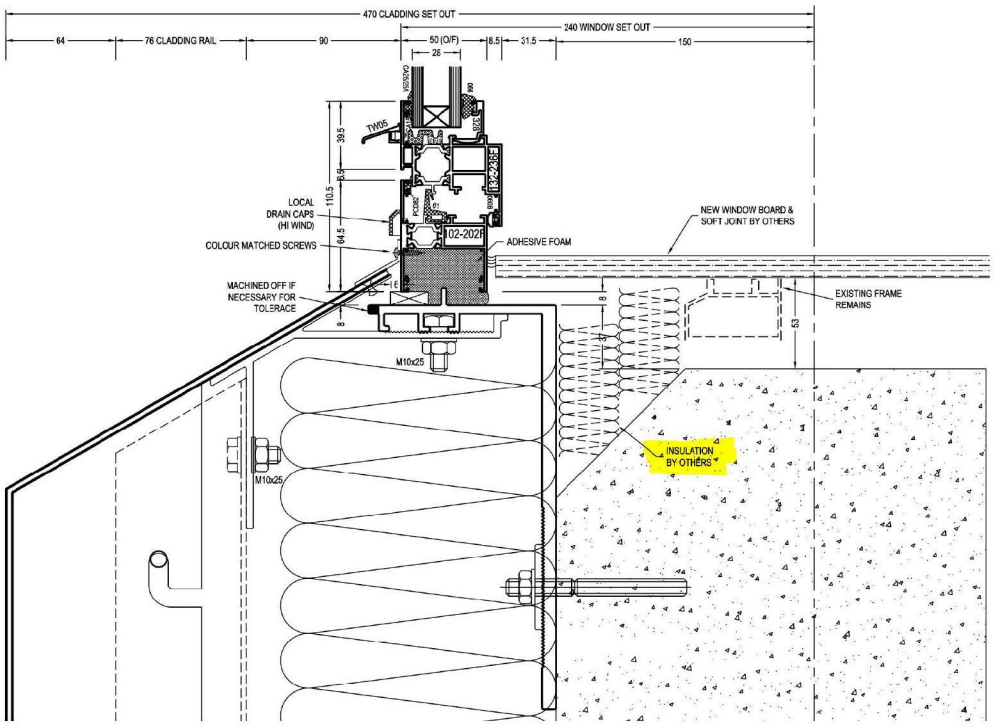


Figure 4.99: Extract from Harley drawing C1059-300-E indicating '*insulation by others*' {HAR00008469}

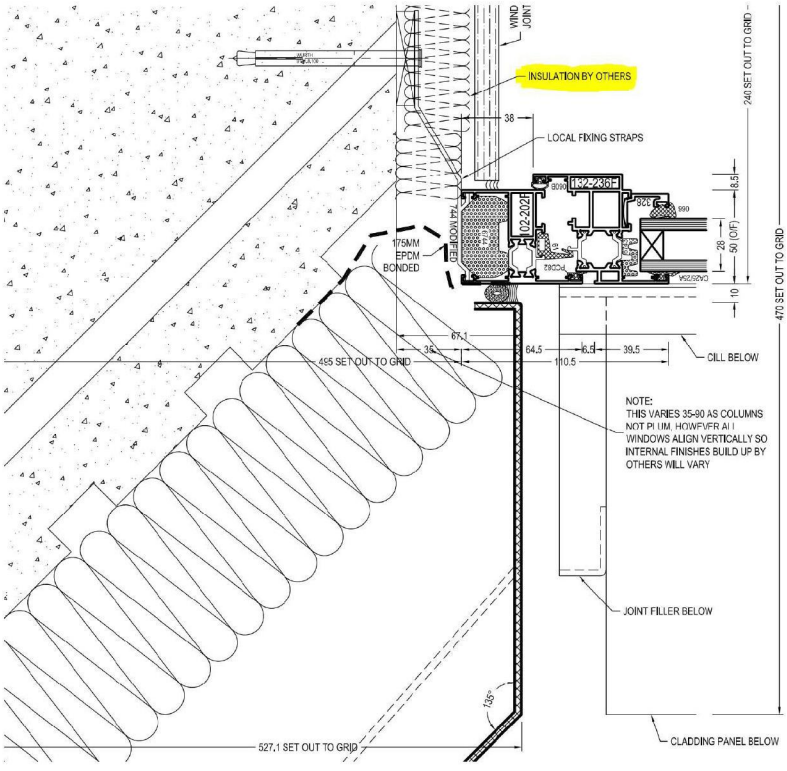


Figure 4.100: Extract from Harley drawing C1059-302-D indicating '*insulation by others*' {HAR00008880}

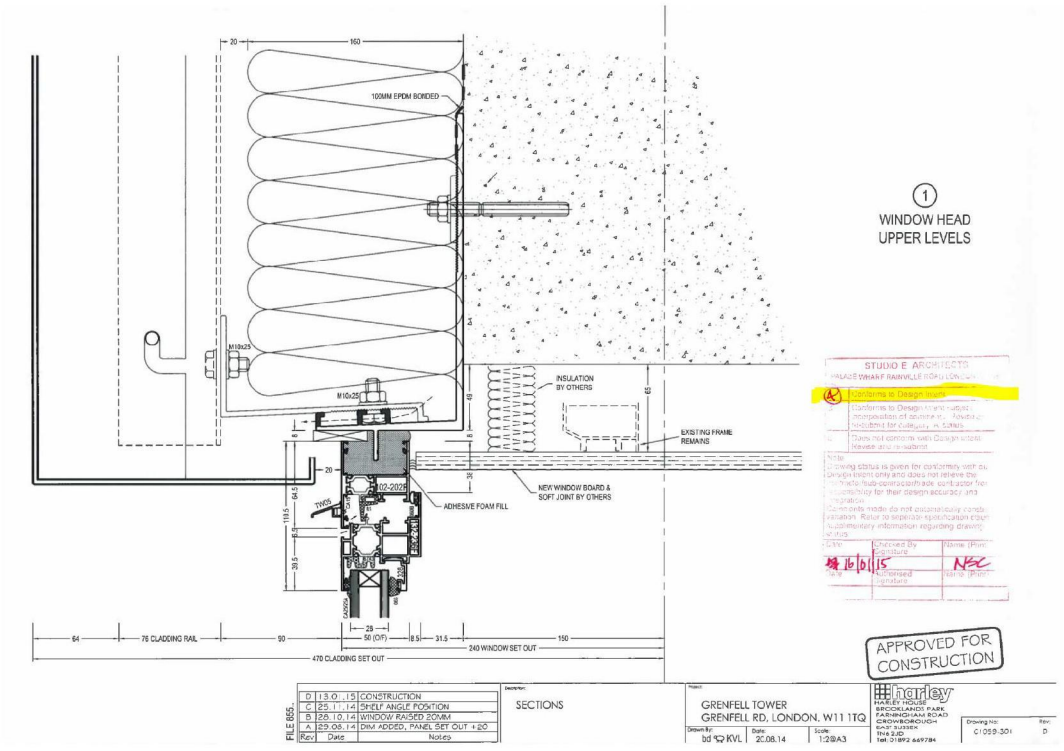


Figure 4.101: Extract from Harley drawing C1059-301 D indicating Studio E stamp Status A '*Conforms to Design Intent*' {SEA00003040}

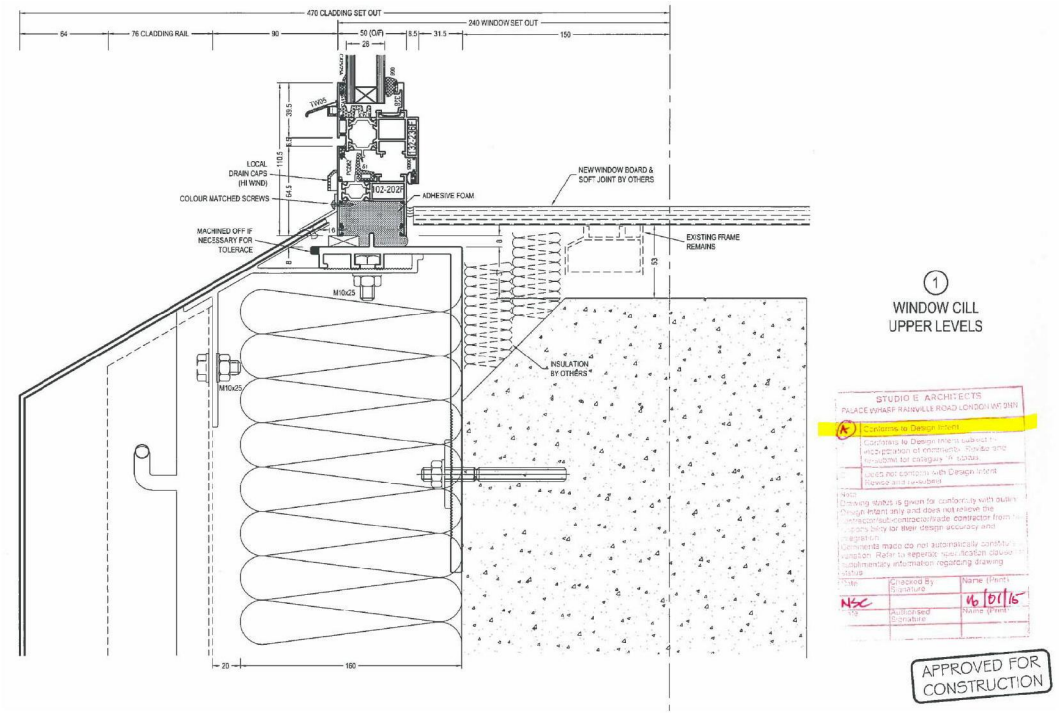


Figure 4.102: Extract from Harley drawing C1059-300-E indicating Studio E stamp Status A '*Conforms to Design Intent*' {SEA00003040}

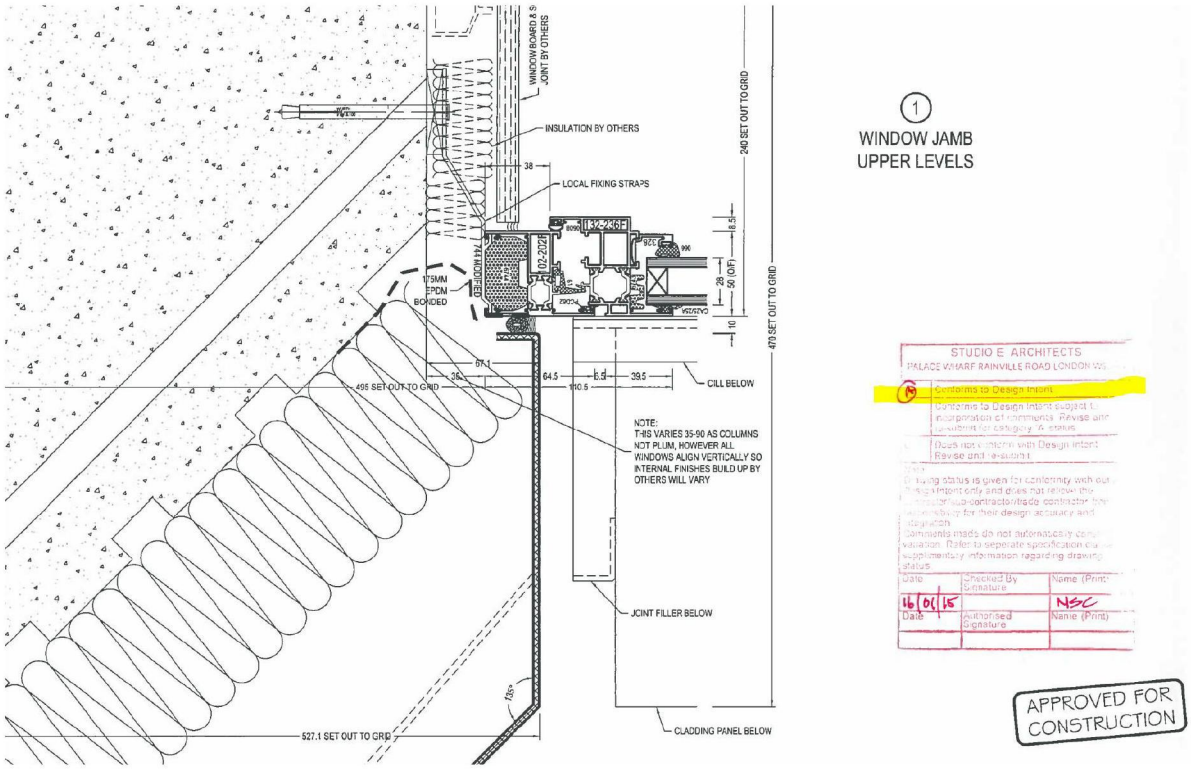


Figure 4.103: Extract from Harley drawing C1059-302-D indicating Studio E stamp Status A '*Conforms to Design Intent*' {SEA00003040}

4.4.144 It seems to be the case that Studio E did very little in the way of providing further information during construction documentation stage to complement that of Harley.

4.4.145 Harley clearly stated that the insulation behind the inner window linings was to be supplied and installed by others and they were silent in terms of its specification. I am therefore not critical of Harley in this respect: they were specialist cladding sub-contractors not general builders and it was for Rydon to identify and engage team resources to carry out this work. I am critical of Studio E only insofar as they do not appear to have addressed the problem when commenting on Harley drawings by ensuring that this material was properly specified to meet the guidance of ADB2 and therefore the requirements of the Building Regulations– or thereafter not reporting to Rydon that inappropriate work was being carried out on site, namely the use of PIR products for packing behind window linings.

4.4.146 The specification and detailing of this product was important as it had a dual role: to provide thermal insulation and also to make a further contribution to inhibiting the passage of fire at the interface of the aluminium window frames and the concrete surrounds.

4.4.147 Rydon's Deed of Appointment with Studio E makes clear the latter's responsibility in this respect and I exhibit an extract from the deed below {RYD00094228} and draw particular attention to clauses 5, 7, 8, 13, 27 and 31.

5. DELETERIOUS MATERIALS

The Consultant warrants to the Contractor that in carrying out the Services it has not and that it will not specify for use or knowingly permit to be used in relation to the design of the Development any materials or substances which the Consultant knows or exercising reasonable skill and care ought to know at the time of specification (save where the Consultant has an ongoing involvement in the Development including without limitation supervision or inspection of the Development in which case at the time of use) are not in accordance with British or European Standards and Codes of Practice (or their equivalent) or which are generally know within the Consultant's profession to be deleterious to health or safety or to the durability or integrity of the Development

7. Responsibility for co-ordinating Building Regulation approval for and on behalf of the Contractor.

8. Seek to ensure that all designs comply with the relevant Statutory Requirements, including Scheme Development Standards.

13. Co-ordinate any design work done by consultants, specialist contractors, subcontractors and suppliers.

27. Examine Subcontractors' and Suppliers' drawings and details, with particular reference to tolerances and dimensional co-ordination, finish, durability, appearance and performance criteria and report to The Contractor.

31. Provide supplementary notes to drawings and provide further drawings to show sufficient information to construct the project to completion consisting (but not limited to) the following:-

a. External wall / internal wall and partition construction details (1:20/1:10/1:5).
b. External wall / ground floor junction details (1:20/1:10/1:5).
c. Window jamb / head / cill details (1:20/1:10/1/15).
d. Door schedule

Figure 4.104: Extract from Rydon's Deed of Appointment with Studio E {RYD00094228}

4.4.148 Routine Design Reviews in line with RIBA recommended practice and compliance with ISO 9001 should have identified problems both during and at the conclusion of the Construction Information Documentation in terms of the failure of the Infill behind internal linings to windows to comply with the Building Regulations or the guidance of paragraph 12.7 of ADB2. This did not happen either because those reviews were not carried out, or because they were not carried out properly. The problem was thus carried into the construction stage work the conclusion of which I which I will later herein review for Snap-Shot 4.

Conclusion Snap-Shot 3: Infill Behind Internal Linings to Windows

4.4.149 The Infill behind internal Linings to windows did not meet the requirements of the Building Regulations or the guidance of ADB2. It should be noted that I have marked Window Head, Jamb and Sill Interface as *'not provided not expected'* as Harley explicitly state on their drawing that this item is by others. Rydon and Studio E were remiss in not resolving this item in a manner compliant with ADB2 guidance as set out under paragraph 12.7.

Commentary on Studio E role and performance during Snap-Shot 3

4.4.150 It is my opinion that Alcoa (as manufacturers), Harley (as self-professed specialists in the application of ACP rainscreen cladding), and Exova (as specialist fire consultants), should each have been aware of the dangers associated with ACP and should, accordingly, have ensured that the product as used for the 2012-16 Works was fully and properly tested, certified, and applied in strict accordance with its certification and with all requirements of ADB2. This they collectively failed to do.

4.4.151 However, I do not believe that these criticisms should diminish the more general criticisms that I have also made of Studio E with respect to its post-novation work under Rydon. Leaving aside the fact that under the terms of their appointment to KCTMO, Studio E should have developed their work with respect to the over-cladding to a far more advanced stage pre-novation; and the fact that such work, properly completed to the end of RIBA Stage F1, should have been available to Rydon and Harley, Studio E clearly produced very little further drawing work for the over-cladding during the period that I have reviewed under Snap-Shot 3 above. This is in stark contrast to their obligations under the Rydon Deed of Appointment.

4.4.152 Mr Crawford's opinion as expressed in paragraph 55 of his statement {SEA00014275} is revealing in this regard. I quote as follows with respect to his view of Studio E's responsibility in terms of checking and commenting on Harley drawings:

'We comment on their drawings only from the perspective of architectural intent'

4.4.153 In referring to the term *'architectural intent'* in this way I understand Mr Crawford to be suggesting that Studio E's role was restricted to addressing issues of appearance and aesthetics in relation to their review of the Harley drawings.

4.4.154 I accept that Studio E had a right to expect a significant level of expertise from Harley in their work, that is developing the Studio E design into production drawings suitable for product ordering and manufacture, and for construction purposes. However, I do not accept that Studio E's duty in terms of their review of Harley drawings, as they were progressed and forwarded to Studio E for comment, was restricted to a commentary on only matters of appearance and aesthetics.

4.4.155 In multiple instances the Harley drawings breached the requirements of the Building Regulations and failed to comply with the guidance in ADB2. Studio E's reviews should have identified such breaches. Part of the problem here was that because Studio E had evidently never understood the requirements of the Building Regulations in relation to the over-cladding work, and had not themselves produced a '*base scheme*' that complied with the guidance of ADB2, they appear to have had neither the necessary knowledge and experience, nor the basic scheme design at hand (as should have been prepared by themselves), against which to competently check the Harley work as it developed.

4.4.156 The failings in the Harley drawings were in part a result of Harley repeating failings that were already inherent in Studio E's drawings. However, they were also partly due to additional errors that Harley introduced which further compounded many of the problems that were already inherent in the Studio E information (e.g. 'raising' the cavity barrier as shown over the windows by Studio E at a level compliant with ADB2 (Figure 4.64) to a level not compliant with ADB2 (Figure 4.83)).

4.4.157 In concluding that in many respects Harley's drawing work was wanting, I do not, however, accept that all responsibility for those failings should be transferred to Studio E in terms of any shortfalls in their checking and review procedures. Harley should have applied a far higher standard of service as would be reasonably expected of a specialist cladding sub-contractor, and particularly (if this was the case) one who was a member of CWCT.

4.4.158 Against that higher standard of service Studio E should have conducted their reviews of Harley drawings, and themselves provided a much fuller design service in relation to the over-cladding work, as was their duty under the terms of their appointment to Rydon.

4.4.159 For their part, Rydon should have managed both their cladding sub-contractor and their architect with greater care, and in particular, should have taken a far more pro-active role in ensuring that information as required to support the Full Plans application with respect to Building Regulations was properly reviewed and issued to Building Control. In this respect I understand that very few of the Harley drawings were ever formally issued to Building Control.

4.5 Snap-Shot 4 – Studio E: '*As Built*' Documentation (May 2016)

4.5.1 I show below the Matrix with Snap-Shot 4 filled in to record my conclusions in terms of the compliance of each item of the work at this stage with the Building Regulations.

a)	envelope insulation:	NOT COMPLIANT
b)	rainscreen cladding:	NOT COMPLIANT
c)	cavity barriers - window openings:	NOT COMPLIANT
d)	cavity barriers - vertical compartment walls:	INADEQUATE DOCS
e)	cavity barriers - horizontal compartment floors:	INADEQUATE DOCS
f)	cavity barriers – the Crown	INADEQUATE DOCS
g)	window infill panels:	INADEQUATE DOCS
h)	internal window head, jamb, sill voids:	INADEQUATE DOCS

Design Element	Studio E Stage D Design Report	Studio E Tender Documentation	Novation	Harley Construction Documentation	Studio E As Built Documentation
Envelope Insulation	✗	✗		●	✗
Rainscreen Cladding	✓	✓		✗	✗
Cavity Barriers (Window Openings)	○	✗		✗	✗
Vertical Cavity Barriers (Compartment Walls)	○	✗		✓	●
Horizontal Cavity Barriers (Compartment Floors)	○	✓		✗	●
Cavity Barriers (The Crown)	○	✗		✗	●
Window Unit Infill Panels	○	●		✗	●
Window Head, Jamb, Sill Interface	○	●		○	●

Legend:
- ✓ Documentation Considered Compliant with ADB2
- ✗ Documentation Considered not to Comply with ADB2
- ○ Documentation Not Provided but Not Expected
- ● Documentation Unclear/ Not Provided But Expected

Figure: 4.105 Reporting Matrix Snap-Shot 4

4.5.2 I comment below on each of the items in sequence.

The Envelope Insulation

Commentary Snap-Shot 4: '*As Built*' Record Envelope Insulation:

4.5.3 The failure to meet the requirements of the Building Regulations and the guidance given within ADB2 with respect to insulation continued throughout this stage of the project (Snap-Shot 4). The over-cladding work was executed on site with the incorporation of insulation that did not comply with Paragraph 12.7 of ADB2.

4.5.4 As required under their Deed of Appointment, Studio E provided a record set of '*As Built*' documentation, as required under paragraph 19 under '*Generally*' {RYD00094228}.

4.5.5 From the evidence I have seen, it seems that Studio E did not record within that documentation the type of insulation, or insulations, that had been incorporated into external wall of the building.

4.5.6 The exhibit below {SEA00003436} shows one of Studio E's '*As Built*' drawings: Section 1279 (06) 120 00. Whilst it does not include any reference to the insulation type that was incorporated within the envelope construction, the highlighted note indicates '*Thermal Insulation H92/776*'. This is a reference to an NBS Specification sheet. However, the completed NBS specification sheet appears not to have been issued as part of the '*As Built*' set {RYD00000435}.

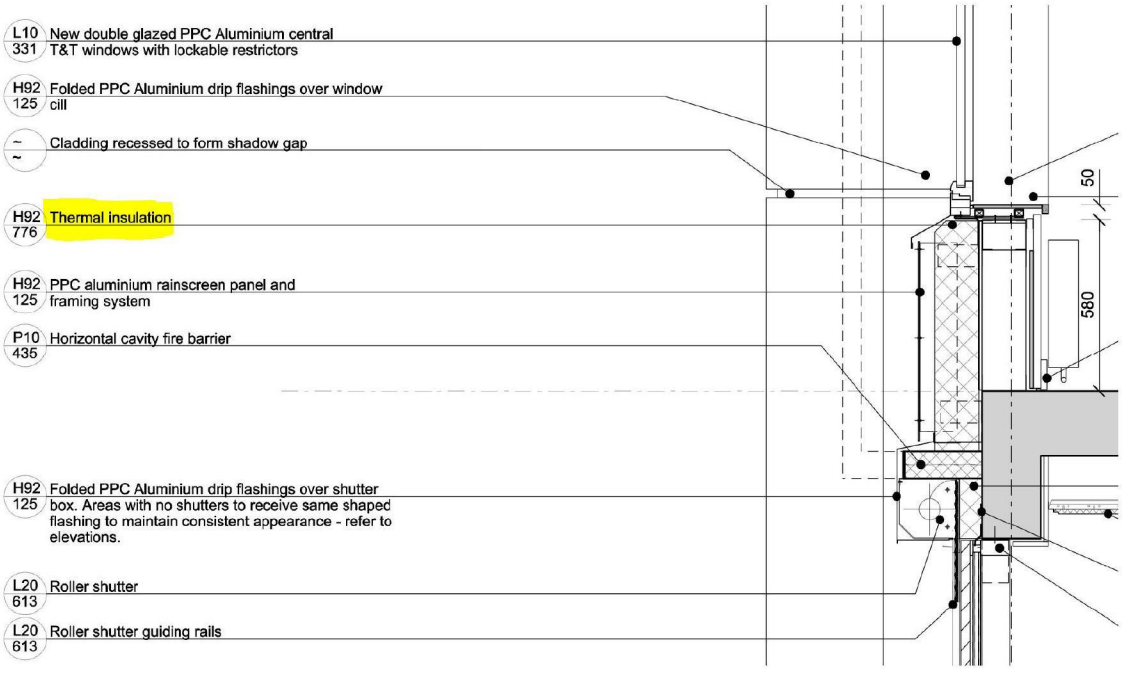


Figure: 4.106 Extract from Studio E drawing 1279 (06) 120 '*Detail Section Sheet 1*' {SEA00003436}
(NB: The extract is from the drawing above but the envelope below the residential area - there is no other reference to the insulation type on the section)

4.5.7 The As-Built documentation, which Studio E had contracted to provide under Clause 19 of the Schedule of Architectural Services under the appointment to Rydon, should certainly have accurately recorded the product information for an item as extensive in its application and as important in its function as the insulation that formed part of the over-cladding system. It did not.

Conclusion Snap-Shot 4: '*As Built*' Record Envelope Insulation

4.5.8 The insulation as incorporated into the building as constructed failed to comply with the guidance given under ADB2 and it also failed to meet the requirements of the Building Regulations.

4.5.9 In spite of the incorporation of Celotex RS5000 into the external walls the building was duly certified and handed over in a condition that constituted a major breach of the Building Regulations, and a complete departure from the guidance provided within ADB2.

4.5.10 Most surprisingly the Building Inspectorate also failed to notice or realise the error at any stage of their inspections of the drawings or during their visits to site where they would have witnessed the PIR insulation being installed.

Rainscreen Cladding

Commentary Snap-Shot 4: '*As Built*' Record Rainscreen Cladding:

4.5.11 Studio E's '*As Built*' record drawings show a combination of ACP and Zinc Rainscreen cladding – the main facades are mostly zinc but reference is made to ACP at the Crown. The two exhibits below illustrate this. This is clearly wrong as the building was clad in ACP.

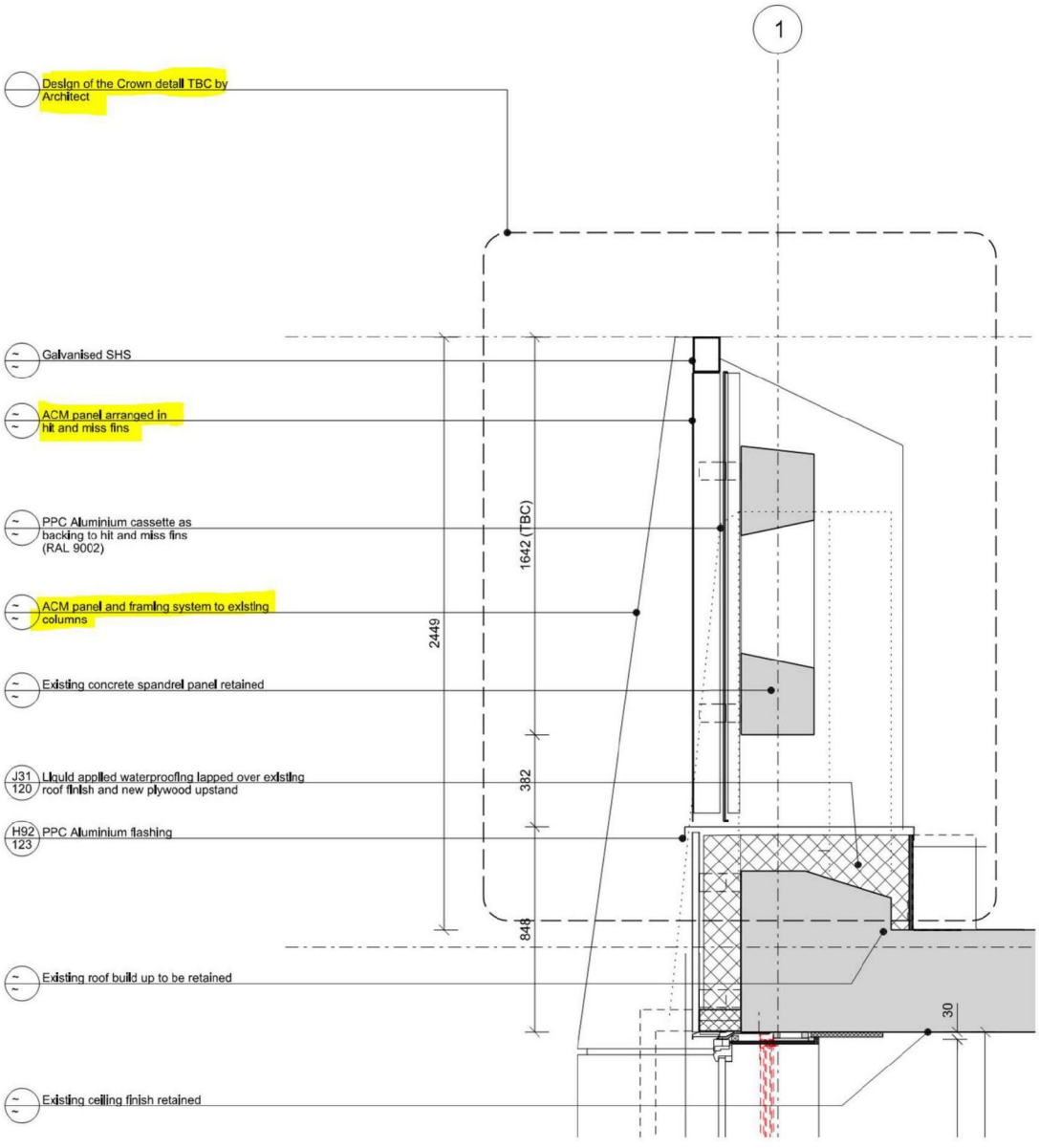


Figure: 4.107 Extract from Studio E drawing 1279 (06) 120 '*Detail Section Sheet 1*' at the Crown {SEA00003436}

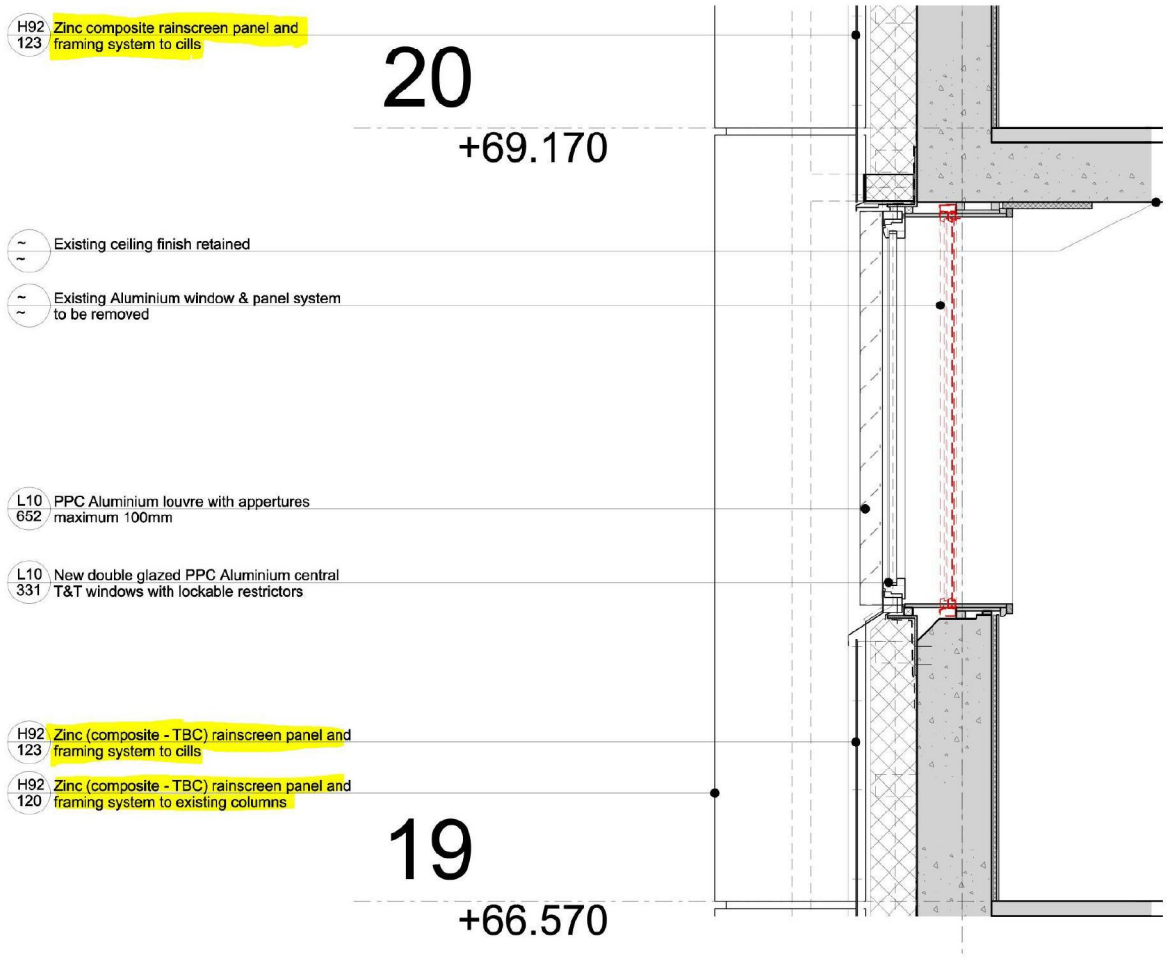


Figure: 4.108 Extract from Studio E drawing 1279 (06) 120 '*Detail Section Sheet 1*' {SEA00003436}

Conclusion Snap-Shot 4: '*As Built*' Record Rainscreen Cladding

4.5.12 The '*As Built*' record drawing was not fit for purpose. It is astonishing that this error was made, and astonishing that the mistake was not apparently spotted during routine checking. The error therefore went uncorrected.

Cavity Barriers

Commentary Snap-Shot 4: '*As Built*' Record Cavity Barriers:

4.5.13 Studio E's '*As Built*' drawing 1279 (06) 120 - 00 *'Detail Section Sheet 1'* {SEA00003436} illustrates cavity barriers and states '*where applicable*'. This is an unacceptably casual reference in what was supposed to be an accurate record of the as-built condition. The specification was not included in the list of '*As Built*' documents {RYD00000435}. As can be seen the *'As Built'* record drawing shows the horizontal cavity barrier that is supposed to align with the compartment floor positioned in accordance with the Harley construction documentation; that is above the finished floor level. This fails to comply with the guidance of ADB2 or the requirements of the Building Regulations.

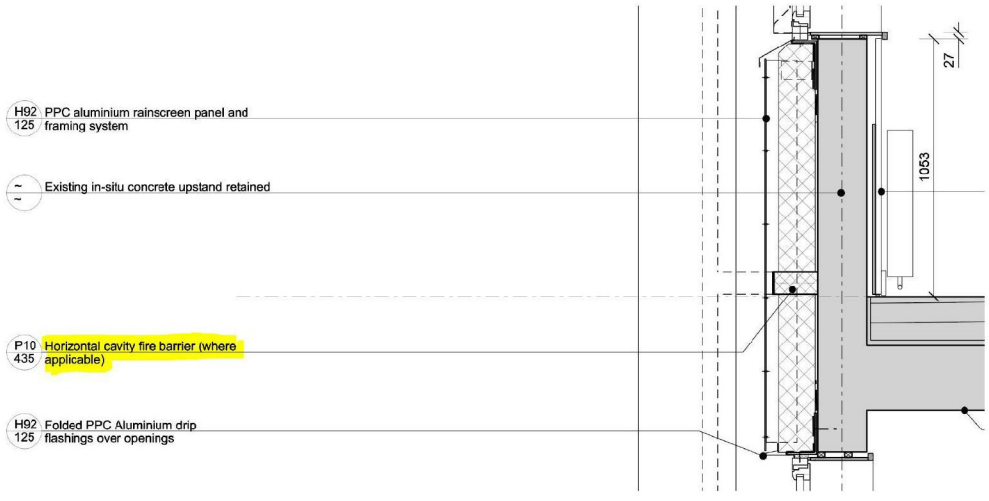


Figure: 4.109 Extract from Studio E drawing 1279 (06) 120 *'Detail Section Sheet 1'* {SEA00003436}

4.5.14 Studio E's *'As Built'* drawing 1279 (06) 120 - 00 '*Detail Section Sheet 1'* {SEA00003436} shown below indicates cavity barriers to the line of the compartment floor and the head of the window only, as annotated on the exhibit below. The cavity barrier at the head (no specification note) could function as both a cavity barrier to the window head and the compartment floor alignment if agreed with the Fire Engineer and the Building Control Officer. However, the *'As-Built'* drawings show the cavity barrier over the window in a position that is inconsistent with the Harley drawings (Figure 4.83), and it seems with the position as installed. There is no cavity barrier indicated to the window sill which, although apparently correct as a record of the as-built condition, represents a failure to meet the recommendations of ADB2.

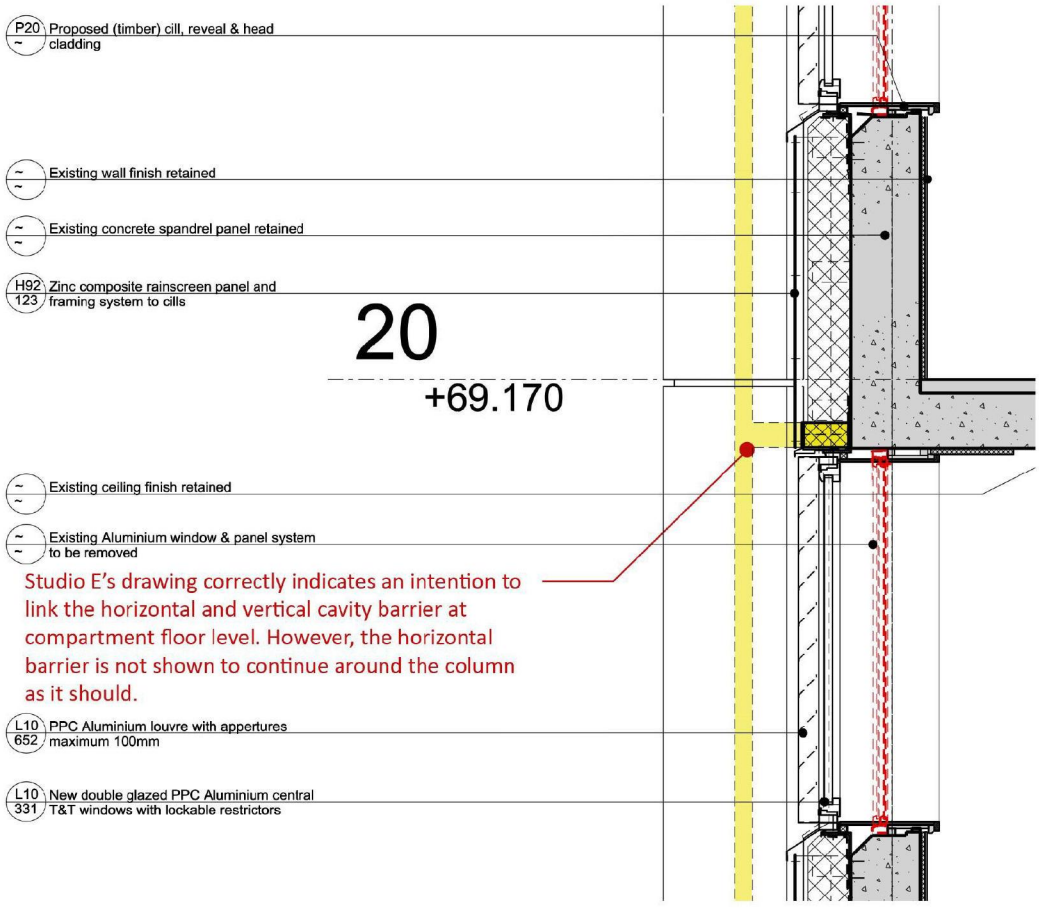


Figure: 4.110 Extract from Studio E drawing 1279 (06) 120 '*Detail Section Sheet 1*' with Vertical and Horizontal Cavity Barrier Highlighted {SEA00003436}

(Additional note added in red)

4.5.15 The remains of the horizontal cavity barrier at Level 19, as shown in the photographs below taken on my second site visit, suggests that the barrier along the line of the compartment floor was installed as per the Harley Construction drawings and not as the Studio E As Built drawing 1279 (06) 120-00 '*Detail Section Sheet 1*'. At level 19 the location of the horizontal barrier, when measured, appears to be approximately 230mm above FFL and higher than the Harley Construction drawings.

Figure: 4.111 and 4.112: Photos taken by HKS at Grenfell Tower on 15 May 2019

4.5.16 Studio E's *'As Built'* drawing information does not include any information regarding the overall positions of the envelope cavity barriers, either on their elevation drawings or 1:50 plan layouts {RYD00000435}.

4.5.17 The remains of a sill detail on Level 4 indicates that there was no cavity barrier installed to the window sills as per the Construction Drawings and Studio E's *'As Built'* Section 1279 (06) 120 - 00. Given the lack of residual material or fixing strap, the remains of a window jamb on level 4 also suggests that there were no proprietary cavity barriers installed at the jamb as per the Construction Drawings.

Figures: 4.113 & 4.114 Photos taken by HKS at Grenfell Tower on 15 May 2019

4.5.18 The remains of a vertical cladding rail at the window sill on Level 04 suggests that there could have been a lack of continuity of the horizontal cavity barrier at this interface. The photograph on the left indicates the size of vertical channel and the photo on the right indicates a typical gap between cassettes, which aligns with the Harley Construction drawings and expected to deal with site tolerances. If the horizontal cavity barriers were cut around and up to the channel there is the potential for by-pass through the gap between the cassette cheek and vertical channel, which the photo looking down the panel suggests.

Figures: 4.115 and 4.116: Photos taken by HKS at Grenfell Tower on 15 May 2019

4.5.19 The cavity barrier at Level 4 (looking down from sill level) also shows the gap between the back of the window infill panels and the intumescent face of the barrier.

Figure: 4.117 Photos taken by HKS at Grenfell Tower on 15 May 2019

Conclusion Snap-Shot 4: '*As Built*' Record Cavity Barriers

4.5.20 The *'As Built'* record drawings did not record an installation that complied with the requirements of the Building Regulations or the guidance in ADB2.

Window Infill Panels

Commentary Snap-Shot 4: As Built Record Window Infill Panels

4.5.21 There appears to be no Studio E 'As Built' Information to indicate the panel insulation type {RYD00000435}.

Conclusion Snap-Shot 4: As Built Record Window Infill Panels

4.5.22 The *'As Built'* record drawings did not record an installation that complied with the requirements of the Building Regulations or the guidance of ADB2. Such information should have been recorded on the 'As-Built' drawings: the infill panels formed an important part of the external wall construction.

Infill Behind Internal Linings to Windows

Commentary Snap-Shot 4: As Built Record Infill Behind Internal Linings to Windows

4.5.23 Studio E's '*As Built*' drawing 1279 (06) 120 00 '*Detail Section Sheet 1*' does not (as shown below) indicate any packing material to the window head or sill {SEA00003436}.

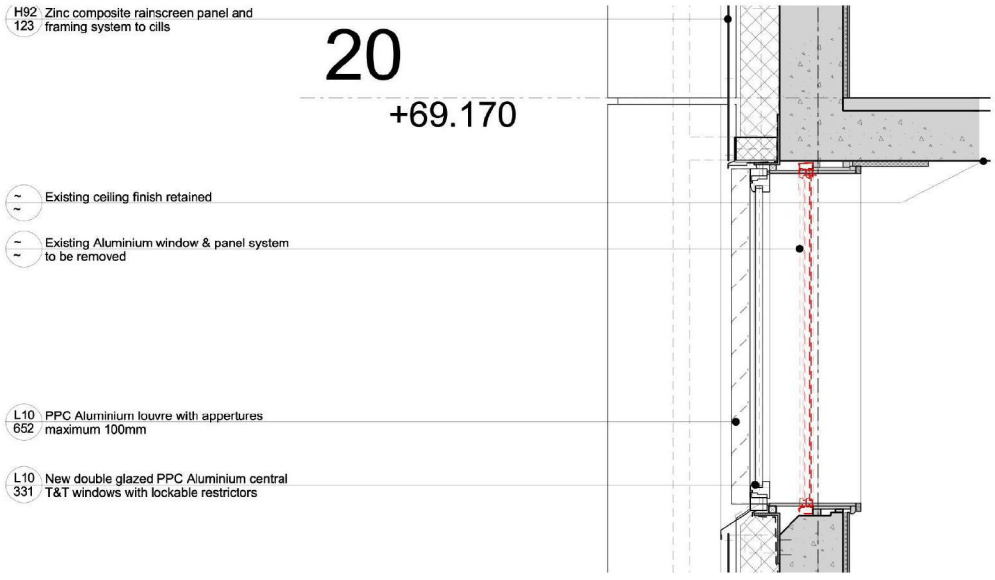


Figure: 4.118 Extract from drawing 1279 (06) 120 '*Detail Section Sheet 1*' {SEA00003436}

4.5.24 The remains of a Level 08 window, as shown in the photographs below, suggests that the jambs and sills were packed with PIR insulation such as the Celotex or Kingspan in lieu of with Rockwool as per Studio E's specification at tender stage (Snap-Shot 2)

Figures: 4.119 and 4.120: Photos taken by HKS at Grenfell Tower on 15 May 2019

4.5.25 An example of the window panel on Level 4 (looking horizontally from a window reveal into the cavity) suggests that between the existing concrete infill inside face the gaps behind the window reveal lining boards have been closed with offcuts of Kingspan Thermapitch and the Celotex. As stated earlier herein, neither product would meet the requirements of ADM Clause 12.7 for insulation to be of limited combustibility.

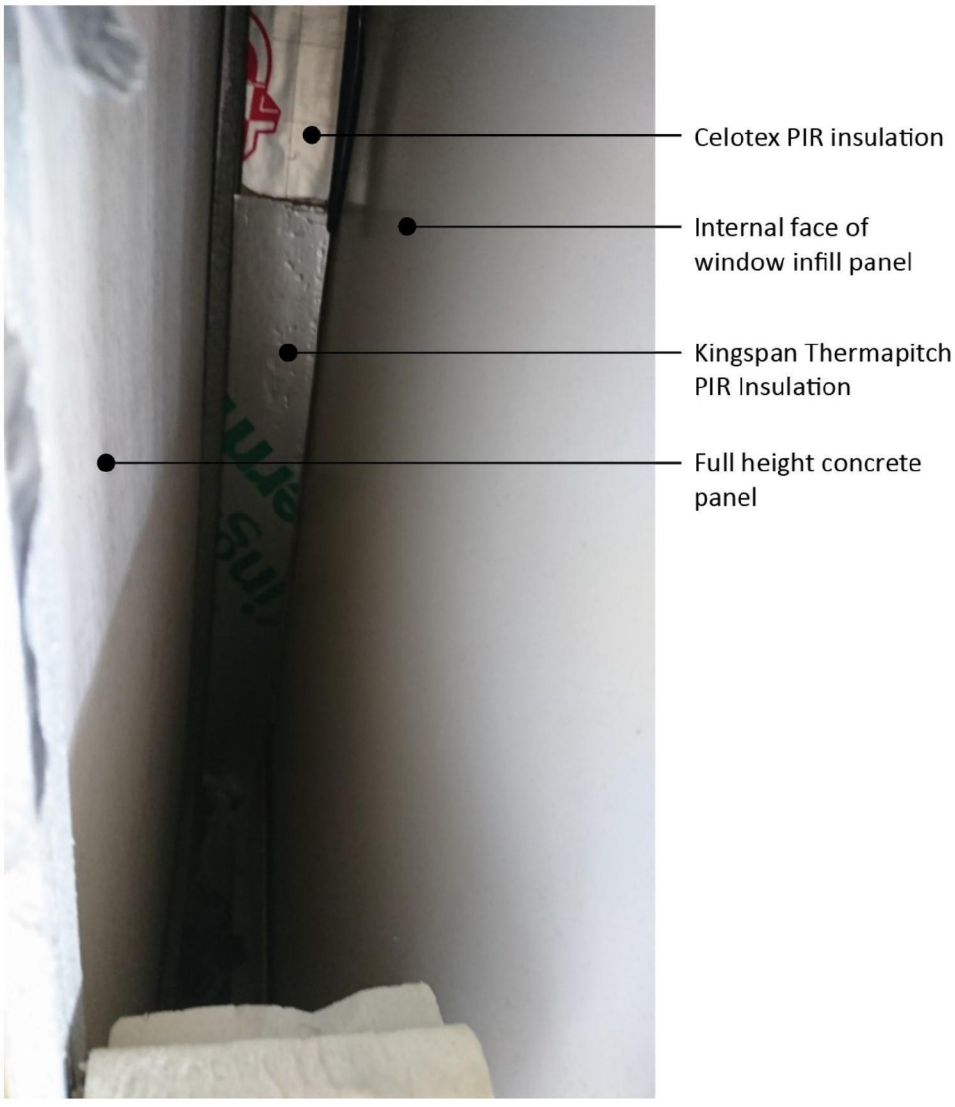


Figure: 4.121 Photos taken by HKS at Grenfell Tower on 15 May 2019

Conclusion Snap-Shot 4: '*As Built*' Record Infill Behind Internal Linings to Windows

4.5.26 I note from the witness statement of Mr Dixon of SD Plastering Ltd that his company was engaged by Rydon to undertake *'cosmetic works in finishing off the surrounds to newly installed windows'* {SDP00000196). He further states under paragraph 20 that SD Plastering Ltd *'did not receive any instructions from Rydon nor any other entity, concerning compartmentation and / or fire resistance in respect of the works'.* In this matter Rydon should have ensured that SD Plastering Ltd were properly briefed with respect to the infill behind the linings and should have ensured that any materials used for this purpose were properly described on Harley or on Studio E drawings, or alternatively secured confirmation from the design team of requirements in this respect. That should have resulted in the realisation that paragraph 12.7 of ADB2 would apply.

4.5.27 The *'As Built'* record drawings did not record an installation that complied with the requirements of the Building Regulations or the guidance of ADB2. Such information should have been recorded on the 'As-Built' drawings.

4.6 Conclusion to Snap-Shots 1-4

Design Element	Studio E Stage D Design Report	Studio E Tender Documentation	Novation	Harley Construction Documentation	Studio E As Built Documentation
Envelope Insulation	✗	✗		●	✗
Rainscreen Cladding	✓	✓		✗	✗
Cavity Barriers (Window Openings)	○	✗		✗	✗
Vertical Cavity Barriers (Compartment Walls)	○	✗		✓	●
Horizontal Cavity Barriers (Compartment Floors)	○	✓		✗	●
Cavity Barriers (The Crown)	○	✗		✗	●
Window Unit Infill Panels	○	●		✗	●
Window Head, Jamb, Sill Interface	○	●		○	●

Legend:

- ✓ Documentation Considered Compliant with ADB2
- ✗ Documentation Considered not to Comply with ADB2
- ○ Documentation Not Provided but Not Expected
- ● Documentation Unclear/ Not Provided But Expected

Figure: 4.122 Completed Snap-shot Matrix

4.6.1 The completed matrix shows the ebb and flow of the various design and specification decisions along the design and construct process is thus as shown above.