CAMBRIDGE FIRERESEARCH

REPORT NUMBER CFR1901142

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

Sponsor:	DLD Contract
Address:	Unit 9 Brookside Business Centre Church Road Swallowfield Reading Berkshire RG7 1TH
Date of test:	14th January 2019

Results:

Test duration:	67 minutes (test discontinued at request of the sponsor)
Integrity	67 minutes (no failure, the test having been discontinued)
Insulation:	67 minutes (no failure, the test having been discontinued)

Summary of test specimen:

A timber joist ceiling sample with three voids and one downlight fitted into each of the voids A, B and C.

Ceiling: 2No 15mm British Gypsum Wallboard
Floor: 22mm thick Egger chipboard.
Downlight A: Eiger Adjustable tilt downlight.
Downlight B: Eiger fixed downlight.
Downlight C: Atlas Adjustable tilt downlight.
Ceiling size:
1700 long x 1200 wide x 247 deep

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Registered in England No. 5602112 Registered Office 5 High Green, Great Shelford, Cambridge CB22 5EG

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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 7 days. For the 7 days the temperature and relative humidity were measured and recorded within the range of 10 to 20°C and 40 to 68% respectively.

1.2 Associated construction

Cambridge Fire Research constructed a 60 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 specimen 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.

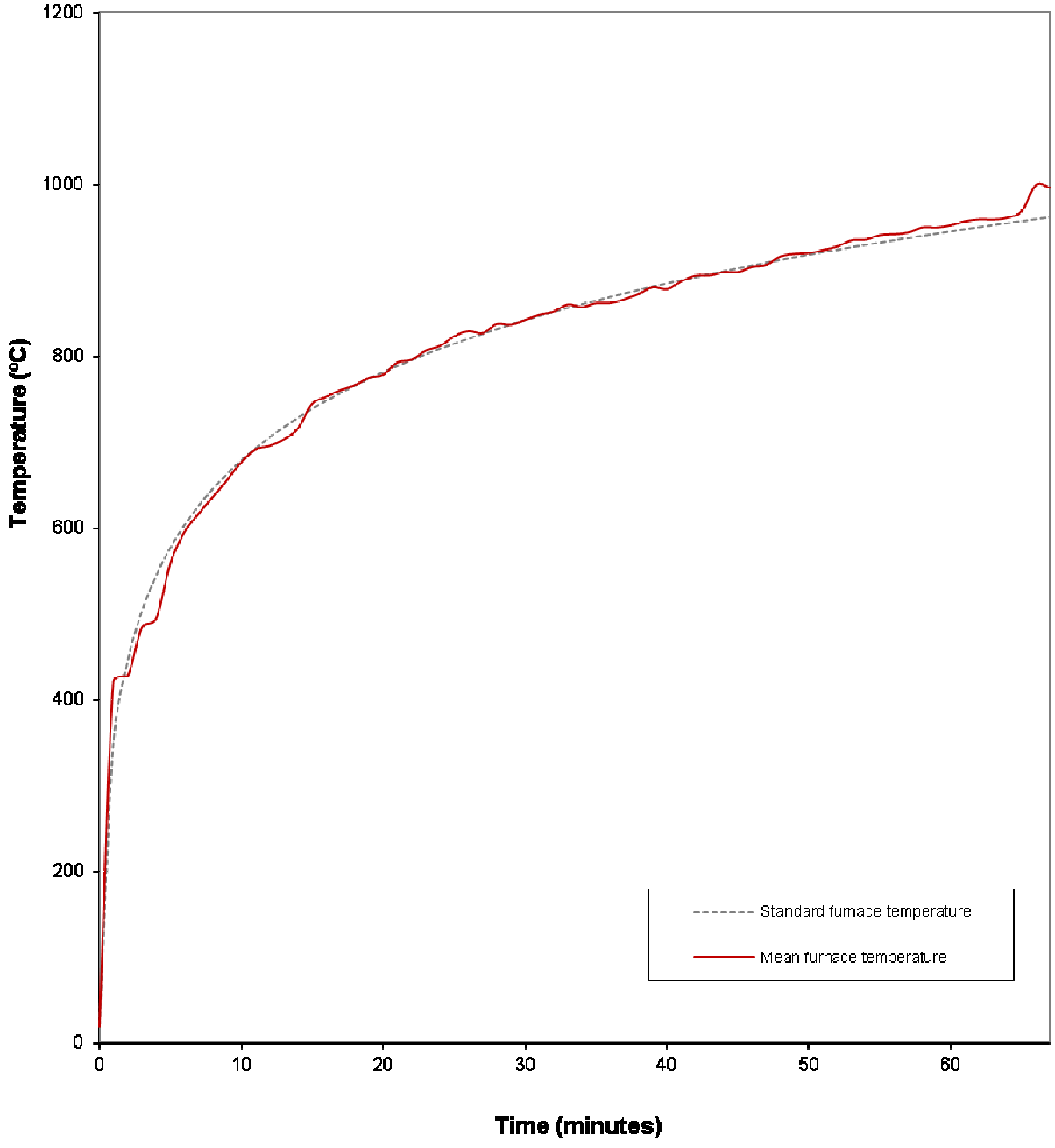
1.6 Specimen Selection

Cambridge Fire Research was not involved in any selection or sampling procedures for the tested specimens.

2 TEST CONDITIONS, INSTRUMENTATION AND MEASURING

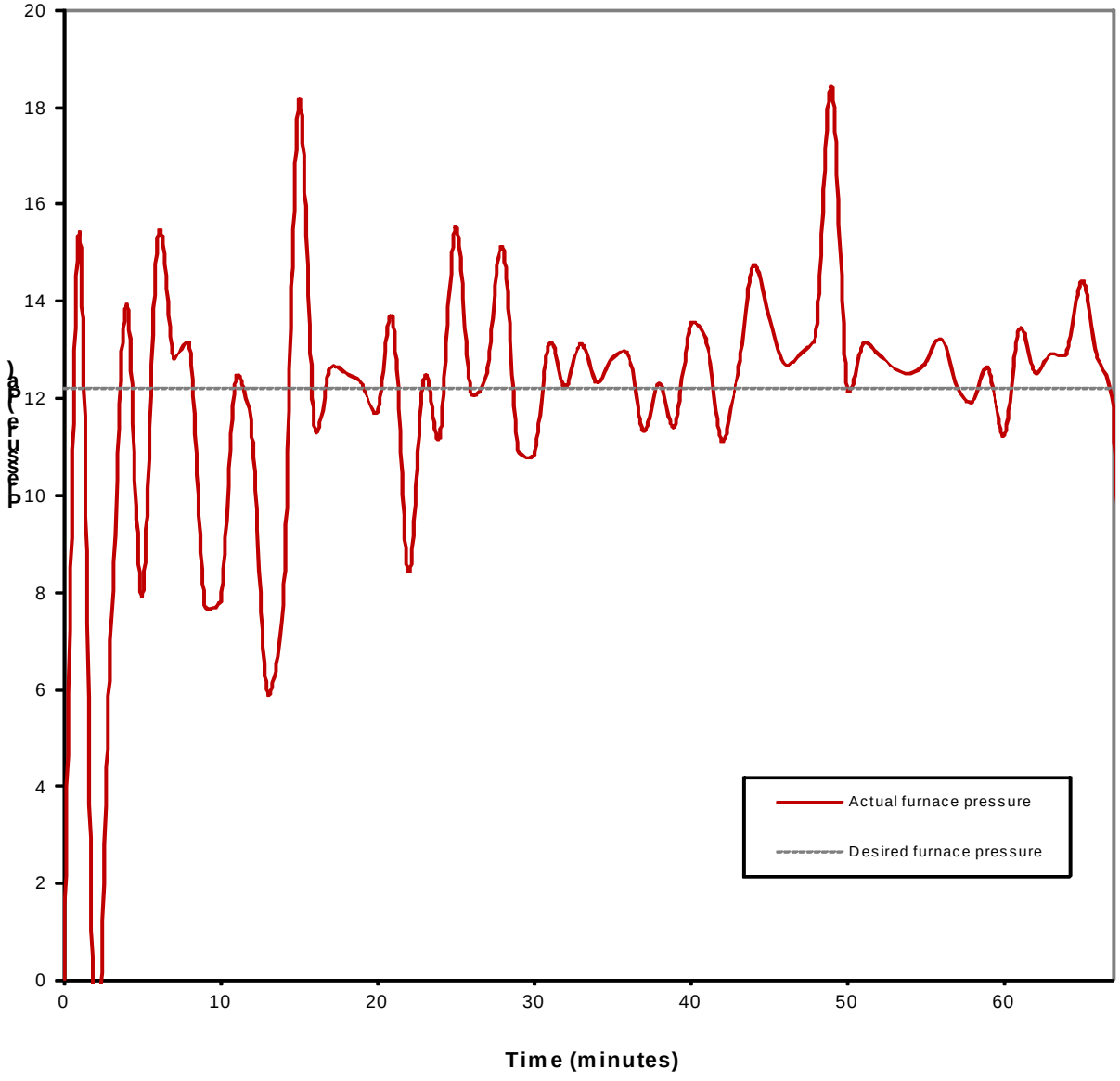
2.1 Furnace temperature

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 13 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 15°C.
Ambient temperature ranged from 14 to 15°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:

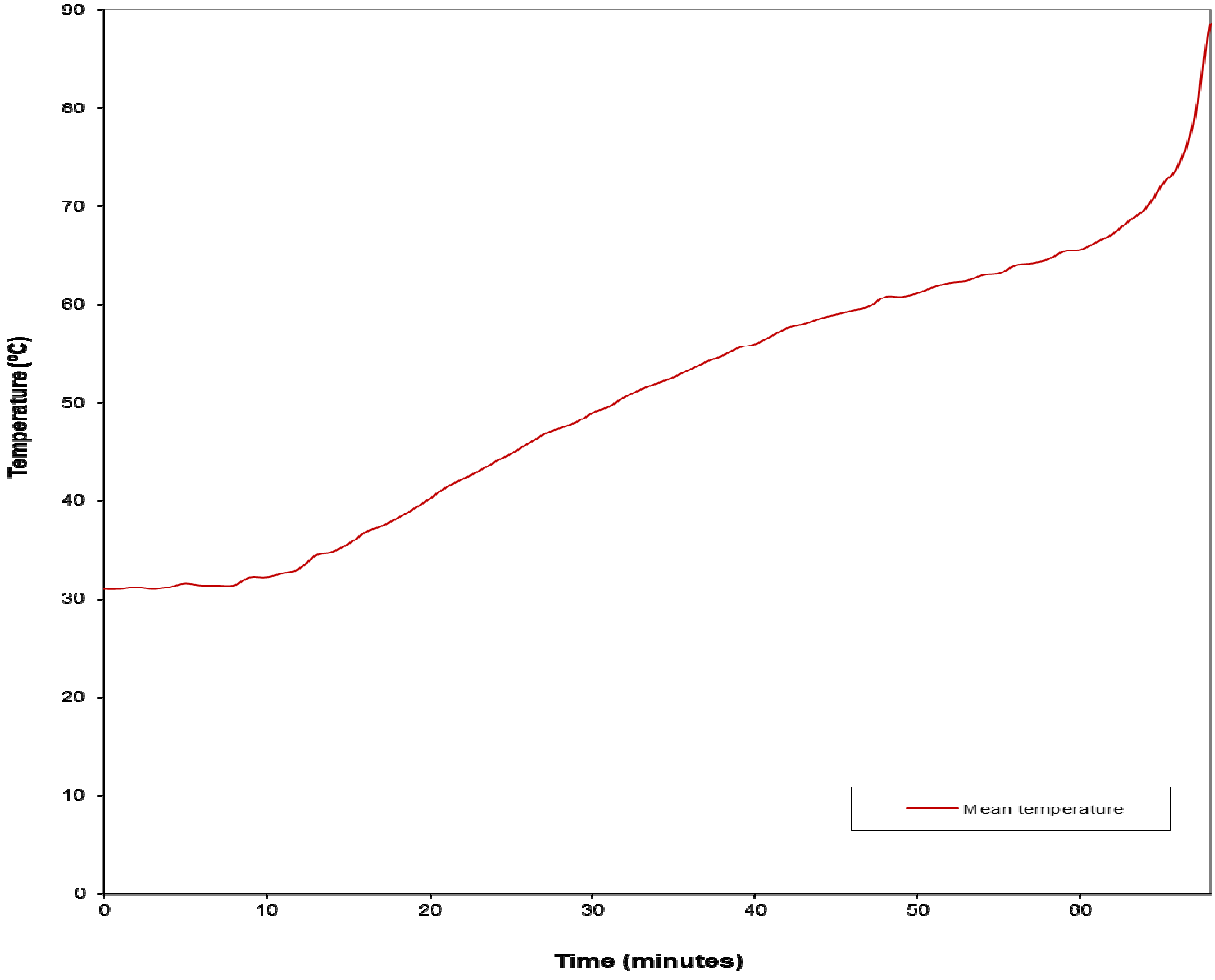
Unexposed face	Channels 16 to 20	(mean and maximum)
	Channels 21 and 22	(information only on floor)
Internal	Channels 26 to 28	(information only, suspended under floor)
	Channels 29 to 31	(information only, on plasterboard)
	Channels 23 to 25	(information only, on joist at mid height)

The positions of these thermocouples are shown in Appendix 4.

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.
05:20	E	Lens of downlight A and C missing.
06:37	E	Internal components of C detached.
08:01	E	Internal components of A detached.
09:40	E	All components of A detached.
15:48	E	Bezel of downlight C softens and distorts.
35:25	E	Section of outer layer of plasterboard detaches at void C with downlight C.
48:49	E	Outer plasterboard layer missing
52:15	E	Inner plasterboard layer cracks at various positions.
53:03	E	Flaming occurs at plasterboard joints.
66:20	E	Centre section of inner plasterboard layer detaches.
67:00	E	Test terminated.

Key
Light smoke/steam – faint wispy
Medium smoke/steam – partially obscuring specimen
Heavy smoke/steam – completely obscuring specimen

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:

T Smith
Technical Officer

Report checked by:

E Southern
Deputy Head of Testing

Report issued: **11th April 2019**

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

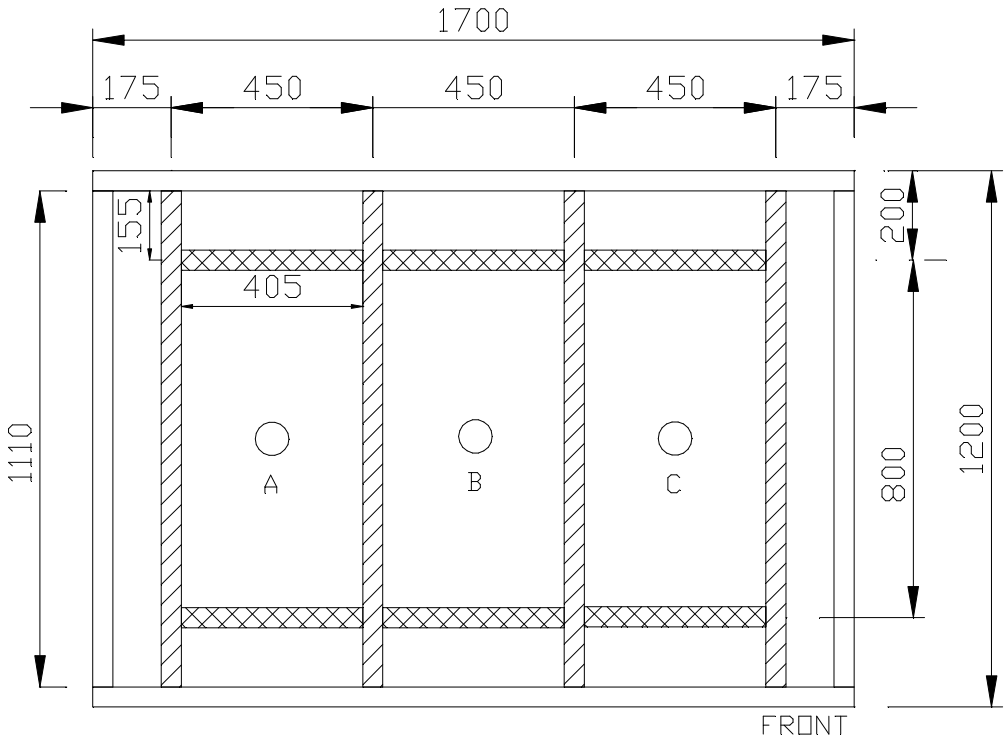
Item	Component	Information
1	**Ceiling layer** Supplier: Name: Description: Overall size (l x w x t):	 British Gypsum Wallboard 2No. Wallboard layers affixed to the exposed side of the perimeter frame, joists and noggins using Ø3.5 x 36 long drywall screws set at 300 * centres for the first layer with 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	**Downlight A**	
	Supplier:	Darklight Design
	Name:	Eiger Adjustable LED tilt downlight
	Description:	An integrated LED downlight with die cast alloy heatsink painted black, an integral LED above a diiffusing lens and reflector. A cast alloy reflector ring is attached to the heatsink with two steel legs and countersunk screws. A cast alloy tilt ring with riveted spring clips is attached to the reflector ring with countersunk screws. A 61 OD x 30 high, 0.6 mm thick steel friction fit sleeve mounts over the tilt ring with self adhesive internal and external graphite based intumescent. The perforated steel plaster ring has a 21 high boss that retains the downlight spring clips and is affixed to the plasterboard with a gypsum based compound. The downlight is fitted central to the void.
	Hole size (Ø):	78
	Weight (g)	288
	Overall size:	
	Downlight (Ø x h):	69 x 92
	Plaster ring (Ø x h):	125 x 21
	Intumescent ring (h x t):	Internal 7 x 1.5, External 30 x 1.5
5	**Downlight B**	
	Supplier:	Darklight Design
	Name:	Eiger LED fixed downlight
	Description:	An integrated LED downlight with die cast alloy heatsink painted black, an integral LED above a diiffusing lens and reflector. A cast alloy reflector ring, with 2No. riveted spring clips, is attached to the heatsink with two steel legs and countersunk screws. A 61 OD x 53 high, 0.6 mm thick steel friction fit sleeve mounts over the reflector ring with self adhesive internal and external graphite based intumescent. The perforated steel plaster ring has a 21 high boss that retains the downlight spring clips and is affixed to the plasterboard with a gypsum based compound. The downlight is fitted central to the void.
	Hole size (Ø):	78
	Weight (g)	320
	Overall size:	
	Downlight (Ø x h):	69 x 86
	Plaster ring (Ø x h):	125 x 21
	Intumescent ring (h x t):	Internal 7 x 1.5, External 53 x 1.5

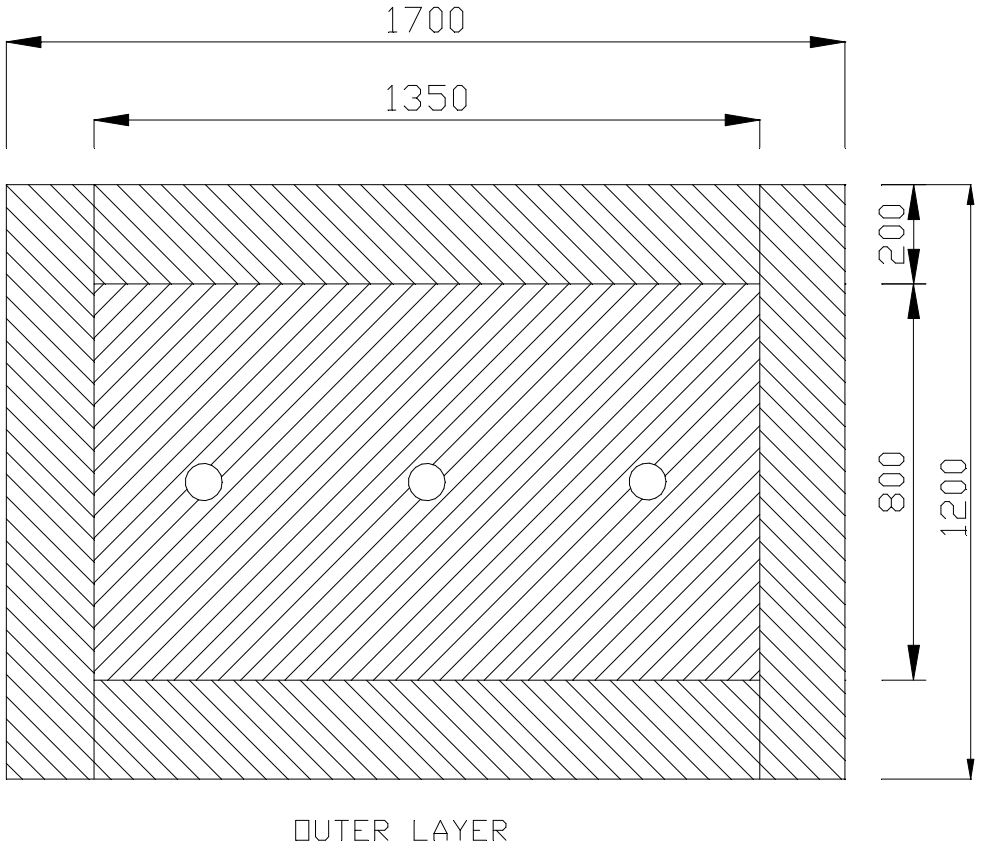
Item	Component	Information
6	**Downlight C**	
	Supplier:	Darklight Design
	Name:	Atlas Adjustable LED tilt downlight
	Description:	An integrated LED downlight with die cast alloy heatsink painted black, an integral LED above a diiffusing lens and reflector. A plastic threaded bush connects the heatsink to a cast alloy reflector ring with riveted spring clips. A 63 OD x 25 high, 0.6 mm thick steel friction fit sleeve mounts over the reflector ring with self adhesive internal and external graphite based intumescent. The downlight is fitted central to the void.
	Hole size (Ø):	68
	Weight (g)	195
	Overall size:	
	Downlight (Ø x h):	76 x 83
	Intumescent disc (h x t):	Internal 10 x 1.5, External 19 x 1.5

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

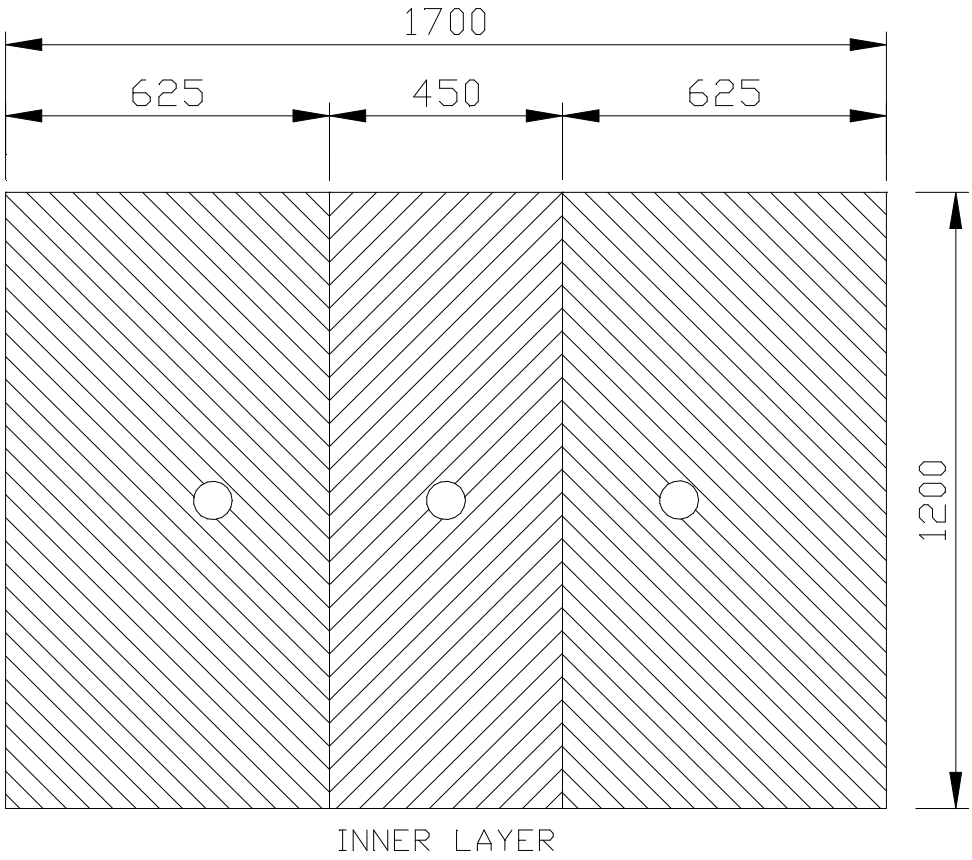
Appendix 1 Figure 1 – Section showing ceiling frame



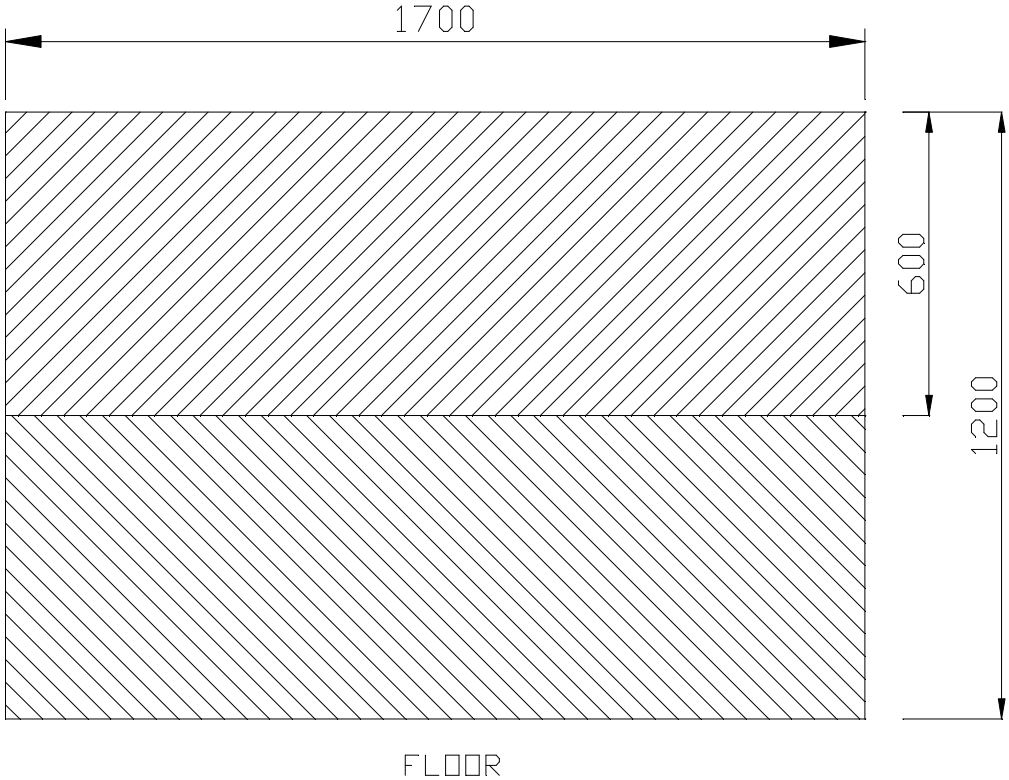
Appendix 1 Figure 2 – Ceiling membrane outer layer



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

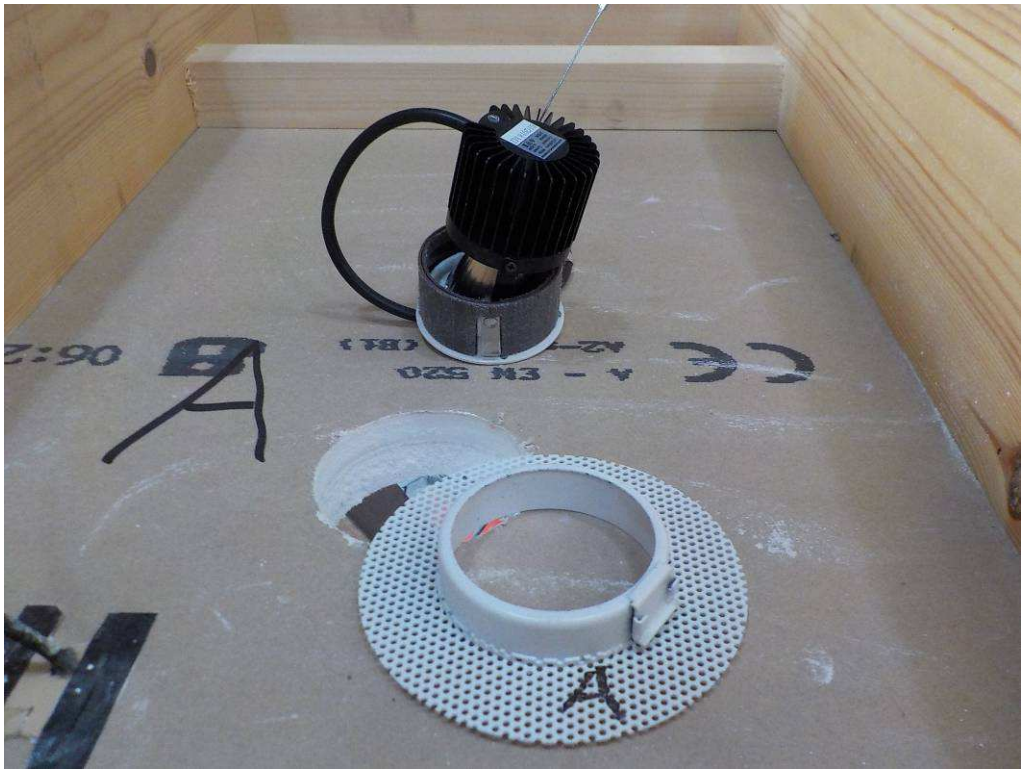


Photo 2.1.2 – Downlight A

Photo 2.1.3 - Downlight A

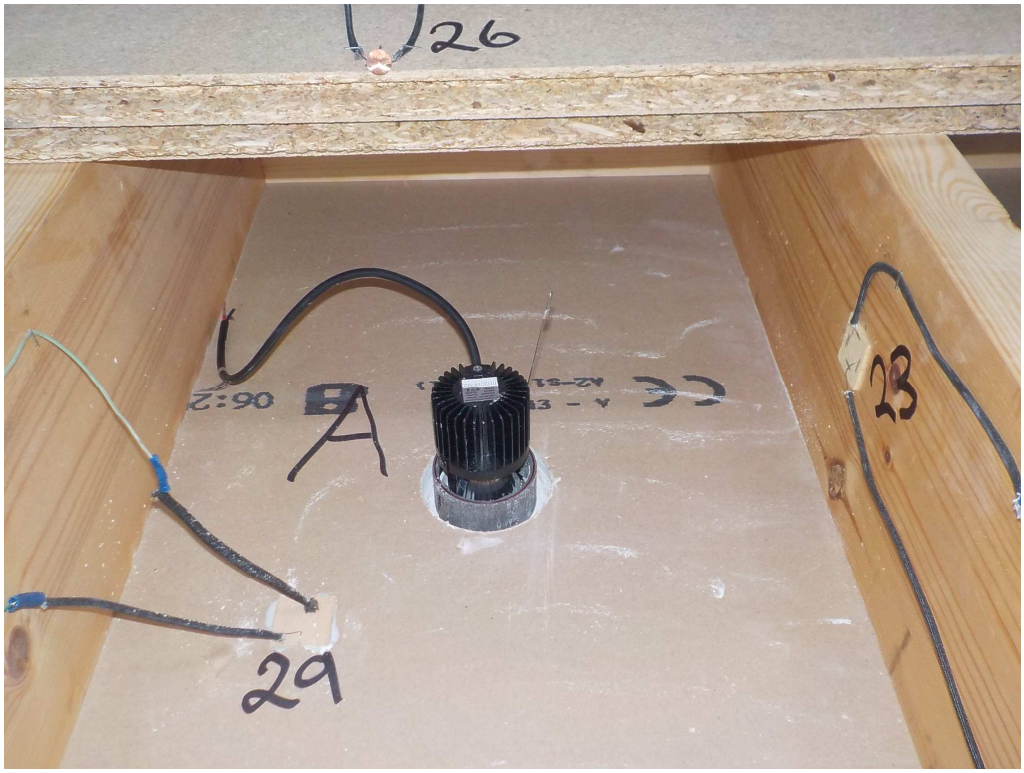


Photo 2.1.4 – Downlight B

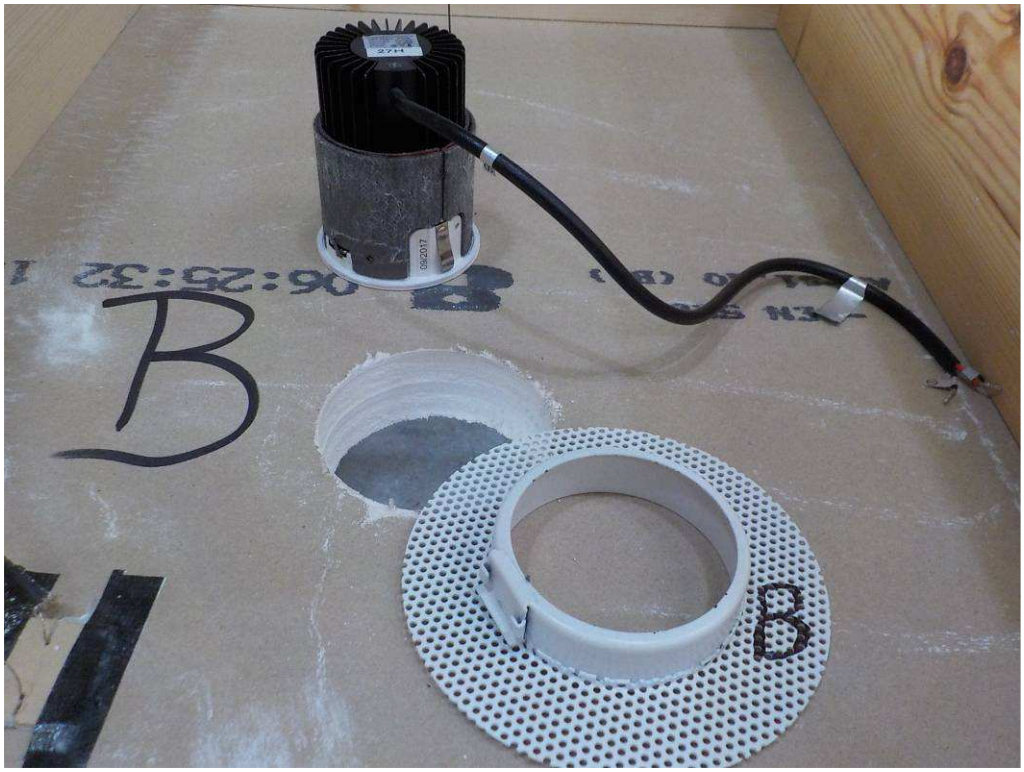


Photo 2.1.5 – Downlight B

Photo 2.1.6 – Downlight B

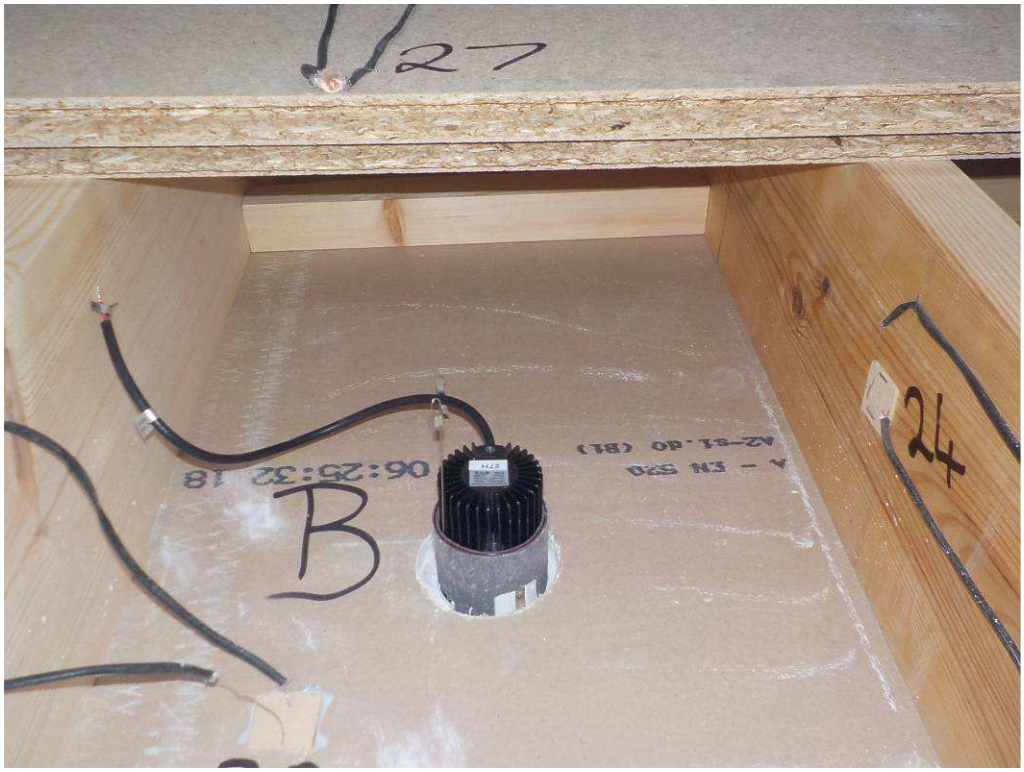


Photo 2.1.7 – Downlight C

Photo 2.1.8 – Downlight C

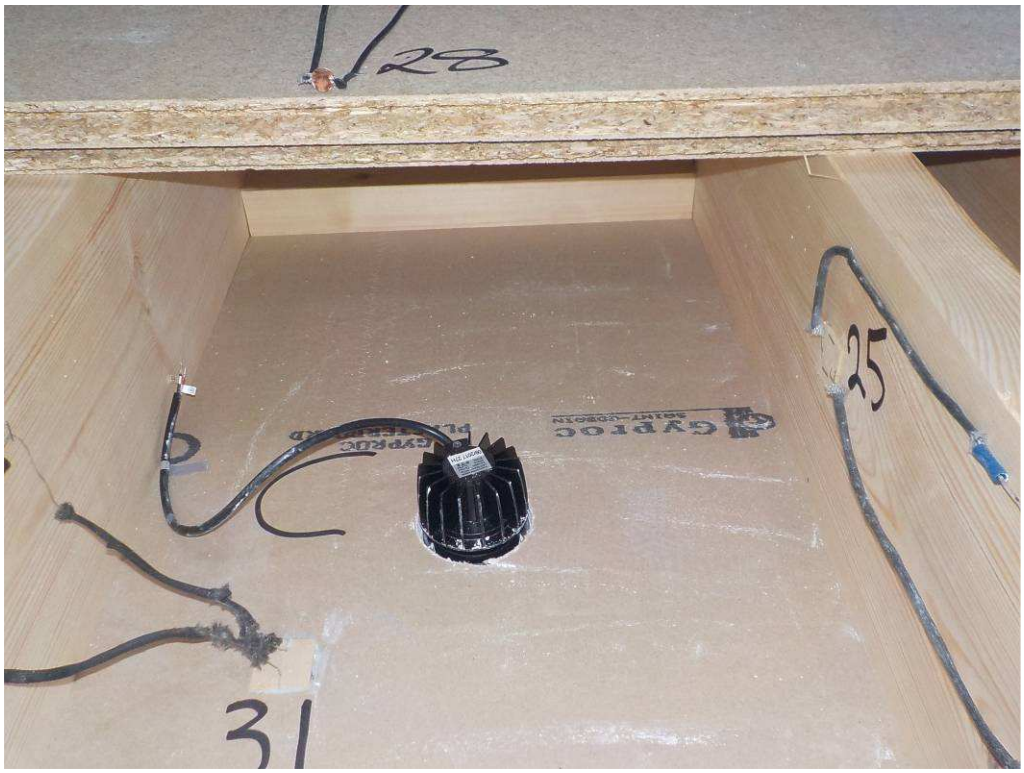


Photo 2.1.9 – Downlights A,B and C

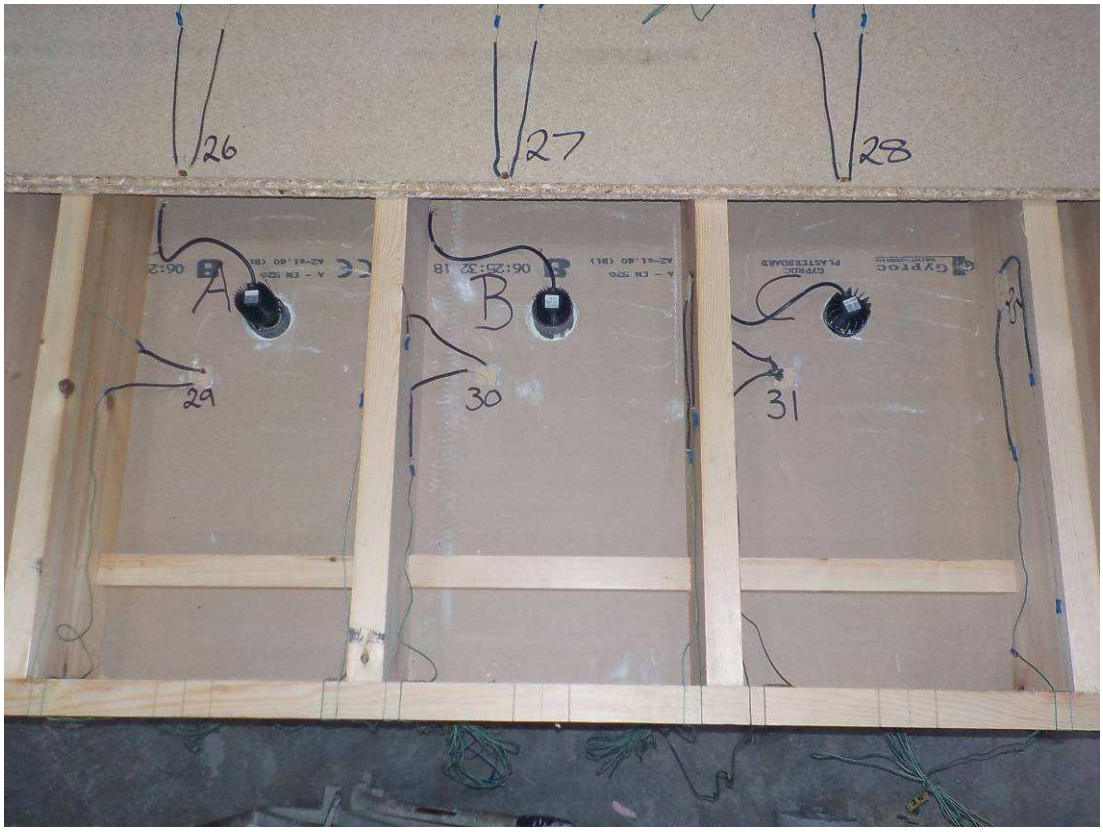


Photo 2.1.10 – exposed surface

Appendix 2.2 During test photos

Photo 2.2.1 – Unexposed face

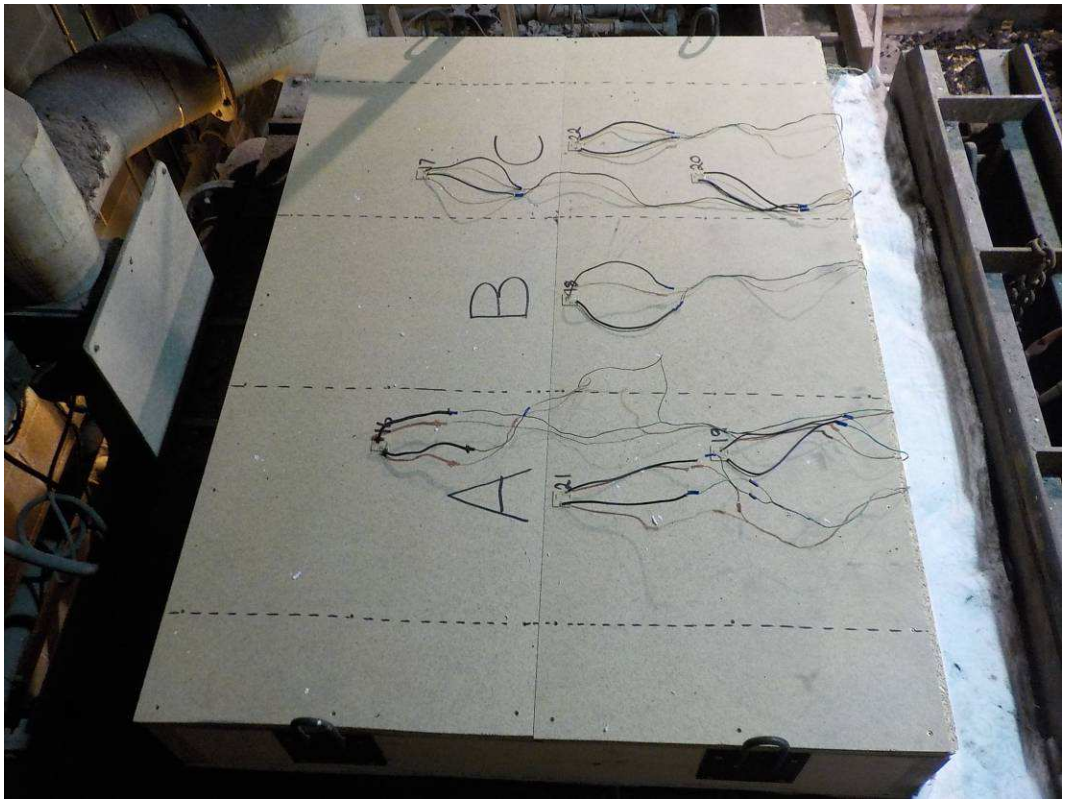


Photo 2.2.2 – Exposed face after 11 minutes.

Photo 2.2.3 – Exposed face after 30 minutes.

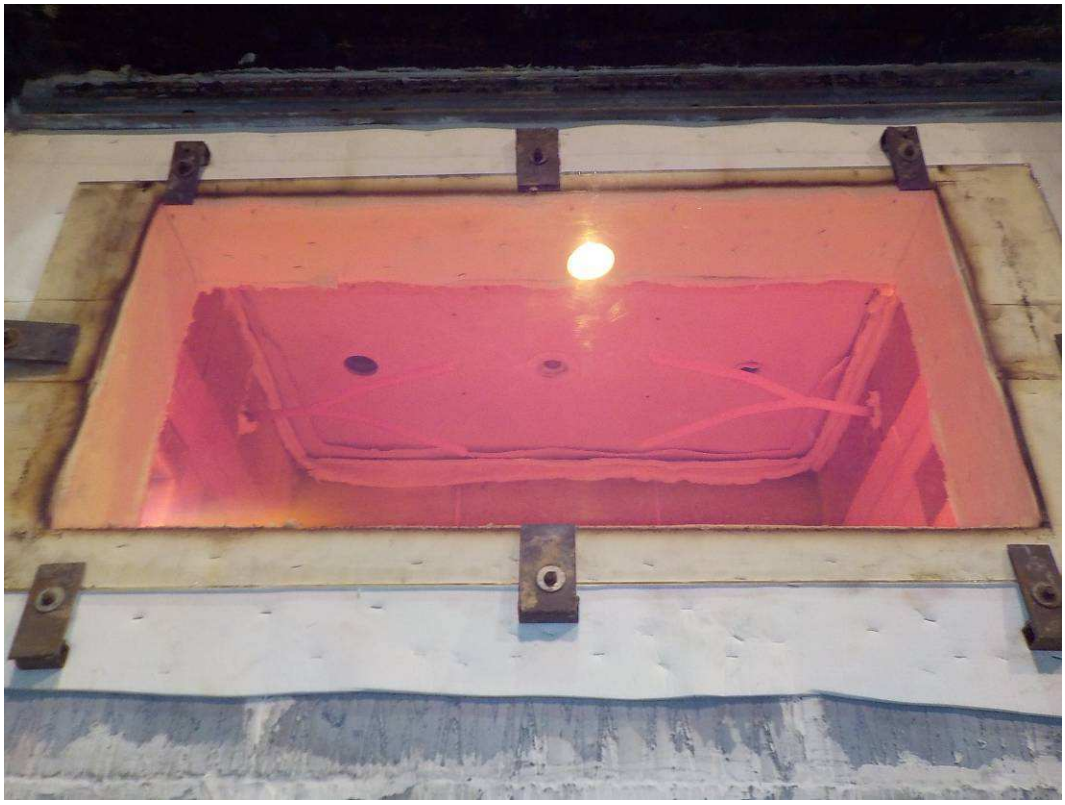


Photo 2.2.4 – Exposed face after 42 minutes.

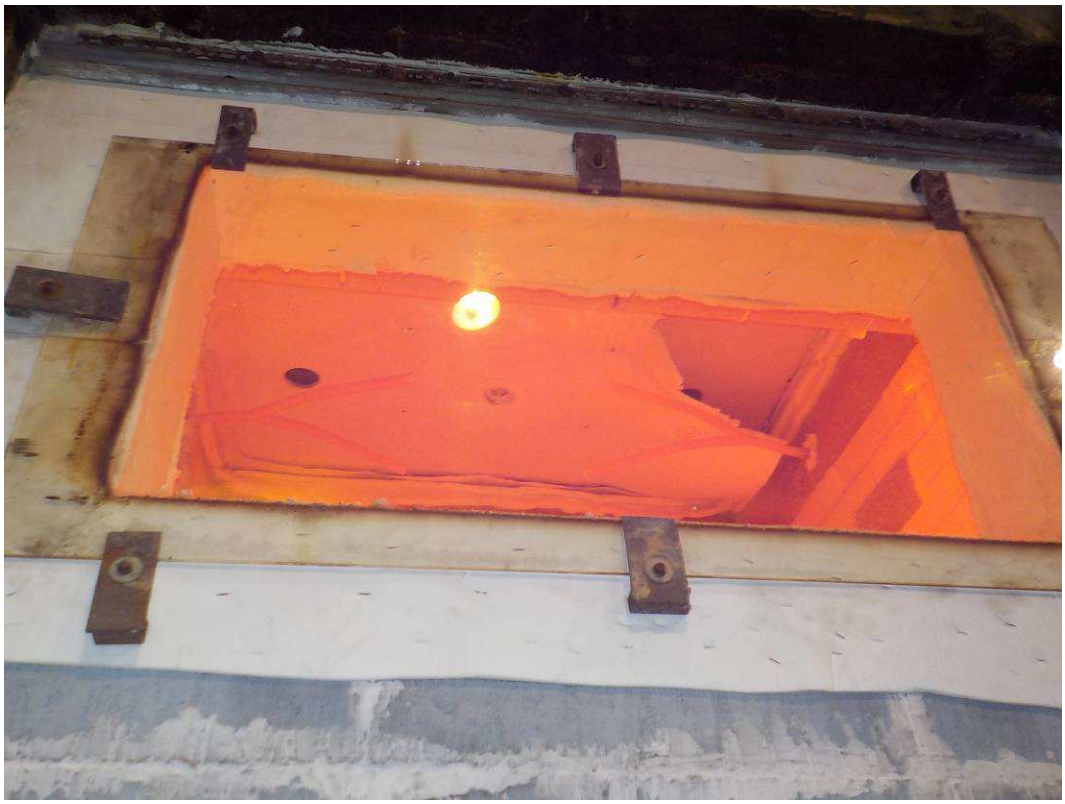
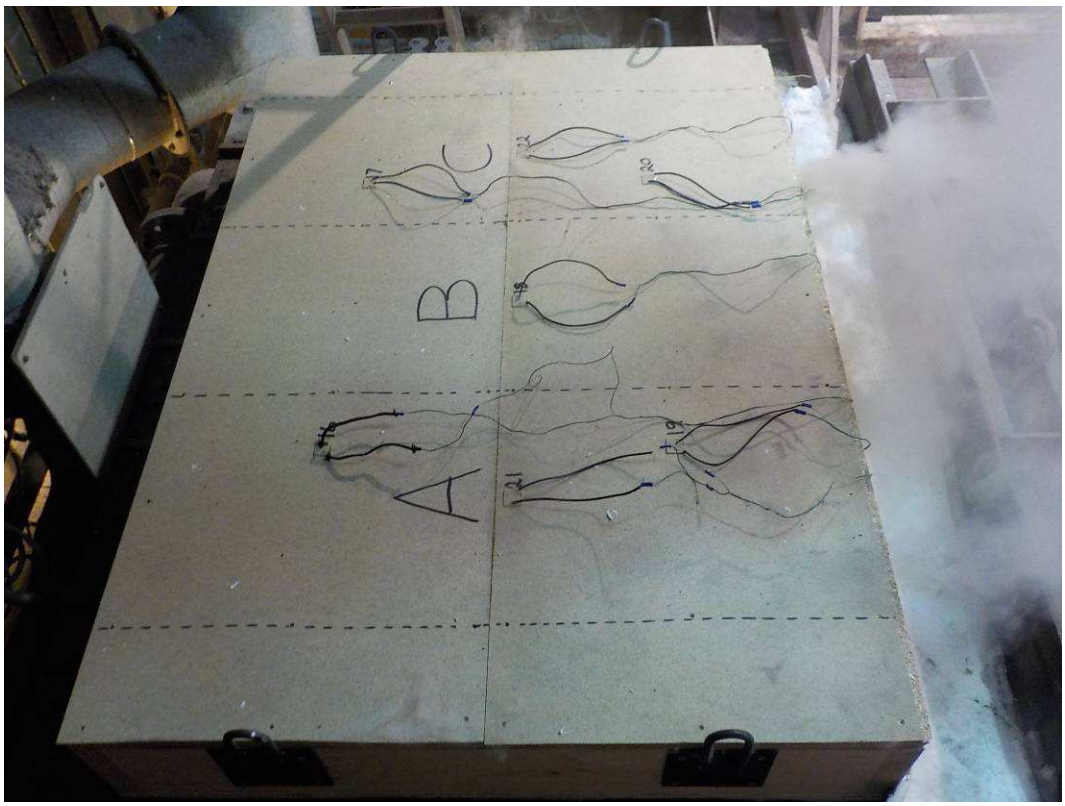


Photo 2.2.5 – Exposed face after 60 minutes.

Photo 2.2.6 – Unexposed face after 67 minutes.



Appendix 2.3 Post-test photos

Photo 2.3.1

APPENDIX 3 POSITIONING OF INSTRUMENTATION

Figure 3.1 – Unexposed face thermocouple positions:

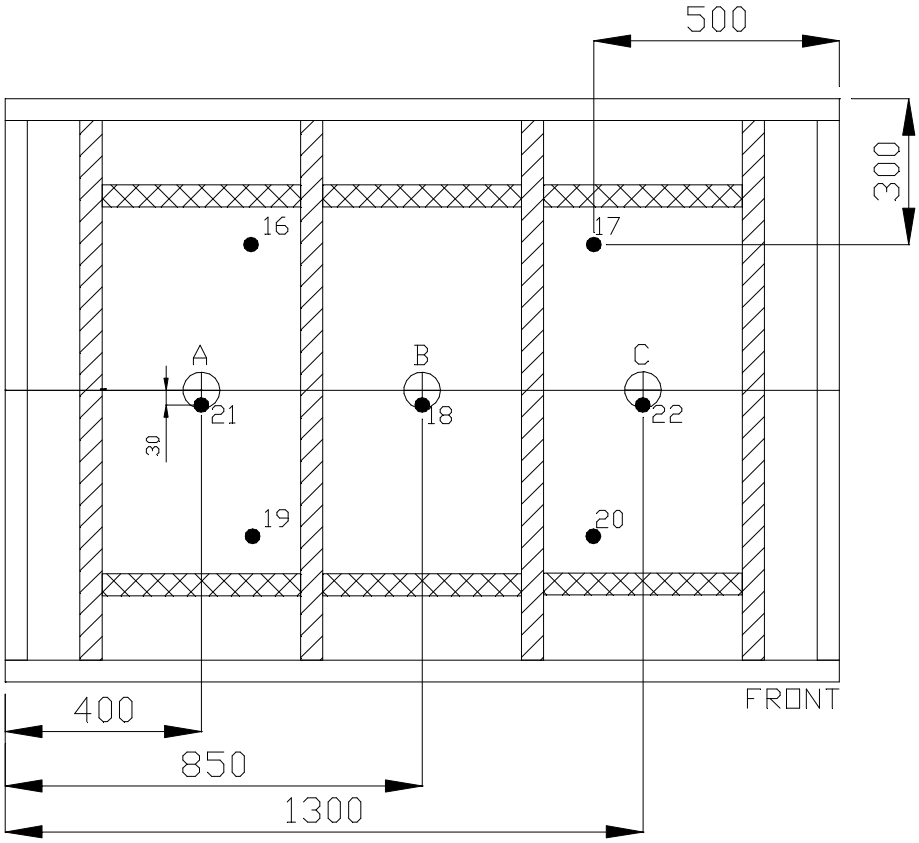
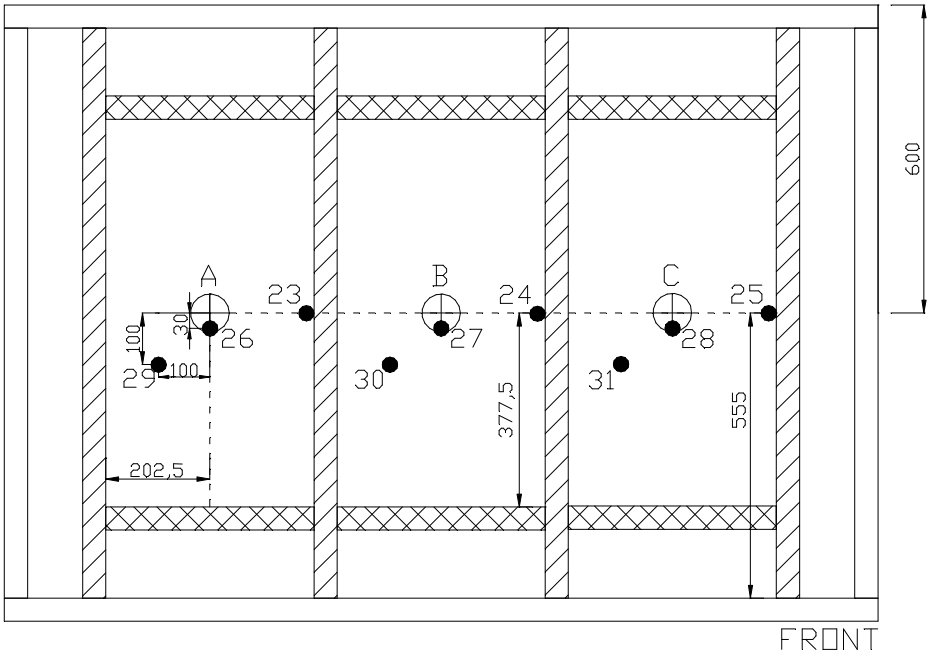


Figure 3.2 – Internal thermocouple positions:



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APPENDIX 4 RECORDED THERMOCOUPLE DATA

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
0	19	20	19	20	20	19	20	16
1	19	20	19	19	19	18	20	17
2	19	20	19	20	20	19	20	17
3	19	19	19	20	19	18	20	17
4	19	19	19	20	19	19	20	18
5	19	19	19	20	19	19	20	19
6	19	19	19	20	19	19	20	20
7	19	20	19	20	19	19	20	24
8	19	19	19	20	19	19	21	25
9	19	20	19	20	20	19	21	33
10	19	20	20	20	19	20	21	41
11	19	20	20	20	20	21	22	48
12	20	20	20	20	20	22	23	53
13	20	20	21	21	20	23	24	57
14	20	21	22	21	21	25	25	60
15	21	21	23	22	21	27	25	63
16	22	21	23	22	22	30	26	65
17	23	22	25	23	23	33	27	65
18	23	23	26	24	23	36	28	70
19	24	24	27	25	24	39	30	72
20	25	24	28	25	24	42	30	69
21	26	25	29	26	25	45	32	75
22	27	26	31	28	26	48	34	73
23	28	26	32	28	26	50	34	77
24	29	27	33	29	27	52	36	78
25	30	28	34	30	28	54	38	79
26	31	28	35	31	29	56	39	80
27	32	29	36	32	29	57	40	81
28	33	30	37	33	30	59	41	83
29	34	31	38	33	31	61	43	84
30	35	32	40	34	32	62	44	85

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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
31	35	32	41	35	32	63	46	87
32	36	33	42	36	33	64	47	88
33	37	34	43	37	34	65	49	90
34	38	35	44	38	35	66	50	91
35	38	35	45	38	35	67	51	91
36	39	36	46	39	36	68	52	93
37	40	37	47	40	37	69	54	93
38	41	37	48	41	37	69	54	94
39	41	38	49	41	38	70	55	94
40	42	39	50	42	38	70	56	95
41	42	39	51	42	39	71	57	96
42	43	40	51	43	39	71	58	96
43	43	40	52	43	40	72	59	96
44	43	40	53	43	40	71	60	96
45	44	41	53	44	41	72	61	97
46	44	42	54	45	42	72	63	97
47	45	42	55	45	42	73	64	98
48	45	43	57	45	43	72	65	99
49	46	43	59	46	44	72	67	101
50	46	44	60	46	44	73	69	103
51	47	44	63	46	45	73	71	106
52	47	45	65	47	46	74	73	108
53	47	45	66	47	48	74	75	111
54	48	46	69	48	51	75	77	119
55	48	47	70	48	54	75	78	129
56	48	49	72	48	58	76	80	139
57	49	52	74	49	63	76	81	149
58	49	55	76	50	67	77	82	159
59	50	58	78	51	71	78	83	169
60	52	62	79	54	75	79	84	178
61	53	65	80	56	78	79	84	187
62	56	69	81	60	81	80	85	195
63	59	72	82	64	83	81	86	203
64	64	77	82	68	85	82	87	210
65	67	81	83	73	86	82	87	219
66	72	84	84	76	87	83	88	228
67	76	87	85	81	88	84	88	240

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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	16	17	17	17	18	16	16	16
1	16	21	35	17	42	16	16	17
2	16	21	29	17	38	17	16	18
3	16	21	33	18	34	17	16	18
4	16	21	41	18	35	17	16	19
5	16	21	44	23	37	18	18	22
6	17	22	182	28	46	20	22	27
7	19	25	64	36	52	25	31	34
8	22	27	46	41	61	34	42	42
9	25	31	45	46	71	46	53	51
10	29	34	43	50	77	59	61	59
11	33	37	37	53	71	67	67	65
12	38	41	33	57	77	74	72	70
13	41	44	52	62	76	78	75	73
14	45	47	42	66	92	81	77	76
15	49	49	43	74	94	83	79	78
16	53	52	43	80	99	85	81	80
17	57	54	39	87	93	86	82	81
18	61	57	44	89	108	87	83	82
19	64	59	39	90	110	88	84	83
20	65	60	41	91	113	88	85	83
21	68	62	41	93	109	89	85	83
22	69	64	38	95	104	90	86	84
23	70	65	46	100	104	90	85	85
24	70	66	44	103	110	90	85	88
25	72	68	43	106	113	90	86	90
26	73	70	44	110	120	90	89	90
27	75	71	40	113	120	92	91	91
28	76	73	41	113	121	94	92	92
29	78	75	40	112	115	93	92	92
30	79	76	41	111	116	93	93	93

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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
31	81	78	44	111	119	95	93	93
32	81	79	45	113	121	94	94	95
33	82	80	47	111	116	96	94	95
34	83	81	44	114	117	96	95	96
35	83	82	43	114	119	98	95	98
36	84	83	41	116	128	98	96	99
37	84	84	40	115	133	99	96	101
38	85	86	41	117	133	102	96	104
39	86	86	45	115	136	105	96	108
40	86	87	44	115	144	107	98	112
41	87	88	47	117	144	109	100	117
42	87	89	47	117	149	110	101	121
43	88	90	44	118	151	111	103	126
44	88	90	47	135	163	112	106	135
45	90	91	43	161	173	113	110	160
46	92	92	45	162	184	115	115	207
47	93	94	47	167	197	116	119	257
48	94	96	47	169	216	116	123	303
49	94	99	47	173	233	117	129	337
50	94	109	45	183	244	119	140	362
51	95	118	44	202	256	122	178	382
52	95	129	45	222	266	126	246	377
53	96	140	47	236	280	136	299	368
54	98	152	45	247	289	171	335	375
55	99	162	46	258	297	239	365	384
56	100	172	46	267	311	297	386	390
57	125	183	45	278	320	340	401	401
58	151	193	46	287	330	368	412	409
59	169	202	47	298	344	388	423	418
60	185	213	48	312	351	403	432	425
61	202	222	47	323	361	413	437	434
62	216	235	48	336	377	423	444	441
63	230	249	47	349	397	430	450	448
64	245	263	47	370	414	436	447	459
65	272	280	47	419	430	441	454	469
66	304	299	48	473	457	446	478	481
67	442	320	49	760	479	453	*	497

* Thermocouple malfunction