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Reaction to fire test report

Melbourne

Test standard:	AS ISO 9705:2003 (R2016)
Test sponsor:	Clear Form Wall Systems Pty Ltd
Product:	Clear Form Fire Retarded Polyvinyl Chloride (PVC) Formwork
Job number:	RTF190201
Test date:	21 February 2020
Version:	R2.0

Warringtonfire, accredited for compliance with ISO/IEC 17025:2017 – Testing

ilac-MRA
NATA
Accreditation No. 3277

Quality management

Version	Date	Summary of amendments including reasons			
R2.0	30 December 2022	Description	Additional report provided to alternative test sponsor.		
			Prepared by	Reviewed by	Authorised by
		Name	Anthony Rosamilia	Mandeep Kamal	Steven Halliday
		Signature			
			*Signed for and on behalf of Warringtonfire		

Executive summary

This report documents the findings of the reaction to fire test of a wall and ceiling lining performed on 21 February 2020 in accordance with AS ISO 9705:2003 (R2016).

Warringtonfire performed the test at the request of the Clear Form Wall Systems Pty Ltd.

The test assembly consisted of a fire test room whose ceiling and three walls were lined with panels (faces) of Clear Form Fire Retarded Polyvinyl Chloride (PVC) Formwork that were screw fixed to the walls and ceiling, leaving the wall with the doorway opening unlined with the test material. A summary of the classifications achieved in accordance with AS ISO 9705:2003 (R2016) and AS 5637.1:2015 is provided in Table 1.

A summary of the classifications achieved in accordance with C/VM2 – Verification Method: Framework for Fire Safety Design is provided in Table 2.

Table 1 Classification for AS ISO 9705:2003 (R2016) and AS 5637.1:2015

Criteria	Results
Group number	1
$SMOGRA_{RC}$ (in $m^2/s^2 \times 1000$)	4.7

Table 2 Classification for AS ISO 9705:2003 (R2016) and C/VM2 – Verification Method: Framework for Fire Safety Design

Criteria	Results
Group number	1 – S
Average smoke production rate (0 to 20 minutes) (in m^2/s)	0.7

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1. Introduction

This report documents the findings of the reaction to fire test of a wall and ceiling lining performed on 21 February 2020 in accordance with AS ISO 9705:2003 (R2016).

Warringtonfire Australia Pty Ltd (Warringtonfire) performed the test at the request of the sponsor listed in Table 3.

Table 3 Test sponsor details

Test sponsor	Address
Clear Form Wall Systems Pty Ltd	26A Harp Street Campsie NSW 2194 Australia

2. Tested system

The test assembly consisted of a fire test room whose ceiling and three walls were lined with panels (faces) of Clear Form Fire Retarded Polyvinyl Chloride (PVC) Formwork that were screw fixed to the walls and ceiling, leaving the wall with the doorway opening unlined. The fire test room was lined by 44 panels of various sizes as detailed in Table 4. A full description of the specimen is provided in Appendix A and Section 3.

The fire test room had studwork walls and ceiling lined with particle board and two layers of 16 mm thick fire-grade plasterboard on the internal side. When unlined, the internal dimensions of the fire test room were 3600 mm long × 2400 mm wide × 2400 mm high. The short wall opposite the ignition source had a centrally located doorway opening which was 800 mm wide × 2000 mm high. The floor was constructed from 18 mm thick cement sheeting.

The schedule of components for the tested system is summarized in Table 5. These were provided by 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 4 Test assembly

Quantity	Location	Size* (nominal)
12	Ceiling	2400 mm long × 300 mm wide
12	Left wall	2390 mm high × 300 mm wide
12	Right wall	2390 mm high × 300 mm wide
8	Rear wall	2390 mm high × 300 mm wide
* refers to visible face		

Table 5 Schedule of components

Item	Description	
Lining		
1	Product name	Clear Form Fire Retarded Polyvinyl Chloride (PVC) Formwork – panel faces
	Material	Polyvinyl chloride (PVC) with fire retardant (embedded)
	Measured uncut sheet size	3000 mm × 300 mm (visible face) × 2.5 mm thick – 310 mm total width and a depth of 10 mm.
	Mass per unit length	1.48 kg/m (measured)
	Density of material	1090 kg/m³ (measured)
	Installation	The panels were clipped together using the snap lock joining system and screw (item 2) fixed to the walls and ceiling. Screw locations were 100 mm from the short edges of the panels, at 200 mm centres along the length of the panels. See drawings in Appendix A.
	Joining method	Utilising the snap lock system of the panels
Fixings		
2.	Product name	Plasterboard screws
	Item name	#8 × 65 mm long screws, needle point, fine thread
	Installation	Used to secure the panels (item 1) to the wall and ceiling as shown in Appendix A.

Table 6 lists the installation details for the test specimen.

Table 6 Installation details

Item	Detail
Start date of construction	19 February 2020
Completion date of construction	20 February 2020
Room lining installed by	Representatives of Warringtonfire

3. Test procedure

Table 7 details the test procedure for this reaction to fire test.

Table 7 Test procedure

Item	Detail	
Statement of compliance	The test was performed in accordance with the requirements of AS ISO 9705:2003 (R2016) to determine the group number that may be assigned to the material using the classification schemes given in AS 5637.1:2015 and C/VM2 – Verification Method: Framework for Fire Safety Design.	
Variations	Smoke obscuration measurements were made using a helium-neon laser smoke photometer, as outlined in Annex H of ISO 9705-1:2016.	
Pre-test conditioning	The lining of the fire test room with the sample material was completed on 20 February 2020. Before construction, the components of the wall system were subject to normal laboratory temperature 20 °C (± 10 °C). The sample material was not subjected to any conditioning as the material was considered to be non-hygroscopic.	
Sampling / specimen selection	The laboratory was not involved in sampling or selecting the test specimen for reaction-to-fire test report.	
Ambient laboratory temperature	Start of the test Minimum temperature Maximum temperature	23 °C 23 °C 25 °C
Initial ambient temperature of the fire test room	21 °C	
Initial horizontal wind speed	0 - 0.3 m/s (measured at a horizontal distance of 1000mm away from the door opening before the test)	
Test duration	1200 seconds at which the system failed to achieve a heat release rate of 1 MW.	
Instrumentation and equipment	The instrumentation was provided in accordance with AS ISO 9705:2003 (R2016) as follows: • The ignition source was a propane gas fuelled box burner, with specifications in accordance with those given in Annex A of AS ISO 9705:2003 (R2016). The burner was placed on the floor in the corner of the room, opposite the doorway, so that two of the side walls of the burner were as close as possible to the specimen material. The gas flow during the test was controlled to provide an amount of gas equivalent to 100 kW of power during the first ten minutes of heat exposure and 300 kW of power during the second ten minutes of heat exposure. • The heat-flux emanating from the fire generated in the room was measured by a Schmidt-Boelter type heat-flux gauge, placed on the floor in the middle of the room. • The products of combustion were collected in an exhaust hood next to the doorway and outside the room. The hood was connected to an exhaust duct 400 mm in diameter, which had instruments inside to measure the conditions and properties of the combustion products during the test. • The volume flow rate was determined using a bidirectional pressure probe attached to a differential pressure transducer together with Type K MIMS thermocouple positioned near the probe. • Smoke obscuration measurements were made using a pair of aligned lenses with a halogen lamp placed at the focal point of one lens and a photo-detector placed at the focal length of an identical lens on the opposite side of the duct. The amount of light obscuration was then determined by comparing the output voltage from the photo-detector	

Item	Detail
	before the ignition source was lit to the output voltage of the photo-detector during the test. The temperature of the exhaust stream near the light beam was measured using a Type K MIMS thermocouple. • An exhaust sampling probe sampled the combustion products which were then analysed by a Servomex 4100 gas purity analyser. The oxygen concentration during the test was determined by paramagnetic oxygen analyser, and the carbon monoxide and carbon dioxide concentrations were determined using infrared sensor equipment, also within the Servomex 4100 gas purity analyser. • The horizontal wind speed was measured using a Testo 425 anemometer at a horizontal distance of 1 m from the centre of the doorway.
System performance	A calibration test was carried out before testing the product. The gas burner was placed centrally and 1 m below the exhaust hood by subjecting it to a stepwise change in heat release shown in Table 8. Data from instruments was collected and analysed every 3 seconds. At steady state conditions, the difference between the mean rate of heat release over 1 minute calculated from the measured oxygen consumption and that calculated from the metered gas output did not exceed ± 5% for each level of heat output – and therefore complied with the requirements of Section 10.1 of AS ISO 9705:2003 (R2016). The system response time was determined by calculating the average time taken for the measured rate of heat release to be within 10% of the final measured rate of heat release. System response data is listed in Table 8 and the system response has been calculated to be 14 s, which is within the 20 s limit required to comply with AS ISO 9705:2003 (R2016).

Table 8 Response time measurements during the step calibration process

Time interval (s)	Target heat output (kW)	Heat output (kW)	Heat measured (kW)	Time (s)	Variance (%)	Response time (s)
0 to 120	0	0	0	0	0	0
120 to 420	100	102	105	132	2.2	12
420 to 720	300	302	294	432	-2.7	12
720 to 1020	100	102	104	738	2.0	18

4. Test measurements, performance criteria and test results

4.1 Test measurements

The measurements taken for the heat flux, volume flow rate, heat release rate and light obscuration – along with the production rate of carbon dioxide – are included in Appendix C.

Table 11 in Appendix B includes observations of any significant behaviour of the specimen and details of the occurrence of the various performance criteria specified in AS ISO 9705:2003 (R2016).

Photographs of the specimen are included in Appendix D.

4.2 Performance criteria and test results

Australia

The group number is a numeric representation of the performance achieved during the AS ISO 9705-2003 (R2016) test and is used as a benchmark for the assessment of internal surface linings when exposed to fire. It was be determined by measuring the time to flashover when tested in accordance with AS ISO 9705-2003 (R2016). The time to flashover is defined the time taken for the total heat release rate to reach 1 MW.

The group classifications are:

- Group 1 – A material that does not reach flashover when exposed to 100 kW for 10 minutes followed by exposure to 300 kW for a further 10 minutes.
- Group 2 – A material that reaches flashover following exposure to 300 kW within 10 minutes after not reaching flashover having first been exposed to 100 kW for 10 minutes.
- Group 3 – A material that reaches flashover between 2 – 10 minutes when exposed to 100 kW.
- Group 4 – A material that reaches flashover within 2 minutes when exposed to 100 kW.

The material subjected to this AS ISO 9705:2003 (R2016) test did not achieve a heat release rate of 1 MW after 600 seconds exposure to a 100 kW heat source, immediately followed by a further 600 seconds exposure to a 300 kW heat source. Therefore, the system has achieved a classification of Group 1.

The maximum average rate of smoke growth for this material occurred at 255 seconds into the test and was found to be 1.2 m^2/s. Therefore, the $SMOGRA_{RC}$ (in $m^2/s^2 \times 1000$) value for the material is 4.7.

Table 9 Classification for AS ISO 9705:2003 (R2016) and AS 5637.1:2015

Criteria	Results
Group number	1
$SMOGRA_{RC}$ (in $m^2/s^2 \times 1000$)	4.7

New Zealand

AS ISO 9705:2003 (R2016) states that it is identical to and has been reproduced from ISO 9705:1993, so the data obtained from the test referenced in this report may be used where data obtained from ISO 9705:1993 is required.

The New Zealand Ministry of Business, Innovation and Employment's verification method – C/VM2 – Verification Method: Framework for Fire Safety Design – provides guidelines on establishing group numbers for lining materials. The scheme allows the classification of materials by group number, which indicates the amount of time taken for the material being tested to reach flashover under ISO 9705:1993 test conditions. It defines flashover to be a heat release rate of 1 MW so materials are classified – in accordance with appendix A of C/VM2 – by the time taken for the heat release rate as measured during the ISO 9705:1993 test – to reach 1 MW.

The group classifications for New Zealand are:

- Group 1 – S – Material that does not reach flashover when exposed to 100 kW for 10 minutes followed by exposure to 300 kW for a further 10 minutes. In addition, the average smoke production rate for the period between 0 and 20 minutes of the test period does not exceed 5.0 m^2/s.
- Group 1 – Material that does not reach flashover when exposed to 100 kW for 10 minutes followed by exposure to 300 kW for a further 10 minutes.
- Group 2 – S – Material that reaches flashover following exposure to 300 kW within 10 minutes after not reaching flashover having first been exposed to 100 kW for 10 minutes. In addition, the average smoke production rate for the period between 0 and 10 minutes of the test period does not exceed 5.0 m^2s^{-1}.
- Group 2 – Material that reaches flashover following exposure to 300 kW within 10 minutes after not reaching flashover having first been exposed to 100 kW for 10 minutes.
- Group 3 – Material that reaches flashover between 2 – 10 minutes when exposed to 100 kW.
- Group 4 – Material that reaches flashover within 2 minutes when exposed to 100 kW.

The material subjected to this AS ISO 9705:2003 (R2016) test did not achieve a heat release rate of 1 MW after 600 seconds exposure to a 100 kW heat source, immediately followed by a further 600 seconds exposure to a 300 kW heat source. Between 0 and 20 minutes of the test period, the average smoke production rate was 0.7 m^2/s. Therefore, the C/VM2 – Verification Method: Framework for Fire Safety Design – classifies this material as Group 1-S.

Table 10 Classification for AS ISO 9705:2003 (R2016) and C/VM2 – Verification Method: Framework for Fire Safety Design

Criteria	Results
Group number	1 - S
Average smoke production rate (0 to 20 minutes) (in m^2/s)	0.7

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 AS ISO 9705:2003 (R2016). 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 1 to Figure 6 were provided by the test sponsor.

All measurements – unless indicated – are in millimetres.

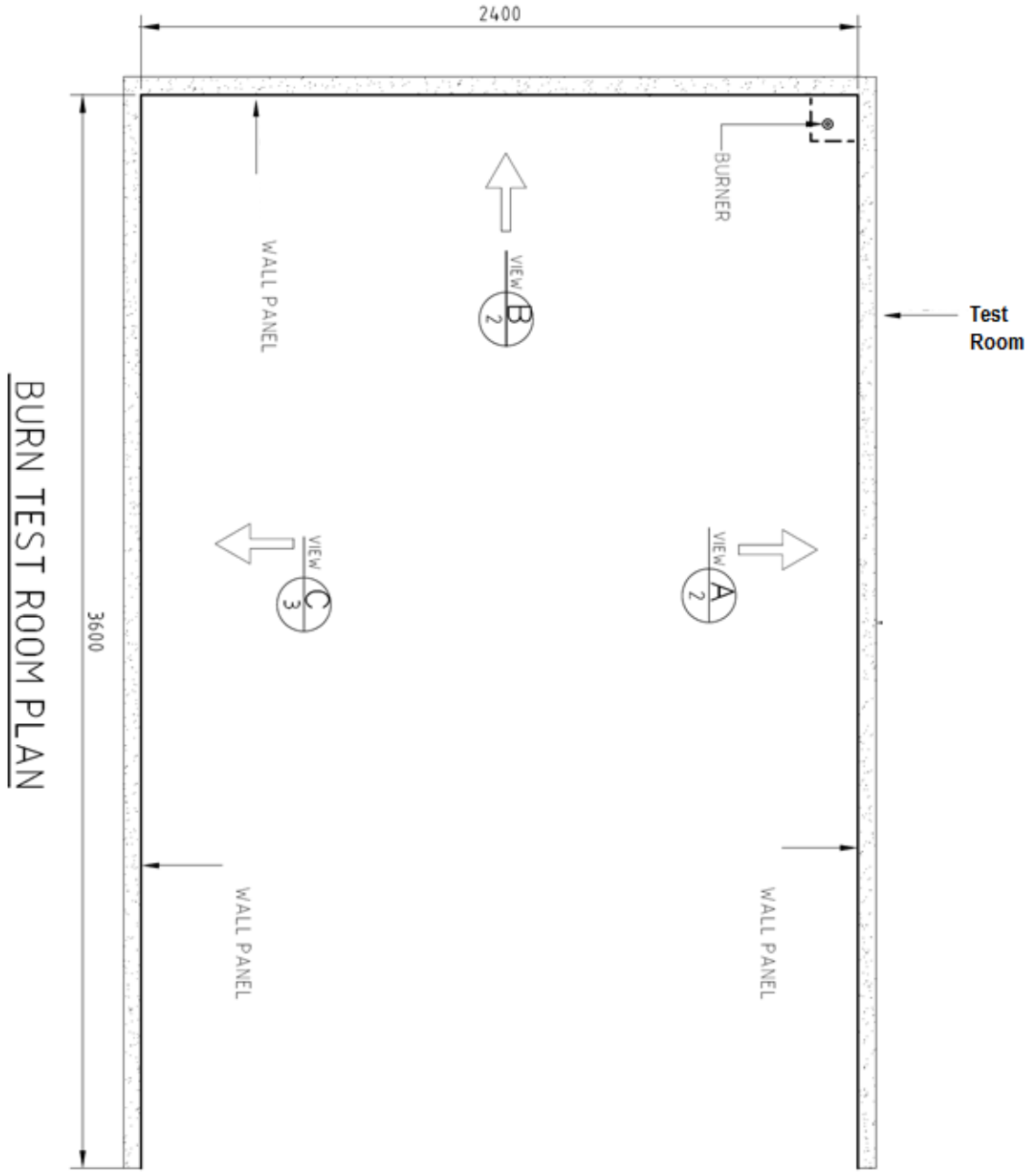

Figure 1 Test Room Layout (dimensions in mm)

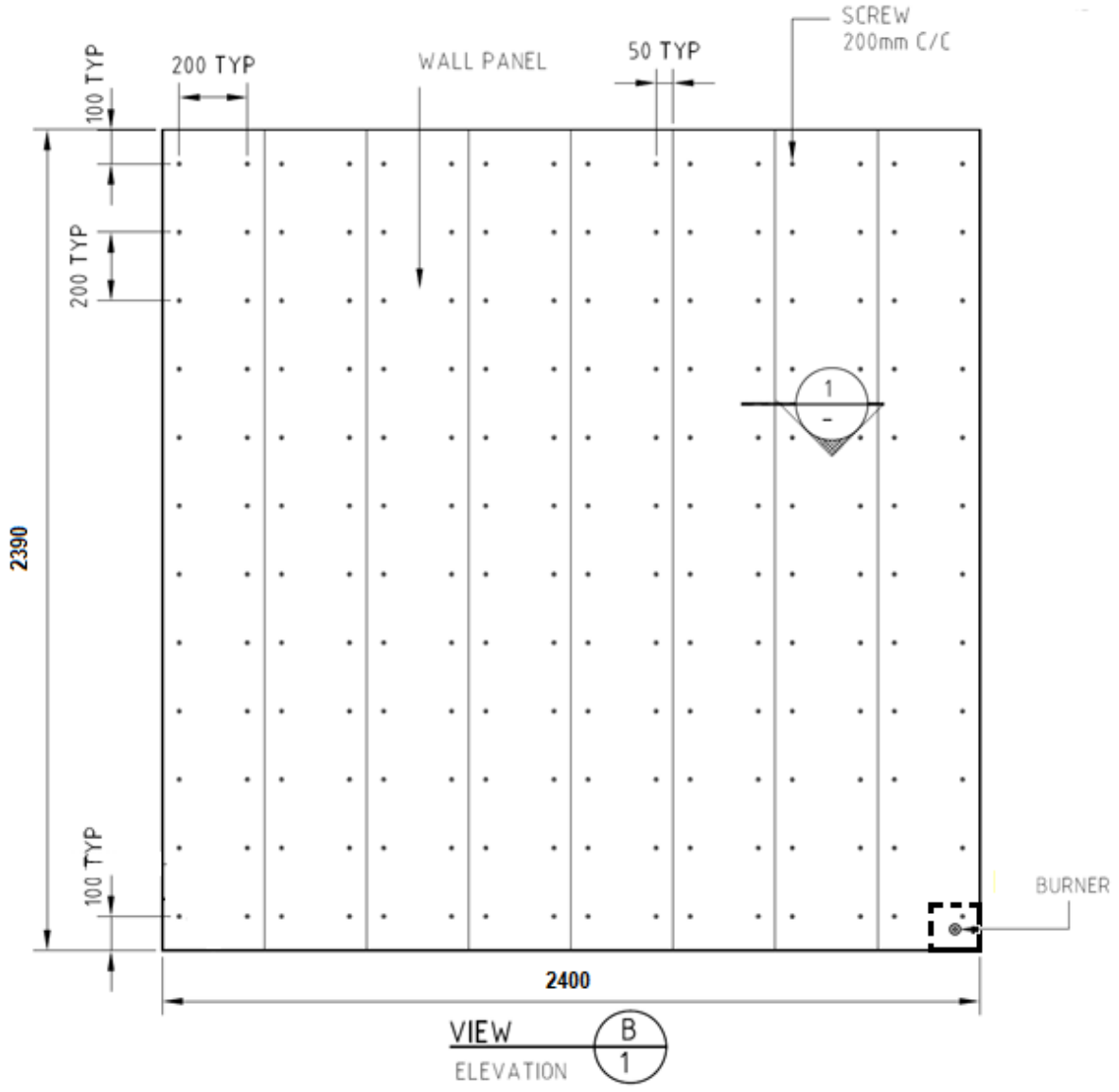

Figure 2 Rear wall (dimensions in mm)

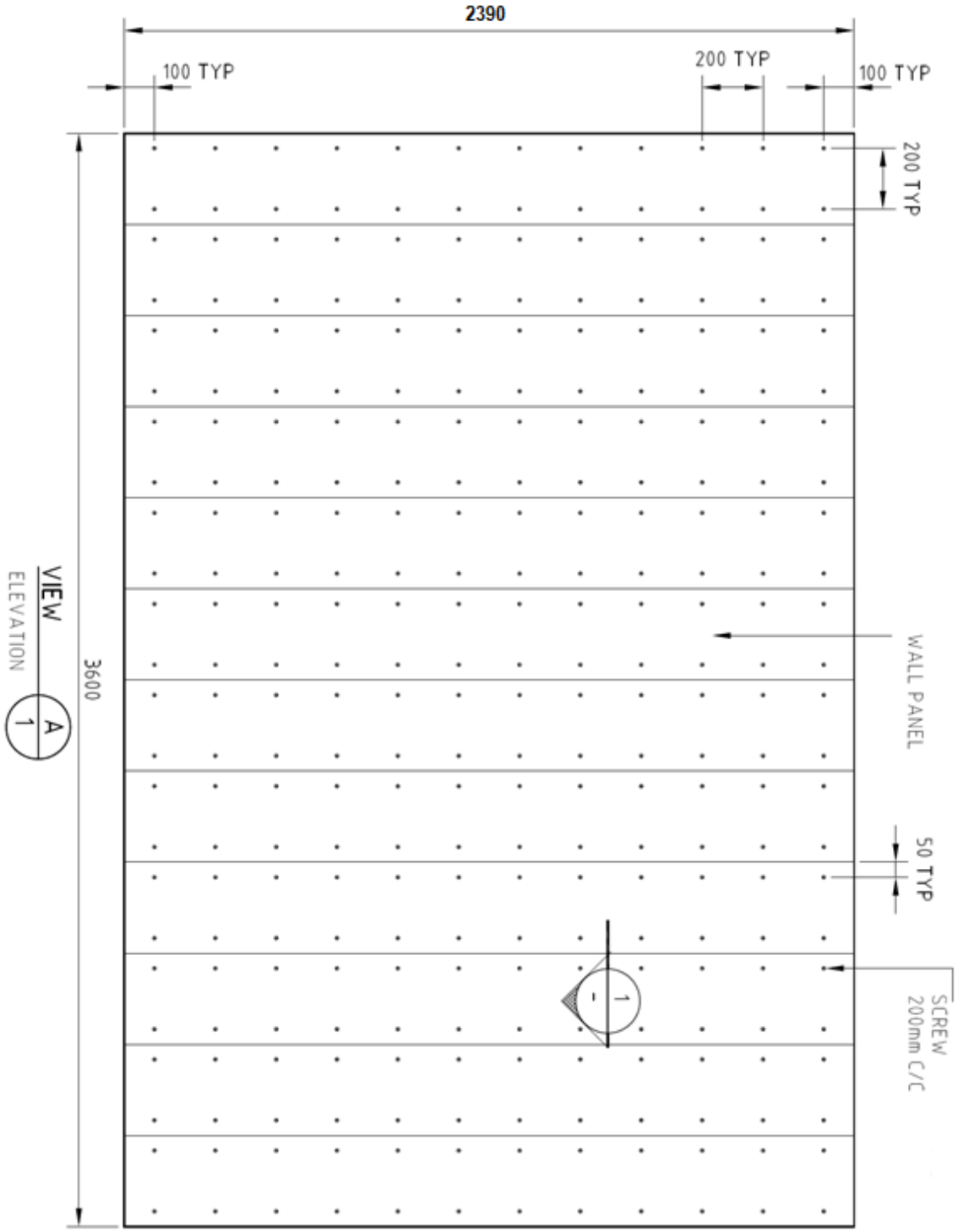

Figure 3 Ceiling (from above) (dimensions in mm)

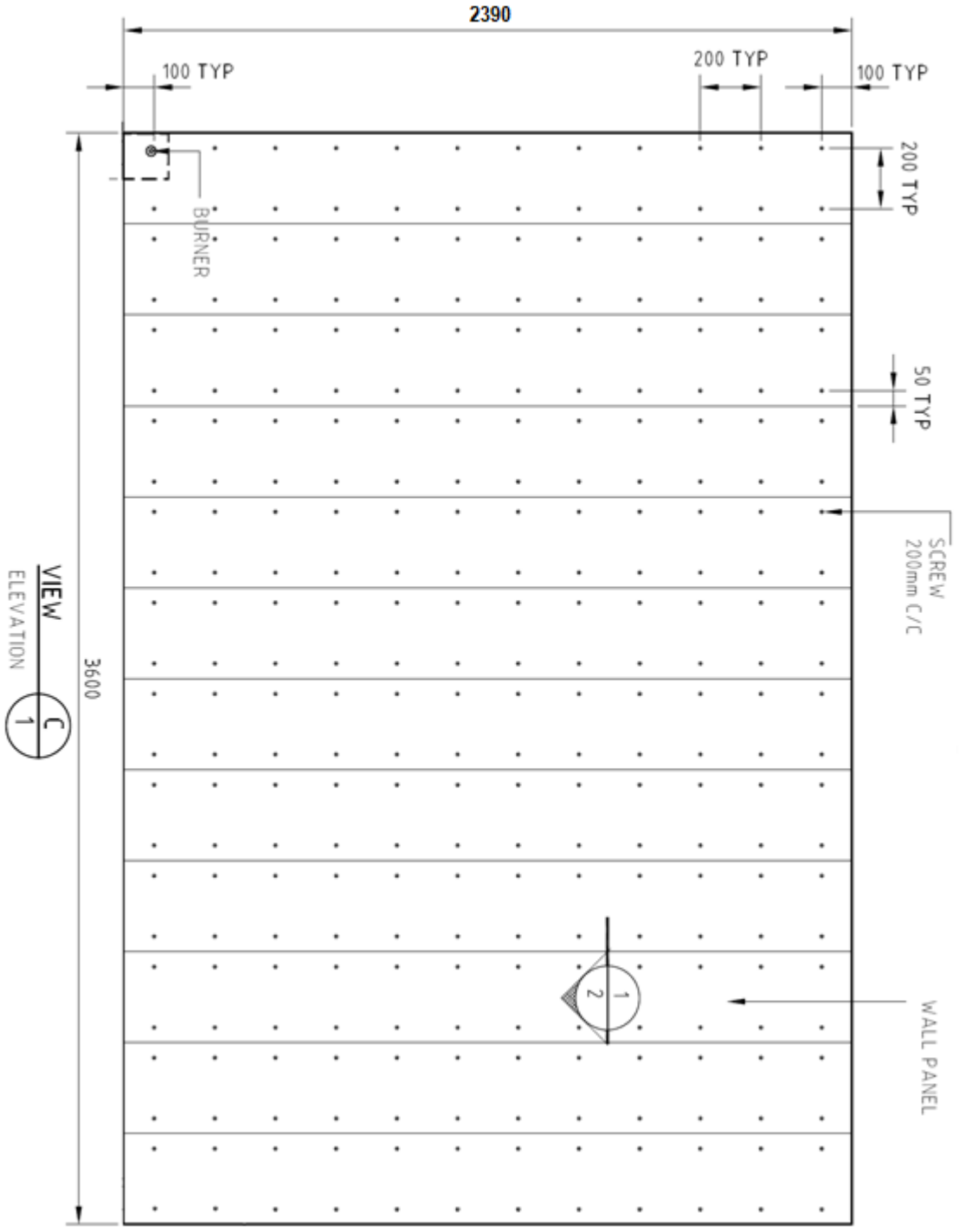

Figure 4 Right side wall (dimensions in mm)

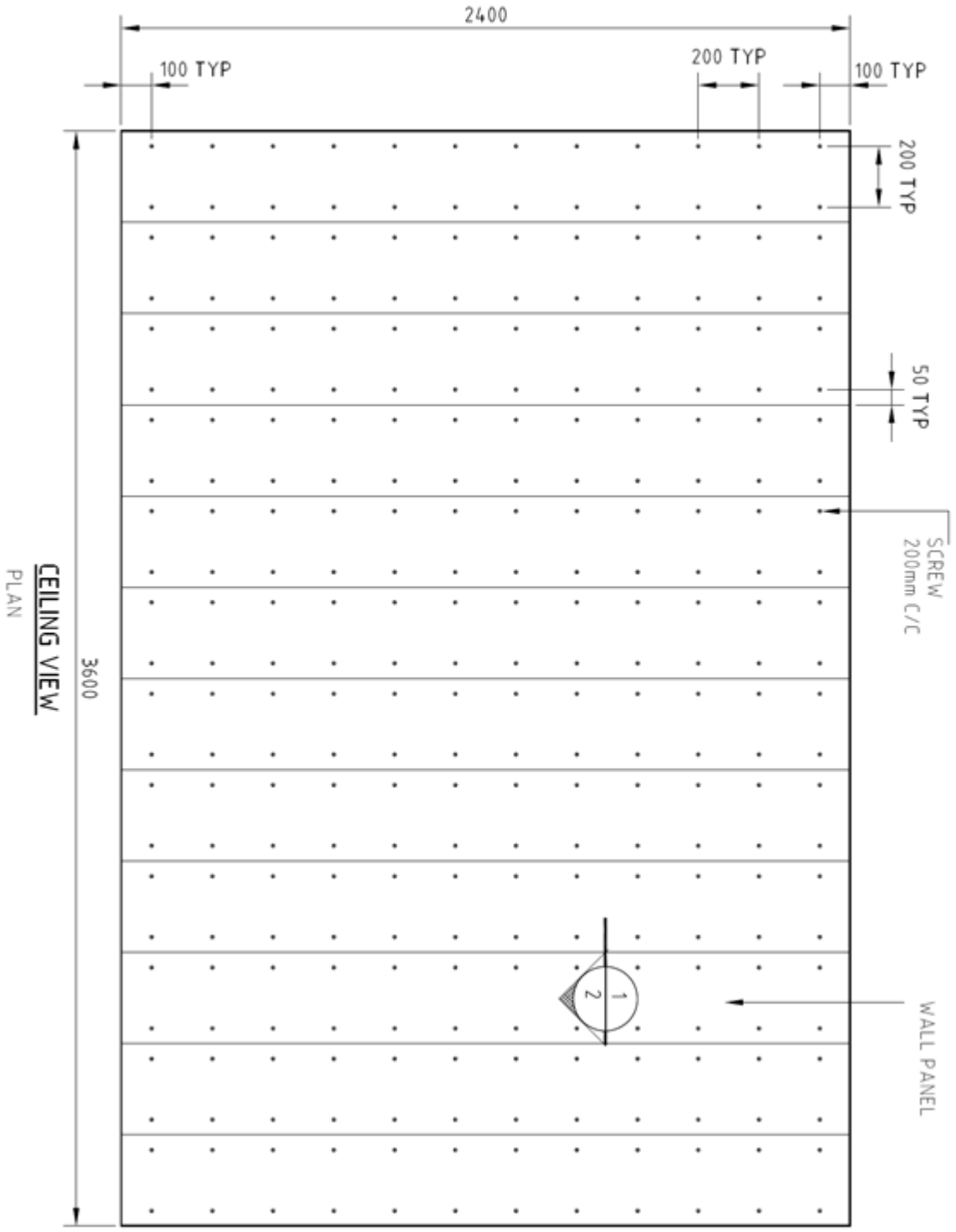

Figure 5 Left side wall (dimensions in mm)

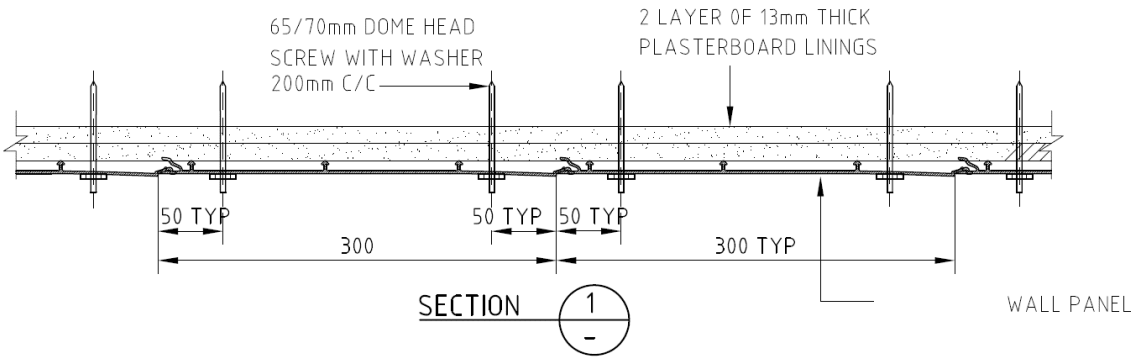

Figure 6 Typical panel to panel join (dimensions in mm)

Appendix B Test observations

Table 11 shows the observations of any significant behaviour of the specimen during the test.

Table 11 Test observations

Time		Observation
Min	Sec	
-02	00	The reaction to fire test was started.
00	00	With the burner output set to 100 kW, the burner was ignited.
00	30	There was discolouration of the panels around the burner.
01	10	Panels began softening and began to detach from the wall and ceiling. A heavy layer of smoke started to build up.
01	30	Material fell on the burner and was flaming.
02	00	The density of smoke within the room increased.
02	40	Panels fell from the ceiling and continued for throughout the test.
03	10	There was smoke emitting from the left wall panels.
05	27	Ceiling panels near the doorway started to soften and detach from the ceiling.
07	30	The density of smoke in the room decreased.
10	00	The burner output was increased to 300 kW.
10	24	The left wall panels began softening and began to detach from the wall.
20	00	Test ended.
Post-test		Debris around the burner was flaming. These were extinguished after 01 minute 15 seconds by Warringtonfire personnel.

Appendix C Test data

C.1 Heat flux

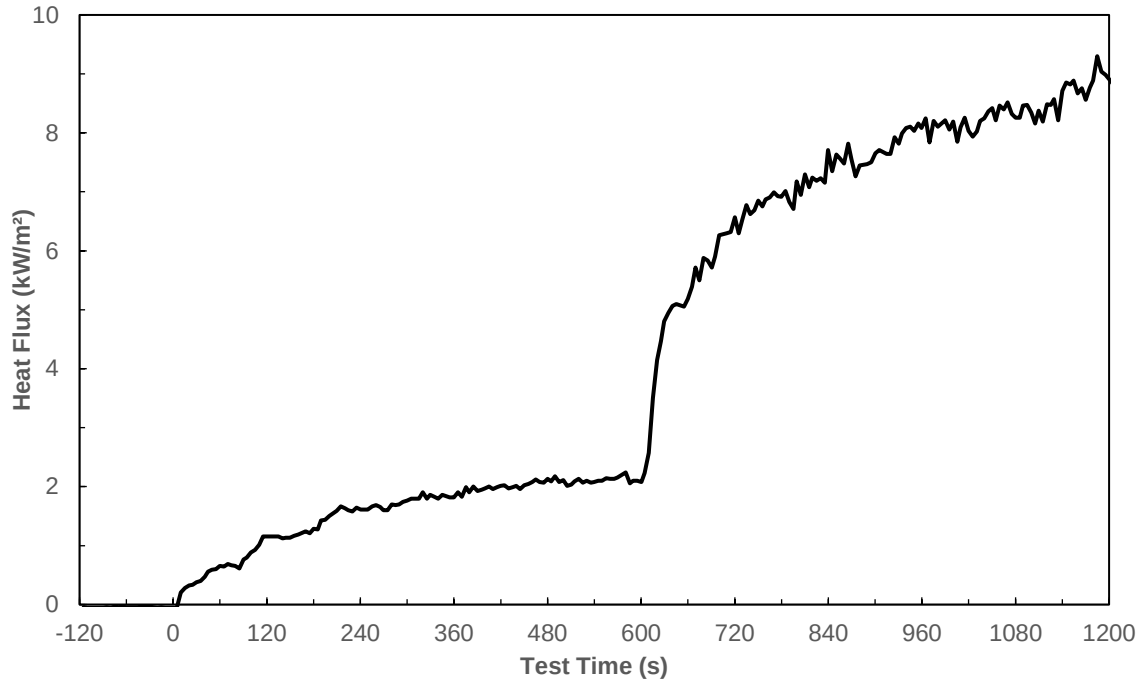

Figure 7 Heat flux vs time

C.2 Volume flow

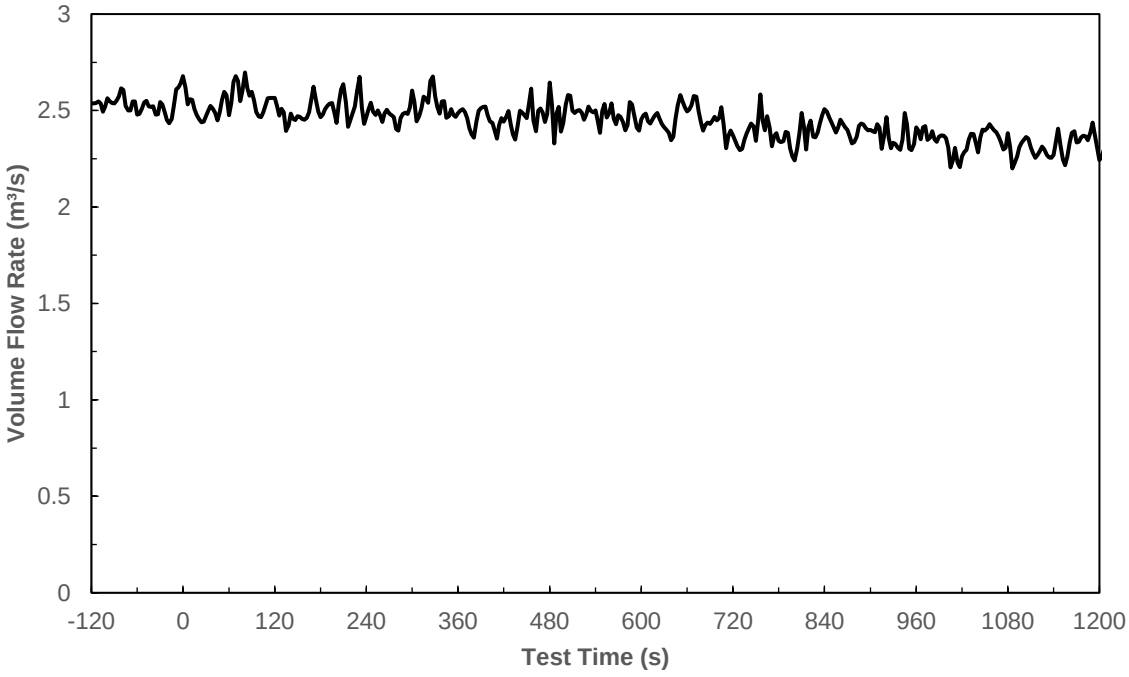

Figure 8 Volume flow rate in duct vs time

C.3 Heat release rate

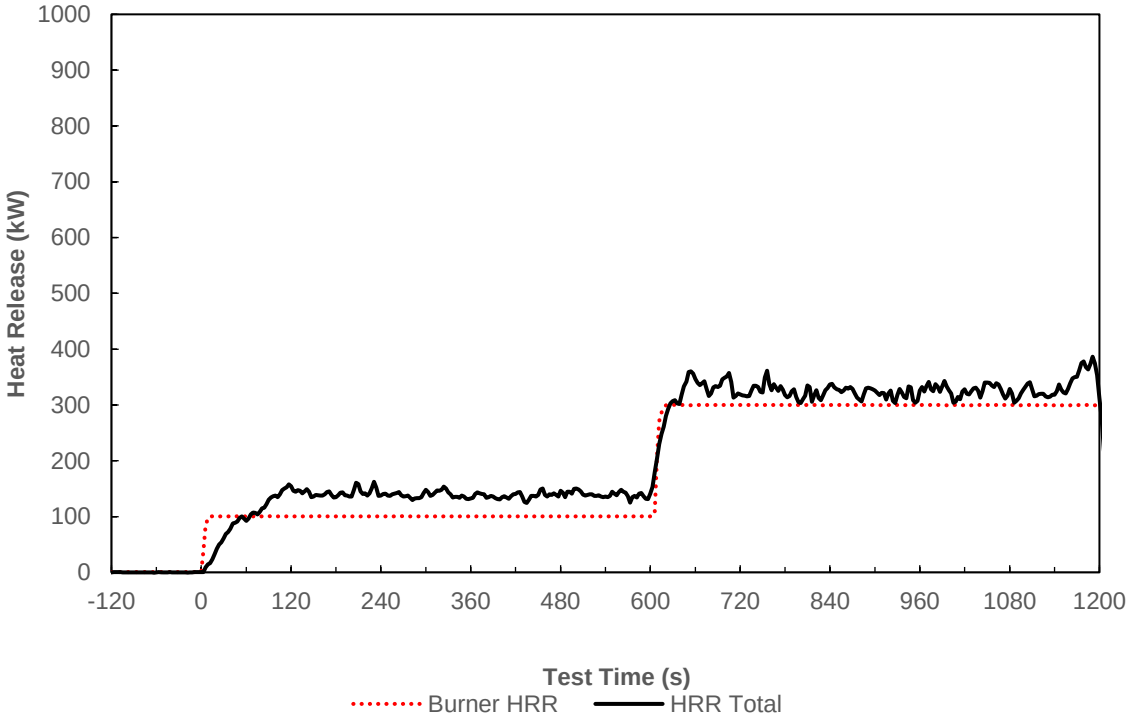

Figure 9 Heat release rate (HRR) of specimen and burner vs time

C.4 Carbon dioxide production

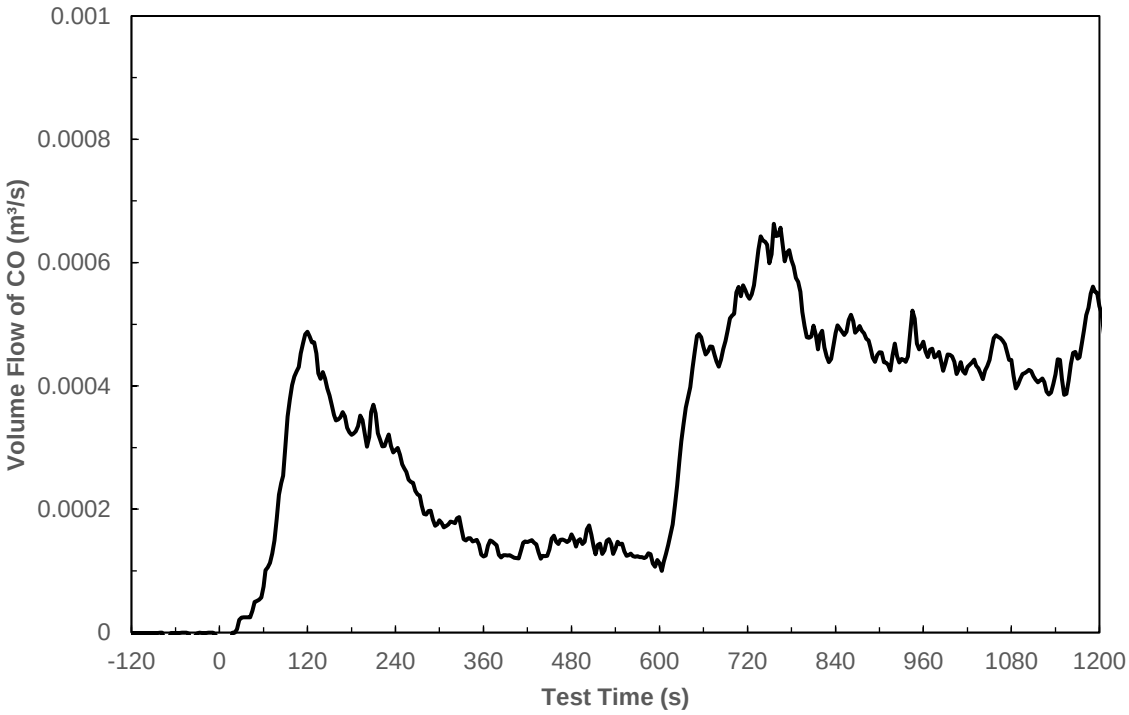

Figure 10 Production of carbon monoxide vs time, at reference temperature and pressure

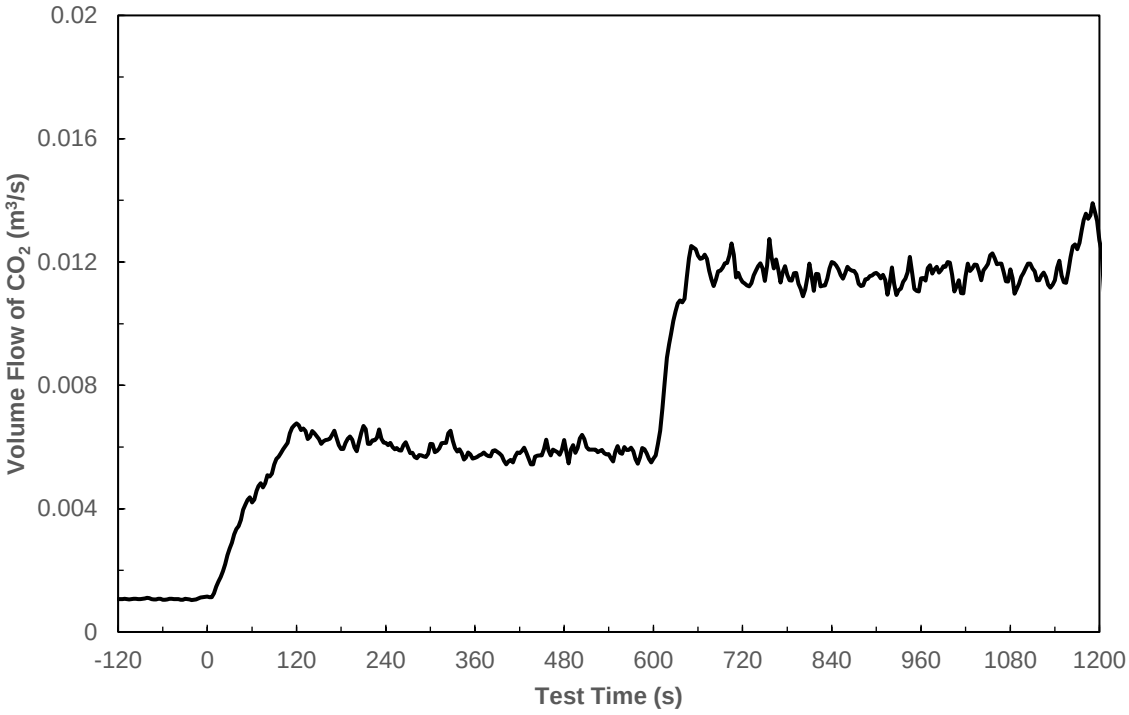

Figure 11 Production of carbon dioxide vs time, at reference temperature and pressure

C.5 Smoke production rate

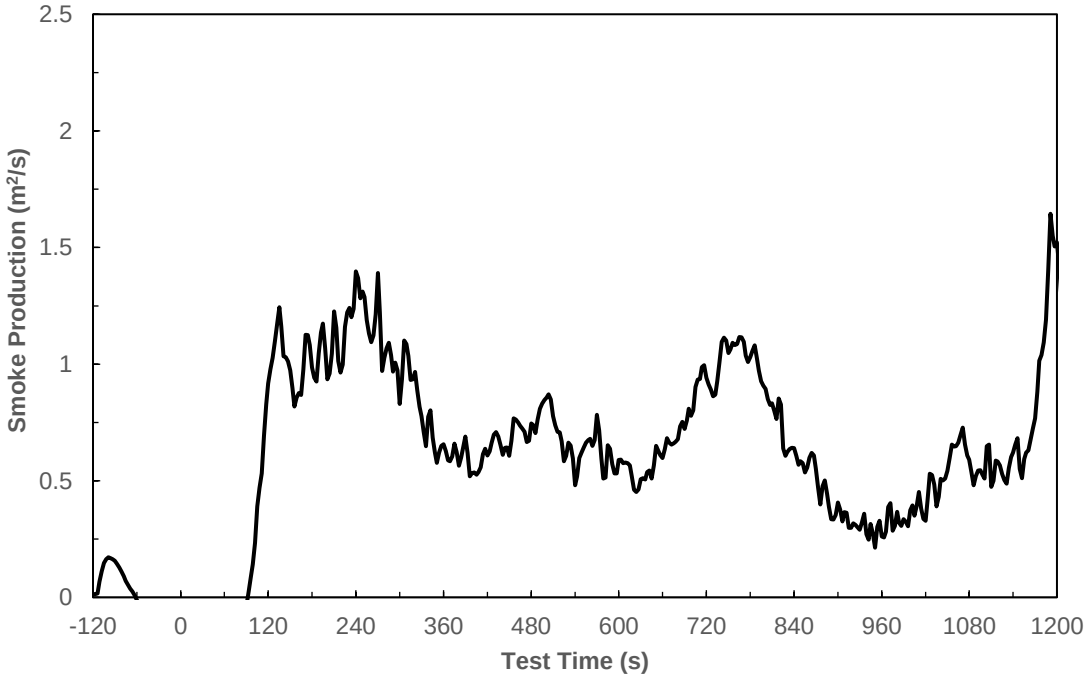

Figure 12 Production of light obscuring smoke vs time, at reference temperature and pressure

C.6 Temperature at different heights

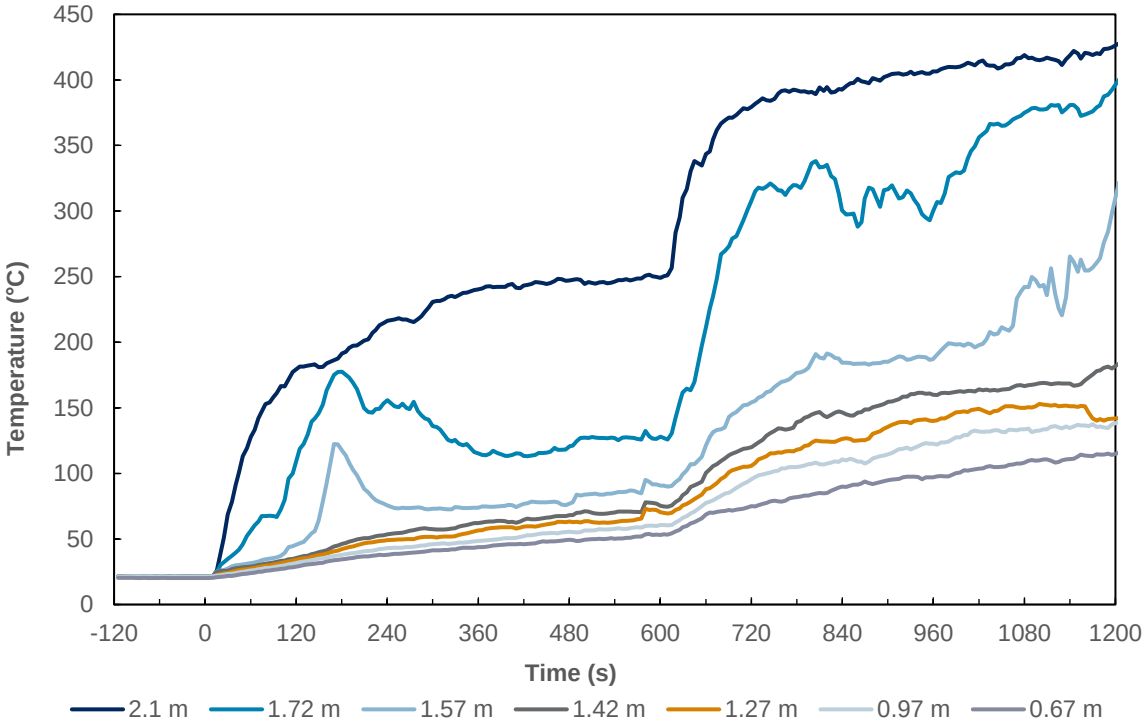

Figure 13 Temperature at the various heights from the floor in the corner opposite to the burner vs time

Appendix D Photographs

Figure 14 The system before the reaction to fire test

Figure 15 The system 4 seconds after burner ignition with the burner output of 100 kW

Figure 16 The specimen 01 minute after burner ignition with the burner output of 100 kW

Figure 17 The specimen 04 minutes 33 seconds after burner ignition with the burner output of 100 kW

Figure 18 The specimen 08 minutes after burner ignition with the burner output of 100 kW

Figure 19 The specimen 10 seconds after burner output was increased to 300 kW

Figure 20 The specimen 05 minutes after burner output was increased to 300 kW

Figure 21 The specimen 10 minutes after burner output was increased to 300 kW – at test end.

Figure 22 The specimen after the reaction-to-fire test

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