The Building Test Centre
British Gypsum Limited
East Leake
Loughborough
Leics. LE12 6NP
Tel (0115) 945 1564
Fax (0115) 945 1562
email btc.testing@bpb.com

Report Number **BTC 13191F**

FULL SCALE FIRE RESISTANCE TEST ON A TWIN FRAME HORIZONTAL BRITISH GYPSUM SHAFTWALL CLAD WITH 15mm GYPROC FIRELINE CONDUCTED IN ACCORDANCE WITH BS EN 1364-2: 1999.

Test Date: 3rd February 2004

www.btconline.co.uk

Customer: **British Gypsum Limited**
East Leake
Loughborough
Leicestershire
LE12 6HX

UKAS TESTING
0296

The Building Test Centre
Fire Acoustics Structures

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FOREWORD

This test report details a full scale fire resistance test on a horizontal British Gypsum ShaftWall ceiling membrane. The test sponsor was British Gypsum Limited.

The test specimen was installed by the British Gypsum Limited. The construction of the specimen took place between the 29th January and 2nd February 2004. British Gypsum Limited designed and selected the materials comprising the test specimen.

The test was carried out on the 3rd February 2004.

This report details the method of construction, the test conditions and the results obtained when the specific element of construction described herein was tested following the procedures outlined in EN 1363-1, and where appropriate EN 1363-2. Any significant deviation with respect to size, construction details, loads, stresses, edge or end conditions other than those allowed under the field of direct application in EN 1364-2 is not covered by this report.

Because of the nature of fire resistance testing and the consequent difficulty in quantifying the uncertainty of measurement of fire resistance, it is not possible to provide a stated degree of accuracy of the result.

REPORT AUTHORISATION

Report Author	Authorised by
Robert Evans MEng. (Hons.), AMIMechE, AIFireE *Project Leader*	**Eur Ing. Paul Howard** BSc. (Hons.), CEng., MIOA *Head of Laboratory*

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The Building Test Centre
British Gypsum Limited
East Leake
Loughborough
Leics. LE12 6NP
Tel (0115) 945 1564
Fax (0115) 945 1562
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TEST CONSTRUCTION

The specimen was constructed in a refractory concrete lined steel restraint frame having an opening of 4000mm long x 3000mm wide.

Gypframe 148EDC80 Extra Deep Flange Floor and Ceiling Channels were fixed to both 3000mm edges of the restraint frame aperture using 60mm fire resistant fixings at 300mm centres, approximately 240mm from the bottom edge of the test frame (bottom flange of channel).

Gypframe 146TSC90 Tabbed Starter Channels were fixed to both 4000mm edges of the restraint frame aperture using 60mm fire resistant fixings at 300mm centres.

Gypframe 146TI90 'Tabbed' I Studs were positioned between the Gypframe 148EDC80 Extra Deep Flange Floor and Ceiling Channel at 600mm centres (spanning 4000mm).

One layer of Gyproc CoreBoard was positioned between the studs and secured in position with Gypframe G102 Retaining Channels inserted between the back of the Gyproc CoreBoard and the tabs in the stud. The Gypframe 146TI90 'I' Studs and the Gypframe 148EDC80 Extra Deep Floor & Ceiling Channels were fixed together using two Gypframe Wafer Head Jack-Point Screws through the lower flange of the channel, one either side of the stud web.

Horizontal joints in the Gyproc CoreBoard were positioned at mid-span, i.e. 2000mm. Sections of Gypframe GA3 Steel Angle were inserted between the board joints and 122mm wide Gyproc CoreBoard fire stops, with beads of Gyproc Sealant along both longer edges, were fixed to the angle using three 32mm Gyproc drywall screws.

The underside of the studs were clad with a single layer of 15mm Gyproc FireLine fixed perpendicular to the studs as follows:

The layer of board was fixed at 234mm centres (6 fixings per board width) within the field of the board, 234mm centres around the ceiling perimeter (4000mm frame edge) and 200mm centres (3000mm frame edge) with 25mm Gyproc Jack-Point Screws.

Gypframe 148DC60 Deep Flange Floor and Ceiling Channels were fixed to both 3000mm edges of the restraint frame aperture using 60mm fire resistant fixings at 300mm centres 20mm below the surface of the Gyproc FireLine (upper flange of channel).

Gypframe 146TSC90 Tabbed Starter Channels were fixed to both 4000mm edges of the restraint frame aperture using 60mm fire resistant fixings at 300mm centres 20mm below the surface of the Gyproc FireLine (upper flange of channel).

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Loughborough
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One layer of Gyproc CoreBoard was positioned between the studs and secured in position with Gypframe G102 Retaining Channels inserted between the back of the Gyproc CoreBoard and the tabs in the stud. The Gypframe 146TI90 'Tabbed' 'I' Studs and the Gypframe 148DC60 Deep Floor & Ceiling Channels were fixed together using two Gypframe Wafer Head Jack-Point Screws through the lower flange of the channel, one either side of the stud web.

Horizontal joints in the Gyproc CoreBoard were positioned at mid-span, i.e. 2000mm. Sections of Gypframe GA3 Steel Angle were inserted between the board joints and 122mm wide Gyproc CoreBoard fire stops, with beads of Gyproc Sealant along both longer edges, were fixed to the angle using three 32mm Gyproc drywall screws.

Gypframe MF6A Perimeter Channels were fixed to the perimeter of the test frame using 60mm fire resistant fixings at 600mm centres. The channels were fixed flush to the underside of the Gypframe 148DC60 Deep Floor & Ceiling Channel/146TSC90 Tabbed Starter Channel framework.

Gypframe MF5 Ceiling Sections were positioned in the Gypframe MF6A Perimeter Channels at 450mm centres perpendicular to the Gypframe 146TI90 'Tabbed' 'I' Studs. The Gypframe MF5 Ceiling Sections and Gypframe 146TI90 'Tabbed' 'I' Studs were fixed together using two Gypframe Wafer Head Jack-Point Screws.

A double layer of 15mm Gyproc FireLine was fixed perpendicular to the Gypframe MF5 Ceiling Sections as follows:

The inner layer was fixed at 234mm centres (6 fixings per board width) within the field of the board. The ceiling perimeter was fixed at 234mm centres along the short edges of the frame and at 225mm centres along the long edges of the frame with 25mm Gyproc drywall screws.

The outer layer was fixed at 234mm centres (6 fixings per board width) within the field of the board. The ceiling perimeter was fixed at 234mm centres along the short edges of the frame and at 225mm centres along the long edges of the frame with 42mm Gyproc drywall screws.

All joints were staggered between layers and board ends coincided with the Gypframe MF5 Ceiling Sections.

All joints and screw spots were finished using Gyproc Joint Tape and Gyproc Joint Filler.

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Loughborough
Leics. LE12 6NP
Tel (0115) 945 1564
Fax (0115) 945 1562
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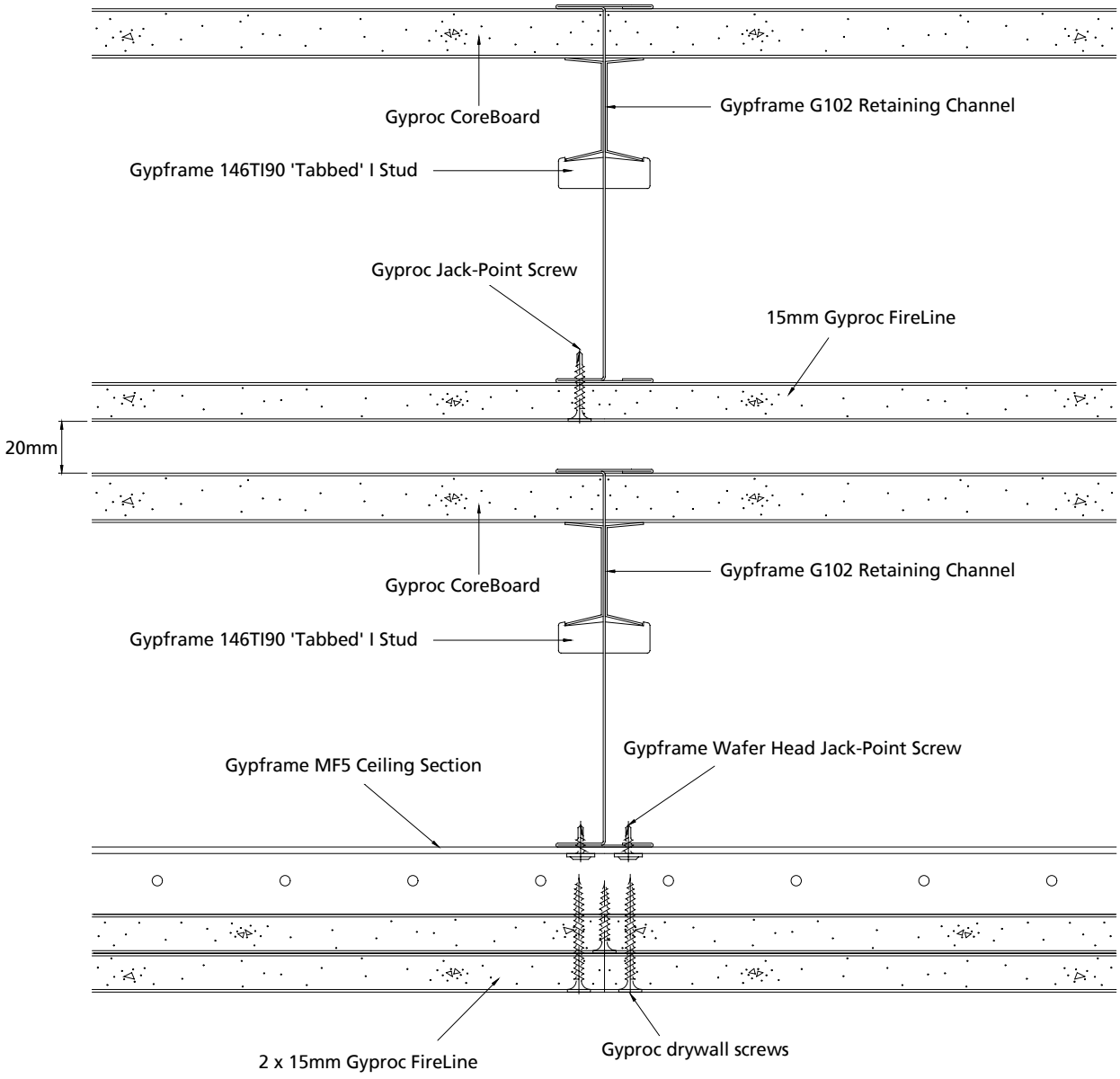

Figure 1. Cross-section of specimen showing the separate frames.

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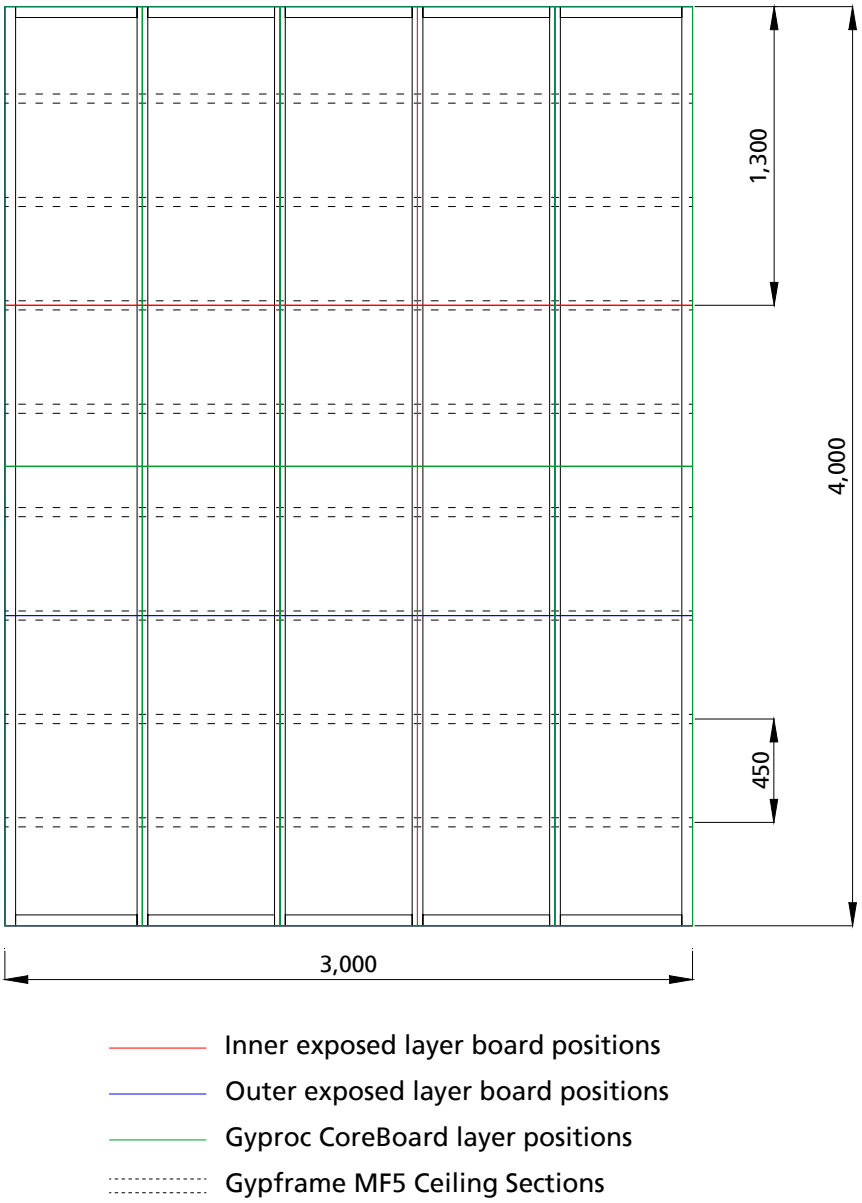

Figure 2. The board layout on the lower frame.

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British Gypsum Limited
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Leics. LE12 6NP
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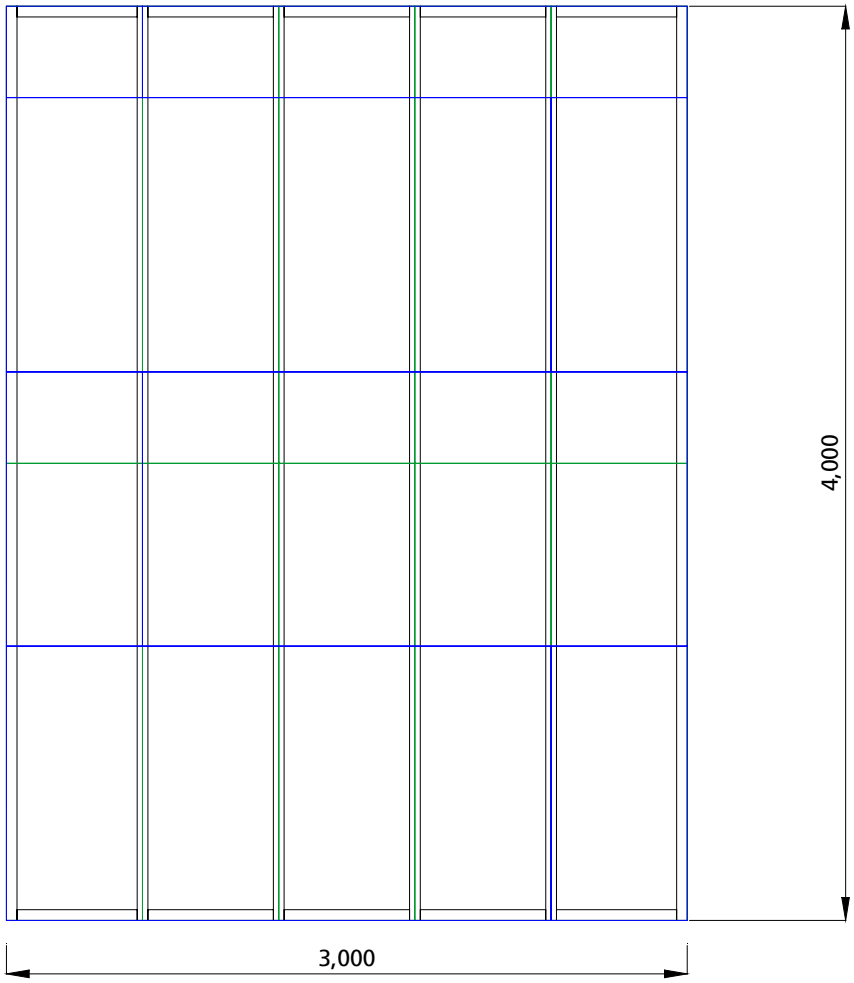

Figure 3. The board layout on the upper frame.

The descriptions of individual components making up the test specimen were provided by the customer and were checked for accuracy wherever possible.

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British Gypsum Limited
East Leake
Loughborough
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TEST MATERIALS

Gyproc FireLine

Nominally, 3000mm (long) x 1200mm (wide) x 15mm (thick), Gyproc FireLine manufactured and supplied by British Gypsum Limited, ex East Leake works.

Actual surface density:	11.59kg/m^2.
Actual thickness:	15.33mm.
Board identification numbers:	16 242 3 03:11
Actual moisture content:	0.74%

The surface density was calculated using the actual weight and size of a selection of the boards used in the test specimen. The moisture content of the plasterboard used in construction was established from measurements made using samples dried to a constant weight in an oven at 40°C.

Gyproc CoreBoard

Nominally, 3000mm (long) x 598mm (wide) x 19mm (thick), Gyproc CoreBoard manufactured and supplied by British Gypsum Limited, ex Robertsbridge works.

Actual surface density:	16.88kg/m^2.
Actual thickness:	18.89mm.
Board identification numbers:	24 233 3 16:33
Actual moisture content:	0.55%

The surface density was calculated using the actual weight and size of a selection of the boards used in the test specimen. The moisture content of the plasterboard used in construction was established from measurements made using samples dried to a constant weight in an oven at 40°C.

Metal Components

i) Gypframe MF6A Perimeter Channel. Manufactured from galvanised mild steel.
ii) Gypframe MF5 Ceiling Section. Manufactured from galvanised mild steel.
iii) Gypframe 146TI90 'Tabbed' 'I' Studs. Manufactured from galvanised mild steel.
iv) Gypframe 146TSC90 Tabbed Starter Channel. Manufactured from galvanised mild steel.
v) Gypframe 148EDC80 Extra Deep Flange Floor & Ceiling Channel. Manufactured from galvanised mild steel.

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vi) Gypframe 148DC60 Deep Flange Floor & Ceiling Channel. Manufactured from galvanised mild steel.
vii) Gypframe G102 Retaining Channel. Manufactured from galvanised mild steel.

All metal components were supplied by British Gypsum Limited.

Fixings

i) 25mm Gyproc drywall screws supplied by British Gypsum Limited.
ii) 32mm Gyproc drywall screws supplied by British Gypsum Limited.
iii) 42mm Gyproc drywall screws supplied by British Gypsum Limited.
iv) 13mm Gypframe Wafer Head Jack-Point Screws supplied by British Gypsum Limited.
v) 25mm Gyproc Jack-Point Screws supplied by British Gypsum Limited.
vi) 60mm fire resistant fixings.

Miscellaneous Components

i) Gyproc Joint Filler supplied by British Gypsum Limited.
ii) Gyproc Paper Tape supplied by British Gypsum Limited.
iii) Gyproc Sealant supplied by British Gypsum Limited.

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TEST PROCEDURE

The test was conducted fully in accordance with BS EN 1364-2: 1999. The asymmetrical specimen was subjected to fire from the underside (plasterboard side) this being the required direction of fire resistance as specified in BS EN 1363-1: 1999.

The test procedure used was EN 1364-2 Issue 1.

The ambient temperature at the commencement of the test was 19°C.

The furnace pressure was set to control at 18 ±2 Pa positive with respect to atmosphere, 100mm below the underside of the specimen, except during the first 5 minutes of the test.

The allowable tolerances are ±5 Pa from 5 minutes to 10 minutes and ±3 Pa from 10 minutes onwards. It is of the opinion of the laboratory that the variations in the furnace pressure exceeding the tolerances stated in BS EN 1363-1:1999 have not unduly influenced the results of this test. The furnace pressure graph is on page 17.

The test conditions did not meet the full requirements of BS EN 1363-1: 1999 as the test frame stiffness did not fully comply. The test centre is of the opinion that these deviations from the documented method will not unduly effect the result of the test.

TEST RESULTS

The requirements of the standard were satisfied for the following periods:

Integrity- Sustained flaming	**117 minutes**	No failure (test discontinued at the request of the customer)
Integrity- Cotton pad	**117 minutes**	No failure (test discontinued at the request of the customer)
Integrity - 6mm gap gauge	**117 minutes**	
Integrity- 25mm gap gauge	**117 minutes**	
Insulation	**117 minutes**	By virtue of integrity

The test was terminated at 117 minutes.

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LIMITATIONS

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 5 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.

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TEST DATA

Observations

Observers: Unexposed face R Evans
Exposed face P Cao and R Evans

Time		*Observations* All observations refer to the exposed face unless otherwise stated.
hrs	mins	
	0	Test started.
	10	The boards had started to char and the jointing material had started to fall into the furnace.
	20	All longitudinal board joints had opened to approximately 3mm.
	30	All board joints had opened to approximately 5-10mm. The boards had sagged slightly between their fixings.
	40	All board joints had opened to approximately 10-15mm. The boards had sagged further between their fixings.
	50	All board joints had opened to approximately 15mm.
1	00	All board joints had opened to approximately 20mm. The boards adjacent to the left-hand longitudinal joint and the lateral joint had come away from their fixings.
1	05	The second row centreboard had peeled into the furnace adjacent to the lateral board joint. The exposed inner layer joints had opened to approximately 20mm.
1	10	Approximately half of the second row centreboard adjacent to the lateral joint fell into the furnace. The exposed inner layer boards had come away from their fixings adjacent to the inner lateral board joint. The exposed inner layer joints had opened to approximately 20-25mm.

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Time		*Observations*
hrs	mins	All observations refer to the exposed face unless otherwise stated.
1	15	Further sections of the outer layer board fell into the furnace. The first row centreboard and right-hand board adjacent to the right-hand longitudinal joint and the lateral joint from the inner layer started to peel into the furnace.
1	20	Sections of the first row centreboard and right-hand board fell into the furnace from the inner layer. The metal frame ceiling grid and studs were exposed.
1	25	The studs had bowed into the furnace. The board joint at mid-span had opened. The surface of the exposed core boards was crazed and cracked.
1	30	Approximately 95% of the inner and outer board layers had fallen into the furnace. The studs had bowed further into the furnace.
1	35	The studs had bowed further into the furnace. The boards remained in position between the stud flanges and retaining channel.
1	40	The entire lower metal frame and boards fell into the furnace.
1	46	All the board joints on the upper frame had opened to approximately 2mm.
1	50	The board joints had opened to approximately 10mm. The studs were visible through the joints. The boards had sagged between their fixings.
1	55	All the board joints had opened to approximately 20-25mm. The board nearest the viewing platform had started to peel into the furnace. *Unexposed face* Discolouration had appeared on the unexposed face adjacent to the channels at each end (3000mm edge) of the specimen.

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Time		*Observations*
hrs	mins	All observations refer to the exposed face unless otherwise stated.
1	57	*Unexposed face* A glow was visible approximately 1750mm from the viewing platform and 600mm from the right-hand side of the specimen. **INTEGRITY FAILURE.** 6mm x 150mm gap gauge would have entered the furnace through the gap approximately 1750mm from the viewing platform and 600mm from the right-hand side of the specimen. **FURTHER INTEGRITY FAILURE.** 25mm diameter gap gauge would have entered the furnace through the gap approximately 1750mm from the viewing platform and 600mm from the right-hand side of the specimen. **TEST TERMINATED** at the request of the customer.

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Furnace Temperature Graph

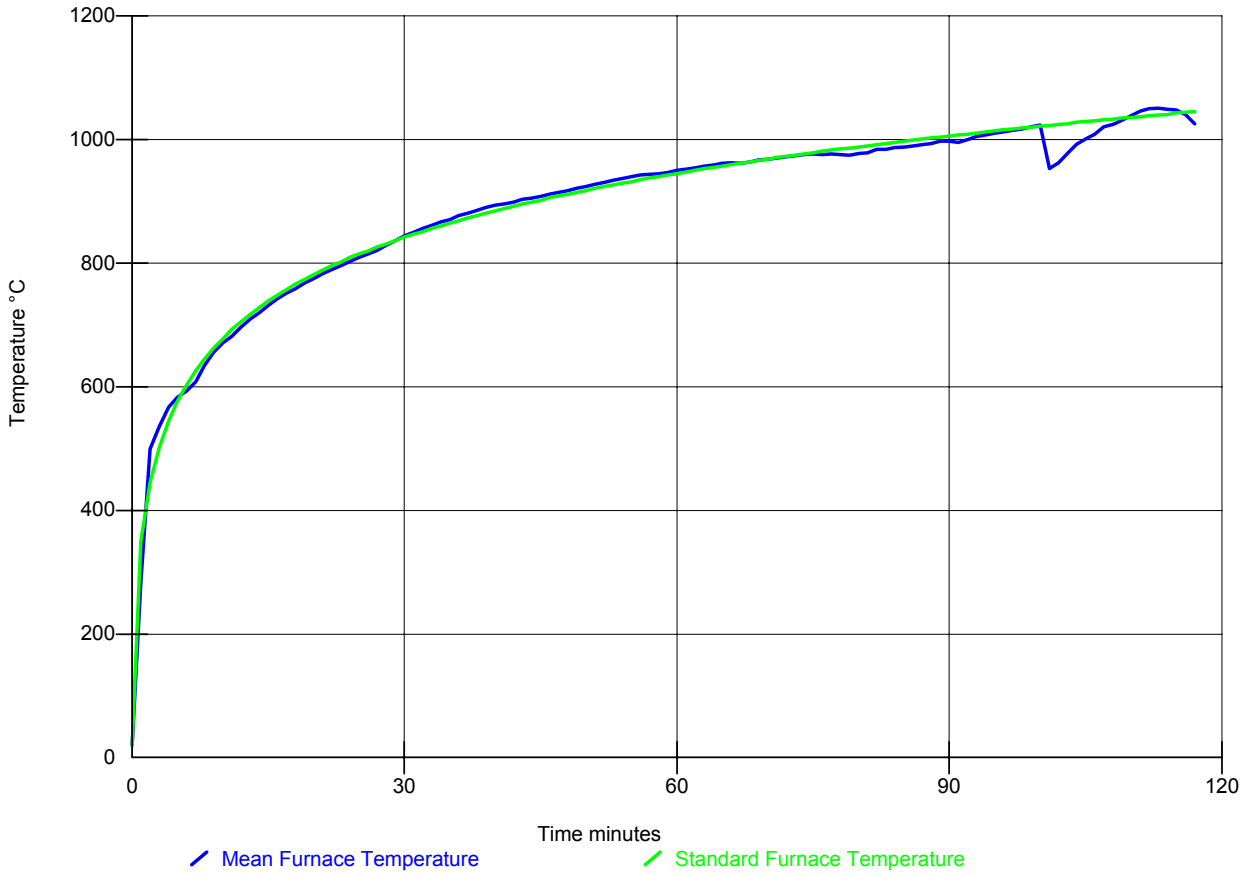

Figure 4. Furnace temperature graph.

The lower frame fell into the furnace at 100 minutes knocking the furnace thermocouples. The furnace stayed within the tolerances stated in BS EN 1363-1: 1999.

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Furnace Pressure Graph

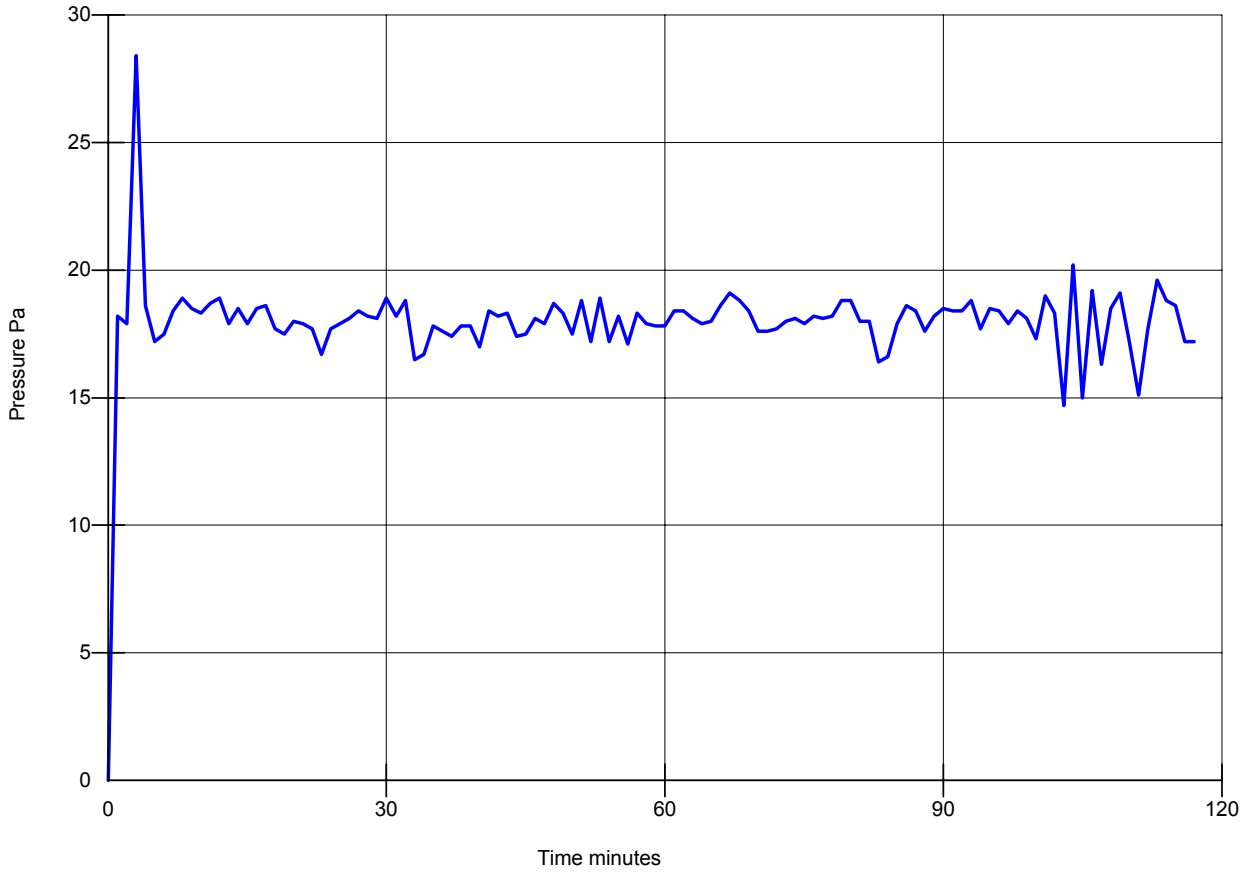

Figure 5. Furnace pressure graph.

The furnace pressure was out of the allowed tolerances during the 103 and 104 minutes.

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Unexposed Face Temperature Graph

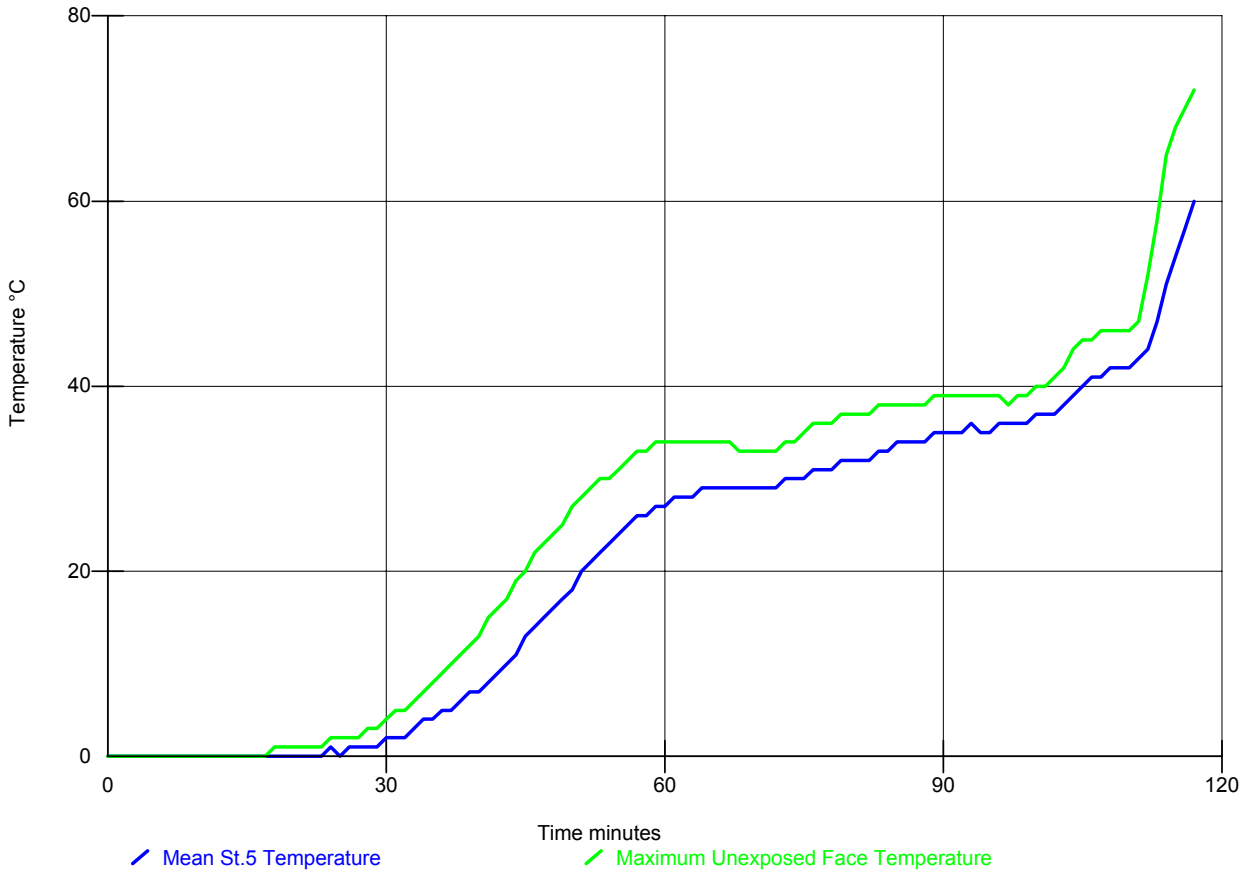

Figure 6. Unexposed face temperature graphs.

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Loughborough
Leics. LE12 6NP
Tel (0115) 945 1564
Fax (0115) 945 1562
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Unexposed Face Thermocouple Layout

Viewing Platform

⊗ Thermocouple positions

Figure 7. Unexposed face thermocouple layout.

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Tel (0115) 945 1564
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Unexposed Face Standard Five Thermocouple Data

Time (mins)	Temperature Rise (°C)				
	Thermocouple No. 20	Thermocouple No. 21	Thermocouple No. 22	Thermocouple No. 23	Thermocouple No. 24
0	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	0	0	0	0
17	0	0	0	0	0
18	1	0	0	0	0
19	1	1	0	0	1
20	1	1	0	1	0
21	1	1	0	1	1
22	1	0	0	0	0
23	1	1	0	0	0
24	1	2	1	1	0
25	1	2	0	0	0
26	2	2	1	1	1
27	2	2	1	1	1
28	3	3	1	1	1
29	3	3	1	1	1
30	4	4	1	1	1
31	4	5	1	1	1
32	5	5	1	2	1
33	6	6	2	2	2
34	7	7	2	2	2
35	7	8	2	2	2

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Time (mins)	Temperature Rise (°C)				
	Thermocouple No. 20	Thermocouple No. 21	Thermocouple No. 22	Thermocouple No. 23	Thermocouple No. 24
36	8	9	2	3	3
37	9	10	3	3	3
38	11	11	3	3	4
39	12	12	4	4	4
40	13	13	4	4	5
41	14	15	4	5	6
42	16	16	5	6	6
43	17	17	5	7	7
44	18	19	6	8	8
45	20	20	7	9	9
46	21	22	7	10	11
47	22	23	8	11	12
48	24	24	9	13	13
49	25	25	9	14	15
50	26	27	10	15	16
51	27	28	11	16	18
52	28	29	12	18	19
53	29	30	13	19	20
54	30	30	14	21	22
55	31	31	14	22	23
56	32	32	15	23	24
57	32	33	16	24	25
58	33	33	17	25	26
59	33	34	17	26	26
60	34	34	18	26	27
61	34	34	19	27	28
62	34	34	19	27	28
63	34	34	20	28	28
64	34	34	20	28	29
65	34	33	21	28	29
66	34	33	21	28	29
67	34	33	21	29	29
68	33	33	22	29	29
69	33	33	22	29	30
70	33	33	22	29	30
71	33	33	22	29	30
72	33	33	22	30	31
73	34	33	23	30	31

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Time (mins)	Temperature Rise (°C)				
	Thermocouple No. 20	Thermocouple No. 21	Thermocouple No. 22	Thermocouple No. 23	Thermocouple No. 24
74	34	33	23	30	31
75	35	34	23	30	31
76	36	34	23	31	31
77	36	35	24	31	32
78	36	35	24	31	32
79	37	35	24	32	32
80	37	35	25	32	33
81	37	36	25	33	33
82	37	36	25	33	33
83	38	37	25	34	34
84	38	37	26	34	34
85	38	38	26	34	34
86	38	38	26	35	35
87	38	38	27	35	35
88	38	38	27	35	35
89	39	39	27	35	35
90	39	39	27	36	36
91	39	39	27	36	36
92	39	39	28	36	36
93	39	39	28	37	37
94	39	38	28	37	37
95	39	38	28	37	37
96	39	38	28	38	38
97	38	38	28	38	38
98	38	38	29	39	39
99	38	38	29	39	39
100	38	39	29	40	40
101	38	39	29	40	40
102	39	39	29	40	41
103	39	40	30	41	42
104	40	41	30	43	44
105	40	42	31	44	45
106	41	43	31	45	45
107	42	44	31	45	46
108	42	44	32	46	46
109	43	45	32	46	46
110	44	45	33	46	46
111	44	45	33	47	47

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Time (mins)	Temperature Rise (°C)				
	Thermocouple No. 20	Thermocouple No. 21	Thermocouple No. 22	Thermocouple No. 23	Thermocouple No. 24
112	44	44	34	52	50
113	44	45	34	58	57
114	46	47	35	63	65
115	49	51	36	67	68
116	55	55	38	68	70
117	61	60	40	70	72

See figure 7 for the location of the thermocouples.

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Loughborough
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Specimen Deflection Data

Time (minutes)	Deflection (mm)
0	0
1	-0.2
2	-0.3
3	-0.5
4	-0.7
5	-0.8
6	-1
7	-1.1
8	-1.3
9	-1.3
10	-1.7
11	-1.6
12	-1.6
13	-1.8
14	-2.2
15	-2.3
16	-2.5
17	-2.5
18	-2.6
19	-2.6
20	-2.6
21	-2.7
22	-2.7
23	-2.7
24	-2.7
25	-2.8
26	-2.7
27	-2.6
28	-2.6
29	-2.4
30	-2.2
31	-2.1
32	-2
33	-1.8
34	-1.7
35	-1.5
36	-1.4

UKAS TESTING
0296

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Time (minutes)	Deflection (mm)
37	-1.3
38	-1.1
39	-0.9
40	-0.9
41	-0.8
42	-0.7
43	-0.7
44	-0.7
45	-0.7
46	-0.8
47	-0.8
48	-0.7
49	-0.9
50	-1
51	-1.1
52	-1.2
53	-1.4
54	-1.4
55	-1.5
56	-1.6
57	-1.8
58	-1.8
59	-1.9
60	-2
61	-2.1
62	-2.1
63	-2
64	-2.1
65	-2
66	-1.9
67	-1.9
68	-1.6
69	-1.4
70	-1
71	-1
72	-0.8
73	-0.7
74	-0.6
75	-0.6

The Building Test Centre
Fire Acoustics Structures

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Time (minutes)	Deflection (mm)
76	-0.5
77	-0.4
78	-0.4
79	-0.3
80	-0.3
81	-0.4
82	-0.4
83	-3.8
84	-3.9
85	-3.9
86	-3.8
87	-3.9
88	-3.7
89	-3.5
90	-3.5
91	-3.6
92	-3.4
93	-3.6
94	-3.6
95	-3.5
96	-3.4
97	-3.1
98	-3.3
99	-3.3
100	-3.3
101	-3.4
102	-3.7
103	-3.6
104	-3.5
105	-3
106	-2.4
107	-1.2
108	0.3
109	2.8
110	7
111	14.5
112	24.2
113	34.6
114	44.8

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Time (minutes)	Deflection (mm)
115	58.4
116	81.6
117	85.0

Deflection measurements were taken from the centre of the specimen.

Negative readings indicate deflection out of the furnace.

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PHOTOGRAPHS

Photograph 1. Exposed face prior to test.

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Fax (0115) 945 1562
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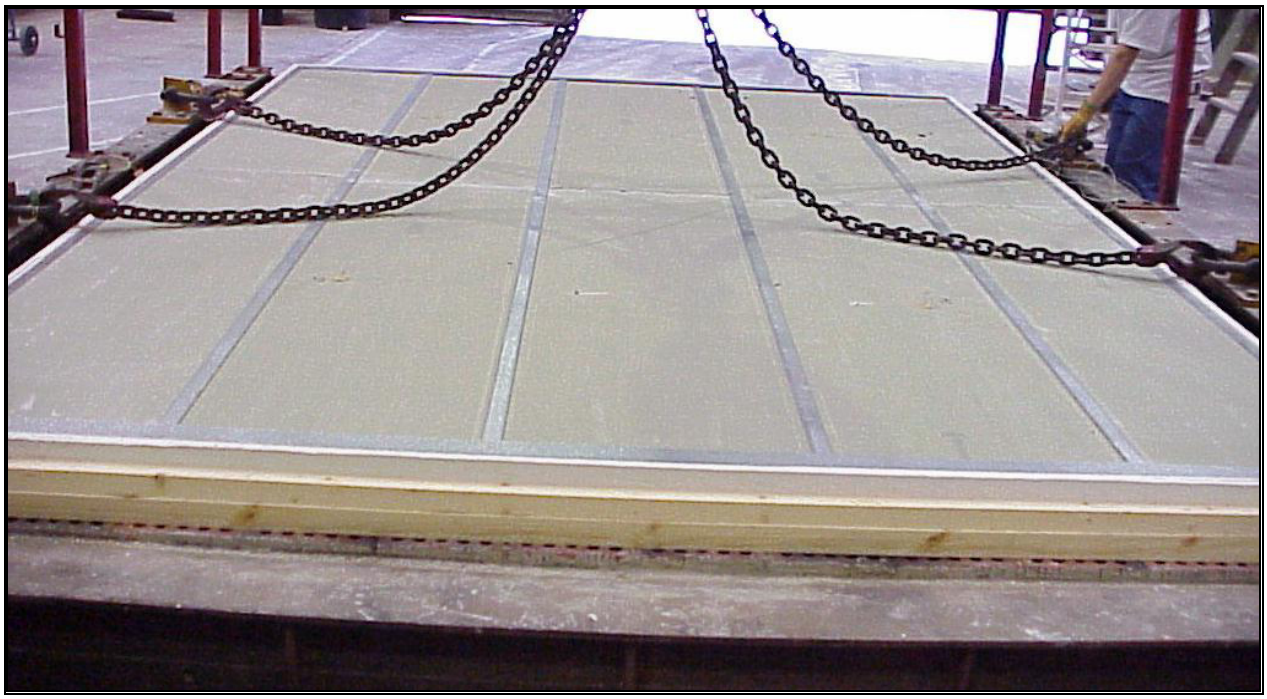

Photograph 2. Unexposed face prior to test.

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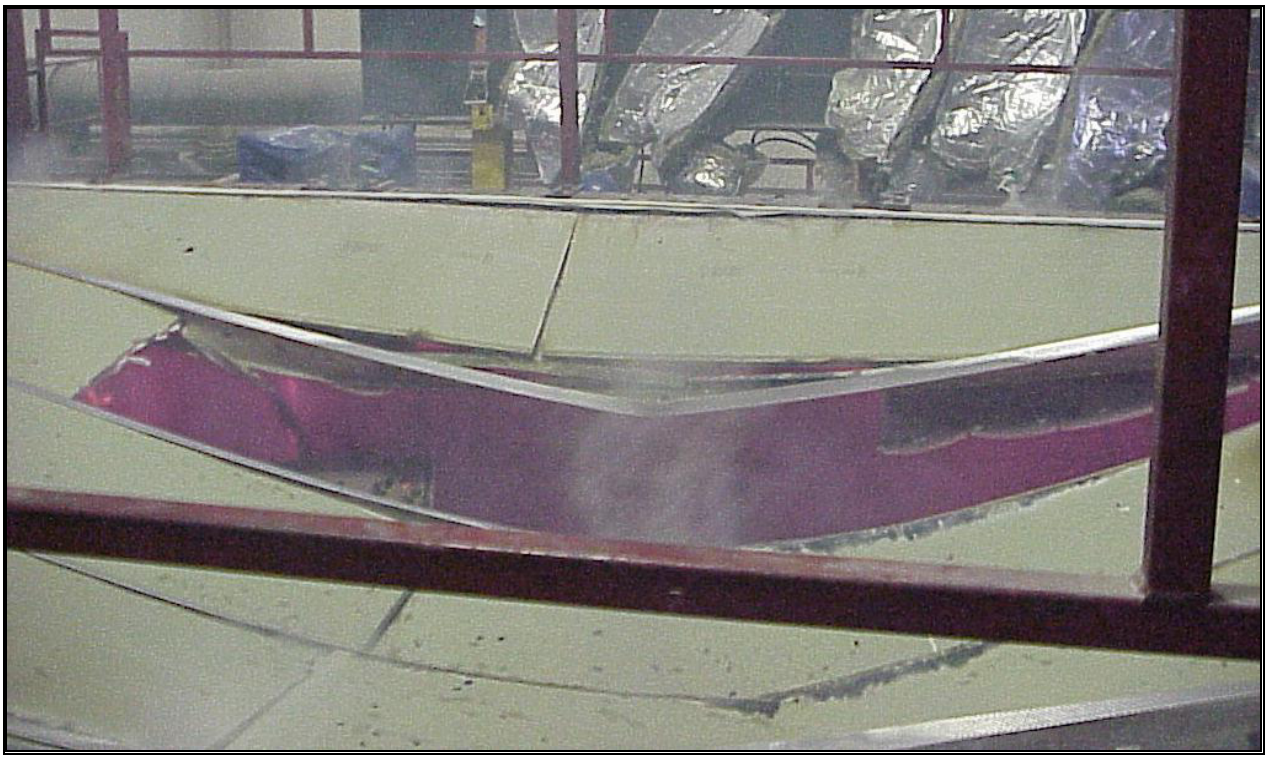

Photograph 3. Unexposed face after test termination at 117 minutes.

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East Leake
Loughborough
Leics. LE12 6NP
Tel (0115) 945 1564
Fax (0115) 945 1562
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FIELD OF DIRECT APPLICATION

The applicability of the test results shall be restricted to other constructions where the installation of the ceiling is carried out from below.

Suspended ceilings with fire from below:

i) Size:

- For ceilings where both length and width are greater than or equal to (4 x 3) m in practice, and which were tested at (4 x 3) m size, and in which the most onerous direction lies in the 4m direction of the furnace, the results may be applied to ceilings up to 4.4m long. There shall be no restriction on application of the result in the width direction. The provisions with respect to most onerous configuration as given in BS EN 1364-2: 1999 Paragraph 6.3.2 shall be followed in the direct application of results.

Maximum Specimen Span	Maximum Specimen Width
4400mm	Unlimited

ii) Fittings:

- Fittings which may be installed are those which have been included in the test specimen, with a distribution per unit area not greater than that tested.

iii) Cavity:

- The test results are valid for cavities of any height.