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TE 200864

TEST REPORT

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

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

Date: 18 October 2000

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SUMMARY

A plasterboard ceiling membrane, constructed from a steel framework with two layers of Lafarge Firecheck plasterboard fixed on the underside, incorporating a Fire Proofing Services Ltd. access panel, was submitted to a fire resistance test in accordance with B.S. 476 : Part 22 : 1987 (Method 9 for ceiling membranes) on 27 July 2000. The ceiling membrane was of overall dimensions 3.5m x 4.15m with the access panel installed in a structural opening, nominally 1185mm x 1185mm, in the centre of the ceiling.

The ceiling incorporating the access panel opening towards the furnace achieved the following fire resistance:

Integrity:	70min
Insulation:	16min

1 OBJECTIVE

To determine, at the request of Fire Proofing Services Ltd., the fire resistance of a plasterboard ceiling membrane incorporating a Fire Proofing Services Ltd. access panel, 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 20 and 21 July 2000 within the 3.5m x 4.15m aperture of a heavily reinforced concrete test frame. The access panel was installed on 24 and 25 July 2000, with the door leaves opening towards the furnace.

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

2.2 Ceiling membrane

2.2.1 General

The ceiling membrane was constructed from a steel framework and two layers of Lafarge Firecheck Plasterboard. The steel frame was constructed from edge channels, primary channels and ceiling channels, which formed a support structure onto which the plasterboard sheets were attached.

Details of the ceiling construction are shown in Figures 1 and 2 and Plate 3.

2.2.2 Edge channel

The edge channel was a U-section channel, nominally 30mm x 26mm x 20mm which was screwed around the perimeter of the aperture in the test frame using 38mm-long Drywall screws with aluminium expansion plugs at nominally 600mm centres.

2.2.3 Ceiling channel

The ceiling channel was of U-section, approximately 50mm wide at the base and 60mm wide at the top. The U-channel was 25mm deep, with two 10mm tabs (parallel with the base of the U shape) along each top edge producing a top-hat-section of overall dimensions 80mm wide x 25mm deep. Ceiling channels were located so that they spanned the length of the test frame at 450mm centres. As the ceiling channels were supplied in lengths of 3600mm, approximately 700mm lengths were also used to allow the ceiling channels to completely span the length of the test frame. The ceiling channels rested in the perimeter channel at each end of the test frame, butting tightly against the frame. Joints between lengths of ceiling channel were made via a 100mm nominal overlap of the channels. As no additional fixings were used at these locations, these joints allowed for expansion during the test.

The ceiling channels were attached below the primary channels using spring-wire clips, which passed around the top of the primary channel, and supported the ceiling channels underneath the 10mm folded tabs

2.2.4 Primary channel

The primary channels were of U-section, nominally 15mm x 45mm x 15mm, and spanned the 3500mm width of the test frame at 600mm centres. The primary channels rested on the edge channel at each side of the test frame, and were attached to it using 14mm-long, Wafer Head, Lafarge Grabber screws.

2.2.5 I-section supporting beams

The ceiling was suspended from four 4.5m-long I-section steel beams spanning the length of the test frame at the locations shown in Figure 1. Lengths of steel angle, nominally 25mm x 25mm x 200mm long, were screwed to the primary channels and to B-line clips using 14mm-long, Wafer Head, Lafarge Grabber screws. The B-line clips were hammered directly on to the bottom flanges of the I-section beams.

2.2.6 Aperture for ceiling panel

A square aperture, nominally 1185mm x 1185mm, was cut in the centre of the steel framework. The aperture, shown in Figure 1, was exactly the same size as the distance between two of the primary channels resulting in a primary channel running along two edges of the aperture. Two lengths of primary channel were then fixed perpendicular to these two channels forming a perimeter of primary channel around the aperture. 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 subsequent fixing of the plasterboard ceiling. The four internal corners of the aperture were reinforced with angle sections nominally 25mm x 25mm x 20mm.

2.2.7 Plasterboard

To complete the ceiling membrane, two layers of 12.5mm thick Lafarge Firecheck plasterboard were fixed to the underside of the ceiling channels, excluding the hole provided for the access panel. The plasterboard was screwed to the ceiling channels (and edge channels where applicable) using Lafarge Grabber screws (25mm and 38mm long). The joints between plasterboard sheets were filled using Lafarge jointing compound and tape.

2.3 Access panel

The access panel consisted of a perimeter frame, providing a clear opening of 1175mm x 1175mm, which was closed with two door leaves, nominally 584.5mm wide. The perimeter frame was made from 1.2mm-thick Zintec steel which had been polyester powder coated to Ral9010 (20% gloss). The 25mm-wide beaded frame (mitred at each corner) was fitted into the ceiling membrane from below overlapping the plasterboard ceiling membrane by approximately 20mm. The frame was fixed in position using nominally 25mm x 15mm steel angle, which was screwed to the primary channels surrounding the structural opening and to the top edge of the perimeter frame. 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, which was filled with mineral wool and fire-resistant mastic. No details of the mineral wool, or fire resistant mastic were supplied by the sponsor. 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 door leaf consisted of a 1mm-thick, folded Zintec steel tray which was polyester powder coated (on the exposed face) in Ral9010 (20% gloss). Each leaf was stiffened using two pre-formed top-hat section stiffeners, welded (one at each side) to the unexposed face of each steel tray. A 12.5mm-thick sheet of Lafarge Megadeco plasterboard, treated with one coat of Lafarge Drywall Sealer, was fixed to the exposed face of each of the door leaf, using 32mm-long drywall screws screwed in to Z-section brackets welded to the door tray. Each door leaf was hung via two hinge pin blocks, one located at each end of a top hat stiffener to the edge of each door leaf, the pin locating in a slot in the panel frame. The right-hand side was secured in the closed position using two budget locks, one each end of the leaf, located in a top hat section. The left-hand leaf was secured using three budget locks, one each end of the leaf and one in the centre, all locks located under the back cover plate (welded to the right-hand leaf).

Details of the ceiling construction, access panel construction and hinge pin detail are given in Figures 1 to 4.

3 CONDITIONING

At the time of construction a representative sample of Firecheck plasterboard was taken and on the day of the test was weighed and placed in a 50°C oven in order to determine its free moisture content by weight loss technique. The plasterboard was found to have a free moisture content of 0.7% and a density of 804kg/m^3.

4 TEST PROCEDURE

4.1 General

The test was carried out on the 27 July 2000 in accordance with B.S. 476 : Part 22 : 1987[1] (method 9 for ceiling membranes) and was witnessed by Messrs. T Beasley, D Blenkinsopp, R. Stokes, and P Carpenter representing the sponsor, and Mr J Kitchener, consultant.

The ambient temperature at the start of the test was 21°C.

4.2 Furnace control

The furnace temperature was measured using ten bare-wire chromel/alumel thermocouples arranged in the furnace as shown in Plate 1, with their measuring junctions 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 specified curve for comparison.

A pressure-sensing head was located 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 sixteen copper/constantan thermocouples, fixed to the surface and covered with an insulating pad. The location of the thermocouples is given in Table 1.

Table 1 Thermocouple locations

Thermocouple number	Location
•1	In the centre of the top left quarter of the ceiling (on the plasterboard).
•2	In the centre of the top right quarter of the ceiling (on the plasterboard).
♦3	In the centre of the top left quarter of the access panel.
♦4	In the centre of the top right quarter of the access panel.
♦5	In the centre of the access panel
6	On the plasterboard ceiling, adjacent to the left hand side of the access panel frame.
7	On the inside frame of the access panel, on the right hand side.
♦8	In the centre of the bottom left quarter of the access panel.
♦9	In the centre of the bottom right quarter of the access panel.
10	On the inside frame of the access panel, at the bottom.
11	On the steel ceiling channel, adjacent to the bottom edge of the access panel
•12	In the centre of the bottom left quarter of the ceiling (on the plasterboard).
•13	In the centre of the bottom right quarter of the ceiling (on the plasterboard).
14	In a ceiling channel, over a corner joint in the bottom layer of plasterboard.
15	In a ceiling channel, over a corner joint in the top layer of plasterboard.
•16	Near the centre of the ceiling, but away from the access panel and ceiling framework.

• = Used to determine the mean surface temperature of the ceiling.

♦ = Used to determine the mean surface temperature of the door panel.

All surface thermocouples were used to determine 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	Observations.
0	Test started.
2½	Smoke starting to issue from both hinged edges of access panel.
5½	Smoke starting to issue from joints between plasterboard of ceiling.
11	Volume of smoke issuing from areas described above is increasing
19	Both access panel leaves are bowing towards the furnace.
22	The area at the hinged edges of the access panel leaves, and at the centre of the access panel (where the leaves meet) is starting to darken and turn a yellow colour.
24	The access panel frame is charring and turning black at the top and bottom edges.
24½	The ceiling and access panel inside the furnace is all intact and glowing red-hot.
28	Two dark brown / black areas are forming at the centre of the access panel where the two leaves meet.
40	The charring of the frame observed at 24min, and the darkening of the leaves observed at 28min has increased.
42	A creaking sound can be heard from the plasterboard ceiling and some charring observed along joints in the unexposed layer of plasterboard.
45	The ceiling and access panel are both intact inside the furnace.
49	A yellow ash is forming at the top and bottom of both access panel leaves.
56	A slight red glow can be seen at the joints between the access panel leaves and frame at the top and bottom of the access panel.
70	Test stopped. No failure of integrity.

The test specimen is shown after 60min and after the test in Plates 5 and 6.

5.2 Temperature measurements

The mean and maximum temperatures recorded on the surface of the ceiling and the surface of the access panel are shown in Figures 6 and 7. The mean temperature limit (140°C rise) was first exceeded on the access panel after 28min, and the maximum temperature limit (180°C rise) was first exceeded after 16min by thermocouple number 10. Individual temperatures recorded on the surface of the ceiling and access panel are given in Figures 8 to 11.

5.3 Deflection measurements

The deflection recorded at the centre of the access panel is plotted against time in Figure 12. A maximum deflection (towards the furnace) of 12.9mm was recorded after 66min of the test.

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 incorporating a double-leaf 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:	70min
Insulation:	16min

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.

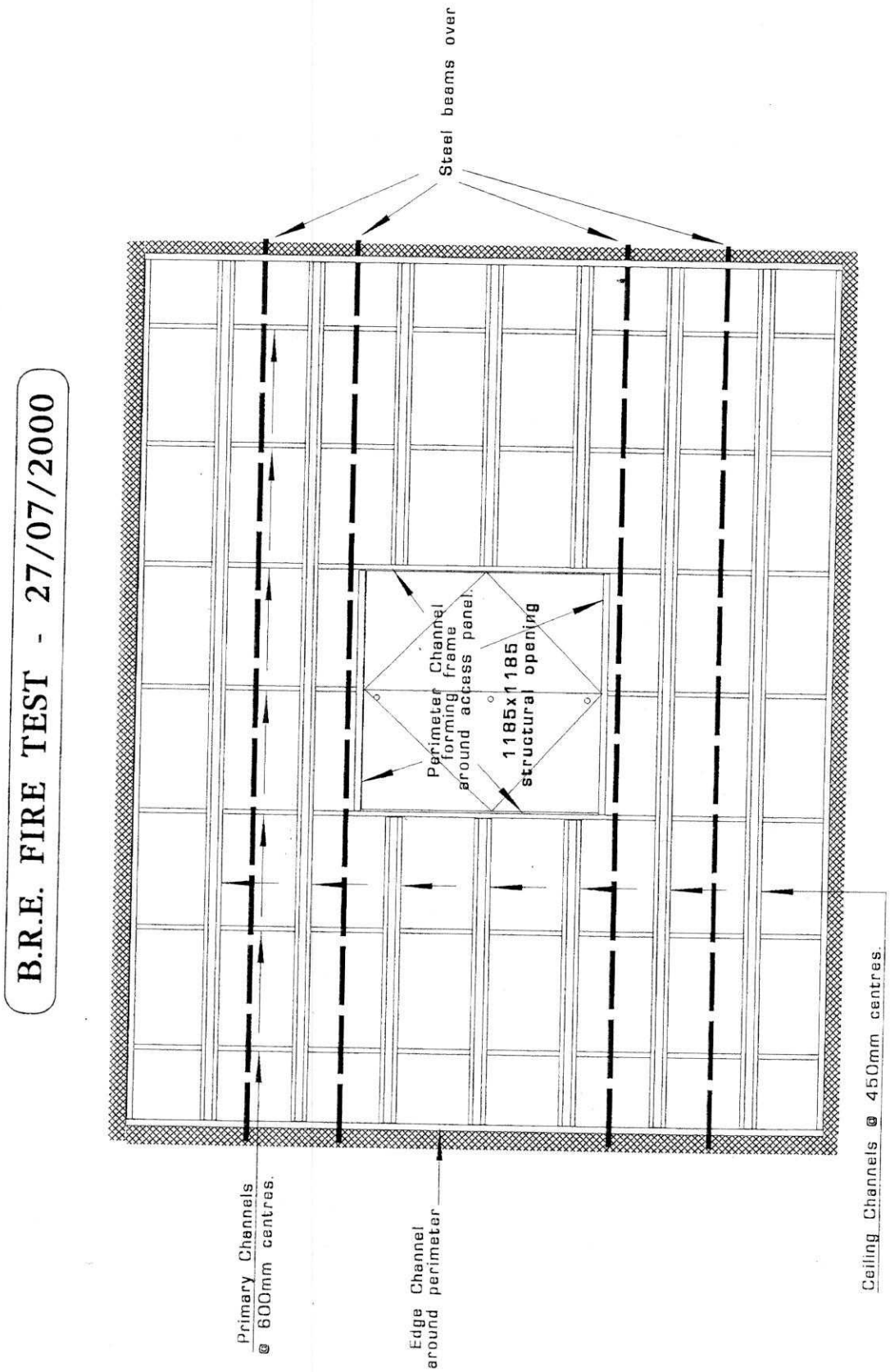

Figure 1 Reflective ceiling plan showing ceiling construction

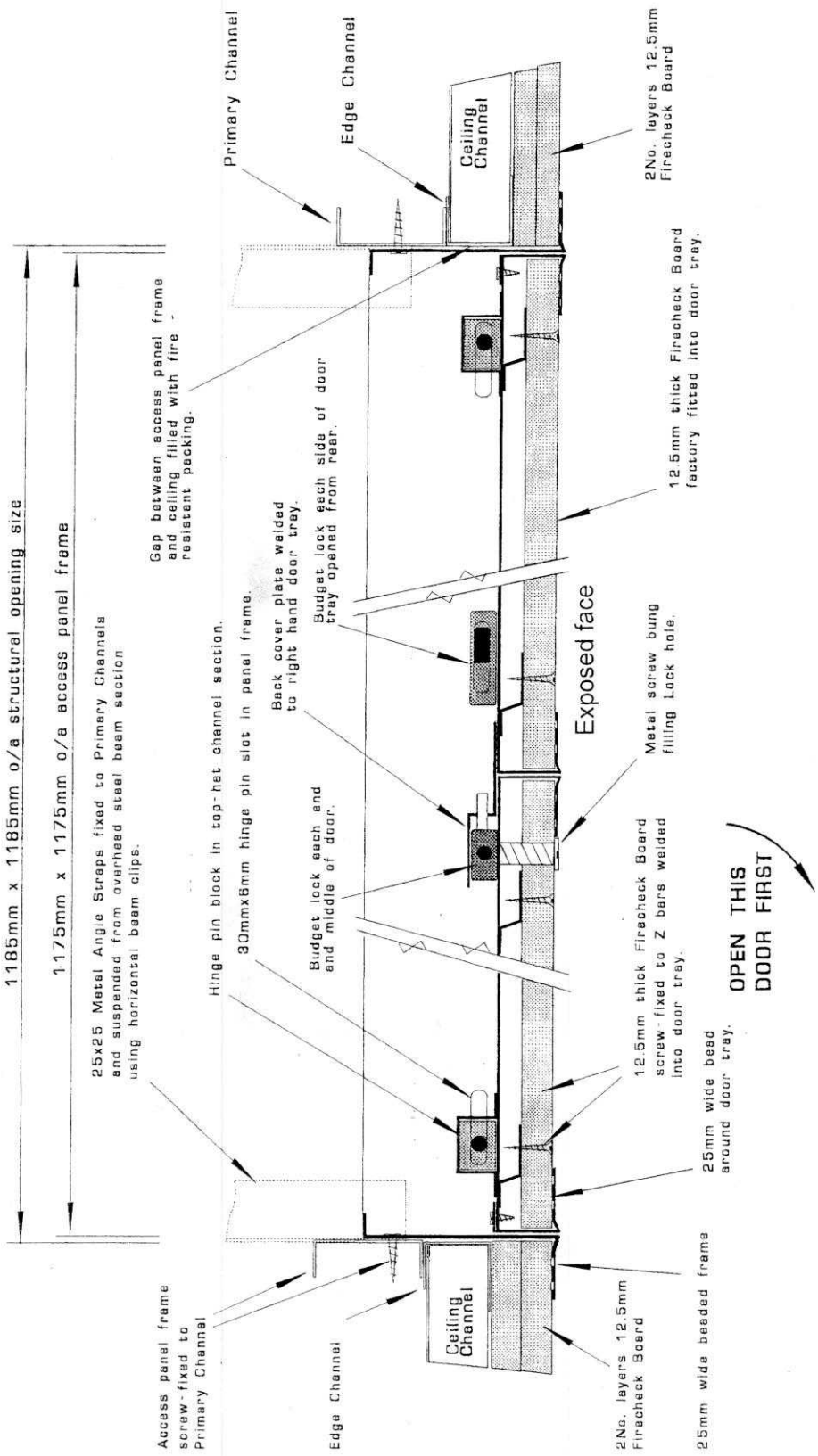

Figure 2 Section through ceiling construction and access panel

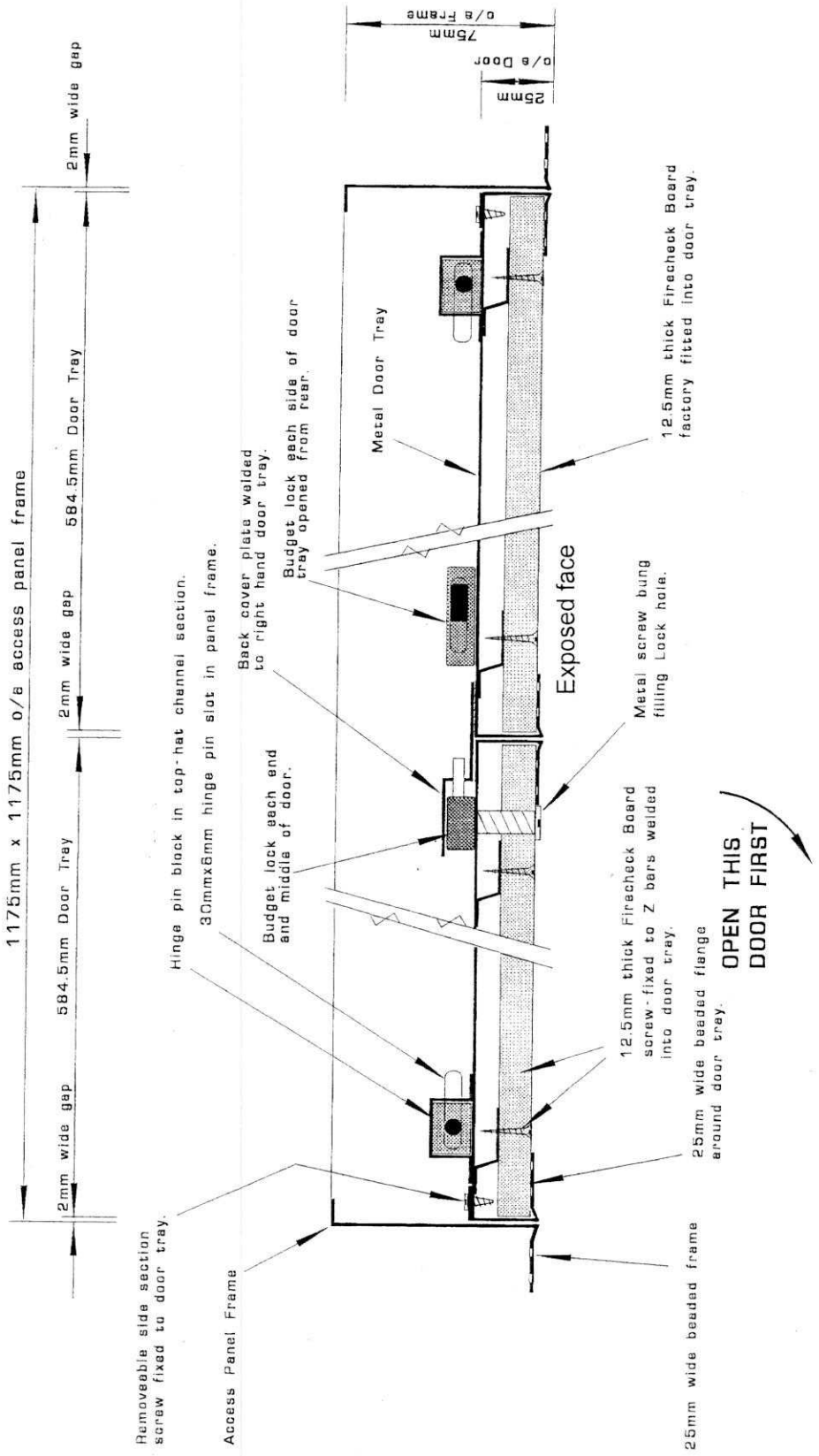

Figure 3 Section through access panel

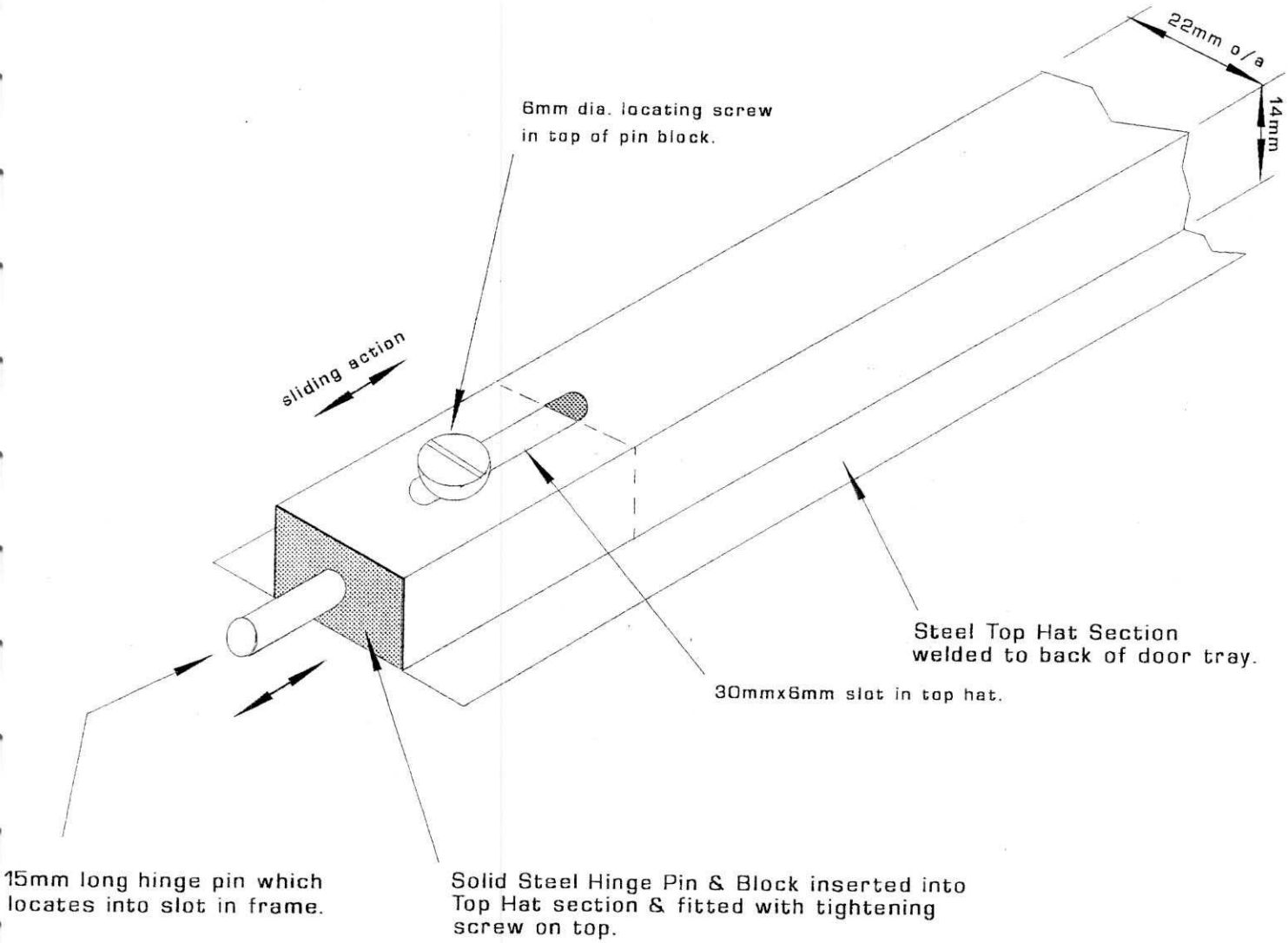

Figure 4 Line drawing showing hinge pin detail situated on back of each door

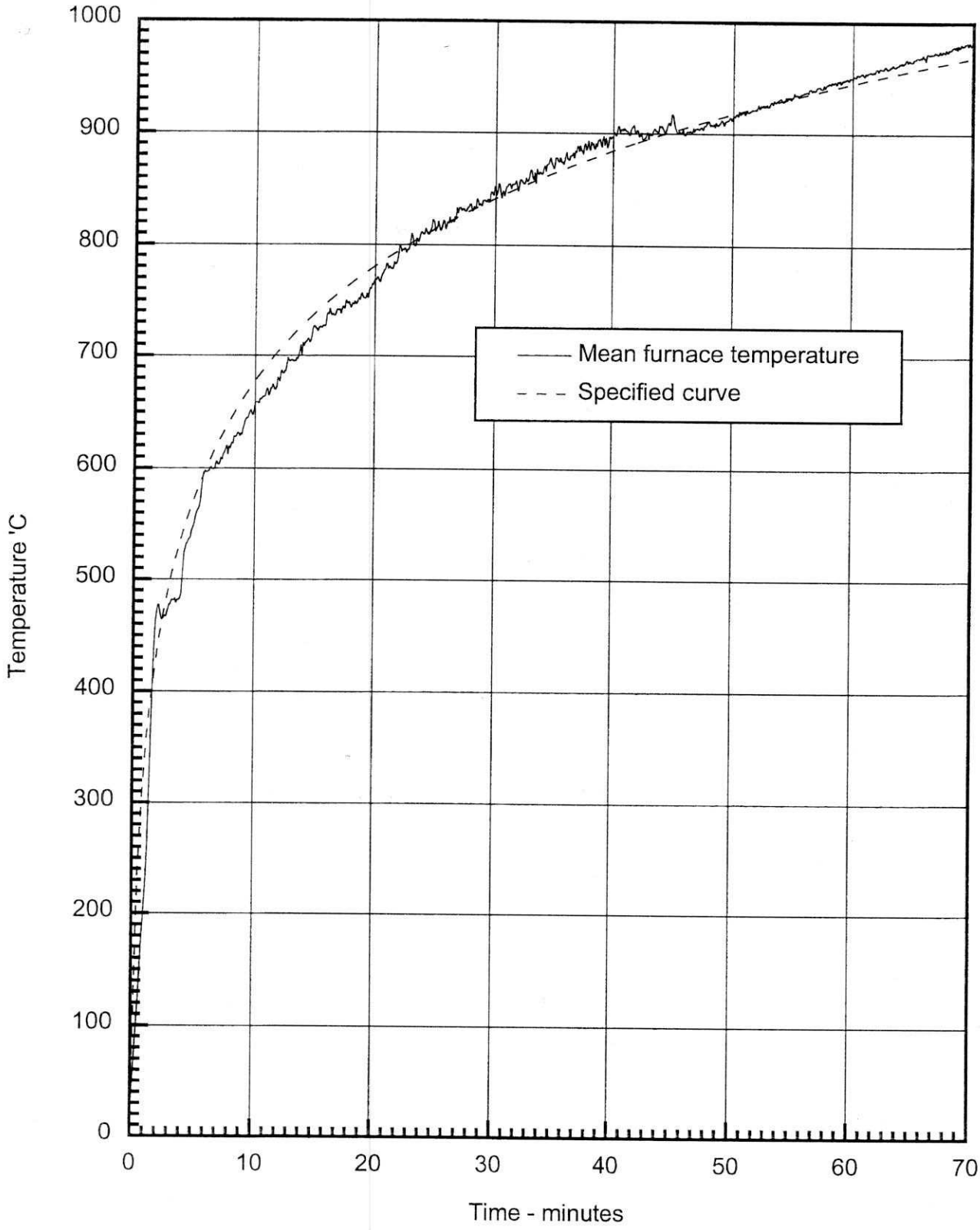

Figure 5 Mean furnace temperature with specified curve for comparison

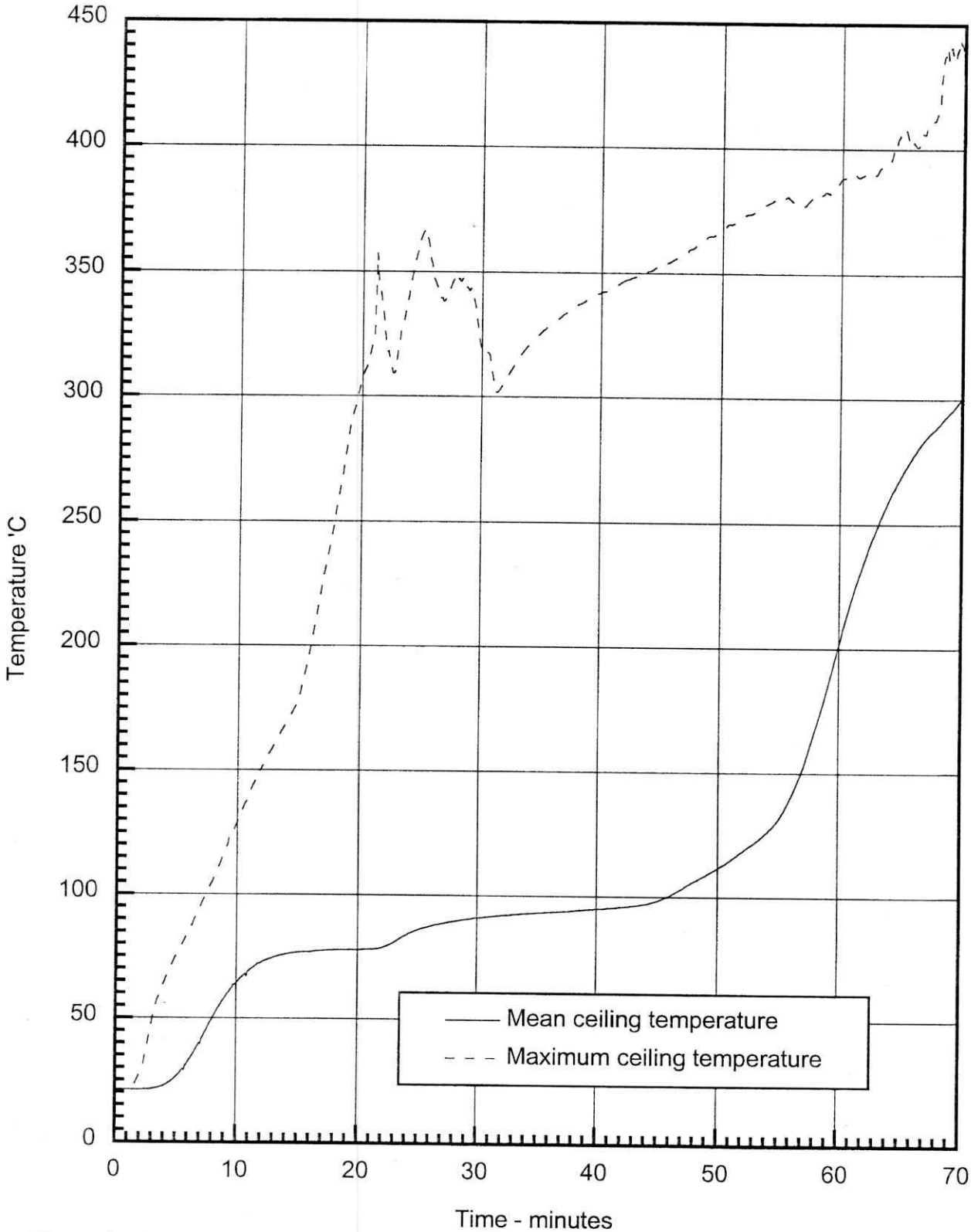

Figure 6 **Mean and maximum temperatures recorded on unexposed surface of ceiling membrane**

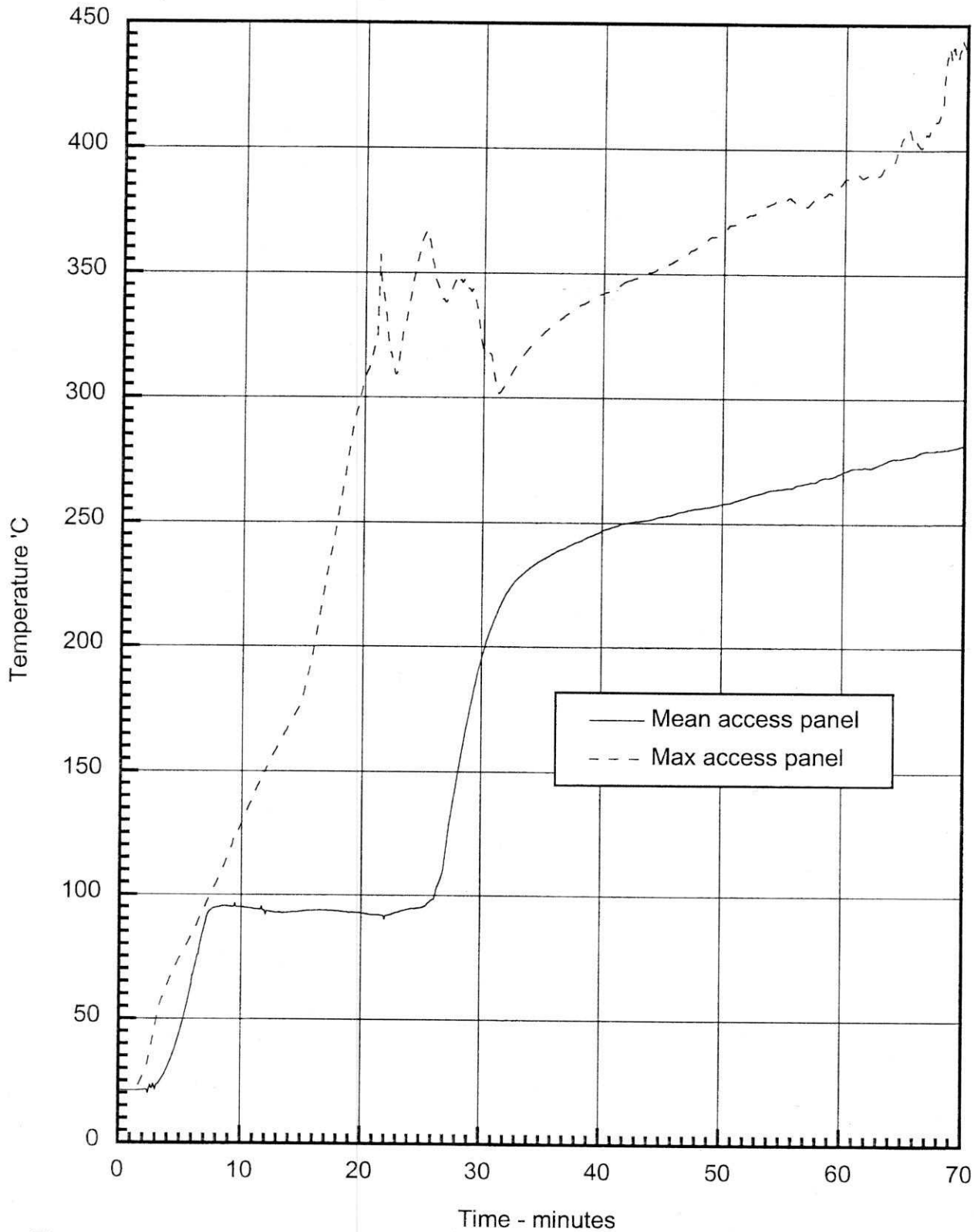

Figure 7 Mean and maximum temperatures recorded on unexposed face of access panel

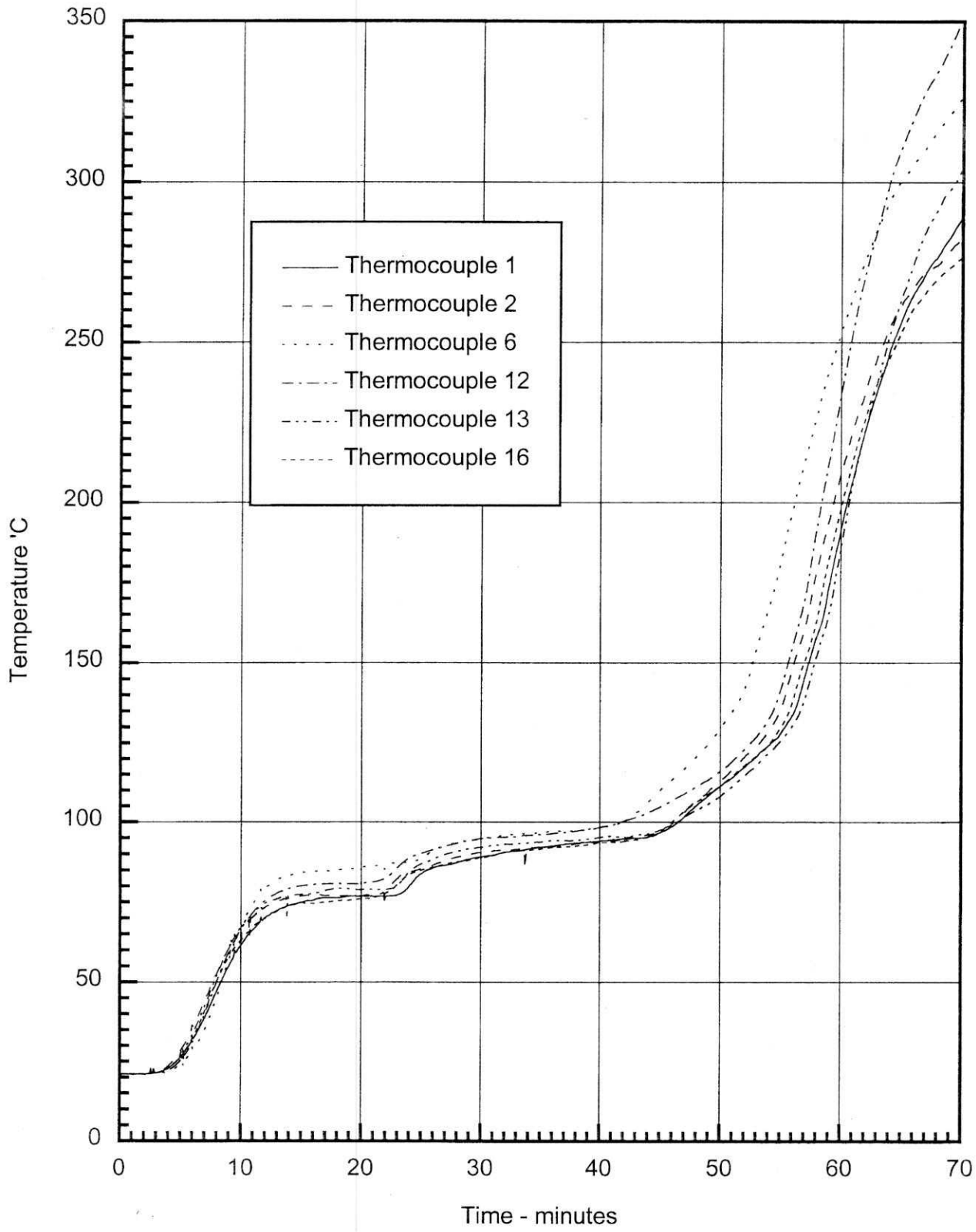

Figure 8 Temperatures recorded by thermocouples affixed to the unexposed face of the plasterboard of the ceiling membrane

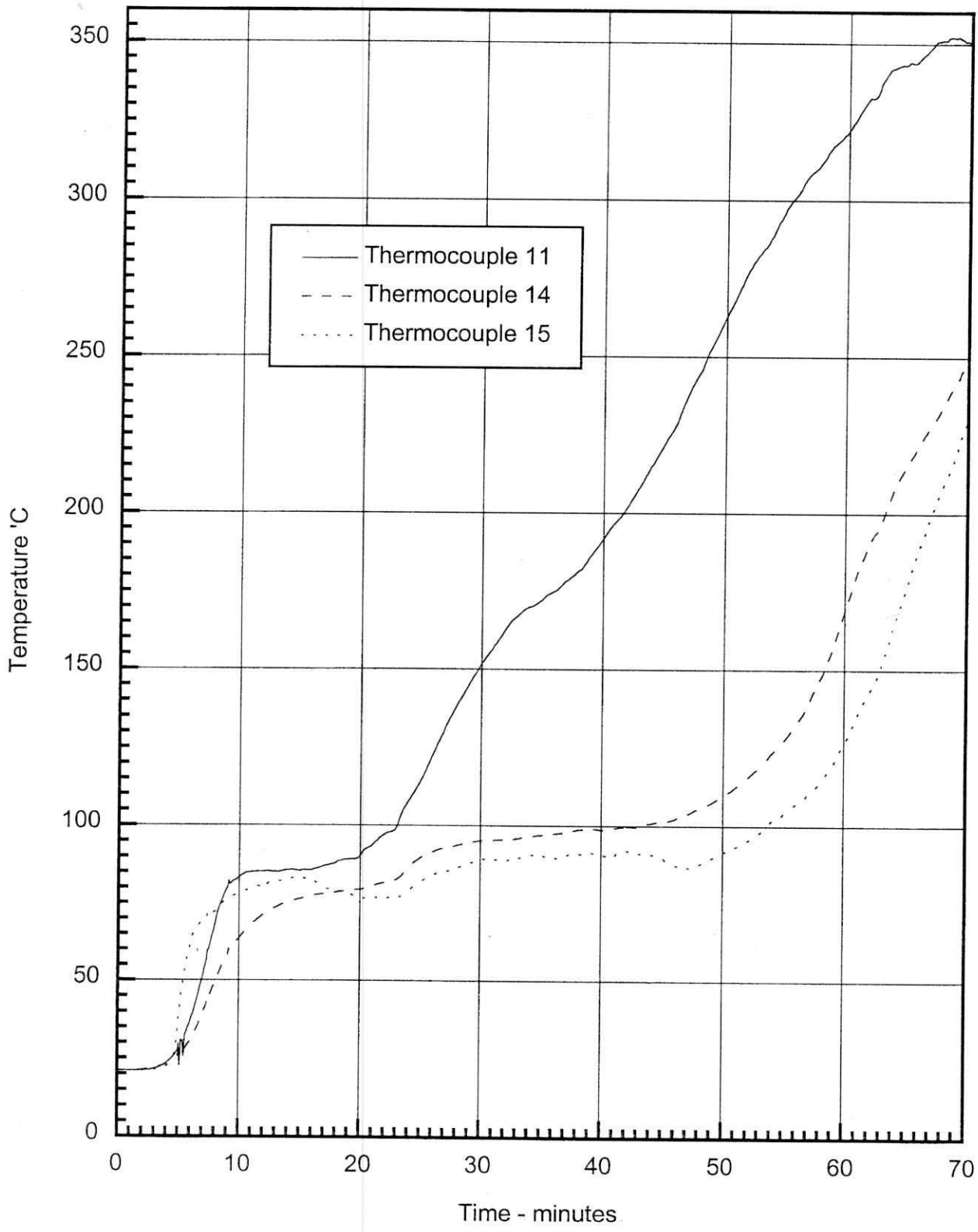

Figure 9 Temperatures recorded by thermocouples affixed to the ceiling channels

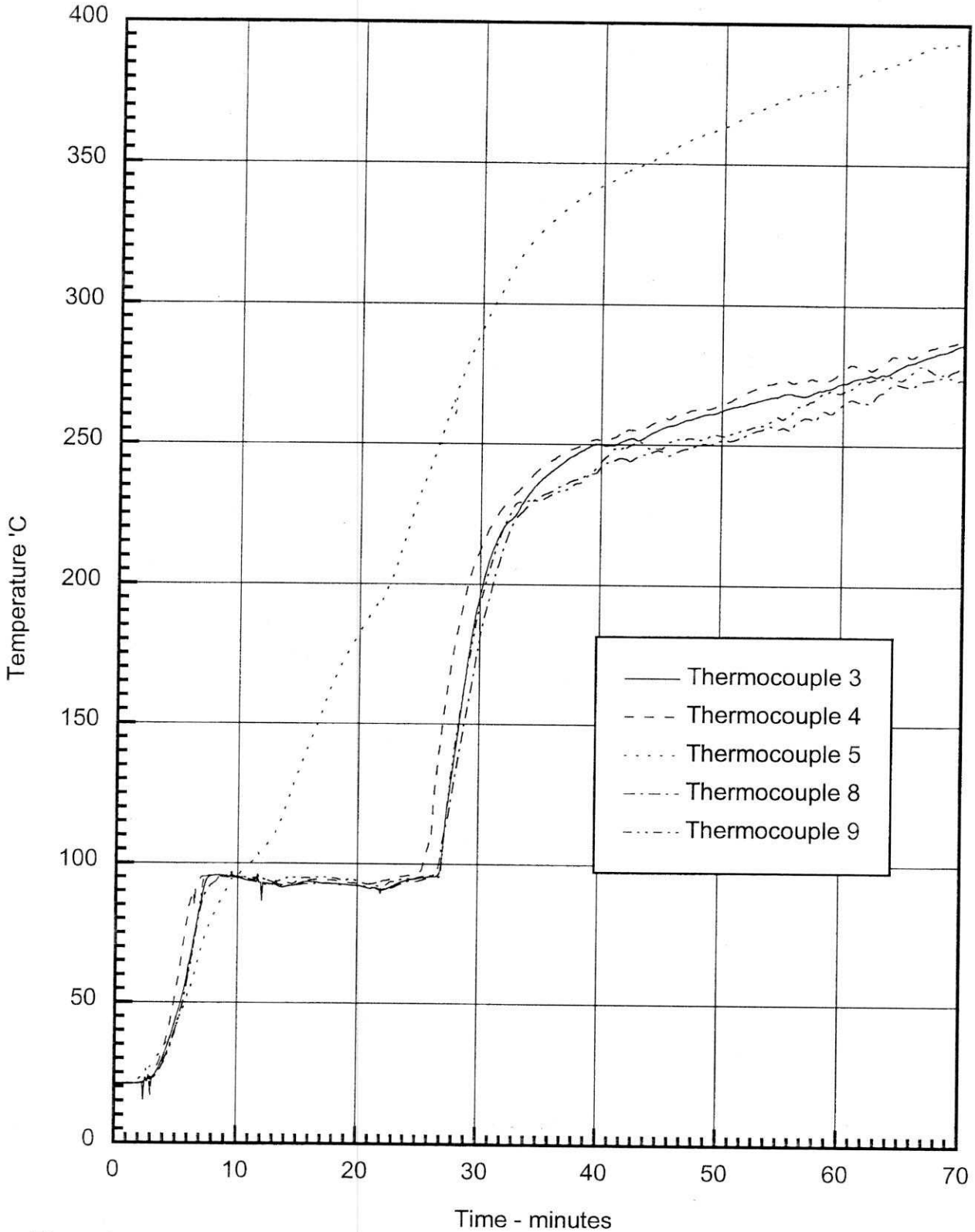

Figure 10 Temperatures recorded by thermocouples affixed to the unexposed face of the access panel

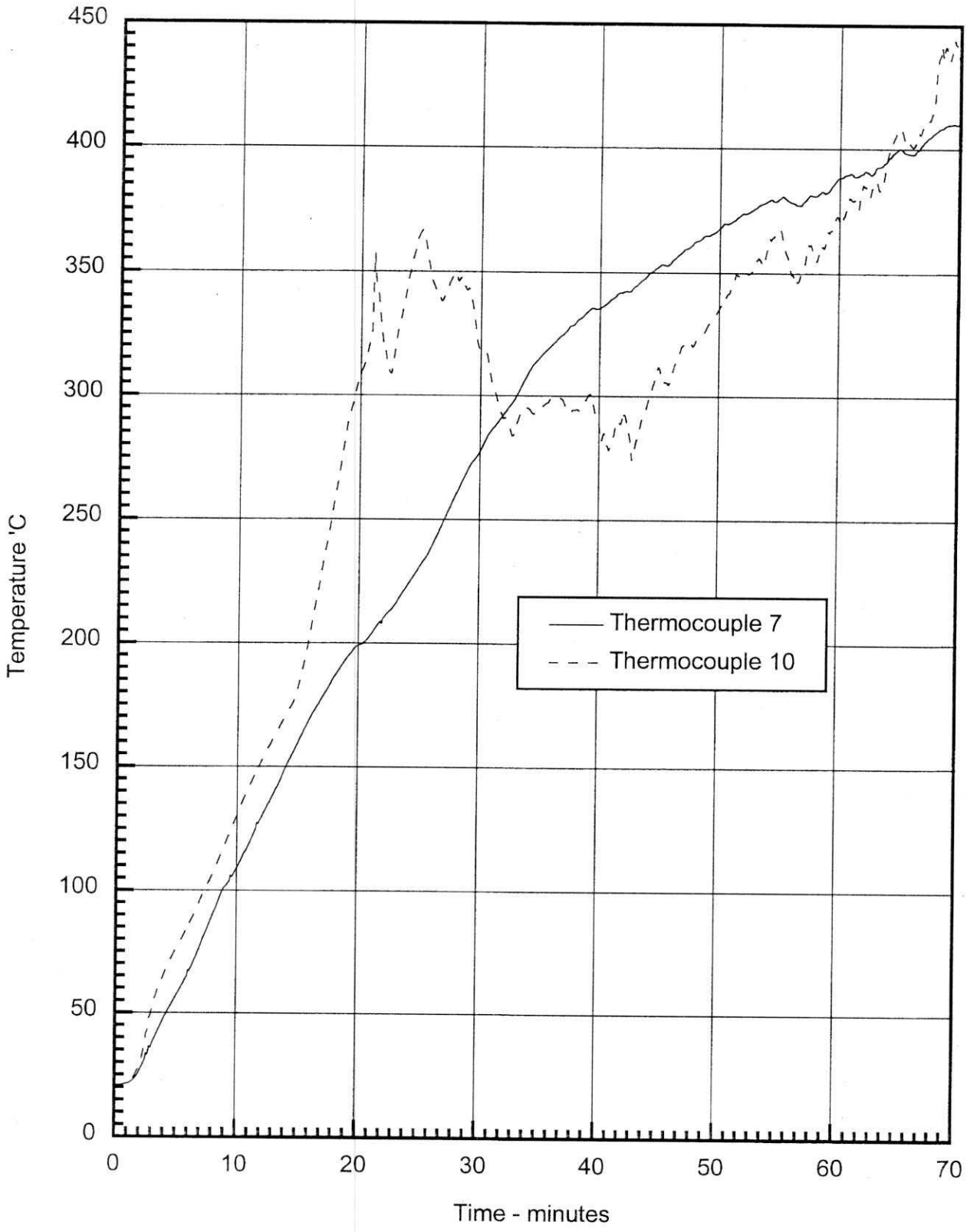

Figure 11 Temperatures recorded by thermocouples affixed to the access panel frame

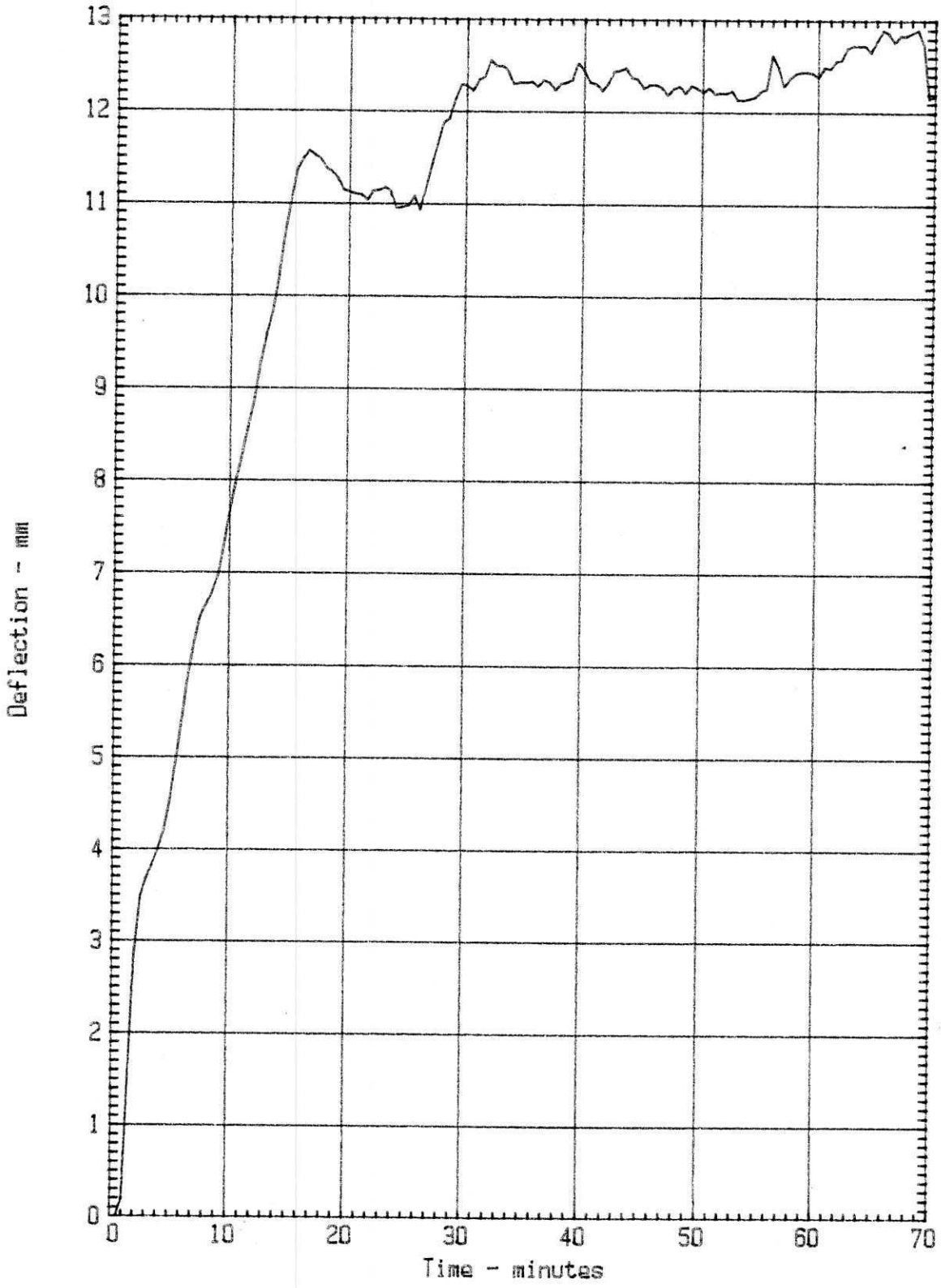

Figure 12 Vertical deflection (towards furnace) recorded at centre of access panel

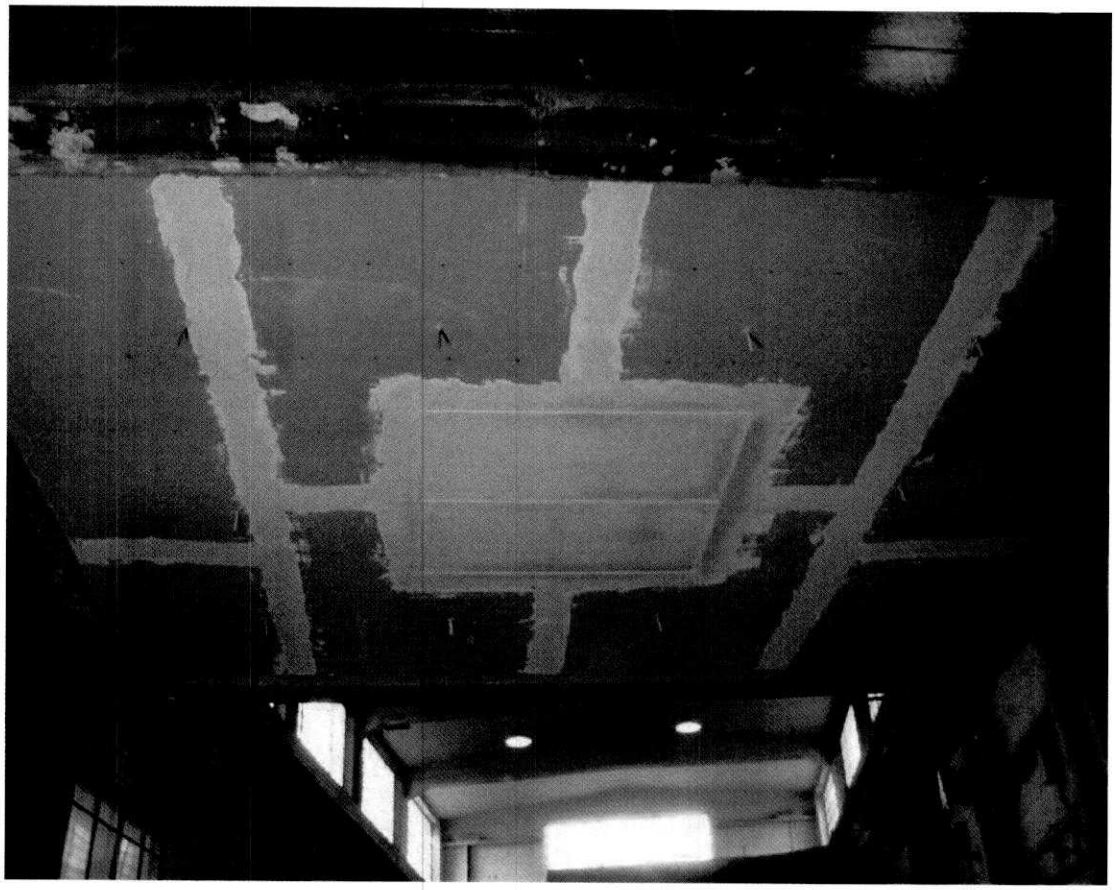

Plate 1 Exposed face of specimen before test showing furnace thermocouple locations

(Neg.No. 001)

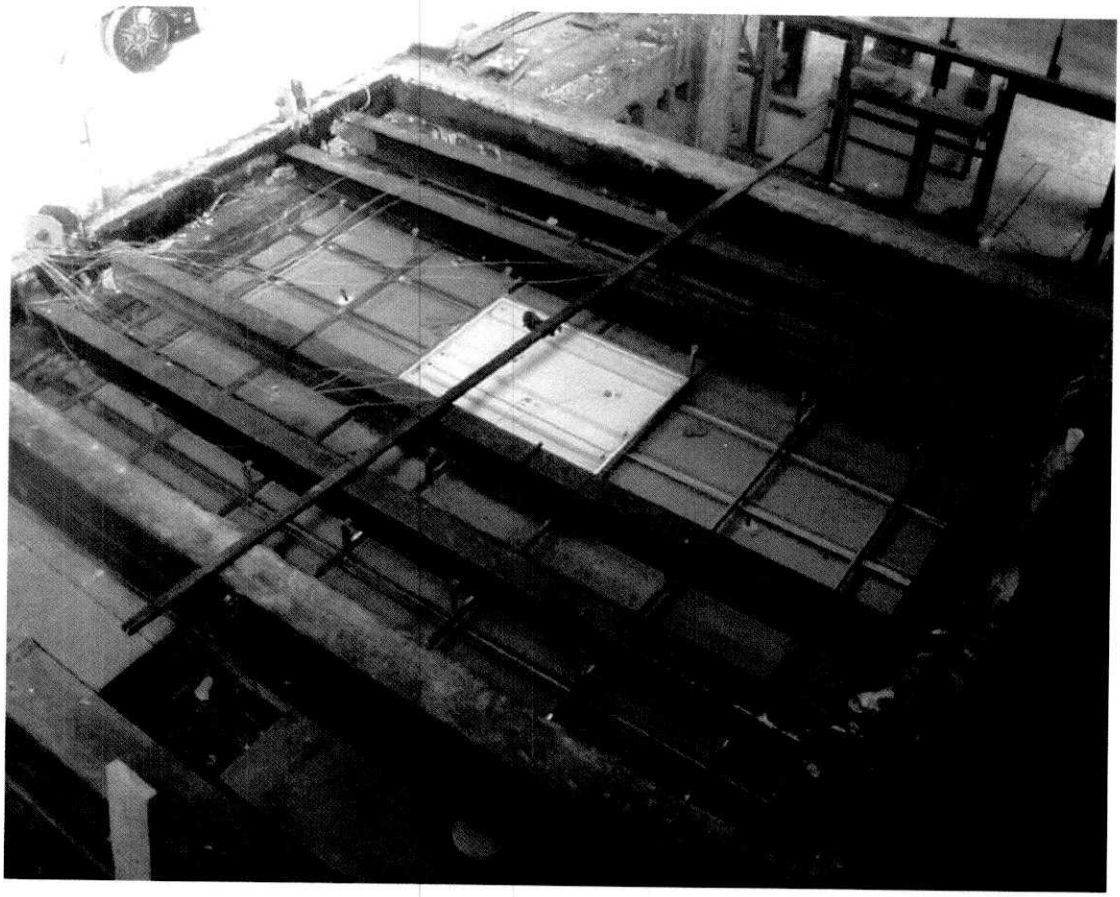

Plate 2 Unexposed face of specimen before test

(Neg.No. 006)

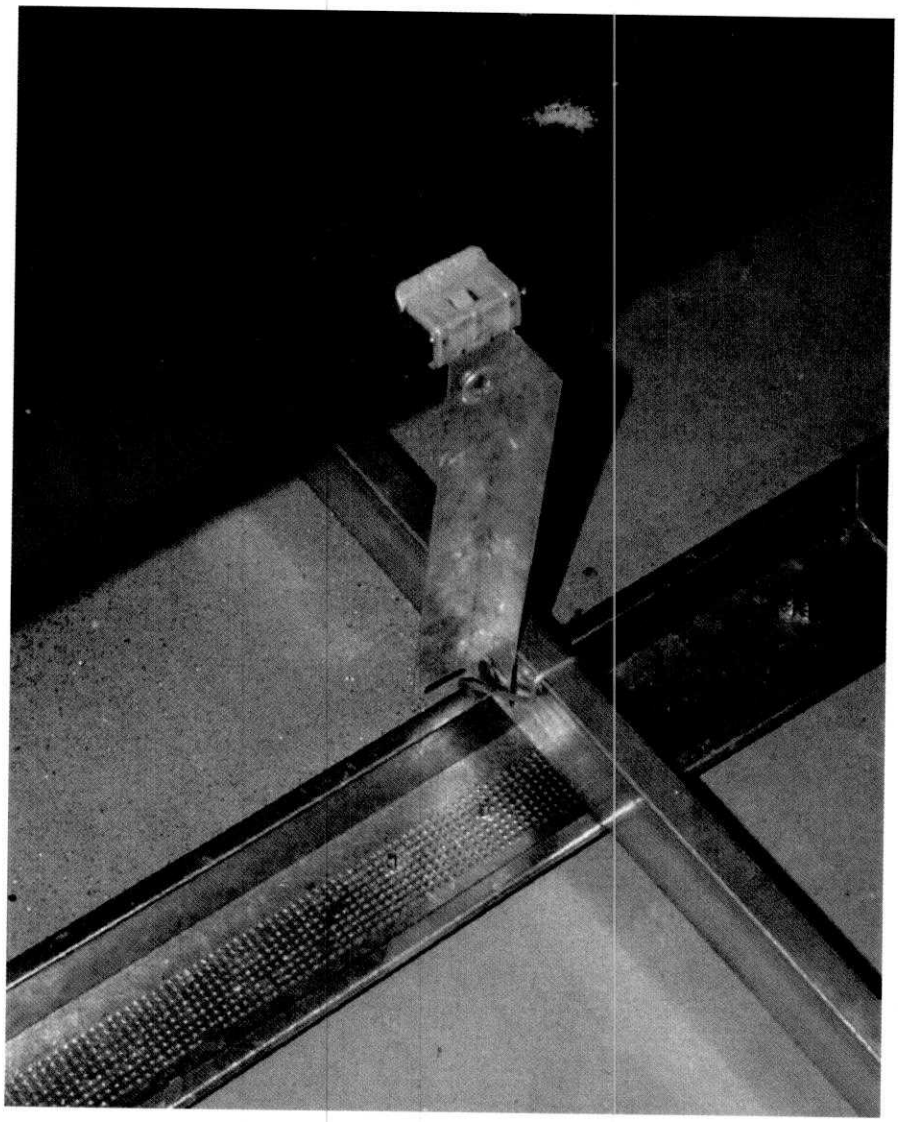

Plate 3 Details of ceiling construction and attachment to supporting I-section beams

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Plate 4 Unexposed face of access door before test

(Neg.No. 007)

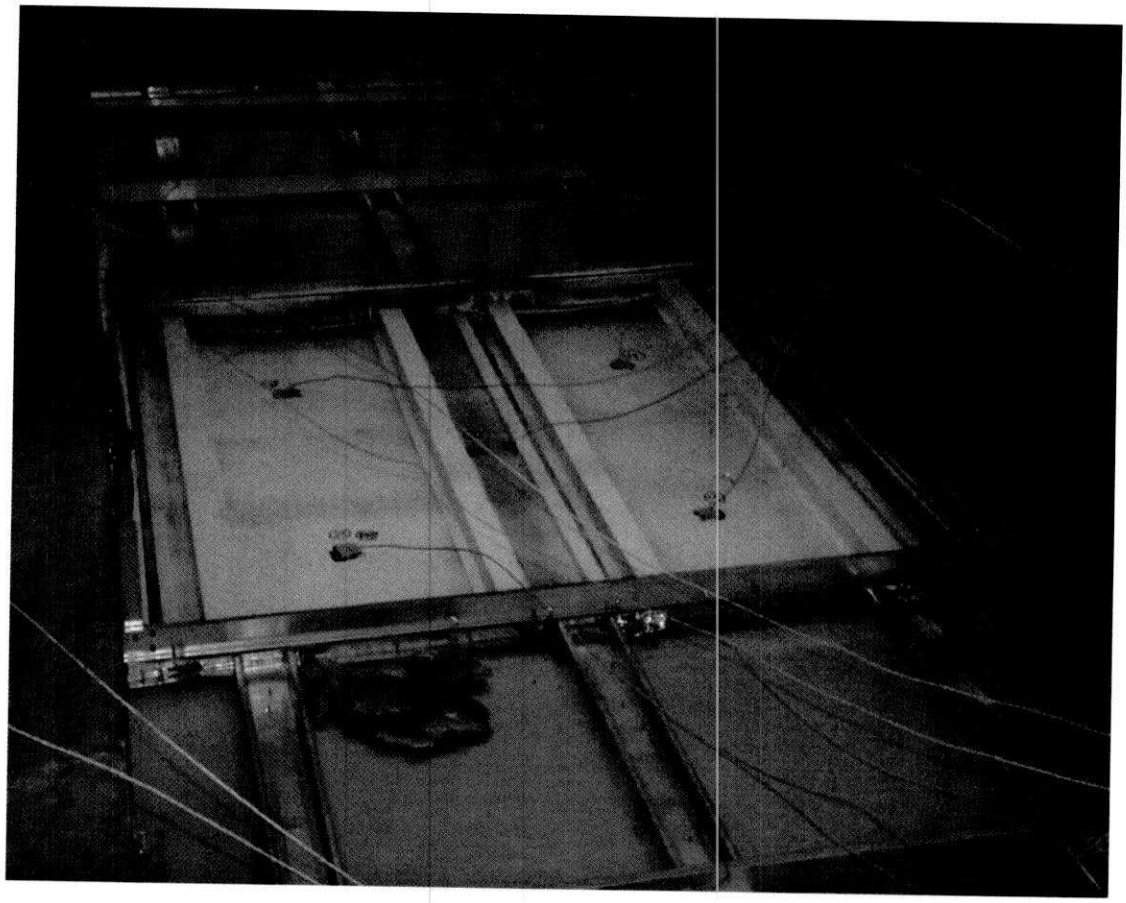

Plate 5 Unexposed face of access door after 60min

(Neg.No. 009)

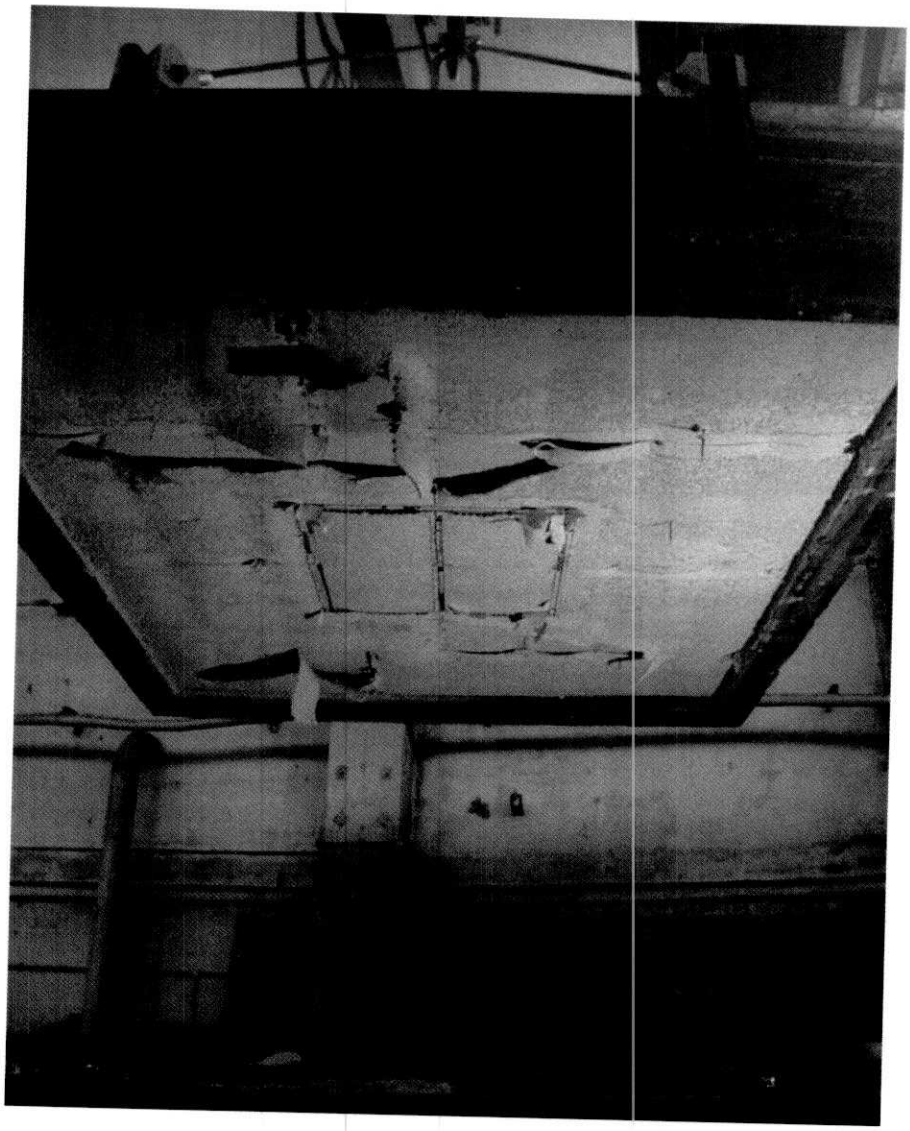

Plate 6 Exposed face of specimen shortly after test

(Neg.No. 0014)

Test and report by:

Signature	K D Fardell
Name	K.D. Fardell
Position	Technical Officer

Approved by:

Signature	Richard A. Jones
Name	R.A. Jones
Position	Centre Head
Reference	KDF/MB
Date	18 October 2000