TEST REPORT NUMBER CFR2001232

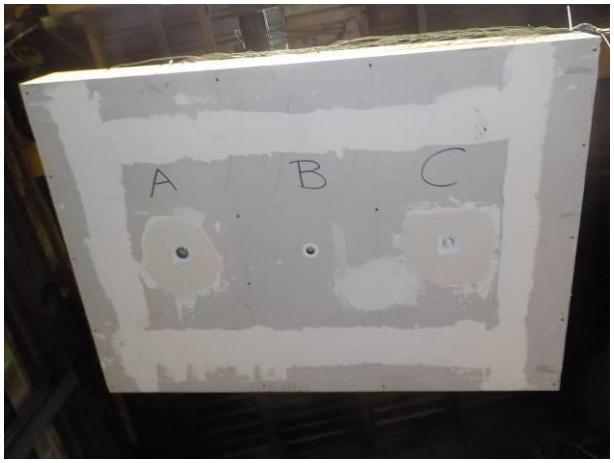
CAMBRIDGE FIRERESEARCH

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:	23rd January 2020

Results:

Test duration:	68 minutes (test discontinued at request of the sponsor)
Integrity	68 minutes (no failure, the test having been discontinued)
Insulation:	68 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: Andes plaster-in tilt downlight.
Downlight B: Atlas Mini tilt downlight.
Downlight C: Eiger plaster-in tilt downlight.
Ceiling size:
1700 long x 1200 wide x 247 deep

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1 PREPARATION FOR TESTING

1.1 Specimen conditioning

The specimen was received by Cambridge Fire Research on 09/01/2020. For the final 7 days that the specimen was on site the temperature and relative humidity were measured and recorded within the range of 7 to 18°C and 48 to 70% 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.

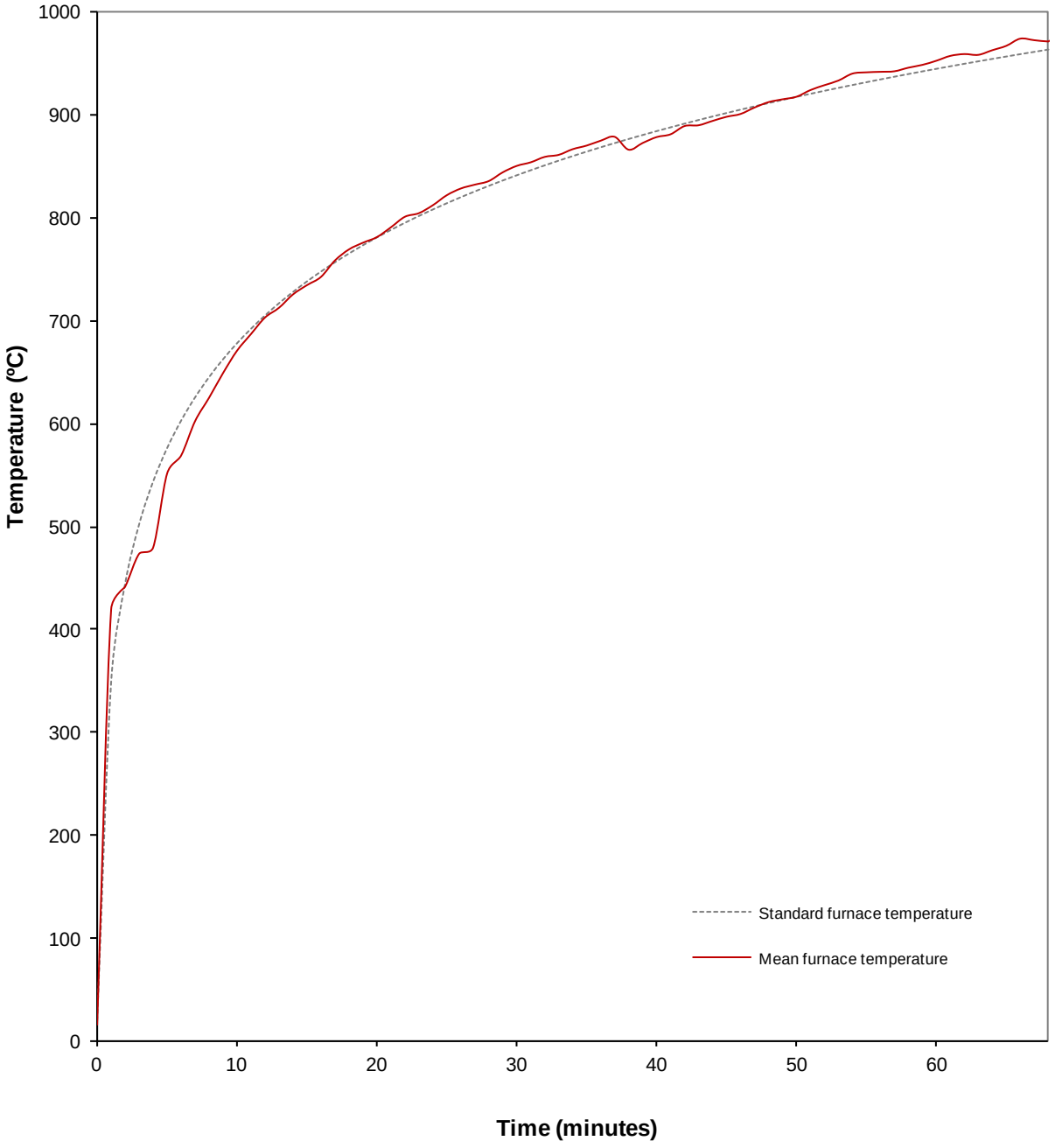
1.6 Specimen Selection

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

2 TEST CONDITIONS, INSTRUMENTATION AND MEASURING

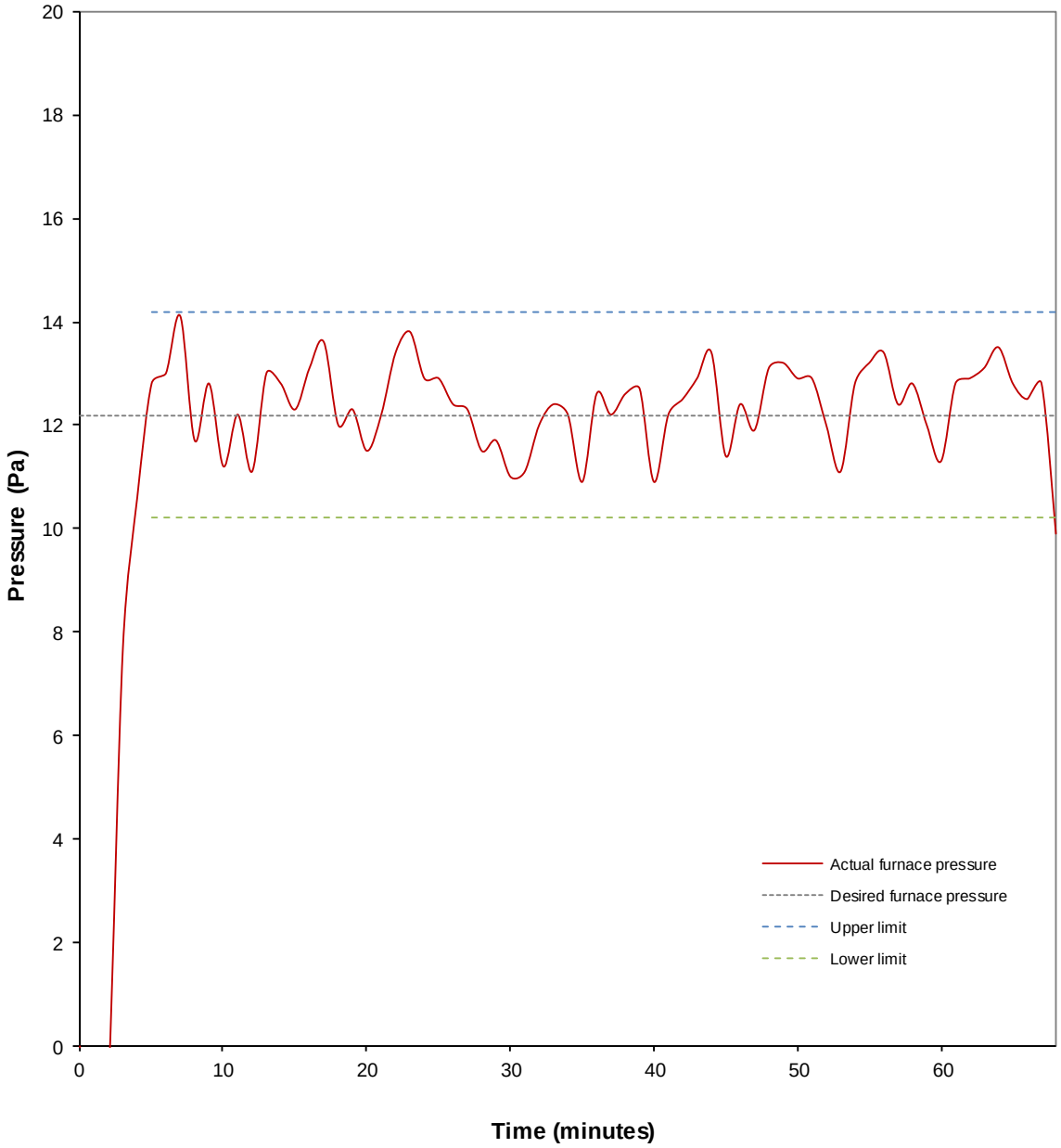
2.1 Furnace temperature

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 1 instantaneous occasion which was a transient event. 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 13°C.
Ambient temperature ranged from 13 °C to 14°C during the test.

2.4 Unexposed face specimen thermocouples

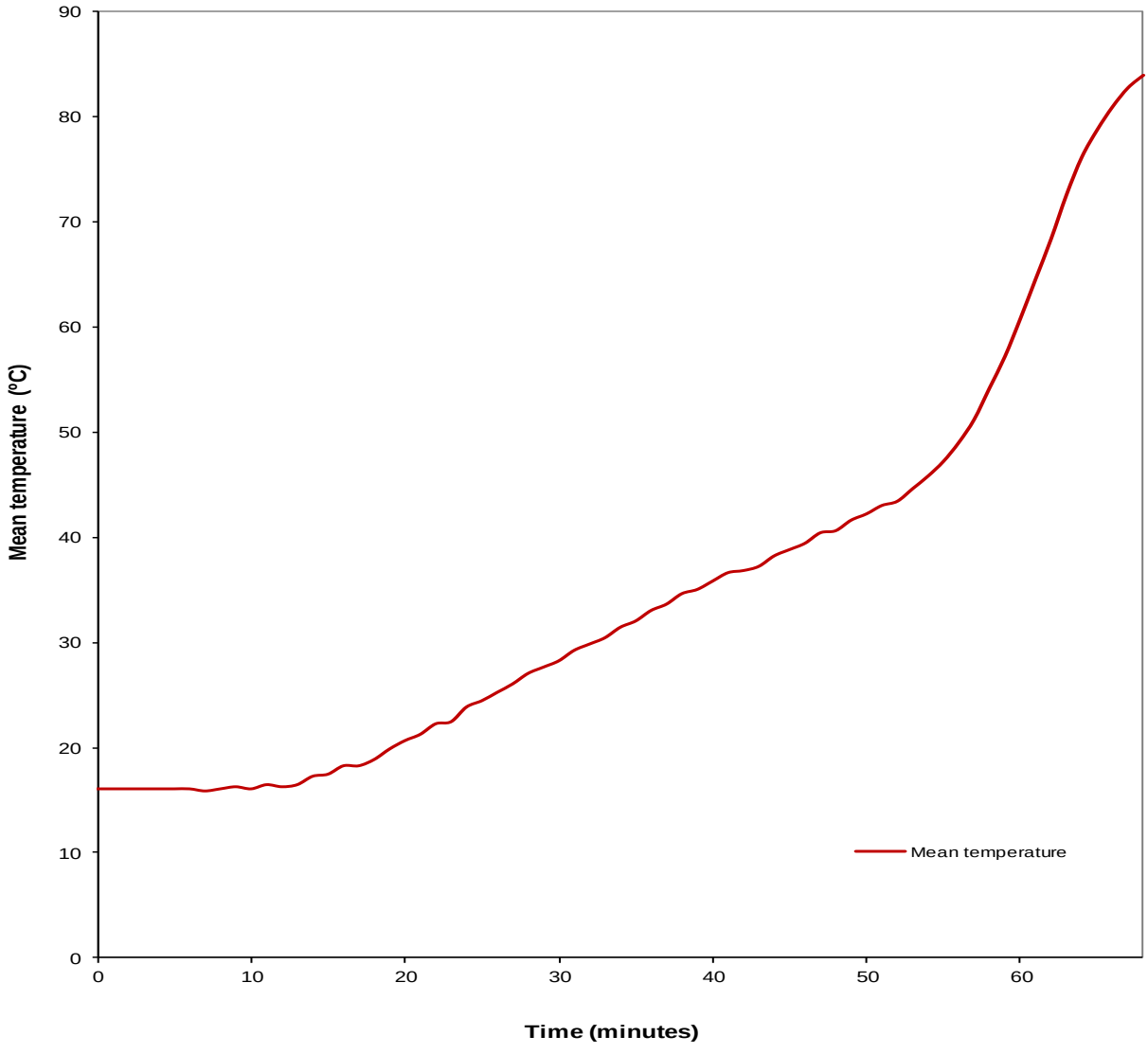
Surface temperature measuring thermocouples of the design specified in the test standard were affixed to the specimen to monitor the temperature rise as follows:

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.
04:17	E	Lens of downlight C melting.
09:28	E	Internal components of downlight C detach.
13:22	E	Lens and bulb of downlight C melt and detach.
25:31	E	Downlight C flange detaches with plaster skim.
36:16	E	Downlight A partially detaches.
37:32	E	Plasterboard outer layer of voids A and B detaches. Downlights A and B missing.
42:39	E	Plasterboard outer layer of void C partially detaches.
46:19	E	Plasterboard outer layer of void C detaches.
52:39	E	Plasterboard inner layer of void B cracks across full width.
55:57	E	Plasterboard inner layer of void A cracks across full width.
68:17		The test is 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
Senior Technical Officer

Report checked by:

D Jackson
Technical Officer

Report issued: **25th February 2020**

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:	British Gypsum
	Name:	Wallboard
	Description:	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.
	Overall size (l x w x t):	1700 x 1200 x 15 (2No layers)
2	**Floor**	
	Manufacturer:	Egger
	Name:	EGGER TG4 22mm
	Description:	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.
	Overall size (l x w x t):	1700 x 1200 x 22
	Density (kg/m^3):	620 *
3	**Ceiling Frame**	
	Supplier:	Cambridge Fire Research
	Species:	Spruce
	Density (kg/m^3):	450 *
	Description:	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.
	Overall size (l x w x h):	1700 x 1200 x 195
	Section size (w x h):	45 x 195 (noggin 45 x 45)

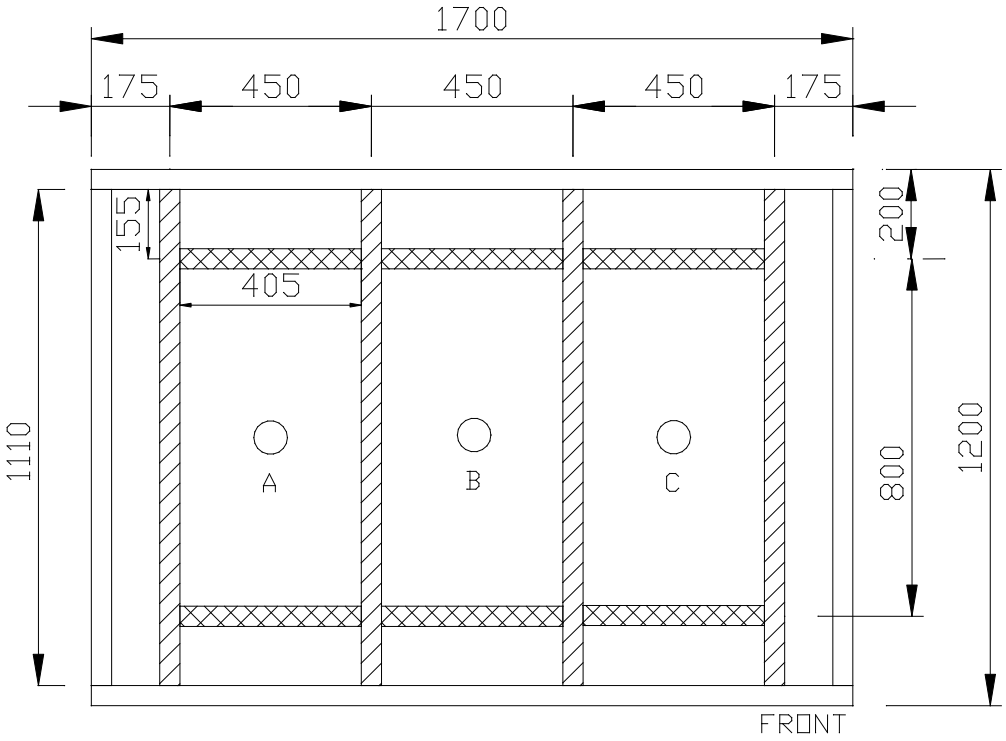
Item	Component	Information
4	**Downlight A**	
	Supplier:	Darklight Design
	Name:	Andes LED tilt plaster-in downlight
	Description:	An integrated LED downlight with die cast alloy heatsink painted black with an integral LED affixed using countersunk screws and a plastic clip on housing retaining the diffusing lens and reflector. A cast alloy body is attached to the heatsink with 4No. M2 x 23 socket cap screws. A silicon ring and o ring sit in recesses in the top of the body sealing against the heatsink. A cast alloy tilt ring with riveted spring clips is attached to the body with countersunk screws and has a glass lens retained with a steel circlip. The perforated steel plaster frame has a 17 high boss that retains the downlight spring clips and is affixed to the plasterboard with 2No. 32mm long drywall screws and gypsum based compound skim. A Ø1 steel retaining wire is attached to the heatsink and plaster frame. The downlight is fitted central to the void. A separate driver unit was not included in this test.
	Hole size:	80
	Weight (g)	455
	Overall size:	
	Downlight (Ø x h):	60 x 88 (Ø64 at tilt ring)
	Plaster frame (w x h):	128 square x 31
	Silicon ring (Ø x t):	ID 45 x 1.5
	Silicon ring (Ø x t):	OD 55, ID 45 x 2.5

Item	Component	Information
5	**Downlight B**	
	Supplier:	Darklight Design
	Name:	Atlas Mini LED tilt downlight
	Description:	An integrated LED downlight with die cast alloy heatsink painted black, with an integral LED, screw threaded into the cast alloy body. The body retains the diffusing lens and reflector. A silicon o ring sits in a recess in the top of the body sealing against the heatsink. A cast alloy tilt ring with spring clip retainers is attached to the body with countersunk screws and has a self adhesive external ring of graphite based intumescent above the bezel, the bezel has an elastomeric ring in contact with the underside of the ceiling. The downlight is fitted central to the void. A separate driver unit was not included in this test.
	Hole size (Ø):	47
	Weight (g)	100
	Overall size:	
	Downlight (Ø x h):	39 x 63 (Ø55 at tilt ring)
	Silicon O ring (Ø x t):	OD 32 x 1.5
	Intumescent disc (h x t):	8 x 1.3
	Bezel seal (Ø x t):	OD 52, ID 45 x 0.7

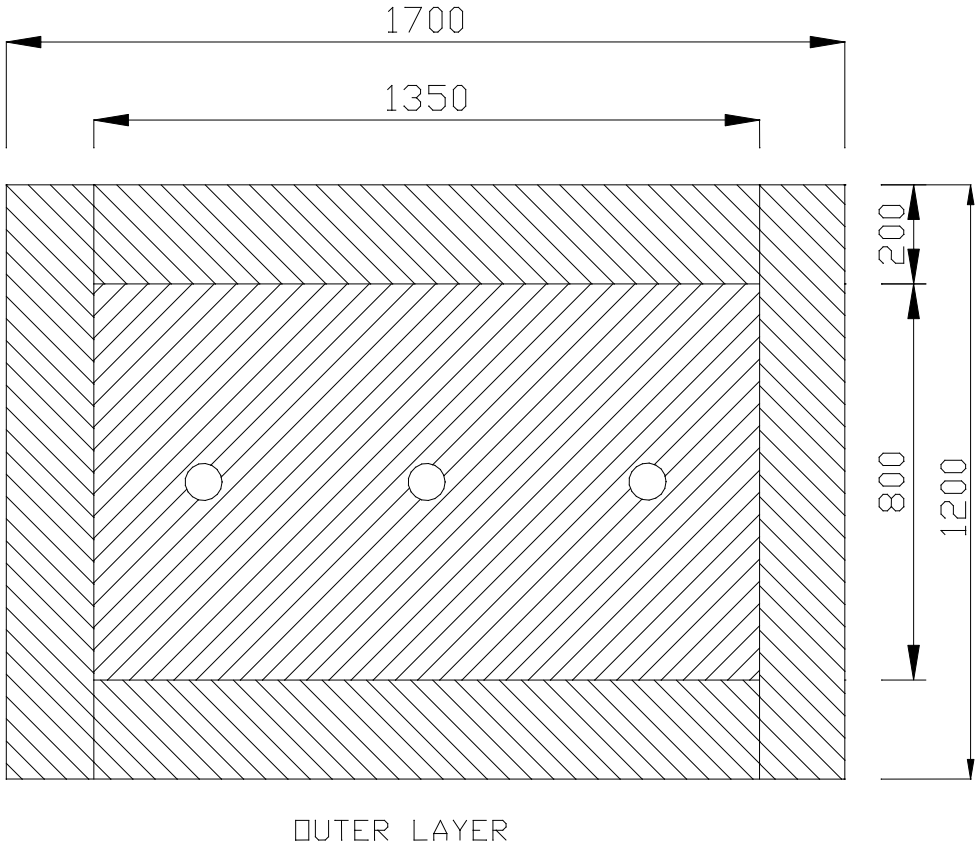
Item	Component	Information
6	**Downlight C**	
	Supplier:	Darklight Design
	Name:	Eiger LED tilt plaster-in downlight
	Description:	An integrated LED downlight with die cast alloy heatsink painted black with an integral LED affixed using countersunk screws and a plastic clip on diffusing lens and reflector. A cast alloy body is attached to the heatsink with 4No. M2 x 23 socket cap screws. A silicon ring sits in a recess in the top of the body sealing against the heatsink. A cast alloy tilt ring with riveted spring clips is attached to the body with countersunk screws. The perforated steel plaster frame has a 17 high boss that retains the downlight spring clips and is affixed to the plasterboard with 2No. 32mm long drywall screws and gypsum based compound skim. A Ø1 steel retaining wire is attached to the heatsink and plaster frame. The downlight is fitted central to the void. A separate driver unit was not included in this test.
	Hole size:	80 square
	Weight (g)	389
	Overall size:	
	Downlight (Ø x h):	60 x 85 (Ø68 at tilt ring)
	Plaster frame (w x h):	128 square x 31
	Silicon ring (Ø x t):	OD 55, ID 45 x 2.5

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

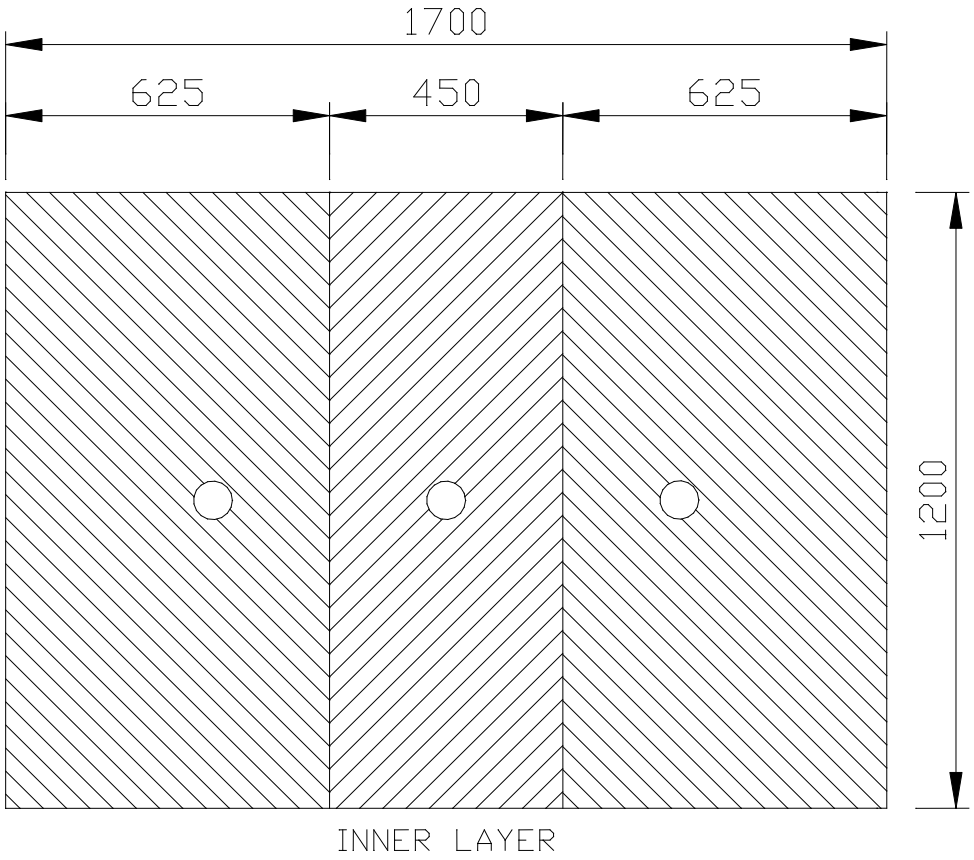
Appendix 1 Figure 1 – Section showing ceiling frame



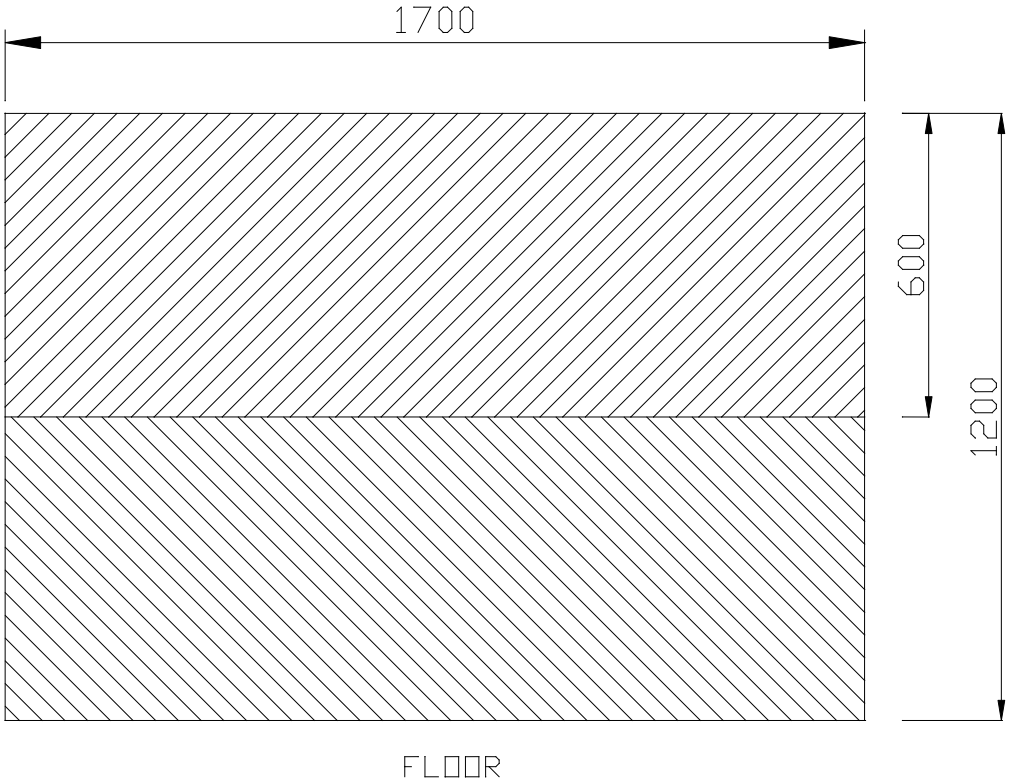
Appendix 1 Figure 2 – Ceiling membrane outer layer



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

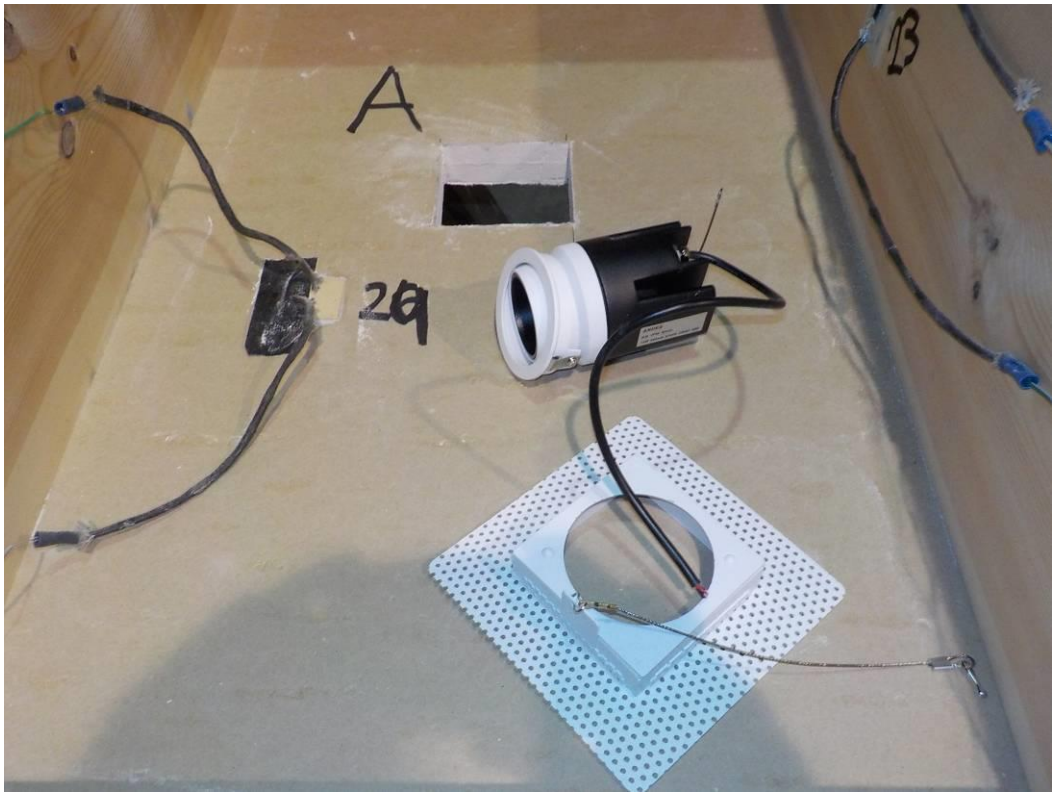


Photo 2.1.2 – Downlight A

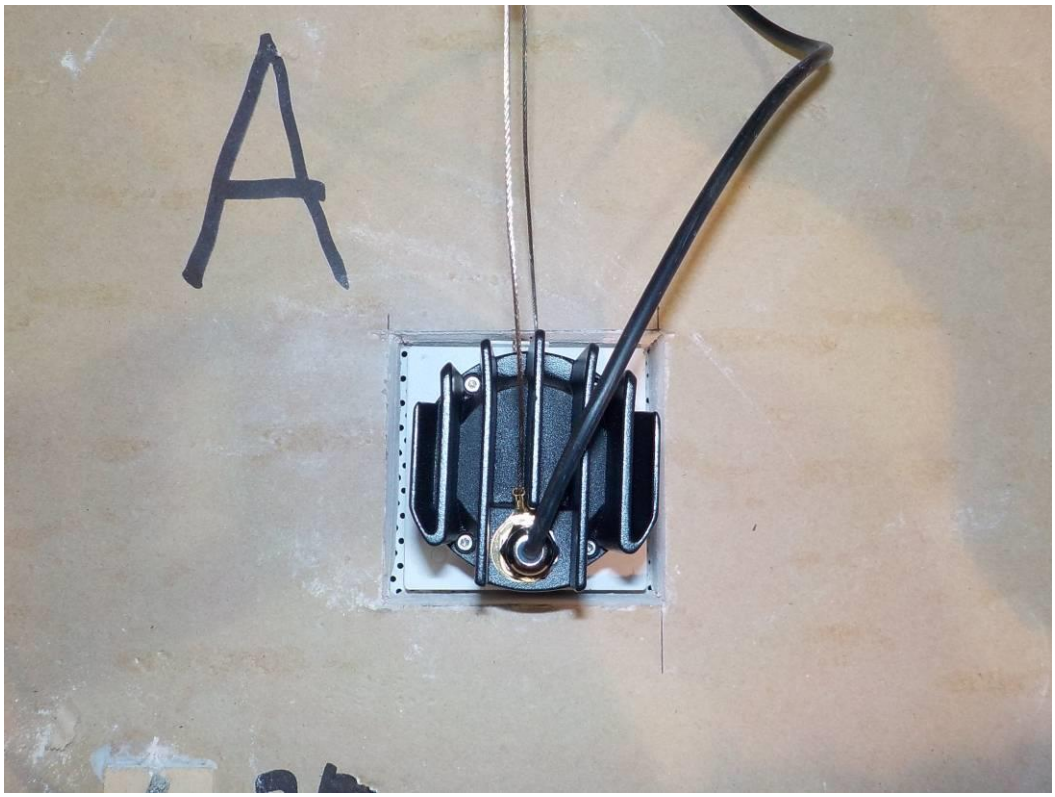


Photo 2.1.3 - Downlight A

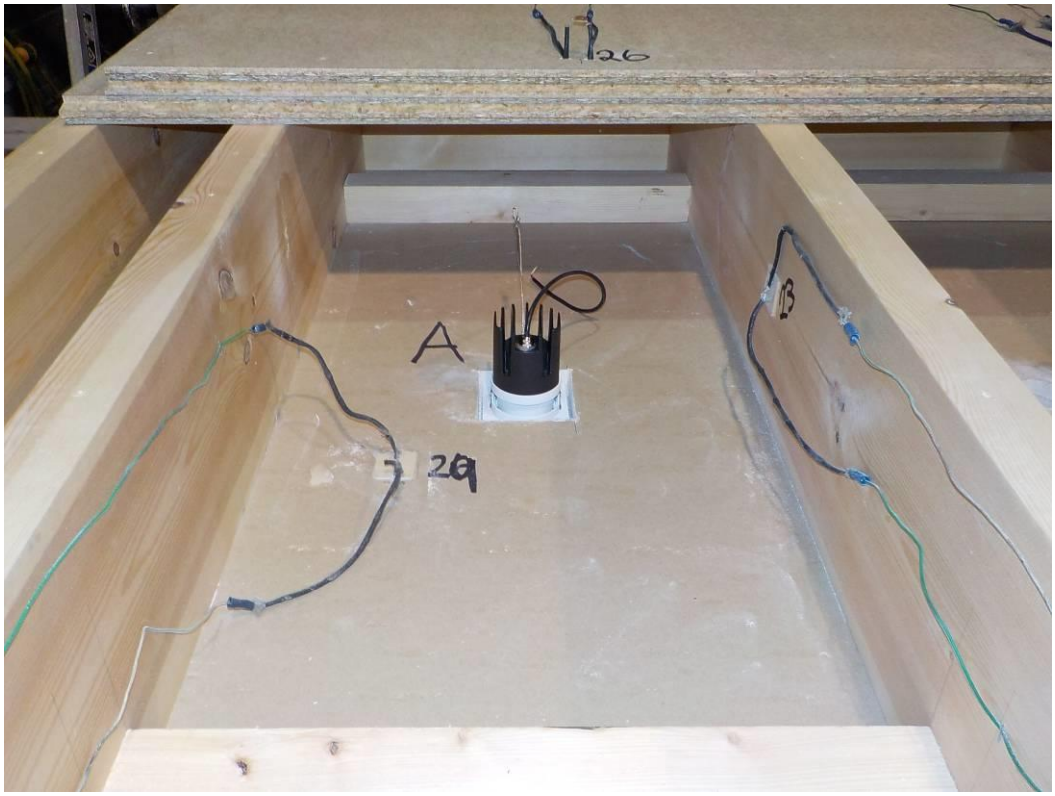


Photo 2.1.4 – Downlight B

Photo 2.1.5 – Downlight B

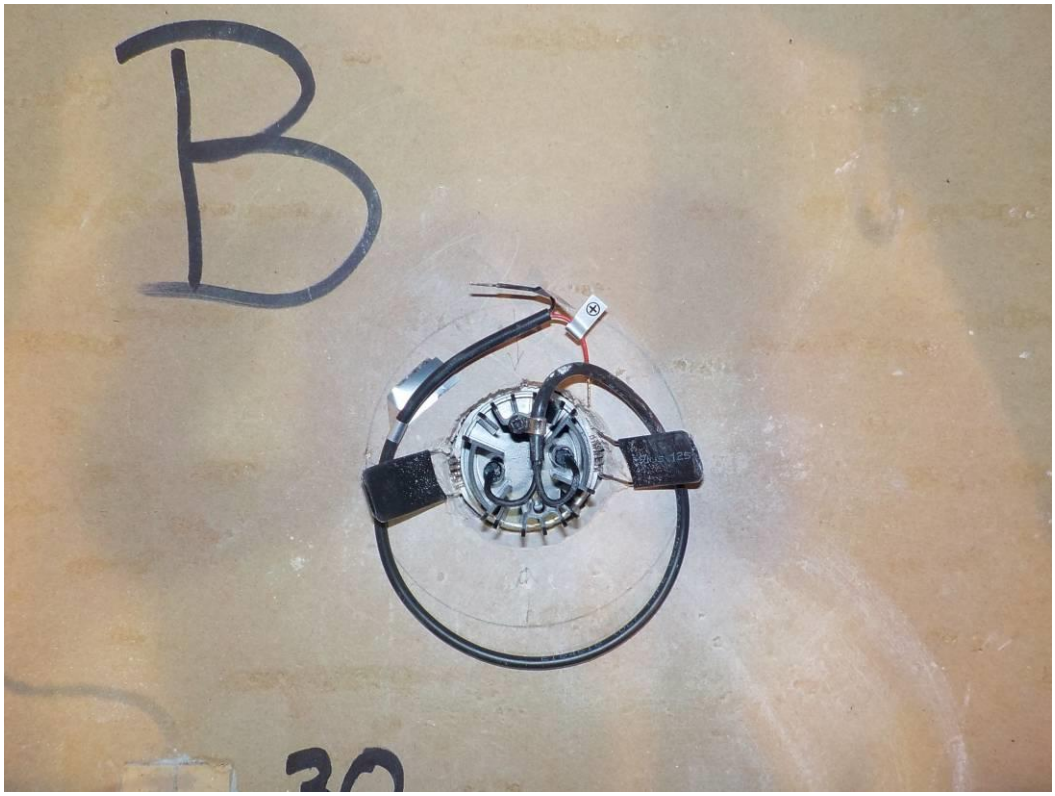


Photo 2.1.6 – Downlight B

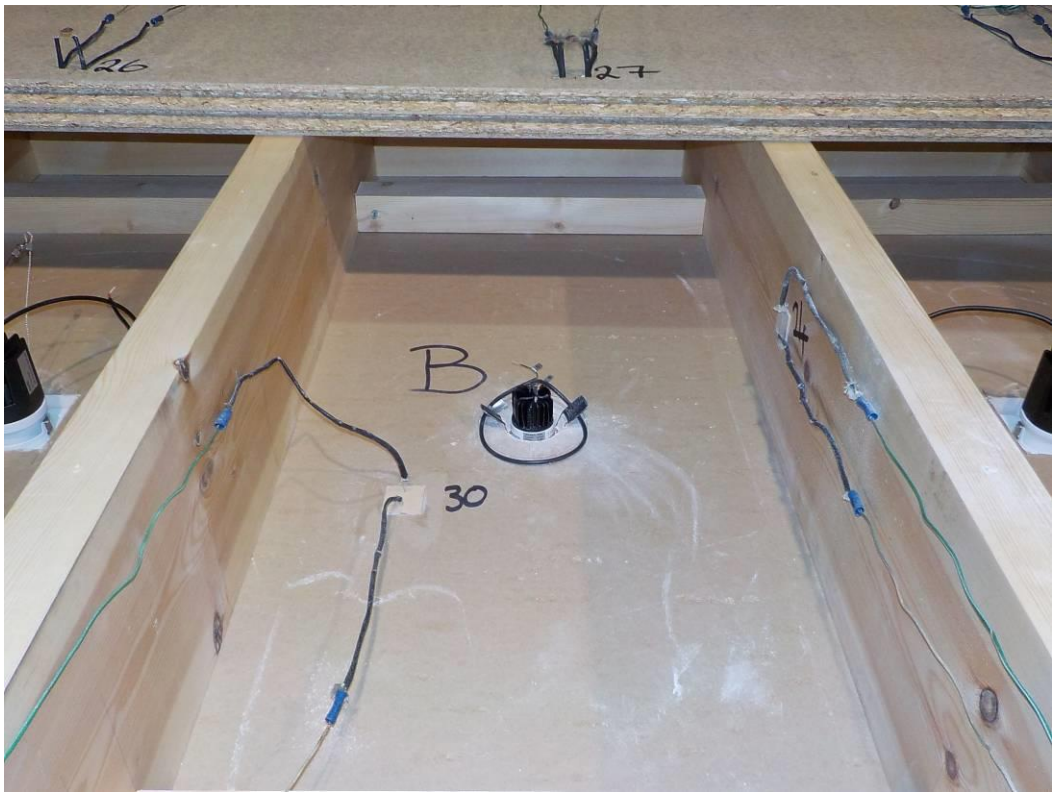


Photo 2.1.7 – Downlight C

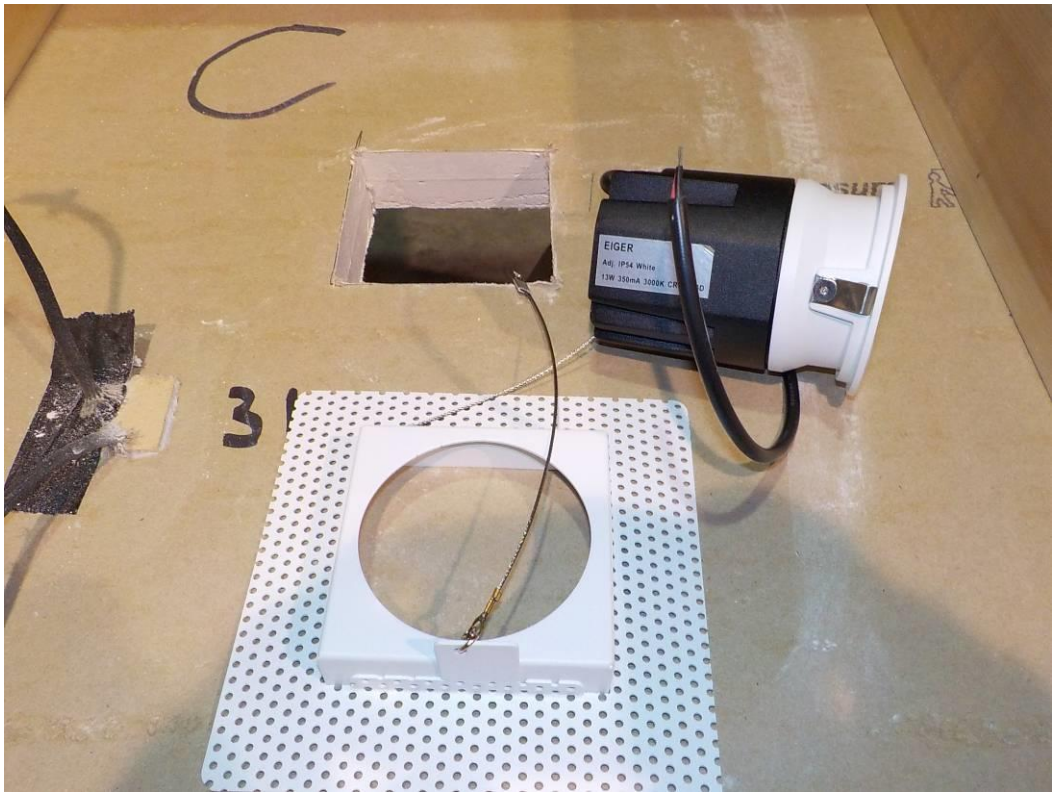


Photo 2.1.8 – Downlight C

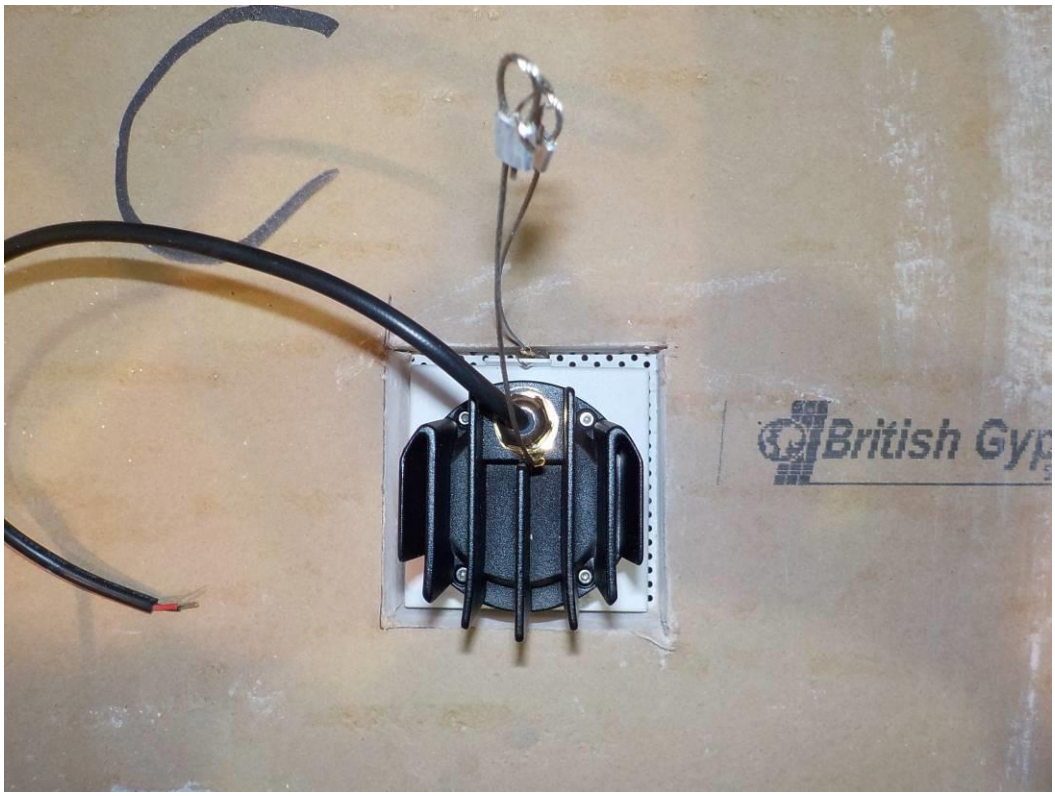


Photo 2.1.9 – Downlight C

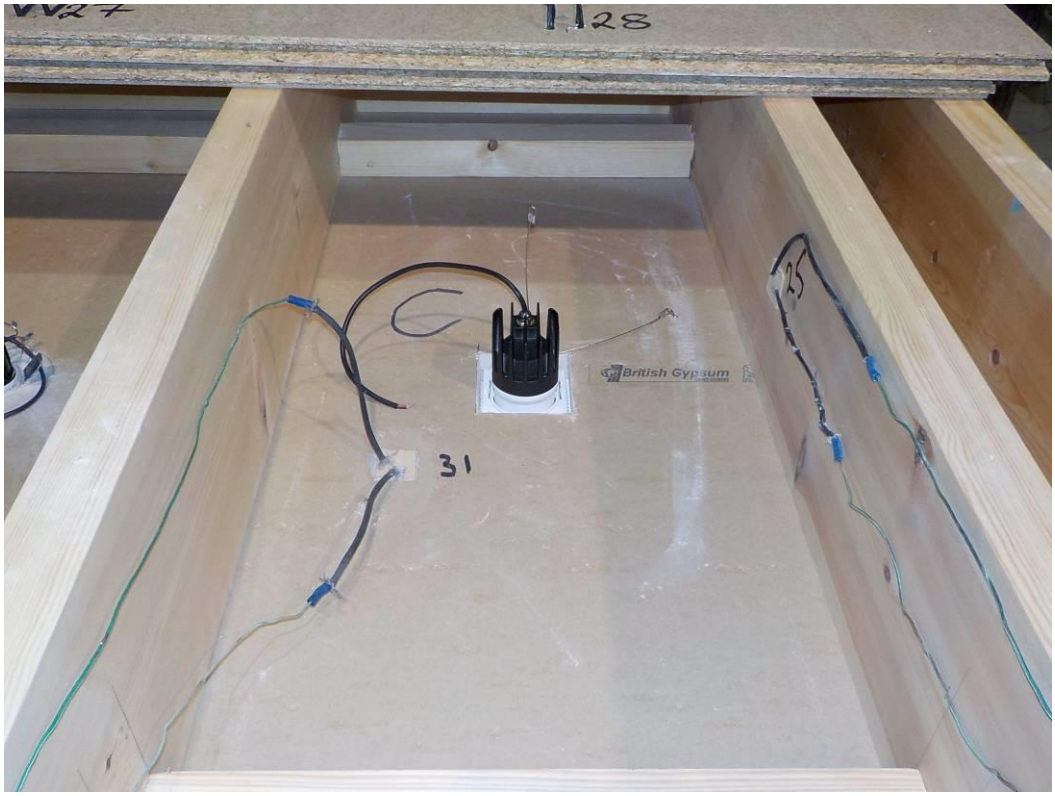


Photo 2.1.9 – Downlights A,B and C

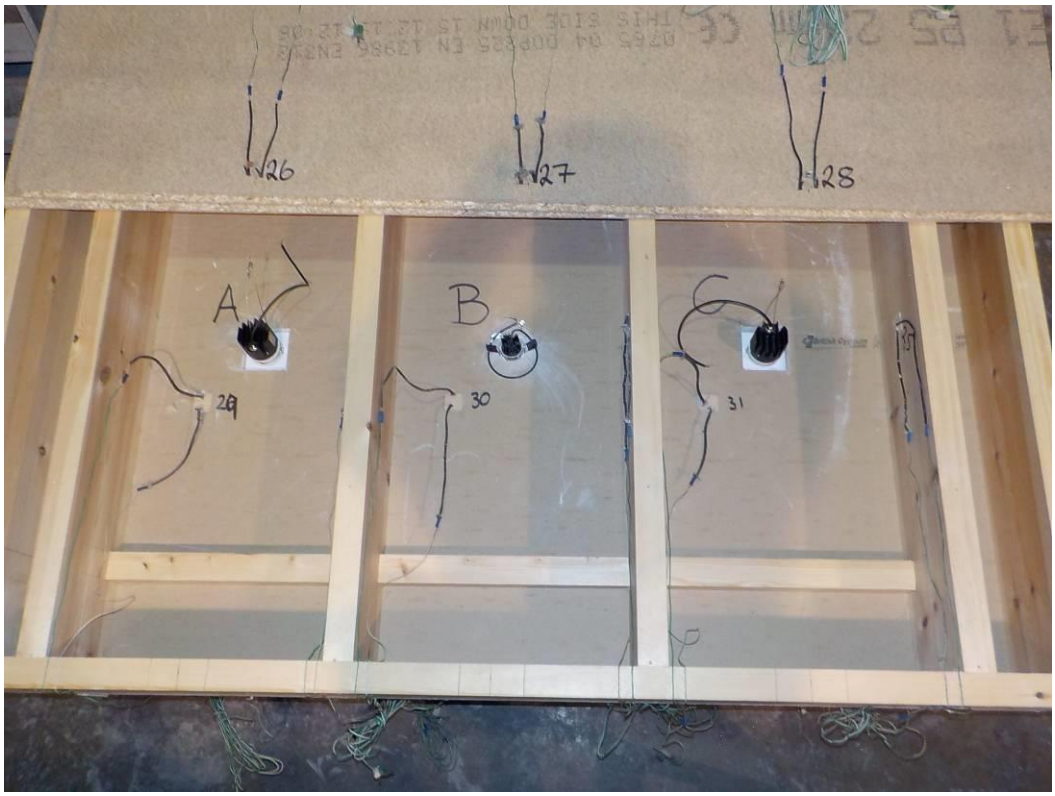
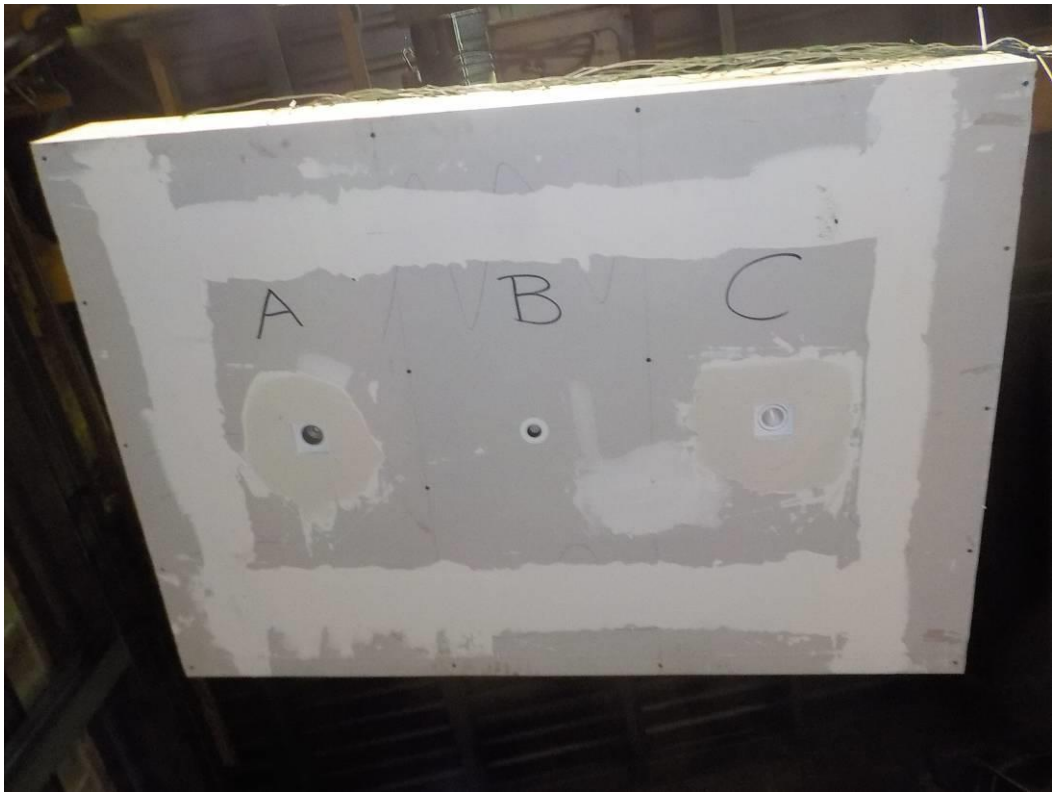


Photo 2.1.10 – exposed surface



Appendix 2.2 During test photos

Photo 2.2.1 – Unexposed face

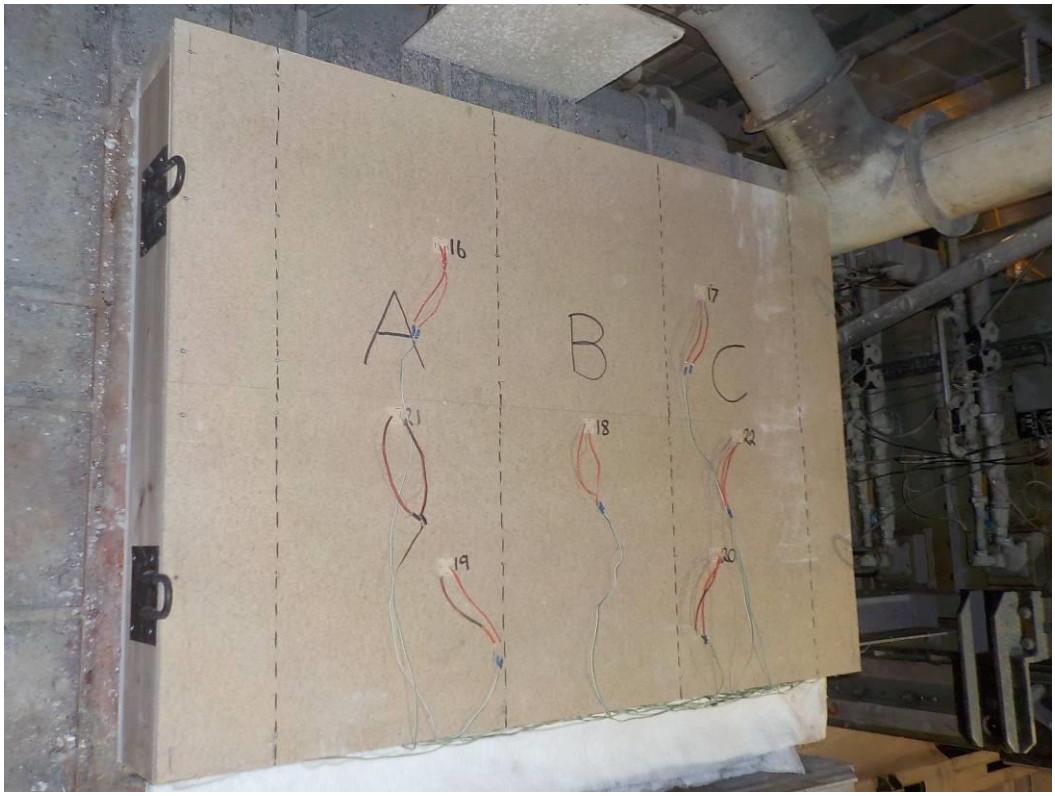


Photo 2.2.2 – Exposed face after 9 minutes.

Photo 2.2.3 – Exposed face after 33 minutes.

Photo 2.2.4 – Exposed face after 37 minutes.

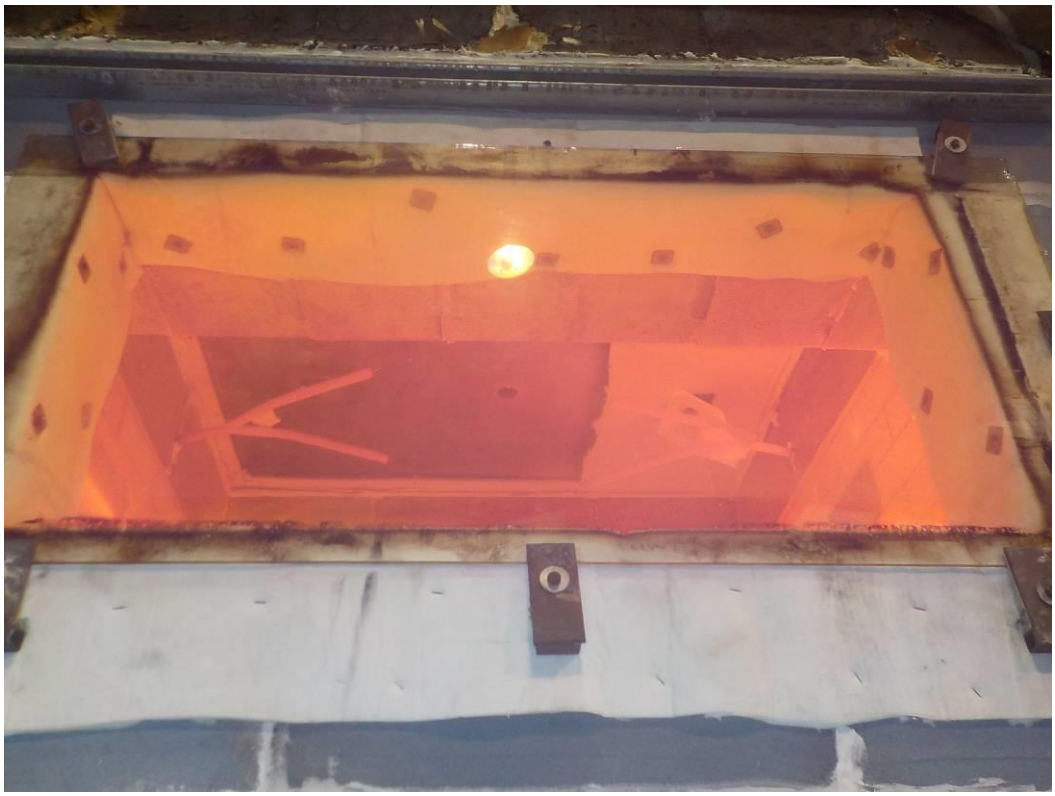
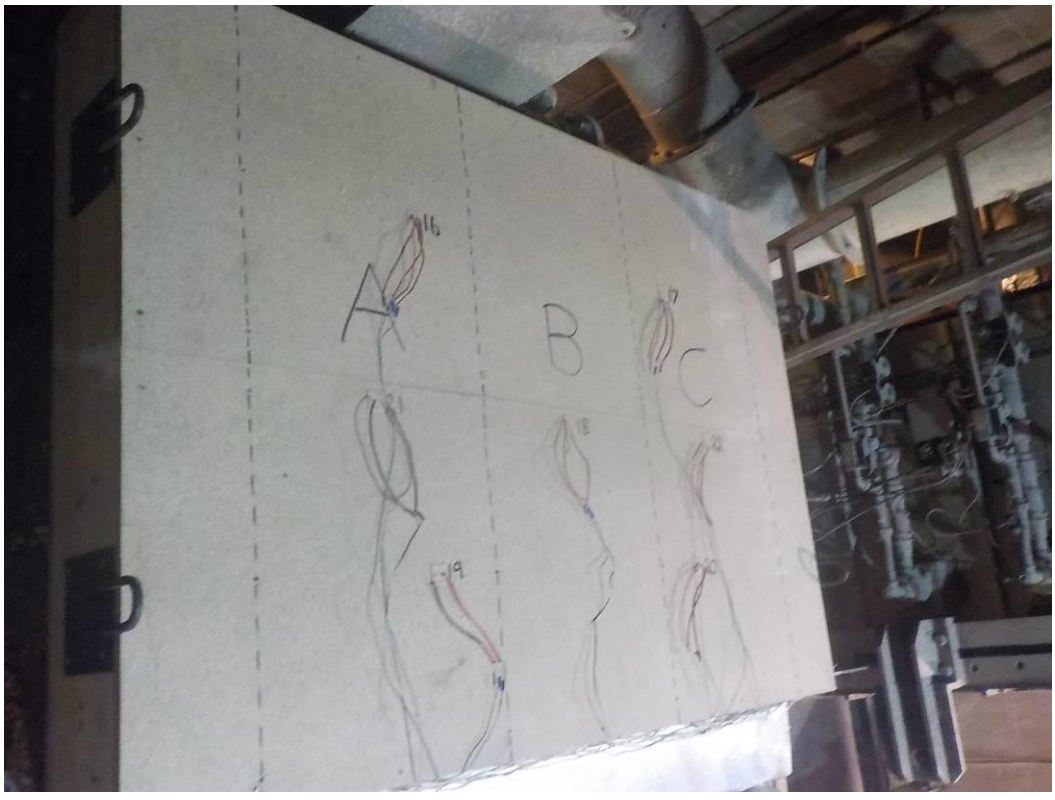


Photo 2.2.5 – Exposed face after 46 minutes.

Photo 2.2.6 – Unexposed face after 68 minutes.



Appendix 2.3 Post-test photos

Photo 2.3.1

APPENDIX 3 POSITIONING OF INSTRUMENTATION

Figure 3.1 – Unexposed face thermocouple positions:

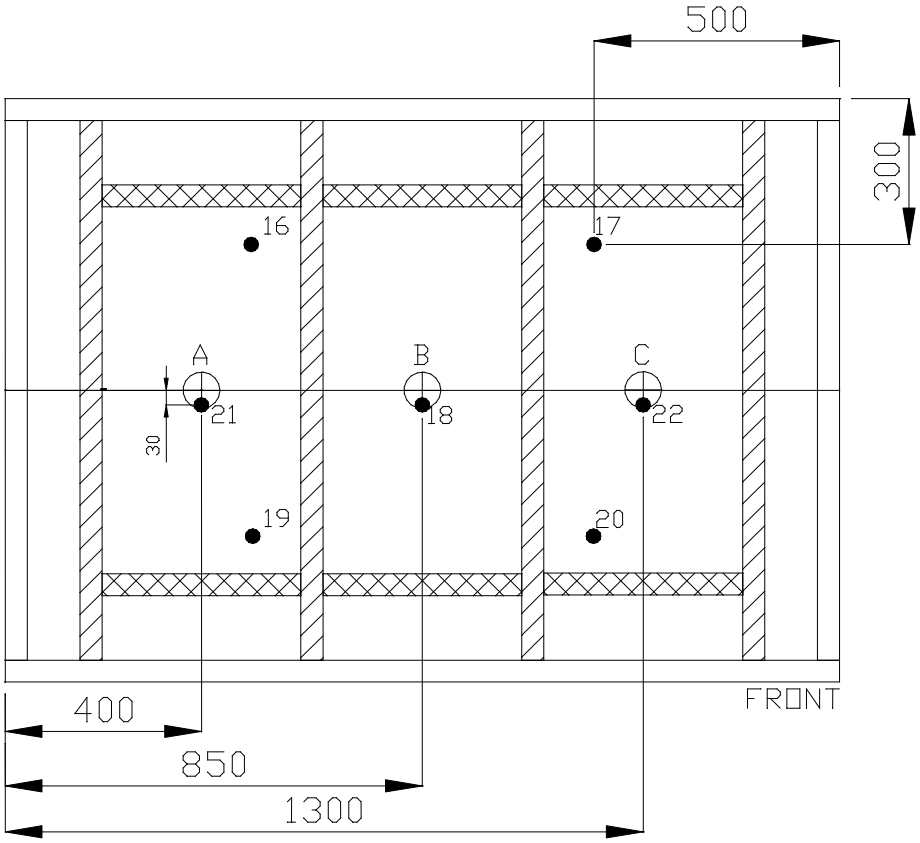
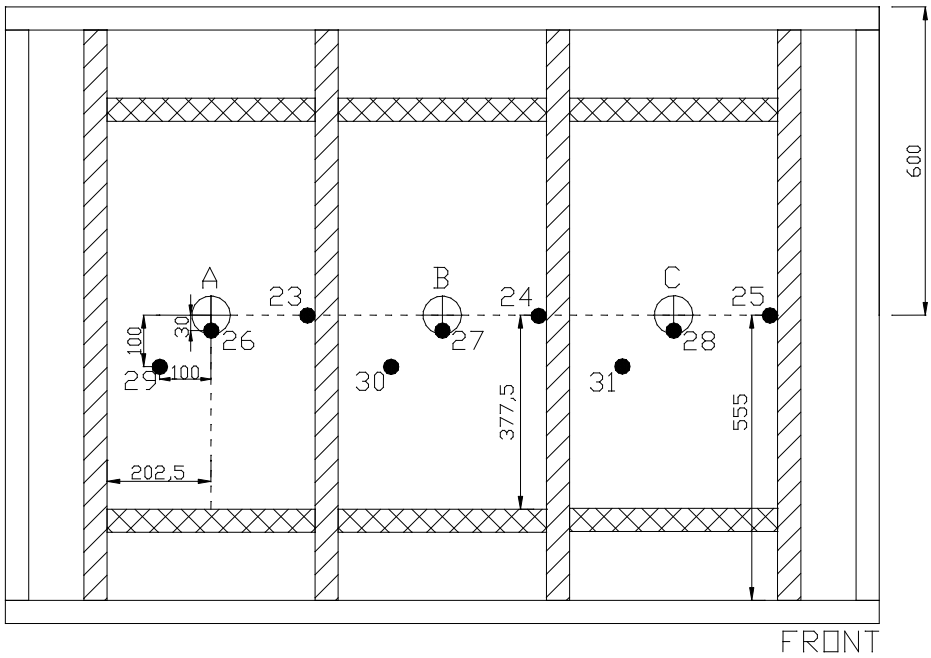


Figure 3.2 – Internal thermocouple positions:



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APPENDIX 4 RECORDED THERMOCOUPLE DATA

Time	T/C 16	T/C 17	T/C 18	T/C 19	T/C 20	T/C 21	T/C 22	T/C 23	T/C 24	T/C 25	T/C 26	T/C 27	T/C 28	T/C 29	T/C 30	T/C 31
min	˚C	˚C	˚C	˚C	˚C	˚C	˚C	˚C	˚C	˚C	˚C	˚C	˚C	˚C	˚C	˚C
0	16	16	16	16	16	16	16	15	16	15	16	16	16	15	15	15
1	16	16	16	16	16	16	16	15	16	16	20	17	18	15	16	15
2	16	16	16	16	16	16	16	15	16	16	22	19	22	15	15	15
3	16	16	16	16	16	16	16	16	16	17	28	21	25	15	16	15
4	16	16	16	16	16	16	16	17	16	17	32	22	29	16	17	16
5	16	16	16	16	16	16	16	18	16	18	36	27	31	18	20	18
6	16	16	16	16	16	16	16	19	16	20	39	30	35	22	25	23
7	15	16	16	16	16	16	16	20	17	21	48	36	44	28	32	32
8	16	16	16	16	16	16	16	22	17	24	59	42	52	37	40	43
9	16	16	17	16	16	16	16	25	17	28	68	47	58	46	47	52
10	16	16	16	16	16	17	16	28	18	32	73	50	63	55	55	60
11	16	16	17	17	16	17	17	32	18	37	74	53	63	63	62	67
12	16	16	17	16	16	17	17	36	18	41	76	57	68	69	67	71
13	16	16	17	17	16	19	18	40	19	45	83	62	72	74	71	75
14	17	17	18	17	17	19	19	44	19	50	92	63	82	78	74	77
15	17	17	19	17	17	20	20	48	20	54	98	64	88	80	76	80
16	17	18	20	18	18	21	22	52	21	57	99	64	91	83	78	82
17	17	18	20	18	18	22	23	54	21	59	94	67	93	84	79	83
18	18	18	21	19	18	24	24	57	22	61	99	71	96	85	79	84
19	19	19	22	20	19	25	25	59	22	63	103	77	98	85	80	84
20	20	20	23	20	20	26	27	61	22	64	110	79	99	86	81	85
21	20	20	24	21	21	27	28	63	23	66	121	82	101	86	81	85
22	21	21	25	22	22	28	29	64	23	67	140	86	102	87	82	86
23	21	21	26	22	22	29	30	65	22	68	148	85	104	87	82	86
24	22	23	27	24	23	31	32	67	23	69	171	88	108	87	83	86
25	23	23	28	24	24	32	33	68	23	70	146	93	110	87	86	87
26	24	24	29	25	24	34	34	69	24	72	134	96	143	88	88	89
27	24	25	30	26	25	35	35	70	24	73	157	95	164	90	89	91
28	25	26	31	27	26	36	37	72	25	74	166	99	164	92	90	92
29	26	26	32	27	27	37	37	73	26	76	176	101	164	92	91	93
30	26	27	33	28	27	39	39	74	27	76	162	100	169	93	92	93
31	27	28	34	29	28	40	41	75	27	78	167	101	173	94	93	90
32	28	28	35	29	29	41	43	76	27	79	154	98	171	94	93	86
33	28	29	36	30	29	42	45	77	28	79	216	99	174	95	94	97
34	29	30	37	31	30	43	47	78	29	82	169	104	178	95	94	94
35	30	30	38	31	31	44	50	79	30	80	188	107	182	96	95	129
36	31	31	39	32	32	46	52	80	30	82	144	110	183	96	96	105
37	31	32	40	33	32	47	54	81	29	84	137	110	185	97	96	92
38	32	33	41	34	33	48	56	84	29	85	183	118	197	98	97	105
39	33	33	42	34	33	49	58	87	30	86	180	116	199	100	99	90
40	33	34	43	35	34	50	59	89	29	87	228	119	201	101	101	100
41	34	35	44	35	35	51	61	90	30	88	199	123	200	103	103	100
42	34	35	44	36	35	53	62	91	30	88	199	121	204	106	106	95
43	34	35	45	36	36	54	64	92	29	89	194	123	208	111	112	100
44	35	36	47	37	36	56	65	93	30	90	221	125	210	119	119	103
45	35	37	48	37	37	58	66	93	30	91	216	127	217	125	126	108
46	36	37	49	38	37	60	67	94	30	92	193	136	216	129	134	116
47	37	38	50	39	38	61	68	95	30	96	216	155	204	137	157	117
48	37	38	51	39	38	63	69	96	30	100	210	170	207	160	205	117
49	38	38	53	40	39	64	69	102	30	104	216	192	209	211	255	122

Time	T/C 16	T/C 17	T/C 18	T/C 19	T/C 20	T/C 21	T/C 22	T/C 23	T/C 24	T/C 25	T/C 26	T/C 27	T/C 28	T/C 29	T/C 30	T/C 31
min	˚C	˚C	˚C	˚C	˚C	˚C	˚C	˚C	˚C	˚C	˚C	˚C	˚C	˚C	˚C	˚C
50	38	39	54	40	40	65	70	111	30	108	238	197	216	267	302	123
51	39	39	56	41	40	67	71	120	30	113	253	207	234	310	328	133
52	39	40	57	41	40	69	71	130	29	120	251	219	258	339	344	167
53	40	40	60	42	41	71	72	140	30	130	274	229	279	359	361	239
54	41	41	62	43	42	73	73	149	29	143	280	237	285	373	374	306
55	42	42	64	45	43	75	74	159	30	157	287	246	301	385	387	352
56	44	43	66	47	45	76	75	169	30	170	298	259	315	394	396	383
57	46	45	68	50	47	77	76	178	30	182	300	269	332	402	403	405
58	49	48	70	53	51	78	77	188	31	195	312	273	346	409	409	421
59	53	51	71	57	54	79	78	198	31	206	325	286	355	415	415	433
60	56	55	73	61	59	79	78	207	32	219	330	295	366	421	387	444
61	60	60	75	65	63	79	79	217	33	230	335	322	375	426	392	453
62	64	65	76	69	68	80	80	226	34	241	342	346	379	431	402	460
63	67	71	78	74	73	80	81	235	35	251	351	370	385	435	415	465
64	71	76	80	77	77	80	81	244	36	260	351	394	388	439	428	471
65	73	79	81	81	80	81	82	253	36	269	356	421	394	443	444	477
66	77	82	82	82	82	81	83	260	37	277	358	443	399	446	459	481
67	79	84	83	84	84	81	83	269	38	285	357	468	399	448	474	485
68	81	86	83	85	85	82	84	276	38	292	361	506	403	450	492	489

* Thermocouple malfunction