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BRE Global Test Report

BS 8414-1:2015 + A1:2017 test on ventilated façade system with phenolic thermal insulation and ACM (ALPOLIC/A2) Cassette panels BML 100 Hook On

Prepared for: Mitsubishi Chemical Corporation

Date: 01 March 2018

Report Number: P109973-1000 **Issue:** 1.0

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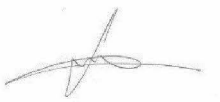
Signature 

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1 Introduction

The test method, BS8414 Part 1:2015 + A1:2017 [1] describes a method of assessing the behaviour of non-load bearing external cladding systems, rain screen over cladding systems and external wall insulation systems when applied to the face of a building and exposed to an external fire under controlled conditions. The fire exposure is representative of an external fire source or a fully developed (post-flashover) fire in a room, venting through an opening such as a window aperture that exposes the cladding to the effects of external flames.

The specification and interpretation of fire test methods is the subject of on-going development and refinement. Changes in associated legislation may also occur. For these reasons it is recommended that the relevance of test reports over 5 years old should be considered by the user. The laboratory that issued the report will be able to offer, on behalf of the legal owner, a review of the procedures adopted for a particular test to ensure that they are consistent with current practices, and if required may endorse the test report.

BRE was not involved in the design, installation, procurement or specification of the materials and cladding system that was submitted for testing. The tested system was defined by the Test Sponsor.

All measurements quoted in this report are nominal unless stated otherwise.

2 Details of test carried out

Name of Laboratory:	BRE Global Ltd.
Laboratory Address:	Bucknalls Lane, Garston, Watford, Hertfordshire. WD25 9XX
Test reference:	P109973-1000
Date of test:	27th October 2017
Sponsor:	Mitsubishi Chemical Corporation
Sponsor address:	1-1, Manurouchi 1-chrome, Chiyoda-ku, Tokyo 100-8251, Japan
Method:	The test was carried out in accordance with BS 8414-1:2015 + A1:2017
Deviations:	None

3 Details of test apparatus used

The product was installed on to wall number 1 of the BRE Global test facility. This apparatus is representative of the face of a building and consists of a masonry structure with a vertical main test wall and a vertical return wall at a 90° angle to and at one side of the main test wall. See *Figure 1*. The main wall includes the combustion chamber.

4 Description of the System

4.1 Summary

Generic cladding type	Rainscreen
Relevant test method	BS 8414-1
Substrate	Masonry
Insulation	100mm-thick (K15) phenolic insulation
Cavity depth	38mm ventilated cavity (from back face of the panel to front face of the insulation)
Vertical cavity barriers	75mm-wide×150mm-deep stone wool vertical cavity barriers with 10mm compression (Siderise RSV90/30).
Horizontal cavity barriers	75mm-wide×115mm-deep stone wool with intumescent horizontal cavity barriers (Siderise RH25G90/30).
External finish	4mm-thick front face Aluminum Composite Material (ACM) cassette panels (Booth Muirie BML100 Hook On) ALPOLIC/A2, with a grey finish

4.2 Description of product

Table 1. List of components parts used in the construction of the system:

Item	Description
1	90mm-high×64mm-wide×100mm-deep×4mm-thick aluminium 'L' shaped brackets fixed with a single 90mm-long×ϕ8mm stainless steel screw anchor with plastic plug
2	100mm-thick K15 phenolic insulation boards
3	120mm-wide×60mm-deep×2mm-thick aluminum 'Y'-section framing
4	75mm-wide×150mm-deep stone wool vertical cavity barriers with 10mm compression (Siderise RSV90/30 labeled "Lamatherm")
5	75mm-wide×115mm-deep stone wool with intumescent horizontal cavity barriers (Siderise RH25G90/30 labeled "Lamatherm")
6	4mm-thick front face Aluminum Composite Material (ACM) cassette panels (Booth Muirie BML100 Hook On) ALPOLIC/A2. The mean calorific value measured for the core was 2.2277 MJ/Kg. BRE Report P110396-1002[2].

4.3 Installation sequence

Onto the masonry support structure the aluminium 'L'-shaped brackets were fixed in position on low density polyethylene isolation pads (5mm-thick) using a single stainless steel screw anchor and plastic plug. On the main face the horizontal spacing between the brackets varied between 300mm and 500mm and on the wing wall the spacing between the brackets was approximately 500mm as specified in the manufacturer's details. The vertical spacing between the brackets varied between 720mm and 970mm and where horizontal cavity barriers were present a spacing of 420mm was used.

The system included vertical and horizontal cavity barriers. On the main face, two 75mm-wide×150mm-deep stone wool vertical cavity barriers, with 10mm compression, were fixed in position either side of the combustion chamber opening with a clear distance of 2100mm between them.

The vertical cavity barriers were skewered to ¾-depth on steel brackets fixed into the masonry wall with one 70mm-long×ϕ4mm anchor. Two steel brackets were used for each length of 1200mm of stone wool cavity barrier.

On the wing wall, one 75mm-wide×150mm-deep stone wool vertical cavity barrier, with 10mm compression, was fixed in position at the edge of the system, approximately 1330mm from the external face of the main wall. Once installed in position the stone wool vertical cavity barriers were compressed by the ACM panels to fully close the 38mm ventilated cavity.

A set of four 75mm-wide×115mm-deep intumescent horizontal cavity barriers were butted up to the continuous vertical barriers and fixed in rows at approximate heights of:

- 80mm above the combustion chamber opening;
- 2395mm above the combustion chamber opening;
- 4725mm above the combustion chamber opening;
- 6360mm above the combustion chamber opening (close to the top of the ventilated system).

The horizontal cavity barriers were fixed through the entire depth on face turned steel brackets. Two steel brackets were used per 1200mm length of stone wool cavity barrier, each fixed into the masonry wall with one 70mm-long×ϕ4mm anchor, positioned above the cavity barrier. The horizontal intumescent cavity barriers were installed with a maximum gap of 25mm to the back face of the panel in accordance with the manufacturer's recommendation.

The 100mm-thick K15 insulation boards (supplied in 1200mm×600mm and cut to fit) were installed in position through the substructure bracket fixing systems and fixed to the support structure (masonry wall) using six 125mm-long×ϕ8mm plastic anchors and six 140mm-long×ϕ8mm stainless steel anchors per full size panel. On the main wall the insulation panels were installed with the long edge orientated horizontally. On the wing wall the insulation panels were installed with the long edge orientated vertically. All the gaps between the insulation panels and the intersection with aluminium brackets or fixings were sealed with aluminium tape as recommended by the manufacturer.

After the insulation was fixed in position the 'Y'-section framing were installed at horizontal spacings ranging from 300mm to 500mm. The aluminum vertical rails, with a typical length of 2300mm, were positioned 10mm inside the thermal insulation with each rail fixed to the brackets with 2×4.8×16mm self-drilling, self-tapping, stainless steel screws. The aluminum rails were installed with a 30mm gap at the floor levels to allow for structural movement. Three brackets supported each section of rail: the middle bracket was fixed while the top and bottom brackets were connected with movement holes.

The external ACM cassette panels (Booth Muirie BML100 Hook On) of the system were installed on to the rail substructure with hook clips (12 hook clips per full size panel), at 500mm horizontal spacings and 450mm-750mm vertical spacings. A nominal vertical and horizontal gap of 20mm was provided between the panels. The measured gaps after installation varied between 18mm and 23mm.

Inside the Booth Muirie BML100 Hook On cassette panels a continuation of the cavity barrier was provided through a mineral wool insert-Siderise Cassette Insert 100mm-wide×50mm-deep. A 25mm horizontal intumescent strip is applied on the back face lower edge of the panel underneath the Siderise Cassette insert in order to seal the ventilation gaps in case of fire exposure, as described by the manufacturer. The full-size ACM cassette panel (Booth Muirie BML100 Hook On) dimensions measured 995mm-wide×2280mm-high.

A pre-fabricated, welded window pod constructed from 5mm-thick aluminium was fixed onto the edge of the combustion chamber opening with eight (two on top, three on both vertical edges) 90mm-long×ϕ8mm stainless steel screw anchor and plastic plugs.

With reference to Figure 2, the panel widths were:

Column 'A' (wing wall) - 1098mm

Column 'B' - 270mm

Column 'C' - 995mm

Column 'D' - 995mm

Column 'E' - 368mm

The panel heights were:

Row 0 - 1962mm

Row 1 - 2284mm

Row 2 - 2284mm

Row 3 - 1864mm

The cladding system measured:

Requirement	Actual measurement
≥6000mm above the top of the combustion chamber	6530mm
≥2400mm width across the main wall	2465mm
≥1200mm width across the wing wall	1315mm
260mm (±100mm) wing wall-combustion chamber opening	245mm
2000mm (H) x 2000mm (W) (±100mm) combustion chamber opening	2000(H)mm×2000(W)mm

5 Test results

5.1 Test Conditions

Test Date: 27th October 2017

Ambient Temperature: 15°C

Wind speed: <0.1 m/s

Frequency of measurement: Data records were taken at 5 second intervals.

Thermocouple locations:

Level 1 – External (50mm proud of the finished face).

Level 2 – External (50mm proud of the finished face).

Level 2 – Midpoint of the cavity.

Level 2 – Midpoint of insulation layer.

5.2 Temperature Profiles

Figures 11-14 provide the temperature profiles recorded during the test. *Figure 8* shows the system before the test.

Parameter	Result
T_s, Start Temperature	15°C
t_s, Start time	2 minutes and 10 seconds after ignition of crib.
Peak temperature / time at Level 2, External	442°C (19 minutes and 45 seconds after t_s).
Peak temperature / time at Level 2, cavity	613°C (29 minutes and 10 seconds after t_s)
Peak temperature / time at Level 2, insulation	154°C (27 minutes and 55 seconds after t_s)

5.3 Visual Observations

Table 2. Visual Observations – Refer to *Figure 3* for system schematic. Height measurements are given relative to a zero at the top of the combustion chamber. Unless otherwise specified, observations refer to the centre line above the hearth.

Time (mins:secs)	t_s (mins:secs)	Description
00:00		Ignition of crib.
01:30		The flames from the combustion chamber are impinging on the cladding system.
02:10	00:00	Start time (t_s) criteria achieved: External temperature 2.5m above the top of the combustion chamber in excess of 215°C (=200°C+T_s).
03:00	00:50	Flame tips to mid-height of panels 1C&1D.
03:30	01:20	Paint removal is observed up to mid-height of panels 1C&1D.
04:00	01:50	Flames tips are visible up bottom edge of panels 2C&2D.
05:00	02:50	Paint removal up to 50% on panels 1C&1D surface.
06:00	03:50	Paint removal and discoloration at bottom edge of panels 2C&2D.
07:30	04:20	Discoloration is observed at the horizontal joint between panels 0A&1A (approximately 200mm from main wall).
08:30	06:20	Paint removal and discoloration up to mid-height on panels 2C&2D.
09:30	07:20	Paint removal and discoloration at bottom edge of panel 1A (approximately 200mm from main wall).
10:00	07:50	Consumption of panels 1C&1D is observed at the bottom edge of the panels. No flaming debris are recorded. The thermal insulation of the system (panels 1C&1D bottom edge) is exposed directly to flaming.
10:30	08:20	Flaming debris with a self-sustained burring duration less than 10 seconds.
11:00	08:50	Flames can be observed on the insulation surface (panels 1C&1D area).
11:30	09:20	Flame tips are visible up to top of panels 2C&2D.

Time (mins:secs)	t_s (mins:secs)	Description
12:00	09:50	Up to 50% consumption of panels 1C&1D.
12:15	10:05	Detachment from panels 1C&1D.
13:00	10:50	An increase in flaming debris is recorded.
13:10	11:00	Detachment from panels 1C&1D.
14:00	11:50	Flame tips are visible up to top of panels 2C&2D.
14:30	12:20	An increase in flaming debris.
15:30	13:20	Approximately 70% consumption of panels 1C&1D.
16:00	13:50	Significant detachment from panel 2D.
16:30	14:20	Discoloration and distortion on panel 1B surface.
17:00	14:50	Significant discoloration and distortion on panels 0A&1A (wing wall).
18:00	15:50	Approximately 80% consumption of panels 1C&1D.
18:30	16:20	Consumption of the central aluminum rails (behind panels 1C&1D).
19:00	17:50	A section of the first horizontal cavity barrier above the combustion chamber is detached (central area of the system).
19:30	17:20	Consumption of panels 2C&2D is observed at the bottom edge of the panels (<5%).
20:00	17:50	The flames enter the cavity behind panels 2C&2D.
21:00	18:50	Approximately 90%-95% consumption of panels 1C&1D.
22:00	19:50	Consumption of 2C&2D panels in central area (along the vertical joint) up to ¾ of height.
23:30	21:20	Discoloration at bottom edge of panels 3C&3D.
24:00	21:50	Discoloration is observed on panels 0A, 1A and 2A.
25:00	22:50	Flame tips up to mid-height of panels 3C&3D

Time (mins:secs)	t_s (mins:secs)	Description
26:00	23:50	Consumption up to ¾ of central aluminium rail (behind panels 2C&2D).
28:00	25:50	Flickers of flame are visible at the vertical joint between panels 1B&1C.
30:00	27:50	Fire source extinguished.
32:00	29:50	Sporadic flaming on the insulation behind panels 2C&2D and above the combustion chamber (panels 1C&1D area).
34:00	31:50	Sporadic flaming on the insulation at the bottom of panel 2C.
38:00	35:50	Sporadic flaming on the insulation behind panels 2B&2C.
47:00	44:50	Flames continue to persist behind panels 2C&2D.
50:00	47:50	All visible flaming has ceased. The insulation is red glowing behind panels 2C&2D.
60:00	57:45	Test terminated.

6 Post-test damage report

6.1 ACM ALPOLIC/A2 cassette panels

Row 0

Panel 0A had significant distortion and approximately 90% discoloration.

Panel 0B had visible distortion and discoloration (<40%).

Panel 0E did not sustained any visible damage.

Row 1

Panel 1A had significant distortion and approximately 90% discoloration.

Panel 1B had distortion and discoloration on surface.

Panel 1C had significant damage and consumption up to 95%-100%.

Panel 1D had significant damage and consumption approximately 90%-95%.

Panel 1E had minor distortion on the surface.

Row 2

Panel 2A had distortion and discoloration on surface (up to 30%-35%).

Panel 2B had distortion and discoloration on surface (approximately 25%-30%).

Panel 2C had significant damage and consumption of approximately 55%-60%.

Panel 2D had significant damage and consumption up to 40%-45%.

Panel 2E had minor discoloration on the left hand edge (looking to main wall).

Row 3

Panel 3A did not sustained any visible damage.

Panel 3B did not sustained any visible damage.

Panel 3C had distortion and discoloration at the bottom edge (horizontal joint between 2C&3C).

Panel 3D had distortion and discoloration at the bottom edge (horizontal joint between 2D&3D).

Panel 3E did not sustained any visible damage.

6.2 Aluminium rail substructure

The central aluminium 'Y'-shaped rail on the main wall was intact from a height of approximately 4.0m-4.4m. The adjacent aluminium 'Y'-shaped rails (500mm offset from central rail to left and right) were fully consumed up to a height of approximately 2.3m-2.4m (behind panels 1C&1D).

Behind panels 2C&2D and 3C&3D, the aluminium rails (500mm offset from central rail to left and right) were discoloured and slightly distorted.

Behind panels 3C&3D, the aluminium rails were intact and slightly discoloured.

The aluminium brackets situated immediately above the combustion chamber were severely damaged or melted.

Following the removal of the ACM panels from the wing wall the aluminium substructure which held the panels in place had not sustained significant damage.

6.3 Thermal insulation (K15 phenolic insulation)

Row 0

Panel 0A Panel 0E had not sustained any visible damage.

Panel 0B had not sustained any visible damage.

Panel 0E had not sustained any visible damage.

Row 1

Panel 1A had not sustained any significant damage.

Panel 1B had not sustained any significant damage.

Panel 1C had sustained significant damage and was consumed up to 90%-95%. The rear aluminum foil of the insulation us visible.

Panel 1D had sustained significant damage and was consumed up to 90%-95%. The rear aluminum foil of the insulation us visible.

Panel 1E had not sustained any visible damage.

Row 2

Panel 2A had not sustained any visible damage.

Panel 2B had not sustained any visible damage.

Panel 2C had sustained significant damage and was consumed between 30%-80%. Uncharred material was visible to the top edge of the panel (underneath the horizontal cavity barrier).

Panel 2D had sustained significant damage and was consumed between 40%-80%. Uncharred material was visible to the top edge of the panel (underneath the horizontal cavity barrier).

Panel 2E had not sustained any visible damage.

Row 3

Panel 3A had not sustained any visible damage.

Panel 3B had not sustained any visible damage.

Panel 3C had discoloration on surface, from white to dark yellow. The aluminium foil remained attached to the insulation.

Panel 3D had discoloration on surface, from white to dark yellow. The aluminium foil remained attached to the insulation.

Panel 3E did not sustained any visible damage.

6.4 Horizontal cavity barriers (Siderise RH25G 90/30)

The horizontal cavity barrier at the base of level 1 panels (directly above the combustion chamber) was intact and undamaged. Detachment of the cavity barrier was observed after water was sprayed onto the system.

The horizontal cavity barrier at the base of level 2 panels remained in position after the fire exposure. The intumescent material reacted across the entire length of the cavity barrier. Behind panel 2E the cavity barrier did not activate. On the wing wall the cavity barrier was partially activated.

The horizontal cavity barrier at the base of level 3 panels remained in position after the fire exposure. The intumescent material reacted on the entire length of the cavity barrier. Behind panel 2E the cavity barrier did not activate. On the wing wall the cavity barrier did not activate.

6.4.1 Vertical (compression) Siderise RSV90/30 cavity barriers

The fire damage to the cladding system on the main wall was contained within the bounds of the vertical cavity barriers across the combustion chamber opening. The cavity barriers remained intact. There was significant charring and discolouration along the inside edges running parallel to the vertical edges of the combustion chamber.

7 Conclusion

BS8414 Part 1:2015 + A1:2017 [1] does not contain acceptance criteria and therefore this test report does not indicate a pass or fail of the product.

8 Reference

1. BS 8414-1:2015 + A1:2017, 'Fire performance of external cladding systems – Part 1: Test method for non-load bearing external cladding systems applied to the masonry face of the building', British Standards Institution, London, 2015.

2. BRE Test report P110396-1002. BS EN ISO 1716 Gross heat of combustion (calorific value).

9 Figures

9.1 Diagrams of finished face of the cladding system

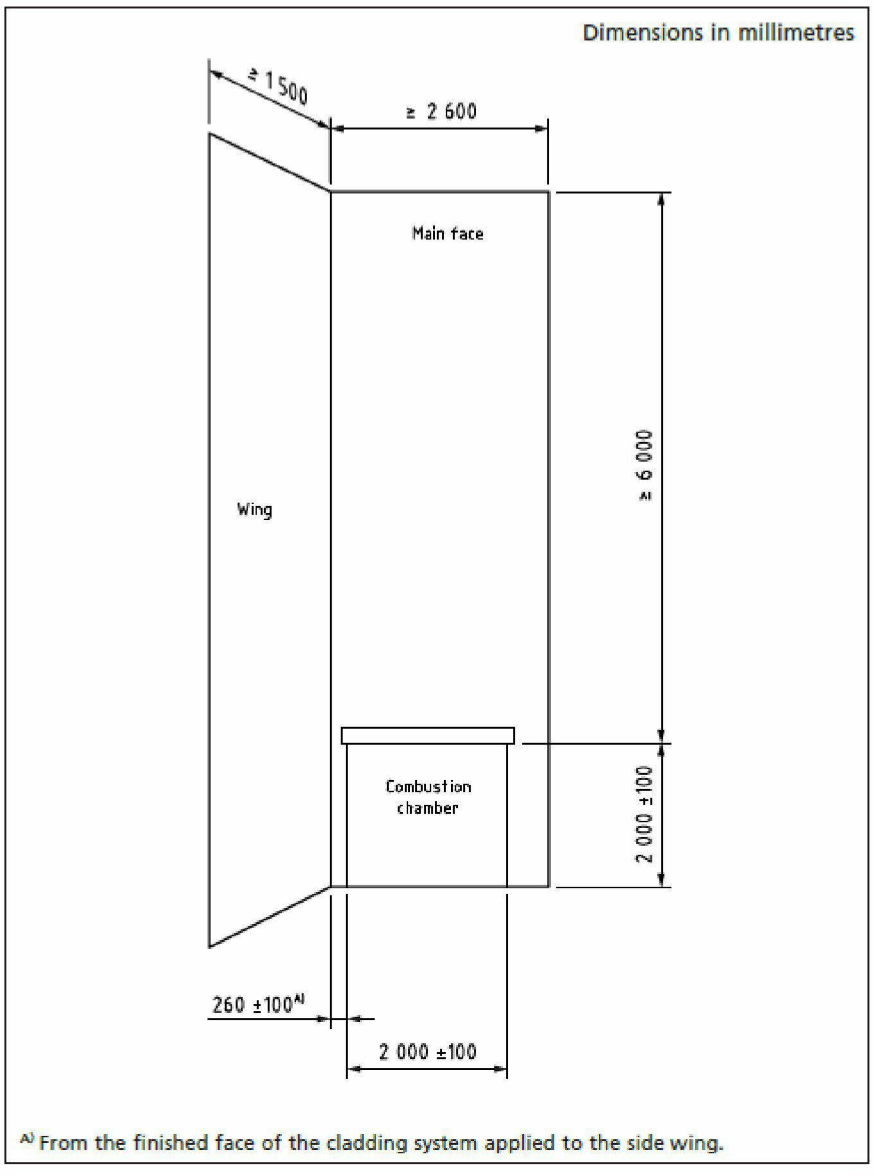

Figure 1. Test apparatus dimensions as specified by test Standard[1].

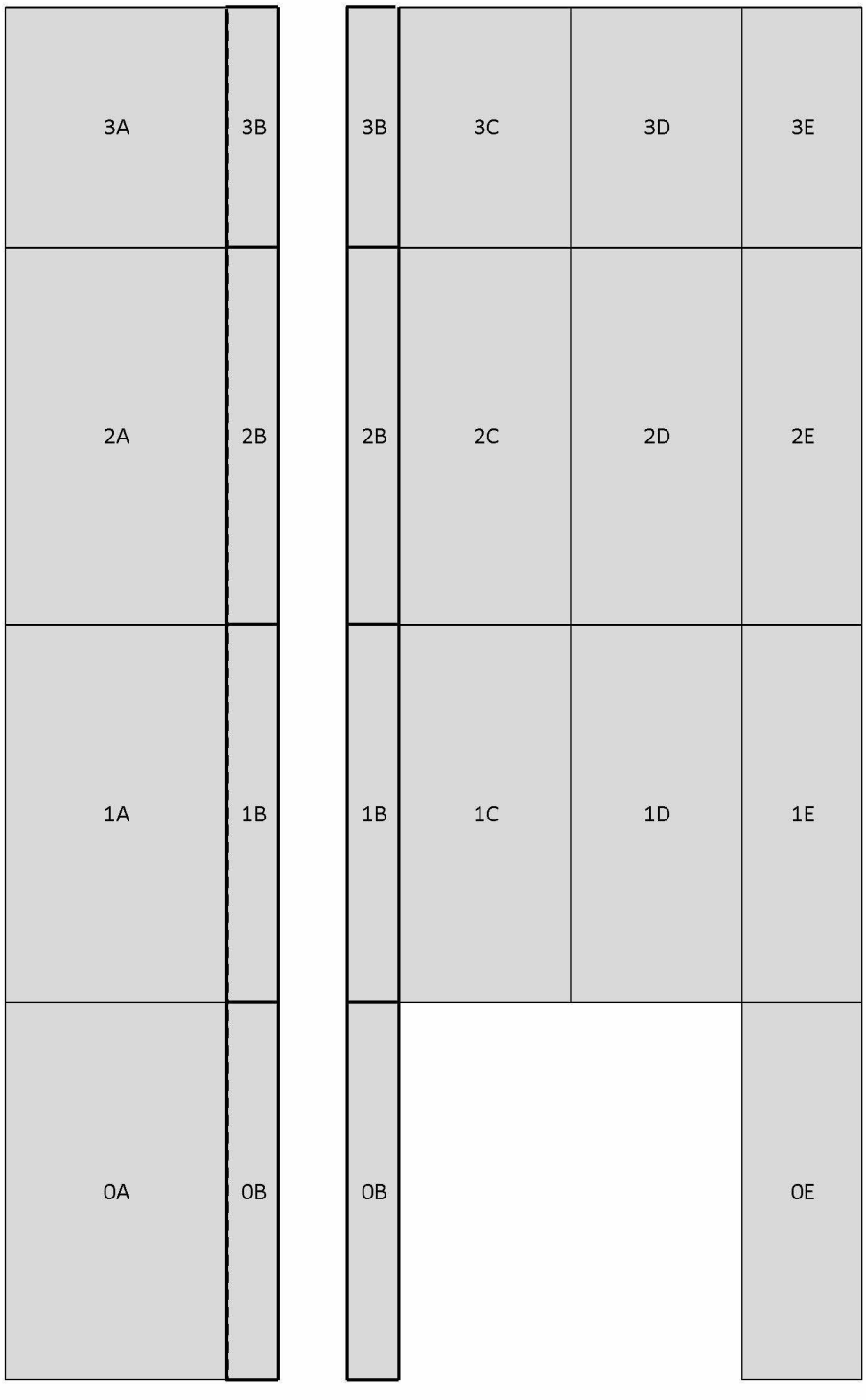

Figure 2. Layout of panels and numbering system used for reporting. Not to scale.

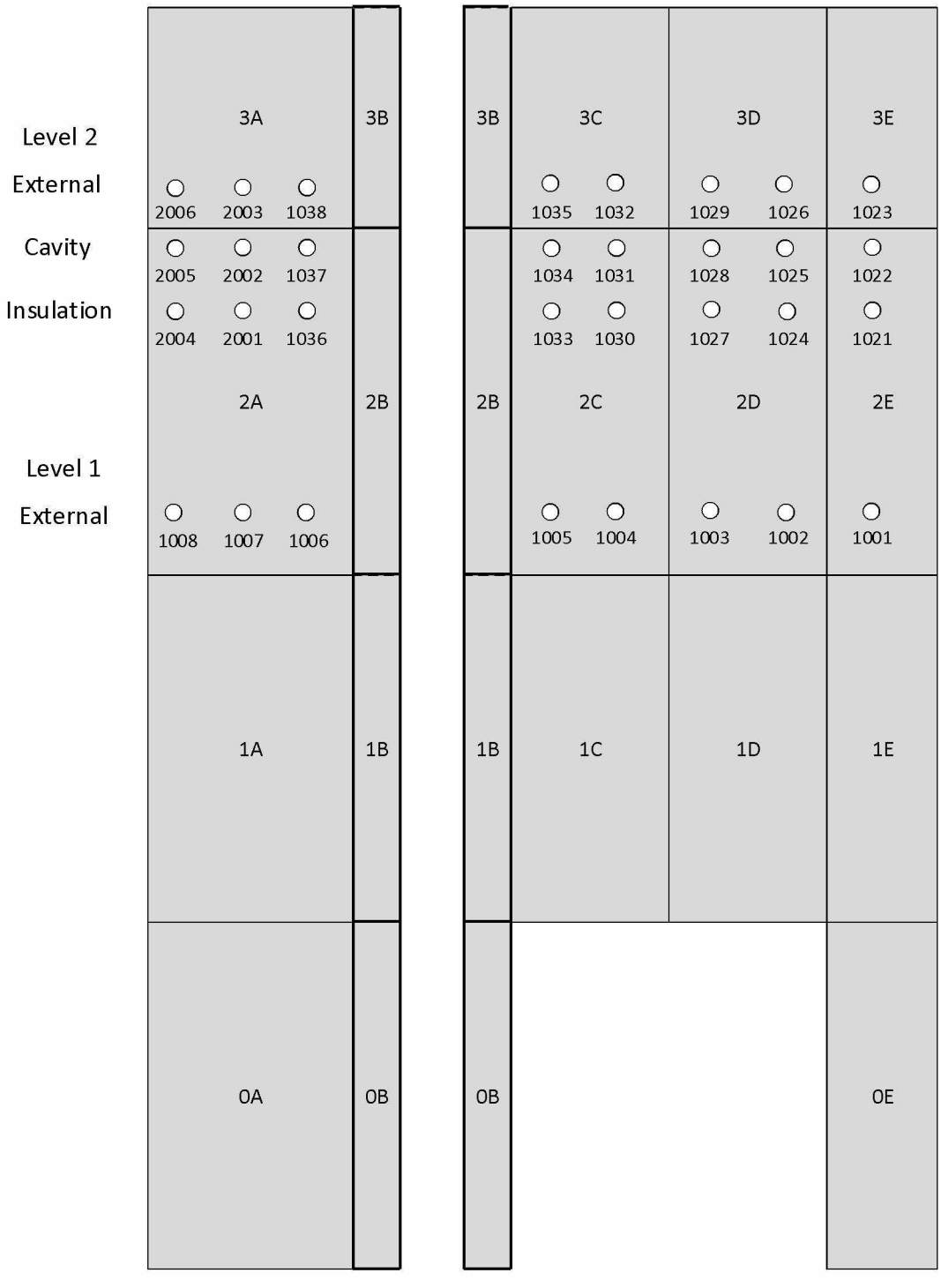

Figure 3. TC positions and panel numbering (0A – 3E). Not to scale.

9.2 Installation photographs

Figure 4. Installation of the thermal insulation, vertical and horizontal cavity barriers

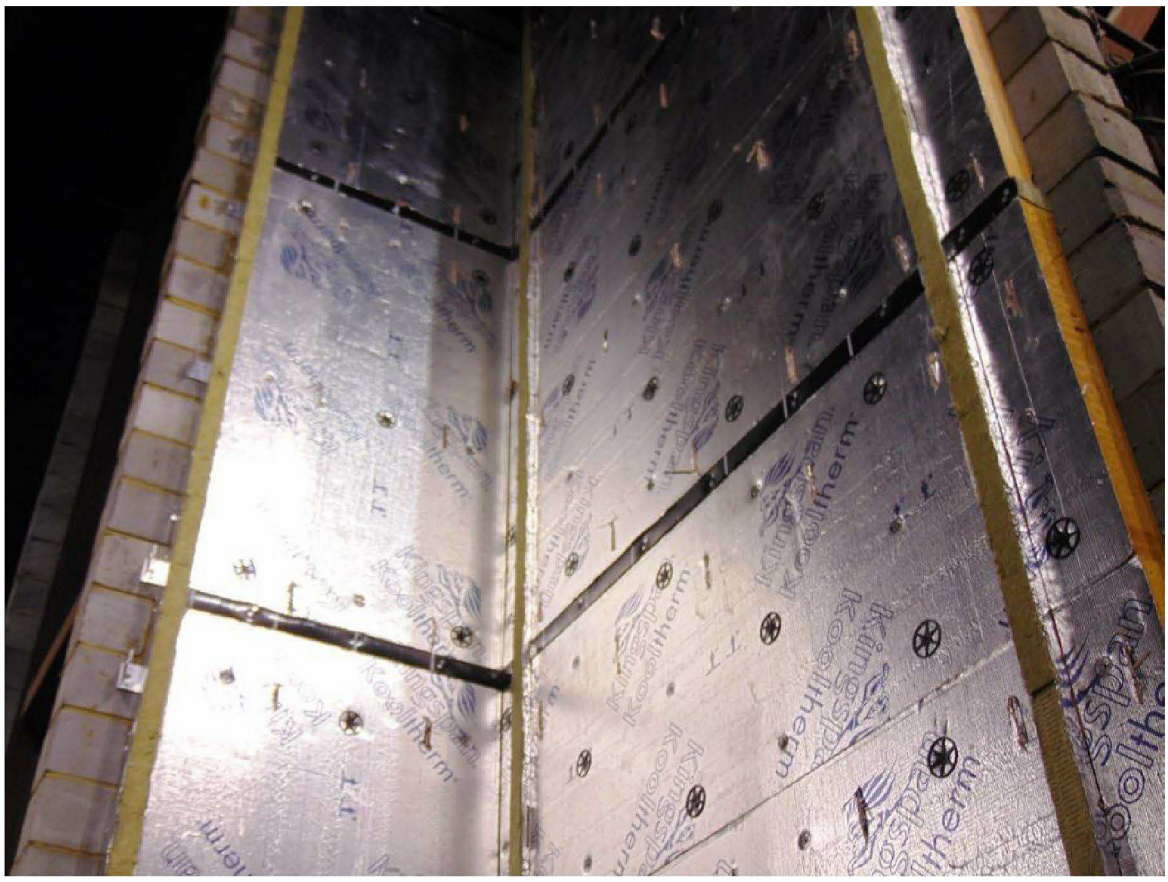

Figure 5. Insulation fixing details (plastic and stainless steel anchors)

Figure 6. Aluminium substructure, cavity barriers (horizontal and vertical) and thermal insulation installed on the system.

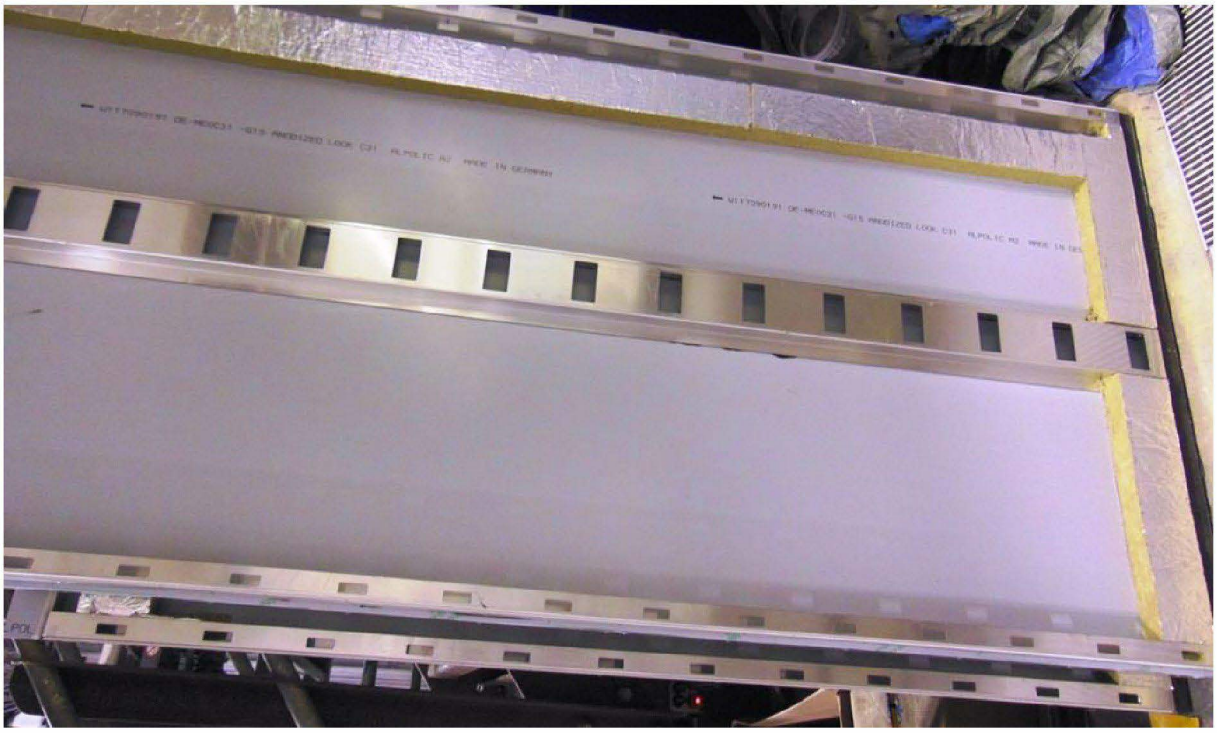

Figure 7. ACM cassette panel - SIDERISE cassette insert detail (back face of the panel)

Figure 8. Completed installation prior to test.

9.3 System drawings

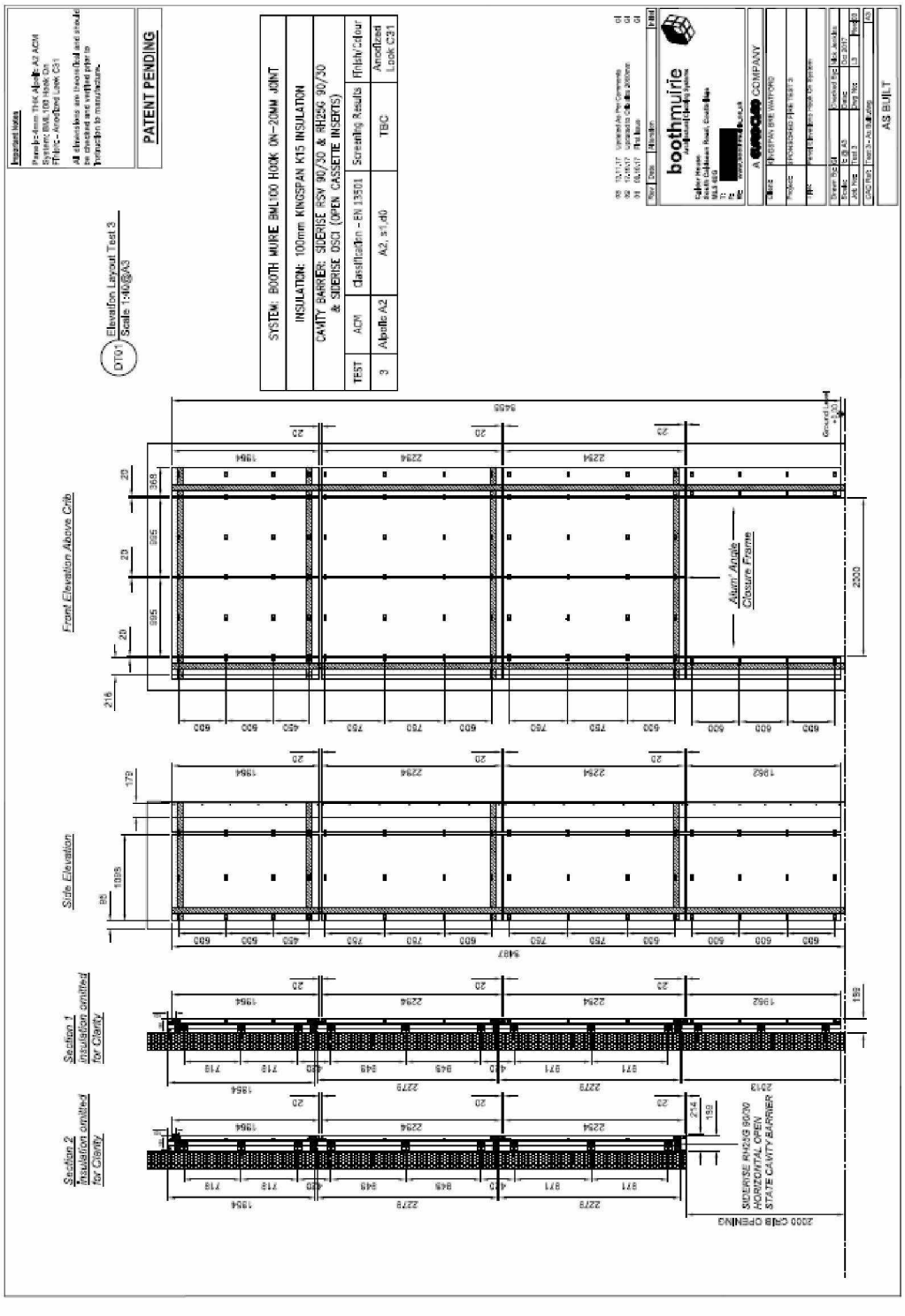

Figure 9. Front elevation, side elevation and vertical sections through the system (supplied by the Test Sponsor).

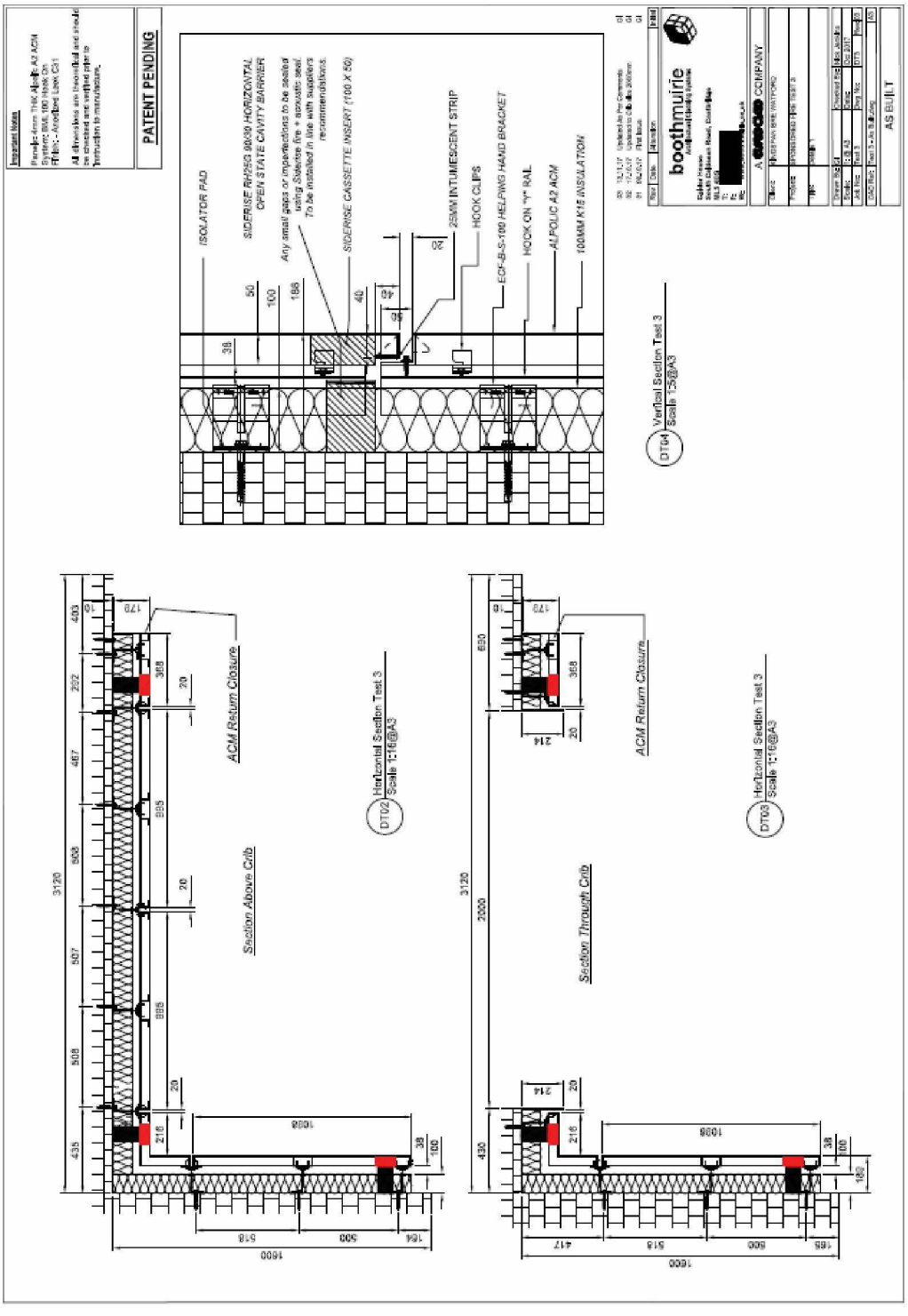

Figure 10. Horizontal section through and above the combustion chamber, vertical section through the cladding system and insulation details for tested system (supplied by the Test Sponsor).

9.4 Temperature data

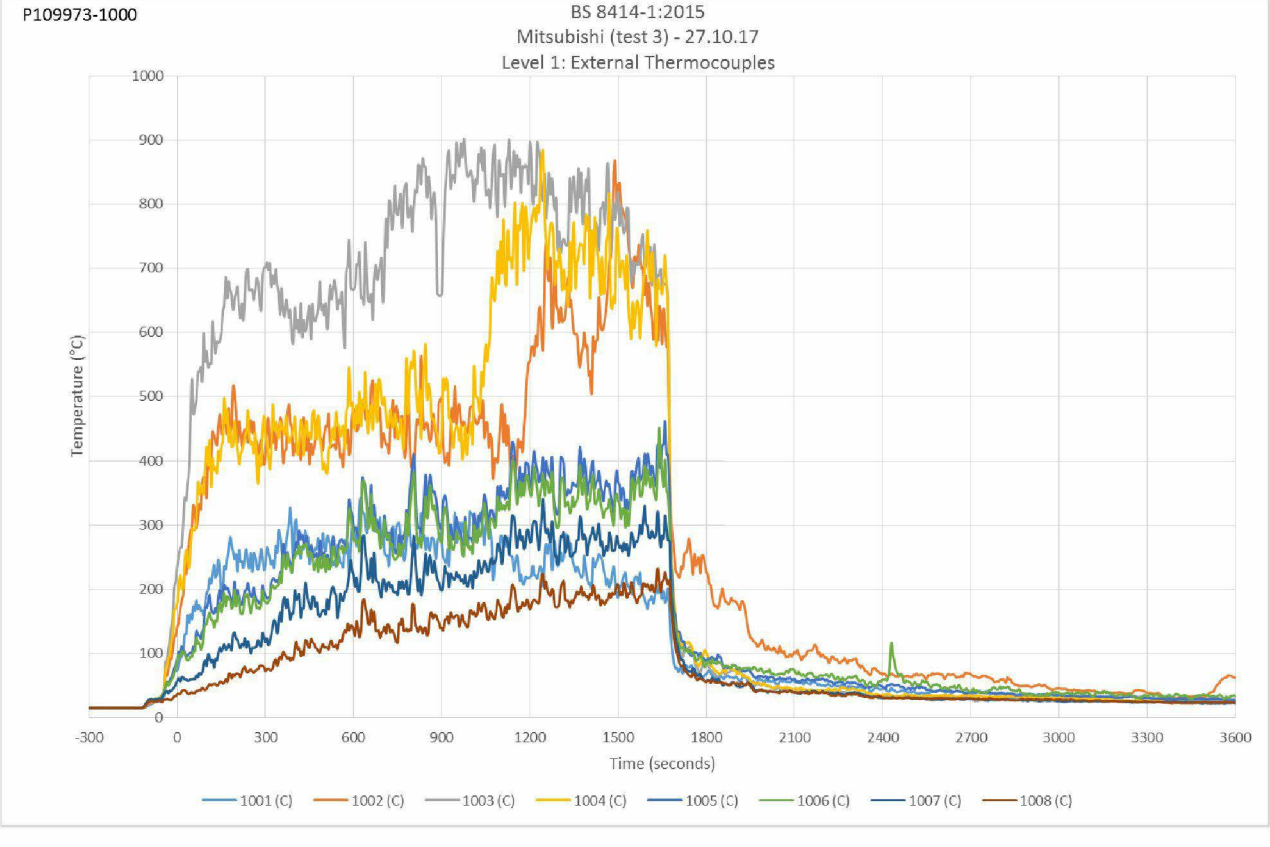

Figure 11. Level 1 external thermocouples.

t_s= 2 minutes and 10 seconds after ignition of the crib.

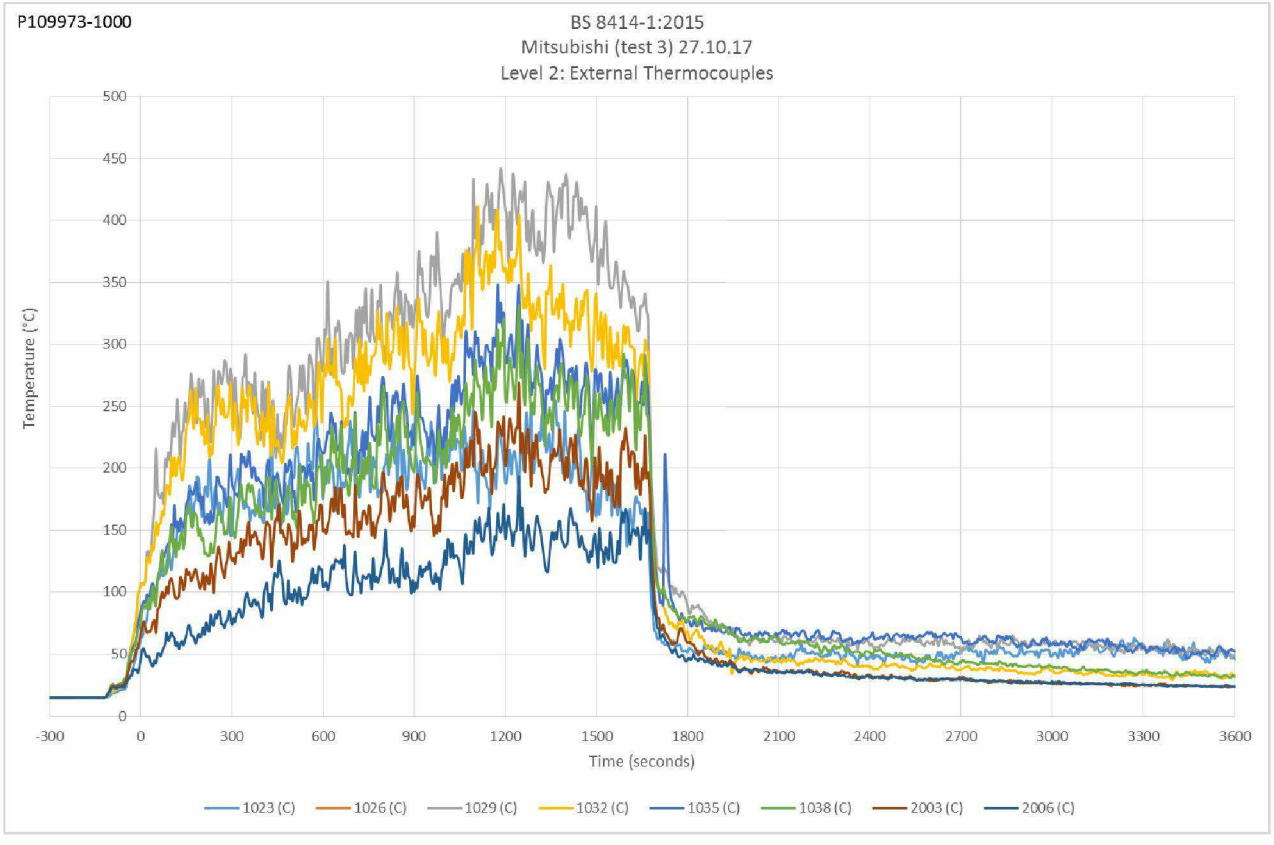

Figure 12. Level 2 external thermocouples.

t_s= 2 minutes and 10 seconds after ignition of the crib.

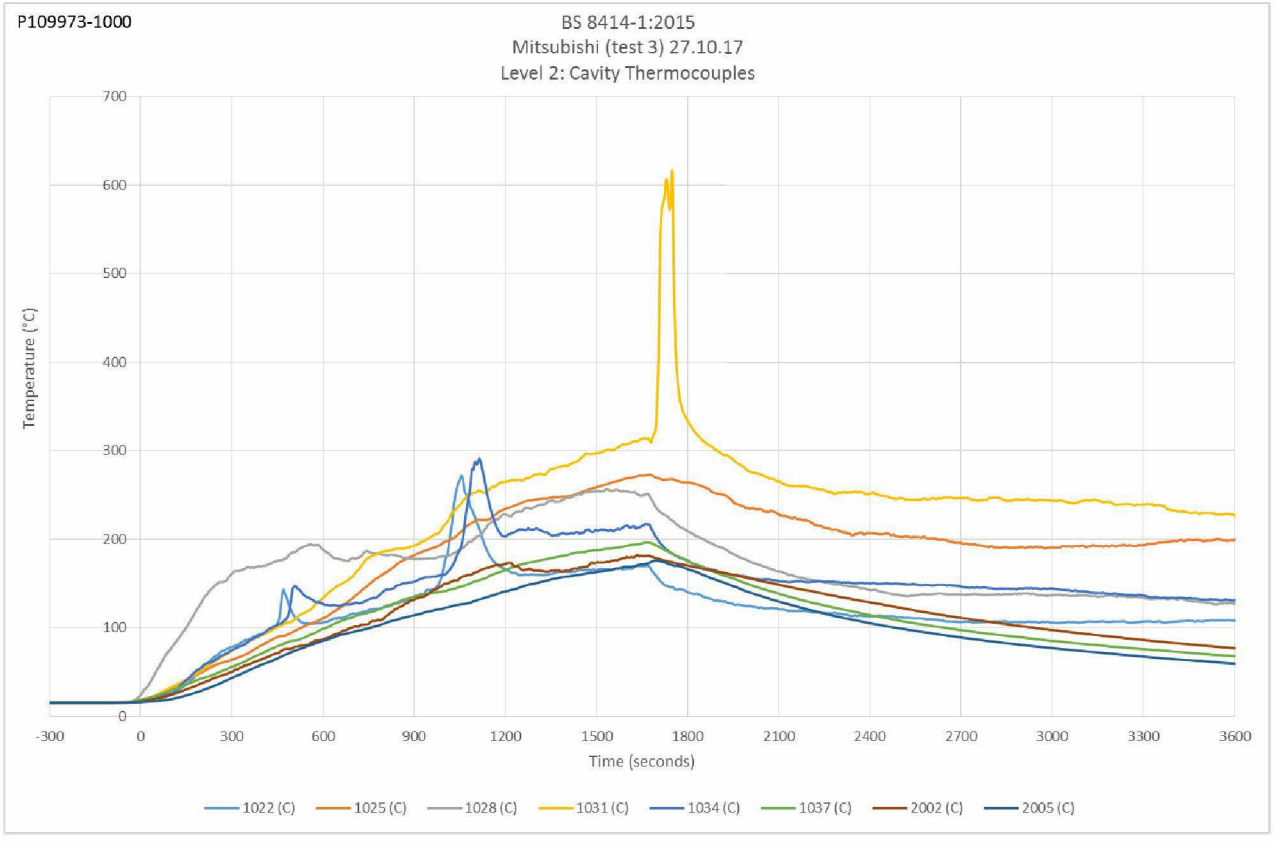

Figure 13. Level 2 cavity thermocouples.

t_s= 2 minutes and 10 seconds after ignition of the crib.

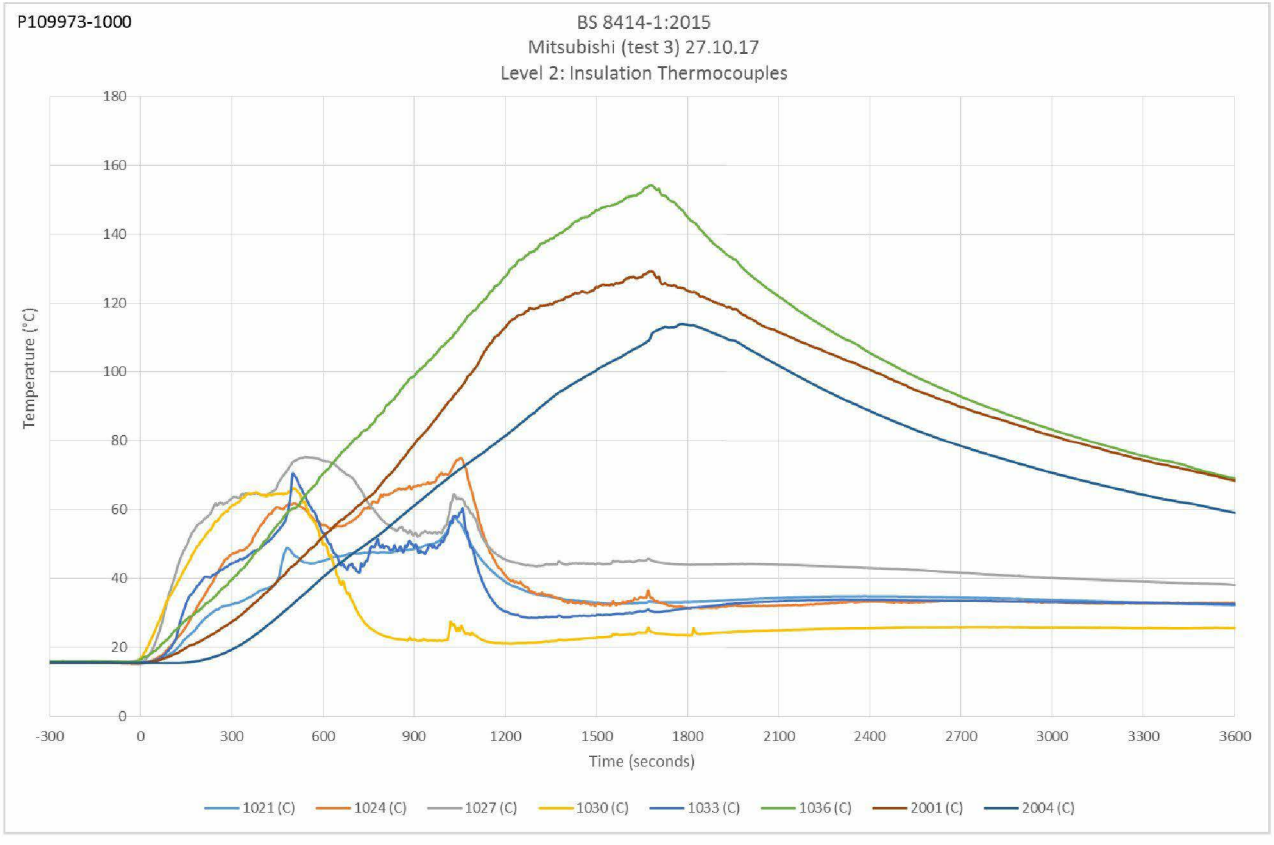

Figure 14. Level 2 insulation thermocouples.

t_s= 2 minutes and 10 seconds after ignition of the crib.

9.5 Post-test photographs

Figure 15. Full height of the system post-test (main and wing wall).

Figure 16. Row 0 post-test (combustion chamber, main and wing wall).

Figure 17. Row 1 post-test (main and wing wall, approximately 2300mm above combustion chamber).

Figure 18. Row 2 post-test (main and wing wall, approximately 2300mm –4600mm above combustion chamber).

Figure 19. Row 3 post-test (main and wing wall, approximately 4600mm – 6500mm above combustion chamber).

Figure 20. Aluminium rail substructure and thermal insulation following removal of ACM panels (main wall, approximately 1800mm-6500mm above the combustion chamber).

Figure 21. Aluminium rail substructure and thermal insulation following removal of ACM panels (wing wall, approximately 1300mm-6500mm above the combustion chamber).

Figure 22. Thermal insulation following removal of ACM panels and aluminium substructure on the main and wing wall (approximately 200mm – 6500mm above combustion chamber.

Report Ends