Reaction-to-fire test report

Wall and ceiling lining tested in accordance with AS ISO 9705:2003 (R2016) and AS 5637.1:2015

Test sponsor: Laminex New Zealand

Product: 4.5 mm Laminex® Aquapanel®

Job number: RTF190134

Test date: 3 September 2019 Revision: R1.0

Amendment schedule

Version	Date	Information about the report			
R1.0	18 September 2019	Description	Initial issue.		
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Executive summary

This report documents the findings of the reaction-to-fire test of a wall and ceiling lining undertaken on 3 September 2019 in accordance with AS ISO 9705:2003 (R2016) and AS 5637.1:2015.

The tested specimen consisted of 4.5 mm Laminex® Aquapanel® panels that were fixed to the test room walls and ceiling using both screws and nail adhesive. The panel to panel joins were made using aluminium jointers. The wall to ceiling panel joins were sealed using silicone sealant.

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 Amendment 5 is provided in Table 2.

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

Criteria	Results
Group number	3
$SMOGRA_{RC}$ (in $m^2/s^2 \times 1000$)	45.0

Table 2 Classification for C/VM2 – Verification Method: Framework for Fire Safety Design

Criteria	Results
Group number	3
Average smoke production rate (0 to 561 seconds)	5.0 m^2/s

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1. Introduction

This report documents the findings of the reaction-to-fire test of a wall and ceiling lining undertaken on 3 September 2019 in accordance with AS ISO 9705:2003 (R2016) and AS 5637.1:2015.

Warringtonfire Australia did the test at the request of the Laminex New Zealand.

Table 3 Test sponsor details

Test sponsor	Address
Laminex New Zealand	88 Mowbray Street Waltham 8023 Christchurch New Zealand

2. Construction details

The test specimen consisted of 4.5 mm Laminex® Aquapanel® panels that were screw and nail-adhesive fixed onto the test room walls and ceiling. The 65 mm screws were fixed at 600 mm centres horizontally and vertically, and the nail-adhesive was applied along the long edges of the panels, at 300 mm centres. The panel to panel joins were joined using aluminium jointers, except the wall to ceiling corners which was sealed using silicone sealant. The end panels were capped using an end cap.

The fire test room had studwork walls and ceiling lined with 18 mm particleboard and two layers of 16 mm thick fire-grade plasterboard on the internal side. The wall with the doorway was lined with two layers of 25 mm thick kaowool insulation. Without the specimen lining, 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 fire test room was lined by 11 panels of various sizes as detailed in Table 4. A full description of the specimen is provided in Appendix A and Section 3.

Table 4 Relative size and location of the lining

Quantity	Location	Size (nominal)
2	Ceiling	2400 mm x 1200 mm
1		2400 mm x 1190 mm
2	Right wall	2394 mm x 1200 mm
1		2394 mm x 1184 mm
2	Left wall	2394 mm x 1200 mm
1		2394 mm x 1184 mm
1	Back wall	2394 mm x 1200 mm
1		2394 mm x 1181 mm

Table 5 Installation details

Item	Detail
Start date of construction	2 September 2019
Completion date of construction	2 September 2019
Room lining installed by	Representatives of Warringtonfire Australia.

3. Schedule of components

Table 6 lists the schedule of components for the test specimen. These were provided by the test sponsor and surveyed by Warringtonfire Australia.

Table 6 Schedule of components

Item	Description	
Lining		
1.	Product name	4.5 mm Laminex® Aquapanel®
	Panel construction	The panels were compact laminates, which were made using phenolic resin saturated kraft papers bonded under heat and pressure. The panels had a reflective white decorative exposed face made using a 0.25 mm thick low pressure laminate paper (LPL) and a 4.25 mm thick non-reflective white kraft paper facing on the unexposed face, as nominated by the test sponsor.
	Measured uncut sheet size	2400 mm x 1202 mm x 4.5 mm thick
	Mass per unit area	7.04 kg/m^2
	Installation	The panels were installed directly onto the room walls and ceiling, with a layer of adhesive (item 5) applied along the long edge of the panels at 300mm centres, with the two ends applied at 50mm offset from the edges. The panels were also screw fixed using 65 mm screws (item 7) at 600mm centres along both the long and short edge of the panels, with the screws used at the end of the panels fixed at 50mm offset from the edges. The ceiling panels were installed first, followed by the wall panels. The panel to panel joins were joined using H jointers (item 2) except for the right/left wall to back wall panels which used internal corner jointers (item 3). The walls to ceiling corners were not joined using jointers, but instead sealed using a silicone sealant (item 6). The end panels which did not join with another panel were capped using end caps (item 4). For more details, refer to Appendix A.
	Jointing method	The wall panels were joined using H-jointers (item 2)/corner jointer (item 3). The grooves of the jointers were filled with 1mm of silicone sealant (item 6). For more details, refer to Appendix A.
2.	Product name	H jointer
	Material	Anodised aluminium alloy
	Jointer dimension	Refer to Figure 10.
	Installation	Used to join the panels (item 1). A 1mm bead of silicone sealant (item 6) was applied in both grooves. For more details, refer to Appendix A.
3.	Product name	Internal corner jointer
	Material	Anodised aluminium alloy
	Jointer dimension	Refer to Appendix A.
	Installation	Used to join the right/left wall panels to the back wall panels (item 1). A 1mm bead of silicone sealant (item 6) was applied in both grooves. For more details, refer to Appendix A.
4.	Product name	End cap
	Material	Anodised aluminium alloy
	Jointer dimension	Refer to Appendix A.
	Installation	Used to cap the ends of the panels that were not joined to another panel. For more details, refer to Appendix A.

5.	Product name	Sika Nailbond Premium
	Material	polyurethane construction adhesive Density: 1.26 g/cm^3 (supplier datasheet)
	Installation	Used to adhere the panels (item 1) to the room walls and ceiling. Each application had a nominal applied diameter of 10mm.
6.	Product name	Sika Sikasil NG – Arctic white
	Material	Silicone sealant Density: 1.03 g/cm^3 (supplier datasheet)
	Installation	Used to seal the corner for the wall to ceiling panel corner. Also applied in the grooves of the jointers (item 2 – 4).
Fixings		
7.	Product name	8g x 65 mm bugle head plasterboard screws
	Installation	Used to screw fix the panels (item 1) to the room walls and ceiling.

4. 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) and AS 5637.1:2015 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	None.
Pre-test conditioning	The fire test room was lined with the sample material on 2 September 2019. Before construction, the components of the wall system were subject to normal laboratory temperature 20 °C (± 10 °C) and humidity conditions. The sample materials were not subjected to any conditioning as the material was considered to be non-hygroscopic, as stated by the client.
Sampling / specimen selection	The laboratory was not involved in sampling or selecting the test specimen for the reaction-to-fire test.
Ambient laboratory temperature	Start of the test: 16 °C Minimum temperature: 16 °C Maximum temperature: 17 °C
Initial ambient temperature of the fire test room	15 °C
Initial horizontal wind speed	0.1 - 0.2 m/s (measured at a horizontal distance of 1000 mm away from the door opening before the test).
Test duration	561 seconds at which a heat release rate of 1 MW was recorded.
Instrumentation and equipment	The instrumentation was provided in accordance with AS ISO 9705:2003 (R2016) as follows: • The fire test room had galvanised studwork walls on three sides and ceiling, where each was lined with two layers of 16 mm fire-grade plasterboard supported by 18 mm thick particleboard on the external side. The floor was 18 mm thick cement sheeting. Without the specimen lining, the room had internal dimensions of 3600 mm long × 2400 mm wide × 2400 mm high with a doorway 800 mm wide × 2000 mm high centrally located in one of the shorter walls. • 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.

Item	Detail
	• The volume flow rate was determined using a bidirectional pressure probe attached to a differential pressure transducer together with mineral insulated metal sheathed (MIMS) Type K 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 opposing 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 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 MIMS Type K 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 gas purity analyser.
System performance	A calibration test was carried out before testing the product. The gas burner was placed directly under and 1000 mm below the exhaust hood – and then the gas supply to the burner was adjusted so that the power output from the burner was 0 kW for 2 minutes, then 100 kW for five minutes then 300 kW for a further five minutes, then 100 kW for five minutes and finally 0kW for two minutes. After that time the test was stopped. 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 12 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	101	99	129	-1.6	9
420 to 720	300	301	303	432	0.8	12
720 to 1020	100	101	103	735	1.4	15

5. Test measurements, performance criteria and test results

5.1 Test measurements

The measurements taken for the heat flux, volume flow rate, heat release rate and light obscuration – along with the production rates of carbon monoxide and 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.

5.2 Performance criteria and test results

Australia

AS 5637.1:2015 allows the classification of materials by group number – this indicates the amount of time taken for the material being tested to reach flashover under AS ISO 9705:2003 (R2016) test conditions. AS 5637.1:2015 defines flashover to be a heat release rate of 1 MW, so materials are classified, in accordance with AS 5637.1:2015, by the time taken for the heat release rate to reach 1 MW.

The group classifications are:

- Group 1 – Materials classified as Group 1 do not reach flashover after ten minutes exposure to a heat source delivering 100 kW immediately followed by a further ten minutes exposure to 300 kW.
- Group 2 – Materials classified as Group 2 reach flashover after ten minutes of exposure to a 100 kW heat source.
- Group 3 – Materials classified as Group 3 reach flashover after two minutes, but before ten minutes of exposure to a 100 kW heat source.
- Group 4 – Materials classified as Group 4 reach flashover before two minutes of exposure to a 100 kW heat source.

The material subjected to this AS ISO 9705:2003 (R2016) test achieved a heat release rate of 1 MW after 561 seconds exposure to a 100 kW heat source. Therefore, the system has achieved a classification of Group 3.

AS 5637.1:2015 also defines the smoke growth rate index, or $SMOGRA_{RC}$, as a quantity which may be obtained from the smoke obscuration measurements in the AS ISO 9705:2003 (R2016) test. The $SMOGRA_{RC}$ for a material is obtained by finding the maximum value of the average rate of smoke growth – where the averages are found from the total smoke obscuration determined over intervals of one minute, then dividing that value by the time that that maximum occurred and multiplying the result by 1000.

The maximum average rate of smoke growth for this material occurred at 423 seconds into the test and was found to be 18.5 m^2/s. Therefore, the $SMOGRA_{RC}$ (in $m^2/s^2 \times 1000$) value for the material is 45.0.

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

Criteria	Results
Group number	3
$SMOGRA_{RC}$ (in $m^2/s^2 \times 1000$)	45.0

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 – Materials classified as Group 1 do not reach flashover after ten minutes exposure to a heat source delivering 100 kW immediately followed by a further ten minutes exposure to 300 kW.
- Group 1 – S – Materials classified as Group 1-S do not reach flashover after ten minutes exposure to a heat source delivering 100 kW immediately followed by a further ten minutes exposure to 300 kW. 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^2s^{-1}.
- Group 2 – Materials classified as Group 2 reach flashover after ten minutes of exposure to a 100 kW heat source.
- Group 2 – S – Materials classified as Group 2-S do not reach flashover after ten minutes exposure to a heat source delivering 100 kW. 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 3 – Materials classified as Group 3 reach flashover after two minutes, but before ten minutes of exposure to a 100 kW heat source.
- Group 4 – Materials classified as Group 4 reach flashover before two minutes of exposure to a 100 kW heat source.

The material subjected to this AS ISO 9705:2003 (R2016) test achieved a heat release rate of 1 MW after 561 seconds of exposure to a 100 kW heat source. Between 0 and 567 seconds of the test period, the average smoke production rate was 5.0 m^2/s. Therefore, the C/VM2 – Verification Method: Framework for Fire Safety Design – classifies this material as Group 3.

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

Criteria	Results
Group number	3
Average smoke production rate (0 to 561 seconds)	5.0 m^2/s

6. Application of test results

6.1 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.

6.2 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 Australia Pty Ltd or another registered testing authority.

6.3 Uncertainty of measurements

It is not possible to provide a stated degree of accuracy of the result, because of the nature of fire resistance testing and the consequent difficulty in quantifying the uncertainty of measurement of fire resistance.

Appendix A Drawings of test assembly

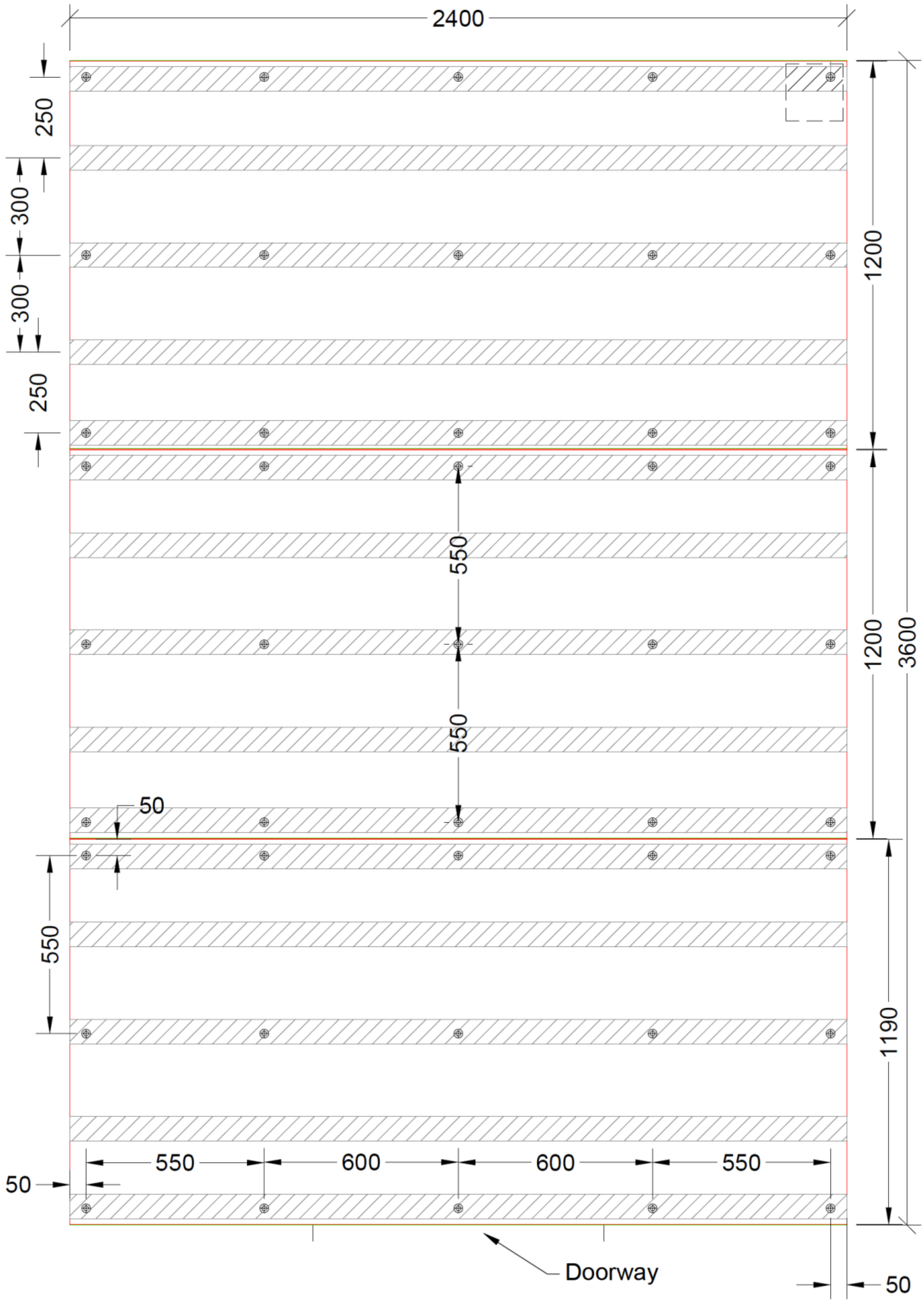

Figure 1 **Reflected ceiling panel arrangement** (dimensions in mm)

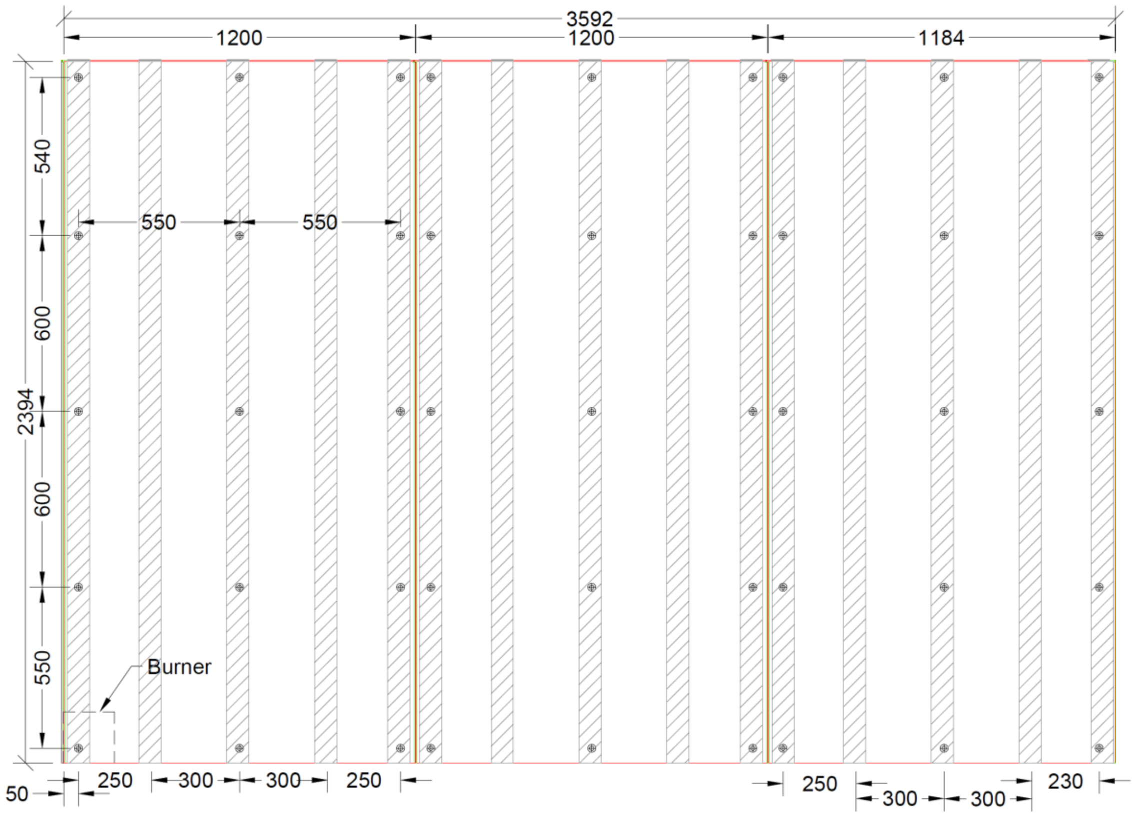

Figure 2 **Right wall panel arrangement (dimensions in mm)**

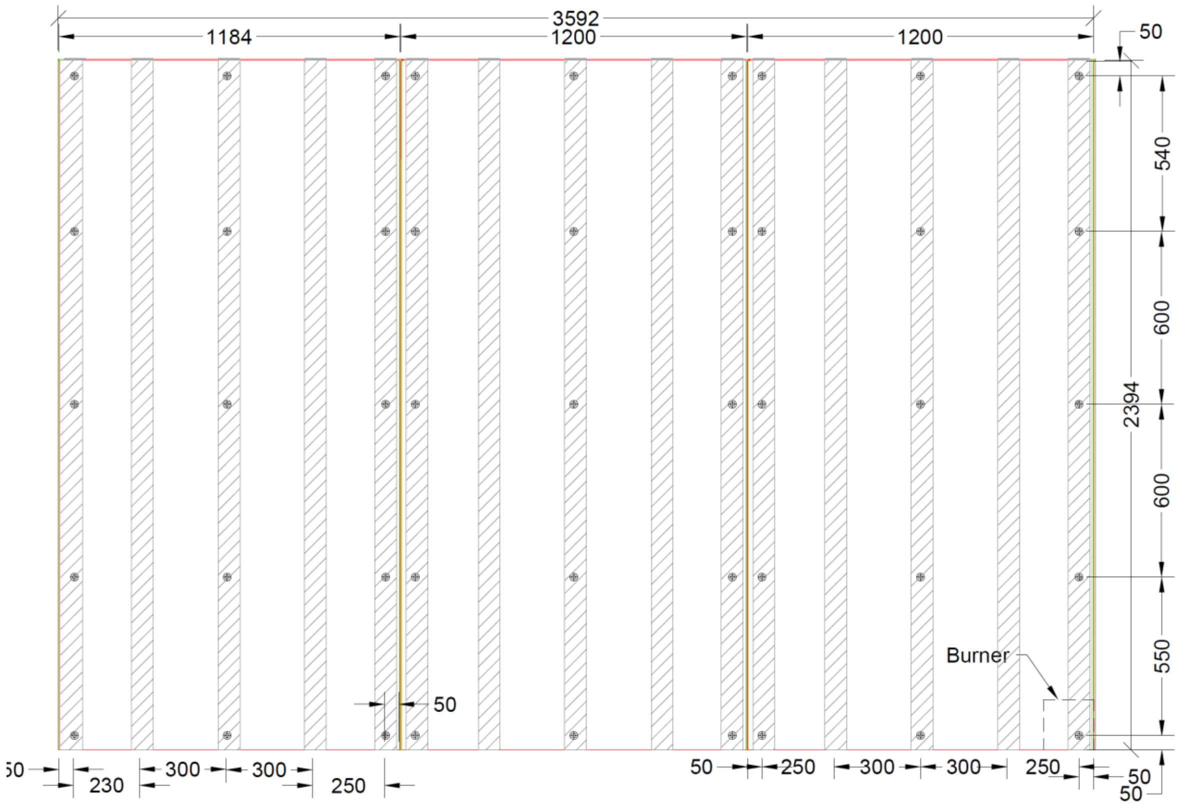

Figure 3 **Left wall panel arrangement (dimensions in mm)**

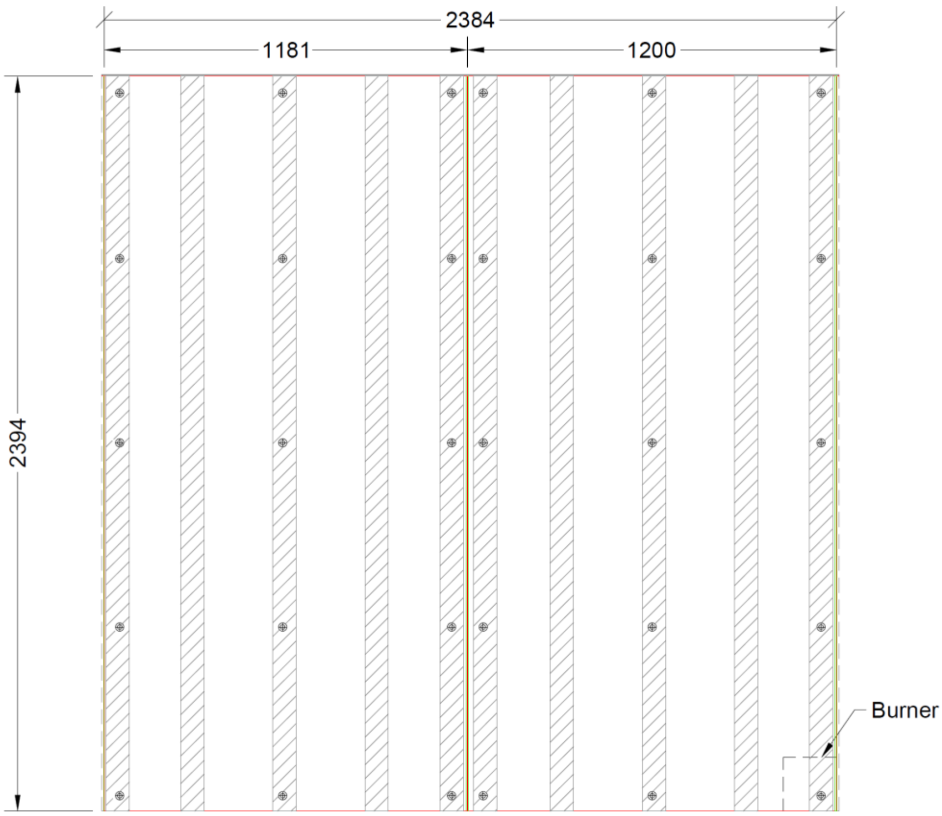

Figure 4 **Back wall panel arrangement (dimensions in mm)**

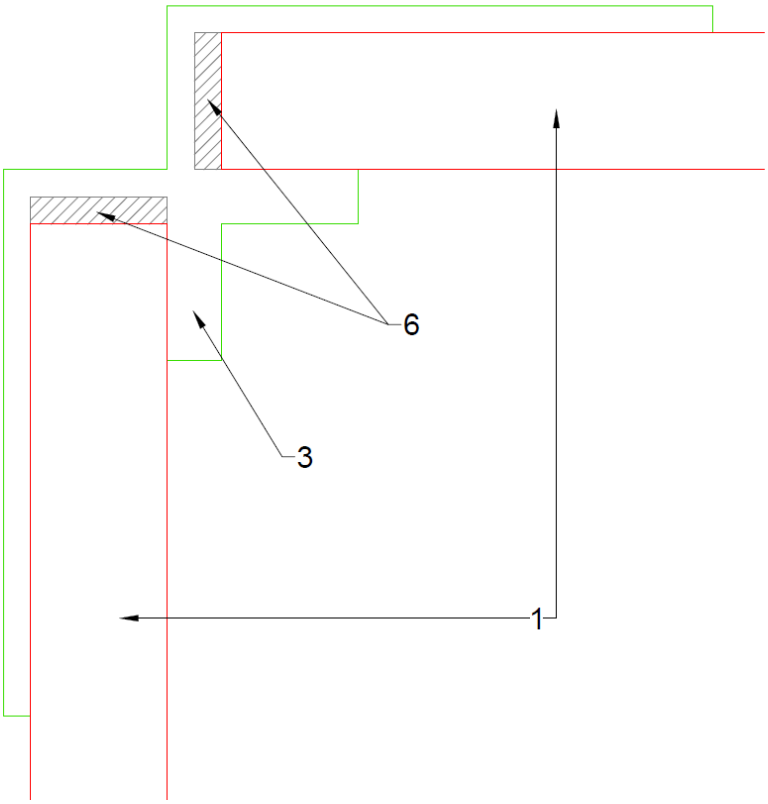

Figure 5 **Panel to panel corner join details**

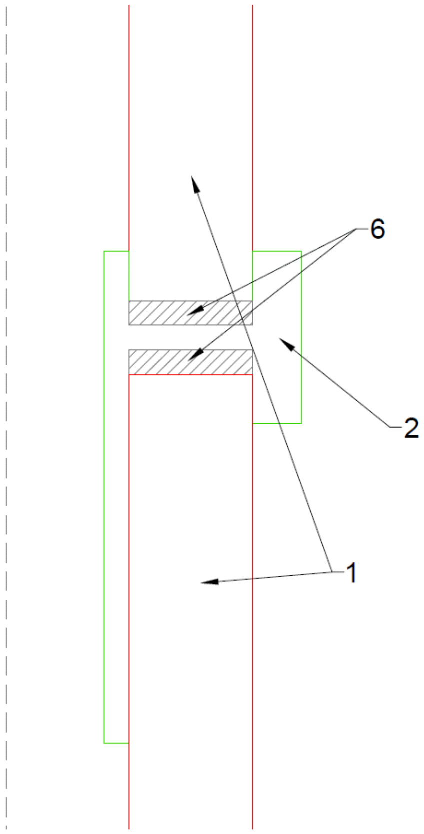

Figure 6 **Panel to panel join details**

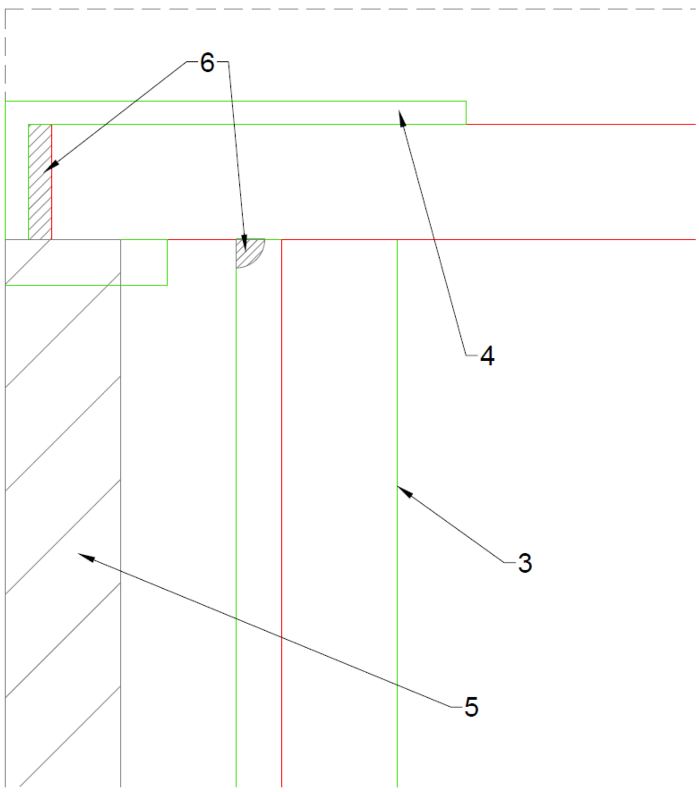

Figure 7 **Back wall to ceiling corner join details**

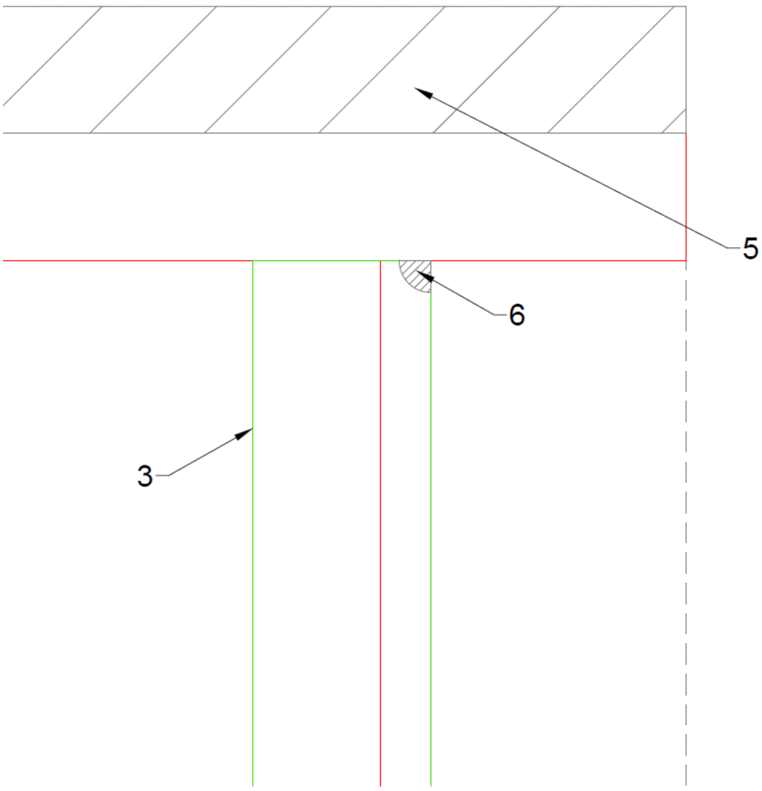

Figure 8 Left/right wall to ceiling panel corner join details

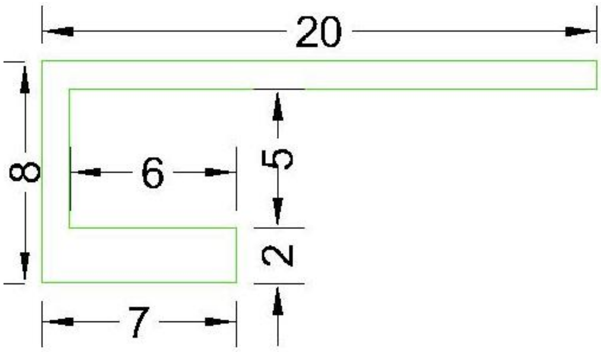

Figure 9 End cap details (dimensions in mm)

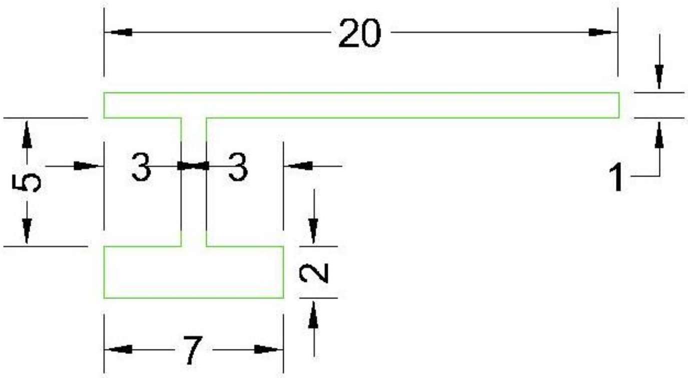

Figure 10 H jointer details (dimensions in mm)

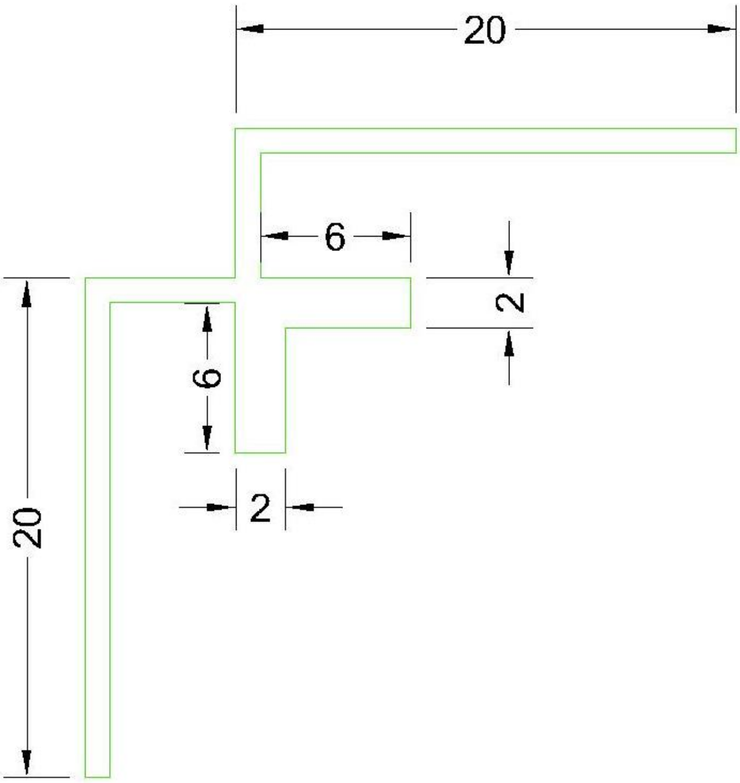

Figure 11 **Internal corner jointer details (dimensions in mm)**

Appendix B Test observations

Table 11 shows 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 an output of 100 kW, the burner was ignited.
00	30	The panels around the burner started to discolour.
00	45	Cracking sounds were heard, and some panel surfaces delaminated.
01	30	Debris started falling from the ceiling panels.
02	09	Flaming debris started to fall from the ceiling.
03	30	A light smoke layer built-up inside the room.
04	45	The smoke layer inside the room thickened and started escaping through the doorway.
05	30	The flames spread across the ceiling panels.
07	30	The flames on the ceiling spread towards the doorway.
08	05	The flames started to escape through the doorway.
09	27	1MW heat output was confirmed.
09	45	The reaction-to-fire test was ended.

Appendix C Test data

C.1 Heat flux

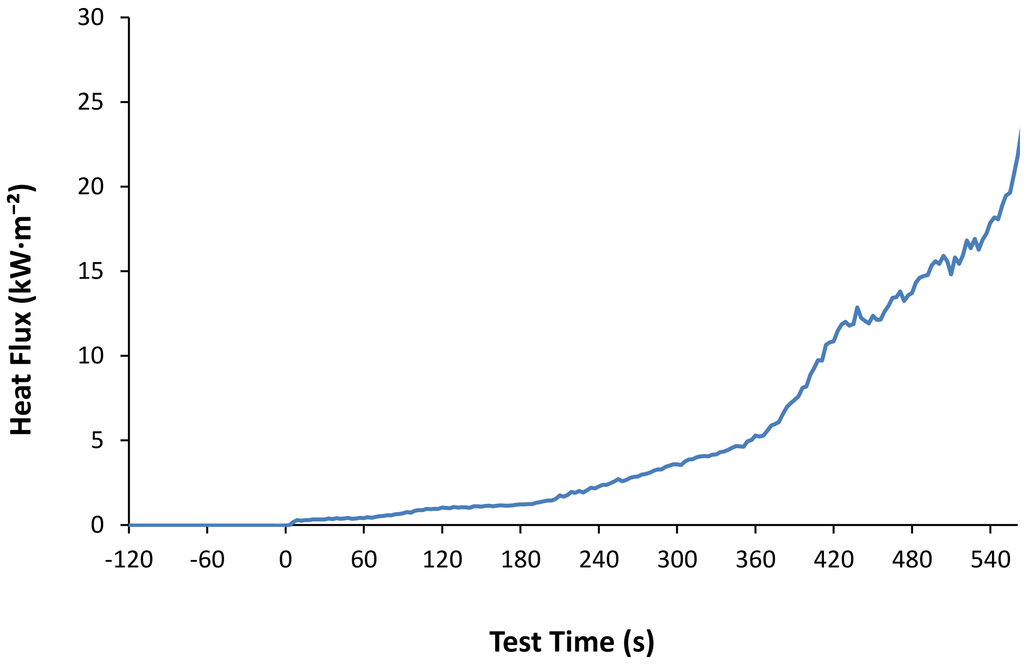

Figure 12 Heat flux vs time

C.2 Volume flow

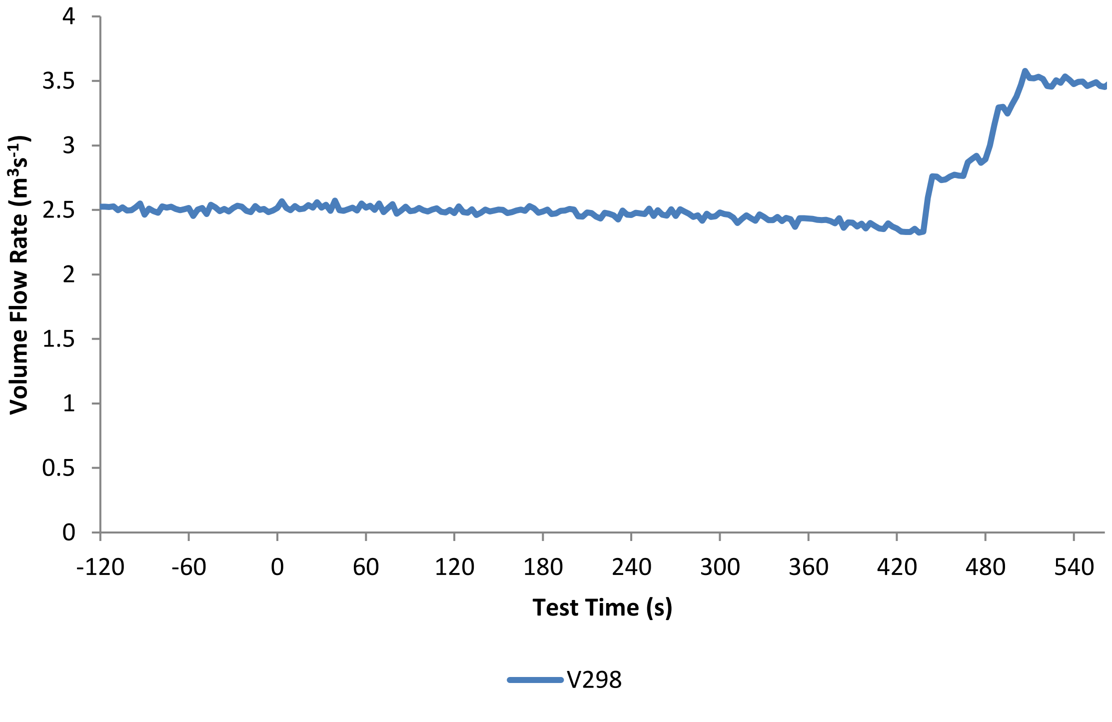

Figure 13 Volume flow rate in duct vs time

C.3 Heat release rate

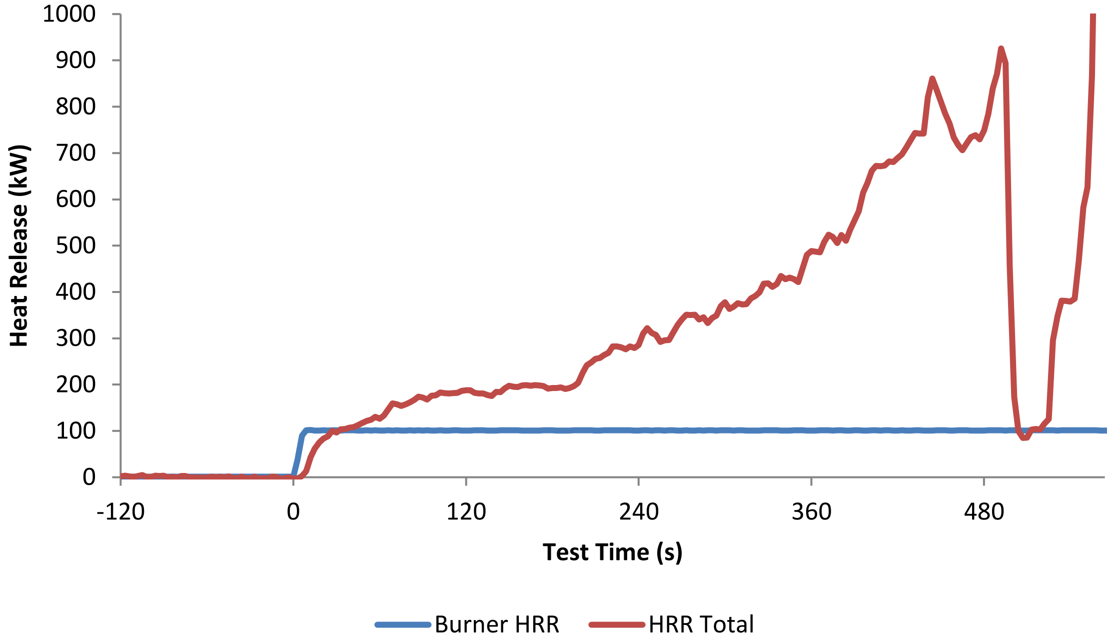

Figure 14 Heat release rate[1] (HRR) of specimen and burner vs time

C.4 Carbon monoxide production

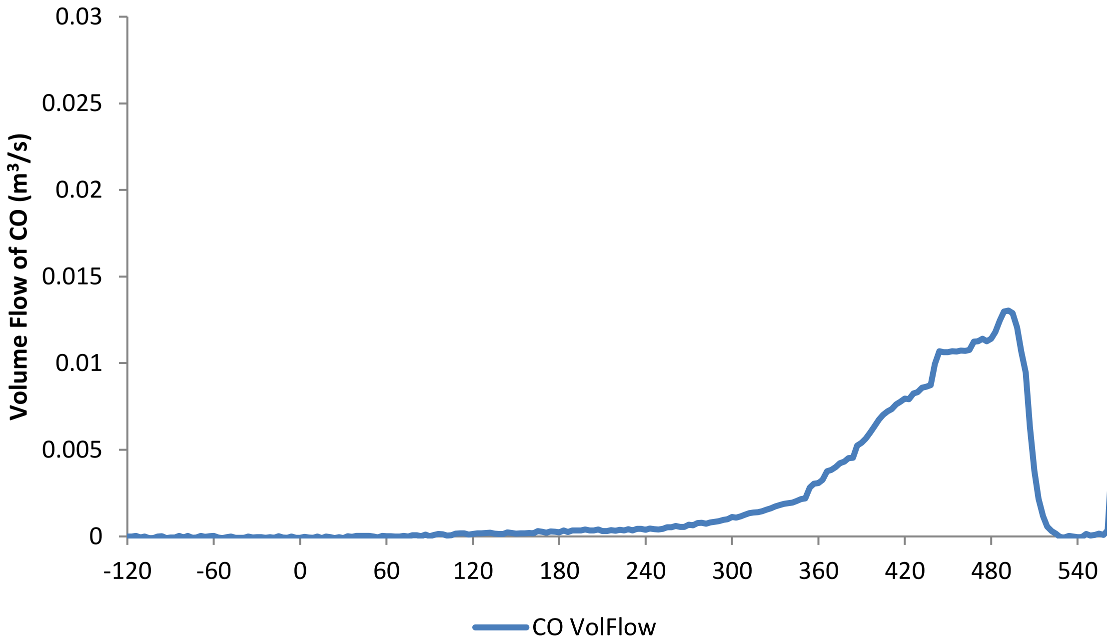

Figure 15 Production of carbon monoxide vs time, at reference temperature and pressure

[1] A drop in the Heat Release Rate was observed at 492 seconds due to a blockage in the gas sampling line, which was cleared at 525 seconds.

C.5 Carbon dioxide production

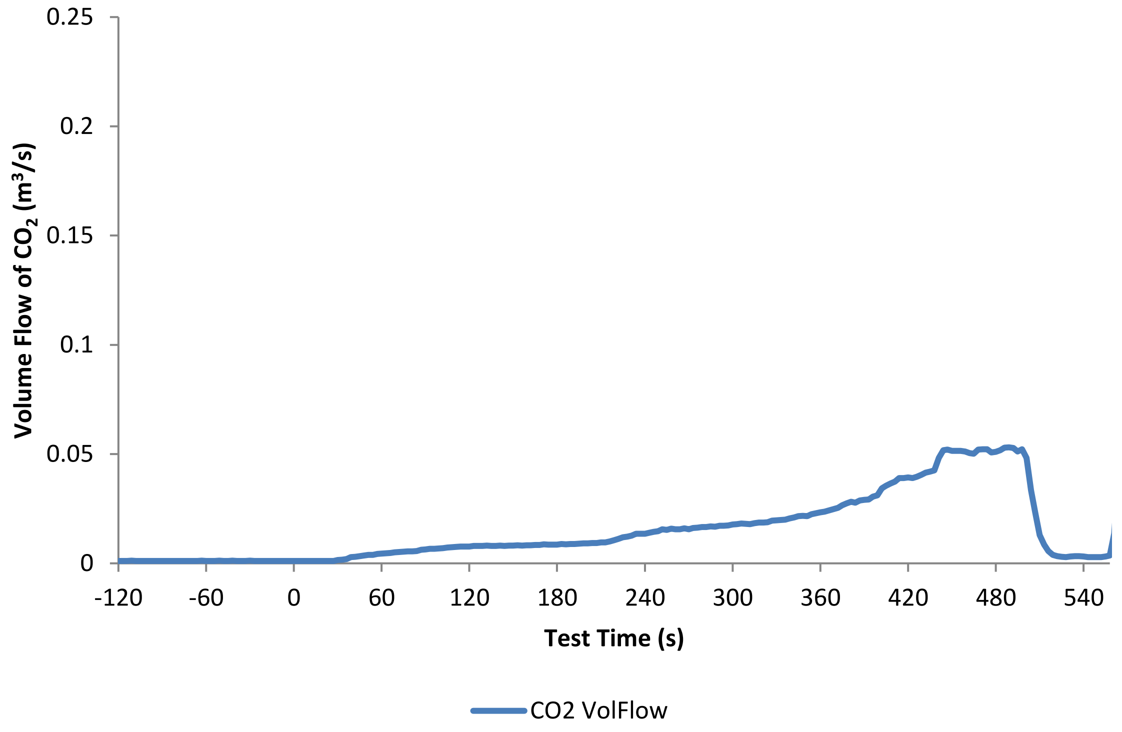

Figure 16 Production of carbon dioxide vs time, at reference temperature and pressure

C.6 Smoke production rate

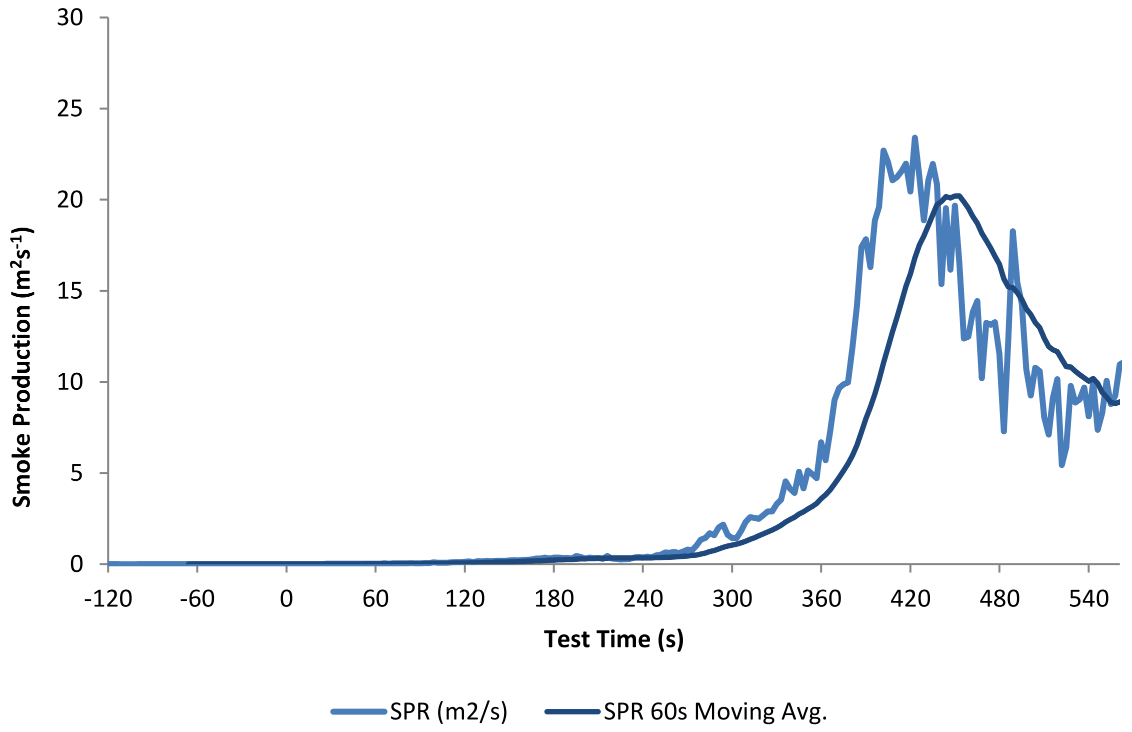

Figure 17 Production of light obscuring smoke vs time, at reference temperature and pressure

C.7 Temperature at different heights

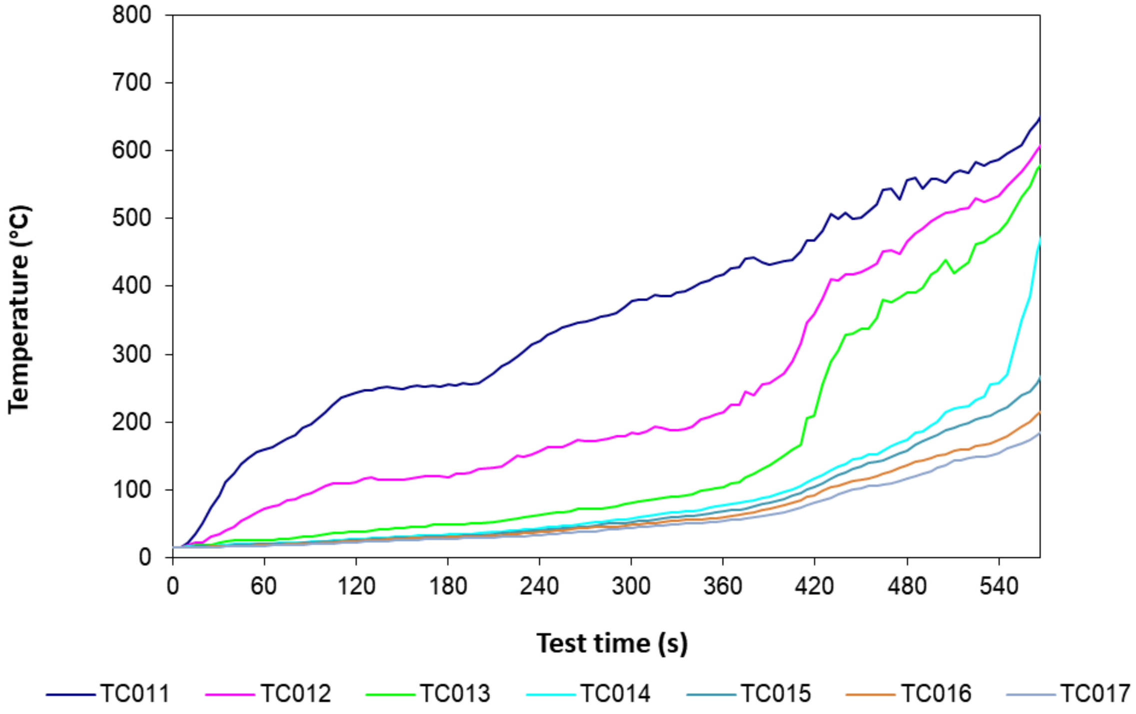

Figure 18 Temperature at height in the corner opposite to the burner vs time

TC011: 2.10 m TC012: 1.72 m TC013: 1.57 m TC014: 1.42 m TC015: 1.27 m
TC016: 0.97 m TC017: 0.67 m (from the room floor)

Appendix D Photographs

Figure 19 The specimen before the reaction-to-fire test

Figure 20 The specimen 12 seconds after burner ignition with a burner output of 100 kW

Figure 21 The specimen 27 seconds after burner ignition with a burner output of 100 kW

Figure 22 The specimen 01 minute 06 seconds after burner ignition with a burner output of 100 kW

Figure 23 **The specimen 02 minutes 02 seconds after burner ignition with a burner output of 100 kW**

Figure 24 **The specimen 03 minutes 18 seconds after burner ignition with a burner output of 100 kW**

Figure 25 The specimen 04 minutes 29 seconds after burner ignition with a burner output of 100 kW

Figure 26 The specimen 05 minutes 32 seconds after burner ignition with a burner output of 100 kW

Figure 27 The specimen 06 minutes 37 seconds after burner ignition with a burner output of 100 kW

Figure 28 The specimen 07 minutes 40 seconds after burner ignition with a burner output of 100 kW

Figure 29 **The specimen 09 minutes 27 seconds after burner ignition with a burner output of 100 kW**

Figure 30 **The specimen after the reaction-to-fire test**