WOOD & GRIEVE ENGINEERS

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Permaform Walling System

BCA Compliance – Fire and Combustibility Report

Prepared for:

Brad Vine
Permaform International Pty Ltd

Prepared by:

Ettienne Jordaan
Project No. 41935
\\WGE-SYD-FS-01\PROJECTS\41935\PROJECT DOCUMENTATION\FIRE ENGINEERING\FIRE ENGINEERING REPORTS

Date:
29th May 2019

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Revision

REVISION	DATE	COMMENT	APPROVED BY
01	**29/05/2019**	**Fire and Combustibility Report**	**Ettienne Jordaan**

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Contents

1. Introduction

Permaform wall system consist of reinforced concrete infill and cast in situ formwork. The formwork, being the Permaform material, is constructed from Polyvinyl Chloride (PVC). The figure below details a typical Permaform constructed wall.

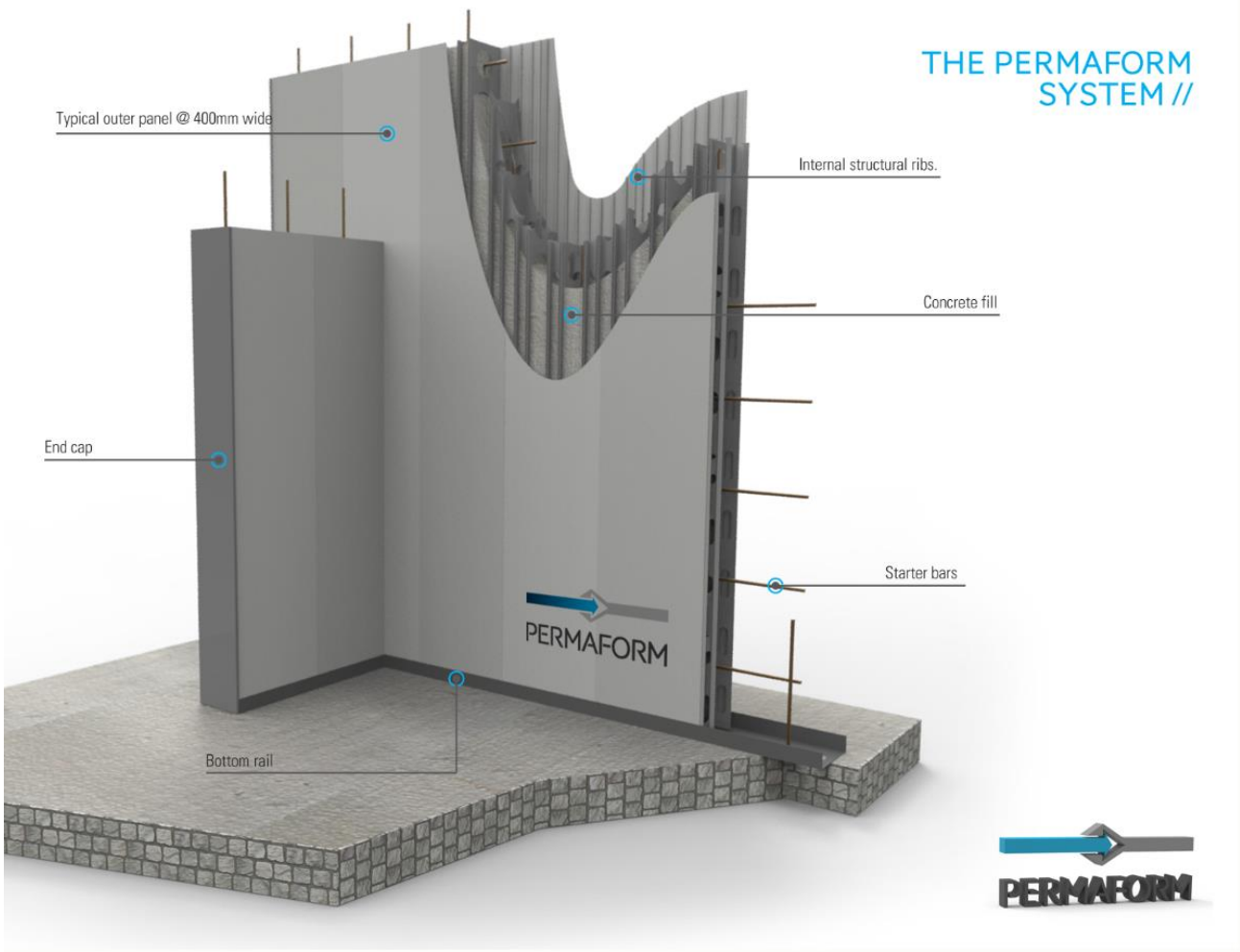


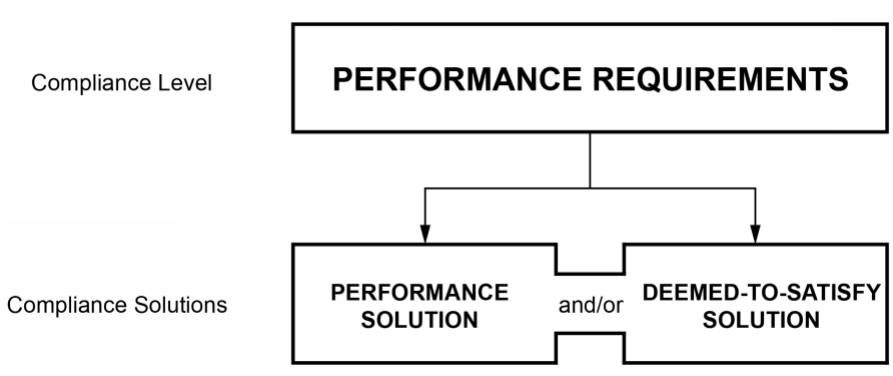
Figure 1: Typical Permaform wall [25]

Permaform consists of two PVC outer layers joined together by PVC ribs. The outer layers of the PVC are designed to be exposed while the PVC ribs are to be embedded into the concrete. It is considered that if the outer layers were removed from the wall assembly then the wall and its components would be non-combustible despite the PVC ribs remaining embedded in the concrete. The ribs which are designed to be encased in concrete do not reduce the fire resistance of the wall. This is demonstrated as Permaform walls achieve an FRL of 95 minutes and 120 minutes for wall thicknesses of 110mm and 150mm respectively.

This document provides guidance on how the use of Permaform on projects, will achieve compliance with the Building Code of Australia (BCA).

2. BCA Compliance

To achieve compliance with the BCA, the Performance Requirements of the BCA must be met. There are two ways to satisfy the Performance Requirements, a Deemed-to-Satisfy (DtS) Solution or a Performance Solution (Alternative Solution). To achieve a DtS solution, the prescriptive requirements of the BCA must be followed. Whereas a Performance Solution is any alternative solution that has been demonstrated to comply with the Performance Requirements of the BCA by a Fire Engineer.



The requirements vary depending on the particular application of the material (i.e. external wall, internal wall, shafts etc.). To address BCA compliance regarding the use of Permaform, the following methods of compliance could be adopted for each application.

Table 1: Permaform Applications and DtS Requirements

Application	BCA DtS Requirements	DtS Solution or Performance Solution	Evidence of Suitability
External Walls **Common Walls**	**Clause C1.9(a)** – External walls and common walls including any covering in Type A and B buildings must be non-combustible.	Performance Solution	Fire Engineering Report specific to the building which demonstrates compliance with the BCA.
Internal Walls **Fire-isolated stairs and fire control rooms**	**Clause C1.10, Clause 4 of Specification C1.10** – Internal wall linings must comply with the group numbers specified in Table 3 of Specification C1.10 and achieve an average specific extinction area less than 250 m^2/kg.	DtS Solution	CSIRO Fire Testing Report and Certificate of Assessment for test carried out in accordance with AS/NZS 3837-1998. Permaform achieved a group number 1 and an average specific extinction area of 236.8 m^2/kg which achieves DtS compliance. Refer to the appended testing report.
Other materials (i.e. shafts and other elements not listed above)	**Clause C1.10, Clause 7 of Specification C1.10** – Other materials and assemblies must achieve a Spread-of-Flame Index of 9 and a Smoke-Developed Index of 8 or less.	DtS Solution	CSIRO Fire Testing Report and Certificate of Assessment for test carried out in accordance with AS1530.3-1999. Permaform achieved a Spread of Flame Index and Smoke Developed Index of 0 and 4 respectively, which achieves DtS compliance for the applications relevant to Permaform. Refer to the appended testing report.

Application	BCA DtS Requirements	DtS Solution or Performance Solution	Evidence of Suitability
FRL of -/60/60 (non-load-bearing)	**Clause A2.3, Specification A2.3** – The FRL of a wall is required to be tested in accordance with AS 1530.4 by an Accredited Testing Laboratory.	DtS Solution	SGS Fire Testing Report for test carried out in accordance with AS 1530.42014. A Permaform wall with a thickness of 110mm achieved an FRL of -/60/60. Refer to the appended testing report.
FRL of -/120/120 (non-load-bearing)	**Clause A2.3, Specification A2.3** – The FRL of a wall is required to be tested in accordance with AS 1530.4 by an Accredited Testing Laboratory.	DtS Solution	SGS Fire Testing Report for test carried out in accordance with AS 1530.42014. A Permaform wall with a thickness of 150mm achieved an FRL of -/120/120. Refer to the appended testing report.

3. Performance Solutions

The BCA DtS requirements permits combustible materials to be applied as internal wall linings if the material achieves the required Group rating. Permaform has been fire tested and achieves a Group 1 material rating and an ASEA of 236.8m^2/kg, meaning that Permaform will comply with the BCA DtS provisions for internal wall applications.

The BCA also permits combustible materials and assemblies in other locations internally such as the construction of a shaft as well as other elements not mentioned in the table above, provided they achieve a Spread-of-Flame Index of 9 or less and a Smoke-Developed Index of 8 or less. Permaform was fire tested and achieved Spread-of-Flame Index of 0 and a Smoke-Developed Index of 4, therefore will also comply with the DtS Provisions of the BCA in these other locations.

Permaform applied as an external wall or a common wall between buildings does not satisfy the BCA DtS provisions. Rather BCA compliance will be demonstrated by providing a Performance Solution which aims to satisfy the BCA Performance Requirements.

The Performance Solution strategy includes:

- Demonstrating the outer PVC layers do not pose undue risk of fire spread via the wall/façade/shaft (refer to fire behaviour of PVC)
- While Permaform is combustible, the BCA permits combustible material such as plasterboard to be used where non-combustible materials are required. The fire performance of Plasterboard will be compared to Permaform, the comparison aims to demonstrate a similar level of fire safety to determine BCA compliance using an equivalence approach.
- Fire testing was conducted in accordance with AS 1530.3:1999. The test confirmed a Spread-of-Flame Index of 0 and a Smoke-Developed Index of 4 for Permaform and as a result is better than or comparable to materials such as Plasterboard, which is considered a DtS compliant solution.

3.1 Fire Behaviour of PVC

When PVC is exposed to high temperatures it will decompose to provide an insulating layer of char that retards further degradation of the virgin PVC material below. The insulating properties of this char layer can provide built-in fire resistance. The rate of char is initially fast but as the char increases it slows as this insulating layer grows.

PVC will combust when exposed to a heat source, but when the source of heat is removed, PVC will typically char and self-extinguish. This makes it difficult to burn and to sustain a fire without another source of heat and therefore would not support rapid fire spread along the façade in which Permaform is present.

PVC is made from a mixture of carbon, hydrogen and chlorine. The chlorine not only gives PVC useful durability properties, but also improves the materials resistance to fire. As mentioned, PVC will not typically burn when a flame or heat is removed. This is due to the chlorine atoms in the polymer, as chlorine improves the fire resistance of plastic polymers. [26]

While PVC is combustible by nature, it is considered to not be a highly flammable material. Flammability of a material can be characterised by the ignition temperature and ability to sustain flame. Materials with a higher ignition temperature are considered to have lower hazard to combustibility. Typically, PVC will ignite when temperatures exceed 435°C [27], in comparison, paper made from cellulose typically has an ignition temperature of 233°C [28]. Furthermore, even though PVC is combustible, its high ignition temperature coupled with its capacity to char translates to a material that is not highly flammable; materials such as paper are considered to be more flammable and more readily facilitate spread of fire faster than PVC.

It should also be noted, the BCA provides a concession for combustible materials to be used where non-combustible materials are required; BCA clause C1.9 states that plasterboard can be used where non-combustible materials are required. Plasterboard contains a plaster core with two outer layers of paper, and as discussed, paper will ignite at lower temperatures than PVC.

Plasterboard when tested in accordance with ASTM E84, has a Flame Spread Index (FSI) of 10-20, while 3mm thick PVC sheet has a FSI of 5-10. [26] The ASTM E84 test method measures flame growth across material, the result, measured as a Flame Spread Index (FSI), which is a scale from 0 to 100; asbestos board has a FSI of 0 and red oak wood has a maximum value of 100. Considering this, it is apparent that even though PVC is combustible, its ability to spread flames via the façade or internally would be limited. This is demonstrated by the AS1530.3-1999 fire test, where Permaform achieved a Spread-of-Flame Index of 0, with 0 being the best and 10 being the worst.

There is a strong indication from the information presented above, that the Permaform outer layers would not support significant flame spread and will likely self-extinguish when the source of heat is removed. The PVC ignition temperature suggests that the Permaform outer layers (PVC) could ignite when an external source of heat is applied (i.e. flames from a window impinging onto the facade), however, with PVC's ability to char coupled with a low Flame Spread Index it suggests that the material away from the original flame source would unlikely be able to sustain flaming combustion that would result in significant fire spread

4. Conclusion

Based on the supporting test data and the inherent performance of PVC lined concrete, Permaform is considered to be capable of complying with the BCA via a combination of DtS Solutions and Performance Solutions as discussed within this document.

Ettienne Jordaan
NSW – C10 Accredited Fire Engineer
VIC – Registered Building Practitioner (Fire Safety Engineer)
For **Wood & Grieve Engineers**

Date: 29/05/2019

Appendix 1 AS/NZS 3837-1998 CSIRO Fire Testing Report and Certificate

INFRASTRUCTURE TECHNOLOGIES
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Test on rigid PVC-based rib-reinforced plastic material for concrete formwork at 50-kW/m² irradiance in accordance with AS/NZS 3837:1998

Fire Testing Report

Author: Alarde, Heherson
Report Number: FNK 11034
Job Number: NK7079

Date: 4 February 2014
Version: Revision B

Client: Permaform Australia Pty Ltd

Commercial-in-confidence

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Client

Permaform Australia Pty Ltd
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AUSTRALIA

Test Report Details

Document: Fire Testing Report

Test Standard: AS/NZS 3837:1998 at 50-kW/m² irradiance

Client: Permaform Australia Pty Ltd

Proposal number: NK7079

Test Report Status and Revision History

VERSION	STATUS	DATE	DISTRIBUTION	COMMENT	FORMAT
Revision A	Draft for internal review	28 January 2014	CSIRO	CSIRO	Word
Revision B	Final for issue	4 February 2014	CSIRO; Permaform Australia Pty Ltd		PDF

Test Report Authorisation

AUTHOR	REVIEWED BY	AUTHORISED BY
Alarde, Heherson	Collins, Russell	Roddy, Brett
4 February 2014	4 February 2014	4 February 2014

Use of this Report

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Important disclaimer

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1 Summary

Sponsored Investigation Report Number FNK 11034

Test on rigid PVC-based rib-reinforced plastic material for concrete formwork at

50-kW/m² irradiance in accordance with AS/NZS 3837:1998

2 Test Details

2.1 Sample Identification

Permaform

2.2 Sponsor

Permaform Australia Pty Ltd
6A Barrow Pl
QUEANBEYAN NSW 2620
AUSTRALIA

2.3 Manufacturer

Permaform Australia Pty Ltd
6A Barrow Pl
QUEANBEYAN NSW 2620
AUSTRALIA

2.4 Job Number

NK7079

2.5 Test Date

21 January 2014

2.6 Description of Sample

The sponsor described the tested specimen as rigid PVC-based, hollow-type rib-reinforced plastic material comprising of two PVC panel facings with internal reinforced PVC ribs, used as permanent formwork for concrete walls. The rigid PVC profile formed the exposed face of the tested specimen. The specimen contained flame-retardant additives.

Nominal thickness of PVC:	2.50 mm
Nominal thickness of concrete block:	47 mm
Nominal total thickness:	50 mm
Nominal density of PVC:	1300 kg/m^3
Nominal total mass:	97.13 kg/m^2
Colour:	beige (PVC)

2.7 Documentation

The following documents were supplied by the sponsor as a full and complete description of the sample:

- Test Agreement and form FTAF33 dated 30 October 2013.

3 Method

3.1 Conditioning of Specimens

Prior to the test, the specimens were conditioned to constant mass at a temperature of 23 ± 2°C and a relative humidity of 50 ± 10%.

3.2 Test Method

Tests were performed in accordance with Australian/New Zealand Standard 3837:1998 Method of test for heat and smoke release rates for materials and products using an oxygen consumption calorimeter. All test specimens were exposed in the horizontal orientation with the standard pilot operating.

Nominally 100 x 100-mm specimens were tested as supplied. Specimens were tested with the use of an edge frame. The edge frame reduces the test surface area to 0.0088-m². The specimens were restrained with a wire grid which further reduced the test surface area to 0.0081 m^2, and this is the area used in calculations.

For the test, specimens were wrapped in aluminium foil so that the four edges and the bottom of the specimen were covered. The foil formed a shallow tray that retained any molten material during testing.

Six specimens were tested at an irradiance level of 50-kW/m².

The nominal exhaust system flow rate for all tests was 0.024-m³/s.

A measured quantity of ethanol was burnt to obtain a C factor to be used in the Heat Release calculations.

3.3 Departure from Standard

In performing heat release rate calibration to determine the orifice constant, *C*, an alternative procedure was employed as specified in Clause 10.2.4 of ISO 5660-1:2002(E) by burning a measured quantity of absolute ethanol.

3.4 Duration of Test

The test is terminated when any one of the following is applicable:

1. 2 minutes have passed since all flaming from the specimen ceased; and
2. the average mass loss over a 1-minute period has dropped below 150-g/m²;
3. 60 minutes have elapsed; or
4. the specimen fails to ignite after a 10-minute exposure.

Note: The mass loss test end criterion was not used for this test.

4 Results and Observations

Observations

4.1.1 SPECIMEN 1

The specimen began to smoke after 10 seconds exposure to the test. The specimen ignited during the test. The test was terminated when two minutes had passed since all flaming from the specimen ceased.

4.1.2 SPECIMEN 2

The specimen began to smoke after 10 seconds exposure to the test. The specimen ignited during the test. The test was terminated when two minutes had passed since all flaming from the specimen ceased.

4.1.3 SPECIMEN 3

The specimen began to smoke after 10 seconds exposure to the test. The specimen ignited during the test. The test was terminated when two minutes had passed since all flaming from the specimen ceased.

4.1.4 SPECIMEN 4

The specimen began to smoke after 10 seconds exposure to the test. The specimen ignited during the test. The test was terminated when two minutes had passed since all flaming from the specimen ceased.

4.1.5 SPECIMEN 5

The specimen began to smoke after 10 seconds exposure to the test. The specimen ignited during the test. The test was terminated when two minutes had passed since all flaming from the specimen ceased.

4.1.6 SPECIMEN 6

The specimen began to smoke after 11 seconds exposure to the test. The specimen ignited during the test. The test was terminated when two minutes had passed since all flaming from the specimen ceased.

4.2 Results of Tests

The results of tests as specified in the Standard are summarised in Table 1.

Test Details:

Date of test: 21/01/14
Test Report Date: 04/02/14
Ethanol burn ('C' factors): 0.038418

Table 1 Results of test

	IRRADIANCE (kW/m²)	TIME TO SUSTAINED BURNING (s)	TEST DURATION (s)	THICKNESS (mm)	SPECIMEN MASS (g)	MASS REMAINING (g)	MASS LOSS (g)	PERCENT OF MASS PYROLYSED (%)	AVERAGE RATE OF MASS LOSS (g/m².s)	PEAK HRR (kW/m²)	AVERAGE HRR (FIRST 60s AFTER IGN)	AVERAGE HRR (FIRST 180s AFTER IGN)	AVERAGE HRR (FIRST 300s AFTER IGN)	TOTAL HEAT RELEASED (MJ/m²)	AVERAGE EHC (MJ/kg)	AVERAGE SPECIFIC EXTINCTION AREA (m²/kg)
Sample 1	50	146	475	48.22	48.32	25.72	22.60	46.77	6.62	67.5	44.5	49.8	38.3	12.28	4.40	256.7
Sample 2	50	146	460	48.37	48.47	15.87	32.60	67.26	7.05	77.9	53.7	58.4	40.8	12.73	3.16	212.5
Sample 3	50	144	470	49.95	50.05	27.65	22.40	44.76	6.43	66.3	36.3	47.8	37.5	11.85	4.29	248.6
Sample 4	50	129	455	48.47	947.35	915.4	32.00	3.38	6.03	67.9	35.6	49.3	36.0	11.32	2.86	174.9
Sample 5	50	162	485	49.17	949.47	927.1	22.40	2.36	7.37	61.4	38.3	40.9	31.8	10.34	3.74	256.5
Sample 6	50	140	470	48.1	973.19	950.1	23.10	2.37	7.43	67.0	37.1	47.6	33.8	10.65	3.73	271.5
Mean		144.5	469.2		502.8	477.0	25.9	27.8	6.8	68.0	40.9	49.0	36.4	11.5	3.7	236.8
SD		10.7	10.7		497.3	497.3	5.0	28.6	0.6	5.4	7.0	5.6	3.3	0.9	0.6	36.2

Figure 1 Heat Release Rate (HRR)

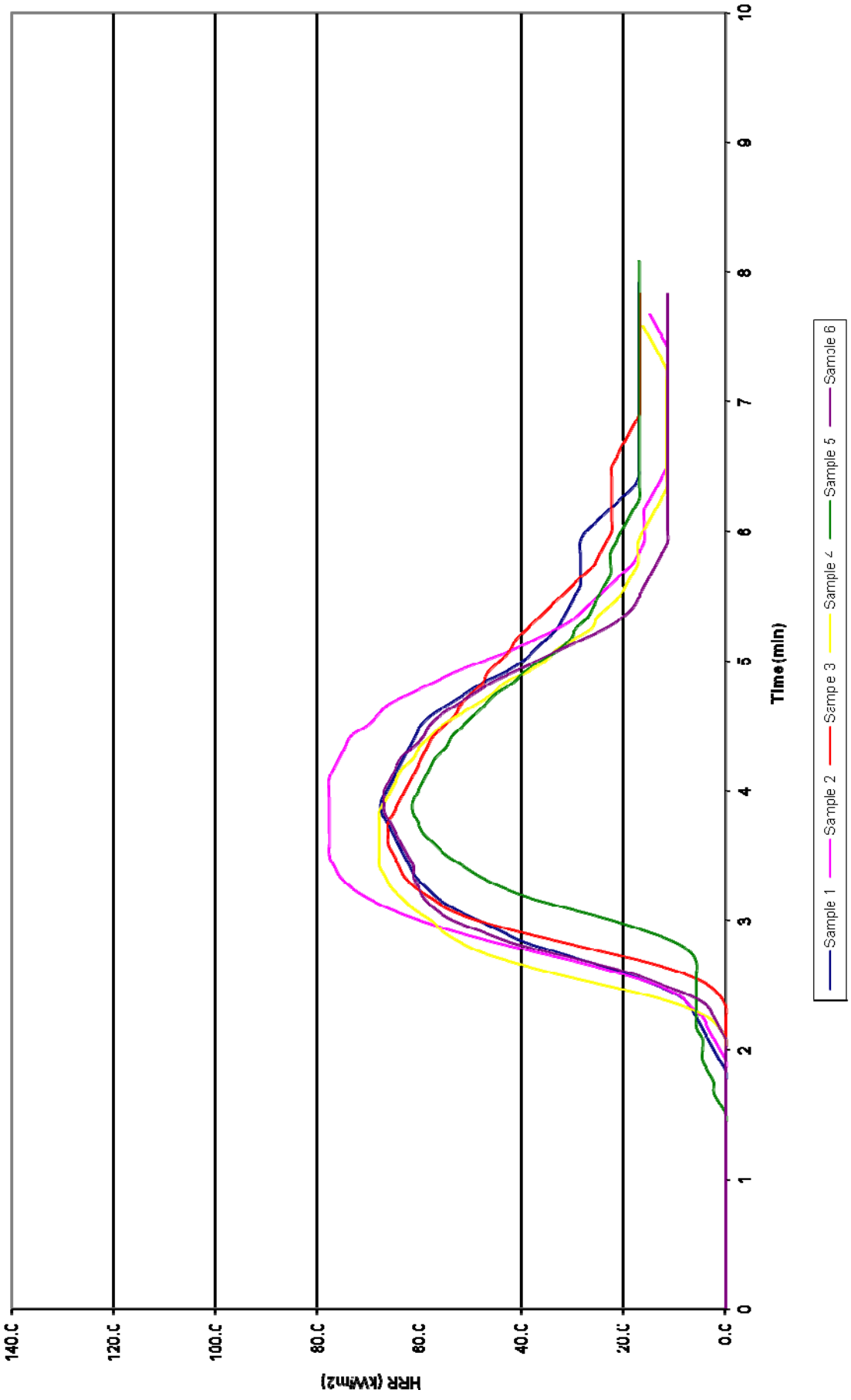
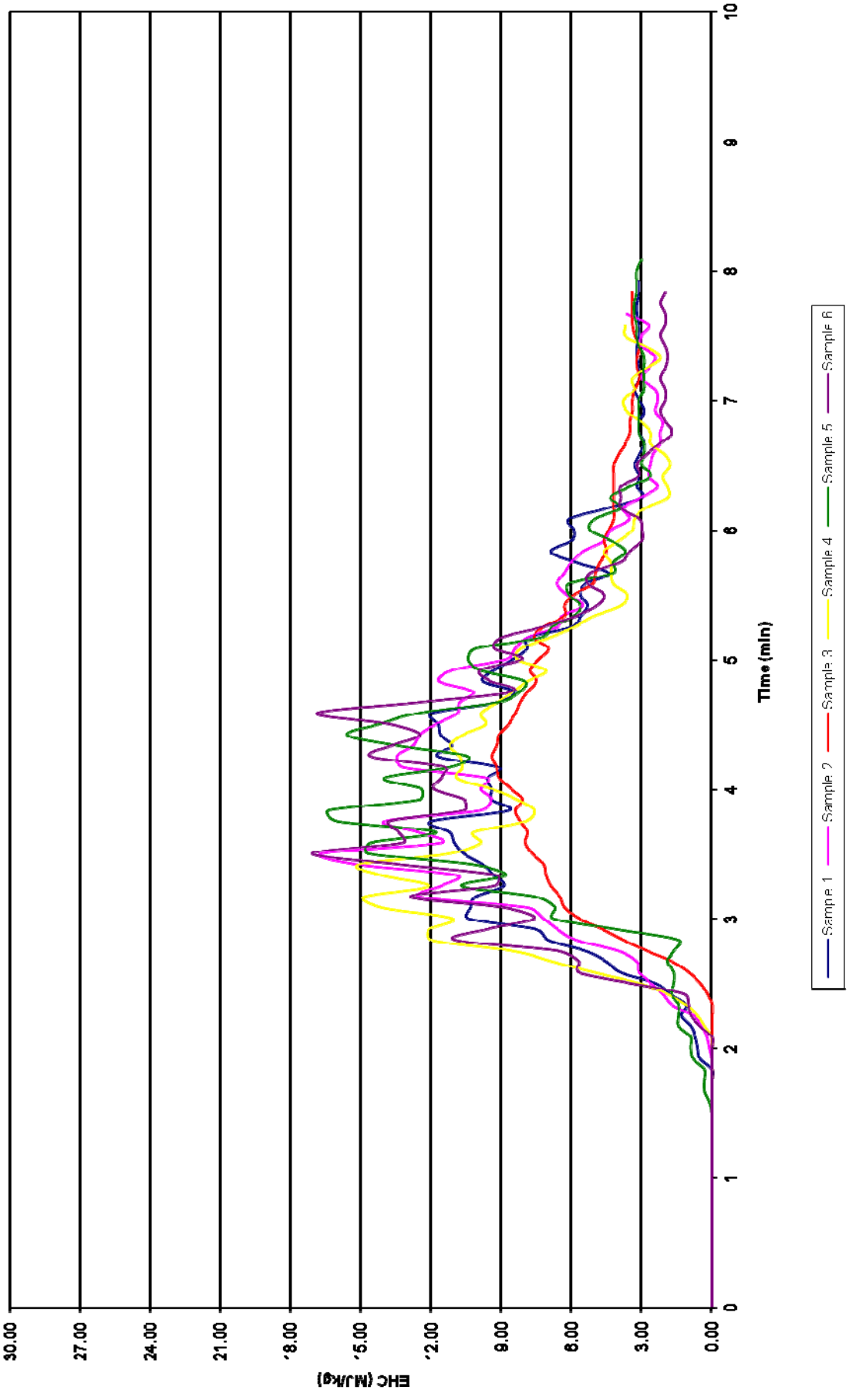


Figure 2 Effective Heat of Combustion (EHC)



5 Assessment Certificate

Figure 3 Certificate of Assessment 1950

Certificate of Assessment

Quote No.: NK7079 **No. 1950**

This is to certify that the specimen described below was tested by the CSIRO Division of Materials Science and Engineering in accordance with Australian/ New Zealand Standard 3837, Method of test for heat and smoke release rates for materials and products using an oxygen consumption calorimeter, 1998, at 50 kW/m², on behalf of:

Permaform Australia Pty Ltd
6A Barrow Pl
QUEANBEYAN NSW 2620
AUSTRALIA

A full description of the test specimen and the complete test results are detailed in the Division's sponsored investigation report numbered FNK 11034.

SAMPLE IDENTIFICATION: Permaform

DESCRIPTION OF SAMPLE: The sponsor described the tested specimen as a rigid PVC-based, hollow-type rib-reinforced plastic material comprising of two PVC panel facings with internal reinforced PVC ribs, used as permanent formwork for concrete walls. The rigid PVC profile formed the exposed face of the tested specimen. The specimen contained flame-retardant additives.

Nominal thickness of PVC:	2.50 mm
Nominal thickness of concrete block:	47 mm
Nominal total thickness:	50 mm
Nominal density of PVC:	1300 kg/m^3
Nominal total mass:	97.13 kg/m^2
Colour:	beige (PVC)

SAMPLE CLASSIFICATION: Group Number: Group 1
(In accordance with Specification A2.4 of the Building Code of Australia.)

Average specific extinction area: 236.8 m²/kg
(Refer to Specification C1.10 section 4(c) of the Building Code of Australia.)

Testing Officer: Heherson Alarde Date of Test: 21 January 2014

Issued on the 4th day of February 2014 without alterations or additions.

Brett Roddy
Team Leader, Fire Testing and Assessments

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Appendix 2 AS1530.4-2014 SGS Fire Testing Reports

PERMAFORM AUSTRALIA LTD

219-18# XINFENG (S) ROAD SHANGHAI CHINA

The following sample(s) was / were submitted and identified on behalf of the client as:

Sample Description:

PERMAFORM PVC WALL - Extruded rigid polyvinyl chloride (PVC)-based, hollow type rib reinforced plastic material comprising of two PVC panel facings with internal reinforced PVC ribs, used as permanent formwork for concrete walls; 110mm in thickness overall. The nominal thickness of the PVC on the face panels are 2.8mm up to 5mm at the anchor points.

Test Requested:

AS 1530.4-2014 Method for fire tests on building materials, components and structures Part 4:

Fire-resistance test of elements of construction

Test Results: -- See attached sheet --

Test Period:

Sample Receiving Date	:	NOV.18, 2015
Test Performing Date	:	NOV.18, 2015 TO NOV.20, 2015

SGS is recognised by the National Association of Testing Authorities Australia (NATA) through a mutual recognition agreement as defined by the Building Code of Australia (BCA) A1.1 as a Registered Testing Authority (RTA).

Signed for and on behalf of
SGS-CSTC Co., Ltd. Anji Branch

Allen Zou
Technical Manager

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1. Introduction

Determine the fire resistance of the non-load bearing vertical separating elements in accordance with section 3 of AS 1530.4-2014: Method for fire tests on building materials, components and structures part 4: Fire-resistance test of elements of construction.

The sample with 3000 mm width by 2750mm height by 110 mm thickness was symmetrical separating element, and one side was exposed to a time-temperature curve as dictated by the Clause 2.10 of AS 1530.4 for a period of 95 minutes under Non-loaded conditions.

2. Test Specimen

2.1 The direction of specimen tested was a random surface

Because of the specimen is a vertical symmetrical separating element

2.2 Description of specimen :

Total nominal installation dimensions of the specimen are 2750 mm length by 3000 mm width by 110 mm thickness.

The tested specimen was assembled by two panels with normal size 1550 mm width by 2750 height and another 1450 mm width by 2750 height. Installation detail, see Figure 1.The tested specimen was symmetrical and the specimen was mounted one side of specimen towards to the heating conditions of the test.

The specimen was installed into a prepared masonry wall with an opening size 3050mm width by2800mm height and fixed by expansible bolt. Between all around of the sample and between two panels were filled with rock wool by laboratory. Installation was conducted by a representative of Lab on 19 NOV, 2015.

To be continued….

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Unit : mm

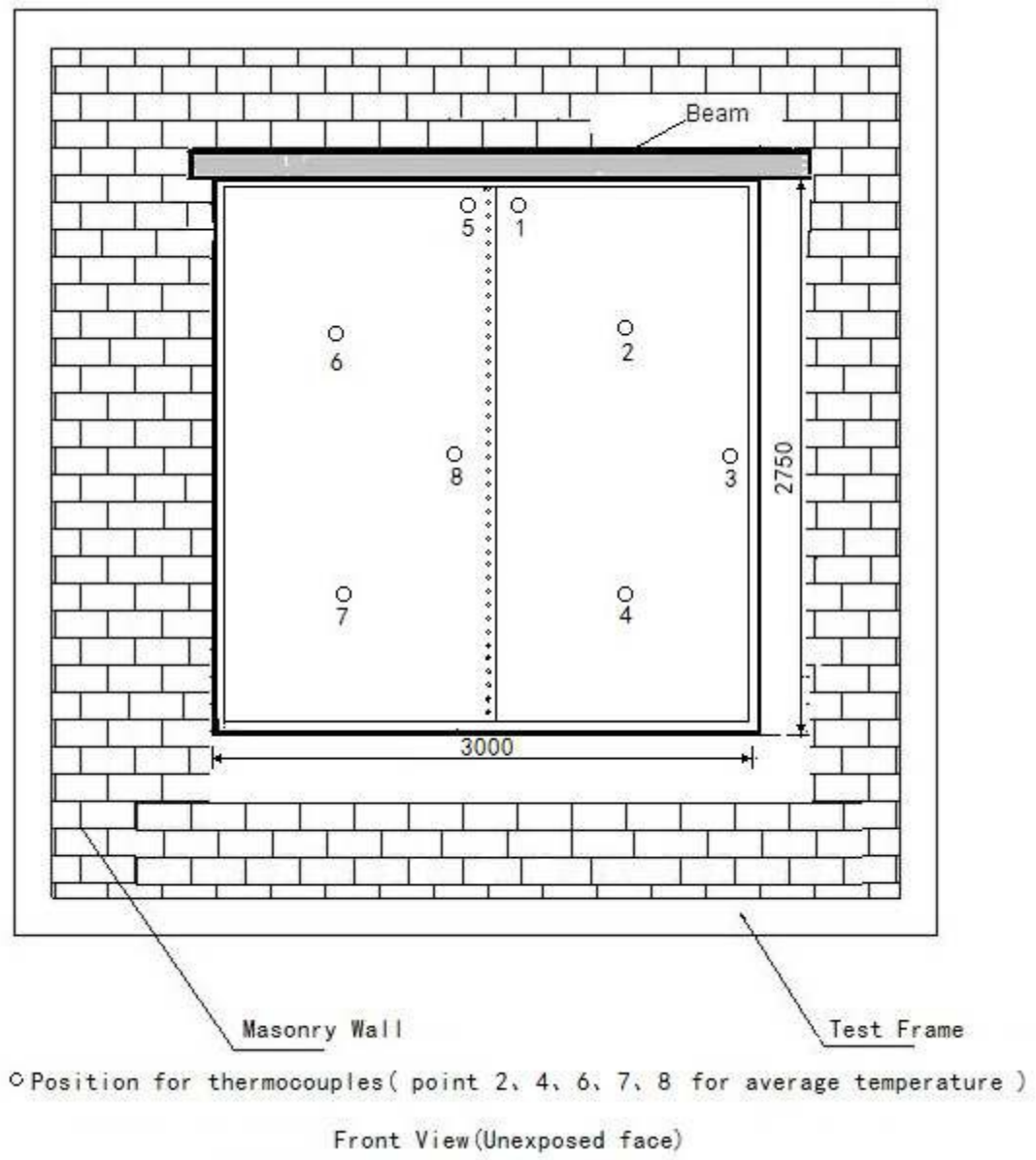

Figure 1 - Elevation drawing of installation (Provided by client)

To be continued….

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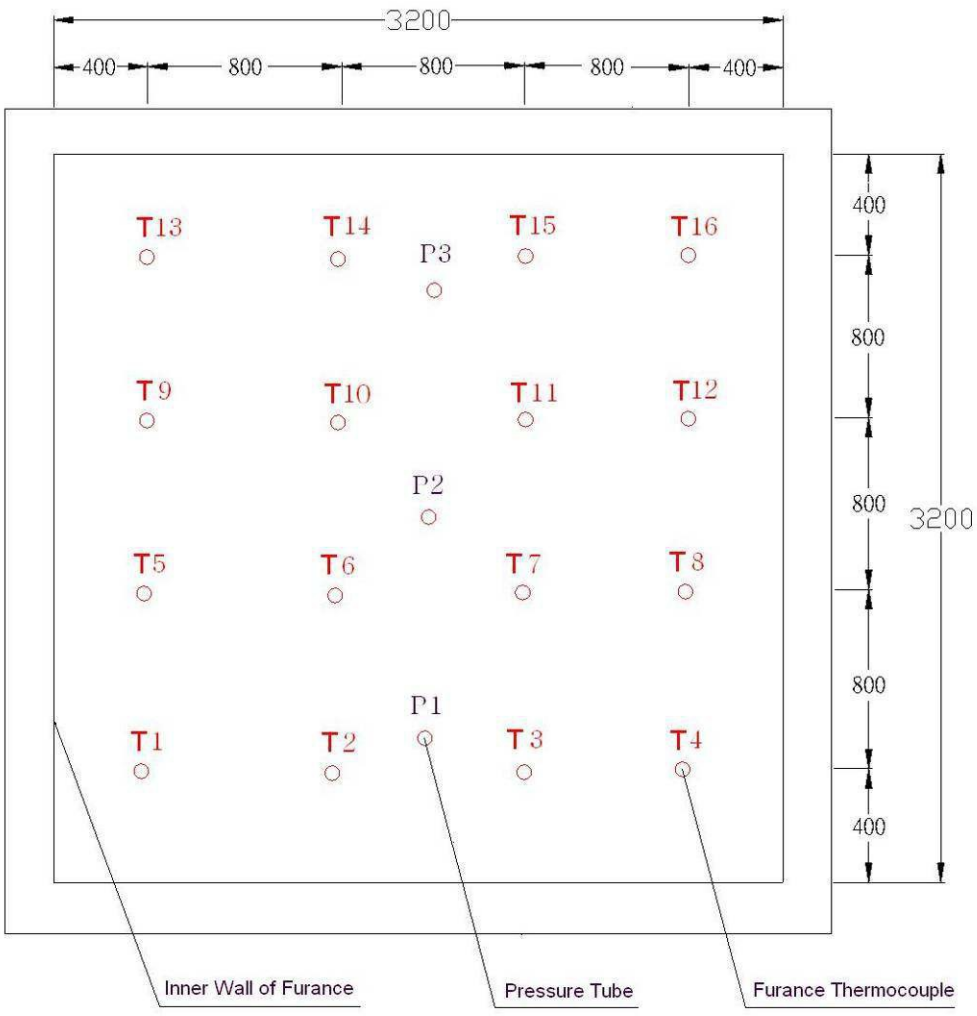
3. Equipment

Sixteen mineral insulated thermocouples were kept at 100 mm away from the surface of the specimen, and were provided to monitor the temperature of the furnace. The locations and reference numbers of the furnace thermocouples are shown in Figure 2.

A pressure sensor was provided to monitor the furnace pressure.

Cotton pads and gap gauges were available to evaluate the impermeability of the specimen to hot gases.



All dimensions are in mm

Figure 2 - Plan of Furnace Thermocouples

To be continued….

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4. Test procedure

The test was conducted in accordance with the procedure specified in AS 1530.4-2014, section 3.

The ambient temperature of test area was 19℃at commence of test with variation of 0℃ during the test.

The furnace was controlled so that the mean furnace temperature, deviation from the mean furnace temperature and uniformity of temperature distribution complied with the requirement of AS 1530.4-2014.

Sixteen furnace thermocouples were used to determine the mean furnace temperature.

The furnace pressure was controlled to comply with the requirements of AS 1530.4-2014, Clause 2.10.3.

The furnace pressure was monitored and controlled. 5 min after the commencement of the test the furnace pressure was 0± 5 Pa of the nominal pressure specified for thewall under test;from 10 min onwards it was 0± 3 Pa of the nominal pressure specified for the particular element under test at a height of approximately 500 mm above the notional floor level.

Cotton pads and gap gauges were used to determine the integrity. The presence ofsustained flaming on the unexposed surface was also checked to determine the integrity. The thermocouples specified in clause 2.2.3.1 were used to determine the insulation of specimen.

5. Test Results

The following data were recorded during the test:

a) The actual mean furnace temperature/ time curve and the standard furnace temperature/ time curve, which were shown in Figure 3.

b) The furnace pressures relative to laboratory atmosphere, at a height of approximately 500 mm above the notional floor level, which were shown in Figure 4.

c) The mean and maximum temperature raises of the unexposed surface of were shown in Figure 5. The individual temperatures recorded on the unexposed surface of the specimen were shown in Table 1.

A summary of the observations made on the general behaviour of the specimen was given in Table 2.

To be continued….

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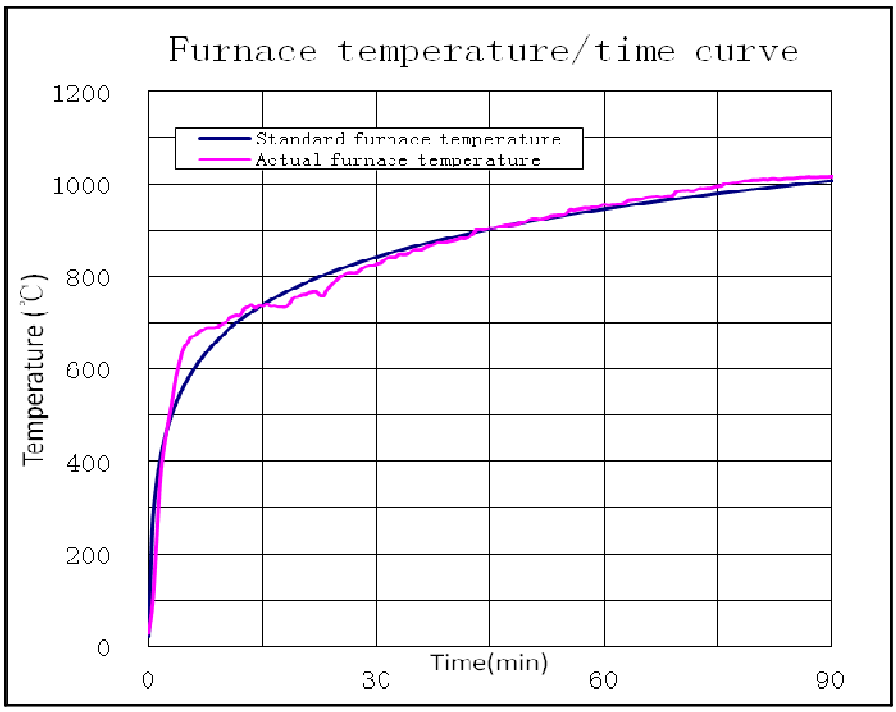

Figure 3 - Actual Mean and Standard Furnace Temperature/Time Curve

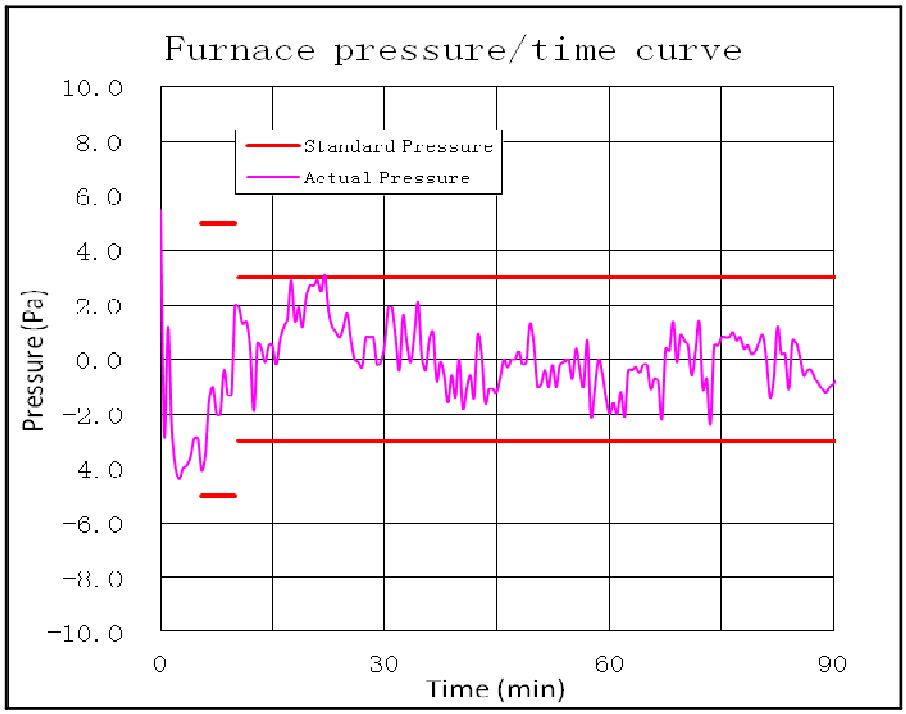

Figure 4 - Furnace Pressures Relative to Laboratory Atmosphere
（500 mm above the notional floor level）

To be continued….

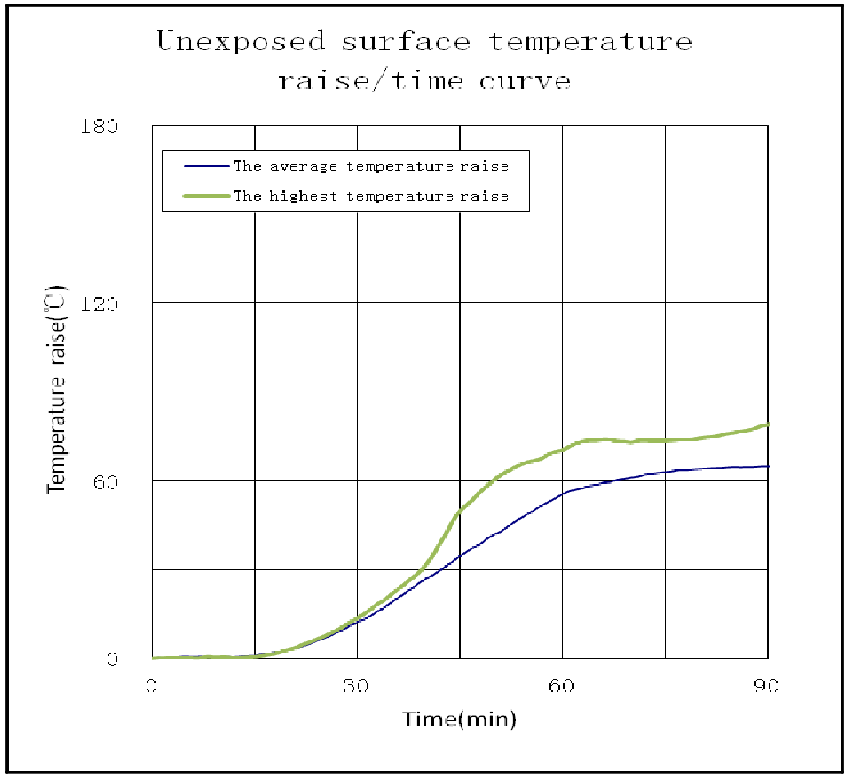

Figure 5 - Temperature raise/time curve

Table 1 Individual Temperatures Recorded on the Unexposed Surface of the Specimen (unit:°C)

Time (min)	1	2	3	4	5	6	7	8
0	18	18	17	17	20	18	18	19
5	19	18	19	17	20	18	19	19
10	19	18	19	17	20	18	19	19
15	20	18	19	18	20	18	20	20
20	21	20	21	20	23	20	22	22
21	22	21	22	21	23	20	23	23
22	23	21	22	21	24	21	23	23
23	23	22	23	22	25	21	24	24
24	24	23	24	23	26	22	26	25
25	25	24	25	24	27	23	26	26
26	25	24	26	25	28	24	28	27
27	26	26	27	26	29	25	29	28
28	27	26	28	27	31	26	30	29
29	28	28	29	28	32	27	32	31

To be continued….

Time (min)	1	2	3	4	5	6	7	8
30	30	29	31	29	33	28	33	32
31	31	30	32	30	35	29	34	34
32	32	31	33	32	36	30	36	35
33	34	32	35	33	38	31	37	37
34	35	33	36	34	40	32	39	38
35	37	34	38	36	42	34	41	40
36	39	36	40	37	43	35	43	42
37	40	37	42	39	45	37	45	43
38	42	38	43	40	47	38	46	45
39	44	40	46	42	49	40	48	46
40	46	41	48	43	51	41	50	48
41	47	42	49	45	54	41	52	50
42	49	43	50	46	58	43	53	52
43	51	45	52	48	62	44	55	54
44	53	46	54	49	66	46	57	56
45	55	47	56	51	69	48	59	58
46	57	49	58	53	72	49	60	60
47	59	50	60	54	74	50	62	62
48	60	51	61	56	76	50	64	64
49	63	52	63	57	78	52	65	66
50	64	54	65	59	80	53	67	68
51	66	54	66	60	82	53	68	70
52	67	56	68	61	83	55	70	72
53	70	57	70	63	84	57	71	74
54	71	58	72	64	85	58	73	76
55	73	60	74	66	86	59	74	79
56	74	61	76	67	87	60	76	82
57	76	61	78	69	87	62	77	84
58	78	61	80	70	89	63	79	86
59	79	61	81	72	90	65	80	88
60	80	62	83	73	90	67	80	90
61	81	63	85	75	90	69	80	91

To be continued….

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Time (min)	1	2	3	4	5	6	7	8
62	82	64	86	75	90	69	80	92
63	84	64	86	75	90	70	80	93
64	85	65	86	76	91	71	80	93
65	85	68	86	76	91	71	80	93
66	86	70	86	77	91	71	81	94
67	86	71	86	77	92	71	81	94
68	86	73	86	78	91	71	81	93
69	86	74	87	79	91	71	81	93
70	87	75	87	79	91	72	81	93
71	86	76	86	80	91	72	81	93
72	87	77	86	81	91	72	82	93
73	87	78	86	82	91	72	81	93
74	87	79	87	83	91	72	81	93
75	87	80	87	83	91	72	81	93
76	87	81	87	83	91	72	81	93
77	87	81	86	84	92	72	82	94
78	87	82	86	84	92	72	82	94
79	86	82	86	84	92	72	82	94
80	86	83	86	84	92	73	83	94
81	86	83	86	84	92	72	83	94
82	87	84	86	84	92	72	83	95
83	87	84	86	84	92	72	83	95
84	87	85	86	84	92	73	83	96
85	87	85	86	84	92	73	83	96
86	87	85	86	84	92	73	82	96
87	87	85	86	85	92	73	83	97
88	87	85	86	84	92	73	83	97
89	87	85	86	84	92	73	83	98
90	87	85	86	84	92	73	83	99
91	87	85	86	84	92	73	84	99
92	87	85	86	85	92	74	84	100
93	87	85	87	85	92	74	84	100
94	88	85	87	85	92	74	84	101
95	88	85	87	85	92	74	84	101

To be continued….

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Table 2 Observations during the Test

Time (min:sec)	Observations
00:00	Furnace fired.
01:00	Smoke start to release from between the panels.
45:00	Slight deformation towards the furnace.
95:30	The deformation been larger than before, The sample keeps fire-resistance performance,test ended as client's requirement was achieved.

6. Performance Criteria (AS 1530.4-2014, Clause 2.12.2 and 2.12.3)

6.1 Integrity

Failure in relation to integrity shall be deemed to have occurred when evaluated as follows:

6.1.1 Cotton pad

The cotton pad in its frame shall be applied against the surface of the test specimen over the crack, fissure or flaming under examination, until ignition of the cotton pad (defined as glowing or flaming) or for a maximum of 30 seconds.

6.1.2 Gap gauges

Gap gauges are used to evaluate the size of any opening in the surface of the test specimen at time intervals that will be determined by the apparent rate of the specimen deterioration.

a) a 6 mm gap gauge can be passed through the specimen so that the gap gauge projects into the furnace and the gauge can be moved a distance of 150 mm along the gap; or

b) a 25 mm gap gauge can be passed through the specimen so that the gap gauge projects into the furnace.

6.1.3 Flaming

Sustained flaming on the surface of the unexposed surface for 10 seconds or longer constitutes integrity failure.

6.2 Insulation

Failure in relation to insulation shall be deemed to have occurred when measured by thermocouples on the unexposed surface, the specimen is deemed to have failed when---

a) the mean temperature of the unexposed surface of the test specimen exceeds the initial temperature by more than 140 ℃; or

b) the temperature at any location on the unexposed surface of the test specimen exceeds the initial temperature by more than 180 ℃

To be continued….

7. Conclusion

The tested specimen has been subjected to a fire resistance test in accordance with AS 1530.4-2014.

The fire resistance of the specimen was judged against the criteria for insulation and integrity as specified clause 6 of this report, and the specimen satisfied the performance requirements for the following period:

Insulation	Integrity
95min	95min

The test was terminated after a period of 95minutes.

None of the above criteria was observed or times exceeded in determination of periods of installation and integrity in excessof 120 minutes.
No surface spalling was detected.

STATEMENT:

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

This report details 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 this standard. Any significant variation with respect to size, constructional details, loads, stresses, edge or end conditions, other than those allowed under the field of direct application in the relevant test method, is not covered by this report.

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

Based on test performance of the full scale fire resistance test it is the opinion of the testing laboratory that temperature endured by a concrete filled Permaform wall would not burn or melt away the polymer webs to create holes under fire conditions.

Therefore the presence of web diaphragms will not affect the FRI capacity and smoke generation for the Permaform product tested in accordance with AS 1530.4-2014.

To be continued….

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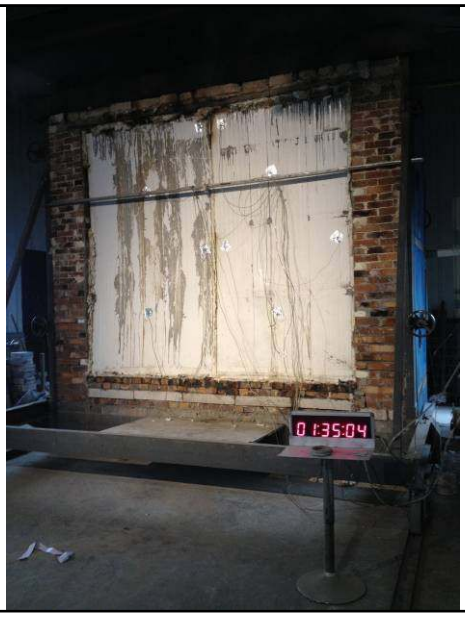
Appendix A Test photographs:

	
Unexposed face before the test	Unexposed face after the test
	
Exposed face before the test	Exposed face after the test

SGS authenticate the photo on original report only

End of report

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PERMAFORM AUSTRALIA LTD

219-18# XINFENG (S) ROAD SHANGHAI CHINA

The following sample(s) was / were submitted and identified on behalf of the client as:

Sample Description:

PERMAFORM PVC WALL - Extruded rigid polyvinyl chloride (PVC)-based, hollow type rib reinforced plastic material comprising of two PVC panel facings with internal reinforced PVC ribs, used as permanent formwork for concrete walls; 150mm in thickness overall. The nominal thickness of the PVC on the face panels are 2.8mm up to 5mm at the anchor points.

Test Requested:

AS 1530.4-2014 Method for fire tests on building materials, components and structures Part 4:

Fire-resistance test of elements of construction

Test Results: -- See attached sheet --

Test Period:

Sample Receiving Date	:	DEC.29, 2015
Test Performing Date	:	DEC.29, 2015 TO DEC.30, 2015

SGS is recognised by the National Association of Testing Authorities Australia (NATA) through a mutual recognition agreement as defined by the Building Code of Australia (BCA) A1.1 as a Registered Testing Authority (RTA).

Signed for and on behalf of
SGS-CSTC Co., Ltd. Anji Branch

Allen Zou
Technical Manager

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1. Introduction

Determine the fire resistance of the non-load bearing vertical separating elements in accordance with section 3 of AS 1530.4-2014: Method for fire tests on building materials, components and structures part 4: Fire-resistance test of elements of construction.

The sample with 3000 mm width by 2750mm height by 150 mm thickness was symmetrical separating element, and one side was exposed to a time-temperature curve as dictated by the Clause 2.10 of AS 1530.4 for a period of 95 minutes under Non-loaded conditions.

2. Test Specimen

2.1 The direction of specimen tested was a random surface

Because of the specimen is a vertical symmetrical separating element

2.2 Description of specimen :

Total nominal installation dimensions of the specimen are 2750 mm height by 3000 mm width by 150 mm thickness.

The tested specimen was assembled by two panels with normal size 1550 mm width by 2750 height and another 1450 mm width by 2750 height. Installation detail, see Figure 1.The tested specimen was symmetrical and the specimen was mounted one side of specimen towards to the heating conditions of the test.

The specimen was installed into a prepared masonry wall with an opening size 3050mm width by2800mm height and fixed by expansible bolt. Between all around of the sample and between two panels were filled with rock wool by laboratory. Installation was conducted by a representative of Lab on 29 DEC, 2015.

To be continued….

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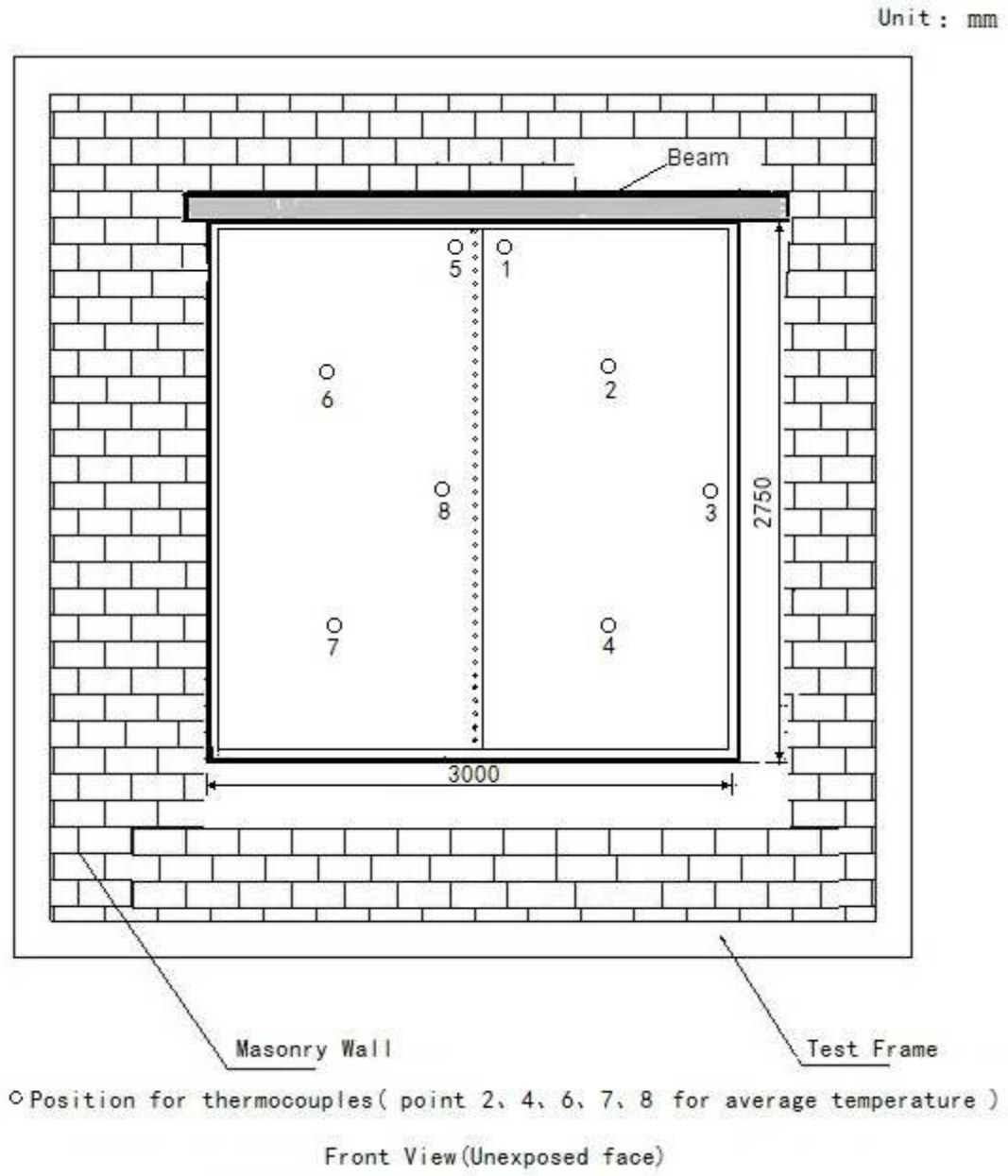

Figure 1 - The drawing of installation

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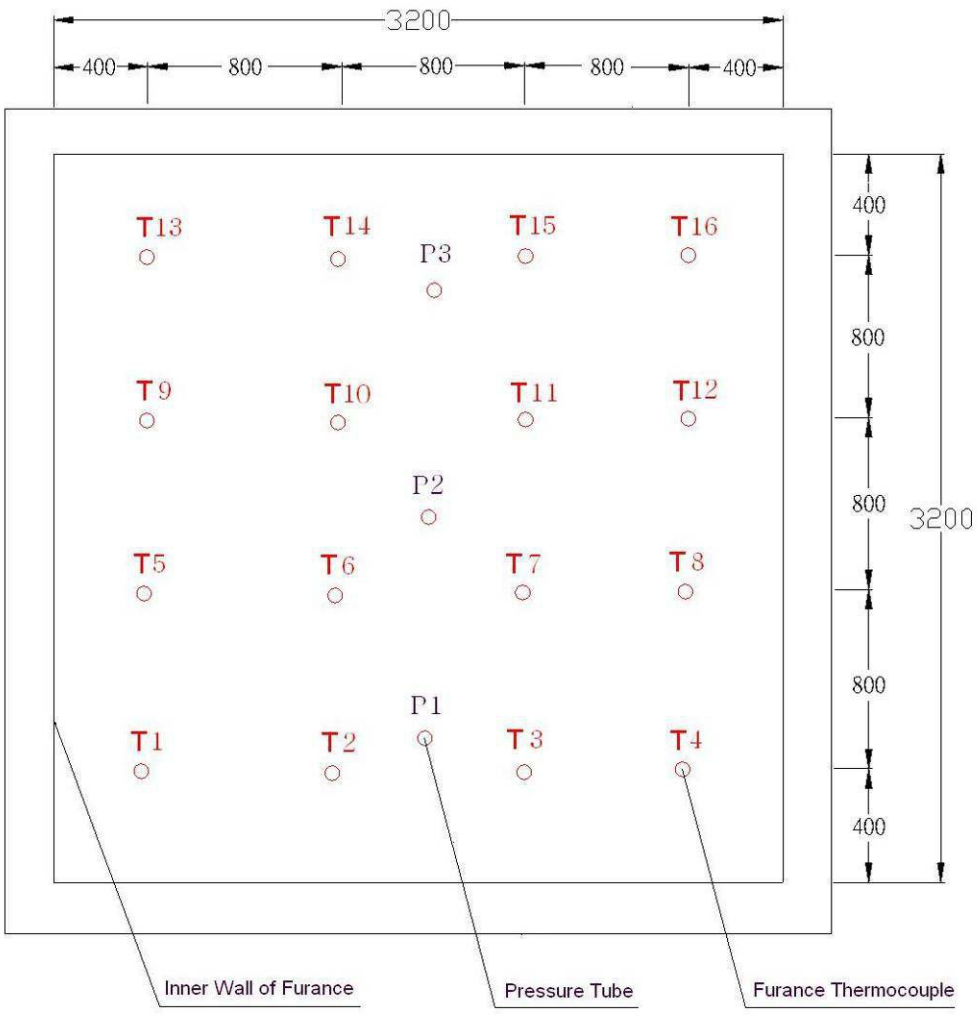
3. Equipment

Sixteen mineral insulated thermocouples were kept at 100 mm away from the surface of the specimen, and were provided to monitor the temperature of the furnace. The locations and reference numbers of the furnace thermocouples are shown in Figure 2.

A pressure sensor was provided to monitor the furnace pressure.

Cotton pads and gap gauges were available to evaluate the impermeability of the specimen to hot gases.



All dimensions are in mm

Figure 2 - Elevation of FurnaceThermocouples

To be continued….

4. Test procedure

The test was conducted in accordance with the procedure specified in AS 1530.4-2014, section 3.
The ambient temperature of test area was 15℃at commence of test with variation of 0℃during the test.
The furnace was controlled so that the mean furnace temperature, deviation from the mean furnace temperature and uniformity of temperature distribution complied with the requirement of AS 1530.4-2014.
Sixteen furnace thermocouples were used to determine the mean furnace temperature.

The furnace pressure was controlled to comply with the requirements of AS 1530.4-2014, Clause 2.10.3. The furnace pressure shall be monitored and controlled. 5 min after the commencement of the test the furnace pressure shall be 0± 5 Pa of the nominal pressure specified for the particular element under test; from 10 min onwards it shall be 0± 3 Pa of the nominal pressure specified for the particular element under test at a height of approximately 500 mm above the notional floor level.

Cotton pads and gap gauges were used to determine the integrity. The sustained flaming on the unexposed surface was also checked to determine the integrity. The thermocouples specified in clause 2.2.3.1 were used to determine the insulation of specimen.

5. Test Results

The following data were recorded during the test:

a) The actual mean furnace temperature/ time curve and the standard furnace temperature/ time curve, which were shown in Figure 3.

b) The furnace pressures relative to laboratory atmosphere, at a height of approximately 500 mm above the notional floor level, which were shown in Figure 4.

c) The mean and maximum temperature raises of the unexposed surface of were shown in Figure 5. The individual temperatures recorded on the unexposed surface of the specimen were shown in Table 1.

A summary of the observations made on the general behaviour of the specimen was given in Table 2.

To be continued….

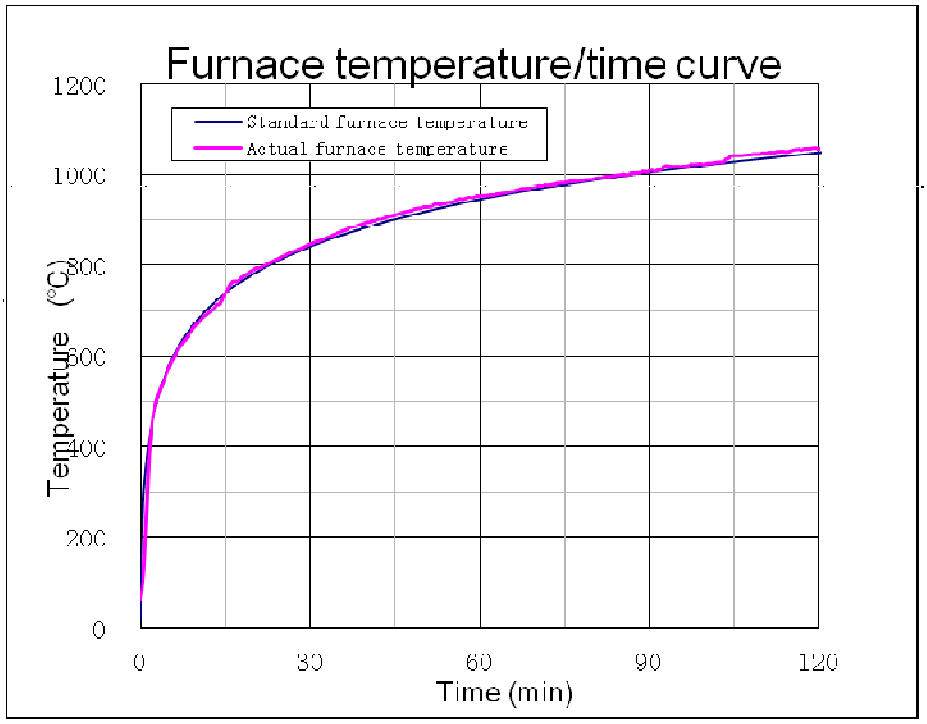


Figure 3 - Actual Mean and Standard Furnace Temperature/Time Curve

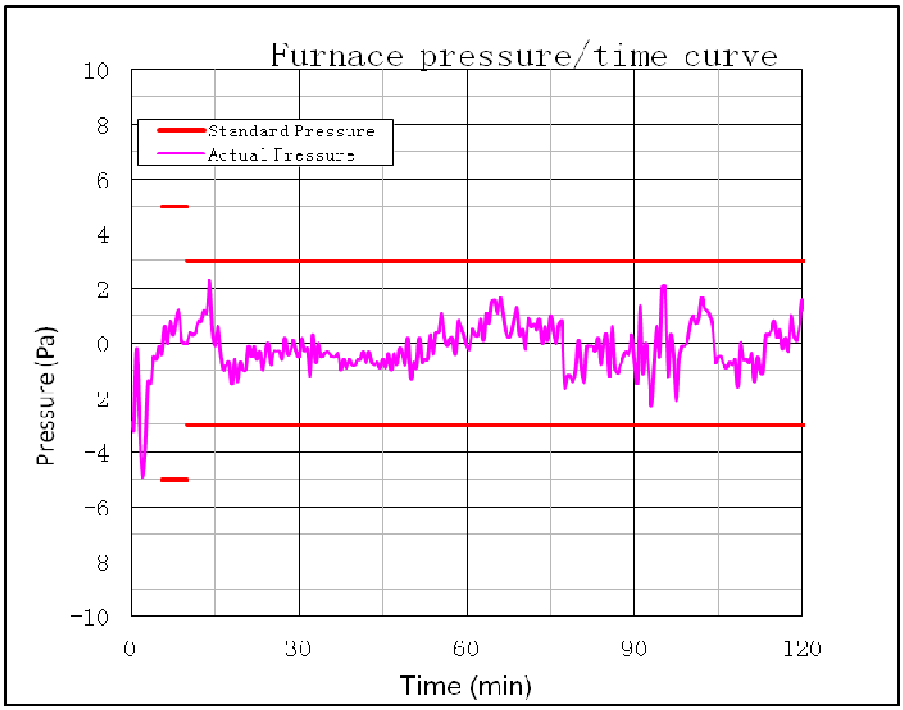


Figure 4 - Furnace Pressures Relative to Laboratory Atmosphere
(500 mm above the notional floor level)

To be continued….

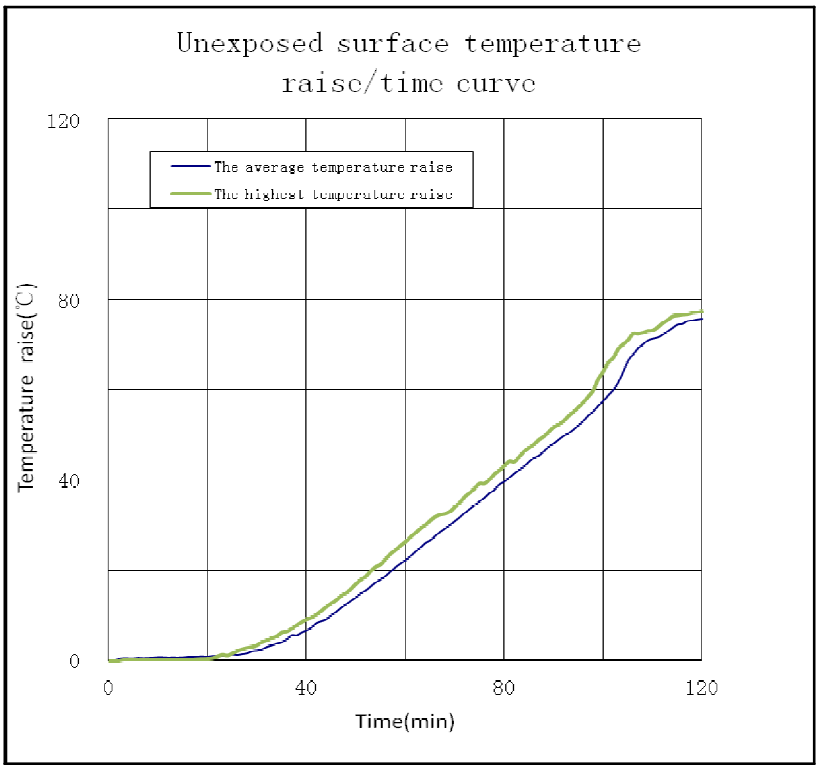


Figure 5 - Temperature raise/time curve

Table 1 Individual Temperatures Recorded on the Unexposed Surface of the Specimen (unit:°C)

Time (min)	Position of Thermocouples							
	1	2	3	4	5	6	7	8
0	15	14	15	14	14	14	14	15
1	15	14	15	14	14	14	14	15
2	15	15	15	14	14	15	14	15
3	15	15	15	14	14	15	14	15
4	15	15	15	14	14	15	14	15
5	15	15	15	14	14	15	14	15
6	15	15	15	14	14	15	14	15
7	15	15	15	14	14	15	14	15
8	15	15	15	14	14	15	14	15
9	15	15	15	14	14	15	14	15
10	15	15	15	14	14	15	14	15
11	15	15	15	14	14	15	14	15

To be continued….

Time (min)	Position of Thermocouples							
	1	2	3	4	5	6	7	8
12	15	15	15	14	14	15	14	15
13	15	15	15	14	14	15	14	15
14	15	15	15	14	14	15	14	15
15	15	15	15	14	14	15	14	15
16	15	15	15	15	14	15	15	15
17	15	15	15	15	14	15	15	15
18	15	15	15	15	14	15	15	15
19	15	15	15	15	14	15	15	15
20	15	15	15	15	15	15	15	15
21	16	15	16	15	15	15	15	15
22	16	15	16	15	15	15	15	16
23	16	15	16	15	15	15	15	16
24	16	15	16	15	15	15	15	16
25	17	15	17	16	15	15	16	16
26	17	15	17	16	16	15	16	16
27	18	15	18	16	16	15	16	16
28	18	15	18	16	17	15	16	16
29	18	15	18	17	17	15	16	16
30	18	16	18	17	17	16	17	17
31	19	16	19	17	18	16	17	17
32	20	16	20	18	18	17	17	17
33	20	17	20	18	18	17	18	18
34	20	17	20	18	19	18	18	18
35	21	18	21	19	19	18	19	18
36	21	19	21	19	20	19	19	19
37	22	19	22	20	20	19	20	21
38	23	20	23	20	21	19	20	19
39	24	20	24	21	22	20	20	20
40	24	21	24	21	22	20	21	20
41	25	21	25	22	23	21	22	21
42	25	22	25	22	24	22	22	23
43	26	23	26	23	24	23	23	23
44	27	23	27	23	25	23	24	23
45	28	24	28	24	26	24	24	24
46	28	25	28	25	27	24	25	25
47	29	25	29	26	28	25	26	26

To be continued….

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Time (min)	Position of Thermocouples							
	1	2	3	4	5	6	7	8
48	30	26	30	27	28	26	27	27
49	31	27	31	27	29	27	27	28
50	32	28	32	28	30	28	28	29
51	33	29	33	29	31	29	29	30
52	34	29	34	29	32	30	30	30
53	35	30	35	31	33	30	31	31
54	36	31	36	32	34	31	32	32
55	36	32	36	32	34	31	32	33
56	38	32	38	33	36	32	33	33
57	39	34	39	34	36	33	34	34
58	40	34	40	35	37	34	35	35
59	41	35	41	36	38	35	36	35
60	41	36	41	37	39	35	37	36
61	42	37	42	38	40	36	38	37
62	43	38	43	39	41	37	39	38
63	44	39	44	40	42	38	40	39
64	45	40	45	41	42	39	40	40
65	46	41	46	42	44	40	42	40
66	47	42	47	42	44	41	42	41
67	47	42	47	43	45	42	43	42
68	48	43	48	44	45	43	44	43
69	48	44	48	45	46	43	45	44
70	49	45	49	46	47	44	46	45
71	50	46	50	47	48	46	47	45
72	51	47	51	47	49	47	47	46
73	52	48	51	48	50	47	48	47
74	53	49	53	49	50	48	49	47
75	54	49	54	50	51	49	50	48
76	54	50	54	51	52	50	51	49
77	55	51	55	52	53	51	52	50
78	56	52	56	53	54	52	53	51
79	57	53	57	54	54	53	54	52
80	58	53	57	54	56	54	54	52
81	59	55	59	55	56	55	55	53
82	59	55	59	56	57	55	56	54
83	60	56	60	57	58	56	57	55

To be continued….

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Time (min)	Position of Thermocouples							
	1	2	3	4	5	6	7	8
84	61	57	61	58	59	57	58	56
85	62	58	62	59	60	58	59	57
86	63	59	63	59	61	59	59	58
87	64	60	64	60	62	59	60	58
88	65	60	65	61	63	60	61	59
89	66	62	66	62	64	62	62	60
90	67	62	67	63	65	62	63	61
91	67	64	67	63	66	64	63	61
92	68	64	68	64	67	64	64	62
93	69	65	69	64	68	65	65	63
94	70	66	70	65	70	65	66	64
95	71	67	71	66	71	67	66	65
96	72	68	72	67	72	68	67	66
97	73	69	73	68	74	69	69	66
98	74	70	74	69	75	70	70	67
99	75	71	75	70	77	71	72	68
100	76	73	76	71	79	73	73	69
101	77	74	77	72	81	74	74	71
102	79	75	79	73	82	75	75	71
103	80	78	80	75	84	77	76	72
104	81	81	82	77	85	81	77	74
105	82	83	83	80	86	84	78	77
106	83	85	84	81	87	86	79	78
107	84	87	85	83	87	87	80	79
108	85	88	86	85	88	88	80	80
109	85	88	87	86	88	88	81	82
110	86	88	88	86	88	88	81	83
111	86	89	88	86	88	89	81	83
112	87	90	89	87	89	90	82	83
113	87	90	89	88	89	90	82	84
114	87	91	90	88	89	91	83	85
115	88	91	90	89	89	91	84	86
116	87	92	90	89	90	92	85	86
117	88	92	91	90	90	92	85	87
118	88	92	91	90	90	92	85	87
119	88	92	91	90	90	92	85	88
120	89	92	92	91	91	92	86	88

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Table 2 Observations during the Test

Time (min:sec)	Observations
00:00	Furnace fired.
01:00	Smoke start to release from between panels .
120:00	Slight deformation towards the furnace. The sample keeps fire-resistance performance end test as client's requirement.

6. Performance Criteria (AS 1530.4-2014, Clause 2.12.2 and 2.12.3)

6.1 Integrity

Failure in relation to integrity shall be deemed to have occurred when evaluated as follows:

6.1.1 Cotton pad

The cotton pad in its frame shall be applied against the surface of the test specimen over the crack, fissure or flaming under examination, until ignition of the cotton pad (defined as glowing or flaming) or for a maximum of 30s.

6.1.2 Gap gauges

Gap gauges are used to evaluate the size of any opening in the surface of the test specimen at time intervals that will be determined by the apparent rate of the specimen deterioration.

a) a 6 mm gap gauge can be passed through the specimen so that the gap gauge projects into the furnace and the gauge can be moved a distance of 150 mm along the gap; or

b) a 25 mm gap gauge can be passed through the specimen so that the gap gauge projects into the furnace.

6.1.3 Flaming

Sustained flaming on the surface of the unexposed surface for 10s or longer constitutes integrity failure.

6.2 Insulation

Failure in relation to insulation shall be deemed to have occurred when measured by thermocouples on the unexposed surface, the specimen is deemed to have failed when---

a) the mean temperature of the unexposed surface of the test specimen exceeds the initial temperature by more than 140 ℃; or

b) the temperature at any location on the unexposed surface of the test specimen exceeds the initial temperature by more than 180 ℃

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7. Conclusion

The tested specimen has been subjected to a fire resistance test in accordance with AS 1530.4-2014.

The fire resistance of the specimen was judged against the criteria for insulation and integrity as specified clause 6 of this report, and the specimen satisfied the performance requirements for the following period:

Insulation	Integrity
≥120 mins	≥120 mins

The test was terminated after a period of 121minutes.

None of the above criteria was observed or times exceeded in determination of periods of installation and integrity in excessof 120 minutes.

No surface spalling was detected.

STATEMENT:

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

This report details 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 this standard. Any significant variation with respect to size, constructional details, loads, stresses, edge or end conditions, other than those allowed under the field of direct application in the relevant test method, is not covered by this report.

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

Based on test performance of the full scale fire resistance test it is the opinion of the testing laboratory that temperature endured by a concrete filled Permaform wall would not burn or melt away the polymer webs to create holes under fire conditions.

Therefore the presence of web diaphragms will not affect the FRI capacity and smoke generation for the Permaform product tested in accordance with AS 1530.4-2014

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Appendix A Test photographs:

	
Unexposed face before the test	Unexposed face after the test
	
Exposed face before the test	Exposed face after the test

SGS authenticate the photo on original report only

End of report

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Appendix 3 AS1530.3-1999 CSIRO Fire Testing Report and Certificate

Certificate of Test

QUOTE No.: NE8147 **REPORT No.: FNE12353**

AS/NZS 1530.3:1999 SIMULTANEOUS DETERMINATION OF IGNITABILITY, FLAME PROPAGATION, HEAT RELEASE AND SMOKE RELEASE

TRADE NAME: Permaform

SPONSOR: Permaform International Pty Ltd
1 Moorebank Ave
MOOREBANK NSW 2170
AUSTRALIA

DESCRIPTION OF SAMPLE: The sponsor described the tested specimen as an extruded polyvinyl chloride (PVC) applied over a 4.5-mm thick fibre reinforced cement (FC) board. The specimen is comprised of one 185-mm by 600-mm and one 265-mm by 600-mm pieces juxtaposed together to form the 450-mm and 600-mm dimensions required for testing.

Nominal thickness of PVC:	2.5 mm
Nominal thickness of FC board:	4.5 mm (measured)
Nominal total thickness:	7 mm
Nominal density of PVC:	1300 kg/m^3
Colour:	white

TEST PROCEDURE: Six (6) samples were tested in accordance with AS/NZS 1530, Method for fire tests on building components and structures, Part 3: Simultaneous determination of ignitability, flame propagation, heat release and smoke release, 1999. For the test, each sample was restrained by one layer of square mesh having 0.8-mm diameter wires and 12-mm x 12-mm nominal aperture size over the exposed face and clamped to the specimen holder in four (4) places.

RESULTS: The following means and standard errors were obtained:

Parameter	Mean	Standard Error
Ignition Time (min)	7.0	0.1
Flame Spread Time (s)	N/A	N/A
Heat Release Integral (kJ/m^2)	15.3	3.1
Smoke Release ($\log_{10}$D)	-1.029	0.068

For regulatory purposes these figures correspond to the following indices:

Ignitability Index (0-20)	Spread of Flame Index (0-10)	Heat Evolved Index (0-10)	Smoke Developed Index (0-10)
13	0	0	4

The results of this fire test 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.

DATE OF TEST: 6 May 2019

Issued on the 27th day of May 2019 without alterations or additions.

Shaw Tran
Testing Officer

Brett Roddy
Team Leader, Fire Assessments

NATA Accredited Laboratory
Number: 165
Corporate Site No 3625
Accredited for compliance with ISO/IEC 17025 – Testing.