

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. : DLR1453 Rev.0
Sample : Kooltherm K15 –Alpolic/fr - BML100



4559

May 2018

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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.,
Pembroke, Leominster,
Herefordshire, England.

Contact email: highrisetechnical@kingspan.com

Contact number: +44 1544 387 382

AFE Job/Sample Number: PD 106193/ C2753C

The test sample consisted of an external wall cladding system (Kooltherm K15 –Alpolic/fr- BML100) 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 12th December 2017 and was to determine the fire performance of an aluminium composite metal 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 DMC2753C/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:

Craig Laidlan - Kingspan Insulation Ltd.

The test was supervised by Akhil Chacko 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	20°C
t_s , start time	165 seconds after ignition of the crib (thermocouple 3)
Peak temperature & time at Level 2 (External)	747°C at 1140 seconds from t_s (thermocouple 11)
Peak temperature / time at Level 2 (Mid-depth of cavity)	397°C at 1404 seconds from t_s (thermocouple 19)
Peak temperature / time at Level 2 (Mid-depth of Kooltherm K15 100mm insulation)	150°C at 1755 seconds from t_s (thermocouple 25)

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 Muir BML 100-HP (Hook Plate System) cassette panels formed from Alpolic/fr ACM.
- ❖ Booth Muir BML 100-HP (Hook Plate System) aluminium vertical Y-rails.
- ❖ Kooltherm K15 100mm insulation.
- ❖ Siderise RH25G 90/30 intumescent horizontal cavity barrier in conjunction with Siderise Open State Cassette Insert.
- ❖ Siderise RV-90/30 vertical cavity barrier in conjunction with Siderise Open State Cassette Insert.

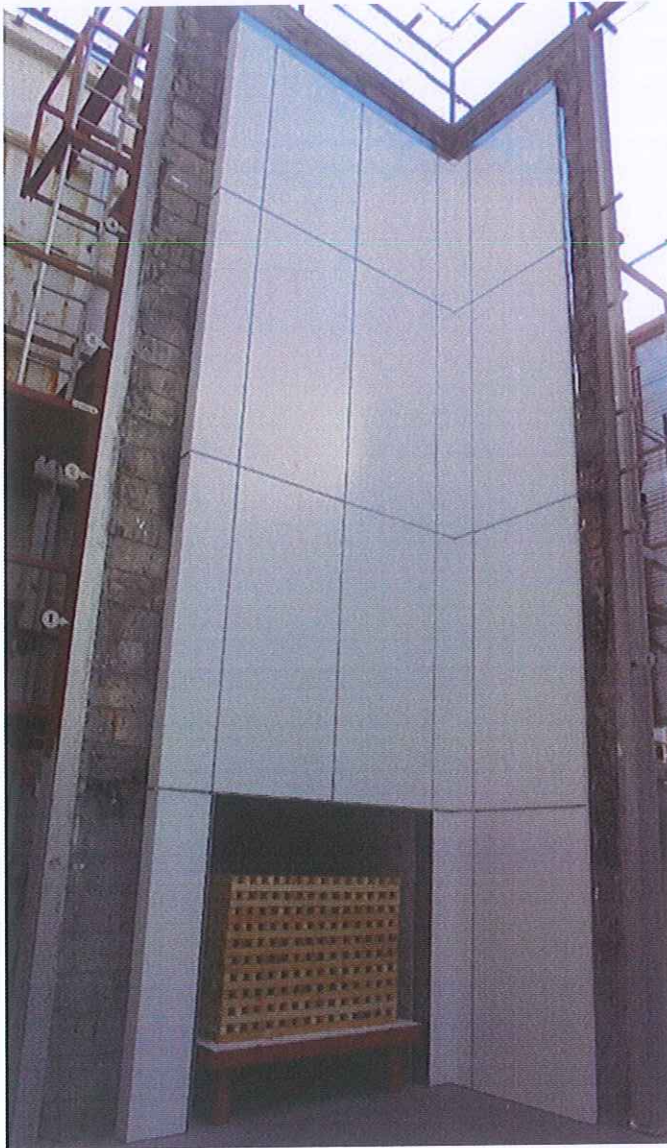
Main wall - 2620mm wide x 8585mm high.

Wing wall - 1320mm wide x 8585mm high.

The top end of the cladding system was closed with 2mm 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 230mm.

Photo DLP C2753C/7259 shows an external view of the sample.

Figure 1 Photo DLP C2753C/7259 External View of the Test Sample



The system components are mentioned in Table 3. Refer to the drawings in Appendix B for sample construction details and dimensions.

Material information described in Table 3 below is as supplied by Kingspan Insulation Ltd.

Table 2 System Details

Component	Description	Installation Details
Bracket	ECF-B-S-80 helping hand bracket and polypropylene plastic thermal shim. See photo DLP C2753C/7025 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 RH25G-90/30, density 80kg/m ³ . See photo DLP C2753C/6999 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 150mm above the combustion chamber opening, 2480mm above combustion chamber, 4810mm above combustion chamber and 6425mm above combustion chamber.
	Vertical cavity barrier: Siderise RV-90/30, 1200x170x75mm, density 80kg/m ³ . See photo DLP C2753C/6999 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	Siderise inserts were placed at the folding of the aluminium composite panels at the cavity barrier locations. It was secured to the back face of the composite 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.
Insulation	Kingspan Kooltherm K15 100mm insulation. See photo DLP C2753C/4840 & DLP C2753C/4839 in Appendix A.	Insulation foam boards were fixed to the masonry wall with steel and plastic pins.

Component	Description	Installation Details
Railing & Hooks	Booth Muir BML 100-HP (Hook Plate System) aluminium vertical Y-rails, 2mm thick. See photo DLP C2753C/4839 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	Booth Muir BML 100-HP (Hook Plate System) cassette panels formed from Alpolic/fr ACM, 4mm thick. Top - Aluminium Skin Core - Mineral filled core Bottom - Aluminium Skin See photo DLP C2753C/7254 in Appendix A.	Aluminium composite 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 8414:2015 + A1:2017 Part 1.

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: 06 Dec. '17 to 09 Dec. '17

Ambient temperature range: 15 - 23°C

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 Sylvestris 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

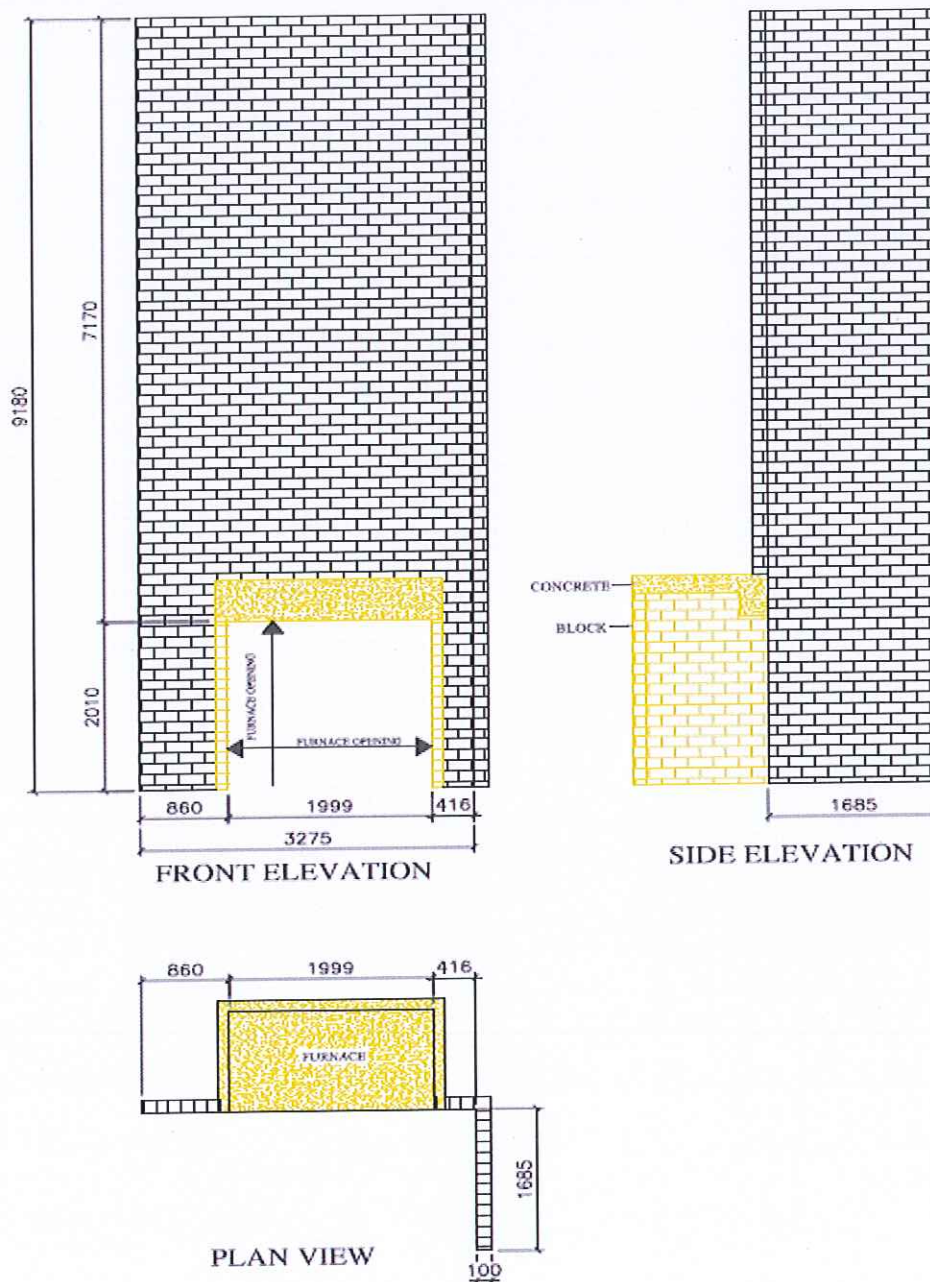
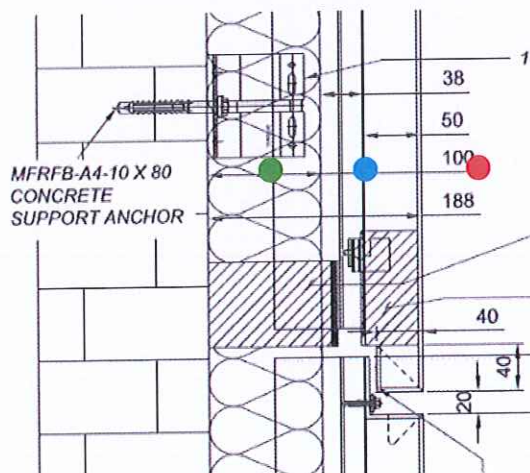
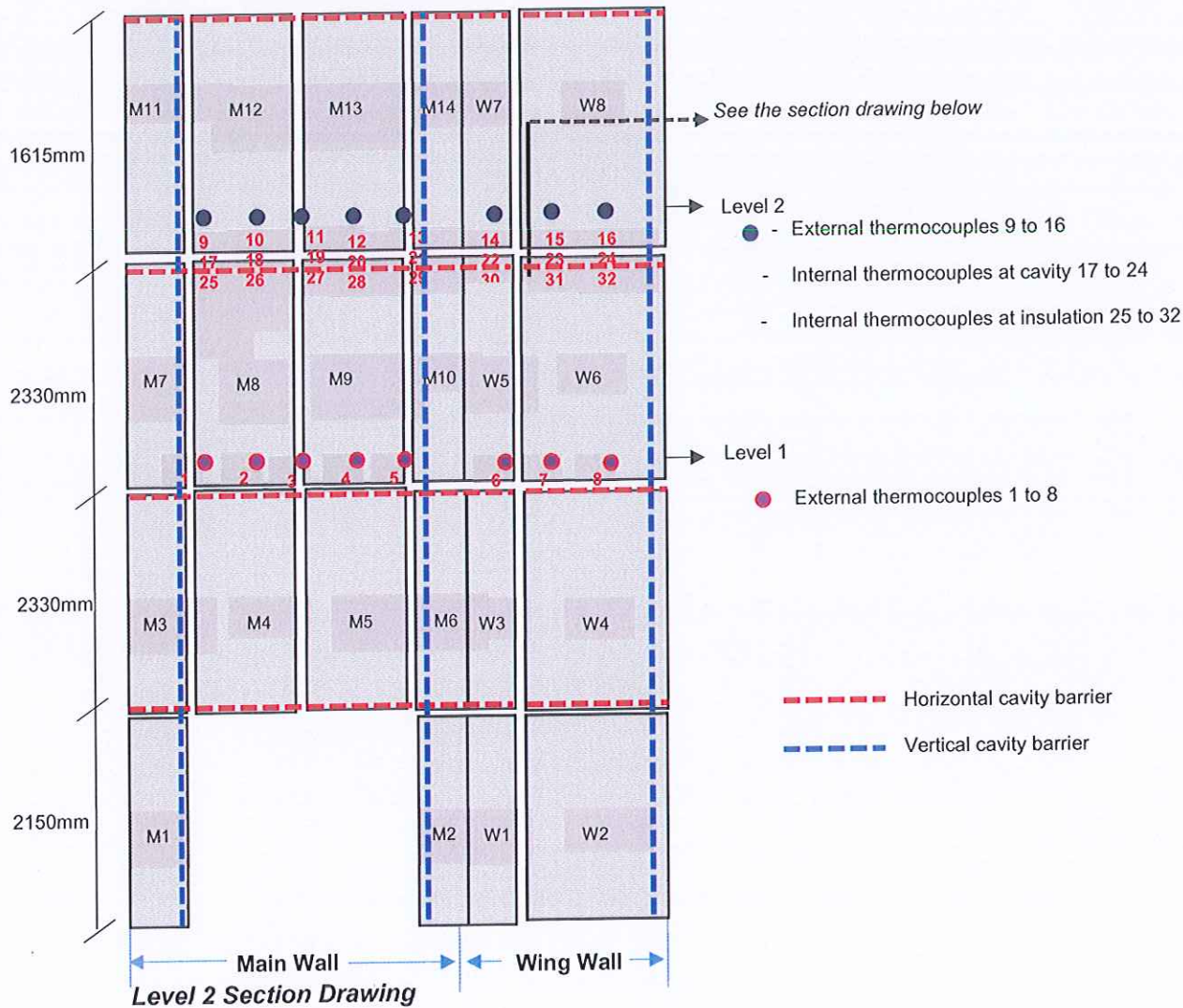


Figure 3 Thermocouple Locations & Panel Numbering



- 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

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: 06 Dec. '17 to 09 Dec. '17

Ambient temperature during installation: 14°C - 23°C

Sample conditioning: Not Specified

Date of testing: 12 Dec. '17.

Ambient temperature: 19°C

Wind speed: 0.8 m/s

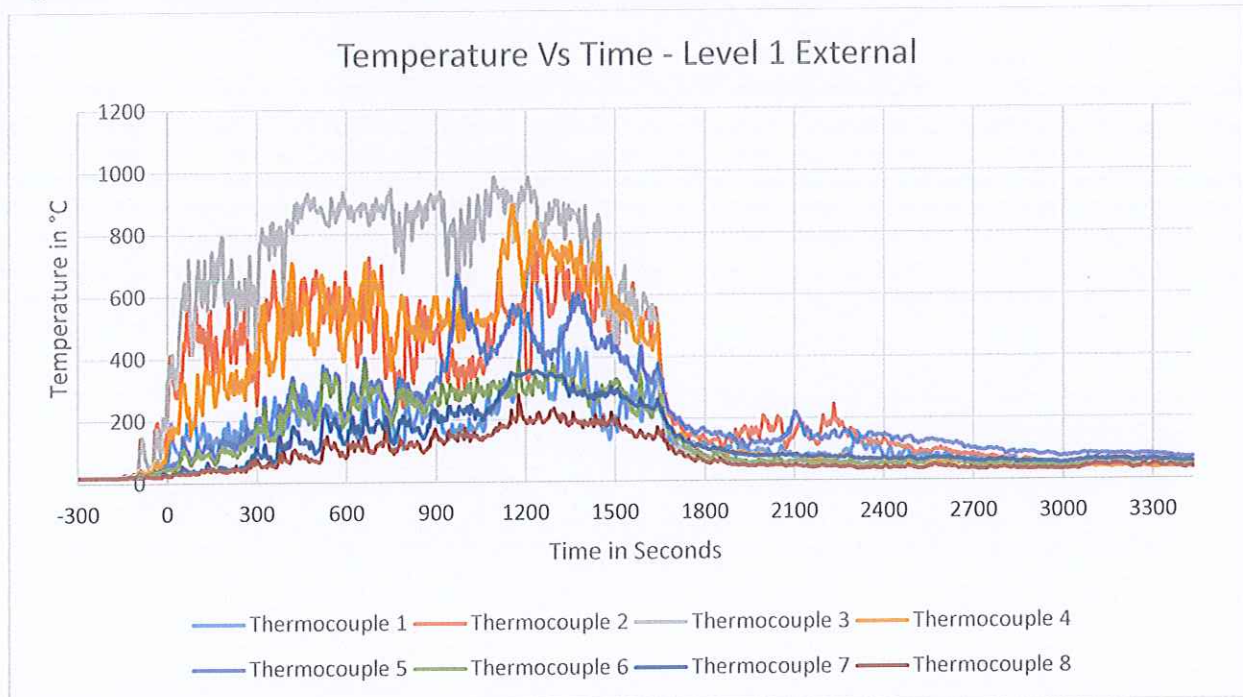
Table below summarises the observations during the test.

Table 3 Visual Observations during the Test

Time	Seconds	Observation	Photo Reference
09:08:08	-	Ignition of crib	-
09:10:35	-	Flames above the combustion chamber.	-
09:10:53	00	Start time t_s , 322.58°C ($\geq T_s + 200^\circ\text{C}$) at thermocouple 3, Level 1 (main wall).	-
09:11:48	55	Buckling observed on panel M4 & M5.	-
09:13:04	132	Top coating burned on panels M4 & M5	-
09:14:47	234	Top coating burned on panels M8	-
09:17:22	389	Flame on panel M4.	-
09:18:00	427	Melted aluminium dripped from main wall.	-
09:18:20	447	Flame on top of flashing above combustion chamber	-
09:18:57	484	Flaming debris fell down from main wall.	DLP C2753C/0001
09:19:02	489	Discolouration observed on panels M4, M5, M6 & M7	-
09:19:09	496	Burning debris fell off the main wall.	-
09:19:31	518	Continued falling of burning debris	-
09:20:06	718	Discolouration on panel W2	DLP C2753C/0002
09:20:23	570	Discolouration on panels M12 and M13	-
09:20:30	577	Sustained flame observed on M4 & M5 vertical joint.	DLP C2753C/0003
09:21:00	607	Flames observed in around burned edges of panel M4	-
09:21:28	635	Sustained flame observed on M8 & M9 vertical joint.	DLP C2753C/0004
09:22:53	720	Burning debris fell off the main wall.	

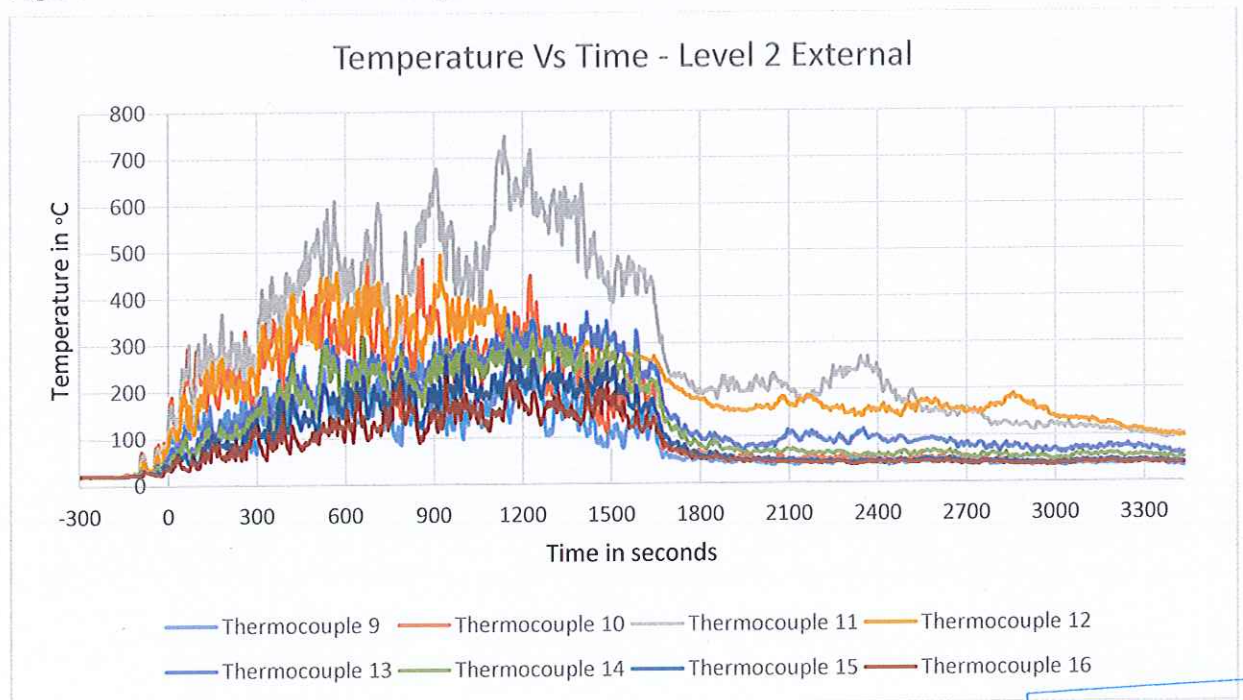
Time	Seconds	Observation	Photo Reference
09:24:12	799	Approximately 50% of panels M4 and M5 were damaged.	-
09:25:24	871	Flame on panel M5 corner.	-
09:25:35	882	Burning debris fell off the main wall	-
09:25:47	894	Sustained flame observed at M8 & M9 panel joint.	-
09:26:43	950	Flames observed inside the panel M5	-
09:27:51	1018	Buckling on corner panel M6-W3.	-
09:28:14	1041	Aluminium railings behind panel M4 and M5 melted	-
09:28:44	1071	Debris fell off the main wall.	DLP C2753C/0005
09:30:38	1185	Sustained flame at corners of panels M4 & M5.	-
09:31:00	1207	Flames observed behind panel M9.	-
09:31:08	1215	Debris fell down from behind panel M9.	-
09:31:26	1233	Debris fell down from behind panel M8.	-
09:32:26	1293	100% of the panels M4 and M5 were consumed by fire.	DLP C2753C/0006
09:33:00	1327	Insulation behind burned panels were exposed as char.	-
09:35:39	1486	Burned insulation behind the panel M4 & M5 fell off.	-
09:37:10	1577	All insulation behind panels M4 and M5 fell off the main wall and core wall was exposed.	-
09:38:08	1635	The heat source was extinguished, observation continued for another 30minutes.	-
09:39:01	1688	Continuous burning above cavity barrier.	-
09:42:46	1913	Intermittent flames lasted for 10minutes behind the panels M8 and M9.	-
09:48:37	2264	Sustained flames observed at top corner of panel M4.	-
10:08:08	3435	No significant changes observed, test was terminated.	-

Figure 4 Thermocouple Readings on Level 1 - External



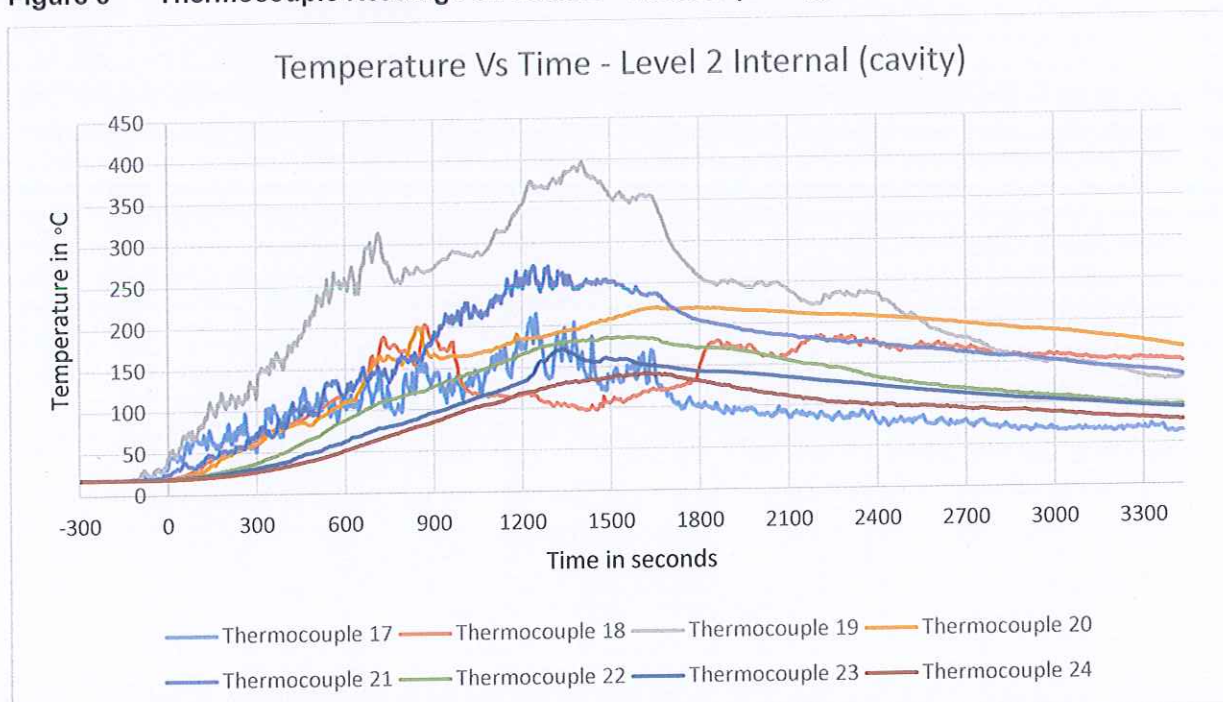
For thermocouple locations see Figure 3.

Figure 5 Thermocouple Readings on Level 2 – External



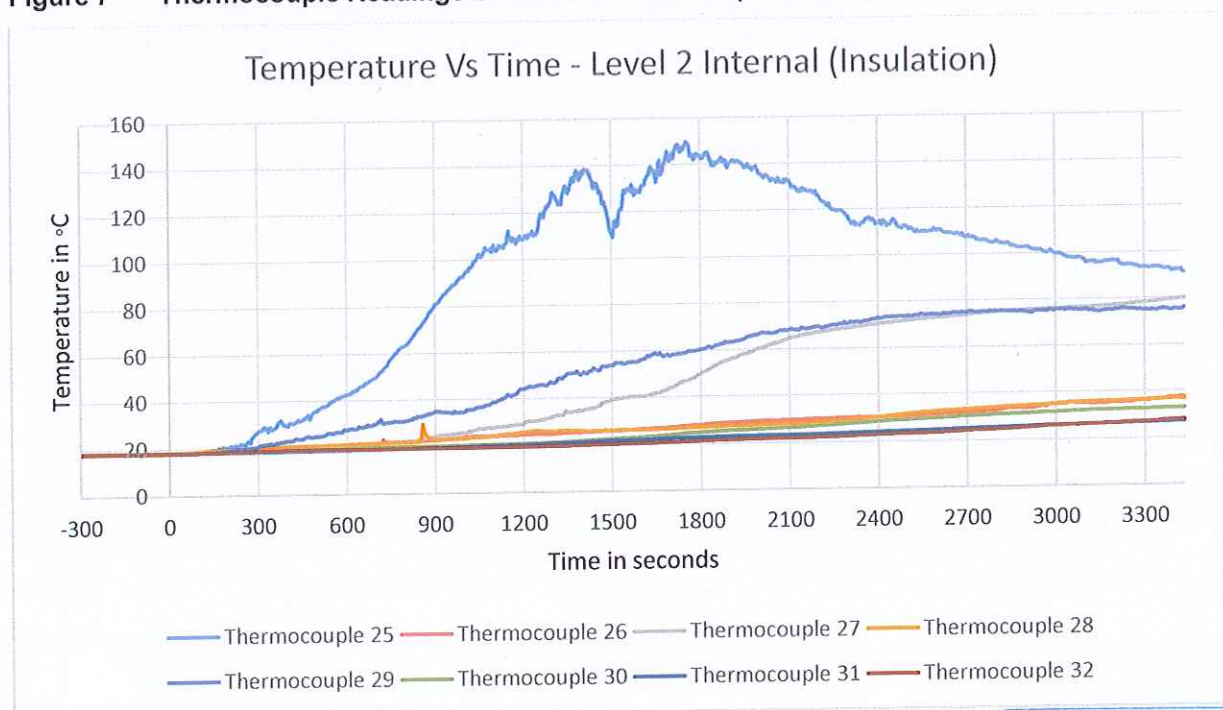
For thermocouple locations see Figure 3.

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



For thermocouple locations see Figure 3.

Figure 7 Thermocouple Readings on Level 2 – Internal (Insulation)



For thermocouple locations see Figure 3.

6.1 Post-test Examination

Table 5 below summarises the post-test observations.

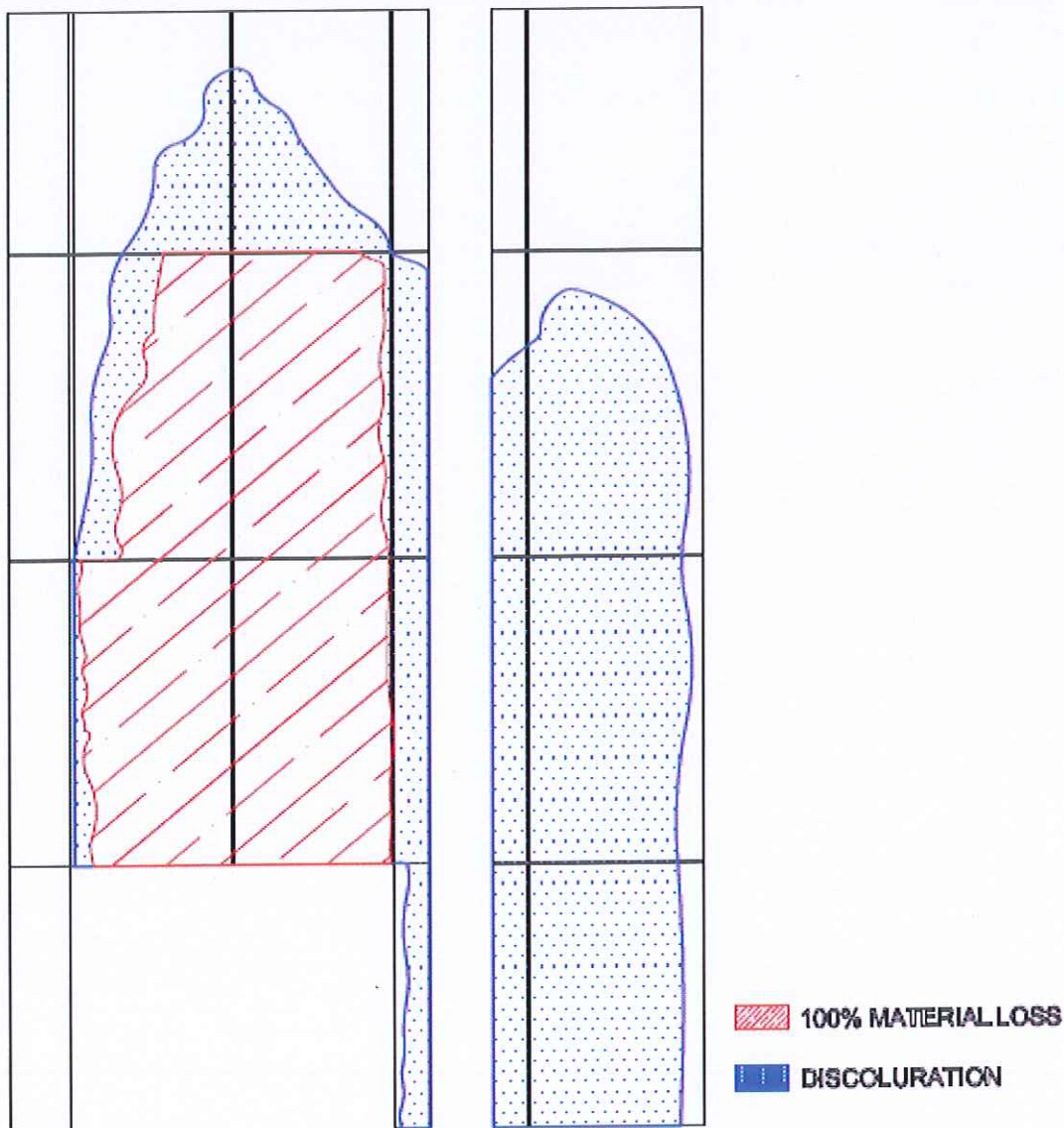
Table 4 Post-test Observations

Sl. No.	Components	Observation	Photo Reference
1	Aluminium composite panels	<p>Approximately 27% of material loss on the panels.</p> <p>Approximately 37% of panel was discoloured.</p> <p>Panels M1, M7, M11 and M14-W7 corner, W8 - No damage was observed.</p> <p>Panel M2-W1 corner – 100% discolouration on W1. Minor discolouration on M2.</p> <p>Panel M3 - Minor discolouration was observed at edge. No other damage was observed</p> <p>Panels M4, M5 - 100% of the panel was consumed by fire.</p> <p>Panel M6-W3 corner - 100% of the panel was discoloured and 1st layer of coating was burned from panel W3.</p> <p>Panel M8 - Approximately 60% of the panel was consumed by fire, the remaining was distorted, discoloured and buckled.</p> <p>Panel M9 - Approximately 90% of the panel was consumed by fire, the remaining was distorted, discoloured and buckled.</p> <p>Panel M10-W5 corner - Minor discolouration was observed.</p> <p>Panels M12, M13 – Top coating was burned at the vertical joint, discolouration was observed</p> <p>Panels M12, M13 – Top coating was burned at the vertical joint.</p> <p>W2- Approximately 80% top coating was burned and discoloured.</p> <p>W4- Approximately 75% top coating was burned, discoloured and buckled.</p> <p>W6- Approximately 50% discolouration was observed.</p>	<p>DLP C2753C/0007</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 at 150mm above the combustion chamber was activated. Melted aluminium debris fell onto the barrier and was compressed by its weight. Material loss and damage was observed.</p> <p>The 2nd horizontal cavity barriers at 2480mm was activated. The expanded intumescent layer was not present on the main wall during dismantling.</p> <p>The 3rd horizontal cavity barriers at 4810mm on main wall was activated and on wing wall was not activated. No material loss were observed.</p> <p>The 4th horizontal cavity barriers at 6425mm on main wall and was partially activated on main wall and on wing wall was not activated. No material loss was observed.</p> <p>Vertical cavity barrier:</p> <p>Minor discolouration and buckling to the vertical cavity barriers extending between panel M1 and combustion chamber.</p> <p>Buckling and minor material loss on vertical cavity barriers extending between combustion chamber and panel M2. No damage to the vertical cavity barrier on wing wall.</p>	DLP C2753C/0008, DLP C2753C/0009 & DLP C2753C/0010.
3	Insulation	<p>100% damage on Kooltherm K15 insulations and core wall was exposed behind panels M4, M5.</p> <p>Insulation behind W3 was discoloured.</p> <p>Insulation behind M8, M9 was damaged and exposed as charcoal.</p> <p>All other insulations were in place without any damage.</p>	DLP C2753C/0008 & DLP C2753C/0009
4	Railing	<p>All railings behind panels M4 & M5 were melted off.</p> <p>Railings behind panels M3, M7, M11, M12 and M13 were discoloured.</p> <p>Railings behind M2-W1 and W2 were buckled and discoloured. All other railings were in place without any damage.</p>	DLP C2753C/0009

Sl. No.	Components	Observation	Photo Reference
5	Brackets	100% of brackets behind panels M4, M5, M6-W4, M8 and M9 were damaged. All other brackets were discoloured and were in place without any damage.	DLP C2753C/0007.

Figure 8 ACM panel damaged area



- Approximately 8m² of the total panel was completely consumed by fire.
- Approximately 10m² of the total panel was discoloured.

Appendix A

Photographs

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

Pre-test Phase



DLP C2753C/4840

Cavity barrier and insulation



DLP C2753C/7025

Aluminium bracket



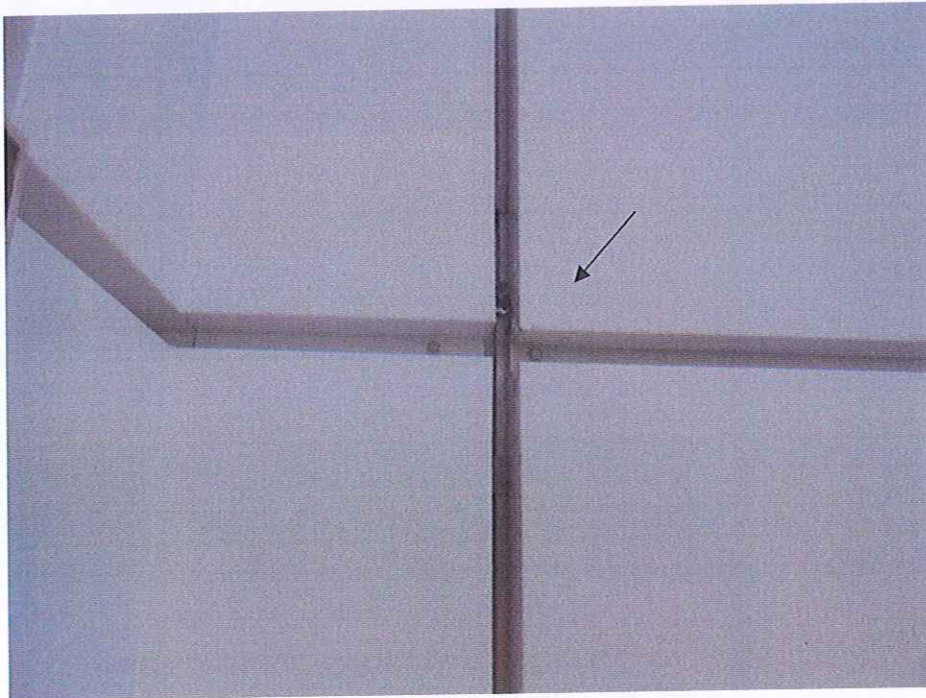
DLP C2753C/6999

Vertical and Horizontal intumescent cavity barrier



DLP C2753C/4839

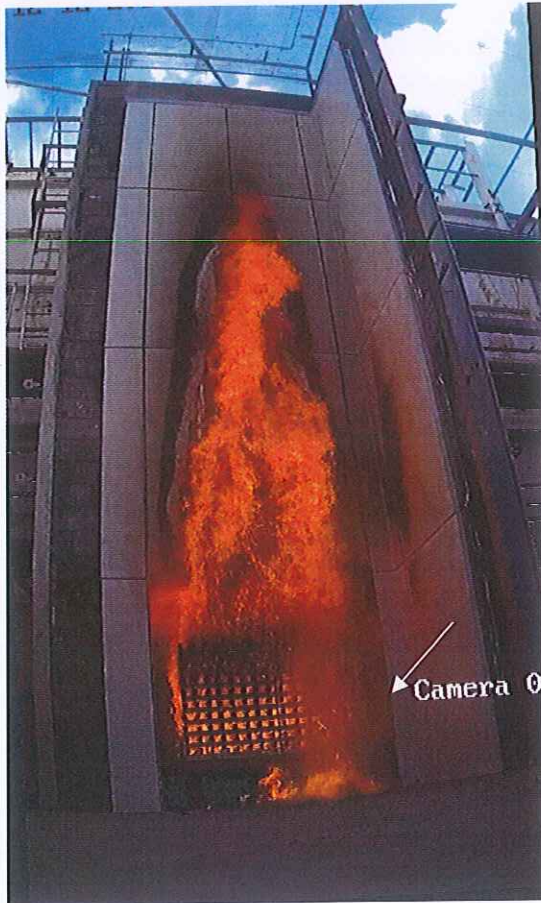
Kooltherm K15 Insulation and Railings



DLP C2753C/7254

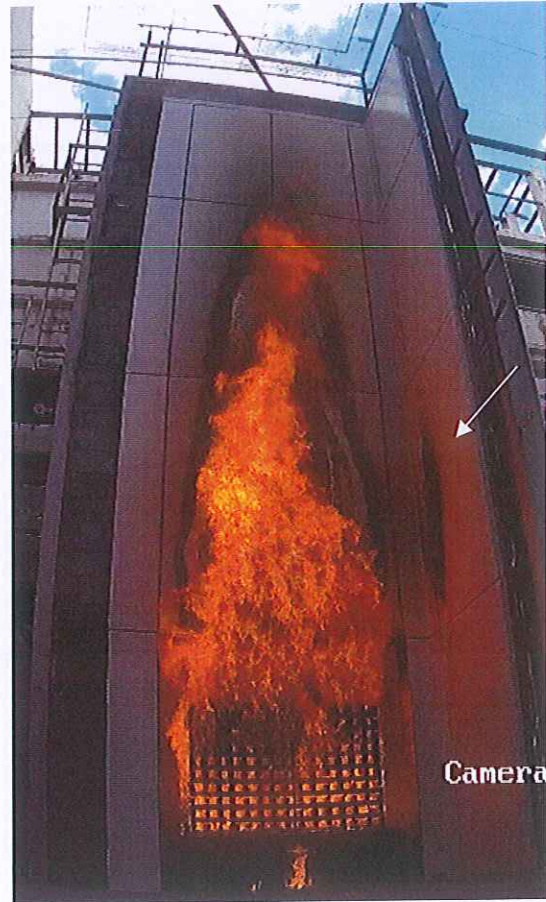
Alpolic/fr ACM panel

Testing Phase



DLP C2753C /0001

Flaming debris fell down from main wall.

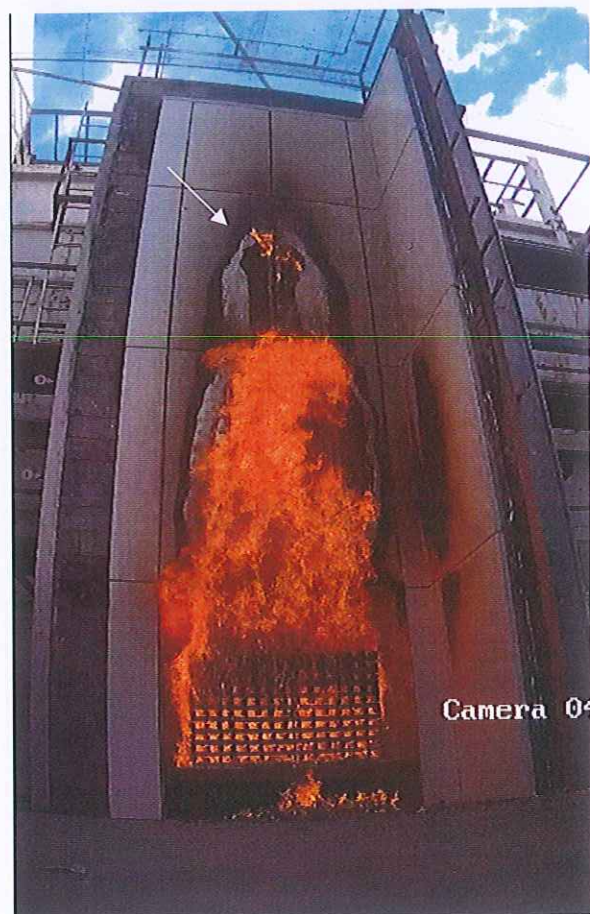


DLP C2753C /0002

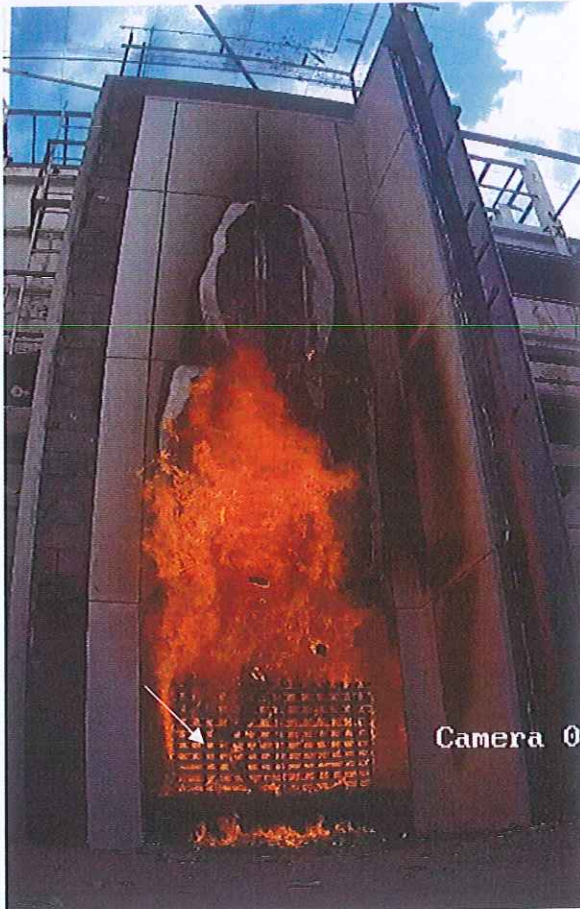
Discolouration on W2



DLP C2753C/0003 Self sustained flame on M4 & M5



DLP C2753C/0004 Self sustained flame between M8 & M9



DLP C2753C/0005 Debris fell off the main wall



DLP C2753C/0006 M4 & M5 panels consumed by fire

Post-Test Phase



DLP C2753C/0007

View of the sample after the test completion



DLP C2753C/0008 Cavity barrier and insulation



DLP C2753C/0009

Burned Kooltherm K15 insulation and railings



DLP C2753C/0010

Cavity barrier at the top of combustion chamber

Appendix B

Drawings

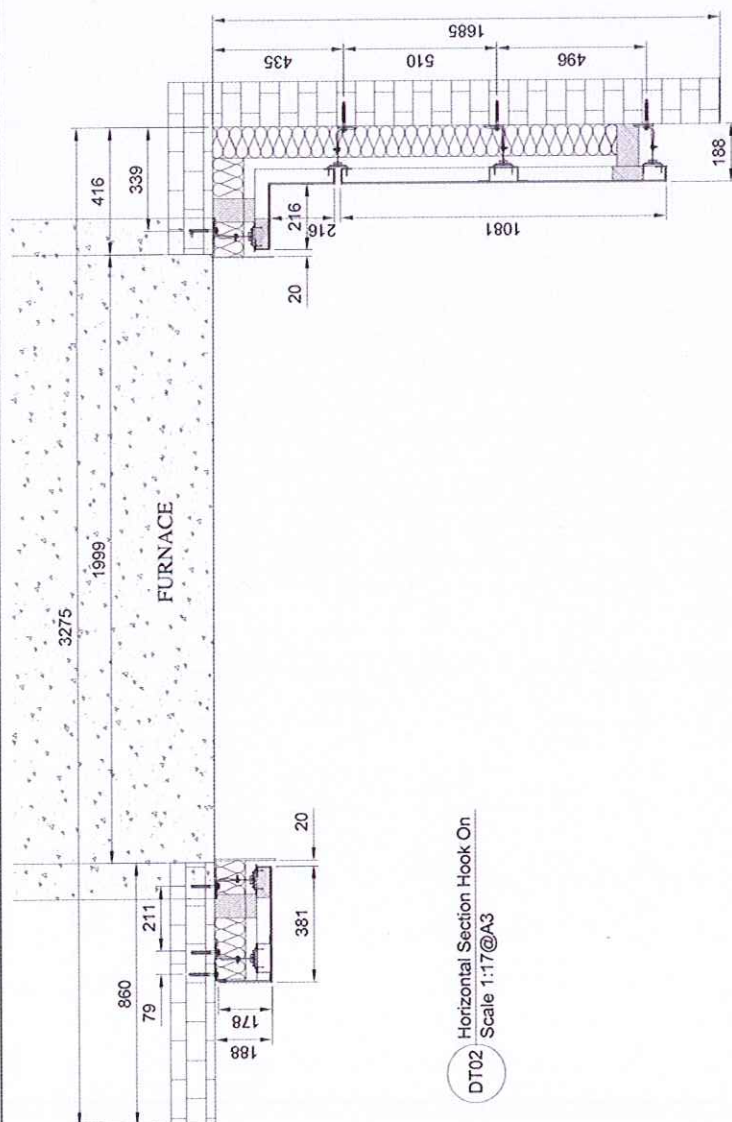
The following three un-paginated sheets are copies of Kingspan Insulation Ltd. drawings numbered:

- HK-2 Rev.04
- HK-2B Rev.03
- HK-L2 Rev.03

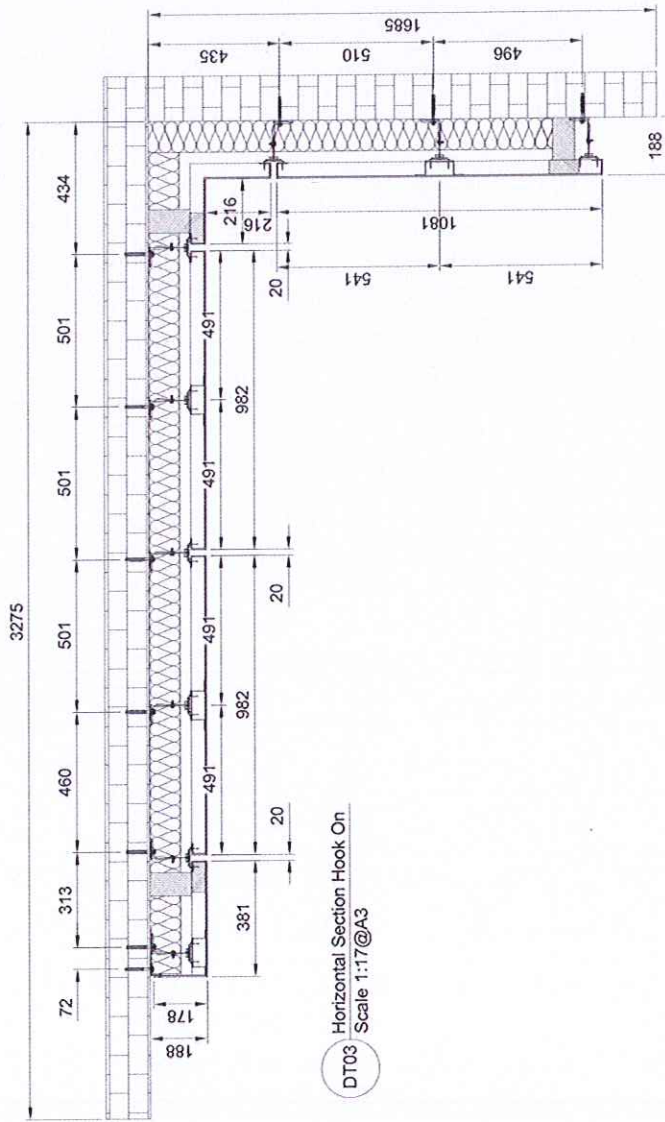
Panels: 4mm THK Alpolic Fr
System: BML 100 Hook On

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

PATENT PENDING



DT02 Horizontal Section Hook On
Scale 1:17@A3



DT03 Horizontal Section Hook On
Scale 1:17@A3

DT04 Enlarged Jamb Detail Hook On
Scale 1:6@A3

04	19.04.18	Kingspan notes amended - As Built	G1
03	19.01.18	Kingspan notes added - As Built	G1
02	16.11.17	Updated To As Built	G1
01	11.10.17	First Issue	G1



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F: 01236 345 515
W: www.boothmulrie.co.uk

A EUROCLAD COMPANY

Client: KINGSPAN

Project: Dubai Fire Test

Title: Test 3 - K15 - Apolic Fr - BML100 - Details

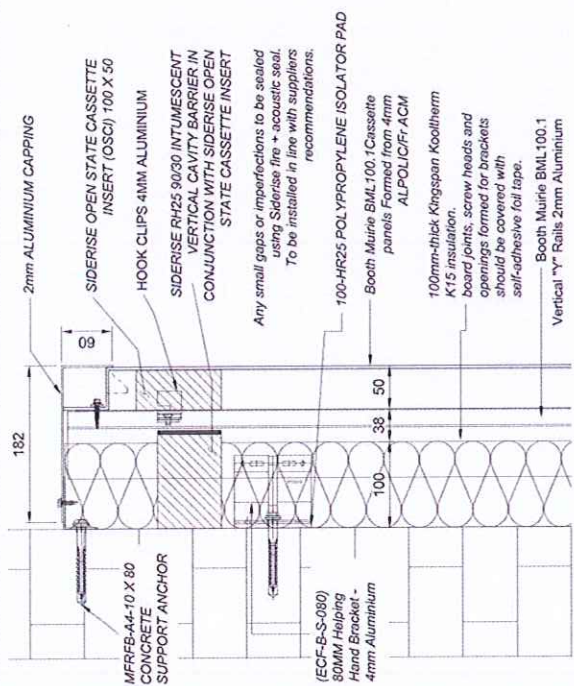
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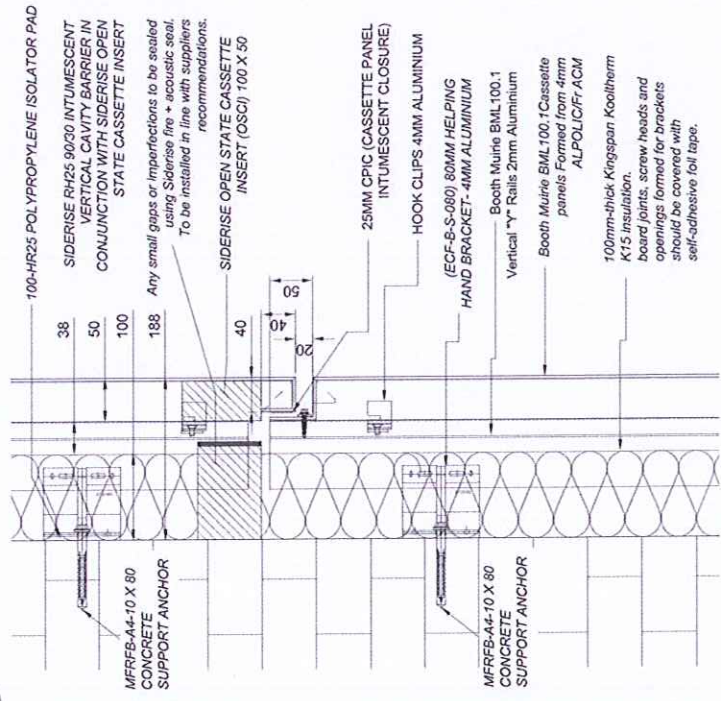
Job No:	Test 3	Dwg No:	HK-2	Rev:0
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ASB III T

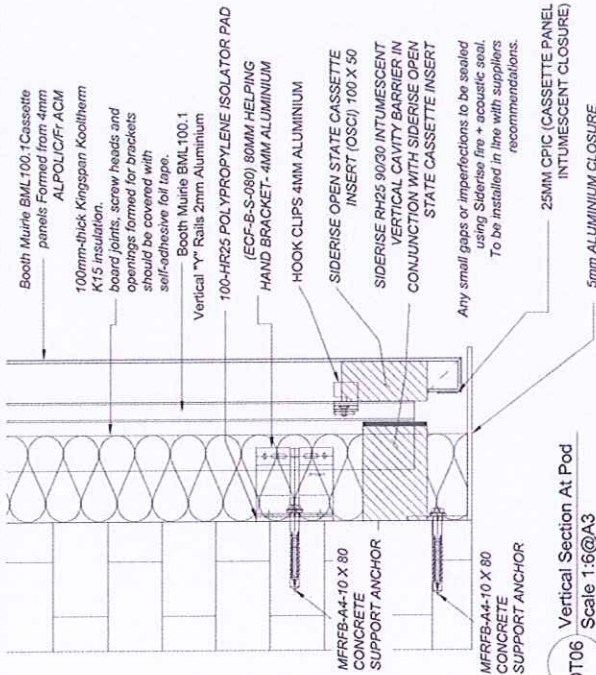




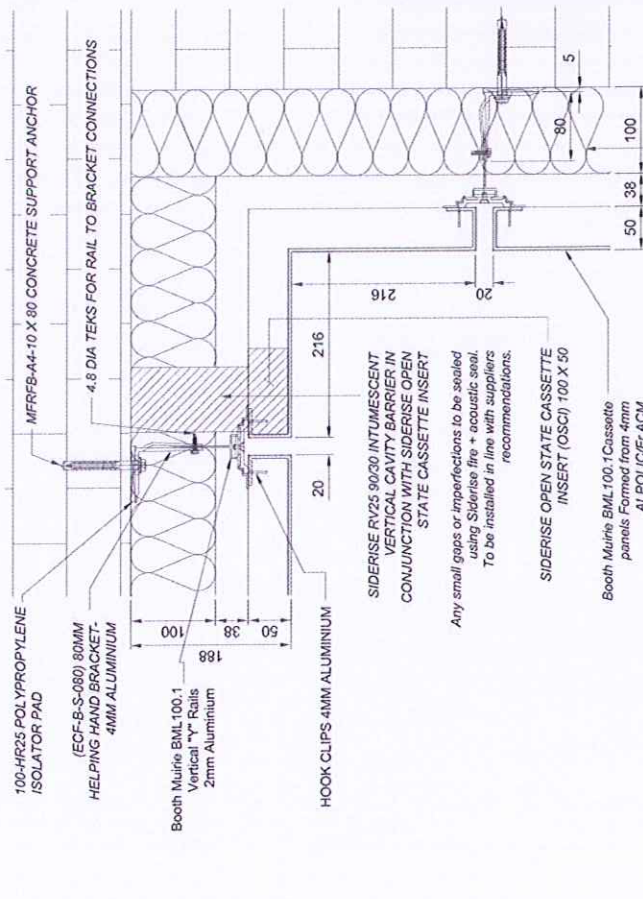
DT05 Vertical Section At Cap
Scale 1:6@A3



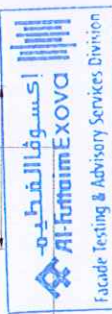
DT07 Vertical Section
Scale 1:6@A3



DT06 Vertical Section At Pod
Scale 1:6@A3



DT08 Horizontal Section Internal Corner
Scale 1:6@A3



Important Notes
Panels: 4mm THK Alpolic Fr System: BML 100 Hook On
All dimensions are theoretical and should be checked and verified prior to instruction to manufacture.

PATENT PENDING

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Architectural Cladding Systems
Calder House
10000 Green Road, Coathbridge
ML5 4EG
T: 01236 345 500
F: 01236 345 515
W: www.boothmuirie.co.uk

A EUROCLAD COMPANY
Client: KINGSPAN
Project: Dubai Fire Test
Title: Test 3 - K15 - Alpolic Fr - BML100 - Details

Drawn By: GI
Scale: 1:6@A3
Job No: Test 3
CAD Ref: Test 3 - As Built - B The.dwg

Checked By: Nick Johnson
Date: OCT 2017
Dwg No: HW-20
Rev: 03

AS BUILT

GI 19.04.19 Kingspan notes amended - As Built
GI 19.01.19 Kingspan notes added - As Built
GI 04.12.17 Updated To As Built

Panels: 4mm Thk Alpolic Fr
 System: BML 100 Hook On

SYSTEM: BOOTH MUIRIE BML100 HOOK ON SYSTEM

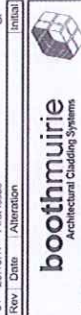
INSULATION: 100mm-thick Kingspan Kooltherm K15 insulation, board joints, screw heads and openings formed for brackets should be covered with self-adhesive foil tape.

CAVITY BARRIER: SIDERISE RSV 90/30 & RH25G 90/30

TEST	ACM	Classification - EN 13501	Screening Results	Finish/Colour
3	Alpolic Fr	B,s1,d0	TBC	Silver Metallic

This Drawing to be read in conjunction with
HK-2 + HK-2B

03	19.01.18	Kingspan notes added - As Built	GI
02	16.11.17	Updated To As Built	GI



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A EUROCLAD COMPANY

Client:	KINGSPAN
---------	----------

Project: Dubai Fire Test

Title: Test 3 - K15 - Apolipoprotein B - BML100 - Elevations

Drawn By: GI	Checked By: Nick Jenkins
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Scale:	1: @ A3	Date:	OCT 2017
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Job No:	Test 3	Dwg No:	HK-L2	Rev:0
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AS BUILT

DT01
Elevation Layout Hook On
Scale 1:40@A3

Front Elevation Above Crib

Side Elevation

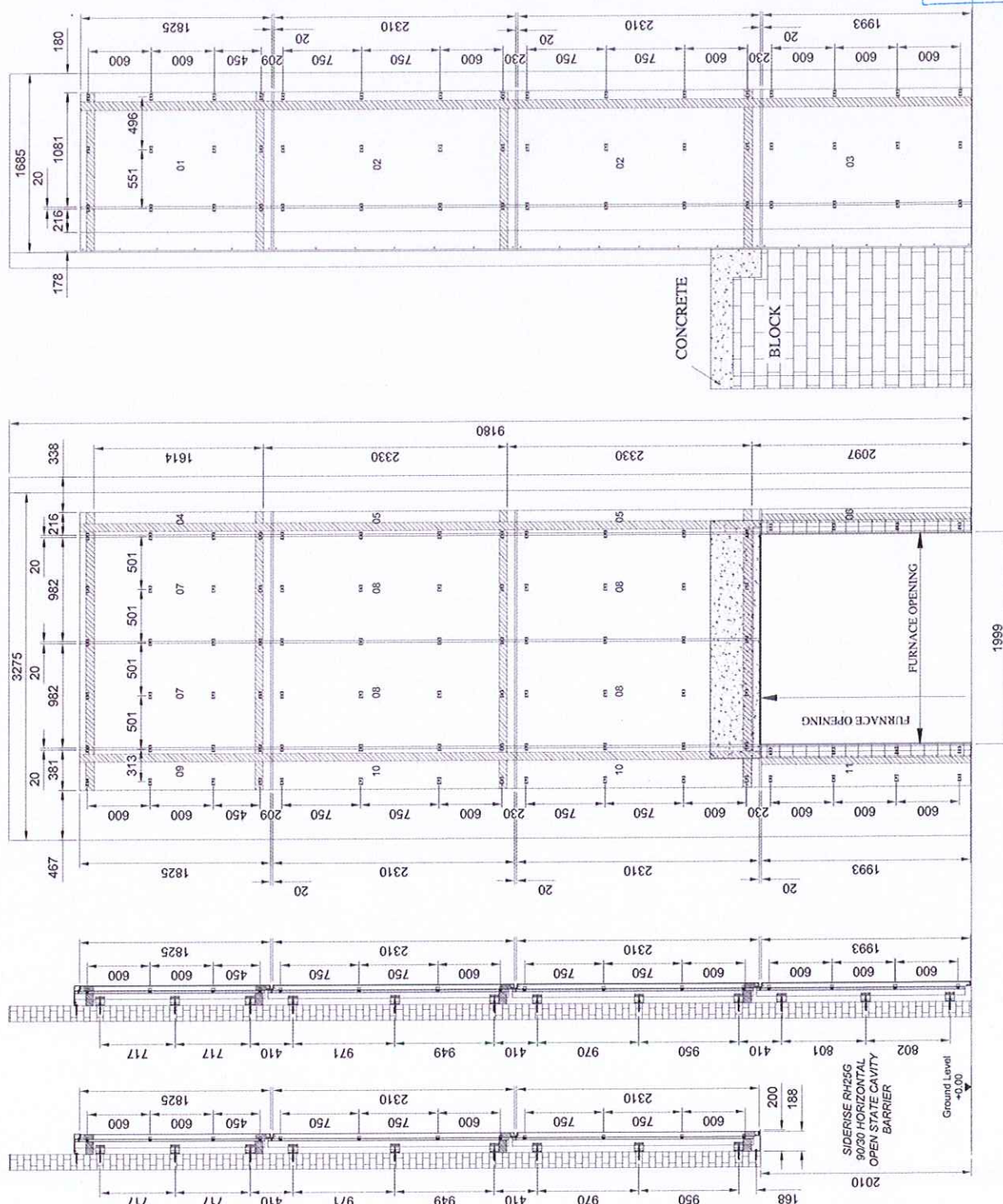
Section 1
insulation omitted
for Clarity

Section 1

insulation omitted
for Clarity

Section 2

Insulation omitted
for Clarity



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Table 5 Document Status

Rev No.	Author	Reviewed & Approved for Issue		
		Name	Signature	Date
0	Arun Kumar M	Manoj Kumar Lab. Manager		30.05.2018