


C A M B R I D G E
FIRE RESEARCH

REPORT NUMBER
CFR1709081

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

Sponsor:	Suzhou Radiant Lighting Technology Co. Ltd.
Address:	West Jiatai Road Shuanglong Industrial Park Fenghuang Town Zhangjiagang Jiangsu China
Date of test:	8 th September 2017

Results:	
Test duration:	101 minutes (test discontinued at request of the sponsor)
Integrity	101 minutes (no failure, the test having been discontinued)
Insulation:	101 minutes (no failure, the test having been discontinued)

	<p>Summary of test specimen</p> <p>A timber joist ceiling sample with three voids and three downlights fitted into 2 x 15 British Gypsum FireLine boards.</p> <p>LED Downlight:s A: 5RS058** B: 5RS060** C: 5RS061**</p> <p>Ceiling size: 1700 long x 1200 wide x 247 deep</p>
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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 19 to 28°C and 43 to 78% respectively.

1.2 Associated construction

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

1.3 Specimen construction

The downlights 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

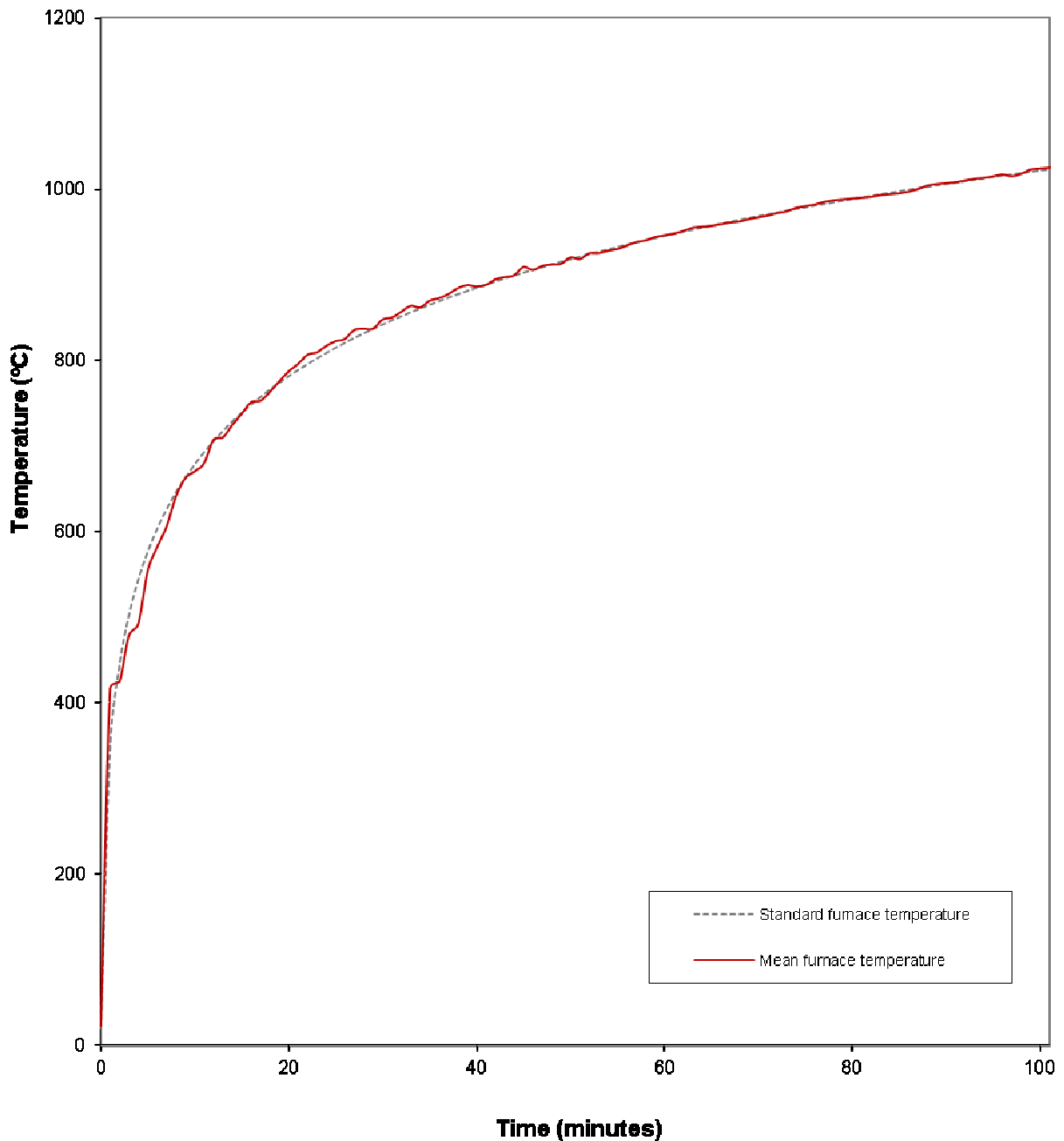
The downlights were installed by Cambridge Fire Research in accordance with the Sponsor's Installation Instructions into the ceiling sample. The installation was carried out from below as in practice.

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

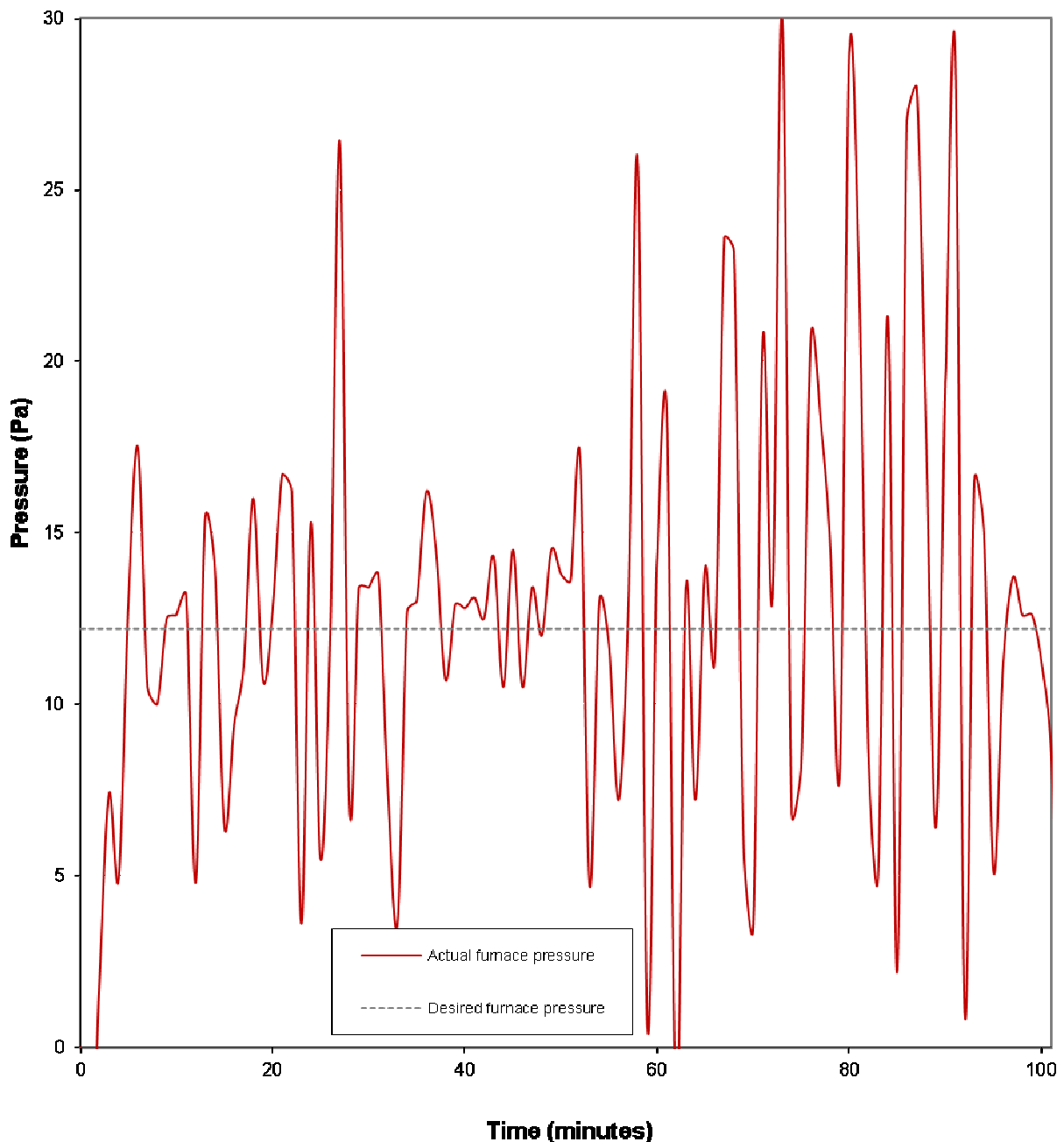
2.1 Furnace temperature

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 58 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 20°C and 21°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:

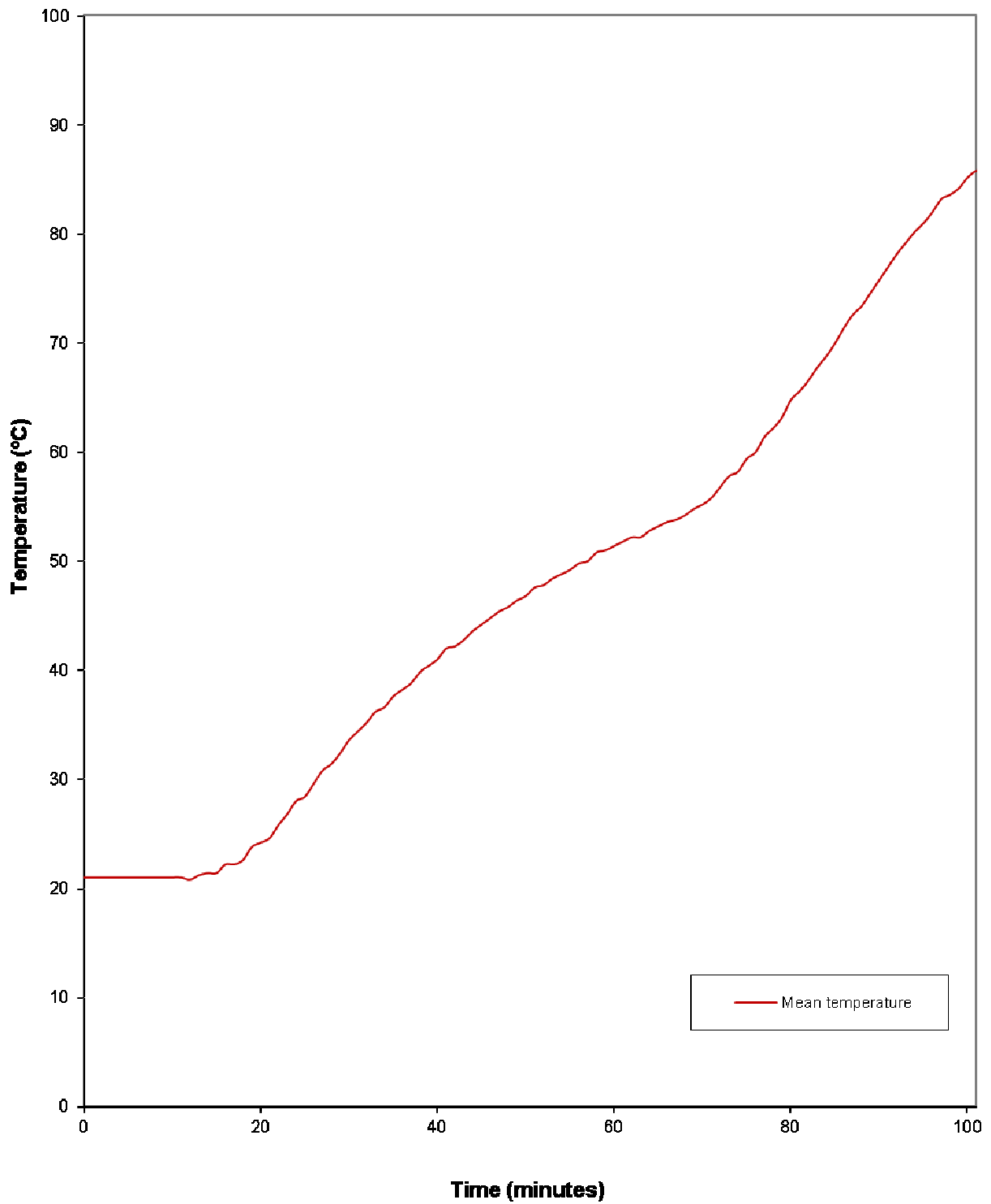
Unexposed face	Channels 16, 17, 18, 19 and 20 Channels 21 and 22	(mean and maximum) (information only)
Internal	Channels 26, 27 and 28 Channels 29, 30 and 31 Channels 23, 24 and 25	(information only, suspended under floor) (information only, on plasterboard) (information only, on joist at mid height)

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 (min:sec)	Face	Observation
00:00		Start of the test.
02:40	E	Bezel of downlight A softening.
03:09	E	Bezel of downlight A missing.
04:55	E	Lens of downlight B softening and dripping.
05:28	E	Bezel of downlight C missing.
05:57	E	Bulb of downlight B drops out.
06:24	E	Ceiling plasterboard charring.
07:09	E	Bezel of downlight B missing.
15:05	E	Plaster skim detaching from joints.
47:01	E	Downlights remain tight to ceiling
82:54	E	Exposed layer of plasterboard partially detached.
85:05	E	Downlight C is missing.
86:48	E	Flaming at void C and at front joint in plasterboard.
88:55	E	Exposed board partially detached at void B and 2 nd layer of plasterboard joint slightly open.
91:30	E	Downlight B pulls out of plasterboard where exposed layer has partially detached.
93:37	E	Plasterboard of void A partially detached.
94:29	E	Downlight A pulls out of plasterboard where exposed layer has partially detached.
94:50	E	Downlight B missing.
95:48	E	Downlight A missing.
97:13	E	Exposed plasterboard layer detached.
98:34	E	Flaming at all voids.
99:00	E	First layer of plasterboard missing.
99:4837	U	Smoke/steam issuing at centre joint of board.
101:06	E	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.

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Report prepared by:



**E Southern
Deputy Head of Testing**

Report checked by:



**T Smith
Technical Officer**

Report issued: 25th September 2017

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 Supplier: Name: Description: Overall size (l x w x t):	British Gypsum FireLine EN520 Type F 2No. FireLine layers affixed to the exposed side of the perimeter frame, joists and noggins using Ø3.5 x 36 long drywall screws set at 300 * centres for the first layer with joints as Appendix 1 Figure 2 and Ø3.5 x 60 long drywall screws set at 300 * centres for the second layer with taped and skimmed joints as Appendix 1 Figure 3. 1700 x 1200 x 15 (2No layers)
2	Floor Manufacturer: Name: Description: Overall size (l x w x t): Density (kg/m ³):	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 250 * centres with joints as Appendix 1 Figure 4. 1700 x 1200 x 22 620 *
3	Ceiling Frame Supplier: Species: Density (kg/m ³): Description: Overall size (l x w x h): Section size (w x h):	Cambridge Fire Research Spruce 450 * Softwood perimeter frame supported with butt jointed joists at 450 centres using 2No. steel countersunk screws per joint set at 110 * vertical centres and 2No. noggins between adjacent joists at 800 centres as Appendix 1 Figure 1. 1700 x 1200 x 195 45 x 195 (noggin 45 x 45)

Item	Component	Information
4	<p>Downlight A Supplier: Name: Description:</p> <p>Hole size (Ø): Weight (g) Overall size (Ø x h):</p>	<p>Suzhou Radiant Lighting Technology Co., Ltd. 5RS058** A 7 LED downlight with steel back can painted black with spring clip retainers and integral driver unit on top of can. A white finish bevelled plastic bezel is attached with plastic clips and magnets fitted to bezel to the back can and contains a multi-faceted plastic diffuser lens The downlight is fitted central to the void.</p> <p>57 187 (including driver) 86 x 75 (including driver)</p>
5	<p>Downlight B Supplier: Name: Description:</p> <p>Hole size (Ø): Weight (g) Overall size (Ø x h): Intumescent ring size (Ø x t): Driver size (l x w x h):</p>	<p>Suzhou Radiant Lighting Technology Co., Ltd. 5RS060** (switchable) An LED downlight with die-cast aluminium heat sink with PCB attached and pressed steel front end. The clear glass lens mount affixed to the front end with magnets and plastic clips also retains a multi-faceted plastic reflector and separate diffuser lens. The steel front end contains the spring clips and four magnets to hold the white steel bezel. An intumescent ring fits around the top face of the steel front end against the ceiling underside. A separate driver is connected to the downlight. The downlight is fitted central to the void.</p> <p>67 196 (excluding driver) 87 x 62 78OD x 68ID x 1 130 x 40 x 25</p>
6	<p>Downlight C Supplier: Name: Description:</p> <p>Hole size (Ø):</p>	<p>Suzhou Radiant Lighting Technology Co., Ltd. 5RS061** (switchable) An LED downlight with die-cast aluminium heat sink with PCB attached. A plastic lens mount and bezel holder is clipped to the heat sink and the steel bezel is held in place with six magnets. The lens is a solid plastic unit with facets and diffusing surface finish together with a conical white plastic reflector. The heat sink contains the spring clips. An intumescent ring fits around the flange of the heat sink so that it is in contact with the ceiling when the downlight is in place. A separate driver is connected to the downlight. The downlight is fitted central to the void.</p> <p>65</p>

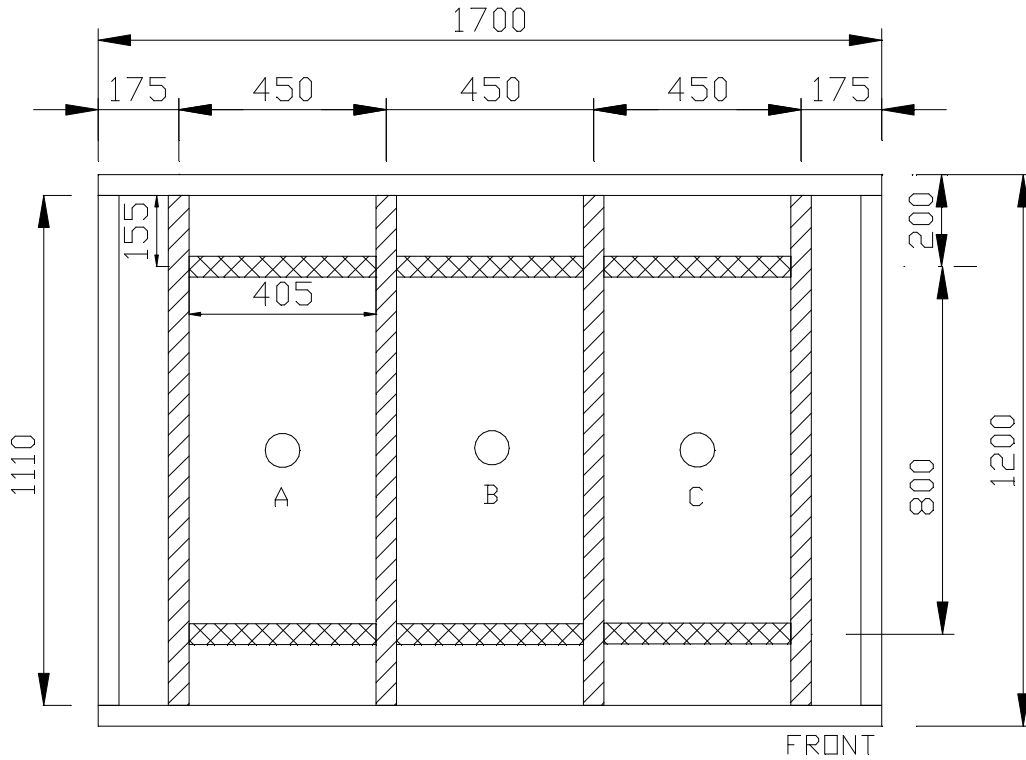
Item	Component	Information
6 cont	Weight (g): Overall size (Ø x h): Intumescent ring size (Ø x t): Driver size (l x w x h):	197 (excluding driver) 82 x 60 75 OD: 63 ID x 1.5 130 x 40 x 25

Key:

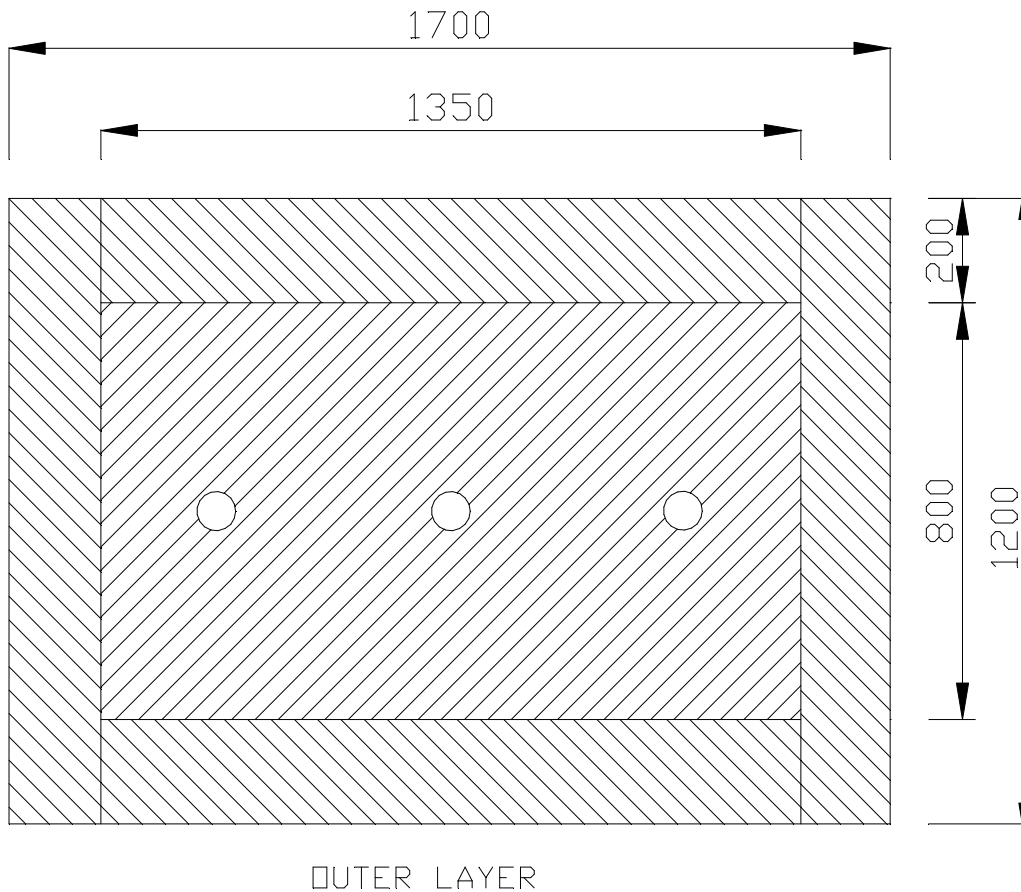
* Nominal value

** Sponsor declared value or detail, not verified by laboratory

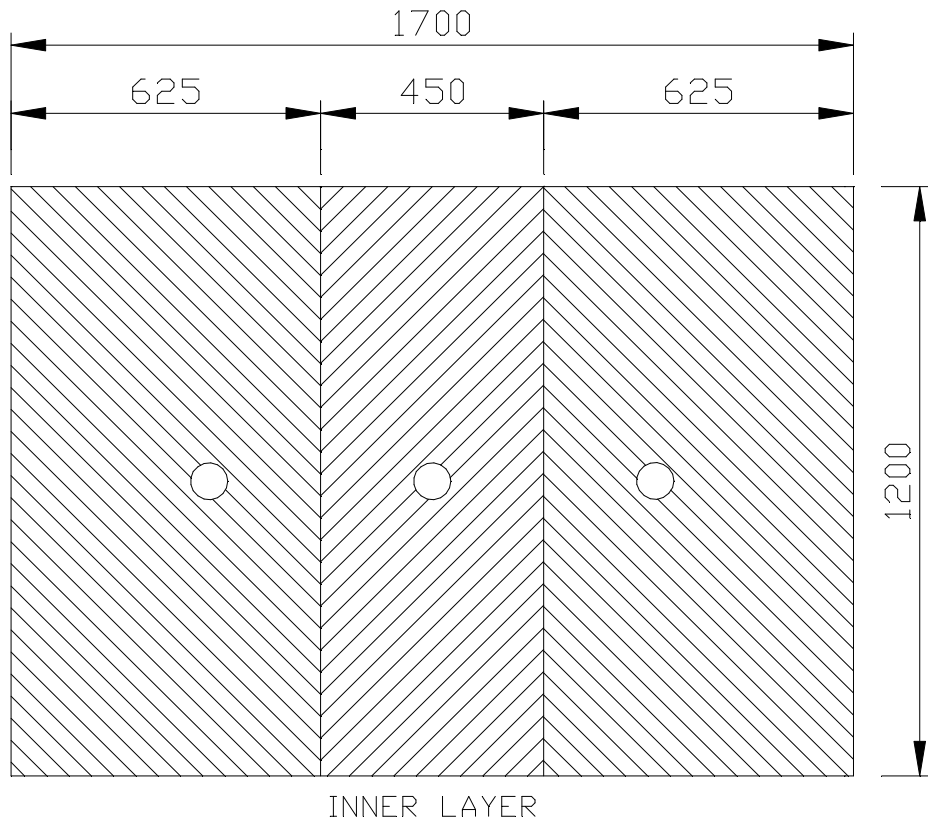
Appendix 1 Figure 1 – Section showing ceiling frame



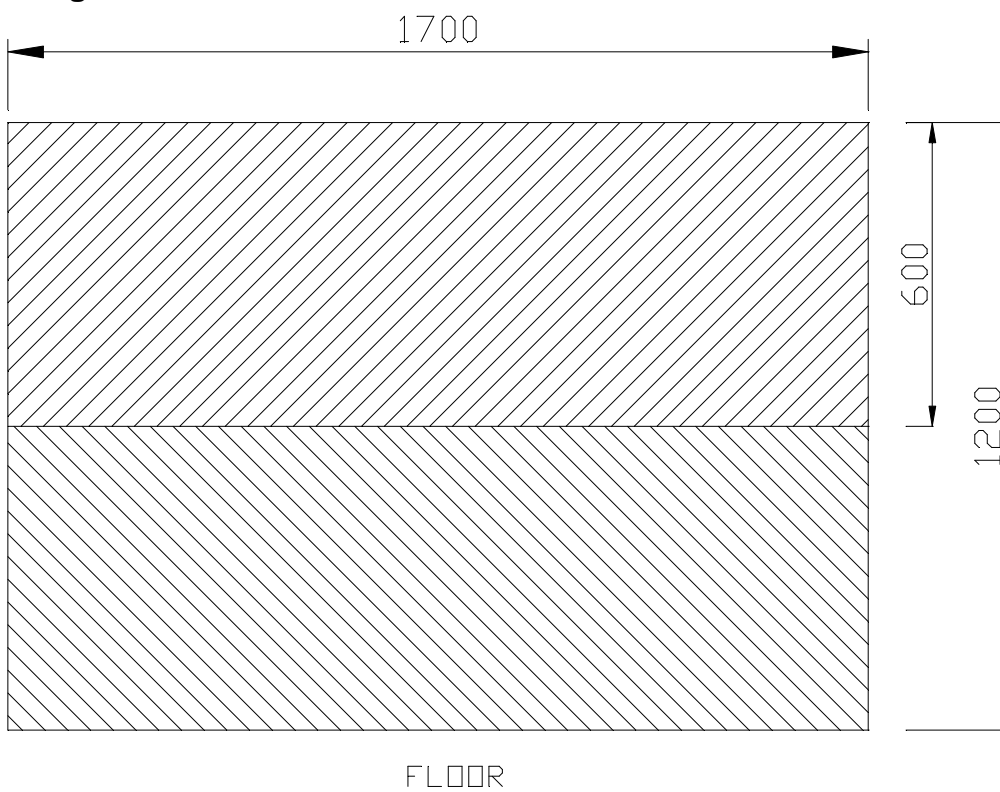
Appendix 1 Figure 2 – Ceiling membrane outer layer



Appendix 1 Figure 3 – Ceiling membrane inner layer



Appendix 1 Figure 4 – Floor



APPENDIX 2 PHOTOGRAPHS

Appendix 2.1 Pre-test photos

Photo 2.1.1 – Downlight A

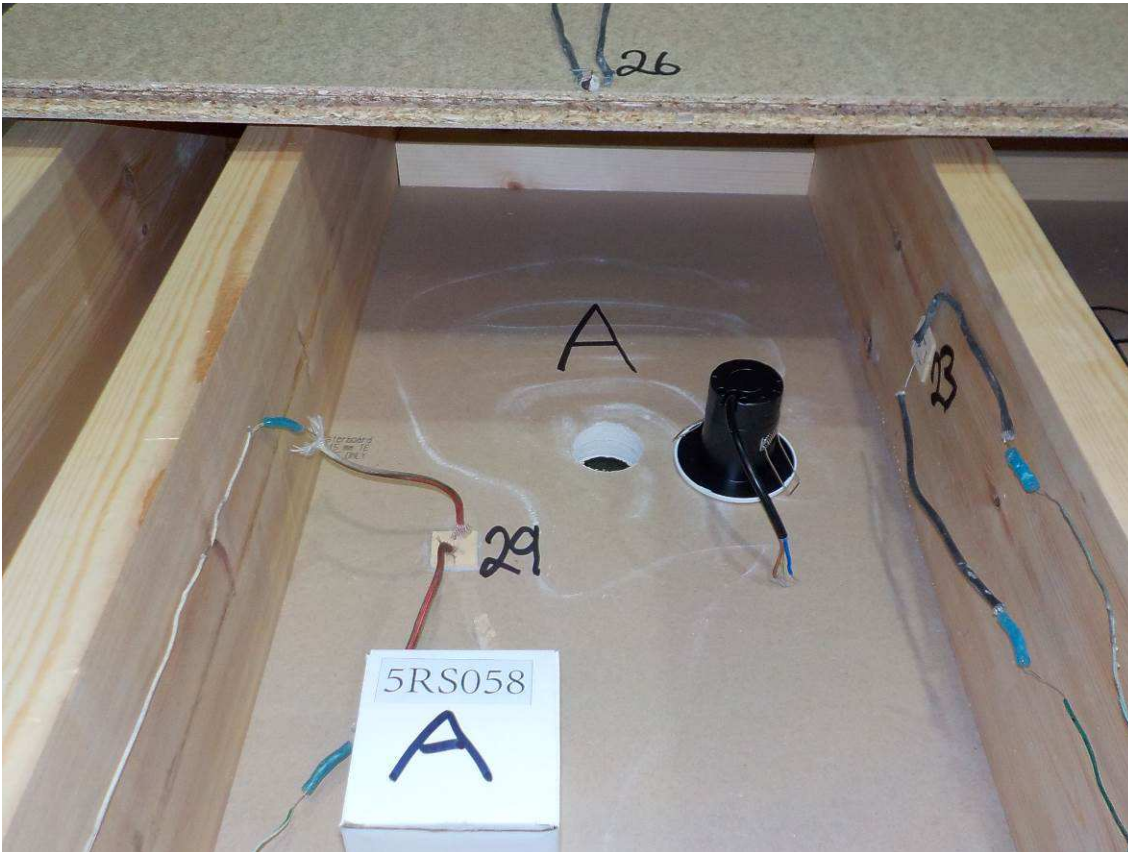


Photo 2.1.2 - Downlight A



Photo 2.1.3 - Downlight A

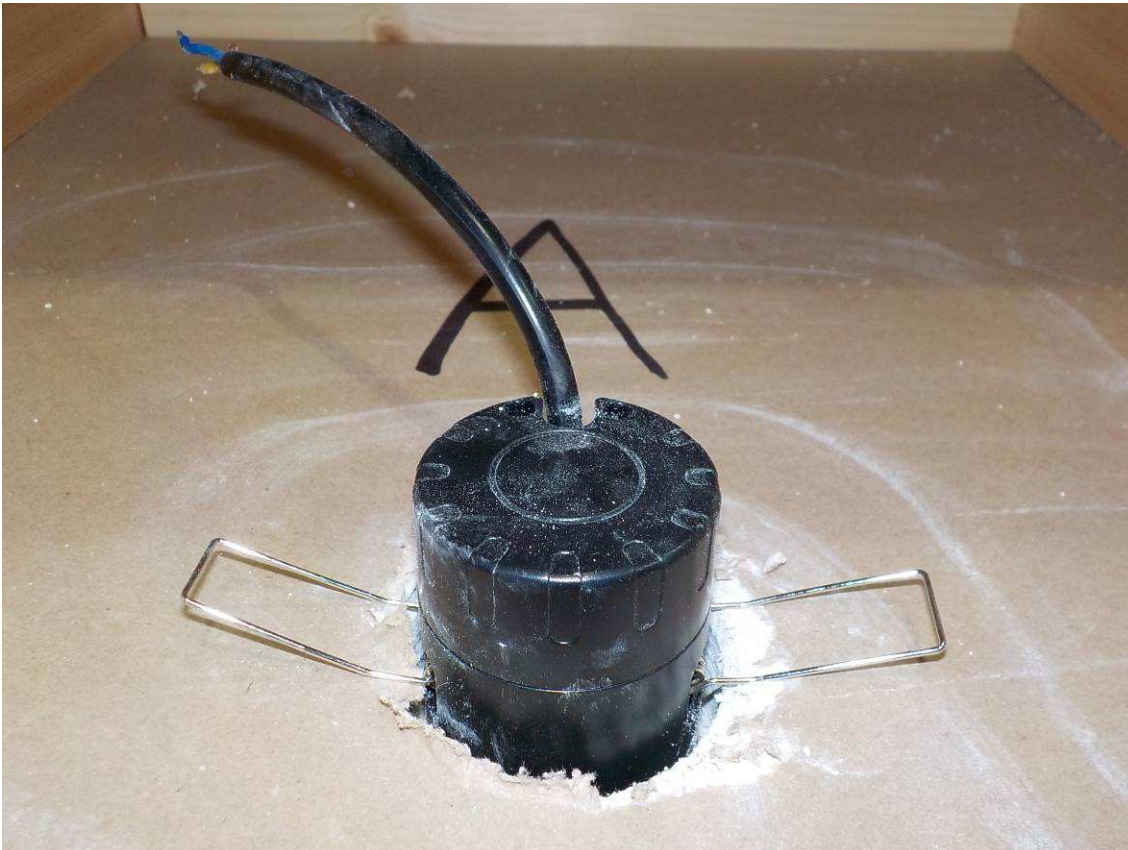


Photo 2.1.4 - Downlight B

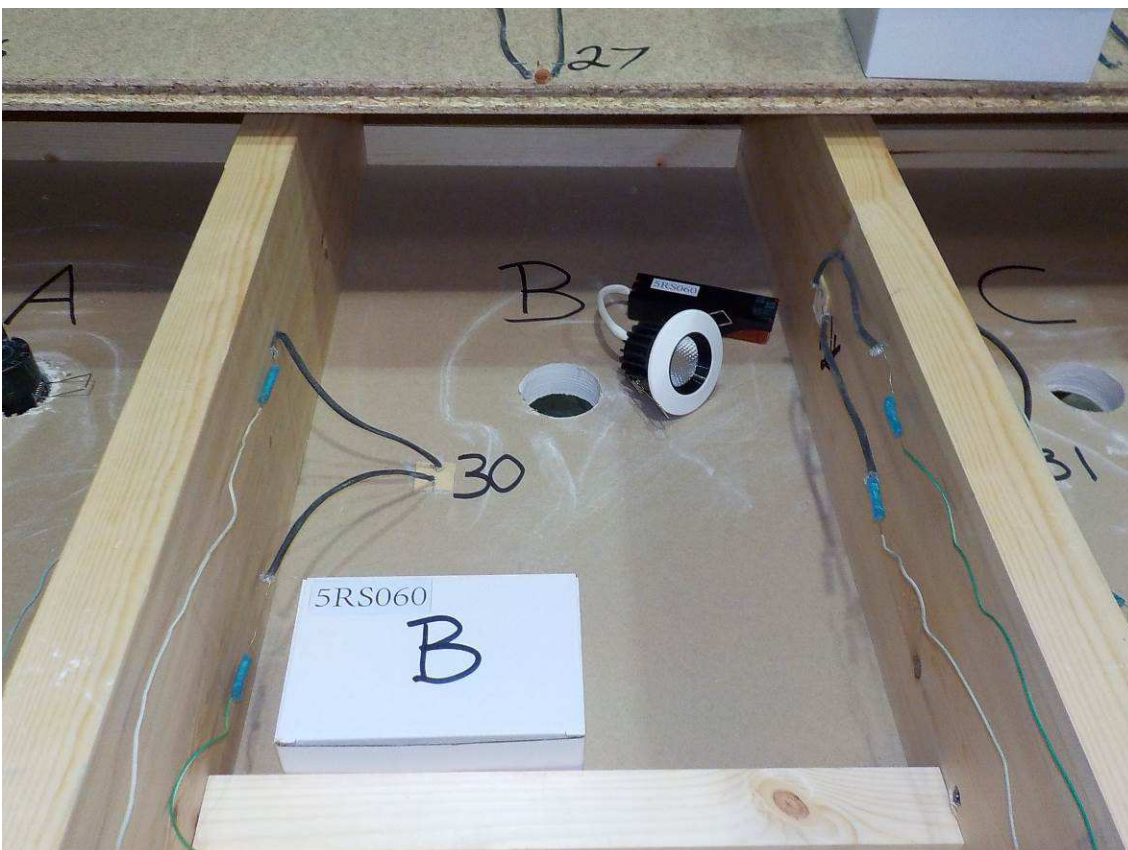


Photo 2.1.5 - Downlight B



Photo 2.1.6 - Downlight B

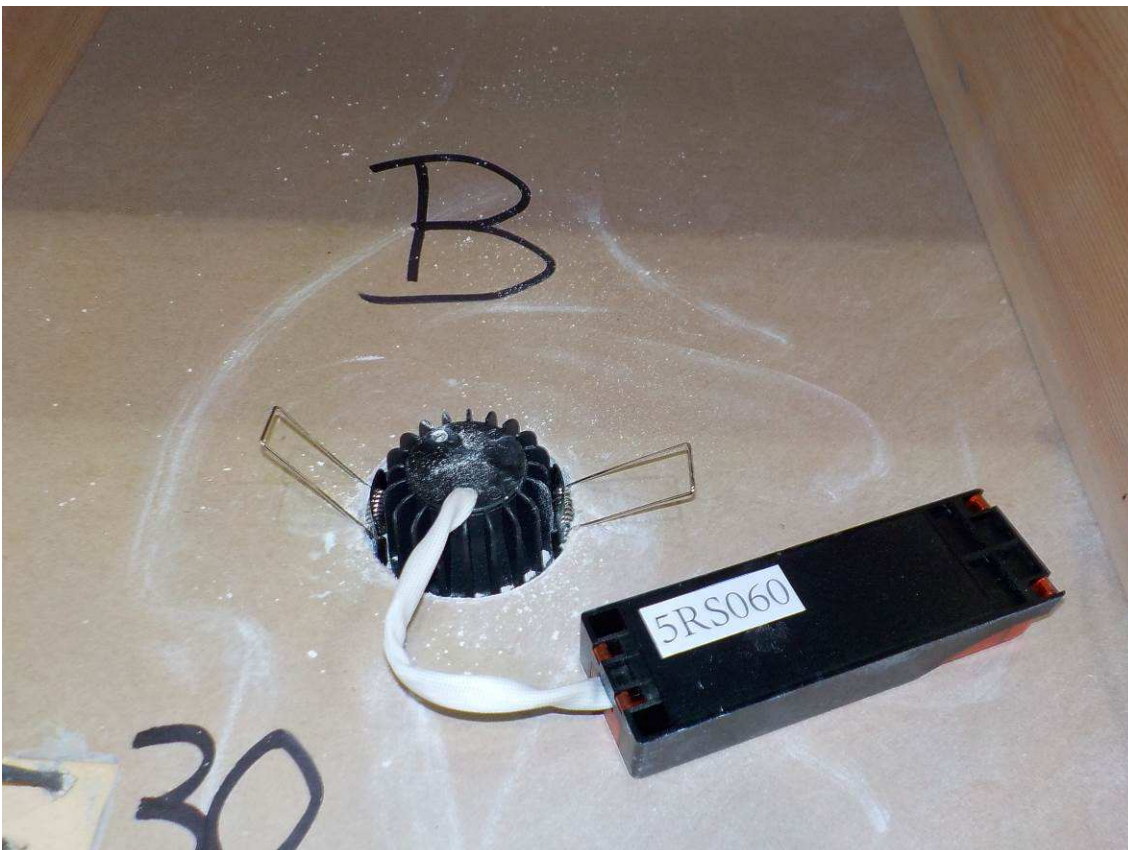


Photo 2.1.7 - Downlight C

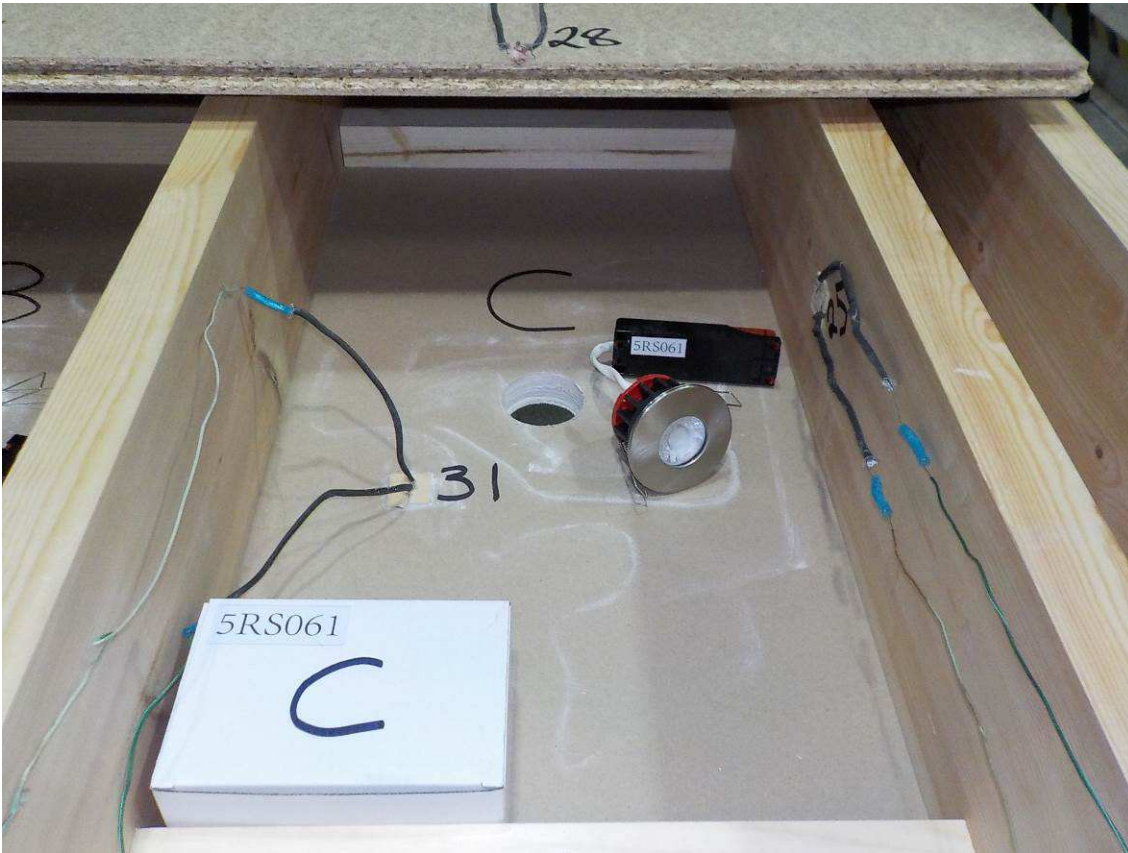


Photo 2.1.8 - Downlight C



Photo 2.1.9 - Downlight C

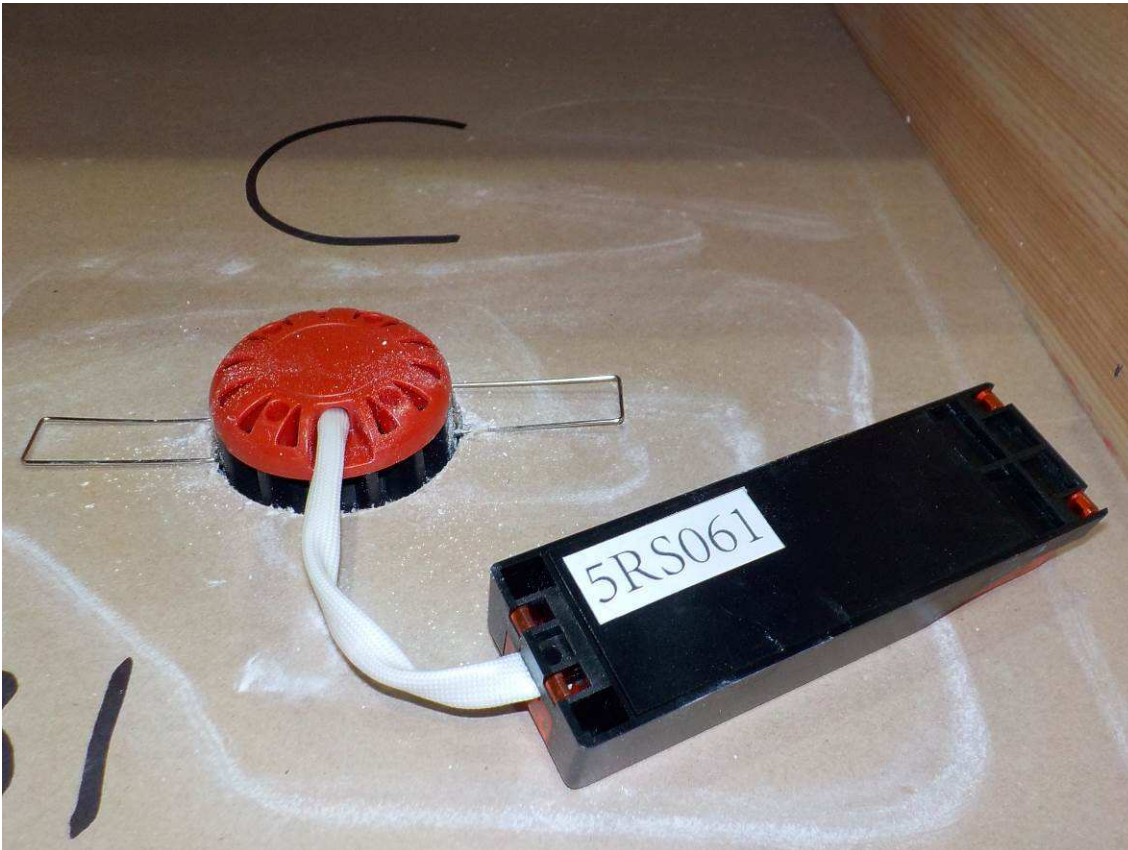
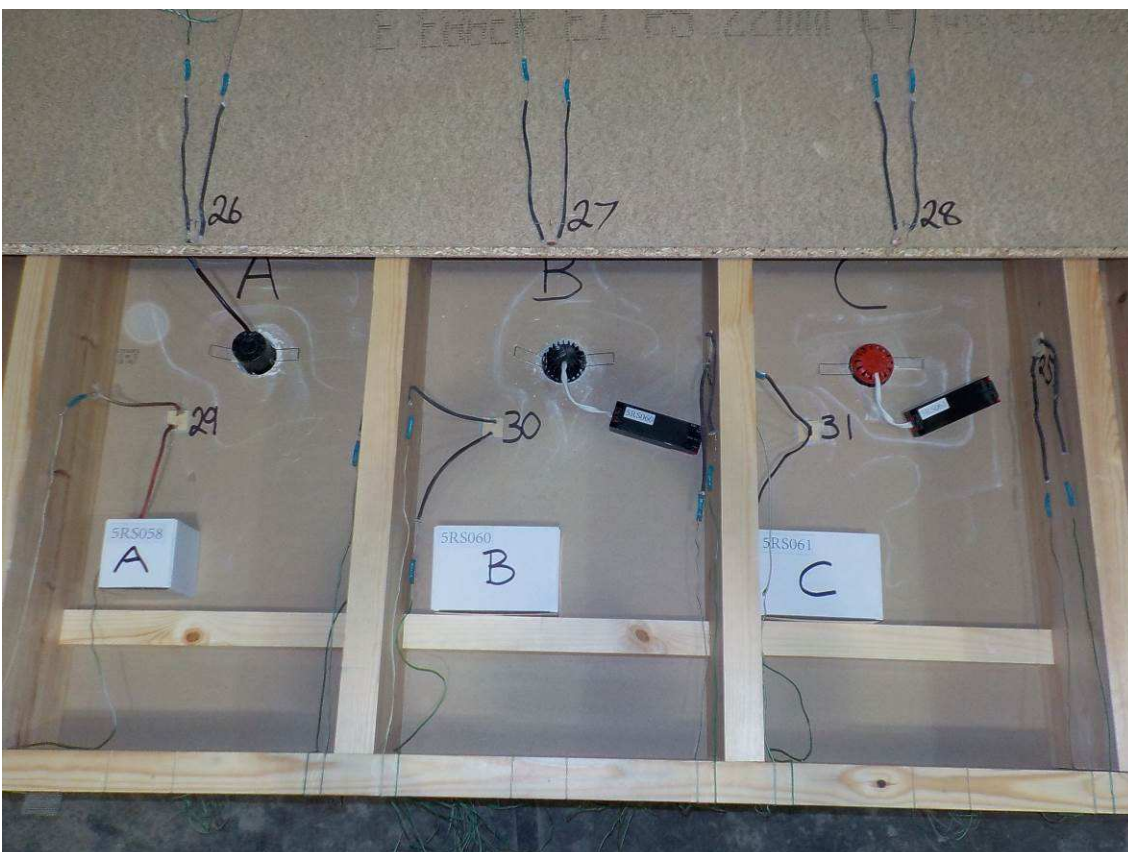


Photo 2.1.10 – Voids A, B and C



Appendix 2.2 During test photos

Photo 2.2.1 – Unexposed face

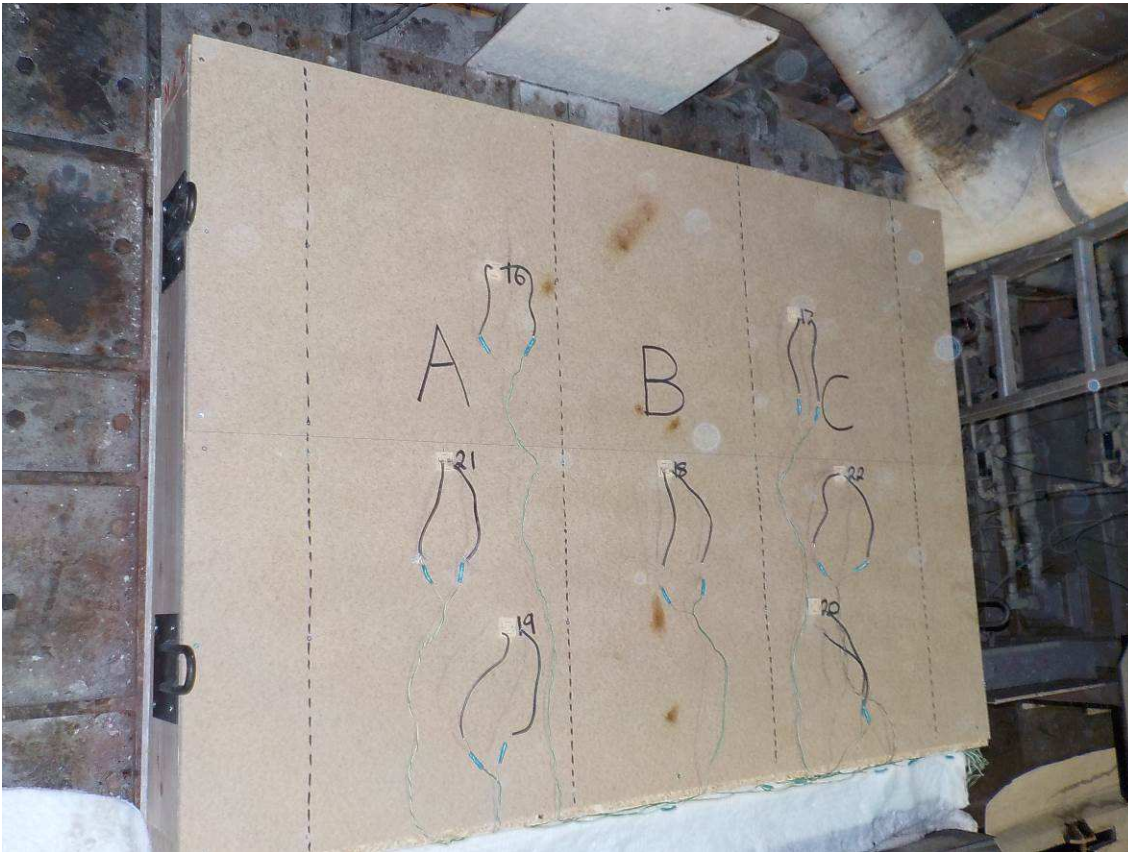


Photo 2.2.2 – Exposed face after 44 minutes.



Photo 2.2.3 – Exposed face after 60 minutes.



Photo 2.2.4 – Exposed face after 83 minutes.



Photo 2.2.5 – Exposed face after 90 minutes.



Photo 2.2.6 – Unexposed face after 90 minutes.

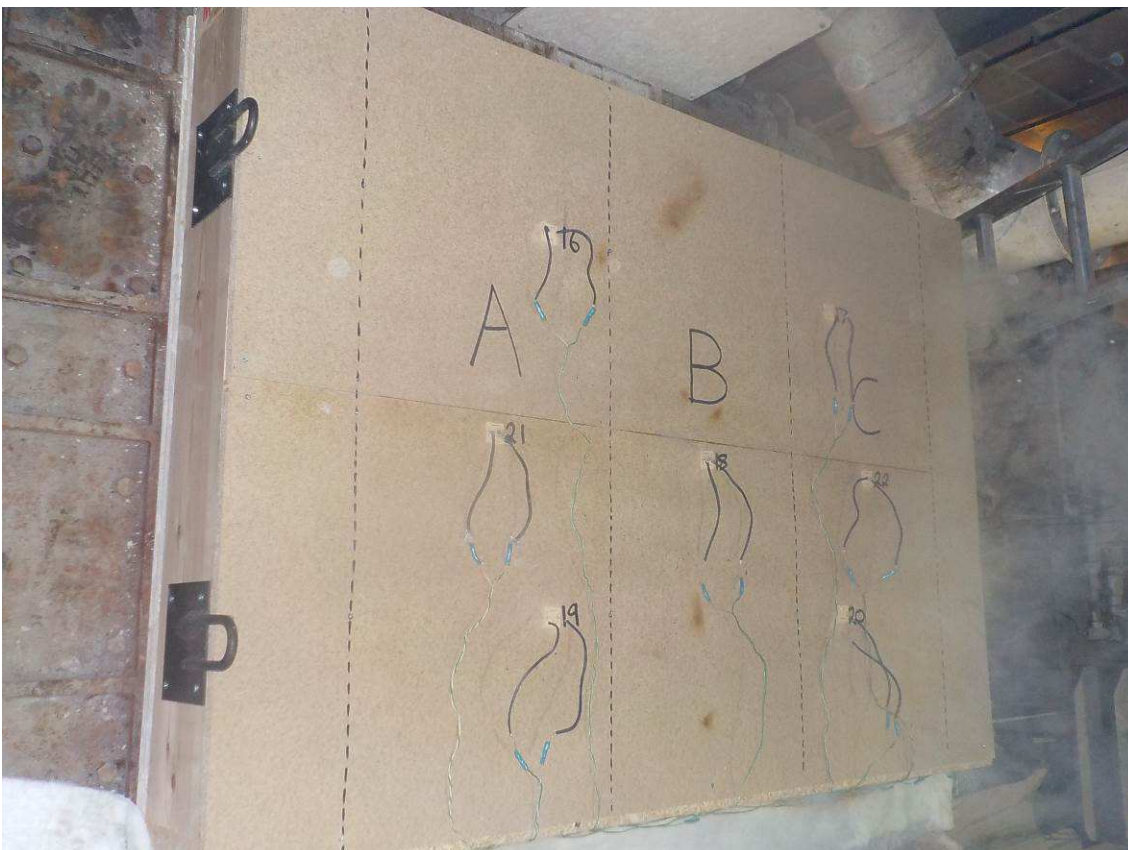
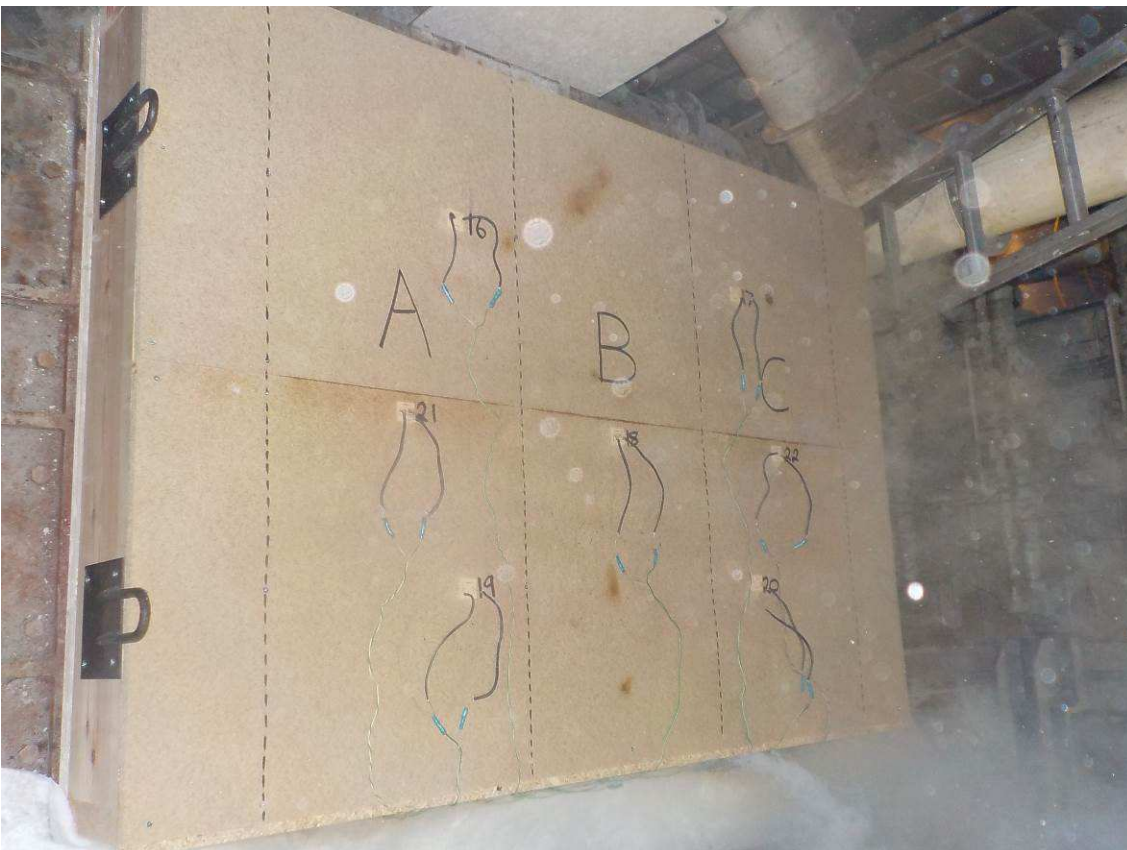


Photo 2.2.7 – Exposed face after 100 minutes.



Photo 2.2.8 – Unexposed face after 100 minutes.



Appendix 2.3 Post-test photos

Photo 2.3.1



APPENDIX 3 POSITIONING OF INSTRUMENTATION

Figure 3.1 – Unexposed face thermocouple positions:

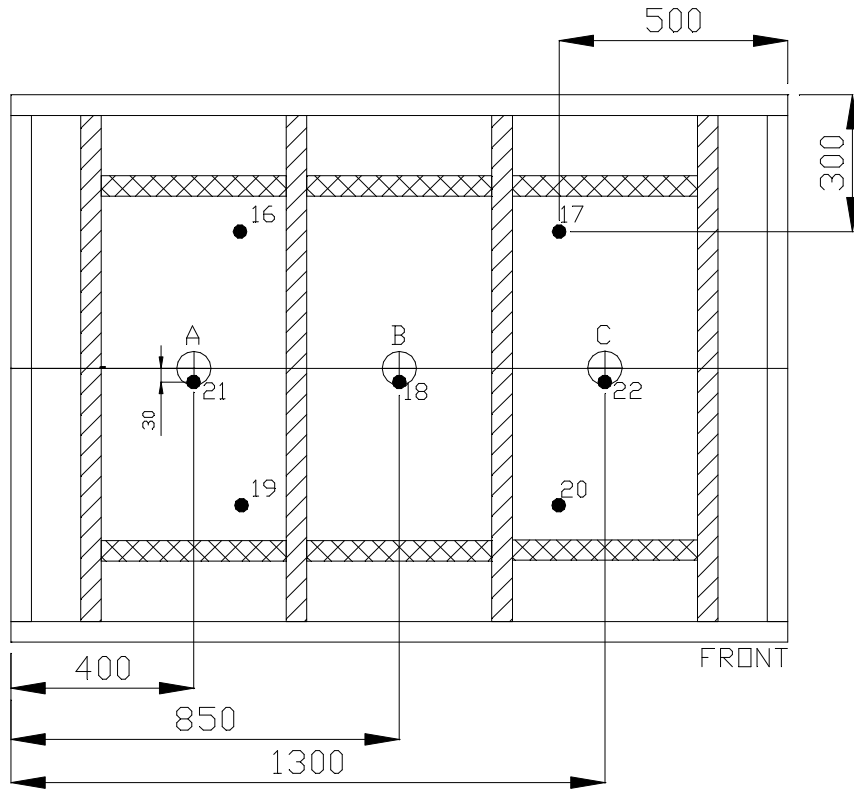
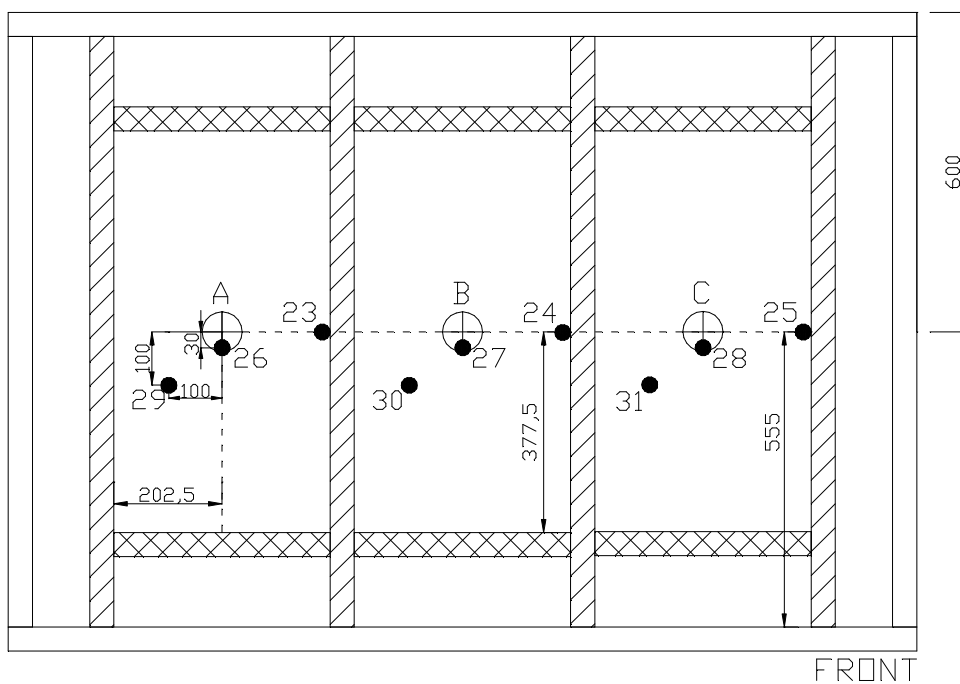
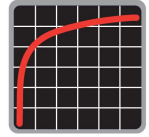


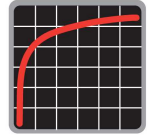
Figure 3.2 – Internal thermocouple positions:



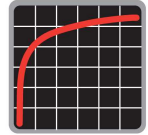


APPENDIX 4 RECORDED THERMOCOUPLE DATA

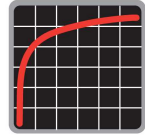
Time min	Chan 16 °C	Chan 17 °C	Chan 18 °C	Chan 19 °C	Chan 20 °C	Chan 21 °C	Chan 22 °C	Chan 23 °C
0	21	21	21	21	21	21	21	21
1	21	21	21	21	21	21	21	21
2	21	21	21	21	21	21	21	21
3	21	21	21	21	21	21	21	21
4	21	21	21	21	21	21	21	20
5	21	21	21	21	21	21	21	21
6	21	21	21	21	21	21	21	21
7	21	21	21	21	21	21	21	22
8	21	21	21	21	21	21	21	22
9	21	21	21	21	21	21	21	24
10	21	21	21	21	21	21	21	26
11	21	21	21	21	21	21	21	28
12	20	21	21	21	21	21	21	31
13	21	21	22	21	21	22	22	35
14	21	21	22	21	22	22	22	38
15	21	21	23	21	21	22	23	42
16	22	22	23	22	22	23	23	46
17	21	22	24	22	22	23	24	50
18	22	22	25	22	22	24	25	54
19	23	23	26	23	24	26	27	58
20	23	24	27	23	24	26	28	61
21	23	24	28	24	24	27	29	63
22	24	25	30	25	25	29	31	65
23	25	26	32	25	26	30	32	67
24	26	27	34	26	27	31	34	69
25	26	27	35	26	28	32	35	71
26	27	28	37	27	29	34	37	72
27	28	29	39	28	30	35	39	73
28	28	30	40	29	30	36	41	75
29	29	30	42	29	32	37	43	77
30	30	31	43	31	33	39	44	78
31	31	32	45	31	33	40	46	79
32	31	33	46	32	34	41	47	80
33	32	34	47	33	35	42	48	80
34	33	34	48	33	35	43	49	80
35	34	35	49	34	36	44	50	81
36	34	35	50	35	37	45	51	82
37	35	36	51	35	37	46	52	83
38	36	37	52	36	38	47	53	83
39	36	37	53	37	39	48	54	84
40	37	38	54	37	39	48	55	85
41	38	39	55	38	40	49	57	85
42	38	39	55	38	41	50	57	86
43	38	40	56	39	41	50	59	87
44	39	40	57	40	42	51	60	87
45	40	41	58	40	42	52	61	88
46	40	41	59	41	43	52	62	89
47	41	42	60	41	43	53	63	89
48	41	42	61	41	44	53	63	89
49	42	43	61	42	44	54	64	90
50	42	43	62	42	45	55	65	90



Time	Chan 16	Chan 17	Chan 18	Chan 19	Chan 20	Chan 21	Chan 22	Chan 23
min	°C	°C	°C	°C	°C	°C	°C	°C
51	43	44	63	43	45	56	66	91
52	43	44	63	43	46	56	67	91
53	43	45	64	44	46	57	67	91
54	44	45	65	44	46	57	68	92
55	44	45	65	45	47	58	68	92
56	45	46	66	45	47	59	69	93
57	45	46	66	45	48	59	69	92
58	46	47	67	46	48	60	69	93
59	46	47	67	46	49	60	70	93
60	46	47	68	47	49	61	70	94
61	47	48	68	47	49	61	70	93
62	47	48	68	48	50	62	71	94
63	47	48	68	48	50	62	71	93
64	48	49	69	48	50	63	71	94
65	48	49	69	49	51	63	71	94
66	49	49	70	49	51	64	71	94
67	49	49	70	49	52	64	72	94
68	49	50	70	49	53	65	72	94
69	49	50	71	50	54	65	72	94
70	49	50	71	50	56	66	72	94
71	50	51	71	50	57	67	73	94
72	50	52	72	51	59	68	74	94
73	50	52	73	52	62	69	74	94
74	50	52	73	52	64	69	74	94
75	51	54	73	53	66	71	75	94
76	51	54	73	54	68	72	75	94
77	52	56	74	55	70	71	76	94
78	52	57	74	56	72	72	76	95
79	53	58	75	57	73	73	76	95
80	54	60	76	59	75	74	78	96
81	55	61	76	60	76	74	78	97
82	56	62	76	62	77	74	78	99
83	57	64	77	63	78	75	78	109
84	58	65	77	65	79	76	78	117
85	60	66	77	67	80	76	79	124
86	62	67	78	69	81	77	79	130
87	63	69	79	70	82	77	80	136
88	65	70	79	71	82	78	81	141
89	66	71	79	73	84	78	81	146
90	68	73	79	74	85	78	82	151
91	69	75	80	75	86	79	82	155
92	71	77	80	76	87	79	83	160
93	72	79	81	77	87	79	83	164
94	73	81	81	78	88	79	83	168
95	74	82	82	79	88	80	84	174
96	75	84	82	80	89	80	84	182
97	76	86	84	81	89	81	84	191
98	77	86	84	82	89	81	85	202
99	78	86	85	83	89	82	85	212
100	80	87	86	84	89	82	87	223
101	81	87	86	86	89	83	87	233



Time	Chan 24	Chan 25	Chan 26	Chan 27	Chan 28	Chan 29	Chan 30	Chan 31
min	°C	°C	°C	°C	°C	°C	°C	°C
0	21	21	21	21	21	21	21	21
1	21	21	21	21	21	21	21	21
2	21	21	21	21	21	21	21	21
3	21	21	21	21	21	21	21	21
4	21	21	21	24	22	21	22	21
5	21	21	22	29	24	23	24	23
6	21	21	25	30	27	26	27	27
7	22	22	27	33	35	30	33	32
8	23	23	30	40	43	35	39	39
9	25	25	35	49	49	42	47	47
10	28	27	43	61	55	49	54	55
11	30	30	48	73	61	57	62	63
12	33	33	52	76	76	63	68	69
13	37	38	58	86	81	69	74	75
14	41	42	61	96	93	74	78	79
15	45	48	64	110	95	77	81	82
16	49	53	69	120	97	80	83	85
17	53	57	75	128	127	82	84	86
18	56	61	76	173	137	83	86	87
19	60	66	79	233	162	85	87	89
20	62	69	82	255	290	86	88	90
21	64	71	81	*	330	87	88	90
22	67	74	86	*	*	88	89	92
23	68	75	86	*	*	89	89	92
24	70	76	88	*	*	90	90	94
25	71	77	87	*	*	90	91	95
26	72	78	90	*	*	90	93	96
27	73	80	96	*	*	89	94	96
28	75	80	111	*	*	97	94	97
29	76	80	106	*	*	*	95	97
30	77	81	113	*	*	*	95	97
31	78	82	130	*	*	*	96	98
32	79	82	136	*	*	*	96	98
33	80	83	247	*	*	*	97	99
34	80	84	*	*	*	*	97	99
35	81	85	*	*	*	*	97	100
36	82	86	*	*	*	*	98	100
37	83	87	*	*	*	*	99	102
38	84	87	*	*	*	*	99	104
39	85	88	*	*	*	*	101	107
40	87	89	*	*	*	*	104	110
41	87	90	*	*	*	*	107	112
42	88	90	*	*	*	*	109	114
43	89	91	*	*	*	*	112	116
44	89	91	*	*	*	*	114	118
45	90	92	*	*	*	*	115	119
46	90	92	*	*	*	*	117	120
47	91	92	*	*	*	*	118	120
48	91	93	*	*	*	*	119	121
49	91	93	*	*	*	*	120	122
50	92	93	*	*	*	*	121	123



Time	Chan 24	Chan 25	Chan 26	Chan 27	Chan 28	Chan 29	Chan 30	Chan 31
min	°C	°C	°C	°C	°C	°C	°C	°C
51	92	93	*	*	*	*	122	124
52	92	93	*	*	*	*	122	126
53	93	94	*	*	*	*	124	127
54	93	93	*	*	*	*	125	129
55	93	94	*	*	*	*	128	133
56	93	94	*	*	*	*	130	137
57	93	94	*	*	*	*	133	141
58	94	94	*	*	*	*	137	154
59	94	94	*	*	*	*	143	167
60	94	94	*	*	*	*	157	178
61	94	93	*	*	*	*	168	194
62	94	93	*	*	*	*	178	216
63	94	93	*	*	*	*	197	234
64	94	93	*	*	*	*	216	249
65	95	93	*	*	*	*	233	263
66	95	92	*	*	*	*	247	275
67	95	93	*	*	*	*	259	286
68	96	93	*	*	*	250	271	295
69	96	93	*	*	*	252	280	303
70	98	94	*	*	*	267	289	310
71	100	94	*	*	*	261	296	316
72	103	95	*	*	*	269	302	321
73	122	97	*	*	*	278	308	325
74	119	103	*	*	*	286	312	329
75	120	111	*	*	*	293	316	332
76	126	114	*	*	*	299	319	335
77	132	121	*	*	*	304	323	338
78	136	126	*	*	*	308	326	342
79	141	131	*	*	*	312	330	345
80	146	136	*	*	*	316	335	349
81	150	140	*	*	*	319	339	352
82	153	144	*	*	*	322	343	356
83	157	149	*	229	*	326	347	364
84	161	154	*	237	*	330	351	379
85	165	161	*	241	*	334	354	401
86	168	170	*	245	*	337	358	425
87	172	178	*	248	*	341	361	445
88	176	188	*	252	*	344	366	462
89	180	198	*	257	*	348	371	474
90	185	209	*	268	*	351	378	483
91	192	221	*	297	*	354	390	493
92	202	233	*	330	365	357	406	502
93	214	245	*	334	377	360	425	511
94	223	256	*	333	389	363	443	519
95	232	268	*	337	396	370	460	526
96	243	279	*	355	406	383	447	531
97	254	291	306	370	420	402	436	538
98	265	302	319	380	428	424	440	545
99	276	314	334	392	438	444	447	551
100	287	327	350	405	451	461	457	557
101	298	341	353	406	457	476	464	564

* Thermocouple malfunction