REPORT NUMBER CFR1508251

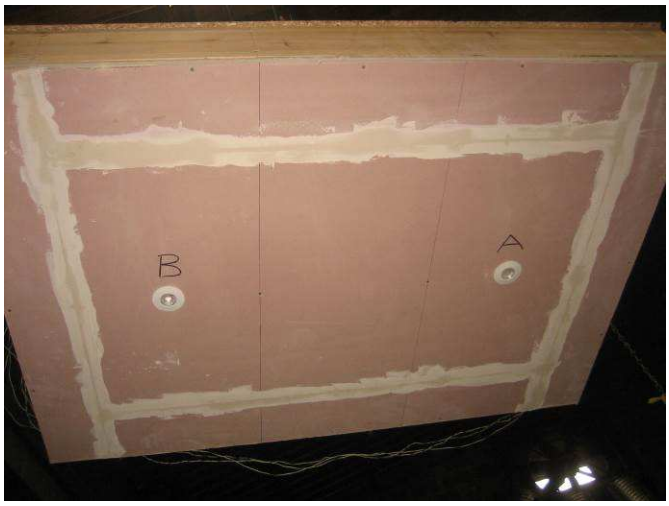
CAMBRIDGE FIRERESEARCH

AD HOC FIRE RESISTANCE TEST TO THE GENERAL PRINCIPLES OF BS 476: PART 21: 1987

Sponsor:	Suzhou Radiant Lighting Technology Co., Ltd
Address:	Jiatai Road West Shuanglong Industrial Park Fenghuang Town Zhangjiagang City Jiangsu China
Date of test:	25th August 2015

Results:

Test duration:	100 minutes (test discontinued at request of the sponsor)
Integrity	100 minutes (no failure)
Insulation:	100 minutes (no failure)



Summary of test specimen :

A timber joist ceiling sample with two voids each containing a downlight fitted into 2 x 15 FireLine.

Downlight A: 5RS014**

Downlight B: 5RS015**

Ceiling size:
1700 long x 1200 wide x 247 deep

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1 PREPARATION FOR TESTING

1.1 Specimen conditioning

The specimen components were at Cambridge Fire Research for a total period of more than 7 days, during which time they were stored, surveyed and prepared for testing. For the final 7 days the temperature and relative humidity were measured and recorded within the range of 18 to 24°C and 59 to 78% respectively.

1.2 Associated construction

Cambridge Fire Research constructed a 90 minute timber joist ceiling sample.

1.3 Specimen construction

The downlighters were supplied by the sponsor.

1.4 Specimen verification

Cambridge Fire Research carried out a detailed survey of the specimens to verify the information provided by the sponsor. This included verifying the materials and dimensions of construction components wherever possible.

Details and drawings of the construction are shown in Appendix 1.

Photographs of details of the construction taken before the test are shown in Appendix 2.

1.5 Specimen installation and fixity

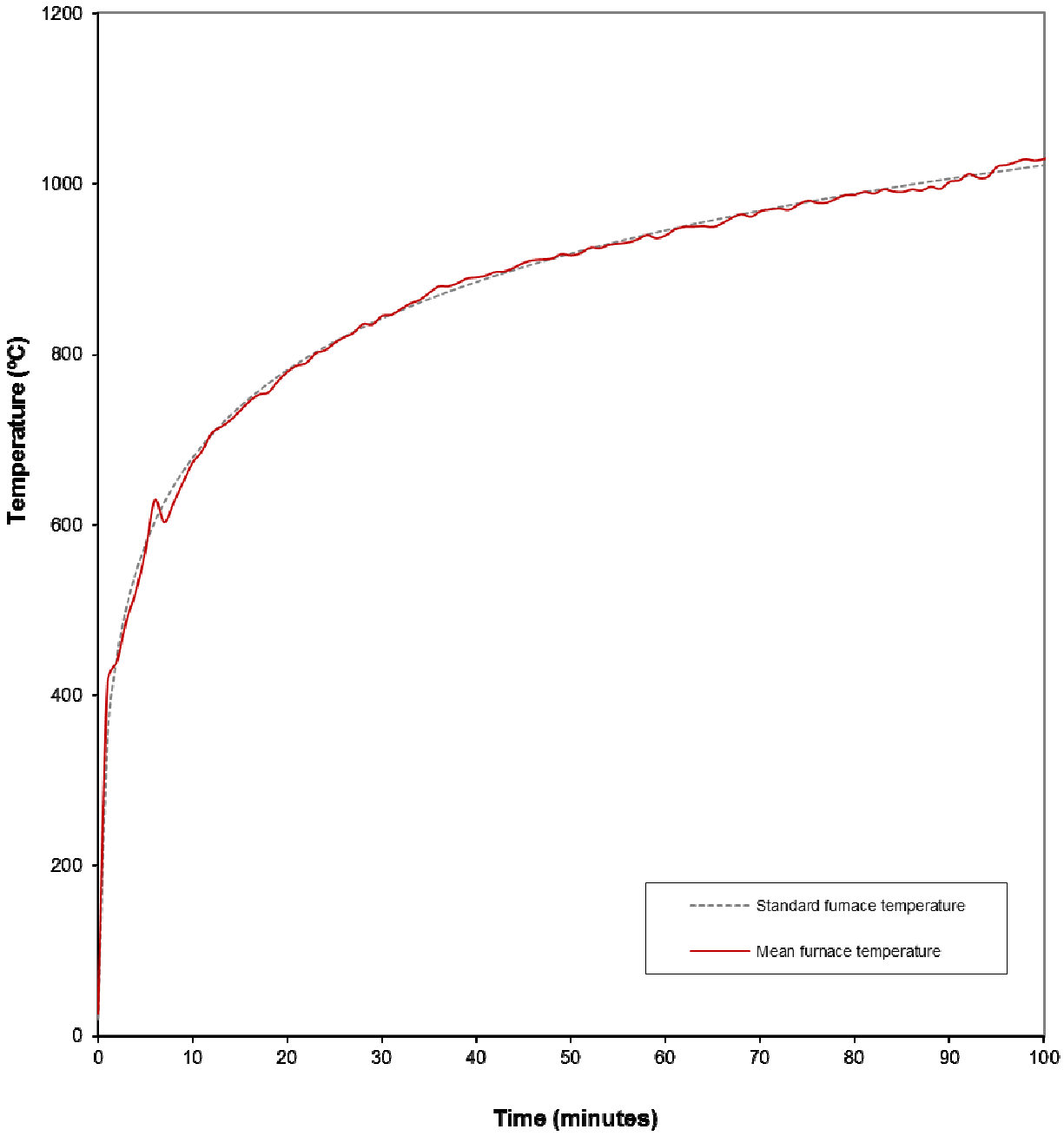
The downlighters were installed by Cambridge Fire Research in accordance with the Sponsor's Installation Instructions into the ceiling sample. The installation was carried out from below as in practice.

The construction was simply supported without restraint from thermally induced movement. It was also not subject to external loading during the test.

2 TEST CONDITIONS, INSTRUMENTATION AND MEASURING

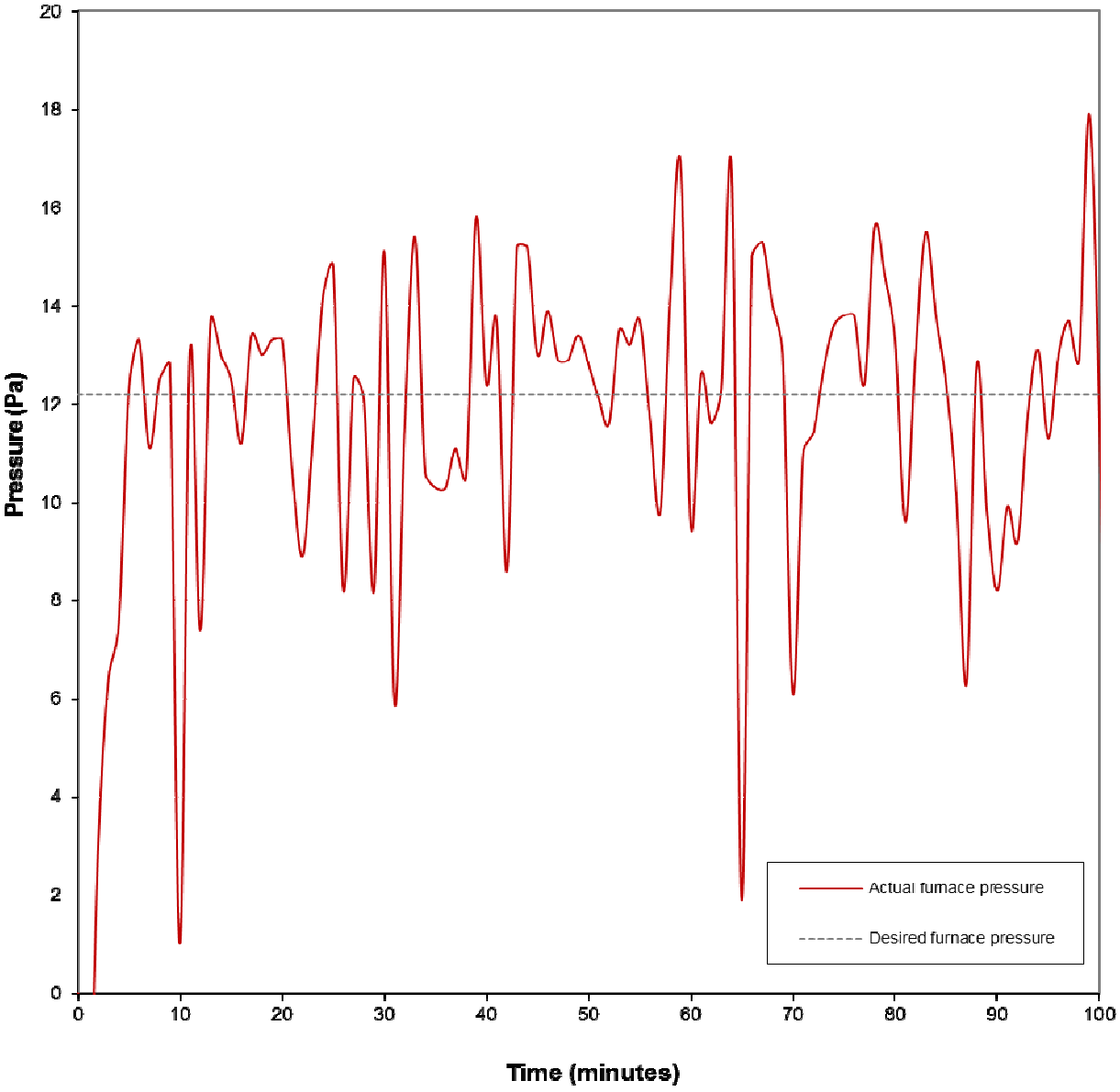
2.1 Furnace temperature

Furnace temperature was controlled so as to follow the standard temperature/time curve defined in the test standard and within the tolerances permitted. The furnace mean temperature was calculated from the output recorded using four furnace thermocouples of the design specified in the test standard. The following graph shows the standard and mean furnace temperature/time data.



2.2 Furnace pressure

Furnace pressure was maintained for the duration of the test at a nominal + 12.2 Pa measured at the pressure sensing head. When a linear pressure gradient of 8.5 Pa/m is applied this equates to + 20 Pa on the underside of the specimen to simulate the furnace conditions for a ceiling measuring 3.35 metres notional height. The furnace pressure was controlled within the tolerances permitted in the test standard except for 32 instantaneous occasions which were transient events. The following graph shows the actual and desired furnace pressure/time data.



2.3 Ambient temperature

Ambient temperature at the start of the test was 20°C.
Ambient temperature ranged between 19°C and 20°C during the test.

2.4 Unexposed face specimen thermocouples

Surface temperature measuring thermocouples of the design specified in the test standard were affixed to the specimen to monitor the temperature rise as follows:

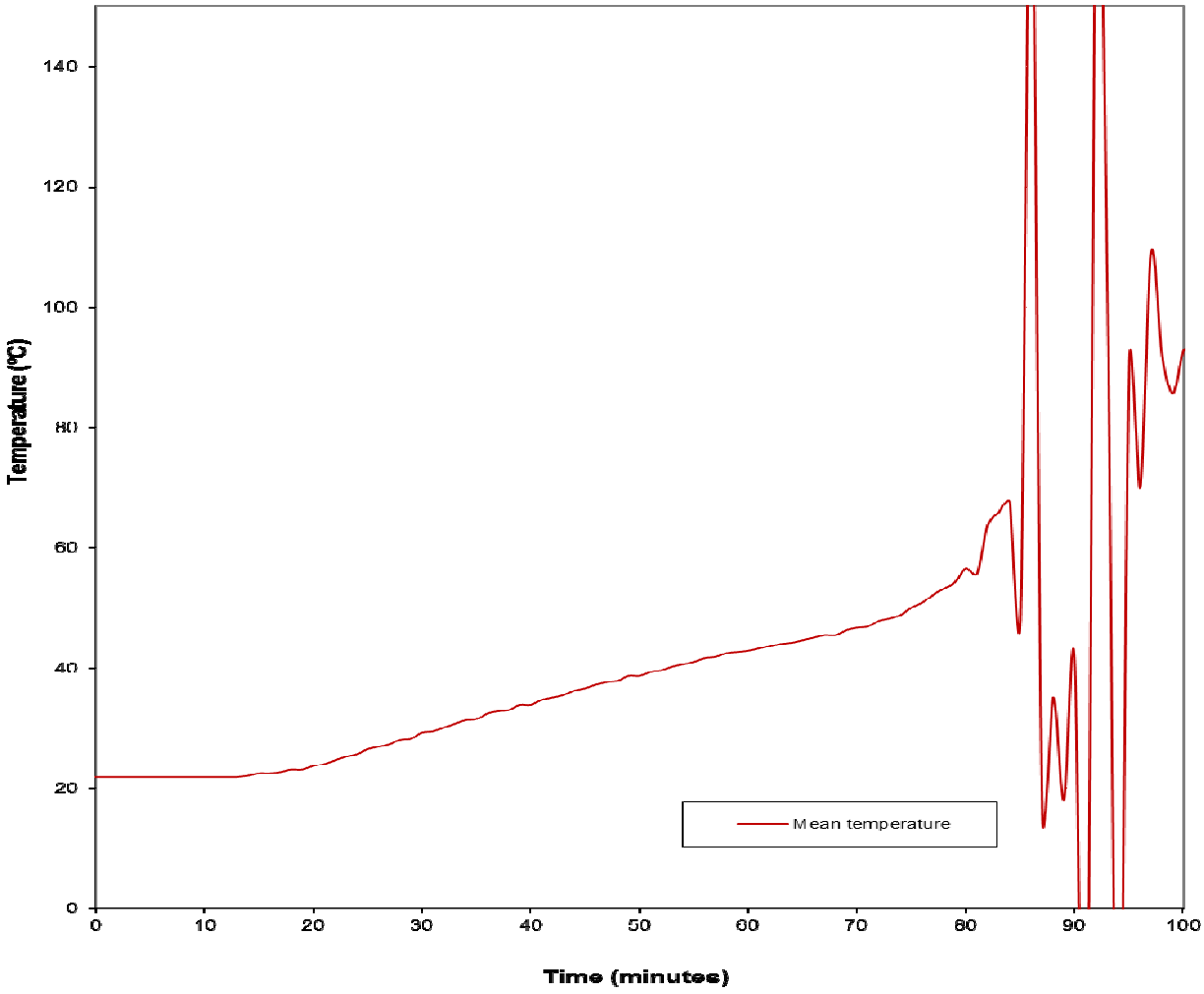
Unexposed face	Channels 16, 17, 18, 19, and 20	(mean and maximum)
	Channels 21 and 22	(maximum only, 50mm from joint)
Internal	Channels 23 and 25	(information only, 25mm down from floor and 50mm from joint)
	Channels 24 and 26	(information only, at mid height and mid width of joist)

The positions of these thermocouples are shown in Appendix 3.

A roving thermocouple was available for measurement of any specific hotspots. Any instances of the use of the roving thermocouple are noted in the observations in Section 3.

The recorded data of all individual thermocouples is shown in the tables in Appendix 3.

The following time/temperature graph shows the mean unexposed face temperature.



3 TEST OBSERVATIONS

Photographs taken during and after the test are shown in Appendix 2.

TEST OBSERVATIONS (E = Exposed face: U = Unexposed face)		
Time	Face	Observation
(min:sec)		
00:00		Start of the test.
05:40	E	Ceiling is charring.
07:52	E	Downlight bezels tight to ceiling. Downlight B bezel is charring.
10:00	E	Downlight A bezel is charring. Glowing in region of downlight B lens.
16:00	E	Lens from each downlight has detached
18:00	E	Ceiling paper layer is missing.
23:45	E	Bezel of each downlight still in position.
32:00	E	Bezel of downlight B is melting.
37:18	E	Bezel of downlight A is melting and downlight has detached from ceiling.
49:40	E	The body of downlight B in position.
54:00	E	Downlight B has partially detached from ceiling but remains hanging nominally 50mm below the ceiling. Material is dripping and flames are visible in the void.
89:00	E	Front half of 1st layer of plasterboard has detached and 2nd layer joints are open nominally 8mm and flames issuing through cracks.
94:29	E	All of 1st layer of plasterboard has detached and B downlight is missing.
96:30	E	Radial cracks are visible from each aperture and additional cracks are visible across the A void.
100:47		Test terminated.

4 LIMITATIONS

1. The test results relate only to the specimens tested. Appendix A of BS476: Part 20: 1987 provides guidance information on the application of fire resistance tests and the interpretation of test data. Application of the results to specimens of different dimensions, orientation or incorporating different components should be the subject of a design appraisal or further testing.

2. The results relate only to the behaviour of the specimen of the element of construction under the particular conditions of test. They are not intended to be the sole criteria for assessing the potential fire performance of the element in use, nor do they reflect the actual behaviour in fires.

3. The fire test was conducted generally in accordance with BS476: Part 21:1987, except that the size of the separating element exposed to the heating conditions in the furnace was limited to 1.4(l) x 1.0(w) m, the ceiling sample was as described and unexposed face thermocoupling was as described. These facts should be taken into account when considering the applicability of the result.

4. No additional loading was applied to the floor.

Report prepared by:

E Southern
Deputy Head of Testing

Report checked by:

E Wilson
Head of Testing

Report issued: **7th September 2015**

APPENDIX 1 SPECIMEN CONSTRUCTION

The item numbers listed in Appendix 1 Table 1 and shown in the figures in Appendix 1 refer to the components of the specimen construction. Any photo numbers refer to those in Appendix 2.

Please note that unless otherwise indicated the following applies:

a) All dimensions and materials of construction were verified by the laboratory.
b) Figures are not to scale.
c) All dimensions are given in mm.

Appendix 1 Table 1

Item	Component	Information
1	**Ceiling layers** **Unexposed layer** Supplier: Name: Description: Overall size (l x w x t): **Exposed layer** Supplier: Name: Description: Overall size (l x w x t): Photo(s):	 British Gypsum FireLine EN520 Type F FireLine board affixed to the exposed side of the perimeter frame and joists with Ø3.5 x 42 long drywall screws set at 300 * centres. Joints were positioned as shown in Appendix 1 Figure 2. 1700 x 1200 x 15 British Gypsum FireLine EN520 Type F FireLine board affixed to the perimeter frame and noggins with Ø3.5 x 60 long drywall screws, set at 300 * centres. Joints were positioned as shown in Appendix 1 Figure 3 and were taped and skimmed. 1700 x 1200 x 15 2.1.13, 2.1.14 and 2.1.15
2	**Floor** Manufacturer: Name: Description: Overall size (l x w x t): Density (kg/m^3): Photo(s):	 Egger EGGER TG4 22mm Moisture resistant tongue and groove chipboard affixed to the unexposed side of the ceiling frame using No.8 x 2” long steel countersunk screws set at 300 * centres. Joints were positioned as shown in Appendix 1 Figure 4. 1700 x 1200 x 22 620 * 2.1.13 and 2.1.14

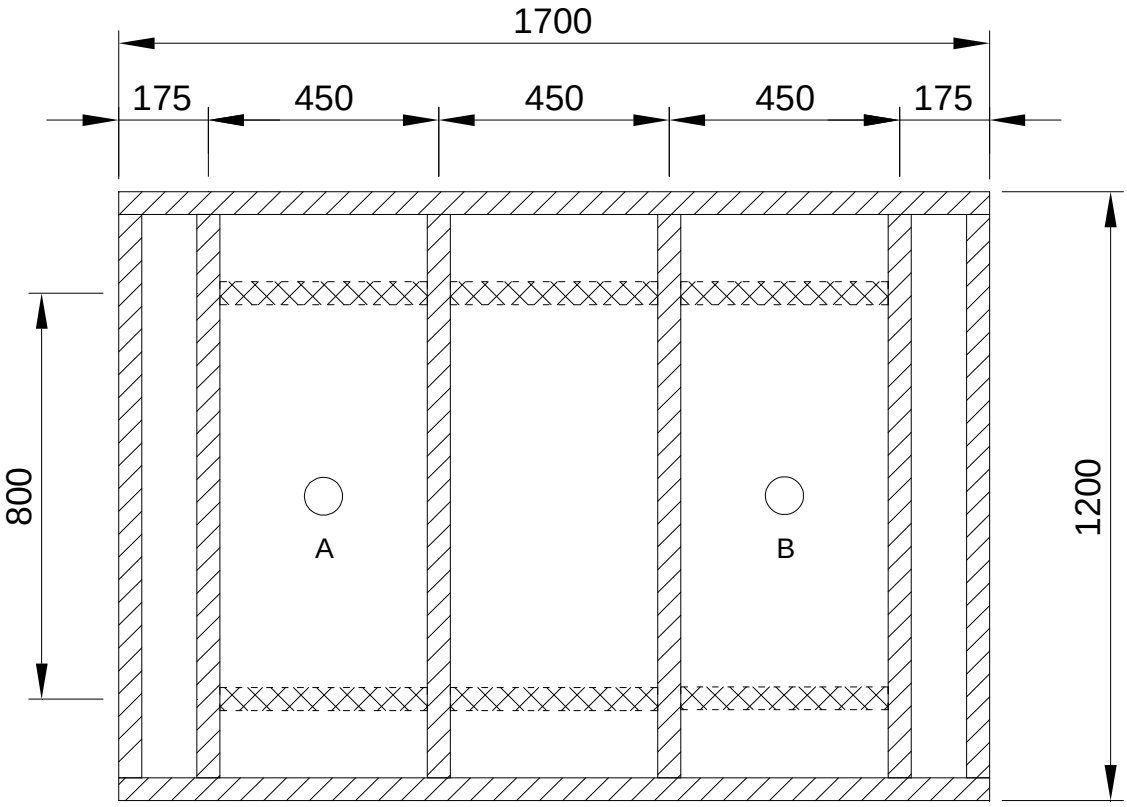
Item	Component	Information
3	**Ceiling Frame**	
	Supplier:	Cambridge Fire Research
	Species:	Spruce
	Density (kg/m^3):	450 *
	Description:	Softwood frame consisting of four perimeter frame members supported with 4 No. joists and 6 No. noggins. All joints are butt joints and fixed with 2 No. steel countersunk screws per joint set at 110 * vertical centres. The joists are set at 450 centres and 2 No. noggins are set between adjacent joists at 800 centres.
	Overall size (l x w x h):	1700 x 1200 x 195
	Component size (l x w x h):	Long frame members: 1700 x 45 x 195 Short frame members: 1110 x 45 x 195 Joists: 1110 x 45 x 195 Noggins: 405 x 45 x 45
	Photo(s):	2.1.13, 2.1.14 and 2.1.15
4.0	**Downlight A**	
	Supplier:	Suzhou Radiant Lighting Technology Co., Ltd
	Name:	5RS014**
	Description:	Downlight fitted within a Ø69 cut out hole located central to void A.
	Weight (g)	359
	Photo(s):	2.1.1 to 2.1.6 and 2.1.13 and 2.1.15
	Subcomponents:	
4.1	**LED housing**	
	Description:	A finned aluminium heatsink and housing for the LED board. The connecting wire exits through a hole at the rear of the unit.
	Overall size (h x Ø):	62.5 x 49 tapering to Ø45 flange for bezel
4.2	**Lens unit**	
	Description:	Plastic lens unit with dimples and frosted central diffuser located within Lens mount.
	Overall size (Ø x h):	41.5 x 13.8
4.3	**Lens mount**	
	Description:	Aluminium cylinder with 6No cooling fins screwed to the LED housing and retaining the spring clip brackets.
	Overall size (Ø x h):	60 x 20
4.4	**Spring clips mount**	
	Description:	Stainless steel bracket affixed to top of LED housing with 3No screws and with cut outs to hold spring clips.
	Overall size (h x w x t):	Legs 62 x 20 x 1.5
4.5	**Front bezel:**	
	Description:	White painted aluminium bezel with screwed connection LED housing.

Item	Component	Information
	Overall size (Ø x h):	80 OD/40 ID x 6
4.6	**Sealing-Gasket:**	
	Supplier:	Suzhou Radiant Lighting Technology Co., Ltd
	Description:	An intumescent** sealing gasket is positioned at the rear of the bezel to provide a seal against the ceiling board.
	Overall size (Ø x h):	77 OD/51 ID x 1.2
4.7	**Spring clips**	
	Description:	2No. spring steel clips at diametrically opposed positions fitted to the Spring clips mount at 35 above the upper face of the sealing gasket **4.6** retaining the downlight to the ceiling.
	Overall size (Ø x l x w):	1.4 x 56 x 18
4.8	**Transformer**	
	Supplier:	Suzhou Radiant Lighting Technology Co., Ltd
	Description:	LED driver in a plastic box affixed to bracket attached to back of downlight housing with mains electricity connectors.
	Overall size (l x w x h):	80 x 35 x 25
5.0	**Downlight B**	
	Supplier:	Suzhou Radiant Lighting Technology Co., Ltd
	Name:	5RS015**
	Description:	Downlight fitted within a Ø69 cut out hole located central to void B.
	Weight (g):	245
	Photo(s):	2.1.7 to 2.1.12 and 2.1.14 and 2.1.15
	Subcomponents:	
5.1	**LED housing**	A finned white painted aluminium heatsink and housing for the LED board. The connecting wire exits through a hole at the rear of the unit.
	Description:	
	Overall size (h x Ø):	60 x 48
5.2	**Lens unit**	
	Description:	Plastic lens unit with dimples and frosted central diffuser located within LED housing.
	Overall size (Ø x h):	41.5 x 13.8
5.3	**Spring clips mount**	
	Description:	White painted integral to the LED housing.
	Overall size (Ø x h x t):	60 x 30 x 3
5.4	**Front bezel:**	
	Description:	White painted aluminium bezel with screwed connection LED housing.
	Overall size (Ø x h):	80 OD/40 ID x 6
5.5	**Sealing-Gasket:**	
	Supplier:	Suzhou Radiant Lighting Technology Co., Ltd
	Description:	An intumescent** sealing gasket is positioned at the rear of the bezel to provide a seal against the ceiling board.

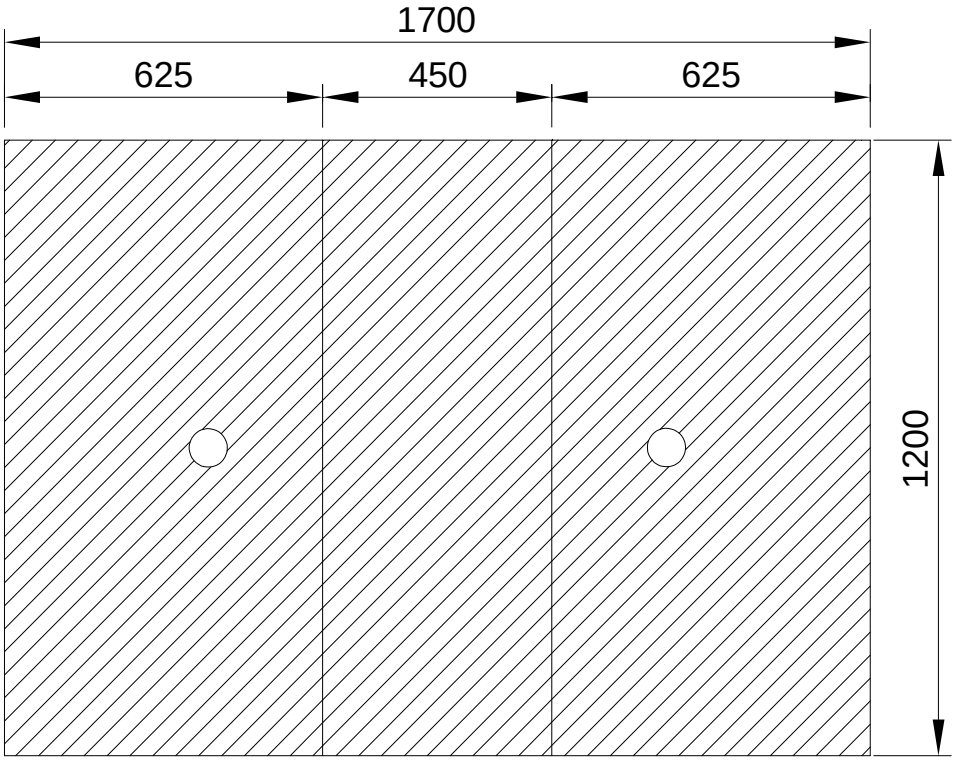
Item	Component	Information
	Overall size (Ø x h):	77 OD/51 ID x 1.2
5.6	**Spring clips**	
	Description:	2No. spring steel clips at diametrically opposed positions fitted to the Spring clips mount at 20.5 above the upper face of the sealing gasket **5.5** retaining the downlight to the ceiling.
	Overall size (Ø x l x w):	1.2 x 40 x 18
5.7	**Transformer**	
	Supplier:	Suzhou Radiant Lighting Technology Co., Ltd
	Model:	Integral with downlight
	Description:	LED driver in a plastic box with mains electricity input and output via plastic lead and connectors.
	Overall size (Ø x h):	53 x 27 with side protrusion 15 x 26 for wire housing.

Key:
* Nominal value
** Sponsor declared value or detail, not verified by laboratory

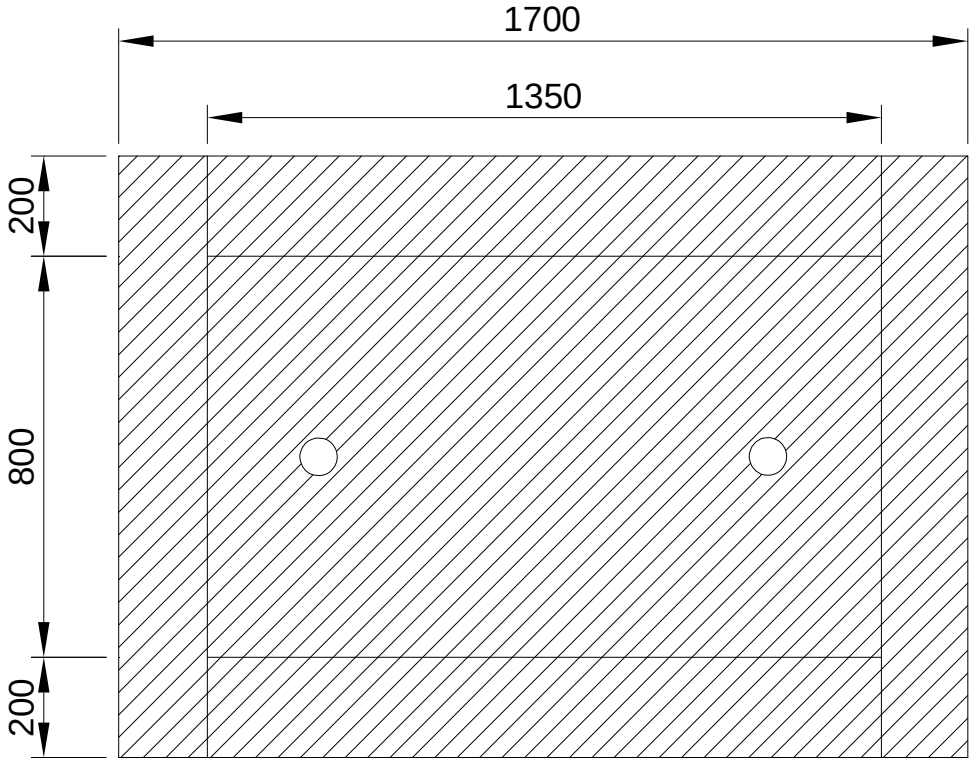
Appendix 1 Figure 1 – Section showing ceiling frame



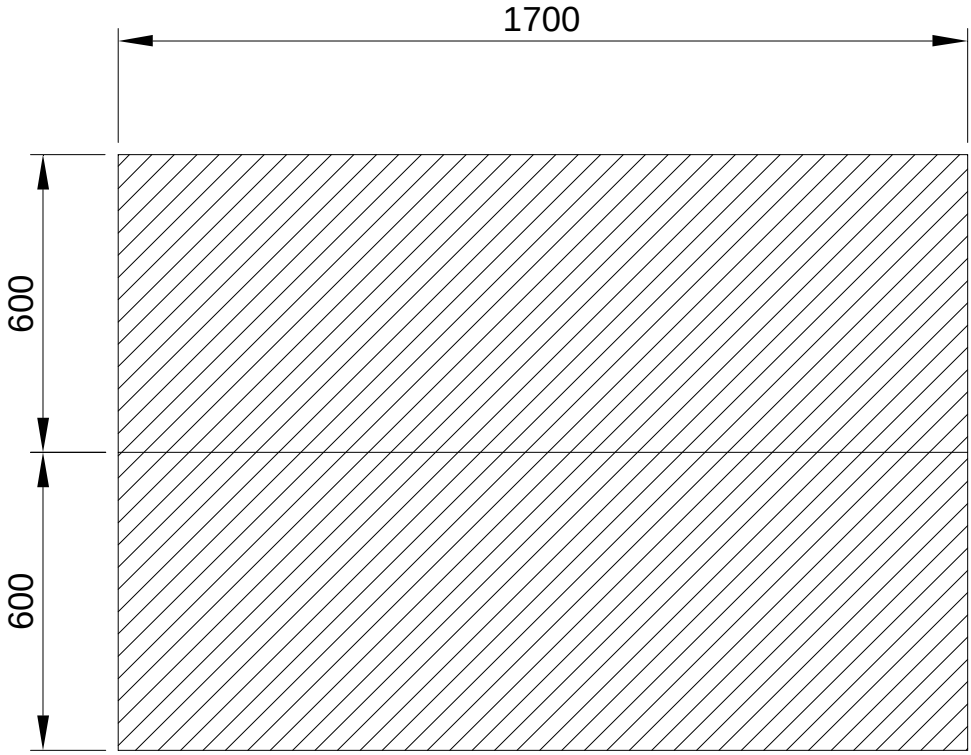
Appendix 1 Figure 2 – Ceiling membrane unexposed layer



Appendix 1 Figure 3 – Ceiling membrane exposed layer



Appendix 1 Figure 4 – Floor



APPENDIX 2 PHOTOGRAPHS

Appendix 2.1 Pre-test photos

Photo 2.1.1 – Downlight A

Photo 2.1.2

Photo 2.1.3

Photo 2.1.4

Photo 2.1.5

Photo 2.1.6

Photo 2.1.7 – Downlight B

Photo 2.1.8

Photo 2.1.9

Photo 2.1.10

Photo 2.1.11

Photo 2.1.12

Photo 2.1.13

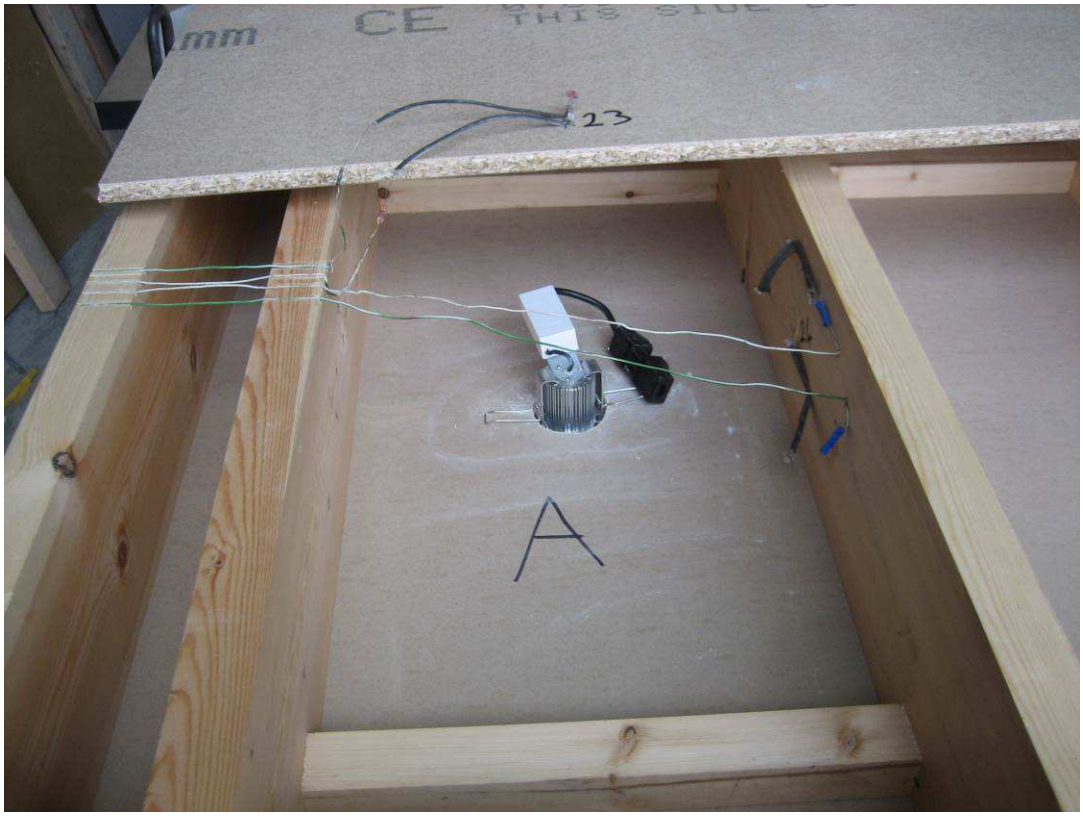


Photo 2.1.14

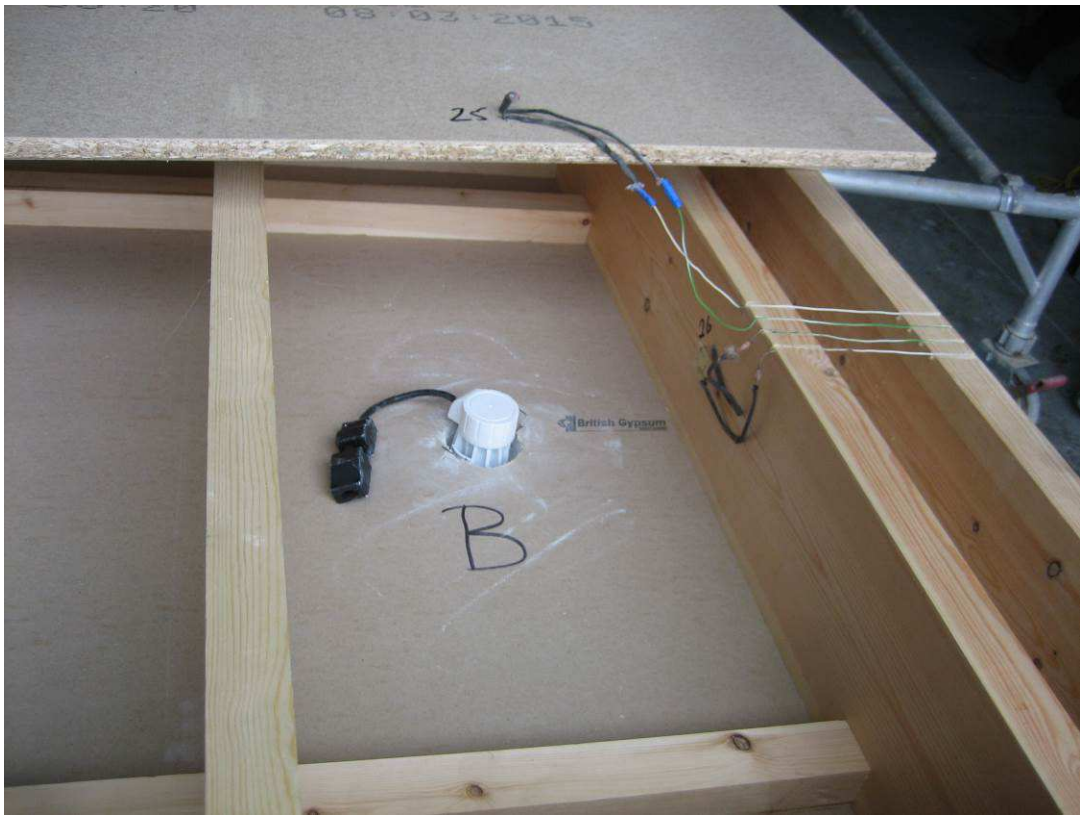
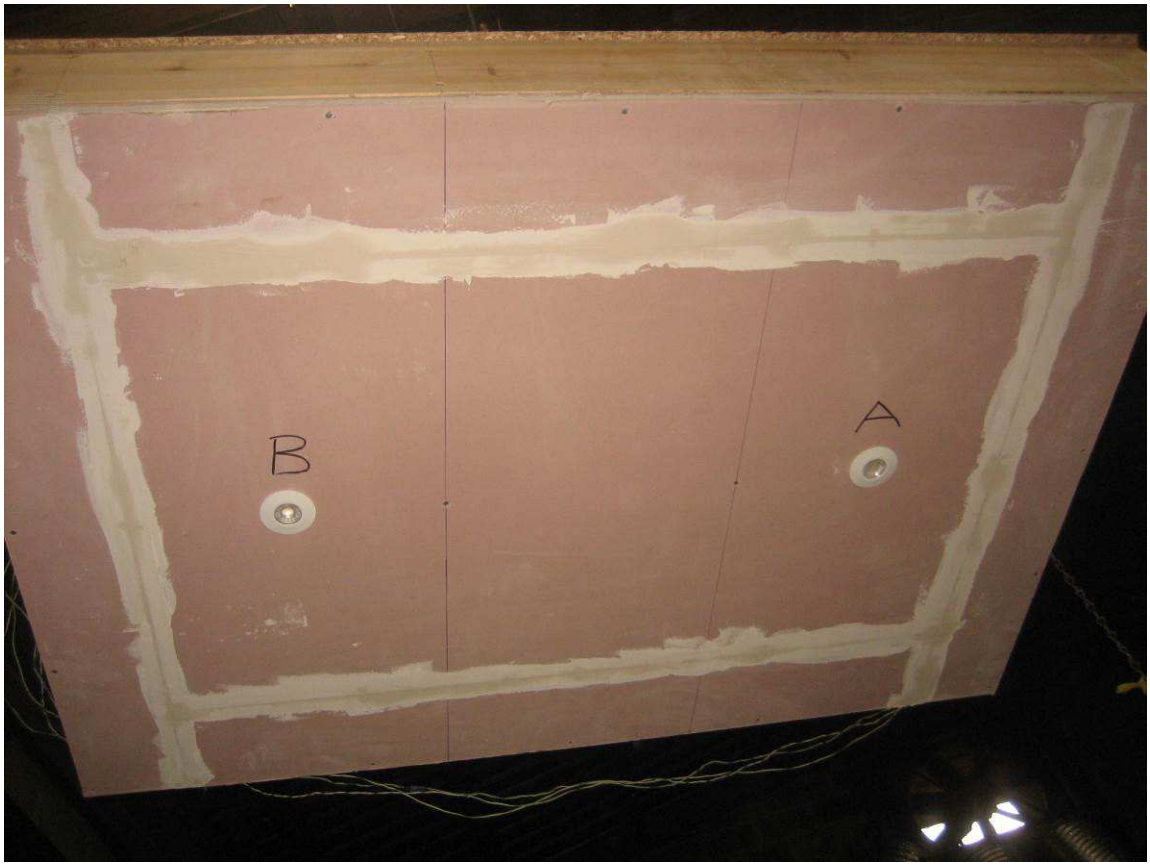


Photo 2.1.15



Appendix 2.2 During test photos

Photo 2.2.1 – Unexposed face

Photo 2.2.2 – Exposed face after 30 minutes.

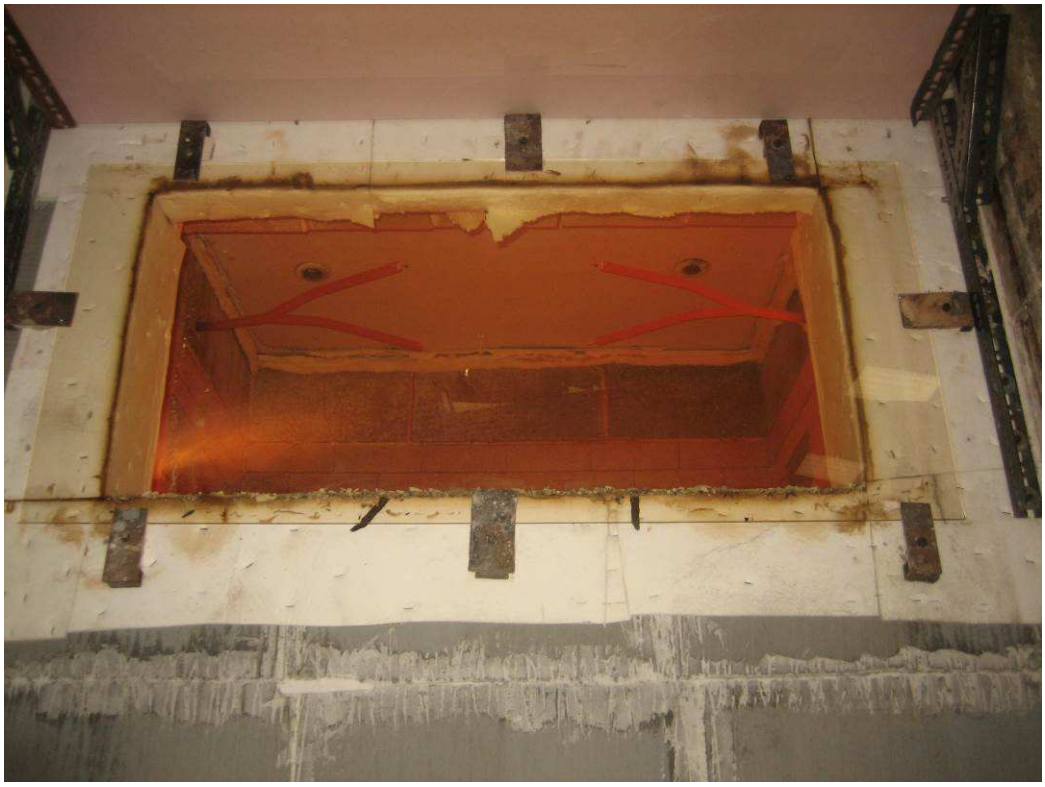


Photo 2.2.3 – Exposed face after 75 minutes.

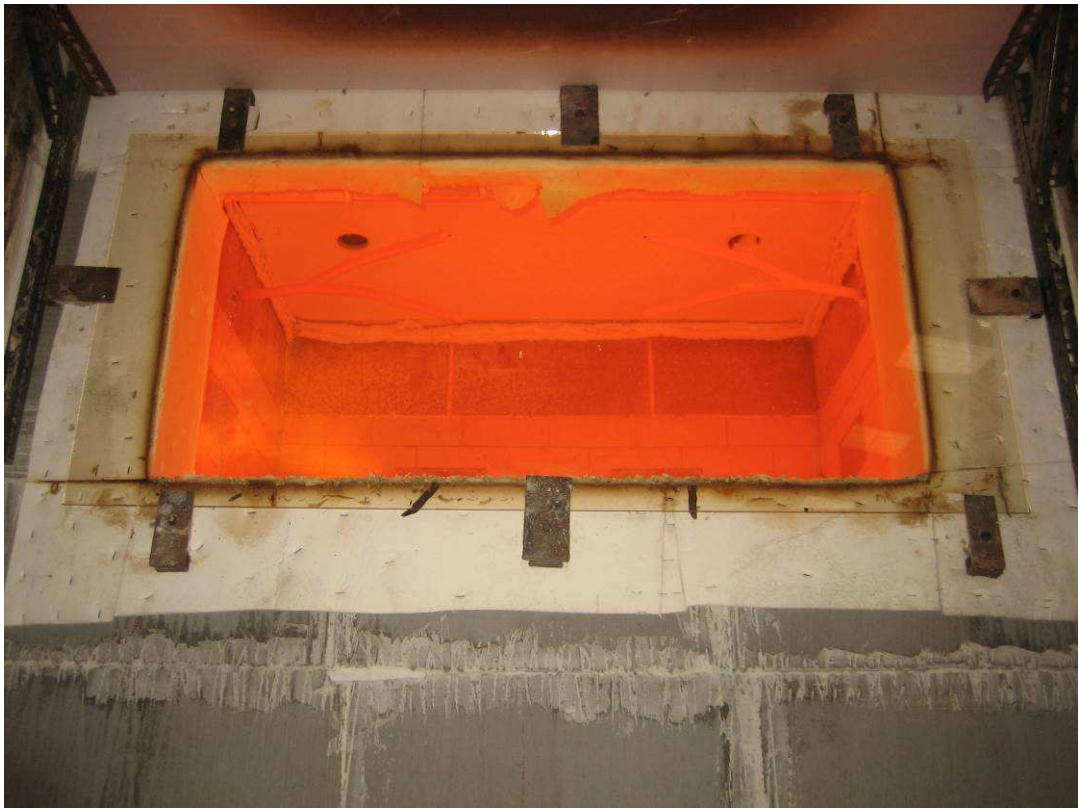


Photo 2.2.4 – Unexposed face after 80 minutes.

Photo 2.2.5 – Exposed face after 90 minutes.

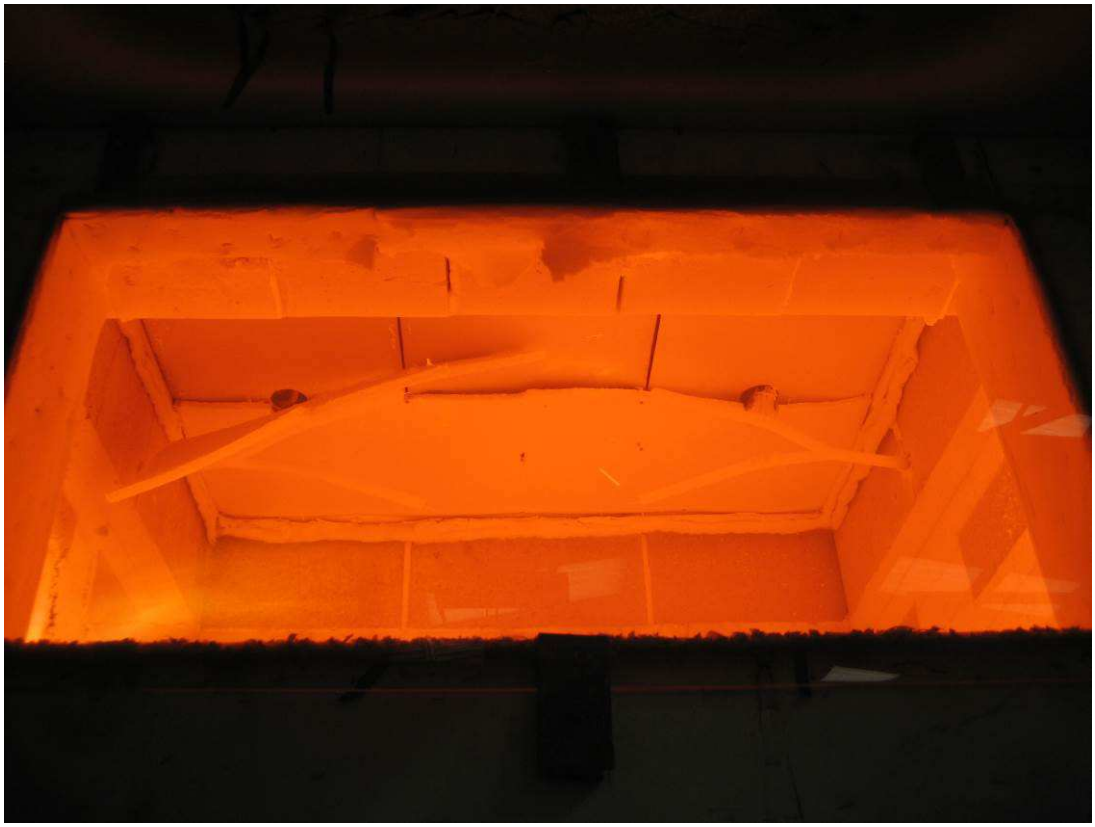
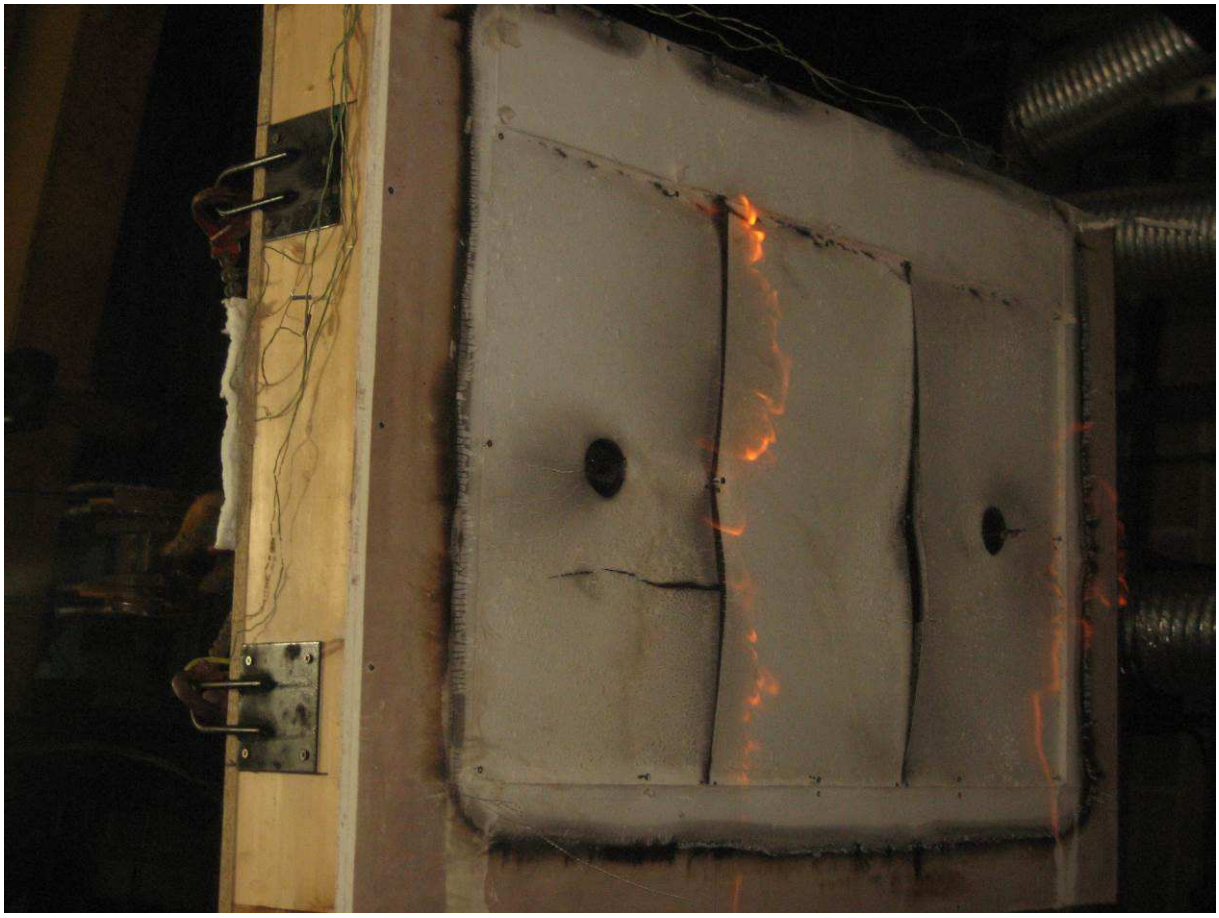


Photo 2.2.6 – Unxposed face after 99 minutes.

Appendix 2.3 Post-test photos

Photo 2.3.1



APPENDIX 3 POSITIONING OF INSTRUMENTATION

Figure 3.1 – Unexposed face thermocouple positions:

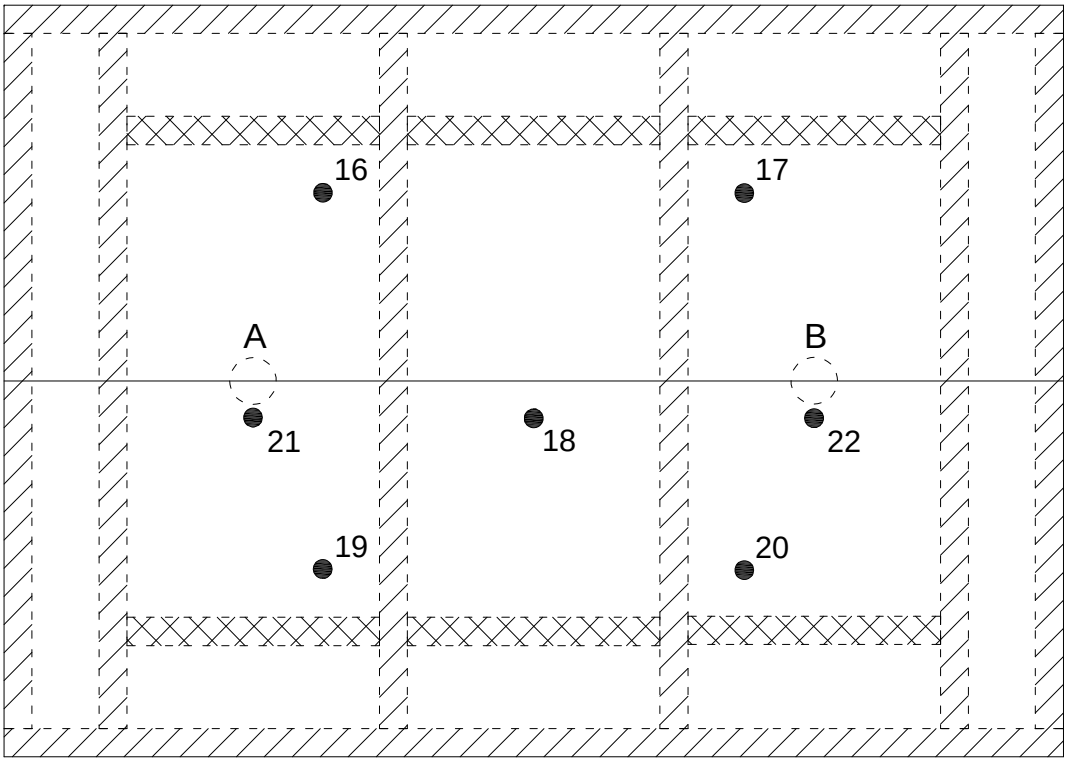
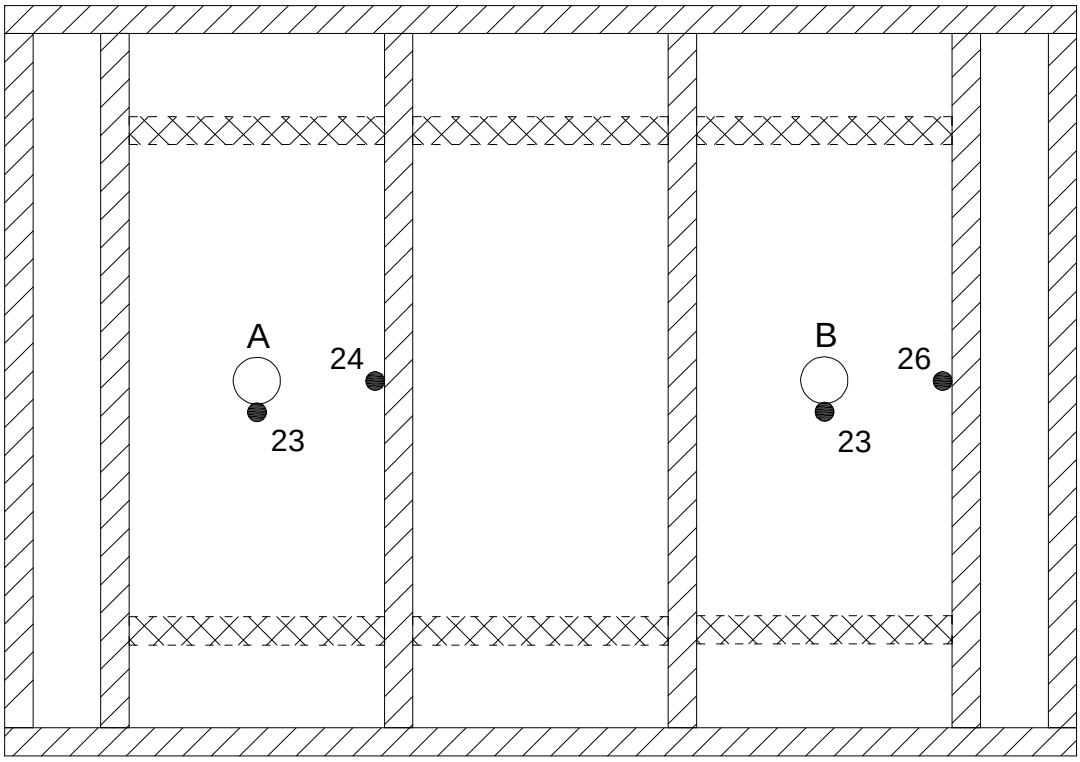


Figure 3.2 – Internal thermocouple positions:



APPENDIX 4 RECORDED THERMOCOUPLE DATA

Time	Chan 16	Chan 17	Chan 18	Chan 19	Chan 20	Chan 21	Chan 22	Chan 23	Chan 24	Chan 25	Chan 26
min	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
0	22	21	22	22	22	22	22	24	23	24	22
1	22	21	22	22	22	22	22	24	23	24	22
2	22	21	22	22	22	22	22	25	23	25	22
3	22	21	22	22	22	22	22	25	23	27	22
4	22	21	22	22	22	22	21	26	23	29	22
5	22	21	22	22	22	22	21	27	24	31	22
6	22	21	22	22	22	22	21	29	24	36	22
7	22	21	22	22	22	22	21	32	25	38	22
8	22	21	22	22	22	22	22	36	25	41	22
9	22	21	22	22	22	22	21	40	27	48	22
10	22	21	22	22	22	22	22	45	29	51	22
11	22	21	22	22	22	22	22	50	31	56	22
12	22	21	22	22	22	22	22	53	34	65	22
13	22	21	22	22	22	23	22	59	37	74	22
14	22	21	23	22	22	23	23	65	40	77	22
15	22	21	23	23	23	23	23	68	43	80	22
16	22	21	23	23	23	23	24	71	46	83	22
17	23	21	23	23	23	24	25	74	49	99	22
18	23	21	24	23	24	25	25	74	51	102	22
19	23	21	24	23	24	25	26	76	54	122	22
20	24	21	24	24	25	26	27	78	56	103	22
21	24	22	25	24	25	27	28	84	58	121	22
22	25	22	25	25	26	28	29	85	60	117	22
23	26	22	26	25	27	28	30	85	61	118	22
24	26	22	26	26	28	29	31	88	63	110	22
25	27	22	27	27	29	30	32	93	64	106	22
26	27	22	28	27	30	31	33	91	65	108	22
27	28	22	28	28	30	32	34	87	66	114	22
28	29	23	29	28	31	32	35	86	68	121	22
29	29	22	29	29	32	33	36	96	69	120	22
30	30	23	30	30	33	34	37	106	70	120	22
31	31	23	30	30	33	34	38	103	71	119	22
32	31	23	31	31	34	35	39	109	73	114	22
33	32	23	32	31	35	36	40	99	73	113	22
34	33	23	32	32	36	37	41	110	75	113	22
35	33	23	32	33	36	38	41	104	76	115	22
36	34	24	33	34	37	38	42	105	76	115	23
37	35	24	34	34	37	39	43	99	78	116	23
38	35	24	34	34	38	40	43	134	80	118	23
39	36	24	35	35	39	40	44	129	81	117	23
40	36	24	35	35	39	41	45	129	82	118	23
41	37	24	36	36	40	42	46	126	83	118	23
42	38	24	36	37	40	43	46	122	84	118	23
43	38	24	37	37	41	44	46	116	85	117	23
44	39	24	38	38	42	44	47	120	86	117	23
45	39	25	38	39	42	45	48	117	86	117	23
46	40	25	39	39	43	46	48	118	87	118	23
47	41	25	39	40	43	47	49	112	87	118	23
48	41	25	40	40	43	48	49	118	87	117	23
49	42	25	41	41	44	49	49	124	88	117	23

Time	Chan 16	Chan 17	Chan 18	Chan 19	Chan 20	Chan 21	Chan 22	Chan 23	Chan 24	Chan 25	Chan 26
min	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
50	42	25	41	41	44	50	50	122	89	116	23
51	43	25	41	42	45	50	50	131	88	118	23
52	44	25	42	42	45	51	51	128	89	118	23
53	44	25	43	43	46	52	51	114	90	116	23
54	45	26	43	43	46	53	52	142	90	117	23
55	45	25	44	44	47	53	52	123	90	120	23
56	46	26	44	45	47	54	52	121	90	124	24
57	46	26	45	45	47	54	52	160	90	127	23
58	47	26	46	45	48	55	53	156	91	131	24
59	47	26	46	46	48	55	53	169	91	135	24
60	47	26	47	46	48	56	54	169	90	138	24
61	48	26	47	46	49	56	54	174	90	144	24
62	48	26	48	47	49	57	54	150	91	150	24
63	49	27	48	47	49	57	55	182	90	157	24
64	49	26	48	48	50	58	55	193	91	163	24
65	50	26	49	48	50	58	56	172	91	169	24
66	50	27	49	49	50	59	57	207	91	175	24
67	50	27	50	49	51	60	58	188	92	180	24
68	50	27	50	49	51	60	60	201	92	185	24
69	51	27	51	50	52	61	61	173	93	189	24
70	51	27	52	51	52	62	62	191	93	193	25
71	51	27	52	51	53	63	64	185	94	198	25
72	52	28	53	52	54	64	65	182	95	202	25
73	52	27	54	53	55	65	67	180	96	206	25
74	52	27	56	53	56	66	68	187	100	210	25
75	53	28	57	55	57	67	70	192	105	215	25
76	53	28	59	56	58	68	71	197	111	217	25
77	54	29	61	57	60	70	73	201	115	222	26
78	53	29	63	59	62	71	74	203	119	225	26
79	54	29	65	60	63	72	75	209	123	230	26
80	60	29	67	62	65	73	76	212	128	234	26
81	50	28	69	64	67	74	77	215	132	238	26
82	84	30	70	66	69	75	78	218	135	240	27
83	89	30	72	68	70	76	78	222	139	244	27
84	94	30	73	69	72	76	79	225	143	248	27
85	*	31	75	71	73	77	79	228	146	252	27
86	*	30	75	72	75	78	80	231	150	255	28
87	*	31	76	74	76	78	80	234	153	259	28
88	*	32	77	75	76	79	81	238	157	258	28
89	*	32	78	76	78	80	81	240	160	268	28
90	*	32	78	77	78	80	81	244	164	284	28
91	*	33	79	78	79	80	81	249	166	296	29
92	*	32	79	78	80	80	82	258	172	329	29
93	*	33	80	79	81	80	82	264	177	346	29
94	*	34	80	80	82	81	83	278	183	343	30
95	*	34	81	81	83	81	83	284	190	361	30
96	*	34	81	81	84	82	84	291	197	375	30
97	*	34	82	82	85	82	84	301	205	388	31
98	*	35	83	83	86	82	85	313	214	394	31
99	*	35	83	84	88	83	86	322	222	399	31
100	*	37	84	85	89	83	87	331	231	410	31

* Thermocouple malfunction