WARRINGTONFIRE
AUSTRALIA
A Jensen Hughes Company

Reaction to fire test report

Test standard: Ad-hoc test based on ISO 13785-1:2002

Test sponsor: Cladding Safety Victoria (CSV)

System: An aluminium composite panel (ACP) wall system and a mock balcony setup representative of an in-situ façade - [redacted]

Job number: RTF230086

Test date: 24 April 2024 Revision: R1.0

WARRINGTONFIRE AUSTRALIA
A Jensen Hughes Company

Quality management

Revision	Date	Information about the report			
R1.0	25 June 2024	Description	Initial issue		
			Prepared by	Reviewed by	Authorised by
		Name	[redacted]		
		Signature			

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Contents

1. Introduction

This report documents the findings of an ad-hoc reaction to fire test of an aluminium composite panel (ACP) wall system and a mock balcony setup representative of an in-situ façade - [redacted] performed on 24 April 2024. The test was based on some general requirements of ISO 13785-1:2002.

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

Table 1 Test sponsor details

Test sponsor	Address
Cladding Safety Victoria (CSV)	717 Bourke Street Docklands VIC 3808 Australia

2. Test specimen

2.1 Schedule of components

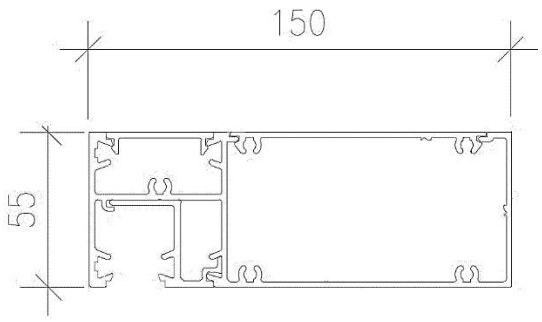
Table 2 describes the test specimen and lists the schedule of components. These were provided by the representatives of the test sponsor and surveyed by Warringtonfire. All measurements were done by Warringtonfire – unless indicated otherwise.

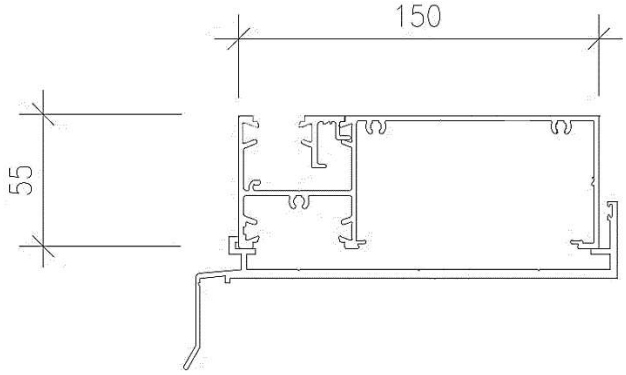
Detailed drawings of the test specimen are provided in Appendix A.

Table 2 Schedule of components

Item	Description		
Cladding			
1.	Item name	Aluminium composite panel (ACP)	
	Product	Aluminium Composite Panel - 4 mm White Gloss/Grey	
	Manufacturer/Supplier	[redacted]	
	Note on Supply of Panel	On behalf of CSV, Warringtonfire acquired the ACPs with close to 100 % polyethylene core. To the best of Warringtonfire's knowledge this is a custom production which the supplier doesn't normally supply. The panels were provided on the basis that this was for research purposes and not any purpose other than fire testing.	
	Batch date	[redacted]	
	Material	The material was nominated as panels consisting of two layers of aluminium sheets sandwiching a layer (core) with close to 100 % polyethylene (PE). Analysis conducted by the analytical centre of UNSW showed that the core consisted of polyethylene (PE) - found to be 96 % w/w - whilst the remainder of the material after the ash test was found to be 3.3 % inert material. Refer to Appendix C for more detailed results.	
		Skins	Front skin – Gloss white Back skin – Light grey
		Core	Black
	Size	Total panel thickness – 4.0 mm Skin thickness – 0.5 mm (both) Uncut: 4.0 m × 1.22 m Refer to Appendix A for individual panel sizing details.	
	Measured mass/unit area densities	Panel areal density – 5.6 kg/m²	
2.	Item name	FR Plasterboard	

Item	Description	
	Product	[redacted]
	Manufacturer/Supplier	[redacted]
	Size	Measured board: 2700 mm × 1200 mm × 13 mm
	Batch Date	27/07/2023
3.	Item name	Back-pan
	Product	0.55 mm thick Galvabond steel
	Supplier	[redacted]
	Size	Measured: 280 mm wide × 1000 mm long
4.	Item name	“Non-combustible” cladding
	Product	[redacted]
	Manufacturer/Supplier	[redacted]
	Size	15 mm thick
	Batch	[redacted]
Glazing and glazing framing		
5.	Item name	Glazing
	Product	10 mm toughened glass
	Manufacturer/Supplier	[redacted]
	Batch	[redacted]
	Material	10CLF
	Size	795 mm × 940 mm × 10.0 mm; and 1260 × 940 mm × 10.0 mm;
6.	Item name	Vertical balustrade framing member
	Product	Slotted aluminium post
	Supplier	[redacted]
	Size	50 mm × 50 mm × 1075 mm tall with a 14 mm wide slot
7.	Item name	Horizontal balustrade framing member
	Product	Slotted aluminium rail
	Supplier	[redacted]
	Size	70 mm wide × 35 mm tall × 2175 mm long
Framing		
8.	Item name	Test rig frame - 90 × 90 SHS frame
	Material	Mild Steel
	Size	89 mm × 89 mm × 5 mm thick – refer to Figure 12 Figure 14
9.	Item name	[redacted]frame mullion [redacted]

Item	Description	
	Profile	
	Material	6060 T5 aluminium alloy
	Manufacturer/Supplier	[redacted]
10.	Item name	Furring Channel - framing
	Size	50 mm wide × 28 mm deep × 0.50 BMT
	Material	Galvanised steel
	Manufacturer/Supplier	[redacted]
11.	Item name	[redacted]standard direct fix clip
	Size	115 mm wide × 30 mm deep × 30 mm high × 1.5 mm thick
	Material	Galvanised steel
	Manufacturer/Supplier	[redacted]
12.	Item name	Steel frame
	Size	Studs and noggings: 90 mm deep × 40 mm wide × 0.7 BMT
	Installation	The steel framing members were riveted (item 18) to one another.
	Material	[redacted]
	Manufacturer/Supplier	[redacted]
Insulation		
13.	Item name	50 mm thick polyethylene terephthalate (PET) insulation
	Density	~13 kg/m^3
	Colour	Dark Grey
	Manufacturer/Supplier	[redacted]
14.	Item name	50 mm thick PU Rock Mineral wool sandwich panel
	Density of core	Unknown
	Manufacturer/Supplier	[redacted]
Sealant/Adhesive		
15.	Item name	Weathering sealant
	Product type	Silicone sealant
	Product name	[redacted]
	Manufacturer	[redacted]
	Usage	Placed at ACP edges and over screw and rivet locations.
16.	Item name	Fire-rated sealant
	Product name	[redacted]
	Manufacturer	[redacted]

Item	Description	
	Usage	Used to seal the gaps between the back-pan (item 3) and the aluminium framing (item 9) behind the air transfer grille (item 21)
Fixings		
17.	Item name	Wafer head screws – zinc coated steel
	Size	6g × 16 to 25 mm long
	Installation	Used to fix back-pan (item 3) to the aluminium mullion (item 9) – four per corner.
18.	Item name	Aluminium rivet
	Size	Ø3 mm
	Installation	Used to fix the air transfer grille (item 21) to the aluminium framing (item 9) and the steel framing (item 12).
19.	Item name	Plasterboard and cladding (used for Promatectect) screws
	Size	8g × 50 to 65 mm - long fine thread SDS
20.	Item name	Furring channel clip screws
	Size	10g × 22 mm long, hex head, self-drilling screws
Other things		
21.	Item name	Air transfer grille
	Product name	[redacted]
	Size	940 mm wide × 270 mm tall × 50 mm deep (45° angled blades)
	Material	6060 T5 aluminium alloy
	Installation	Installed within the aluminium framing (item 9) above the ACPs (item 5). The blades were angled at an upward slope starting from the outside going into the wall. The grille was fixed to the aluminium framing using aluminium rivets (item 18), one rivet at each corner of the grille.
	Manufacturer/Supplier	[redacted]
22.	Item name	Vermin mesh – chicken wire
	Size	940 mm wide × 270 mm tall
	Material	Galvanised steel
	Installation	The chicken wire was installed behind the air transfer grille.
23.	Item name	Aluminium sill with weepholes
	Size	165 mm × 30 mm tall flanges × 2 mm thick. Containing weepholes
	Profile	
	Material	6060 T5 aluminium alloy
	Manufacturer/Supplier	[redacted]

Item	Description	
	Installation	Installed above the Promatectect board (item 4) compartment residing over the SHS unit (item 8).

Installation method

Test Rig:	The test rig frame (item 8) was the main support for the test specimen. The specimen was fixed to the test rig via the aluminium framing (item 9). The SHS was also used at the false floor level. Steel studs (item 12) were also used at the false floor level.
External wall:	The aluminium framing (item 9) consisted of extrusions around the perimeter and a central vertical member. Steel back-pans (item 3) were fixed to the back of the aluminium framing (item 9) using screws (item 17) fixed – at 200 mm centres around the perimeter. Furring channel clips (item 11) were screw fixed (item 20) to the aluminium framing – fixing at ~1200 mm centres vertically. Slotted into the clips were steel furring channels (item 10). Within the furring channels polyester insulation (item 13) was fitted. Two layers of plasterboard (item 7) were screw (item 19) fixed to the back of the furring channels. Screw fixings were at 600 mm centres for the first layer and 200 mm to 300 mm centres. To the front face of the back-pan (item 3) was installed mineral wool insulation (item 14). ACP (item 5) was used to clad the majority of the front side of the aluminium framing (item 9). The ACPs (item 5) were “glazed in” the aluminium framing inside grooves and behind aluminium beads. The perimeter of the visible ACP and aluminium framing was sealed with a 10 mm bead of sealant (item 15).
Balcony:	At the false floor level, a balcony structure was created. Details of this are shown in Appendix A. The balcony consisted of the horizontal member of the test rig (item 8) and steel framing (item 12). The steel false floor was capped with 2 layers of “non-combustible” Promatect board (item 4). The boards were fixed to the steel substructure with self-drilling plasterboard screws (item 19) - at 500 mm centres.
Wall base:	The base of the walls - at the floor junction – consisted of an aluminium sill (item 23) fixed upon a Promatectect board (item 4) protected SHS unit (item 8).

For more details regarding the description of the specimen refer to Appendix A.

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 on 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. 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	
Ambient laboratory temperature	Start of the test	17 °C
Instrumentation and equipment	• Twelve 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 at various positions 50 mm away from the specimen. These locations are shown in Figure 1 and Figure 2 • Six 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 inside the specimen at the centre of the cavity. These locations are shown in Figure 1 and Figure 2. • The incident heat flux was measured in four locations: on the top of the specimen in line with the front face of the top wall, on the front face of the balcony in line with the balcony, in front of the glazing and behind the glazing. The heat flux was measured using Schmidt-Boelter type heat flux gauge with a range of 0-20 kW/m^2, 0-100 kW/m^2, 0-50 kW/m^2 and 0-20 kW/m^2, respectively. • Two plates with 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 50 mm away from the grills. These locations are shown in Figure 1 and Figure 2. • 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 in front of the specimen.	
Test procedure	• At least two minutes of baseline data was collected prior to burner ignition. Temperature and heat flux data was collected at 5 s intervals. • The heat output from the burner was held at 500 kW for 30 minutes. The burner was then turned off and the specimen observed for a further 30 minutes. • The test was ended at 60 minutes after burner ignition.	
Test number	Test four of a proposed four.	
Variations between test RTF230083.	• The test specimen contained a glazing element compared to the original test which was unprotected. • The source for the ACP was different – as listed in the schedule of components, Table 2. • The vermin mesh was different – as listed in the schedule of components, Table 2. • The colour of the PET insulation was different – as listed in the schedule of components, Table 2.	

4. Test measurements and results

Instrument locations are shown in Figure 1 and Figure 2. The results from the tests are summarised below. Photographs of the specimen are included in Appendix B.

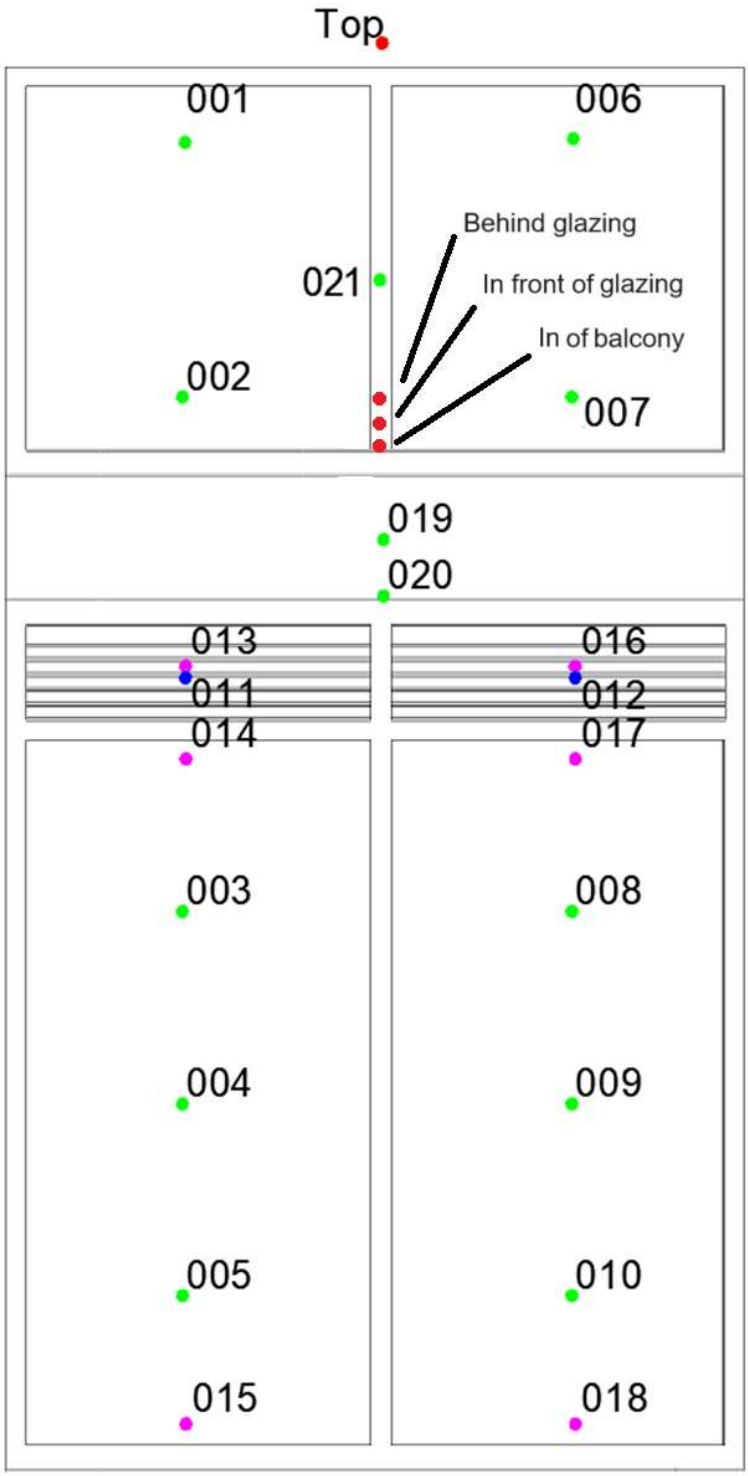


Figure 1 Instrumentation positions – View from in front of specimen

Heat Flux gauge **External 1.5 mm MIMS** **Internal 1.5 mm MIMS** **Plate thermocouple**

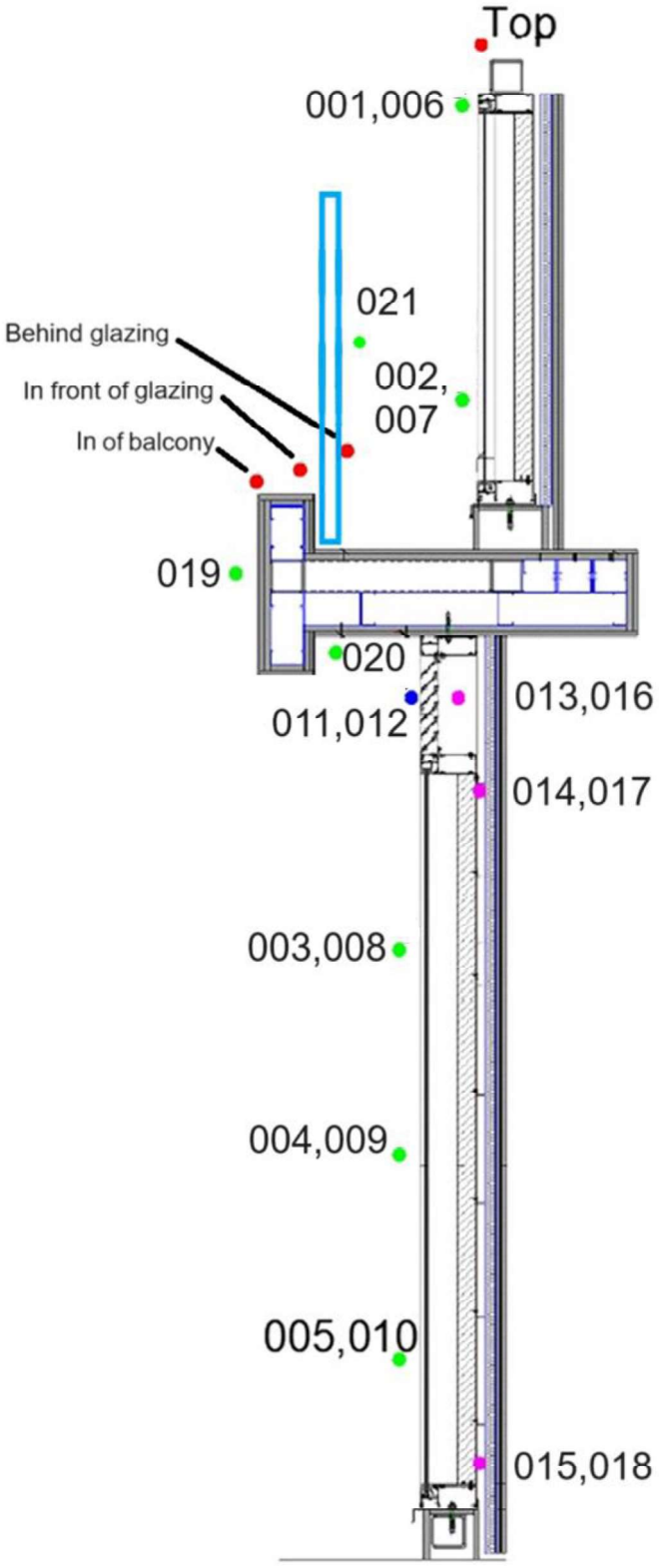


Figure 2 Instrumentation positions – View from the side of the specimen

Heat Flux gauge **External 1.5 mm MIMS** **Internal 1.5 mm MIMS** **Plate thermocouple**

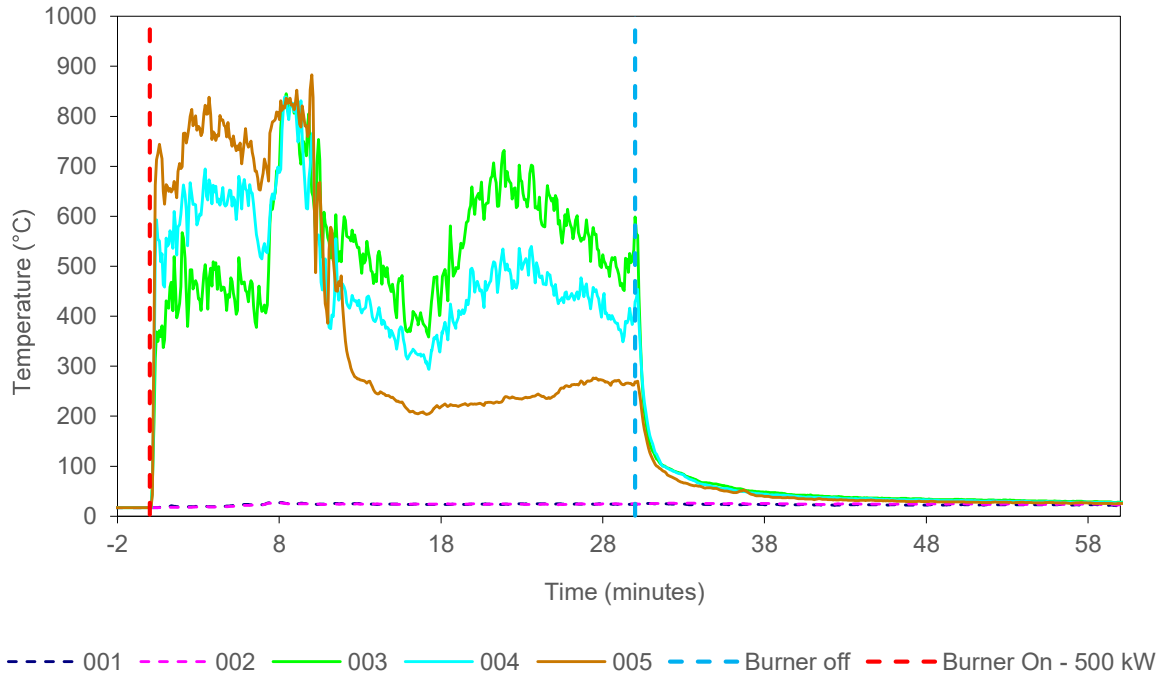


Figure 3 **External temperature data collected by thermocouples placed 50 mm from the front face of the specimen – East facade**

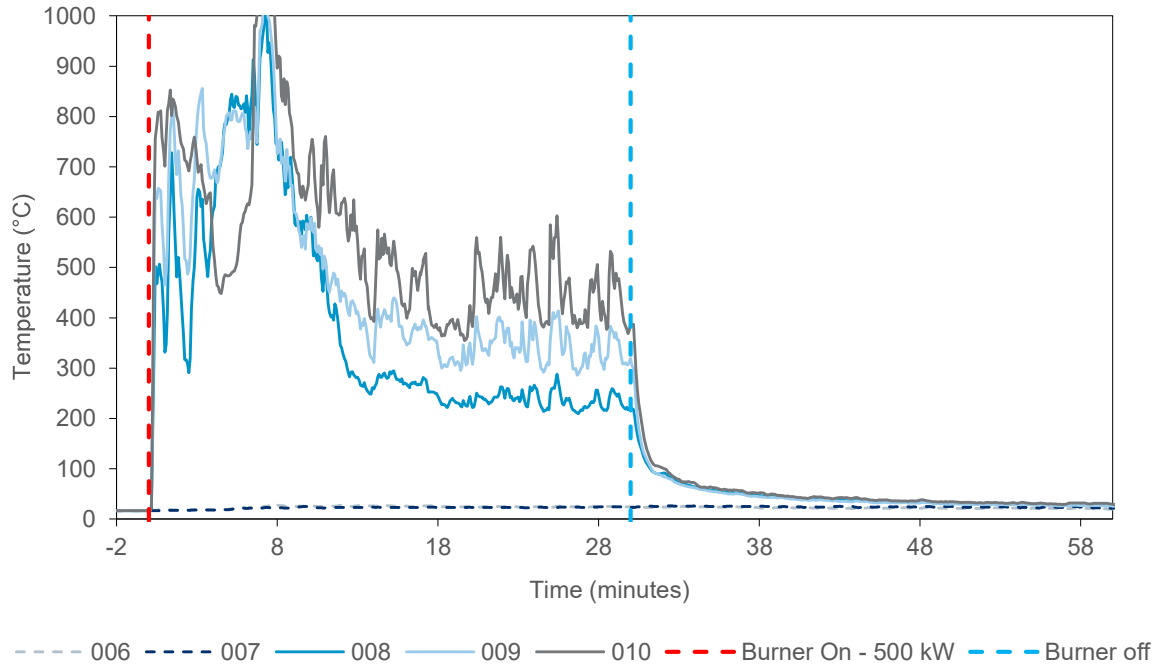


Figure 4 **External temperature data collected by thermocouples placed 50 mm from the front face of the specimen – West facade**

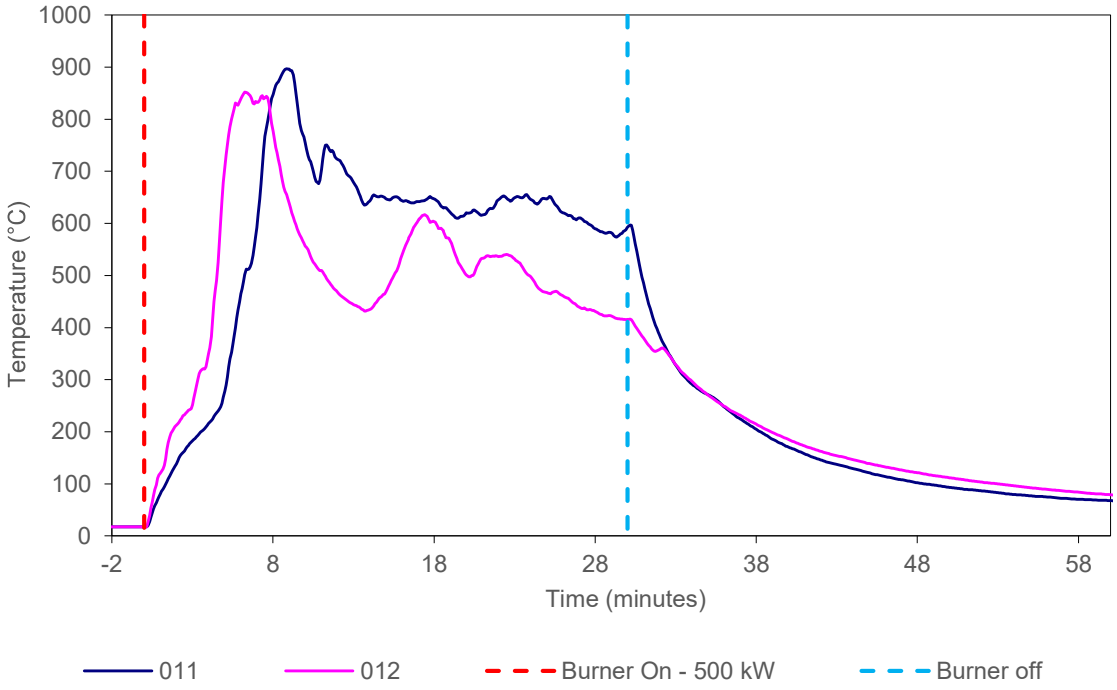


Figure 5 **External temperature data collected by plate thermocouples placed 50 mm from the front face of the specimen**

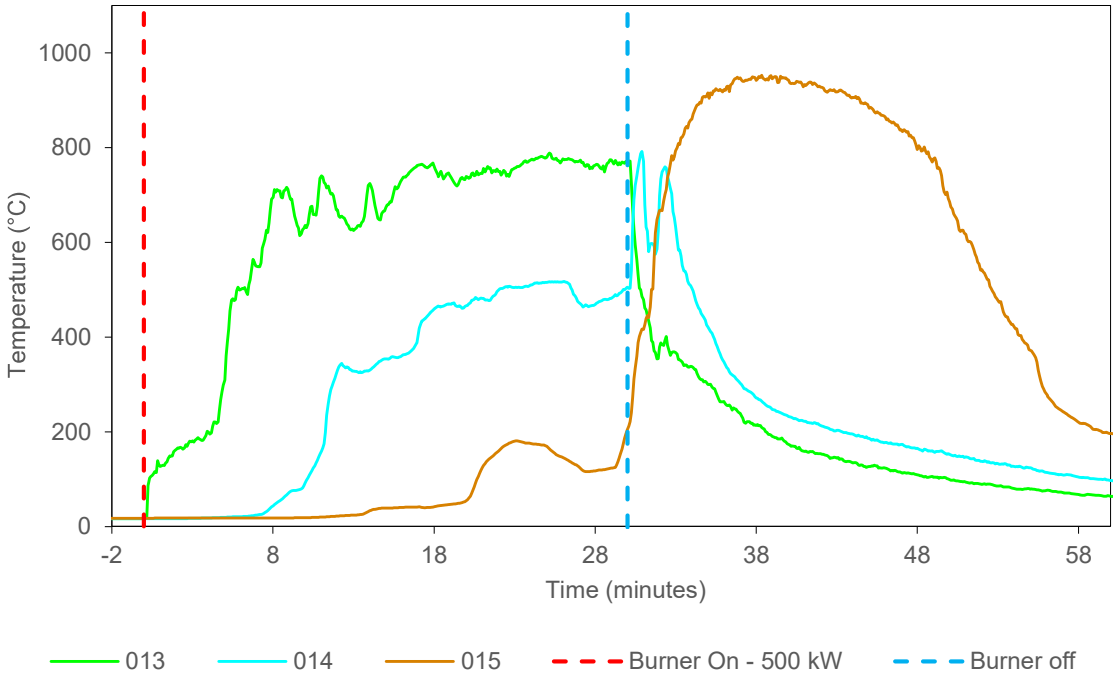


Figure 6 **Internal temperature data collected by thermocouples placed within the cavity – between the internal and external segments of the specimen – East façade**

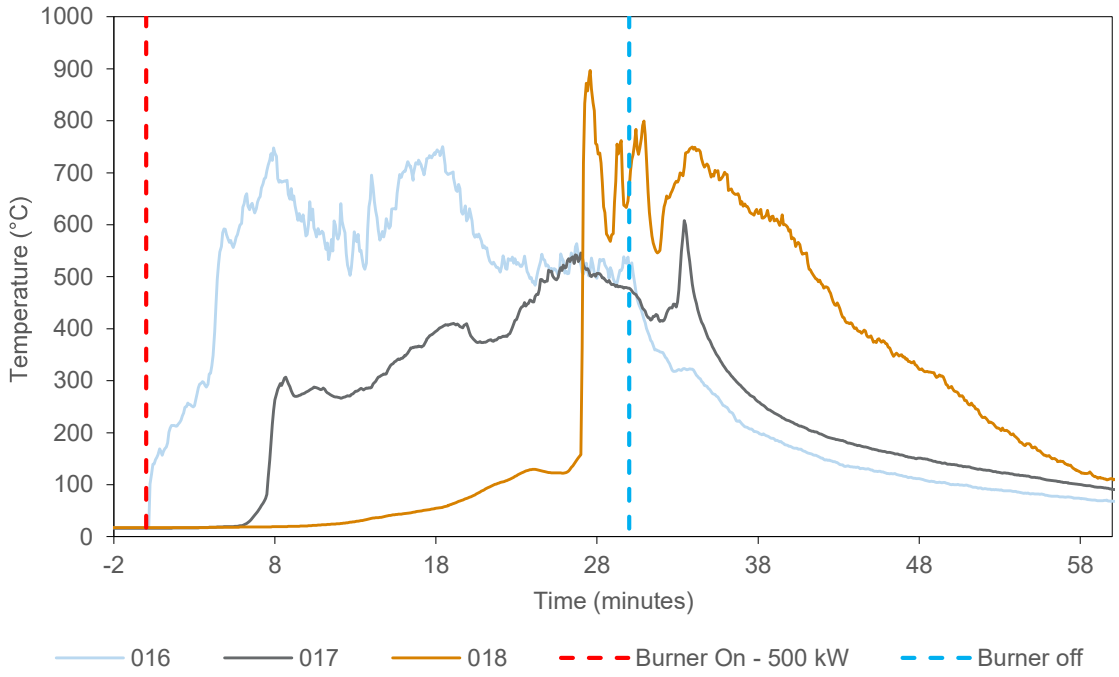


Figure 7 **Internal temperature data collected by thermocouples placed within the cavity – between the internal and external segments of the specimen – West façade**

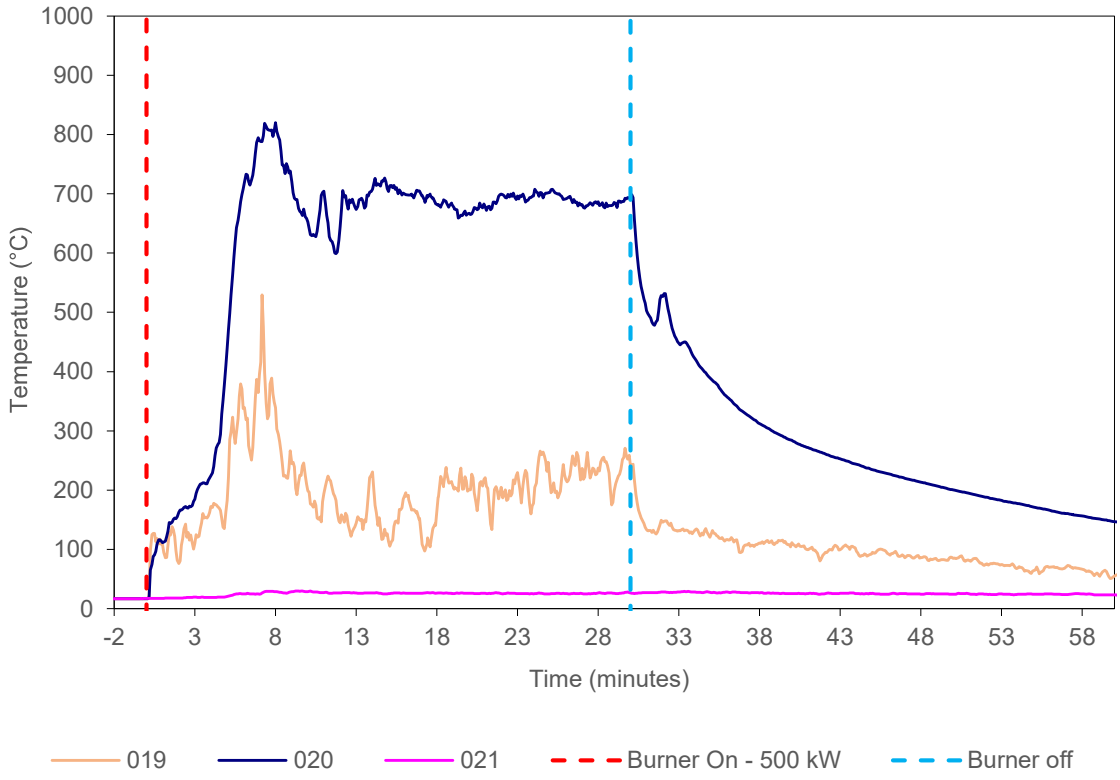


Figure 8 **External temperature data collected by thermocouples placed 50 mm from balcony face and underside cavity and behind glazing**

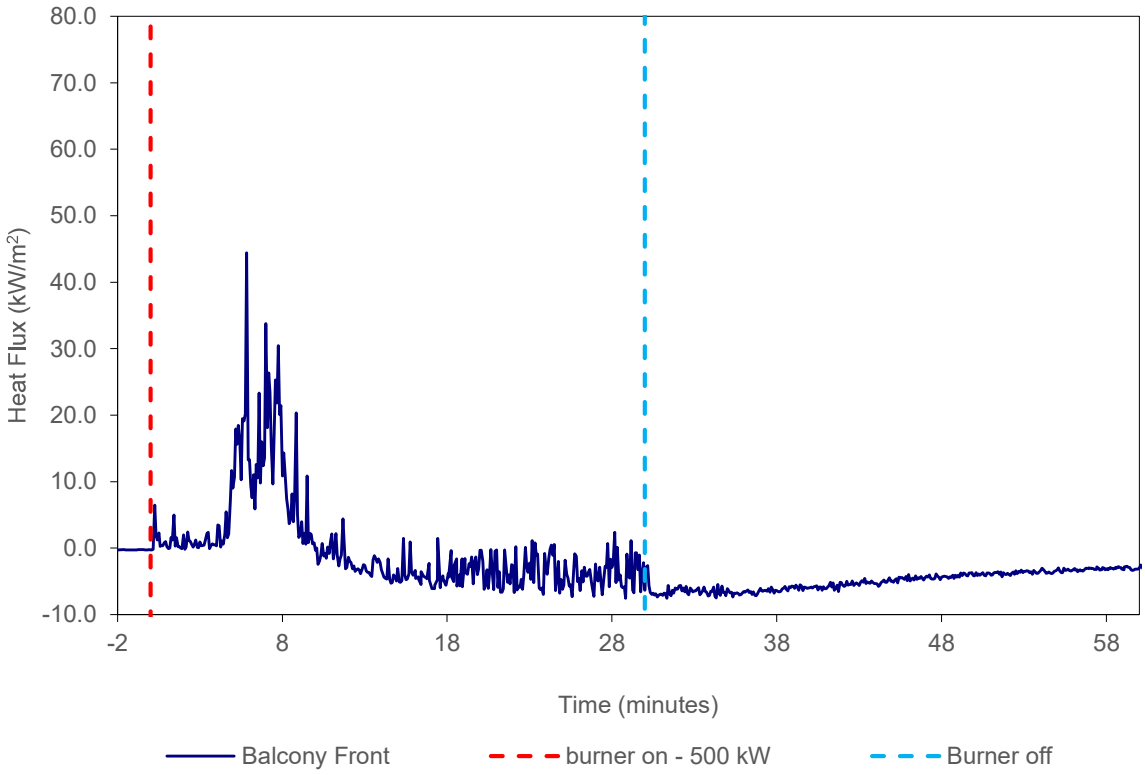


Figure 9 **Heat flux data collected by heat flux gauge at the top front of balcony**

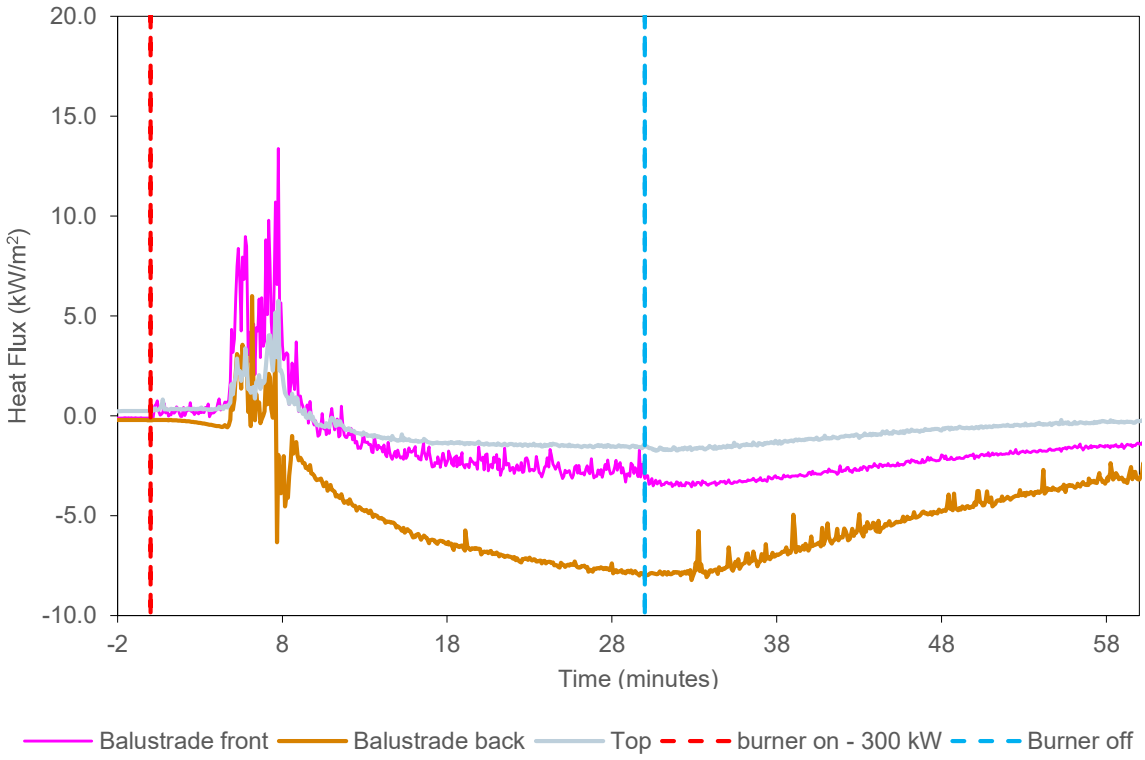


Figure 10 **Heat flux data collected by heat flux gauge at the top front of balcony**

Figure 11 Designation for test specimen observations

Table 4 shows the observations of any significant behaviour of the specimen during the test.

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		Section	Observation
Min	Sec		
-2	00	All	Data collection started.
0	00	All	The reaction to fire test was started with the burner ignited to a 500 kW heat output.
0	05	All	Flames reached A2 and B2.
1	00	A1/B1	The panel skins were discoloured.
2	00	A1/B1	The panel skins had further discoloured.
2	30	All	There were light smoke emissions.
3	54	A1	There was flaming at the top of the panel near the sealant.

Time		Section	Observation
Min	Sec		
4	00	B2	The louvres had deformed.
4	06	B2	Flames were emitting through the louvres.
4	20	B3	Flames were reaching the top of the balcony.
4	45	A3	Flames were reaching the top of the balcony
4	45	A4	Flames were reaching the top of the glazing.
4	46	A1	The sealant was on fire.
5	00	A2	Flames were coming out of the louvres.
5	00	B4	Flames were consistently reaching the top of the glazing.
6	00	A1	It was evident that a gap between the back-pan and the lower left side of the panel was present.
6	03	B1	It was evident that the left side of the panel had opened up.
6	07	A1	It was evident that the right side of the panel had opened up.
6	17	A1/B1	The flaming sealant was hanging down from the top of the panels and dripping.
6	20	B1	Flaming droplets were being projected from the panel.
6	23	B1	A piece of panel skin, roughly 0.4 m by 0.4 m had detached from the specimen. The specimen started emitting darker and heavier smoke and flaming of the specimen had increased.
6	30	B1	There was flaming debris in front of the burner.
6	40	A4/B4	Flames were consistently reaching the top of the glazing.
6	46	A1	It was evident that the right side of the panel had opened up.
6	55	A2/A3/B1 /B2/B3	Flaming in front of the specimen was heavy.
7	22	A1	The front skin of the panel was detaching which exposed the core material. The core material was flaming.
7	25	A1/A2/A3 A4	There was heavy flaming in front of the specimen.
8	00	A1/A2/A3 B1/B2/B3	There was still heavy flaming and smoke coming from the specimen. There was a lot of flaming debris in front of the specimen.
9	00	A3/B3	Flames were consistently reaching the top of the balcony.
9	49	A1	The front skin of the panel was delaminating. It appeared to be only attached at the left side.
9	52	B1	It appeared that most of the core material of the ACP had burnt and/or melted away from its original position.
9	58	A1	A hole had opened up in the back of the ACP. Flames were coming out through that hole from the back of the panel.
10	00	A2/B2	It was evident that the louvres had heavily deformed.
10	43	A1	The back of the ACP had fallen forward over the burner.
10	45	A1	Flaming from the left side of the ACP had increased.
10	57	A4	Flames were consistently reaching the level of glazing.
11	40	A1	The front skin of the ACP had detached and fallen over the burner.
12	00	A3	Flames had died done and were only consistently reaching the front of the balcony.
15	00	A2/B2	Flames were only consistently reaching the bottom of the balcony.

Time		Section	Observation
Min	Sec		
17	00	All	Flaming and smoking of the specimen was significantly reduced.
20	00	A1/B1/A2/B2	Flaming of the specimen was mainly present at the duct position and behind the ACPs.
30	00	All	The burner was turned off. Some independent flaming was still present at A2, B2, and the middle of A1/A2.
31	23	B2/B3	Flaming from the grill under the balcony had increased and was licking in front of the balcony.
32	04	B2/B3	Flaming from the grill under the balcony had died down and no longer was licking in front of the balcony. Heavy smoke was emitting from the specimen.
32	06	A2	Flaming was still present in this section.
34	22	A2	Flaming had increased.
35	25	A2	Flaming had died off and was replaced by smoke emissions.
36	00	A1/B1	Flaming was still present between these sections at the bottom.
42	00	All	The amount of smoke emitting from the specimen was low.
50	00	All	Flaming of the specimen was not evident.
60	00	All	The reaction to fire 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 3. 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 12 to Figure 18 were provided by representatives of Warringtonfire. Figure 14 to Figure 18 were modified by Warringtonfire – name change of insulation. Dimensions, unless specified, are in mm.

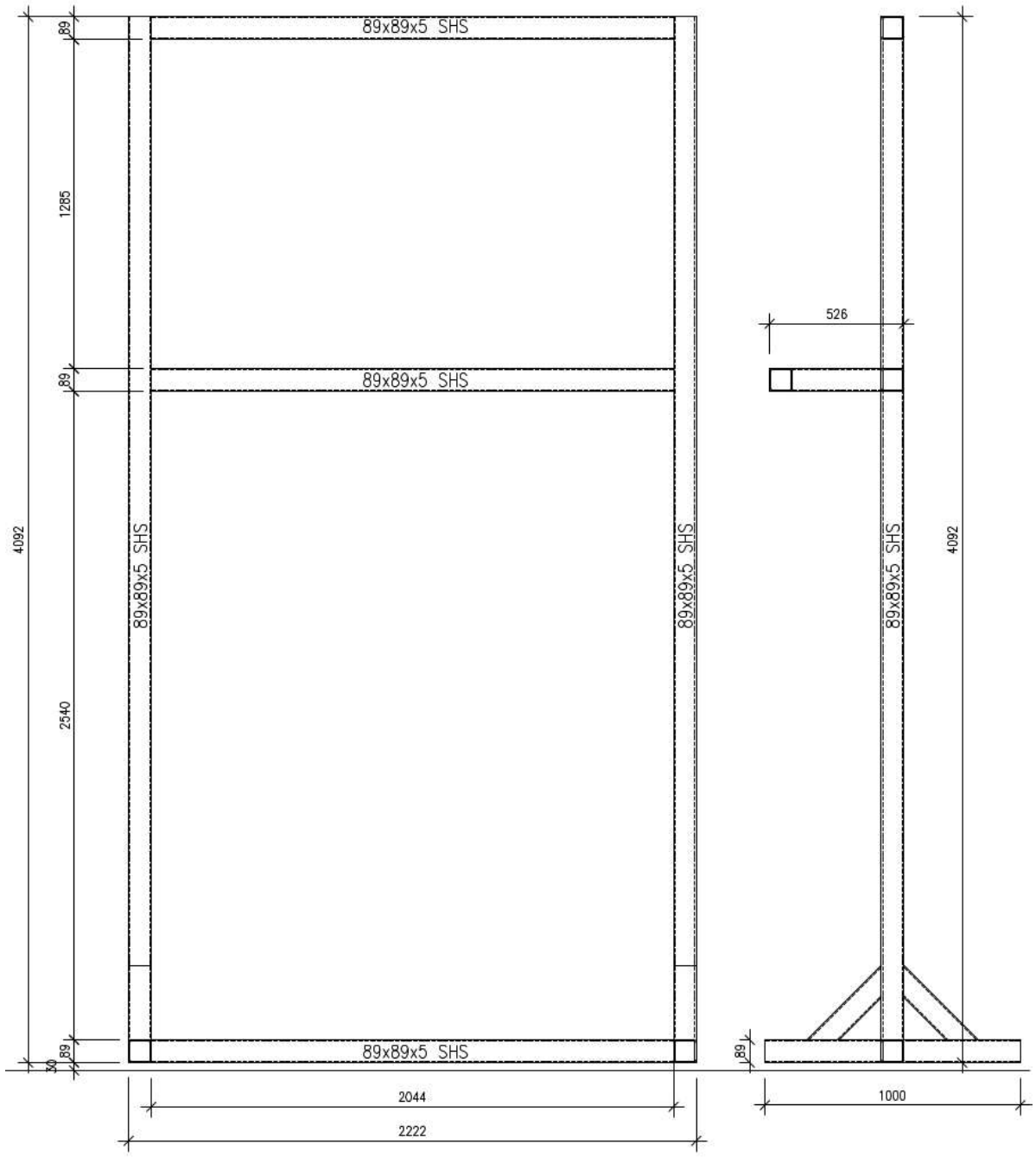


Figure 12 Elevation of test frame.

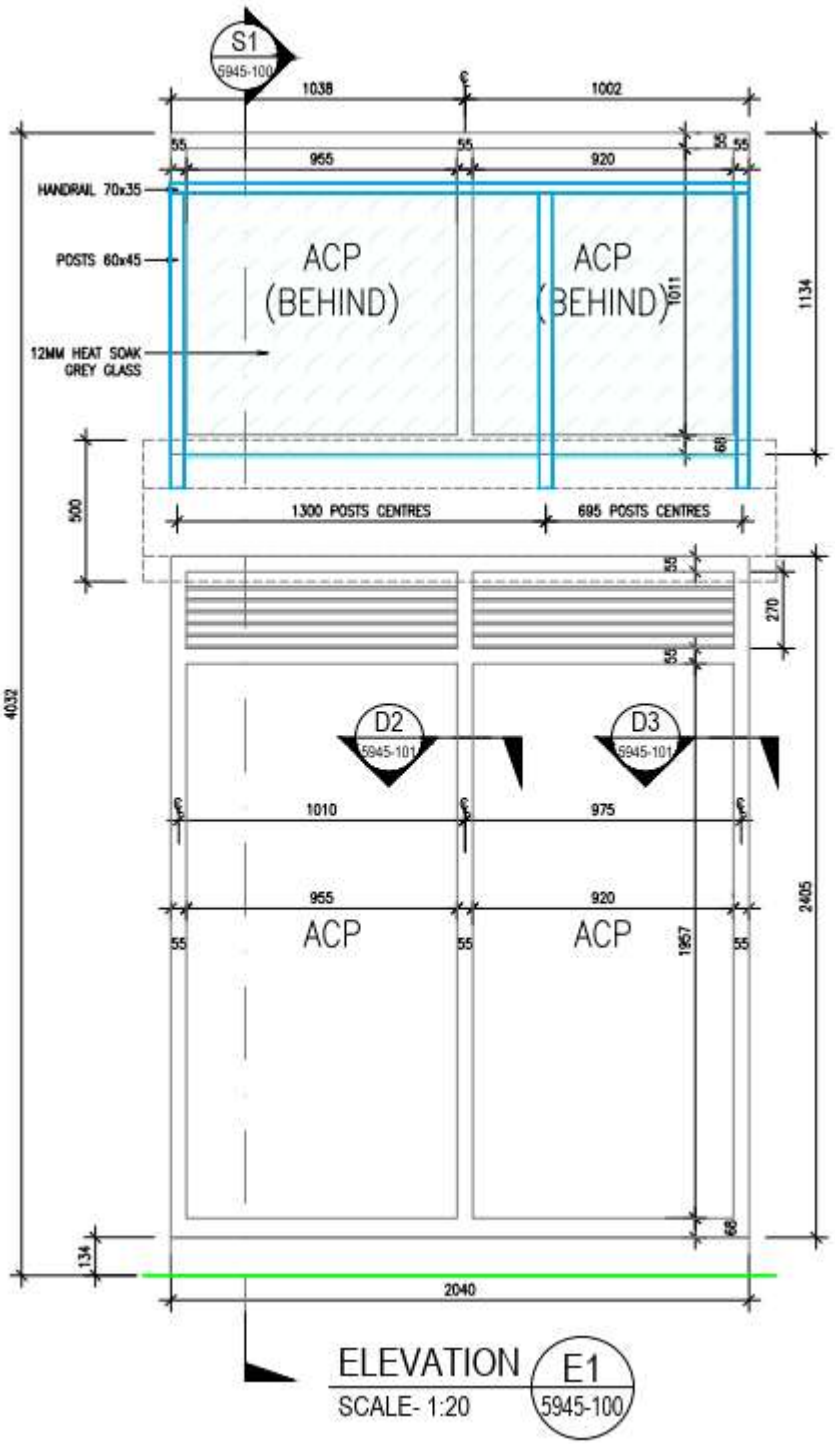


Figure 13 System assembly – Front view

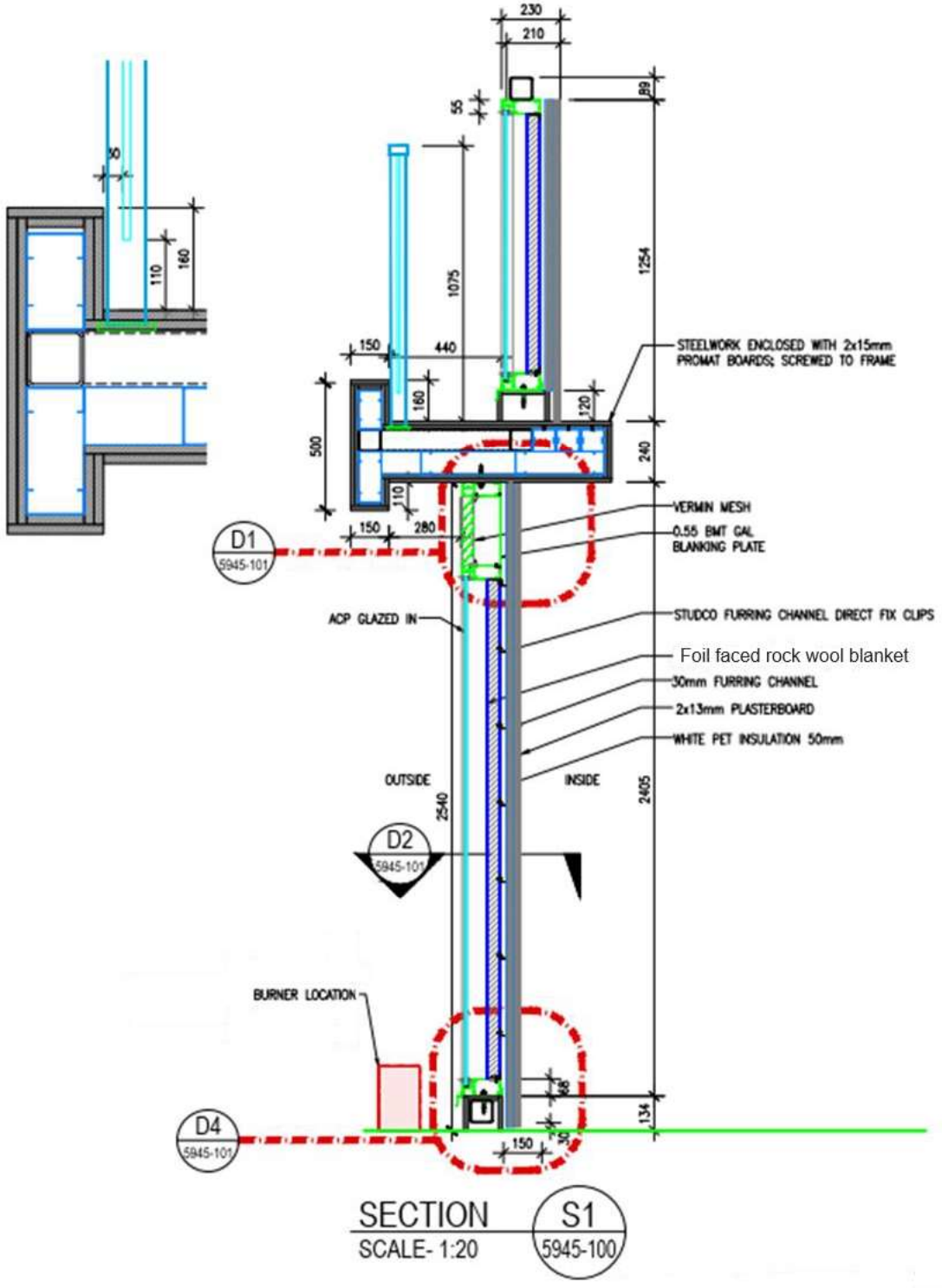


Figure 14 System assembly –Side view

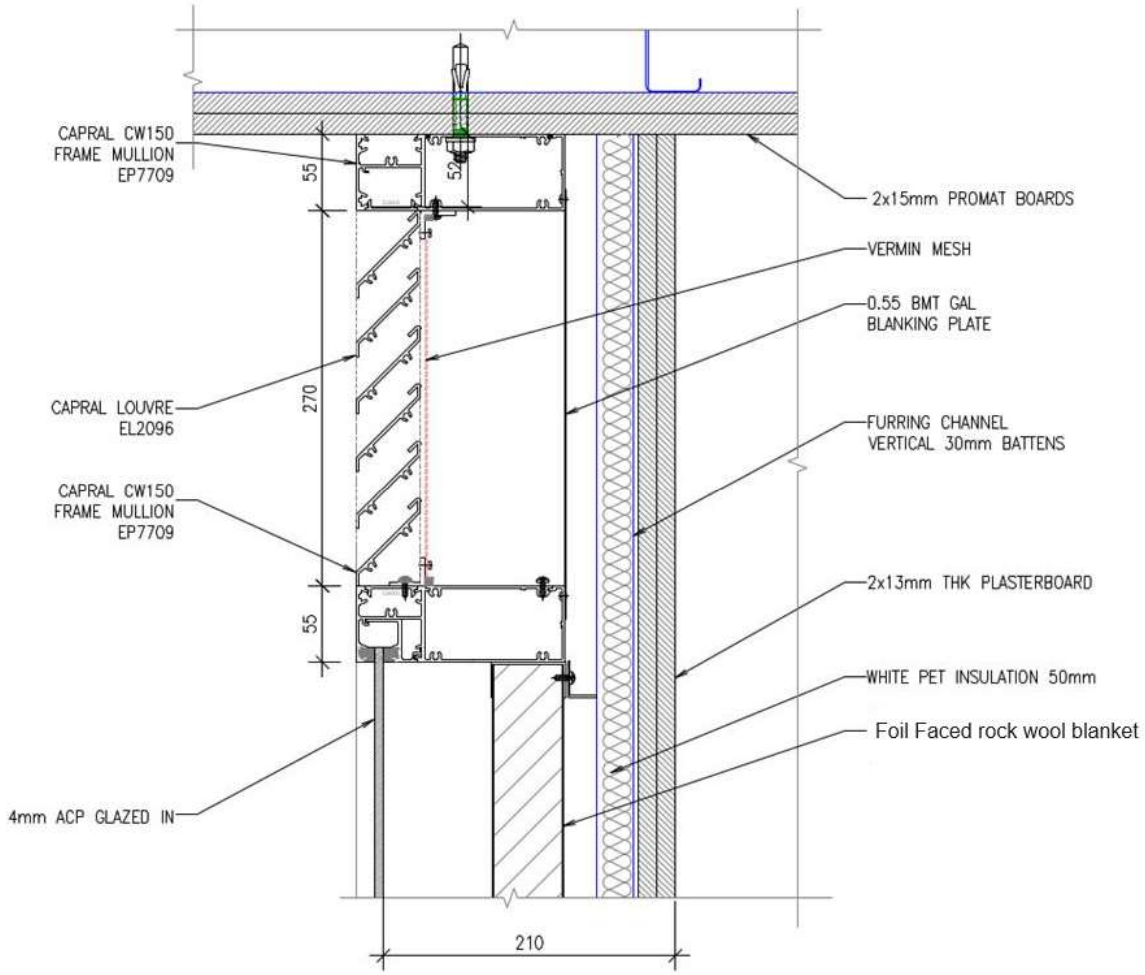


Figure 15 System detail – Detail D1

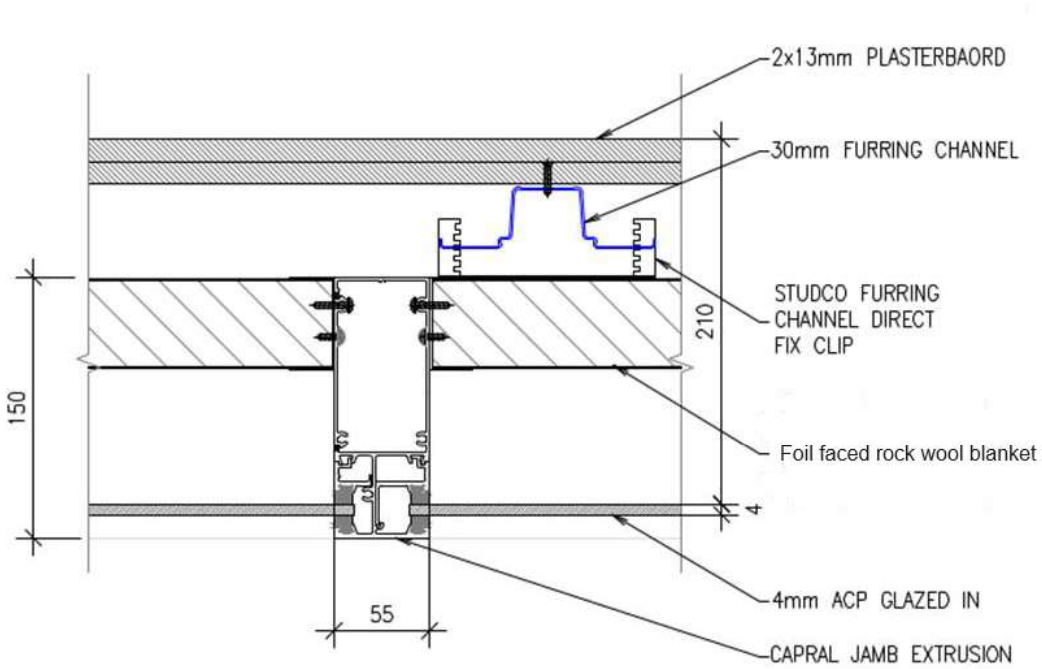


Figure 16 System detail – Detail D2

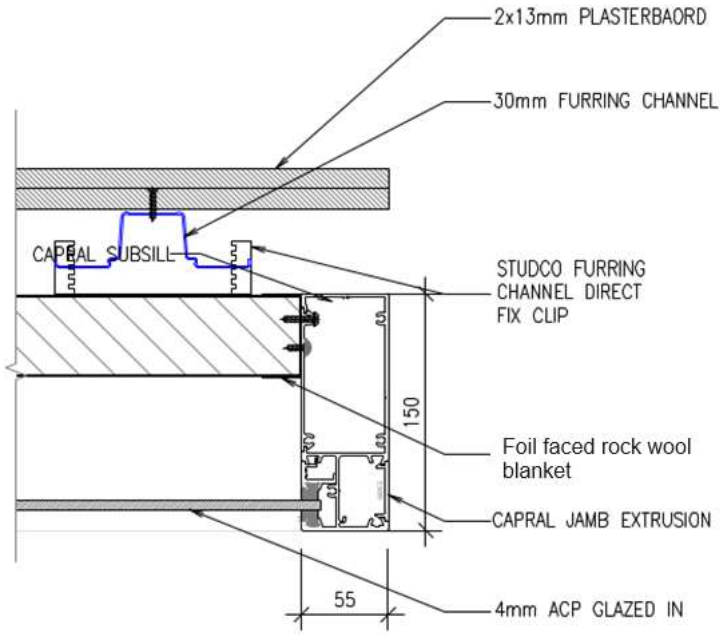


Figure 17 System detail – Detail D3

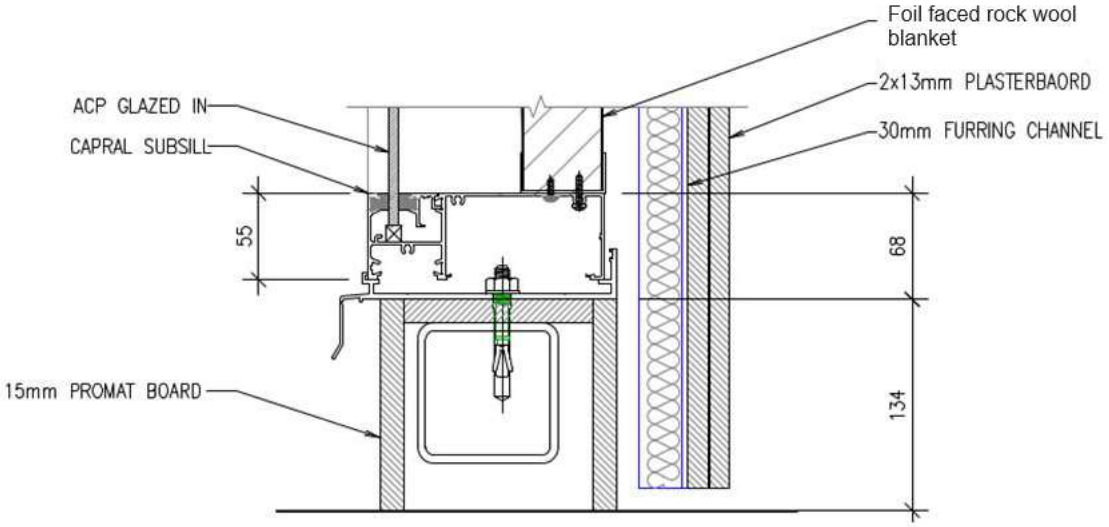


Figure 18 System detail – Detail D4

Appendix B Photographs

Figure 19 The specimen before the reaction to fire test

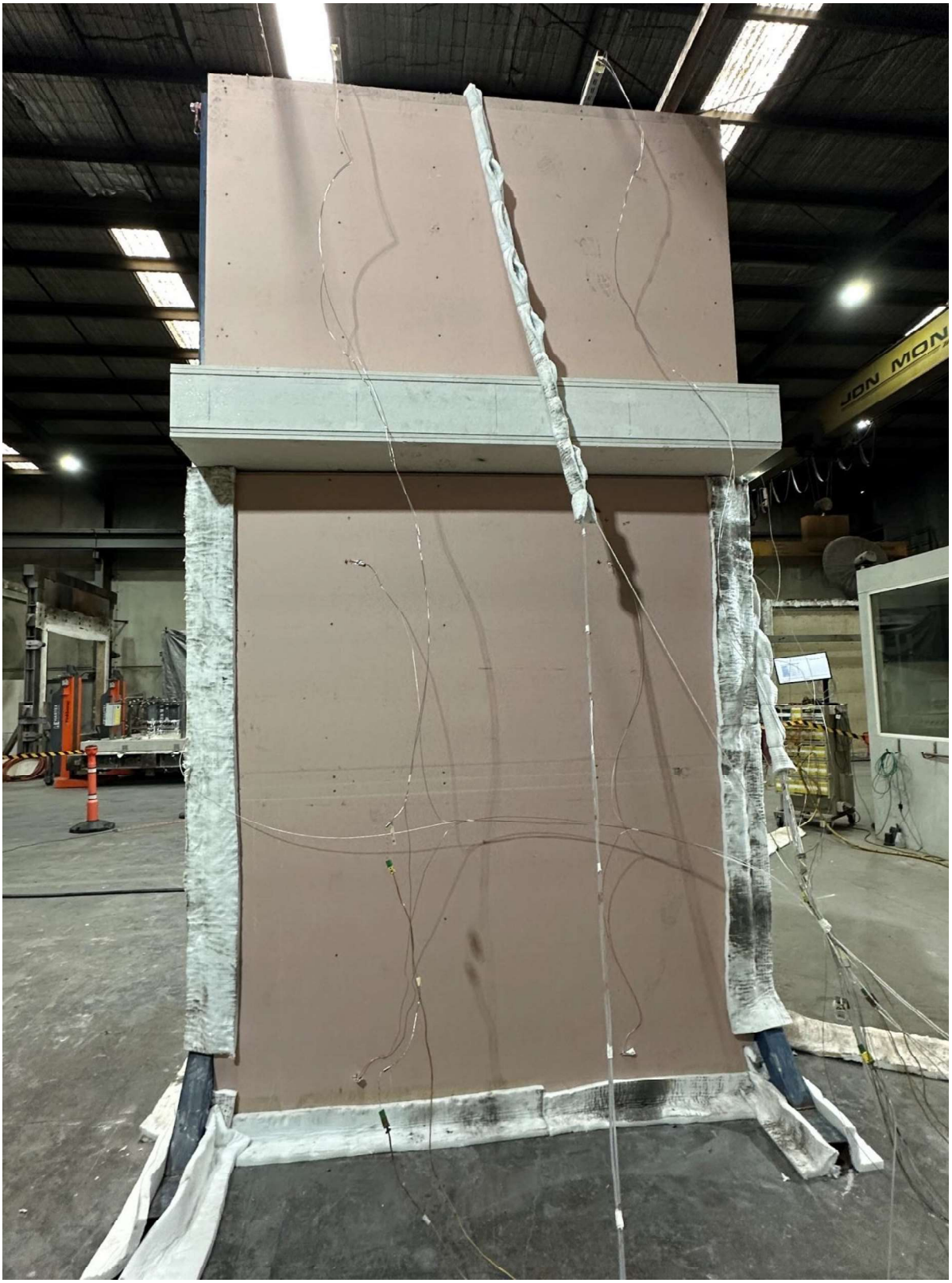


Figure 20 The specimen before the reaction to fire test – unexposed side

Figure 21 The specimen 40 seconds into the test (burner output set to 500 kW)

Figure 22 The specimen 1 minutes into the test

Figure 23 The specimen 2 minutes into the test

Figure 24 The specimen 3 minutes into the test

Figure 25 The specimen 4 minutes into the test

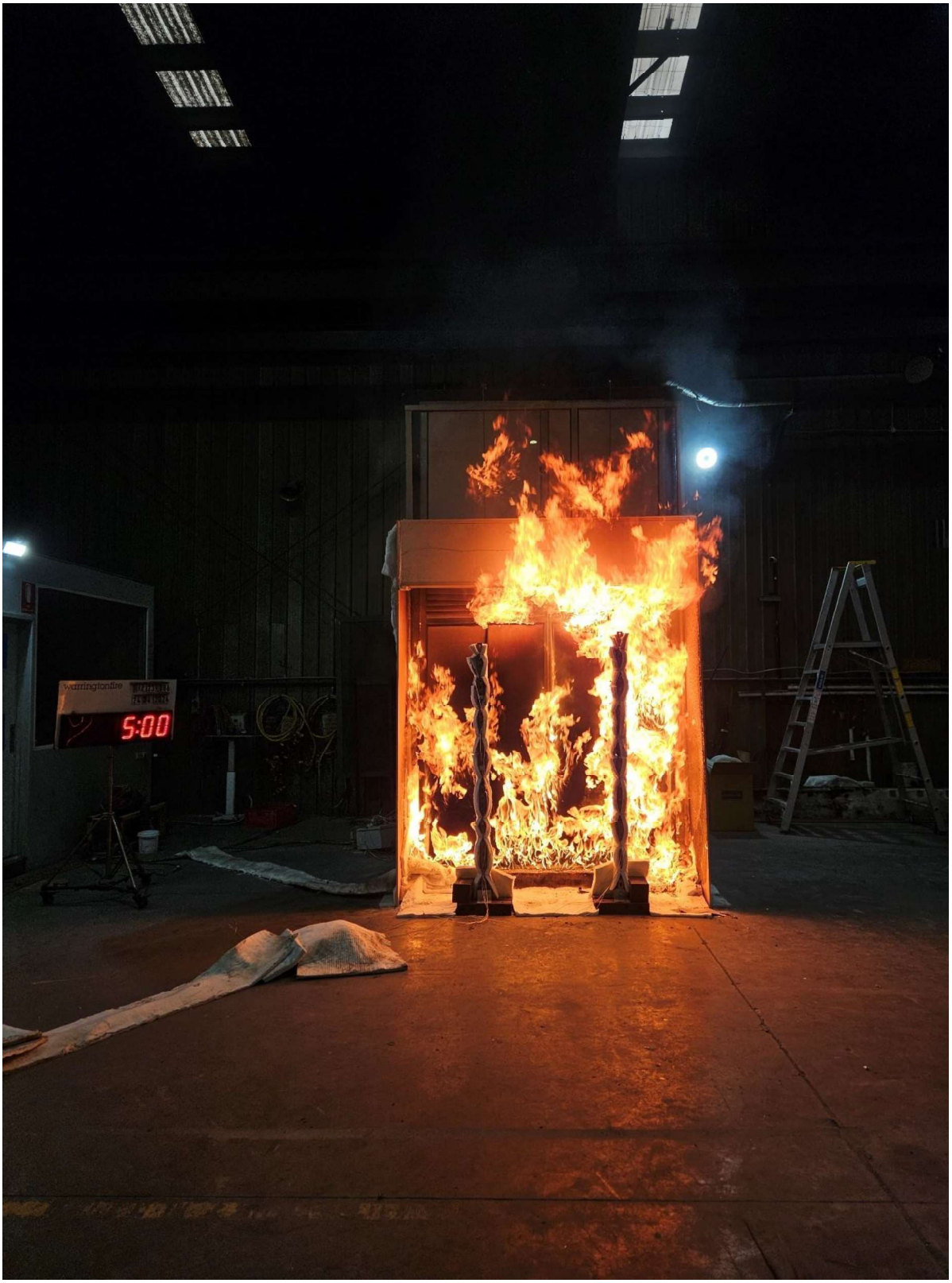


Figure 26 The specimen 5 minutes into the test

Figure 27 The specimen 6 minutes into the test

Figure 28 The specimen 7 minutes into the test

Figure 29 The specimen 7 minutes 8 seconds into the test

Figure 30 The specimen 9 minutes into the test

Figure 31 The specimen 10 minutes into the test

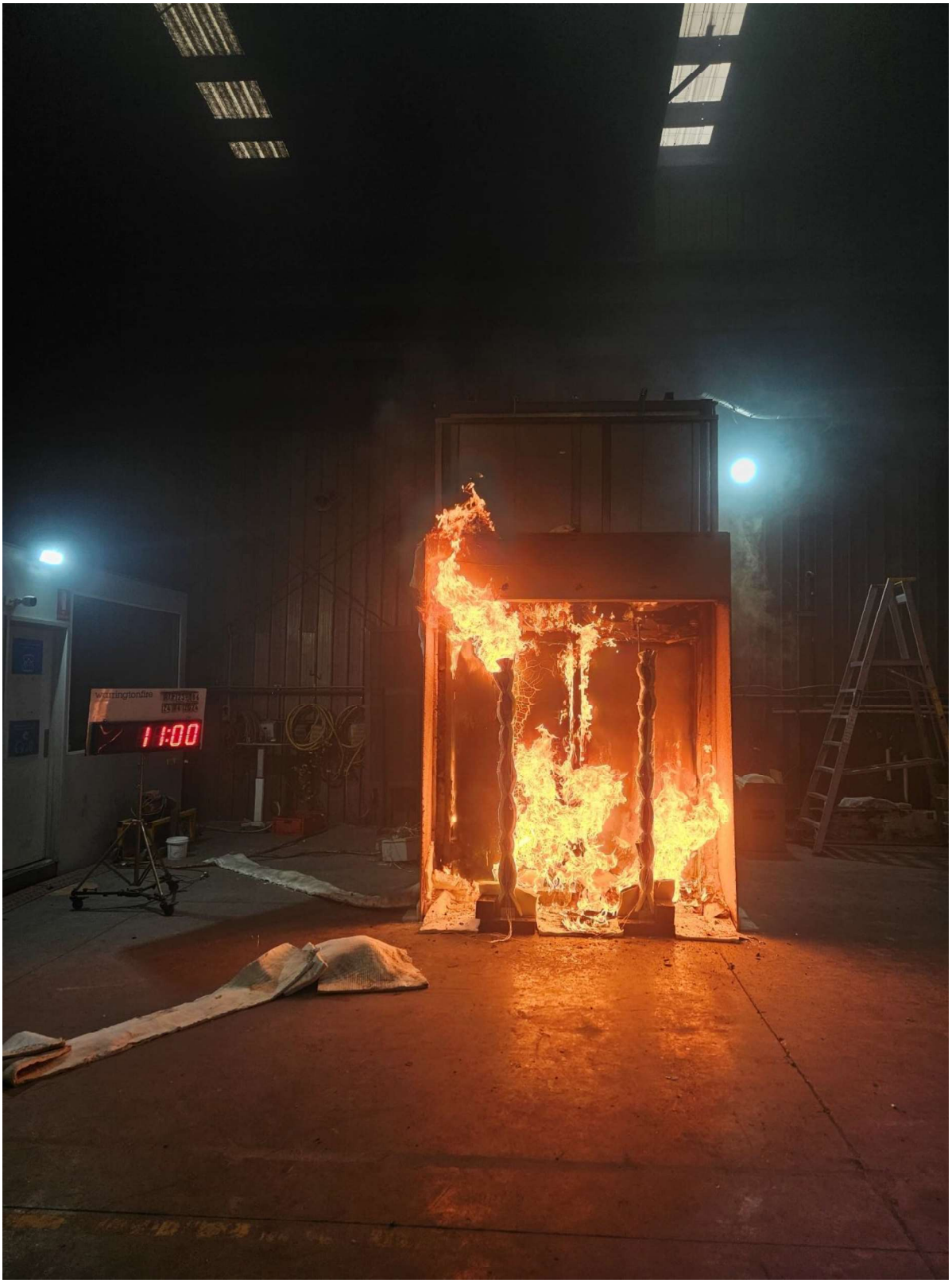


Figure 32 The specimen 11 minutes into the test

Figure 33 The specimen 12 minutes into the test

Figure 34 The specimen 14 minutes into the test

Figure 35 The specimen 16 minutes into the test

Figure 36 The specimen 20 minutes into the test

Figure 37 The specimen 25 minutes into the test

Figure 38 The specimen 30 minutes into the test

Figure 39 The specimen 3 seconds after the burner was turned off (30 minutes 3 seconds into the test)

Figure 40 The specimen 1 minute after the burner was turned off (31 minutes into the test)

Figure 41 The specimen 1 minute 42 seconds after the burner was turned off (31 minutes 42 seconds into the test)

Figure 42 The specimen 32 minutes 8 seconds after the burner was turned off (40 minutes into the test)

Figure 43 The specimen 4 minutes 38 seconds after the burner was turned off (34 minutes 38 seconds into the test)

Figure 44 The specimen 22 minutes 9 seconds after the burner was turned off (42 minutes 9 seconds into the test)

Figure 45 The specimen 24 minutes 52 seconds after the burner was turned off (54 minutes 52 seconds into the test)

Figure 46 The specimen at the end of the test.

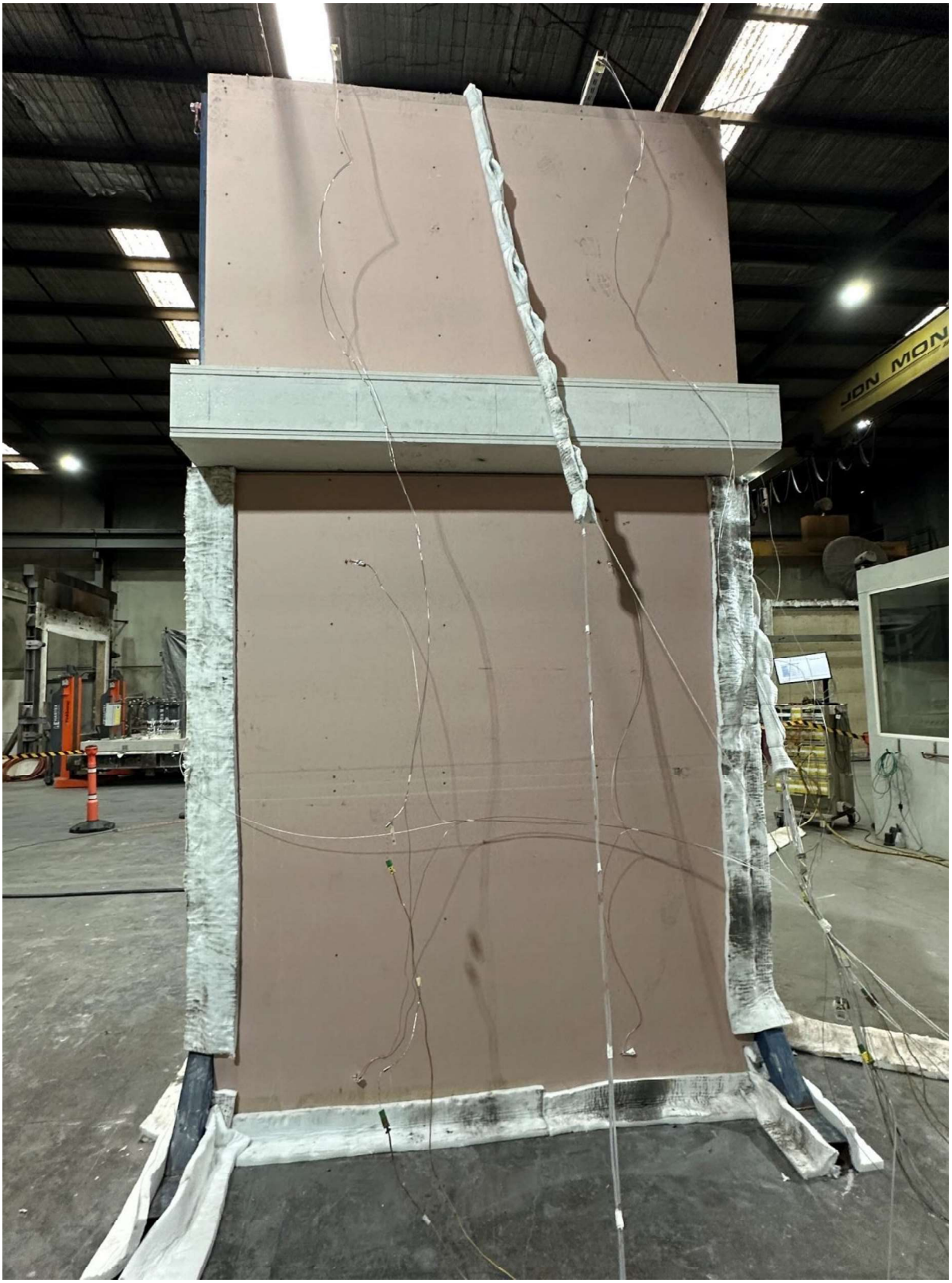


Figure 47 The specimen after the test – unexposed side.

Appendix C Chemical Analysis Results

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Test Report

Prepared by:

ANALYSIS OF CLADDING SAMPLES

For

Company: Warrington Fire
Contact: ***Steven Halliday***
Date: 22 February 2024

Project No: 24021

Prepared by: Dominic D'Adam
Approved by: Afsaneh Khansari

COMMERCIAL-IN-CONFIDENCE

UNSW SYDNEY

Analysis of Cladding Samples

1. SAMPLES

One envelope containing three ACP cores was received for analysis. The samples were identified as follows:

CCL sample coding	Client sample coding
24021-1	#1 - 100%
24021-2	#2 - 100%
24021-3	#3 - 45% Non FR

CCL has been asked to identify the polymer and the filler (s) in the samples by FT/IR, quantitate and identify the mineral filler in the samples and classify them in accordance with the ICA cladding scheme.

2. METHODOLOGY AND RESULTS

The aluminium metals were removed from the ACPs cladding polymer, and the flat surface of the polymer sample was abraded to remove any surface adhesive. The surface of the sample was analysed directly by FTIR. The FT-IR spectra are presented in Figures 1-3.

The core of the samples was then ashed to determine their percentage mineral content (Table 1). If sufficient (>0.5 g) ash was found in the sample, it was analysed for elemental composition by X ray fluorescence spectroscopy. Results are presented in Table 2.

Table 1 Ash content of 24021-1-3

Sample coding	Ash content (w/w%)
24021-1	3.3
24021-2	3.0
24021-3	40.0

Table 2 Elemental composition of sample 24021-3

Element Oxide	wt.%
Na2O	0.36
MgO	9.67
Al2O3	0.71
SiO2	6.47
P2O5	0.03
SO3	1.58
K2O	0.12
CaO	47.18
TiO2	0.88
V2O5	0.01
Cr2O3	<0.01
Mn3O4	0.03
Fe2O3	0.70
NiO	<0.01
CuO	0.05
ZnO	1.74
SrO	0.15
ZrO2	<0.01
BaO	2.04
HfO2	<0.01
PbO	<0.01
SnO2	0.01
CoO	<0.01
L.O.I.	29.50

NOTE: (i) L.O.I.= loss on ignition at 1,050 °C.

3. CONCLUSIONS

The cladding sample #1 consisted of 3.3% inert material and approximately 96% polyethylene polymer.

The cladding sample #1 is classified as ICA category A.

The cladding sample #2 consisted of 3.0% inert material and approximately 97% polyethylene polymer.

The cladding sample #2 is classified as ICA category A.

The cladding sample #3 consisted of 33.7% calcium carbonate, 5.6% magnesium hydroxide, 2.5% other inert material and approximately 58% polyethylene polymer.

The cladding sample #3 is classified as ICA category A.

The ICA Classification assigned is correct as per the September 2020 revision of the ICA Guidelines.

The reader is reminded that we can only analyse and classify the content of samples actually presented to us. We can offer no guarantee that this composition or classification is valid for cladding as a whole, because some types of cladding can be inhomogeneous, and a sample may not be representative of the cladding as a whole. Anyone using our results should consider these sampling issues and uncertainties before they generalise the results we present to anybody of cladding as a whole.

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22 February 2024

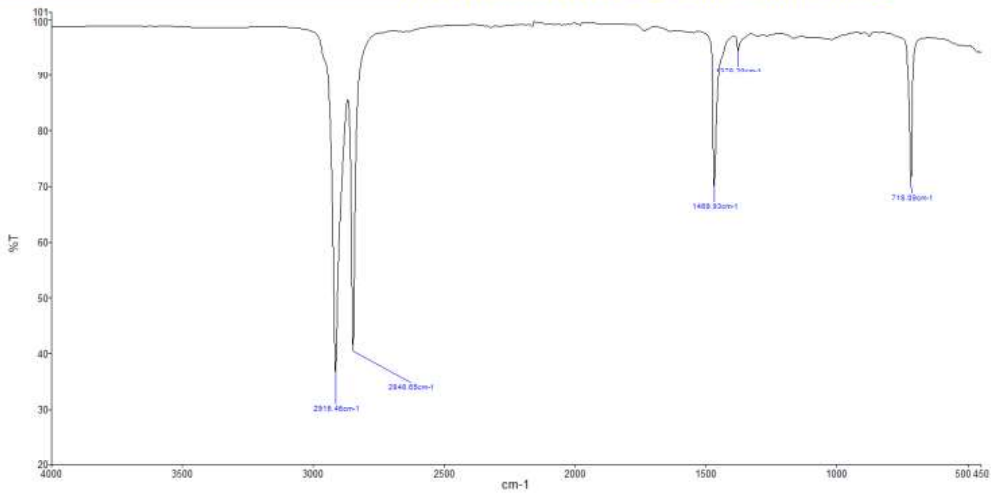

Figure 1. FT-IR spectrum of sample #1

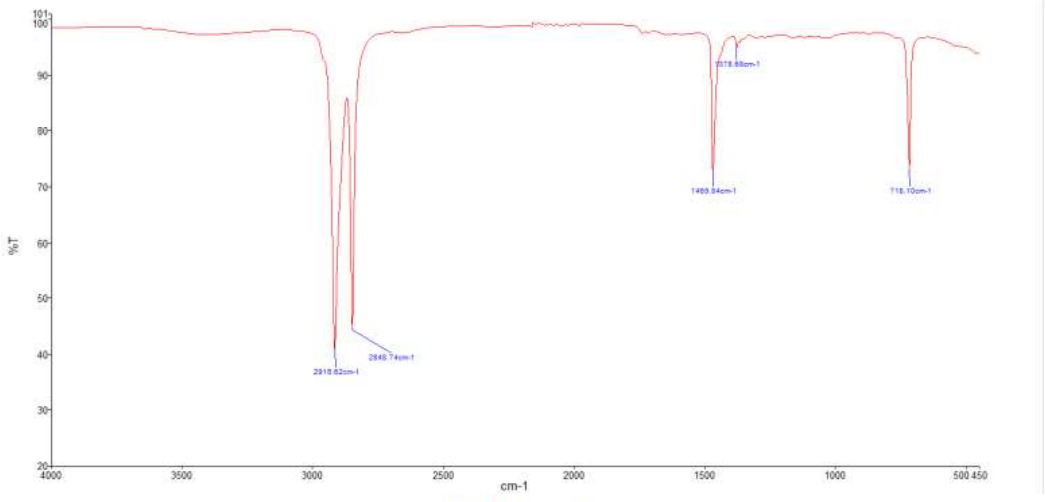

Figure 2. FT-IR spectrum of sample #2

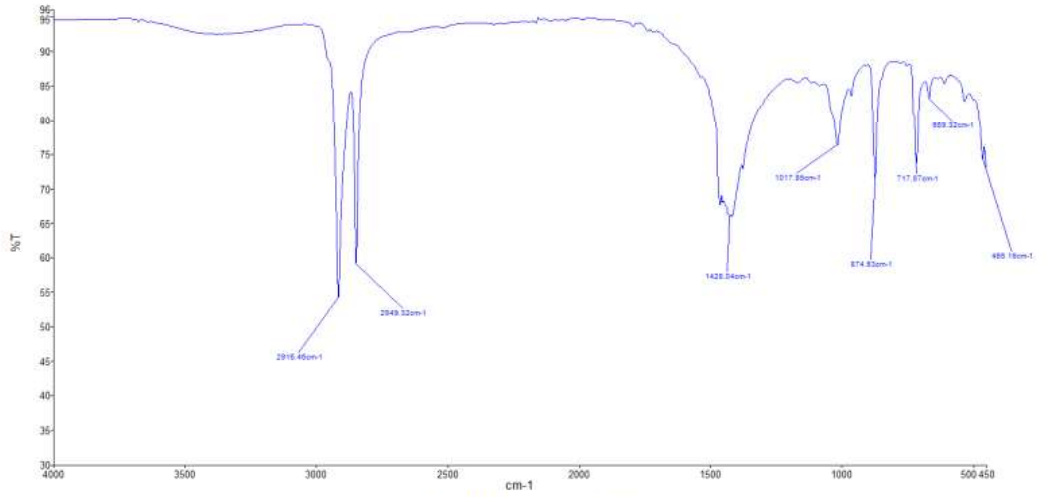

Figure 3. FT IR spectrum of sample #3

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