

# BRE Global Test Report

**BS 8414-2:2015 + A1:2017 Test on a brickwork cladding system with Kingspan Kooltherm K15 insulation.**

**Prepared for:** Kingspan Insulation Limited

**Date:** 26th October 2018

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## 1 Introduction

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The test method, BS8414-2:2015 + 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.

All materials and products used in the test were supplied and installed by the Test Sponsor. BRE Global were not involved in the sample selection process and therefore cannot comment upon the relationship between samples supplied for test and the samples supplied to market.

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



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## 2 Test Details

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<b>Name of Laboratory:</b>	BRE Global Ltd.
<b>Laboratory Address:</b>	Bucknalls Lane, Garston, Watford, Hertfordshire, WD25 9XX.
<b>Test reference:</b>	P112065-1000
<b>Date of test:</b>	2 <sup>nd</sup> May 2018
<b>Sponsor:</b>	Kingspan Insulation Limited
<b>Sponsor address:</b>	Pembridge, Leominster, Herefordshire, HR6 9LA, UK
<b>Method:</b>	The test was carried out in accordance with BS 8414-2:2015 + A1:2017
<b>Deviations:</b>	None



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### 3 Details of Test Apparatus

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The product was installed on to wall number 4 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 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

<b>Generic cladding type</b>	Masonry
<b>Relevant test method</b>	BS 8414-2:2015 + A1:2017
<b>Test frame</b>	Structural steel frame
<b>Insulation</b>	Kingspan Kooltherm K15 phenolic insulation (80mm-thick & 100mm-thick)
<b>Cavity depth</b>	50mm
<b>Vertical cavity barriers</b>	Siderise EW-CB30 stone wool cavity barrier (75mm-wide × 155mm-deep)
<b>Horizontal cavity barriers</b>	Siderise RH25G-090/030 stone wool open state cavity barrier with intumescent strip (75mm-high × 125mm-deep)
<b>External finish</b>	Wienerberger Waresley Red Stock bricks (219mm-wide × 102mm-deep × 63mm-high)

### 4.2 Description of product

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

Item	Description
1	British Gypsum Gyproc Wallboard (12.5mm-thick boards, double layer, fitted to internal face of partition).
2	Kingframe galvanised steel horizontal 'C'-shaped head channel (104mm-deep × 67mm-high × 1.8mm-thick).
3	Kingframe galvanised steel horizontal 'C'-shaped base channel (104mm-deep × 55mm-high × 1.2mm-thick).
4	Kingframe galvanised steel vertical 'C'-shaped stud (100mm-deep × 50mm-wide × 1.2mm-thick).
5	Euroform Versapanel cement particle board (12mm-thick).
6	Kingspan nilvent breather membrane.



7	Galvanised steel profiled capping brackets (297mm-deep×35mm-high×3mm-thick).
8	Aluminium 'U'-shaped capping (420mm-deep×40mm-high×3mm-thick).
9	Galvanised steel skewers (320mm-long×25mm-wide×1mm-thick).
10	Siderise EW-CB30 stone wool vertical cavity barrier (75mm-wide×155mm-deep).
11	Galvanised steel skewers (355mm-long×25mm-wide×1mm-thick).
12	Siderise RH25G-090/030 stone wool horizontal open state cavity barrier with intumescent strip (75mm-high×125mm-deep).
13	Kingspan Kooltherm K15 phenolic insulation (80mm-thick & 100mm-thick).
14	Ancon 25/14 wall tie support channel (14mm-deep×25mm-wide).
15	Aluminium combustion chamber surround side flashing (245mm-deep×65mm-wide×3mm-thick).
16	Aluminium combustion chamber surround top flashing (245mm-deep×65mm-high×3mm-thick).
17	Catnic LA/L10 galvanised steel external wall lintel (95mm-deep×158mm-high×2400mm-wide×2mm-thick).
18	Ancon SD25/100 wall ties (105mm-deep×20mm-wide×2mm-thick).
20	Wienerberger Waresley Red Stock bricks (102mm-deep×219mm-wide×63mm-high).



#### 4.2.1 Installation sequence

A Kingframe SFS (Steel Framing System) was constructed using Items 2-4 in *Table 1*. The partition was fitted flush with the front face of the floor slabs, fixed to the slabs and ground using 6×70mm countersunk Tapcon self-drilling screws at 100-400mm centres.

The vertical studs of the partition were set at 600mm centres and fixed to the horizontal channels using 4×25mm self-drilling screws. The stud spacing was reduced to 90mm at edge of framing.

A double layer of British Gypsum Gyproc Wallboard was fitted to the internal face of the partition (long edge horizontal) using Easydrive 3.5×50mm drywall screws at nominal 500mm vertical centres for the first layer, 230-600mm vertical centres for the second layer with horizontal centres in line with the studs of the partition.

A single layer of Euroform Versapanel cement particle board was fitted to the external face of the partition (long edge horizontal) and around the combustion chamber surround using 5.5×50mm self-drilling screws with horizontal centres in line with the studs of the partition and 100-300mm vertical centres (five fixings per column per board).

There was a 5-8mm gap between adjacent cement particle boards.

Euroform Versaseal-FS grey sealant was applied to gaps between adjacent cement particle boards.

Kingspan nilvent breather membrane was fitted to the external face of the cement particle board using Arrow 14mm T50 staples.

Aluminium profiled brackets were fixed to the top of the partition using 5.5×50mm self-drilling screws (two per bracket), the brackets were fitted at 400-500mm centres.

Aluminium capping (Item 8 in *Table 1*) was fixed to the aluminium profiled brackets using 5.5×50mm self-drilling screws at 400-500mm centres in two rows 240mm apart.

Galvanised steel folded skewers (Item 9 in *Table 1*) were fixed to the cement particle board using 5.5×45mm self-drilling screws at 300mm centres in three columns located either side of the combustion chamber opening (290mm and 2320mm from the main-wing wall junction) and towards the outside edge of the wing wall (1615mm from the main-wing wall junction).

Siderise EW-CB30 stone wool vertical cavity barriers were pressed onto the skewers in columns.

Galvanised steel folded skewers (Item 11 in *Table 1*) were fixed to the cement particle board using 5.5×45mm self-drilling screws at 300mm centres in four rows located: 80mm, 365mm, 2940mm and 5450mm above the top of the combustion chamber.

Siderise RH25G-090/030 stone wool horizontal open state cavity barriers with intumescent strip 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 horizontal cavity barriers in place. Each row was interrupted by the vertical cavity barriers. All gaps between insulation boards and cavity barrier were sealed with aluminium tape.

A single layer of 100mm-thick Kingspan Kooltherm K15 insulation was fixed to the cement particle board using 4.8×100mm self-drilling screws with Ø75mm plastic insulation retaining discs and 5.5×150mm self-drilling screws with Fixfast SP-SS-50-F1 Ø50mm metal insulation retaining discs. Aluminium tape was applied over the heads of insulation fixings and gaps between insulation boards.

From the outside edge of the combustion chamber to the outside edge of the main wall up to a height of the second row horizontal cavity barrier a single layer of 80mm-thick Kingspan Kooltherm K15 insulation was fitted.



Nine insulation fixings were used per full size board (three along both outer edges and three along the vertical centreline of the board). Smaller sections of insulation were secured using six fixings (two along both outer edges and two along the horizontal/vertical centreline of the board).

Aluminium flashing (Items 15 and 16 in *Table 1*) was fitted around the combustion chamber opening. The flashing was fixed to the external face of the cement particle board using 5.5×50mm self-drilling screws at 380mm centres. The flashing was fixed with 10mm-thick spacers and stone wool packed within the gap between the cement particle board and the flashing. Intumescent acrylic sealant was also used to seal the 10mm gap. Stone wool insulation was packed into the 20-30mm gap between the aluminium flashing and the cavity barriers surrounding the combustion chamber.

Ancon 25/14 wall tie support channels were fixed to the external face of the insulation, cement particle board and studs using 5.5×150mm self-drilling screws at 340-450mm vertical centres. The channels were fixed at 370-600mm centres on the main wall and 410-600mm on the wing wall.

A brick wall was constructed from Wienerberger Waresley Red Stock bricks and a standard sand/cement mortar mix 60-70mm from the external face of the insulation. At 450mm vertical centres and horizontal centres in line with wall tie support channels, Ancon SD25/100 wall ties were slotted into the support channels and embedded within the mortar.

A galvanised steel lintel spanned the combustion chamber opening to support the bricks as they were built above. Dowsil 719 Weather Proofing sealant was used to seal the perimeter of the combustion chamber surround flashing once the masonry wall was complete.

The cladding system measured:

Requirement	Actual measurement
≥6000mm above the top of the combustion chamber	6020mm
≥2400mm width across the main wall	2800mm
≥1200mm width across the wing wall	1683mm
260mm (±100mm) wing wall-combustion chamber opening	238mm
2000mm×2000mm (±100mm) combustion chamber opening	1900mm-wide× 1982mm-high



## 5 Test Results

### 5.1 Test conditions

**Test Date:** 2<sup>nd</sup> May 2018

**Ambient Temperature:** 13°C

**Wind speed:** 0.5 m/s (test undertaken indoors).

**Frequency of measurement:** Data records were taken at ten 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 brick.

**Level 2** – Midpoint of cavity.

**Level 2** – Midpoint of insulation.

**Level 2** – Midpoint of cement particle board.

**Level 2** – Midpoint of partition.

**Level 2** – Midpoint of plasterboard.

### 5.2 Temperature profiles

*Figures 13-20* provide the temperature profiles recorded during the test. *Figure 8* shows the system before the test.

Parameter	Result (whole test)	Result (t <sub>s</sub> +15mins)
T <sub>s</sub> , Start Temperature	13°C	n/a
t <sub>s</sub> , Start time	01:50 after ignition of crib.	n/a
Peak temperature / time at Level 2, External	423°C (t <sub>s</sub> +04:20).	423°C (t <sub>s</sub> +04:20).
Peak temperature / time at Level 2, Brick	61°C (t <sub>s</sub> +46:40).	23°C (t <sub>s</sub> +15:00).



Peak temperature / time at Level 2, Cavity	54°C (t <sub>s</sub> +38:50).	17°C (t <sub>s</sub> +12:40).
Peak temperature / time at Level 2, Insulation	51°C (t <sub>s</sub> +41:10).	14°C (t <sub>s</sub> +12:50).
Peak temperature / time at Level 2, Cement Particle Board	49°C (t <sub>s</sub> +41:20).	14°C (t <sub>s</sub> +13:30).
Peak temperature / time at Level 2, Partition	45°C (t <sub>s</sub> +39:10).	15°C (t <sub>s</sub> +14:40).
Peak temperature / time at Level 2, Plasterboard	18°C (t <sub>s</sub> +56:10).	15°C (t <sub>s</sub> +14:50).



### 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* (mm:ss)	t <sub>s</sub> (mm:ss)	Description
00:00		Ignition of crib.
01:25		Flame tips impinging on cladding system.
01:50	00:00	Start time (t <sub>s</sub> ) criteria achieved: External temperature 2.5m above the top of the combustion chamber in excess of 213°C (=200°C+T <sub>s</sub> ).
03:00	01:10	Smoke from outside edge of main wall.
03:40	01:50	Flame tips to 4m above top of combustion chamber.
04:40	02:50	Flame tips to Level 2 thermocouples.
05:00	03:10	Minor distortion to sides of combustion chamber surround.
07:10	05:20	Minor distortion to top of combustion chamber surround.
09:45	07:55	Further distortion to top of combustion chamber surround.
10:30	08:40	Flaming from outside edge of combustion chamber surround.
11:25	09:35	Flaming debris from top of combustion chamber surround.
11:35	09:45	Further flaming debris from top of combustion chamber surround.
11:45	09:55	Flaming from wing wall edge of combustion chamber surround.
13:35	11:45	Consumption of combustion chamber surround top.
14:00	12:10	Flaming from wing wall edge combustion chamber surround has ceased.
14:25	12:35	Partial detachment of combustion chamber surround top.
14:51	13:01	Further detachment of combustion chamber surround top.
16:00	14:10	Discolouration of main wall to a height of 2.5m above top of combustion chamber.



<b>Time* (mm:ss)</b>	<b>t<sub>s</sub> (mm:ss)</b>	<b>Description</b>
16:20	14:30	Detachment of stone wool from top of combustion chamber surround.
17:30	15:40	Flaming between top of combustion chamber surround and bricks.
18:00	16:10	Detachment of stone wool from top of combustion chamber surround.
19:05	17:15	Further detachment of stone wool from top of combustion chamber surround.
20:00	18:10	Discolouration of main wall to a height of 3.5m above top of combustion chamber.
22:00	20:10	Detachment of stone wool from combustion chamber surround.
23:00	21:10	Sporadic flame tips to 5m above top of combustion chamber.
24:15	22:25	Cracks formed along mortar towards top right-hand corner of combustion chamber.
27:20	25:30	Detachment of stone wool from top of combustion chamber surround.
28:20	26:30	Detachment of stone wool from top of combustion chamber surround.
28:40	26:50	Top of combustion chamber surround mostly consumed.
30:00	28:10	Crib extinguished.
30:50	29:00	Intermittent flaming from top and outside edge of combustion chamber surround.
31:10	29:20	Flaming from outside edge of combustion chamber surround has ceased.
31:25	29:35	Flaming from top of combustion chamber surround has ceased.
32:00	30:10	Smoke emission from top and sides of cladding system
33:30	31:40	Smoke emission limited towards top outer edge of main wall.
38:20	36:30	Significant reduction in smoke emission.
39:40	37:50	Smoke emission from top outer edge of wing wall.
44:30	42:40	Further reduction in smoke emission.



<b>Time* (mm:ss)</b>	<b>t<sub>s</sub> (mm:ss)</b>	<b>Description</b>
60:00	58:10	Test finished.

\*Time from point of ignition.



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## 6 Post-Test Damage Report

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### 6.1 Mechanical performance

Flaming debris from the top edge of the combustion chamber surround was recorded between 11 minutes 25 seconds and 11 minutes 35 seconds. Non-flaming debris from the combustion chamber surround was recorded between 14 minutes 25 seconds and 28 minutes 20 seconds. At 28 minutes 40 seconds most of the top edge had been consumed.

Ongoing combustion was limited to the vicinity of the combustion chamber surround and continued until 31 minutes 25 seconds.

### 6.2 System damage

#### 6.2.1 External brick wall

There was cracking in the brickwork and mortar surrounding the combustion chamber. There was a 700mm-long vertical crack in the brickwork adjacent to the inside edge of the combustion chamber. See *Figure 22*. There was minor cracking along the mortar from each corner of the combustion chamber joining at approximately 1m above the centre line of the combustion chamber. See *Figure 23*. There were vertical hairline cracks in the bricks from approximately 1-1.4m above the top of the combustion chamber. See *Figure 24*.

There was discolouration from the top of the combustion chamber to the top of the main wall tapering up from approximately 1900mm to 1500mm-wide. See *Figure 21*.

#### 6.2.2 Combustion chamber surround

The top edge was more than 90% consumed. See *Figure 29*.

The sides were distorted and discoloured towards the top with a small area of consumption (approximately 20mm-wide × 150mm-high) on the edge furthest from the wing wall.

#### 6.2.3 Galvanised steel lintel

Discolouration across full-width with minor distortion. See *Figure 25*.

#### 6.2.4 Phenolic insulation

Insulation remained intact and in place with localised areas of discolouration to surface of outer foil immediately above the combustion chamber opening. See *Figure 26*.

#### 6.2.5 Vertical rails

No visible damage.

#### 6.2.6 Horizontal (intumescent) cavity barriers

All horizontal cavity barriers remained intact and in place. Evidence of intumescent expansion was observed on the first and second rows. See *Figure 28*.



### 6.2.7 Vertical (compression) cavity barriers

All vertical cavity barriers remained intact and in place. There were localised areas of discolouration on the main wall vertical cavity barriers from the ground to the height of the first row horizontal cavity barrier. See *Figure 28*.

### 6.2.8 Breather membrane

The breather membrane remained intact and in place with localised areas of discolouration around the combustion chamber opening. See *Figure 29*.

### 6.2.9 Cement particle board

The cement particle board remained intact and in place with localised areas of discolouration around the combustion chamber opening. See *Figure 30*.

### 6.2.10 Lightweight steel framework partition

The lightweight steel framework partition remained intact and in place with localised areas of discolouration around the combustion chamber opening. See *Figure 32*.

### 6.2.11 Plasterboard

No visible damage.

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## 7 Conclusion

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BS8414-2:2015 + A1:2017 [1] does not contain acceptance criteria and therefore this test report does not indicate a pass or fail of the product.



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## 8 Reference

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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

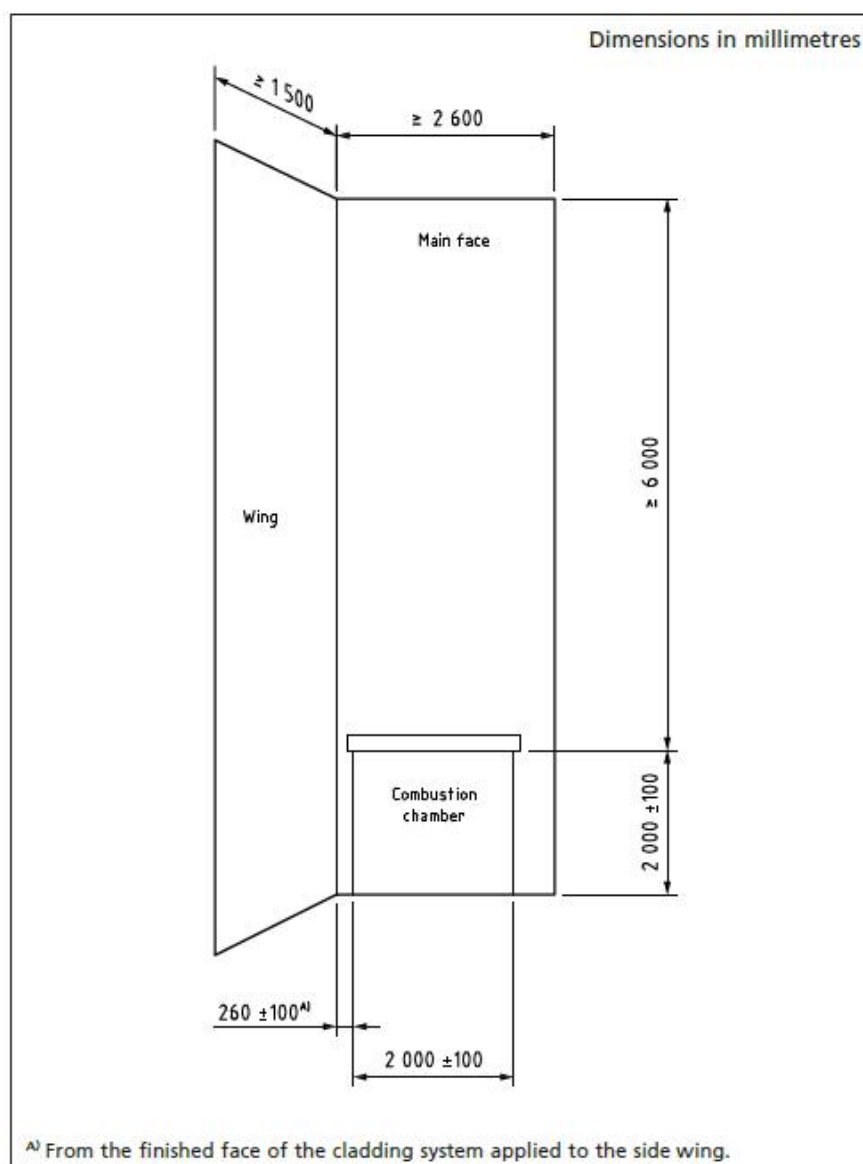


Figure 1. Test apparatus dimensions as specified by test Standard<sup>[1]</sup>.

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



## 9.2 Diagrams of finished face of the cladding system

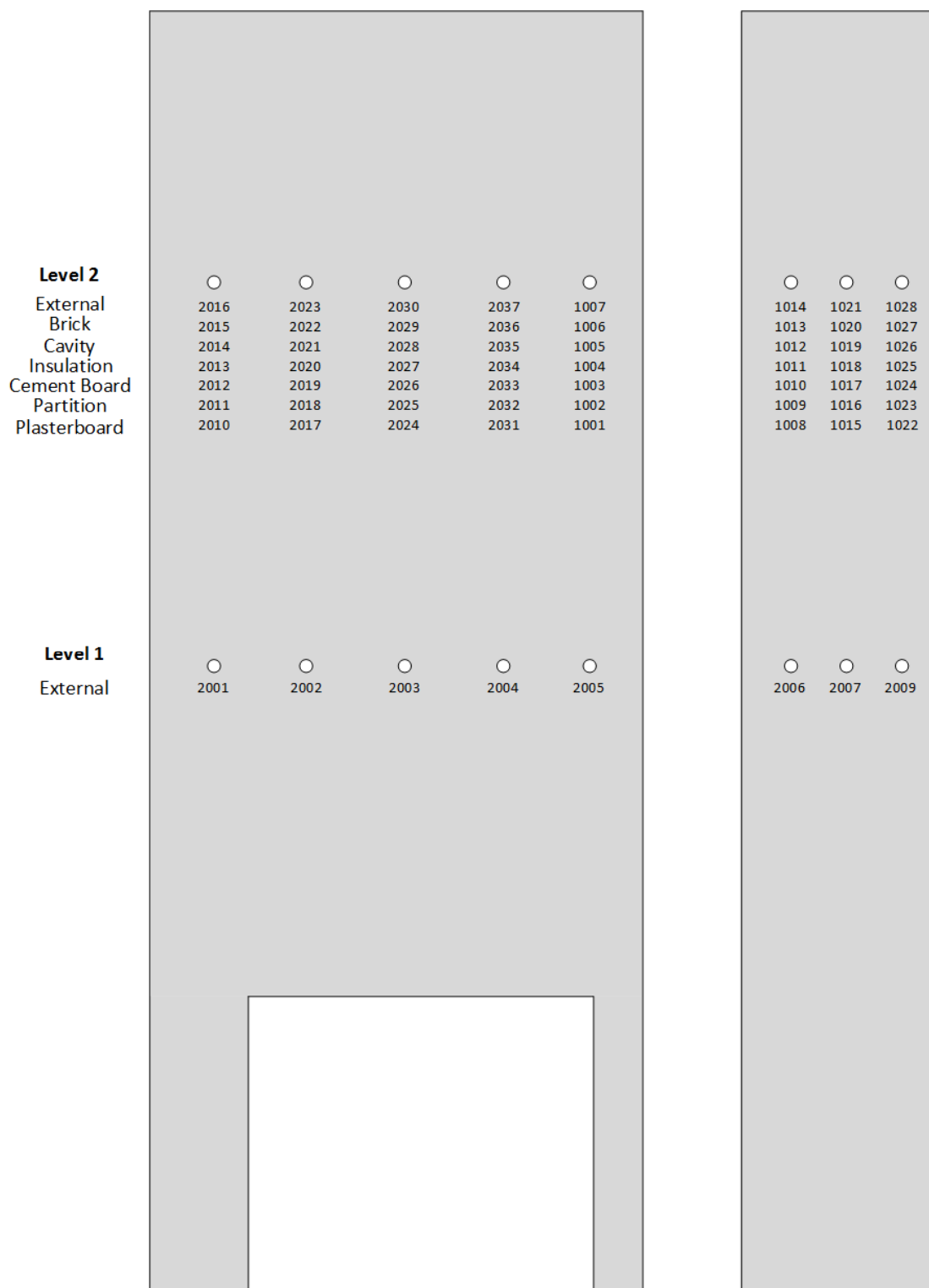


Figure 2. TC positions. Not to scale.



### 9.3 Installation photographs



Figure 3. Lightweight steel framework partition with plasterboard fitted to rear.



Figure 4. Cement particle board.



Figure 5. Breather membrane.



Figure 6. Cavity barriers, insulation and rails.



Figure 7. Combustion chamber surround flashing.

Note: stone wool insulation packed between flashing and cavity barriers.



Figure 8. Full-height photograph of cladding system prior to test.



### 9.4 System drawings

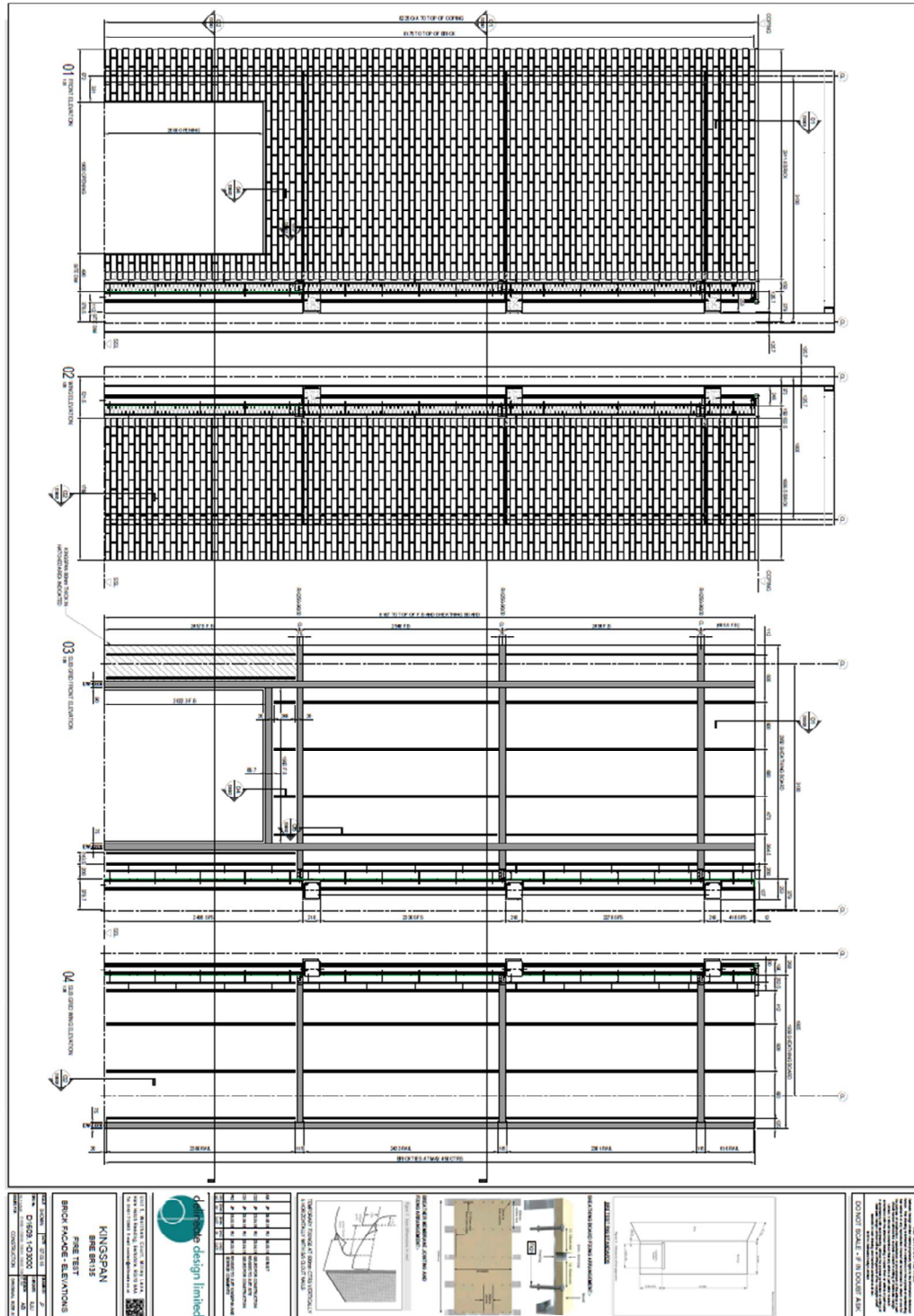


Figure 9. Brick façade and locations if barriers (supplied by Test Sponsor).

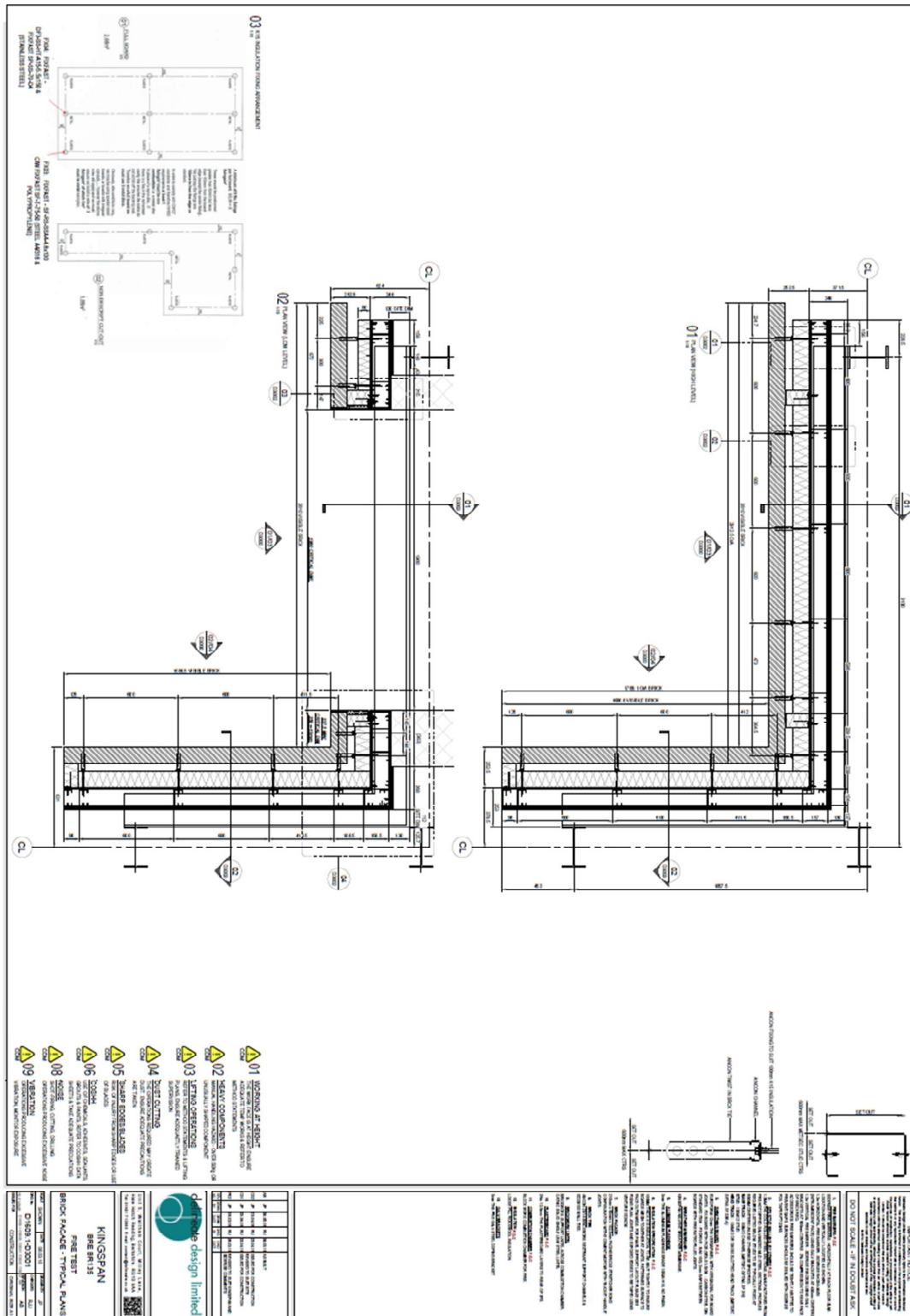


Figure 10. Plan view cross sections (supplied by Test Sponsor).







### 9.5 Temperature data

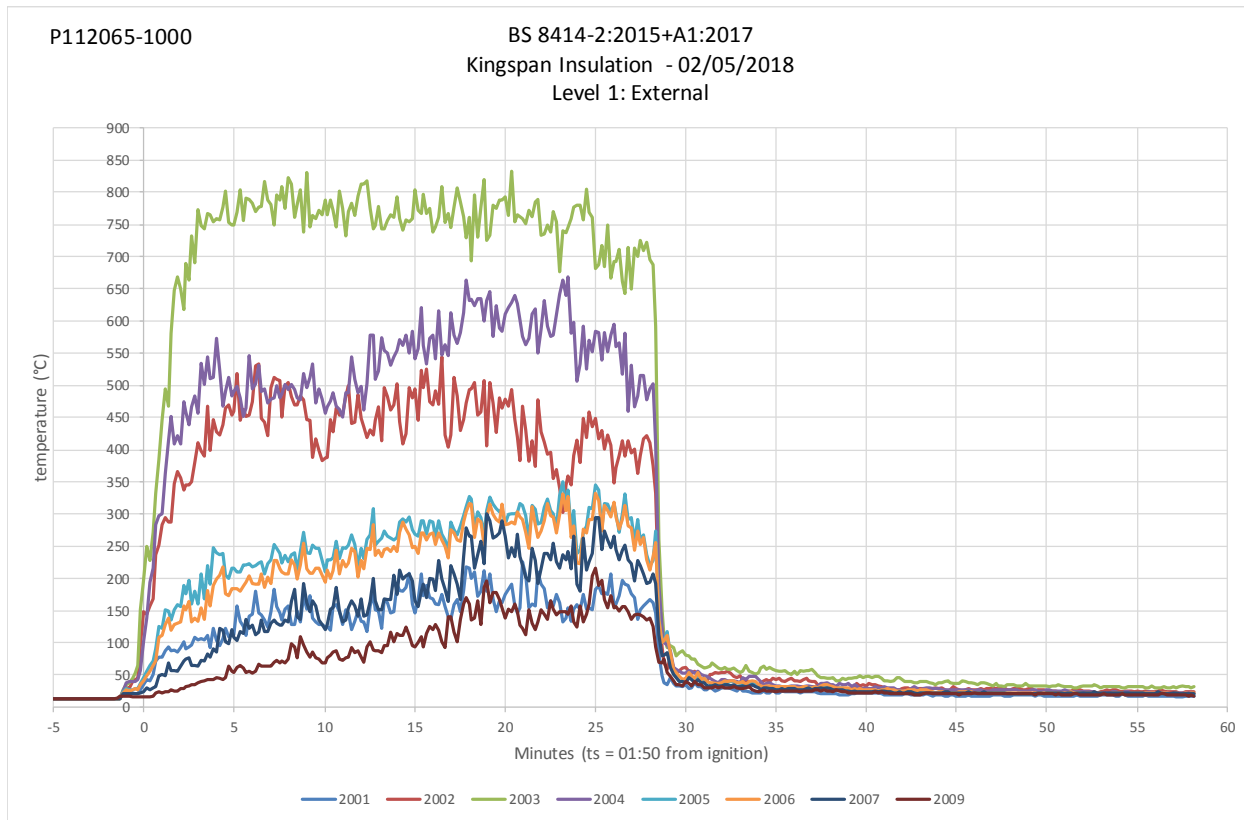


Figure 13. Level 1 external thermocouples.

ts=1 mins 50 secs after ignition of the crib.

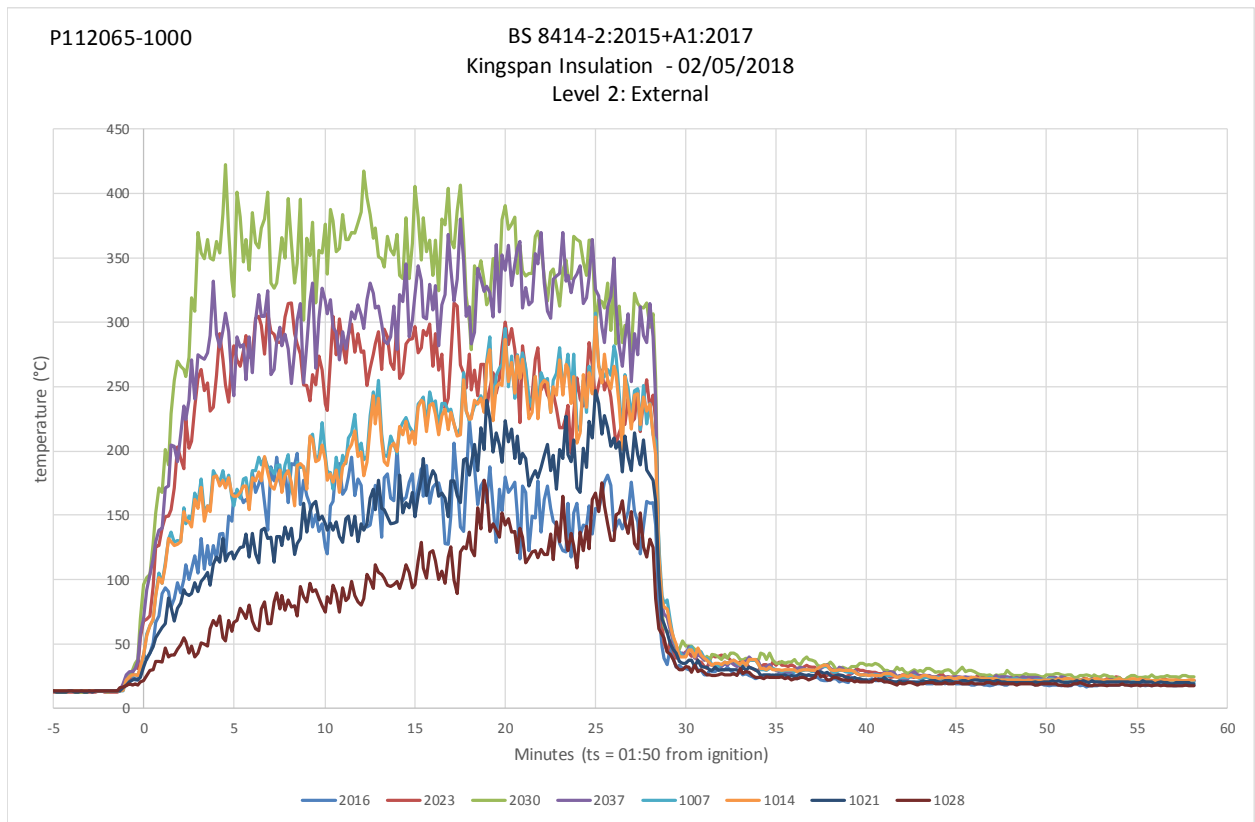


Figure 14. Level 2 external thermocouples.

$t_s=1$  mins 50 secs after ignition of the crib.

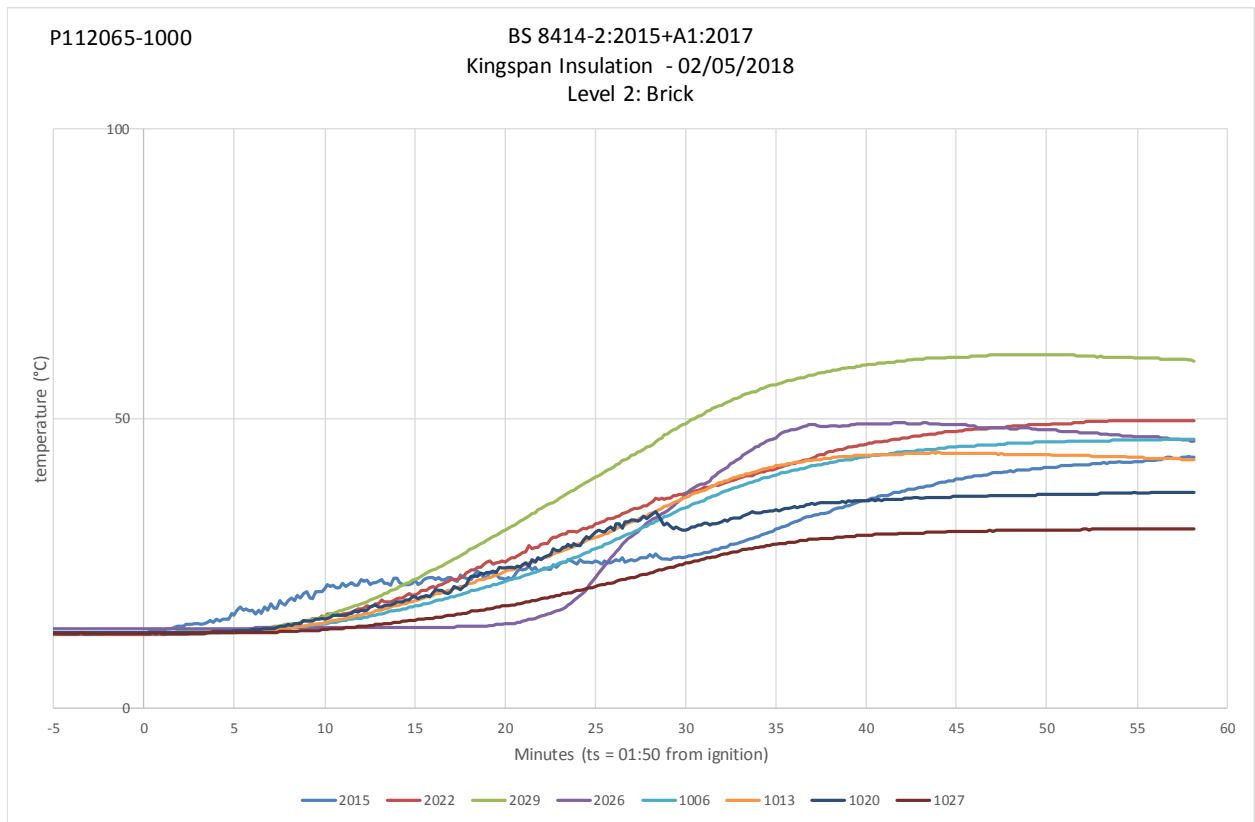


Figure 15. Level 2 brick thermocouples.

$t_s=1$  mins 50 secs after ignition of the crib.

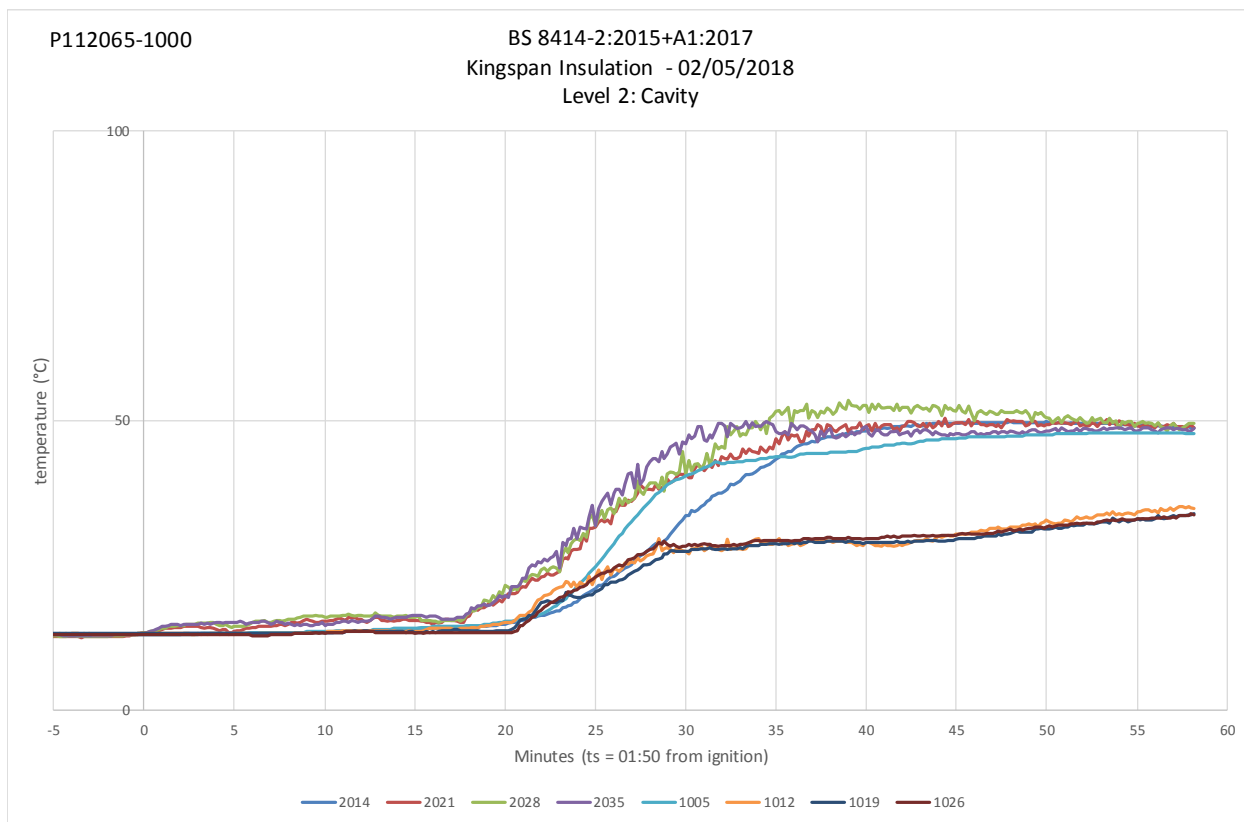


Figure 16. Level 2 cavity thermocouples.

$t_s=1$  mins 50 secs after ignition of the crib.

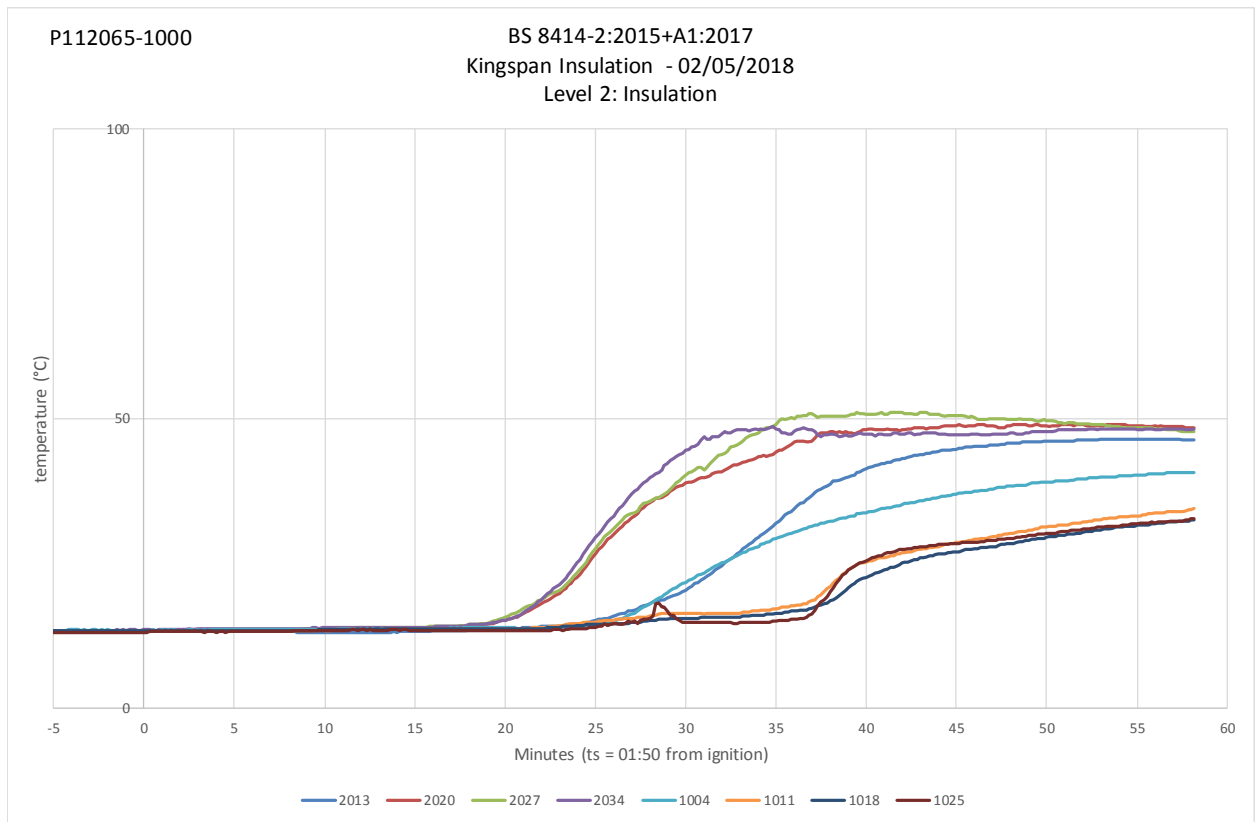


Figure 17. Level 2 insulation thermocouples.

$t_s=1$  mins 50 secs after ignition of the crib.

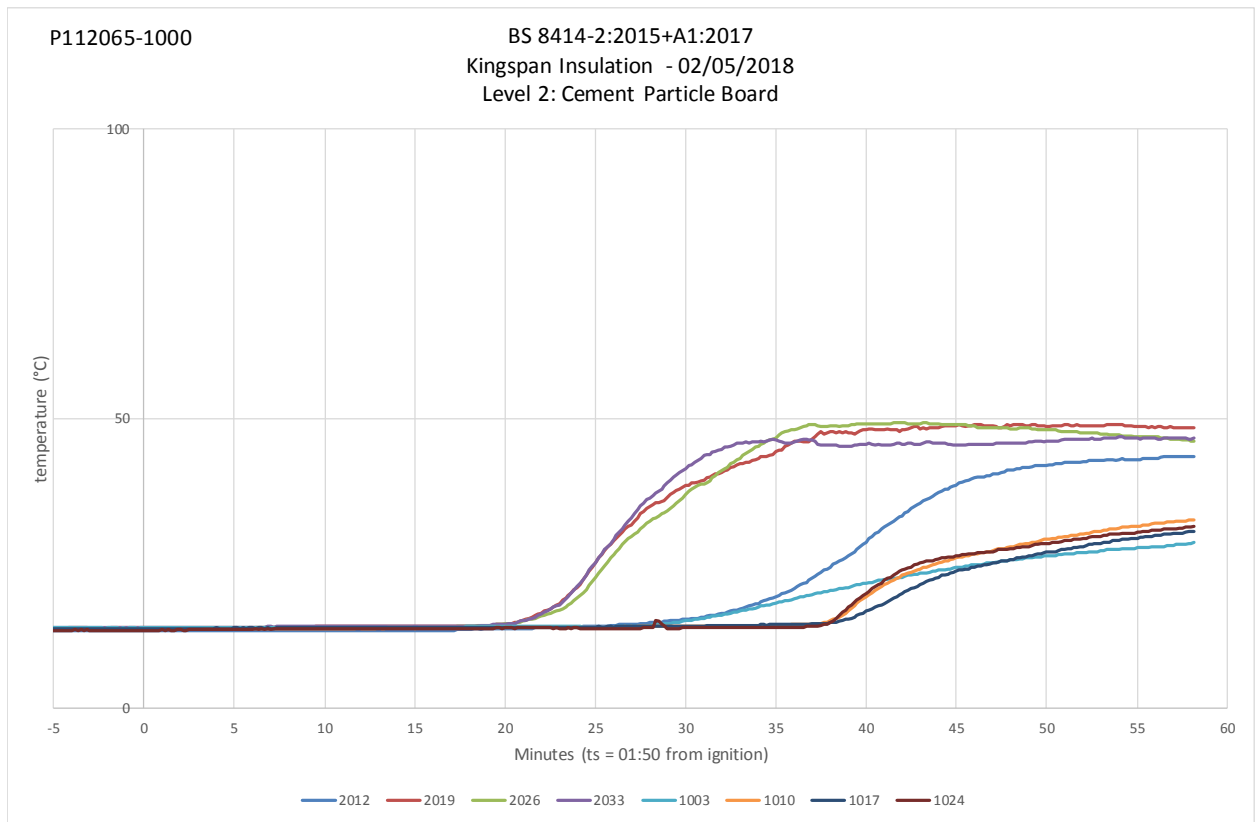


Figure 18. Level 2 cement particle board thermocouples.

$t_s=1$  mins 50 secs after ignition of the crib.

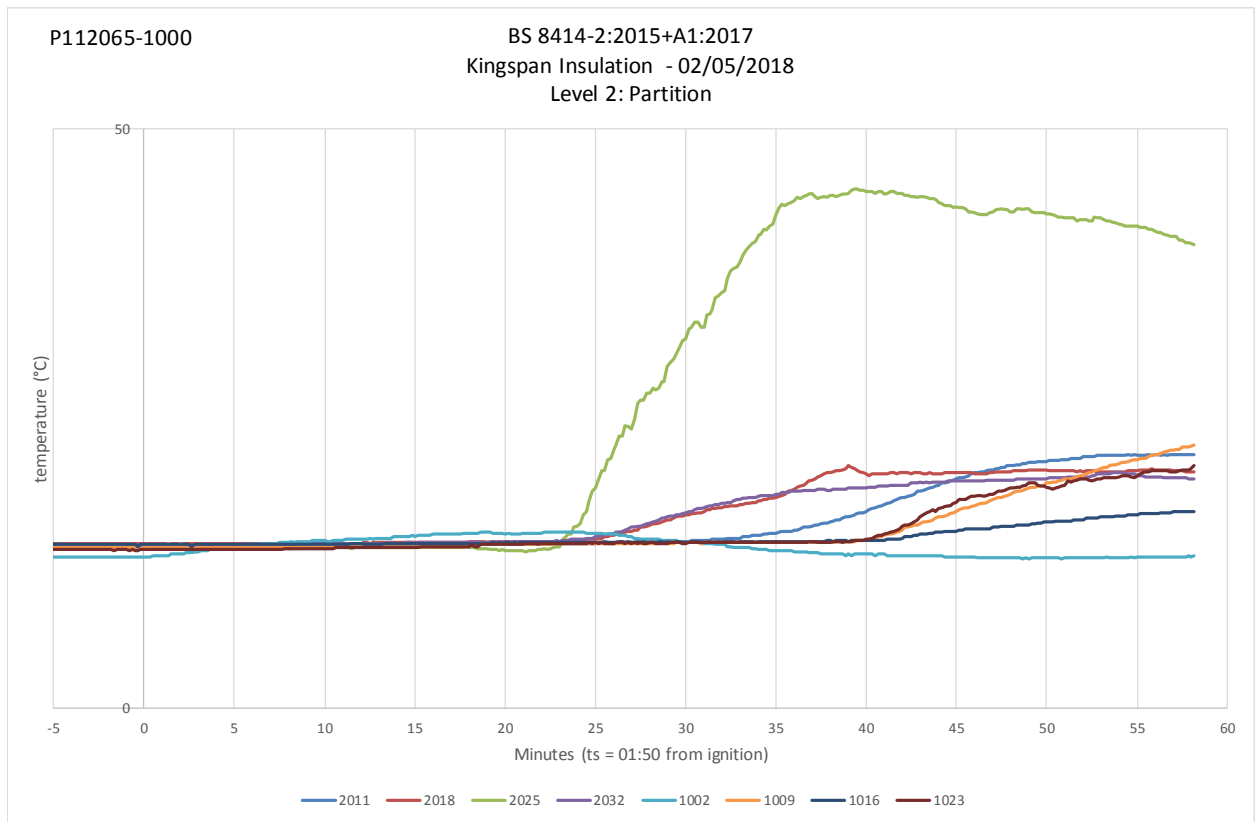


Figure 19. Level 2 lightweight steel framework partition thermocouples.

$t_s=1$  mins 50 secs after ignition of the crib.

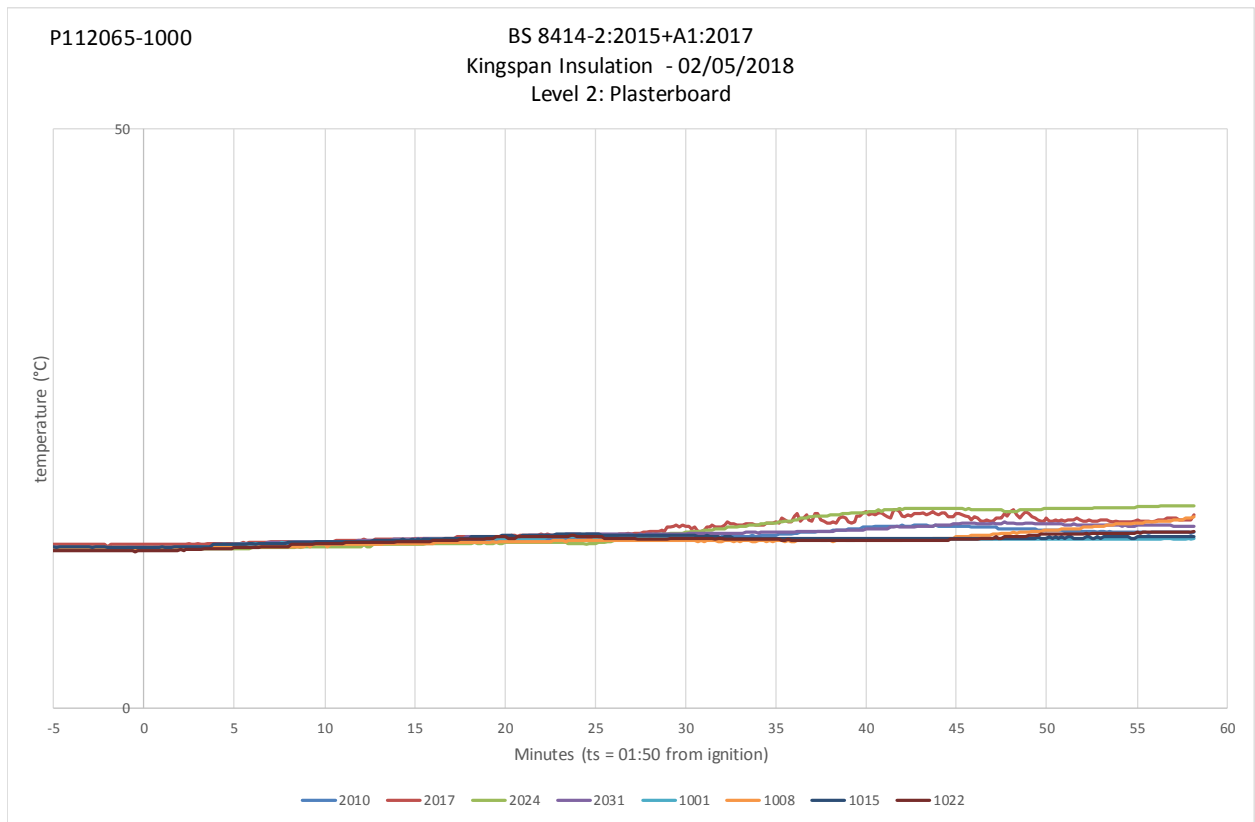


Figure 20. Level 2 plasterboard thermocouples.

$t_s=1$  mins 50 secs after ignition of the crib.



## 9.6 Post-test photographs



Figure 21. Full-height photograph of cladding system after test.



Figure 22. Cracking local to inside edge of combustion chamber opening.



Figure 23. Cracking in brick façade.

Note: crack pattern highlighted using marker pen.



Figure 24. Cracking in brick façade above combustion chamber.

Note: crack pattern highlighted using marker pen.



Figure 25. Photograph of steel lintel after test.



Figure 26. Photograph of insulation from ground to a height of third row horizontal cavity barrier.

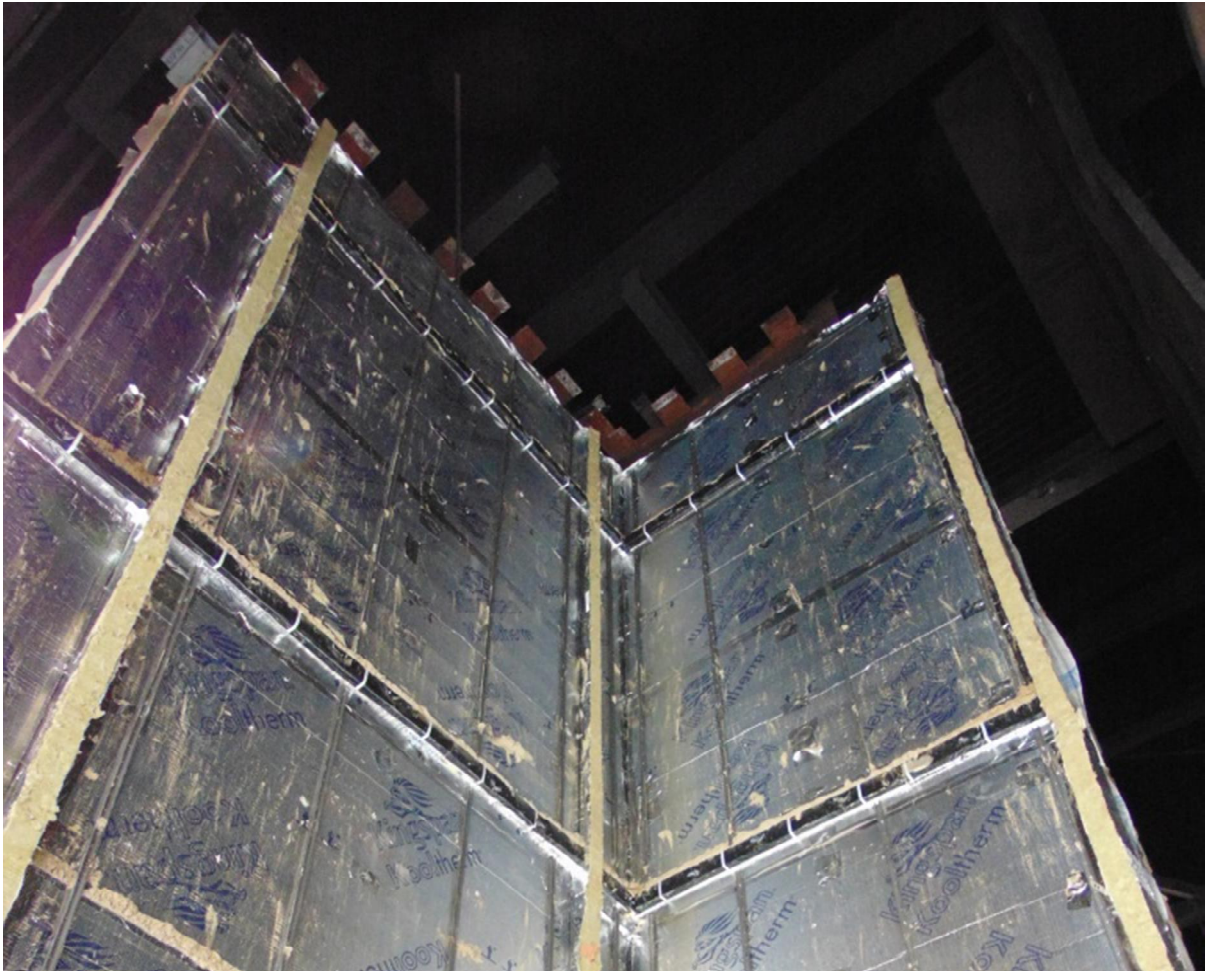


Figure 27. Photograph of insulation from a height of third row horizontal cavity barrier to top of cladding system.



Figure 28. Photograph of horizontal and vertical barriers after test.



Figure 29. Photograph of breather membrane after test.



Figure 30. Cement particle board immediately surrounding combustion chamber.



Figure 31. Cement particle board from a height of approximately 2000mm above the top of the combustion chamber to the top of the cladding system.



Figure 32. Lightweight steel framework partition from ground to first row floor slabs.



Figure 33. Lightweight steel framework partition from first row floor slabs to top of cladding system.