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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:	**14th December 2017**
Report Number:	**P107017-1000 Issue: 1**

BRE Global Ltd
Watford, Herts
WD25 9XX

Customer Services 0333 321 8811

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

Prepared by

Name David Farrington

Position Fire Test Manager

Date 14 December 2017

Signature 

Authorised by

Name Stephen Howard

Position Director of Fire Testing and Certification

Date 14 December 2017

Signature 

Table of Contents

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:	P107017-1000
Date of test:	9th October 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

3 Details of Test Apparatus

The product was installed on to wall number two 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.

Figure 1 Schematic of test apparatus

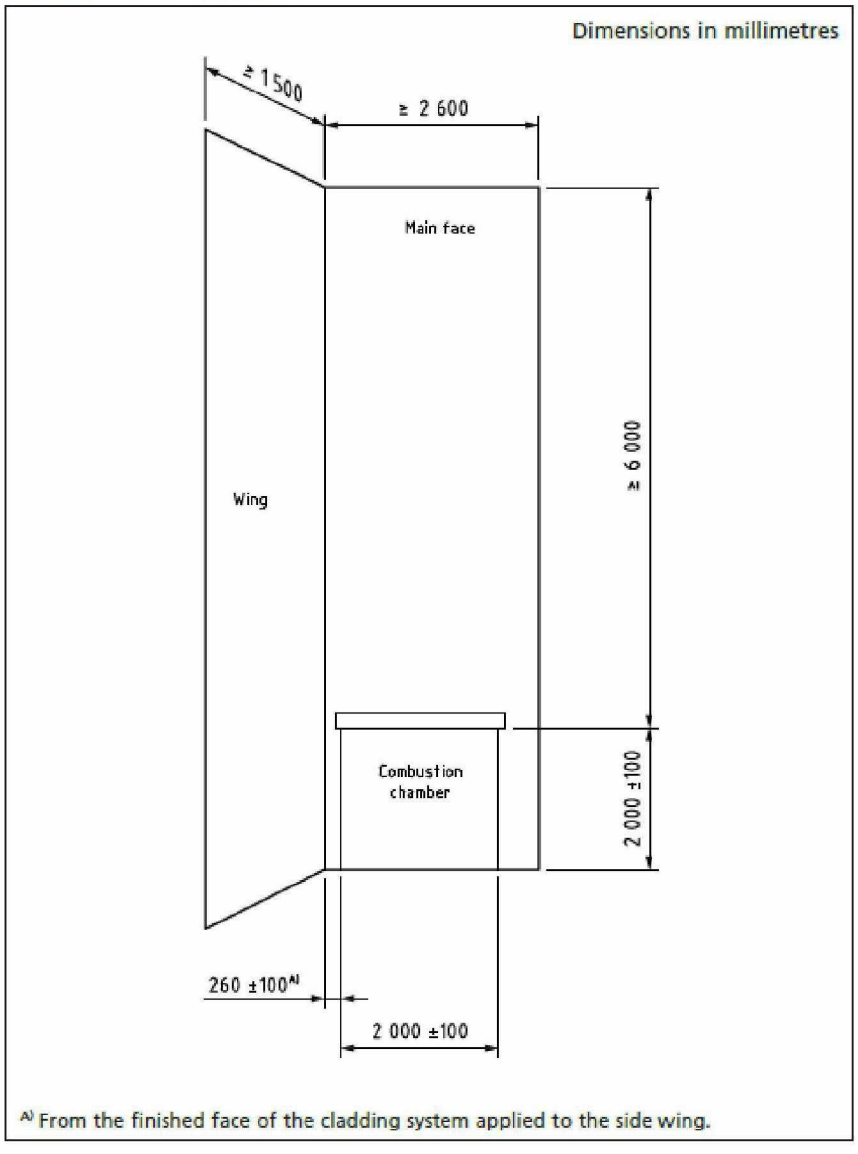

Figure 1. Test apparatus dimensions as specified by test Standard[1].

4 Description of the System

4.1 Summary

Generic cladding type	Rain screen
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 (CAT2[2])

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 (CAT2[2] core material).

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 (see *Table 1*). 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 4mm panel gap was left between adjacent panels.

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

Column 'A' (wing wall) - 1340mm

Column 'B' - 388mm

Column 'C' - 968mm

Column 'D' - 969mm

Column 'E' - 231mm

The panel heights were:

Row 0 - 1988mm,

Row 1- 2326mm,

Row 2 - 2326mm

Row 3 - 1833mm

Requirement	Actual measurement
≥6000mm above the top of the combustion chamber	6510mm
≥2400mm width across the main wall	2580mm
≥1200mm width across the wing wall	1340mm
260mm (±100mm) wing wall-combustion chamber opening	245mm
2000mm x 2000mm (±100mm) combustion chamber opening	2000mm×1940mm

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

Test date: 9th October 2017

Ambient Temperature: 15°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 10-13 provide the temperature profiles recorded during the test. *Figure 7* shows the system before the test.

Parameter	Result
T_s, Start Temperature	15°C
t_s, Start time	1 minute 55 seconds after ignition of crib.
Peak temperature / time at Level 2, External	606°C (23 minutes 55 seconds after t_s.)
Peak temperature / time at Level 2, Cavity	232°C (21 minutes 10 seconds after t_s.)
Peak temperature / time at Level 2, Insulation	189°C (21 minutes 15 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		Ignition of crib.
0:30		Flame tips to top of crib.
1:00		Flames sporadically escaping combustion chamber.
1:40		Flames consistently escaping combustion chamber.
1:55	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).
2:00	00:05	Flames tips to mid-height of panels 1C&1D.
2:20	00:25	Flames tips to top of panels 1C&1D.
2:45	00:50	Sporadic flaming to mid-height of panels 2C&2D.
3:05	01:10	Panel coating removed up to mid-height of panels 1C&1D.
3:45	01:50	Flame tips to mid-height of panels 2C&2D.
4:00	02:05	Sporadic flaming to top of panels 2C&2D. Flame movement towards wing wall up to 1000mm above combustion chamber.
4:50	02:55	Panel coating removed up to top of panels 1C&1D. Flame movement towards wing wall up to mid-height of wing wall panel 1A.
5:45	03:50	Full width of combustion chamber flame tapering to mid-height of panels 2C&2D.
6:45	04:50	Panel coating removed to a height approximately 1000mm above the base of panels 2C&2D.

Time* (mins:secs)	t_s (mins:secs)	Description
7:20	05:25	Small infrequent flaming droplets. Sustained flaming on the floor at the base of system.
8:00	06:05	Panel coating removed up to mid-height panels 2C&2D Flaming to top of panels 2C&2D, sporadic flame tips to mid-height of 3C&3D.
9:10	07:15	Increased frequency of flaming debris. Partial consumption of panel 1D.
10:00	08:05	Continuous flaming debris.
10:11	08:16	Panel coating removed and distortion of wing wall panel 1A. Transient surface flaming.
10:55	09:00	Consumption up to top of panel 1D.
11:45	09:50	Central aluminium rail beneath panels 1C&1D is visible, a section approximately 1250mm-long has been consumed. Panel coating removed to top of wing wall panel 1A.
13:30	11:35	Consumption of panels has reached a steady state at the base of panels 2C&2D.
13:35	11:40	Detachment of thin, floating debris (foil face of insulation) approximately 300mm x 300mm.
15:15	13:20	Consumption at base of panels 2C&2D. Significant distortion/sagging on window pod around combustion chamber.
16:00	14:05	Approximately 75% consumption of panels 1C&1D. Significant pool fire on the floor at the base of system.
17:00	15:05	Complete consumption of central aluminium rail at junction between panels 1C&1D, 75% consumption of aluminium rails either side.
17:45	15:50	Partial consumption of panel 2D up to approximately 400mm from base of panel.
20:00	18:05	Flaming debris from panels 2C&2D.
21:00	19:05	Approximately 100mm-long section of the aluminium central rail exposed and partially consumed at the base of panels 2C&2D.

Time* (mins:secs)	t_s (mins:secs)	Description
22:30	20:35	Flaming beneath panels 2C&2D on edge of consumption zone.
24:00	22:05	Discolouration of wing wall up to mid-height at 2A. Flame tips to top of panels 2C&2D. Sporadic flaming to mid-height of panels 3C&3D.
26:00	24:05	Sporadic flaming to top of panels 3C&3D. Consumption up 75% height of panels 2C&2D.
27:30	25:35	Small collapse of crib.
29:00	27:05	No significant visible change since the last observation.
29:45	27:50	Flaming to top of remains of panel 2C&2D junction.
30:00	28:05	Crib extinguished.
31:00	29:05	Flaming from beneath panels 2C&2D. Black/orange, cracked, 'lava'-like appearance to exposed insulation.
33:30	31:35	Flaming reduced but still present. Loud continuous crackling persists.
42:00	40:05	Flaming persists, crackling has subsided. Orange glow subsided from insulation.
48:00	26:05	Small, non-flaming droplets.
50:00	28:05	Detachment from beneath/within top of panels 2C&2D. Increased flaming from mid-height, flames extend to top of panels 2C&2D.
52:00	50:05	Flaming reduced to panel consumption zone.
52:30	50:35	Flame emission from junction between panels 2D&2E at mid-height.
57:00	55:05	Flaming reduced at panel 2D&2E junction. Flaming continues from insulation at the top of panel 2D consumption zone.
60:00	58:05	Test terminated.

*Time from point of ignition.

6 Post-Test Damage Report

6.1 ACM panels

Row 0 – Panel 0A was significantly distorted and discoloured (approximately 70% panel coating removed, 25% dark discolouration). On panel 0B there was a small area (approximately 300mmx150mm) of dark discolouration in the top left hand corner of the panel (adjacent to the combustion chamber). Panel OE was not visibly damaged.

Row 1 – Panel 1A was significantly distorted and discoloured (approximately 50% panel coating removed, 25% dark discolouration). Panel 1B was significantly distorted and discoloured (approximately 50% panel coating removed, 50% dark discolouration). Panels 1C and 1D were both almost fully consumed. Panel 1E was distorted and darkly discoloured in a 50mm-wide full-height vertical strip in line with the combustion chamber opening.

Row 2 – Panel 2A was distorted and discoloured (<10% panel coating removed, 50% dark discolouration). Panel 2B was distorted and discoloured at the base of the panel (small areas of panel coating removed, 40% dark discolouration). Panels 2C and 2D were damaged across the full panel surface: panel consumed (55% and 40% respectively), distorted and discoloured across the remaining panel. An area approximately 1500mm x 400mm of panel 2D remained loosely attached with consumption of the panel core. Small holes approximately 50mm x 300mm and 50mm x 50mm were observed in panel 2D approximately 3750mm above combustion chamber. Panel 2E was distorted and slightly discoloured.

Row 3 – Panels 3A&3B had minor distortion. Panel 3C was distorted and discoloured (small areas of panel coating removed, approximately 30% dark discolouration). Panel 3D was distorted and discoloured (small areas of panel coating removed, approximately 25% dark discolouration). Panel 3E had minimal visible damage.

6.2 Aluminium rail substructure

The central aluminium 'T'-shaped rail on the main wall was fully consumed up to a height of approximately 4m. Partial consumption and distortion continued to the top of 2C-2D panel junction.

The 'L'-shaped rails to the left and right of centre on the main wall were fully consumed up to a height of approximately 3.5m. Partial consumption and distortion continued for approximately 500mm.

6.1 Phenolic Insulation

On the main wall face, at the location of panel/s (refer to *Figure 2)*:

- 0E. The foil facing on the insulation remained intact
- 1B. Dark discolouration towards the second horizontal cavity barrier and small areas of detachment/consumption of foil facing.
- 1C&1D. Small amount of charred insulation remains. Rear foil facing visible across approximately 10%, mostly intact.
- 1E. Foil facing of insulation intact Slight discolouration in places.
- 2B. Minor discolouration of the foil facing.
- 2C. Charring of the insulation occurred in decreasing severity between the second and third cavity barrier. External foil facing and some uncharred insulation remained adjacent to the third horizontal cavity barrier. The internal foil facing was not visible.

- 2D. Damage to the insulation was similar to that observed beneath panel 2C, however; a band of significant insulation consumption and detachment extended from approximately mid-height to approximately 300mm below the third cavity barrier. The blockwork was exposed in an approximately 300mm-width which would have been directly below the damaged edge of the remains of panel 2D.
- 2E. Insulation appeared to be undamaged.
- 3B. Insulation appeared to be undamaged.
- 3C&3D. Discolouration of the foil facing most pronounced along centre line of combustion chamber opening.
- 3E. Insulation appeared to be undamaged.

On the wing wall face, beneath panel (refer to *Figure 2)*:

- 0A. The foil facing on the insulation remained intact.
- 1A. Blistering and slight discolouration of the foil facing up to mid-width adjacent to the main wall. Minimal damage from outside edge of wing wall to mid-width.
- 2A. Minor blistering and discolouration was observed in patches directly adjacent to the main wall
- 3A. Insulation appeared to be undamaged.

6.2 Vertical cavity barriers

The Siderise RSV 90/30 vertical cavity barriers on the main and wing wall remained intact throughout the height of the system. On the main, there was minor surface discolouration up to the height of the third horizontal cavity barrier. The wing wall vertical cavity barrier sustained no visible damage.

6.3 Horizontal (intumescent) cavity barriers

Directly above the combustion chamber, the intumescent strip of the Siderise RH25G 90/30 horizontal open state cavity barrier had activated but was destroyed (directly in line with the combustion chamber opening) up to the vertical cavity barriers, beyond these there was evidence of activation across the full width of main and wing walls.

The second row horizontal cavity barrier had activated but was significantly damaged (directly in line with the combustion chamber opening) up the vertical cavity barriers, beyond these there was evidence of activation across the full width of main and wing walls.

The third row horizontal cavity barrier had fully activated across the central 2000mm-width (directly in line with the combustion chamber opening). Partial activation of the intumescent strip occurred across the wing wall. Evidence of slight heat damage was visible at the outside edge of the main wall.

The fourth row horizontal cavity barrier had partially activated across the central 2000mm-width (directly in line with the combustion chamber opening). Partial activation of the intumescent strip occurred up to mid-width on the wing wall. At the outside edge of the main wall there was no evidence of activation.

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. Government Building Safety Programme – Explanatory Note, Published by Department for Communities and Local Government (DCLG) following Grenfell Tower fire on 14 June 2017, document undated.

9 Figures

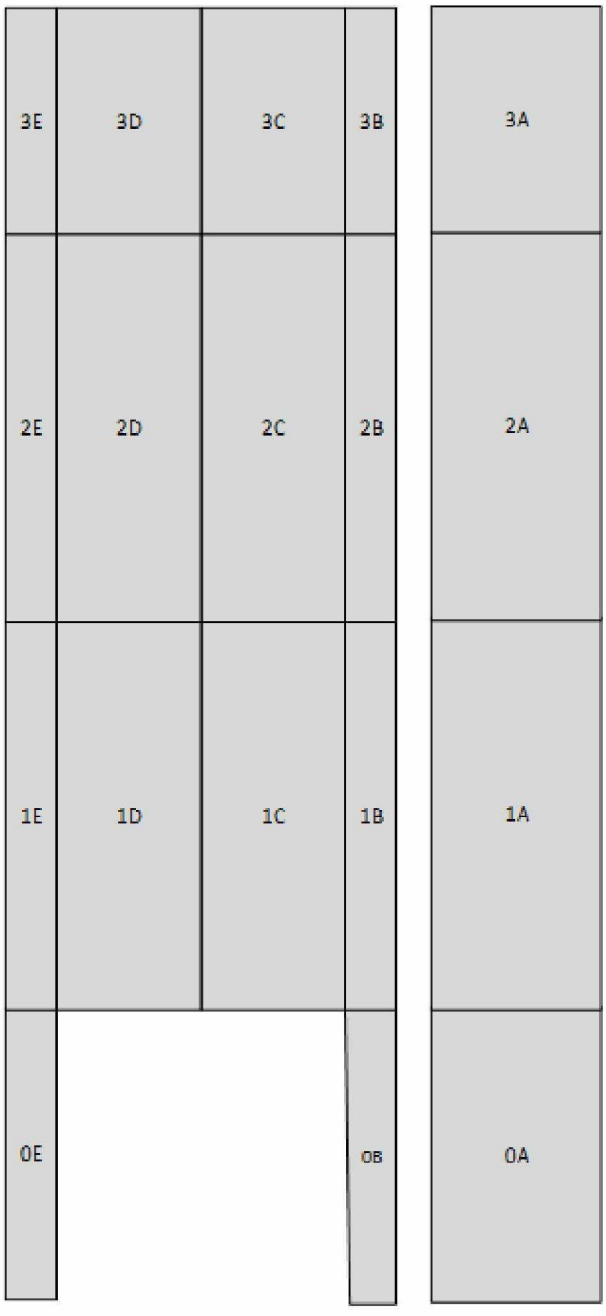

Figure 2. Layout of panels and numbering system used for reporting. Not to scale.

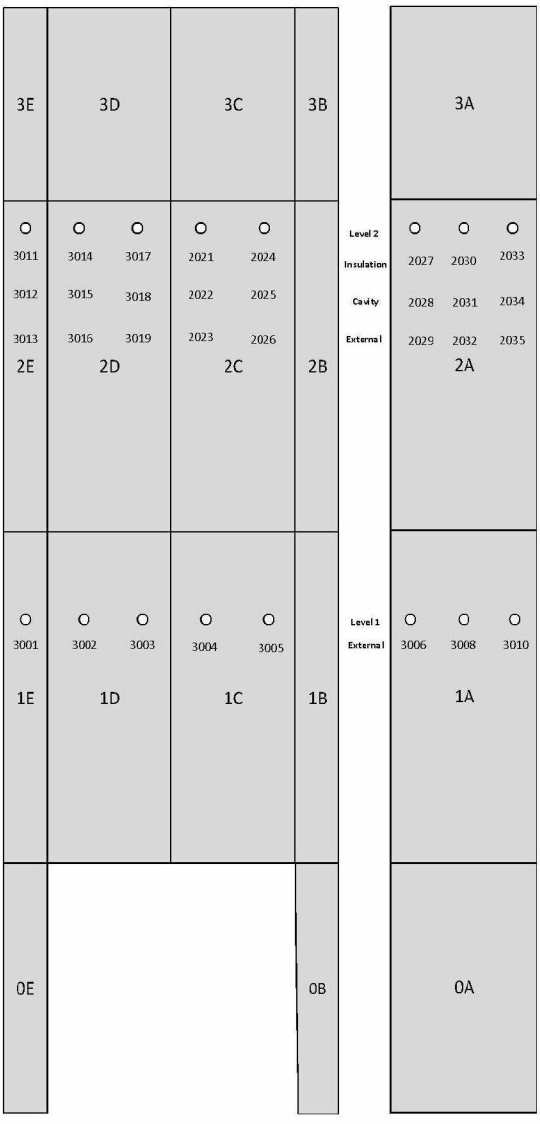

Figure 3. TC positions and panel numbering (0A – 3E). Not to scale.

9.1 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. Partial installation of Siderise RH25G 90/30 horizontal open state cavity barriers and Kingspan Kooltherm K15 insulation.

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

Figure 7. Completed installation prior to test.

9.2 System drawings

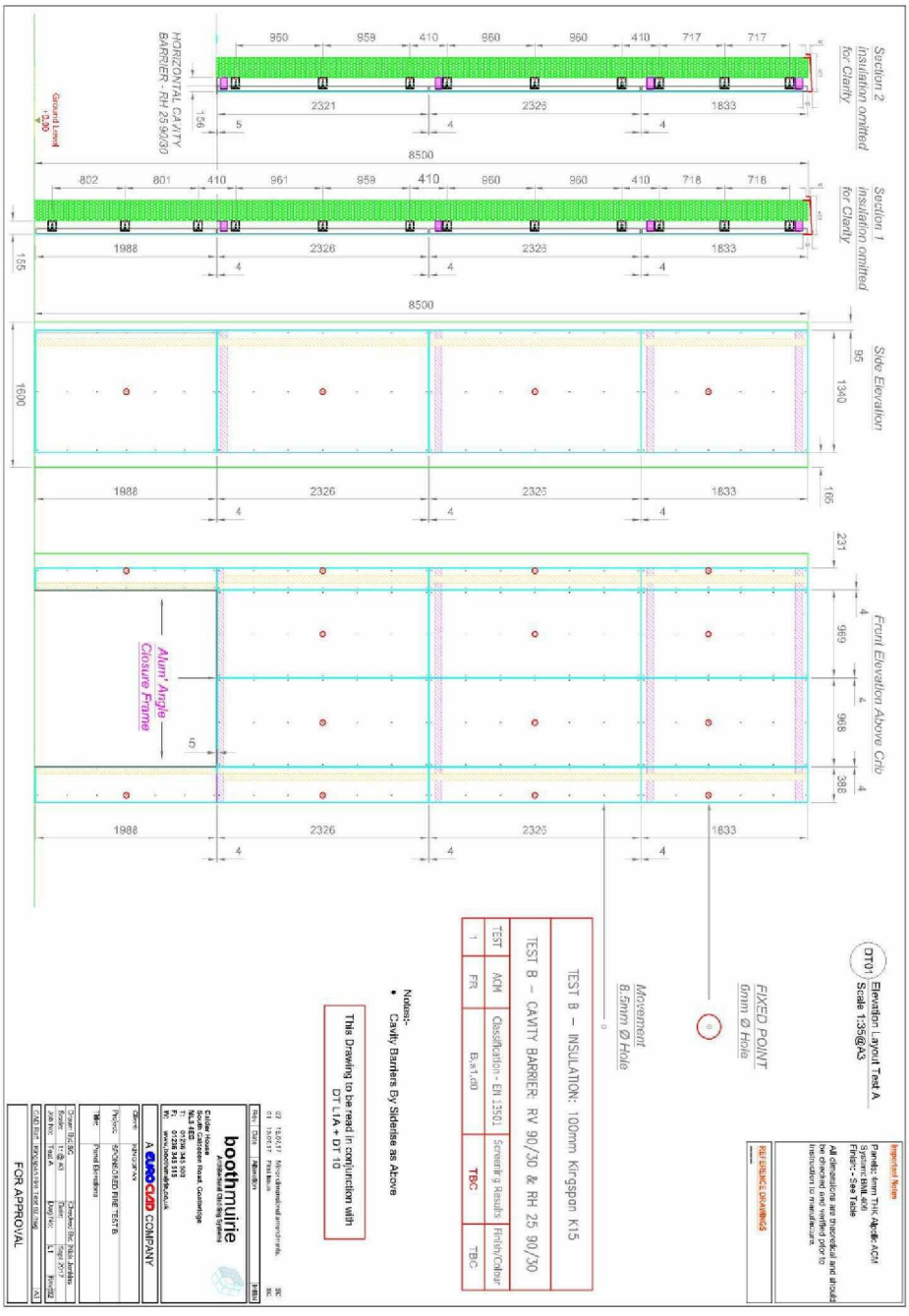

Figure 8. Elevation of system (supplied by the Test Sponsor).

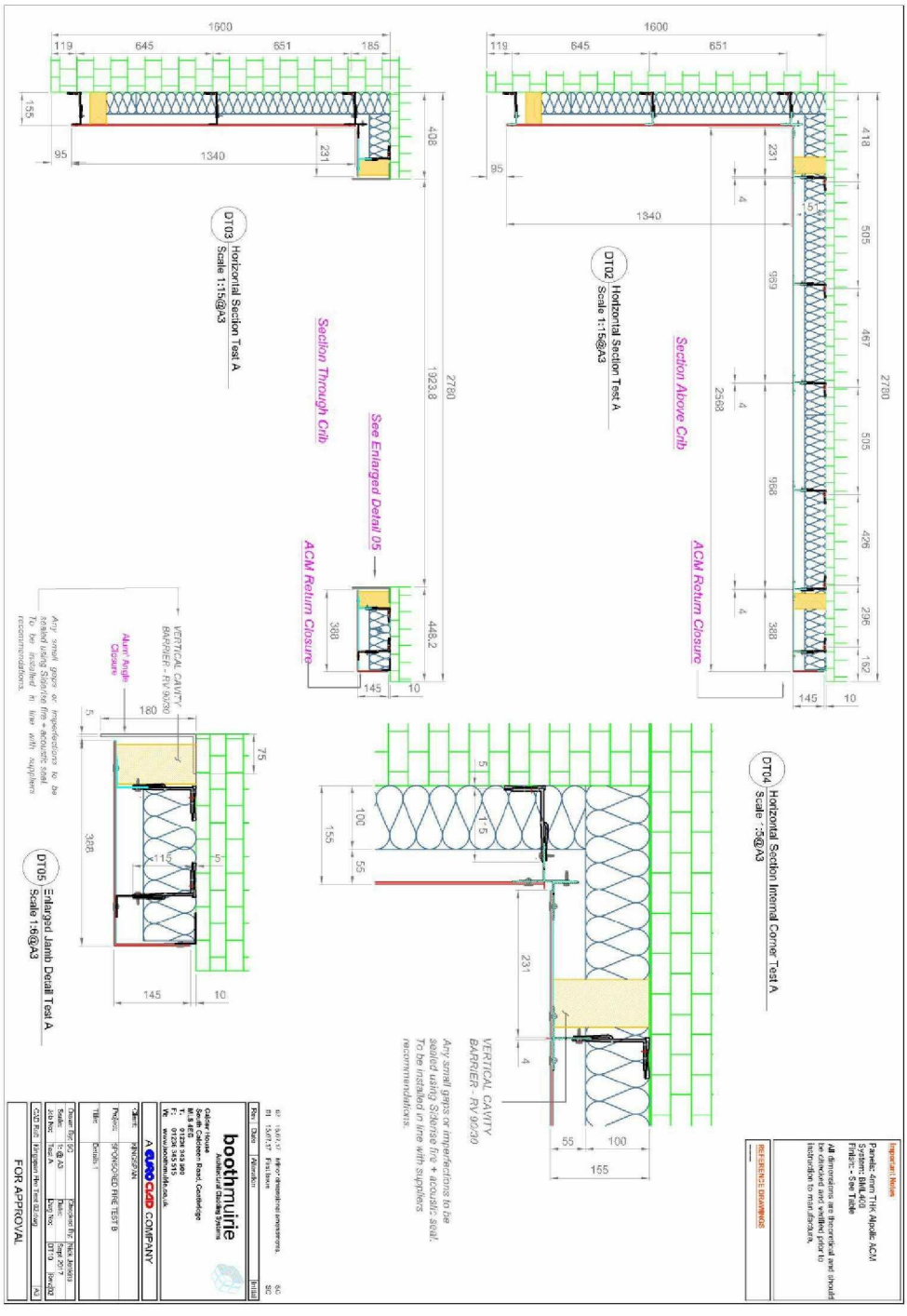

Figure 9. Horizontal cross section of system (supplied by the Test Sponsor).

9.3 Temperature data

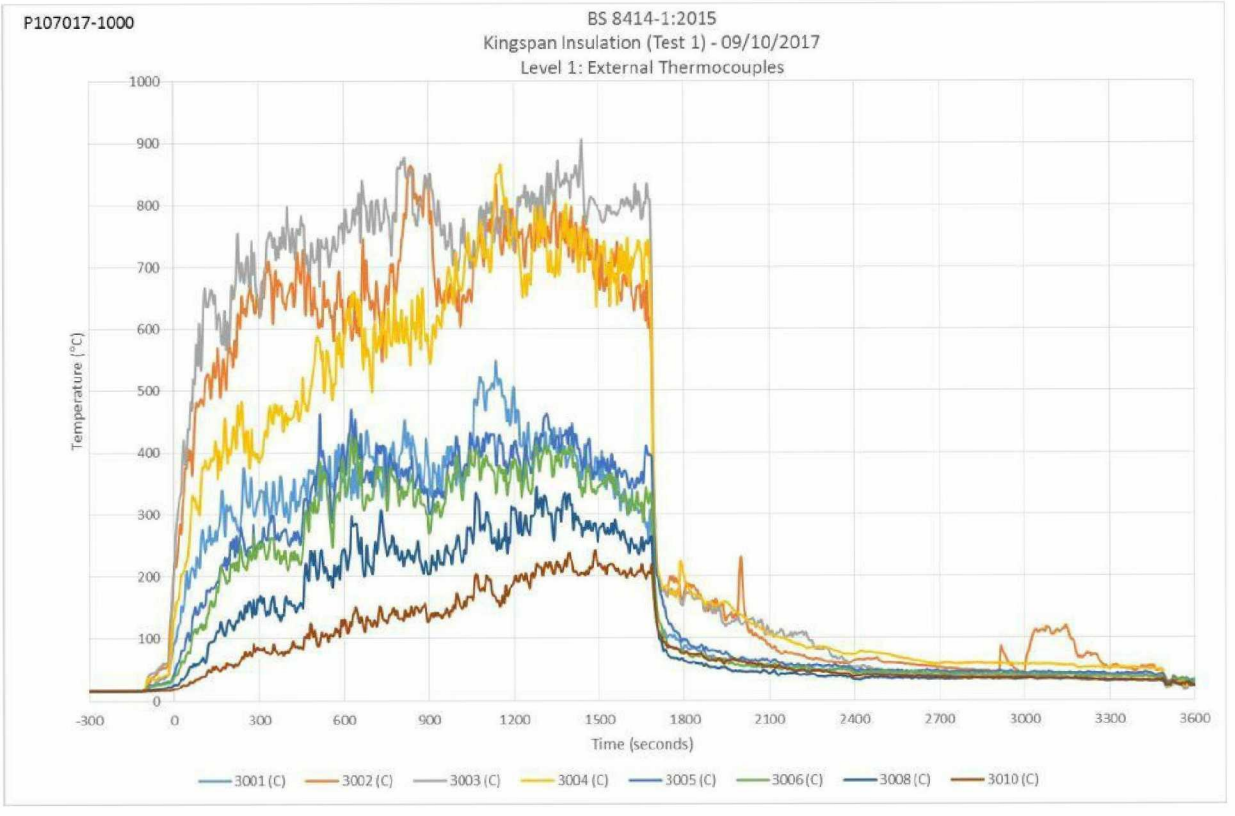

Figure 10. Level 1 external thermocouples.

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

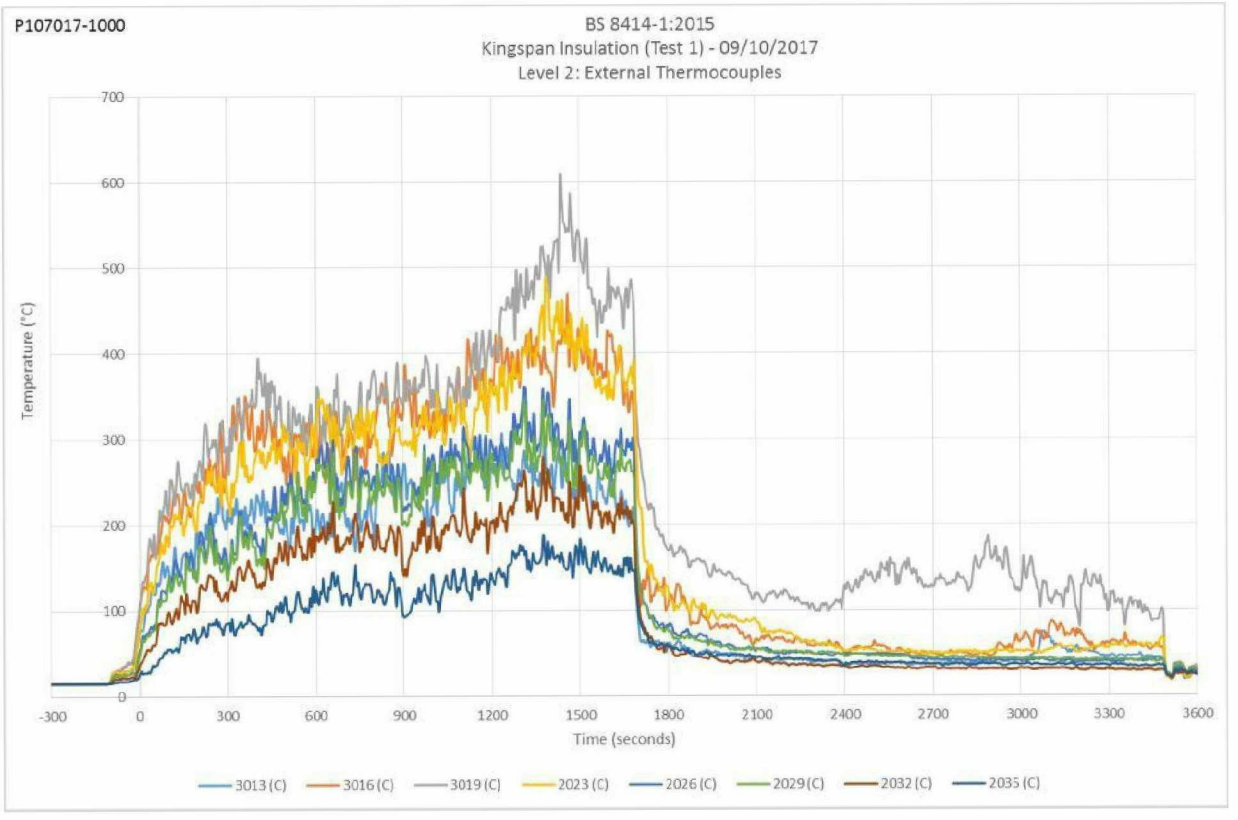

Figure 11. Level 2 external thermocouples.

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

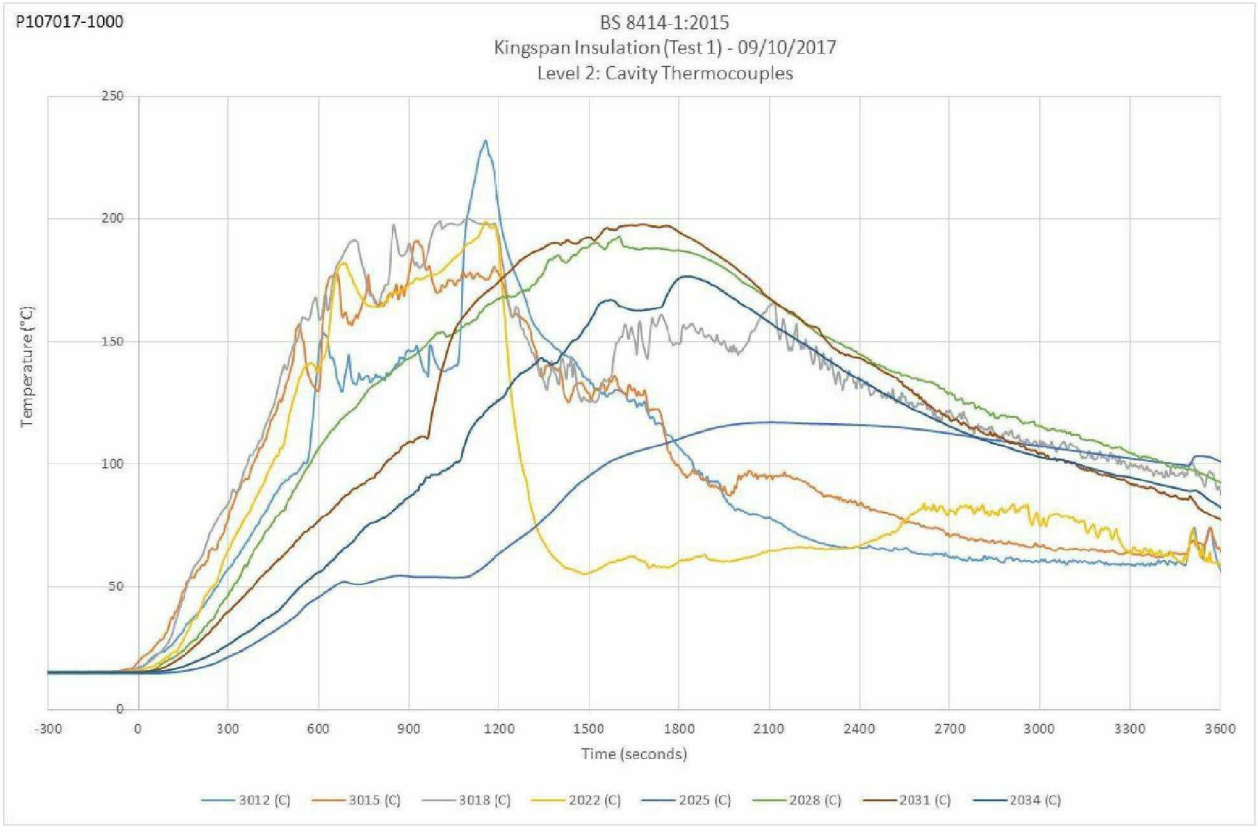

Figure 12. Level 2 cavity thermocouples.

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

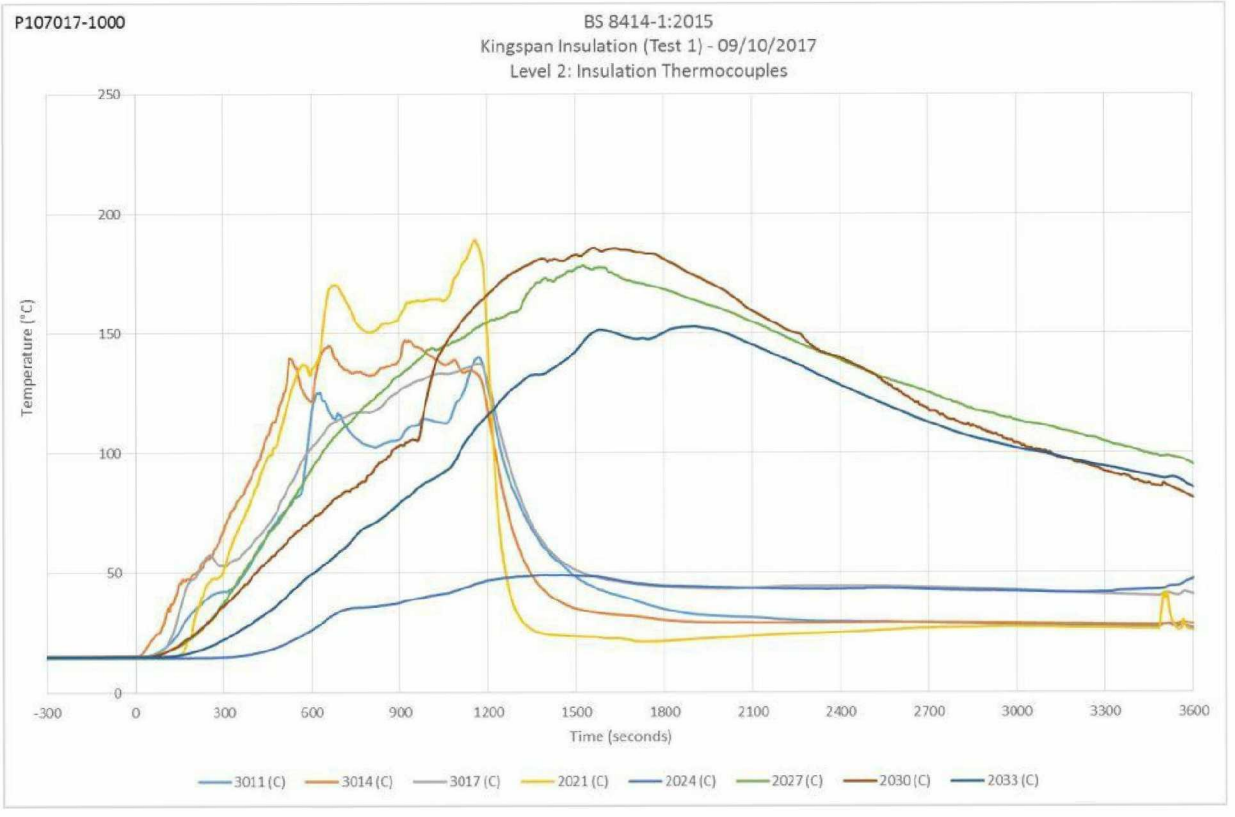

Figure 13. Level 2 insulation thermocouples.

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

9.4 Post-test photographs

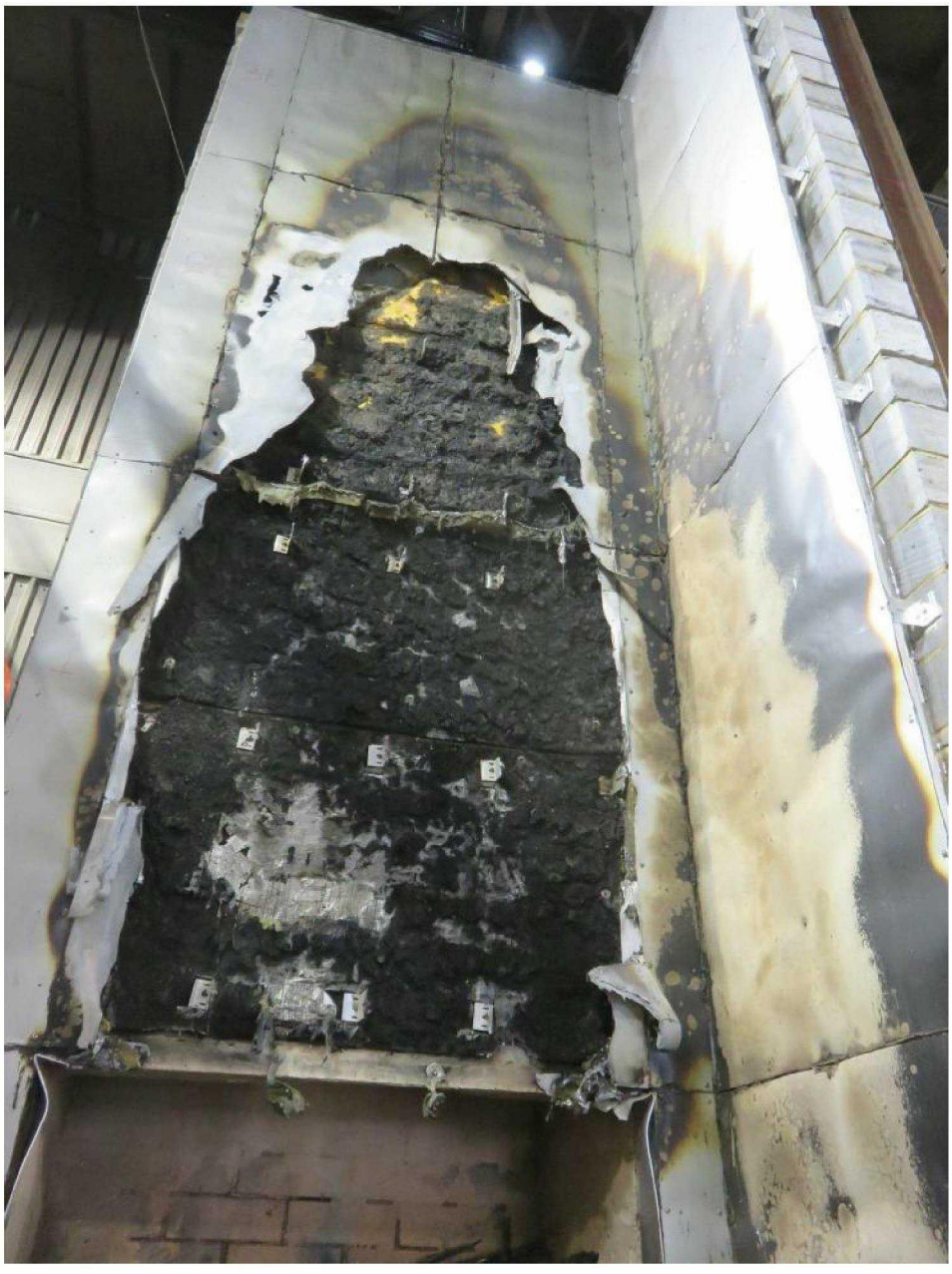

Figure 14. Full-height photograph immediately after test.

Figure 15. Post-test photo of exposed insulation on the main wall.

Figure 16. Full-height photograph of system following removal of ACM panels and aluminium rail substructure.

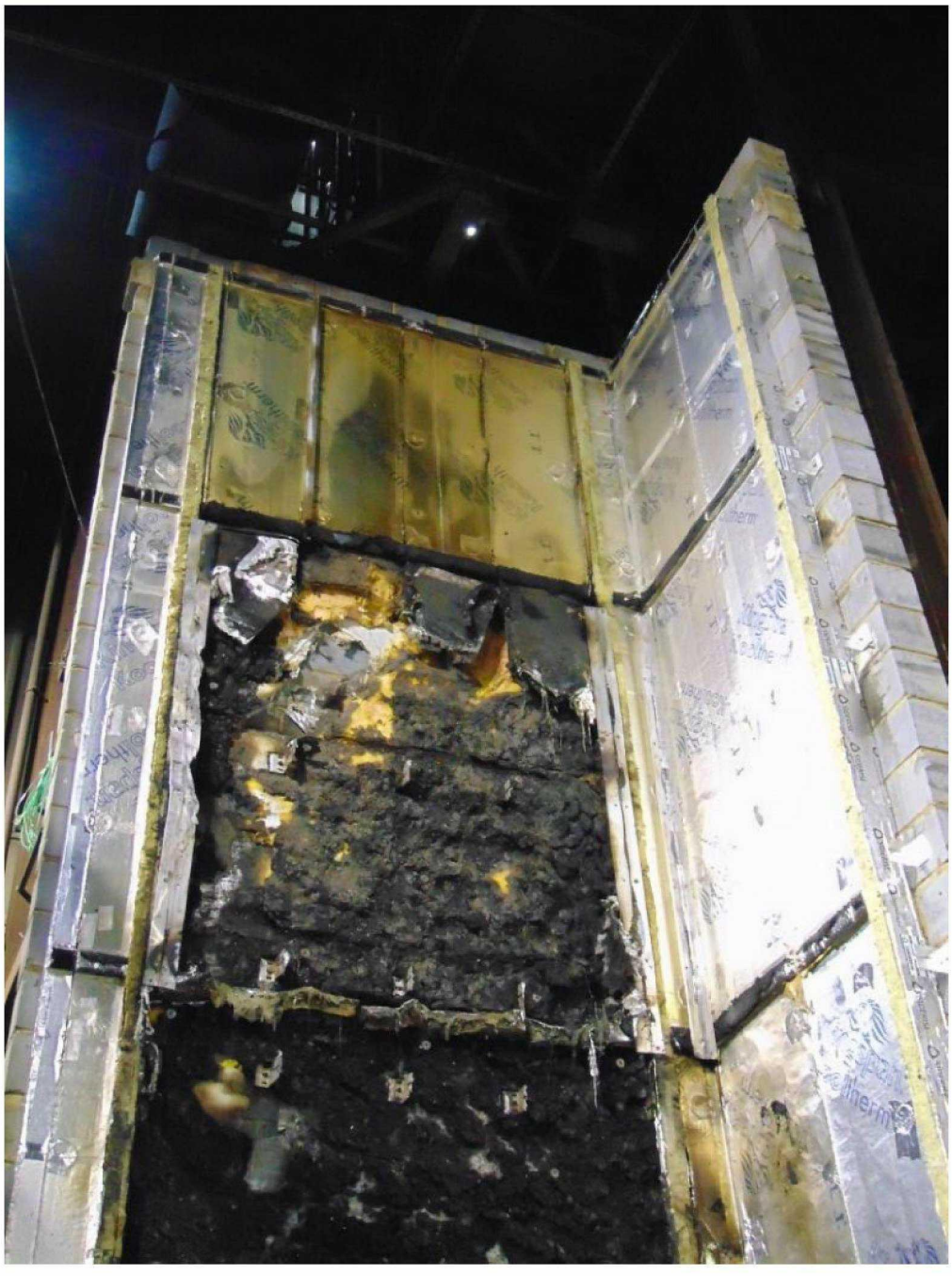

Figure 17. Post-test photo of system following removal of cladding panels.

Note: majority of aluminium rail substructure has been removed.

Figure 18. Post-test photo between second and third row Siderise RH25G 90/30 horizontal open state cavity barriers.

Note: majority of aluminium rail substructure has been removed.

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

Note: majority of aluminium rail substructure has been removed.

Report Ends