LPC Laboratories
Centre for Fire and Security Testing
Melrose Avenue, Borehamwood, Hertfordshire, WD6 2BJ
Telephone: 020 8207 2345 Facsimile: 020 8207 6305

TE 200479

TEST REPORT

Title: Fire resistance test in accordance with B.S. 476 : Part 22 : 1987 on a plasterboard ceiling membrane with a Fire Proofing Services Ltd. access panel fitted.

Client: Fire Proofing Services Ltd.,
13 Shilton Road,
Barwell,
Leicestershire,
LE9 8NB.

Date: 14 September 2000

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Melrose Avenue, Borehamwood, Hertfordshire, WD6 2BJ
Telephone: 020 8207 2345 Facsimile: 020 8207 6305

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CONTENTS

SUMMARY

A plasterboard ceiling membrane, constructed from a steel framework with two layers of Lafarge Firecheck plasterboard fixed on the underside, had a Fire Proofing Services Ltd. access panel installed and was submitted to a fire resistance test in accordance with B.S. 476 : Part 22 : 1987 (Method 9 for ceiling membranes) on 22 June 2000. The ceiling membrane was 3.5m x 4.15m overall and the access panel was installed in a structural opening, nominally 1185mm x 1185mm, in the centre of the ceiling.

The fire resistance of the ceiling was found to be:

Integrity:	65min
Insulation:	19min

1 OBJECTIVE

To determine, at the request of Fire Proofing Services Ltd., the fire resistance of a plasterboard ceiling membrane with a Fire Proofing Services Ltd. access panel installed in the centre, when tested in accordance with B.S. 476 : Part 22 : 1987[1] (Method 9 for ceiling membranes).

2 TEST CONSTRUCTION

2.1 General

The ceiling membrane was installed on 16 and 19 June 2000 within a 3500mm x 4150mm aperture of a heavily reinforced concrete test frame. The access panel was installed on 19 and 20 June 2000, so that the doors opened into the furnace.

The general construction is shown in Figure 1, and in Plates 1 to 4 before the test.

2.2 Ceiling membrane

The ceiling membrane, shown in Figure 1, was constructed from a steel framework and two layers of Lafarge Firecheck Plasterboard. The steel framework was constructed from edge channels, primary channels and ceiling channels which formed a support structure for the plasterboard to be screwed to. The edge channel was a U-section channel with one side deeper than the other, nominally 30mm x 26mm x 20mm, and was screwed around the perimeter of the aperture in the test frame, as shown in Figure 1, using 38mm-long Drywall screws with aluminium expansion plugs. Ceiling channels were then positioned so that they spanned between the two 3.5m long edges of the test frame at 450mm centres, as shown in Figure 1. The ceiling channels were primarily U-sections, approximately 60mm wide x 25mm deep, but had two 10mm folded tabs along their top edge producing a top-hat-section of overall dimensions 80mm wide x 25mm deep. Because the ceiling channels were only 3600mm long secondary lengths of channel were cut down, approximately 700mm long, to allow the ceiling channels to completely span across the test frame. The ends of the channels sat in the edge channels around the perimeter of the test frame and where joins were made the two joining lengths of ceiling channel overlapped each other meaning that one piece just sat in the other. This method of joining also allowed for expansion during the test as the channels were free to slide over each other. The primary channels were positioned so that they spanned between the two 4150mm edges of the test frame above the ceiling channels at 600mm centres. The primary channels were C-section channels, nominally 15mm x 45mm x 15mm, the ends of which sat on top of the edge channels and were fixed in position using 14mm-long, Wafer Head, Lafarge Grabber screws. At every position where the primary channels passed over the top of the ceiling channels the ceiling channels were fixed to the primary channels using clips that passed around the top of the primary channels and supported the ceiling channels underneath the 10mm folded tabs.

The whole framework was supported from above by four, 4.5m-long I-section steel beams that were laid across the top of the test frame in the positions shown in Figure 1. Lengths of steel angle, nominally 25mm x 25mm x 200mm long, were screwed to the primary channels using 14mm-long, Wafer Head, Lafarge Grabber screws and were fixed to the flange's of the steel beams via clips which clipped onto the flange and were screwed to the steel angle using 14mm-long, Wafer Head, Lafarge Grabber screws.

A square hole, nominally 1185mm x 1185mm, was cut in the centre of the framework to allow installation of the access panel. The hole, shown in Figure 1, was exactly the same size as the distance between two of the primary channels meaning that primary channels ran along two edges of the hole. Two shorter lengths of primary channel were then fixed spanning between the existing two channels forming a perimeter of primary channel around the hole. Edge channels were then screwed to the underside of the perimeter primary channels, as shown in Figure 1, to support the ends of the ceiling channels that had been cut away, as shown in Figure 2, and to allow plasterboard to be fixed to it later. The four internal corners of the hole were reinforced with angle sections, nominally 25mm x 25mm x 20mm. To complete the ceiling membrane, two layers of Lafarge Firecheck plasterboard, 12.5mm thick, were fixed to the underside of the framework, excluding the hole allowed for the access panel, by screwing the plasterboard to the ceiling channels (and edge channels where applicable) using Lafarge Grabber screws (25mm and 38mm long). The joins in the plasterboard were then filled using Lafarge jointing compound and tape.

2.3 Access panel

Details of the access panel are shown in Figures 2 and 3. The access panel consisted of a perimeter frame, providing a clear opening of 1095mm x 1095mm, which was closed via two door leaves, nominally 586.5mm wide x 1173mm. The perimeter frame was made from 1.2mm-thick Zintec steel which had been polyester powder coated to Ral9010 (20% gloss) and had a section as showed in Figure 3. The frame was fitted into the ceiling membrane from below and had a 25mm-wide picture frame surround (mitred in each corner) on its bottom edge which overlapped the plasterboard ceiling membrane by approximately 20mm, as shown in Figure 2. The frame was fixed in position using a steel angle, nominally 25mm x 15mm, which was screwed to the primary channels surrounding the structural opening and to the top edge of the perimeter frame, as shown in Figure 2. Due to the shape of the frame where the steel angle was fixed, a void was left between the access panel frame and the ceiling membrane, shown in Figure 2, which was filled with mineral fibre and fire resistant mastic. The top edge of the frame overlapped the door leaves by approximately 40mm, which reduced the clear opening of the access panel to 1095mm x 1095mm.

Each of the door leaves consisted of 1mm-thick, folded Zintec steel tray which was polyester powder coated (on the exposed face) in Ral9010 (20% gloss). Each leaf was internally stiffened via two pre-formed top-hat section stiffeners that were welded to the sides and bottom of the steel trays, as shown in Figure 3. A 12.5mm-thick sheet of Lafarge Megadeco plasterboard, treated with one coat of Lafarge Drywall Sealer, was fixed to the rear face (unexposed face) of each of the door leaves, as shown in Figure 3. The Megadeco plasterboard was fixed in position via 32mm-long drywall screws screwed into the stiffeners and folded returns of the door tray (shown in Figure 3). Each of the door leaves was hung via a continuous hinge that was welded to the door trays and was bolted to the frame using three M6 bolts welded to the frame at 300mm centres (shown in Figure 3). The meeting stile between the two door leaves is shown in Figure 3 and the passive leaf was fitted with a 1.2mm-thick steel locking angle/meeting astragal, as shown in Figure 3, which overlapped the active leaf by approximately 25mm. The passive leaf was fitted with two Budget locks, as shown in Figure 3, that engaged approximately 14mm with steel angles, nominally 20mm x 15mm, fixed to the surrounding frame. The two locks were operated from the unexposed face of the leaf via a Budget key. The active leaf was fitted with a three point locking system that incorporated a mid-span latch, nominally 18mm x 33mm, that engaged with the passive leaf and two shoot bolts that engaged in corresponding housings fixed to the frame. The three point locking was operated from the exposed face of the construction via a Budget key, as shown in Figure 3.

2.4 Miscellaneous

The access panel was fitted with three fire retardant smoke seals, shown in Figure 3. One continuous seal around the perimeter of the frame and two seals incorporated in the meeting stile of the two leaves.

The lock hole on the exposed face was fitted with a plastic dome plug and collar.

The access panel was not opened before the test as a Budget key was not supplied by the sponsor.

3 CONDITIONING

At the time of construction a representative sample of the Firecheck plasterboard was taken and on the day of the test was weighed and placed in a 50°C oven for 24 hours in order to find the free moisture content by weight loss technique. The plasterboard was found to have a free moisture content of 0.53% and a density per unit area of 10.2kg/m^2.

4 TEST PROCEDURE

4.1 General

The test was carried out on 22 June 2000 in accordance with B.S. 476 : Part 22 : 1987[1] (method 9 for ceiling membranes). The test was witnessed by Messrs. T. Beasley, D. Blenkinsopp, C. Marvin, M. Parker and P. Carpenter representing the sponsor, and Mr J Kitchener, consultant.

The ambient temperature at the start of the test was 17.9°C.

4.2 Furnace control

The furnace temperature was measured by means of ten bare-wire chromel/alumel thermocouples arranged in the furnace as shown in Figure 4, with their measuring junctions located 100mm below the exposed face of the ceiling. The furnace was controlled so that the mean of these thermocouple readings followed the time/temperature relationship of B.S. 476 : Part 20 : 1987[2]. The mean temperature is plotted against time in Figure 5 with the standard curve for comparison.

A pressure sensing head monitored pressure in the furnace 100mm below the ceiling. The pressure conditions within the furnace were maintained in accordance with Section 3.2 of B.S. 476 : Part 20 : 1987[2].

4.3 Temperature measurements on specimen

The temperature of the unexposed face of the test specimen was measured by means of twenty-one copper/constantan thermocouples, fixed to the surface and covered with an insulating pad. The position of each thermocouple is shown in Figure 4 and Table 1.

Table 1 Thermocouple locations

Thermocouple	Position
1	On the plasterboard in the centre of one ¼ section of the ceiling membrane.
2	On the plasterboard in the centre of one ¼ section of the ceiling membrane.
3	On the plasterboard adjacent to one edge of the access panel.
4	On one side of the perimeter frame of the access panel.
5	In the centre of one ¼ section of the access panel.
6	In the centre of one ¼ section of the access panel.
7	On one side of the perimeter frame of the access panel.
8	In the centre of the access panel.
9	On one side of the perimeter frame of the access panel.
10	On the plasterboard adjacent to one edge of the access panel.
11	On the plasterboard adjacent to one edge of the access panel.
12	In the centre of one ¼ section of the access panel.
13	In the centre of one ¼ section of the access panel.
14	On the plasterboard adjacent to a join in the top layer of plasterboard.
15	In a ceiling channel, over a join in the top layer of plasterboard.
16	On one side of the perimeter frame of the access panel.
17	On the plasterboard adjacent to one edge of the access panel.
18	On the plasterboard in the centre of one ¼ section of the ceiling membrane.
19	On the plasterboard in the centre of one ¼ section of the ceiling membrane.
20	On the plasterboard adjacent to a join in the top layer of plasterboard.
21	In a ceiling channel, over a join in the top layer of plasterboard.

Thermocouples 1,2,10,18 and 19 were used to monitor the mean temperature of the unexposed face of the construction, and thermocouples 5,6,8,12 and 13 were used to monitor the mean temperature of the unexposed face of the access panel. All of the thermocouples were used to measure the maximum temperature of the unexposed face of the construction.

4.4 Deflection measurements

A linear deflection transducer was connected via a fine steel wire to the centre of the access panel to continuously measure vertical deflection throughout the test at that point.

5 RESULTS

5.1 Observations

Observations made during the test are given in Table 2. Unless otherwise stated observations are from the unexposed face.

Table 2 Observations

Time min : s	Observations
0:00	Test started.
3:00	Slight smoke issuing from around the edges of the access panel.
5:00	Volume of smoke has increased.
6:00	Slight smoke starting to issue from the joins in the plasterboard.
12:00	Smoke is now starting to issue from the edges of the construction. The smoke is heaviest from around the edges of the access panel and from the joins in the plasterboard.
16:00	Smoke volume has generally increased. The edges of the backing plasterboard on each of the door leaves in the access panel are starting to blacken.
19:00	Failure of insulation due to the temperature of thermocouple 7.
24:00	A slight crack has developed in the backing plasterboard of one of the door leaves running across the whole width of the door leaf.
32:00	A similar crack as at 24min has appeared in the second door leaf. Both of the cracks meet at the meeting stile between the two door leaves.
37:00	Each door leaf is heavily discoloured centrally, down the whole length, in the form of a strip approximately 150-200mm wide.
39:00	The two cracks in the door leaves now have lots of smaller cracks emanating from them at right angles and are also heavily charred. The cracks are approximately 4-5mm wide and both of the door leaves are now completely discoloured. (see Plate 5)
46:00	The joins in the plasterboard partition are starting to discolour.
56:00	The hinged edge of each door leaf is heavily charred and cracked.
61:00	All of the joins in the plasterboard are now blackened and the paper backing sheet on the back of the plasterboard is starting to char in places.
65:00	Failure of integrity due to the fact that the doors fell open.
	Test stopped.

The test specimen is shown after the test in Plates 6 and 7.

5.2 Temperature measurements

The temperatures recorded on the unexposed face of the specimen along with the mean temperature of the unexposed face of the construction (calculated from thermocouples 1,2,10,18, and 19) and the mean temperature of the unexposed face of the access panel (calculated from thermocouples 5,6,8,12 and 13) are plotted against time in Figures 6 to 10. The maximum temperature measured was 559°C recorded by thermocouple 7 at the end of the test.

The maximum temperature limit for insulation (180°C rise) was exceeded after 19min by thermocouple 7.

5.3 Deflection measurements

The deflection recorded by the transducer is plotted against time in Figure 11. A maximum of 34.5mm was recorded at the end of the test. The position of maximum deflection was at the point of measurement, and was towards the furnace.

6 PERFORMANCE CRITERIA

The standards[1,2] state that a ceiling membrane is regarded as having a fire resistance (expressed in minutes) that is equal to the elapsed time (in completed minutes) between the commencement of heating and the termination of heating, or until failure to meet the integrity or insulation criteria occurs, whichever is the sooner.

Integrity : Failure is deemed to occur:

a) when collapse or sustained flaming for not less than 10s on the unexposed face occurs;

b) when cracks, gaps or fissures allow flames or hot gases to cause flaming or glowing of a cotton fibre pad;

c) when a 6mm-diameter gap gauge can penetrate through a gap into the furnace, other than at sill level in doorsets, and be moved in the gap for a distance of at least 150mm;

d) a 25mm-diameter gap gauge can penetrate through a gap into the furnace.

Insulation : Failure is deemed to occur:

a) when the mean unexposed face temperature increases by more than 140°C above its initial value;

b) when the temperature recorded at any positions on the unexposed face is in excess of 180°C above the initial mean unexposed face temperature;

c) when integrity failure occurs.

The results only relate 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.

7 CONCLUSIONS

A plasterboard ceiling membrane with a Fire Proofing Services Ltd. access panel installed in the centre, as described in this report, when tested in accordance with British Standard 476 : Part 22 : 1987 (Method 9) achieved the following fire resistance:

Integrity: 65min
Insulation: 19min

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.

8 REFERENCES

1 Fire tests on building materials and structures. Part 22. Methods for determination of the fire resistance of non-loadbearing elements of construction. British Standard 476 : Part 22 : 1987. British Standards Institution, London, 1987.

2 Fire tests on building materials and structures. Part 20. Method for determination of the fire resistance of elements of construction (general principles). British Standard 476 : Part 20 : 1987. British Standards Institution, London, 1987.

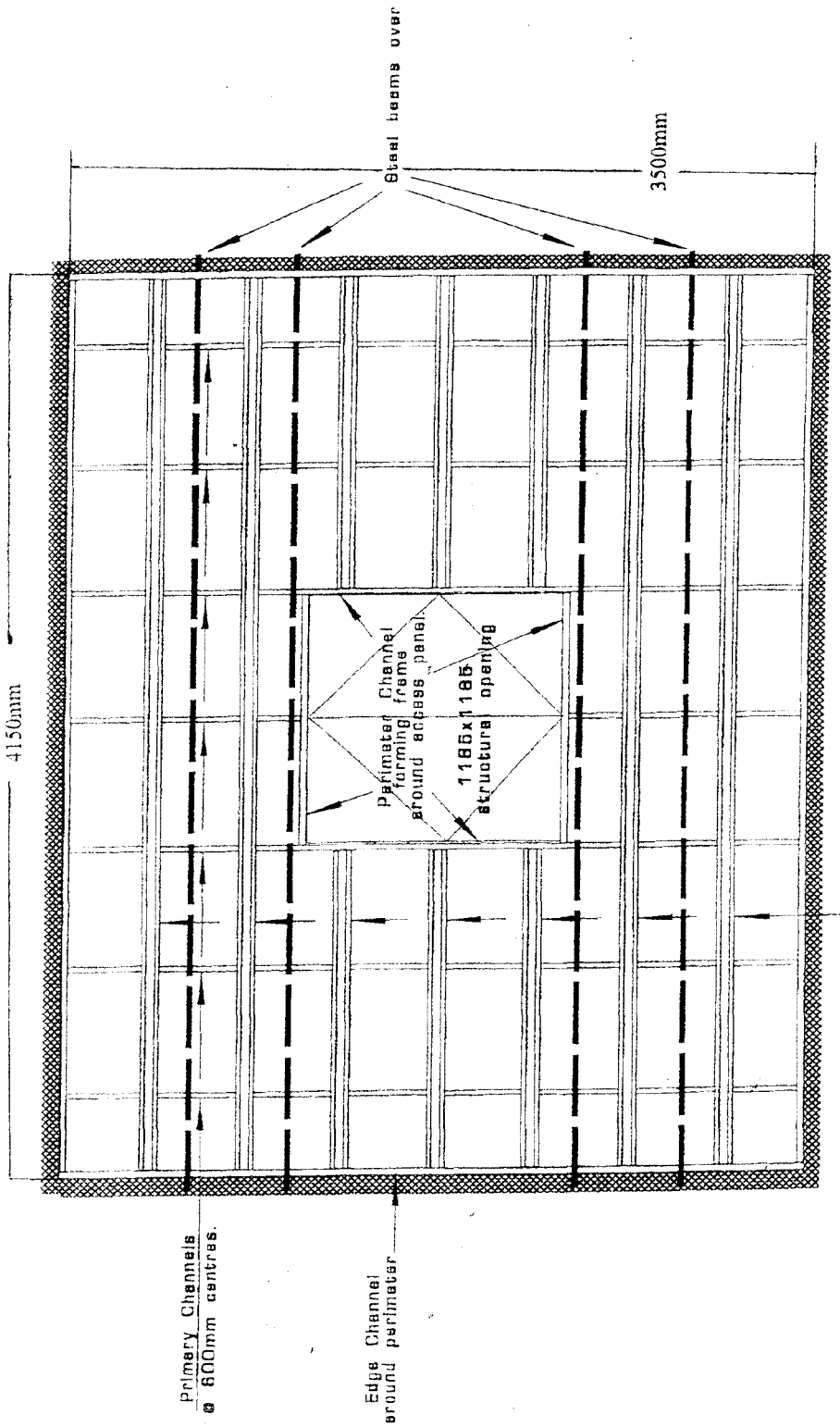


Figure 1 General construction of test specimen

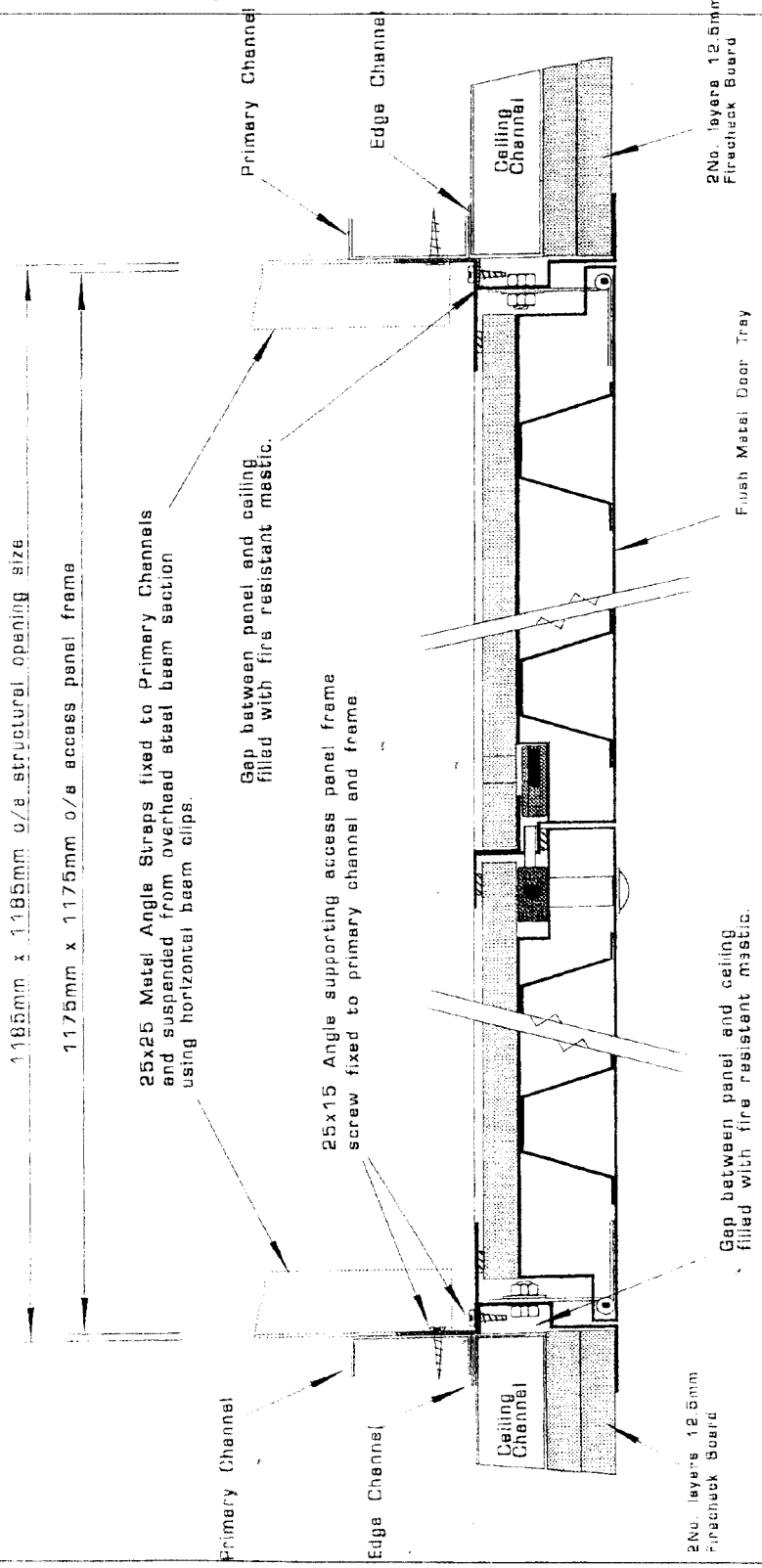


Figure 2 Meeting detail between the access panel and ceiling membrane

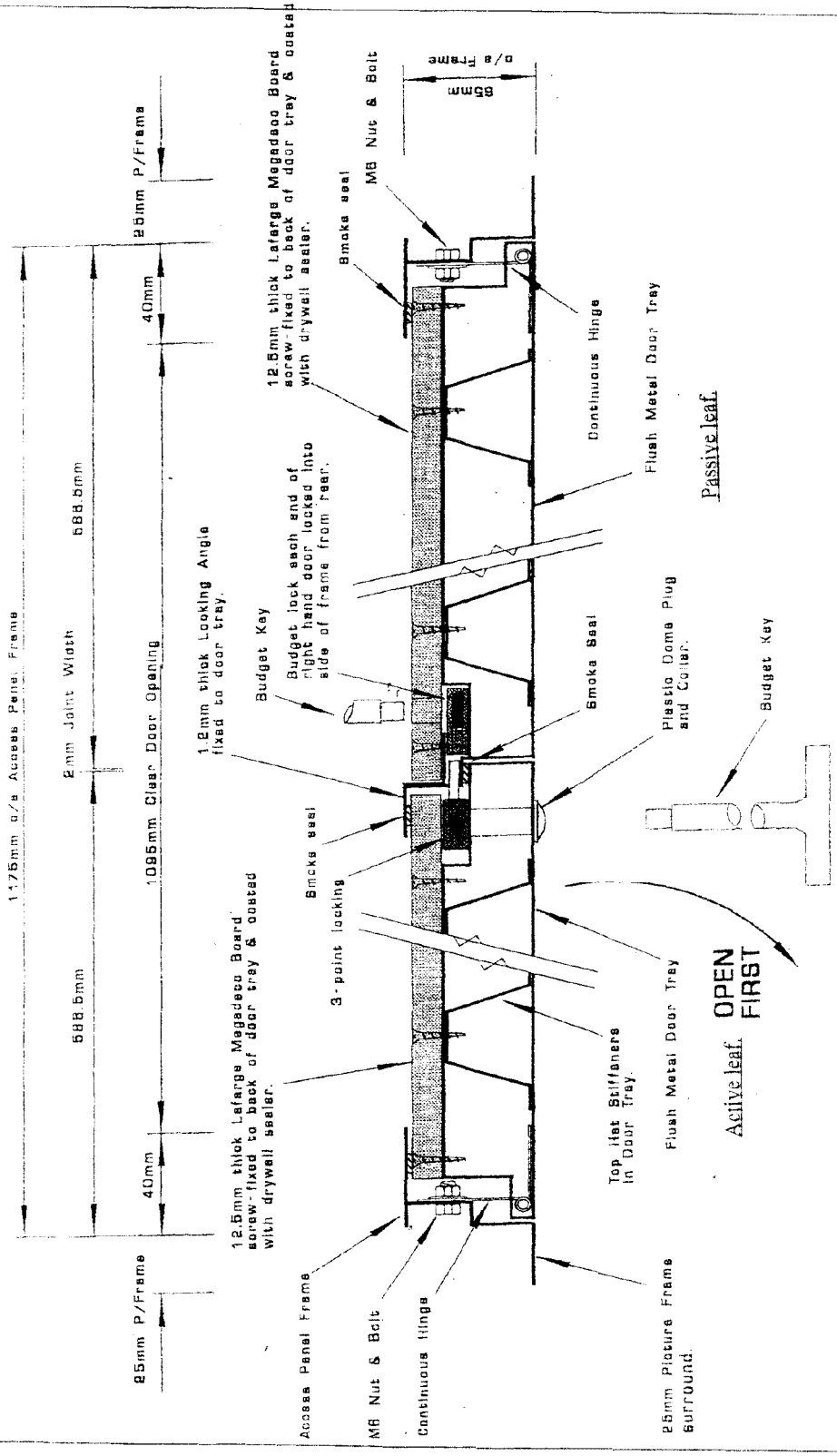
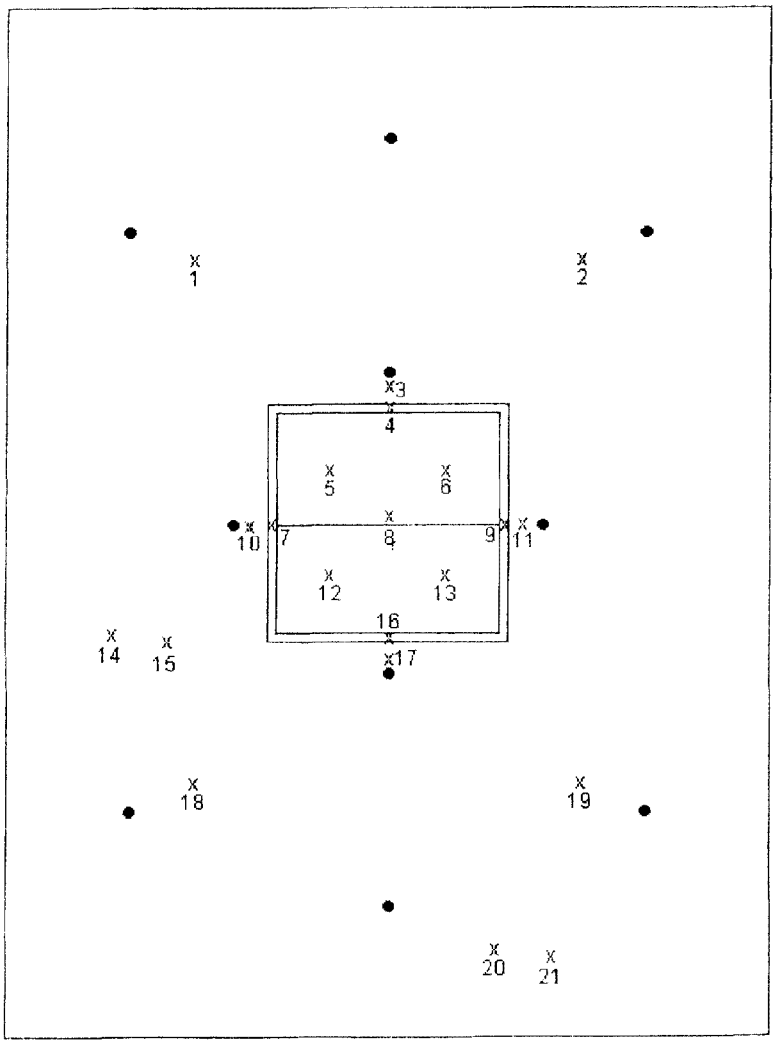


Figure 3 Access panel detail



x = Unexposed Face Thermocouple positions (numbered 1 - 21).

● = Furnace Thermocouple positions.

Figure 4 Thermocouple locations

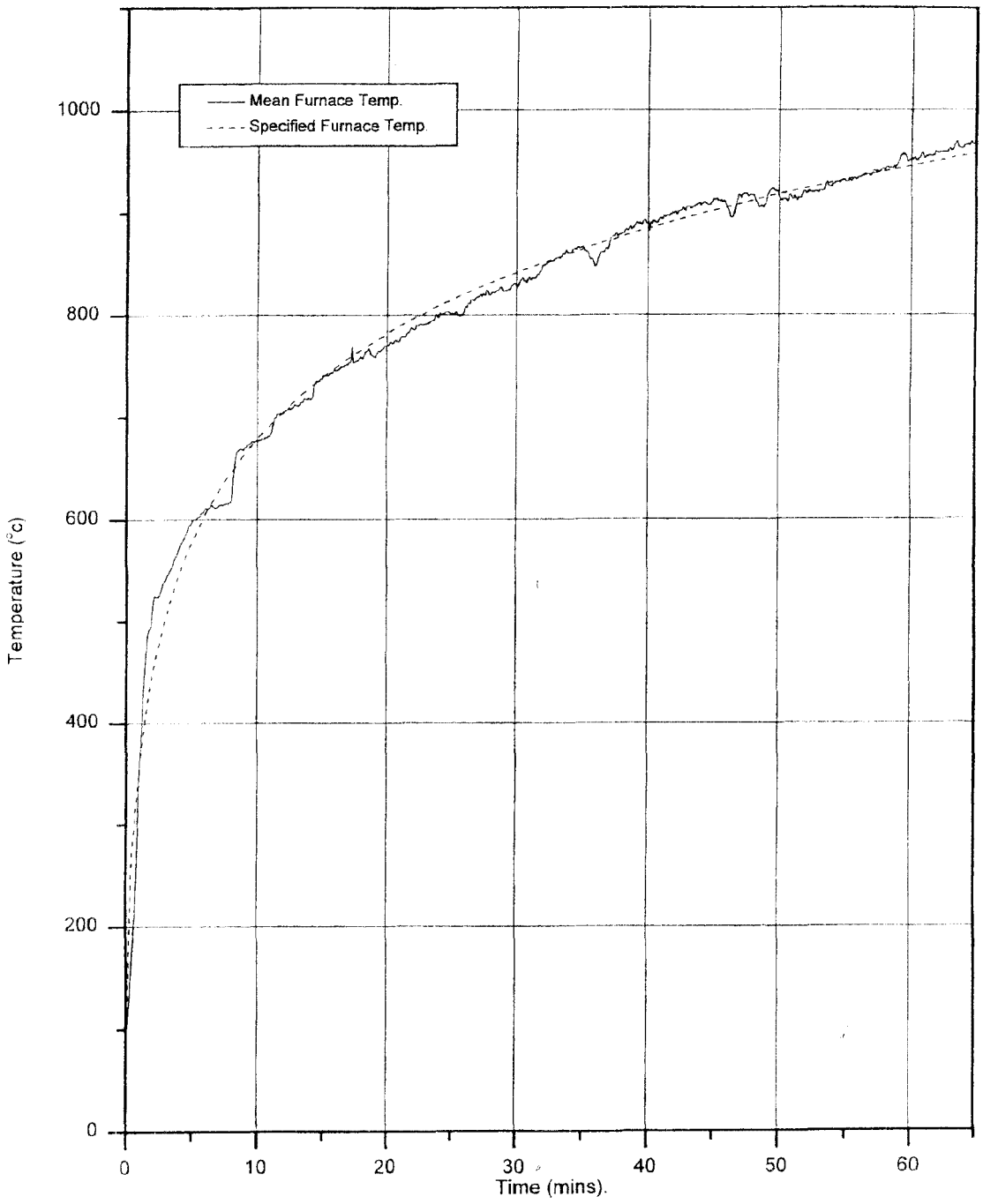


Figure 5 Furnace temperature

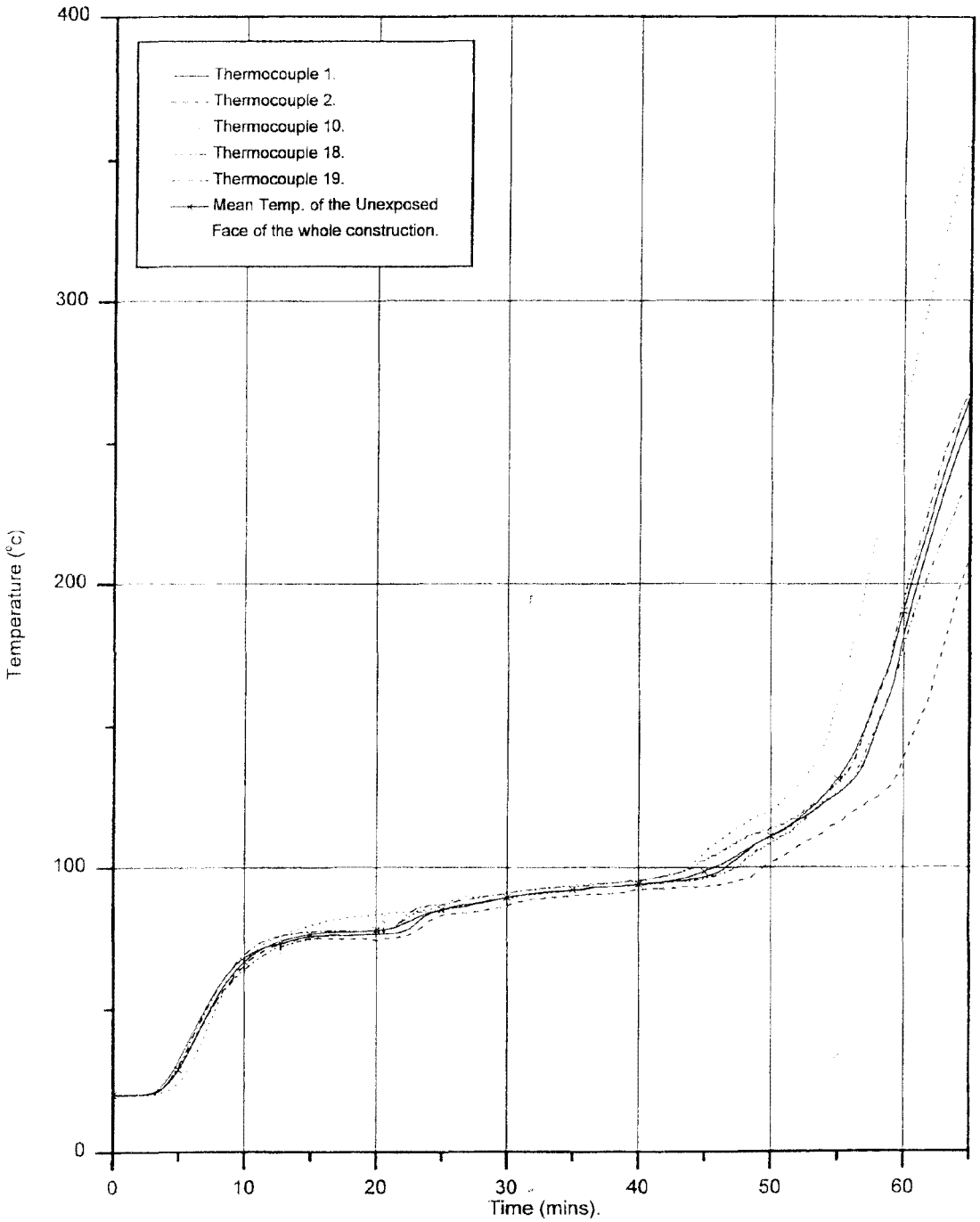


Figure 6 **Temperatures recorded from the ceiling membrane including mean temperature of the construction**

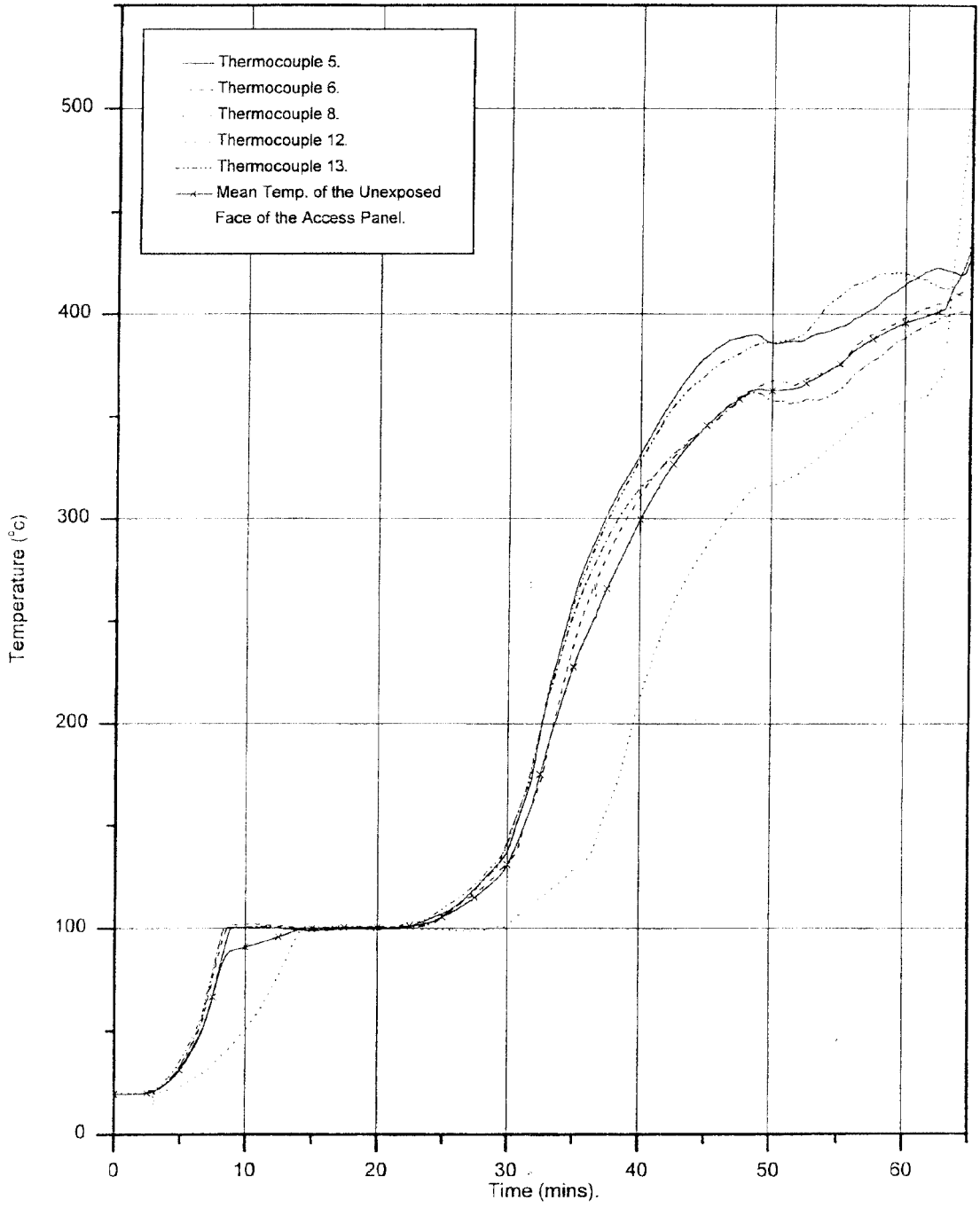


Figure 7 Temperatures recorded from the thermocouples on the access panel

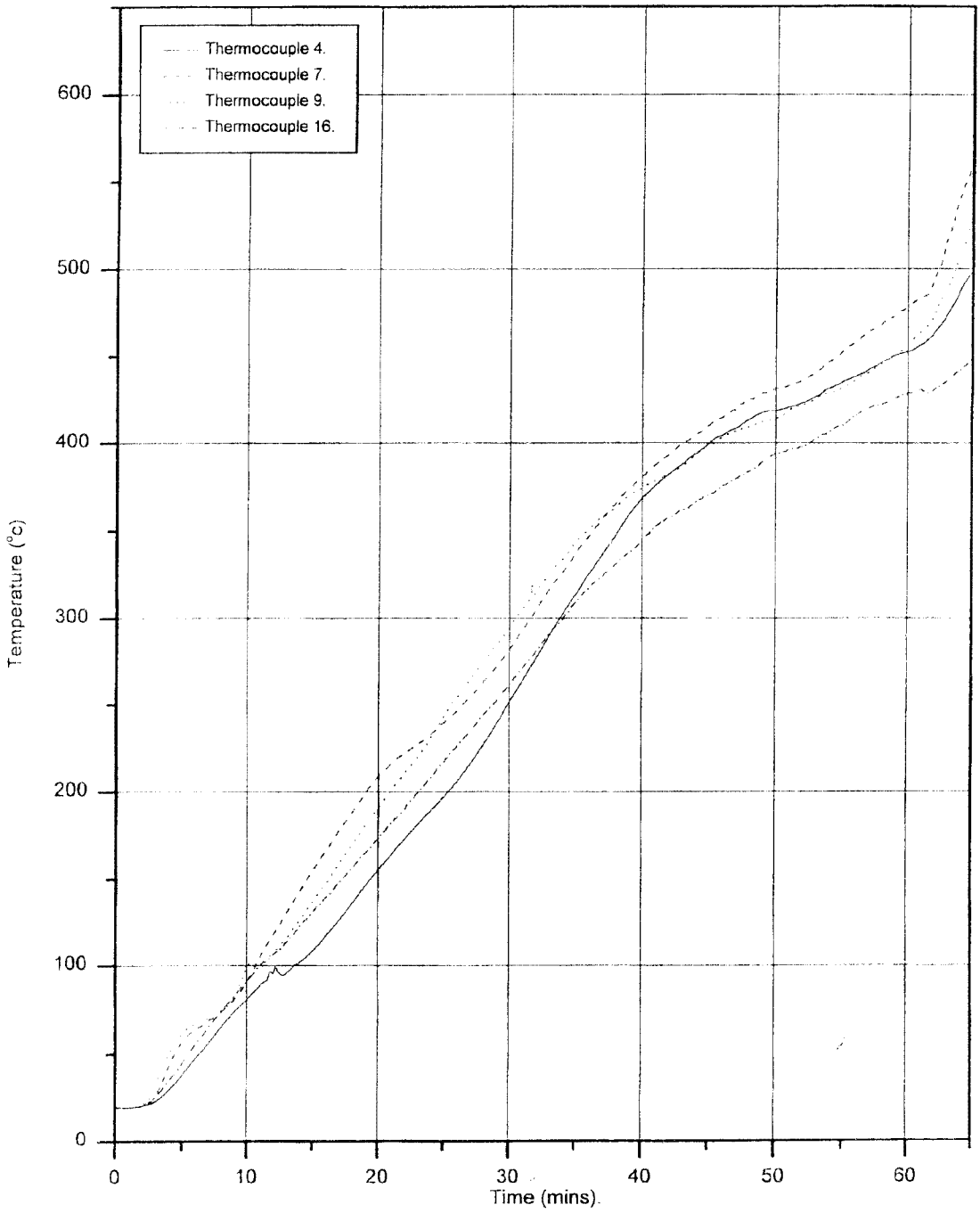


Figure 8 Temperatures recorded from the thermocouples positioned on the access panel frame

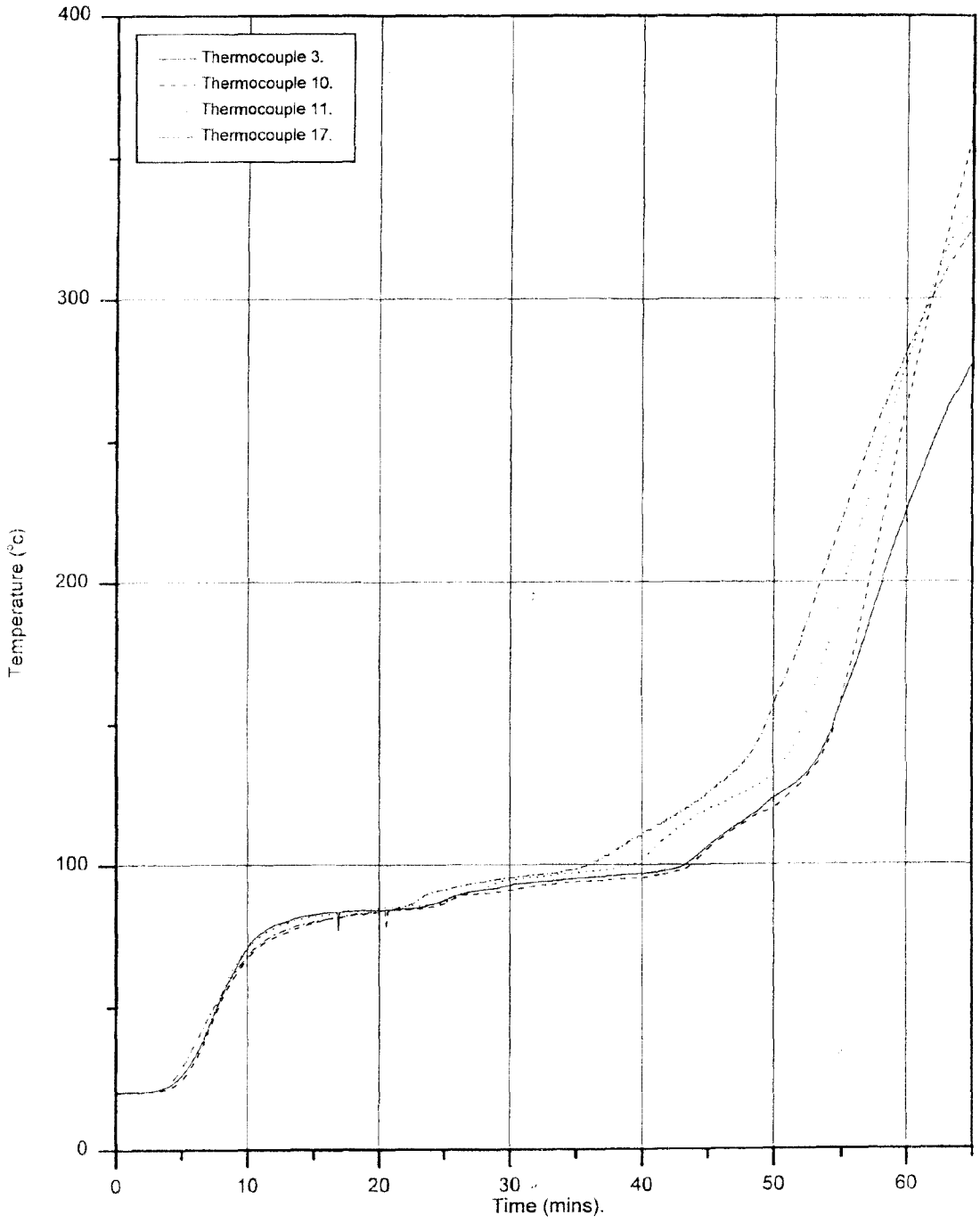


Figure 9 **Temperatures recorded from the thermocouples on the ceiling membrane surrounding the access panel**

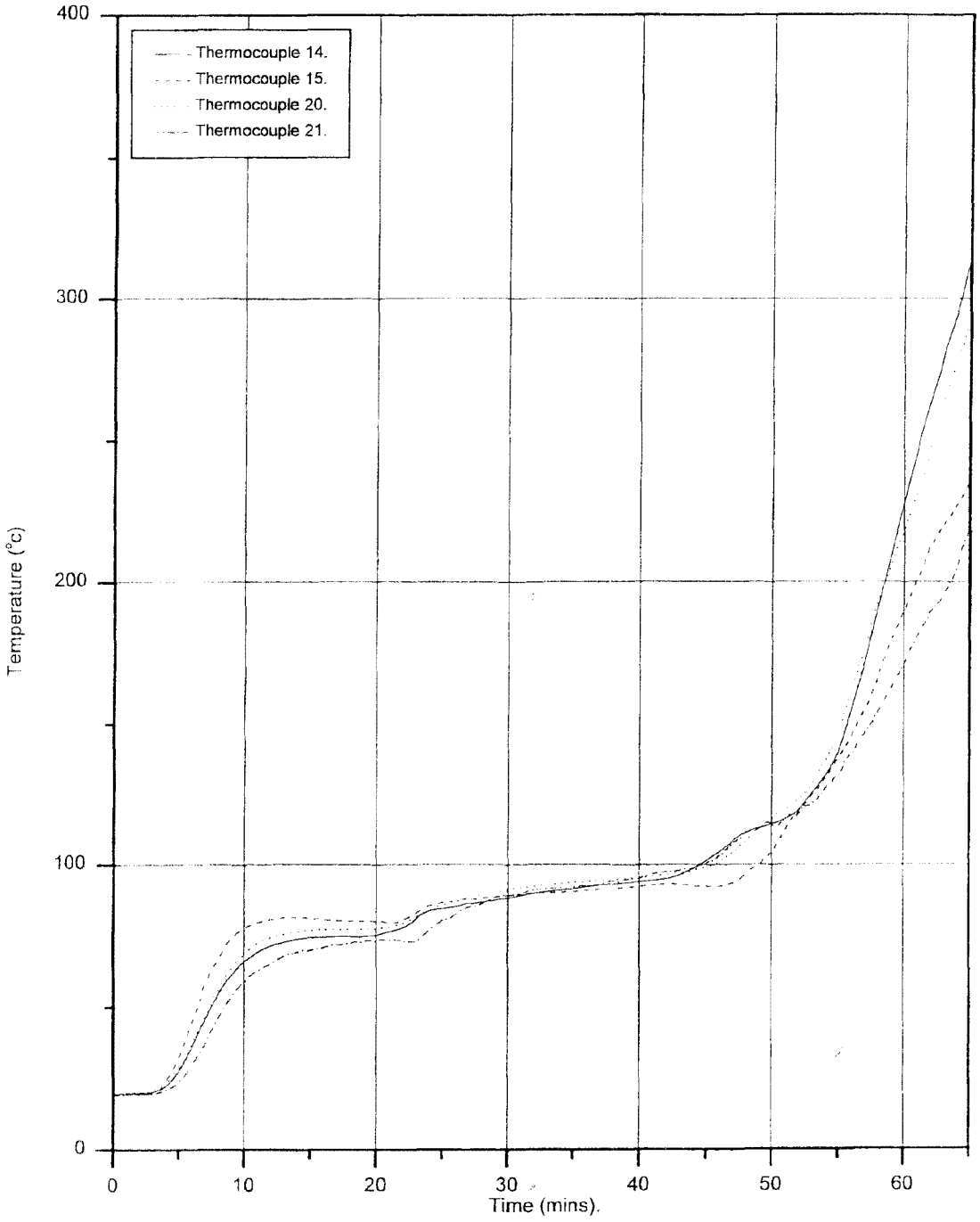


Figure 10 **Temperatures recorded from the thermocouples positioned adjacent to the joins in the plasterboard**

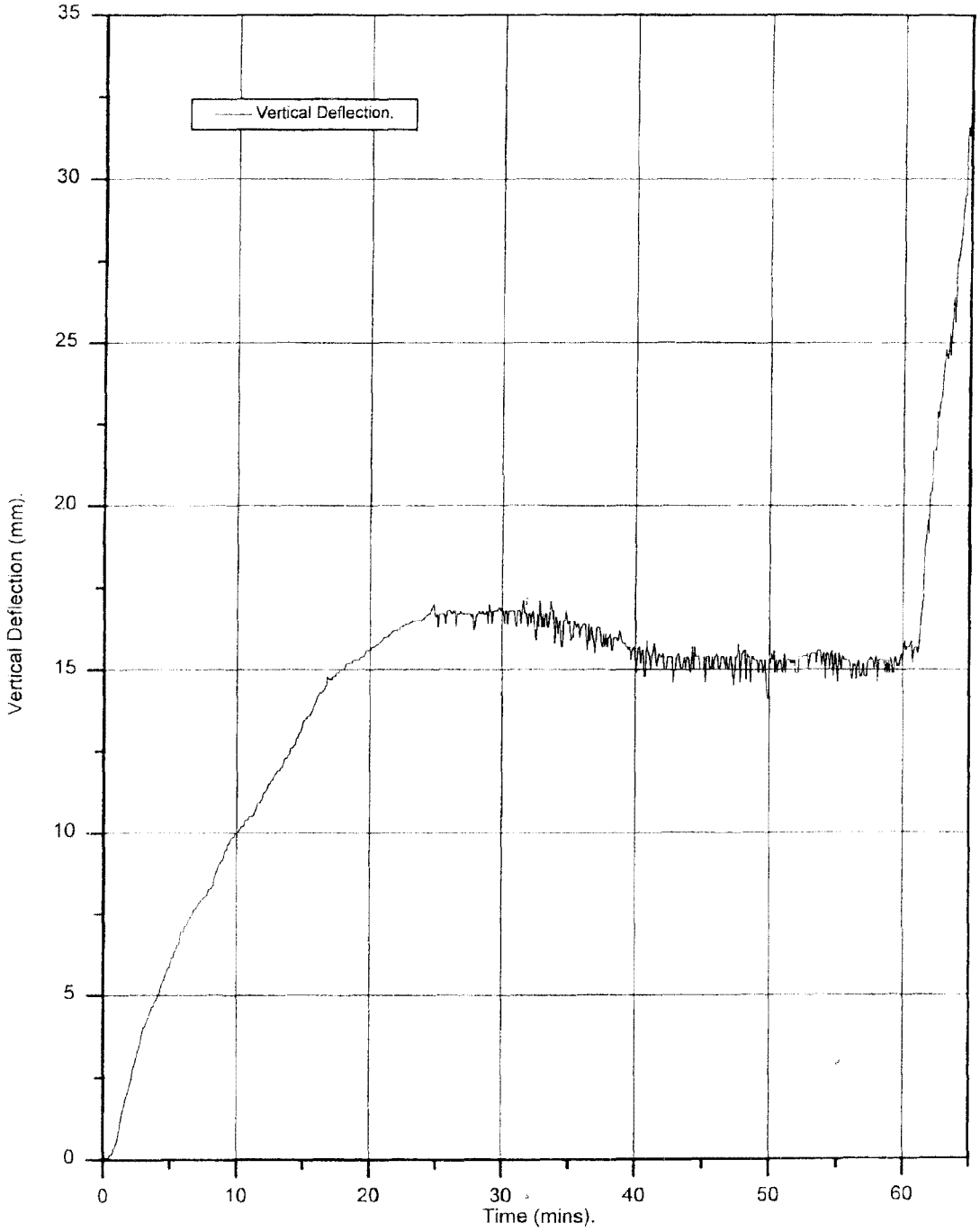


Figure 7 Vertical deflection

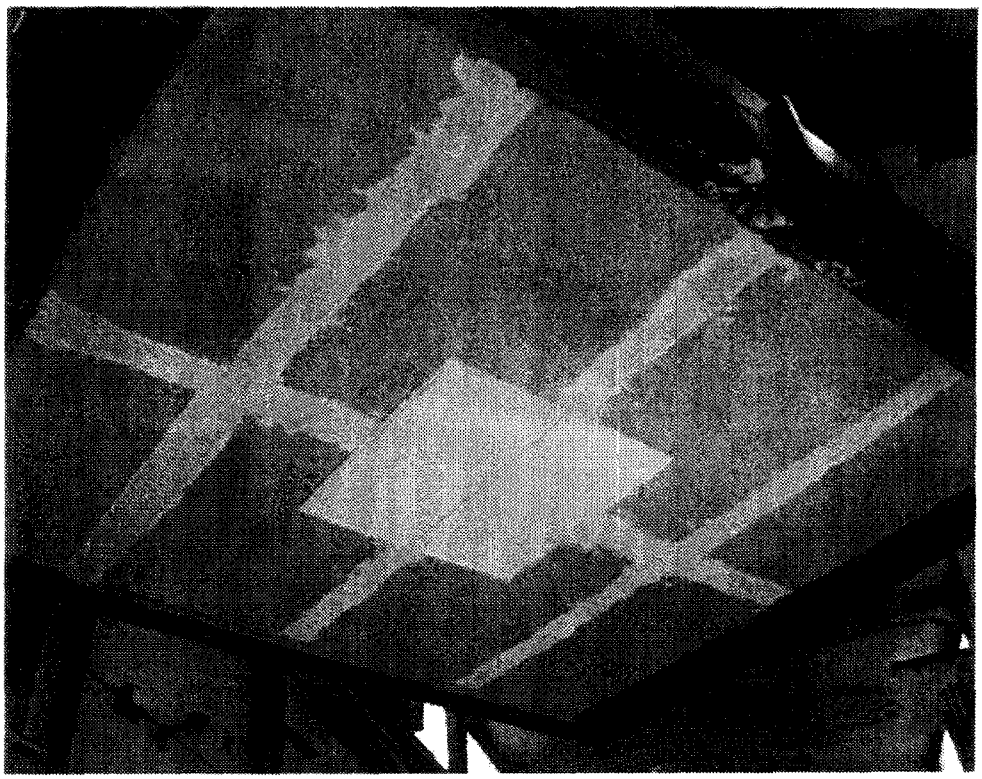


Plate 1 Exposed face of construction before test

(Neg.No. 002)

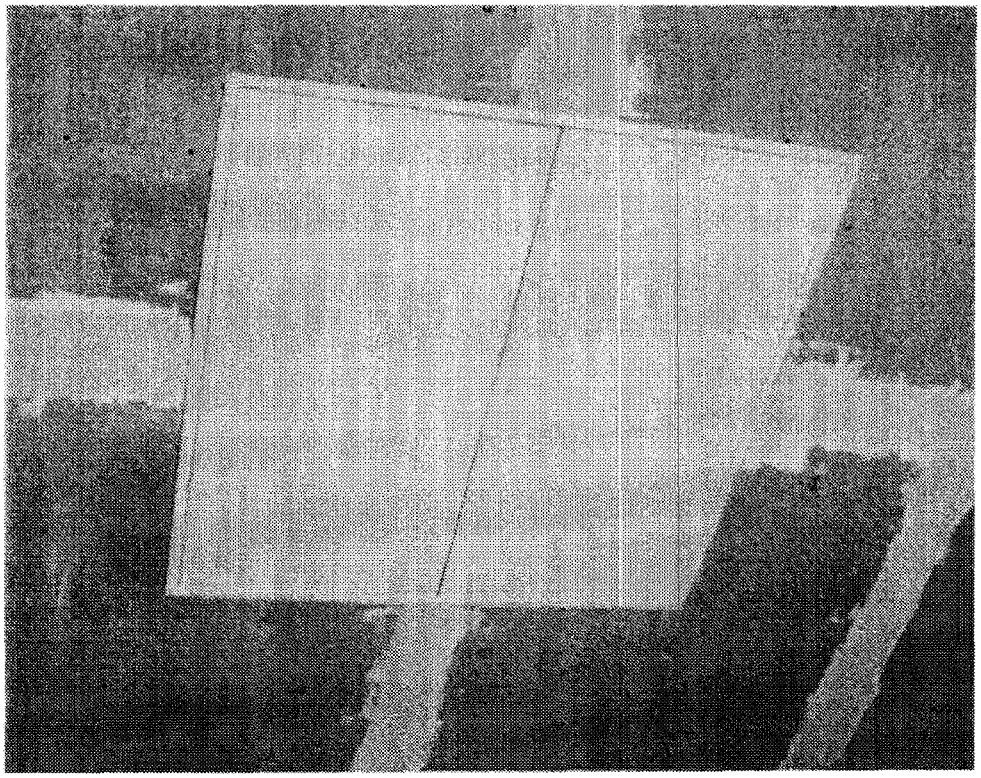


Plate 2 Exposed face of access panel before test

(Neg.No. 003)

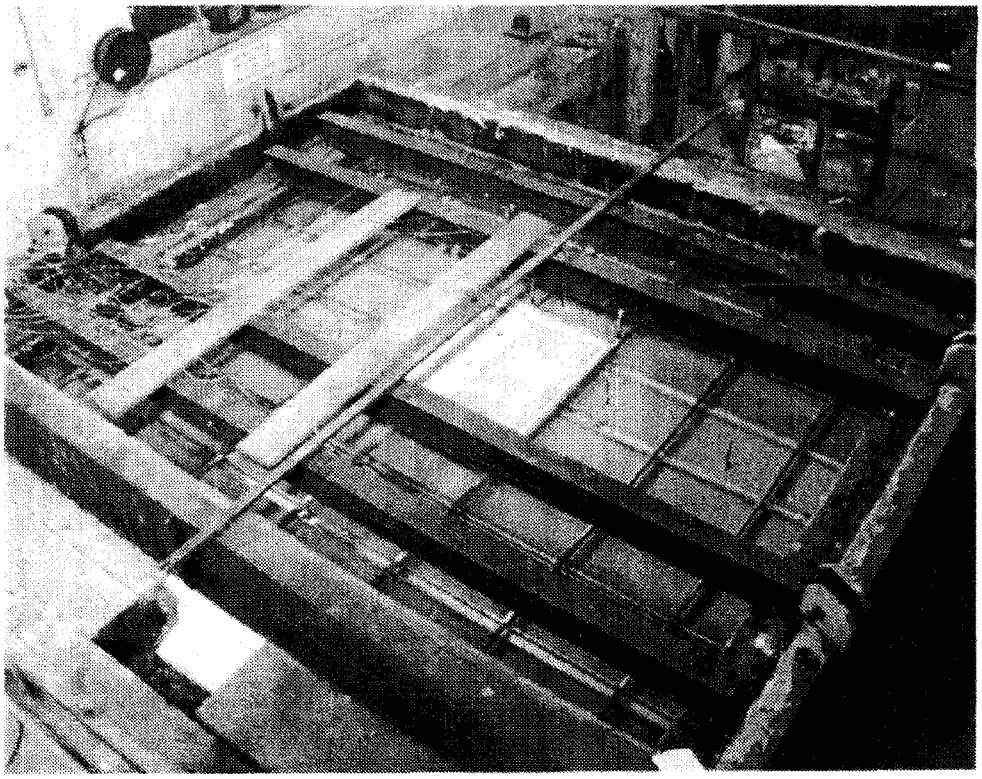


Plate 3 Unexposed face of construction before test

(Neg.No. 005)

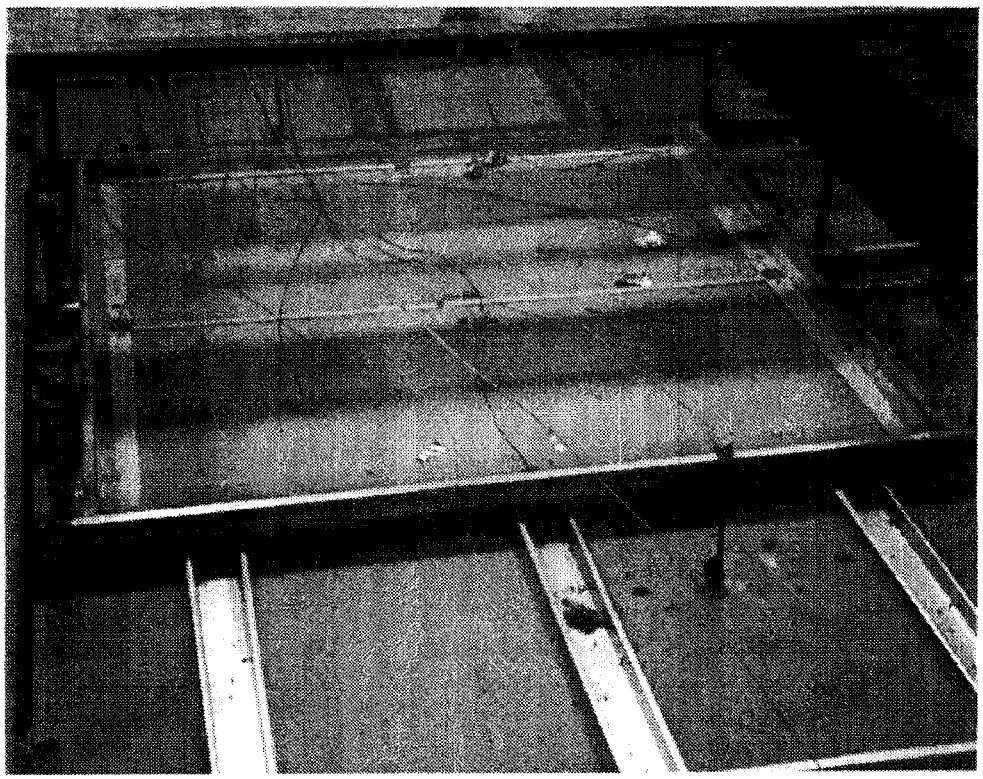


Plate 4 Unexposed face of access panel before test

(Neg.No. 008)

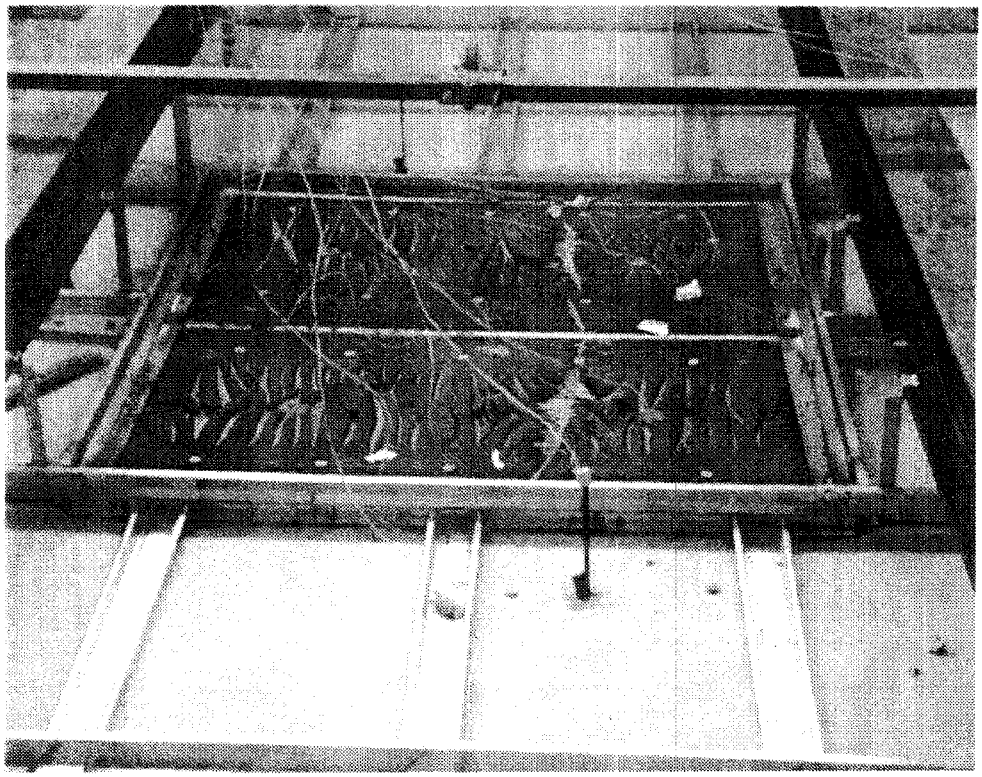


Plate 5 Cracking of plasterboard backing of door leaves

(Neg.No. 0010)

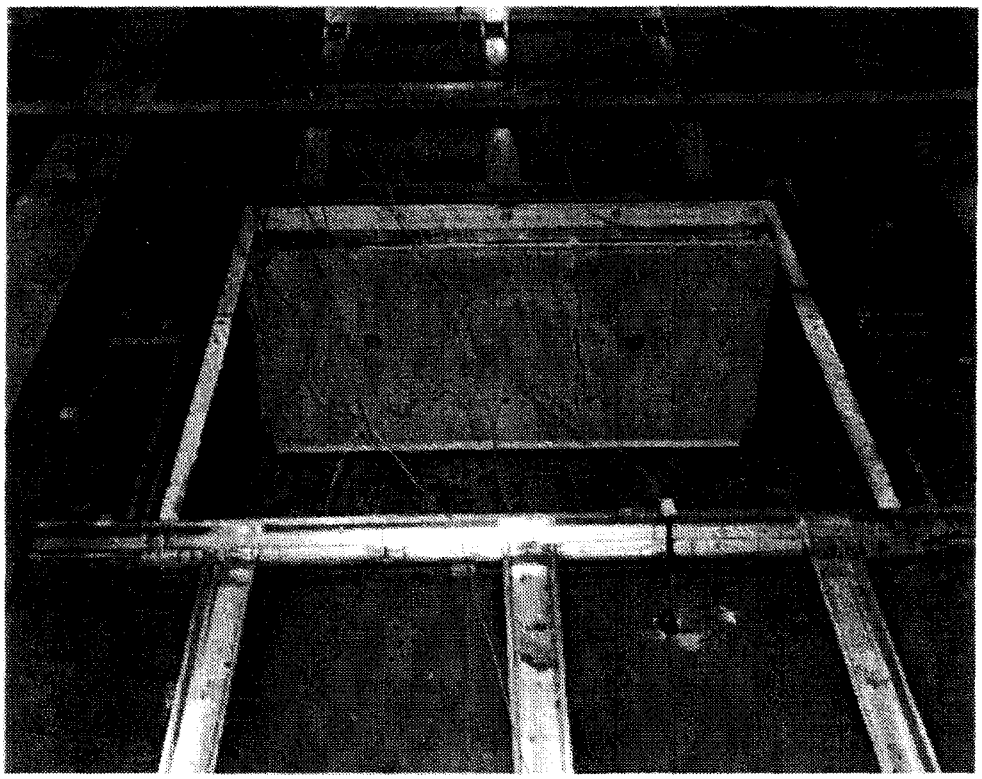


Plate 6 Unexposed face of construction after test

(Neg.No. 0015)

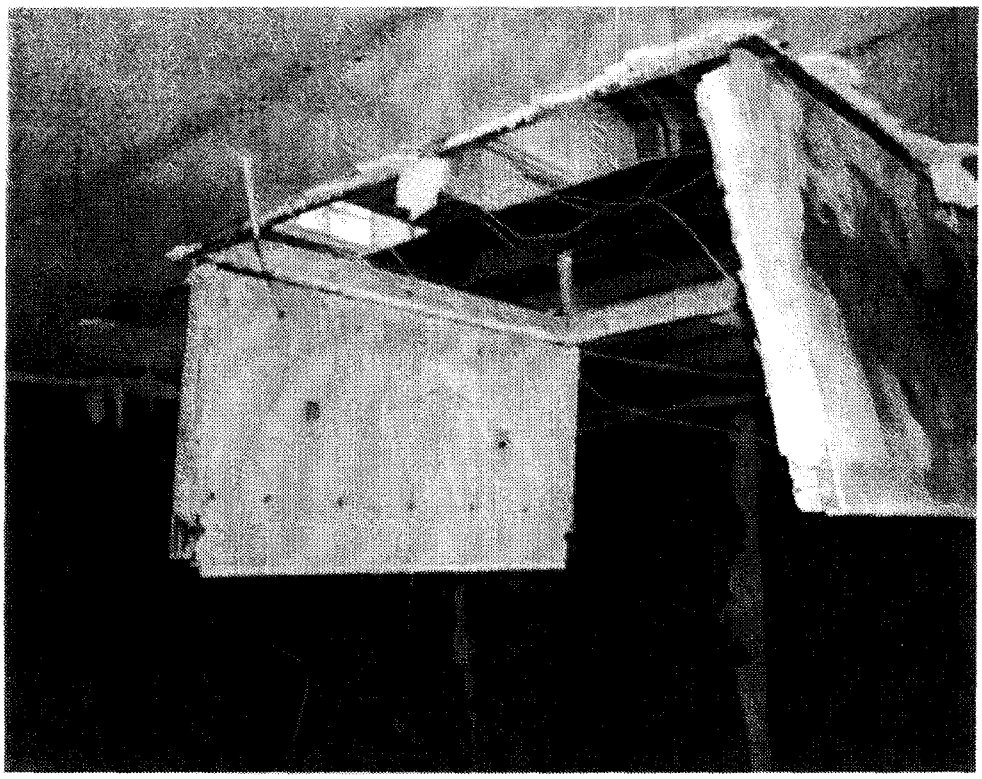


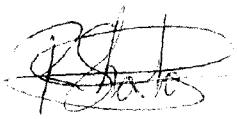
Plate 7 Exposed face of construction after test

(Neg.No. 0012)

LPC Laboratories
Centre for Fire and Security Testing
Melrose Avenue, Borehamwood, Hertfordshire, WD6 2BJ
Telephone: 020 8207 2345 Facsimile: 020 8207 6305

TE 200479

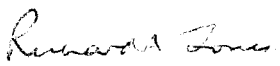
Test and report by:



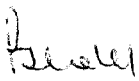
R. Shorto
Technical Officer

RS/MB
14 September 2000

Approved by:



R.A. Jones
Section Manager, Building Products



P.J. Field
Laboratory Manager