

**Grenfell Tower – fire safety investigation:**  
**The fire protection measures in place on the night of the fire, and conclusions as to:**  
**the extent to which they failed to control the spread of fire and smoke;**  
**the extent to which they contributed to the speed at which the fire spread.**

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**Phase 1 Report – Appendix E**

**Compliance assessment: external fire spread Regulation B4**

**REPORT OF**

**Dr Barbara Lane FREng FRSE CEng**

**Fire Safety Engineering**

**24<sup>th</sup> October 2018**

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<b>Specialist Field</b>	:	Fire Safety Engineering
<b>Assisted by</b>	:	Dr Susan Deeny, Dr Peter Woodburn, Dr Graeme Flint, Mr Tom Parker, Mrs Danielle Antonellis, Mr Alfie Chapman
<b>On behalf of</b>	:	Grenfell Tower Inquiry
<b>On instructions of</b>	:	Cathy Kennedy, Solicitor, Grenfell Tower Inquiry
<b>Subject Matter</b>	:	To examine the circumstances surrounding the fire at Grenfell Tower on 14 <sup>th</sup> June 2017
<b>Inspection Date(s)</b>	:	6 <sup>th</sup> October, 1 <sup>st</sup> November, 7-9 <sup>th</sup> November 2017

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Dr Barbara Lane  
Ove Arup & Partners Limited  
13 Fitzroy Street  
London W1T 4BQ

## **Appendix E– Compliance assessment: external fire spread Regulation B4**



## CONTENTS

<b>E1</b>	<b>Introduction</b>	<b>E-1</b>
<b>E2</b>	<b>Schedule of Arconic Inc. Reynobond Architecture Wall Cladding Panel reaction to fire test and classification evidence</b>	<b>E-2</b>
<b>E3</b>	<b>Celotex thermal insulation- Reaction to fire performance</b>	<b>E-10</b>
E3.2	Schedule of disclosed National test reaction to fire test/classification reports	E-10
E3.3	Variations in the chemical composition of Celotex PIR insulation products	E-16
E3.4	Variability of Celotex PIR reaction to fire performance	E-17
<b>E4</b>	<b>Review of BS8414 test data for Celotex PIR Insulation</b>	<b>E-22</b>
E4.1	Approach	E-22
E4.2	Documents considered	E-23
E4.3	Review of test <i>BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen</i> produced by BRE Global on 01/08/2014	E-25
E4.4	Review of <i>The Fire Performance of Celotex- PIR Façade cladding systems when tested following BS 8414 Part 2:2005</i> produced by Exova Warrington Fire on 26/05/2015	E-31
E4.5	Withdrawal of the test report BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen produced by BRE Global on 01/08/2014	E-32
E4.6	BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen produced by BRE Global on 01/08/2018	E-41
E4.7	Summary of compliance of the use of Celotex PIR insulation on Grenfell Tower	E-49
<b>E5</b>	<b>Schedule of Kingspan reaction to fire test and classification evidence</b>	<b>E-49</b>
E5.1	Kooltherm K15 reaction to fire test and classification evidence	E-49
E5.2	Schedule of Kingspan Thermapitch TP10 reaction to fire test and classification evidence	E-55
<b>E6</b>	<b>Review of BS 8414 evidence for Kingspan Phenolic Insulation</b>	<b>E-60</b>
<b>E7</b>	<b>Schedule of Siderise fire resistance test and classification test evidence</b>	<b>E-62</b>

## **E1 Introduction**

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- E1.1.1** Section 11 of my Expert report provides my assessment of the compliance of the external rain screen cladding system as installed at Grenfell Tower, based on the fire test reports provided to me at this stage in the Public Inquiry.
- E1.1.2** This Appendix contains all the fire test evidence I have relied upon in making my assessment. I also provide some additional commentary on this evidence that is not material to the compliance of the façade system installed on Grenfell Tower, but is useful to assist in understanding the fire performance of the materials installed.
- E1.1.3** In Section E2 I have provided a complete schedule of reaction to fire test evidence currently available to me for Arconic Inc. Reynobond Architecture Wall Cladding Panels. I have also used this test evidence in my assessment of BBA Agrément Certificates for Reynobond Architectural Wall Panels in Appendix O of my Expert report.
- E1.1.4** In Section E3, I have provided a complete schedule of reaction to fire test evidence currently available to me for the Celotex thermal insulation. This table does not include the test and/or classification data which is not relevant to meeting the requirement of ADB 2013 12.7 for Limited Combustibility (Table A7 of ADB 2013). However, I explain the difference in chemical composition between different Celotex 5000 products and review the apparent variability of reaction to fire performance of the Celotex 5000 insulation.
- E1.1.5** In Section E4 I review BS 8414 test data, classification reports and desktop assessments submitted by Celotex for their PIR insulation products. I explain how the 2014 test data and assessment reports are not applicable to Grenfell Tower as built external wall construction. I also explain the errors and omissions I found between the rainscreen system tested in 2014 and the associated fire test documentation that was then issued. I also provide a review of the newly commissioned BS 8414 test report by Celotex for their PIR insulation products. I explain how these newly commissioned tests are also not relevant to the Grenfell Tower as built external wall construction.
- E1.1.6** In Section E4.7, I have provided a complete schedule of reaction to fire test evidence currently available to me for Kingspan thermal insulation.
- E1.1.7** In Section E6, I review the BS 8414 test data submitted by Kingspan for their phenolic insulation products used with an ACP rainscreen.
- E1.1.8** In Section E7, I have provided a complete schedule of the fire resistance test evidence I have received for Siderise cavity barriers.



## **E2 Schedule of Arconic Inc. Reynobond Architecture Wall Cladding Panel reaction to fire test and classification evidence**

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- E2.1.1** In Table E.1 I have listed all the reaction to fire test reports and classification reports for Arconic Inc. Reynobond Architecture Wall Cladding Panels which have been made available to the Public Inquiry.
- E2.1.2** This includes Reynobond 33 (2mm, 3mm, and 4mm); Reynobond RB160 and Reynobond 55 PE (riveted and cassette); and Reynobond 55 FR.
- E2.1.3** These include test reports and classification reports under the National and European test frameworks. These frameworks are described in full in Appendix F.
- E2.1.4** In Section 11, I have presented evidence that the specific Reynobond Architecture Wall Cladding Panels purchased and installed at Grenfell Tower was Reynobond 55 PE. I have explained in Section 8 of my report that a cassette type system was installed on Grenfell Tower, however it was not formed or fixed in accordance with any of the standard Arconic details.
- E2.1.5** In Table E.1 I have highlighted in yellow all of the test evidence and classification evidence which is relevant to the Reynobond 55 PE cassette system used for Grenfell Tower. This is the relevant test evidence which I have used in my assessment of compliance in Section 11 of my Expert report.
- E2.1.6** The BBA Agrément certificates which have been disclosed to the Public Inquiry are for Reynobond Architectural Wall Panels. I have highlighted all the available BBA Agrément certificates in red. I have done this because it is my opinion that there are serious errors and omissions in the Agrément certificates issued for *Reynobond Architecture Wall Cladding Panels*. I explain all of this in Appendix O.
- E2.1.7** All test evidence and classification evidence listed in Table E.1 which is not highlighted is not relevant to Grenfell Tower because it is either for a different Arconic Reynobond Architecture Wall Cladding Panel product or different method of fixing (for example riveted instead of cassette).

Table E.1 Schedule of the Arconic Inc. Reynobond Architecture Wall Cladding Panels reaction to fire test evidence currently available (note evidence is listed in chronological order)(Cassette systems highlighted in yellow) (BBA certificates are highlighted in red. I have serious concerns with the information provided in the BBA Agrément certificates that I discuss further in Appendix O)

Report Title	Report Sponsor	Report Author	Date of issue	Product description	Test standards	Classification	Test heat exposure	Product Name	Fixing type	Core material	Panel thickness (mm)	PE Core thickness (mm)	Aluminium thickness (mm)	Classification report/ Test report/ BBA certificate number	Relativity Document
Test report WARRES NO. 70708 BS 476-6 1989 Method of test for fire propagation for products	Reynolds Aluminium France SA	Warrington Fire	14/03/1997	Reynobond RB 160 PE	BS 476-6	I=0.3 i1=0.0	Surface only	Reynobond RB 160 PE	Not Stated	PE	4	3	0.5	WARRES NO. 70708	ARC00000355
Test report WARRES NO. 70707 BS 476-7 1997 Method of classification of the surface spread of flame of products	Reynolds Aluminium France SA	Warrington Fire	14/03/1997	Reynobond RB 160 PE	BS 476-7	Class 1	Surface only	Reynobond RB 160 PE	Not Stated	PE	4	3	0.5	WARRES NO. 70707	ARC00000356
Summary of WARRES NO. 70707 & WARRES NO. 70708 including opinion of compliance with the requirements for a class 0 surface as defined in paragraph A12(b) of Approved Document B, fire safety to the building regulations 1991	Reynolds Aluminium France SA	Warrington Fire	14/03/1997	Reynobond RB 160 PE	BS 476-7 BS 476-6	Class 0	Surface only	Reynobond RB 160 PE	Not Stated	PE	4	3	0.5	WARRES NO. 70708 & WARRES NO. 70707	ARC00000357
Warrington Fire Research Report 132316	ALCOA ARCHITECTURAL PRODUCTS	Warrington Fire	12/09/2003	Reynobond 55 FR	BS 476-7	Class 1	Surface only	Reynobond 55 FR	Not Stated	FR Core	4	3	0.5	WARRES NO. 132316	BBA00000050
Warrington Fire Research Report 132317	ALCOA ARCHITECTURAL PRODUCTS	Warrington Fire	12/09/2003	Reynobond 55 FR	BS 476-6	I=1.0 i1=0.0	Surface only	Reynobond 55 FR	Not Stated	FR Core	4	3	0.5	WARRES NO. 132317	BBA00000053
REACTION TO FIRE CLASSIFICATION REPORT No. RA05-0005A ACCORDING TO THE EUROPEAN STANDARD NF EN 13501-1+A1:2013	ALCOA ARCHITECTURAL PRODUCTS S.A.S.	CSTB	07/01/2005	REYNOBOND ® 55 PE Riveted system grey/green Duragloss 5000 coating	BS EN ISO 11925-2 BS EN 13823	B- S2, D0	Surface and core	Reynobond 55 PE	Riveted	PE	4	3	0.5	RA05-0005A	ARC00000358
RAPPORT D'ESSAIS DE REACTION AU FEU N0 RA05-0005A SELON LES NORMES EUROPEENNES NF EN 13823 ET NF EN ISO 11925-5 (FRENCH LANGUAGE ONLY)	ALCOA ARCHITECTURAL PRODUCTS	CSTB	07/01/2005	REYNOBOND ® 55 PE system rivete gris/vert Duragloss 5000 coating	NF EN ISO 11925-2 NF EN 13823	Not stated but result mean it is Class B	Surface and core	Reynobond 55 PE	Riveted	PE	4	3	0.5	RA05-0005A	ARC00000359
RAPPORT D'ESSAIS DE REACTION AU FEU N0 RA05-0005B SELON LES NORMES EUROPEENNES NF EN 13823 ET NF EN ISO 11925-5 (FRENCH LANGUAGE ONLY)	ALCOA ARCHITECTURAL PRODUCTS	CSTB	07/01/2005	REYNOBOND ® 55 PE system a cassette (chants fermes) gris/vert Duragloss 5000 coating	NF EN ISO 11925-2 NF EN 13823	Not stated but results mean it is Class E	Surface and core	Reynobond 55 PE	Cassette	PE	4	3	0.5	RA05-0005B	ARC00000360
Warrington fire test report No. 157537 BS 476: Part 6:1989 Method of Test for fire propagation of products	ALCOA ARCHITECTURAL PRODUCTS	Warrington Fire	14/09/2006	REYNOBOND 33 (Overall thickness 2mm)	BS 476-7	I = 0.9 i1 =0.2	Surface only	Reynobond 33 PE	Not Stated	PE	2	1.4	0.3	WF 157537	<u>ARC00000364</u>



Report Title	Report Sponsor	Report Author	Date of issue	Product description	Test standards	Classification	Test heat exposure	Product Name	Fixing type	Core material	Panel thickness (mm)	PE Core thickness (mm)	Aluminium thickness (mm)	Classification report/ Test report/ BBA certificate number	Relativity Document
Warrington fire test report No. 157530 BS 476: Part 7:1997 Method for classification of the surface spread of flame of products	ALCOA ARCHITECTURAL PRODUCTS	Warrington Fire	14/09/2006	REYNOBOND 33 (Overall thickness 2mm)	BS 476-7	Class 1	Surface only	Reynobond 33 PE	Not Stated	PE	2	1.4	0.3	WF 157530	<a href="#">ARC00000366</a>
Warrington fire test report No. 157532 BS 476: Part 7:1997 Method for classification of the surface spread of flame of products	ALCOA ARCHITECTURAL PRODUCTS	Warrington Fire	14/09/2006	REYNOBOND 33 (Overall thickness 4mm)	BS 476-7	Class 1	Surface only	Reynobond 33 PE	Not Stated	PE	4	3.4	0.3	WF 157532	ARC00000367
Summary of WFs No's 157530 & 157537 including opinion of compliance with the requirements for a class 0 surface as defined in paragraph A13(b) of Approved Document B, (2000 edition incorporating 2002 amendments) 'Fire Safety', To the Building Regulations 2000	ALCOA ARCHITECTURAL PRODUCTS	Warrington Fire	14/09/2006	REYNOBOND 33 (Overall thickness 2mm)	BS 476-7 BS 476-6	Class 0	Surface only	Reynobond 33 PE	Not Stated	PE	2	1.4	0.3	WF 157530	ARC00000366
Summary of WFs No's 157532 & 157535 including opinion of compliance with the provisions for a class 0 surface as defined in paragraph A13(b) of Approved Document B, (2000 edition incorporating 2002 amendments) 'Fire Safety', To the Building Regulations 2000	ALCOA ARCHITECTURAL PRODUCTS	Warrington Fire	14/09/2006	REYNOBOND 33 (Overall thickness 4mm)	BS 476-7 BS 476-6	Class 0	Surface only	Reynobond 33 PE	Not Stated	PE	4	3.4	0.3	WF157532 & WF157355	ARC00000363
Summary of WFs No's 157531 & 157536 including opinion of compliance with the provisions for a class 0 surface as defined in paragraph A13(b) of Approved Document B, (2000 edition incorporating 2002 amendments) 'Fire Safety', To the Building Regulations 2000	ALCOA ARCHITECTURAL PRODUCTS	Warrington Fire	14/09/2006	REYNOBOND 33 (Overall thickness 3mm)	BS 476-7 BS 476-6	Class 0	Surface only	Reynobond 33 PE	Not Stated	PE	3	2	0.3	WF157530 & WF157357	ARC00000361
Warrington fire test report No. 157535 BS 476: Part 6:1989 Method of Test for fire propagation of products	ALCOA ARCHITECTURAL PRODUCTS	Warrington Fire	15/09/2006	REYNOBOND 33 (Overall thickness 4mm)	BS 476-6	I = 0.9 i1 = 0	Surface only	Reynobond 33 PE	Not Stated	PE	4	3.4	0.3	WF 157535	<a href="#">ARC00000365</a>
REACTION TO FIRE CLASSIFICATION REPORT No. RA06-0372 ACCORDING TO THE EUROPEAN STANDARD NF EN 13501-1	ALCOA ARCHITECTURAL PRODUCTS	CSTB	19/10/2006	REYNOBOND ® FR with gold Duragloss ® 5000 coating Riveted system	EN 13823 EN ISO 11925-2	B-S1, d0	Surface and core	Reynobond ® FR	Riveted	PE	4	3	0.5	RA06-0372	BBA00000054

Report Title	Report Sponsor	Report Author	Date of issue	Product description	Test standards	Classification	Test heat exposure	Product Name	Fixing type	Core material	Panel thickness (mm)	PE Core thickness (mm)	Aluminium thickness (mm)	Classification report/ Test report/ BBA certificate number	Relativity Document
Agrément Certificate 08/4510 Arconic Inc. cladding Panels Reynobond Architecture Wall Cladding Panels	Alcoa Architectural products s.a. s	BBA	14/01/2008	REYNOBOND standard panel with grey/green Duragloss 5000 coating	Not Stated	B- S2, D0	Surface and core	Reynobond 55 PE	Riveted	PE	3,4,6	Not Stated	Not Stated	BBA 08/4510	ARC00000368
REACTION TO FIRE CLASSIFICATION REPORT No. RA11-0032 ACCORDING TO THE EUROPEAN STANDARD NF EN 13501-1+A1:2013	ALCOA ARCHITECTURAL PRODUCTS S.A.S.	CSTB	09/02/2011	REYNOBOND ® 55 PE Riveted system	BS EN ISO 11925-2 BS EN 13823	B- S1, D0	Surface and core	Reynobond 55 PE	Riveted	PE	4	3	0.5	RA11-0032	ARC00000383
REACTION TO FIRE CLASSIFICATION REPORT No. RA11-0244 ACCORDING TO THE EUROPEAN STANDARD NF EN 13501-1+A1:2013	ALCOA ARCHITECTURAL PRODUCTS	CSTB	12/10/2011	REYNOBOND Architecture PE Cassette system	BS EN ISO 11925-2	E	Surface and core	Reynobond 55 PE	Cassette	PE	4	3	0.5	RA11-0244	ARC00000386
REACTION TO FIRE CLASSIFICATION REPORT No. RA13-0333 ACCORDING TO THE EUROPEAN STANDARD NF EN 13501-1+A1:2013	ALCOA ARCHITECTURAL PRODUCTS S.A.S.	CSTB	31/01/2014	REYNOBOND ® 55 PE	BS EN ISO 11925-2	E	Surface and core	Reynobond 55 PE	Cassette and riveted	PE	4	3	0.5	RA13-0333	ARC00000393
REACTION TO FIRE CLASSIFICATION REPORT No. RA13-0333 ACCORDING TO THE EUROPEAN STANDARD NF EN 13501-1+A1:2013	ALCOA ARCHITECTURAL PRODUCTS S.A.S.	CSTB	04/12/2014	REYNOBOND ® 55 PE (cassette system)	BS EN ISO 11925-2	E	Surface and core	Reynobond 55 PE	Cassette	PE	4	3	0.5	RA13-0333	ARC00000395

Report Title	Report Sponsor	Report Author	Date of issue	Product description	Test standards	Classification	Test heat exposure	Product Name	Fixing type	Core material	Panel thickness (mm)	PE Core thickness (mm)	Aluminium thickness (mm)	Classification report/ Test report/ BBA certificate number	Relativity Document
REACTION TO FIRE CLASSIFICATION REPORT No. RA14-0339 ACCORDING TO THE EUROPEAN STANDARD NF EN 13501-1+A1:2013	ALCOA ARCHITECTURAL PRODUCTS S.A.S.	CSTB	04/12/2014	REYNOBOND® 55 PE Riveted system Duragloss ® 5000 35 µm finish	BS EN ISO 11925-2 BS EN 13823	C - s2, d0	Surface and core	Reynobond 55 PE	Riveted	PE	4	3	0.5	RA14-0339	ARC00000397
REACTION TO FIRE CLASSIFICATION REPORT No. RA15-0200 ACCORDING TO THE EUROPEAN STANDARD NF EN 13501-1+A1:2013	ALCOA ARCHITECTURAL PRODUCTS S.A.S.	CSTB	22/09/2015	REYNOBOND® 55 PE Riveted system Duragloss ® 5000 35 µm finish (translucent core)	BS EN ISO 11925-2 BS EN 13823	C - s2, d0	Surface and core	Reynobond 55 PE	Riveted	PE	4	3	0.5	RA15-0200	ARC00000402
REACTION TO FIRE CLASSIFICATION REPORT No. RA15-0200 ACCORDING TO THE EUROPEAN STANDARD NF EN 13501-1+A1:2013	ALCOA ARCHITECTURAL PRODUCTS S.A.S.	CSTB	22/09/2015	REYNOBOND® 55 PE Riveted system Duragloss ® 5000 35 µm finish (black core)	BS EN ISO 11925-2 BS EN 13823	C - s2, d0	Surface and core	Reynobond 55 PE	Riveted	PE	4	3	0.5	RA15-0200	ARC00000402
REACTION TO FIRE CLASSIFICATION REPORT No. RA15-0201 ACCORDING TO THE EUROPEAN STANDARD NF EN 13501-1+A1:2013	ALCOA ARCHITECTURAL PRODUCTS S.A.S.	CSTB	22/09/2015	REYNOBOND® 55 PE (cassette system) (translucent core)	BS EN ISO 11925-2	E	Surface and core	Reynobond 55 PE	Cassette	PE	4	3	0.5	RA15-0201	ARC00000405
REACTION TO FIRE CLASSIFICATION REPORT No. RA15-0201 ACCORDING TO THE EUROPEAN STANDARD NF EN 13501-1+A1:2013	ALCOA ARCHITECTURAL PRODUCTS S.A.S.	CSTB	22/09/2015	REYNOBOND® 55 PE (cassette system) (black core)	BS EN ISO 11925-2	E	Surface and core	Reynobond 55 PE	Cassette	PE	4	3	0.5	RA15-0201	ARC00000405



Report Title	Report Sponsor	Report Author	Date of issue	Product description	Test standards	Classification	Test heat exposure	Product Name	Fixing type	Core material	Panel thickness (mm)	PE Core thickness (mm)	Aluminium thickness (mm)	Classification report/ Test report/ BBA certificate number	Relativity Document
Agrément Certificate 08/4510 Arconic Inc. cladding Panels Reynobond Architecture Wall Cladding Panels 2nd issue	Arconic Inc. Architectural products s.a. s	BBA	04/08/2017	Front cover states: Reynobond Architecture Wall Cladding Panels  Table 3 states: ST with grey/green Duragloss 5000 coating  FR with gold Duragloss 5000 coating  FR with metallic grey PVDF	Not Stated	B- S2, D0 <sup>1</sup> (for ST with grey/green Duragloss 5000 coating)  B-S1, d0 (FR with gold Duragloss 5000 coating)  Class 0 or 'low risk' (for FR with metallic grey PVDF)	Not Stated	ST with grey/green Duragloss 5000 coating  FR with gold Duragloss 5000 coating  FR with metallic grey PVDF	Riveted	PE	3,4,6	Not Stated	0.5	BBA 08/4510	ARC00000415
Certificate 08/4510 Product sheet 1 Second Issue Amended	Arconic Architectural Products s.a. s	BBA	22/09/2017	Front cover states: Reynobond Architecture Wall Cladding Panels  Table 3 states: FR with gold Duragloss 5000 coating  FR with metallic grey PVDF coating	Not Stated	B-S1, d0 (FR with gold Duragloss 5000 coating)  Class 0 or 'low risk' (for FR with metallic grey PVDF coating)	Not Stated	FR with gold Duragloss 5000 coating  FR with metallic grey PVDF coating	Riveted	PE	3,4,6	Not Stated	0.5	BBA 08/4510	BBA00000049

<sup>1</sup> Note the BBA certificate states an incorrect reaction to fire performance as the riveted was re classified as Class C in 2014 prior to the issue of the BBA certificate



- E2.1.8** In Table E.2 I have listed all the Arconic Inc. Reynobond Architecture Wall Cladding Panels which have test evidence or classification evidence of achieving Class 0 (national Class) or Class B-s3, d2 or better (European class) at the time the report was issued.
- E2.1.9** These panels meet the Diagram 40 ADB 2013 reaction to fire performance for an external surface at any dimension over 18m for a building with a height 18m or more as I identified in Appendix F.
- E2.1.10** As can be seen, none of the products listed in Table E.2 are relevant to Grenfell Tower, because a Reynobond 55PE Cassette system was purchased and installed.
- E2.1.11** The disclosed evidence for the Arconic Reynobond Architecture Wall Cladding Panels therefore does not demonstrate compliance of the ACP rainscreen system installed on Grenfell Tower with Clause 12.6 of ADB 2013.
- E2.1.12** The only alternative method to demonstrate compliance would be to “*meet the performance criteria given in the BRE Report Fire performance of external thermal insulation for walls of multi storey buildings (BR 135) for cladding systems using full scale test data from BS 8414-1:2002 or BS 8414-2:2005*” as stated in paragraph 12.5 of ADB 2013.
- E2.1.13** No full scale test data from BS 8414-1:2002 or BS 8414-2:2005 for Reynobond Architecture Wall Cladding panels has been disclosed to me to date by Arconic to demonstrate that any of their systems can comply with Clause 12.5 of ADB 2013 in any form.
- E2.1.14** I have highlighted all the available BBA Agrément certificates in red. This is due to serious errors and omissions I have found in the Agrément certificates issued for *Reynobond Architecture Wall Cladding Panels*. I explain all of this in Appendix O.

Table E.2 Arconic Inc. systems that have been tested and/or classified to meet Class 0 (National Class) or Class B-s3, d2 or better (European Class)

Date of issue of report	Product description in report	Fixing type	Classification stated in Report	Classification report/ Test report/ BBA certificate number	Relativity Document
14/03/1997	Reynobond RB 160 PE	N/A National test standard used	Class 0	WARRES NO. 70708 & WARRES NO. 70707	ARC00000357
07/01/2005	REYNOBOND ® 55 PE Riveted system grey/green Duragloss 5000 coating	Riveted	B- S2, D0	RA05-0005A	ARC00000358
07/01/2005	REYNOBOND ® 55 PE system rivete gris/vert Duragloss 5000 coating	Riveted	Not stated but result mean it is Class B	RA05-0005A	ARC00000359
14/09/2006	REYNOBOND 33 (Overall thickness 2mm)	N/A National test standard used	Class 0	WF 157530	ARC00000366
14/09/2006	REYNOBOND 33 (Overall thickness 4mm)	N/A National test standard used	Class 0	WF157532 & WF157355	ARC00000363
14/09/2006	REYNOBOND 33 (Overall thickness 3mm)	N/A National test standard used	Class 0	WF157530 & WF157357	ARC00000361
14/01/2008	Reynobond Architectural Wall Panel	Refer to Appendix O	Class 0	BBA 08/4510	ARC00000368
09/02/2011	REYNOBOND ® 55 PE Riveted system	Riveted	B- S1, D0	RA11-0032	ARC00000383
04/08/2017	Reynobond Architectural Wall Panel	Refer to Appendix O	B- s1, D0 or B- s2, D0	BBA 08/4510	ARC00000415



## **E3 Celotex thermal insulation- Reaction to fire performance**

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- E3.1.1** In Section E3.2 I list all of the National classification reaction to fire test reports that have been disclosed to me for any Celotex PIR insulation.
- E3.1.2** In Section E3.3 I provide a review of test evidence which demonstrates the differences in chemical composition between different Celotex PIR insulation products.
- E3.1.3** In Section E3.4 I provide my analysis of an apparent variability in the reaction to fire performance of Celotex PIR insulation products.

### **E3.2 Schedule of disclosed National test reaction to fire test/classification reports**

- E3.2.1** Celotex FR5000 was originally specified in the employer's requirements (HAR00000872) however Celotex RS5000 was purchased (as evidenced by the purchase orders SIG00000010, HAR00000583 and HAR00000781).
- E3.2.2** Celotex have disclosed test and classification reports for three named PIR foam product ranges. These are RS5000, FR5000 and 5050. I note all three of these products are also defined as either "line 1" or "line 2".
- E3.2.3** I have listed all of the disclosed test/ classification evidence disclosed to the Inquiry in Table E.3 for these three products. I have highlighted in green all the test and/or classification evidence which was available prior to or during the Grenfell Tower 2012-2016 refurbishment.
- E3.2.4** To comply with Section 12.7 of ADB 2013, an insulation material must achieve Limited Combustibility using National Classification methods in Table A7 of ADB 2013 (Using BS 476-11 or BS 476-4) or material of limited combustibility using European Classification methods in Table A7 of ADB 2013 (Class A2 or better) (see Appendix F of this report).
- E3.2.5** The only National Classification reaction to fire performance that I have received to date for Celotex PIR Insulation is based on the tests BS 476-6 and BS476-7.
- E3.2.6** Neither BS 476-6 or BS476-7 can be used to demonstrate limited combustibility, the required performance for compliance with section 12.7 of ADB 2013. The relevant national test standards for demonstrating limited combustibility are BS 476-4 and BS476-11.
- E3.2.7** Therefore, no evidence has been disclosed to me to date to demonstrate that any Celotex insulation has been tested to the standard required for use as an insulation material, where the topmost storey of a building is greater than 18m.

- E3.2.8** I therefore consider all of the test data listed below, not to be relevant test data regarding the construction of Grenfell Tower.
- E3.2.9** Based on this the use of Celotex PIR insulation was noncompliant with paragraph 12.7 of ADB 2013 for use on Grenfell Tower.
- E3.2.10** The only alternative method to demonstrate compliance would be to “*meet the performance criteria given in the BRE Report Fire performance of external thermal insulation for walls of multi storey buildings (BR 135) for cladding systems using full scale test data from BS 8414-1:2002 or BS 8414-2:2005*” as stated in paragraph 12.5 of ADB 2013.
- E3.2.11** I review the available BS 8414 and BR 135 evidence for Celotex PIR insulation in E4.
- E3.2.12** As a result, there is no evidence available to me which demonstrates that the Celotex insulation material used on Grenfell Tower was capable of meeting the functional requirement B4 of the Building Regulations.



Table E.3: Celotex 5000 range of PIR insulation reaction to fire performance to British Standard tests (note tests relate to surface exposure of insulation material only) (test/classification reports available prior to or during the Grenfell Tower refurbishment are highlighted in green)

Report title	Report sponsor	Report produced by	Relativity reference	Date of test	Date of issue of report/ letter	Product Manufacturer	Product description	Test/ classification standard referenced	Classification/ test result stated in Report	Line	Classification report/ Test report/ BBA certificate number	Disclosed by
BS 476-6:1989+A1:2009 test on Celotex FR5000 Line 1 (S-2011-379)	Celotex Ltd	BRE Global	CEL00000378	16/11/2011	18/11/2011	Celotex	'FR5000 Line 1' Foam type: CP400E (formulation specification 28-028) Density: 32kg/m3 Facing- Stucco silver foil facer	BS 476-6	I=5.2 i1=0.6 i2=2.5 i3=2.1	1	275714	Celotex
BS 476-6:1989+A1:2009 test on Celotex FR5000 Line 2 (S-2011-379)	Celotex Ltd	BRE Global	CEL00000379	17/11/2011	18/11/2011	Celotex	'FR5000 Line 2' Foam type: HP400E (formulation specification 28-028) Density: 32kg/m3 Facing- Stucco silver foil facer	BS 476-6	I=5.2 i1=0.4 i2=2.6 i3=2.2	2	275717	Celotex
BS 476-6:1989+A1:2009 test on Celotex RS5000	Celotex Ltd	BRE Global	CEL00000384	17/11/2011	14/07/2014	Celotex	Celotex RS5000 Foam type: HP400E Density: 32kg/m3	BS 476-6	I=5.2 i1=0.4 i2=2.6 i3=2.2		275717A	Celotex
BS 476-7: 1997 test on Celotex FR5000 Line 1 (S-2011-379)	Celotex Ltd	BRE Global	CEL00000380	21/11/2011	22/11/2011	Celotex	'FR5000 Line 1' Foam type: CP400E (formulation specification 28-028) Density: 32kg/m3 Facing- Stucco silver foil facer	BS 476-7	Class 1	1	275715	Celotex
BS 476-7: 1997 test on Celotex FR5000 Line 2 (S-2011-379)	Celotex Ltd	BRE Global	CEL00000381	21/11/2011	22/11/2011	Celotex	'FR5000 Line 2' Foam type: HP400E (formulation specification 28-038) Density: 32kg/m3 Facing- Stucco silver foil facer	BS 476-7	Class 1	2	275719	Celotex
BS 476-7: 1997 test on Celotex RS5000	Celotex Ltd	BRE Global	CEL00000385	21/11/2011	14/07/2014	Celotex	Celotex RS5000 Foam type: HP400E Density: 32kg/m3	BS 476-7	Class 1		275719A	Celotex
Class 0 classification	Celotex Ltd	BRE Global	CEL00000382	N/A	22/11/2011	Celotex	Class O classification letter for both Line 1	BS 476-6 BS 476-7	Class 0	1	275716	Celotex
Class 0 classification	Celotex Ltd	BRE Global	CEL00000383	N/A	22/11/2011	Celotex	Class O classification letter for both Line 2	BS 476-6 BS 476-7	Class 0	2	275720	Celotex
Class 0 classification	Celotex Ltd	BRE Global	CEL00000386	N/A	14/07/2014	Celotex	Class O classification letter for RS5000	BS 476-6 BS 476-7	Class 0		275720A	Celotex

Report title	Report sponsor	Report produced by	Relativity reference	Date of test	Date of issue of report/ letter	Product Manufacturer	Product description	Test/ classification standard referenced	Classification/ test result stated in Report	Line	Classification report/ Test report/ BBA certificate number	Disclosed by
BS 476-7: 1997 Surface spread of flame test on RS5160-Line 2	Celotex	BRE Global	CEL00002533	26/06/2017	25/01/2018	Celotex	RS5160-Line 2	BS 476-7	Class 1	2	P107614-1009 Issue 1	Celotex
BS 476-7: 1997 Surface spread of flame test on RS5100-Line 1	Celotex	BRE Global	CEL00002543	26/06/2017	25/01/2018	Celotex	RS5100-Line 1	BS 476-7	Class 1	1	P107614-1003 Issue 1	Celotex
BS 476-7: 1997 Surface spread of flame test on FR5100-Line 2	Celotex	BRE Global	CEL00002574	26/06/2017	25/01/2018	Celotex	FR5100- Line 2	BS 476-7	Class 1	2	P107614-1015 Issue 1	Celotex
BS 476-7: 1997 Surface spread of flame test on FR5025-Line 1	Celotex	BRE Global	CEL00002579	26/06/2017	25/01/2018	Celotex	FR5025-Line 1	BS 476-7	Class 1	1	P107614-10012 Issue 1	Celotex
BS 476-7: 1997 Surface spread of flame test on RS5100-Line 2	Celotex	BRE Global	CEL00002586	26/06/2017	25/01/2018	Celotex	RS5100-Line 2	BS 476-7	Class 1	2	P107614-1006 Issue 1	Celotex
BS 476-7: 1997 Surface spread of flame test on RS5025-Line 1	Celotex	BRE Global	CEL00002817	26/06/2017	25/01/2018	Celotex	RS5025- Line 1	BS 476-7	Class 1	1	P107614-1000 Issue 1	Celotex
BS 476-6: 1989+A1 2009 Fire propagation test on RS5100- Line 2	Celotex	BRE Global	CEL00002711	08/08/2017	25/01/2018	Celotex	RS5100- Line 2	BS 476-6	I= 22.1 i1= 12.9 i2= 8 i3= 1.2	2	P107614-1007 Issue 1	Celotex
BS 476-6: 1989+A1 2009 Fire propagation test on RS5100- Line 1	Celotex	BRE Global	CEL00002751	10/08/2017	25/01/2018	Celotex	RS5100- Line 1	BS 476-6	I= 25.1 i1= 14.3 i2= 9.6 i3= 1.2	1	P107614-1004 Issue 1	Celotex
BS 476-6: 1989+A1 2009 Fire propagation test on FR5100- Line 2	Celotex	BRE Global	CEL00002693	11/08/2017	25/01/2018	Celotex	FR5100- Line 2	BS 476-6	I= 18.7 i1= 10.2 i2= 7.4 i3= 1.1	2	P107614-1016 Issue 1	Celotex
BS 476-6: 1989+A1 2009 Fire propagation test on RS5025- Line 1	Celotex	BRE Global	CEL00002692	14/08/2017	25/01/2018	Celotex	RS5025- Line 1	BS 476-6	I= 17 i1= 11.6 i2= 4.9 i3= 0.5	1	P107614-1013 Issue 1	Celotex
BS 476-6: 1989+A1 2009 Fire propagation test on RS5025- Line 1	Celotex	BRE Global	CEL00002624	15/08/2017	25/01/2018	Celotex	RS5025- Line 1	BS 476-6	I= 19.1 i1= 13.20 i2= 5.37 i3= 0.50	1	P107614-1001 Issue 1	Celotex



Report title	Report sponsor	Report produced by	Relativity reference	Date of test	Date of issue of report/ letter	Product Manufacturer	Product description	Test/ classification standard referenced	Classification/ test result stated in Report	Line	Classification report/ Test report/ BBA certificate number	Disclosed by
Letter from T Mort (Exova Warrington fire) to Mr J Mahoney Celotex	Celotex	Exova Warrington Fire	CEL00009429	Not stated	01/11/2017	Celotex	Celotex 5050 line 1 29-08-17 15:17A	BS 476-6	Test invalidated- due to deformation of the specimens blocking the burner posts of the gas burner of the test apparatus	1	388961	Celotex
Letter from T Mort (Exova Warrington fire) to Mr J Mahoney Celotex	Celotex	Exova Warrington Fire	CEL00009430	Not stated	01/11/2017	Celotex	Celotex 5050 line 1 29-08-17 15:17B	BS 476-6	Test invalidated- due to deformation of the specimens blocking the burner posts of the gas burner of the test apparatus	1	388963	Celotex
Letter from T Mort (Exova Warrington fire) to Mr J Mahoney Celotex	Celotex	Exova Warrington Fire	CEL00009431	Not stated	01/11/2017	Celotex	Celotex 5050 line 2 31-08-17 21:02	BS 476-6	Test invalidated- due to deformation of the specimens blocking the burner posts of the gas burner of the test apparatus	2	388965	Celotex
Letter from T Mort (Exova Warrington fire) to Mr J Mahoney Celotex	Celotex	Exova Warrington Fire	CEL00009432	Not stated	01/11/2017	Celotex	Celotex 5160 line 2 09-03-17 15:38-15:39	BS 476-6	Test invalidated- due to deformation of the specimens blocking the burner posts of the gas burner of the test apparatus	2	388969	Celotex
Class 1 Assessment report	Celotex	Exova Warrington Fire	CEL00009427	N/A	03/11/2017	Celotex	Celotex 5050 Line 2; Celotex 5160 Line 2	BS 476-7	Class 1	2	391512	Celotex
BS 476-7 Method for classification of the surface spread of flame of products	Celotex	Exova Warrington Fire	CEL00009422	18/09/2017	01/11/2017	Celotex	Celotex 5050 Line 1	BS 476-7	Class 1	1	388960	Celotex
BS 476-7 Method for classification of the surface spread of flame of products	Celotex	Exova Warrington Fire	CEL00009423	18/09/2017	01/11/2017	Celotex	Celotex 5050 Line 1	BS 476-7	Class 1	1	388962	Celotex
BS 476-7 Method for classification of the surface spread of flame of products	Celotex	Exova Warrington Fire	CEL00009424	18/09/2017	01/11/2017	Celotex	Celotex 5050 Line 2	BS 476-7	Class 1	2	388964	Celotex
BS 476-7 Method for classification of the surface spread of flame of products	Celotex	Exova Warrington Fire	CEL00009425	18/09/2017	01/11/2017	Celotex	Celotex 5050 Line 2	BS 476-7	Class 1	2	388966	Celotex
BS 476-7 Method for classification of the surface spread of flame of products	Celotex	Exova Warrington Fire	CEL00009426	18/09/2017	01/11/2017	Celotex	Celotex 5160 Line 2	BS 476-7	Class 1	2	388968	Celotex

Report title	Report sponsor	Report produced by	Relativity reference	Date of test	Date of issue of report/ letter	Product Manufacturer	Product description	Test/ classification standard referenced	Classification/ test result stated in Report	Line	Classification report/ Test report/ BBA certificate number	Disclosed by
BS 476-6: 1989+A1 2009 Fire propagation test on RS5160- Line 2	Celotex	BRE Global	CEL00002668	05/10/2017	25/01/2018	Celotex	RS5160- Line 2	BS 476-6	I= 6.6 i1= 2 i2= 2.8 i3= 1.7	2	P107614-1020 Issue 1	Celotex
BS 476-6: 1989+A1 2009 Fire propagation test on 5050- Line 1	Celotex	BRE Global	CEL00002719	05/10/2017	25/01/2018	Celotex	5050- Line 1	BS 476-6	I= 7.1 i1= 1.1 i2= 4.3 i3= 1.7	1	P107614-1018 Issue 1	Celotex
BS 476-6: 1989+A1 2009 Fire propagation test on 5050- Line 2	Celotex	BRE Global	CEL00002795	05/10/2017	25/01/2018	Celotex	5050- Line 2	BS 476-6	I= 10.5 i1= 4.6 i2= 4.4 i3= 1.5	2	P107614-1019 Issue 1	Celotex



### **E3.3 Variations in the chemical composition of Celotex PIR insulation products**

**E3.3.1** Celotex FR5000 was originally specified in the employer's requirements (HAR00000872) however Celotex RS5000 was purchased (as evidenced by the purchase orders SIG00000010, HAR00000583 and HAR00000781).

**E3.3.2** On 23/10/2018 Linklaters on behalf of their client Celotex stated the following regarding the differences between these products (CEL00010054).

Within Celotex's operational team, FR5000 and RS5000 are regarded as the same product at the point of manufacture. They are designated as either FR or RS after production and prior to despatch. The different designations assist the business in assessing and tracking the market for the product. The FR5000 product was launched in 2011. Celotex commissioned a test, conducted in May 2014, to BS 8414-2:2005, of a multi component rainscreen cladding system, which included a sample of the product as one component, and thereafter, from August 2014, the product was also marketed as RS5000.

**E3.3.3** This corroborates Celotex's statement on 01/09/2017 that the 5000 range of materials (which includes RS5000, and FR5000) share the same core<sup>2</sup>.

**E3.3.4** Paragraph 4.2, 4.3, and 4.4 of the 23/10/2018 Linklaters letter states:

- 4.2** As explained at paragraph 1.5 above, Celotex has two production lines in its Hadleigh factory on which PIR is made, called Hipchen and Hennecke. Both lines were used to make FR5000/RS5000. The Hipchen machine is a free rising foam line and uses one layer of glass fibre reinforcement in FR5000/RS5000 for boards below 60mm in depth and two layers of glass fibre reinforcement for boards of 60mm depth or greater. The Hennecke machine is a restrained rise foam line and products from this machine do not contain glass fibre. For product sold as FR5000/RS5000, the Hennecke line is typically used to manufacture boards greater than 100mm in depth and the Hipchen machine is generally used to manufacture boards of lesser depth.
- 4.3** The FR5000/RS5000 product is made with materials purchased from a range of third party suppliers who change from time to time. The two main chemicals are methylene diphenyl diisocyanate ("MDI") and a pre-mixed polyol blend. On the Hennecke line, the pre-mixed polyol blend is called "ElastoPIR 1039/501" ("501 Polyol"). It is purchased from BASF and contains polyol, surfactant and fire retardant.
- 4.4** When FR5000 was launched in 2011, 501 Polyol was used on the Hipchen line. In 2012, trials of a different pre-mixed polyol blend called "ElastoPIR 1039/503" ("503 Polyol") (also purchased from BASF and understood to contain polyol, surfactant, fire retardant and water) took place on the Hipchen line, prior to that blend being used more consistently on that line from August 2012. A copy of a Change Note associated with that change has been provided to the Inquiry.<sup>14</sup> This change was not applied to the Hennecke line which continued to use 501 Polyol. BASF has stated that the detailed formulation of 501 Polyol and 503 Polyol blends is its confidential proprietary information, although it has indicated that it would provide that information to the Inquiry, should the Inquiry request it.<sup>15</sup>

**E3.3.5** Since 2012 there has therefore been a chemical difference between the two lines of PIR foam produced with the same product name by Celotex.

**E3.3.6** The Celotex RS5000 purchase orders (SIG00000010, HAR00000583 and HAR00000781) do not state whether "line 1" or "line 2"

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<sup>2</sup> <https://www.celotex.co.uk/5000-test> (accessed 05/04/2018)

insulation was purchased for Grenfell Tower. I do not know how any party could choose a “Line” or know which “Line” they had been supplied with.

**E3.3.7** In the next section I compare the fire performance of each “Line” using the disclosed test and/or classification evidence for each to understand if the different chemical composite is significant for the reaction to fire performance of the product.

## **E3.4 Variability of Celotex PIR reaction to fire performance**

**E3.4.1** I note that Celotex stated on their website on 01/09/2017<sup>3</sup>:

*“After careful consideration, we have taken the decision to temporarily suspend supply of some of our 5000 product range in light of a recent and unexpected test result. This relates to Celotex FR5000, Celotex CG5000, Celotex CF5000 and Celotex SL5000 which share the same insulation core and facer.”<sup>1</sup>*

*We recognize that this decision could have some practical implications for some of our customers for which we apologise. We hope in the present circumstances which are explained in further detail below, that customers will understand the reasons behind our decision.*

*A sample of our 5000 product was tested under Parts 6 and 7 of British Standard 476 (“BS 476”) in 2011 and achieved a Class 0 fire rating*

*In April 2017, we sent a sample of RS5000 for independent testing under both Parts 6 and 7 of BS 476. We were surprised when we learned, in August 2017, that whilst this sample continues to meet the standard for Class 1, the sample did not achieve a Class 0 rating. A sample of this product was used in a full system test for a rainscreen cladding system in 2014, where the system passed.*

**E3.4.2** Further to this Linklaters stated by letter to the inquiry on 23/10/2018 (CEL00010054).

recently, Celotex sent further samples of RS5000 taken from both manufacturing lines for testing under Parts 6 and 7 of BS476. The samples submitted for testing at Exova in September 2017 met the criteria under Part 7 of BS476.<sup>8</sup> The testing undertaken at Exova under Part 6 of BS476 in the same month could not be completed because the insulation swelled and the tests were deemed invalid due to the deformation of the specimens blocking the burner ports of the gas apparatus, such that the gas input could not be maintained.<sup>9</sup> Testing at the BRE in October 2017 under Part 6 of BS476 showed that samples of RS5000 taken from both manufacturing lines met the criteria for a Class 0 rating.<sup>10</sup> In finalising its classification letters the BRE relied upon the Part 6 testing it conducted in October 2017 and a combination of the Part 7 test reports from the testing previously conducted by the BRE and Exova.<sup>11</sup>

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<sup>3</sup> <https://www.celotex.co.uk/5000-test> (accessed 05/04/2018]

- E3.4.3** Based on my understanding of the Celotex disclosure, the statement on the Celotex website 01/09/2017 and the Linklaters letter on 23/10/2018 is that Celotex insulation has been tested or assessed to BS476-6 and BS 476-7 on November 2011; July 2014; August 2017; September 2017; and October 2017 and a different fire performance was observed from the Celotex sample in each of these tests.
- E3.4.4** Table E.4 below lists the test reports that correspond to the dates stated above.



Table E.4 Test reports that correspond to the dates Celotex PIR has been classified using the National Classification system

Date referenced in Linklaters letter 23/10/2018	Test centre	BS 476-6 test reports/letters of conformation of result	BS 476-7 test reports	Classification letter
November 2011	BRE	CEL00000378; CEL00000379	CEL00000380; CEL00000381	CEL00000382; CEL00000383
July 2014	BRE	CEL00000384	CEL00000385	CEL00000386
August 2017	BRE	CEL00002711 CEL00002751 CEL00002693 CEL00002719 CEL00002692 CEL00002624	CEL00002533; CEL00002574; CEL00002579; CEL00002586; CEL00002817; CEL00002543	
September 2017	Exova	CEL00009429 CEL00009430 CEL00009431 CEL00009432	CEL00009422 CEL00009423 CEL00009424 CEL00009425 CEL00009426	CEL00009427 CEL00009433
October 2017	BRE	CEL00002668 CEL00002795 CEL00002719	Referenced successful August 2017 BS 476-7 tests	CEL00008421

- E3.4.5** Based on my review of the test reports listed in Table E.4, all of the Celotex products achieved Class 1 when tested to BS 476-7.
- E3.4.6** The graph in Figure E1 below compares the ' $I$ ' and ' $i_1$ ' results (obtained from the test reports listed in Table E.4) for Celotex 5000 PIR over time for both "line 1" and "line 2" when tested to BS 476-6.
- E3.4.7** Note that ' $I$ ' is the sum of the ' $i_1$ ', ' $i_2$ ' and ' $i_3$ ' values.
- E3.4.8** Based on Figure E1 I find the following:
- a) There appears to be no significant difference between Line 1 and Line 2 PIR foams in terms of the ' $i_1$ ' and  $I$  value to BS 476-6
  - b) The  $I$  and  $i_1$  results for the August 2017 tests are significantly higher (for both line 1 and line 2) than the November 2011 tests and the October 2017 tests. For example, the  $I$  value for the RS5000 tested in August 2017 is four times higher than that of the FR5000 line 1 tested in November 2011.
- E3.4.9** It is not clear if this variance is caused by the differences in chemical composition described in Section E3.3 between the insulation samples or whether this variability is caused by issues with the repeatability of the test standard.
- E3.4.10** If it is the former the Inquiry should establish the specific 'line' of FR5000 that was installed on Grenfell Tower.

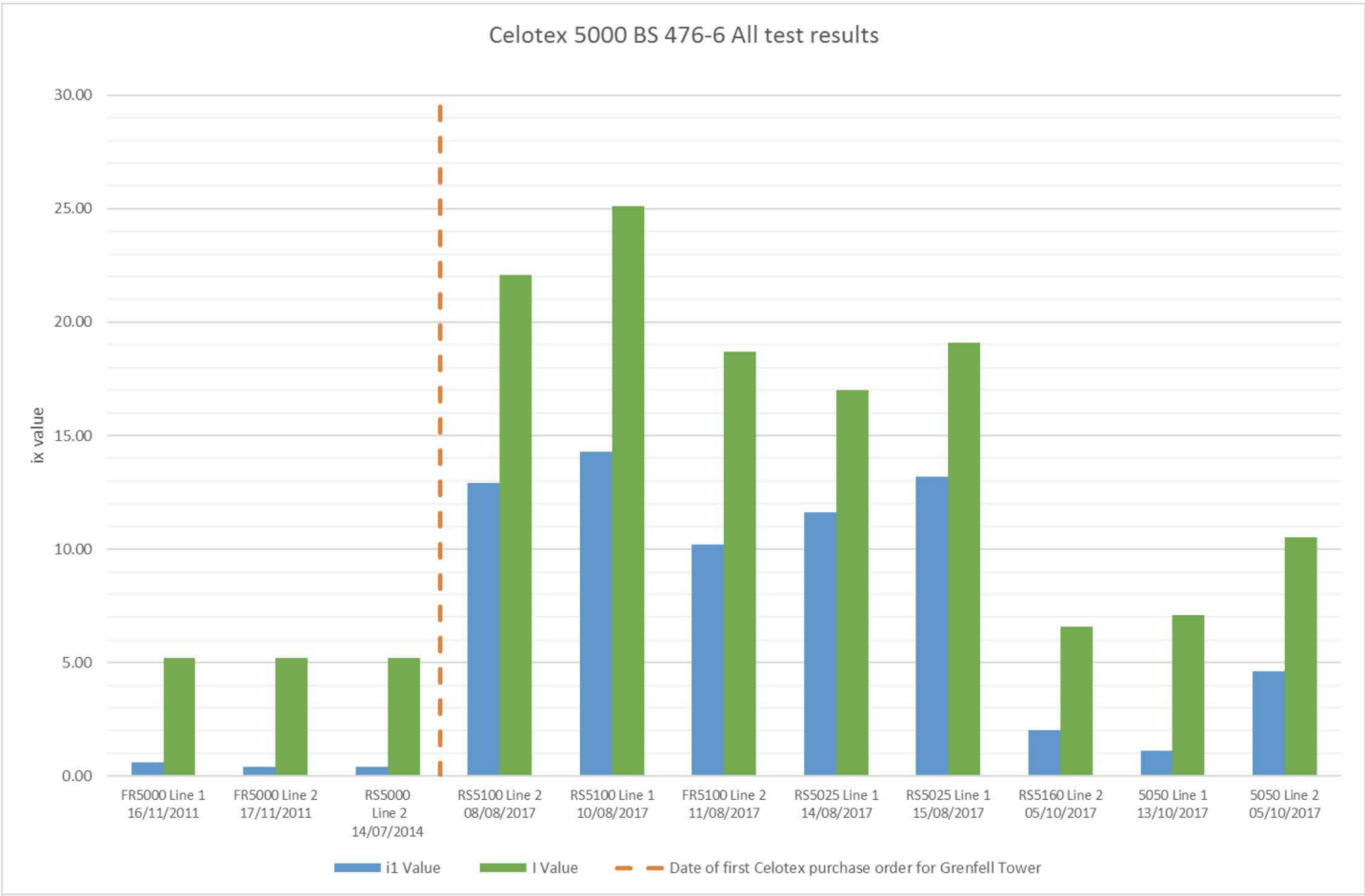


Figure E1 Celotex 5000 BS 476-6 test results

## E4 Review of BS8414 test data for Celotex PIR Insulation

### E4.1 Approach

- E4.1.1** Table E.5 below provides a short description of all the large scale tests which have been disclosed to me to date for Celotex PIR insulation for reference.
- E4.1.2** External walls should either meet the guidance given in paragraphs 12.6 to 12.9 of the Approved Document B (see my main report Section 11 for my analysis in that regard) or, as per the provisions made in paragraph 12.5 of ADB 2013, meet the performance criteria given in the BRE Report *Fire performance of external thermal insulation for walls of multi storey buildings* (BR 135), using full scale test data from BS 8414-1:2002 or BS 8414-2:2005.
- E4.1.3** At the time of the refurbishment works at Grenfell Tower, BS 8414-1:2002 *Fire performance of external cladding systems. Test method for non-loadbearing external cladding systems applied to the face of the building*, and 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* applied. Neither of these standards are current but they are cited in ADB 2013.
- E4.1.4** In accordance with ADB 2013 Appendix A section 1, the as built construction must:
- a) *“Be in accordance with a specification or design that has been shown by test to be cable of meeting that performance” or*
  - b) *“Have been assessed from test evidence against appropriate standards, or by using relevant design guides, as meeting that performance”*
- E4.1.5** I have explained the meaning of “test evidence” in Section 3 of my report.
- E4.1.6** I have also explained my opinion that any difference between the Grenfell Tower rainscreen cladding system and the system tested in the relevant supporting fire test evidence means that test evidence cannot be relied upon to demonstrate compliance with the provisions made in Section 12 of the ADB 2013, and particularly if no other supporting evidence is provided.
- E4.1.7** I have considered the absence of relevant test evidence to be a breach of the Building Regulations.
- E4.1.8** I have reviewed the large scale test evidence (either test or assessment reports) made available to me as I have presented in Table E.5, on this basis.
- E4.1.9** I am aware there is a body of opinion that does not consider differences in tested system with an as-built system to be non-compliant with the provisions



made in ADB 2013, nor therefore a breach of the Building Regulations. I do not agree with this body of opinion.

## **E4.2 Documents considered**

- E4.2.1** Three sets of evidence have been disclosed to me by Celotex which are relevant to my assessment of the compliance of the Grenfell Tower rainscreen cladding system with Section 12.5 of ADB.
- E4.2.2** In Section E4.3 I have compared the Grenfell Tower rainscreen cladding system with the only system that Celotex have had tested to BS 8414 test and its associated BR135 classification report, dated August 2014.
- E4.2.3** In Section E4.4 I have reviewed an assessment report dated 2015 that provides an extended field of application using this 2014 test evidence. I have compared the contents of the 2015 assessment report with the constructed Grenfell Tower rainscreen cladding system.
- E4.2.4** In January – February 2018 Celotex withdrew the BS 8414-2:2005 test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen produced by BRE Global on 01/08/2014. In Section E4.5 I provide an analysis of the 2014 tests and explain that I discovered substantial differences between the system tested and the system reported in the fire test reports.
- E4.2.5** On 23/10/2018, by letter submitted to the Inquiry on behalf of Celotex by Linklaters, Celotex confirmed that my analysis was correct, in that the system as tested to BS 8414-2 in 2014 was incorrectly reported in the associated 2014 test report and BR135 classification report.
- E4.2.6** As a result, Celotex have commissioned a re-test of the 2014 façade assembly *“aimed to mirror, as closely as possible, the system as described in the August 2014 report”*. I have reviewed the 2018 re-run of BS 8414-2 test and associated BR135 classification report for the Celotex insulation in Section E4.6.
- E4.2.7** I find none of this fire test data provides relevant fire test evidence for the purposes of demonstrating compliance of the constructed rainscreen cladding system at Grenfell Tower.



Table E.5 BS 8414/ BR 135 classification report/ BR135 assessment reports disclosed to the Public Inquiry at this time by Celotex

Relativity	Company that disclosed the report	Report title	Report Date	Report Author	Report Prepared for	Report reference number	Report type	Reference to where I review the test/ assessment reports in this Appendix
CEL00000374	Celotex Insulation Ltd	<i>BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen</i>	01/08/2014	BRE Global Ltd	Celotex Insulation Ltd	295369	BS 8414-2 test report for Celotex insulation used in conjunction with a Marley Eternit Natura decorative Rainscreen cladding panels	Refer to section E4.3
CEL00001329	Celotex Insulation Ltd	<i>Classification report in accordance with the requirements of BR 135:2013 annex B</i>	11/08/2014	BRE Global Ltd	Celotex Insulation Ltd	295255 Issue 2	Associated BR135 assessment report for the test <i>BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen</i> referenced in row 2	
CEL00001116	Celotex Insulation Ltd	<i>The Fire Performance of Celotex- PIR Façade cladding systems when tested following BS 8414 Part 2:2005</i>	26/05/2015	Exova Warrington Fire	Celotex Insulation Ltd	WF No 351551	Desktop assessment only to classify the use of Celotex PIR insulation with the following cladding panels: 103mm brickwork; 8mm Terracotta tiles; A1 (i.e. non-combustible) cladding laminates; and solid aluminum in addition to the Eternit board previously tested. No additional test evidence presented to extend the field of application of the test <i>BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen</i> referenced in row 2.	Refer to section E4.4
CEL00004943	Celotex Insulation Ltd	<i>BS 8414-1:2015 +A1:2017 Test on a ventilated Marley Eternit rainscreen system with Celotex RS5000 insulation</i>	30/04/18	BRE Global Ltd	Celotex Insulation Ltd	P104852-1000 issue 1	BS 8414-2 test report for Celotex insulation used in conjunction with a Marley Eternit Natura decorative Rainscreen cladding panels	Refer to Section E4.6

### **E4.3     Review of test *BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen* produced by BRE Global on 01/08/2014**

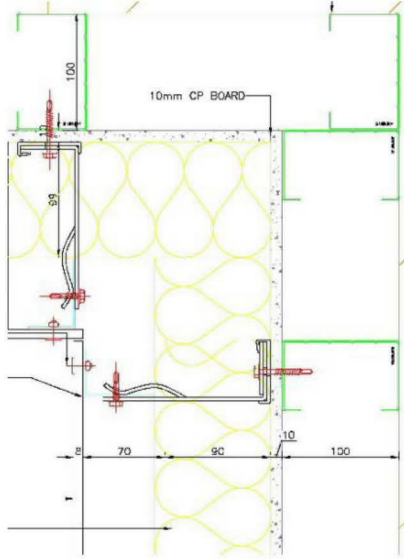
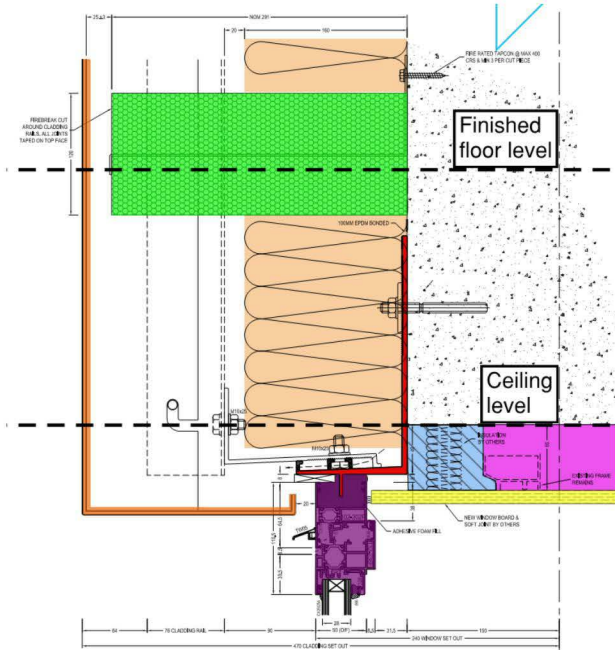
- E4.3.1**     In this section I compare the Grenfell Tower external wall as-built condition to the external wall system tested in *BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen* (CEL00000374) produced by BRE Global on 01/08/2014.
- E4.3.2**     Note Celotex has now withdrawn this test/classification report due to discrepancies between what was tested in 2014 and what was reported in the BS 8414 test report and associated BR135 classification report. I discuss these discrepancies further in Section E4.5.
- E4.3.3**     I provide my full comparison between the tested system and the rainscreen cladding system installed on Grenfell Tower in E4.6.
- E4.3.4**     BR 135 states “*The classification applies only to the system as tested and detailed in the classification report. The classification report can only cover the details of the system as tested.*”
- E4.3.5**     Therefore, any fundamental difference between the tested construction and the inspected as built construction on Grenfell Tower, would result in the classification no longer being applicable to the installed system.



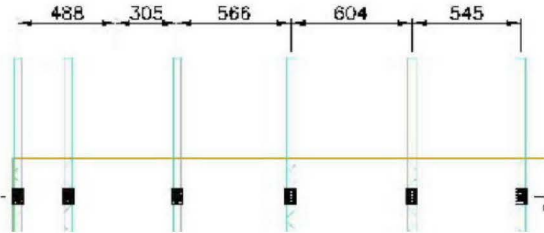
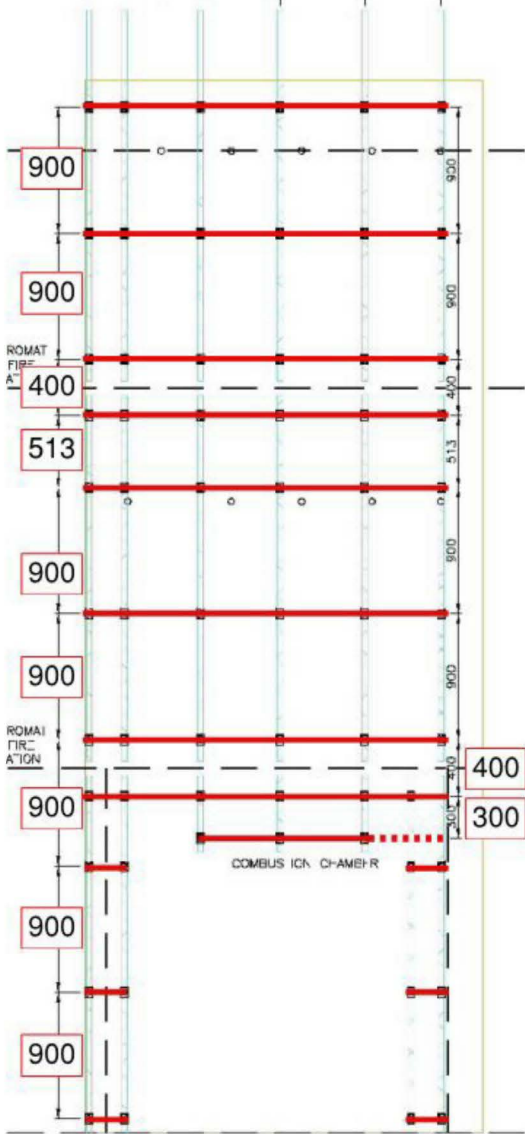
Table E.6: Review of test report *BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen* produced by BRE Global on 01/08/2014 compared to the Grenfell Tower external wall

NO.	Construction component	BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen produced by BRE Global on 01/08/2014 (CEL00000374)	Cladding system as installed on Grenfell Tower	Commentary and significance of stated differences
1	Test standard referenced	BS 8414-2: 2005: - which is relevant to <i>non-loadbearing external cladding systems fixed to and supported by a structural steel frame</i>	An external rain screen over cladding system was affixed directly to the exterior face of the building. Therefore, BS 8414-1:2002 <i>Fire performance of external cladding systems test method for non-loadbearing external cladding systems applied to the face of the building, applies.</i>	BS 8414-2:2005 states: “ <i>This method of test does not apply to non-loadbearing external rainscreen over cladding systems or external wall insulation systems applied to the face of a building, the fire testing of which are covered in BS 8414-1.</i> ” The test standard used is therefore not relevant to Grenfell Tower
2	Substructure	Steel frame	Concrete	The complete substructure materials tested are entirely different to the wall materials at Grenfell Tower.
		Two layers of 10mm wall board affixed to structural steel frame, with Simco EFS 100mm Light steel frame system (LSF)	Concrete	
		12mm magnesium oxide	None	
3	Insulation description	100mm Celotex RS5000 insulation board	Column: 100mm Celotex RS5000 insulation Spandrel: 2 layers of 80mm Celotex RS5000 insulation or 2 layers of 80mm Kingspan K15 insulation  (concluded from purchase orders SIG00000010, HAR00000583 and HAR00000781 and observed on site)	The column insulation was identical in material and dimensions. The spandrel insulation at Grenfell Tower comprised of two separate layers – not tested. The spandrel insulation installed in Grenfell Tower was also substantially thicker than that tested.
4	Insulation fixing method	Mechanically attached to the sheathing board with 100mm self-tapping screws and plastic washers	Impaled on 180mm stakes – metal with plastic sheath	Fixing method tested not in place at Grenfell Tower.
5	Ventilated cavity (mm)	61mm according to design drawings	139mm for columns (refer to drawing HAR00008902) 156mm spandrels (refer to drawing HAR00008879)	Cavity at Grenfell Tower is more than twice as wide as was tested
6	Rainscreen cladding panel	Marley Eternit Natura decorative rain screen board: Fibre-reinforced cement boards of Class A2-s1, d0 as according to BBA certificate 06/4355 <sup>4</sup> 12mm according to Section 3.3.4 of the test report	Arconic Inc. Reynobond 55 PE, cassette fixing (Identified from purchase order HAR00000916 and observed onsite): 4mm in thickness: comprised of 3mm polyethylene core between 0.5mm aluminium panels Cassette system Class E as according to EN13501-1 (refer to Section 11 of main report)	The Marley Eternit Natura decorative rain screen board used in the BRE test is classified as Class A2. The Arconic Inc. Reynobond 55 PE, cassette fixing used on Grenfell Tower is Class E. These materials have substantially different fire performance.
7	Fixing method	Self-tapping screws and plastic washers (note the fixing spacing and screw sizes are not states in the test report)	Cassette (hung top and bottom) as evidenced onsite	The Grenfell Tower system is hung at the top and bottom hooked over the cladding rails with no mechanical fixing. The tested panel is screw fixed (i.e. mechanically through fixed) to the brackets.

<sup>4</sup> <https://www.marleyeternit.co.uk/~media/Files/Product-Files/Facades/Brochures/BBA-EQUITONE-Natura.pdf>

REPORT OF SPECIALIST FIELD ON BEHALF OF:	DR BARBARA LANE FIRE SAFETY ENGINEERING GRENFELL TOWER INQUIRY			
NO.	Construction component	BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen produced by BRE Global on 01/08/2014 (CEL00000374)	Cladding system as installed on Grenfell Tower	Commentary and significance of stated differences
8	Cladding frame/brackets	Aluminium helping hand brackets, L and T rails mechanically attached to the carrier rails using self-tapping stainless steel screws and washers.	Metal angle/rail (coloured red) fixed to original concrete, with metal brackets (coloured blue) spaced along the metal angle/rail. The brackets support a cladding rail (coloured yellow), cassettes of cladding panels are then hung on the cladding rails.	The cladding brackets in the test are fixed to a steel stud construction whereas in Grenfell tower the cladding brackets were fixed to the concrete structure.
				



NO.	Construction component	BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen produced by BRE Global on 01/08/2014 (CEL00000374)	Cladding system as installed on Grenfell Tower	Commentary and significance of stated differences
9	Horizontal spacing of cladding frame/brackets	<p>Variable, between 305 and 604mm as detailed below:</p> 	Brackets and cladding rails off this the continuous metal angle are spaced at 700mm centres.	The spacing of the cladding brackets in Grenfell Tower was greater than that tested.
10	Vertical spacing of cladding frame/brackets	<p>Approximately 900mm with additional rows of brackets at each level of thermocouples and the combustion chamber opening, as per the diagram below:</p> 	Approximately 1184mm – between metal brackets fixed at top and bottom of window openings. Cassettes also hung on cladding rail adjacent to top and bottom of the window openings.	The spacing of the cladding brackets in Grenfell Tower was greater than that tested.

NO.	Construction component	BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen produced by BRE Global on 01/08/2014 (CEL00000374)	Cladding system as installed on Grenfell Tower	Commentary and significance of stated differences
11	Fire breaks/ cavity barriers	Lamatherm CW-RHS Horizontal Intumescent expanding fire break Lamatherm CW-RSV Vertical non expanding fire breaks	Siderise RH open state horizontal cavity barriers installed vertically and horizontally (observed during my site investigation as discussed in Section 11)	Historically known as Lamatherm, Lamaphon, and Lamapro, now rebranded as SIDERISE, I have assumed that there is no significant difference between the cavity barriers used.
12	Fire break/ cavity barrier fixing method	Fixed using the manufacturers recommended fixings.	Mechanically fixed using support brackets. The brackets are bolted onto the existing concrete structure at 400mm centres. The cavity barrier is then impaled onto the bracket, with the protruding end counter folded to retain the cavity barrier (based on my site investigations)	As above.
13	Cavity barrier fixing substrate	Cavity barrier spans between Marley Eternit Natura decorative rain screen board and plasterboard	The cavity barriers span between concrete and Reynobond 55 PE cassette cladding panels	The cavity barriers in Grenfell Tower span between a combustible ACP panel Class E type, and concrete, whereas the as tested construction is between a limited combustibility external cladding panel and plasterboard.





- E4.3.6** I conclude from my comparison that there are multiple significant differences between the rainscreen system tested in *BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen* produced by BRE Global on 01/08/2014 and *BS 8414-1:2015 +A1:2017 Test on a ventilated Marley Eternit rainscreen system with Celotex RS5000 insulation* on 30/04/18, when compared with the as built Grenfell Tower construction.
- E4.3.7** The most significant discrepancies are:
- a) The test standard for steel framed buildings was used and not BS 8414-1 which is the relevant standard for the over cladding system on Grenfell Tower;
  - b) The insulation used in Grenfell Tower was Celotex RS 5000 as tested, however the thickness of the insulation on the spandrels on Grenfell Tower was thicker i.e. 160mm instead of the 100mm tested;
  - c) The Eternit cladding in the test was screwed in place whereas the ACP cassettes on Grenfell Tower were hung on the cladding rails;
  - d) The Marley Eternit board used in the test is a cementitious board not the combustible ACP panels with a polymeric core, used on Grenfell Tower.
- E4.3.8** This test report therefore does not classify the inspected as built Grenfell Tower rainscreen cladding system. It cannot therefore be relied upon to demonstrate compliance with the provisions made in Section 12.5 of the ADB 2013.
- E4.3.9** Further, it cannot be relied upon to demonstrate that the external wall at Grenfell Tower meets the functional requirement B4 of the Building Regulations.
- E4.4** ***Review of The Fire Performance of Celotex- PIR Façade cladding systems when tested following BS 8414 Part 2:2005 produced by Exova Warrington Fire on 26/05/2015***
- E4.4.1** Celotex have disclosed a report titled *The Fire Performance of Celotex- PIR Façade cladding systems when tested following BS 8414 Part 2:2005* (CEL00001116) produced by Exova Warrington Fire on 26/05/2015.
- E4.4.2** This report is a desktop assessment only with no additional test evidence presented.
- E4.4.3** The purpose of the report is to extend the field of application of the test *BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen* (reviewed in Section E4.3 above) to



assess the use of Celotex PIR insulation with four different outer cladding panels.

- E4.4.4** The assessment covers the following four cladding panels for use above 18m: 103mm brickwork; 8mm Terracotta tiles; A1 (i.e. non-combustible) cladding laminates; and solid aluminium.
- E4.4.5** Exova Warrington Fire conclude that the Celotex insulation would achieve the required performance of BR135 with any of the following three external cladding systems: 103mm brickwork; 8mm Terracotta tiles; A1 (i.e. non-combustible) cladding laminates rainscreen panel. The classification applies only to those full systems, and as detailed in the report.
- E4.4.6** None of these three rainscreen cladding types are in anyway representative of the ACP panel installed in Grenfell Tower. None of them contain a combustible polyethylene core.
- E4.4.7** This assessment report therefore cannot be used to classify the as built construction at Grenfell Tower, as per the provisions made in Section 12.5 of the ADB 2013.
- E4.4.8** Further, it cannot be relied upon to demonstrate that the as-built construction at Grenfell Tower complies with the functional requirements of the Building Regulations 2010.
- E4.4.9** Please also note that Exova Warrington fire assessed the likely performance of solid aluminium panels as the rain screen cladding when used in conjunction with the Celotex insulation. It is stated in their report:

*“Compared to the tested construction with fibre cement boards, the insulation material and the fire breaks are exposed to a more intense fire situation. The effect of this increased exposure is difficult to quantify, but it could result in a more intense burning of the insulation material and possibly an earlier failure of fire breaks, and possibly a failure of the fire breaks to restrict the fire to the area observed in the test described in BRE 295369. Consequently, it can’t be assumed new construction will still meet the requirements outlined in BR135.”*

**E4.5** **Withdrawal of the test report BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen produced by BRE Global on 01/08/2014**

- E4.5.1** I have reviewed two letters issued to the Public Inquiry by Linklaters on behalf of Celotex:
- a) “Celotex BS: 8414:2 Test” 30 January 2018 (CEL00007957)
  - b) “Celotex BS: 8414:2 Test” 08 February 2018 (CEL00007958)

**E4.5.2** In their 30<sup>th</sup> January 2018 Celotex wrote to the Public Inquiry about a BS8414:2 test of its RS5000 product carried out in May 2014. Celotex advised that there were differences between its Celotex RS5000 system as tested and the description of the system in the report. No specific report references are provided in the letter.

**E4.5.3** The test in May 2014 is reported in *BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen* (CEL00000374) produced by BRE Global on 01/08/2014 (reviewed in Section E4.3). There is also an associated classification report *Classification report in accordance with the provisions of BR 135:2013 annex B* produced by BRE Global on 01/08/2014 and a desktop assessment *The Fire Performance of Celotex- PIR Façade cladding systems when tested following BS 8414 Part 2:2005* (CEL00001116) produced by Exova Warrington Fire on 26/05/2015 (reviewed in Section E4.4).

**E4.5.4** In their letter dated 23/10/2018 Linklaters on behalf of Celotex stated:

3.2.3 Where the outer cladding panel is orange-coloured on the photographs, we understand the outermost panel was an 8mm Marley Eternit panel and, at those levels, only, there was immediately behind the Marley Eternit cladding panel, a 6mm magnesium oxide board.

**E4.5.5** I have included the photograph supplied by Linklaters in Figure E.2. Linklaters have advised that ‘where the outer cladding panel is orange coloured’ they believe 6mm Magnesium oxide board was added immediately behind 8mm Marley Eternit board.

**E4.5.6** As I have described in E4.3 the *BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen* test report and Celotex’s statement on 8<sup>th</sup> February 2018 describes a single layer of 12mm Marley Eternit Natura board being used as the external surface only.

**E4.5.7** The inclusion of Magnesium oxide boards was not shown on the drawings of the system included in the BRE Global Ltd report of the test. Nor in the BRE Global Ltd Classification report.

**E4.5.8** The only reference to Magnesium oxide board is in the BRE Global Ltd report of the test, which refers to a 12mm Magnesium oxide sheathing board located behind the RS5000 insulation. This does not therefore form part of the external surface and is not visible in the photograph supplied by Linklaters.

**E4.5.9** I have marked my understanding of the location of the 6mm Magnesium oxide board immediately behind 8mm Marley Eternit board in Figure E.3 as described by Linklaters and Celotex using the photograph accompanying their letter of 8<sup>th</sup> February 2018.



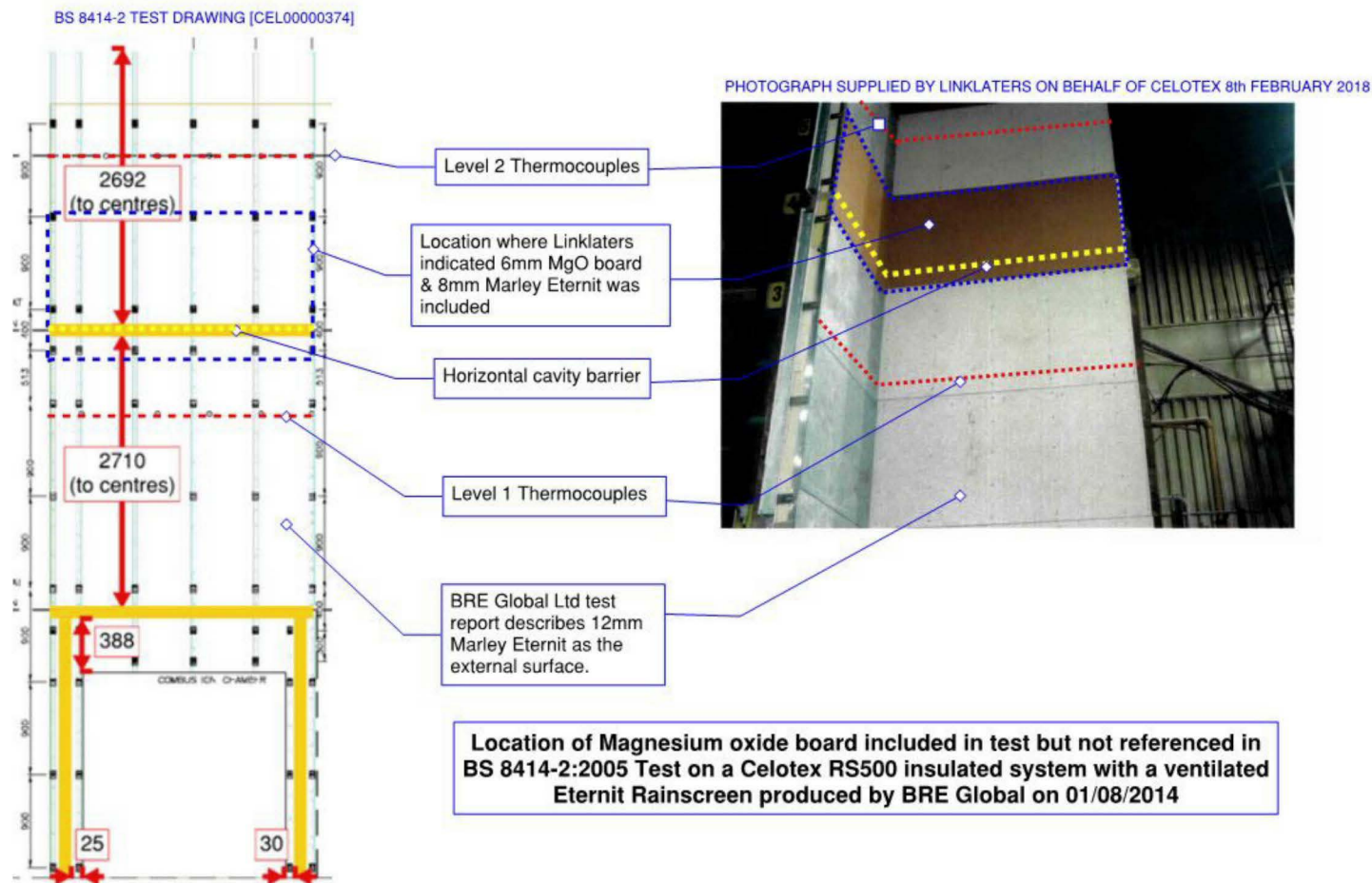


Figure E.2 Location of Magnesium oxide board included in test but not referenced in BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen produced by BRE Global on 01/08/2014

BS 8414-2 POST TEST REPORT PHOTO [CEL00000374] : LEFT DAMAGE TO EXTERNAL SURFACE, RIGHT: EXTERNAL SURFACE REMOVED

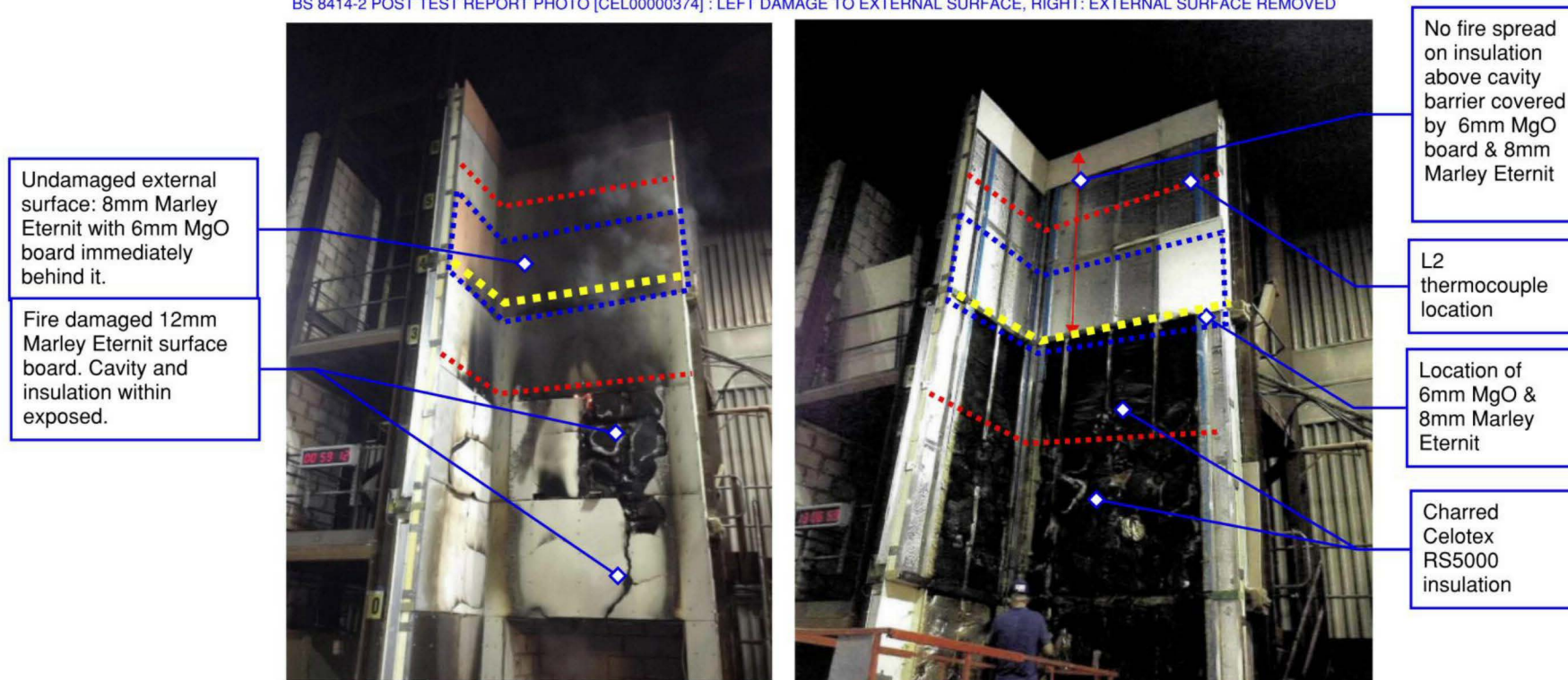


Figure E.3 Location of Magnesium oxide board included in test but not referenced in BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen produced by BRE Global on 01/08/2014 – Post-test images



- E4.5.10** My understanding is therefore that a 6mm magnesium oxide and 8mm Marley Eternit board was positioned directly between the two layers of thermocouples that determine the pass fail rating of BR135: between Level 1 and 2 (refer to Figure E.3).
- E4.5.11** By placing both boards in this location, the external surface appears to remain more intact during the fire test, thus enhancing the performance of the horizontal open state cavity barriers to operate effectively in the cavity.
- E4.5.12** I have marked the position of the open state cavity barriers as described by the BRE Global Ltd test report (CEL00000374) in Figure E.2.
- E4.5.13** This could result in the Level 2 thermocouples in the cavity and the Level 2 thermocouples on the outside surface recording a lower temperature, due to the enhanced performance of the cavity barriers.
- E4.5.14** This is also evidenced in the photos taken after the fire, as shown in Figure E.3, which show that the external surface board has fallen from the cladding rig below where the double layer was installed. The external surface remains intact where the double layer has been included.
- E4.5.15** In paragraph 4 of the 8<sup>th</sup> February 2018 Linklaters letter they also state that the following items are currently unknown in relation to how the test sample was constructed:
- a) whether a 10mm gap between the external surface boards was present or consistently present in the test sample as set out in the test drawings,
  - b) whether the 54mm deep ventilation cavity behind the external surface was present or consistently present in the test sample as set out in the test drawings; and
  - c) whether a vertical gap where the main face of the test sample meets the wing wall was present or consistently present in the test sample as set out in the test drawings (Note Linklaters do not state what vertical join they are referring to. The only vertical gap I have observed in the test report drawings is a 10mm vertical gap between the external surface boards)
- E4.5.16** The presence or not of gaps in the external surface, as described in points (a) and (c) above, has a significant impact on the performance of the system. Where they are present, as they were in Grenfell Tower, then external flames and hot smoke from the test fire can pass directly into the cavity which contains the combustible insulation and ignite it.

- E4.5.17** However, where they are absent, as the Linklaters letter implies they may have been, the external surface is continuous and acts as a physical barrier to flame and hot smoke entering the cavity and therefore can contribute to delaying ignition of the combustible insulation.
- E4.5.18** Finally, the depth of the ventilation cavity between the external surface and the insulation is also significant for the fire spread performance of a rainscreen system. The depth of the cavity controls the amount of air available to any flame within it. Once flames are able to penetrate the cavity, a narrower cavity where air flow is more restricted will increase the height of a flame within it and so expose more of the combustible insulation to flames.
- E4.5.19** It should be noted that I have identified additional technical issues relating to the test report BS 8414-2:2005 *Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen* not mentioned in the Linklaters letter, as follows.
- E4.5.20** The photographs of the system as installed appear to have different characteristics to those described within the main text of the report, as I explain below.
- E4.5.21** The provision of cavity barriers is different in the photograph (Figure 2 in BRE report) relative to the design drawings (Figure 7 in BRE report):
- a) Additional vertical cavity barriers were installed in the test above level 1, but are not shown on the test drawings;
  - b) An additional 3<sup>rd</sup> horizontal cavity barrier was installed in the test, but is not represented in the test drawings.
- E4.5.22** BRE report figure 2 is shown in Figure E.4.
- E4.5.23** BRE report figure 7 is shown in Figure E.5 and Figure E.6.



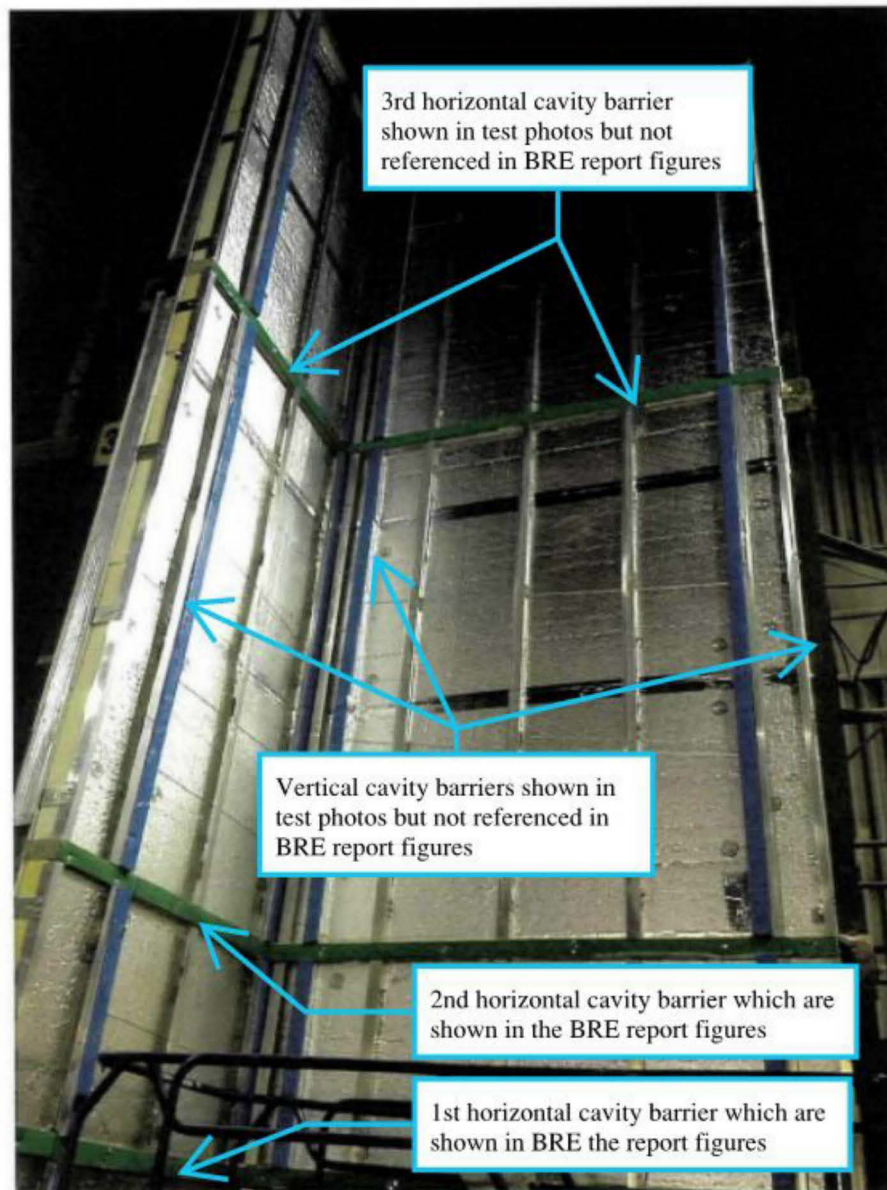
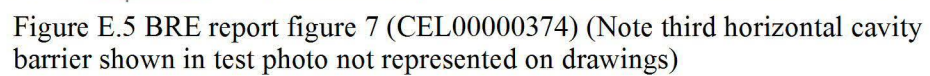


Figure E.4 BRE report figure 2- photograph of test specimen (CEL00000374)





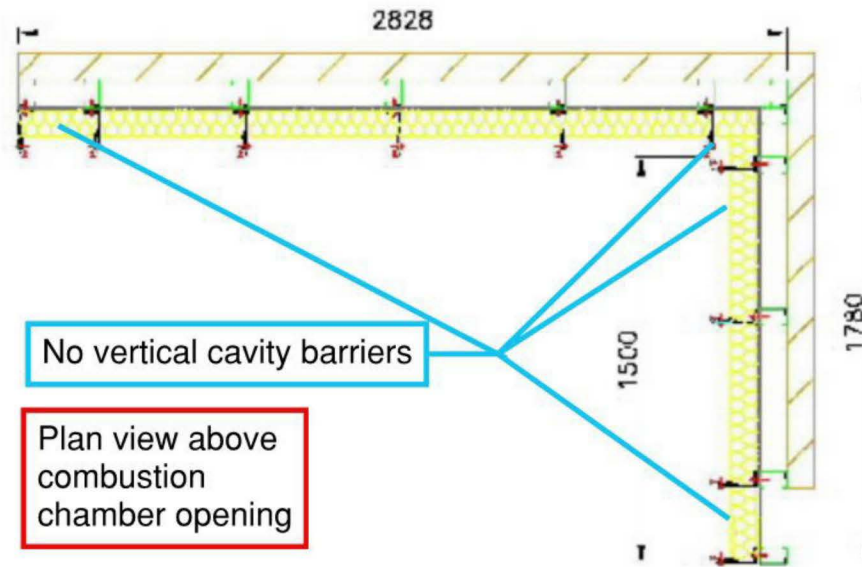


Figure E.6 BRE report figure 7 (CEL00000374) no vertical cavity barriers shown however test photo shows them in place

**E4.5.24** Since publication of my preliminary Phase 1 report on 12<sup>th</sup> April 2018, a further letter dated 23/10/2018 (CEL00010054) has been received by the Public Inquiry from Linklaters on behalf of Celotex stating;

- 3 The differences between the system tested in May 2014 and the description of that system in the report of the test**
  - 3.1** In Section E8 of her Report, Dr Lane has set out some views as to what the differences are between the system tested to BS8414-2 in May 2014 and the description of that system in the BRE's report of the test issued in August 2014 and the Celotex product literature for RS5000. In particular, Dr Lane comments as to where she believes, based on the photographs in the test report, that magnesium oxide boards were used in the system as tested.
  - 3.2** As Celotex indicated to the Grenfell Tower Inquiry in its Position Paper dated 9 February 2018, we were instructed to prepare a BS 8414-2 Summary Paper. This was provided to the Inquiry on 28 September 2018. We do not seek to repeat the contents of that Paper in this letter but we should draw the following points to Dr Lane's attention:
    - 3.2.1** For the purposes of building the system tested in May 2014, it appears that Celotex ordered two thicknesses of Marley Eternit Natura cladding panels, namely 8mm and 12mm.
    - 3.2.2** We understand that those cladding panels which appear white on the photographs of the tested system were 12mm Marley Eternit.
    - 3.2.3** Where the outer cladding panel is orange-coloured on the photographs, we understand the outermost panel was an 8mm Marley Eternit panel and, at those levels, only, there was immediately behind the Marley Eternit cladding panel, a 6mm magnesium oxide board.
  - 3.3** As you know, Celotex commissioned a further system test to BS 8414-2 in April 2018 which aimed to mirror, as closely as possible, the system as described in the August 2014 report. The results from that test show that the rainscreen cladding system tested (which included RS5000 as one component) met the performance criteria specified in BR 135. Celotex made an announcement about the result of the test on 2 May 2018.<sup>12</sup> The test reports issued by the BRE in respect of the April 2018 test have been provided to the Inquiry.<sup>13</sup>

- E4.5.25** This statement from Linklaters confirms the concern I had raised concerning the location of the magnesium board in the preliminary issue of my Phase 1 report.
- E4.5.26** I have reviewed the evidence of the BS8414-2 test commissioned by Celotex in April of this year (2018) in Section E4.6.
- E4.6** **BS 8414-2:2005 Test on a Celotex RS5000 insulated system with a ventilated Eternit Rainscreen produced by BRE Global on 01/08/2018**
- E4.6.1** In their letter dated 30<sup>th</sup> January 2018, Celotex advised the Public inquiry:
- “The current management team has recently determined that were differences between the system as tested under BS 8414-2 and the description of that system in the report of the test. These differences were carried through into the company’s marketing of RS5000.”*  
(CEL00007957)
- E4.6.2** Linklaters stated in their letter to the inquiry dated 23/10/2018:
- “As you know, Celotex commissioned a further system test to BS 8414-2 in April this year which aimed to mirror, as closely as possible, the system as described in the August 2014 report”*  
(CEL00010054)
- E4.6.3** I have reviewed the revised 2018 BS 8414-2 test report and associated BR135 classification report for completeness.
- E4.6.4** However, the new report, like the 2014 report, is not relevant for demonstrating compliance of the Reynobond Architecture Wall Cladding Panels installed on Grenfell Tower for the reasons I have given in Section E4.3.
- E4.6.5** One of the most significant discrepancies in the 2014 testing was that the Test documentation stated that only 12mm Marley Eternit Board was installed for the full height of the façade system. In reality, at the location of the horizontal cavity barriers, a combination of 8mm Marley Eternit board and 6mm of Magnesium Oxide board was used in the 2014 test (as confirmed by Linklaters letter dated 23/10/2018 (CEL00010054).
- E4.6.6** From my review of the 2018 test/classification report, it appears that the 2018 test was undertaken with 12mm of Marley Eternit Board for the full height of the façade system. This is in accordance with the documentation from the 2014 test.



- E4.6.7** It appears the 2018 test was also undertaken using the same number of cavity barriers as installed in the 2014 test, rather than as reported in the 2014 test report (3 horizontal cavity barriers).
- E4.6.8** While the 2018 test reflects the system as described in the 2014 report, I have concerns about the methodology used in this test. In particular, the test involved the complete sealing of the junction of the combustion chamber and the façade with non-combustible cement fibre board and firebreaks.
- E4.6.9** I will discuss this issue as part of my culture of compliance assessment in my Phase 2 report.

Table E.7 Review of differences noted between 2014 and 2018 test on a ventilated Marley Eternit rainscreen system with Celotex RS5000 insulation

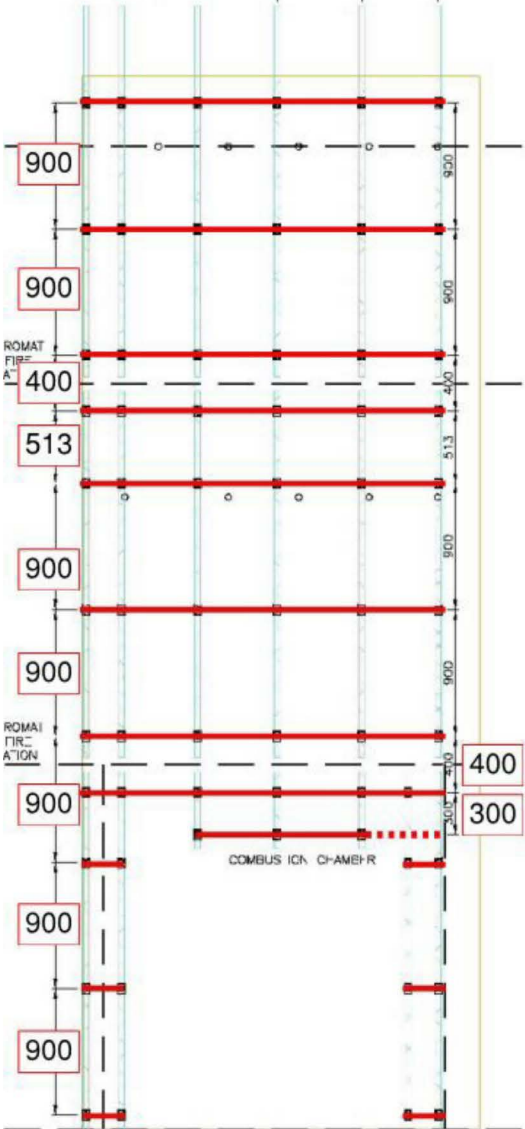
NO.	Construction component	BS 8414-2:2005 <i>Test on a Celotex RS500 insulated system with a ventilated Eternit Rainscreen produced by BRE Global on 01/08/2014 [CEL00000374]</i>	BS 8414-1:2015 +A1:2017 <i>Test on a ventilated Marley Eternit rainscreen system with Celotex RS5000 insulation on 30/04/18</i>	Difference noted between 2014 and 2018 <i>Test on a ventilated Marley Eternit rainscreen system with Celotex RS5000 insulation</i>
1	Test standard referenced	BS 8414-2: 2005: - which is relevant to <i>non-loadbearing external cladding systems fixed to and supported by a structural steel frame</i>	BS 8414-2:2015 + A1:2017 ... <i>fixed to and supported by a structural steel frame</i> The 2015 full revision removed the option to provide a set design fire output using a source other than a wood crib, otherwise changes when compared to the 2005 standard were mostly to align language with part 1.	The retest of April 2018 still uses part 2 of the BS8414 standard, i.e. mounted on a steel frame and not comparable to system affixed directly to buildings. However, it is updated to the 2015 version.
2	Substructure	Lightweight steel frame	Lightweight steel frame	None
		<b>Inside face (non-rainscreen):</b> Two layers of 10mm wall board affixed to structural steel frame, with Simco EFS 100mm Light steel frame system (LSF)	<b>Inside face (non-rainscreen):</b> Two layers of 9.5mm Knauf plasterboard	None
		<b>Exterior face (rainscreen side):</b> 12mm magnesium oxide sheathing boards	<b>Exterior face (rainscreen side):</b> 12mm <i>Versaliner</i> magnesium oxide sheathing boards fixed to light steel frame system. 4mm joints between panels filled with <i>Versaseal</i> acrylic intumescent sealant.	Minor – sealant may just not have been mentioned in the previous test.
3	Insulation description	100mm Celotex RS5000 insulation board	100mm Celotex RS5000 insulation board	None
4	Insulation fixing method	Mechanically attached to the sheathing board with 100mm self-tapping screws and plastic washers	Mechanically attached to the sheathing board with 135mm self-tapping screws with 70mmx70mm insulation retaining plates.	Screws are lengthened in the 2018 retest.
5	Ventilated cavity (mm)	61mm according to design drawings	54mm	Depth of the cavity is reduced by 7mm in the 2018 retest.
6	Rainscreen cladding panel	Marley Eternit Natura decorative rain screen board: Fibre-reinforced cement boards of Class A2-s1, d0 as according to BBA certificate 06/4355 <sup>5</sup> 12mm thickness according to Section 3.3.4 of the test report. Spacing of panels not specified but gap present at inside corner of 10mm.  [Note that the letter from Linklaters on behalf of Celotex dated 30/01/2018 states that there were differences between the system as tested and the description of the system within the report]	Marley Eternit Natura decorative rain screen board: Fibre-reinforced cement boards of Class A2-s1, d0 as according to BBA certificate 06/4355 <sup>6</sup> 12mm according to Section 3.3.4 of the test report. Five large panels of 1240mm height were installed above the combustion chamber opening over the full width of the main wall. Air gaps of 10mm incorporated throughout rainscreen panels.	The same cladding panels are reported to be used in the text of the reports.
7	Fixing method	Self-tapping screws and plastic washers (note the fixing spacing and screw sizes are not states in the test report)	5.5x50mm self-drilling screws with 16mm dia EPDM washers at 150-690mm vertical centres (horizontal centres coincident with structural steelwork).	None
8	Cladding frame/brackets	Aluminium helping hand brackets, L and T rails mechanically attached to the carrier rails using self-tapping stainless steel screws and washers.	Aluminium helping hand brackets, L and T rails mechanically attached to the carrier rails using self-tapping stainless steel screws and washers.	None

<sup>5</sup> <https://www.marleyeternit.co.uk/~media/Files/Product-Files/Facades/Brochures/BBA-EQUITONE-Natura.pdf>

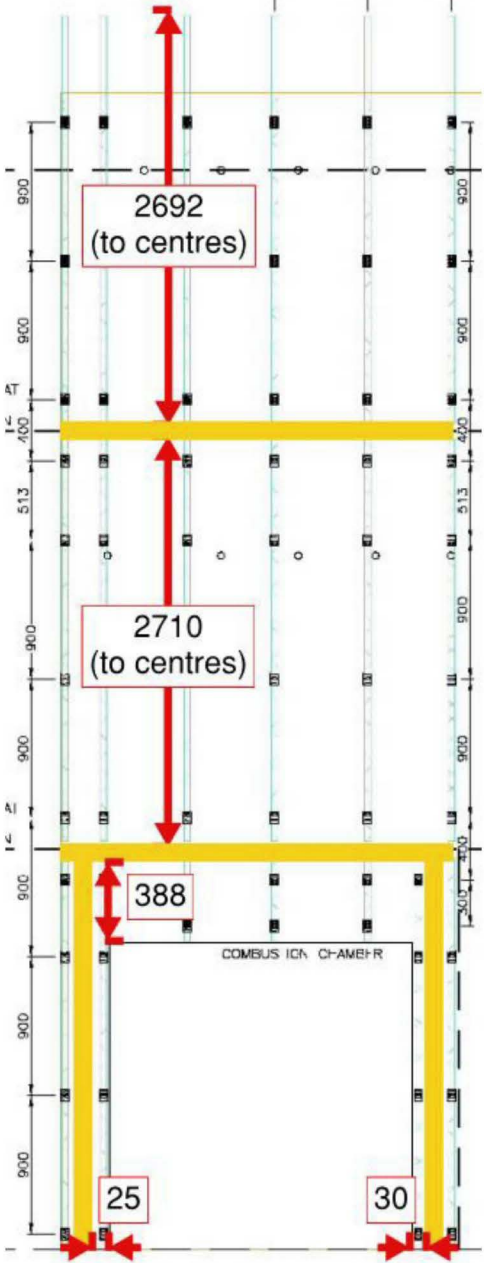
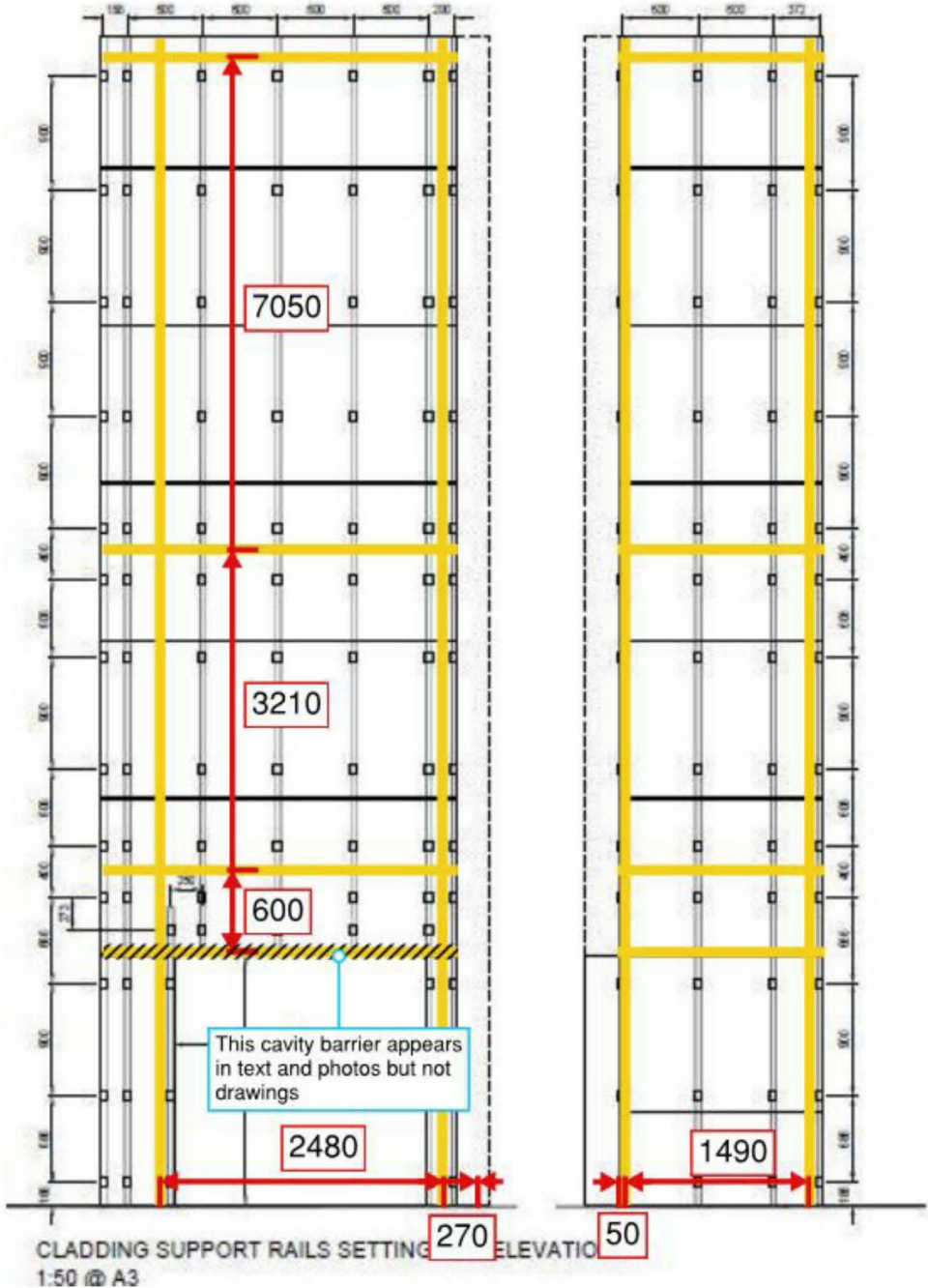
<sup>6</sup> <https://www.marleyeternit.co.uk/~media/Files/Product-Files/Facades/Brochures/BBA-EQUITONE-Natura.pdf>

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NO.	Construction component	BS 8414-2:2005 Test on a Celotex RS500 insulated system with a ventilated Eternit Rainscreen produced by BRE Global on 01/08/2014 [CEL00000374]	BS 8414-1:2015 +A1:2017 Test on a ventilated Marley Eternit rainscreen system with Celotex RS5000 insulation on 30/04/18	Difference noted between 2014 and 2018 Test on a ventilated Marley Eternit rainscreen system with Celotex RS5000 insulation
10	Vertical spacing of cladding frame/brackets	<p>Approximately 900mm with additional rows of brackets at each level of thermocouples and the combustion chamber opening, as per the diagram below:</p> 	<p>Approximately 900mm with additional rows of brackets at each level of thermocouples and the combustion chamber opening.</p>	<p>Minor – similar spacing.</p>

NO.	Construction component	BS 8414-2:2005 Test on a Celotex RS500 insulated system with a ventilated Eternit Rainscreen produced by BRE Global on 01/08/2014 [CEL00000374]	BS 8414-1:2015 +A1:2017 Test on a ventilated Marley Eternit rainscreen system with Celotex RS5000 insulation on 30/04/18	Difference noted between 2014 and 2018 Test on a ventilated Marley Eternit rainscreen system with Celotex RS5000 insulation
11	Fire breaks/ cavity barriers	Lamatherm CW-RHS Horizontal Intumescent expanding fire break Lamatherm CW-RSV Vertical non expanding fire breaks	Siderise RVG-090/030/151-159 stone wool cavity barrier (75mm-thick × 155mm-deep) Siderise RH25G-090/30/144-156 stone wool open state cavity barrier with intumescent strip (75mm-thick × 130mm-deep) – 24mm gap	Minor- the cavity barriers have changed from Lamatherm CW-RHS Horizontal Intumescent expanding fire break and Lamatherm CW-RSV Vertical non expanding fire breaks in the 2014 test to Siderise RVG-090/030/151-159 stone wool cavity barrier (75mm-thick × 155mm-deep) Siderise RH25G-090/30/144-156 stone wool open state cavity barrier with intumescent strip (75mm-thick × 130mm-deep) – 24mm gap Siderise have confirmed separately that there is no material difference between CW-RHS and RH25G; or CW-RSV and RVG cavity barriers
12	Fire break/ cavity barrier fixing method	Fixed using the manufacturers recommended fixings.	Pressed onto galvanised steel folded skewers (320mm-long × 25mm-wide × 1mm-thick) fixed to the sheathing board	Minor - The manufacturer’s recommended fixing is impaled on support brackets at 600mm centres.
13	Cavity barrier fixing substrate	Cavity barrier spans between Marley Eternit Natura decorative rain screen board and plasterboard	Cavity barrier spans between Marley Eternit Natura decorative rain screen board and plasterboard	None

NO.	Construction component	BS 8414-2:2005 Test on a Celotex RS500 insulated system with a ventilated Eternit Rainscreen produced by BRE Global on 01/08/2014 [CEL00000374]	BS 8414-1:2015 +A1:2017 Test on a ventilated Marley Eternit rainscreen system with Celotex RS5000 insulation on 30/04/18	Difference noted between 2014 and 2018 Test on a ventilated Marley Eternit rainscreen system with Celotex RS5000 insulation
14	Spacing of cavity barriers	<p>Spacing of the horizontal cavity barriers is shown in the diagram below. Vertical barriers were not provided other than around the combustion chamber opening:</p>  <p>The above diagram shows the arrangement as per the report drawings. In photographs and the report text the cavity barrier arrangement was instead similar to the 2018 retest.</p>	<p>Spacing of the horizontal cavity barriers is shown in the diagram below:</p>  <p>CLADDING SUPPORT RAILS SETTING ELEVATION 1:50 @ A3</p>	<p>Significant – the 2014 tested assembly appearing in photographs resembled the arrangement of the 2018 retest and not the drawings of the report.</p>



NO.	Construction component	BS 8414-2:2005 <i>Test on a Celotex RS500 insulated system with a ventilated Eternit Rainscreen</i> produced by BRE Global on 01/08/2014 [CEL00000374]	BS 8414-1:2015 +A1:2017 <i>Test on a ventilated Marley Eternit rainscreen system with Celotex RS5000 insulation</i> on 30/04/18	Difference noted between 2014 and 2018 <i>Test on a ventilated Marley Eternit rainscreen system with Celotex RS5000 insulation</i>
15	Total thickness of system from substrate to outer surface of rainscreen	169mm	166mm	

## **E4.7 Summary of compliance of the use of Celotex PIR insulation on Grenfell Tower**

- E4.7.1** The disclosed evidence in Section E3 does not demonstrate compliance of the use of Celotex PIR insulation as part of the rainscreen system installed on Grenfell Tower with Clause 12.7 of ADB 2013.
- E4.7.2** The only alternative method to demonstrate compliance would be to “*meet the performance criteria given in the BRE Report Fire performance of external thermal insulation for walls of multi storey buildings (BR 135) for cladding systems using full scale test data from BS 8414-1:2002 or BS 8414-2:2005*” as stated in paragraph 12.5 of ADB 2013.
- E4.7.3** In Section E4.3, E4.4, and E4.6 I have reviewed all evidence provided to me regarding BR 135, and BS 8414 test or assessment evidence, for the use of Celotex PIR Insulation.
- E4.7.4** From this review I have found that none of the disclosed evidence is relevant to the rainscreen system installed on Grenfell Tower.
- E4.7.5** None of the disclosed evidence demonstrates that the use of Celotex PIR as part of the rainscreen system installed on Grenfell Tower was compliant with Clause 12.5 of ADB 2013 either.

## **E5 Schedule of Kingspan reaction to fire test and classification evidence**

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### **E5.1 Kooltherm K15 reaction to fire test and classification evidence**

- E5.1.1** In Section 8 & 11 I have presented evidence that Kingspan Kooltherm K15 was installed in the Grenfell Tower external wall.
- E5.1.2** I have listed all the reaction to fire test reports and classification reports for Kingspan Kooltherm K15 insulation panels available to the Public Inquiry in Table E.8. I have received fire resistance test reports which are not relevant to reaction to fire performance. I have disregarded these test reports (Table E.9)
- E5.1.3** Table E.8 includes test reports and classification reports under the National and European test frameworks.
- E5.1.4** To comply with Section 12.7 of ADB 2013 an insulation material must achieve Limited Combustibility using National Classification methods in Table A7 of ADB 2013 (Using BS 476-11 or BS 476-4) or material of limited combustibility using European Classification methods in Table A7 of ADB 2013 (Class A2 or better) (see Appendix F of this report).

- E5.1.5** The only National Classification reaction to fire performance that I have received to date for Kingspan Kooltherm K15 is based on the tests BS 476-6 and BS476-7.
- E5.1.6** Neither BS 476-6 or BS476-7 can be used to demonstrate limited combustibility, the required performance for compliance with section 12.7 of ADB 2013. The relevant national test standards for demonstrating limited combustibility are BS 476-4 and BS476-11.
- E5.1.7** None of the European classification reaction to fire performance that I have received to date for Kingspan Kooltherm K15 achieves Class A2 or better as required for demonstrating limited combustibility.
- E5.1.8** Therefore, the reaction to fire test evidence disclosed for Kingspan Kooltherm K15 is not relevant to demonstrating compliance of the as built external wall of Grenfell Tower with Section 12.7 of ADB 2013.
- E5.1.9** The only alternative method to demonstrate compliance would be to “*meet the performance criteria given in the BRE Report Fire performance of external thermal insulation for walls of multi storey buildings (BR 135) for cladding systems using full scale test data from BS 8414-1:2002 or BS 8414-2:2005*” as stated in paragraph 12.5 of ADB 2013.
- E5.1.10** I review any available BR 135, and BS 8414 test or assessment evidence for the use of Kingspan Kooltherm K15 in Section E6.



Table E.8: Schedule of the reaction to fire test reports and classification reports for KingspanKooltherm K15 insulation panels

Report Title	Sponsor	Report Produced by	Date of issue of report	Date test was undertaken	Product name referenced in report	Test Standards Referenced in Report	Reaction to fire classification/ Test result stated in report	No. Samples tested	Thickness of Insulation referenced in report (mm)	Insulation foam material	Exposed face	Classification report/ Test report/ BBA certificate number	Relativity Document
Certificate 08/4582 Product Sheet 1 First Issue	Kingspan Insulation Ltd	BBA	27/10/2008	N/A	KOOLTHERM K15 RAINSCREEN INSULATION BOARD	BS 8414-1:2002 BS EN 1364-1:1999	Class 0  BRE 135 criteria satisfied for BS 8414-1 test  53 minutes fire resistance to BS EN 1364-1	N/A	20-140	Phenolic insulation board	Cement board over cladding for BS 8414-1 test  Fermacell wallboard for BS EN 1364-1 test	08/4582	BBA00000038
Class 0 classification (references reports 248640 and 248638)	Kingspan Insulation Ltd	BRE Global	01/12/2008	27/11/2008 25/11/2008	K15, K10, Kool duct blank	BS 476-6 BS476-7	Class 0	N/A classification report	20	Phenolic insulation core	Aluminium foil	248640/ 248638	KIN00000252
Certificate 08/4582 Product Sheet 1 First Issue	Kingspan Insulation Ltd	BBA	06/04/2010	N/A	KOOLTHERM K15 RAINSCREEN INSULATION BOARD	BS 8414-1:2002 BS EN 1364-1:1999	Class 0 (as defined in the documents supporting the Building Regulations)  The certificate does not explicitly state BRE 135 criteria satisfied for BS 8414-1 test.  53 minutes fire resistance to BS EN 1364-1	N/A	20-140	Phenolic insulation board	Cement board over cladding for BS 8414-1 test  Fermacell wallboard for BS EN 1364-1 test	08/4582-PS1-I1	BBA00000037
BS 476: Part 7: 1997 Method of classification of the surface spread of flame of products	Kingspan Insulation Ltd	Exova Warrington Fire	08/07/2011	06/05/2011	K7/ K8/ K9/ K10/ K12/ K15/ KDI batch 1000028524	BS 476-7	Class 1	6	25	KDI batch 1000028524	Aluminium foil	306833	KIN00000258
BS 476-6: 1989 + A1: 2009 test on K7/ K8/ K9/ K10/ K12/ K15/ K17/ KDI batch 100054590-T2763	Kingspan Insulation Ltd	BRE Global	03/07/2012	09/05/2012	K7/ K8/ K9/ K10/ K12/ K15/ K17/ KDI batch 100054590-T2763	BS 476-6	I = 3.9 i1 = 1	3	25.7	KDI batch 100054590-T2763	Aluminium foil	279315	KIN00000255

Report Title	Sponsor	Report Produced by	Date of issue of report	Date test was undertaken	Product name referenced in report	Test Standards Referenced in Report	Reaction to fire classification/ Test result stated in report	No. Samples tested	Thickness of Insulation referenced in report (mm)	Insulation foam material	Exposed face	Classification report/ Test report/ BBA certificate number	Relativity Document
BS 476-6: 1989 + A1: 2009 test on Kooltherm K3/K5/K7/K8/K9/K10/K12/ K15/K17/ K18/ KDI Batch 8100057791	Kingspan Insulation Ltd	BRE Global	12/07/2012	09/07/2012	K3/K5/K7/K8/K9/K10 /K12/K15/K17/ K18/ KDI Batch 8100057791	BS 476-6	I = 9.1 i1 = 3.3	3	24	KDI Batch 8100057791	Phenolic foam	280455	KIN00000254
Class 0 classification (references report 280721 and 280455)	Kingspan Insulation Ltd	BRE Global	12/07/2012	12/07/2012 12/07/2012	K3/K5/K7/K8/K9/K10 /K12/K15/K17/ K18/ KDI Batch 8100057791	BS 476-6 BS476-7	Class 0	N/A classification report	24	KDI batch 1000028524	Phenolic foam	280722	KIN00000259
Class 0 Classification (references reports 287649, and 285085)	Kingspan Insulation Ltd	BRE Global	18/06/2013	17/06/2013 22/05/2013	K7, K8, K9, K12, K15, K17/ KDI batch 8100082350	BS 476-6 BS476-7	Class 0	N/A classification report	25	KDI batch 8100082350	Aluminium foil	287966	KIN00000251
Declaration of Performance Kooltherm K15 1000.CPR.2013.K15.001	Kingspan Insulation Ltd	Kingspan Insulation Ltd	01/07/2013	N/A	Kooltherm K15	BS EN 13501-1	C-s1, d0	N/A classification report	N/A classification report	N/A classification report	N/A classification report	1000.CPR.2013.K15.001	KIN00000130
BBA Agreement certificate 14/5134 Kooltherm K15 Rainscreen Insulation Board	Kingspan Insulation Ltd	BBA	17/12/2013	N/A	Kooltherm K15 Rainscreen insulation board	Not stated	Class 0	N/A classification report	40-140mm	Not stated	Aluminium foil	Aug-82	KIN00000454
Certificate 08/4582 Product sheet 1 Second Issue	Kingspan Insulation Ltd	BBA	17/12/2013	N/A	Kooltherm K15 Rainscreen insulation board	Not stated for surface spread of flame BS 8414-1:2002	Class 0 BRE 135 criteria satisfied for BS 8414-1 test.	N/A classification report	40-100mm	Phenolic insulation board	Composite foil	08/4582-PS1-12	BBA00000036
CLASSIFICATION OF REACTION TO FIRE PERFORMANCE IN ACCORDANCE WITH EN 13501-1:2007+A1: 2009	Kingspan Insulation Ltd	Exova Warrington fire	03/03/2015	N/A	Kooltherm K15	EN ISO 11925-2 EN 13823	C-s1, d0	N/A classification report	50	Phenolic foam	Composite foil	WF 349131	BBA00000039
BBA Agrément certificate 14/5134 Kooltherm K15 Rainscreen Insulation Board	Kingspan Insulation Ltd	BBA	08/08/2015	N/A	Kooltherm K15 Rainscreen insulation board	BS EN 13501-1:2007	C-s1, d0	N/A classification report	40-140	Not stated	Aluminium foil	14/5134	KIN00000054
Classification of reaction to fire performance in accordance with EN 13501-1: 2007 + A1: 2009 on K15	Kingspan Insulation Ltd	BRE Global	01/10/2015	N/A	K15	EN 13501-1:2007+A1: 2009	C-s1, d0	N/A classification report	140	Phenolic insulation board	N/A classification report	P100160-1000-4 Issue 1	BBA00000043



Report Title	Sponsor	Report Produced by	Date of issue of report	Date test was undertaken	Product name referenced in report	Test Standards Referenced in Report	Reaction to fire classification/ Test result stated in report	No. Samples tested	Thickness of Insulation referenced in report (mm)	Insulation foam material	Exposed face	Classification report/ Test report/ BBA certificate number	Relativity Document
Certificate 14/5134 Product Sheet 7 First Issue	Kingspan Insulation Ltd	BBA	08/10/2015	N/A	KOOLTHERM K15 RAINSCREEN INSULATION BOARD	Not stated	Class 0	N/A classification report	40-140	Phenolic insulation core	N/A classification report	14/5134 Product Sheet 7	BBA00000040
BS 476-6 indicative test result conformation letter	Kingspan Insulation Ltd	Exova Warrington Fire	03/11/2015	29/10/2015	K15 Black	BS 476-6	S= 18.03 s1= 6.69	1	50	Not stated	Aluminium foil	357955	KIN00000264
Certificate 14/5134 Product Sheet 7 First Issue Amendment	Kingspan Insulation Ltd	BBA	16/11/2015	N/A	KOOLTHERM K15 RAINSCREEN INSULATION BOARD	BS EN 13501-1:2007	C-s1, d0	N/A classification report	40-140	Phenolic insulation core	N/A classification report	14/5134 Product Sheet 7	BBA00000031
Declaration of Performance Kooltherm K15 1000.CPR.2013.K15.002	Kingspan Insulation Ltd	Kingspan Insulation Ltd	01/01/2016	N/A	Kooltherm K15	BS EN 13166:2012 +A2:2016	C-s1, d0	N/A classification report	N/A classification report	N/A classification report	N/A classification report	1000.CPR.2013.K15.002	KIN00000129
BS 476-6: 1989 + A1: 2009 test on Faceless Kooltherm	Kingspan Insulation Ltd	BRE Global	18/01/2016	14/01/2016	Faceless Kooltherm-K8, K7, K12, K10, K15, K18, K17, K9 KDIO and Koolduct batch number 81000175530-1000 D.O.M 18/10/2015	BS 476-6	I = 15 i1 = 5.1	3	26.1	Batch number 81000175530 -1000 D.O.M 18/10/2015	Phenolic foam	P100160-1001-1 issue 1	KIN00000262
BS 476-6: 1989 + A1: 2009 Fire propagation test on 1963 facing	Kingspan Insulation Ltd	BRE Global	19/02/2016	19/02/2016	K15, KD, K18 and K17 blank insulation board facer SAP number 1963	BS 476-6	I = 1.8 i1 = 1.7	3	0.38	N/A only facing tested	Aluminium foil	P100160-1002-2 issue 1	KIN00000253
BS 476: Part 7: 1997 Method of classification of the surface spread of flame of products	Kingspan Insulation Ltd	Exova Warrington Fire	12/09/2016	23/08/2016	Kooltherm K15 Batch Number 8100202585	BS 476-7	Class 1	6	25	K15 Batch Number 8100202585	Aluminium foil	370679	KIN00000257
BS 476-6 indicative test result conformation letter	Kingspan Insulation Ltd	Exova Warrington Fire	12/09/2016	11/08/2016	Kooltherm K15 Batch Number 8100202585	BS 476-6	S= 15.25 s1= 10.95	1	25	K15 Batch Number 8100202585	Aluminium foil	370678	KIN00000260



Table E.9 Fire performance test data disclosed for Kingspan Kooltherm K15 which is not reaction to fire test data and which I have therefore disregarded.

Report Title	Sponsor	Report Produced by	Date of issue of report	Date test was undertaken	Product name referenced in report	Test Standards Referenced in Report	Reaction to fire classification/ Test result stated in report	No. Samples tested	Thickness of Insulation referenced in report (mm)	Insulation foam material	Exposed face	Classification report/ Test report/ BBA certificate number	Relativity Document
BRE Report 218611	Kingspan Metl-Con Ltd,	BRE Global	26/10/2004	15/09/2004	Kingspan Kooltherm K15 Insulation	BS EN 1364-1:1999	53 minutes integrity and insulation	1	60	Phenolic insulation core	12.5mm Fermacell wallboard	218611	BBA00000032
BRE Report CC252772	Kingspan Off-site Ltd	BRE Global	29/06/2009	N/A	Kingspan Off-Site steel-framed, loadbearing internal wall systems	Assessment report	60 minutes fire resistance	N/A	Not stated	Kingspan Kooltherm K15 Insulation	Not stated	CC 252772	BBA00000041

## **E5.2 Schedule of Kingspan Thermapitch TP10 reaction to fire test and classification evidence**

- E5.2.1** In Section 11, I have presented evidence that Kingspan Thermapitch TP10 is a potential product matching the appearance of window reveal thermal insulation in the inspected as built external wall of Grenfell Tower.
- E5.2.2** I have listed all the reaction to fire test reports and classification reports for Kingspan TP10 PIR insulation available to me in Table E.10.
- E5.2.3** These include test reports and classification reports under the National and European test frameworks. These frameworks are described in full in Appendix F.
- E5.2.4** To comply with Section 12.7 of ADB 2013 an insulation material must achieve Limited Combustibility using National Classification methods in Table A7 of ADB 2013 (Using BS 476-11 or BS 476-4) or material of limited combustibility using European Classification methods in Table A7 of ADB 2013 (Class A2 or better) (see Appendix F of this report).
- E5.2.5** The only National Classification reaction to fire performance that I have received to date for Kingspan Thermapitch TP10 is based on the tests BS 476-6 and BS476-7.
- E5.2.6** Neither BS 476-6 or BS476-7 can be used to demonstrate limited combustibility, the required performance for compliance with section 12.7 of ADB 2013. The relevant national test standards for demonstrating limited combustibility are BS 476-4 and BS476-11.
- E5.2.7** None of the European classification reaction to fire performance that I have received to date for Kingspan Thermapitch TP10 achieves Class A2 or better as required for demonstrating limited combustibility.
- E5.2.8** Therefore, the reaction to fire test evidence disclosed for Kingspan Thermapitch TP10 is not relevant to demonstrating compliance of the as built external wall of Grenfell Tower with Section 12.7 of ADB 2013.
- E5.2.9** The only alternative method to demonstrate compliance would be to “*meet the performance criteria given in the BRE Report Fire performance of external thermal insulation for walls of multi storey buildings (BR 135) for cladding systems using full scale test data from BS 8414-1:2002 or BS 8414-2:2005*” as stated in paragraph 12.5 of ADB 2013.
- E5.2.10** No BR 135, and BS 8414 test or assessment evidence for the use of Kingspan Thermapitch TP10 has been disclosed to me to date.
- E5.2.11** I therefore consider the use of Thermapitch TP10 on Grenfell Tower noncompliant with paragraph 12.5 and 12.7 of ADB 2013.



Table E.10: Schedule of the reaction to fire test reports and classification reports for Kingspan Thermapitch TP10 insulation panels

Report Title	Sponsor	Report Produced by	Date of issue of report	Date test was undertaken	Product name referenced in report	Test Standards Referenced in Report	Classification/ Test result stated in report	No. Samples tested	Thickness (mm)	Insulation foam material	Exposed face	Classification report/ Test report/ BBA certificate number	Relativity Document
Reaction to fire classification report of Kingspan TP10, TF70 TW50 and TW55 in End use applications	Kingspan Insulation Ltd	Warrington Fire Research	30/07/2003	N/A Classification report	TP10, TF70 TW50 and TW55	BS EN 13501-1 BS EN 11925-2 BS EN 13823	Class B S2 d0	42 (36 to BS EN ISO 11925-2 and 6 to BS EN 13823)	17mm-120mm	PIR	Aluminium foil	Warres Report No E133638	KIN00000287
Reaction to fire classification report of Kingspan TP10, TF70 TW50 and TW55 in End use applications	Kingspan Insulation Ltd	Warrington Fire Research	30/07/2003	N/A Classification report	TP10, TF70 TW50 and TW55	BS EN 13501-1 BS EN 11925-2 BS EN 13823	Class B S2 d0	42 (36 to BS EN ISO 11925-2 and 6 to BS EN 13823)	17mm-120mm	PIR	Aluminium foil	Warres Report No E133638	KIN00000304
Agrément Certificate No 95/3126	Kingspan Insulation Ltd	BBA	15/03/2005	N/A Classification report	THERMAPITCH TP10 ZERO ODP (PITCHED ROOF INSULATION)	BS 476-7:1987	Class 1	N/A Classification report	25-120	Rigid Urethane Foam	Aluminium foil	Agrément Certificate No 95/3126 Third issue*	KIN00000491
Certificate 08/ 4590 Product Sheet 1	Kingspan Insulation Ltd	BBA	03/10/2008	N/A Classification report	KINGSPAN TW55 THERMAWALL FRAMING BOARD INSULATION	BS 476-7:1997	Class 1	N/A Classification report	20-120	PIR	Aluminium foil	08/4590 Product Sheet 1	KIN00000488
Certificate 95/3126 Product sheet 1 First Issue	Kingspan Insulation Ltd	BBA	30/01/2009	N/A Classification report	KINGSPAN THERMAPITCH TP10	BS 476-7:1987	Class 1	N/A Classification report	25-140	PIR	Aluminium foil	95/3126 Product Sheet 1	BBA00000045
BBA Agrément certificate 95/3126 Kingspan Thermapitch TP10	Kingspan Insulation Ltd	BBA	30/01/2009	N/A Classification report	Kingspan Thermapitch TP10	BS 476-7	Class 1	N/A Classification report	25-140mm	PIR	Aluminium foil	95/3126	KIN00000276
Declaration of Performance Thermapitch TP10 1000.CPR.2013.TP10.001	Kingspan Insulation Ltd	Kingspan Insulation Ltd	01/07/2013	N/A Classification report	Kingspan Thermapitch TP10	BS EN 13501-1	D, s2 d0	N/A Classification report	Not stated	Not stated	Not stated	1000.CPR.2013.TP10.001	KIN00000277
BS 476-7 Method of classification of the surface spread of flame of products	Kingspan Insulation Ltd	Exova Warrington Fire	24/07/2014	29/05/2014	Thermapitch TP10; Thermawall TW55; Thermafloor TF70; Thermawall TW50; Batch number 1000-8100121751	BS 476-7	Class 1	6	50	PIR Batch number 1000-8100121751	Aluminium foil	341207	KIN00000282



Report Title	Sponsor	Report Produced by	Date of issue of report	Date test was undertaken	Product name referenced in report	Test Standards Referenced in Report	Classification/ Test result stated in report	No. Samples tested	Thickness (mm)	Insulation foam material	Exposed face	Classification report/ Test report/ BBA certificate number	Relativity Document
BS 476-7 Method of classification of the surface spread of flame of products	Kingspan Insulation Ltd	Exova Warrington Fire	24/07/2014	29/05/2014	Thermapitch TP10; Thermawall TW55; Thermafloor TF70; Thermawall TW50; Batch number 1000-8100121751	BS 476-7	Class 1	6	50	PIR Batch number 1000-8100121751	Aluminium foil	341207	KIN00000299
Classification of Reaction to fire performance in accordance with EN13501-1:2007 + A1 :2009	Kingspan Insulation Ltd	Exova Warrington Fire	03/03/2015	Not stated	Thermapitch TP10; Thermawall TW55; Thermafloor TF70; Thermawall TW50;	BS EN 13501-1 BS EN 11925-2	Class E	16	>60mm	PIR Foam TF70/ TP10/ TW55/ TW50	Composite aluminium foil	WF349135	KIN00000284
Classification of Reaction to fire performance in accordance with EN13501-1:2007 + A1 :2009	Kingspan Insulation Ltd	Exova Warrington Fire	03/03/2015	Not stated	Thermapitch TP10; Thermawall TW55; Thermafloor TF70; Thermawall TW50;	BS EN 13501-1 BS EN 11925-2	Class E	16	>60mm	PIR Foam TF70/ TP10/ TW55/ TW50	Composite aluminium foil	WF349135	KIN00000301
Declaration of Performance Thermapitch TP10 1000/1001.CPR.2013.TP10.002	Kingspan Insulation Ltd	Kingspan Insulation Ltd	01/01/2016	N/A Classification report	Kingspan Thermapitch TP10		D, s2 d0	N/A Classification report	Not stated	Not stated	Not stated	1000/1001.CPR.2013.TP10.002	KIN00000278
Declaration of Performance Thermapitch TP10 1000/1001/1034.CPR.2013.TP10.003	Kingspan Insulation Ltd	Kingspan Insulation Ltd	01/01/2016	N/A Classification report	Kingspan Thermapitch TP10		E	N/A Classification report	Not stated	Not stated	Not stated	1000/1001/1034.CPR.2013.TP10.003	KIN00000279
Declaration of Performance Thermapitch TP10 1000.CPR.2013.TP10.004/ 1000.CPR.2013.TP10.004	Kingspan Insulation Ltd	Kingspan Insulation Ltd	01/01/2016	N/A Classification report	Kingspan Thermapitch TP10		E	N/A Classification report	Not stated	Not stated	Not stated	1000.CPR.2013.TP10.004/ 1000.CPR.2013.TP10.004	KIN00000280
Classification of Reaction to fire performance in accordance with EN13501-1:2007 + A1 :2009 (based results from X)	Kingspan Insulation Ltd	Exova Warrington Fire	20/07/2016	Not stated	Thermapitch TP10; Thermawall TW55; Thermafloor TF70; Thermawall TW50 full fill; Ecotherm Ecoversal Ecotherm Ecocavity Ecotherm Ecocavity T and G full fill INNO FIX	BS EN 13501-1 BS EN 11925-2 EN/TS 15117	Class E	12 (6No. 60mm; 6No. 20mm)	0mm, 60mm	PIR Foam Thermapitch TP10; Thermawall TW55; Thermafloor TF70; Thermawall TW50 full fill; Ecotherm Ecoversal Ecotherm Ecocavity Ecotherm Ecocavity T and G full fill INNO FIX	Aluminium foil	WF367450	KIN00000285

Report Title	Sponsor	Report Produced by	Date of issue of report	Date test was undertaken	Product name referenced in report	Test Standards Referenced in Report	Classification/ Test result stated in report	No. Samples tested	Thickness (mm)	Insulation foam material	Exposed face	Classification report/ Test report/ BBA certificate number	Relativity Document
Extended Field of application report in accordance with EN/TS 15117:2005	Kingspan Insulation Ltd	Exova Warrington Fire	20/07/2016	N/A extended field of application report	Thermapitch TP10; Thermawall TW55; Thermafloor TF70; Thermawall TW50 full fill; Ecotherm Eco-versal Ecotherm Eco-cavity Ecotherm Ecocavity T and G full fill INNO FIX	BS EN 13501-1 BS EN 11925-2 EN/TS 15117	Class E	N/A assessment report	>20mm	Thermapitch TP10; Thermawall TW55; Thermafloor TF70; Thermawall TW50 full fill; Ecotherm Eco-versal Ecotherm Eco-cavity Ecotherm Ecocavity T and G full fill INNO FIX	Aluminium foil	WF367449	KIN00000286
Classification of Reaction to fire performance in accordance with EN13501-1:2007 + A1 :2009 (based results from X)	Kingspan Insulation Ltd	Exova Warrington Fire	20/07/2016	Not stated	Thermapitch TP10; Thermawall TW55; Thermafloor TF70; Thermawall TW50 full fill; Ecotherm Eco-versal Ecotherm Eco-cavity Ecotherm Ecocavity T and G full fill INNO FIX	BS EN 13501-1 BS EN 11925-2 EN/TS 15117	Class E	12 (6No. 60mm; 6No. 20mm)	0mm, 60mm	PIR Foam Thermapitch TP10; Thermawall TW55; Thermafloor TF70; Thermawall TW50 full fill; Ecotherm Eco-versal Ecotherm Eco-cavity Ecotherm Ecocavity T and G full fill INNO FIX	Aluminium foil	WF367450	KIN00000302
Extended Field of application report in accordance with EN/TS 15117:2005	Kingspan Insulation Ltd	Exova Warrington Fire	20/07/2016	N/A extended field of application report	Thermapitch TP10; Thermawall TW55; Thermafloor TF70; Thermawall TW50 full fill; Ecotherm Eco-versal Ecotherm Eco-cavity Ecotherm Ecocavity T and G full fill INNO FIX	BS EN 13501-1 BS EN 11925-2 EN/TS 15117	Class E	N/A assessment report	>20mm	Thermapitch TP10; Thermawall TW55; Thermafloor TF70; Thermawall TW50 full fill; Ecotherm Eco-versal Ecotherm Eco-cavity Ecotherm Ecocavity T and G full fill INNO FIX	Aluminium foil	WF367449	KIN00000303
BS 476-7 Method of classification of the surface spread of flame of products	Kingspan Insulation Ltd	Exova Warrington Fire	15/03/2017	09/03/2017	TF70/ TP10/ TW55/ TW50 Batch No. 8100223891	BS 476-7	Class 1	6	20	PIR Foam TF70/ TP10/ TW55/ TW50	Aluminium foil	378317	KIN00000281



Report Title	Sponsor	Report Produced by	Date of issue of report	Date test was undertaken	Product name referenced in report	Test Standards Referenced in Report	Classification/ Test result stated in report	No. Samples tested	Thickness (mm)	Insulation foam material	Exposed face	Classification report/ Test report/ BBA certificate number	Relativity Document
Class 1 assessment report- Assessment of the ability of a range of foil faced polyisocyanurate (PIR) insulation board materials to comply with the requirements of Class 1 when tested in accordance with BS 476: Part 7:1997	Kingspan Insulation Ltd	Exova Warrington Fire	15/03/2017	29/05/2014 09/03/2017	TF70/ TP10/ TW55/ TW50	BS 476-7	Class 1	12 (6 No. 20mm thickness and 6 No. 50mm thickness)	20-50mm	PIR Foam TF70/ TP10/ TW55/ TW50	Aluminium foil	381173	KIN00000283
BS 476-7 Method of classification of the surface spread of flame of products	Kingspan Insulation Ltd	Exova Warrington Fire	15/03/2017	09/03/2017	TF70/ TP10/ TW55/ TW50 Batch No. 8100223891	BS 476-7	Class 1	6	20	PIR Foam TF70/ TP10/ TW55/ TW50	Aluminium foil	378317	KIN00000298
Class 1 assessment report- Assessment of the ability of a range of foil faced polyisocyanurate (PIR) insulation board materials to comply with the requirements of Class 1 when tested in accordance with BS 476: Part 7:1997	Kingspan Insulation Ltd	Exova Warrington Fire	15/03/2017	29/05/2014 09/03/2017	TF70/ TP10/ TW55/ TW50	BS 476-7	Class 1	12 (6 No. 20mm thickness and 6 No. 50mm thickness)	20-50mm	PIR Foam TF70/ TP10/ TW55/ TW50	Aluminium foil	381173	KIN00000300
Certificate 14/5133 Product Sheet 5 First Issue	Kingspan Insulation Ltd	BBA	18/05/2017	N/A Classification report	Kingspan Thermapitch TP10	BS EN 13501-1:2007	Class E	N/A Classification report	20-140mm	PIR	Aluminium foil	14/5133 Product sheet 5	BBA0000004 4



## **E6      Review of BS 8414 evidence for Kingspan Phenolic Insulation**

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- E6.1.1**      In Table E.11 I provide a schedule of the large scale façade evidence tests disclosed by Kingspan to the Public Inquiry relating to the use of Kingspan phenolic insulation and an ACP rainscreen system.
- E6.1.2**      None of the assemblies tested and classified contain Reynobond 55 PE ACP. Therefore, none of this evidence is relevant to the as built external wall of Grenfell Tower. They cannot therefore be relied upon to demonstrate compliance with the provisions made in Section 12.5 of the ADB 2013.
- E6.1.3**      Further, the tests cannot be relied upon to demonstrate external wall at Grenfell Tower meets the functional requirement B4 of the Building Regulations.
- E6.1.4**      .

Table E.11 Schedule of Kingspan assessment reports/test reports/classification reports relevant to ACP panels

Report title	Test sponsor	Date	Prepared by	Relevance to Grenfell Tower	Reference
BS 8414-1:2015 + A1:2017 test on a ventilated façade system with Kingspan Kooltherm K15 insulation and Alpolic/fr panels.	Kingspan Insulation Ltd	14/12/17	BRE	N/a – not tested with Reynobond 55 PE ACP rainscreen system as installed on Grenfell Tower	KIN00000141
BS 8414-1:2015 + A1:2017 test on ventilated façade system with Kingspan (K15) thermal insulation and Booth Muirie BML400 ACP rainscreen system rivet fixed	Mitsubishi Chemical Corporation	18/01/18	BRE	N/a – not tested with Reynobond 55 PE ACP rainscreen system as installed on Grenfell Tower	KIN00000149
An assessment of the fire performance of two external wall systems for block A, Kew Bridge Road Phase 2 against BR 135, Third Edition	Kingspan Insulation Limited	16/10/15	BRE	N/a – neither of the proposed systems considered by the assessment use Reynobond 55 PE ACP rainscreen system as installed on Grenfell Tower	KIN00000159
An assessment of the fire performance of two external wall systems for Kew Bridge Road Phase 2	Kingspan Insulation Ltd	22/09/15	BRE	N/a – neither of the proposed systems considered by the assessment use Reynobond 55 PE ACP rainscreen system as installed on Grenfell Tower	KIN00000160
An assessment of the external wall system for the Riverlight project, London against the provisions given in Section 12 of Approved Document B, Volume 2	Kingspan Insulation Ltd	26/06/12	BRE	N/a –the proposed system considered by the assessment does not use Reynobond 55 PE ACP rainscreen system as installed on Grenfell Tower	KIN00000165
Assessment of the fire performance of an external wall system for use on high rise buildings as featured on Commercial Road, London	Kingspan Insulation Ltd	7/10/16	Exova	N/a –the proposed system considered by the assessment does not use Reynobond 55 PE ACP rainscreen system as installed on Grenfell Tower	KIN00000169
Assessment of the fire performance of an external wall system for use on high rise buildings as featured on Hale Village Pavilion	Bellway Homes Ltd	24/07/15	Exova	N/a – neither of the proposed systems considered by the assessment use Reynobond 55 PE ACP rainscreen system as installed on Grenfell Tower	KIN00000172
Assessment of the fire performance of an external wall system for use on high rise buildings as featured on T4 Premier Inn, Heathrow Airport	Kingspan Insulation Ltd	27/06/17	Exova	N/a –the proposed system considered by the assessment does not use Reynobond 55 PE ACP rainscreen system as installed on Grenfell Tower	KIN00000173
BS 8414-2:2015 + A1:2017 Test on a ventilated façade system with Kingspan Kooltherm insulation (100mm-thick) and Alpolic A2 panels (4mm-thick).	Kingspan Insulation Ltd	25/07/2018	BRE	N/a – not tested with Reynobond 55 PE ACP rainscreen system as installed on Grenfell Tower	KIN00000492
BRE Report 220876	Kingspan Insulation Ltd	08/12/2005	BRE Global	N/A - not tested with Reynobond 55 PE ACP rainscreen system as installed on Grenfell Tower	BBA00000035
Kingspan K15 insulated system with a ventilated Terracotta tile rainscreen. Classification of fire performance in accordance with BR 135: 2013 Annex B	Kingspan Insulation Ltd	21/09/2015	BRE Global	N/A - not tested with Reynobond 55 PE ACP rainscreen system as installed on Grenfell Tower	BBA00000042
Kingspan Insulation Cladding system with a Terracotta tile rainscreen. Classification of fire performance in accordance with BR 135: 2013 Annex B	Kingspan Insulation Ltd	14/04/2015	BRE Global	N/A - not tested with Reynobond 55 PE ACP rainscreen system as installed on Grenfell Tower	BBA00000034
Carea Insulated façade system. Classification of fire performance in accordance with BR 135: 2013 Annex B	Carea Façade	08/06/2015	BRE Global	N/A - not tested with Reynobond 55 PE ACP rainscreen system as installed on Grenfell Tower	BBA00000033
BRE Report 220876	Kingspan Insulation Ltd	08/12/2005	BRE Global	N/A - not tested with Reynobond 55 PE ACP rainscreen system as installed on Grenfell Tower	BBA00000035



## E7 Schedule of Siderise fire resistance test and classification test evidence

- E7.1.1** I have listed all the fire resistance test reports and classification reports for any Siderise cavity barrier/fire stopping products made available to me in Table E.12.
- E7.1.2** None of the test evidence or assessment reports included in Table E.12 are for the performance of Siderise cavity barriers when installed between a concrete wall and a combustible ACP rainscreen system.
- E7.1.3** This means that none of the test reports or assessment reports are relevant to the as built external wall construction of Grenfell Tower.
- E7.1.4** Therefore, they cannot be relied upon to demonstrate compliance with the provisions made in Section 12.8 of the ADB 2013.

Table E.12 Schedule of the reaction to fire test reports and classification reports for side rise cavity barriers

Relativity reference	Report/ Drawing number	Report title	Sponsor	Report/ Drawing date
SIL00000211	WF Assessment report No: 311394/A Issue 2	The fire resistance performance of Lamatherm rainscreen fire barriers	Siderise insulation ltd	20/09/2011
SIL00000212	328279/A	The fire resistance performance of four specimens of floor mounted open state cavity barriers. Tested using the general principles of draft standard ASFP TG 3 N64 (Fourth draft Feb 2013)	Siderise insulation ltd	23/07/2013



Relativity reference	Report/ Drawing number	Report title	Sponsor	Report/ Drawing date
SIL00000214	BMT/FEI/F14008B	A fire resistance test performed on three vertical cavity barrier seals within a concrete supporting construction	Siderise insulation ltd	25/04/2014
SIL00000222	WFRC Assessment report 136497	The Fire resistance performance of CW cavity barrier and fire stops for curtain walling in terms of BS 476: Part 20:1987	Lamatherm Products Ltd	01/03/2004
SIL00000223	WFRC Assessment report 179319 Issue 2	The fire resistance performance of Siderise Lamatherm CW-RS cavity barriers complete with Technofire 64854A intumescent	Siderise insulation ltd	30/01/2009
SIL00000224	WF report No: 194496B Issue 2	Fire resistance test utilising the general principles of BS 476: 20:1987 on five specimens of floor mounted linear gap seals	Siderise insulation ltd	26/08/2010
SIL00000229	Siderise RH and RV cavity barriers for use in external buildings	-	Siderise insulation ltd	01/08/2015