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TNO Building and
Construction Research

Contact person
P.W.M. Kortekaas

Centre for Fire Research
Lange Kleiweg 5, Rijswijk
P.O. Box 49
2600 AA Delft
The Netherlands

Phone +31 15 284 20 00
Fax +31 15 284 39 90

**Determination of the fire resistance of a floor
structure with a suspended ceiling containing
light fittings provided with fire-resistant co-
vers, manufactured by Environmental seals.**

Date
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Author(s)
P.W.M. Kortekaas
Ing. P.W. van de Haar

Sponsor : Environmental Seals Ltd.
Envirograf House
Barfreston
Kent CT15 7JG
United Kingdom



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6 TEST CONSTRUCTION

6.1 General

The investigation was carried out on a floor/ceiling structure with dimensions of approximately 3.2 x 4.0 m and comprised of floor elements of aerated concrete, steel joists and a suspended ceiling.

The suspended ceiling was comprised of ceiling panels manufactured by Armstrong, type Prima Fine Fissured, and an exposed suspension framework constructed of tee-section steel, manufactured by Armstrong, type Trulok Prelude. Four light fittings manufactured by Crompton lighting and Illuma, were mounted in the ceiling. The upper surfaces of the light fittings were provided with fire-resistant covers manufactured by Environmental Seals.

6.2 Materials¹

6.2.1 Floor and supporting construction

The floor structure was comprised of:

- four IPE 140 steel joists, length 4600 mm, span $L_1 = 4150$ mm;
- six floor elements of reinforced aerated concrete, thickness 150 mm, with the following dimensions:
 - 3050 x 750 mm (4 elements);
 - 3050 x 400 mm (2 elements).

The floor was assembled in a supporting comprised of a steel test frame lined with aerated concrete elements with a wall thickness of 150 mm. The internal dimensions of the supporting construction frame were 4000 x 3200 mm.

6.2.2 Ceiling framework

The ceiling sections were constructed from 'stitched'² cold-rolled thermogalvanized steel strips, finished with a powdered epoxy-resin coating on the exposed surfaces.

- main beam (1), type Trulok Prelude, BP 314033A, principle dimensions 3600 x 38 x 24 mm, thickness 0.33 mm;
- cross tee (2), type Trulok Prelude, BP 113033A, principle dimensions 1200 x 38 x 24 mm, thickness 0.33 mm;
- wall moulding (3), type Trulok Prelude, BPT 2424H, principle dimensions 3050 x 24 x 24 mm, thickness 0.5 mm.

The structure also made use of Sealfast rapid fasteners (4), comprised of two lengths of 4 mm Ø steel wire and a connector. The positions of these fasteners are shown in Figure 1.

¹ The figures between brackets refer to the corresponding components in the parts list

² 'Stitched' refers to indentations pressed into the body of the tee section. According to the client this increases the rigidity of the section.

- attachment of the wall mouldings on the inner surface of the aerated-concrete frame, at a distance of approx. 280 mm from the underside of the steel joist to the underside of the wall moulding, with UPAT nails at a centre-to-centre distance of approx. 300 mm;
- attachment of the lead anchors and the rapid fasteners, centre-to-centre distance 1200 mm, in the direction of the span of the steel joists, as shown in Figure 1;
- shortening of the main beams to lengths of approx 1.72 m and 1.48 m and the hanging of the rapid fasteners with the location of the connectors and the fire-breaks as shown in Figure 1, centre-to-centre distance between the main beams approx. 1200 mm;
- adjustment of the rapid fasteners to the correct length;
- installation the cross tees, centre-to-centre distance approx. 600 mm;
- installation of the light fittings (see Figure 1);
- attachment of the fire-resistant provisions (see Figures 2, 3 and 4);
- attachment of the other ceiling panels, using clips located centrally on each side of the ceiling panel;
- sealing of the joints between the floor elements and the recesses in the aerated-concrete framework with rock-wool.

7 THE CONSTRUCTION OF THE STRUCTURE

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: the supporting and the floor of joists and aerated-concrete floor elements.

Armstrong BV, Breda

: the manufacture and installation of the suspended ceiling with exposed suspension framework and ceiling panels.

Environmental Seals Ltd

: the installation of the light fittings and the fire-resistant covers.

8 TEST METHOD

8.1 Inspection of the test piece

During construction and assembly the specifications of the materials and components were checked against the information that had been previously supplied.

8.2 Conditioning

The structure investigated in this report was located in the Centre for Fire Research's test hall in the period between the beginning of its construction until the completion of the fire test. The ambient temperature was 20 ± 5 °C and the relative humidity was $50 \pm 10\%$.

10 MEASUREMENT RESULTS

10.1 *The determination of the density³ and the equilibrium moisture content⁴*

Ceiling panels type Prima Fine Fissured

- density : 243 kg/m³
- moisture content (w/w) : 1.3 %

10.2 *The fire test*

The results of the measurements are shown in Figures 6 to 14.

During the heating period the overpressure in the oven and the temperature and velocity of the air outside of the oven were in compliance with the requirements stated in NEN 6069:1997.

11 SUMMARY

The most important results from the investigation are summarized in table 1.

Table 1 Summary of the test results.

Criterion	Period from the beginning of the heating period during which the criterion was still just met
Load bearing capacity	51 min.
Integrity	51 min.
Thermal insulation	51 min.

12 CONCLUSIONS

The Fire-resistance with respect to the separating function as well as with respect to the loadbearing capacity, as determined in accordance with NEN 6069:1997 was **51 minutes**.

³ Determined prior to drying.

⁴ Determined after drying the sample at 105°C for 24 hours.

15 REMARK

After the test, the fire-resistant covers over the 1200 x 600 mm light fittings were still clearly visible (see photo 5). The covers over the other light fittings could no longer be seen.



P.W.M. Kortekaas



P.W. van de Haar

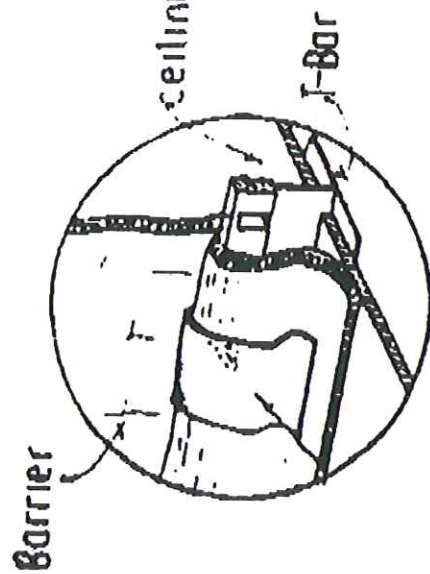
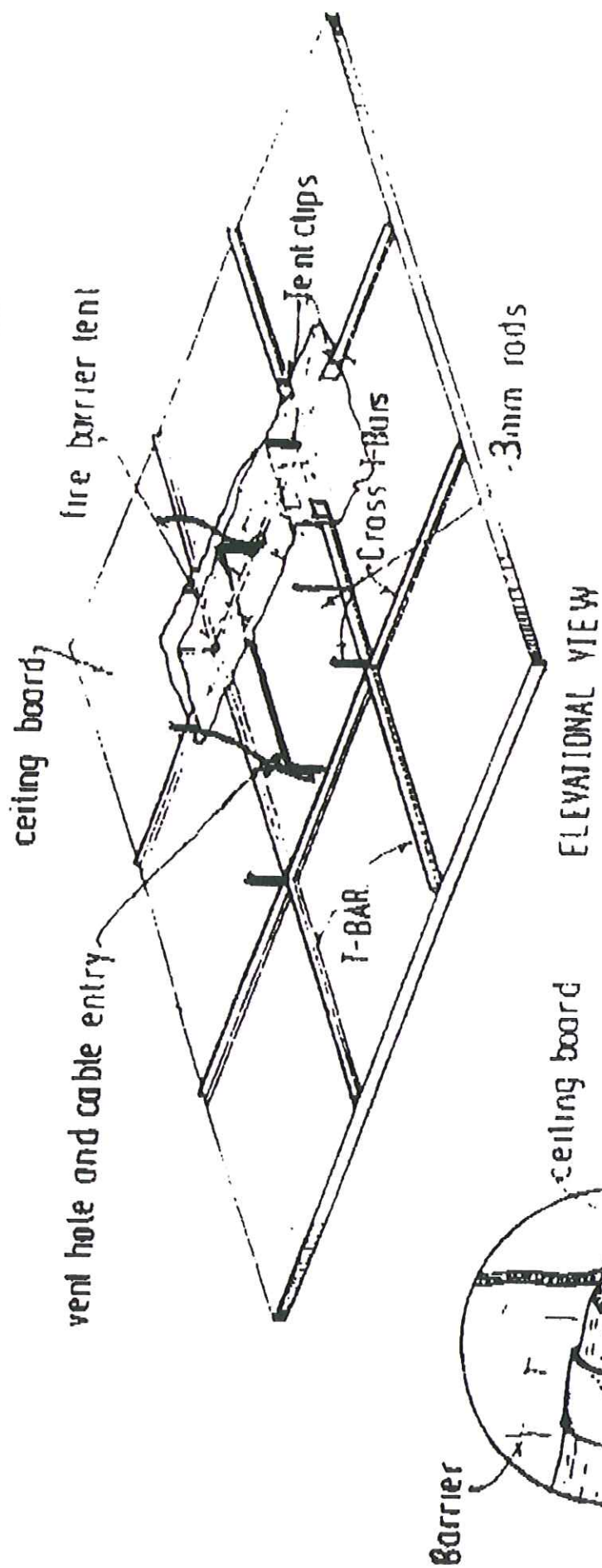
Appendix A

Observations during the heating trial

H = Observation on the side exposed to direct heat

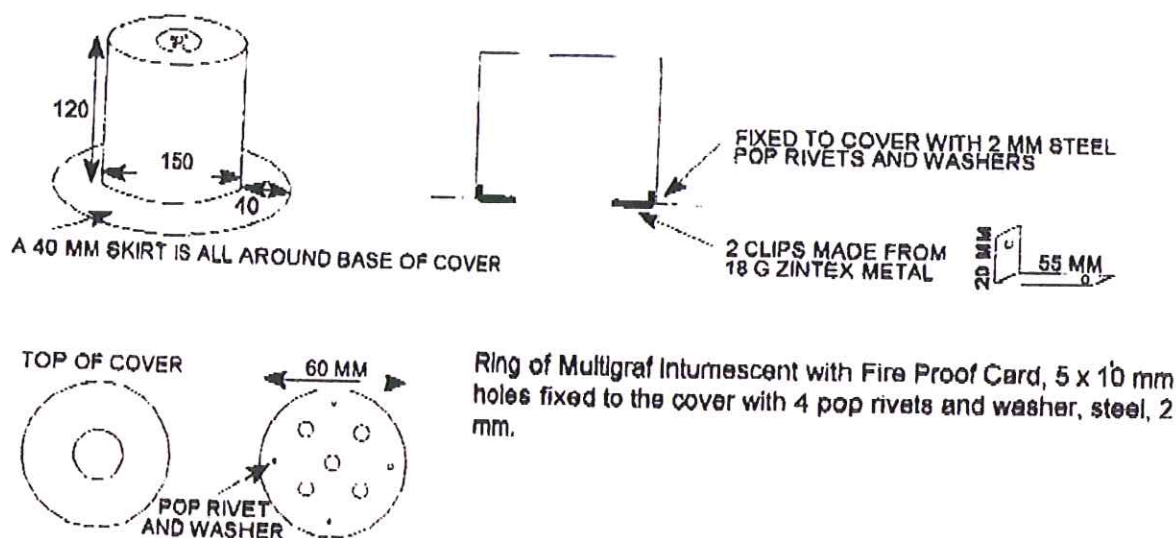
N = Observation on the side not exposed to direct heat

Time [min.]		Observation
0		Heating begins
2	H	Perspex panel of light fitting a) has fallen out
5	H	Fire-breaks activated
8	N	Emission of smoke above the floor
33	H	The ceiling sags slightly in the vicinity of light fittings a) and b).
40	H	An opening is visible between the edge sections and the trimmed ceiling panels adjacent to light fittings a) and b).
42	H	A small trimmed panel at the side of and between light fittings a) and b) has fallen out.
48	H	The central ceiling panel adjacent to light fittings a) and b) has fallen out.
51	N	Maximum sag attained. End of heating

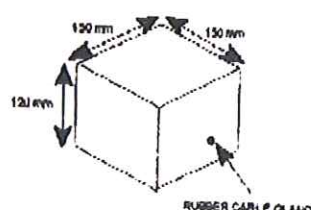


VIEW FROM OUTSIDE TENT

Envirograf Ref. No. 03201, size: 150 mm dia x 120 mm high. Made from 400 gram glass cloth impregnated with Envirograf GC Coating.



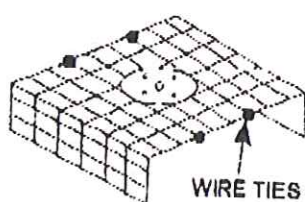
Envirograf Intumescent Cage, made from 12 mm weld mesh, 18 g wire, 150 mm x 150 mm x 120 mm high. Consisting of a mesh body, lined with Multigraf Intumescent Sheet Material with external fire faced card, white.



Stapled into mesh frame with 26/6 staples.

The frame has fitted on one side a 12 mm rubber cable gland.

On the opposite side are fitted 2 x 18 g metal brackets, 30 mm x 20 mm, welded to the cage.



The lid consists of a 12 mm weld mesh top, 18 g wire. This is returned down at two sides by 15 mm, lined with Multigraf Intumescent Sheet Material, fixed with 26/6 staples and wired on top of the frame with 18 g wire ties.

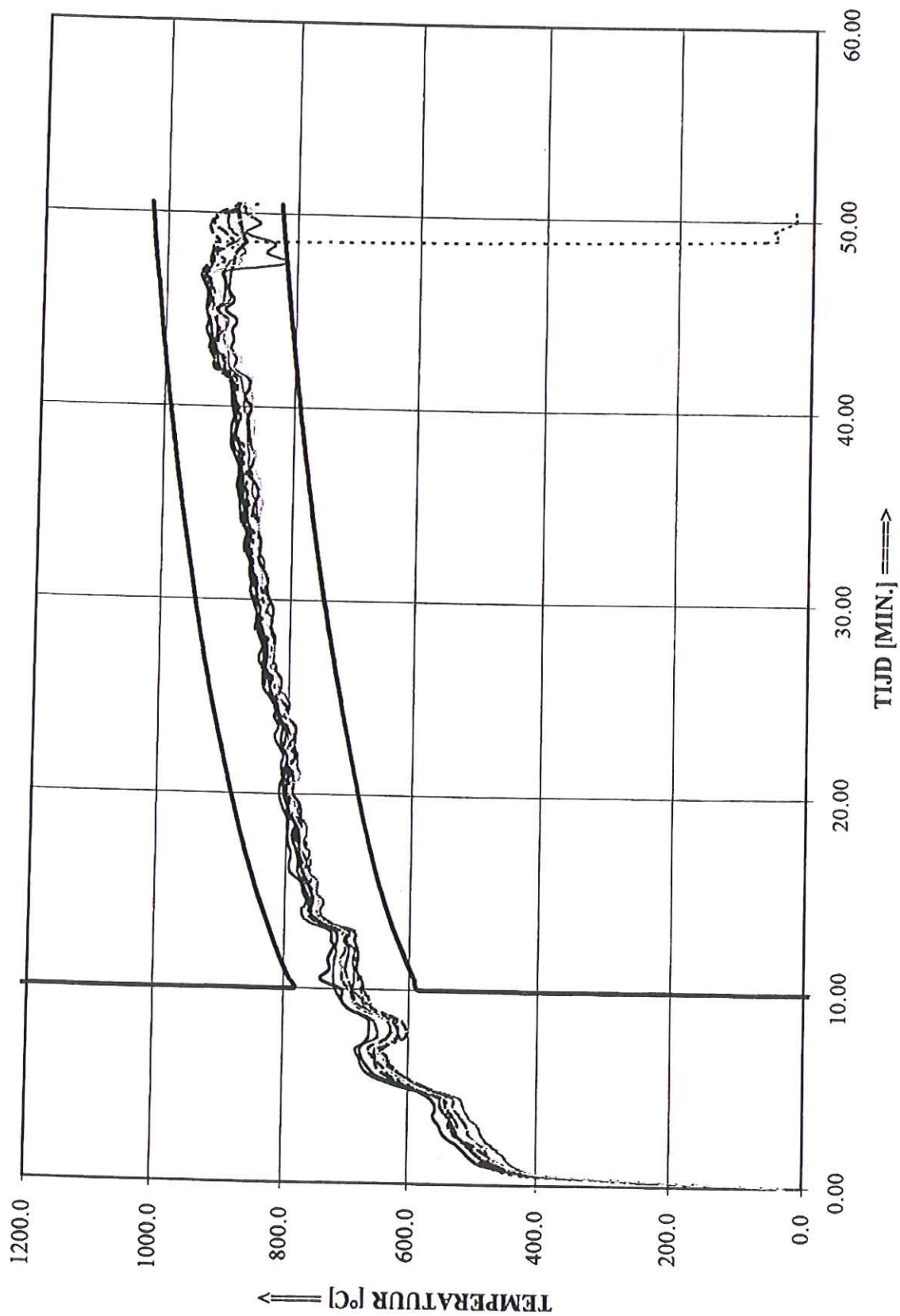
On top of the lid is a ring of Intumescent with Fire Card, 60 mm diameter, 5 x 10 mm holes pop rivetted to the mesh with card inside and metal washers using 2 mm steel pop rivets.

The lid is also sealed on the inside with a coating around the edges of Envirograf SIL Silicone Sealant.

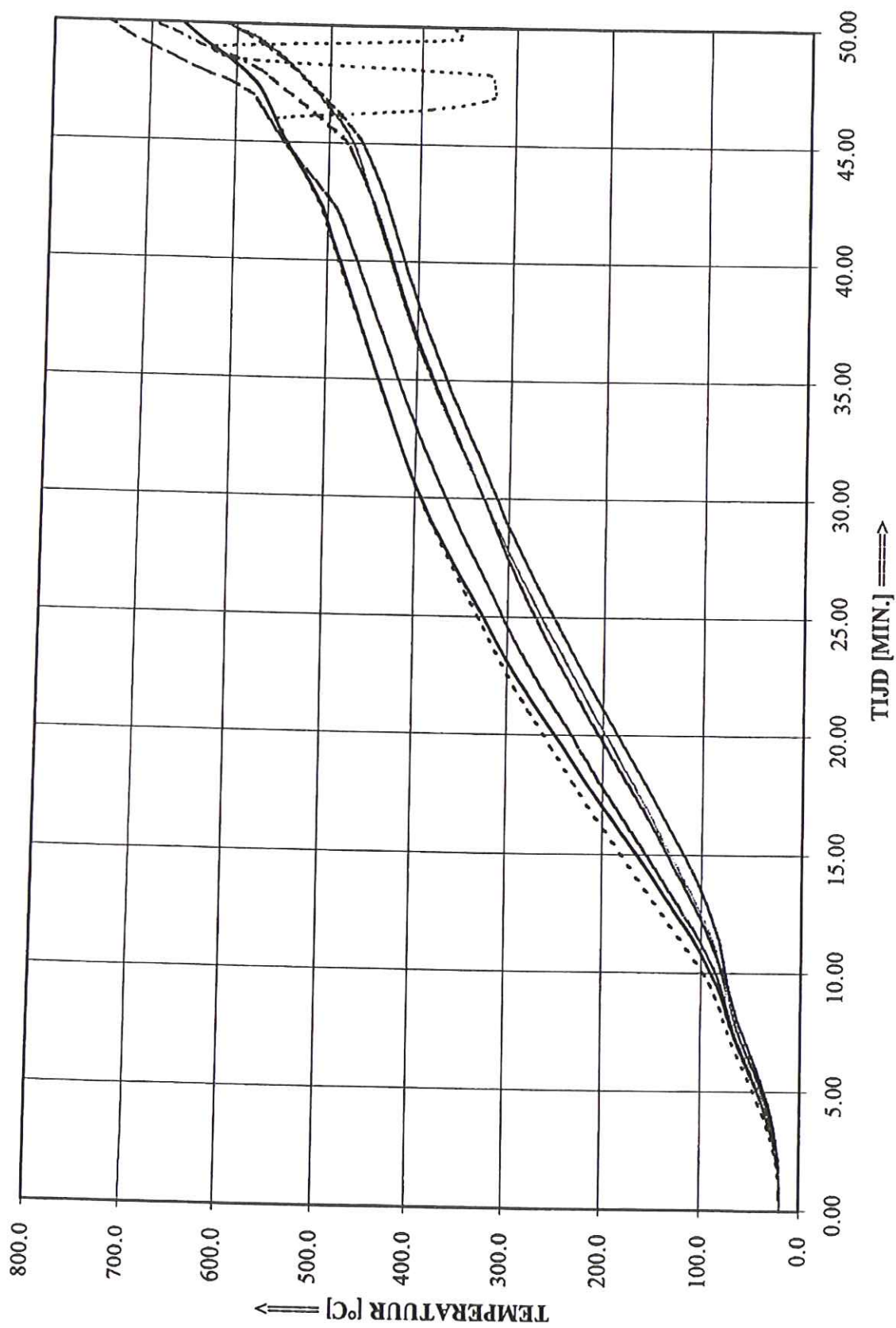
The Fire Cage is adhered to the ceiling using Envirograf Sealer Adhesive under the mesh and the metal brackets.

Figuur 4





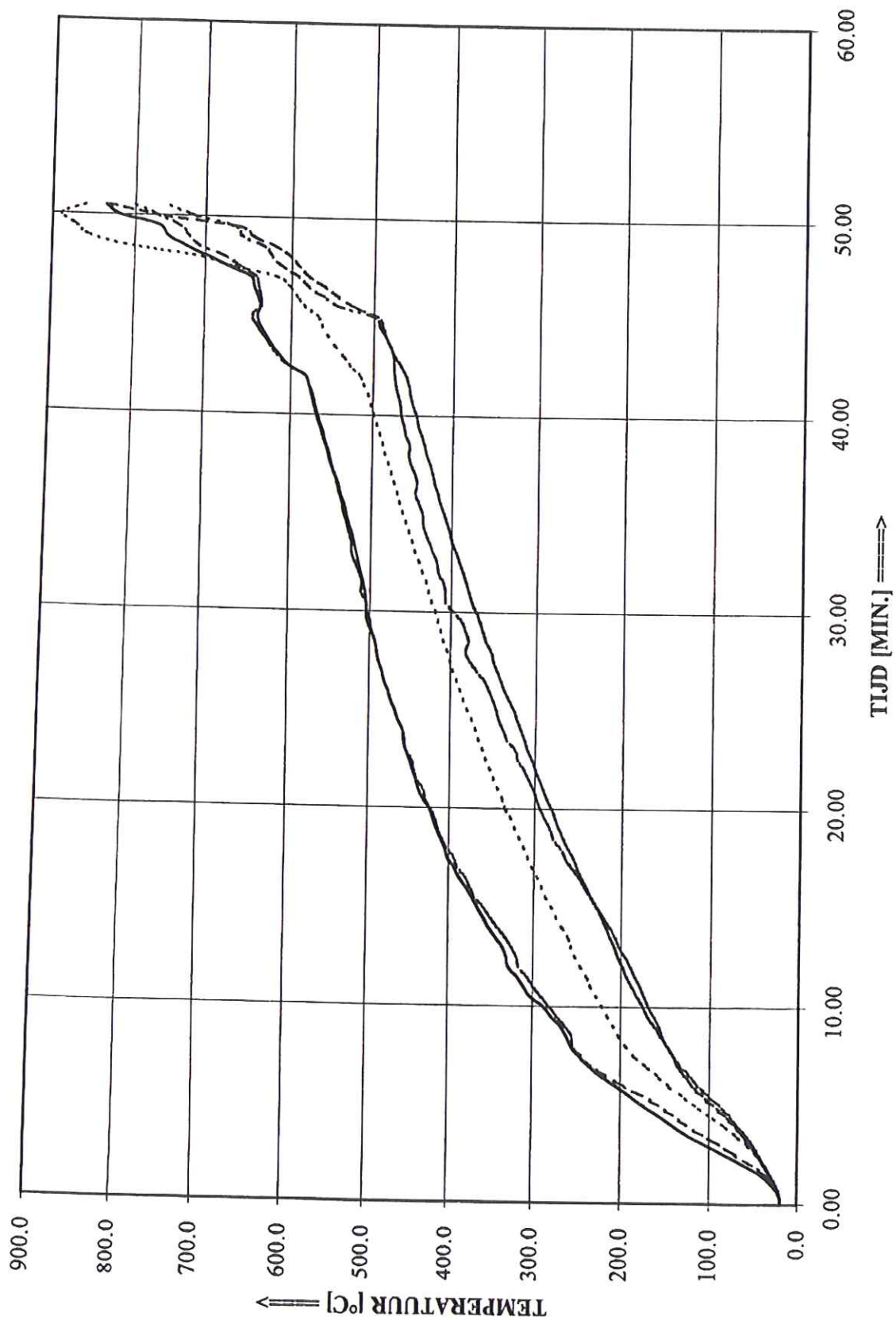
Figuur 6 : Gemeten gastemperaturen in de oven



- TST 1
- - TST 2
- ... TST 3
- . - TST 4
- - - TST 5
- TST 6



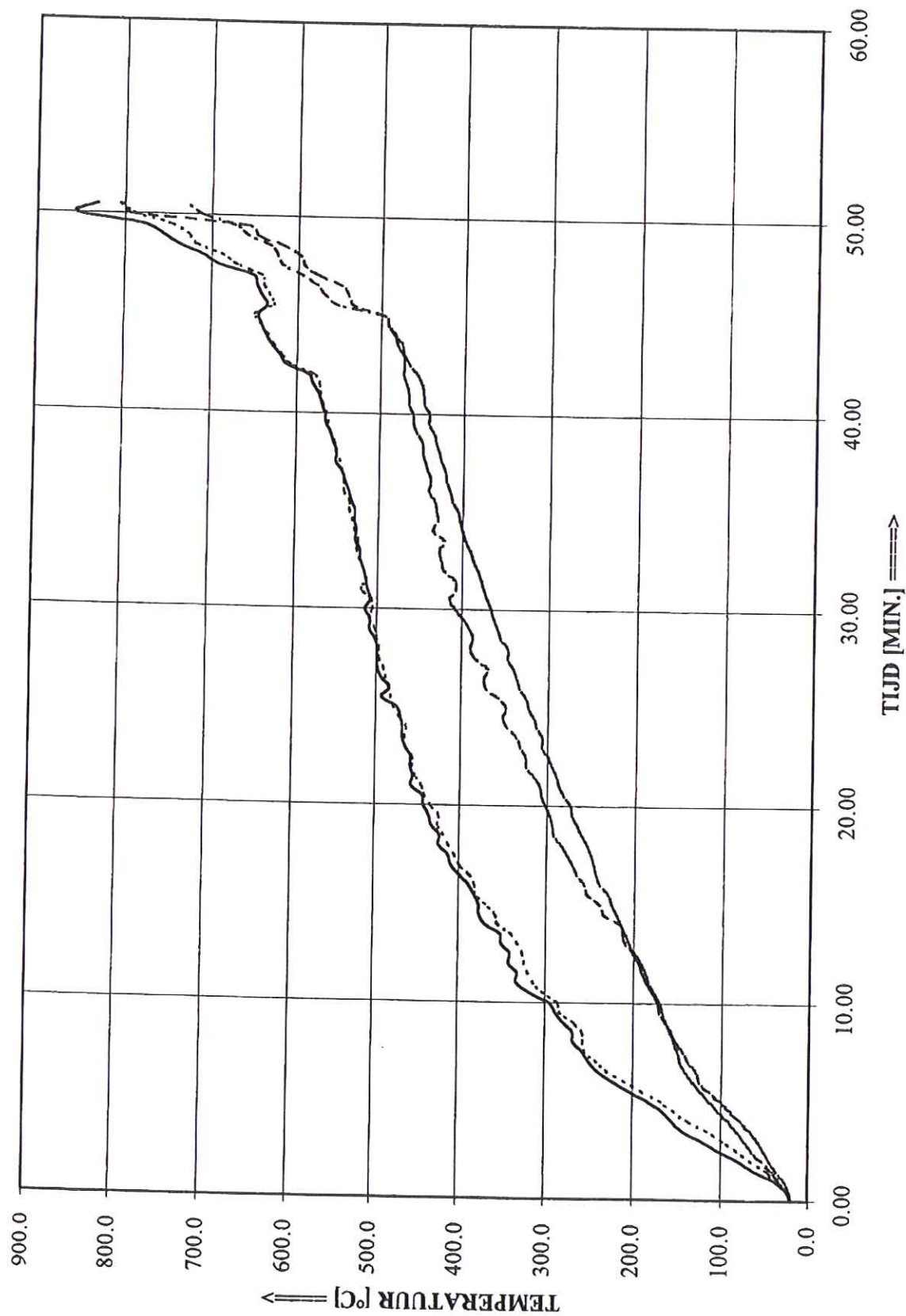
Figuur 8 Gemeten oppervlakte-temperaturen van de onderflenzen



— T SP 13
 - - T SP 14
 . . . T SP 15
 - - - T SP 16
 - - - T SP 17



Figuur 10 : Gemeten luchttemperaturen in het plenum



— T SP 18
 --- T SP 19
 T SP 20
 - . - . T SP 21



Figuur 12 Gemeten luchttemperaturen in het plenum boven de lichtarmaturen

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