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BRE Global Test Report

BS 8414-2:2015 + A1:2017 Test on a ventilated façade system with Kingspan Kooltherm insulation (100mm-thick) and Alpolic A2 panels (4mm-thick).

Prepared for: Kingspan Insulation Limited

Date: 25th July 2018

Report Number: P109938-1000 **Issue: 1**

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1 Introduction

The test method, BS8414 Part 2:2015 + A1:2017 [1] describes a method of assessing the behaviour of non-load bearing external cladding systems, rainscreen 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 Test Details

Name of Laboratory:	BRE Global Ltd.
Laboratory Address:	Bucknalls Lane, Garston, Watford, Hertfordshire. WD25 9XX
Test reference:	P109938-1000
Date of test:	5th February 2018
Sponsor:	Kingspan Insulation Limited
Sponsor address:	Pembridge, Leominster, Herefordshire, HR6 9LA, UK
Method:	The test was carried out in accordance with BS 8414-2:2015 + A1:2017
Deviations:	None

3 Details of Test Apparatus

The product was installed on to wall number 3 of the BRE Global test facility. This apparatus is representative of a structural steel framed building and consists of a structural steel test frame with a vertical main test wall and a vertical return wall at a 90º 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 8414-2:2015 + A1:2017
Substrate	Structural steel frame
Insulation	Kingspan Kooltherm (100mm-thick)
Cavity depth	50mm
Vertical cavity barriers	Siderise Lamatherm RV-90/30 stone wool cavity barrier (75mm-thick×160mm-deep)
Horizontal cavity barriers	Siderise Lamatherm RH25G-90/30 stone wool cavity barrier (75mm-thick×125mm-deep)
External finish	4mm-thick Alpolic A2 ACM panels (Booth Muirie BML400 rivet fixed)

4.2 Description of product

Table 1. List of component parts used in the construction of the system

Item	Description
1	Kingframe SFS (steel framing system) comprising galvanised, cold formed steel 'C' & 'U'-sections with 100×50mm studs.
2	12.5mm-thick plasterboard (double layer, fitted to internal face of partition).
3	12mm-thick Versapanel cement particle board.
4	Galvanised steel 'U'-shaped channels (170mm-wide×20mm-deep×2mm-thick).
5	Aluminium 'L'-shaped brackets (85mm-deep×50mm-wide×120mm-high×5mm-thick).
6	Galvanised steel folded skewers (320mm-long×25mm-wide).

7	Siderise Lamatherm RV-90/30 stone wool vertical cavity barriers (75mm-thick×160mm-deep).
8	Galvanised steel folded skewers (350mm-long×25mm-wide).
9	Siderise Lamatherm RH25G-90/30 stone wool horizontal cavity barriers with intumescent strip (75mm-thick×125mm-deep).
10	100mm-thick Kingspan Kooltherm K15 insulation.
11	Aluminium 'T'-shaped rails (120mm-wide×60mm-deep×2mm-thick).
12	Aluminium 'L'-shaped rails (40mm-wide×60mm-deep×2mm-thick).
13	Aluminium 'L'-shaped angles (175mm×70mm×5mm-thick).
14	4mm-thick Alpolic A2 ACM panels (Booth Muirie BML400 rivet fixed).

4.3 Installation sequence

A lightweight steel framework partition was constructed from 100mm×55mm 'C'-section Kingframe SFS studwork. The horizontal sections were fixed into the 'floor slabs' and the ground using 5.5×40mm self-drilling screws. The vertical sections were fixed to the horizontal sections at 465-600mm centres on the main wall and 265-600mm centres on the wing wall using 5.5×25mm self-drilling screws.

A double layer of 12.5mm-thick plasterboard was fitted with long edge horizontal to the internal face of the partition using 3.5×38mm drywall screws at 265-600mm horizontal and 390mm vertical centres. Versaseal-FS Euroform Grey sealant was applied between adjacent boards.

A single layer of 12mm-thick cement board was fixed with long edge vertical to the external face of the partition using 3.5×38mm drywall screws at 265-600mm horizontal and 390mm vertical centres. Versaseal-FS Euroform Grey sealant was applied between adjacent boards.

'U'-shaped channels (170mm-wide×20mm-deep×2mm-thick) were fitted horizontally to the external face of the cement board at 420-960mm vertical centres. The channels were fixed using 5.5×45mm self-drilling screws at 600mm horizontal and 145mm vertical centres.

'L'-shaped brackets (85mm-deep×50mm-wide×120mm-high×5mm-thick) were fixed to the 'U'-shaped channels at 485mm horizontal centres using two 5.5×45mm self-drilling screws per bracket.

Galvanised steel folded skewers (320mm-long×25mm-wide) were fixed to the cement board at nominal 600mm vertical centres in three columns located either side of the combustion chamber opening (approximately 280mm and 2280mm from the main-wing wall junction) and one at the outside edge of the wing wall (approximately 2405mm from the main-wing wall junction).

Siderise Lamatherm RV-90/30 stone wool vertical cavity barriers (75mm-thick×160mm-deep) were pressed onto the skewers in columns. On the wing wall each vertical column was interrupted by the horizontal cavity barriers.

Galvanised steel folded skewers (350mm-long×25mm-wide) were fixed to the cement board at 300-450mm horizontal centres in four rows located: 0mm, 2400mm, 4800mm and 6600mm above the top of the combustion chamber.

Siderise Lamatherm RH25G-90/30 stone wool horizontal cavity barriers with intumescent strip (75mm-thick×125mm-deep) were pressed onto the skewers in rows. A cut was made along the length of the skewers local to the tip and the ends were folded to opposite sides to secure the intumescent cavity barriers in place. On the main wall each horizontal row was interrupted by the vertical cavity barriers which extended the full height.

100mm-thick Kingspan Kooltherm K15 insulation was fitted to the cement board using 6.1×125mm screws with 70mm insulation retaining discs and 5.5×150mm screws with 70mm insulation retaining discs alternating at 600mm horizontal and 770mm vertical centres. The discs were sealed with silver tape.

120mm-wide×60mm-deep×2mm-thick 'T'-shaped rails were fixed to the 'L'-brackets in columns located: at the outer edges of the combustion chamber and in line with the vertical centreline of the combustion chamber on the main wall (from the top of the combustion chamber up to the full height of the cladding system) and at the main-wing wall junction on the wing wall. The rails were fixed using 5.5×55mm self-drilling screws.

40mm-wide×60mm-deep×2mm-thick 'L'-shaped rails were fixed to the remaining 'L' brackets using 5.5×55mm self-drilling screws.

B1 foam was used to seal the gaps around the 'L'-brackets in the Kingspan Kooltherm insulation and silver tape was applied over the B1 foam.

4mm-thick Alpolic A2 ACM panels were fitted to the rails using 4.8×16mm Booth Muirie BML400 rivets at 640mm horizontal, 320mm vertical centres on the wing wall and 110-460mm horizontal, 380mm vertical centres on the main wall.

The panels at the outer edge of the main wall returned around the edges where they were fixed using a single column of rivets at 380mm vertical centers.

There was a gap of 20mm between adjacent ACM panels.

175mm×70mm×5mm 'L'-shaped angles were fitted to the combustion chamber surround to form a window pod using 5.5×55mm at 480mm vertical centres for the angles fixed to the sides of the combustion chamber opening and 580mm horizontal centers for the angle fixed to the top of the combustion chamber opening.

The cladding system measured:

Requirement	Actual measurement
≥6000mm above the top of the combustion chamber	7145mm
≥2400mm width across the main wall	2600mm
≥1200mm width across the wing wall	1350mm
260mm (±100mm) wing wall-combustion chamber opening	220mm
2000mm x 2000mm (±100mm) combustion chamber opening	2000mm-wide ×2000mm-high

5 Test Results

5.1 Test conditions

Test Date: 5th February 2018

Ambient Temperature: 7°C

Wind speed: 0 m/s

Frequency of measurement: Data records were taken at five 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 cavity layer.

Level 2 – Midpoint of insulation layer.

Level 2 – Midpoint of cement board.

Level 2 – Midpoint of partition.

Level 2 – Midpoint of plasterboard.

5.2 Temperature profiles

Figures 13-19 provide the temperature profiles recorded during the test. *Figure 9* shows the system before the test.

Parameter	Result
T_s, Start Temperature	7°C
t_s, Start time	2 minutes 0 seconds after ignition of crib.
Peak temperature / time at Level 2, External	834°C (39 minutes 5 seconds after t_s).
Peak temperature / time at Level 2, Cavity	256°C (41 minutes 50 seconds after t_s).
Peak temperature / time at Level 2, Insulation	167°C (18 minutes 30 seconds after t_s).
Peak temperature / time at Level 2, Cement particle board	87°C (18 minutes 15 seconds after t_s).
Peak temperature / time at Level 2, Partition	48°C (21 minutes 35 seconds after t_s).
Peak temperature / time at Level 2, Plasterboard	24°C (17 minutes 5 seconds after t_s).

5.3 Visual observations

Table 1. Visual Observations – Refer to *Figure 2* for system schematic. Height measurements are approximate and given relative to a zero at the top of the combustion chamber. Unless otherwise specified, observations refer to the centre line above the combustion chamber on the main wall.

Time* (mins:secs)	t_s (mins:secs)	Description
00:00		Ignition of crib.
00:35		Flame tips to top of crib.
01:25		Flame tips impinging on cladding system.
01:55		Flame tips to mid-height of panels 1C/1D.
02:00	00:00	Start time (t_s) criteria achieved: External temperature 2.5m above the top of the combustion chamber in excess of 207°C (=200°C+T_s).
02:45	00:45	Flame tips to top of panels 1C/1D.
03:00	01:00	Detachment of material from base of panels 1C/1D.
03:40	01:40	Flame tips to mid-height of panels 2C/2D.
04:30	02:30	Detachment of material from base of panels 2C/2D.
05:10	03:10	Intermittent flame tips to top of panels 2C/2D.
05:40	03:40	Distortion up to top of panels 2C/2D.
06:40	04:40	Detachment of material to mid-height of panels 2C/2D.
06:50	04:50	Distortion from base of panel 0A to base of panel 1A.
07:35	05:35	Flame tending to wing wall (base of panel 1A).
08:05	06:05	Dark discolouration at base of panel 1A.
08:25	06:25	Distortion of top of combustion chamber surround.
08:45	06:45	Detachment of material at base of panel 1A.
09:35	07:35	Flame tips to top of panels 2C/2D.
09:55	07:55	Distortion of panels 3C/3D.

Time* (mins:secs)	t_s (mins:secs)	Description
10:40	08:40	Smoke from junction between panels 2E/3E and edge of main wall.
11:15	09:15	Consumption of panel 1C (local to junction between 1C/1D).
11:30	09:30	Dark discolouration and material detachment at base of panel 1B.
12:05	10:05	Flaming debris from cladding system.
12:40	10:40	Consumption of panel 1D (local to junction between 1C/1D).
12:55	10:55	Flaming behind panel 1C.
13:25	11:25	Consumption of panel 2C (bottom right-hand corner).
14:05	12:05	Flaming debris from cladding system.
14:15	12:15	Debris fire at base of cladding system.
14:35	12:35	Flaming detachment from cladding system.
15:20	13:20	Distortion of panel 2A.
15:50	13:50	Flaming detachment from cladding system.
16:10	14:10	Dark discolouration of and material detachment from panel 2D.
16:45	14:45	Non-flaming debris from cladding system.
17:05	15:05	Dark discolouration from base of panel 0A to top of panel 1A.
17:30	15:30	Consumption of panel 2D (bottom left-hand corner).
18:05	16:05	Flaming detachment from cladding system.
18:15	16:15	Sustained debris fire at base of cladding system.
18:50	16:50	Intermittent flame tips to mid-height of panels 3C/3D.
19:10	17:10	Partial crib collapse.
19:25	17:25	Flaming debris from cladding system.
19:50	17:50	Consumption to mid-height of panels 2C/2D.

Time* (mins:secs)	t_s (mins:secs)	Description
20:10	18:10	Detachment of burnt insulation.
20:40	18:40	Dark discolouration to top of panels 2C/2D.
21:00	19:00	Flame tips to top of panels 2C/2D.
21:30	19:30	Discolouration at base of panels 3C/3D.
22:10	20:10	Patches of dark discolouration at base of panel 2A.
22:35	20:35	Material detachment at base of panel 3C.
22:55	20:55	Flaming behind panel 2C.
23:35	21:35	Intermittent flame tips to mid-height of panels 3C/3D.
24:20	22:20	Distortion of combustion chamber surround sides.
25:10	23:10	Flaming behind panels 2C/2D.
26:10	24:10	Sustained debris fire at base of cladding system.
27:15	25:15	Flaming from junction between panels 2C/3C.
28:10	26:10	Flaming at base of panel 3C (from behind panel).
28:35	26:35	Consumption to top of panels 2C/2D.
29:00	27:00	Consumption at base of panel 3C.
30:00	28:00	Crib extinguished.
30:10	28:10	Flaming insulation behind panels 1C, 1D, 2C and 2D.
32:20	30:20	Flaming at base of panel 3C.
33:00	31:00	Flaming reduced to glow behind panels 1C/1D.
33:20	31:20	Flaming of left-hand side of panel 1C and right-hand side of panel 1D.
33:40	31:40	Flaming towards top of panels 2C/2D (lower part glowing).
38:00	36:00	Continued flaming towards top of panels 2C/2D

Time* (mins:secs)	t_s (mins:secs)	Description
40:10	38:10	Flaming behind panel 1C progressing up to approximately 200mm above the base of panel 2C.
40:50	38:50	Flaming at top of panels 2C/2D progressing up to approximately 300mm above the base of panels 3C/3D.
42:00	40:00	Non-flaming debris from insulation behind panel 2D.
43:15	41:15	Significant reduction in flaming behind panel 1C (flaming continues at top of panel).
44:40	42:40	Significant reduction in flaming behind panel 2D (flaming continues at top of panel).
45:50	43:50	Intermittent flaming at base of panel 1C.
48:20	46:20	Flaming at base of panel 1C ceased.
49:30	47:30	Non-flaming debris from cladding system.
50:05	48:05	Reduced intensity of all flaming.
50:10	48:10	Flaming at base of panel 1D ceased.
50:40	48:40	Flaming behind panel 1C ceased.
60:00	58:00	Test terminated.

*Time from point of ignition.

6 Post-Test Damage Report

6.1 Mechanical performance

Flaming debris was observed from the cladding system from 12 minutes 5 seconds until approximately 19 minutes 25 seconds. A small fire formed at the base of the cladding system as a result. Consumption of ACM panels was observed tapering up to a height of approximately 5m above the top of the combustion chamber. Detachment of insulation and horizontal cavity barriers was also observed.

After the crib was extinguished flaming continued within the exposed insulation until approximately 35 minutes 10 seconds where the flaming was concentrated behind the remainder of panels 1C, 1D, 2C and 2D. All flaming ceased at 50 minutes 40 seconds.

6.2 ACM panels

With reference to *Figure 2* the damage to the ACM panels was as follows:

Panel 0A – 70% of coating removed and 20% dark discolouration and panel distorted.
Panel 0B – Intact and in place with distortion across panel.
Panel 0E – dark discoloration at top left-hand corner, no visible damage across the rest of the panel.

Panel 1A – 70% coating removed and 20% dark discolouration, panel distorted.
Panel 1B – 90% dark discolouration with distortion.
Panel 1C – 80% consumed. 80% of coating removed and 20% dark discolouration on the remainder of the panel.
Panel 1D – 80% consumed. 60% of coating removed and 30% dark discolouration on the remainder of the panel.
Panel 1E – localised areas of dark discolouration with minor distortion across the panel.

Panel 2A – 30% dark discolouration with distortion across the panel.
Panel 2B – dark discolouration at bottom left-hand corner. Distortion across panel.
Panel 2C – 40% consumed. 60% of coating removed and 20% dark discolouration on the remainder of the panel.
Panel 2D – 40% consumed. 40% coating removed and 20% dark discolouration on the remainder of the panel.
Panel 2E – dark discolouration at bottom left-hand corner. Minor distortion across panel.

Panel 3A – intact and in place. Slight distortion.
Panel 3B – intact and in place. Slight distortion.
Panel 3C – slight consumption at base of panel (<0.01m^2). 30% dark discolouration and 10% of coating removed.
Panel 3D – 20% dark discolouration with 10% of coating removed. Heavy distortion at base with slight distortion throughout panel.
Panel 3E – no visible damage.

Combustion chamber surround

The left-hand side of the combustion chamber surround was distorted and discoloured from the top to approximately 1800mm above the floor.
The top of the combustion chamber surround was 90% consumed.
The right-hand side of the combustion chamber surround had 5% consumption towards the top with dark discolouration.

6.3 Aluminium rail substructure

Main wall

Between the ground and top of the combustion chamber opening

There was no visible damage.

Between the top of the combustion chamber and third row of horizontal cavity barriers

The first vertical rail from the edge of the main wall had slight distortion.

The second vertical rail from the outer edge of the main wall had localised areas of dark and pale discolouration with heavy distortion along the rail.

The third, fourth and fifth rails from the outer edge of the main wall were fully consumed.

The sixth vertical rail from the outer edge of the main wall had localised areas of dark and pale discolouration with heavy distortion along the length.

Between the third and fourth row of horizontal cavity barriers

The first rail from the outer edge of the main wall had slight distortion.

The second rail from the outer edge of the main wall had localised areas of dark and pale discolouration with heavy distortion along the rail.

The third, fourth and fifth rails from the outer edge of the main wall had 90% dark discolouration with localised areas of pale and smoke discolouration.

The sixth rail from the outer edge of the main wall had localised areas of smoke discolouration.

Wing Wall

Between the ground and top of the combustion chamber opening

There was no visible damage.

Between the top of the combustion chamber and third row of horizontal cavity barriers

The first rail from the inner edge of the wing wall had localised areas of dark discolouration.

The second rail from the inner edge of the wing wall had localised areas of smoke discolouration.

The third rail from the inner edge of the wing wall had no visible damage.

Between the third and fourth row of horizontal cavity barriers

There was no visible damage.

6.4 Insulation

Main wall

Between the ground and first row of horizontal cavity barriers

There was no visible damage.

Between the first and second row of horizontal cavity barriers

Between the outer edge of the main wall and the vertical cavity barrier located adjacent to the outer edge of the main wall there was no visible damage.

Between the vertical cavity barrier located adjacent to the outer edge of the main wall and the vertical cavity barrier located adjacent to the main-wing wall junction there was 95% detachment of insulation exposing the cement board layer. The remaining insulation was charred.

Between the vertical cavity barrier located adjacent to the main-wing wall junction and the main-wing wall junction there was no visible damage.

Between the second and third row of horizontal cavity barriers

Between the outer edge of the main wall and the vertical cavity barrier located adjacent to the outer edge of the main wall there was no visible damage.

Between the vertical cavity barrier located adjacent to the outer edge of the main wall and the vertical cavity barrier located adjacent to the main-wing wall junction there was 80% detachment of insulation exposing the cement board layer. The remaining insulation was charred.

Between the vertical cavity barrier located adjacent to the main-wing wall junction and the main-wing wall junction there was no visible damage.

Between the third and fourth row of horizontal cavity barriers

Between the outer edge of the main wall and the vertical cavity barrier located adjacent to the outer edge of the main wall there was no visible damage.

Between the vertical cavity barrier located adjacent to the outer edge of the main wall and the vertical cavity barrier located adjacent to the main-wing wall junction there was 50% dark discolouration, 20% pale discolouration and 30% smoke discolouration.

Between the vertical cavity barrier located adjacent to the main-wing wall junction and the main-wing wall junction there was no visible damage.

Wing wall

There was no visible damage to the insulation on the wing wall throughout the height of the cladding system.

6.5 Vertical cavity barriers

The vertical barrier located at the outer edge of the main wall had localised areas of dark and pale discolouration between the top of the combustion chamber and the third row of horizontal cavity barriers. The rest of the barrier had no visible damage.

The vertical cavity barrier located adjacent to the main-wing wall junction had localised areas of dark and pale discolouration from the top of the combustion chamber to the top of the cladding system. The rest of the barrier had no visible damage.

The vertical cavity barrier at the outer edge of the wing wall had no visible damage.

6.6 Horizontal (intumescent) cavity barriers

First row of horizontal cavity barriers

Main wall

Between the outer edge of the main wall and the vertical cavity barrier located adjacent to the outer edge of the main wall there was no activation of the intumescent strip.

Between the vertical cavity barrier located adjacent to the outer edge of the main wall and the vertical cavity barrier adjacent to the main-wing wall junction there was 90% detachment of the cavity barrier. The remainder of the barrier had dark discolouration.

Between the vertical cavity barrier adjacent to the main-wing wall junction and the main-wing wall junction there was partial activation of the intumescent strip.

Wing wall

Between the main-wing wall junction and the vertical cavity barrier adjacent to the outer edge of the wing wall there was full activation of the intumescent strip.

Between the vertical cavity barrier adjacent to the outer edge of the wing wall and the edge of the wing wall there was no activation of the intumescent strip.

Second row of horizontal cavity barriers

Main wall

Between the outer edge of the main wall and the vertical cavity barrier located adjacent to the outer edge of the main wall there was no activation of the intumescent strip.

Between the vertical cavity barrier located adjacent to the outer edge of the main wall and the vertical cavity barrier adjacent to the main-wing wall junction there was full activation of the intumescent strip with partial detachment of the barrier.

Between the vertical cavity barrier adjacent to the main-wing wall junction and the main-wing wall junction there was partial activation of the intumescent strip.

Wing wall

Between the main-wing wall junction and the outer edge of the wing wall there was full activation of the intumescent strip.

Third row of horizontal cavity barriers

Main wall

Between the outer edge of the main wall and the vertical cavity barrier located adjacent to the outer edge of the main wall there was no activation of the intumescent strip.

Between the vertical cavity barrier located adjacent to the outer edge of the main wall and the main-wing wall junction there was full activation of the intumescent strip.

Wing wall

Between the main-wing wall junction and the outer edge of the wing wall there was partial activation of the intumescent strip.

Fourth row of horizontal cavity barriers

Main wall

Between the outer edge of the main wall and the vertical cavity barrier located adjacent to the outer edge of the main wall there was no activation of the intumescent strip.

Between the vertical cavity barrier located adjacent to the outer edge of the main wall and the main-wing wall junction there was partial activation of the intumescent strip.

Wing wall

Between the main-wing wall junction and the outer edge of the wing wall there was partial activation of the intumescent strip.

6.7 'U'-shaped channels

On the main wall the first to the fifth 'U'-shaped channel from the top of the combustion chamber had dark discolouration between the vertical cavity barriers on the main wall. The rest of the channels had no visible damage.

6.8 'L'-shaped brackets

The 'L'-shaped brackets on the main wall between the vertical cavity barriers had heavy distortion with partial consumption of the brackets within the flame damage zone. The rest of the brackets had no visible damage.

6.9 Cement particle board

On the main wall there were areas of dark and pale discolouration where the insulation and cavity barriers had detached. The area of discolouration extended from the top of the combustion chamber up to a height of the approximately 200mm above the top of the third row of horizontal cavity barriers and was mostly contained between the vertical cavity barriers on the main wall. There were areas of dark discolouration at the edges immediately surrounding the combustion chamber opening.

On the wing wall there was an area of dark discolouration approximately 250mm-wide×50mm-high at a height of approximately 2300mm above the top of the combustion chamber.

6.10 Partition

There was no visible damage.

6.11 Plasterboard

There was no visible damage.

7 Conclusion

BS8414 Part 2:2015 + 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 8414-2:2015 + A1:2017, 'Fire performance of external cladding systems – Part 2: Test method for non-loadbearing external cladding systems fixed to and supported by a structural steel frame', British Standards Institution, London, 2015.

9 Figures

9.1 Dimensions of test apparatus

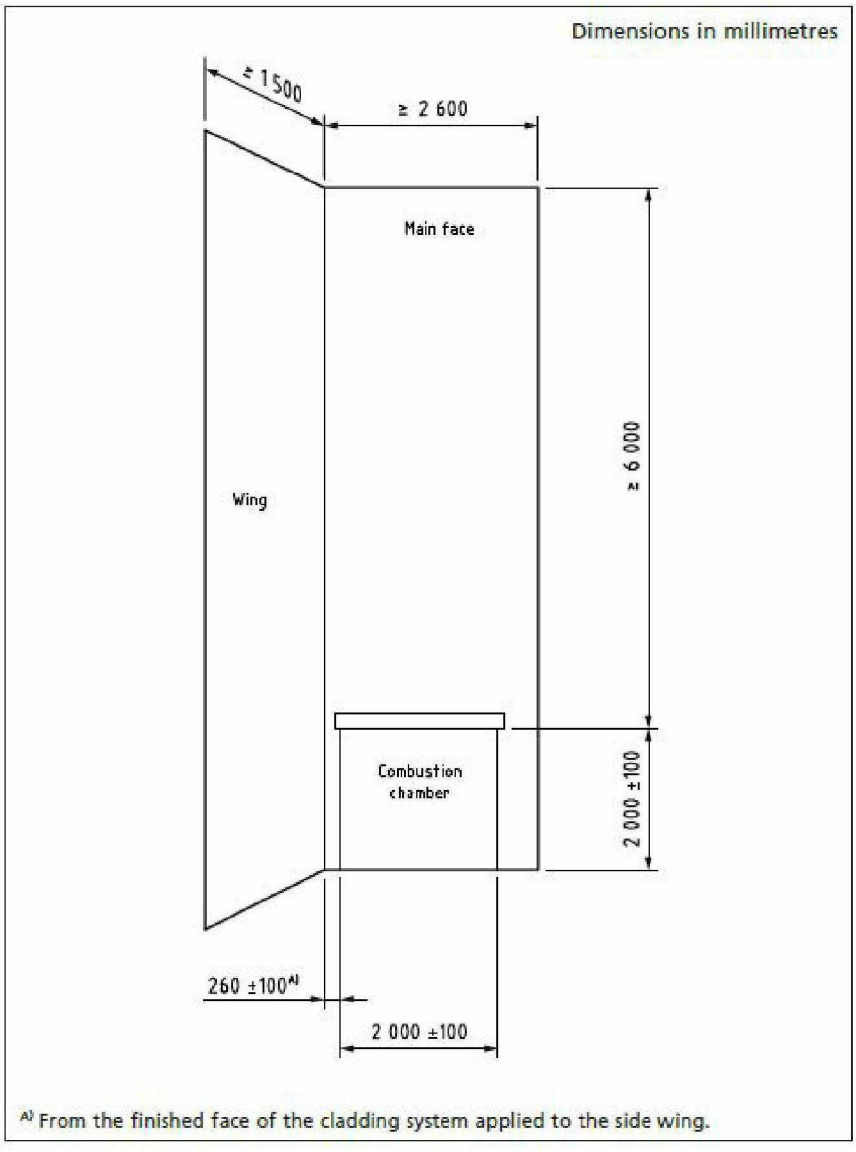

Figure 1. Test apparatus dimensions as specified by test Standard[1].

Note: The test apparatus may be constructed left- or right-handed.

9.2 Diagrams of finished face of the cladding system

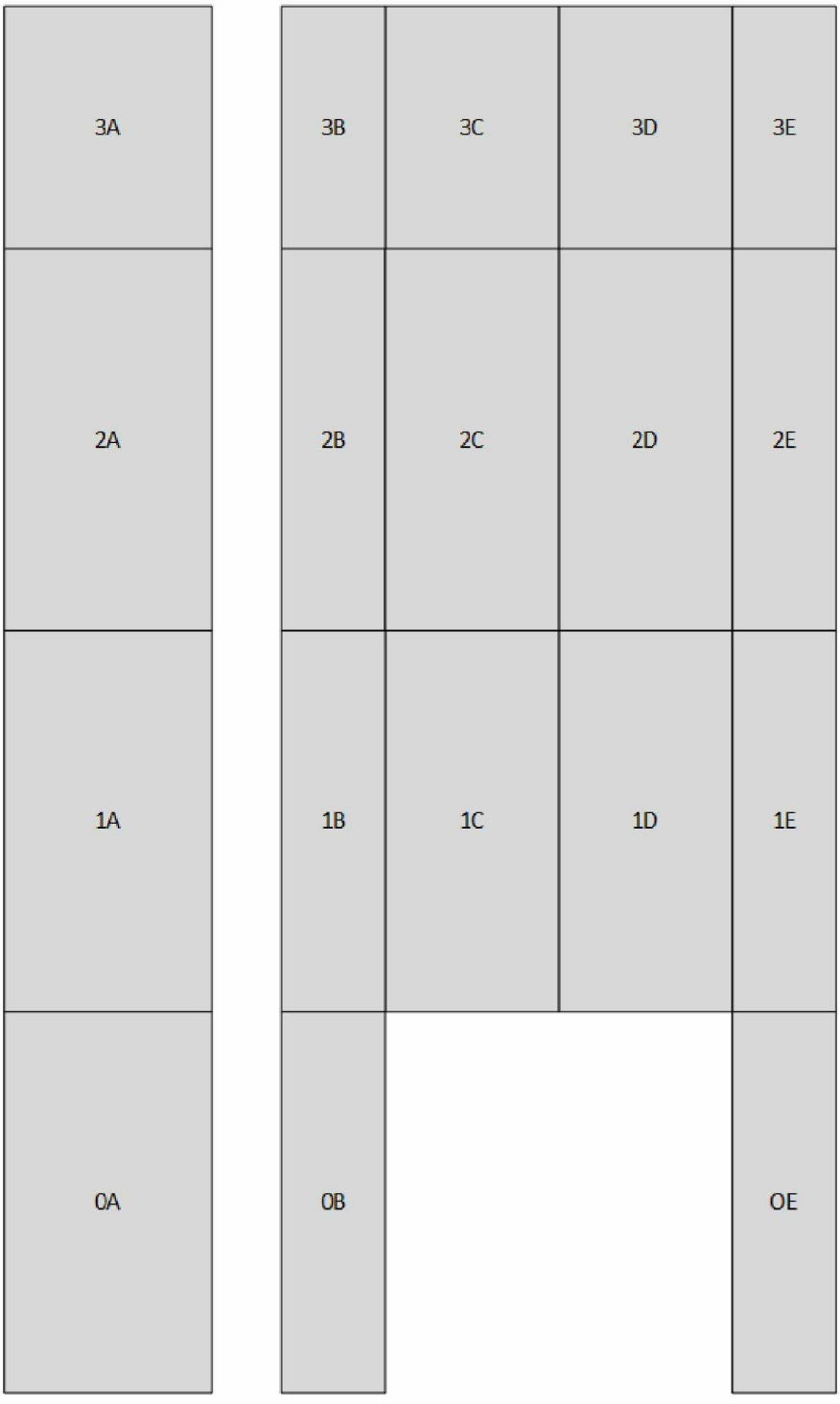

Figure 2. Layout of panels and numbering system used for reporting. Not to scale.

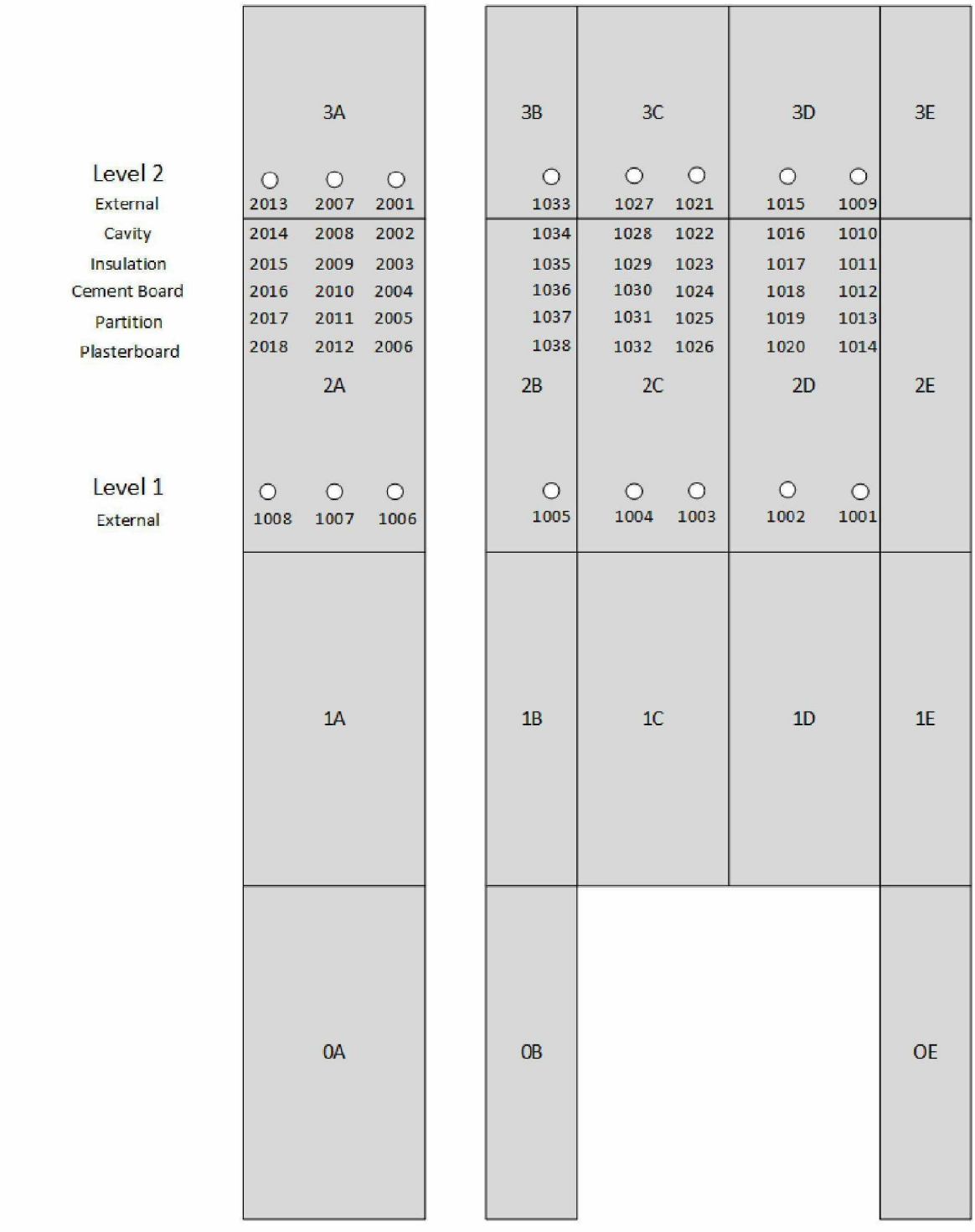

Figure 3. TC positions and panel numbering (0A – 3E). Not to scale.

9.3 Installation photographs

Figure 4. Kingframe SFS (Steel Framing System) fitted between 'floor slabs'.

Figure 5. Cement particle board fitted to external face of Kingframe partition.

Figure 6. 'U'-shaped channels and 'L'-brackets fitted to cement particleboard.

Figure 7. Insulation and cavity barriers fitted to system.

Figure 8. Vertical rails fitted to system.

Figure 9. Full-height photograph of cladding system prior to test.

9.4 System drawings

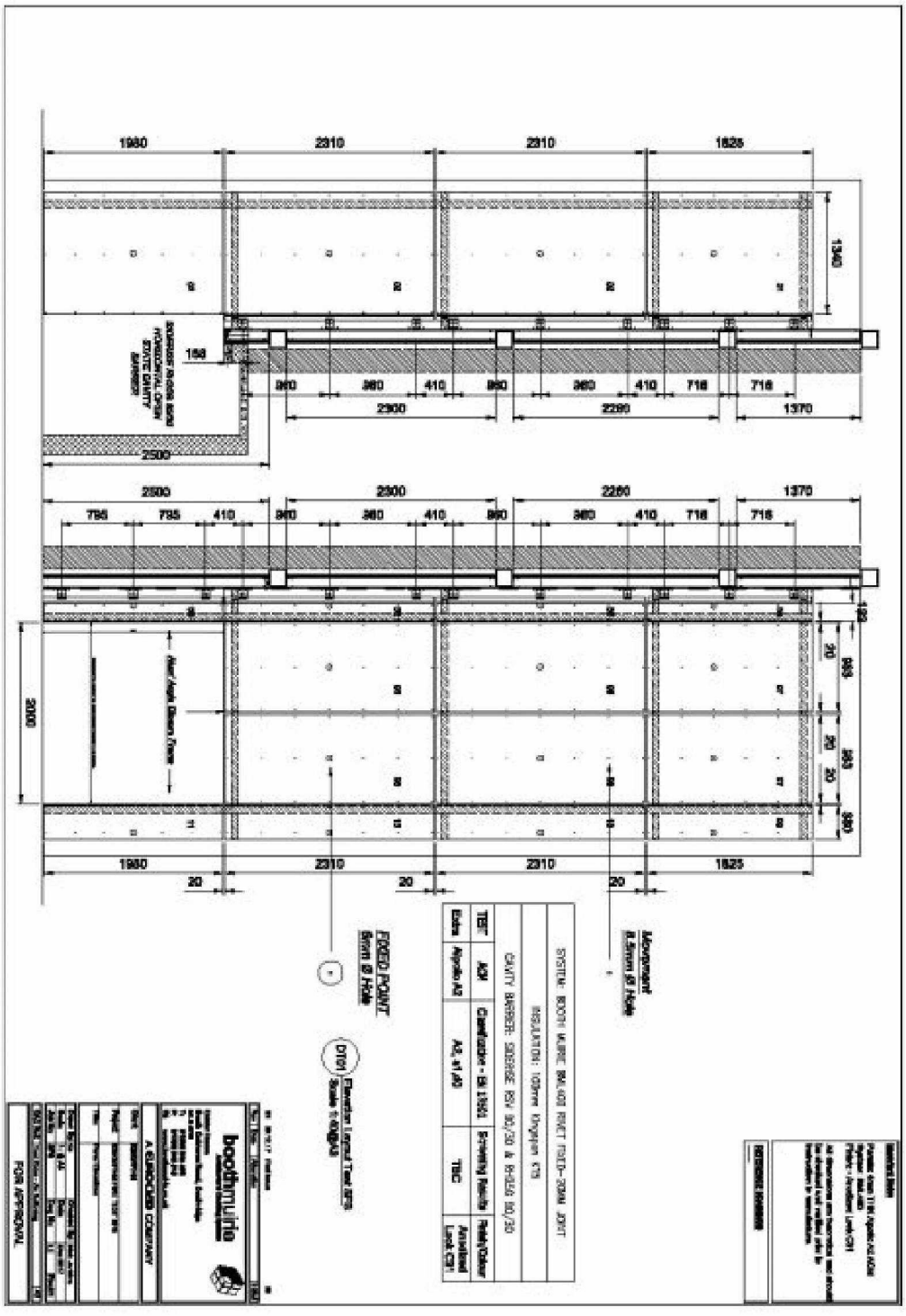

Figure 10. ACM panel dimensions (supplied by Test Sponsor).

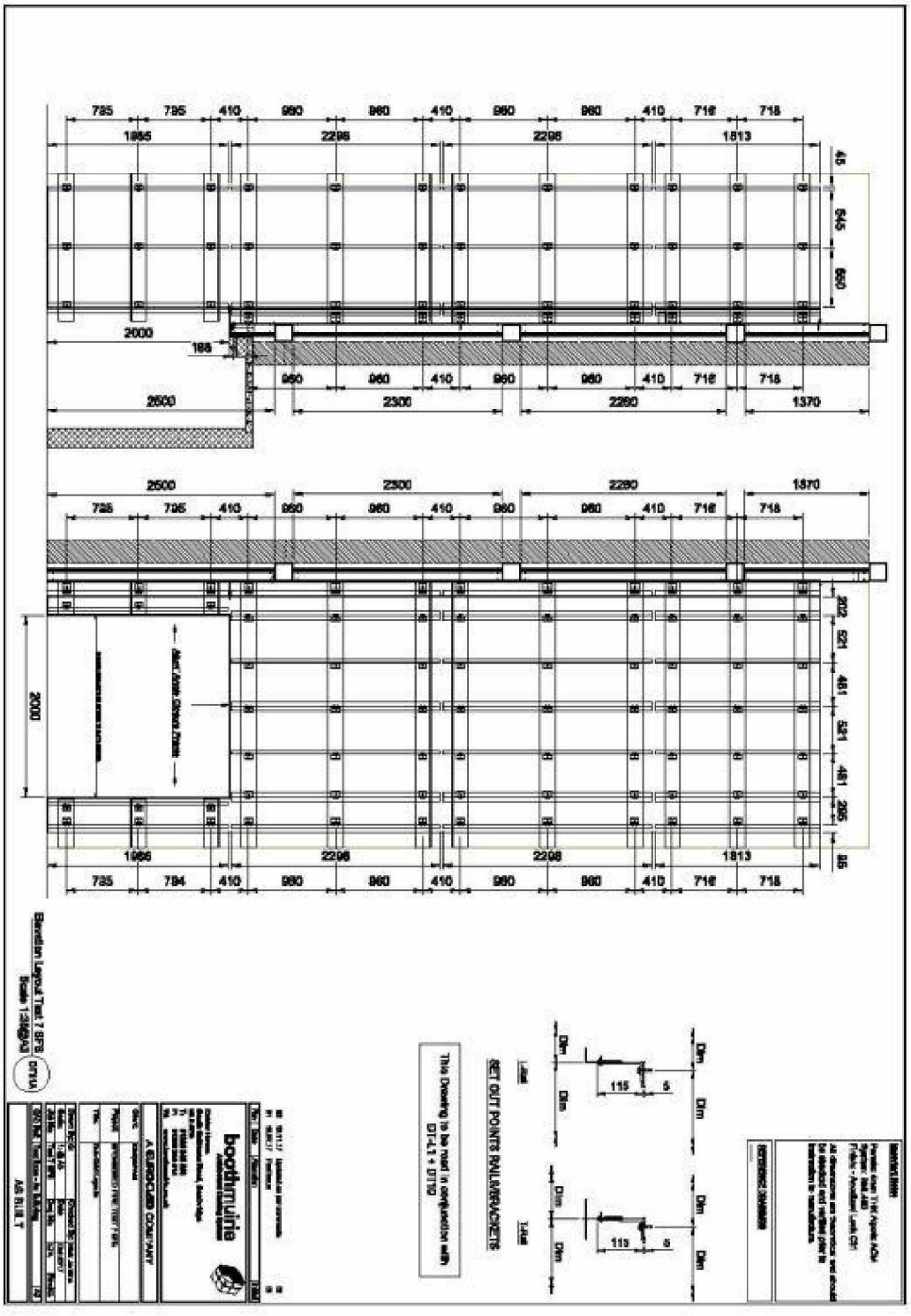

Figure 11. Rail and 'L'-shaped bracket locations (supplied by Test Sponsor).

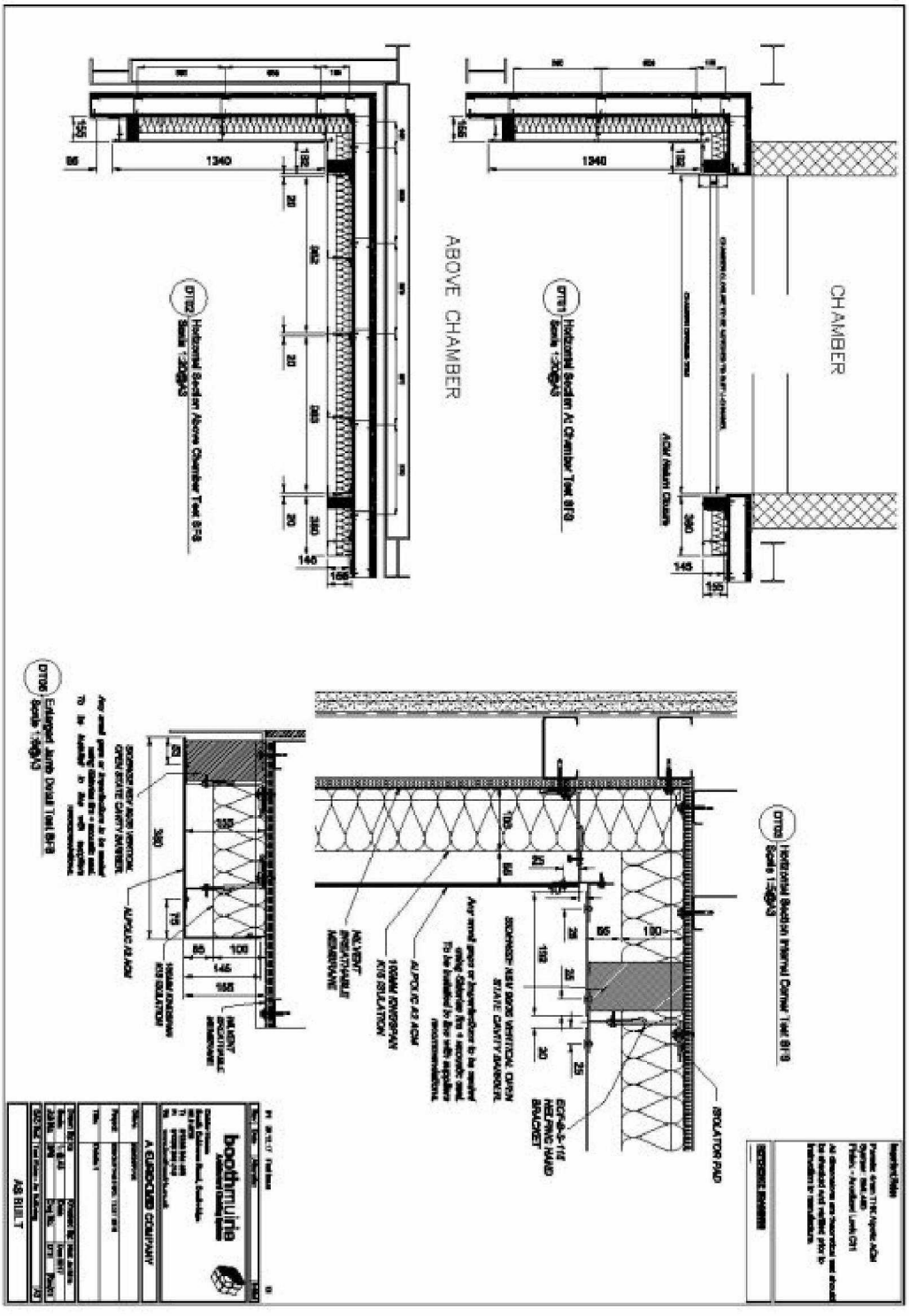

Figure 12. Cross-section views of cladding system (supplied by Test Sponsor).

9.5 Temperature data

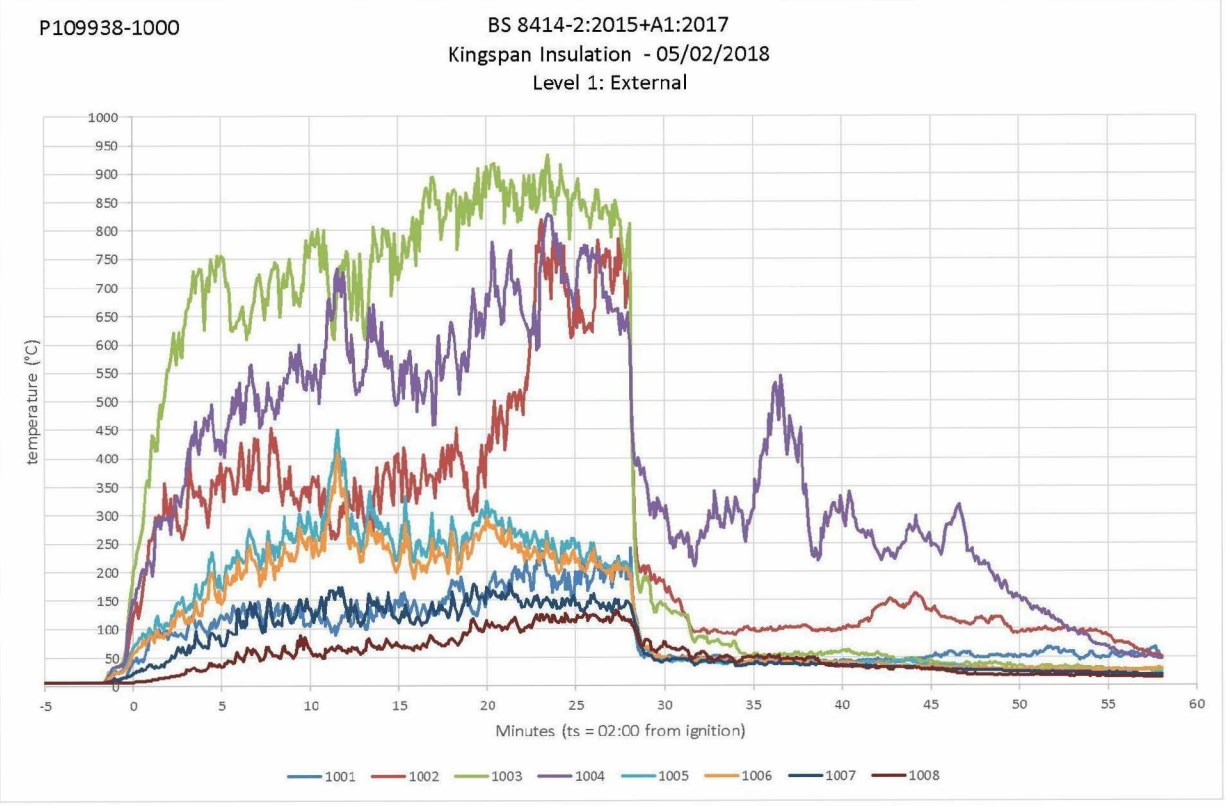

Figure 13. Level 1 external thermocouples.

t_s=2 mins 0 secs after ignition of the crib.

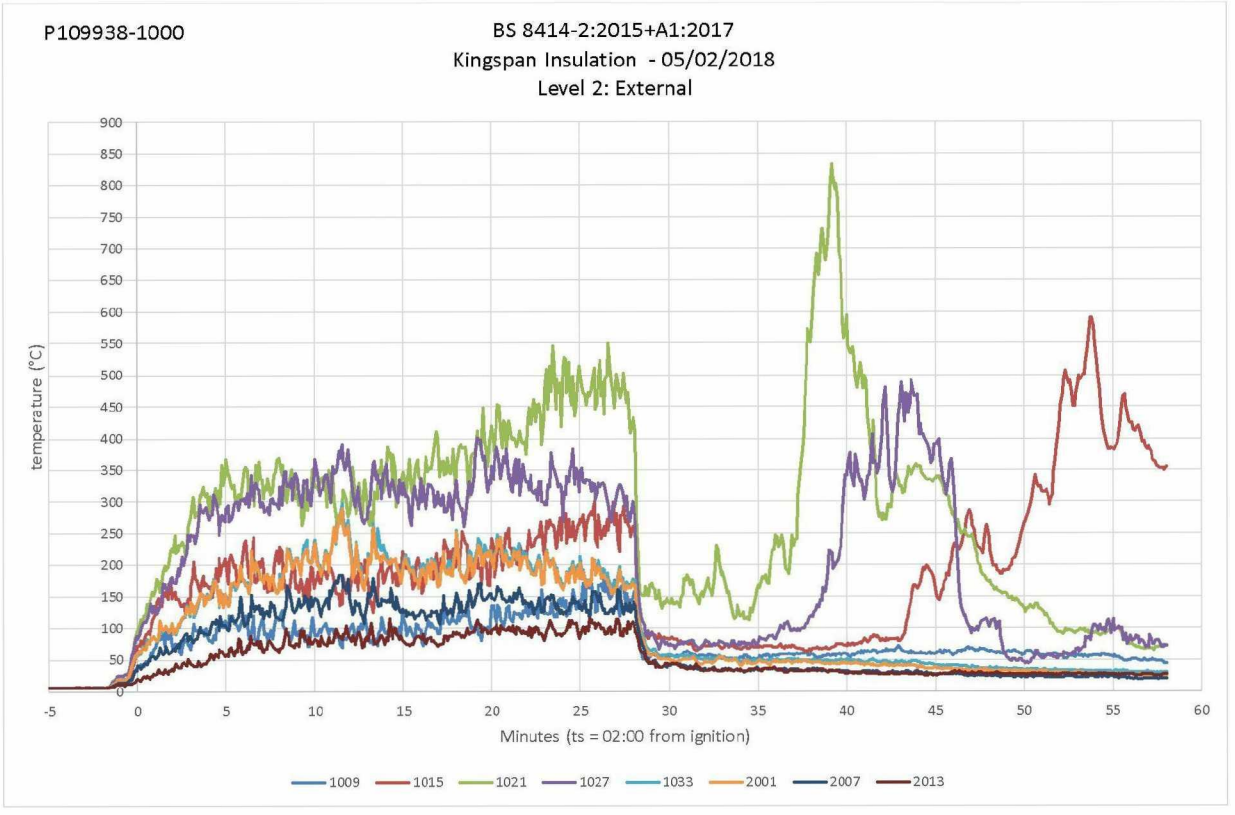

Figure 14. Level 2 external thermocouples.

t_s=2 mins 0 secs after ignition of the crib.

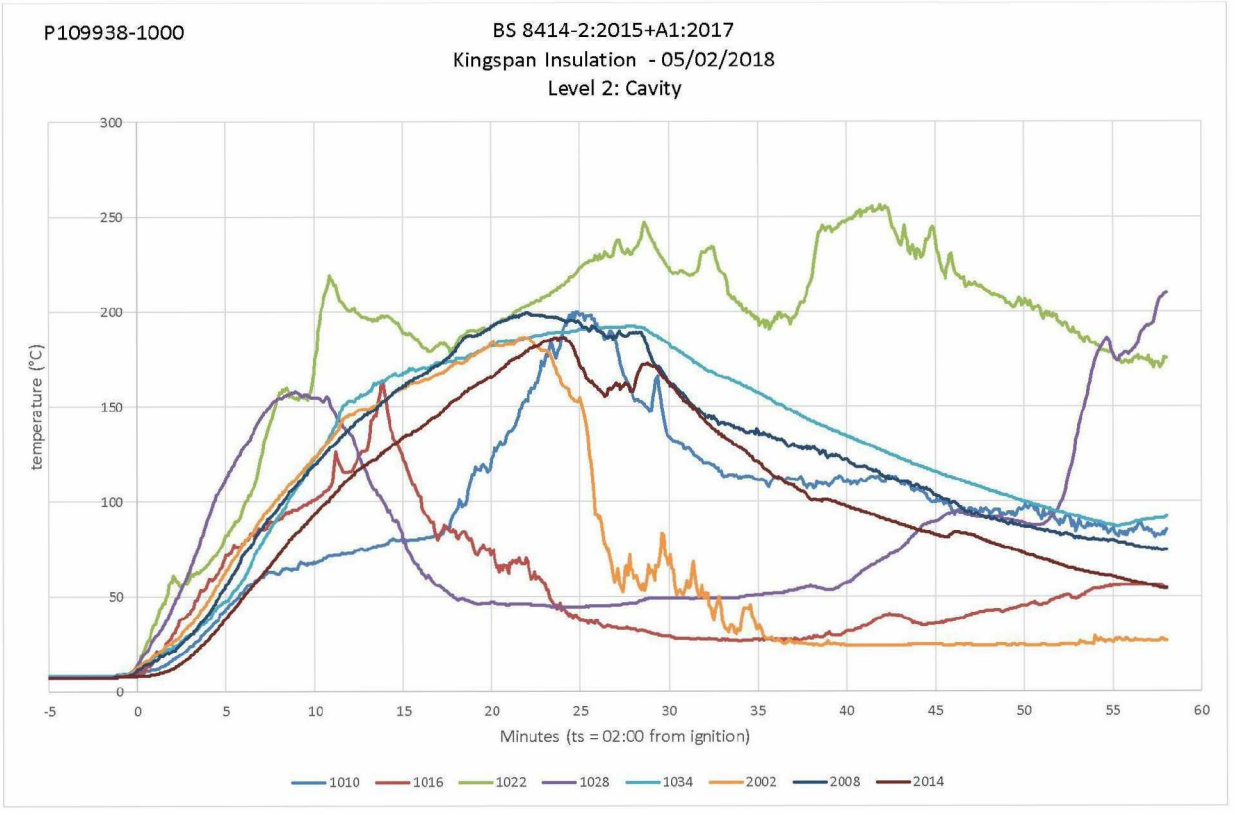

Figure 15. Level 2 cavity thermocouples.

t_s=2 mins 0 secs after ignition of the crib.

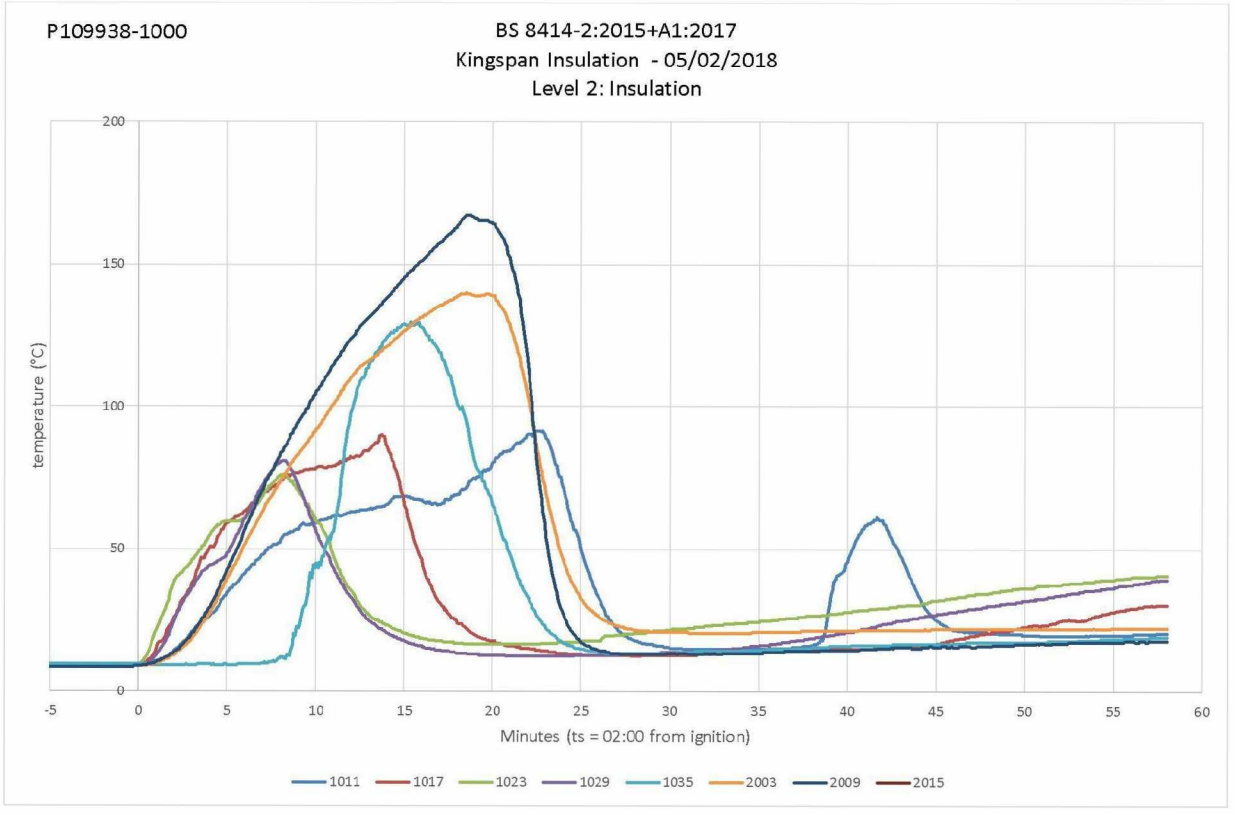

Figure 16. Level 2 insulation thermocouples.

t_s=2 mins 0 secs after ignition of the crib.

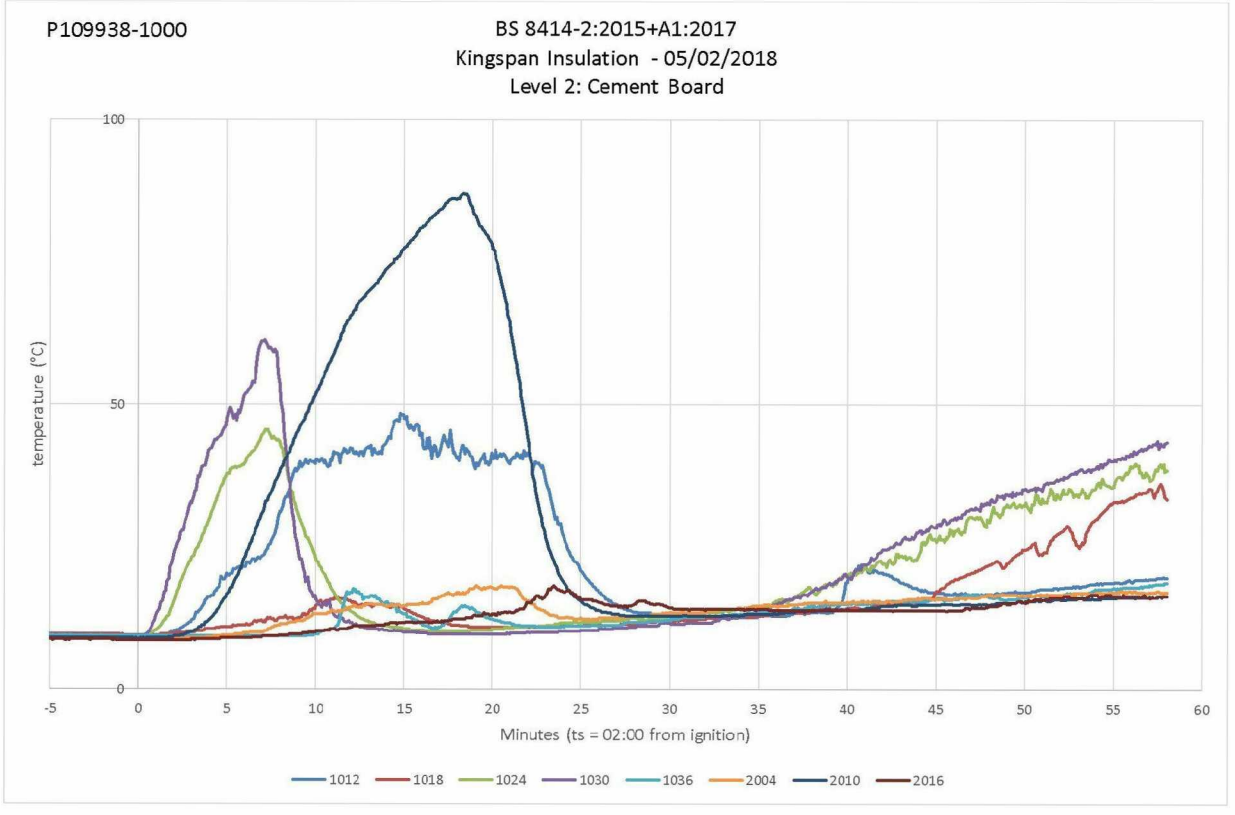

Figure 17. Level 2 cement particle board thermocouples.

t_s=2 mins 0 secs after ignition of the crib.

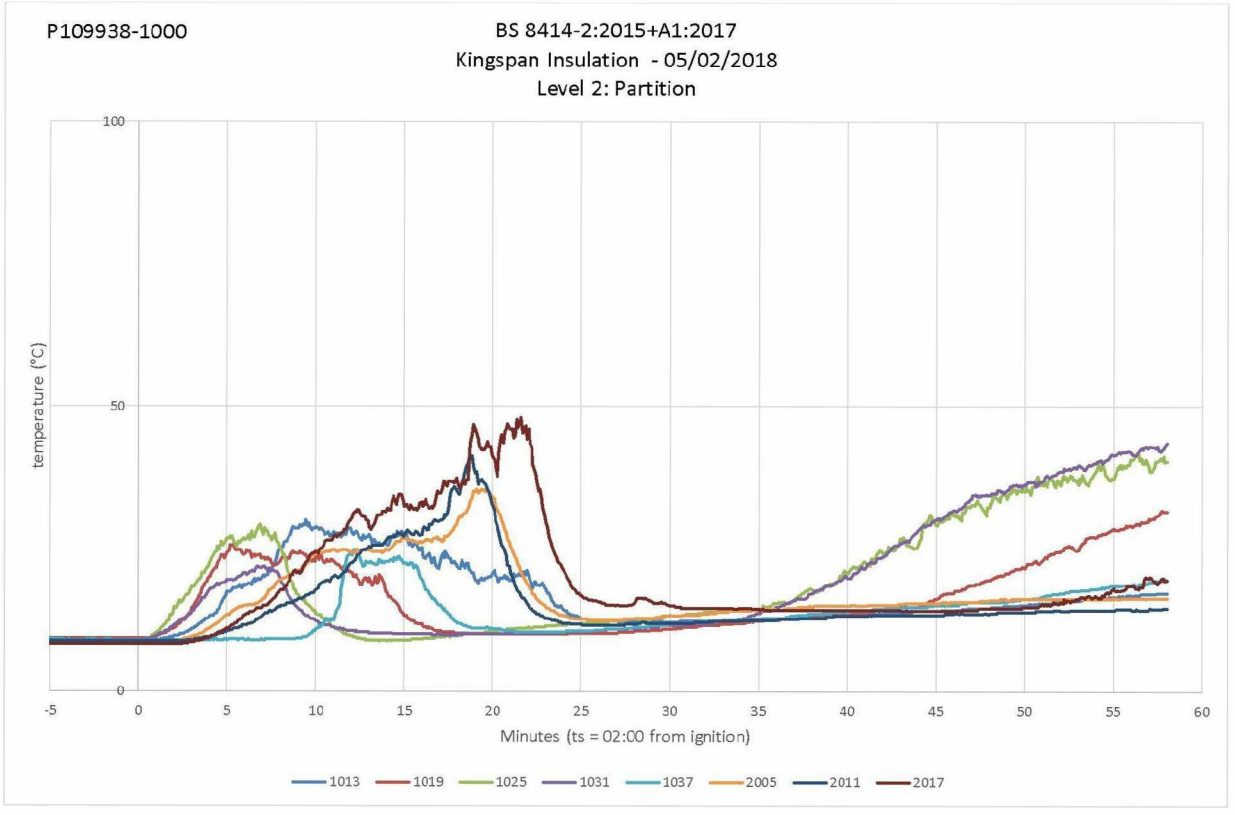

Figure 18. Level 2 partition thermocouples.

t_s=2 mins 0 secs after ignition of the crib.

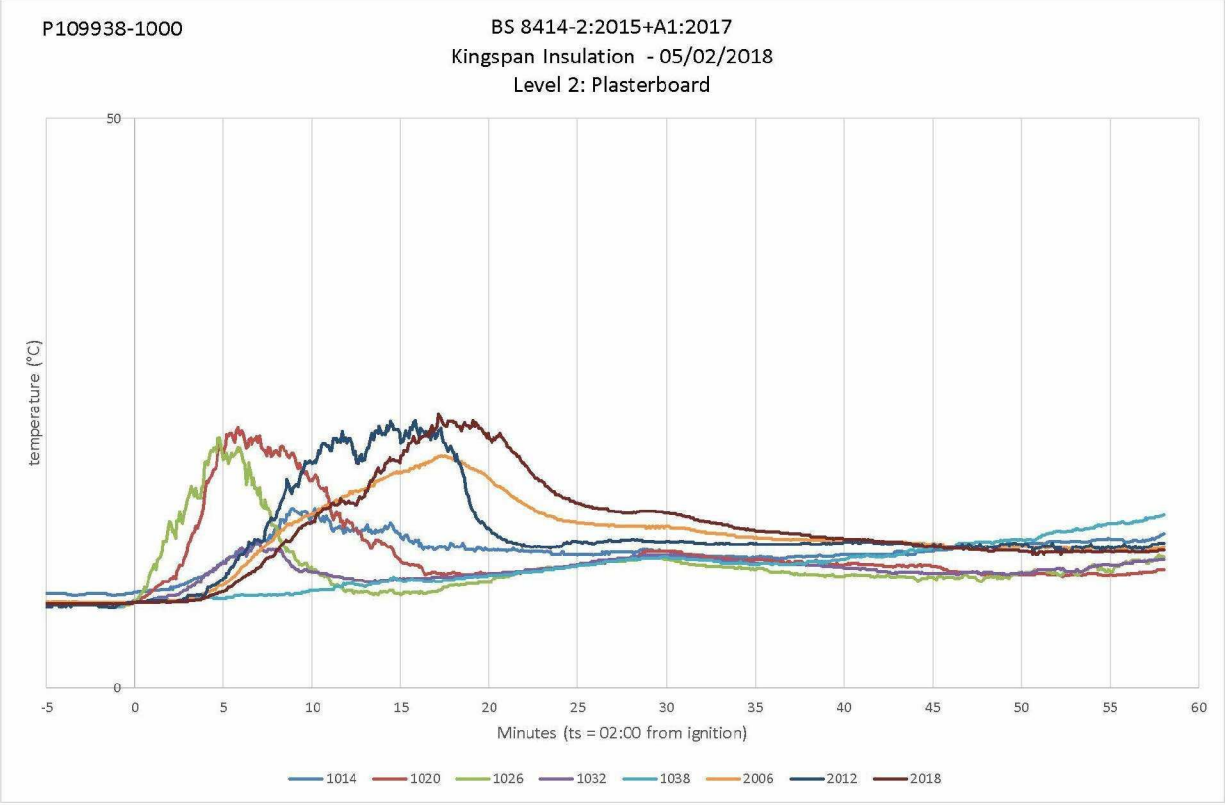

Figure 19. Level 2 plasterboard thermocouples.

t_s=2 mins 0 secs after ignition of the crib.

9.6 Post-test photographs

Figure 20. Full-height photograph of cladding system immediately after test.

Figure 21. Damage to panels between ground and top of combustion chamber opening.

Figure 22. Damage to panels between top of combustion chamber and a height of approximately 5000mm above the top of the combustion chamber.

Figure 23. Damage to panels between a height of approximately 4000mm and 6000mm above the top of the combustion chamber.

Figure 24. Damage to panels between a height of approximately 6000mm above the top of the combustion chamber and the top of the cladding system.

Figure 25. Full-height photograph of damage to insulation.

Figure 26. Damage to insulation between ground and top of combustion chamber opening.

Figure 27. Damage to insulation between top of combustion chamber and a height of approximately 4500mm above the top of the combustion chamber.

Figure 28. Damage to panels between a height of approximately 5000mm above the top of the combustion chamber and the top of the cladding system.

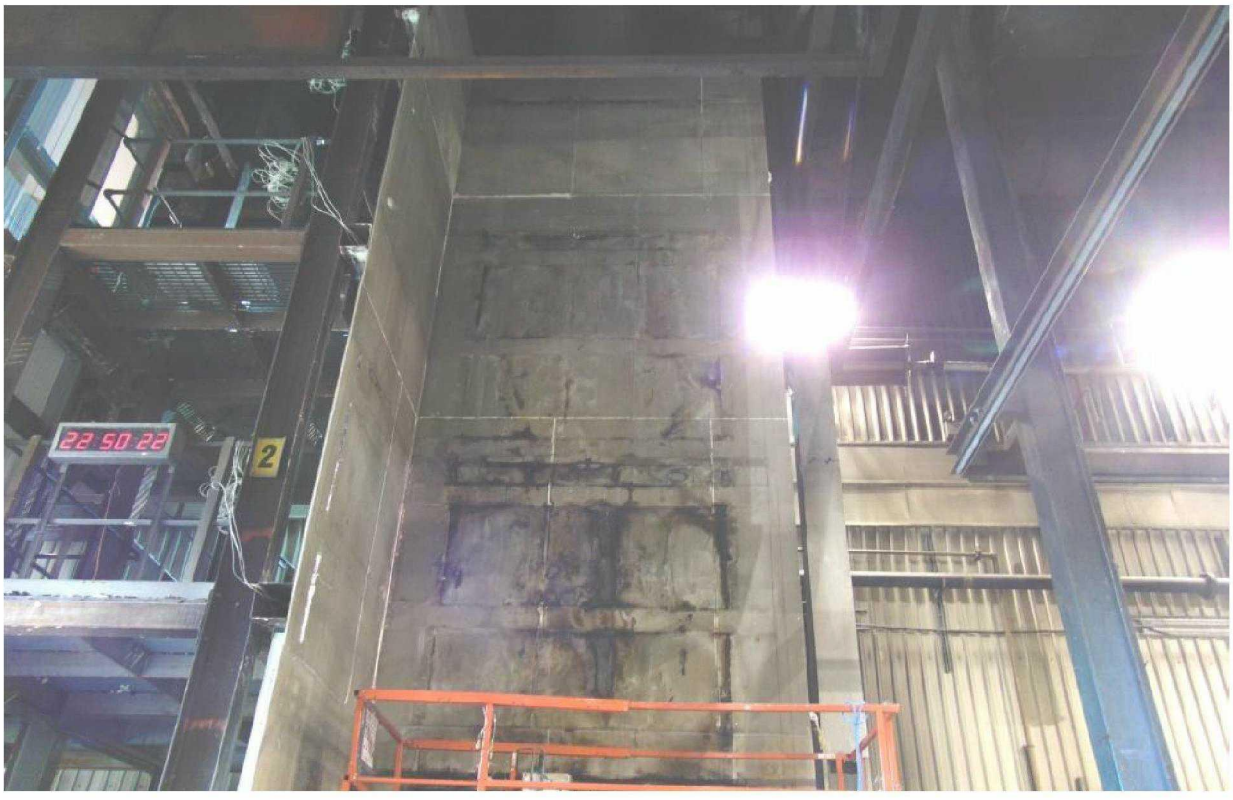

Figure 29. Damage to cement board from the top of the combustion chamber to the top of the cladding system.

Report Ends