

Fire Performance Testing of an External Cladding System
BS 8414-1:2015 + A1:2017

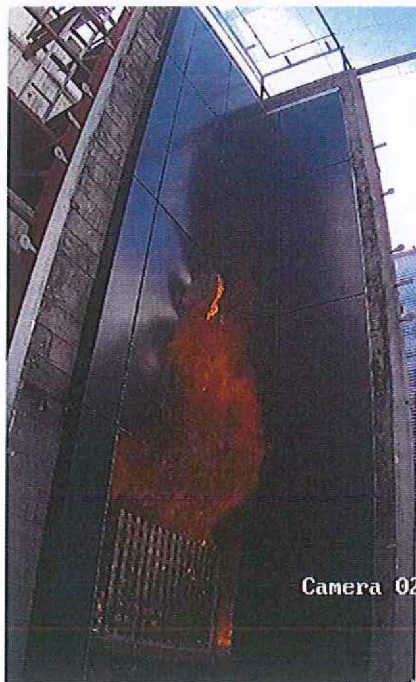
Test Report

Prepared for : Kingspan Insulation Ltd.

Project : System Development

Report No. : DLR1448 Rev.0

Sample : Kooltherm K15 100mm - 3mm Aluminium Cassette



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1. Introduction

This report describes the fire performance test carried out at Al Futtaim Exova (AFE) laboratory in Dubai at the request of:

Kingspan Insulation Ltd.,
Pembridge, Leominster,
Hertfordshire, England.

Contact email: highrisetechnical@kingspan.com

Contact number: [REDACTED]

AFE Job/Sample Number: PD 106193 / C2753B

The test sample consisted of an external wall cladding system (Kooltherm K15 100mm - 3mm Aluminium Cassette) installed by Kingspan Insulation Ltd.

Exova Group Limited is a wholly owned subsidiary of Clayton Dubilier and Rice. Exova is the world's largest provider of testing services employing over 4,000 staff in 130 laboratories worldwide (UK, Europe, North America, Asia, Asia Pacific and the Middle East) and offering a very wide and diverse range of testing services.

This test report is personal to the client, confidential, non-assignable and shall not be reproduced, except in full, without prior written approval of AFE.

1.1 Purpose of Testing

The test was carried out on 3rd December 2017 and was to determine the fire performance of an aluminium panel external wall cladding system fixed to the masonry face when exposed to external fire under controlled conditions. The test method was in accordance with AFE test method statement DMC2753B/MSrev0, which was in accordance with the following standards:

- ▶ BS 8414-1: 2015 + A1:2017

This test report relates only to the actual sample as tested and described herein.

The tests were witnessed wholly or in part by:

Linzi Hobbs	-	Kingspan Insulation Ltd.
Shawn Morris	-	Kingspan Insulation Ltd.

The test was supervised and conducted by Akhil Chacko & Shibu Varghese of Al Futtaim Exova.

1.2 Terms and Definitions

1.2.1 Level 1 Height

2500mm above the top of the combustion chamber opening on the test apparatus.

Refer to section 4 for details.

1.2.2 Level 2 Height

5000mm above the top of the combustion chamber opening on the test apparatus.

Refer to section 4 for details.

1.2.3 Start Temperature, T_s

Mean temperature of the thermocouples at Level 1, five minutes prior to ignition of the heat source.

1.2.4 Start Time, t_s

Time when the temperature recorded by any external thermocouple at Level 1 equals or exceeds 200°C above T_s and remains above this value for at least 30 seconds.

2. Test Summary

The cladding system was tested in accordance with BS 8414-1:2015 + A1:2017 without any early termination of the test.

Table 1 Observations

Parameters	Temperature data/observations
T_s , start temperature	25 °C
t_s , start time	387 seconds after ignition of the crib (thermocouple 3)
Peak temperature & time at Level 2 (external)	635°C at 1293 seconds from t_s (thermocouple 12)
Peak temperature / time at Level 2 (internal cavity)	383°C at 1440 seconds from t_s (thermocouple 20)
Peak temperature / time at Level 2 (internal Kingspan Kooltherm K15 100mm insulation)	85°C at 2697 seconds from t_s (thermocouple 27)

For full details refer to Section 6.

The above results are valid only for the conditions under which the tests were conducted.

3. Description of the Test Sample

The test specimen mainly comprised of:

- Booth Muirie BML 100-HP (Hook Plate System) cassette panels formed from 3mm aluminium and powder coated
- Booth Muirie BML 100-HP (Hook Plate System) aluminium vertical Y rails
- Koolltherm K15 100mm insulation
- Siderise RH25 S-90/30 intumescent horizontal cavity barrier in conjunction with Siderise Open State Cassette Insert
- Siderise RV25 - 90/30 intumescent vertical cavity barrier in conjunction with Siderise Open State Cassette Insert

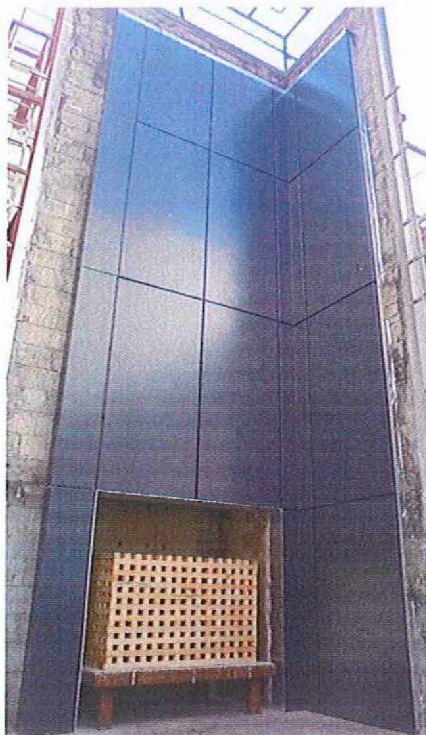
Main wall - 2615mm wide x 8580mm high.

Wing wall - 1315mm wide x 8580mm high.

The top end of the cladding system was closed with 3mm thick aluminium sheet. The main wall side was closed with the aluminium panel folded inward and the wing wall side was left opened. Interface between the cladding system and the combustion chamber was covered with 5mm thick aluminium sheet. The distance of the finished face of the wing wall to the side opening of the combustion chamber was 240mm.

Photo DLP C2753B/6798 shows an external view of the sample.

Figure 1 Photo DLP C2753B/6798 External View of the Test Sample



The system components are mentioned in Table 2. Refer to the drawings in Appendix B for sample construction details and dimensions.

Material information described in Table 2 below is as supplied by Kingspan Insulation Ltd.

Table 2 System Details

Component	Description	Installation Details
Bracket	ECF-B-S-080 Helping Hand bracket 80x60x4mm and polypropylene plastic thermal shim. See photo DLP C2753B/6448 in Appendix A.	The brackets were fixed to the masonry with MFRFB-10/80 A4 wall fixings and nylon wall plugs. Polypropylene plastic shims were placed between masonry wall and brackets.
Cavity barrier	Horizontal intumescent cavity barrier: Siderise RH25 S-90/30, 1200x135x75mm, density 80kg/m ³ . See photo DLP C2753B/6463 in Appendix A.	The horizontal cavity barriers were fixed to the masonry with RS350 brackets and MFRFB-10/80 A4 wall fixings and nylon wall plugs. 4 horizontal continuous cavity barriers were fixed to the main wall and wing wall, at 75mm, 2410mm, 4740mm and 6355mm above the combustion chamber.
	Vertical cavity barrier: Siderise RV-90/30, 1200x170x75mm, density 80kg/m ³ . See photo DLP C2753B/6457 in Appendix A.	Three continuous vertical cavity barriers were fixed to the masonry, two on the main wall and one on the wing wall with RS195 brackets and MFRFB-10/80 A4 wall fixings and nylon wall plugs.
	Cassette insert: Siderise open state cassette insert (OSCI) 100x50mm See photo DLP C2753B/6600 in Appendix A.	Siderise inserts were placed at the folding of the aluminium cassette panels at the cavity barrier locations. It was secured to the back face of the cassette panel by a self-adhesive strip.
	Intumescent closure: 25mm Siderise cassette panel intumescent closure (CPIC)	Intumescent closure was placed on the bottom internal face of aluminium cassette panel folding.

Component	Description	Installation Details
Insulation	Kingspan Kooltherm K15 100mm insulation See photo DLP C2753B/6554 in Appendix A.	Kooltherm K15 100mm insulation foam boards were fixed to the masonry wall with DHM-130-A2 steel pins and DHK140 plastic pins.
Railing & Hooks	2mm thick aluminium Y-Rail, See photo DLP C2753B/6554 in Appendix A.	Railings were fixed to the brackets and screwed with it by 4.8mm diameter TEK screws.
	4mm thick aluminium hook clips	Aluminium hook clips were fixed to the Y-rail with flat head screws.
Panel	3mm thick aluminium cassette panel See photo DLP C2753B/6600 in Appendix A.	Aluminium cassette panels were fixed to the railings with aluminium hook clips.

AFE was not involved in the design, procurement, installation and specification of the materials or system.

The installation and conditioning of the test sample was carried out in a controlled environment as required in BS 8414-1:2015 + A1:2017.

Sample installation

AFE monitored the installation of the sample based on the drawings supplied by Kingspan Insulation Ltd, which are included in Appendix B of this report. Any deviation of the installation from these drawings were recorded and reported.

Date of installation: 25 Nov. '17 to 28 Nov. '17

Ambient temperature range: 20 - 30°C

Variations Observed

No variations were observed.

4. Test Apparatus

4.1 Test Rig

The test specimen was installed on a purpose-built test rig constructed by AFE as per the BS 8414-1:2015 + A1:2017 standard.

The rig comprised of two mutually perpendicular walls (constructed from the masonry bricks of compressive strength: 7.3 N/mm², density: 730kg/m³ and thermal conductivity: 0.18W/mK), one referred to as the main wall with a width of 3275mm and the other as the wing wall with a width of 2685mm. The total height of the test rig was 9180mm.

A combustion chamber with an opening of 1999mm x 2010mm was positioned at the base of the main vertical wall.

Refer to Figure 2 below for a schematic diagram of the test rig.

4.2 Heat Source

A timber crib, 1500mm x 1000mm in plane and 1000mm in height, was constructed using Pinus Silvestris softwood sticks as described in BS 8414-1:2015 + A1:2017 with a first layer consisting of 10 long sticks of 1500mm. The next layer consisted of 15 short sticks was evenly distributed to cover an area of 1500mm x 1000mm.

The process was repeated to give a total of 20 layers of sticks, giving a nominal height of 1000mm. The crib was constructed on a solid steel platform positioned 400mm above the floor of the combustion chamber and placed centrally and displaced 100mm from the back wall of the chamber.

The crib was ignited using 16 strips of low density fibreboard, soaked for 5 minutes in 5 litres of white spirit.

4.3 Thermocouples

All thermocouples used conformed to BS EN 60584-1:2013, Type K (Chromel / Alumel). The thermocouples were mineral insulated and had a nominal 1.5mm diameter with insulated junctions. Data acquisition was performed at 3 second intervals.

The locations of the thermocouples on the specimen were as shown in Figure 3.

4.3.1 External thermocouples at Levels 1 and 2

Thermocouples were positioned in front of the main wall on the centre line and at 500mm & 1000mm each side of the centre line of the combustion chamber (five locations). Thermocouples were also positioned in front of the wing wall, at 150mm, 600mm & 1050mm from the finished face of the main wall (three locations).

4.3.2 Internal thermocouple locations at Level 2

Thermocouples were positioned within each layer of the main test wall face greater than 10mm on the centre line and at 500 mm and 1000 mm each side of the centre line of the combustion chamber (five locations). Thermocouples were also positioned within each layer of the wing test wall face greater than 10mm at 150 mm, 600 mm and 1050 mm from the finished face of the main test wall face (three locations).

Figure 2 Schematic View of the Test Rig

Note: All dimensions are in mm, the drawing is not to scale

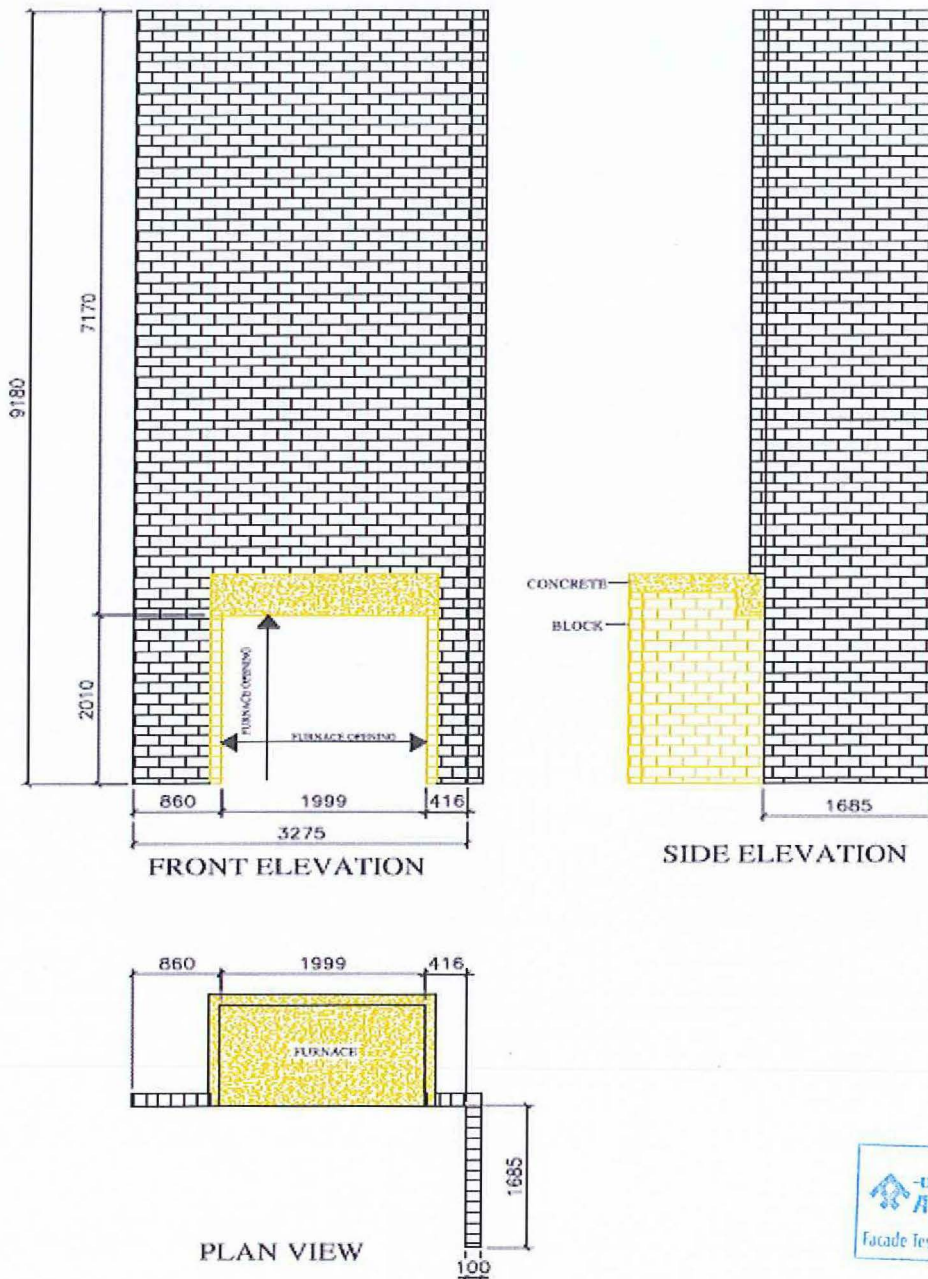
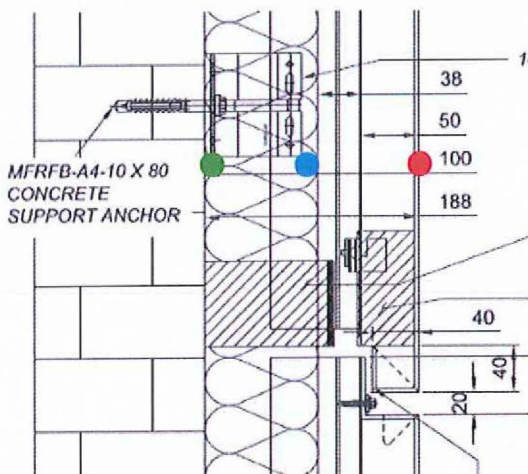
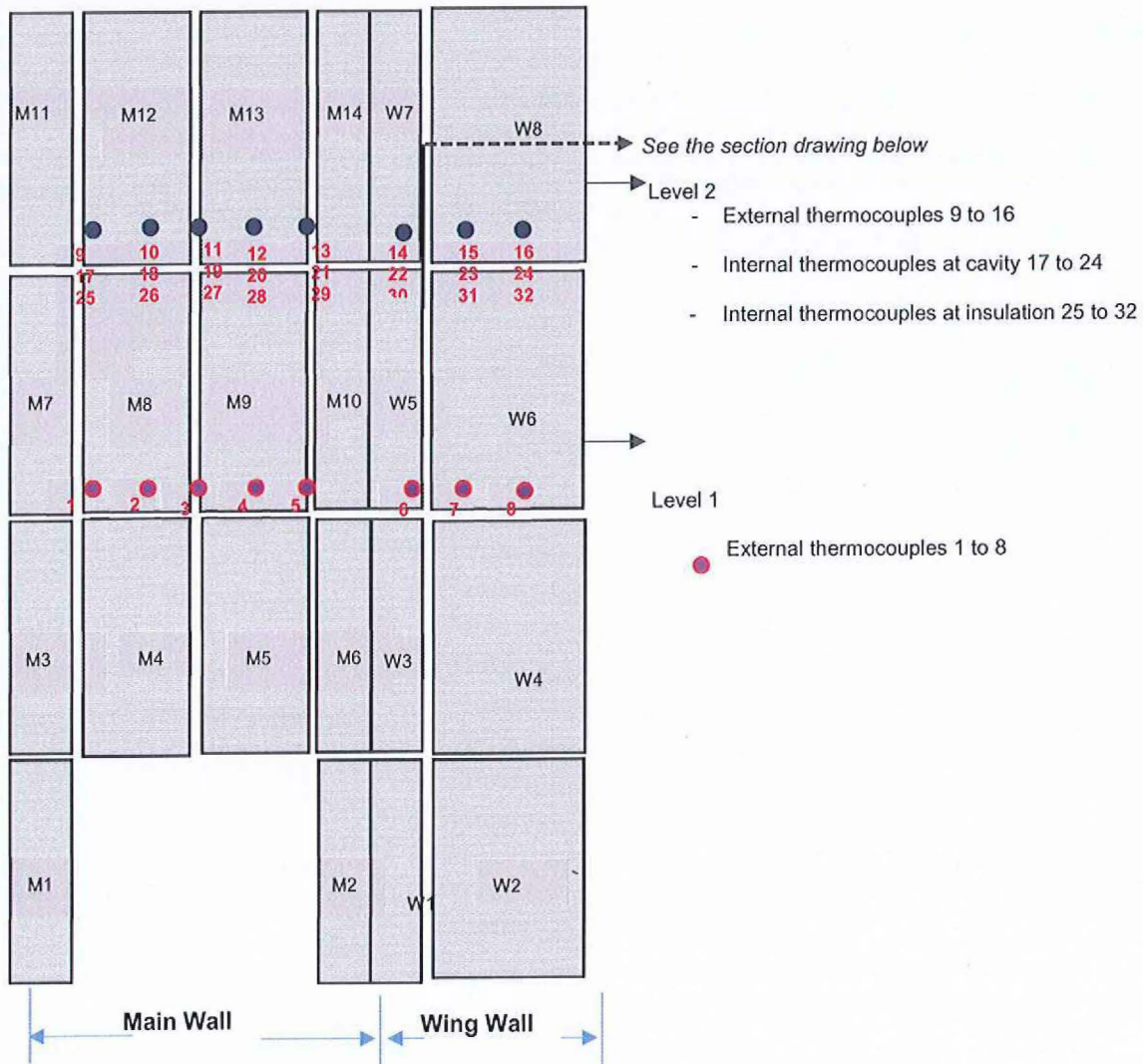


Figure 3 Thermocouple Locations & Panel Numbering



- Level 2, external thermocouples 9 to 16
- Level 2, internal thermocouples in cavity 17 to 24
- Level 2, internal thermocouples in the insulation 25 to 32

Level 2 Section Drawing

5. Test Procedures

5.1 Testing

The environmental conditions were recorded.

The data acquisition and video recording was started 5 minutes prior to ignition of the fuel source. Then fuel source was ignited.

Significant events were recorded, including;

- changes in flaming conditions
- change in the mechanical behaviour of the cladding system
- the detachment of any part of the sample
- fire penetration through any fire stops in the cladding system

The heat source was extinguished 30 minutes after ignition. The data acquisition was continued to 60 minutes from ignition.

5.2 Post-test Examination

After the test was terminated, the sample was allowed to cool. The sample was then examined for damage, including the following.

- Spalling
- Melting
- Deformation
- Delamination
- The extent of flame spread over the surface of the cladding system
- The extent of flame spread and/or damage within intermediate layers
- An estimate of flame spread and/or damage within cavities
- The extent to which the external face of the cladding system has burnt away or become detached
- Details of any collapse or partial collapse

Smoke staining and discolouration were not considered damage in this context.

6. Test Data / Observations

Installation date: 25 Nov. '17 to 28 Nov. '17

Ambient temperature during installation: 20°C - 30°C

Sample conditioning: Not specified

Date of testing: 03 Dec. '17.

Ambient temperature: 25°C

Wind speed at the start of the test: 1.0 m/s

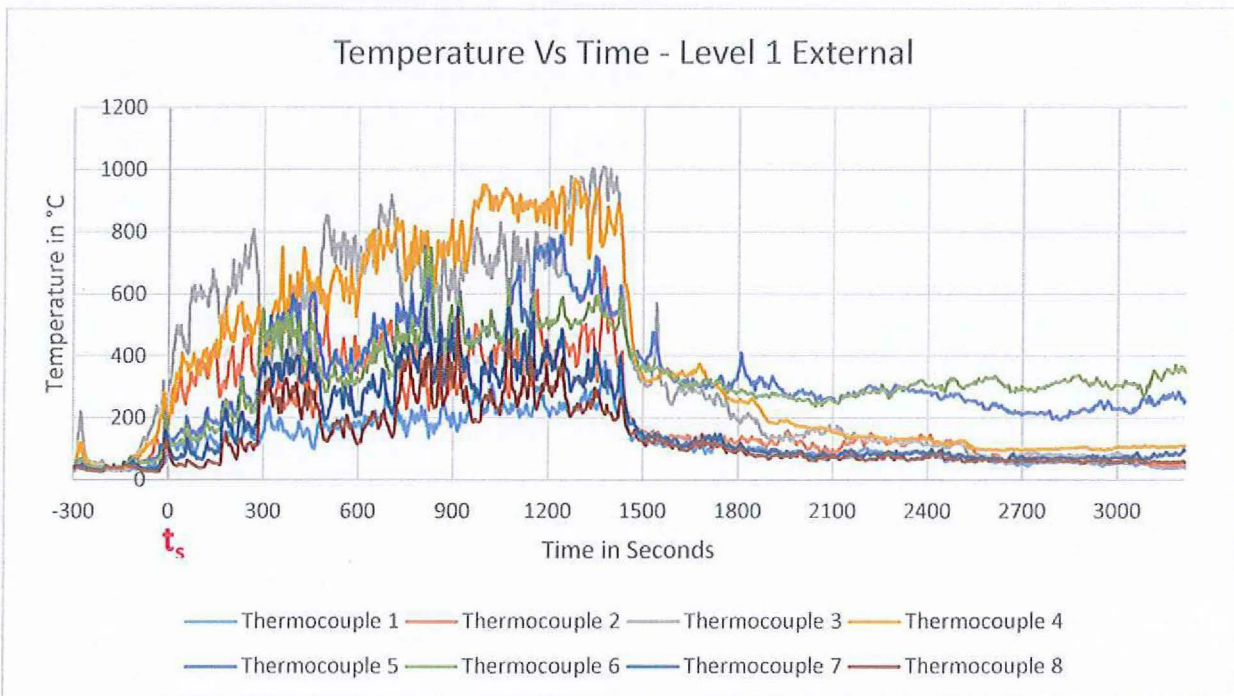
Table 3 below summarises the observations during the test.

Table 3 Visual Observations During the Test

Time	Seconds	Observation	Photo Reference
10:10:45	-	Ignition of crib	-
10:12:11	-	Flames above the combustion chamber.	-
10:17:11	00	Start time t_s , 267.38°C ($T_s+200^\circ\text{C}$) at thermocouple 3, Level 1 (main wall).	-
10:20:21	190	Flames reached 2000mm above the combustion chamber.	-
10:20:35	152	1 st layer of coating of panels M4 & M5 started to burn.	DLP C2753B/0001
10:21:39	268	Flame tip reached 3000mm high.	-
10:22:24	313	5mm thick aluminium flashing at the perimeter of the combustion chamber opening buckled.	-
10:22:49	338	Flames on the top of 5mm thick aluminium flashing at the perimeter of the combustion chamber.	-
10:22:53	342	Melted, flaming debris fell down.	-
10:22:59	348	Smoke observed from panels M3 & M4 vertical joint.	-
10:24:48	457	Discolouration observed on panels M4 & M5.	-
10:24:54	463	Sustained flame observed on panels M5 & M6 vertical joint.	DLP C2753B/0002
10:25:40	509	Panels M4 & M5 melted.	-
10:26:33	562	Railings behind panels M4 & M5 melted.	-
10:29:41	750	Burning debris fell from the main wall.	-
10:30:49	819	Burning debris fell from the main wall.	-

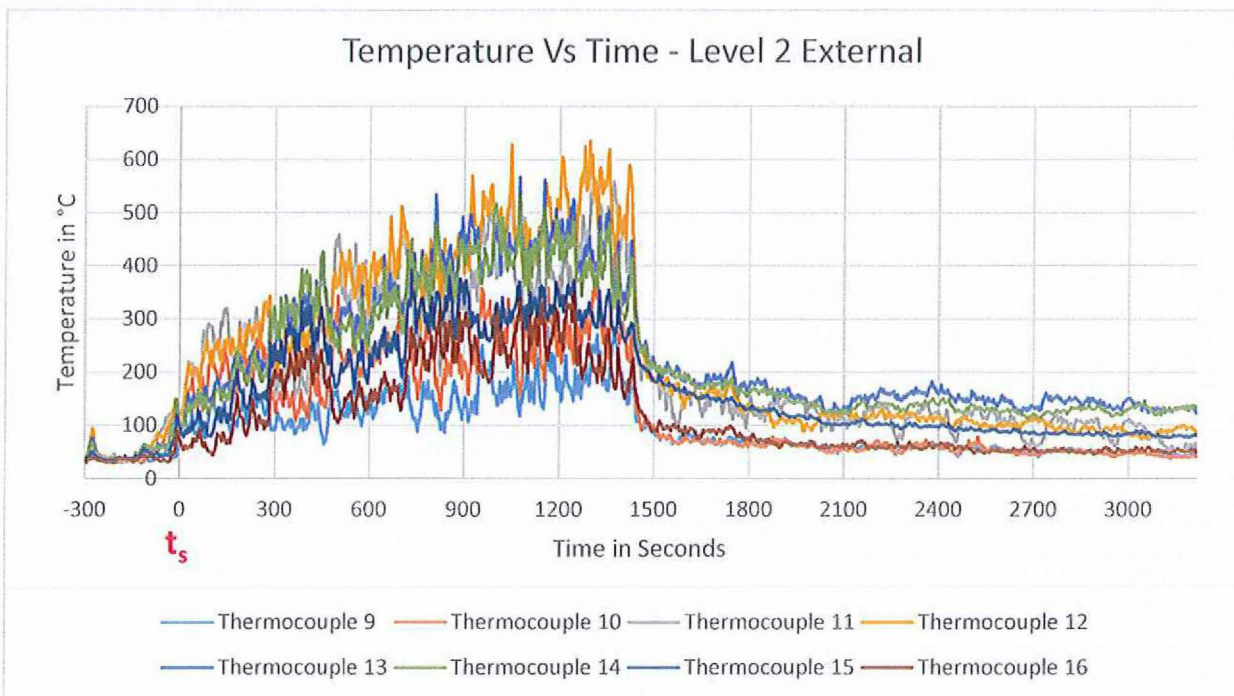
Time	Seconds	Observation	Photo Reference
10.31.39	868	Flames observed between panes W2 & W3 horizontal joint.	-
10.33.13	962	Sustained flame observed on panels W5 & W6 vertical joint.	DLP C2753B/0003
10.33.39	988	Flames observed between panels W5 & W6 vertical joint.	-
10.33.55	1004	Discolouration observed on panels M8 & M9.	-
10.35.00	1069	Panels M8 & M9 melted.	-
10.38.22	1271	Panel M5 fell from the main wall.	DLP C2753B/0004
10.39.38	1347	Kooltherm K15 insulation behind panels M4, M5, M8 & M9 was exposed as charcoal.	-
10.40.44	1413	The heat source was extinguished, observation continued for another 30 minutes.	-
10.41.07	1436	Intermittent flames behind panels M8 and M9.	-
10.42.17	1506	Intermittent flames from the Kooltherm K15 insulation behind panels M4 and M5.	-
10.51.42	2071	Flames behind panel M9 and above the first horizontal cavity barrier.	-
11:10:44	3213	No significant changes observed. Test terminated 60 minutes after ignition.	-

Figure 4 Thermocouple Readings on Level 1 - External



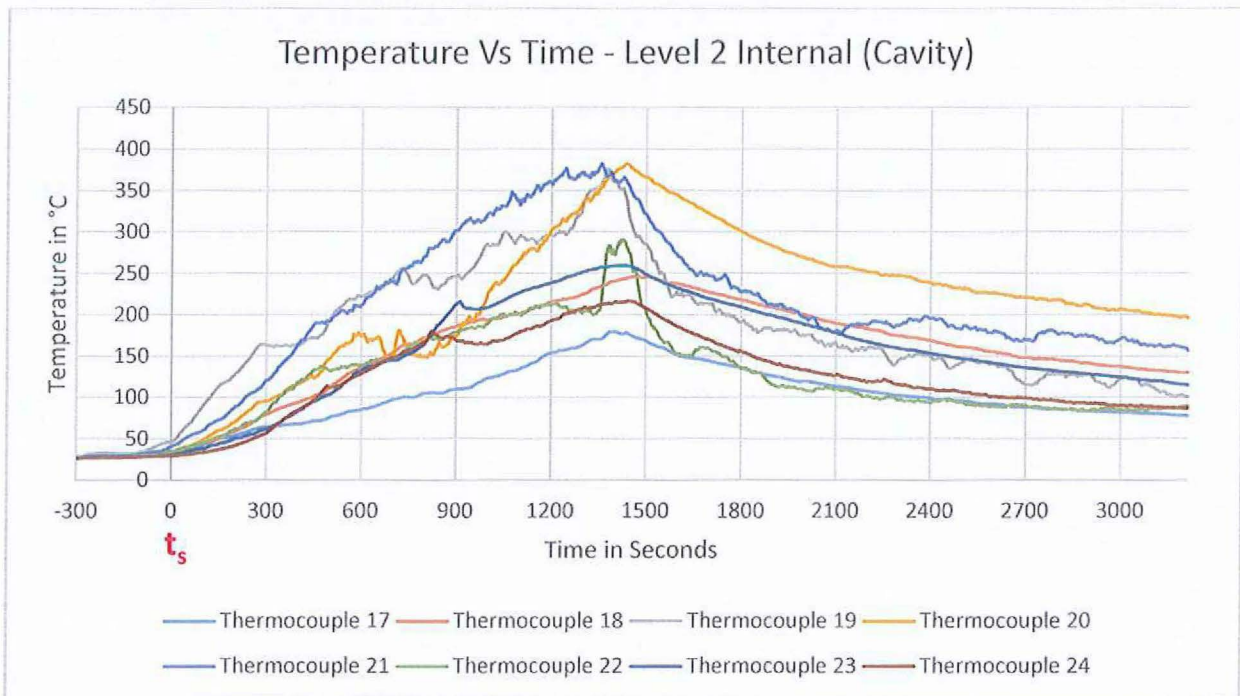
For thermocouple locations see Figure 3.

Figure 5 Thermocouple Readings on Level 2 - External



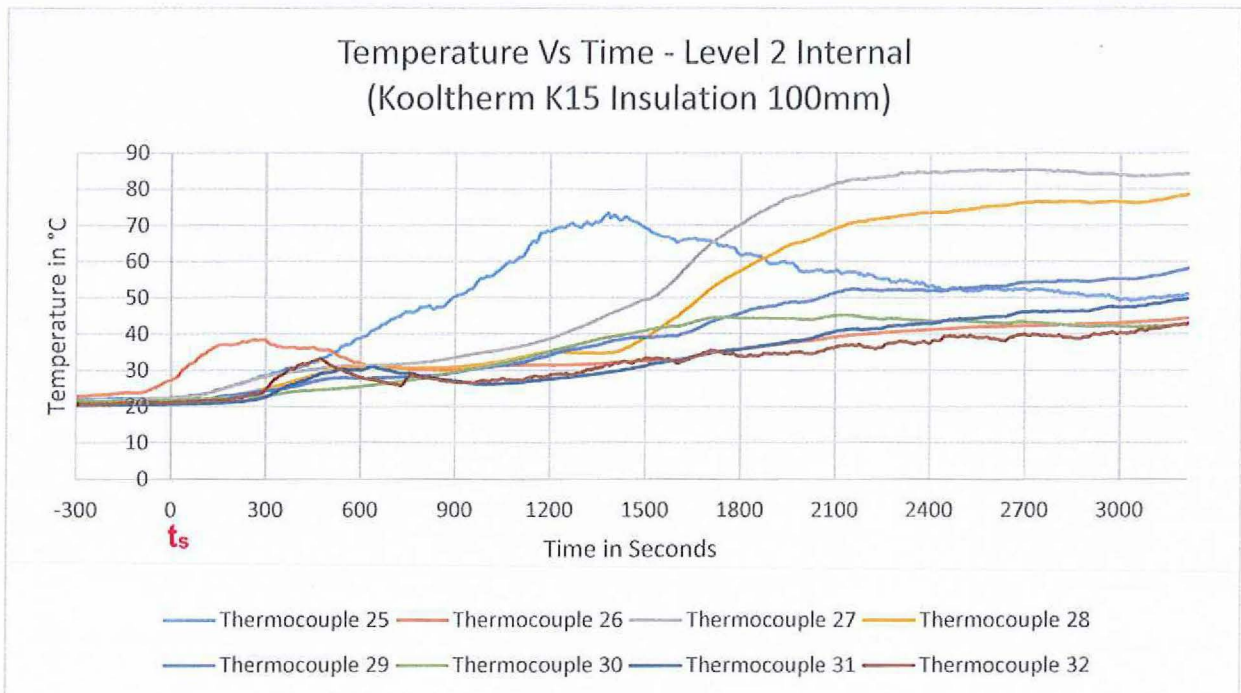
For thermocouple locations see Figure 3.

Figure 6 Thermocouple Readings on Level 2 - Internal (Cavity)



For thermocouple locations see Figure 3.

Figure 7 Thermocouple Readings on Level 2 - Internal (Kooltherm K15 Insulation 100mm)



For thermocouple locations see Figure 3.

6.1 Post-test Examination

Table 4 below summarises the post-test observations.

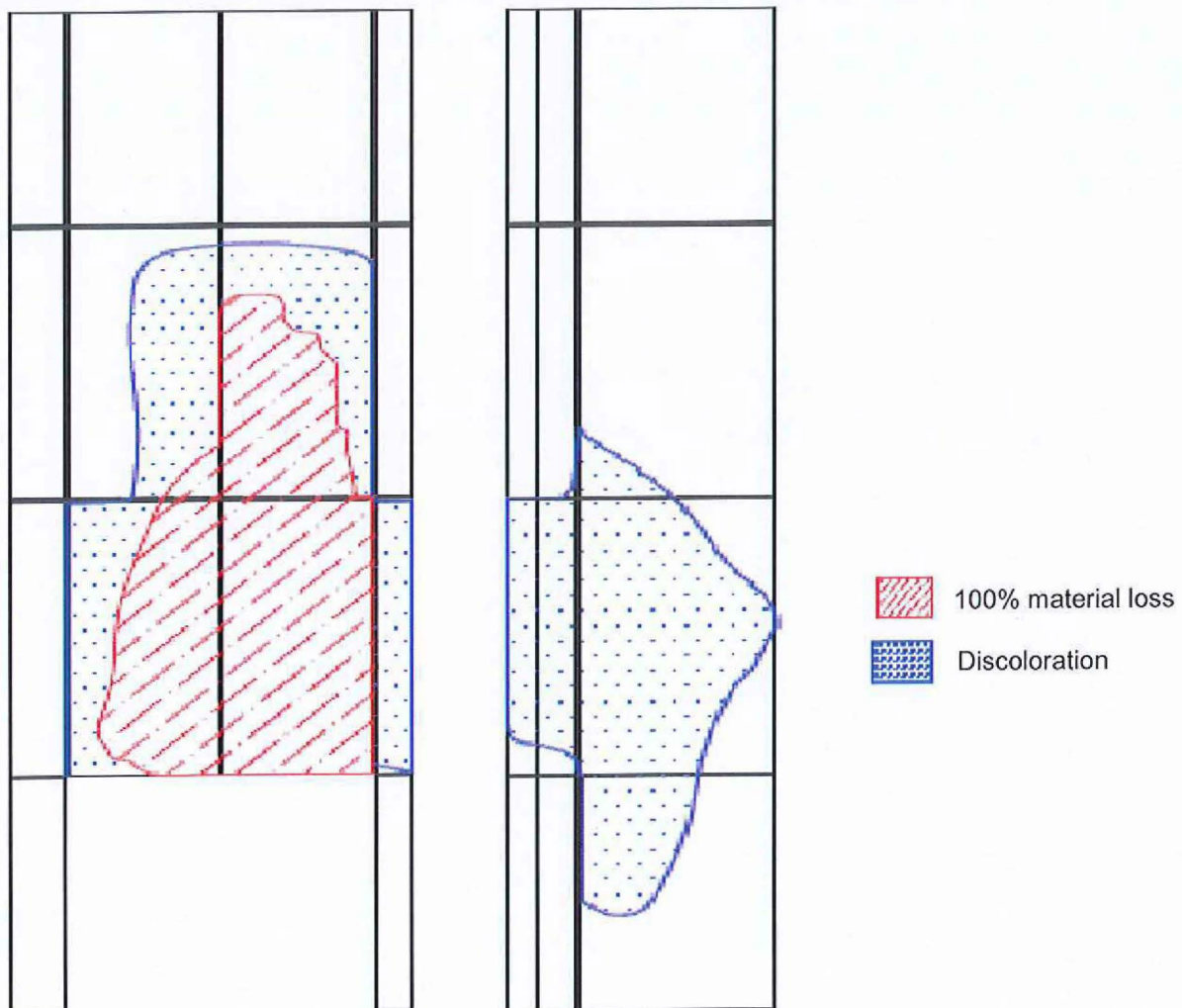
Table 4 Post-test Observations

Sl. No.	Components	Observation	Photo Reference
1	Aluminium panels	<ul style="list-style-type: none"> Approximately 28% (5m²) of complete material loss on main wall aluminium panels. No material loss on wing wall aluminium panels. Approximately 19% (3.4m²) of discolouration on main wall aluminium panels. Approximately 28% (3.6m²) of discolouration on main wall aluminium panels. <p>Panels M1, M7, M11, M14-W7 corner & W8 - No damage was observed.</p> <p>Panel M2-W1 corner – Minor discolouration.</p> <p>Panel M3 - Minor discolouration at the corner. No other damage was observed</p> <p>Panel M4 - Approximately 50% of the panel was consumed in fire, the remaining was distorted, discoloured and buckled.</p> <p>Panel M5 - 100% of the panel was consumed in fire.</p> <p>Panel M6-W3 corner - 90% of the panel was discoloured and the 1st coating was burned.</p> <p>Panel M8 - Approximately 10% of the panel was consumed in fire, the remaining was distorted, discoloured and buckled.</p> <p>Panel M9 - Approximately 60% of the panel was consumed in fire, the remaining was distorted, discoloured and buckled.</p> <p>Panels M10-W5 corner, M12 & M13 – Minor discolouration.</p> <p>Panel W2- Approximately 25% of the top coating was burned and discoloured.</p> <p>Panel W4 - Approximately 85% top coating was burned and discoloured and buckled.</p> <p>Panel W6 - Minor discolouration.</p>	<p>DLP C2753B/0005</p> <p>See Figure 8 in this section for area details.</p>

Sl. No.	Components	Observation	Photo Reference
2	Cavity barrier	<p>Horizontal intumescent cavity barrier:</p> <p>The 1st horizontal cavity barrier above the combustion chamber was activated. Melted aluminium and middle core of the panel debris fell onto the barrier and was compressed by its weight. Material loss and damage was observed.</p> <p>The 2nd horizontal cavity barrier at 2330mm above the combustion chamber was activated. The expanded intumescent layer was not present on the main wall during dismantling.</p> <p>The 3rd horizontal cavity barrier at 4660mm above the combustion chamber on main wall and wing wall was activated. No material loss was observed.</p> <p>The 4th horizontal cavity barrier at 6274mm above the combustion chamber on main wall and wing wall was activated. No material loss was observed.</p> <p>Vertical cavity barrier:</p> <p>Minor discolouration to the vertical cavity barrier extending between panel M1 and the combustion chamber.</p> <p>Buckling and minor material loss on vertical cavity barrier extending between the combustion chamber and panel M2.</p> <p>Minor discolouration to the vertical cavity barrier on wing wall.</p>	DLP C2753B/0006, DLP C2753B/0007 & DLP C2753B/0008.
3	Insulation	<p>100% damage on Kooltherm K15 insulations and core wall was exposed behind panels M4, M5, M6-W3, M9 & M10-W5.</p> <p>Insulation behind panels W2, W4 & W6 were charred and exposed as charcoal.</p> <p>Discoloration was observed to insulations behind panels M1, M3, M7, M11, M12, M14-W7 & W8.</p>	DLP C2753B/0007
4	Railing	<p>Railings behind panels M4, M5, M6-W3, W4, M8 & M9 were melted. Railings behind panels M1, M3, M7, M11, M12, M13, M14-W7 and W8 were discoloured.</p> <p>Railings behind panels M2-W1 & W2 were buckled and discoloured.</p>	DLP C2753B/0007

SI. No.	Components	Observation	Photo Reference
5	Bracket	100% of the brackets behind panels M4, M5 & M6-W4 were damaged. All other brackets were discoloured and were in place without damage.	DLP C2753B/0007.

Figure 8 Area Map Showing the Condition of the aluminium panels after the Test



- Approximately 5m² of the total aluminium panels was completely consumed by fire.
- Approximately 7m² of the total aluminium panels was discoloured.

Appendix A

Photographs

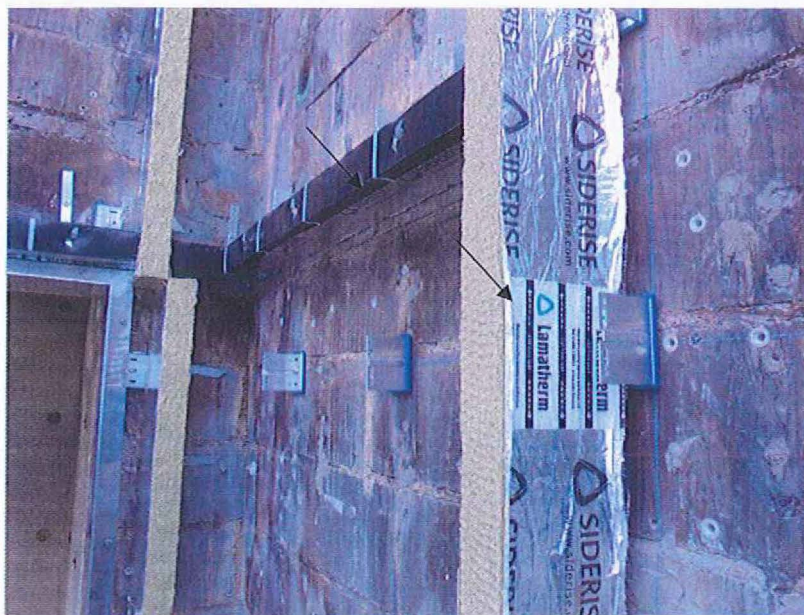
Note: Any warp in the images is due to fish eye effect of the camera.

Pre-test Phase



DLP C2753B/6448

Aluminium bracket



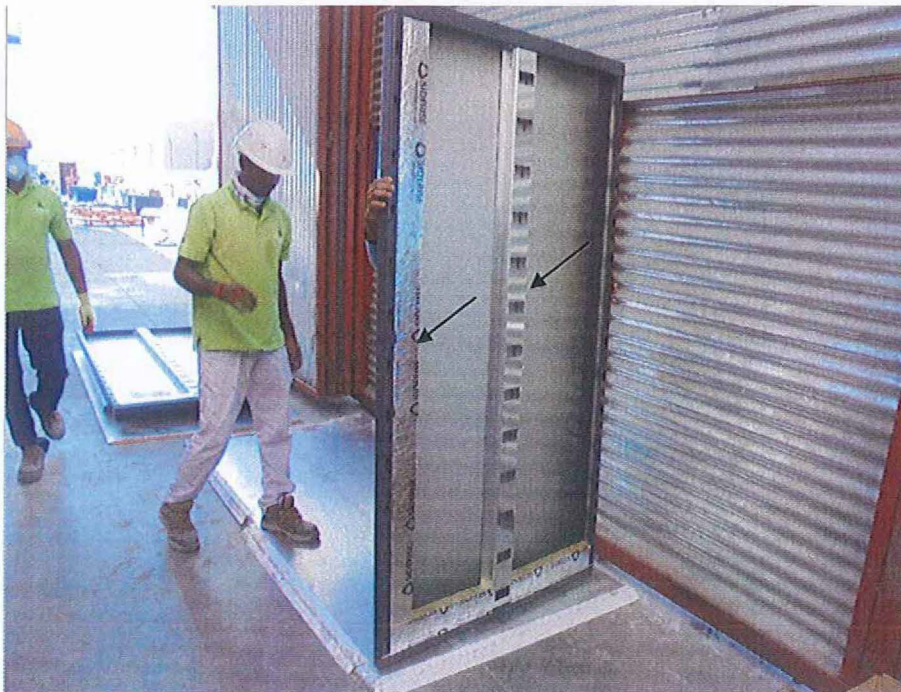
DLP C2753B/6457

Vertical and horizontal intumescent cavity barriers



DLP C2753B/6463

Aluminium flashing and horizontal intumescent cavity barrier above combustion chamber



DLP C2753B/6600

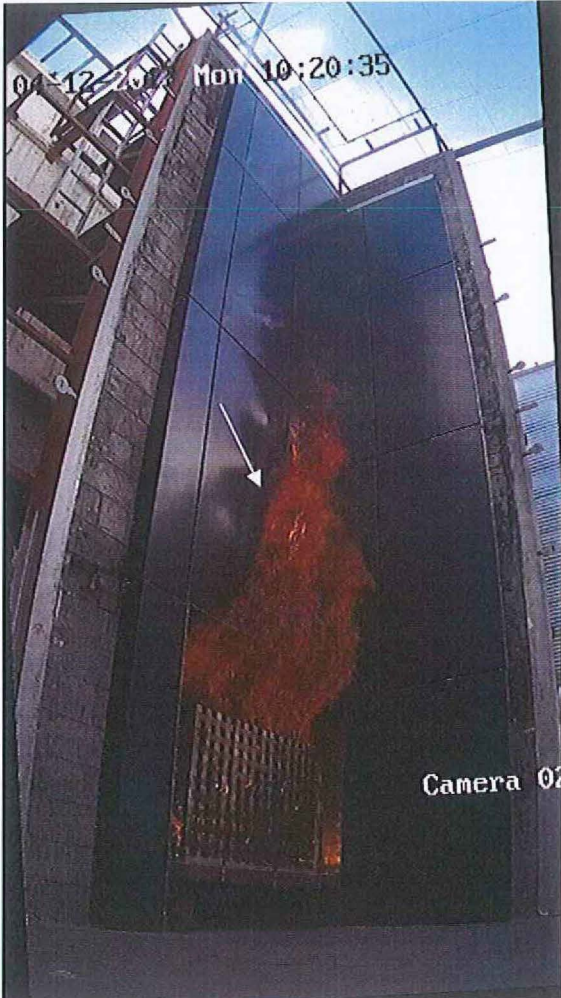
Aluminium cassette panel with cassette insert



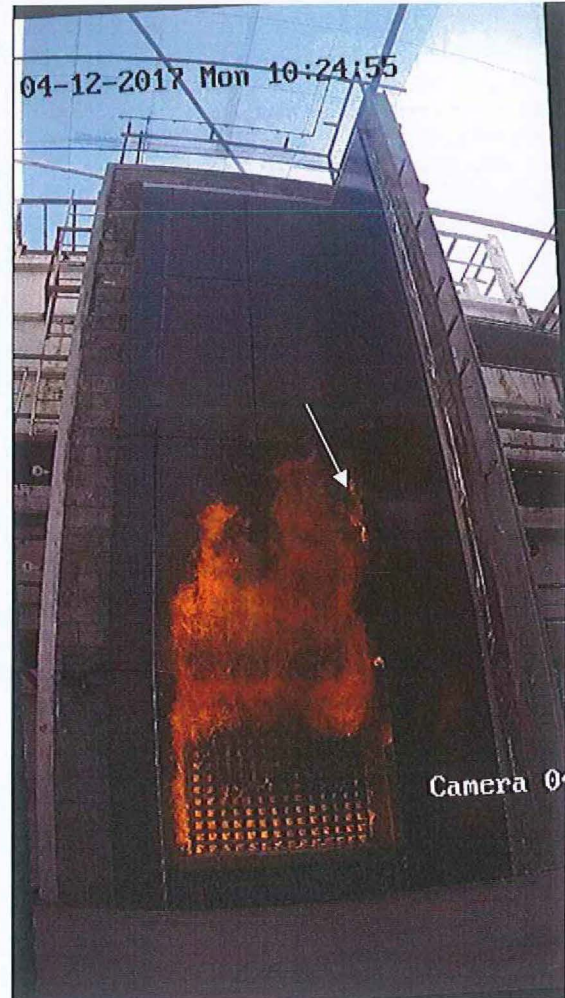
DLP C2753B/6554

Kooltherm K15 insulation 100mm & aluminium foil tape

Testing Phase



DLP C2753B/0001 1st layer of coating started to burn.



DLP C2753B/0002 Continuous flame observed on panels M5 & M6 vertical joint.



DLP C2753B/0003 Continuous flame observed on W5 & W6 vertical joint.



DLP C2753B/0004 Panel M5 fell from the main wall.

Post-Test Phase



DLP C2753B/0005

View of the sample after the test completion



DLP C2753B/0007

View of the sample
without panels



DLP C2753B/0008

View of the cavity
barriers



DLP C2753B/0006

Cavity barrier at the top of combustion chamber

Appendix B

Drawings

The following three un-paginated sheets are copies of Kingspan Insulation Ltd. drawings numbered:

- HK-1 Rev. 02
- HK-1B Rev. 01
- HK-L1 Rev. 02

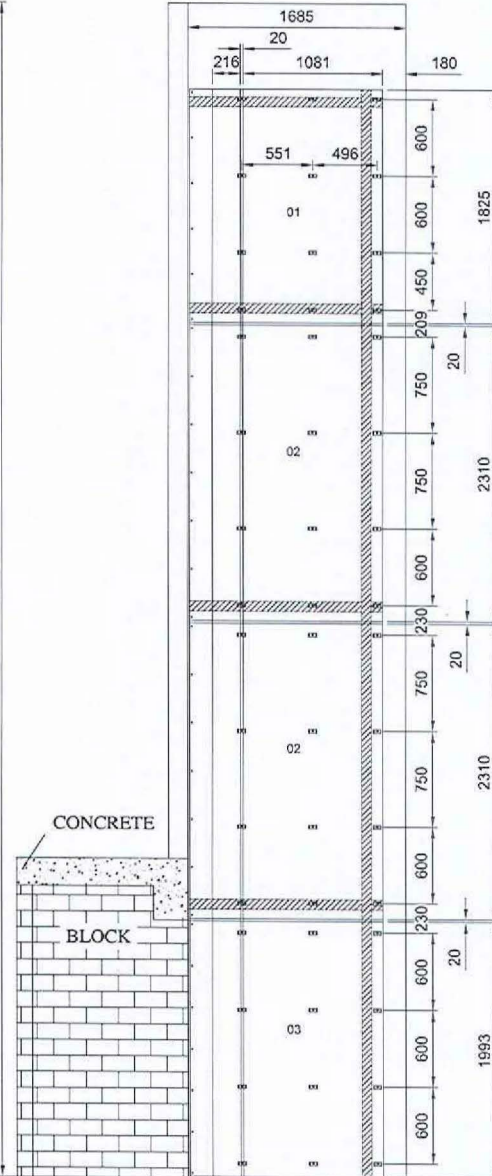
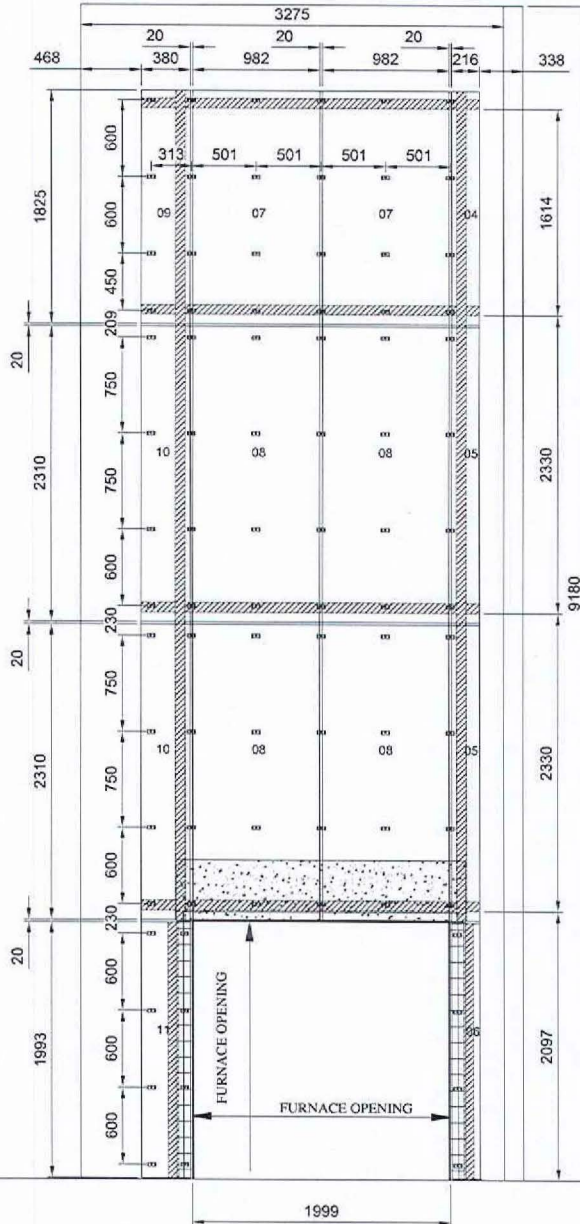
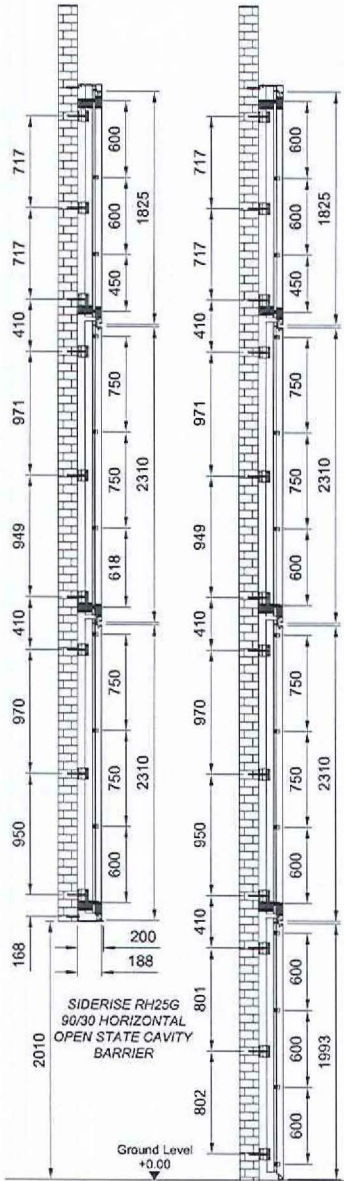
DT01 Elevation Layout
Scale 1:40@A3

Section 2
insulation omitted
for Clarity

Section 1
insulation omitted
for Clarity

Front Elevation Above Crib

Side Elevation



Important Notes
Panels: 3mm Thk PPC Aluminium
System: BML 100 Hook On
All dimensions are theoretical and should be checked and verified prior to instruction to manufacture.

PATENT PENDING

SYSTEM: BOOTH MUIRE BML100 HOOK ON SYSTEM				
INSULATION: 100mm-thick Kingspan Kooltherm K15 insulation. board joints, screw heads and openings formed for brackets should be covered with self-adhesive foil tape.				
CAVITY BARRIER: SIDERISE RSV 90/30 & RH25G 90/30				
TEST	ACM	Classification - EN 13501	Screening Results	Finish/Colour
2	3mm Aluminium	TBC	TBC	PPC Finish

This Drawing to be read in conjunction with HK-1 + HK-1B



03 19.01.18 Kingspan notes added - As Built GI
02 16.11.17 Updated To As Built GI
01 20.10.17 First Issue GI

Rev	Date	Alteration	Initial

boothmuire
Architectural Cladding Systems
Calder House
South Caldeen Road, Coatbridge
ML5 4EG
T: [Redacted]
F: [Redacted]
W: www.boothmuire.co.uk

A **EUROCAD** COMPANY

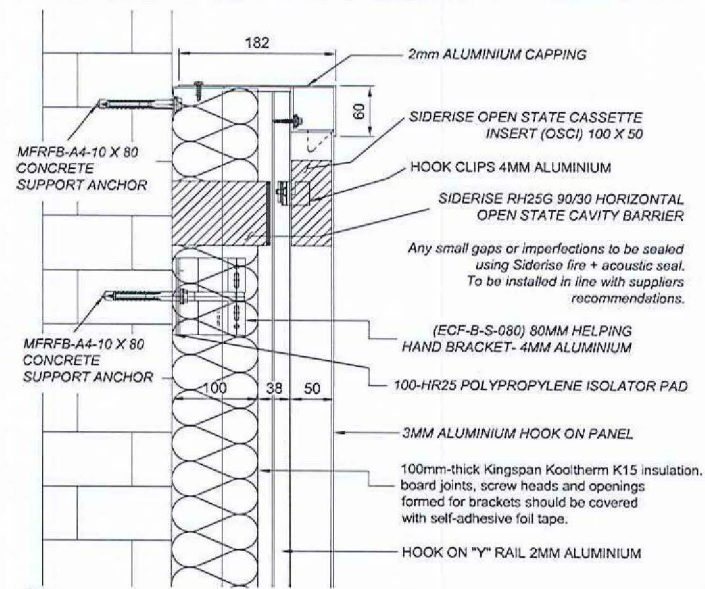
Client: KINGSPAN
Project: Dubai Fire Test
Title: Test 2 - K15 - 3mm Alum - BML100 - Elevations

Drawn By: GI Checked By: Nick Jenkins
Scale: 1:40 A3 Date: OCT 2017
Job No: Test 2 Dwg No: HK-L1 Rev:003

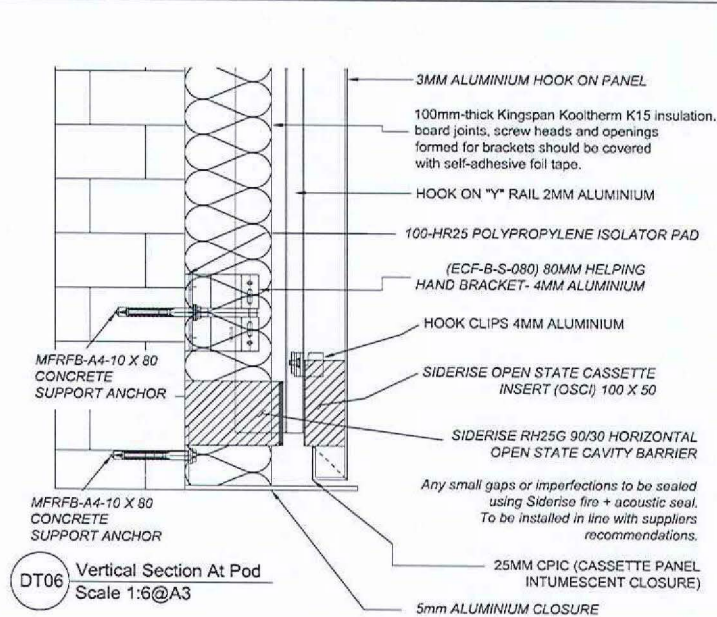
CAD Ref: Test 2 - As Built: A.dwg A3

AS BUILT

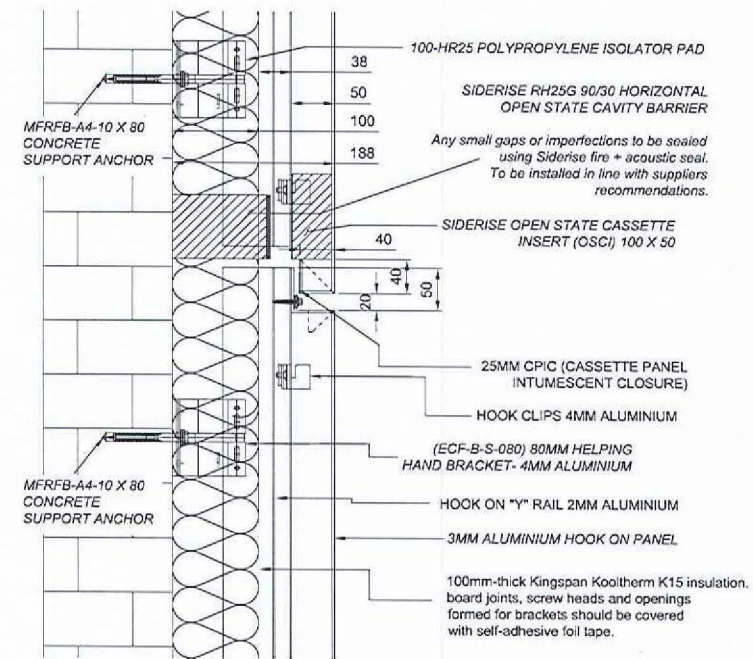
KIN00000477/29



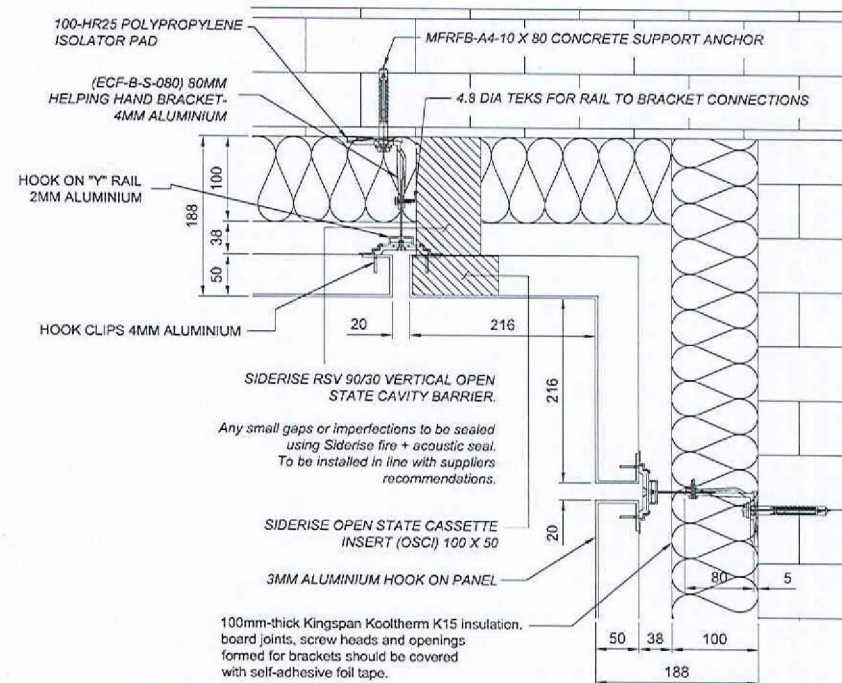
DT05 Vertical Section At Cap
Scale 1:6@A3



DT06 Vertical Section At Pod
Scale 1:6@A3



DT07 Vertical Section
Scale 1:6@A3



DT08 Horizontal Section Internal Corner
Scale 1:6@A3

Important Notes

Panels: 3mm Thk PPC Aluminium System: BML 100 Hook On

All dimensions are theoretical and should be checked and verified prior to instruction to manufacture.

PATENT PENDING



02	19.01.18	Kingspan notes added - As Built	GI
01	04.12.17	Updated To As Built	GI
Rev	Date	Alteration	Initial
<p>boothmuirie Architectural Cladding Systems</p> <p>Calder House South Calderston Road, Coatbridge ML5 4EG T: [REDACTED] F: [REDACTED] W: www.boothmuirie.co.uk</p> <p>A EUROCLAD COMPANY</p>			
Client:	KINGSPAN		
Project:	Dubai Fire Test		
Title:	Test 2 - K15 - 3mm Alum - BML100 - Details		
Drawn By:	GI	Checked By:	Nick Jenkins
Scale:	1: @ A3	Date:	OCT 2017
Job No:	Test 2	Dwg No:	HK-1B Rev102
CAD Ref:	Test 2 - As Built.dwg		A3
AS BUILT			

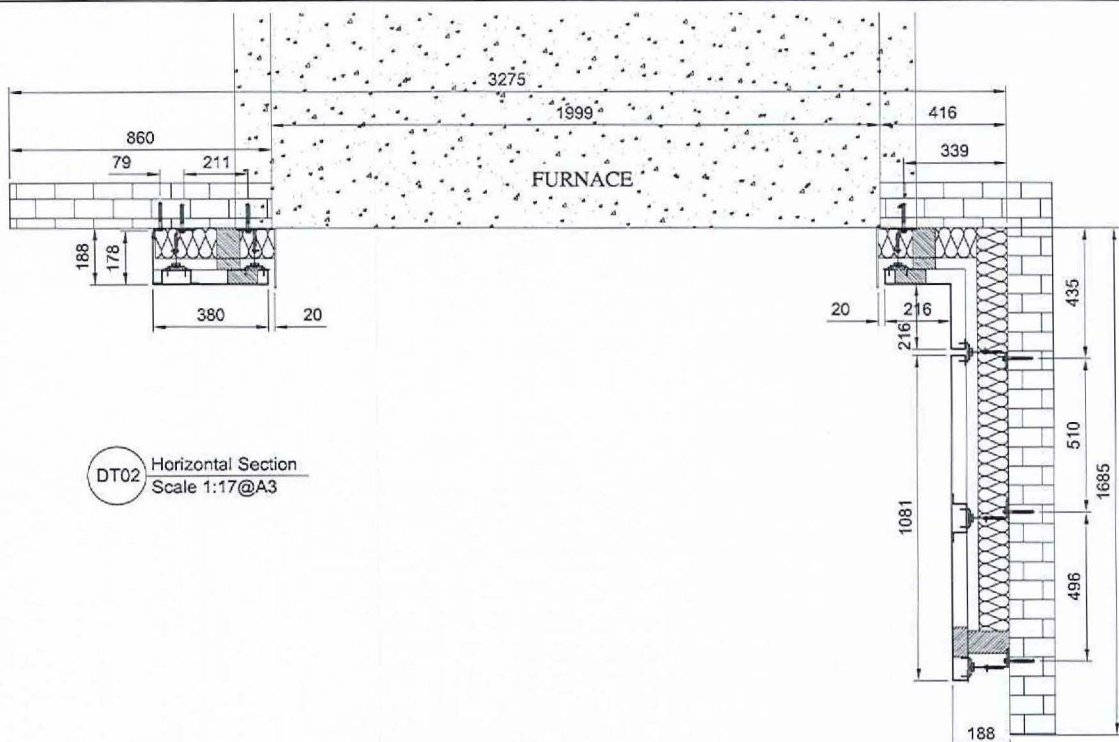
KIN00000477/30

Important Notes

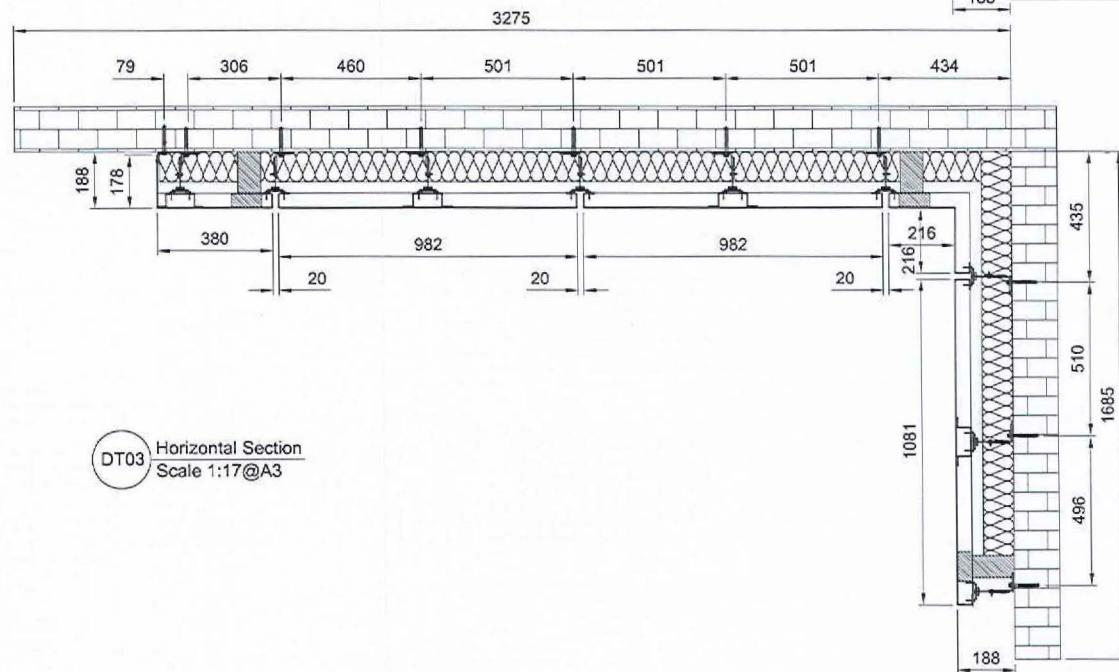
Panels: 4mm THK PPC Aluminium
System: BML 100 Hook On

All dimensions are theoretical and should be checked and verified prior to instruction to manufacture.

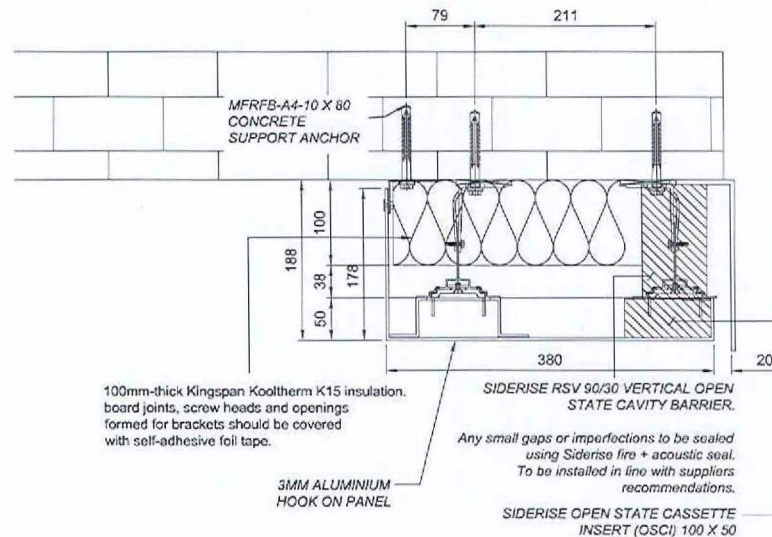
PATENT PENDING



DT02 Horizontal Section
Scale 1:17@A3



DT03 Horizontal Section
Scale 1:17@A3



DT04 Enlarged Jamb Detail
Scale 1:6@A3

100mm-thick Kingspan Kooltherm K15 insulation, board joints, screw heads and openings formed for brackets should be covered with self-adhesive foil tape.

SIDERISE RSV 90/30 VERTICAL OPEN STATE CAVITY BARRIER.

Any small gaps or imperfections to be sealed using Siderise fire + acoustic seal. To be installed in line with suppliers recommendations.

SIDERISE OPEN STATE CASSETTE INSERT (OSCI) 100 X 50



03	19.01.18	Kingspan notes added - As Built	GI
02	16.11.17	Updated To As Built	GI
01	26.10.17	First Issue	GI

Rev	Date	Alteration	Initial
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boothmuir
Architectural Cladding Systems



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A EUROCAD COMPANY

Client:	KINGSPAN
Project:	Dubai Fire Test
Title:	Test 2 - K15 - 3mm Alum' - BML100 - Details

Drawn By:	GI	Checked By:	Nick Jenkins
Scale:	1: @ A3	Date:	OCT 2017
Job No:	Test 2	Dwg No:	HK-1 Rev:03

CAD Ref:	Test 2 - As Built: A.dwg	A3
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AS BUILT

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Table 5 Document Status

Rev No.	Author	Reviewed & Approved for Issue		
		Name	Signature	Date
0	Arun Kumar	Manoj Kumar Lab. Manager		13.03.2018