

Title:

The Fire Resistance Performance Of A Loadbearing Timber Floor Assembly Protected by a Plasterboard Ceiling And Incorporating Down Light Assemblies, When Tested in Accordance with BS 476: Part 21: 1987, Clause 7

Date of Test:

15th April 2020

Issue 1:

29th April 2020

WF Report No.

426806



Prepared for:

Collingwood Lighting Ltd

Brooklands House
Sywell Airport
Business Park,
Wellingborough Road,
Sywell
Northampton
Northamptonshire
NN6 0BN



0249

Test Specimen

Summary of Tested Specimen

The timber floor had overall nominal dimensions of 4290 mm long by 2980 mm wide and comprised engineered I-joists, 4200 mm long, at nominally 600 mm centres. The depth of the joists was 220 mm.

The upper surface of the floor comprised nominally 22 mm thick tongue and groove chipboard flooring nailed and glued to the top chord of the joists.

The floor assembly was protected on its underside by a direct fixed ceiling, formed from a single layer of 15 mm thick Type A British Gypsum 'Wallboard'. The ceiling boards were screw fixed to the soffit of the joists. The joints were covered with scrim tape and skimmed with Gyproc Joint Compound.

The ceiling incorporated eight no. 'Collingwood Lighting Ltd' down light fittings, referenced as follows:

Test Ref.	Model Ref.	Description
A1-A4	H2 Pro 550 (DLE472XXXX)	Fixed LED downlight fitted with H2 bezel
B1-B4	Newlec 400 (NLFRDLX)	Fixed LED downlight fitted with H2 bezel

X refers to various LED and lens variants.

The floor supported a uniformly distributed load of 110 kg/m². This load was provided by the test sponsor as to represent the expected working load for the floor construction in practice.

Detailed drawings of the test specimen(s) and a comprehensive description of the test construction based on a detailed survey of the specimen(s) and information supplied by the sponsor of the test are included in the Test Specimen and Schedule of Components sections of this report.

Performance Criteria and Test Results

Loadbearing Capacity	<p>The specimen is deemed to have failed if it's no longer able to support the test load. This is taken to be when either the maximum allowable deflection or rate of deflection is exceeded.</p> <table border="1" data-bbox="512 434 1385 685"> <thead> <tr> <th>Criteria</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>(L) Length of clear span, <i>in mm</i></td> <td>4100</td> </tr> <tr> <td>(d)Depth of Structural Section, <i>in mm</i></td> <td>220</td> </tr> <tr> <td>Max Deflection (L/20) - <i>in mm</i></td> <td>205</td> </tr> <tr> <td>Rate (L² / 9000d) - <i>in mm</i></td> <td>8.5</td> </tr> <tr> <td>Rate is not applicable until (L/30) is exceeded - <i>in mm</i></td> <td>136.7</td> </tr> </tbody> </table> <p>The specimen satisfied this requirement for the 31-minute duration of the test.</p>	Criteria	Value	(L) Length of clear span, <i>in mm</i>	4100	(d)Depth of Structural Section, <i>in mm</i>	220	Max Deflection (L/20) - <i>in mm</i>	205	Rate (L ² / 9000d) - <i>in mm</i>	8.5	Rate is not applicable until (L/30) is exceeded - <i>in mm</i>	136.7
Criteria	Value												
(L) Length of clear span, <i>in mm</i>	4100												
(d)Depth of Structural Section, <i>in mm</i>	220												
Max Deflection (L/20) - <i>in mm</i>	205												
Rate (L ² / 9000d) - <i>in mm</i>	8.5												
Rate is not applicable until (L/30) is exceeded - <i>in mm</i>	136.7												
Integrity	It is required that there is no collapse of the specimen, no sustained flaming on the unexposed surface and no loss of impermeability.												
Integrity Result	<p>31 minutes</p> <p>No failure*</p>												
Insulation	Insulation: It is required that the mean temperature rise of the unexposed surface shall not be greater than 140°C and that the maximum temperature rise shall not be greater than 180°C. Insulation failure also occurs simultaneously with integrity failure												
Insulation Result	<p>31 minutes</p> <p>No failure*</p>												

*Test duration. The test was discontinued after a period of 31 minutes for safety reasons.

Date of Test 15th April 2020

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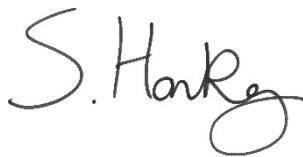
Signatories



Responsible Officer
C. Sweeney*
Technical Officer



Approved
W. Drazkiewicz*
Technical Manager – Fire Resistance



Head of Department
S. Hankey*
Business Unit Head – Fire Resistance

* For and on behalf of **Warringtonfire**.

Report Issued: 29th April 2020

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Revision History

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Reason for Revision:	

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CONTENTS**PAGE NO.**

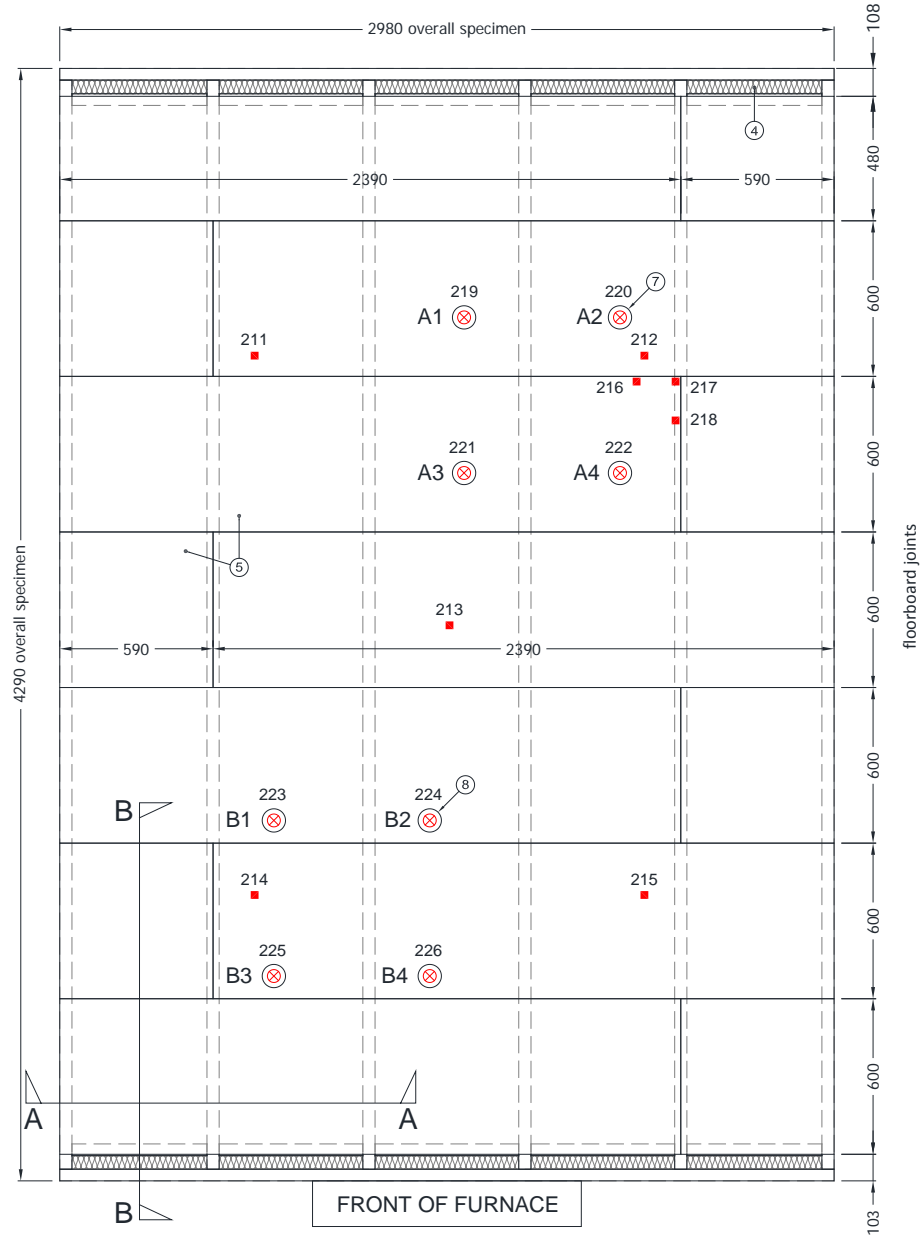
TEST SPECIMEN	2
PERFORMANCE CRITERIA AND TEST RESULTS.....	3
SIGNATORIES.....	4
REVISION HISTORY	5
TEST CONDITIONS.....	7
TEST SPECIMEN	8
SCHEDULE OF COMPONENTS.....	14
TEST OBSERVATIONS	17
TEMPERATURE, PRESSURE AND DEFLECTION DATA.....	21
ON-GOING IMPLICATIONS.....	30

Test Conditions

Standard	<p>Clause 7 of BS 476: Part 21: 1987 'Methods for determination of the fire resistance of loadbearing elements of construction'.</p> <p>The purpose of the test was to evaluate the performance of a timber floor construction protected by a ceiling of known fire resistance, when incorporating down lighter light fitting assemblies.</p>
Sampling	<p>Warringtonfire was not involved in the sampling or selection of the tested specimen or any of the components.</p> <p>The results obtained during the test only apply to the test samples as provided by the test sponsor.</p>
Installation	<p>Representatives of Warringtonfire assembled the floor construction and installed the downlighters between the 8th and 9th April 2020.</p>
Conditioning	<p>The specimen's storage, construction, and test preparation took place in the test laboratory over a total, combined time of eight days. Throughout this period of time both the temperature and the humidity of the laboratory were measured and recorded as being within a range of from 10°C to 23.5°C and 29.5% to 60% respectively.</p>
Instruction to Test	<p>The test was conducted on the 15th April 2020 at the request of Collingwood Lighting Ltd, the test sponsor.</p>
Ambient Temperature	<p>The ambient air temperature in the vicinity of the test construction was 18°C at the start of the test with a maximum variation of -1°C during the test.</p>
Furnace	<p>The furnace was controlled so that its mean temperature complied with the requirements of BS 476: Part 20: 1987, Clause 3.1, using eight mineral insulated thermocouples distributed over a plane 100 mm from the underside of the test construction.</p>
Thermocouples	<p>Thermocouples were provided to monitor the unexposed surface of the specimen. The output of all instrumentation was recorded at no less than one-minute intervals. The locations and reference numbers of the various unexposed surface thermocouples are shown in Figure 1. Additional thermocouples were included for information purposes only. These additional thermocouples were installed within the assembly during its construction located at mid height of the cavity adjacent to the light fittings.</p>
Loadbearing Capacity Criteria	<p>A linear deflection transducer was provided at the approximate centre on the unexposed surface of the specimen to record its vertical deflection.</p>
Furnace Pressure	<p>After the first five minutes of testing and for the remainder of the test, the furnace atmospheric pressure was controlled so that it complied with the requirements of BS 476: Part 20: 1987, Clause 3.2.2 (including allowance for transient occurrences in-line with Clause 12(l)). The calculated pressure differential relative to the laboratory atmosphere at a position 100 mm below the underside of the assembly was 20 (±2) Pa</p>

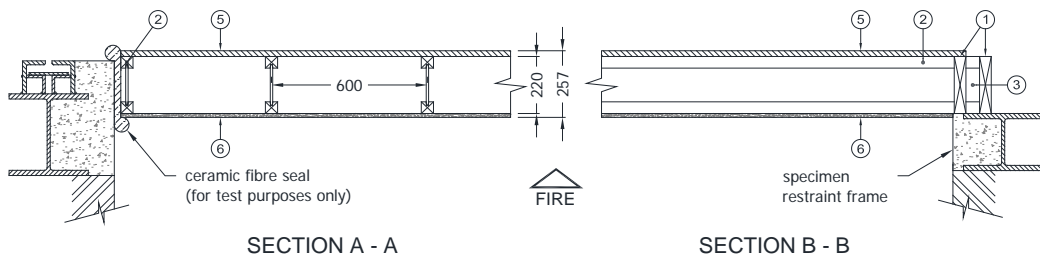
Test Specimen

Figure 1 – General plan view of test specimen showing thermocouple positions - Unexposed face



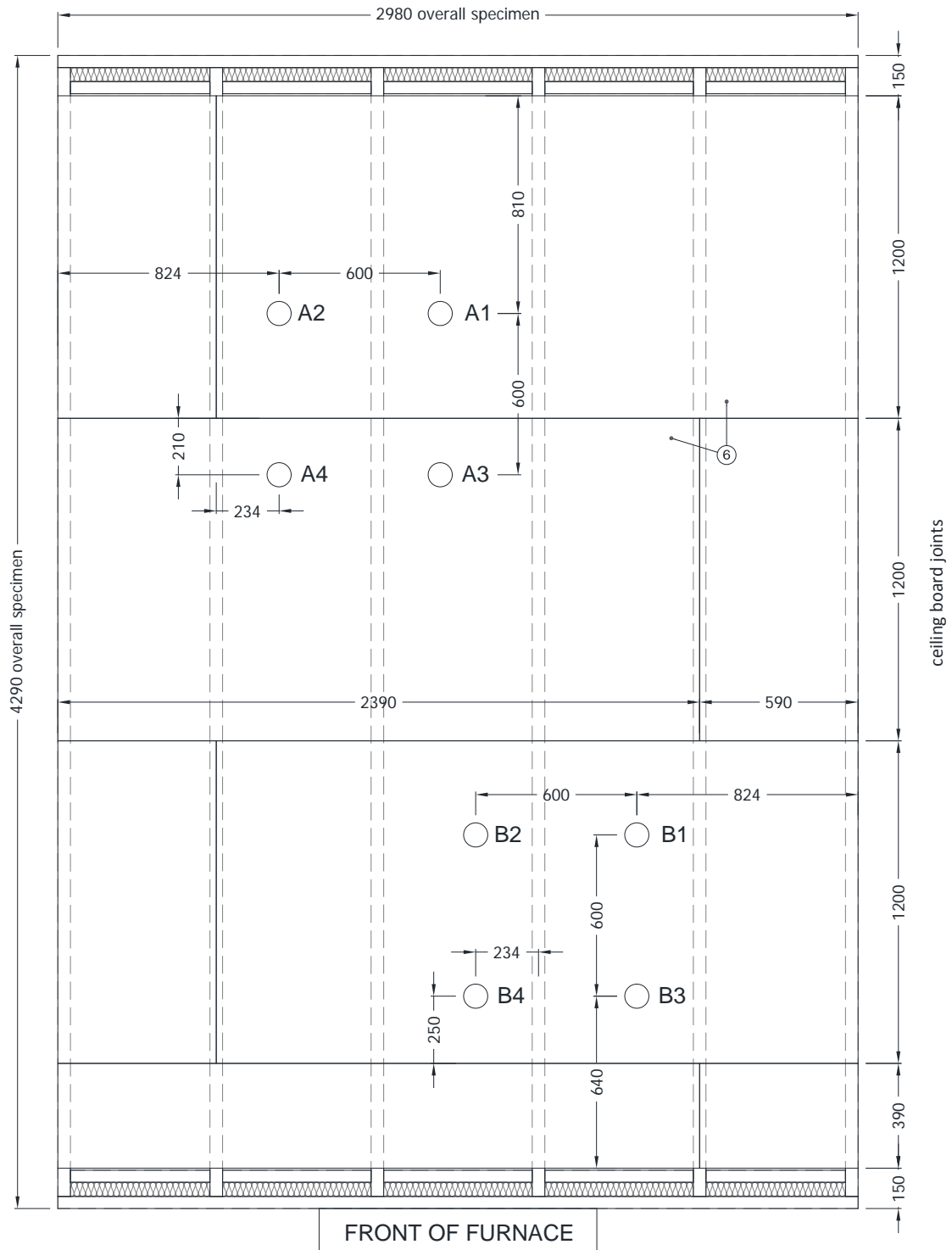
GENERAL PLAN VIEW OF TEST SPECIMEN SHOWING THERMOCOUPLE POSITIONS - UNEXPOSED FACE

- Positions of surface thermocouples
- ⊗ Positions of minerally insulated thermocouples at mid-cavity, adjacent to each downlight



Do not scale. All dimensions are in mm

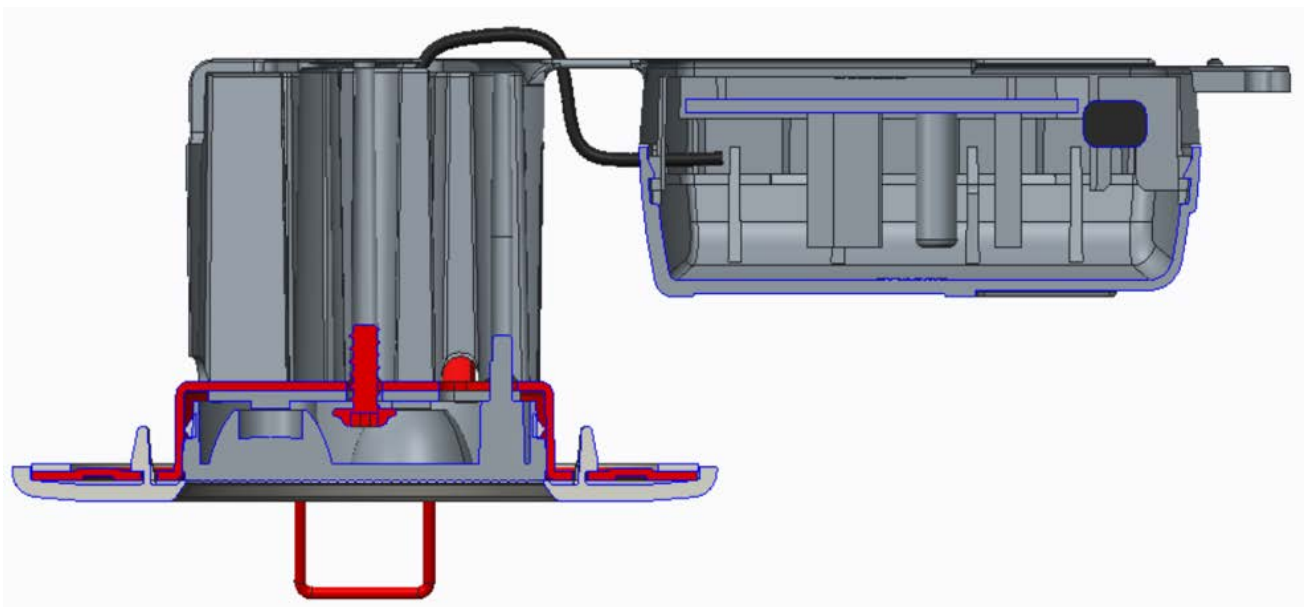
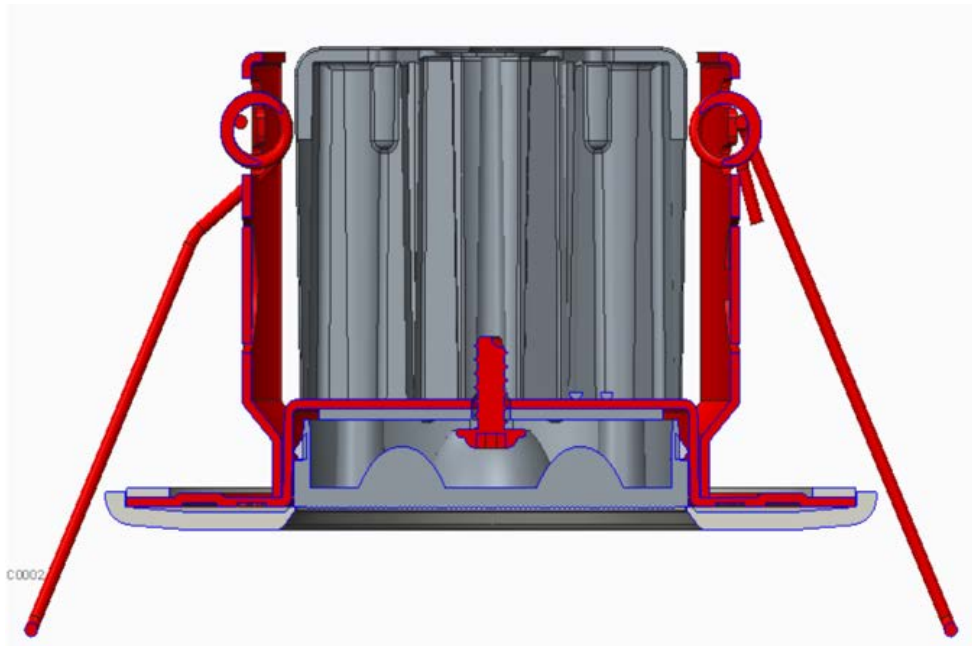
Figure 2 – General plan view of test specimen - Exposed face



GENERAL PLAN VIEW OF TEST SPECIMEN
- EXPOSED FACE

Do not scale. All dimensions are in mm

Figure 3 – Typical vertical sections through specimens A1 – A4: H2 Pro 550 (DLE472XXXX)



Do not scale. All dimensions are in mm

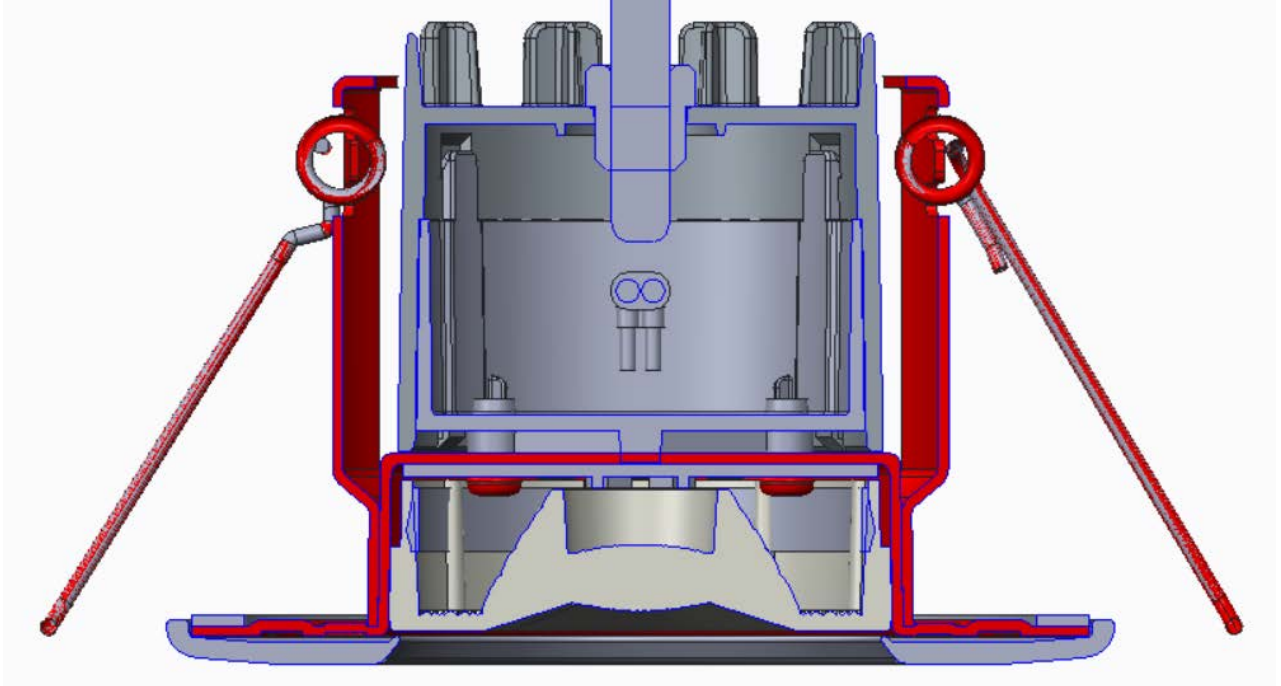
Figure 4 – Client’s drawing: H2 Pro 550 (DLE472XXXX)

编号	变更内容	变更单号	变更者	变更日期
1				
2				
3				

20	接线端子_CM-238-3P-P-1A white connector	2101700497	1	PCS	PC+钢steel+黄铜copper		
19	LF-接线盒_DL P 3A EF connector	2210600139	1	PCS	PC+copper 黄铜		
18	侧盖(接线盒)EF connector cover	2210600138	1	PCS	PC		
17	LED-螺丝_机牙 screws	2031910057	3	PCS	iron 1018		
16	PLF-A 底座(接线盒) EF connector base	2210600137	1	PCS	PC		
15	螺丝(A070) 自攻 3*8 screws	2031910099	2	PCS	iron 1018		
14	PLF-铜针_DL P 4A copper pin	2170300077	3	PCS	copper黄铜		
13	PLF-B_驱动盒下盖 driver down cover	2171100013	1	PCS	PA66		
12	电线 cable		1	PCS	PVC		
11	电线 cable		1	PCS	PVC		
10	电线 cable	2190200260	1	PCS	PVC		
9	驱动		1	PCS			
8	驱动盒上盖driver upper cover	2171100014	1	PCS	PA66		
7	弹簧_spring	2180400089	2	PCS	弹簧钢 steel		
6	面环组件_fir can	2171800066	1	PCS	SFCC		
5	光源组件		1	PCS			
4	泡棉 PE foam	2993500027	1	PCS	EVA		
3	螺丝_screw	2180100131	1	PCS	iron 1018		
2	密封圈_seal gasket	2993100045	1	PCS	硅胶 silicon		
1	透镜 lens	2160100210	1	PCS	PC		
序号	塑料面环ID	序号	部品名称	ID	数量	单位	备注

Do not scale. All dimensions are in mm

Figure 5 – Typical vertical sections through specimens B1 – B4: Newlec 400 (NLFRDLX)



Do not scale. All dimensions are in mm

Figure 6 – Client’s drawing: Newlec 400 (NLFRDLX)

编号	变更理由	日期
1		
2		
3		

17	接线端子_CM-238-3P-P-1A white connector	2101700355	1	PCS	PC+钢steel+黄铜copper
16	LF-接线盒_DL-P-3A_EF connector	2170600036	1	PCS	PC
15	侧盖(接线盒)EF connector cover	2170600035	1	PCS	PC
14	电源线_cable	2190201685	1	PCS	PVC
13	线扣_cabel clip	2171100053	1	PCS	PC
12	驱动盒上盖_driver upper cover	2170600275	1	PCS	PC
11	驱动组件_electronic components		1	PCS	
10	驱动盒下盖_driver down cover	2170600227	1	PCS	PC
09	电线_cable		1	PCS	
08	弹簧_spring	2180400089	2	PCS	弹簧钢 steel
07	面环组件_fir can	2171800085	1	PCS	DC04+SPCC
06	泡棉_PE foam	2993500027	1	PCS	EVA
05	光源组件_LEDs components		1	PCS	
04	螺丝_自攻_3*10_1018_screws	2031910432	3	PCS	iron 1018
03	密封圈_seal gasket	2993100054	1	PCS	硅胶 siicon
02	反光纸_reflector paper	2160100487	1	PCS	PET
01	透镜_lens	2160100291	1	PCS	PC
序号	部品名称	ID	数量	单位	备注

Do not scale. All dimensions are in mm

Schedule of Components

(Refer to Figures 1 to 6)

(All values are nominal unless stated otherwise)

(All other details are as stated by the sponsor)

<u>Item</u>	<u>Description</u>
1. End beams & end noggins	
Manufacturer	: James Jones & Sons Limited
Reference	: JJ-Beam (Glulam)
Material	: Glue laminated timber
Section size	: 45 mm wide x 220 mm deep
Density	: 497 kg/m ³ (measured)
Fixing method	: Through fixed to joists with two nails to top and bottom flanges at each joint
Fixings	
i. type	: Ring shank nails
ii. size	: 100 mm long x 3.1 mm diameter
2. Timber I-Joists	
Manufacturer	: James Jones & Sons Limited
Reference	: JJI-Joist (JJI-220A+)
Material	: Softwood flange and OSB web.
Section size	: 47 mm wide x 220 mm deep spaced at 600 mm centres 9 mm thick OSB web
Density	: 500 kg/m ³ (flange – measured) 692 kg/m ³ (web – measured)
3. Pattress	
Material	: OSB (Oriented Strand Board)
Thickness	: 18 mm
Overall size	: 100 mm long x 130 mm wide
Fixing method	: Fixed to ends of joists with adhesive and through web with two screws per pattress
Fixings	
i. manufacturer	: Knauf
ii. reference	: Drywall Screws Self Tapping 258311
iii. type	: Black phosphate coated steel
iv. size	: 38 mm long x 3.5 mm diameter
Adhesive	
i. reference	: Chipstick D4
ii. type	: Chipboard flooring and wood adhesive
4. Insulation	
Manufacturer	: Knauf
Reference	: SK Dritherm Cavity Slab
Material	: Glass mineral wool
Thickness	: 50 mm
Density	: 25 kg/m ³ (measured)
Fixing method	: Cut to size and fitted between end noggins and end beams (item 1)

<u>Item</u>	<u>Description</u>
5. Floorboards	
Manufacturer	: Norbord
Reference	: Caberfloor P5
Material	: Chipboard (tongue & groove)
Thickness	: 22 mm
Density	: 630 kg/m ³ (measured)
Fixing method	: Through fixed to timber framework with nails and adhesive
Fixings	
i. manufacturer	: Timco
ii. reference	: BAR65B
iii. type	: Bright annular ring shank nails
iv. size	: 65 mm long x 3.35 mm diameter
v. centres	: 600 mm
Adhesive	
i. reference	: Norbord Caberfix D4
ii. type	: Polyurethane adhesive
6. Ceiling boards	
Manufacturer	: British Gypsum
Reference	: Gyproc Wallboard
Material	: Aerated high-density gypsum core encased in strong paper liners
Thickness	: 15 mm
Density	: 726 kg/m ³ (measured)
Fixing method	: Through fixed to timber framework with screws
Fixings	
i. manufacturer	: Timco
ii. reference	: Fine Thread Bugle Head Drywall Screws
iii. type	: Black phosphate coated steel
iv. size	: 42 mm long x 3.5 mm diameter
v. centres	: 230 mm (edge), 230 mm (field)
Tape	
i. manufacturer	: Everbuild
ii. reference	: EuroScrim
Filler	
i. manufacturer	: British Gypsum
ii. reference	: Gyproc EasyFill 60
7. Specimens A1 – A4	
Manufacturer	: Collingwood Lighting Ltd.
Reference	: H2 Pro 550 (DLE472XXXX)
Description	: Fixed LED downlight fitted with H2 bezel. IP65 rated.
Material	: Mild steel / V0 rated plastic insulation protector built in. Plastic bezel
Overall sizes	:
i. height	: 49 mm
ii. overall diameter	: 90 mm
iii. cut-out diameter	: 64 mm

Item**Description****8. Specimens B1 – B4**

Manufacturer	:	Collingwood Lighting Ltd.
Reference	:	Newlec 400 (NLFRDLX)
Description	:	Fixed LED downlight fitted with H2 bezel
Material	:	Mild steel / V0 rated plastic insulation protector built in. Plastic bezel.
Overall sizes	:	
i. height	:	60 mm
ii. overall diameter	:	85 mm
iii. cut-out diameter	:	64 mm

Test Observations

Time		All observations are from the unexposed face unless noted otherwise.
-60	00	Load applied.
00	00	The test commences.
05	00	Intermittent flaming at the down light positions across the plasterboard on the exposed face.
07	11	The plasterboard is discolouring on the exposed face; the joint coverings are beginning to fall away.
10	22	Paper layer of plasterboard is burning away on the exposed face.
12	00	Glowing at the plasterboard joints on the exposed face.
14	00	Steam/smoke release from the supported ends of the floor construction.
15	00	Plastic bezels of the down lights have burnt away.
17	00	Long edges of the plasterboard begin to ripple, causing gaps to open up at the joints.
18	30	Flaming at down light position 'A3' on the exposed face.
20	00	Steam/smoke release increases at the supported ends of the floor construction.
21	00	The gaps at the plasterboard joints are now around 20mm on the exposed face.
22	20	Flaming at all 'Specimen A' down light positions.
27	30	Large section of plasterboard has fallen from the central section, intense flaming in the furnace.
28	00	More plasterboard falls from centre of the exposed face.
29	00	The joists are now exposed in the centre of the floor on the exposed face.
30	00	The floor is bowing in its centre; inside of furnace is not visible due to intense flaming.
31	00	Test discontinued for safety reasons.

Test Photographs

The exposed face of the floor assembly prior to test



The unexposed face of the floor assembly prior to test



The unexposed face of the floor assembly after 10 minutes of testing



The unexposed face of the floor assembly after 20 minutes of testing



The unexposed face of the floor assembly after 30 minutes of testing



Temperature, Pressure and Deflection Data

Mean furnace temperature, together with the temperature/time relationship specified in BS 476:
Part 21: 1987

Time Mins	Specified Furnace Temperature Deg. C	Actual Furnace Temperature Deg. C
0	20	45
1	349	307
2	445	432
3	502	543
4	544	521
5	576	572
6	603	594
7	626	624
8	646	648
9	663	659
10	678	685
11	693	697
12	706	705
13	717	727
14	728	731
15	739	730
16	748	748
17	757	745
18	766	759
19	774	773
20	781	788
21	789	796
22	796	804
23	802	812
24	809	812
25	815	817
26	820	820
27	826	831
28	832	845
29	837	837
30	842	841
31	847	828

Individual and mean temperatures recorded on the unexposed surface of the floor

Time Mins	T/C Number 211 Deg. C	T/C Number 212 Deg. C	T/C Number 213 Deg. C	T/C Number 214 Deg. C	T/C Number 215 Deg. C	Mean Temp Deg. C
0	20	20	20	21	20	20
1	20	20	20	21	20	20
2	20	20	20	21	20	20
3	20	20	20	21	20	20
4	20	20	20	21	20	20
5	20	20	21	21	20	20
6	20	20	21	21	20	20
7	20	20	21	21	20	20
8	20	20	21	21	20	20
9	20	20	21	21	20	20
10	21	21	21	21	21	21
11	21	21	22	22	21	21
12	22	22	23	22	22	22
13	23	23	23	23	22	23
14	24	24	24	24	23	24
15	25	25	25	24	24	25
16	26	26	26	25	25	26
17	27	27	27	26	26	27
18	28	28	28	27	26	27
19	29	29	29	28	27	28
20	30	31	30	29	28	30
21	32	32	31	30	29	31
22	33	33	32	31	30	32
23	34	34	33	32	31	33
24	35	35	34	33	32	34
25	36	36	35	33	33	35
26	38	37	36	34	34	36
27	39	38	36	35	35	37
28	40	40	37	36	36	38
29	42	41	38	37	37	39
30	44	43	40	38	38	41
31	49	48	47	39	39	44

Individual temperatures recorded adjacent to joints in the flooring

Time Mins	T/C Number 216 Deg. C	T/C Number 217 Deg. C	T/C Number 218 Deg. C
0	20	20	20
1	20	20	20
2	20	20	20
3	20	20	20
4	20	20	20
5	20	20	20
6	20	20	20
7	20	20	20
8	20	20	20
9	21	20	20
10	21	21	20
11	22	21	20
12	23	22	21
13	24	23	21
14	25	24	21
15	26	25	22
16	28	26	23
17	29	27	23
18	30	28	24
19	32	29	24
20	33	31	25
21	34	32	26
22	35	33	27
23	36	34	27
24	38	35	28
25	39	37	29
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27	41	39	31
28	43	40	31
29	45	42	32
30	51	45	33
31	65	57	35

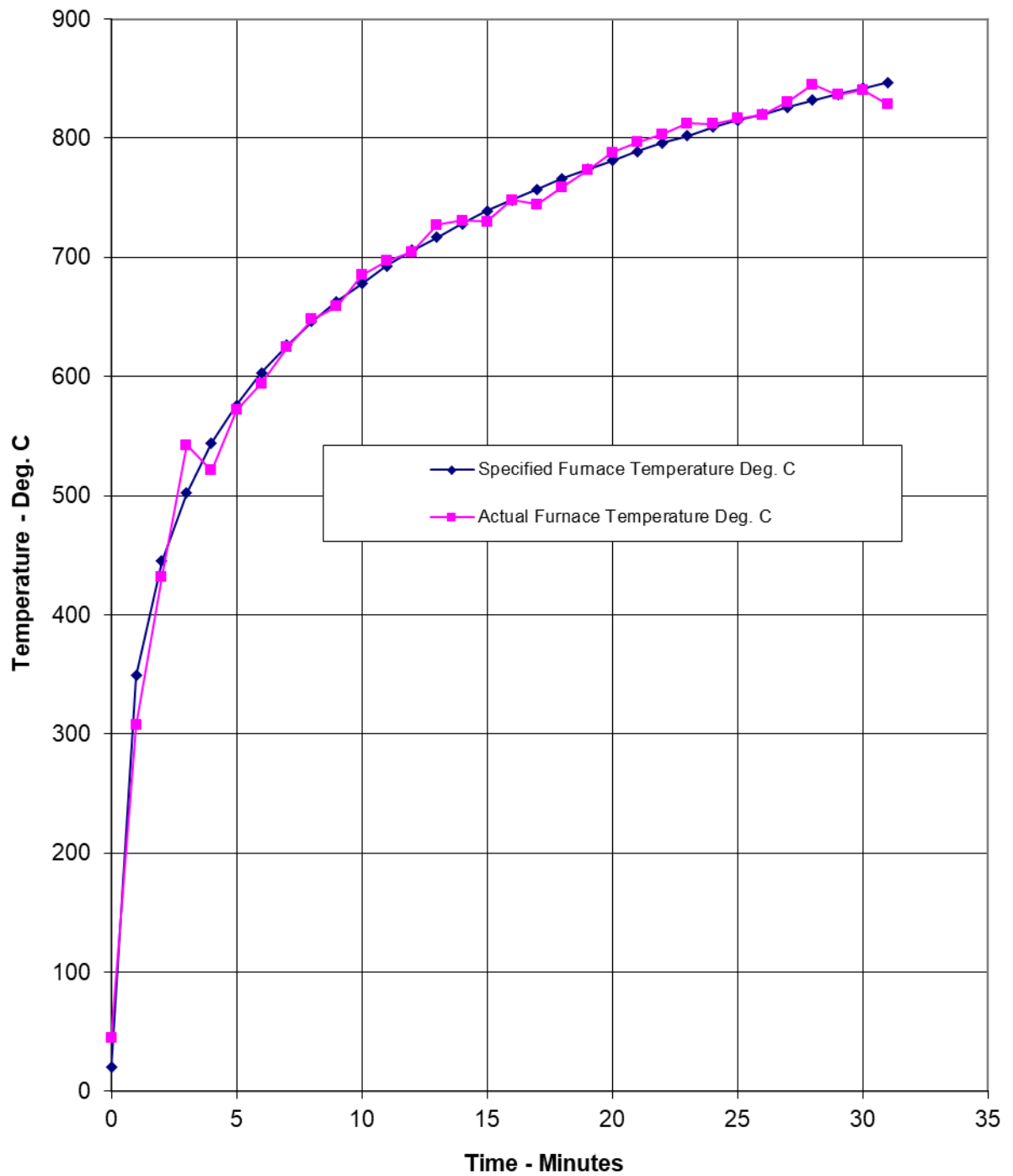
Individual temperatures recorded mid-height of the air cavity

Time Mins	T/C Number 219 Deg. C	T/C Number 220 Deg. C	T/C Number 221 Deg. C	T/C Number 222 Deg. C	T/C Number 223 Deg. C	T/C Number 224 Deg. C	T/C Number 225 Deg. C	T/C Number 226 Deg. C
0	23	24	23	20	20	20	21	20
1	26	25	23	20	20	21	22	20
2	28	26	25	22	21	22	22	21
3	37	38	34	28	24	26	28	28
4	43	43	48	39	31	34	32	32
5	54	51	60	52	45	45	39	40
6	61	59	66	62	54	56	48	49
7	65	65	70	67	57	60	55	55
8	70	69	74	70	63	65	62	60
9	75	74	79	75	68	70	64	64
10	80	79	85	81	73	75	69	70
11	86	84	92	85	78	79	74	74
12	90	88	96	90	82	83	78	78
13	94	92	99	95	85	86	82	83
14	96	95	102	98	89	90	85	87
15	99	97	105	98	92	93	89	89
16	101	99	107	101	94	95	91	91
17	103	101	109	102	96	98	93	94
18	106	103	112	105	98	99	94	97
19	108	106	114	107	99	101	96	98
20	113	109	121	111	101	102	99	100
21	127	119	130	119	102	104	101	102
22	144	135	151	136	105	109	103	104
23	167	161	177	160	109	117	106	108
24	186	182	201	184	118	128	111	114
25	202	194	228	201	129	142	117	124
26	215	209	248	218	143	163	125	134
27	226	224	258	239	161	181	137	154
28	240	233	276	254	378	195	241	165
29	523	669	737	469	411	326	285	223
30	708	750	744	583	422	395	287	259
31	759	795	798	738	615	709	357	589

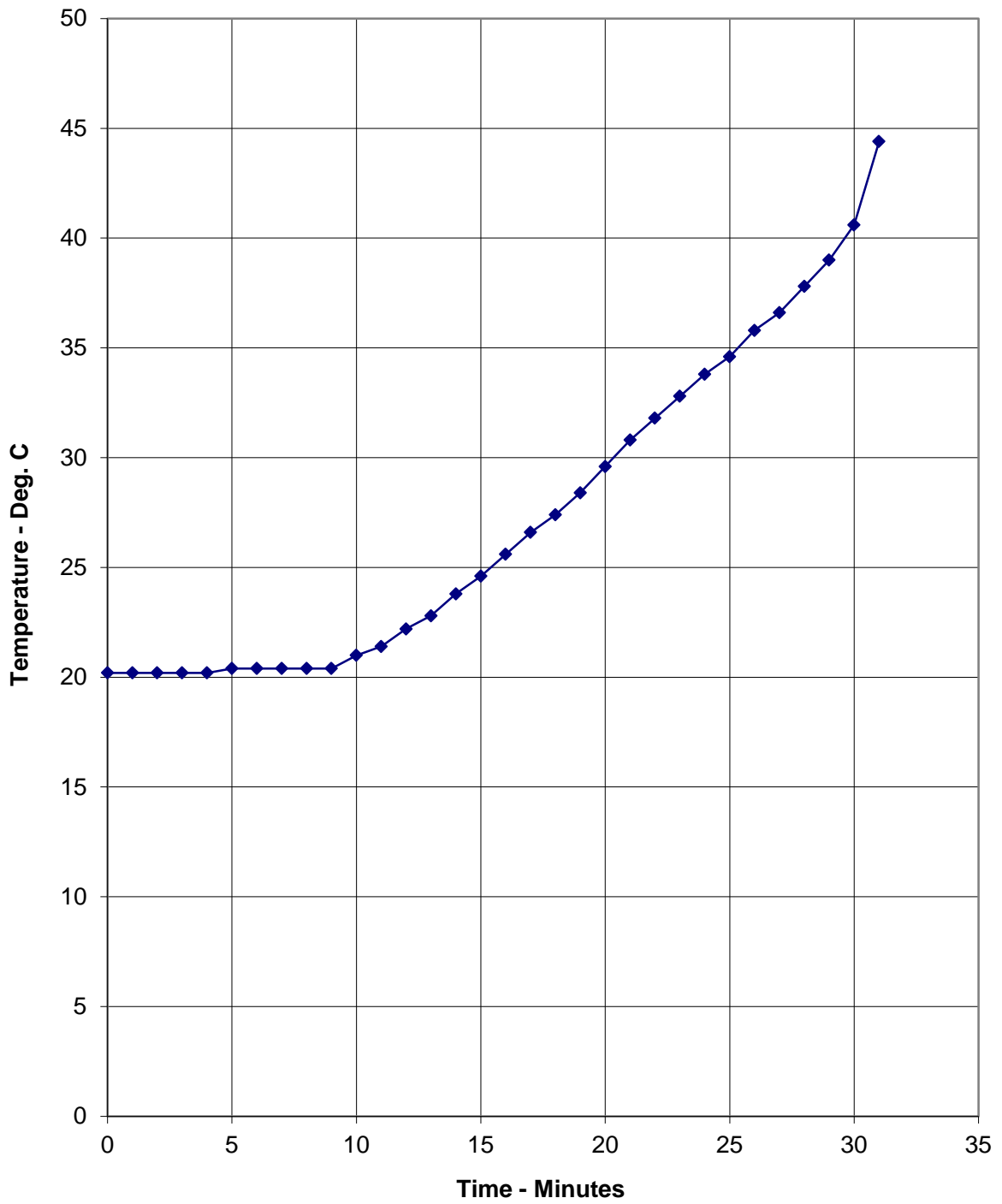
Deflection and rate of deflection of the floor assembly during the test

Time Mins	Central Vertical Deflection mm	Rate Of Deflection mm/min
0	0.000	0.000
1	-0.218	-0.218
2	0.168	0.386
3	0.285	0.117
4	0.285	0.000
5	0.386	0.101
6	0.504	0.118
7	0.604	0.100
8	0.722	0.118
9	0.990	0.268
10	1.376	0.386
11	1.662	0.286
12	1.930	0.268
13	2.148	0.218
14	2.753	0.605
15	3.139	0.386
16	3.743	0.604
17	4.179	0.436
18	4.683	0.504
19	5.069	0.386
20	5.556	0.487
21	6.227	0.671
22	6.546	0.319
23	7.050	0.504
24	7.654	0.604
25	8.040	0.386
26	8.309	0.269
27	8.695	0.386
28	9.248	0.553
29	11.179	1.931
30	16.953	5.774
31	32.563	15.610

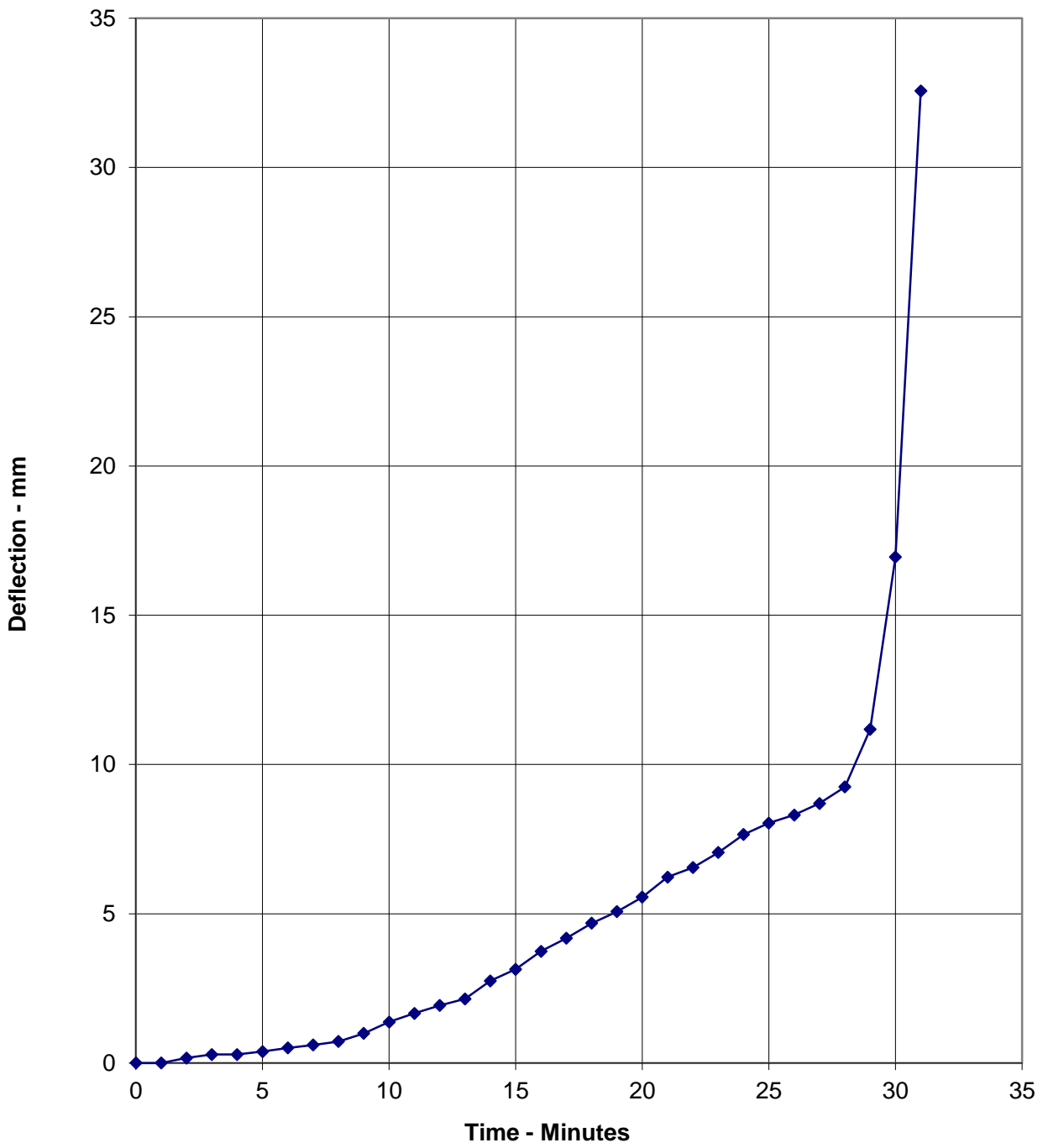
Graph showing specified and actual furnace temperatures



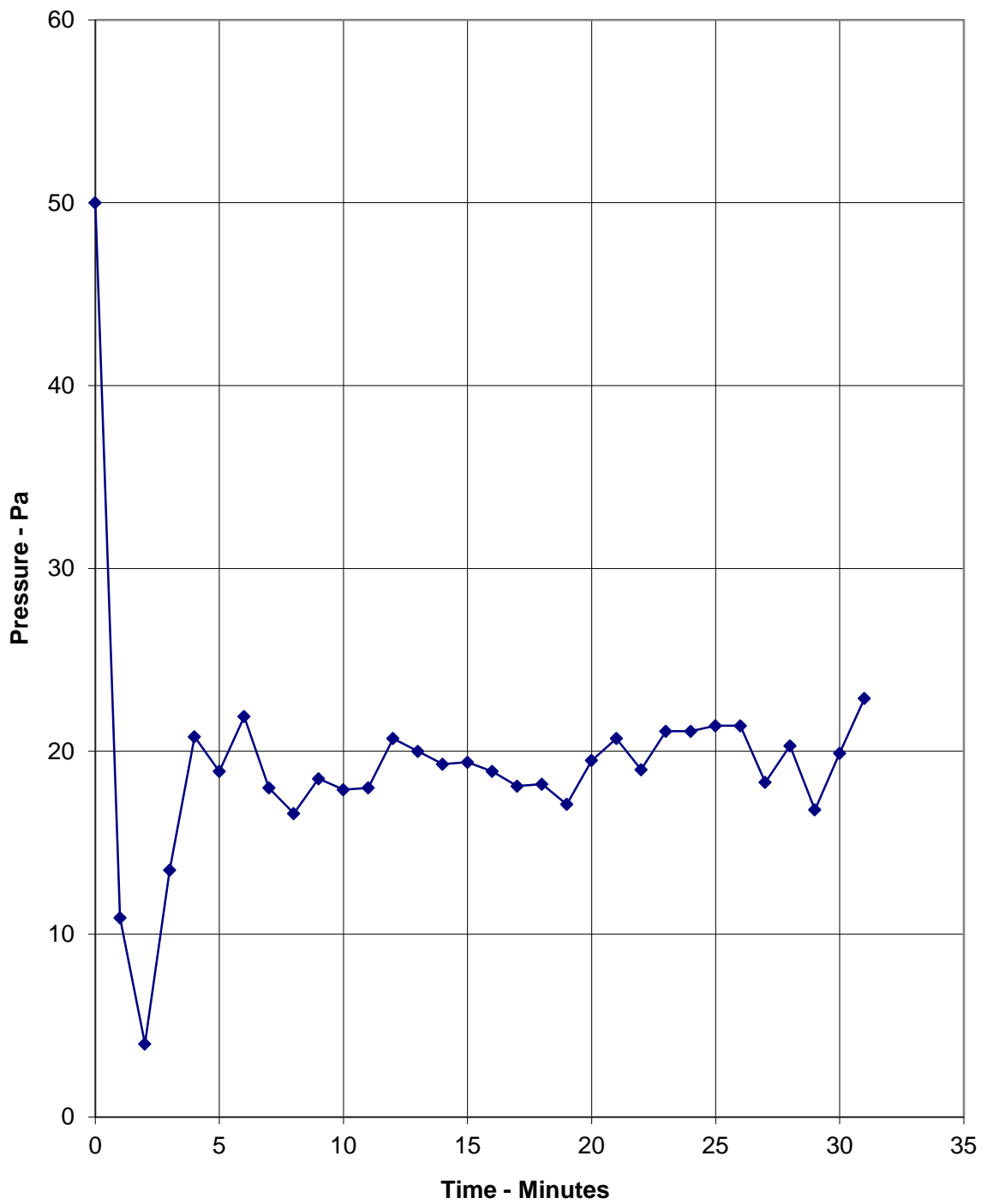
Graph showing mean unexposed surface temperature of the floor assembly



Graph showing the central vertical deflection of the floor assembly during the test



Graph showing recorded furnace pressure 100 mm below the underside of the floor assembly



On-going Implications

Limitations

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.

The test results relate only to the specimen tested. Appendix A of BS 476: Part 20: 1987 provides guidance information on the application of fire resistance tests and the interpretation of test data. Application of the results to assemblies of different dimensions or incorporating different components should be the subject of a design appraisal.

The tested assembly was asymmetrical, the test results may not be appropriate to situations where the assembly is mounted in the opposite orientation to that tested.

Review

The specification and interpretation of fire test methods are the subject of ongoing development and refinement. Changes in associated legislation may also occur. For these reasons it is recommended that the relevance of test reports over five years old should be considered by the user. The laboratory that issued the report will be able to offer, on behalf of the legal owner, a review of the procedures adopted for a particular test to ensure that they are consistent with current practices, and if required may endorse the test report.

Fire Test Study Group

Certain aspects of some fire test specifications are open to different interpretations. The Fire Test Study Group have identified a number of such areas and have agreed Resolutions which define common agreement of interpretations between fire test laboratories which are members of the Group. Where such Resolutions are applicable to this test they have been followed