WARRINGTONFIRE
AUSTRALIA
A Jensen Hughes Company

Reaction to fire test report

Test standard: Ad-hoc test based off ISO 13785-1:2002 with an additional wind component.

Test sponsor: Owners Corporation Plan Number [redacted]

System: Aluminium composite panel wall system representative of the in-situ wall located at [redacted] VIC 3004 – Scenario 1

Job number: RTF230054

Test date: 22 May 2023 Revision: RR1.0

WARRINGTONFIRE
AUSTRALIA
A Jensen Hughes Company

Quality management

Revision	Date	Information about the report			
RR1.0	29 November 2024	Description	Initial issue		
			Prepared by	Reviewed by	Authorised by
		Name	[redacted]	[redacted]	[redacted]
		Signature			

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Contents

1. Introduction

This report documents the findings of three ad-hoc reaction to fire tests for an Aluminium composite panel (ACP) and glazing external wall cladding system performed on 22 May 2023. The test was based off some general requirements of ISO 13785-1:2002 with an additional wind component.

Warringtonfire performed the test at the request of the test sponsor listed in Table 1.

Table 1 Test sponsor details

Test sponsor	Address
[redacted]	

2. Test specimen

2.1 Schedule of components

Table 2 describes the test specimen and lists the schedule of components. These were provided by the representatives of the test sponsor and surveyed by Warringtonfire. All measurements were done by Warringtonfire – unless indicated otherwise.

Detailed drawings of the test specimen are provided in Appendix A.

Table 2 Schedule of components

Item	Description	
Cladding		
1.	Item name	ACP Panelling - cassetted
	Product	[redacted]
	Manufacturer/Supplier	[redacted]
	Material	The panels – which were commercially sourced - consisted of two layers of aluminium sheets sandwiching a layer of polyethylene (PE) with fire-retardant core. The core was grey in colour. These were selected to replicate the panels found onsite at [redacted] Chemical analysis was conducted on both the site samples and the commercially available samples, and the results were: • [redacted]: report number 22155 conducted by the analytical centre of UNSW showed that the core consisted of 73.4 % aluminium trihydrate, 0.6 % inert filler and 26 % PE. • Site sample 1: report number 202212 sample #1 conducted by the analytical centre of UNSW showed that the core consisted of 69.8 % aluminium trihydrate, 1.6 % inert filler and 29 % PE. • Site sample 2: report number 202212 sample #2 conducted by the analytical centre of UNSW showed that the core consisted of 69.5 % aluminium trihydrate, 1.6 % inert filler and 29 % PE. Refer to Appendix C for more detailed results.
	Size	As shown in Figure 22. Thickness – 4 mm Skin thickness – 0.5 mm Depth – 150 mm (200 mm total cavity depth)
	Batch	[redacted]
	Nominated mass densities	Panel areal density – 7.5 kg/m²
2.	Item name	Back-pan

Item	Description	
	Product	Nominally 0.9 mm thick Galvabond sheet, measured 0.6 mm
	Supplier	[redacted]
	Material	Galvanised steel
	Batch	[redacted]
	Size	Measured: 1160 mm wide × 3700 mm tall, 0.6 mm thick – in segments.
Glazing		
3.	Item name	Double glazing
	Material	IGU-5 mm 'Bite' / 6 mm CLEAR HEAT STRENGTHENED / 6.76 mm CLEAR LAMINATE
	Size (nominal)	1188 mm wide × 1800 mm tall × 5 mm/6 mm/6.76 mm with a 12 mm black spacer.
	Manufacturer/Supplier	[redacted]
	Batch	[redacted]
4.	Item name	Single glazing
	Material	6 mm toughened glass
	Size (nominal)	1182 mm wide × 1800 mm tall × 6 mm thick
	Manufacturer/Supplier	[redacted]
	Batch	[redacted]
Framing		
5.	Item name	Test rig frame - 90 × 90 SHS and 200 × 90 PFC frame
	Size	90 mm × 90 mm × 5 mm thick and 200 mm × 90 mm × 10 mm thick – refer to Figure 21.
6.	Item name	Aluminium curtain wall transom/mullions (rectangular hollow sections) – framing
	Size	65 mm to 70 mm wide × 116 mm deep × 3 mm thick.
	Manufacturer/Supplier	[redacted]
7.	Item name	Aluminium angles - framing
	Size	25 mm wide × 50 mm deep × 3 mm thick
	Manufacturer/Supplier	[redacted]
8.	Item name	Aluminium angles – for middle double back-pan unit.
	Size	25 mm wide × 50 mm deep × 3 mm thick
	Manufacturer/Supplier	[redacted]
	Installation	Used to secure the secondary back-pan in the within the middle module. The angle was screw fixed to both the back-pan (item 2) and the aluminium framing (item 6) using screws (item 18).
9.	Item name	Aluminium stiffener - framing
	Size	3 mm thick × 150 mm deep
	Manufacturer/Supplier	[redacted]
10.	Item name	Curtain wall bracket
	Size	150 mm deep (7 mm thick) × 75 tall (10 mm thick) × 100 mm wide
	Installation	Used to secure the 3 modules to the test rig using tek screws.

Item	Description	
Smoke seal		
11.	Item name	Smoke seal
	Size	0.55 mm thick galvanised steel
	Manufacturer/Supplier	[redacted]
Penetration		
12.	Item name	Exhaust
	Size	Backing plates: 355 mm × 355 mm × 0.6 mm thick Large tube: Ø155 mm × 330 mm long × 0.5 mm thick Small tube: Ø100 mm × 300 mm long × 0.6 mm thick Cap: Ø200 mm × 0.6 mm thick Connecting strips: 45 mm × 5 mm wide × 0.5 mm thick
	Material	Galvanised steel
	Manufacturer/Supplier	[redacted]
	Pictures	  Exposed side Unexposed side
	Installation	These penetrating elements were a galvanised steel tube with a smaller galvanised steel tube inside. On the glazing side was a circular cap connected to the large tube via 15-off strips. Between the glazing and the inner back-pan was a square compartment made from galvanised steel which hid the tubing.
Insulation		
13.	Item name	90 mm thick polyethylene terephthalate (PET) insulation
	Density	10 kg/m^3
	Manufacturer/Supplier	[redacted]
14.	Item name	50 mm thick aluminium - with fibre-glass mesh - foil faced rockwool insulation
	Density of core	40 kg/m^3
	Manufacturer/Supplier	[redacted]
Sealant/Adhesive		
15.	Item name	Weathering sealant - silicone sealant
	Product name	[redacted]
	Manufacturer/Supplier	[redacted]
	Usage	Placed at ACP edges and screw and rivet locations.
16.	Item name	Back-pan sealant - Fire-rated mastic
	Product name	[redacted]
	Manufacturer/Supplier	[redacted]
	Usage	Used between the back-pans (item 2) and the aluminium framing (item 7).

Item	Description	
17.	Item name	Penetration sealant
	Product name	[redacted]
	Manufacturer/Supplier	[redacted]
	Usage	Used between the back-pans (item 2) and the aluminium framing (item 7).
Fixings		
18.	Item name	Tek screws SDS – zinc coated steel – for fixing the back-pan
	Size	10g × 24 mm long
	Installation	Used to fix aluminium angles (item 8) to the aluminium frame (item 6) at max. 500 mm centres
19.	Item name	Wafer head screws – zinc coated steel
	Size	10g × 16 mm long
	Installation	Used to fix aluminium angles (item 8) to the aluminium frame (item 6) at max. 500 mm centres
20.	Item name	Wafer head screws – zinc coated steel
	Size	10g × 20 mm long
	Installation	Used to fix the penetration backing plate (item 12) to the back-pan (item 2) of the central module.
21.	Item name	Wafer head screws – zinc coated steel
	Size	10g × 21 mm long
	Installation	Used to fix ACP (item 1) to the aluminium stiffener (item 9) – four per corner.
22.	Item name	Aluminium rivets
	Size	Ø4 mm
23.	Item name	Fast-fix washers and pin weld (to hold insulation)
	Size	115 mm × 3 mm pins and 25 mm × 25 mm fast fix washers.
24.	Item name	Tek screws for curtain wall bracket
	Size	14 g × 35 mm long
25.	Item name	Tek screws for smoke seal to false slab i.e., C-Purlin
	Size	14 g × 35 mm long

Installation method

Test rig:	The test rig frame (item 5) was the main support for the test specimen, however, there were two C-purlin sections that acted as false slabs (200 mm tall). The test specimen, 3-off modules – interconnected through aluminium framing (item 6), was fixed to the test rig using curtain wall brackets (item 10) and fixings (item 24) – see Figure 23 & Figure 24. Each module extended from the bottom of the specimen to the top.
Framing:	The main framing for the external wall was composed of aluminium extrusions (item 6) which were screw fixed together. Aluminium angles (item 8) – horizontal edges - and stiffeners (item 9) – on the vertical edges - were fixed to the aluminium framing (item 6), using wafer head screws (item 20) and aluminium rivets (item 22), respectively.
Cladding:	The front face of the specimen was cladded with cassetted ACPs (item 1), which were fixed to the aluminium stiffeners (item 9) and the aluminium angles (item 8) using aluminium rivets (item 22), 2-off at 300 mm centres. See Figure 22 for panel locations. The back side of the framing was closed off with steel back-pans (item 2) screw fixed (item 18) at 300 mm centres. PET insulation (item 13) was fixed to the back-pan using fast-fix washers and pin combinations (item 19) that were welded to the back-pan. The centre module had an extra back-pan behind the glazing (item 4). This was fixed to the aluminium framing (item 6)

Item	Description
	using screws (item 18) and aluminium angles (item 8). Foil-faced rockwool insulation (item 14) was inserted between the two back-pans (item 2) of the centre module.
Glazing	The glazing, both double (item 3) and single (item 4), were attached to the aluminium framing (item 6) as shown in Figure 22 to Figure 27 and Figure 28. The glazing was sealed around the perimeter with weather sealant (item 15).
Smoke seal	Smoke seal barrier (item 11) was attached to C-purlins of the test rig (item 5) with screw fixings (item 24) at approximate 600 mm centres. PET insulation (item 13) was installed into the 60 mm wide cavity above the barrier (item 12).
Penetration	The penetration went through holes in the single glazing (item 4) and back-pans (item 2) of the second module. These were fixed to the back-pan and the window with a steel sheet (backing plate), using screws and sealant and just sealant, respectively.

3. Test procedure

Table 3 details the test procedure for this reaction to fire test.

Table 3 Test procedure

Item	Detail
Statement of compliance	The ad-hoc test – which was based off ISO 13785-1:2002 - was performed to determine the reaction to fire performance of an external wall cladding when exposed to heat from a simulated external fire with flames impinging directly upon a façade with an added wind component. The test utilises a burner used in ISO 13785-1:2002 with the specimen mimicking the as-is construction of the façade.
Sampling / specimen selection	The laboratory was not involved in sampling or selecting the test specimen for the reaction to fire test. The results obtained during the test only apply to the test samples as received and tested by Warringtonfire.
Test duration	60 minutes
Instrumentation and equipment	• 21 mineral insulated metal sheathed (MIMS) Type K thermocouples with an overall diameter of 1.5 mm with the measuring junction insulated from the sheath were positioned 60 mm in front of the face of the test specimen. Refer to Figure 1 and Figure 4 for details on positioning. • The incident heat flux on the top of the specimen in line with the front face of test specimen was measured using a Schmidt-Boelter type heat flux gauge with a range of 0-100 kW/m^2. • The incident heat flux 500 mm behind the outer glazings – burner side and non-burner side – was measured using two Schmidt-Boelter type heat flux gauges with a range of 0-50 kW/m^2 and 0-20 kW/m^2, respectively. • The incident heat flux 80 mm behind the central glazing was measured using a Schmidt-Boelter type heat flux gauge with a range of 0-20 kW/m^2. • Temperatures above and below the cladding were measured by seven 100 mm × 100 mm × 0.7 mm plate thermocouples with mineral insulated metal sheathed (MIMS) Type K thermocouples with an overall diameter of 1 mm with the measuring junction electrically insulated from the sheath. The thermocouple hot junction was fixed to the geometric centre of the plate by a small steel strip made from the same material as the plate. The plate thermocouples included 97 mm × 97 mm × 10 mm inorganic insulation pads. Before the first use of the plate thermocouples, they were aged by being exposed to heat in a fire-resistance test furnace for 90 min under the standard temperature/ time curve. Refer Figure 1 and Figure 4 for details on positioning. • The fire source was a propane (95% purity) gas burner 1.2 m long × 0.1 m deep × 0.15 m tall. The burner was placed on the floor below the specimen with approximately 15 mm overlap with the ACP. • Airflow across the front of the specimen was provided by a square array of 4-off pedestal fans. Model FA-23105 – 3 blades with a fan diameter of 750 mm. The centre of the fans were located at the approximate heights of 1.5 m and 2.3 m from the floor and 0.5 m and 1.3 m from the guide wall. The fans were at the settings that provided the airflow listed in Table 4. • A guide wall – 2.8 m tall × 3.0 m wide was butted up to the specimen and blanking wall and placed at a 45° angle in relation to the specimen. • A blanking wall was used to get baseline data. This was setup similarly to the test setup, with the guide wall placed at a 45° angle. The blanking wall was 3.6 m tall × 3.6 m wide and lining with 13 mm FR plasterboard. The thermocouple instrumentation listed above – without the heat flux gauges - were used to obtain baseline data. A shield for the burner made from FR plasterboard and Hebel block work – having a cavity 1.2 m × 0.15 m, 500 mm above the floor - was used during the baseline data test. • The horizontal wind speed was measured using a hot wire anemometer.

Item	Detail
Calibration procedure	• At least two minutes of baseline data was collected prior to burner ignition. • The burner was ignited, and the output held for 300 kW for 5 minutes under normal laboratory conditions. • The next five minutes of burner output was maintained at 300 kW, however, airflow across the blanking wall was introduced by activating the fans. • The burner was turned off with the airflow across the blanking wall maintained. • Temperature and heat flux data was collected at 5 s intervals.
Test procedure	• At least two minutes of baseline data was collected prior to producing air flow across the specimen. Data of for baseline airflow was collected for at least 5 minutes. Temperature and heat flux data was collected at 5 s intervals. • The heat output from the burner was held at 300 kW for the 30 minutes. The burner was then turned off and data recorded for the next 30 minutes.
Variation between tests – referencing test reports RTF220102 R1.0 to R3.0	• The burner was located on the opposing side of the specimen. • The same system was tested three times without a wind component. In this test, a guiding wall was positioned at the burner end of the specimen end 45° out-of-plane. Air movement (wind) across the specimen was created by four fans located at the other end of the guiding wall - refer to Figure 3 and Figure 4. • The bottom of the centre and left modules were capped with fire-rated plasterboard. • The burner was located in the same position, however, was protected from immediate wind interaction by a plasterboard and Hebel block housing that of the height of the bottom of the ACP, with a horizontal opening 150 mm deep × 1.2 m wide.

4. Test measurements and results

This section documents the instrumentation for the baseline and specimen tests, and the results for the baseline and specimen tests. Photographs of the specimen are included in Appendix B.

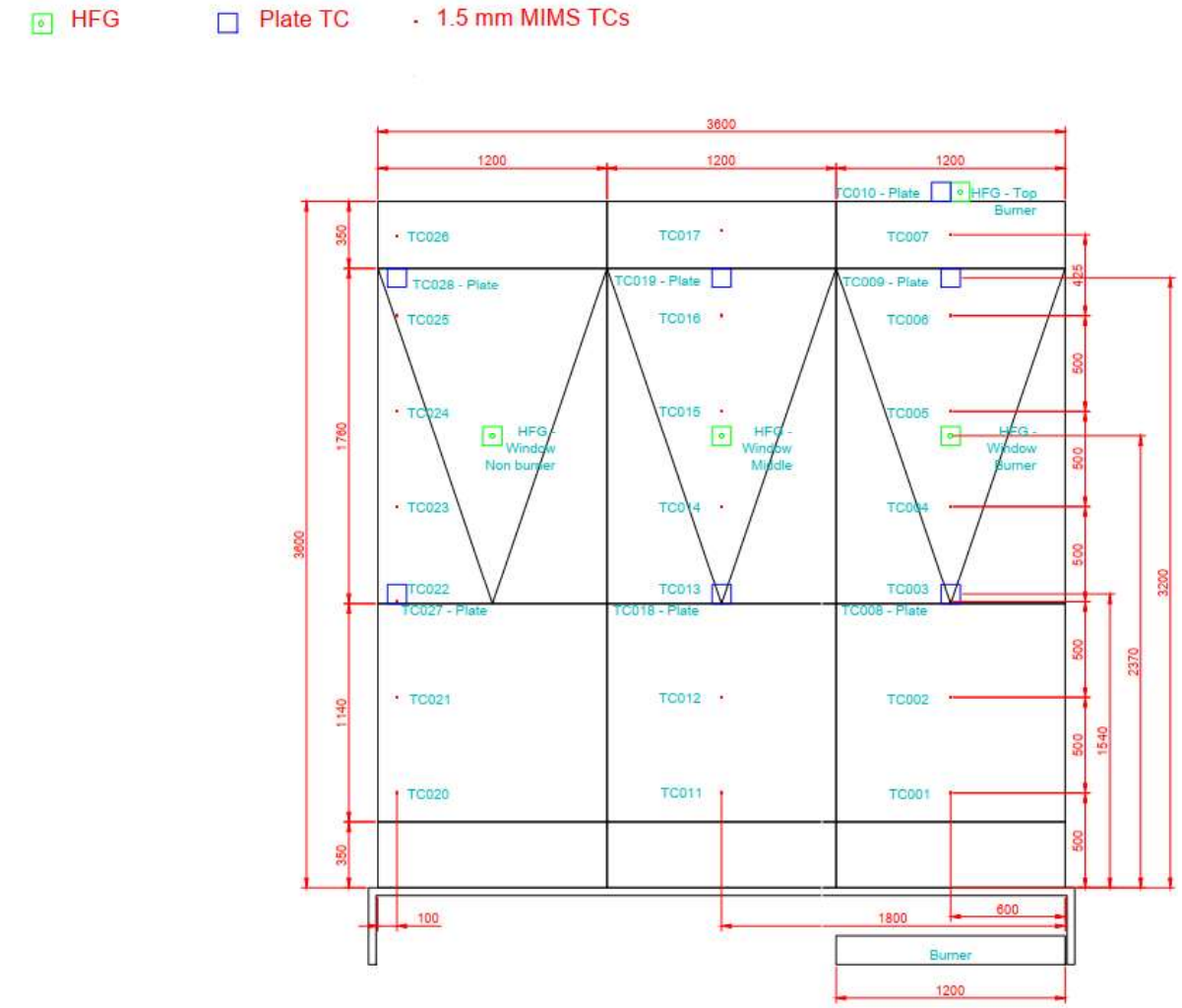

Figure 1 Instrumentation locations

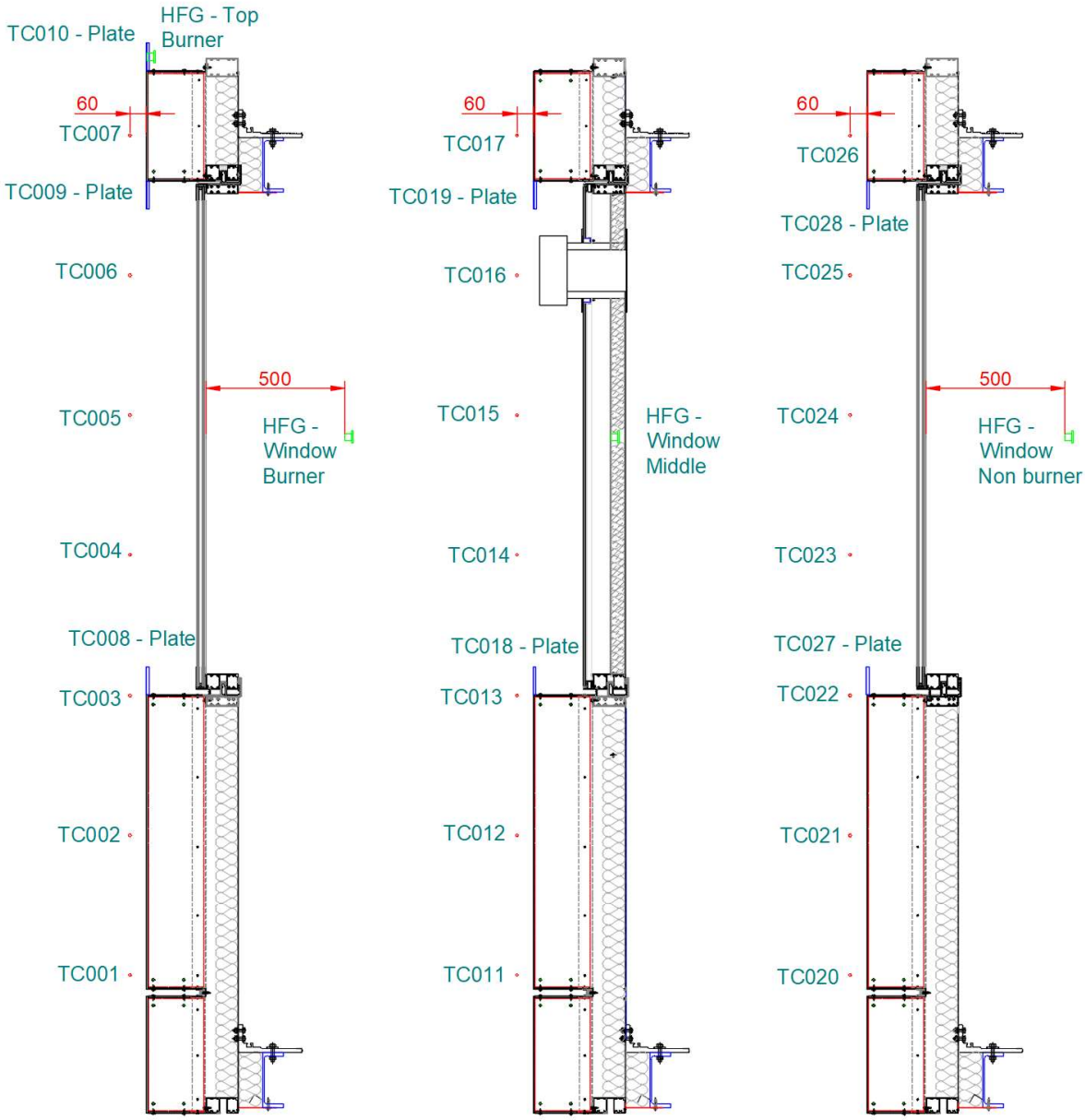

Figure 2 Instrumentation locations – sections

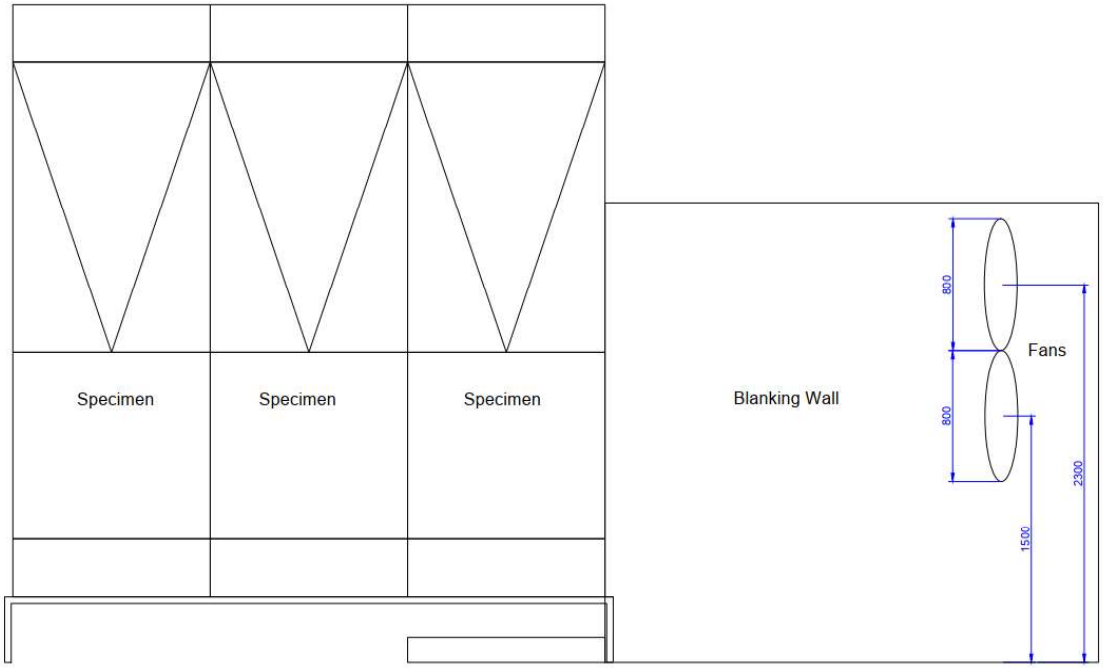

Figure 3 Instrumentation locations – Elevation

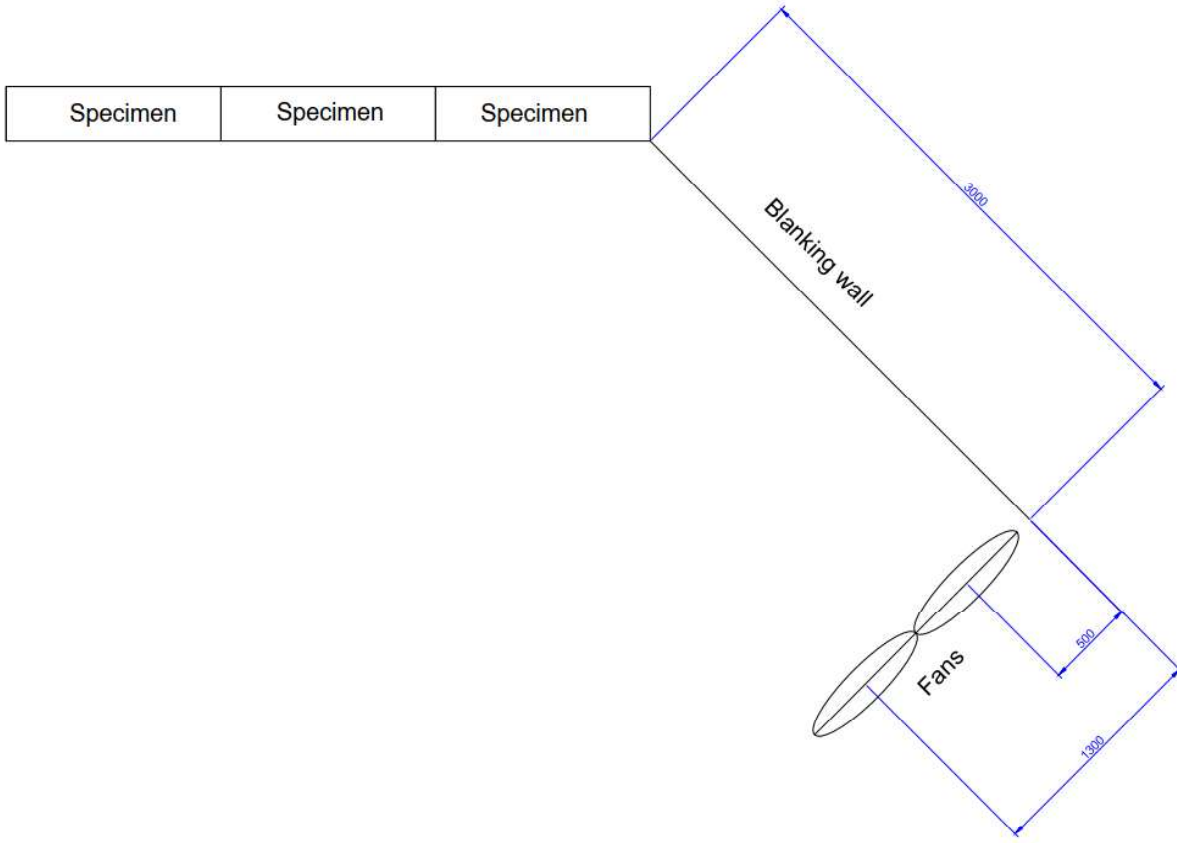

Figure 4 Instrumentation locations – Plan view

Figure 5 Photograph of baseline setup – 1.5 mm MIMS thermocouples were measuring 60 mm from the plasterboard.

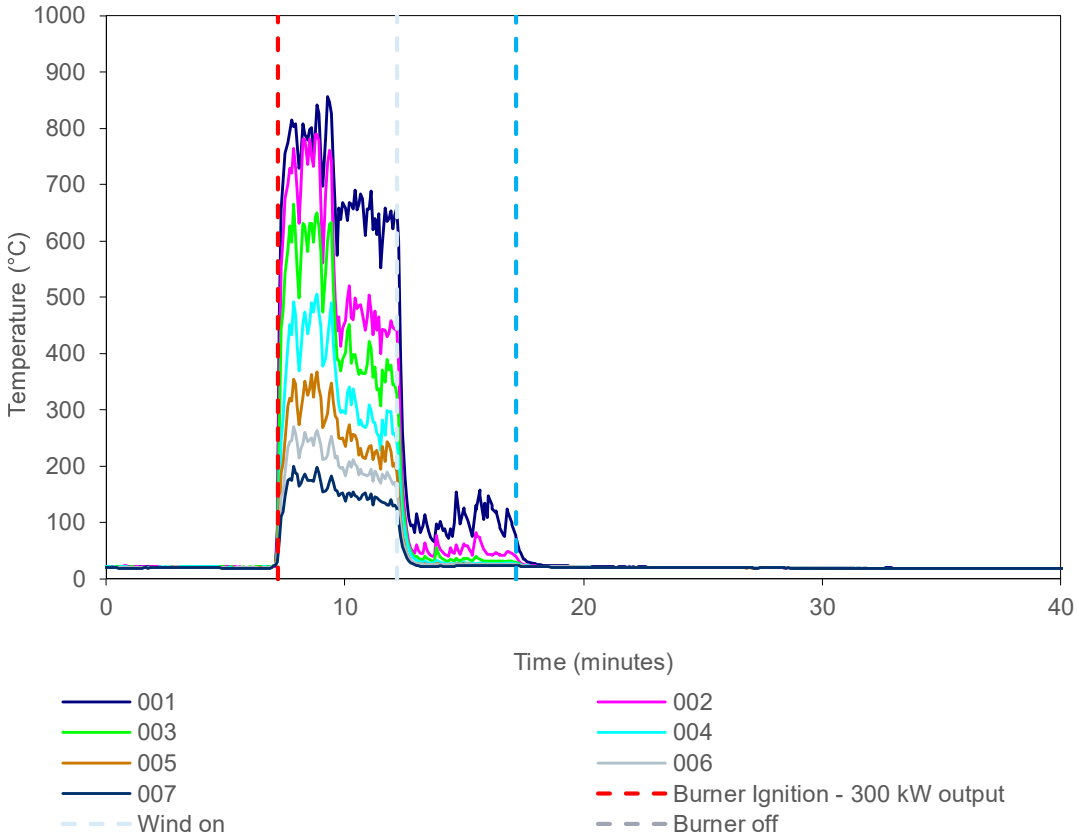

Figure 6 **Baseline data collection - 1.5 mm MIMS thermocouples placed 60 mm from the front face of the blanking wall - in-line with the burner.**

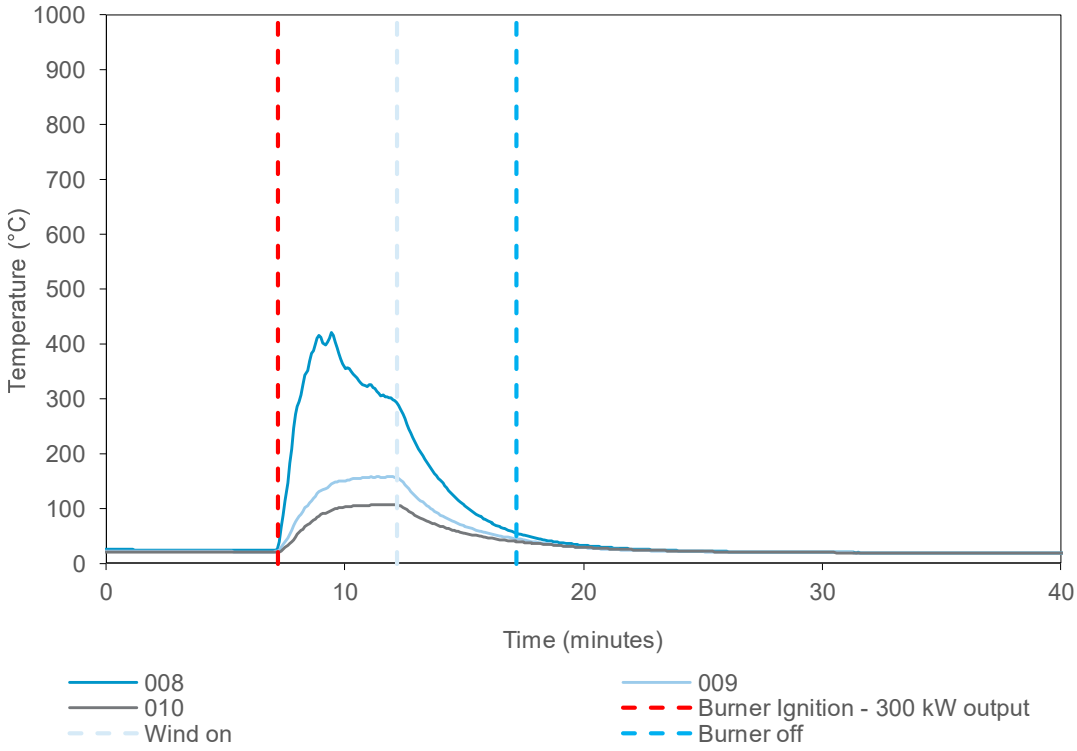

Figure 7 **Baseline data collection - Plate thermocouples placed 60 mm from the front face of the blanking wall - in-line with the burner.**

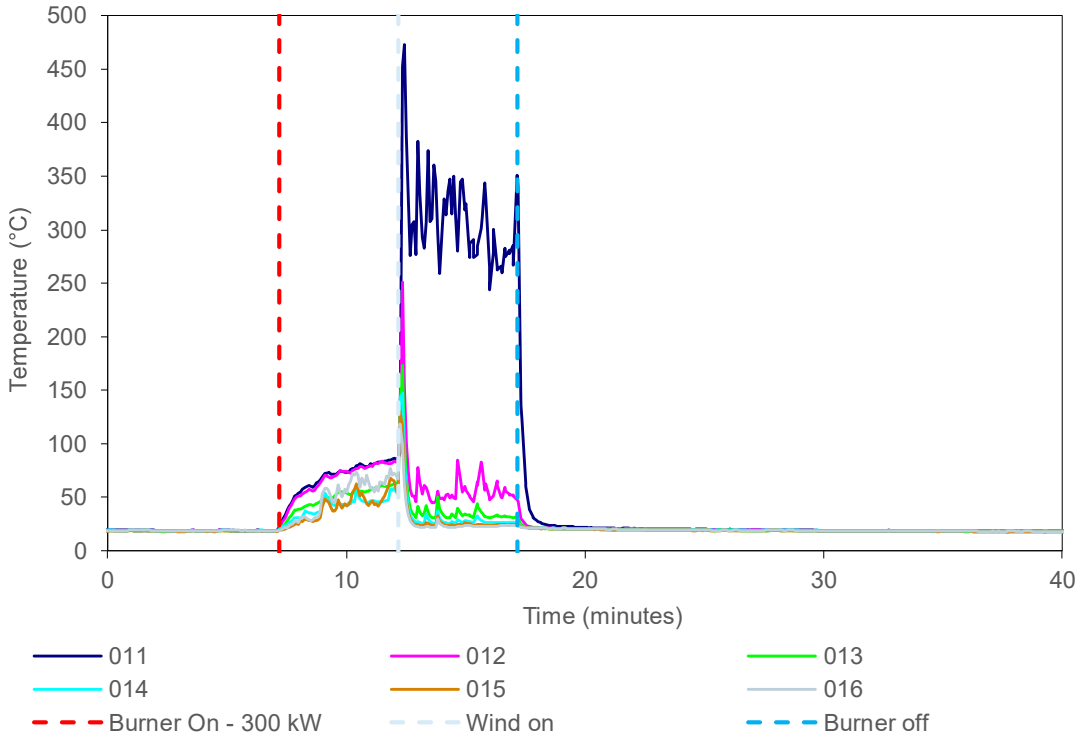

Figure 8 **Baseline data collection - 1.5 mm MIMS thermocouples placed 60 mm from the front face of the blanking wall – centre.**

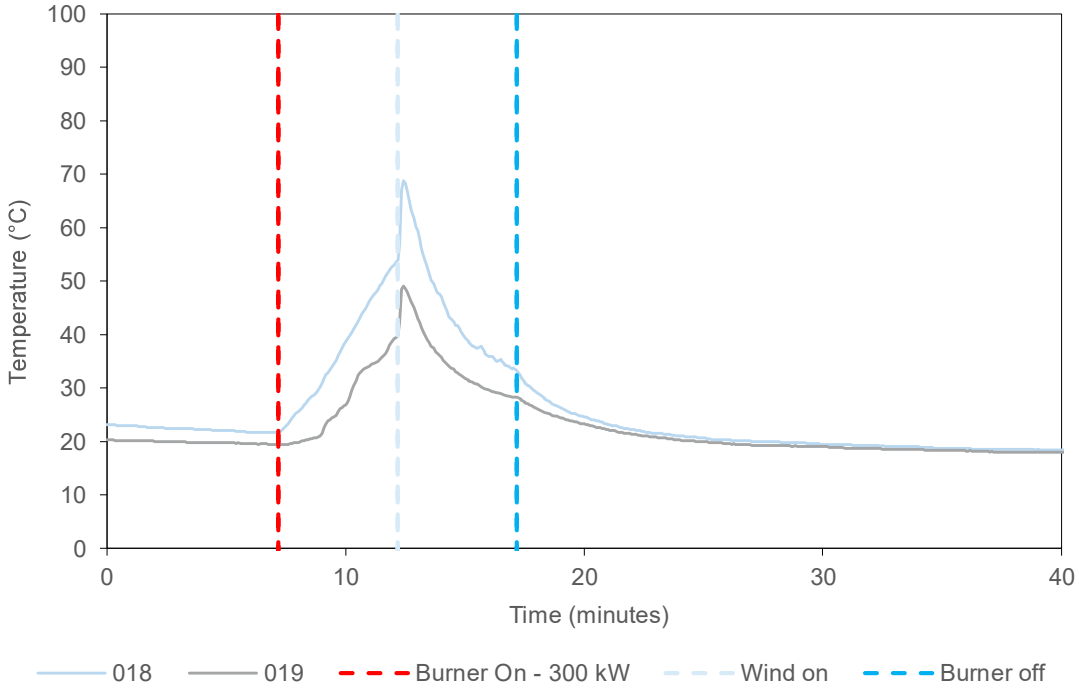

Figure 9 **Baseline data collection - Plate thermocouples placed 60 mm from the front face of the blanking wall - centre.**

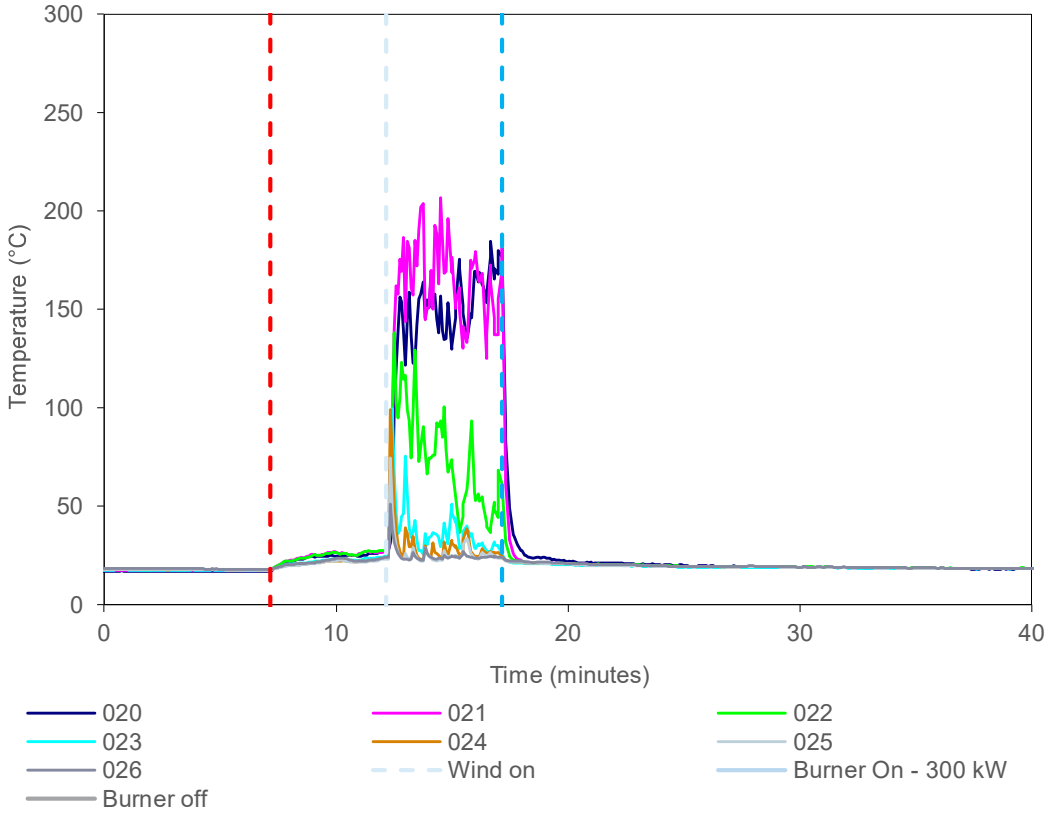

Figure 10 Baseline data collection - 1.5 mm MIMS thermocouples placed 60 mm from the front face of the blanking wall - away from burner.

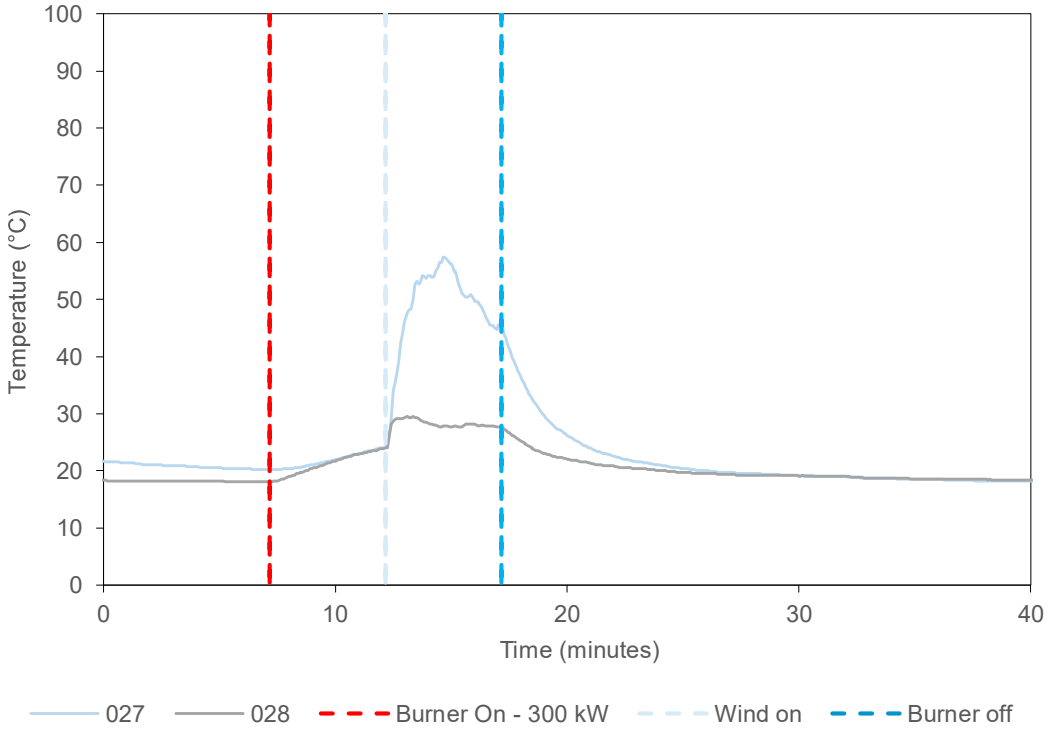

Figure 11 Baseline data collection - Plate thermocouples placed 60 mm from the front face of the blanking wall - away from burner.

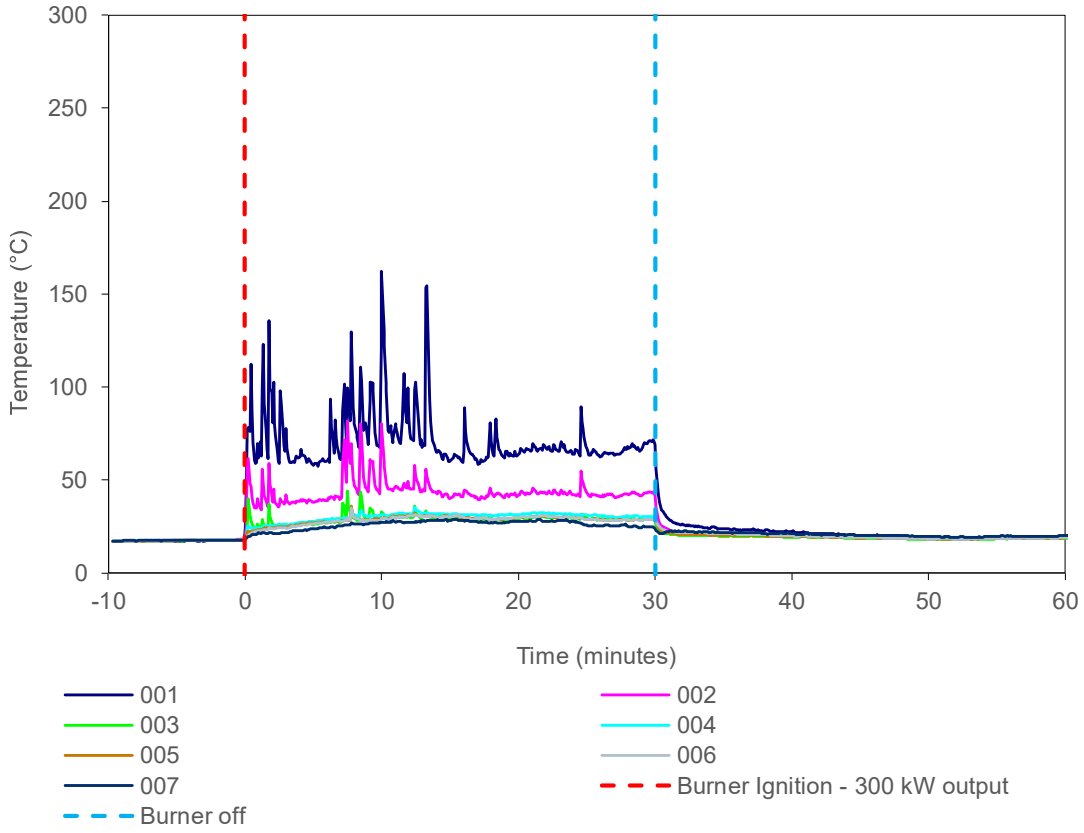

Figure 12 Test - External temperature data collected by thermocouples placed 60 mm from the front face of the specimen - in-line with the burner.

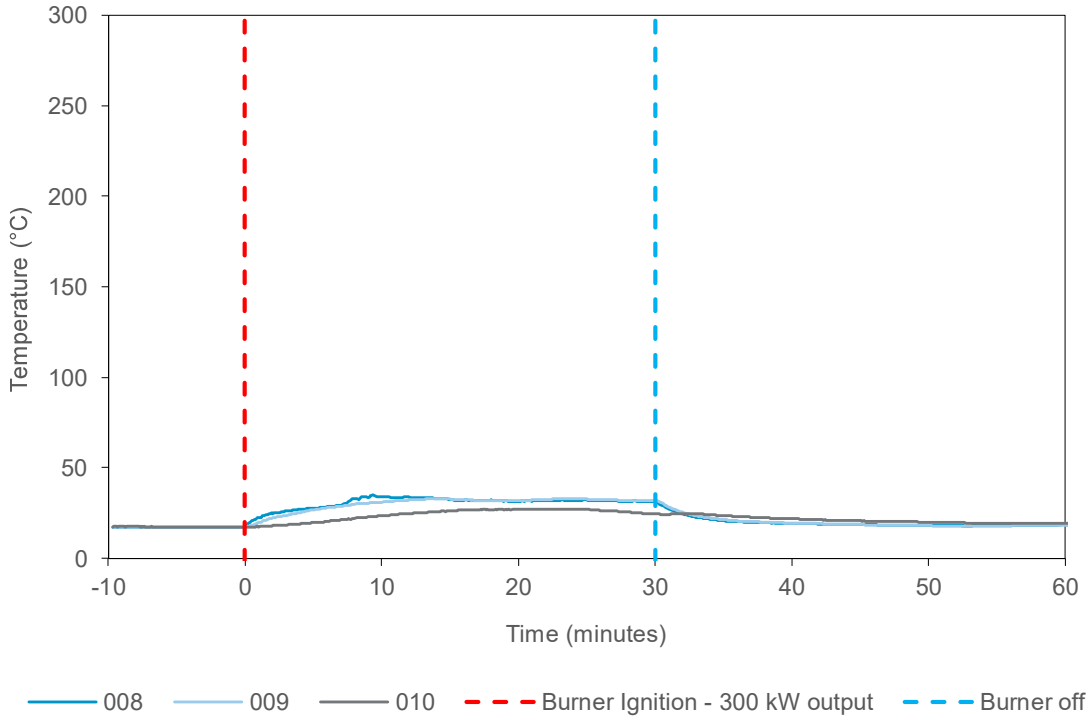

Figure 13 Test - External temperature data collected by thermocouples in-line with ACP, above and below, respectively - in-line with the burner.

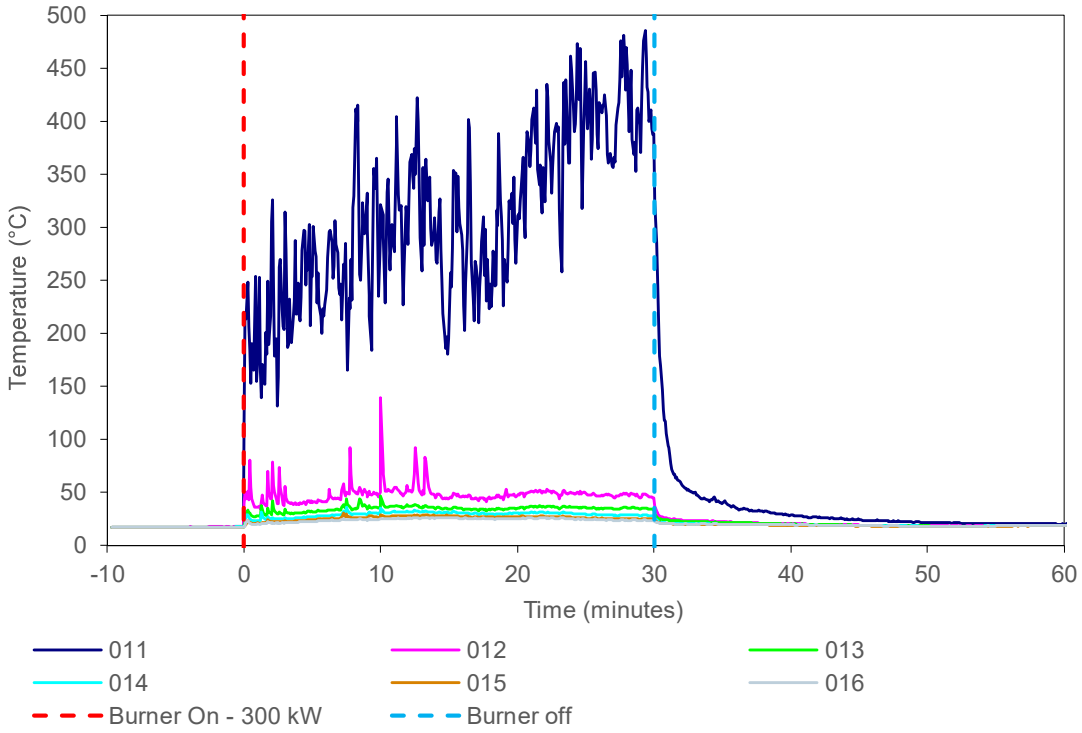

Figure 14 Test - External temperature data collected by thermocouples placed 60 mm from the front face of the specimen – central module.

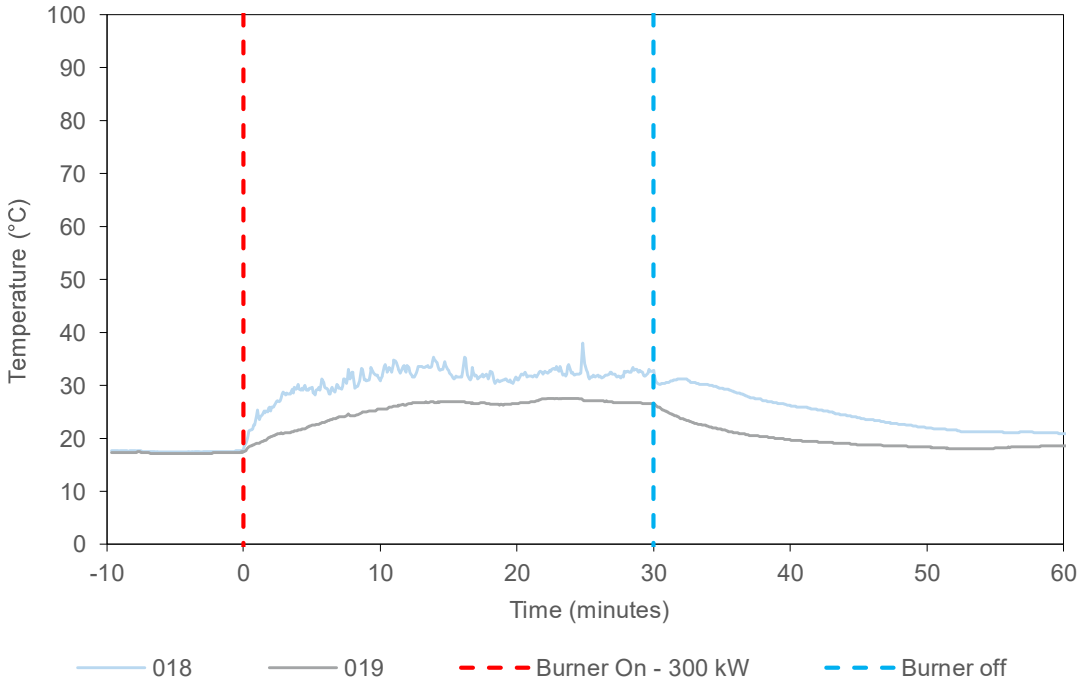

Figure 15 Test - External temperature data collected by thermocouples in-line with ACP, above and below, respectively – central module.

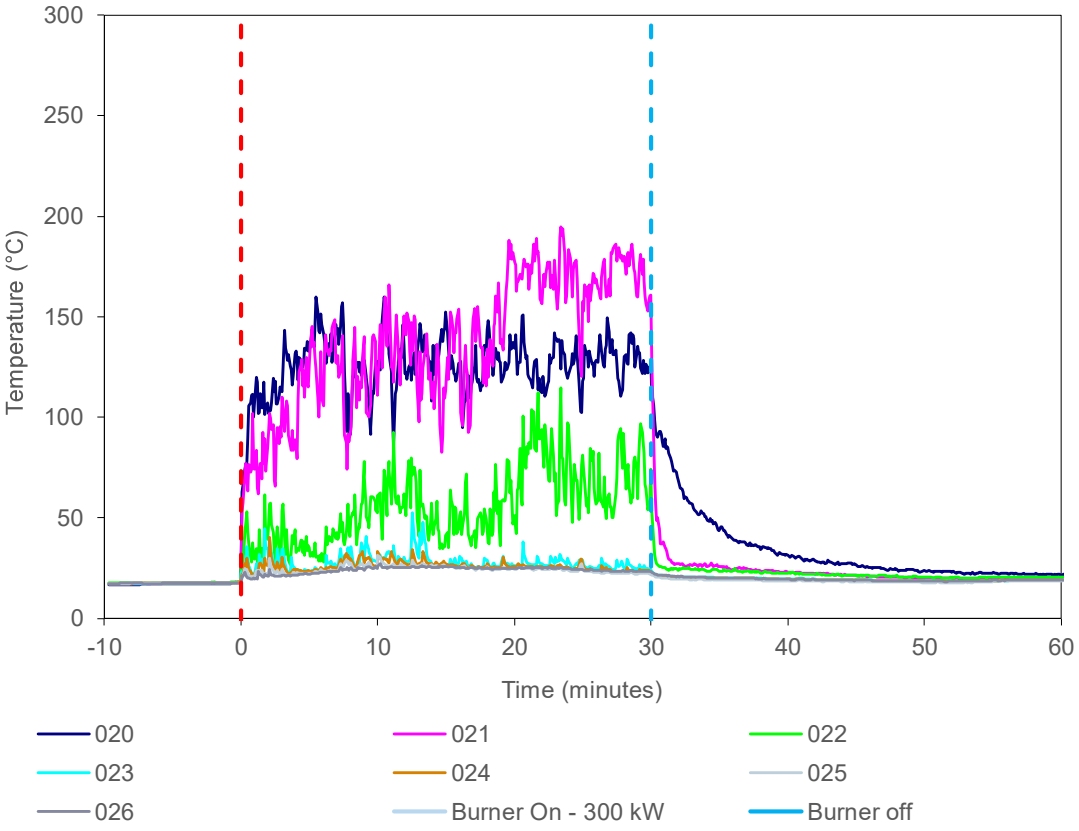

Figure 16 Test - External temperature data collected by thermocouples placed 60 mm from the front face of the specimen – away from burner.

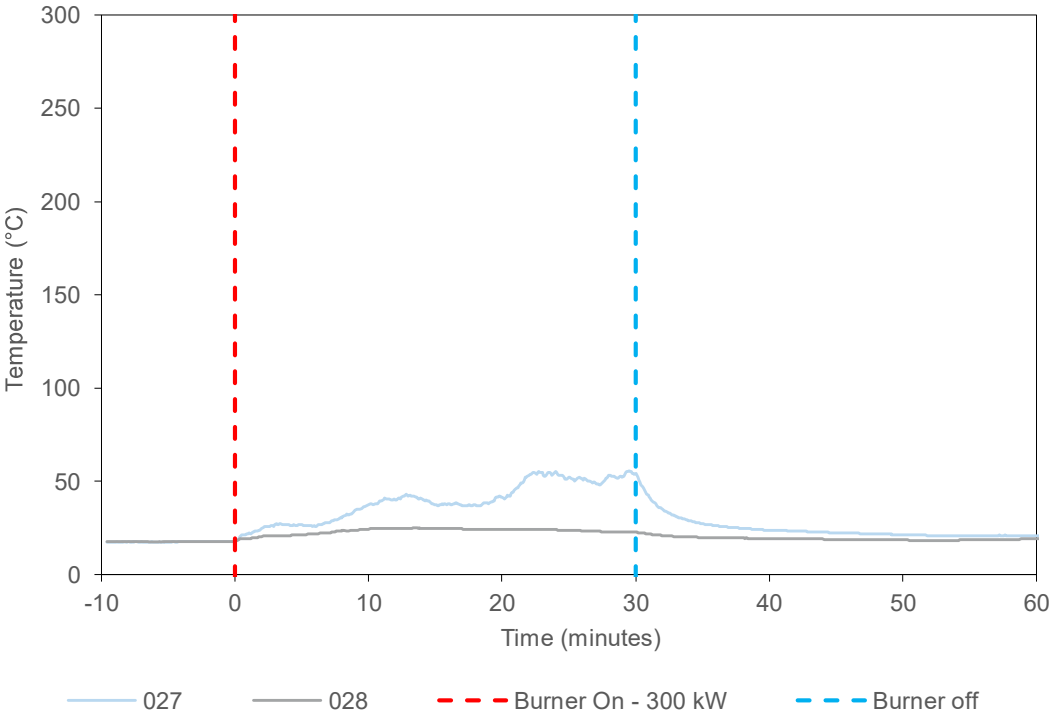

Figure 17 Test - External temperature data collected by thermocouples in-line with ACP, above and below, respectively – away from burner.

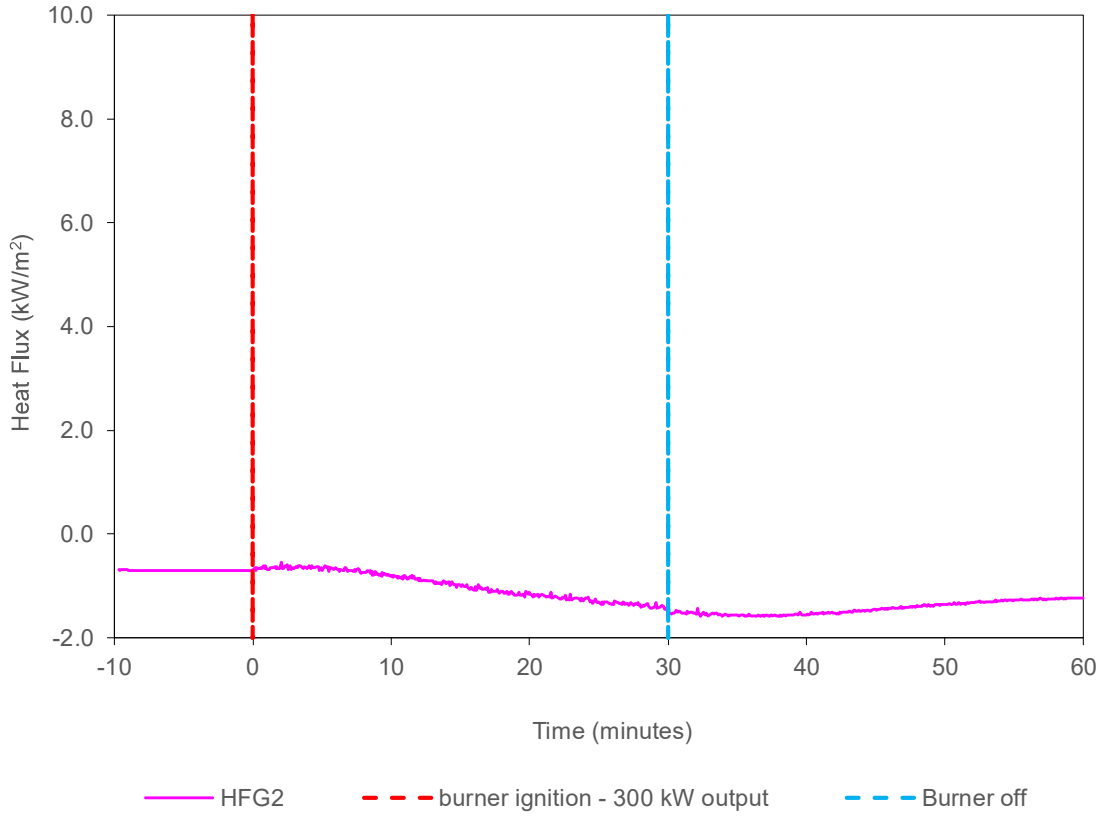

Figure 18 Test - Heat flux data collected by heat flux gauge at the top of the specimen above the burner.

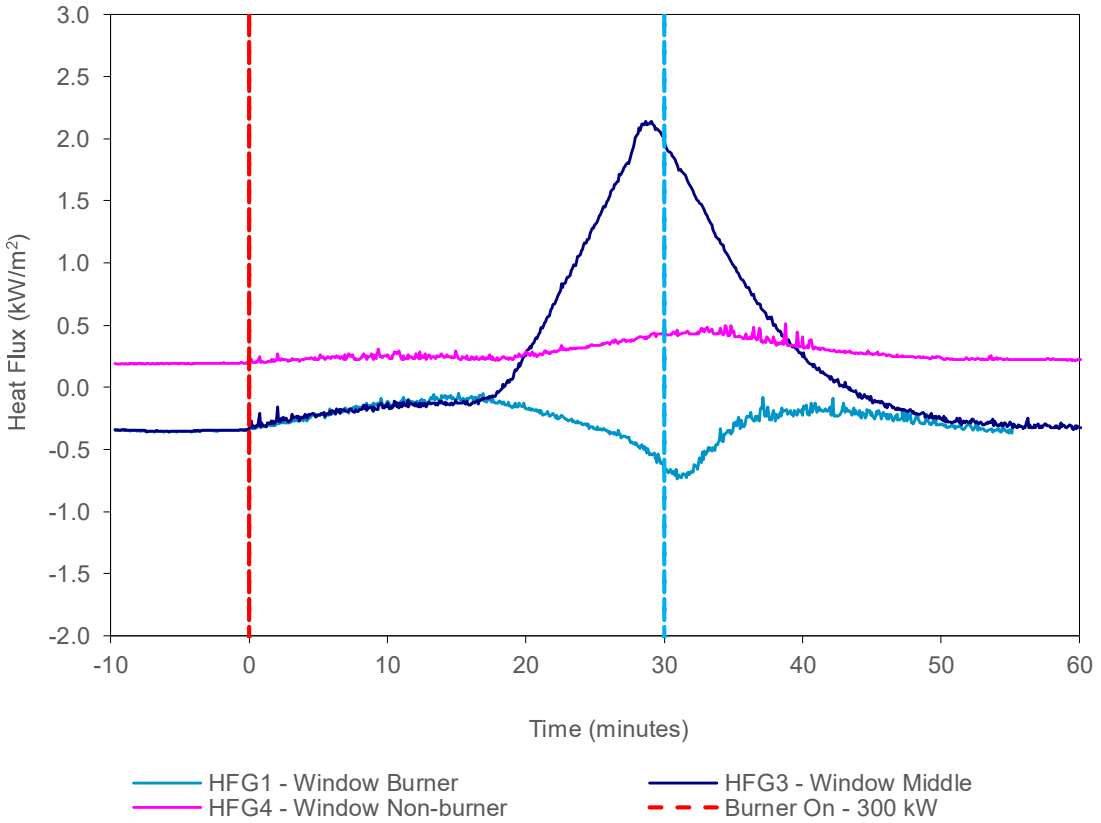

Figure 19 Test - Emitted heat flux measured by heat flux gauges behind the glazing units.

Figure 20 Designation of section for the test observations.

Table 4 shows the observations of any significant behaviour of the specimen during the test. Figure 19 shows the panel and glazing designations sighted in the observations.

Video recordings were also taken of the test. A copy of the video recording is available upon request from the test sponsor or by contacting Cladding Safety Victoria. The video of the test should be viewed in conjunction the contents of this report.

Table 4 Test observations

Time		Observation
Min	Sec	
-7	00	Wind on. Data collection started.
-2	35	The wind speed just below TC003 was 1.7 – 2.0 m/s.
-2	20	The wind speed just below TC003 was 2.0 – 2.5 m/s.
-2	05	The wind speed just below TC003 was 1.9 – 2.4 m/s.
0	00	The reaction to fire test was started with the burner ignited with a heat output set at 300 kW.
0	14	The flames from the burner were being blown in front of panel 2, at times covering most of it.
1	30	The paint of panels 1 and 2 had paint charring.
3	00	Panels 1 and 2 had deformed/warped slightly.
7	00	Most of the panel 2 paint had the paint charred/burnt off.
7	08	It was observed that the core of panel 2 (most) had been exposed to the flame and is now on fire. This was the same with the bottom left corner of panel 1.
7	42	There was a large puff of flames at the of the bottom of panel 1.

8	45	There was flaming debris that came from panel 2.
10	00	The core of panel 2 continues to burn.
15	30	The cassette structure of panel 2 has been breached.
16	30	There was smoke emitting between the ACP joints of panels 10 & 11 and 11 & 12.
18	00	There was flaming within the cavity of panel 2.
20	00	There is smoke emitting through the back pan of panel 2 on the unexposed side.
25	00	There is more smoke emitting at the top of the specimen. It also appears that the cassette of panel 1 has been breached.
25	10	It appears that the right side of panel 3 has been breached and the core is flaming.
25	50	There is smoke emitting from the top of panel 5.
26	54	Unexposed side –The flaming is coming through a gap formed on the top of the back pan and aluminium framing behind panel 2.
27	00	Unexposed side – behind panel 2, there are flaming droplets from the top of the back pan. The insulation of the smoke seal has caught on fire.
30	00	The burner was turned off.
30	04	It was evident that the panel 1 cassette had been breached at the bottom left hand side.
30	10	The ACP of panels 1, 2 and 3 continue flaming.
32	30	Flaming of panels 1, 2 and 3 has died off significantly.
32	38	Unexposed side – the insulation of the smoke seal behind panel 1 has caught on fire.
36	14	Unexposed side – flaming at the top of the back pan and smoke seal of panel 2 has stopped. The insulation of the smoke behind panel 1 continue burning.
38	15	Only flaming in the cassette of panel 2 remains evident.
39	00	No flaming on the exposed side is evident.
40	00	No flaming on the unexposed side is evident.
60	00	The test was ended.

5. Application of test results

5.1 Test limitations

The results of these fire tests may be used to directly assess fire hazard, but it should be recognised that a single test method will not provide a full assessment of fire hazard under all fire conditions.

These results only relate to the behaviour of the specimen of the element of construction under the particular conditions of the test. They are not intended to be the sole criteria for assessing the potential fire performance of the element in use, and they do not necessarily reflect the actual behaviour in fires.

5.2 Variations from the tested specimen

This report details methods of construction, the test conditions and the results obtained when the specific element of construction described here was tested following the procedure outlined in Table 2. Any significant variation with respect to size, construction details, loads, stresses, edge or end conditions is not addressed by this report.

It is recommended that any proposed variation to the tested configuration should be referred to the test sponsor. They should then obtain appropriate documentary evidence of compliance from Warringtonfire or another accredited testing authority.

5.3 Uncertainty of measurements

Because of the nature of reaction to fire testing and the consequent difficulty in quantifying the uncertainty of measurements obtained from a reaction to fire test, it is not possible to provide a stated degree of accuracy of result.

Appendix A Drawings of test assembly

The drawings of the test assembly in Figure 21 to Figure 28 were provided by the representatives of Warringtonfire. Dimensions, unless specified, are in mm.

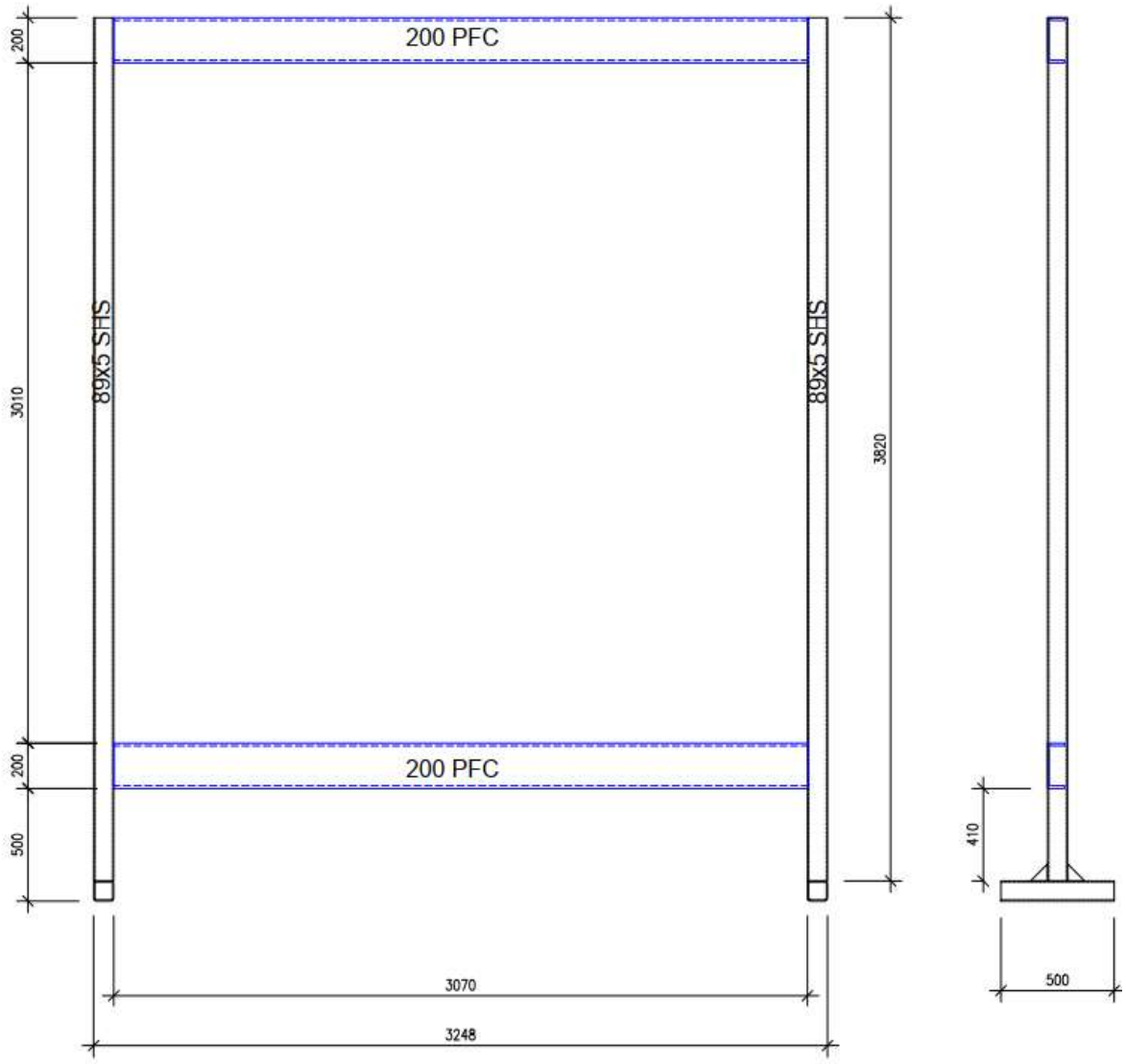

Figure 21 Elevation of rig support.

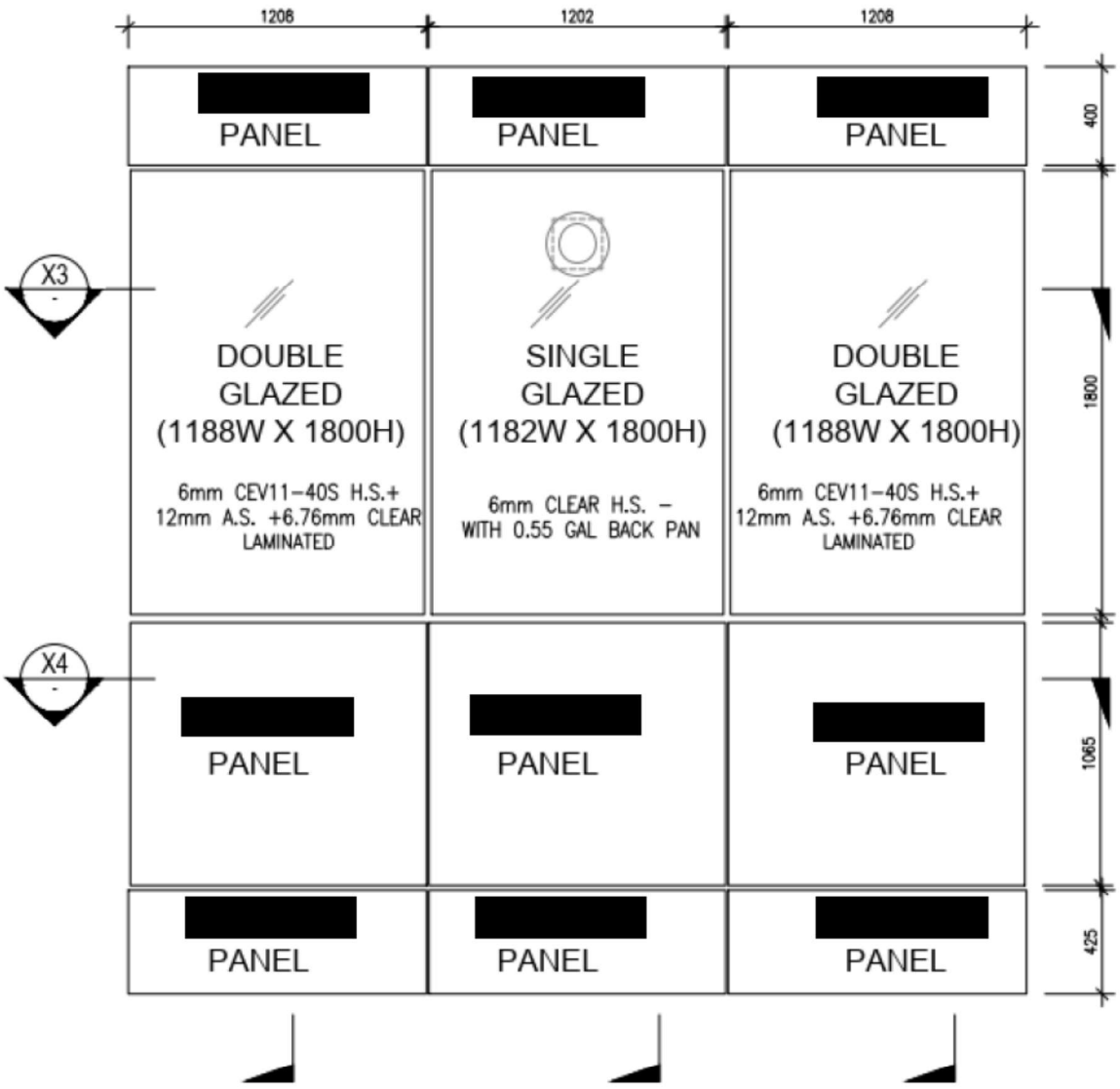

Figure 22 System assembly – Front view

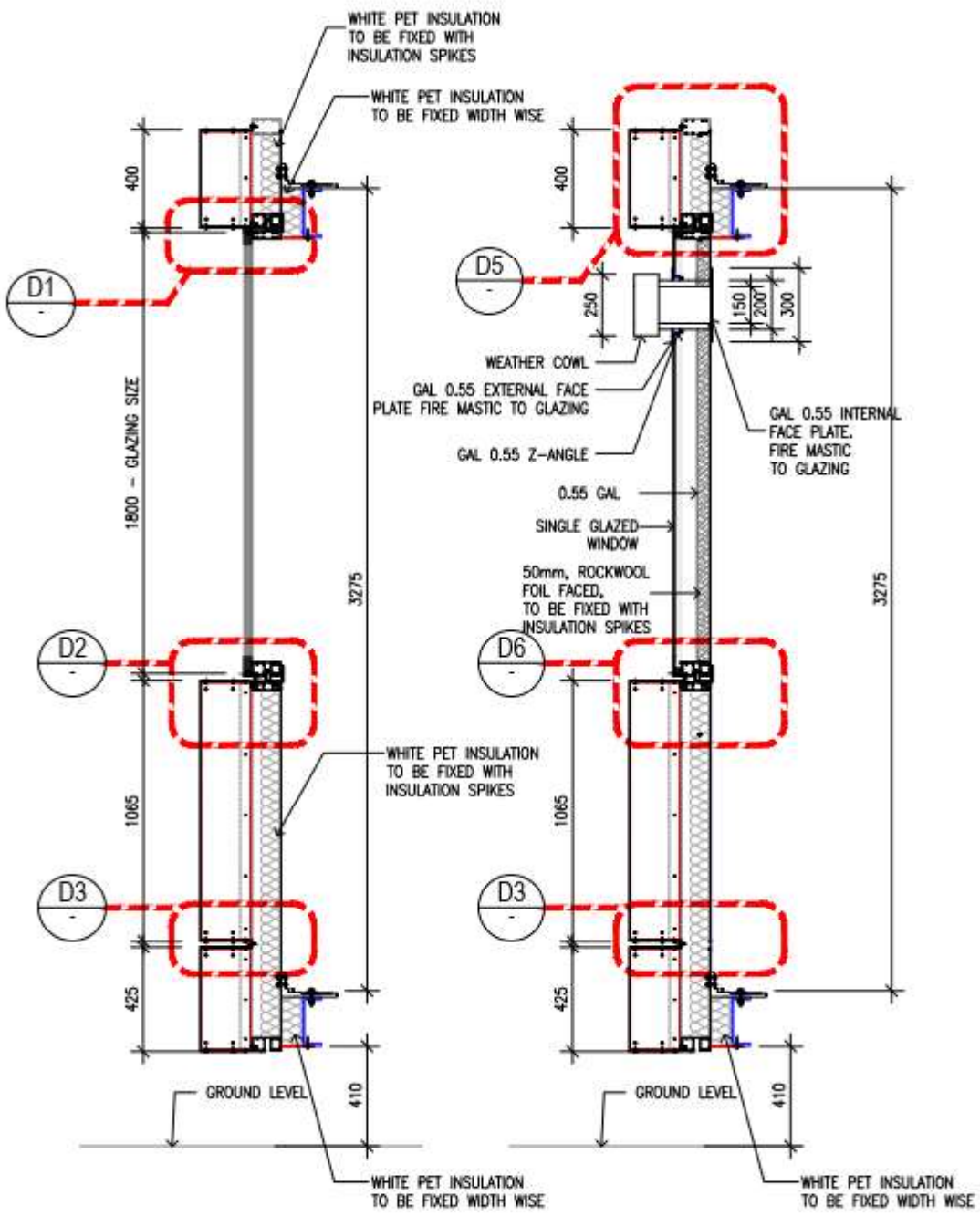

Figure 23 System assembly – vertical cross-sectional view.

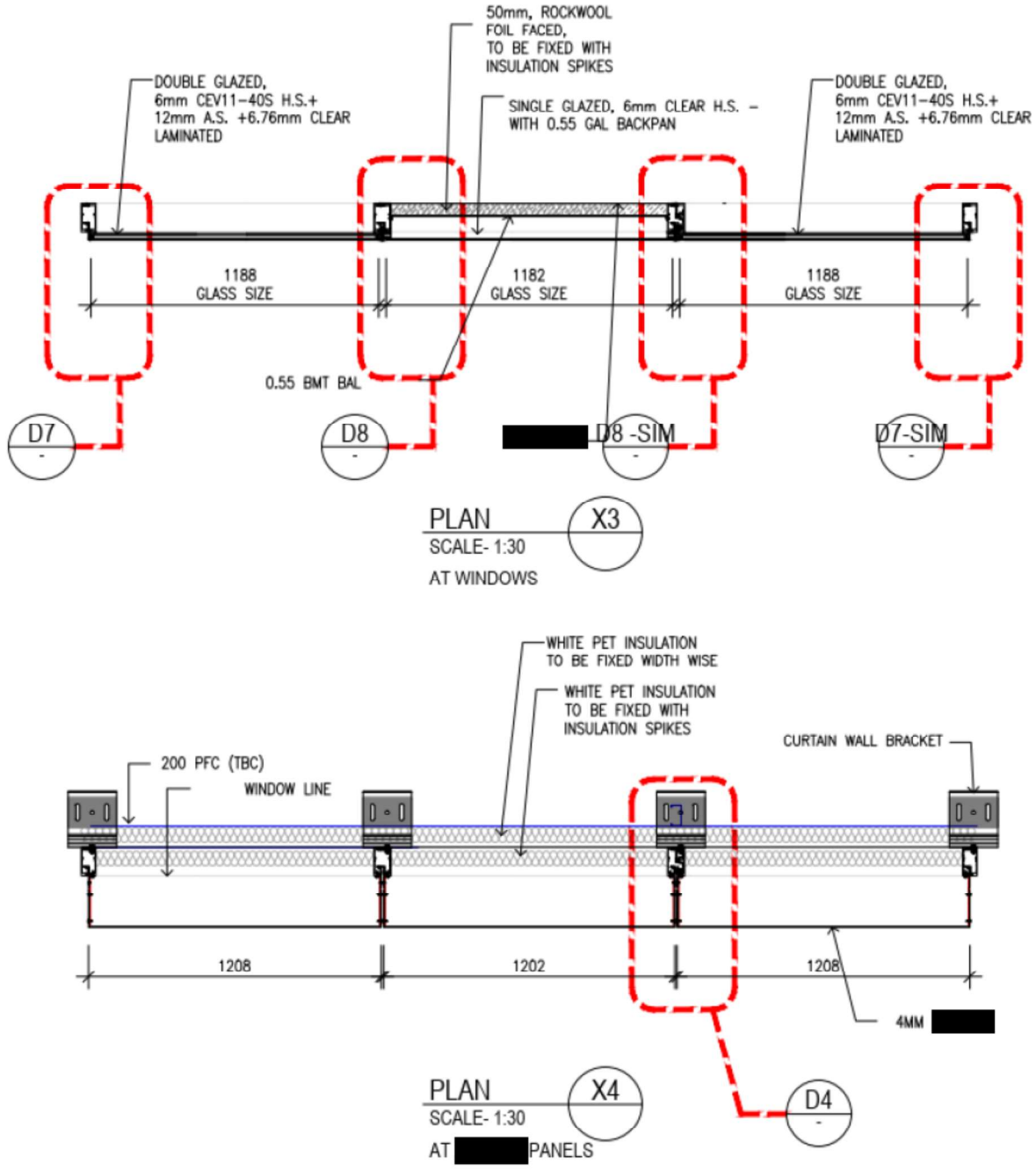

Figure 24 System assembly – vertical cross-sectional view.

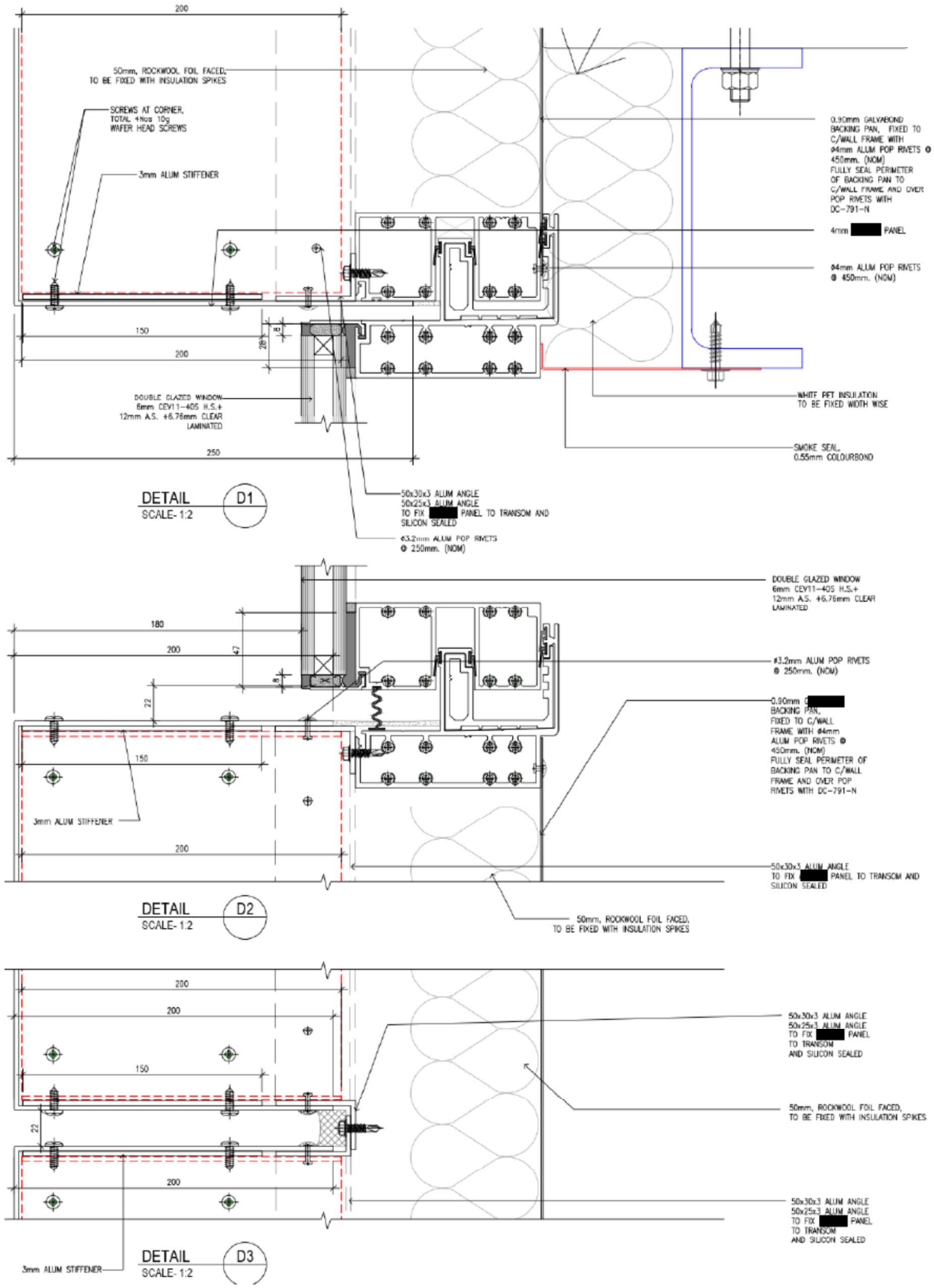

Figure 25 **System assembly – Vertical cross-sectional view.**

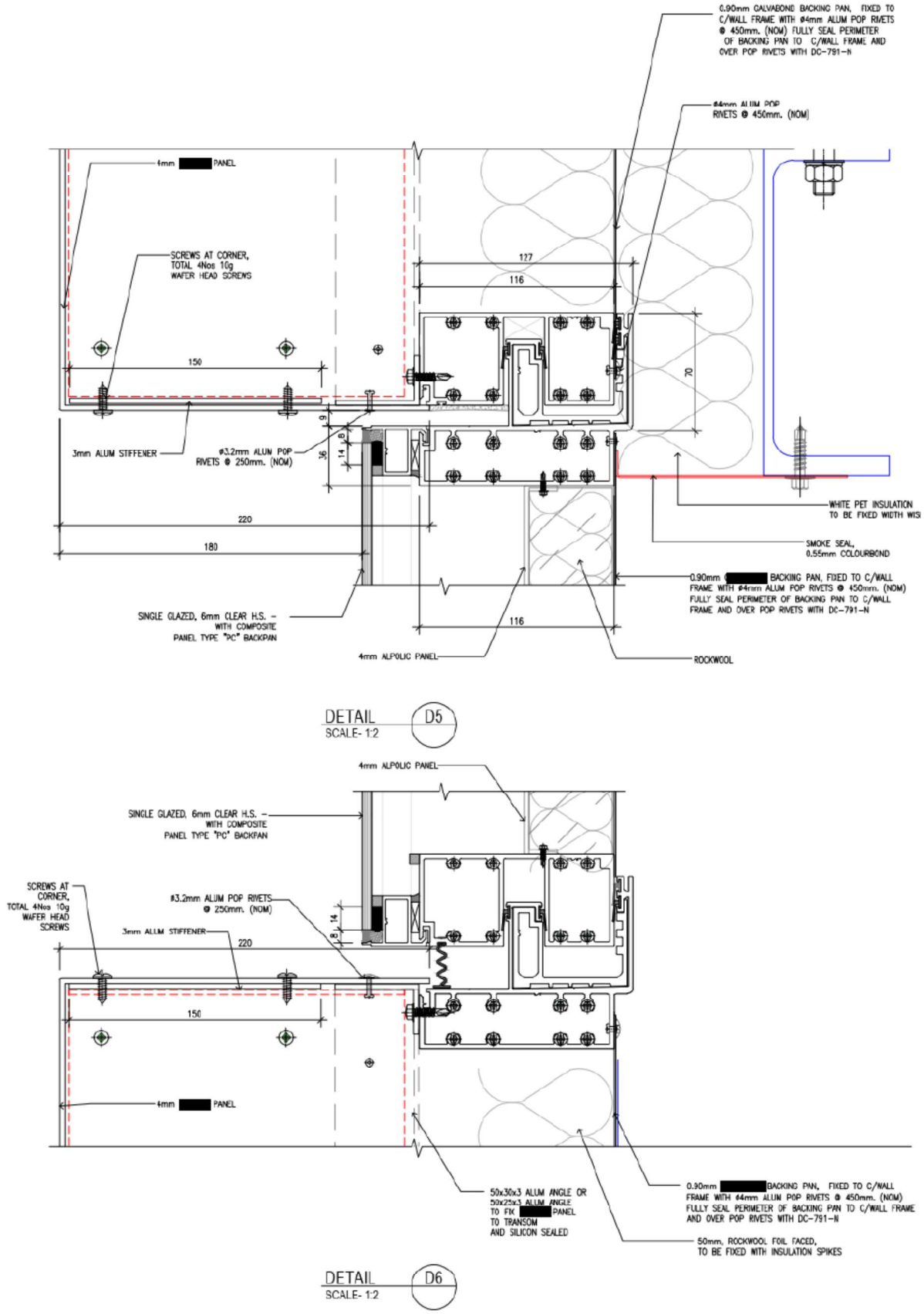

Figure 26 System assembly – Vertical cross-sectional view.

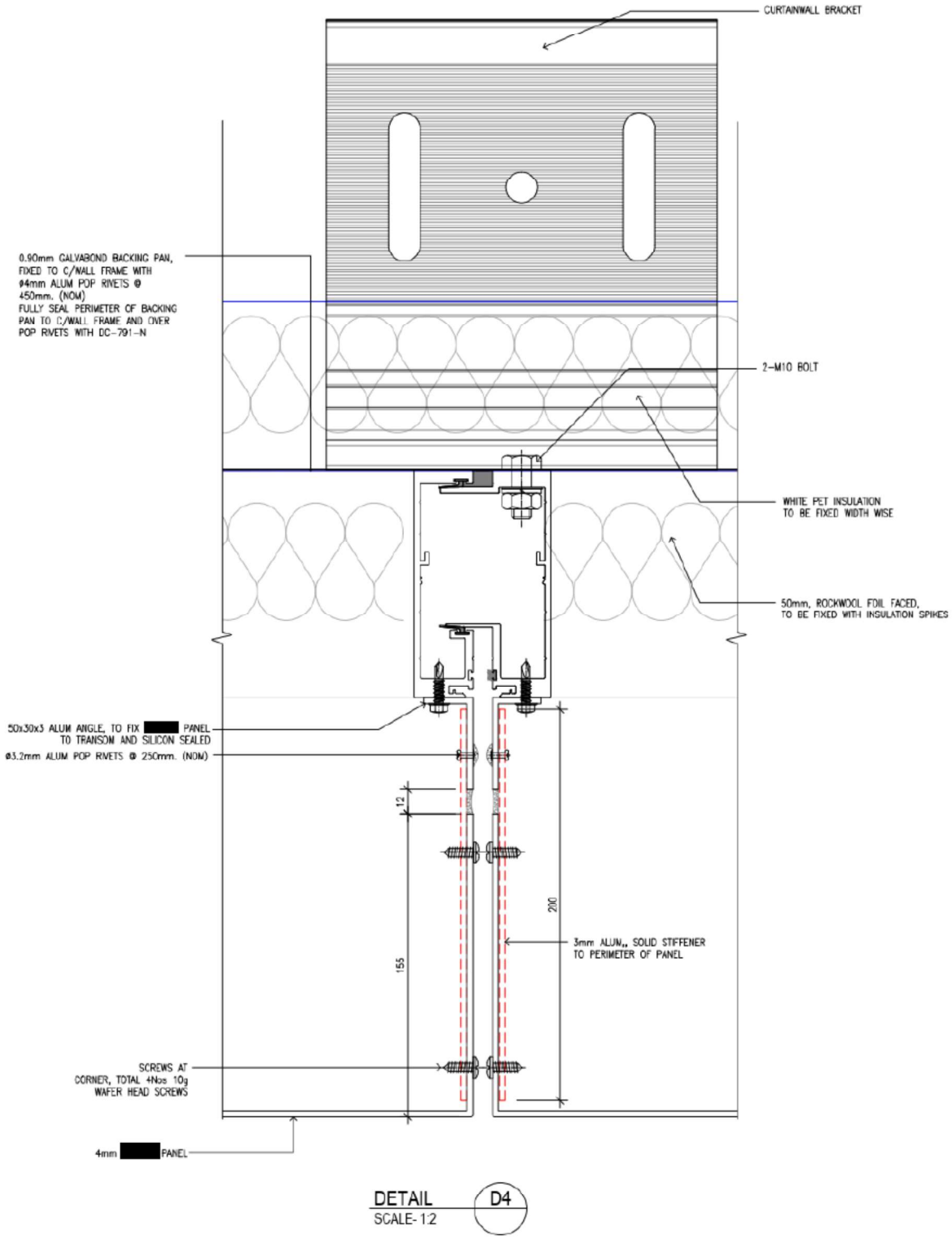

Figure 27 System assembly – vertical cross-sectional view.

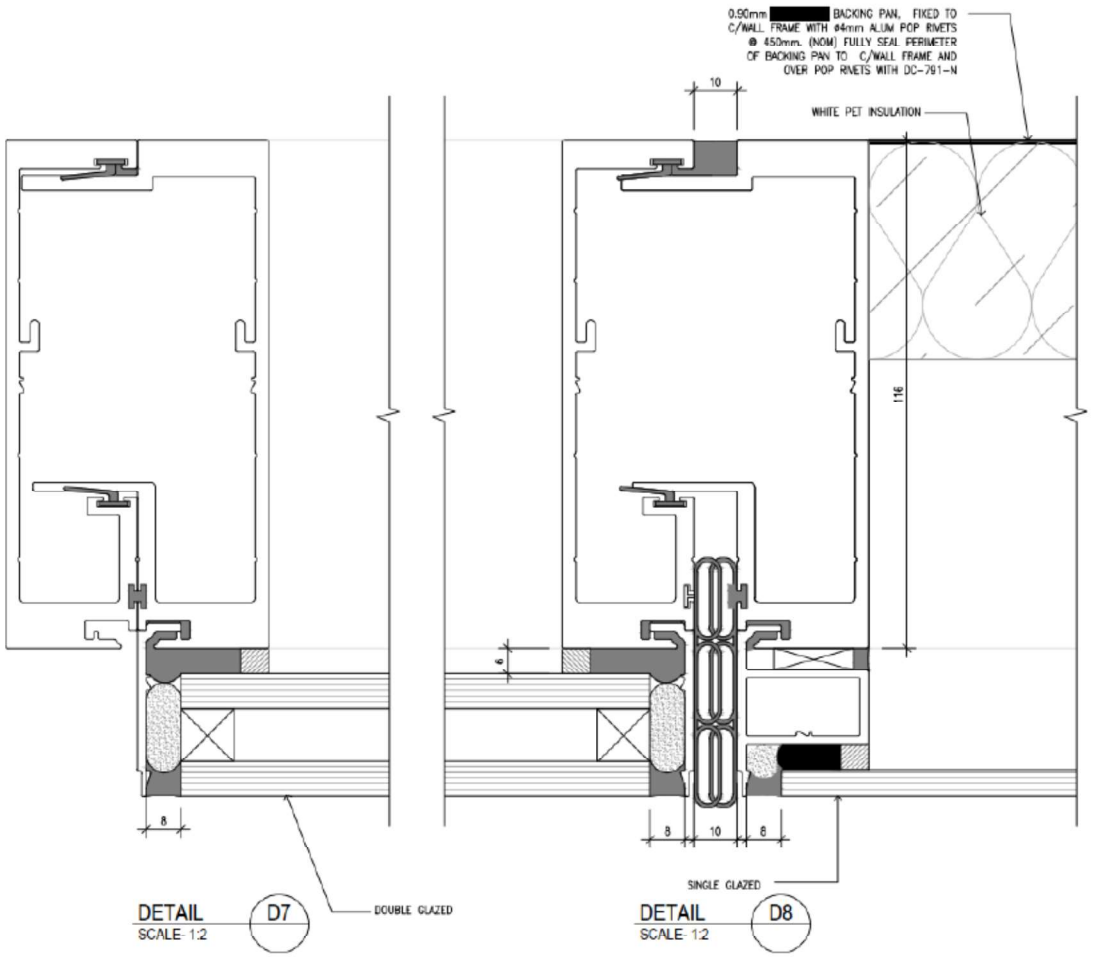

Figure 28 System assembly – vertical cross-sectional view.

Appendix B Photographs

Figure 29 **The specimen and test setup (angled - exposed side) before the reaction to fire test**

Figure 30 **The specimen before the reaction to fire test - exposed side.**

Figure 31 **The specimen before the reaction to fire test - unexposed side.**

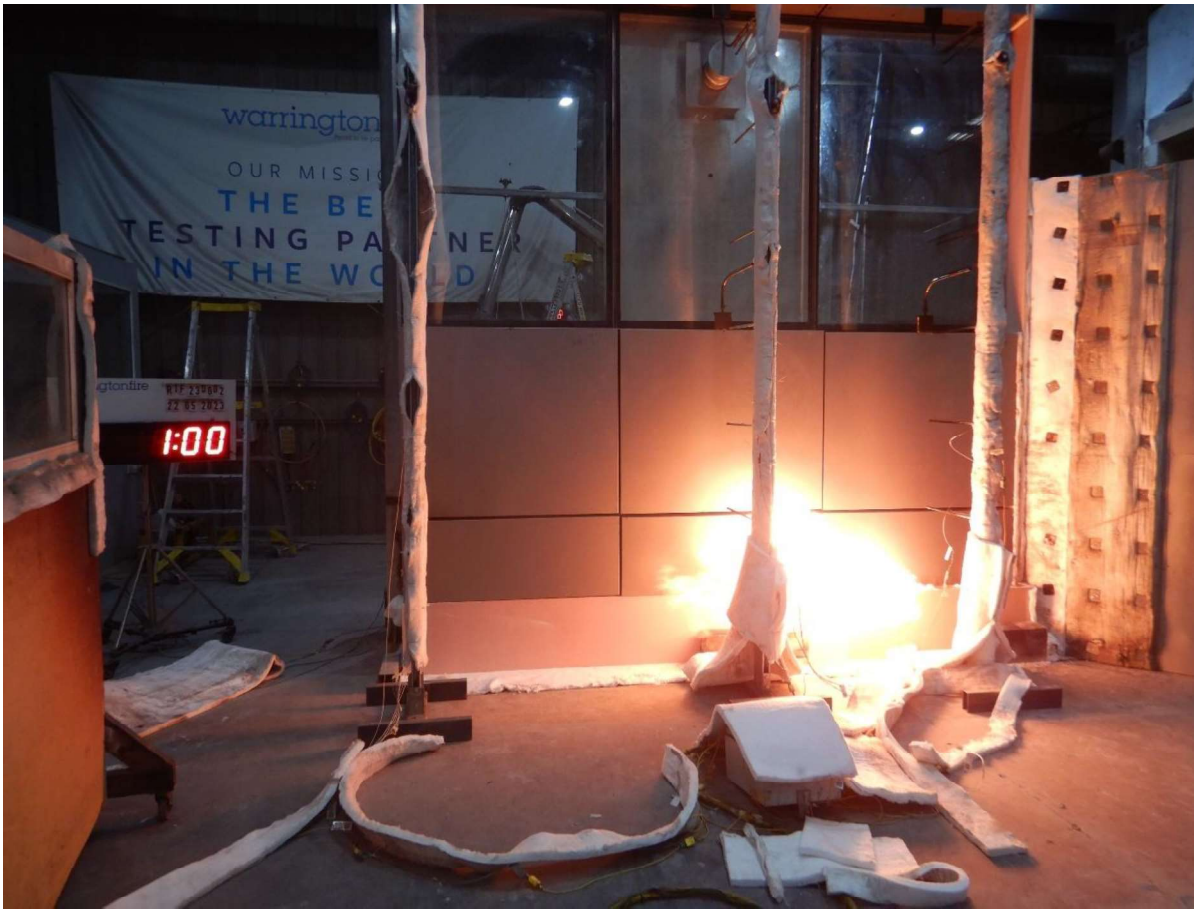

Figure 32 **The specimen 1 minute into the test (burner output at 300 kW and wind on)**

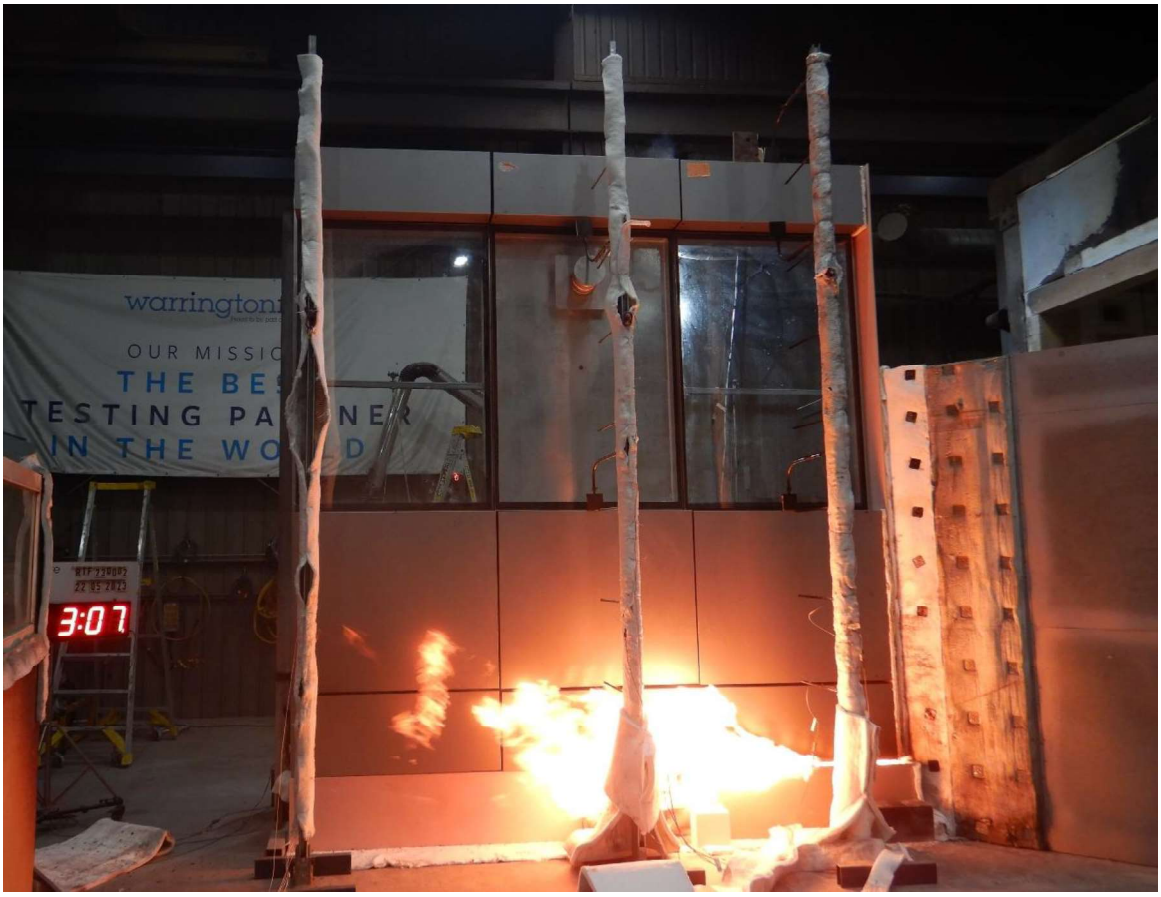

Figure 33 **The specimen 3 minutes 7 seconds into the test (burner output at 300 kW and wind on)**

Figure 34 **The specimen 7 minutes into the test (burner output at 300 kW and wind on)**

Figure 35 **The specimen 10 minutes into the test (burner output at 300 kW and wind on)**

Figure 36 **The specimen 13 minutes 25 seconds into the test (burner output at 300 kW and wind on).**

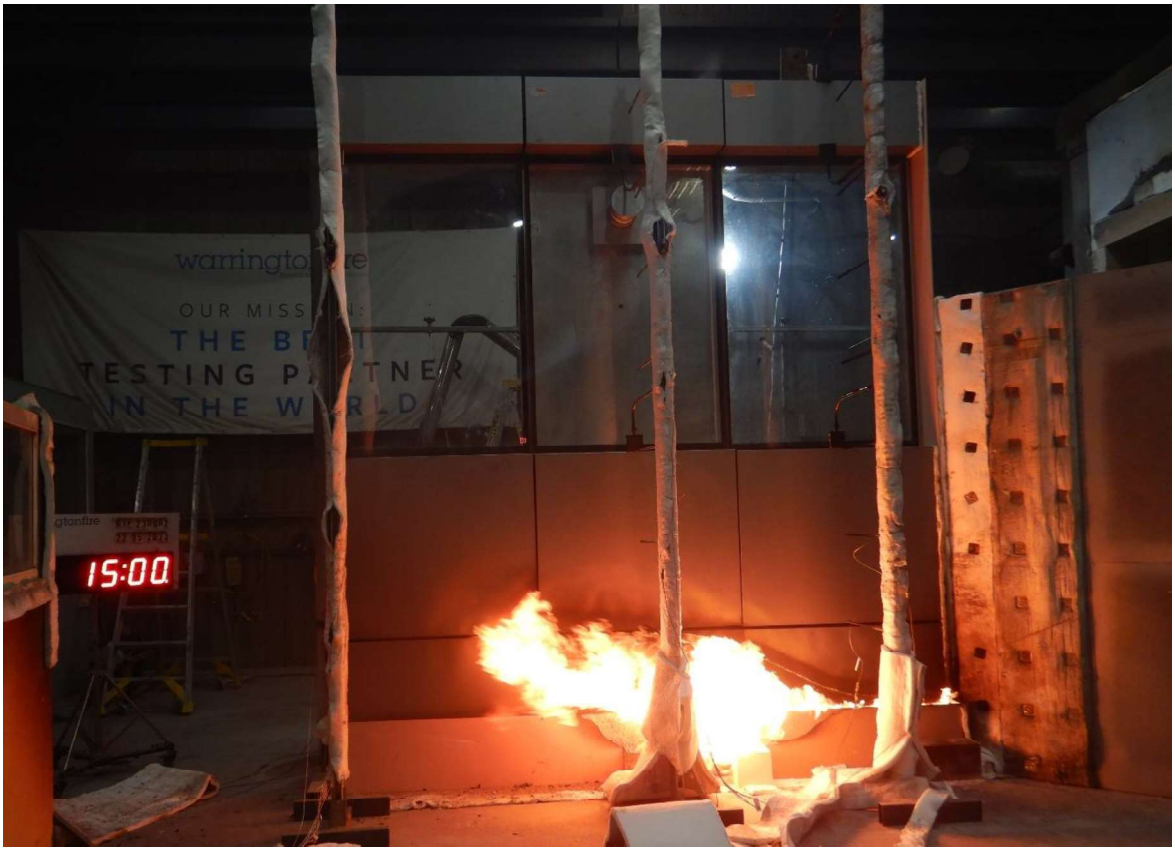

Figure 37 **The specimen 15 minutes into the test (burner output at 300 kW and wind on).**

Figure 38 **The specimen 18 minutes 38 seconds into the test (burner output at 300 kW and wind on).**

Figure 39 **The specimen 20 minutes into the test (burner output at 300 kW and wind on).**

Figure 40 **The specimen 23 minutes into the test (burner output at 300 kW and wind on).**

Figure 41 **The specimen 25 minutes 55 seconds into the test (burner output at 300 kW and wind on).**

Figure 42 **The specimen 26 minutes 54 seconds into the test (burner output at 300 kW and wind on) – unexposed side.**

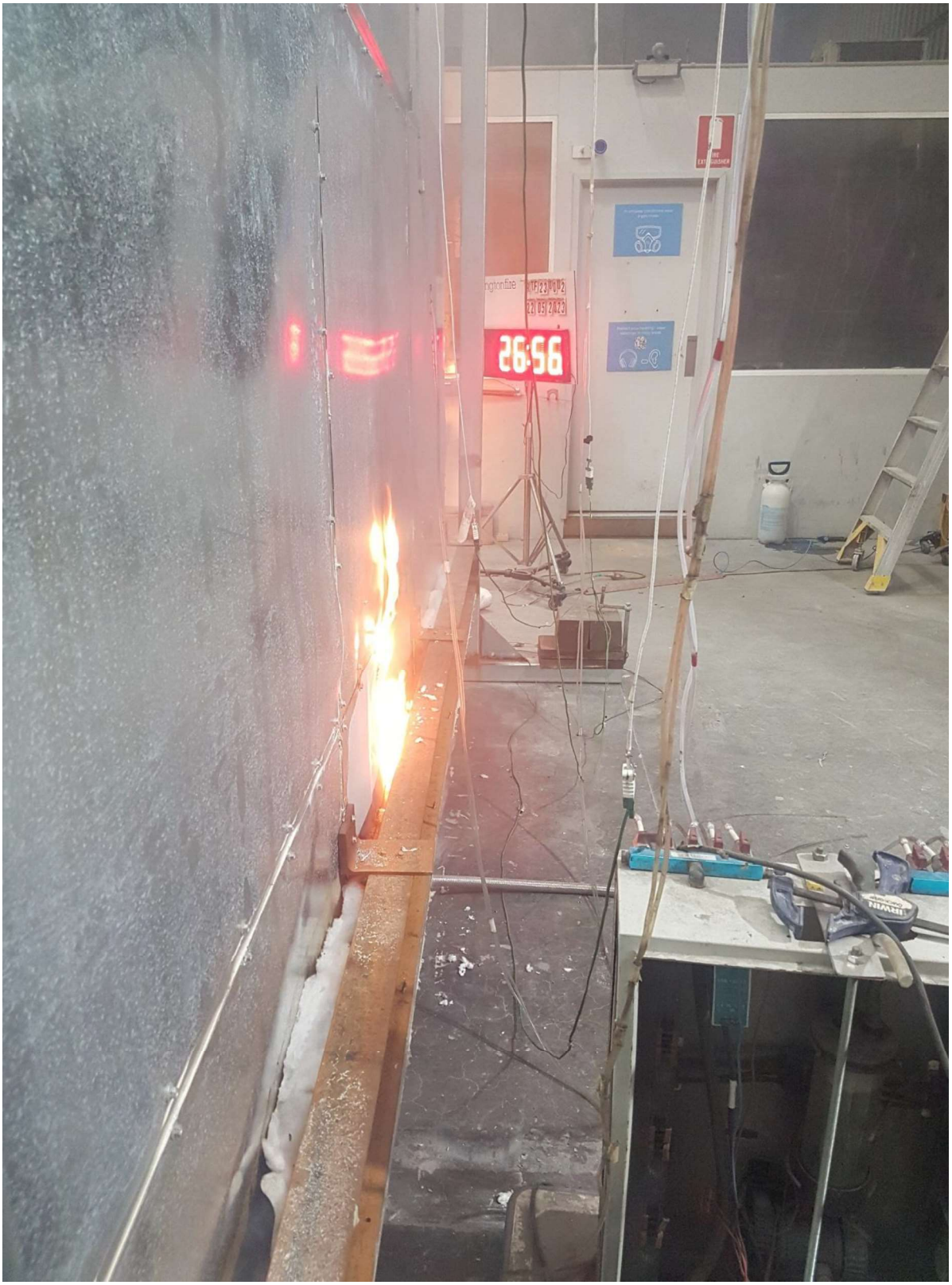

Figure 43 **The specimen 26 minutes 56 seconds into the test (burner output at 300 kW and wind on) – unexposed side.**

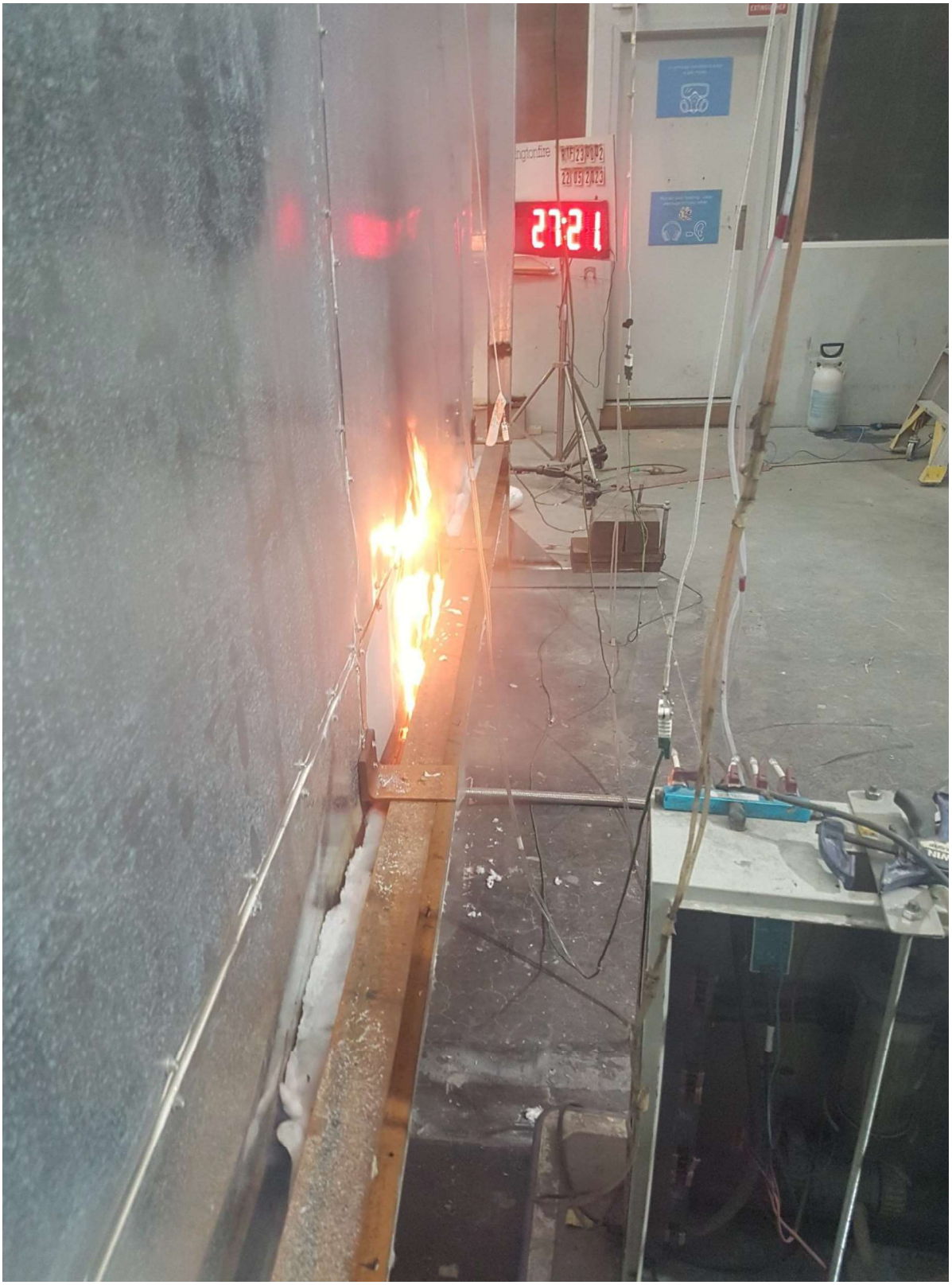

Figure 44 **The specimen 27 minutes 21 seconds into the test (burner output at 300 kW and wind on) – unexposed side.**

Figure 45 **The specimen 27 minutes 46 seconds into the test (burner output at 300 kW and wind on).**

Figure 46 **The specimen 27 minutes 52 seconds into the test (burner output at 300 kW and wind on) – unexposed side.**

Figure 47 **The specimen 28 minutes 45 seconds into the test (burner output at 300 kW and wind on) – unexposed side.**

Figure 48 **The specimen 29 minutes into the test (burner output at 300 kW and wind on).**

Figure 49 **The specimen 30 minutes into the test (burner output at 300 kW and wind on).**

Figure 50 **The specimen 30 minutes 6 seconds into the test – just after burner is turned off.**

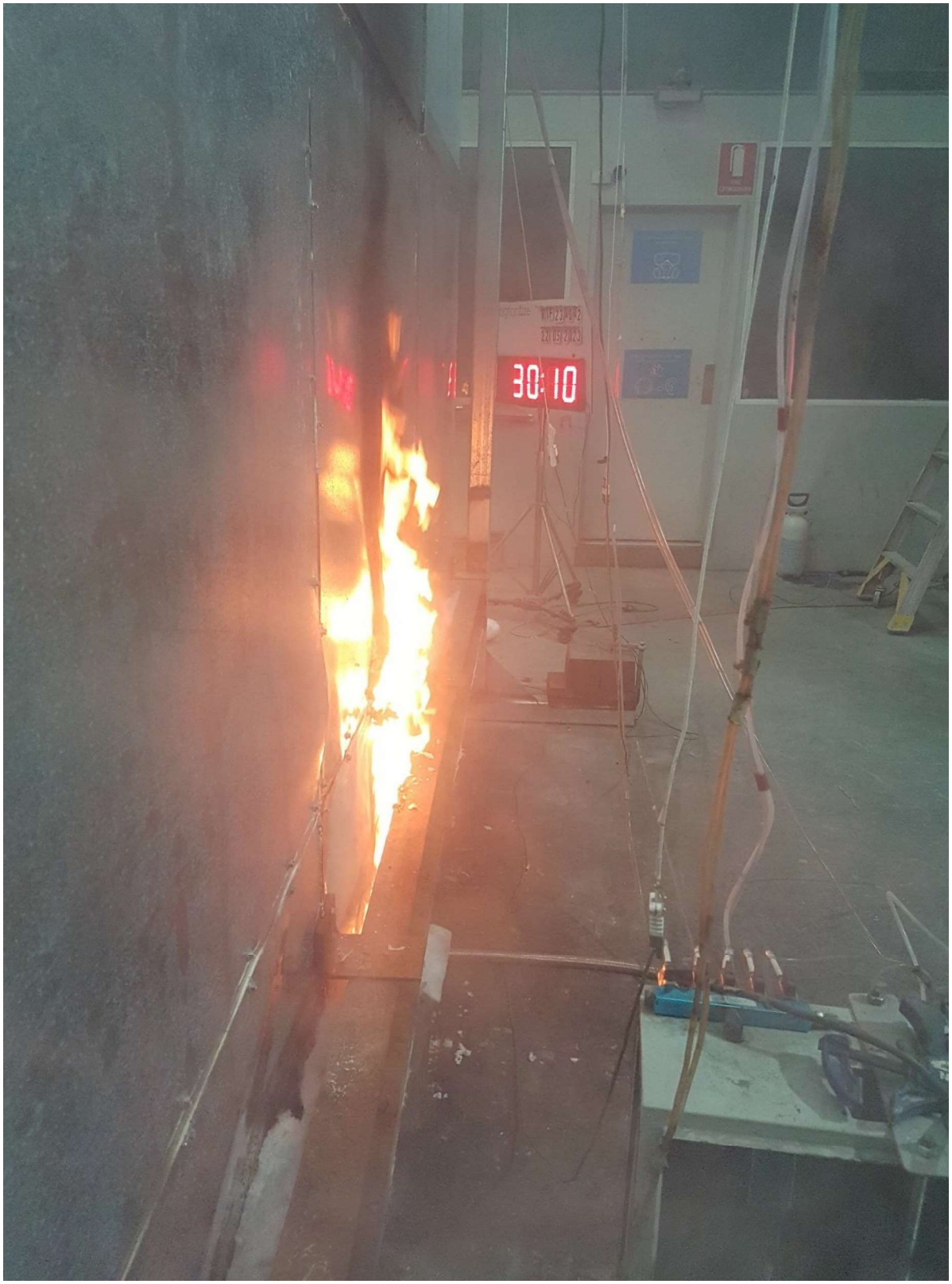

Figure 51 **The specimen 30 minutes 10 seconds into the test – just after burner is turned off – unexposed side.**

Figure 52 **The specimen 30 minutes 35 seconds into the test –burner off – unexposed side.**

Figure 53 **The specimen 31 minutes 30 seconds into the test (burner off).**

Figure 54 **The specimen 38 minutes 46 seconds into the test (burner off).**

Figure 55 **The specimen 39 minutes 25 seconds into the test – just after burner is turned off – unexposed side.**

Figure 56 **The specimen at the end of test.**

Figure 57 **The specimen at the end of test – unexposed side.**

Appendix C Chemical Analysis Results

Mineral content	ALPOLIC™ Report No.: 22155	Site sample #1 Report No.: 202212	Site sample #2 Report No.: 202212
	Composition of the ash - %		
Mineral content	46.7	47.2	47.1
Alumina	98.6	96.7	96.5
Sodium oxide	0.46	0.45	0.49
Iron oxide	<0.01	<0.01	<0.01
Titanium oxide	<0.01	<0.01	<0.01
Calcium oxide	0.02	<0.01	<0.01
Nickel oxide	<0.01	<0.01	<0.01
Magnesium oxide	0.20	0.21	0.21
Silica oxide	<0.01	<0.01	<0.01
Sulphur trioxide	<0.01	<0.01	<0.01
Phosphorous pentoxide	<0.01	<0.01	<0.01
Potassium oxide	<0.01	<0.01	<0.01
Zinc oxide	<0.01	<0.01	<0.01
Barium oxide	<0.01	<0.01	<0.01
Manganese oxide	<0.01	<0.01	<0.01
Copper oxide	<0.01	<0.01	<0.01
Chromium oxide	<0.01	<0.01	<0.01
Lead oxide	<0.01	<0.01	<0.01
Loss on ignition (1050 °C)	Not determined due to insufficient mass of ash		

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