TEST REPORT

Reaction to fire test in accordance with AS ISO 9705 – 2003 and AS 5637.1:2015 of a room lined with NRG Greenboard panels.

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On behalf of Exova Warringtonfire Aus Pty Ltd

GENERAL CONDITIONS OF USE

CONTENTS

1 CONSTRUCTION DETAILS

TEST ASSEMBLY

The test assembly comprised a fire test room whose ceiling and three walls were lined with the material being subjected to the test. The fire test room comprised of studwork walls and ceiling lined with plywood and two layers of 16mm thick fire grade plaster board on the internal side. When unlined the fire test room had the internal dimensions of 3600mm long by 2400mm wide by 2400mm high. The short wall opposite the ignition source had a centrally located doorway opening 800mm wide by 2000mm high. The room was lined with the sample material on three walls and the ceiling, leaving the wall with the doorway opening unlined.

TEST SPECIMEN

The test specimen comprised a wall and ceiling lining of a nominal 1200mm wide x 2400mm long x 40mm thick expanded polystyrene NRG Greenboard panels. The panels were installed onto the burn room walls and ceiling using 40mm wide plastic washers assembled onto 10g x 75mm bugle head needle point screws. The fixings were located 50mm from the board edges/joins and spaced at 600mm centres vertically and 300mm centres horizontally. The joins between the panels were further sealed with a bead of

The burn room was lined by approximately 13 NRG Greenboard panels each of the sizes as detailed in Table 1.1 below:

Table 1.1: Nominal size and locations of the NRG Greenboard panels.

Quantity	Position	Size (nominal)
1	Rear wall	2400mm long × 1160mm high
1		2400mm long × 1200mm high
1	Left hand side wall	2400mm long × 1160mm high
1		2400mm long × 1200mm high
1		1150mm long × 1160mm high
1		1150mm long × 1200mm high
1	Right hand side wall	2400mm long × 1160mm high
1		2400mm long × 1200mm high
1		1150mm long × 1160mm high
1		1150mm long × 1200mm high
3	Ceiling	2400mm long × 1200mm wide

Note: Further details are provided in Figures A1.1 to A1.3 and the ‘Schedule of Components’ in Section 2.

ASSEMBLY AND INSTALLATION METHODS

The wall and ceiling system was constructed by representatives of NRG Building Systems Pty Ltd on 27 April 2018.

2 SCHEDULE OF COMPONENTS

Item	Description		
Lining			
1	Item Name	NRG Greenboard	
	Description	Expanded Polystyrene	
	Overall Size	1200mm wide x 2400mm long x 40mm thick (nominal)	
	Density	20.1 kg/m^3 (measured)	
	Installation	The panels were fixed directly onto the burn room walls and ceiling using the screws and washers (item 2 and 3 – see figure A1.1 to A1.4 in Appendix 1). Max screw centres: Wall: 300mm vertical centers and 600mm horizontal centers. Ceiling: 300mm lengthwise centers and 300mm widthwise centers.	
Fixings			
2	Item Name	Screws	
	Description	10g x 75mm long square drive bugle head needle point	
	Installation	Used to secure the NRG Greenboard (item 1) to the burn room walls.	
3	Item Name	NRG Greenboard Washers	
	Description	40mm wide plastic washer	
	Installation	Used in conjunction with the screws (item 2) to secure the lining board (item 1) to the burn room walls and ceiling.	
Sealant			
4	Item Name	Bosman Styrofoam Adhesive	
	Description	Polyurethane expanding foam	
	Installation	Used to seal and fill joins between NRG Greenboard panels	

3 TEST PROCEDURE

STATEMENT OF COMPLIANCE

The test was performed in accordance with the requirements of AS ISO 9705 - 2003 pursuant to AS 5637.1:2015 with the purpose of determining the Group Number that may be assigned to the material using the classification schemes given in The National Construction Code of Australia.

VARIATIONS TO TEST METHOD

The burner flamed out on two occasions during the test period due to molten material detaching from the specimen and smothering the flame. The burner was successfully re-ignited on both occasions though the results presented in this report show data up to the second instance where the burner had flamed out for a significant period of time. The test was compliant to AS ISO 9705-2003 up to this point. The test was subsequently allowed to continue for the duration as outlined in AS ISO 9705-2003 for research purposes only.

PRE-TEST CONDITIONING

The burn room was lined with the sample material on 27 April 2018, during which time the specimen was subject to normal laboratory ambient temperature and humidity conditions.

SAMPLING / SPECIMEN SELECTION

The laboratory was not involved in the sampling or selection of the test specimen material for the reaction to fire test.

AMBIENT TEMPERATURE

The ambient temperature at the start of the test was 23°C.

TEST DURATION

The test was terminated 1200 seconds after burner ignition.

INSTRUMENTATION AND EQUIPMENT

The equipment used for the test was in accordance with AS ISO 9705 – 2003 and is detailed below:

The fire test room consisted of galvanised studwork walls and ceiling, where each was lined with two layers of 16mm fire grade plasterboard supported by 15mm thick plywood on the external side. The floor comprised of 9mm thick cement sheeting. Without the specimen lining, the room had inner dimensions of 3600mm × 2400mm × 2400mm in height with a doorway 800mm wide × 2000mm high centrally located in one of the shorter walls.

The ignition source was a propane gas fuelled box burner, whose specifications were in accordance with those given in AS ISO 9705 Annex A. The burner was placed on the floor in the corner of the room, opposite the doorway, where 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 100kW of power during the first ten minutes of heat exposure and 300kW 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-Bolter type heat-flux gauge, placed within the floor in the middle of the room.

The products of combustion were collected in an exhaust hood adjacent to the doorway, outside of the room. The hood was connected to an exhaust duct 400mm in diameter, within which were instruments 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 in conjunction with a Type K MIMS thermocouple located near to 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 to 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 the paramagnetic oxygen analyser, whilst the carbon monoxide and carbon dioxide concentrations were determined using infrared sensor equipment, also within the SERVOMEX analyser.

SYSTEM PERFORMANCE

A calibration test was carried out prior to the testing of the product. The gas burner was placed directly under and 1000 mm below the exhaust hood and the gas supply to the burner was adjusted such 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 0 kW for two minutes, after which time the test was stopped. Data from the 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 so complied with the requirements of AS ISO 9705 – 2003 Section 10.1.

The system response was determined by calculating the average time taken for the measured Rate of Heat Release to be within 10% of the final measured value of Rate of Heat Release. System response data is shown in Table 4.1 of Section 4 and the system response has been calculated to be 7 s, which is within the 20 s limit required to comply with AS ISO 9705 – 2003.

4 TEST MEASUREMENTS

INITIAL CONDITIONS

The horizontal wind speed at a horizontal distance of 1000 mm away from the door opening was measured just prior to the test and was found to be 0.2 ms^{-1}, which is less than 0.5 ms^{-1} and so satisfies the requirement of AS/ISO 9705 – 2003 Section 12.1.2. The ambient temperature in the region of the fire test room was 23°C at the start of the test.

HEAT FLUX MEASUREMENTS

Heat flux measurements are provided in A3.1 in Appendix 3.

VOLUME FLOW RATE MEASUREMENTS

Volume flow rate measurements are provided in A3.2 in Appendix 3.

HEAT RELEASE RATE MEASUREMENTS

The Rate of Heat Release from the specimen and the burner are provided in A3.3 in Appendix 3.

CARBON MONOXIDE AND CARBON DIOXIDE PRODUCTION RATES

The rate of production of carbon monoxide and carbon dioxide are given in A3.4 and A3.5, respectively, in Appendix 3.

LIGHT OBSCURATION MEASUREMENTS

The smoke production rate is given in A3.6 in Appendix 3.

OBSERVATIONS

A table that includes observations of the significant behaviour of the specimen and details of the occurrence of the various performance criteria specified in AS ISO 9705 - 2003 is provided in Appendix 2. Photographs of the specimen are included in Appendix 4.

CALIBRATION TEST

The results of the calibration test are detailed in Table 4.1 below.

Time Interval (s)	Target Heat Output (kW)	Heat Output (kW)	Heat Measured (kW)	Time (s)	Variance (%)	Response Time (seconds)
0 to 120	0	0	0	-	-	-
120 to 420	100	100	105	144	3.5	6
420 to 720	300	300	294	420	-2.3	6
720 to 1020	100	100	102	789	1.2	9
1020 to 1140	0	0	0	-	-	-

Table 4.1: Response time measurements during the step calibration procedure

The response time, or delay time, as defined in Section 10.2 of AS ISO 9705 – 2003, of the system was found to be 7 seconds. This is in accordance with AS ISO 9705 – 2003 Section 10.2, which requires the delay time to be less than 20 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.

5 TEST RESULTS

The National Construction Code of Australia (NCC) and AS 5637.1:2015 allow the classification of materials by Group Number, which indicates the amount of time taken for the material being tested to reach flashover under AS ISO 9705 – 2003 test conditions. The NCC and AS 5637.1:2015 define flashover to be a Heat Release Rate of 1 MW, so materials are classified, in accordance with NCC 2016 Spec C1.10 and AS 5637.1:2015 , by the time taken for the Heat Release Rate, as measured during the AS ISO 9705 test, to reach 1MW as per the scheme below;

- 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 2 minutes, but before 10 minutes of exposure to a 100 kW heat source.
- Group 4 – Materials are classified as Group 4 is they reach flashover before 2 minutes of exposure to a 100 kW heat source.

The material subjected to this AS ISO 9705 test reached a Heat Release Rate of 219 kW after 120 seconds of the test period. Therefore the system has achieved a classification of Group 3.

The NCC and AS 5637.1:2015 also define the smoke growth rate index, or $SMOGRA_{RC}$, as a quantity which may be obtained from the smoke obscuration measurements obtained in the AS ISO 9705 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 maximum occurred and multiplying the result by 1000.

The maximum average rate of smoke growth for this material occurred at 297 seconds into the test, and was found to be 10.0 m^2s^{-1}. Therefore the $SMOGRA_{RC}$ value for this material is 33.7 m^2s^{-2} x 1000.

Group Number	**3**
SMOGRARC	**33.7 m^2s^{-2} x 1000**

6 APPLICATION OF TEST RESULTS

TEST LIMITATIONS

The results of this fire test may be used to directly assess fire hazard, but it should be recognized that a single test method will not provide a full assessment of fire hazard under all fire conditions. The results only relate to the behaviour of the specimen of the element of the 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 nor do they necessarily reflect the actual behaviour in fires**.**

VARIATIONS FROM THE TESTED SPECIMENS

This report details the methods of construction, the test conditions and the results obtained when the specific element of construction described herein was tested following the procedure outlined in AS ISO 9705 - 2003. Any significant variation with respect to size, constructional 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 in the first instance to obtain appropriate documentary evidence of compliance from Exova Warringtonfire Aus Pty Ltd or another Registered Testing Authority.

UNCERTAINTY OF MEASUREMENT

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

APPENDIX 1 DRAWINGS OF TEST ASSEMBLY

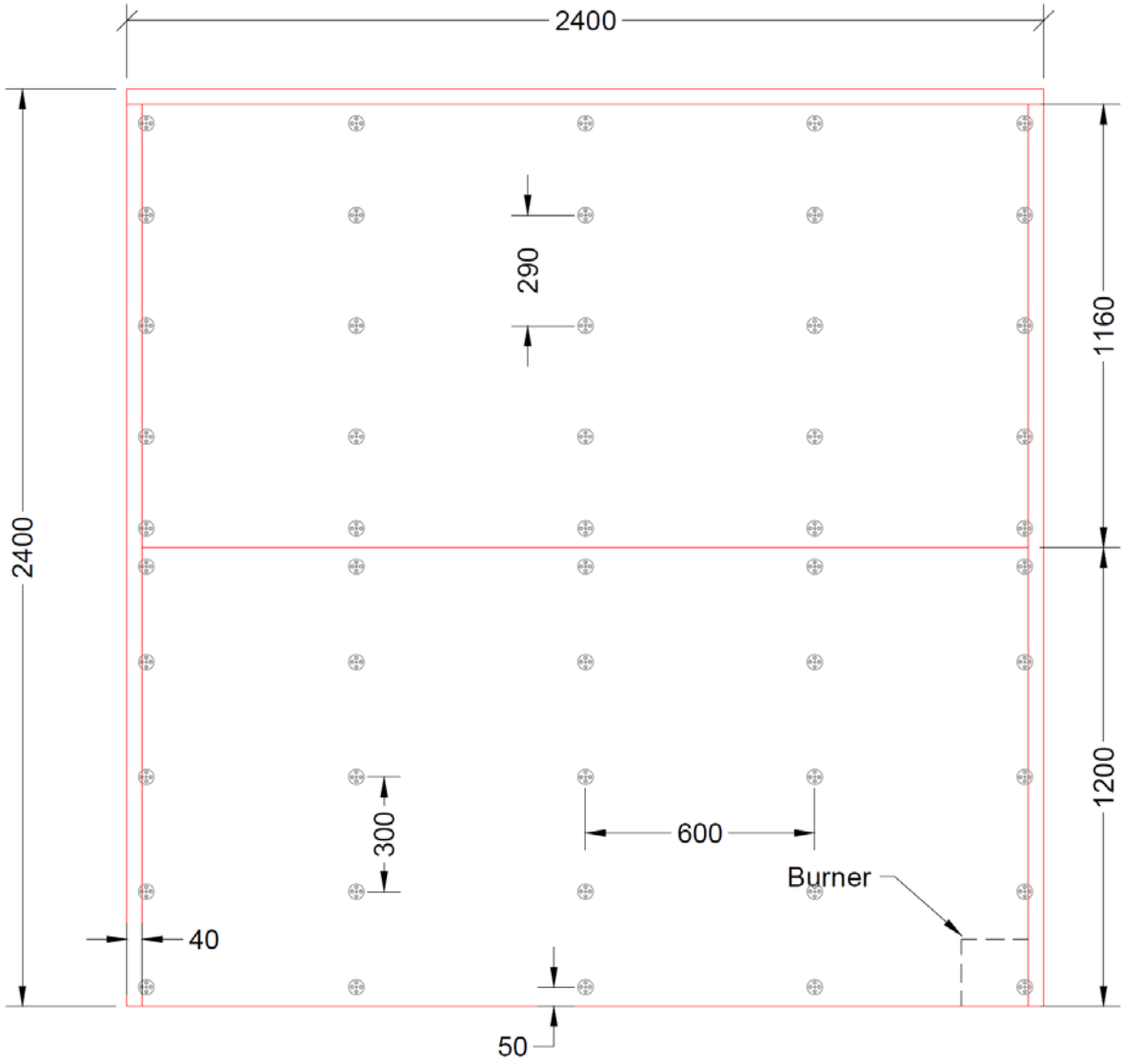

Figure A1.1: Rear Wall

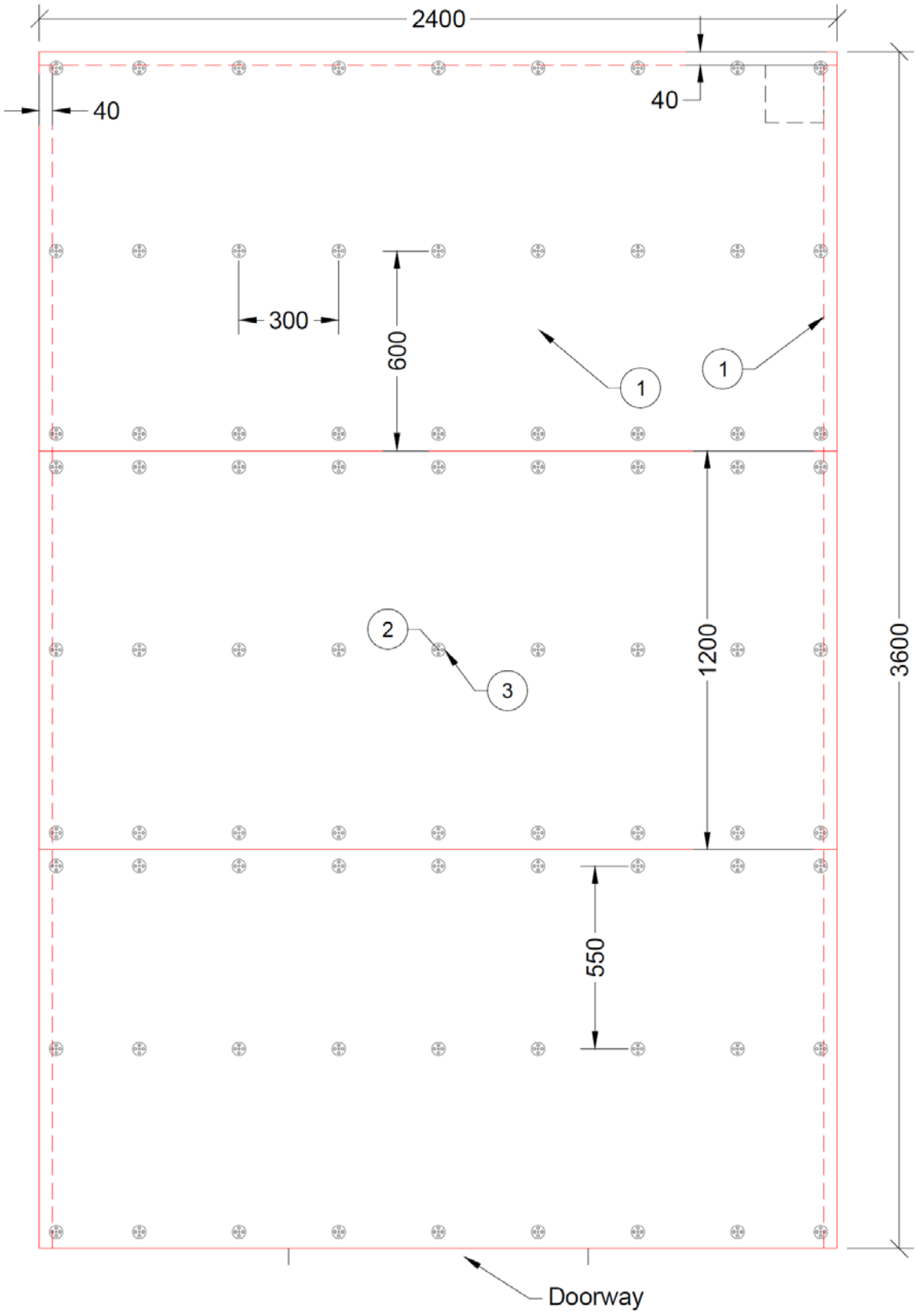

Figure A1.2: Ceiling

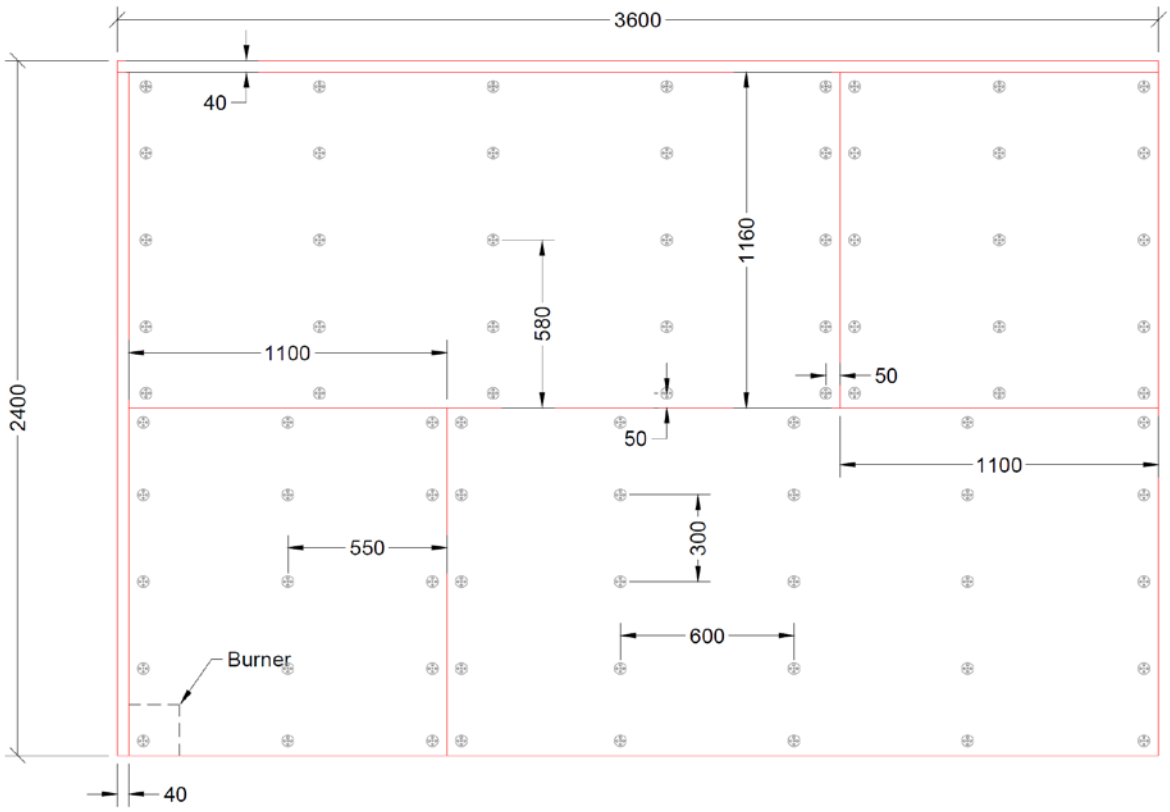

Figure A1.3: Right Side Wall

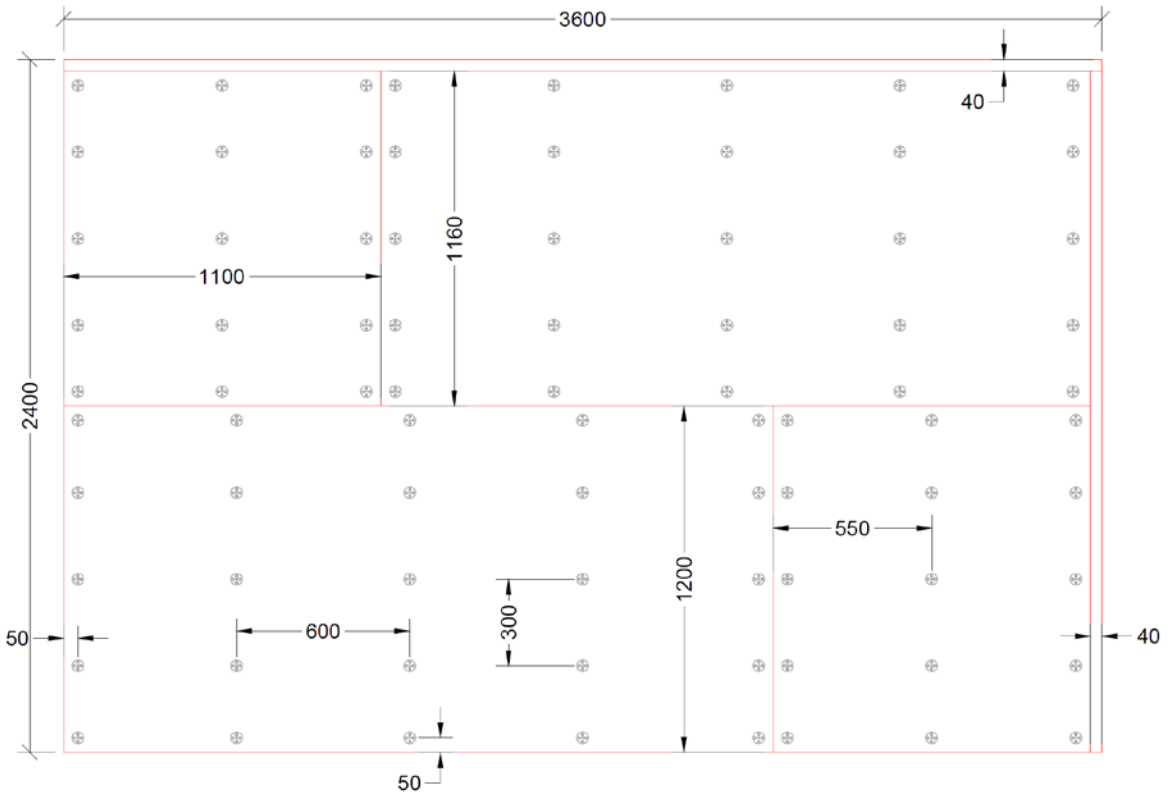

Figure A1.4: Left Side Wall

APPENDIX 2 TEST OBSERVATIONS

The following include observations of the significant behaviour of the specimen.

Time		Observations
Min	Sec	
0	00	Fire resistance test commenced
02	00	Burner ignition with an exposure of 100 kW
02	16	The ceiling had begun to flame
02	33	Molten flaming material was dripping from the ceiling
02	40	Smoke had begun to escape from the doorway
03	10	The level of smoke had increased in the burn room
03	34	Localised flaming was evident along the north wall closest to the burner flames at mid-height
04	00	Molten debris had fallen onto the burner, smothering the flame
04	12	Burner successfully re-ignited
04	30	Material was detaching from the entire length of the ceiling up to the doorway
05	22	Flaming material had accumulated on the ground close to the burner
06	40	A smoke layer had formed and occupied the upper half of the burn room
07	27	Significant amount of molten debris had fallen onto the burner, smothering and extinguishing the burner flame
08	00	Burner successfully re-ignited and the test continued
22	00	Reaction to fire test terminated and specimen extinguished

APPENDIX 3 TEST DATA

A 3.1 HEAT FLUX

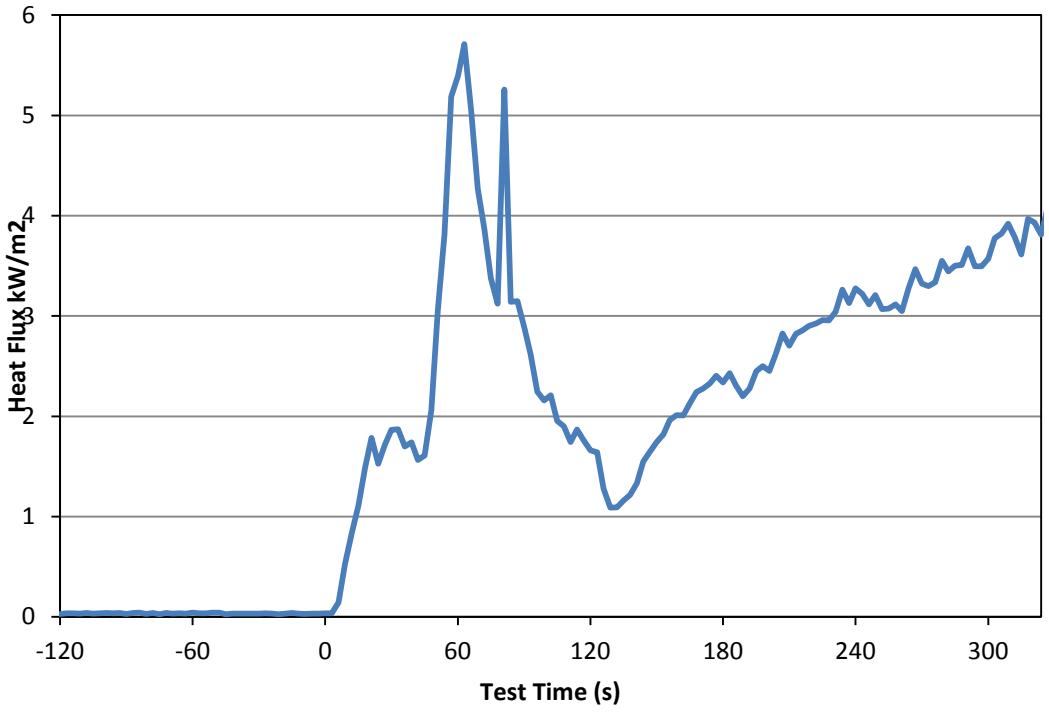

Figure A3.1: Heat flux vs time

A 3.2 VOLUME FLOW

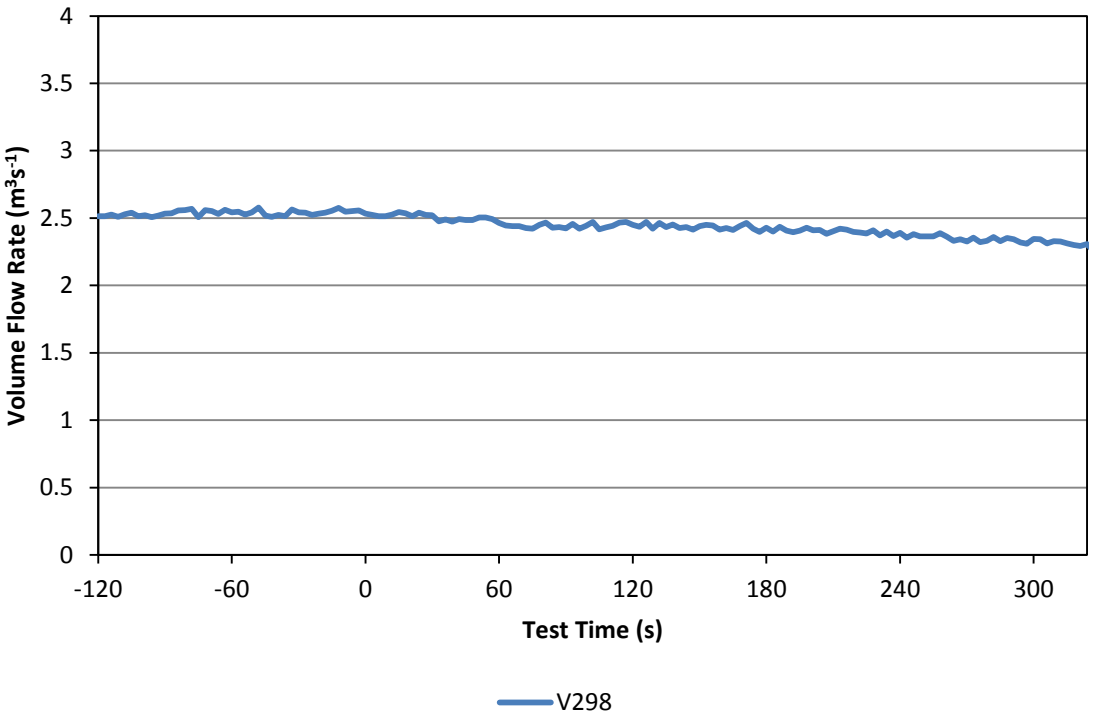

Figure A3.2: Volume flow rate in duct vs time

A 3.3 HEAT RELEASE RATE

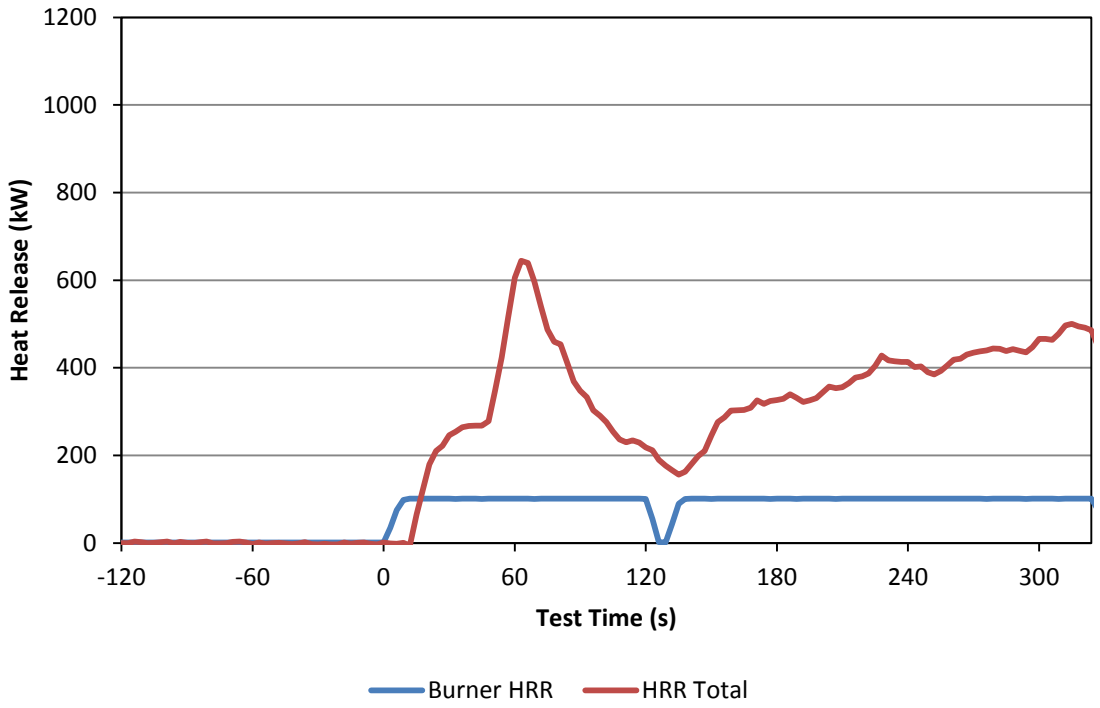

Figure A3.3: Heat Release Rate (HRR) of specimen and burner vs time

A 3.4 CARBON MONOXIDE PRODUCTION

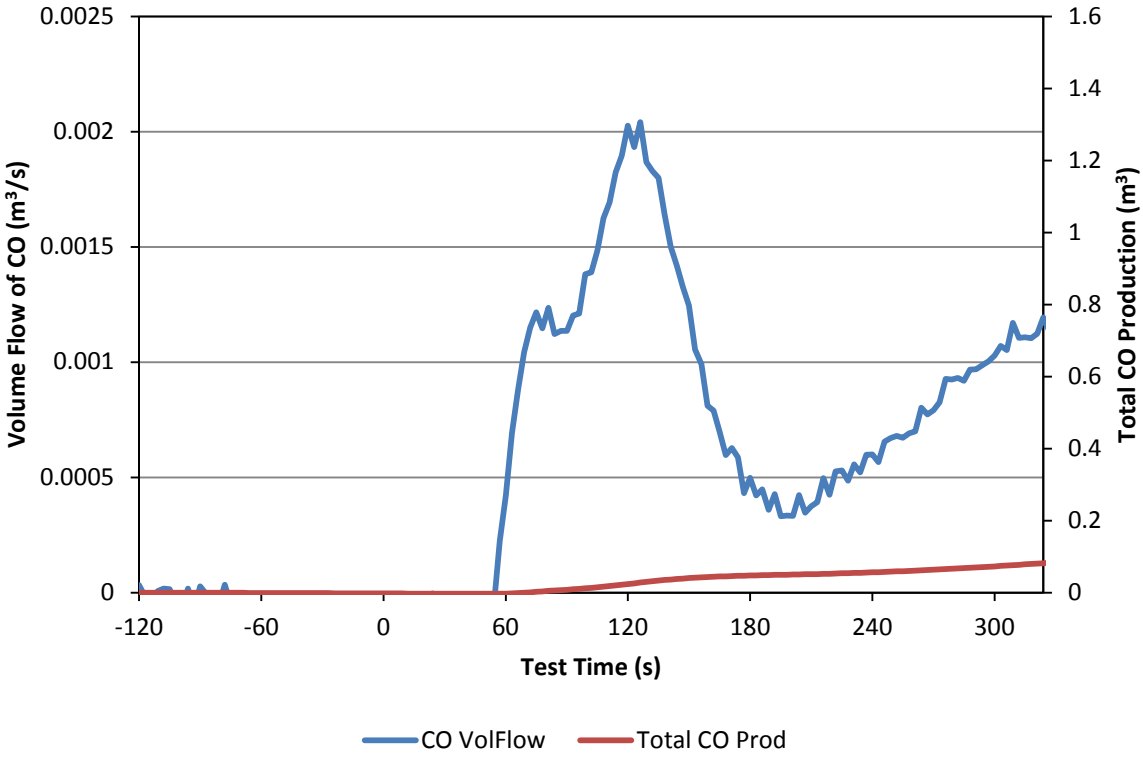

Figure A3.4: Production of carbon monoxide versus time, at reference temperature and pressure

A 3.5 CARBON DIOXIDE PRODUCTION

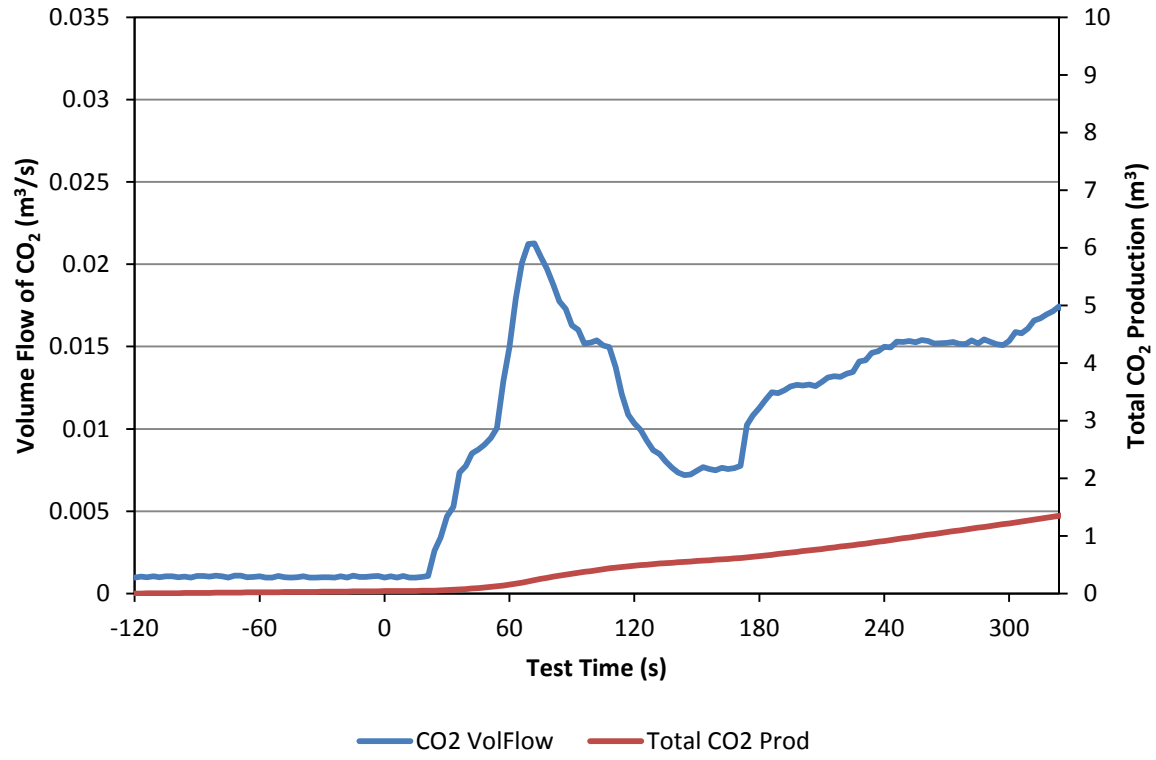

Figure A3.5: Production of carbon dioxide versus time, at reference temperature and pressure

A 3.6 SMOKE PRODUCTION RATE

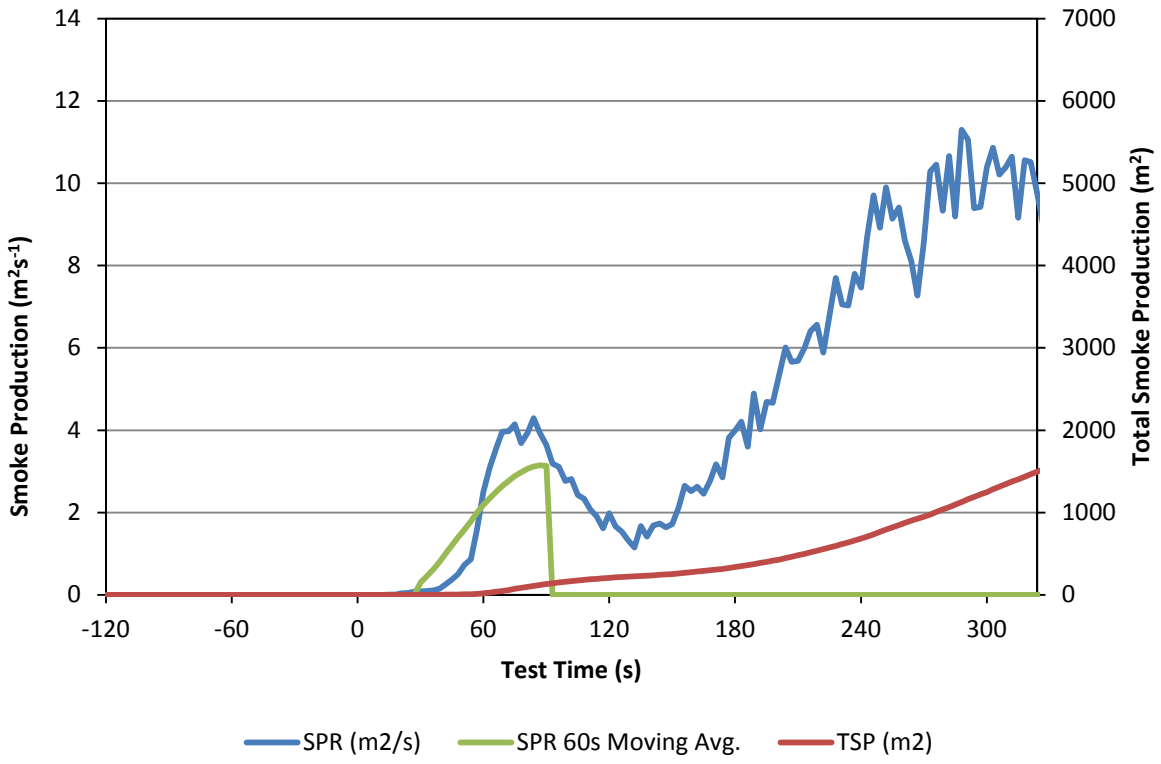

Figure A3.6: Production of light obscuring smoke versus time

APPENDIX 4 PHOTOGRAPHS

Figure A4.1. Specimen before commencement of the reaction to fire test.

Figure A4.2 Specimen at the commencement of the reaction to fire test.

Figure A4.3 Specimen 1 minutes 25 seconds after burner ignition.

Figure A4.4 Specimen 5 minutes 38 seconds after burner ignition.

Figure A4.5 Specimen 7 minutes 26 seconds after burner ignition (prior to burner flame out).

Figure A4.6 Specimen 8 minutes 01 second after burner ignition (after re-ignition of the burner).

Figure A4.7 Specimen at the end of the reaction to fire test