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BRE Global Test Report

BS 8414-1:2015 + A1:2017 test on a ventilated façade system with Kingspan Kooltherm K15 insulation and Alpolic/fr panels.

Prepared for: Kingspan Insulation Limited

Date: 11th January 2018

Report Number: P109939-1000 **Issue: 1**

BRE Global Ltd
Watford, Herts
WD25 9XX

Customer Services [redacted]

Prepared for:
Kingspan Insulation Limited
Pembridge,
Leominster,
Herefordshire,
HR6 9LA,
UK

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Prepared by

Name David Farrington

Position Fire Test Manager

Signature 

Authorised by

Name Stephen Howard

Position Director of Fire Testing and Certification

Date 11 January 2018

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 Test Details

Name of Laboratory:	BRE Global Ltd.
Laboratory Address:	Bucknalls Lane, Garston, Watford, Hertfordshire. WD25 9XX
Test reference:	P109939-1000
Date of test:	7th November 2017
Sponsor:	Kingspan Insulation Limited
Sponsor address:	Pembridge, Leominster, Herefordshire, HR6 9LA, UK
Method:	The test was carried out in accordance with BS 8414-1:2015 + A1:2017
Deviations:	None

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3 Details of Test Apparatus

The product was installed on to wall number one of the BS 8414-1[1] 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. The test apparatus may be constructed left- or right-handed.

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4 Description of the System

4.1 Summary

Generic cladding type	Rainscreen
Relevant test method	BS 8414-1
Substrate	Masonry
Insulation	Kingspan Kooltherm K15 (100mm-thick)
Cavity depth	50mm between insulation and facade
Vertical cavity barriers	Siderise RSV 90/30 vertical cavity barriers (75mm-thick x 155mm-deep)
Horizontal cavity barriers	Siderise RH25G 90/30 horizontal open state cavity barriers (75mm-thick x 125mm-deep)
External finish	4mm-thick Mitsubishi Alpolic/fr

4.2 Description of product

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

Item	Description
1	150mm-long x 90mm-wide x 5mm-thick 'L'-shaped aluminium brackets fixed to the wall using one apoloMEA MFR FB 10-80 SSKS.
2	155mm-deep x 75mm-thick Siderise RSV 90/30 vertical cavity barriers - labelled 'Lamatherm'. Secured to ¾ depth using B65/110 galvanised steel brackets fixed to the wall using one apoloMEA MFR FB 10-80 SSKS.
3	125mm-deep x 75mm-thick Siderise RH25G 90/30 horizontal open state cavity barriers with intumescent strip. Skewered onto face turned RS 350 galvanised steel brackets fixed to the wall using one apoloMEA MFR FB 10-80 SSKS.
4	100mm-thick Kingspan Kooltherm K15 insulation. Foil faced on both sides. Supplied in 2.4m x 1.2m sheets. The insulation was secured to the wall using 4.8mm x 160mm A4 stainless steel screws (BS-A4-4.8 x 160) with washers (SP-SS-70-D4) and 4.8mm x 160mm A4 stainless steel screws (BS-A4-4.8 x 160) with Fixfast DHK120 plastic fixings.
5	40mm-wide x 60mm-deep x 2mm-thick aluminum 'L' shaped rails.
6	120mm-wide x 60mm-deep x 2mm-thick aluminum 'T' shaped rails.
7	4mm-thick ACM (aluminium composite material) panels. Mitsubishi Alpolic/fr Core material mean calorific value was measured at 13.6 MJ/Kg. BRE Report P110396-1004[2].

4.3 Installation sequence

'L'-shaped brackets to carry the 'T' and 'L'-shaped rails were fixed to the masonry structure using one apoloMEA MFR FB 10-80 SSKS per bracket. The combined aluminium substructure was referenced Allface System F1.10.

Three rows of brackets were installed between the first Siderise RH25G 90/30 horizontal open state cavity barriers (located at the top of the combustion chamber opening) and the second horizontal cavity barrier. Three rows of brackets were installed between the second and third horizontal cavity barriers and a further three rows between the third and fourth horizontal cavity barrier. The horizontal spacing between brackets ranged 300-700mm.

The Siderise RSV 90/30 vertical cavity barriers were skewered to ¾-depth on B65/100 galvanised steel brackets and fixed onto the masonry wall at nominal 300mm vertical centres using one apoloMEA MFR FB 10-80 SSKS fixing. On the main wall, the vertical cavity barriers were aligned vertically such that the inner edge was aligned with the vertical edges of the combustion chamber.

On the wing wall, a single Siderise RSV 90/30 vertical cavity barrier was located at the outside edge of the system approximately 1350mm from the face of the main wall.

Siderise RH25G 90/30 horizontal open state cavity barriers were fitted to the masonry wall on RS 350 galvanised steel skewers secured with one apoloMEA MFR FB 10-80 SSKS at 350mm–400mm horizontal centres. The barriers were pushed over the fixings such that they protruded through the cavity barrier. The protruding end was turned through 90^0 by hand to secure the barrier in place.

Siderise RH25G 90/30 horizontal open state cavity barriers were fitted at approximate heights above the combustion chamber opening of: 0m, 2400mm, 4600mm and 6500mm.

100mm-thick Kingspan Kooltherm K15 insulation was supplied in 2.4m x 1.2m sheets and cut to size where necessary. Each full-size sheet was secured to the masonry wall using 15 fixings across 3 rows. The washers in each row alternated between metal (SP-SS-70-D4) and plastic (Fixfast DHK120). The insulation was push fitted over the 'L'-shaped brackets. The joints, screw heads and openings formed for the brackets were covered with self-adhesive aluminium tape.

'T' and 'L'-shaped rails were fixed to the 'L'-shaped brackets to form Allface System F1.10. On the main wall, the 'T'-shaped rails were installed vertically and aligned with the centre and the vertical edges of the combustion chamber. 'L'-shaped rails were installed at mid-width between the 'T'-shaped rails and at the outside edge of the system. On the wing wall, only 'L'-shaped rails were installed – located centrally and at the outside edge of the system. At the main-wing wall junction, 'T' and 'L'-shaped rails were coupled to create a corner section.

Mitsubishi Alpolic/fr ACM panels were installed on to the aluminium rail substructure (Allface System F1.10). The flat panels were Booth Muirie BML 400 Rivet fixed (4.8mm x 16mm steel rivets) into the Allface System F1.10 at nominal 300mm vertical centres and 400mm horizontal centres. A 10mm panel gap was left between adjacent panels.

With reference to *Figure 2*, the panel widths were:

Column 'A' (wing wall) - 1340mm

Column 'B' - 288mm

Column 'C' - 993mm

Column 'D' - 992mm

Column 'E' - 385mm

The panel heights were:

Row 0 - 1985mm,

Row 1- 2320mm,

Row 2 - 2320mm

Row 3 - 1830mm

Requirement	Actual measurement
≥6000mm above the top of the combustion chamber	6502mm
≥2400mm width across the main wall	2659mm
≥1200mm width across the wing wall	1345mm
260mm (±100mm) wing wall-combustion chamber opening	256mm
2000mm x 2000mm (±100mm) combustion chamber opening	2002mm (w)×2008mm (h)

4.4 Conditioning of the specimen

The system did not require conditioning between completion of construction and the test.

5 Test Results

5.1 Test conditions

Ambient Temperature: 13/°C

Wind speed: <0.1 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

For each layer, thermocouples were applied in sequence from the outer edge of the main wall to the outer edge of the wing wall.

5.2 Temperature profiles

Figures 12-15 provide the temperature profiles recorded during the test. *Figure 7* shows the system before the test.

Parameter	Result
T_s, Start Temperature	13°C
t_s, Start time	1 minute 55 seconds after ignition of crib.
Peak temperature / time at Level 2, External	800°C (27 minutes 35 seconds after t_s.)
Peak temperature / time at Level 2, Cavity	236°C (7 minutes 30 seconds after t_s.)
Peak temperature / time at Level 2, Insulation	160°C (25 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
0:00		Crib Ignited
0:35		Flames to top of crib
1:30		Flames escaping combustion chamber
1:50		Flame tips to mid height of panels 1C/1D
1:55	0:00	Start time (t_s) criteria achieved: External temperature 2.5m above the top of the combustion chamber in excess of 213°C (=200°C+T_s).
2:30	0:35	Flames tips to top of panels 1C/1D.
4:00	2:05	Flame tips to mid-height of panels 2C/2D. Delamination within flame impingement zone to ¾ height panels 1C/1D.
5:45	3:50	Approximately 25% of surface coating of panels 2C/2D delaminated.
6:45	4:50	Flame tips to top of panels 2C/2D. Flames full width of combustion chamber. Distortion of window pod surrounding combustion chamber.
8:00	6:05	Slight distortion of wing wall panel 1A.
8:25	6:30	Small quantity of flaming droplets.
9:00	7:05	Delamination to mid height of panels 2C/2D.
9:15	7:20	Flames leaning towards wing wall panel 1A.
9:45	7:50	Increased production of flaming droplets, small pool fire at base of system.
11:15	9:20	Insulation exposed at midpoint of the junction of panels 1C/1D due to melting of panels.

Time* (mins:secs)	t_s (mins:secs)	Description
11:45	9:50	Approximately 1m x 0.5m hole in panels visible – central rail can be seen.
12:15	10:20	Distortion of central rail where exposed.
12:30	10:35	Consumption of central rail at centre of panels 1C/1D.
13:00	11:05	Black discolouration on wing wall panel 1A (approximately 500mm wide) adjacent to main wall.
14:00	12:05	Pool fire at base of wall.
15:15	13:20	50% consumption of panels 1C/1D. Small area of consumption at base of panels 2C/2D.
16:15	14:20	Dark discolouration full height, half width wing wall panel 1A.
17:00	15:05	Detachment from above combustion chamber opening.
17:45	15:50	Consumption of framing system in area of panels 1C/1D.
18:30	16:35	Increased consumption, distortion and flaming at the base of panels 2C/2D.
19:00	17:05	Dark discoloration to ¾ height 2C/2D. Consumption of part of panels 2C (0.5m x 0.5m), 2D (1m x 1m). Approximate dimensions.
20:45	18:50	Discolouration 80% - height of panels 2C/2D. Flame tips to 5m above combustion chamber.
21:30	19:35	Consumption (0.5m x 0.5m) of panels 2C/2D and 85% of 1C/1D
22:30	20:35	Dark discolouration 85% of height and 75% of width panel 0A
23:45	21:50	Consumption to mid height panels 2C/2D.
24:00	22:05	Sporadic flaming to mid height of panels 3C/3D, approx. 90% consumption of panels 1C/1D. 30% consumption of panel 2C and 25% consumption of 2D.

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Time* (mins:secs)	t_s (mins:secs)	Description
25:30	23:35	Consumption of centre and left centre framing system beneath panel 2C where exposed.
26:00	24:05	Small section of the crib collapses.
26:30	24:35	Flames tending towards wing wall panel 1A.
27:30	25:35	Approx 70% consumption of panel 2C, 40% consumption of panel 2D.
28:30	26:35	Consumption to the top of panels 2C/2D, flaming detachment of foil facing.
29:30	27:35	Approx 1m wide consumption at the top of panels 2C/2D.
30:00	28:05	Crib extinguished.
31:30	29:35	Flaming persists to top left of panel 2C, extending approximately 250mm onto panel 3C. Flaming persists on insulation at former location of top right of panel 2D. Exposed insulation black/ orange.
33:00	31:05	Flaming has subsided at top right of panel 2D. Flaming persists on insulation at former centre of panels 2C/2D (localised 300mm x 300mm) & top right of 1D (200mm x 200mm)
35:00	33:05	Continued flaming beneath remaining top left of panel 2C. Approx 100% consumption of panels 1C/1D, 85% consumption of panel 2C, 45% consumption of panel 2D.
42:00	40:05	Flaming has reduced
43:30	41:35	Flaming has further reduced.
47:00	45:05	Increased flaming beneath the remains of panel 2D along left edge and at 2D/2E junction.
49:00	47:05	Flame tips extending onto panel 3D at centre line of combustion chamber.
49:20	47:25	Detachment of material from beneath panel 2D.
50:55	49:00	Consumption of panel 2D at mid height adjacent to panel 2E. Increased flaming. Continued flame spread at base of panel 3D.

Time* (mins:secs)	t_s (mins:secs)	Description
52:30	50:35	Droplets from vicinity of panel 2D/3D junction.
53:30	51:35	Consumption at base of panel 3D.
53:50	51:55	Increased flaming at top of panel 2D. Sporadic flaming at panel 3C/3D junction.
54:30	52:35	Flaming droplets & detachment of material from panel 3D/2D junction.
55:30	53:35	Flaming on base of panels 3C ceased. Flickering remains beneath cavity barrier.
56:40	54:45	Increased flaming to mid height of panel 3D.
57:35	55:40	Flaming detachment from panel 3D/2D junction.
60:00	58:05	End of test

*Time from point of ignition.

6 Post-Test Damage Report

6.1 ACM panels

Panel 0A. Intact and in place. Dark discolouration of panel and distortion

Panel 0B. Intact and in place. Minor discoloration top and bottom right hand corner.

Panel 0E. Intact and in place. Minor discoloration top and bottom left hand corner.

Panel 1A. Intact and in place. Dark discolouration of panel and distortion

Panel 1B. Intact and in place. Discoloration and distortion full height of panel.

Panel 1C. Fully consumed.

Panel 1D. Fully consumed

Panel 1E. Intact and in place. Minor discoloration and distortion to left hand edge.

Panel 2A. Intact and in place. Dark discolouration of panel and distortion to ¾ of height of panel.

Panel 2B. Intact and in place. Distortion and discoloration to full height of panel.

Panel 2C. Approx 90-95% consumed.

Panel 2D. Approximately 50% consumed. Section remaining in the form of an inverted triangle 600mm width at top x 100mm at base (full panel height). Panel loosely attached at outside vertical edge and distorted away from the wall.

Panel 2E. Intact and in place. Minor discoloration and distortion to left hand edge.

Panel 3A. Intact and in place. Some heat distortion of the panel, but no discolouration.

Panel 3B. Intact and in place. Some heat distortion of the panel, but no discolouration.

Panel 3C. Intact and in place. Some heat distortion of the panel, aluminium exposed at the base of the panel, smoke discolouration to mid height.

Panel 3D. A section at the base of the panel approx. 250mm(w) x 75mm(h) consumed, remaining panel intact and in place. Some heat distortion and discolouration of the panel.

Panel 3E. No visible damage.

6.2 Aluminium rail substructure

Main wall

All of the framing system directly above the combustion chambers up to the height of the third cavity barrier (4600mm above combustion chamber) was consumed. Framing on the main wall above the third cavity barrier was intact and in place. There was some heat damage and discoloration to the central 'T' section.

Left hand 'T' section at the inside edge of the combustion chamber was consumed to the height of second cavity barrier (approx 2400mm above combustion chamber). Intact above this level.

Right hand 'T' section at the outside edge of the combustion chamber was consumed at height approximately 1.5m to 2.2m and 2.5m to 3.0m. Above the third cavity barrier, the framing was intact.

Wing Wall

The framing was intact and in place for the full height of the wing wall. There was some heat distortion and discolouration to the framing at the junction of the main and wing walls between the first and second cavity barriers.

6.1 Phenolic Insulation

The insulation under panels (with reference to figure 2):

0A. Surface discolouration to the foil. The remaining insulation was undamaged.

1A. Surface discoloration to foil.

1B surface discolouration to foil

1C&1D. Insulation largely destroyed. Masonry substrate visible through foam.

1E. Undamaged

2A. Insulation undamaged.

2B. Minor surface discolouration to foil.

2C & 2D Extensive damage and charring to insulation. Masonry substrate visible in places.

2E. Undamaged.

3A. Largely undamaged.

3B Minor surface discolouration.

3C&3D -Surface discoloration to foil facing.

3E Undamaged.

6.2 Vertical cavity barriers

Intact and in place. There was some discoloration to the barriers up to the level 3 cavity barrier on the main wall.

Wing wall vertical cavity barrier was undamaged.

6.3 Horizontal (intumescent) cavity barriers

Cavity barrier 1. (In line with the top of the combustion chamber)

The cavity barrier directly above the combustion chamber was destroyed. At the junction of 0E & 1E it had not activated. On the wing wall, the barrier had activated across the full width.

Cavity barrier 2 (approx. 2400mm above combustion chamber)

The stone wool section of barrier remained attached to the masonry substrate across the width of the main wall. The intumescent section was in longer in place directly above the combustion chamber, the remaining intumescent on the main and wing walls had activated.

Cavity Barrier 3. (approx. 4600mm above combustion chamber)

Intact and in place. The intumescent had activated across the full width of the cavity barrier with the exception of the short section on the outside edge of the main wall.

Cavity Barrier 4. (approx. 6500mm above combustion chamber)

Intact and in place. The intumescent had activated across the central section of the barrier in line with the top 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 P110396-1004. EN ISO 1716 Gross heat of combustion (calorific value) test on the core of Alpolic/fr. 30th November 2017

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9 Figures

Figure 1 Schematic of test apparatus

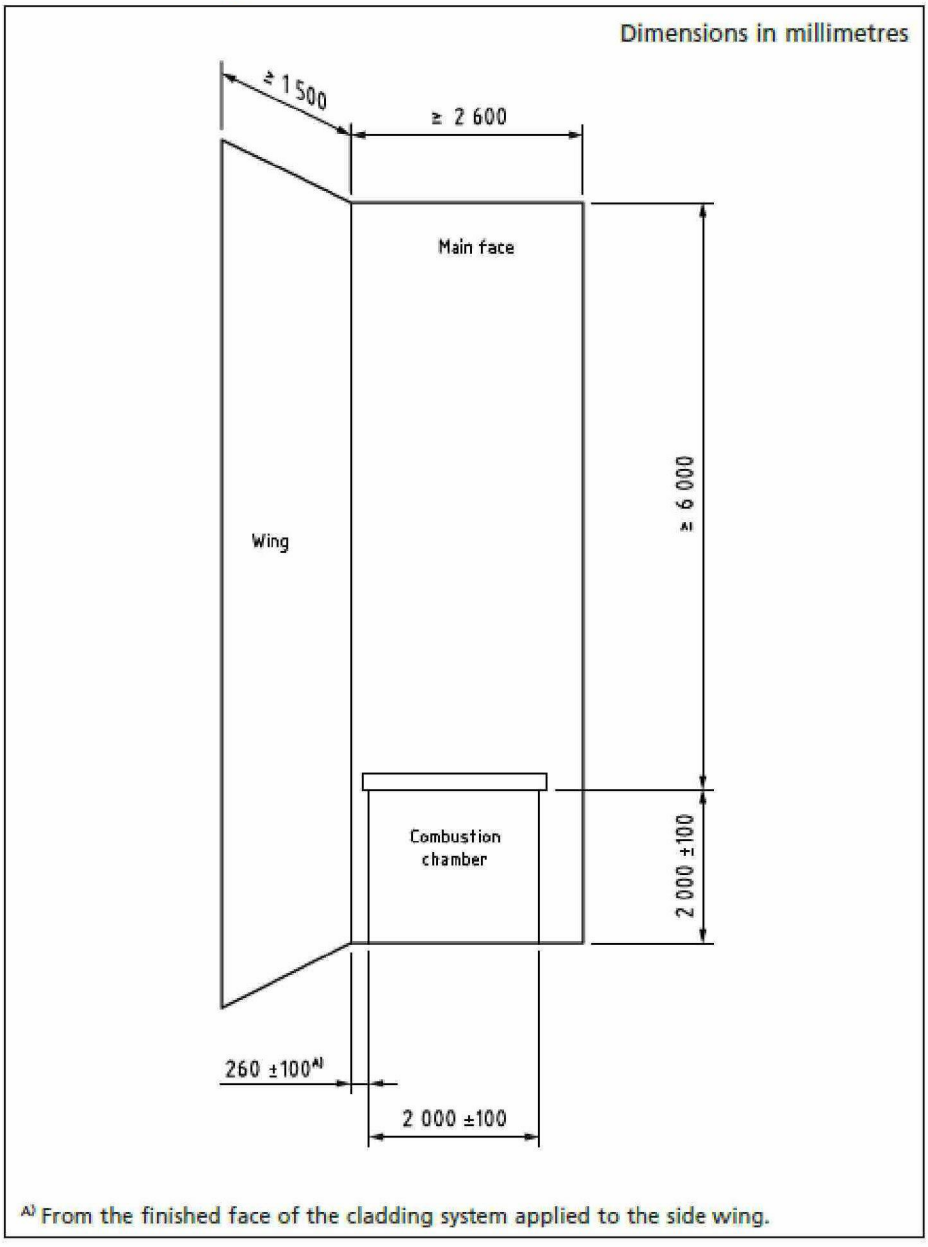

Figure 1. Test apparatus dimensions as specified by test Standard[1].

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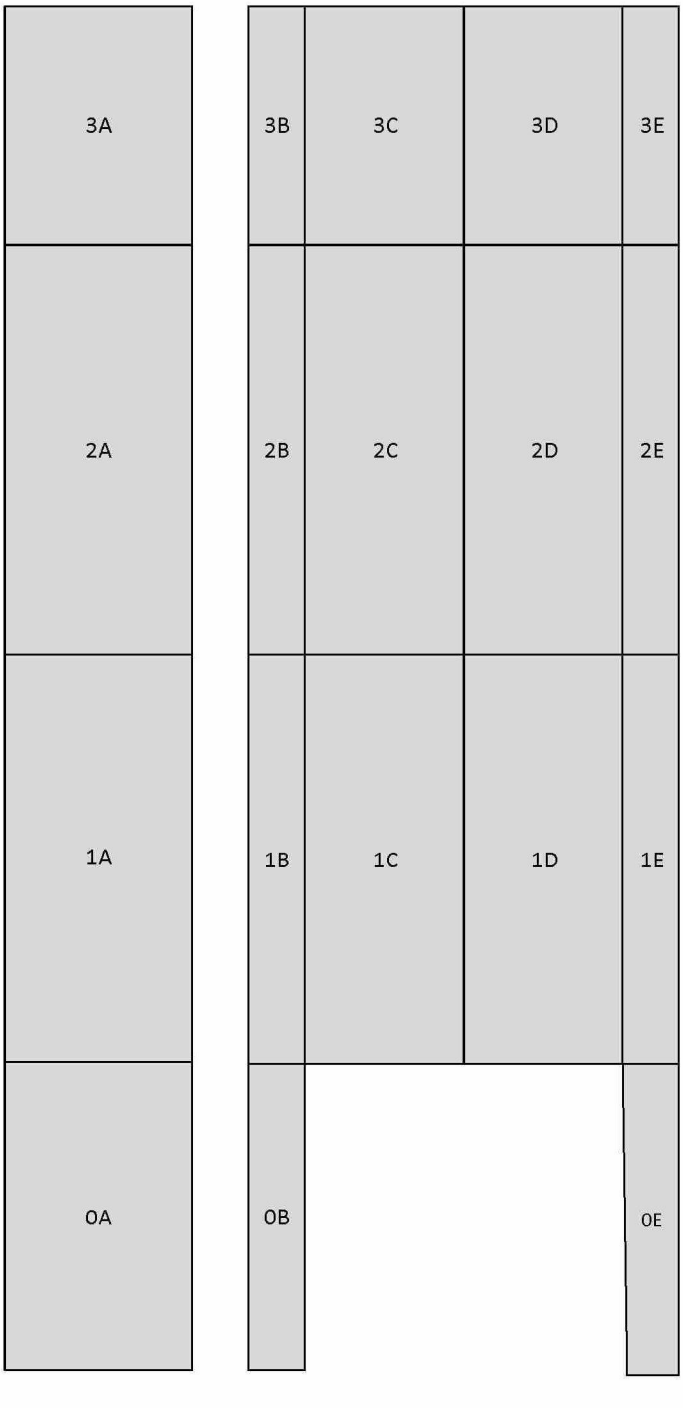

Figure 2. Layout of panels and numbering system used for reporting. Not to scale.

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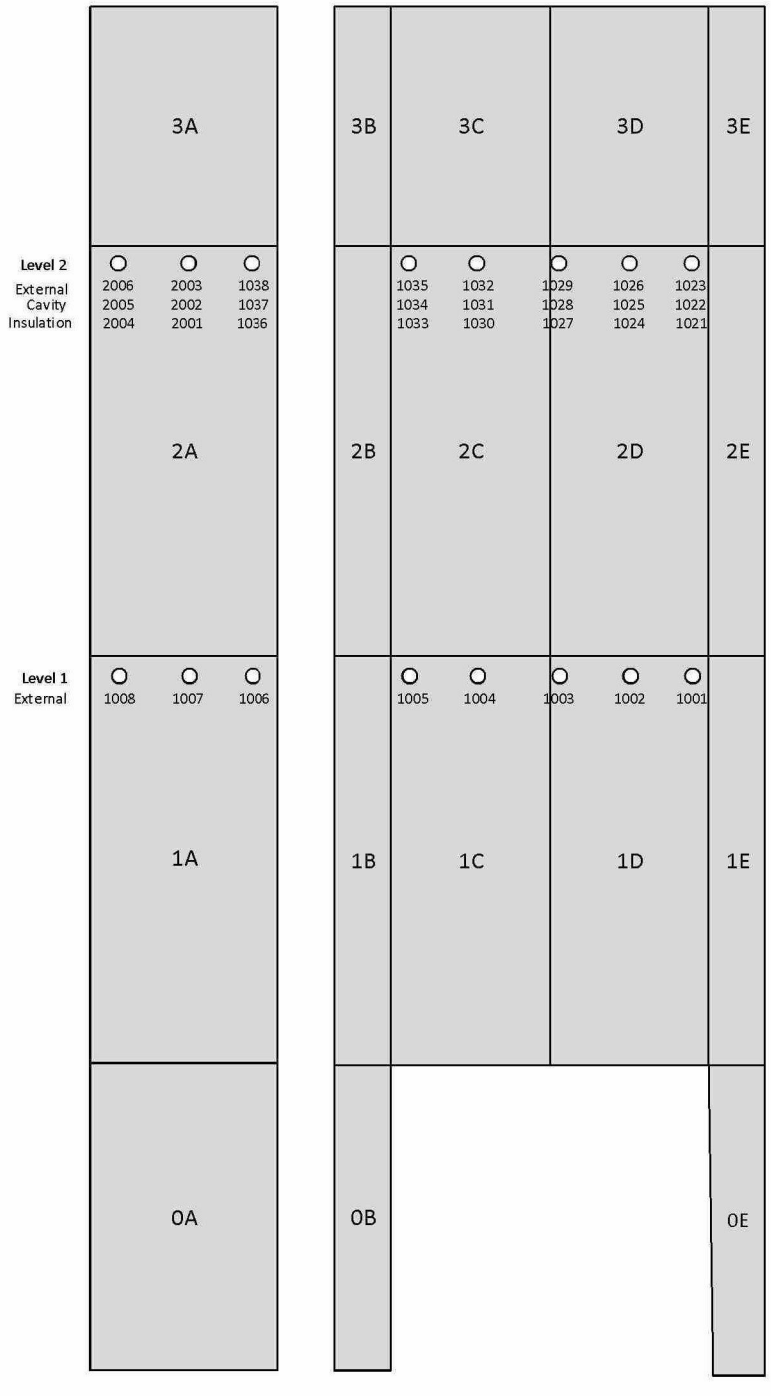

Figure 3. TC positions and panel numbering (0A – 3E). Not to scale.

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9.1 Installation photographs

Figure 4. 'L'-shaped aluminium brackets installed with Siderise RSV 90/30 vertical cavity barriers fitted on main and wing wall.

Figure 5.Installation of Siderise RH25G 90/30 horizontal open state cavity barriers and Kingspan Kooltherm K15 insulation.

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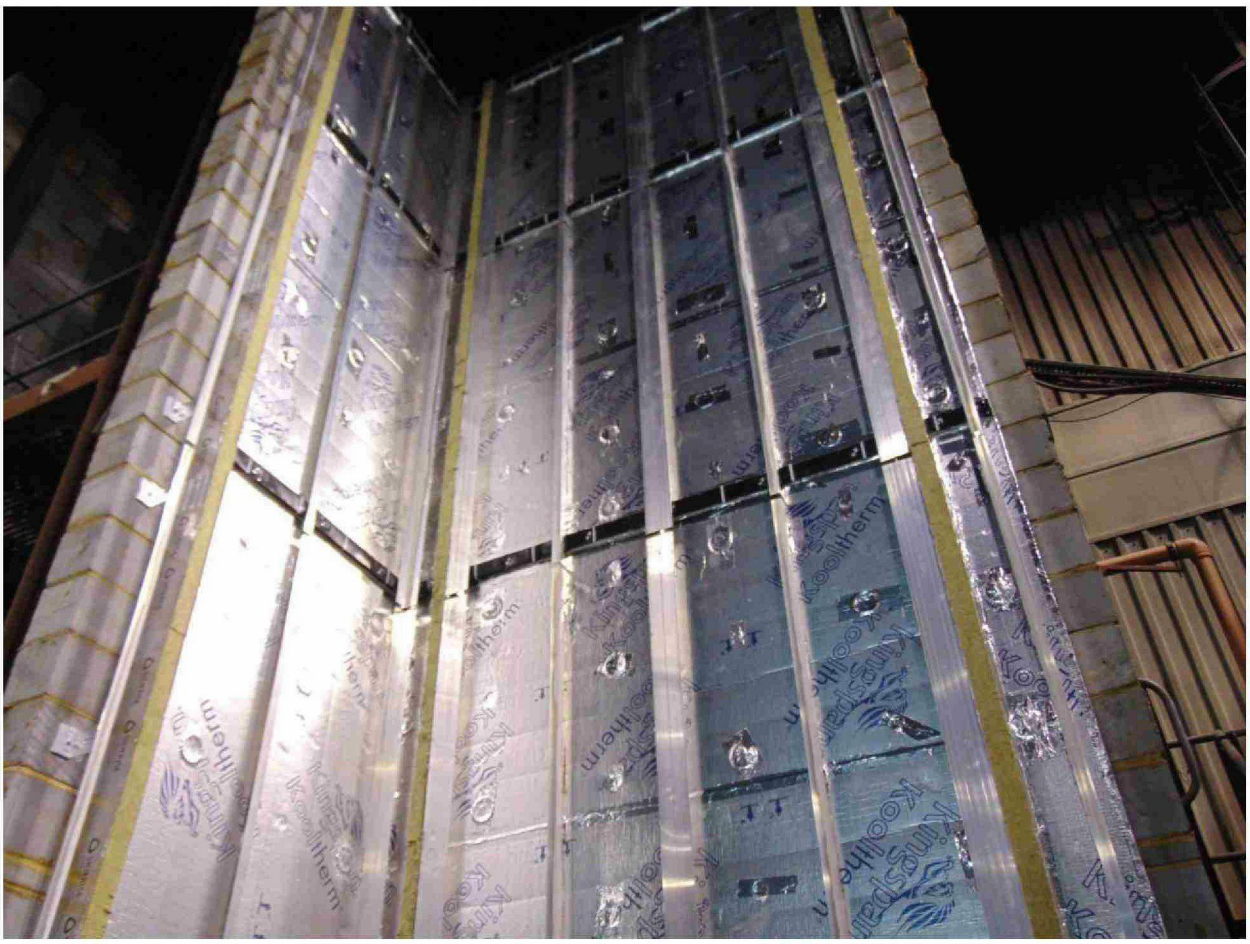

Figure 6. Completed installation of Allface System F1.10 aluminium rail substructure.

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Figure 7. Completed installation prior to test.

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9.2 System drawings

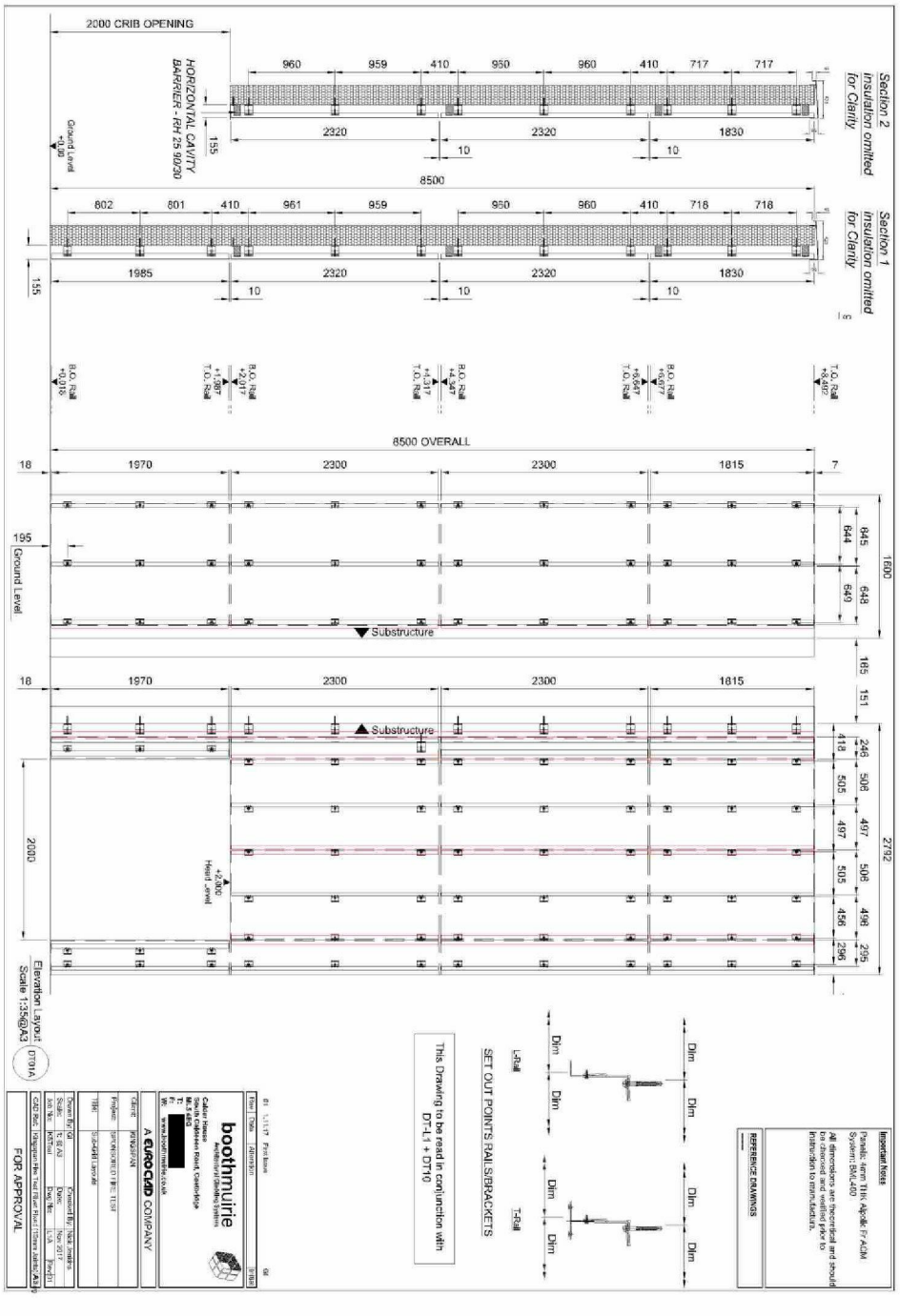

Figure 8. Elevation of system (supplied by the Test Sponsor).

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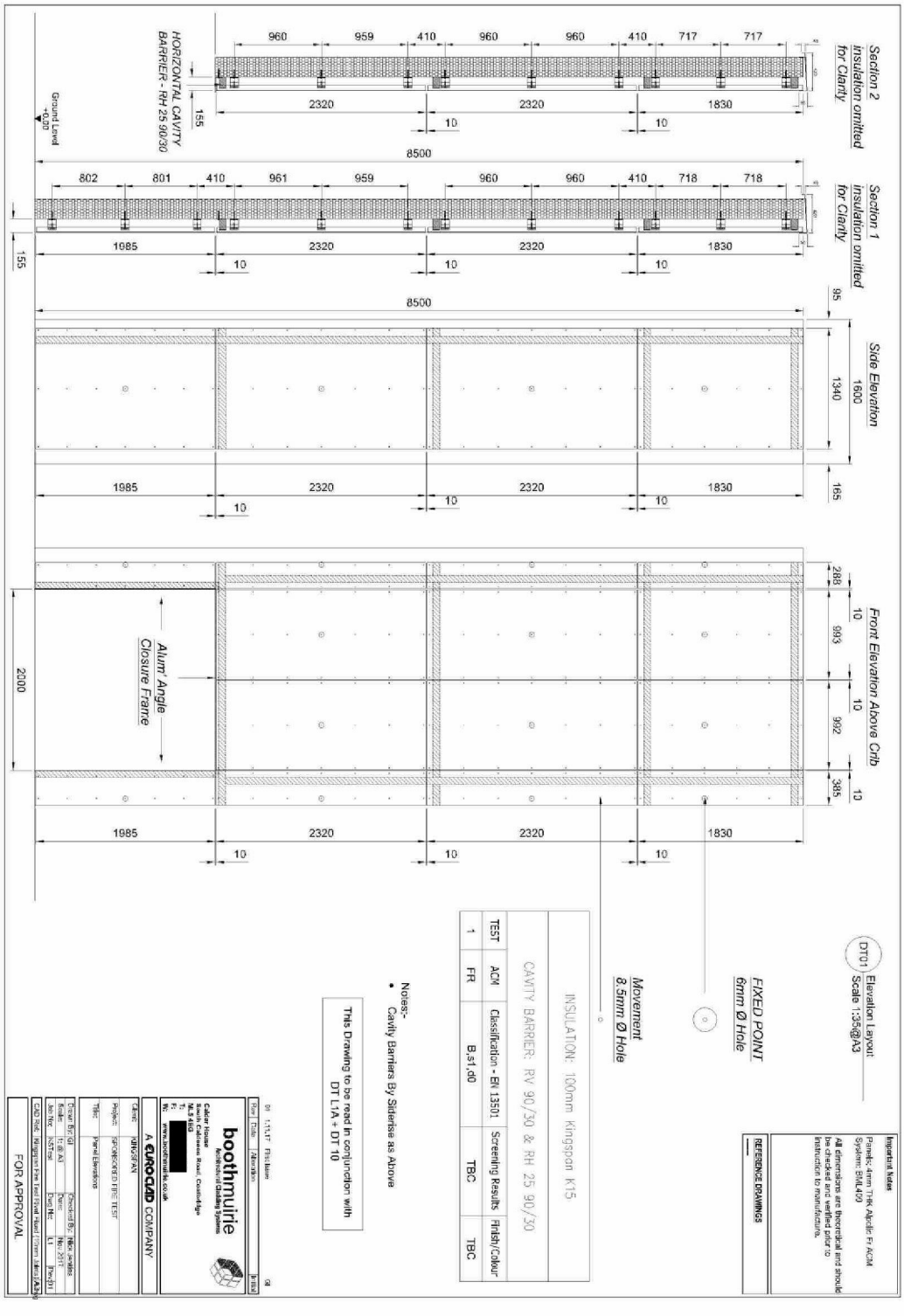

Figure 9. Elevation of system (2) (supplied by the Test Sponsor).

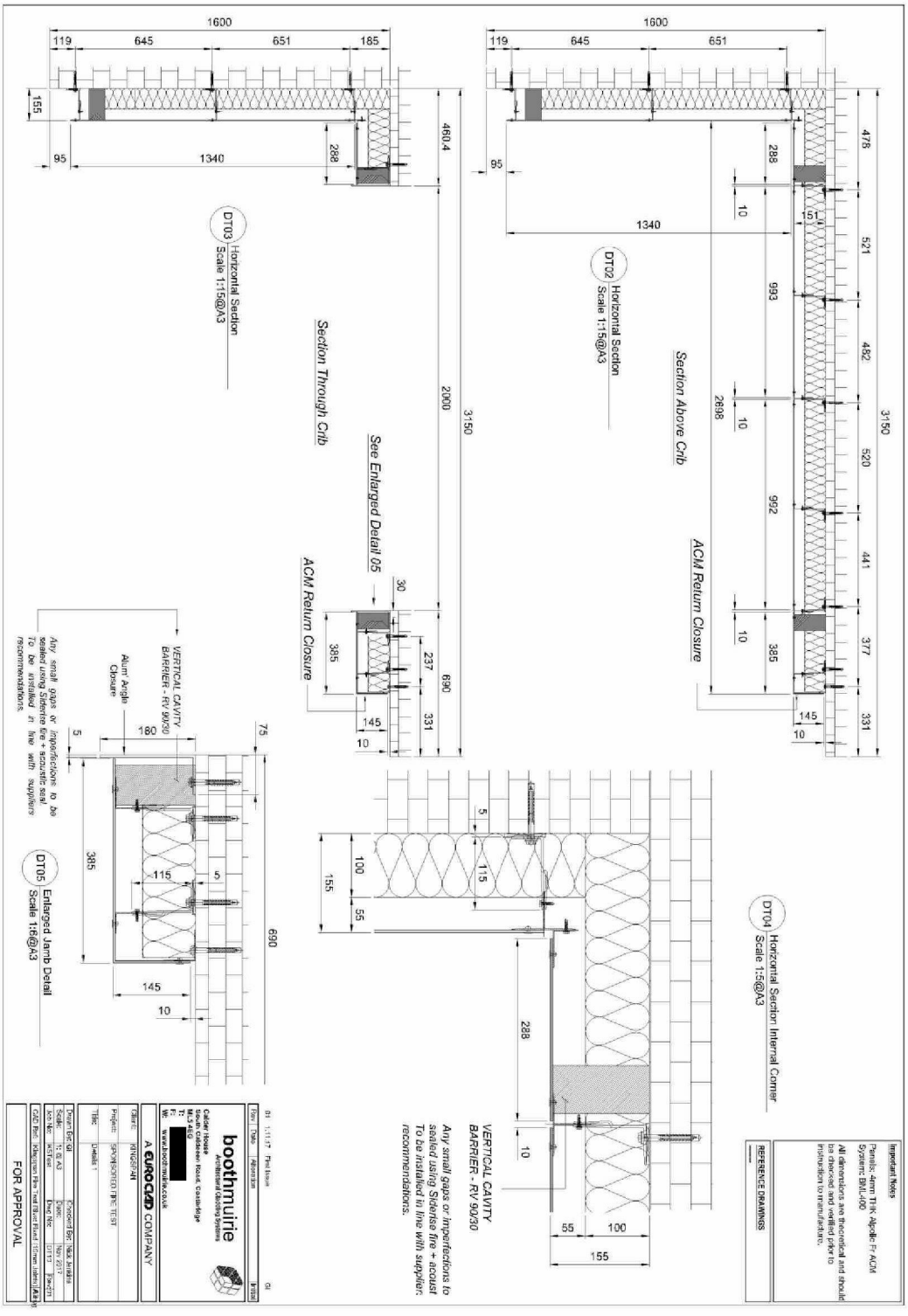

Figure 10. Cross section of the system (supplied by the Test Sponsor).

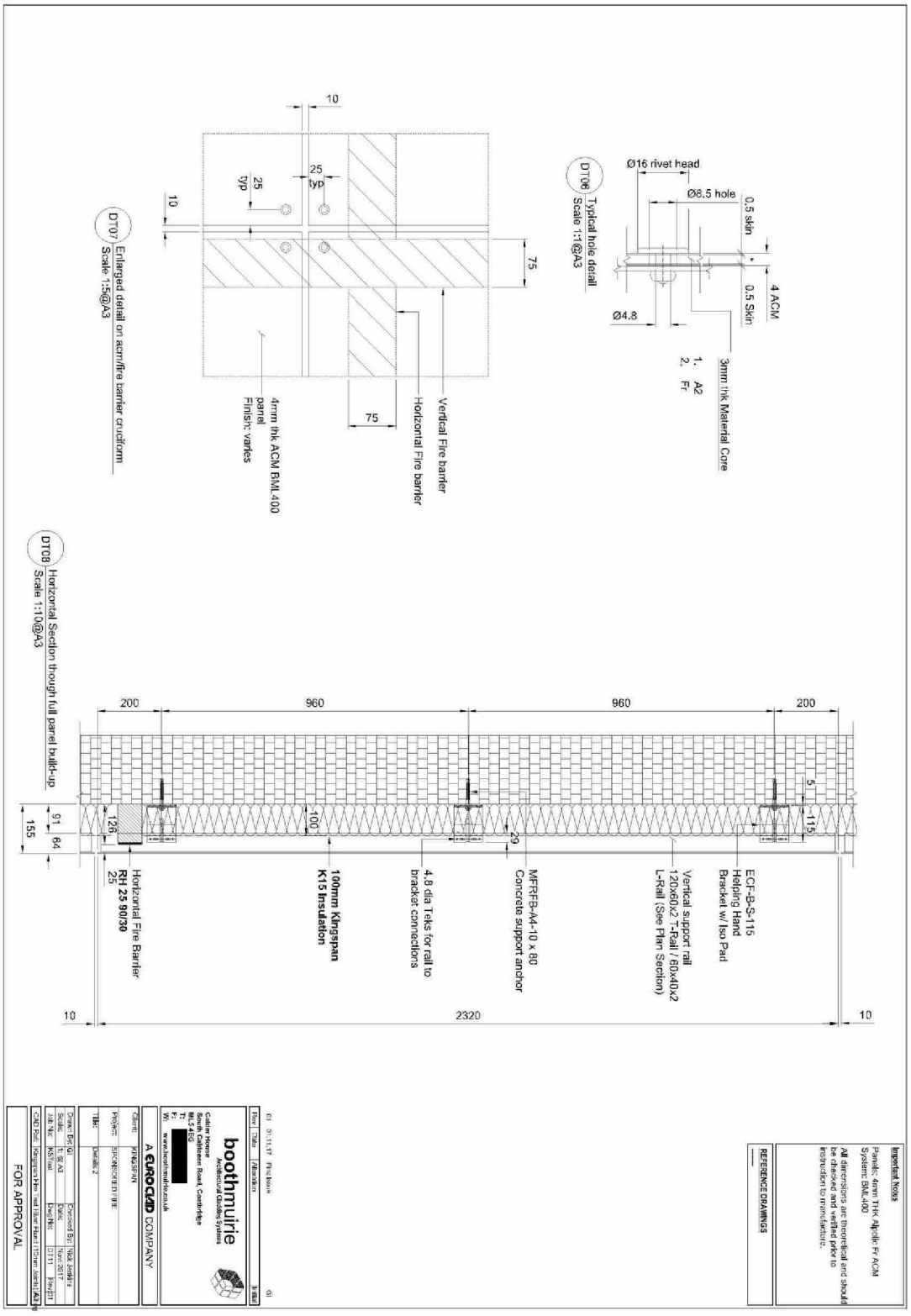

Figure 11. Construction drawings (supplied by the test sponsor).

9.3 Temperature data

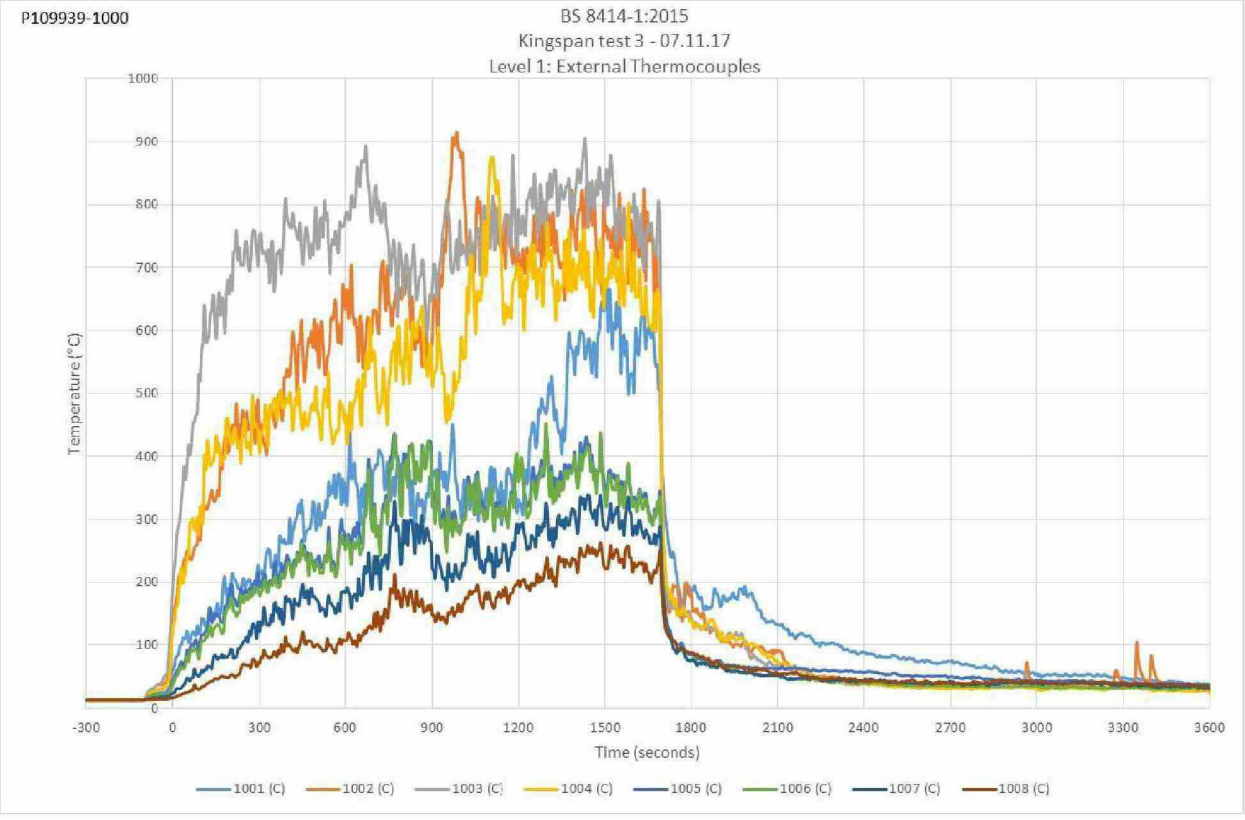

Figure 12. Level 1 external thermocouples.

t_s= 1 minute 55 seconds after ignition of the crib.

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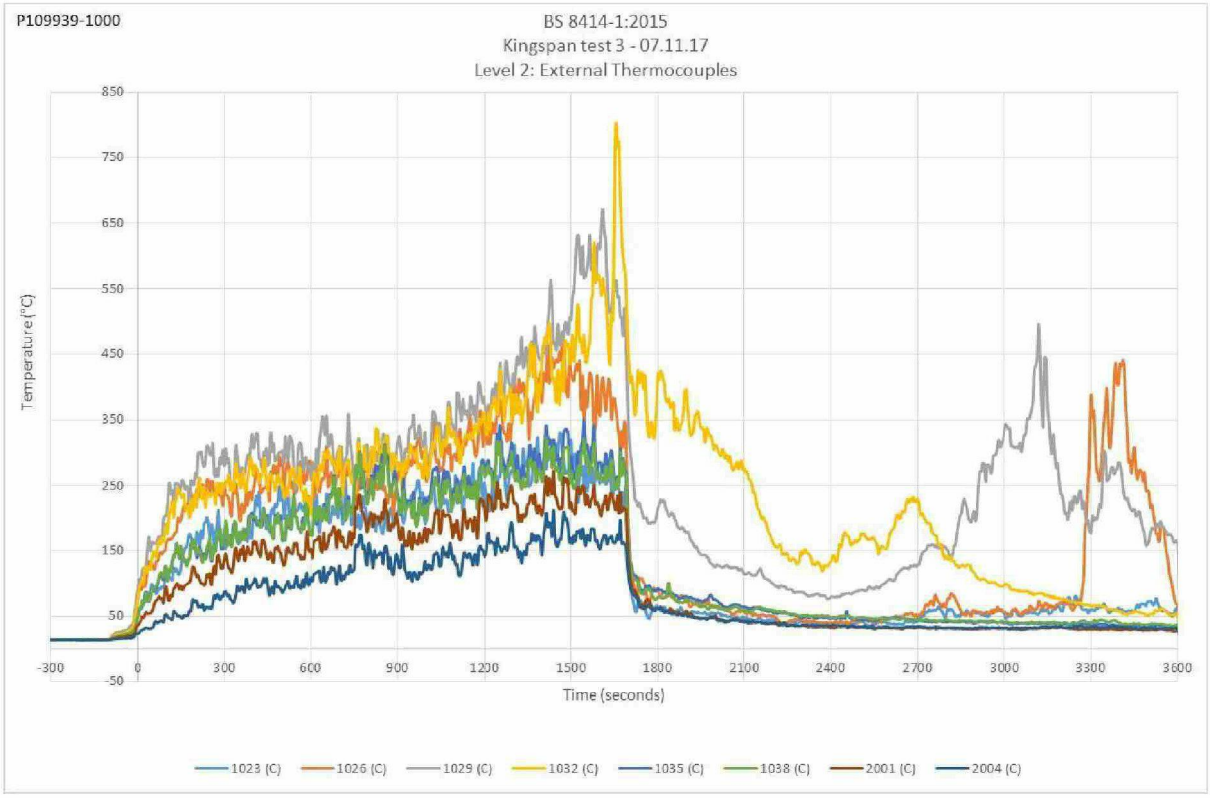

Figure 13. Level 2 external thermocouples.

t_s= 1 minute 55 seconds after ignition of the crib.

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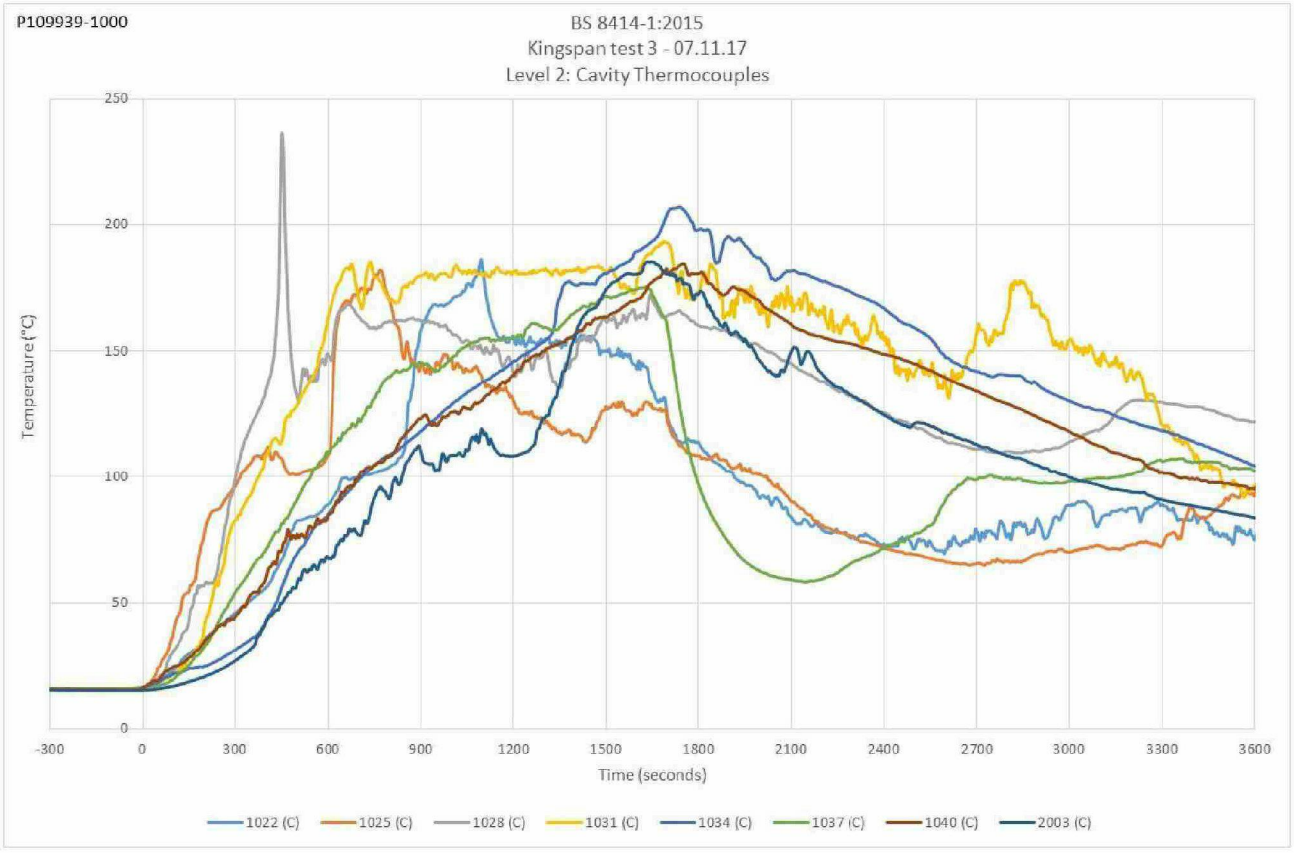

Figure 14. Level 2 cavity thermocouples.

t_s= 1 minute 55 seconds after ignition of the crib.

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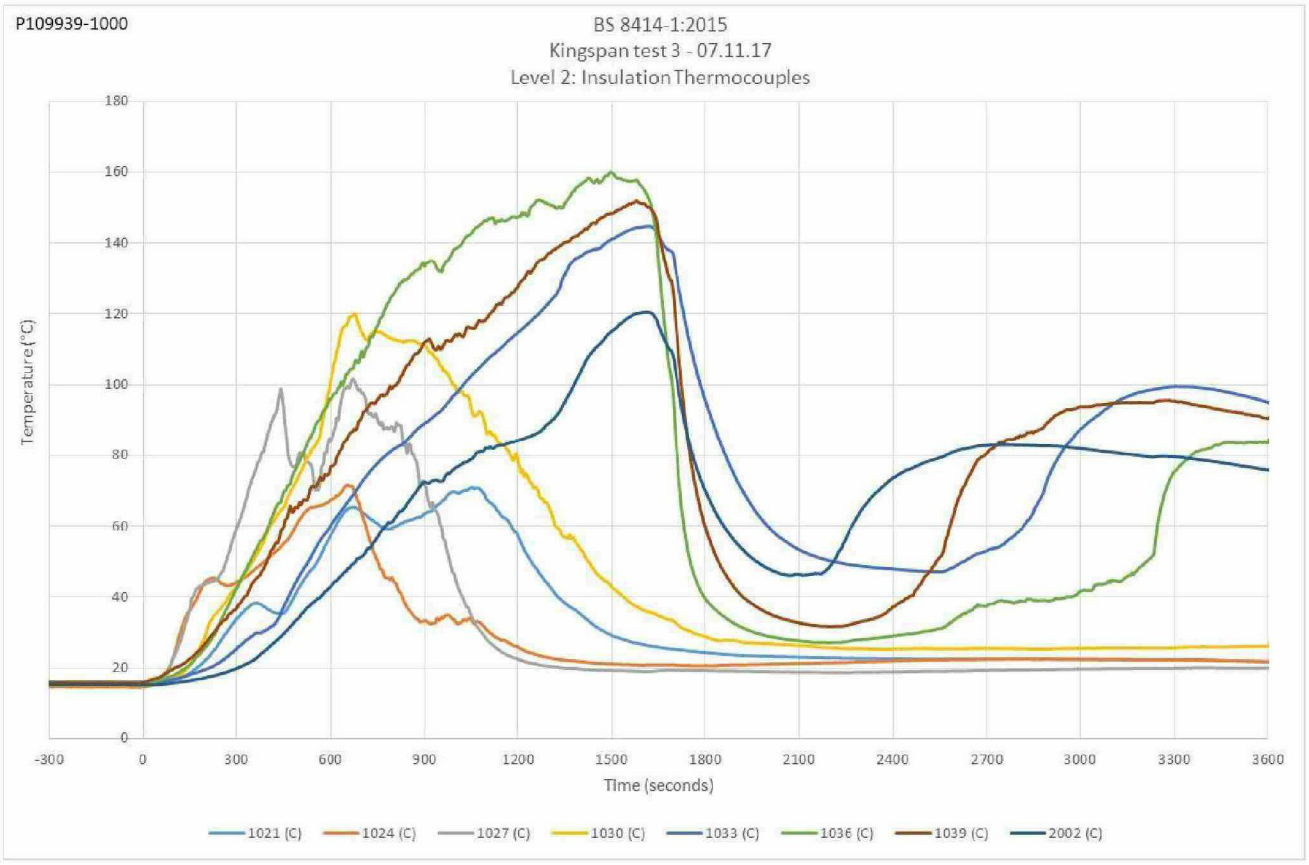

Figure 15. Level 2 insulation thermocouples.

ts= 1 minute 55 seconds after ignition of the crib.

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9.4 Post-test photographs

Figure 16. Full-height photograph at test termintation.

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Figure 17. Full-height photograph of system following removal of ACM panels

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Figure 18. Post-test photo showing insulation and cavity barrier above combustion chamber.

Figure 19. Post-test photo showing second and third row Siderise RH25G 90/30 horizontal open state cavity barriers.

Note: majority of aluminium rail substructure has been removed.

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Figure 20. Post-test photo showing third and fourth row Siderise RH25G 90/30 horizontal open state cavity barriers.

Note: majority of aluminium rail substructure has been removed.

Report Ends

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