

Efectis Nederland report

2007-Efectis-R0750

Determination of the fire resistance according to EN 1364-3: 2006 of a glazed curtain wall, Forster Thermfix Vario EI 60

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Date March, 2008

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Number of pages 27
Number of appendices 3

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Project name Forster Thermfix Vario EI 60
Project number **2007318**



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This report is issued by the TNO company Efectis Nederland BV (previously **TNO** Centre for Fire Research). TNO decided, in response to international developments and requests by customers, to collaborate with two European Egolf partners, both highly experienced in fire safety: the Norwegian **Sintef/NBL** and the French **CTICM**. Thus, through scaling up, a more comprehensive service of high quality and a wider range of facilities can be offered. In order to achieve this, the fire safety related activities of the partners involved have been privatised in this collaboration. With respect to TNO this has led to the privatisation on the 1st of July of 2006 the activities of the TNO Centre for Fire Research via the establishment of the company Efectis Nederland BV.

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1 Subject

Glazed curtain wall, type Forster Thermfix Vario EI 60, EW 60, E 60 manufactured by Forster Rohr & Profiltechnik AG.

2 Investigation

Determination of the fire resistance of a glazed curtain wall according to EN 1364-3: 2006.

3 Sponsor

AGC Flat Glass Europe sa
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4 Place and data regarding the investigation

The investigation took place at the laboratory of Efectis Nederland BV in Rijswijk, The Netherlands.

Installation of the specimen : September, 24th up to 28th 2007

Fire test : October, 2nd, 2007

5 Investigated construction

5.1 General

The fire test was performed on a glazed curtain wall designed to reach an EI 60 fire resistance according to EN 1364-3 2006.

The tested element was made of:

- Steel frame modular elements.
- Glazed panes.
- A horizontal seal.
- A vertical seal.

Overall dimensions of the element: 4625 x 3836 mm (w x h)

See Figure 11.1 up to Figure 11.14 for more details on the construction.

5.2 Curtain wall frame

The steel frame is made with studs and cross members.

Both types of elements are made with:

- A steel hollow rectangular section [1, 2, 3]¹, 45 x 90 t = 1.8 mm, 45 x 110 t = 1.8 mm and 60 x 110 t = 1.8 mm, see Figure 11.5.
- A stainless steel clamp profile, U shaped [4, 5, 6], 42 x 17 t = 1.25 mm and 57 x 17 t = 1.25 mm, see Figure 11.8.
- an aluminium external covering profile, U shaped [7, 8, 9] 45.5 x 19 t = 1.5, 45.5 x 23 t = 1.5 and 60.5 x 19 t = 1.5 mm, see Figure 11.9.

These elements are connected together by means of hollow rectangular steel elements [25, 26, 27] 70 x 40 t = 2.5 or 90 x 40 t = 2.5 elements welded on the sides of the studs, inserted in cross members and secured with M5 x 12 screws.

Each cross member (transom) is equipped with 2 profiled steel parts 90 x 40 t = 2.5 mm screwed in the groove folded in hollow rectangular sections 110 x 45 mm, see Figure 11.12.

5.3 Connection with supporting floors

Frame studs are connected on both supporting floors by means of steel angles [28], 78 x 300 thickness = 2.5 mm on which steel sheet of 63 x 53 and 115 x 63 thickness = 3 are welded.

The steel angles are fixed on the top of both floors by screws [40] HUS 7.5 x 120 mm (HILTI) + Ø28 mm washers, at 318/340 mm centres around.

The bottoms of the studs are inserted in U parts and are secured by 1 screw M8 x 65. The tops of the studs are inserted in U parts and are secured by 2 screws M8 x 65. More details can be found in Figure 11.11.

¹ The numbers between the brackets refer to the material lists in Figure 11.13 and Figure 11.14

5.4 Glazing

The openings between frame elements are filled by:

- 10 glazed panes;
- 9 blind panels.

Glazed panes characteristics:

- Trade reference: “Pyrobel 25 EG-1GU” with composition Pyrobel 25 EG –air space 12 – 6 FICl (6 mm Float Clear)
- Manufacturer: Glaverbel Czech
- Dimensions : 1308 x 411.5, 1500 x 411.5, 1116 x 411.5, 483 x 411.5, 1308 x 1455.5, 1500 x 2928, 1116 x 2928, 483 x 1455.5 (w x h).

Each glazed pane is equipped with an intumescing strip Gluske Kerafix Flexpan 200 [35] - 25.4 x 2.2 mm, one per rebate, before installation in the frame openings.

Two profiled rubber strips are inserted on both sides of panes between frame elements and external cramp U profiles.

One of the two panes per rebate is installed on both supporting steel parts with intermediate strip Gluske Flammi 12, 26 x 80 x 4 mm [21].

5.5 Panels

In front of lower and upper construction floors, panels [23] are installed in frame openings, instead of glazings.

The panels are made of 3 layers of Promatect-H thickness = 20 + 12 + 12 mm assembled together with Promat K84 glue [42] and 2 external aluminium sheets thickness = 1.5 mm.

Blind facade panels characteristics:

- Trade reference: thickness = 47 mm
- Manufacturer: Forster
- Dimensions: 1325 x 188, 1325 x 138, 88 x 1878 mm (w x h)

One of the two blind facade panels per rebate are equipped with an intumescing strip Gluske Kerafix Flexpan 200 [35], on its 4 sides, before installation in the frame openings.

5.6 Horizontal seal

In front of lower and upper construction floors, behind blind facade panels, a horizontal seal is installed, see Figure 11.2. It is build up of steel sheet material with a mineral wool filling.

It is limited vertically by top and bottom frame cross members and horizontally by extremity of floors and blind facade panels.

This inner volume is filled with mineral wool strips of Rockwool [36].

5.7 Vertical seal

In front of vertical supporting construction wall, 150 mm thickness, a vertical seal construction is installed, see figure 11.4.

This inner volume is filled with mineral wool strips Rockwool [36]- thickness = 50 mm.

On rear side, the sealing between both frame studs and vertical wall is made by:

- a mineral wool strip of Rockwool [36].
- a silicon mastic fillet Gluske fire protecting silicone B1, DIN 4102 [39] 20 x 5 mm (w x t) around

It is delimited vertically by 2 frame studs at 105 mm centres and horizontally by extremity of wall and blind facade panels.

Dimensions of the rear sealing: 140 x 20 mm (depth x w)

6 Production of the construction

- Curtain wall : Forster Profilsysteme
- Supporting construction : Efectis Nederland BV Rijswijk, The Netherlands.

6.1 Verification of the specimen

Efectis Nederland BV was not involved in the selection procedure of the specimen. During mounting the used materials and parts were verified against the supplied data.

6.2 Conditioning

From the moment of installation until the fire test the construction was stored in the laboratory of Efectis Nederland BV with the following conditions:

- Ambient temperature : $20 \pm 5^{\circ}\text{C}$.
- Relative humidity : $50 \pm 10 \%$.

6.3 Density and humidity measurements

Material	Density [kg/m ³]
Blind facade panel, Promatect H	870

6.4 Fire test

6.4.1 Test conditions

The test was performed under the conditions as specified in EN 1364-3: 2006 according to following conditions:

- standard fire curve as designed in EN 1363-1 on the internal face of the curtain wall;
- pressure conditions as designed in EN 1363-1, i.e. $+20 \pm 3$ Pa at 100 mm under the soffit of upper floor and 0 Pa at 500 mm above the top of the lower floor.

6.4.2 Measurements

During the heating period, the following data were measured and registered:

- ambient temperatures inside the furnace with 8 plate thermometers (TPL 1 to TPL 8), regularly distributed over the directly heated area referenced S2 according to EN 1364-3: 2006
- temperatures of the S2 area as referenced by EN 1364-3: 2006 standard and as the tested element is required for EI (i → o) classification : TK 1 up to TK 25
- temperatures of the S3 area as referenced by EN 1364-3: 2006 standard and as the tested element is required for EI (i → o) classification : TK 26 up to TK 46
- temperatures of the S4 area as referenced by EN 1364-3: 2006 standard and as the tested element is required for EI (i → o) classification : TK 47 up to TK 52 and TK 73 and 74
- temperatures of the S5 area as referenced by EN 1364-3: 2006 standard and as the tested element is required for EI (i → o) classification : TK 53 up to TK 66
- temperatures of the S6 area as referenced by EN 1364-3: 2006 standard and as the tested element is required for EI (i → o) classification : TK 67 up to TK 71
- ambient pressures inside the furnace
- deflection at the centre and the free edge of the test specimen

See Appendix B for further information about positions of sensors.

7 Observations during heating

At the 75th minute flames were visible longer than 10 seconds at the location C. A detailed description of the observations is given in appendix A.

8 Test results

8.1 Test results

Test results are given in graphs in appendix B.

8.2 Uncertainty of measurement

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.

9 Summary

According to the EN 1364-3: 2006 a Forster curtain wall construction of the type Thermfix vario was investigated. It which was exposed tot the internal fire curve on the internal face of the curtain wall.

The most important results of the investigation are given in table 1 as required by EN 1364-3: 2006 standard.

9.1 Surface S2

Table 1: Summary of test results

Criterion	Time measured from the start of the test during which, conform to EN 1364-3: 2006, the criterion was reached.	
	Time	Criterion failure or no failure
Integrity [E] <ul style="list-style-type: none">• Cotton wool pad• Opening gauges• Sustained flaming (> 10 sec)	75 minutes 75 minutes 75 minutes	Failure Failure Failure
Thermal insulation [I] <ul style="list-style-type: none">• Average temperature increase +140°C• Maximum temperature increase +180°C	75 minutes 75 minutes	Failure Failure

Radiation [W] <ul style="list-style-type: none"> • Radiative flux > 15 kW/m² 	75 minutes	Failure
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The test was stopped after 76 minutes.

9.2 Surface S3

Table 2: Summary of test results

Criterion	Time measured from the start of the test during which, conform to EN 1364-3: 2006, the criterion was reached.	
	Time	Criterion failure or no failure
Integrity [E] <ul style="list-style-type: none"> • Cotton wool pad • Opening gauges • Sustained flaming (> 10 sec) 	76 minutes 76 minutes 76 minutes	No failure No failure No failure
Thermal insulation [I] <ul style="list-style-type: none"> • Average temperature increase +140°C • Maximum temperature increase +180°C 	76 minutes 76 minutes	No failure No failure

The test was stopped after 76 minutes.

9.3 Surface S4

Table 3: Summary of test results

Criterion	Time measured from the start of the test during which, conform to EN 1364-3: 2006, the criterion was reached.	
	Time	Criterion failure or no failure
Integrity [E] <ul style="list-style-type: none"> • Cotton wool pad • Opening gauges • Sustained flaming (> 10 sec) 	76 minutes 76 minutes 76 minutes	No failure No failure No failure
Thermal insulation [I] <ul style="list-style-type: none"> • Average temperature increase +140°C • Maximum temperature increase +180°C 	76 minutes 76 minutes	No failure No failure

The test was stopped after 76 minutes.

9.4 Surface S5

Table 4: Summary of test results

Criterion	Time measured from the start of the test during which, conform to EN 1364-3: 2006, the criterion was reached.	
	Time	Criterion failure or no failure
Integrity [E] <ul style="list-style-type: none"> • Cotton wool pad • Opening gauges • Sustained flaming (> 10 sec) 	76 minutes 76 minutes 76 minutes	No failure No failure No failure
Thermal insulation [I] <ul style="list-style-type: none"> • Average temperature increase +140°C • Maximum temperature increase +180°C 	76 minutes 76 minutes	No failure No failure

The test was stopped after 76 minutes.

9.5 Surface S6

Table 5: Summary of test results

Criterion	Time measured from the start of the test during which, conform to EN 1364-3: 2006, the criterion was reached.	
	Time	Criterion failure or no failure
Integrity [E] <ul style="list-style-type: none"> • Cotton wool pad • Opening gauges • Sustained flaming (> 10 sec) 	76 minutes 76 minutes 76 minutes	No failure No failure No failure
Thermal insulation [I] <ul style="list-style-type: none"> • Average temperature increase +140°C • Maximum temperature increase +180°C 	76 minutes 76 minutes	No failure No failure

The test was stopped after 76 minutes.

9.6 Horizontal seal

Table 6: Summary of test results

Table 9.1

Criterion	Time measured from the start of the test during which, conform to EN 1364-3: 2006, the criterion was reached.	
	Time	Criterion failure or no failure
Integrity [E] <ul style="list-style-type: none"> • Cotton wool pad • Opening gauges • Sustained flaming (> 10 sec) 	76 minutes 76 minutes 76 minutes	No failure No failure No failure
Thermal insulation [I] <ul style="list-style-type: none"> • Maximum temperature increase +180°C 	76 minutes	No failure

The test was stopped after 76 minutes.

9.7 Vertical seal

Table 6: Summary of test results

Table 9.2

Criterion	Time measured from the start of the test during which, conform to EN 1364-3: 2006, the criterion was reached.	
	Time	Criterion failure or no failure
Integrity [E] <ul style="list-style-type: none"> • Cotton wool pad • Opening gauges • Sustained flaming (> 10 sec) 	76 minutes 76 minutes 76 minutes	No failure No failure No failure
Thermal insulation [I] <ul style="list-style-type: none"> • Maximum temperature increase +180°C 	75 minutes	Failure

The test was stopped after 76 minutes.

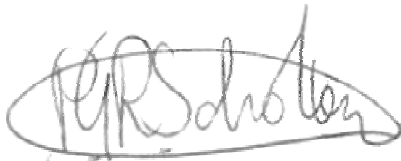
10 Field of direct application of test results

The results formulated in chapter 9 are only valid for curtain wall constructions, which are the same in detail to the investigated constructions, including materials and means of assembly used.

They are also directly applicable to constructions where one or more of the following changes are made relative to the construction tested:

- a) Decrease in the modular width and height of glazed and non-glazed areas.
- b) Decrease in distance between the mullions and transoms.
- c) Increase in mullion sizes.
- d) Increase in panel or panel thickness.
- e) Decrease in the distance in between fixing centres, vertical and horizontal.
- f) Increase in floor thickness and/or density.
- g) Increase in seal thickness, measured in the direction of the floor and/or wall thickness, and increase of the density of a seal of mineral wool.
- h) Decrease in seal width.

Test results are valid for curtain walling systems of increased width provided the construction details (distance of mullions etc.) are the same as the one tested. The results are valid for curtain walling systems of greater height (extending over more than one floor) provided the distance between the floors is equal to or smaller than that tested.



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11 Drawings

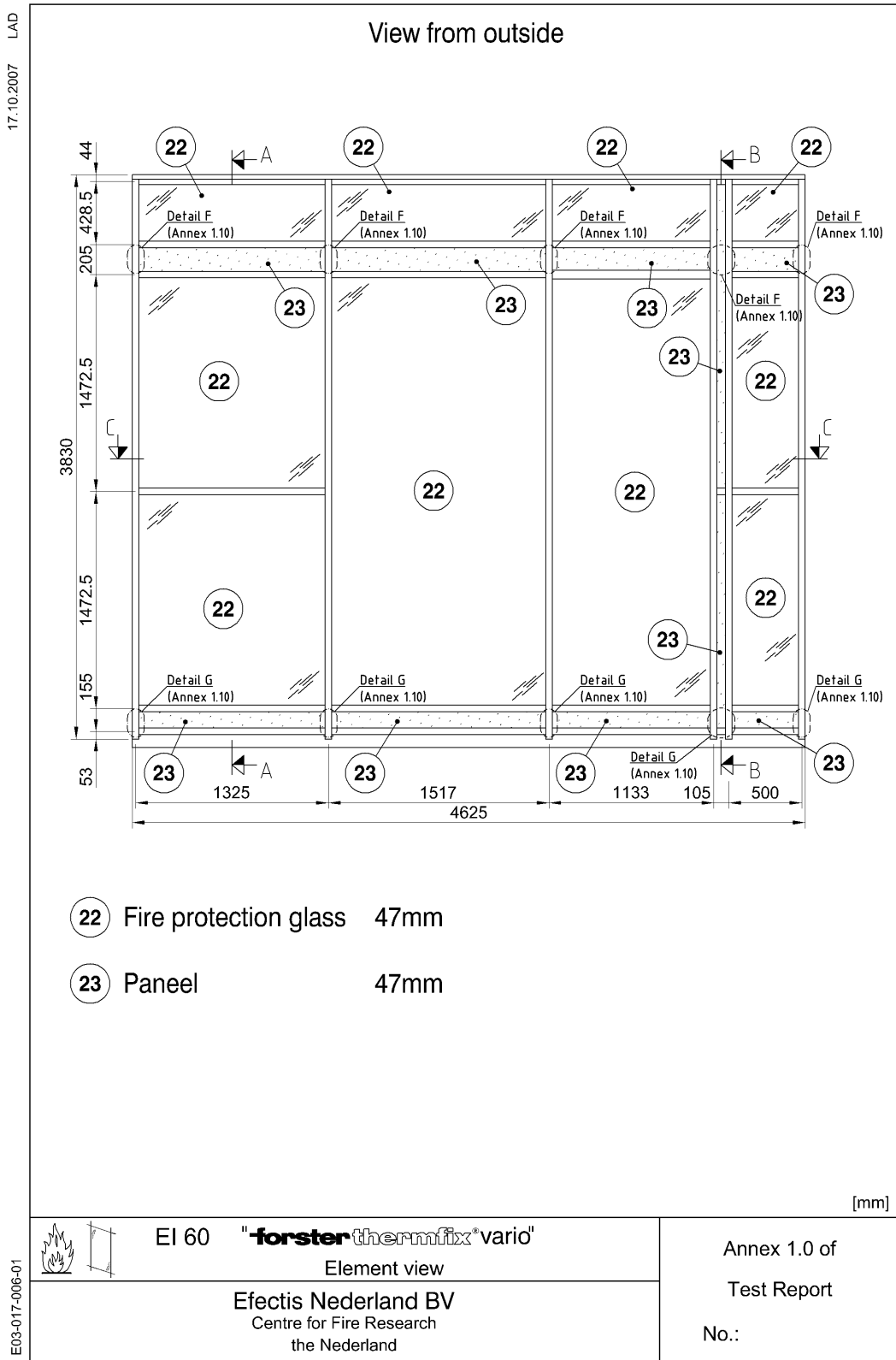


Figure 11.1

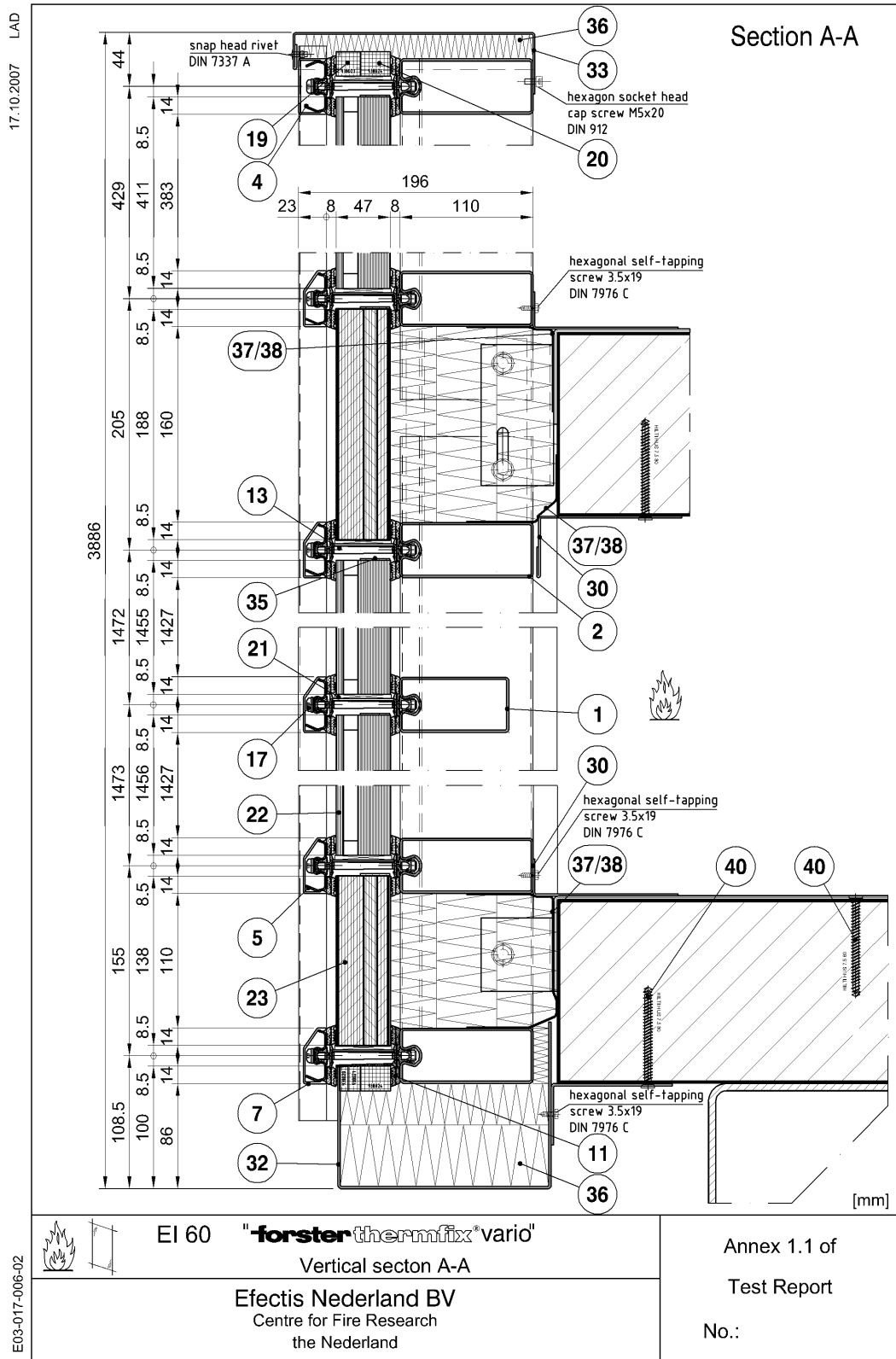


Figure 11.2

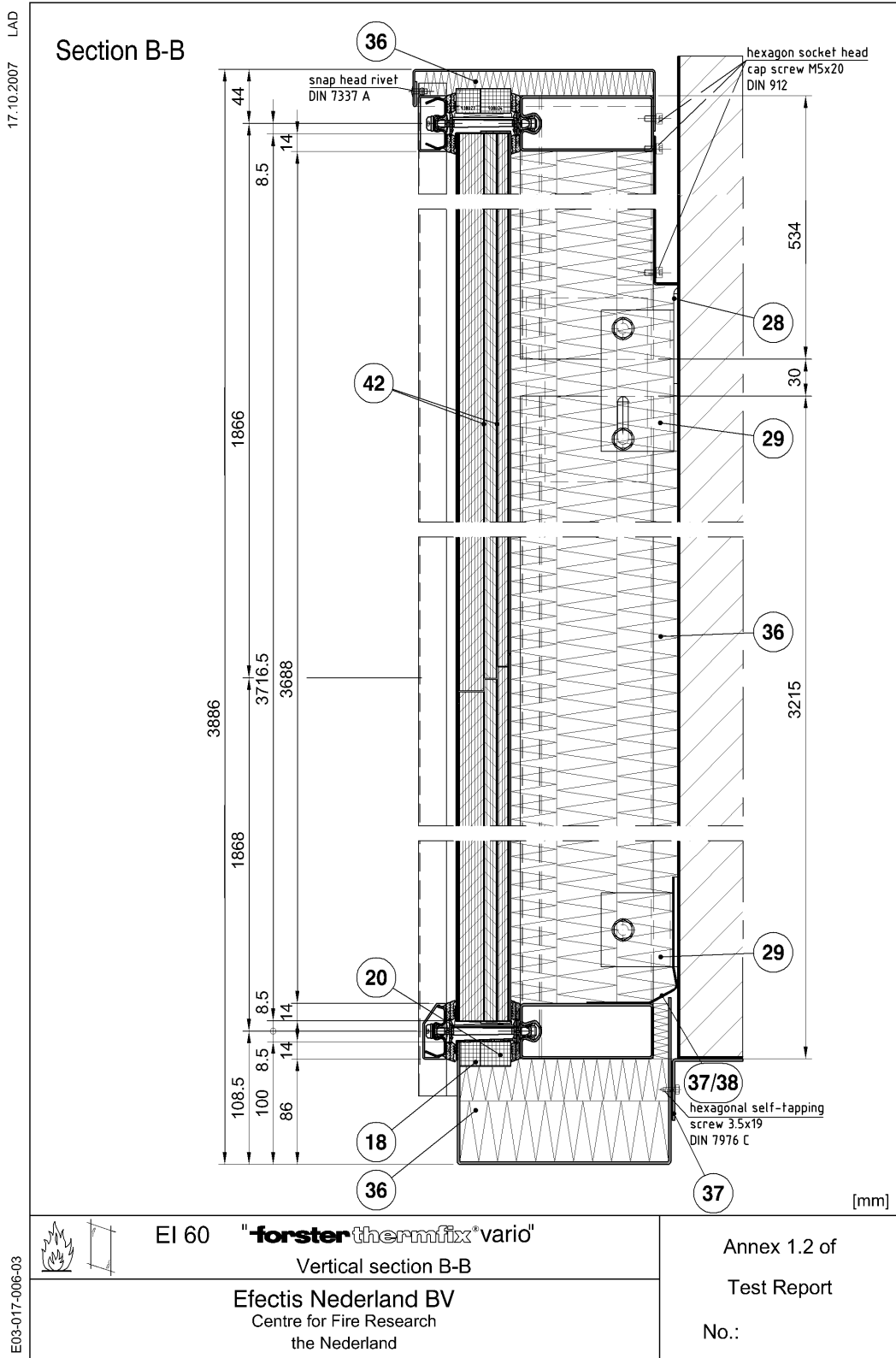


Figure 11.3

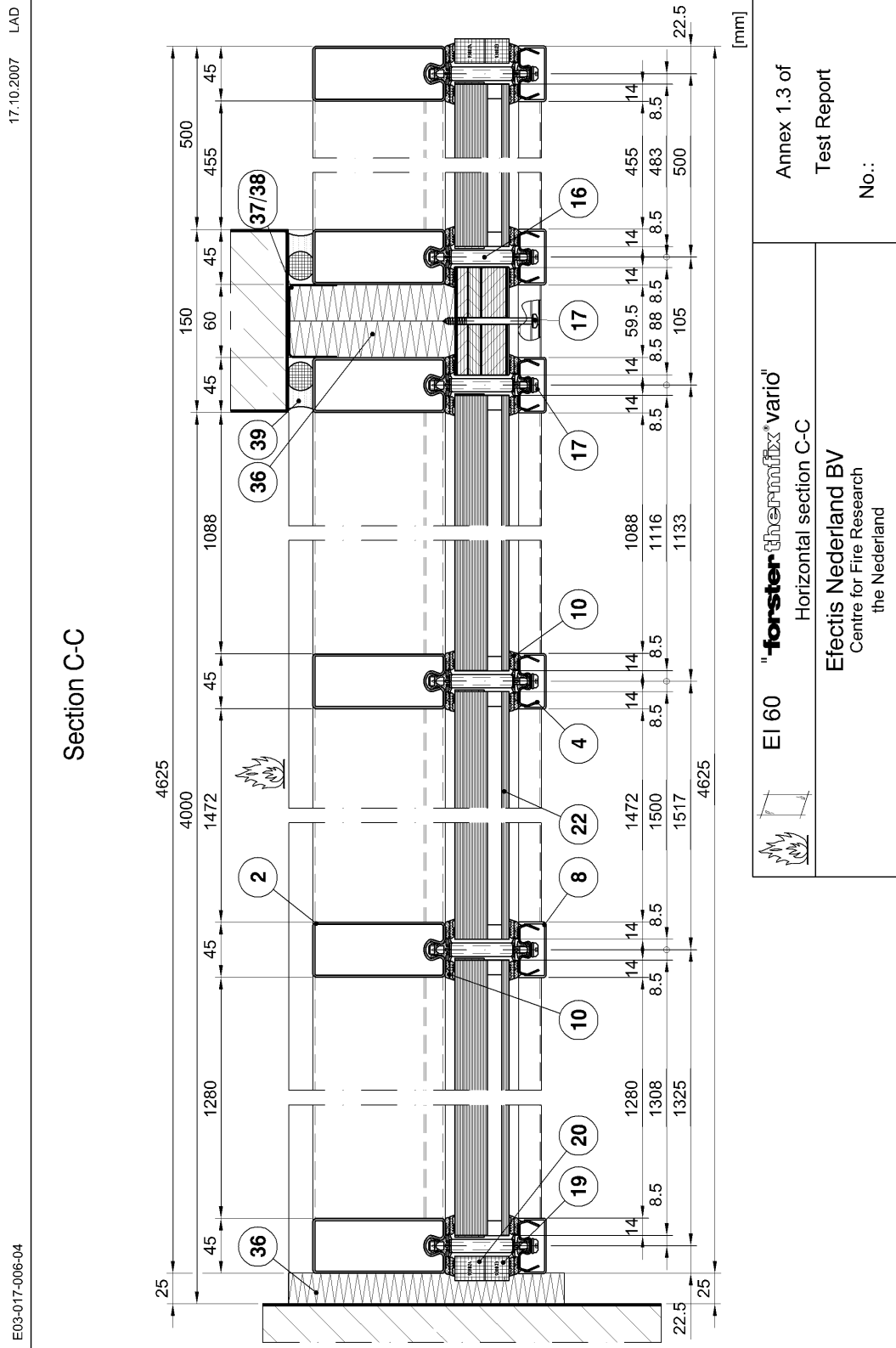


Figure 11.4

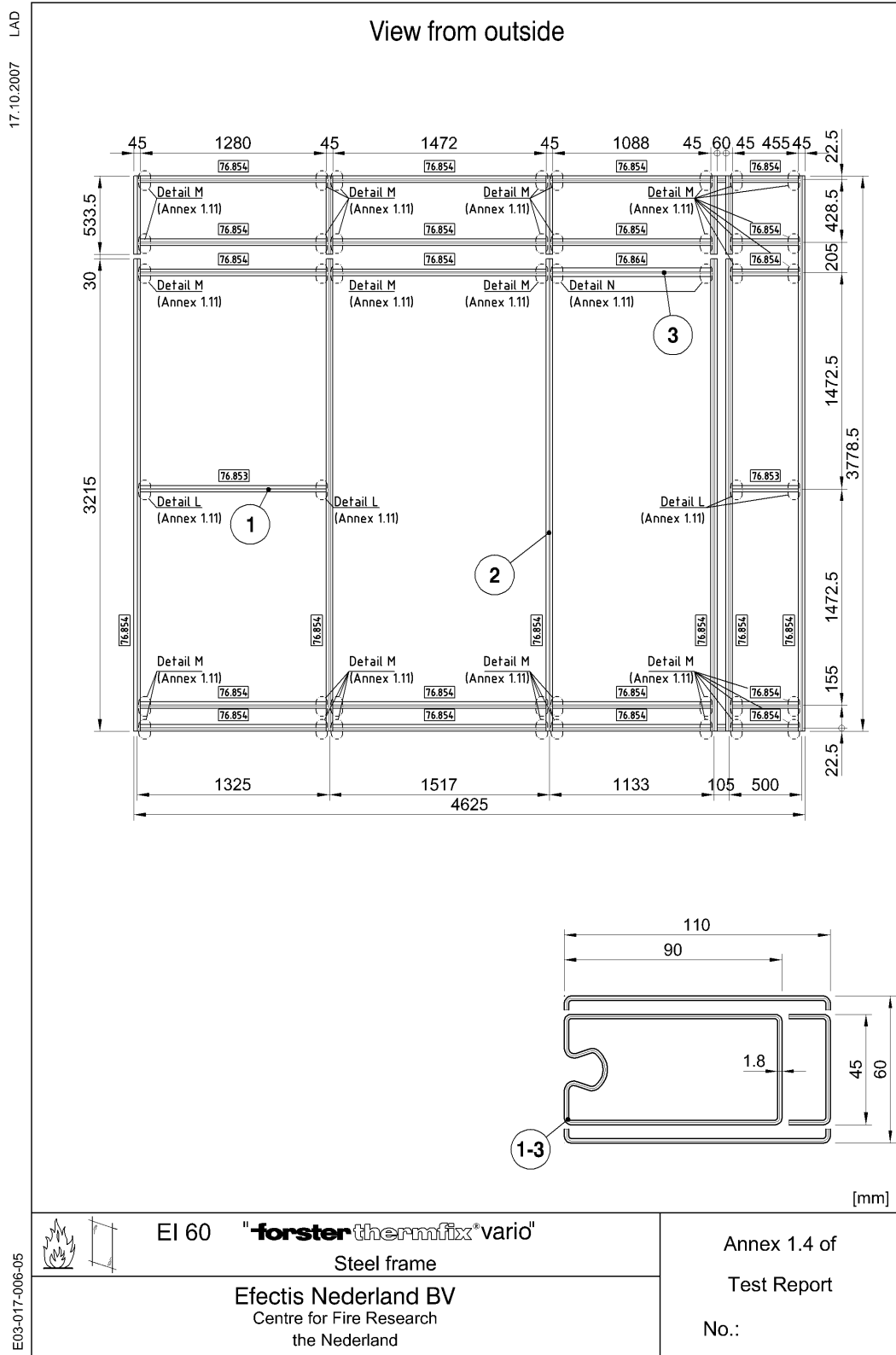


Figure 11.5

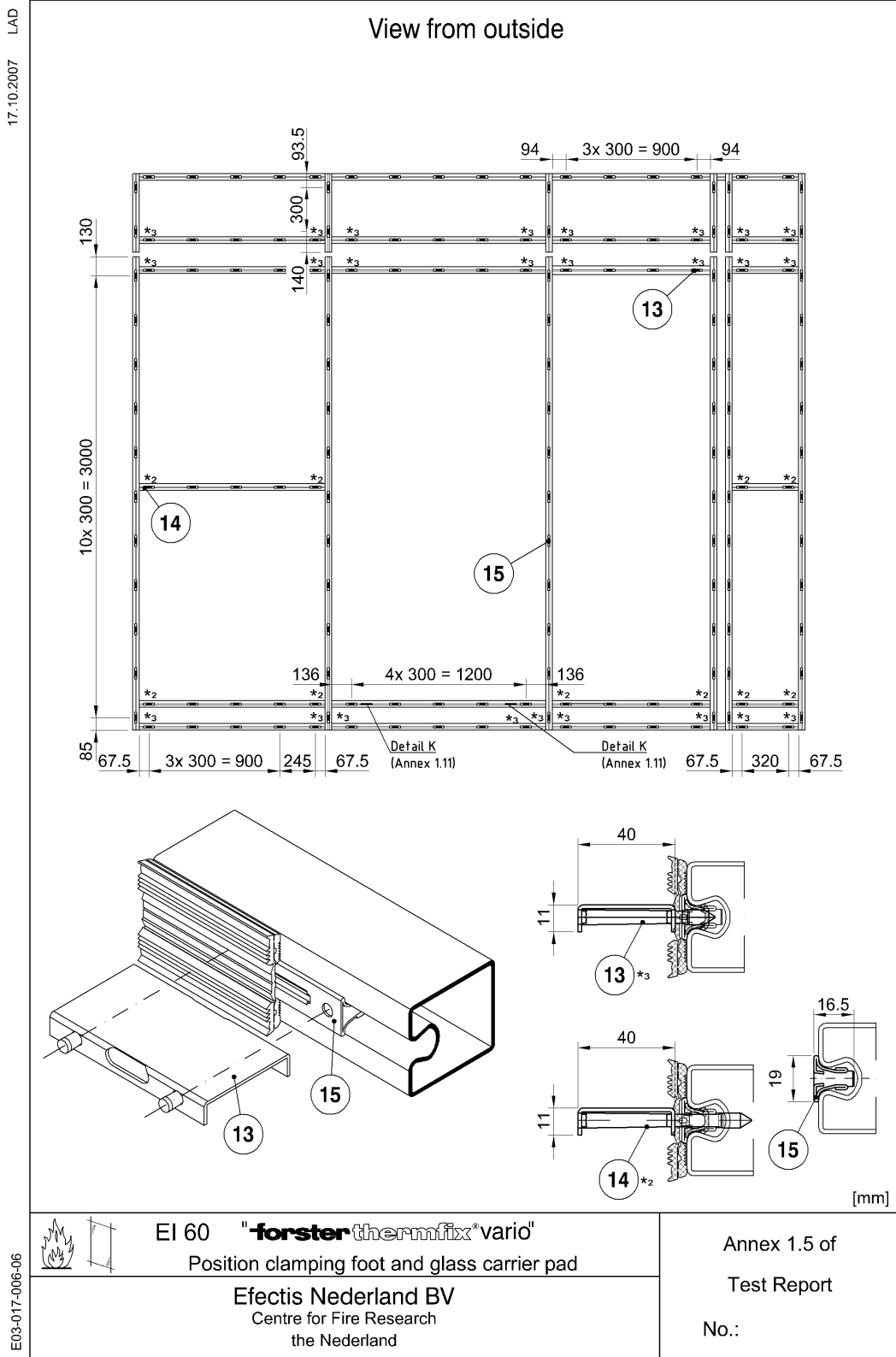


Figure 11.6

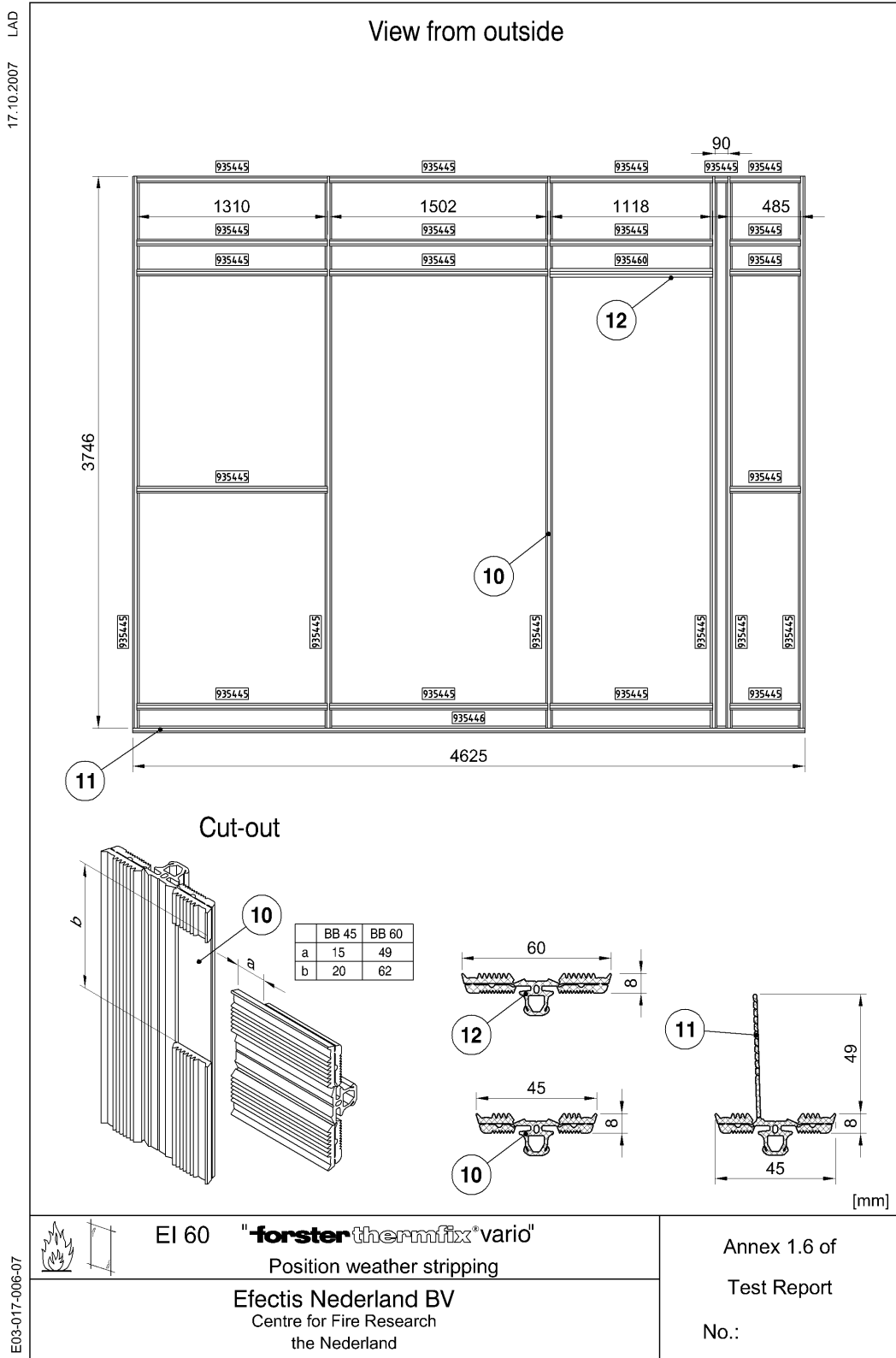


Figure 11.7

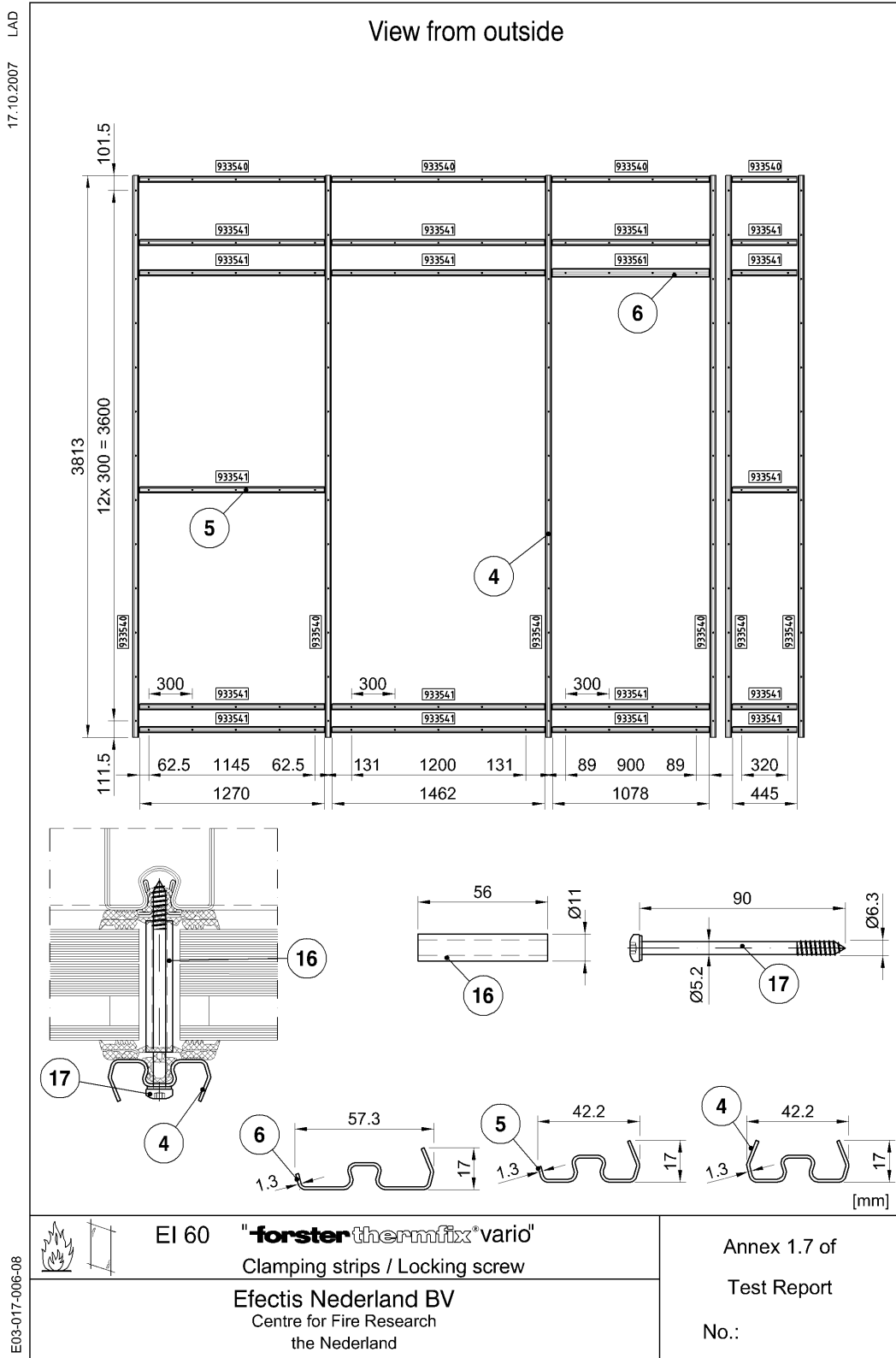


Figure 11.8

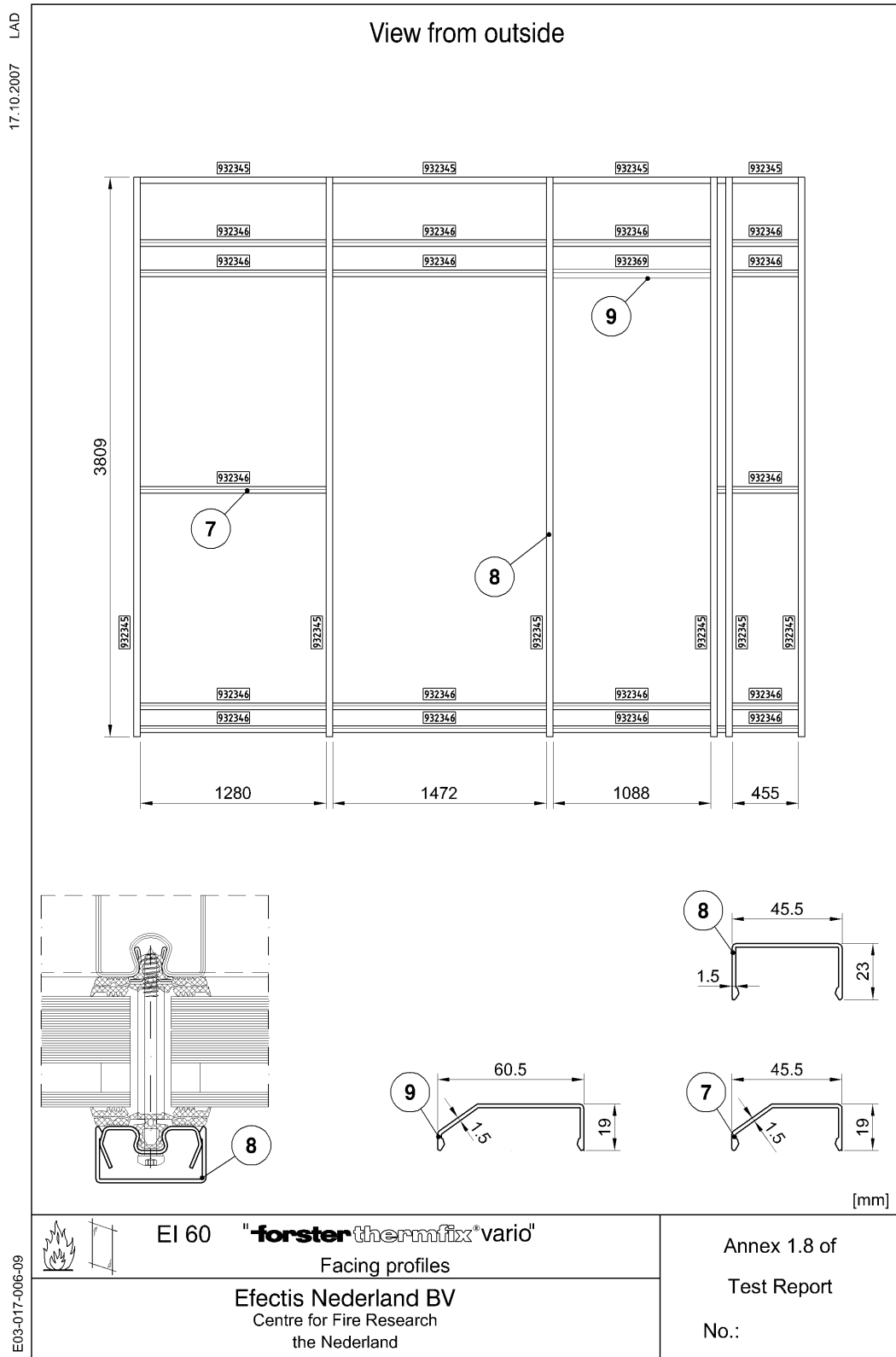


Figure 11.9

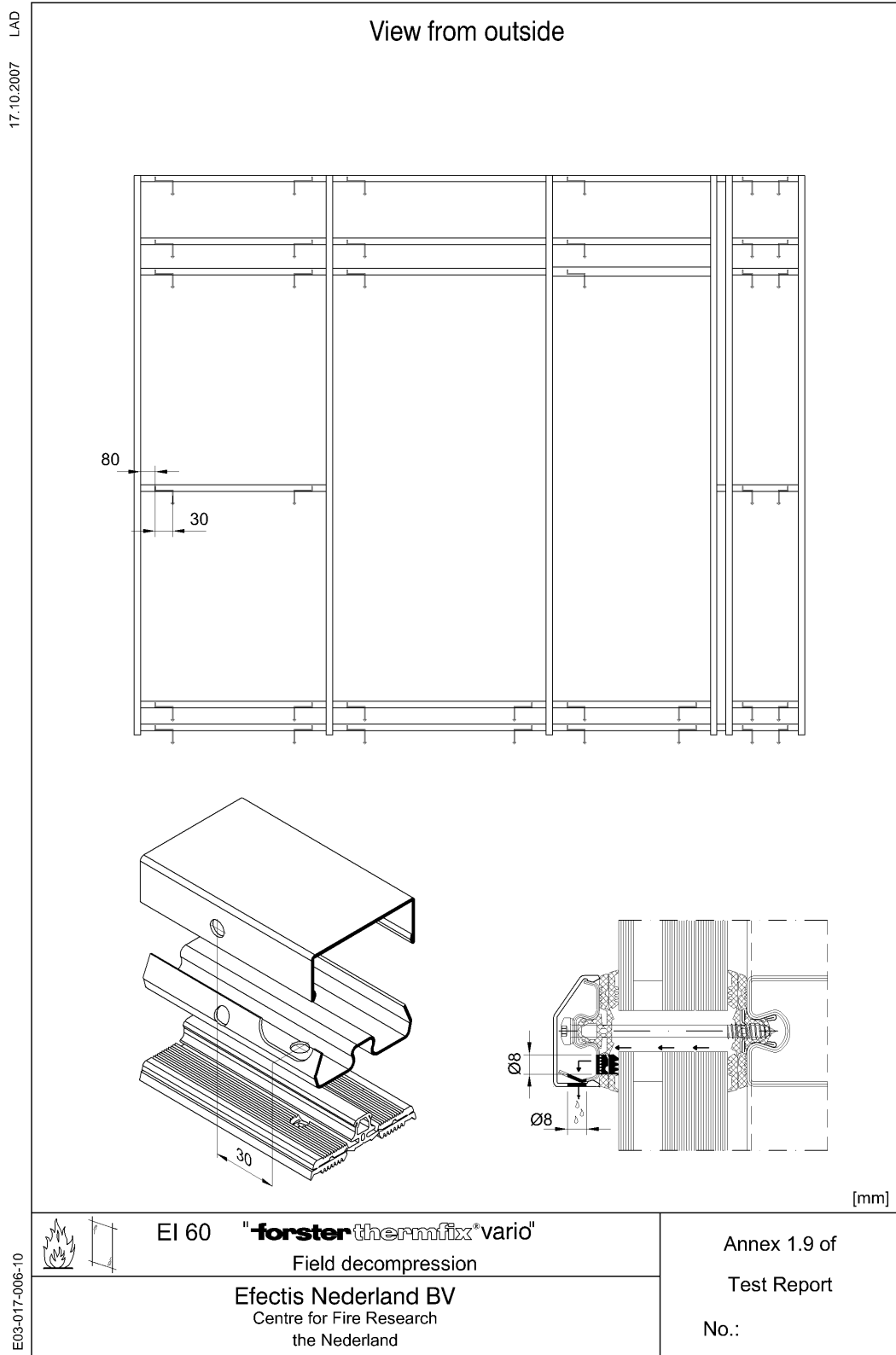


Figure 11.10

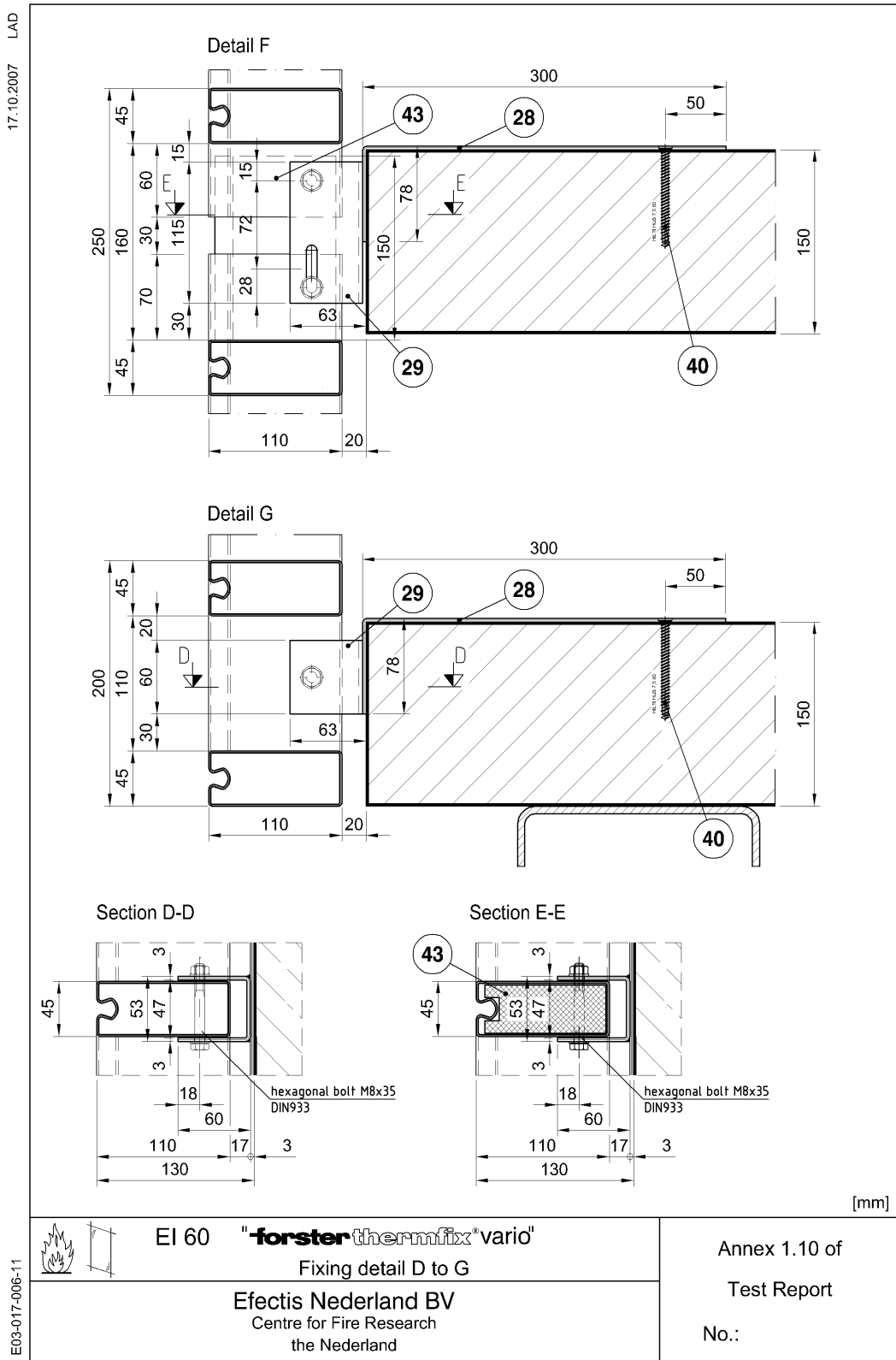


Figure 11.11

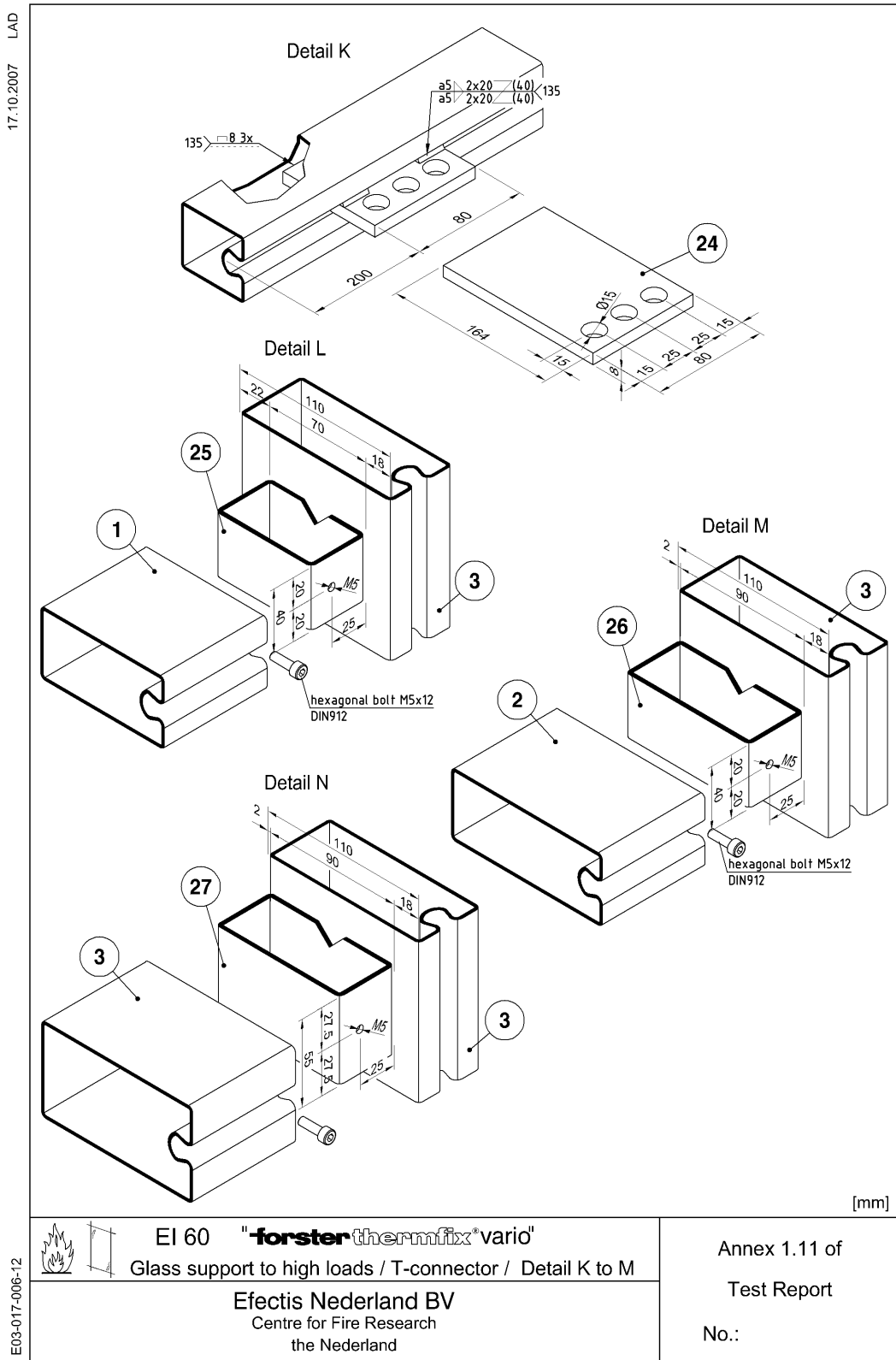


Figure 11.12

17.10.2007 LAD

E03-017-006-13

Pos.	Appellation	Dim. (mm)	Article. No.	Material	No.mat.	Authorization	Classification	Test certificate
1	Profile	45 x 90	76.853	E 195 (DD11)	1.0331			
2	Profile	45 x 110	76.854	E 195 (DD11)	1.0331			
3	Profile	60 x 110	76.864	E 195 (DD11)	1.0331			
4	Clamping strip	42 x 17	933540	X5CrNi18-10	1.4301			
5	Clamping strip	42 x 17	933541	X5CrNi18-10	1.4301			
6	Clamping strip	57 x 17	933561	X5CrNi18-10	1.4301			
7	Facing profile	45 x 19	932346	AlMgSi0.5				
8	Facing profile	45 x 23	932345	AlMgSi0.5				
9	Facing profile	60 x 19	932369	AlMgSi0.5				
10	Weatherstripping	45 x 8	935745	EPDM (Dätwyler- material 4 5615 1)				
11	Weatherstripping	45 x 8	935460	EPDM (Dätwyler- material 4 5615 1)				
12	Weatherstripping	60 x 8	935446	EPDM (Dätwyler- material 4 5615 1)				
13	Glass carrier pad	30 x 90	936725	X5CrNi18-10				
14	Glass carrier pad	30 x 90	936737	X5CrNi18-10	1.4301			
15	Clamping foot		936570	X5CrNi18-10	1.4301			
16	Spacer	Ø11 x 56	936858	PEHD				
17	Locking screw	90	936815	X5CrNi18-10	1.4301			
18	Spacer profile	7 x 20	938020	Duripanel		CE 0763-CPD-8802		
19	Spacer profile	20 x 20	938023	Duripanel		CE 0763-CPD-8802		
20	Spacer profile	25 x 20	938024	Duripanel		CE 0763-CPD-8802		
21	Glass support	28 x 80 x 3-4		Gluske Flammi 12		3482/0189-Fe/Wi		
22	Fire protection glass	47		Glaverbel "Pyrobel 25"				
23	Paneel 47 thickness	1.5 / 44 / 1.5		1.5mm CrNi / Promatect-H / 1.5mm Alu				
24	Flat stainless steel	80x 8- 146		X5CrNi18-10	1.4301			
25	Rectangular hollow section	70x 40 -40		S355J2H				
26	Rectangular hollow section	90x 40 -40		S355J2H				
27	Rectangular hollow section	90x 40 -55		S355J2H				
28	Steel sheet	300x 78		DD11				
29	Steel sheet	3mm 63x 53x 63		DD11				
30	Steel sheet	1.5mm 100x 50		DD11				
31	Aluminium	2mm 100x 50		AlMn				
32	Aluminium	2mm 100x177x136		AlMn				
33	Aluminium	1.5mm 50x 200x 44		AlMn				



EI 60

"forster thermifix vario"
 Material list

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Annex 1.12 of
 Test Report
 No.:

Figure 11.13

17.10.2007 LAD

E03-017-006-14

Pos.	Appellation	Dim. (mm)	Article. No.	Material	No.mat.	Authorization	Classification	Test certificate
34	Steel sheet 1.5mm	30x 120		DD11				
35	Intumescent strip	24.5x 2.2	948000	Gluske Keratix flexpan 200				
36	Insulation			Rockwool, 60kg/m3			A1, DIN 4102	
37	Vapourbarrier			Illbruck windowfilm inside	566-3-1570			
38	Glue for Pos. 37			Illbruck seampaste	09290-2666346			
39	Fire protection Silicone			Gluske fire protection Silicone			B1, DIN 4102	
40	Screw	80	HUS 7.5x80	Hilti				
41								
42	Glue		K84	Promat glue K84				
43	Fire barrier	150		Palstop PAX		P-BRA09-549003		


 <p>Ei 60</p>	<p>"forster thermifix vario"</p> <p>Material list</p>	<p>Annex 1.13 of Test Report</p>
<p>Efectis Nederland BV Centre for Fire Research the Nederland</p>		<p>No.:</p>

Figure 11.14

A Observations

Time [min-sec]	Observations
0	Start of the fire test.
1	Panes A and B crack
2	Cracks appear in panes C
3	Some smoke appears
4	The interlayer has fully reacted
7	Smoke appears at the top of the construction at the profiles a and b
12	Displacement is present at the horizontal profiles d, e and f
19	Some discolouration is present at the junction g. Some liquid is coming out of the profiles d and f
32	A bulge is present at pane C at k
39	A part of the interlayer sags approximately 53 cm
50	Some cracks appear in the vertical seal
60	The interlayer of pane C changes its colour
60	Some liquid is visible at the bottom of pane C
69	Another cracks appears at pane A, Some pieces of glass have fallen to the cold side. Thermocouple 3 is fallen of the construction
71	The edge profile deforms at p, in the pane
72	More smoke escapes fro the crack in pane A Deformation of the edge of pane at q
73	Pane C has cracked
75	Flames appear longer than 10 s at the cracks in pane C. End of integrity E
76	End of the test

B Test results

Graph: B1: Furnace temperatures

Graph: B2: Deviation of the fire curve

Graph : B3: Furnace Pressure

Figure B4: Location of the thermocouples during the fire test on surface 2

Figure B5: Location of the thermocouples during the fire test on surface 2

Figure B5: Location of the thermocouples during the fire test on surface 3

Figure B7: Location of the thermocouples during the fire test on surface 4

Figure B8: Location of the thermocouples during the fire test on surface 5

Figure B9: Location of the thermocouples during the fire test on surface 6

Figure B10: Position of the observations

Graph : B11: Surface temperatures of panes A and B (surface 2)

Graph : B12: Surface temperatures of panes C and D (surface 2)

Graph : B13: Surface temperatures of panes A, B, C and D (surface 2)

Graph : B14: Surface temperatures of profiles (surface 2)

Graph : B15: Surface temperatures of panes E, F and G at the backside (surface 3 part 1)

Graph : B16: Surface temperatures of panes E, F and G at the backside (surface 3 part 2)

Graph : B17: Surface temperatures of profiles at the backside (surface 3)

Graph : B18: Surface temperatures of panes H and I and profiles at the backside (surface 4)

Graph : B19: Surface temperatures of panes E, F and G (surface 5)

Graph : B20: Surface temperatures of profiles (surface 5)

Graph : B21: Surface temperatures of panes H and I (surface 6)

Graph : B22: Surface temperatures of horizontal, TC S1, TC S2, TC S4 and vertical, TC S5, TC S6, gap seals

Graph : B23: Deforming of the curtain wall

Graph : B 24: Radiation at 1.0 m distance from the specimen

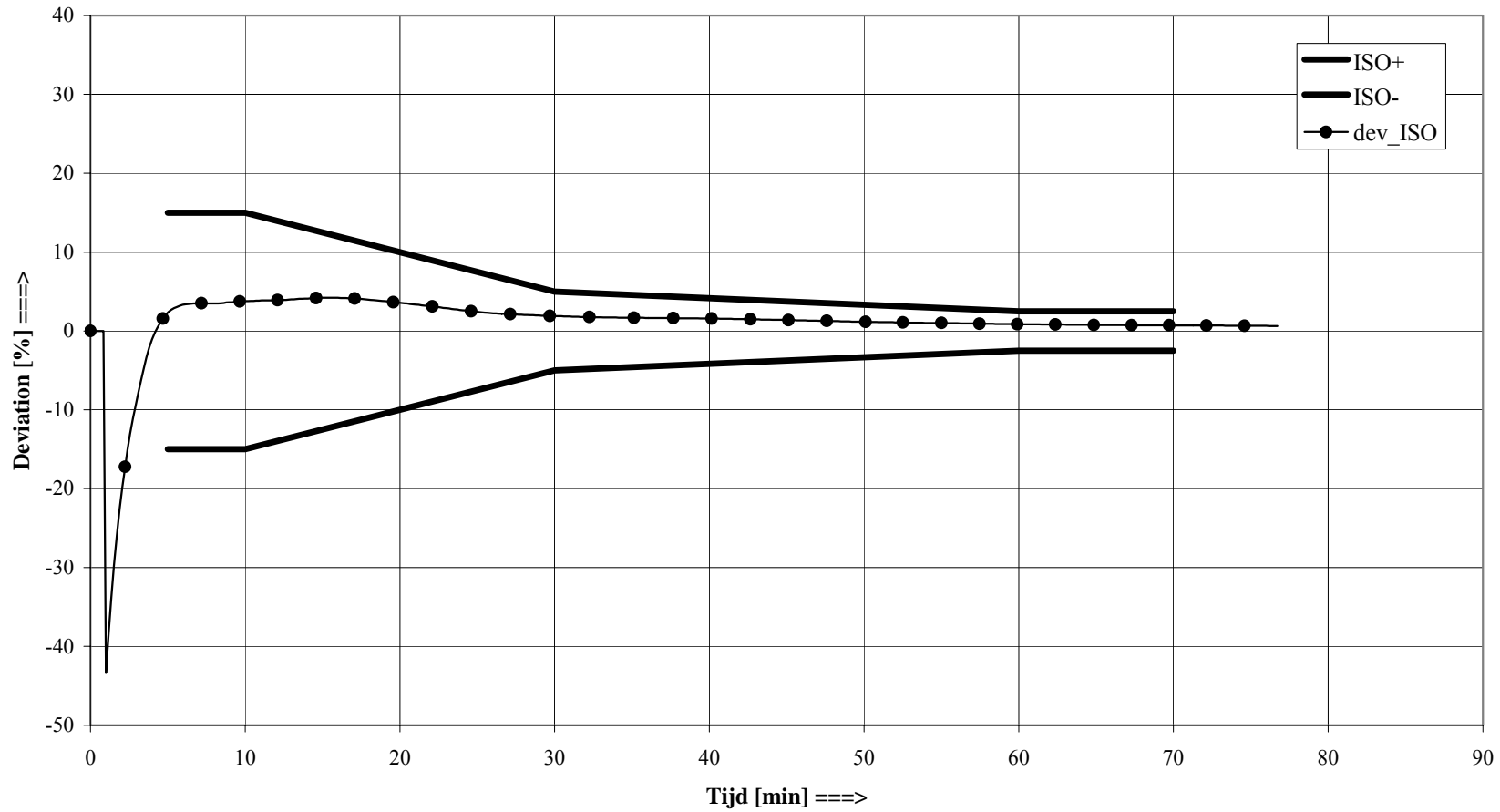
Centre for Fire Safety

Date: 10/2/2007

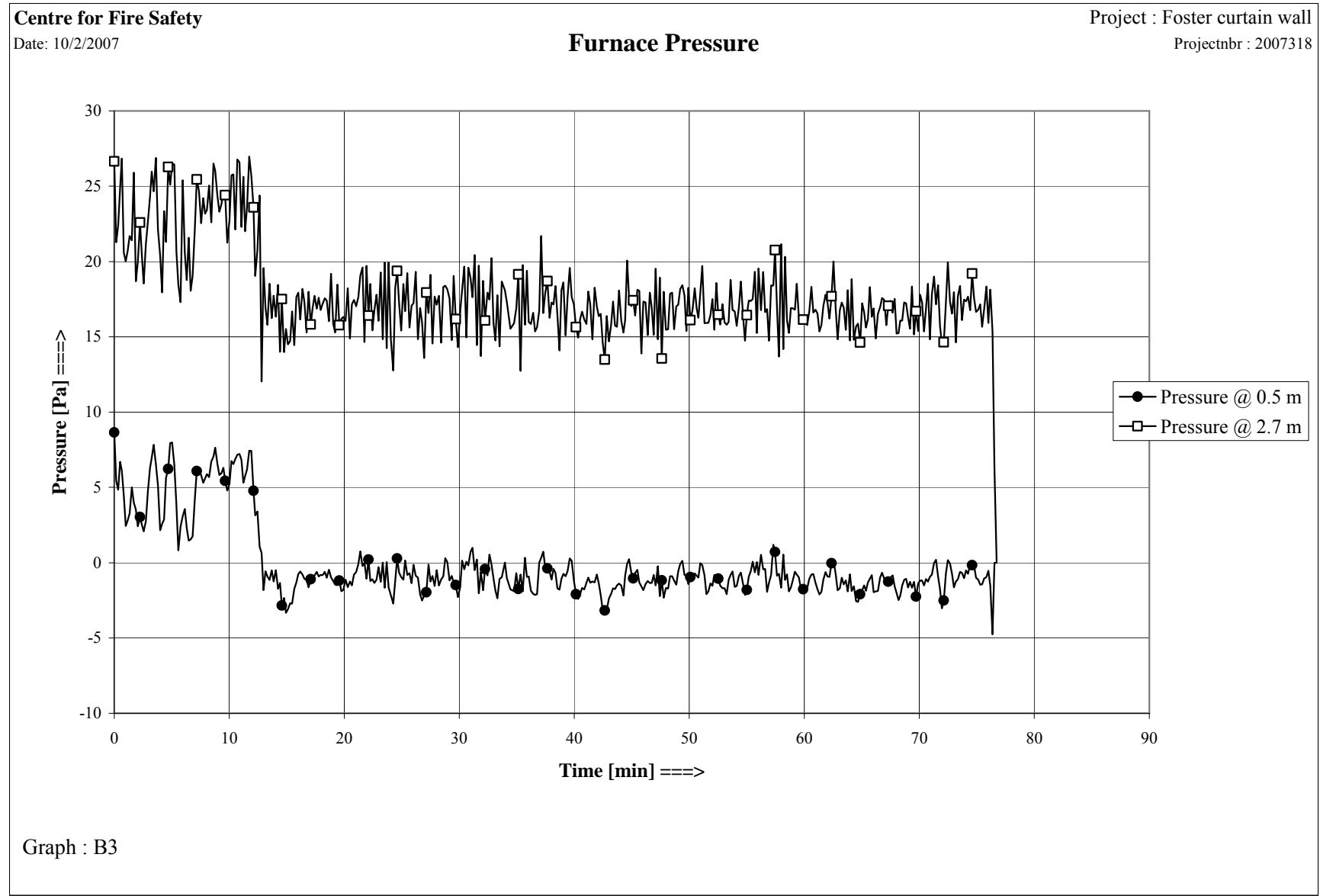
Deviation of the fire curve

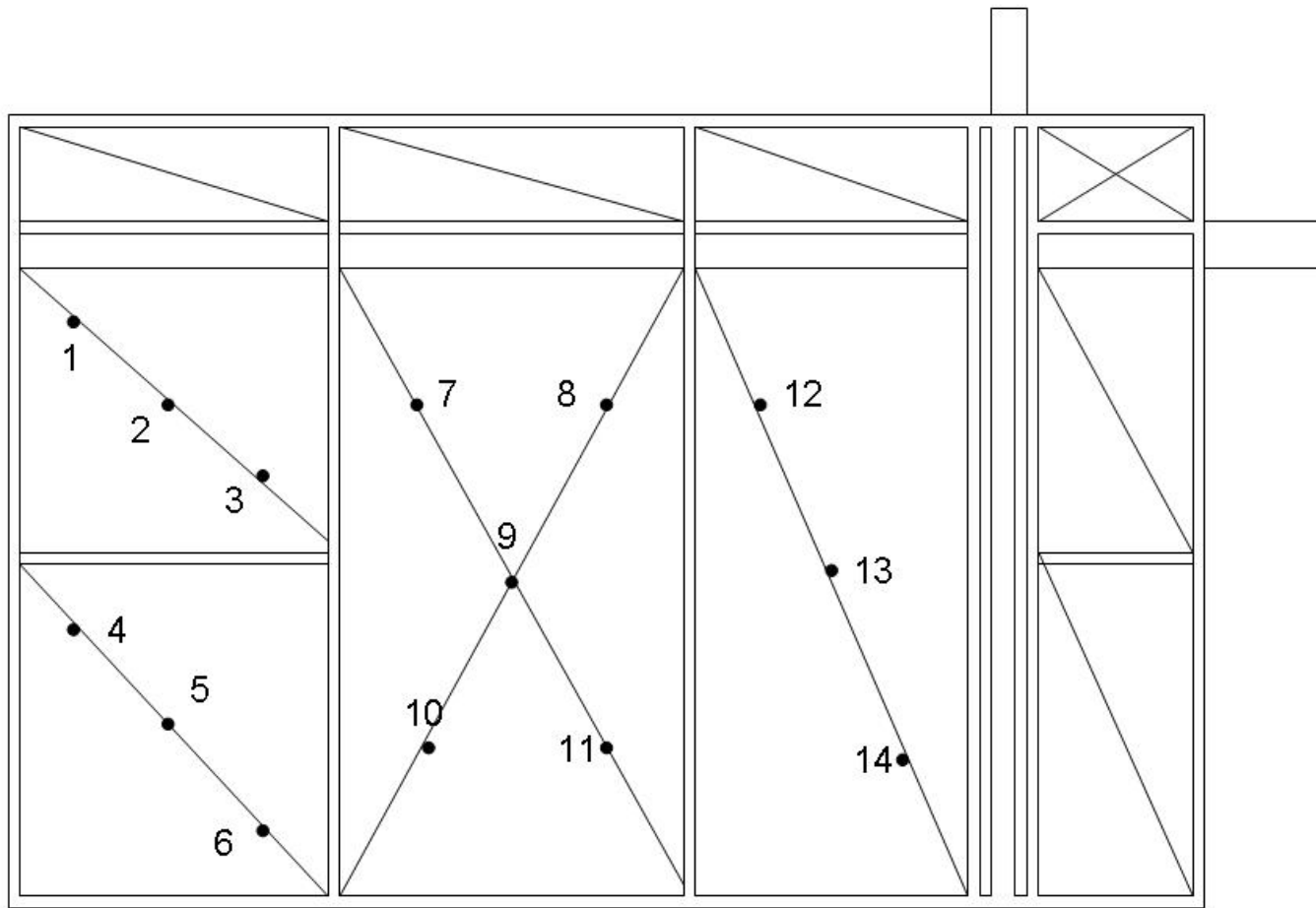
Project : Foster curtain wall

Projectnbr : 2007318



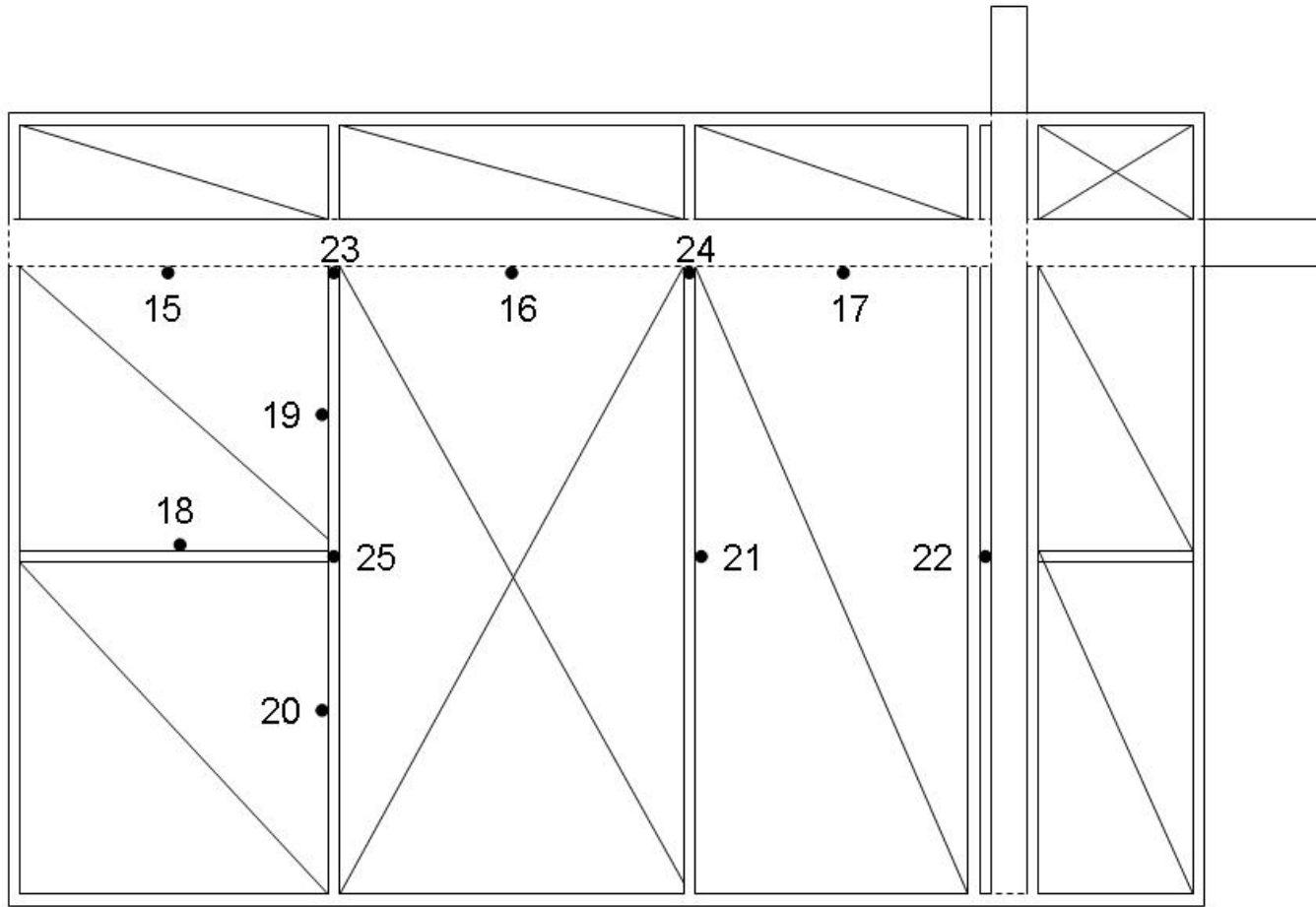
Graph: B2





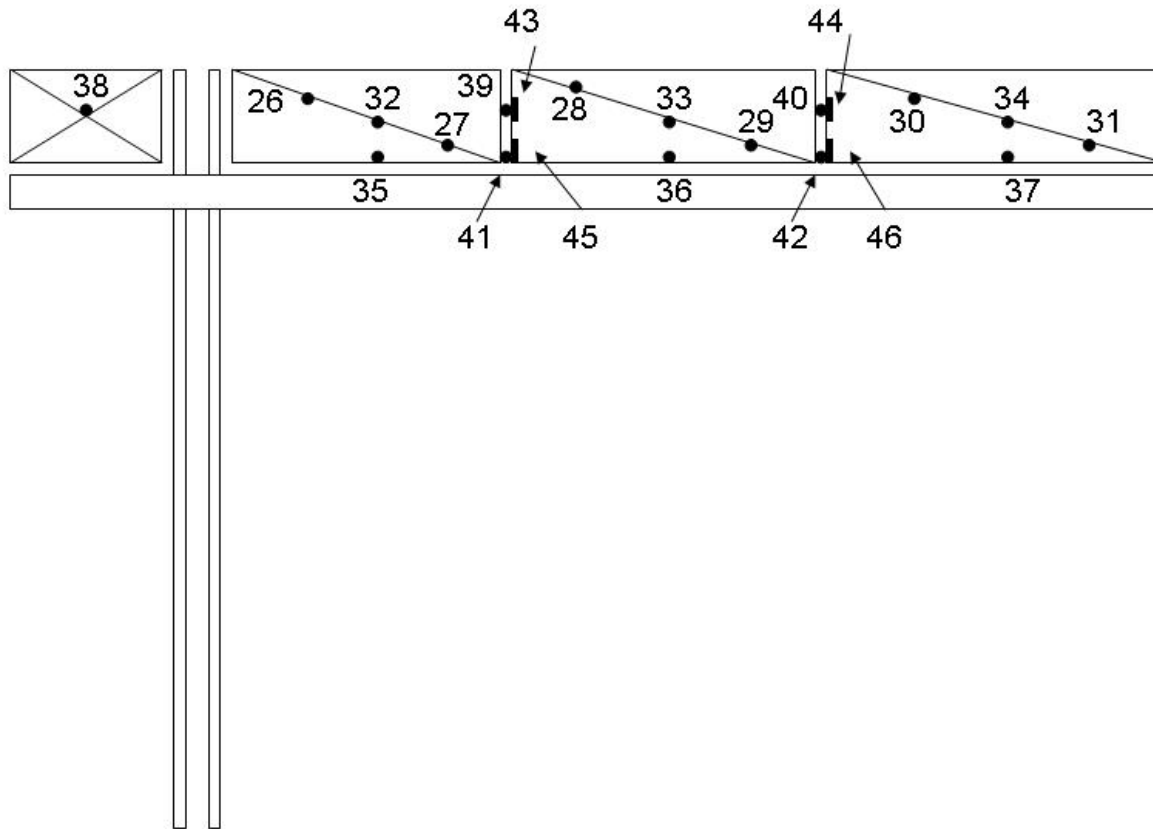
Surface 2 average temperatures

Figure B4: Location of the thermocouples during the fire test on surface 2



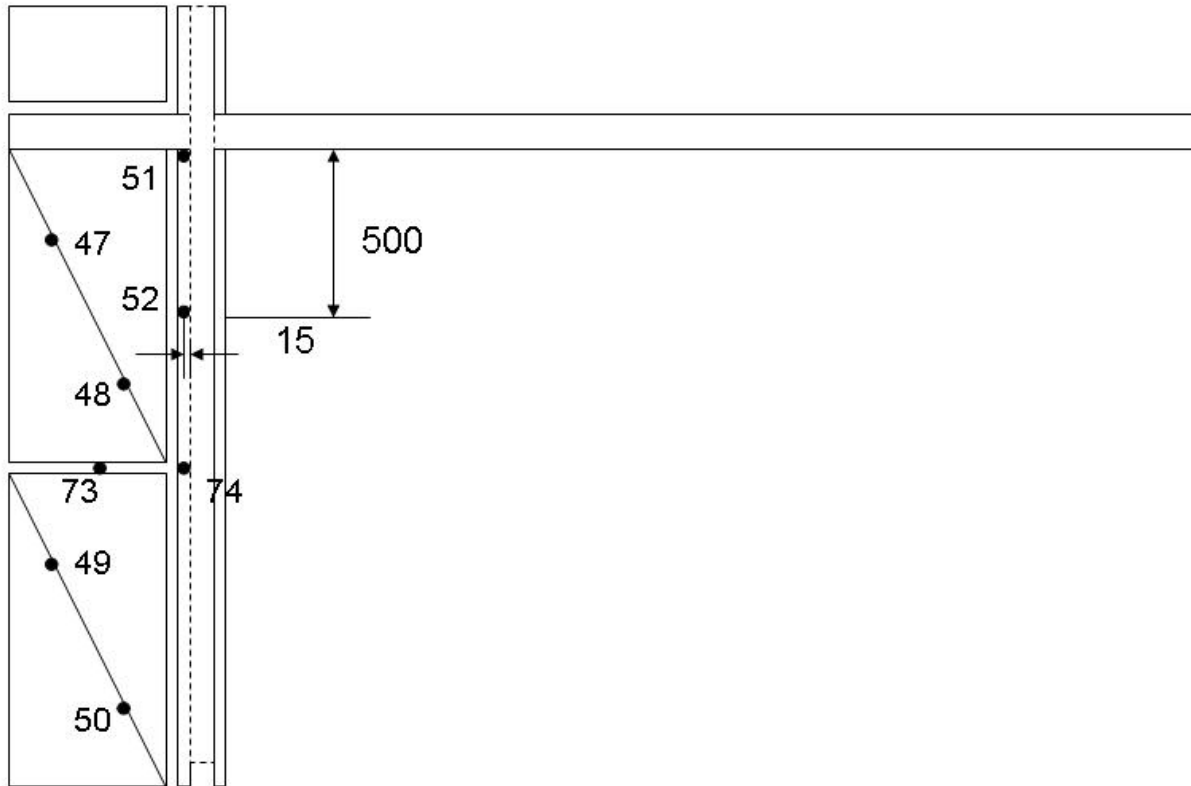
Surface 2 maximum temperatures

Figure B5: Location of the thermocouples during the fire test on surface 2



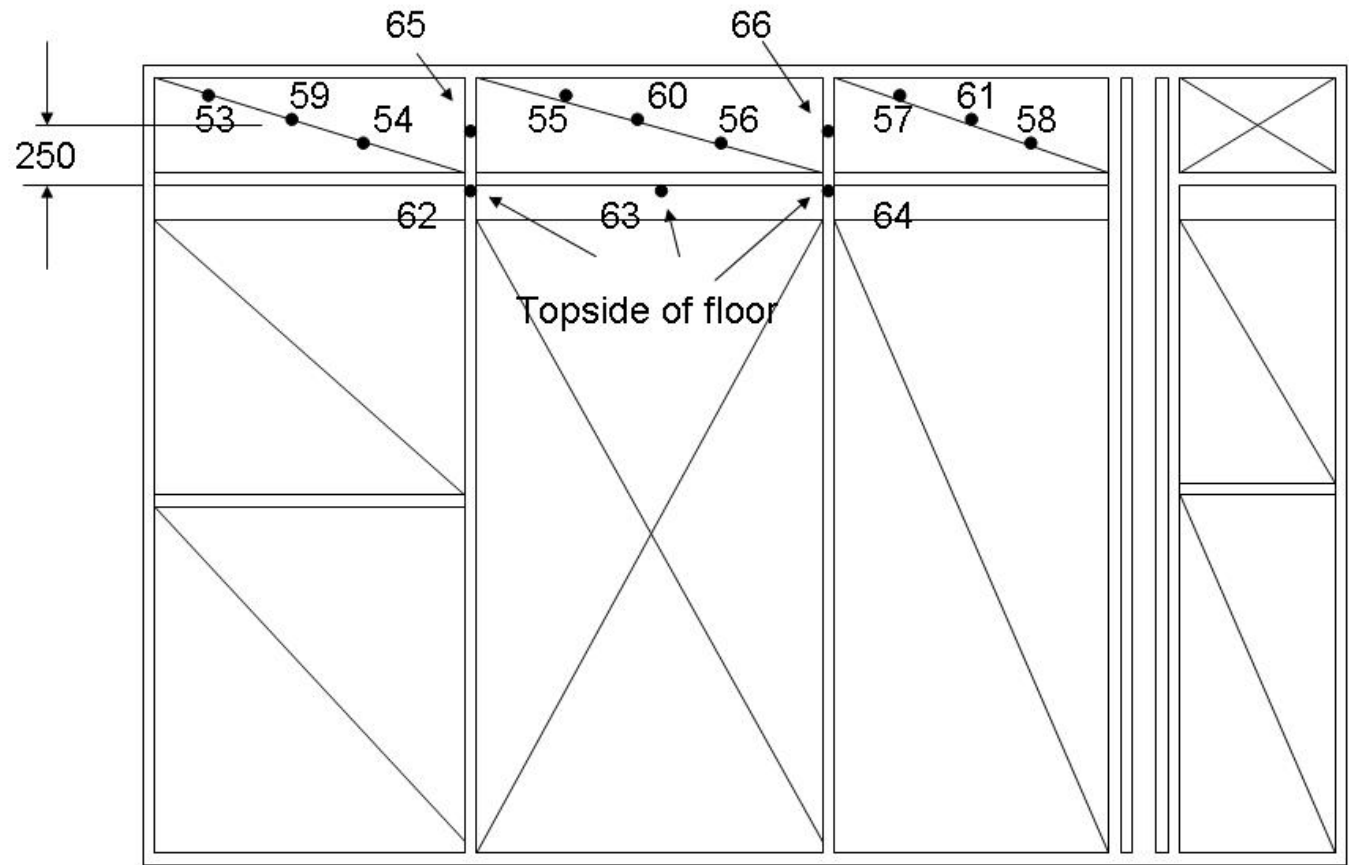
Surface 3 average and maximum temperatures

Figure B6: Location of the thermocouples during the fire test on surface 3



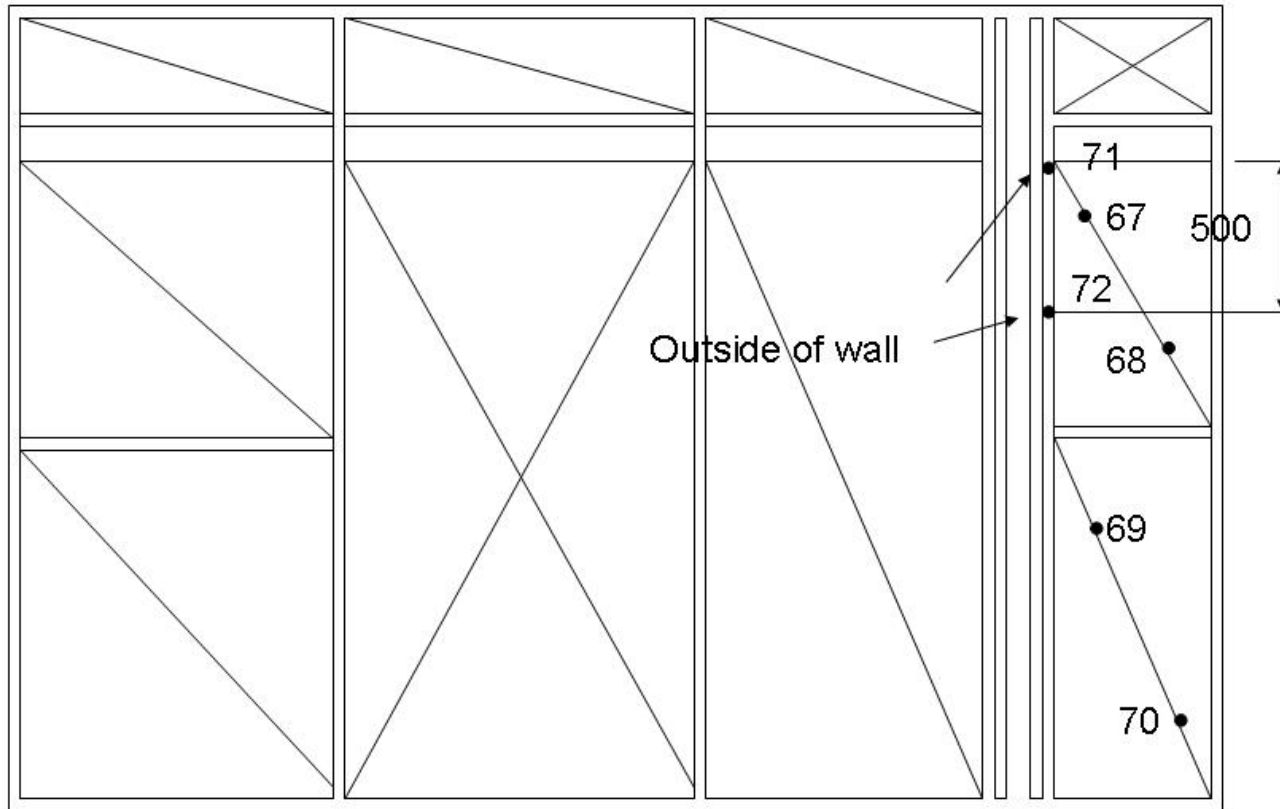
Surface 4 average and maximum temperatures

Figure B7: Location of the thermocouples during the fire test on surface 4



Surface 5 average and maximum temperatures

Figure B8: Location of the thermocouples during the fire test on surface 5



Surface 6 average and maximum temperatures

Figure B9: Location of the thermocouples during the fire test on surface 6

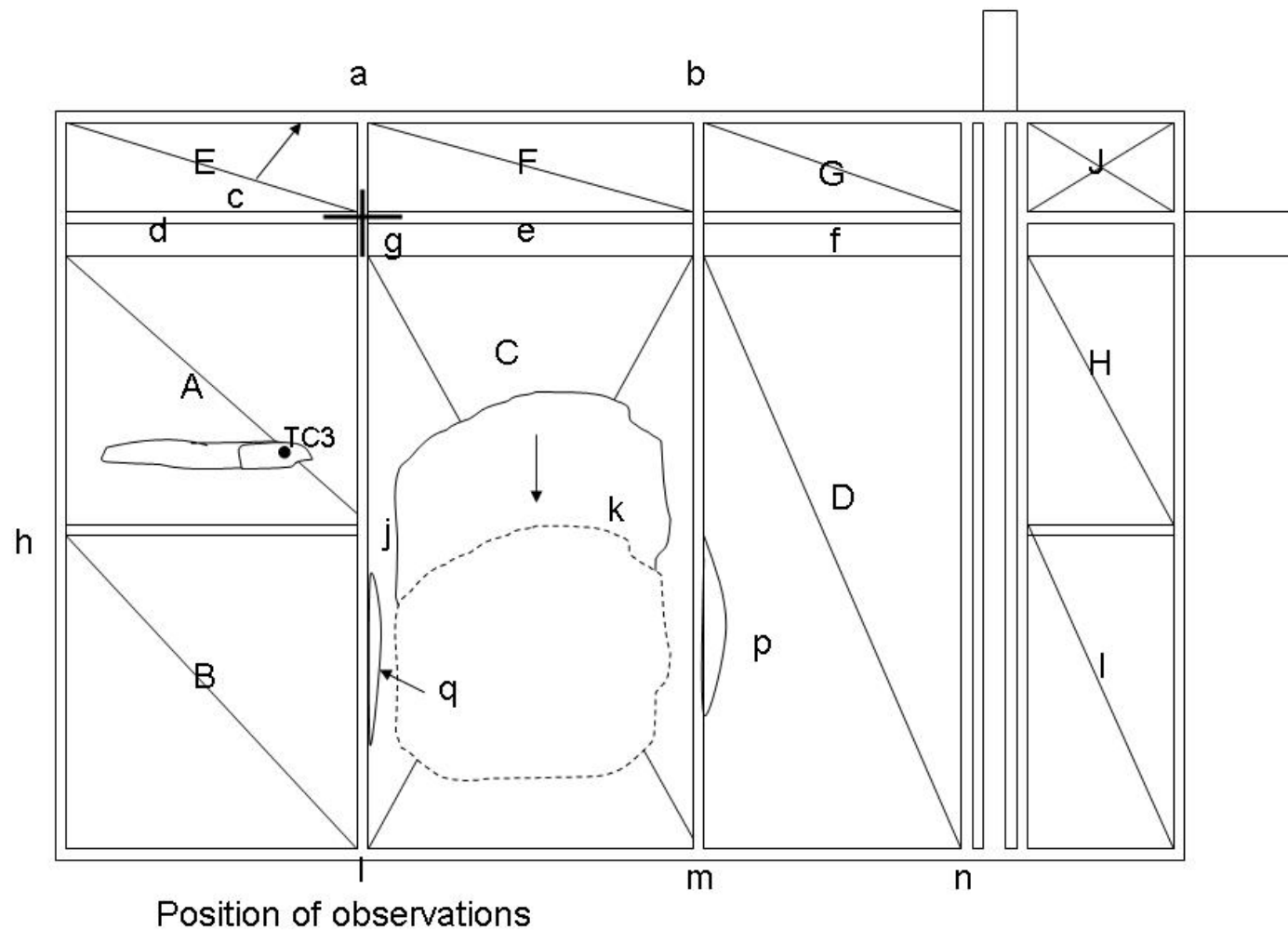
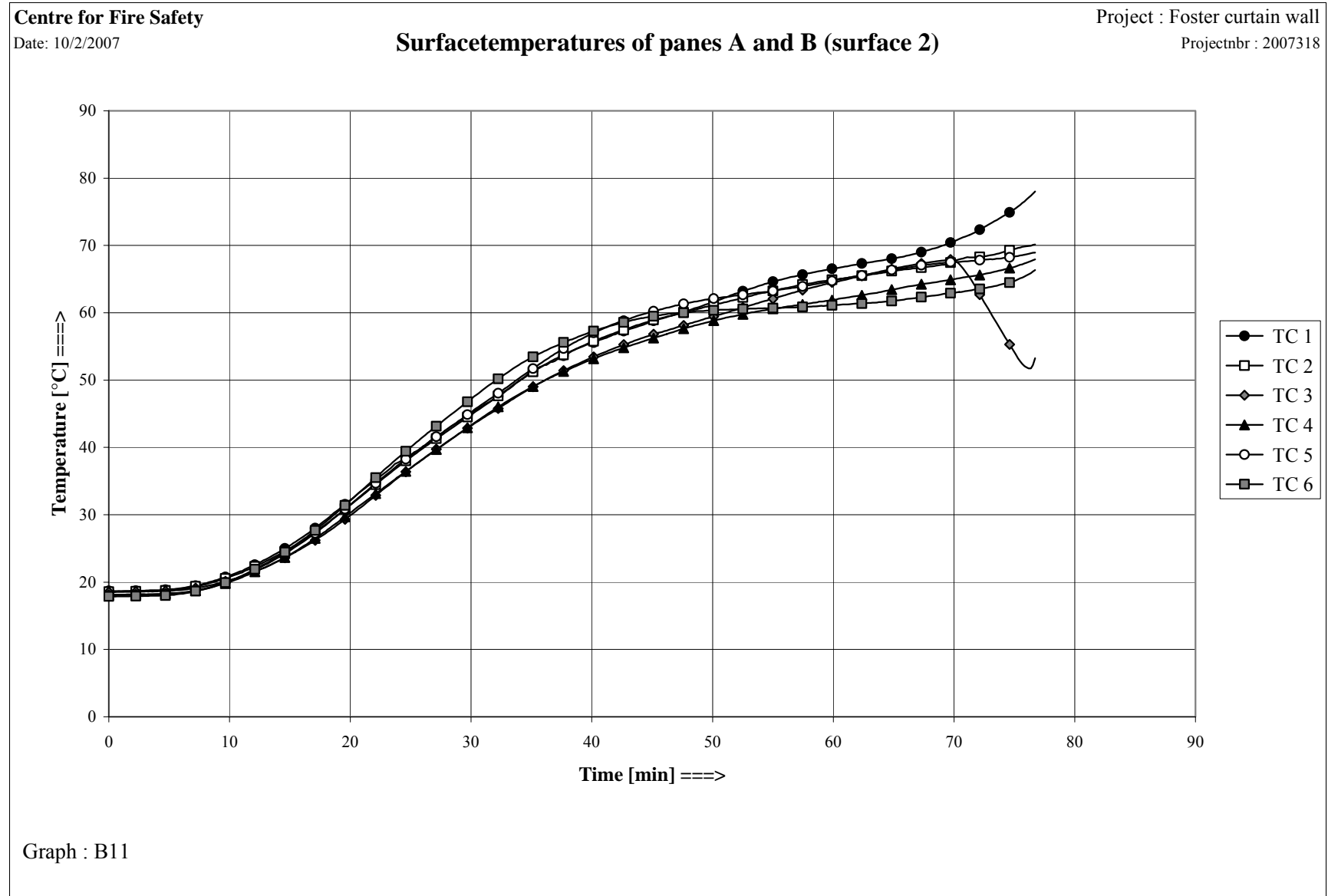


Figure B10: Position of the observations



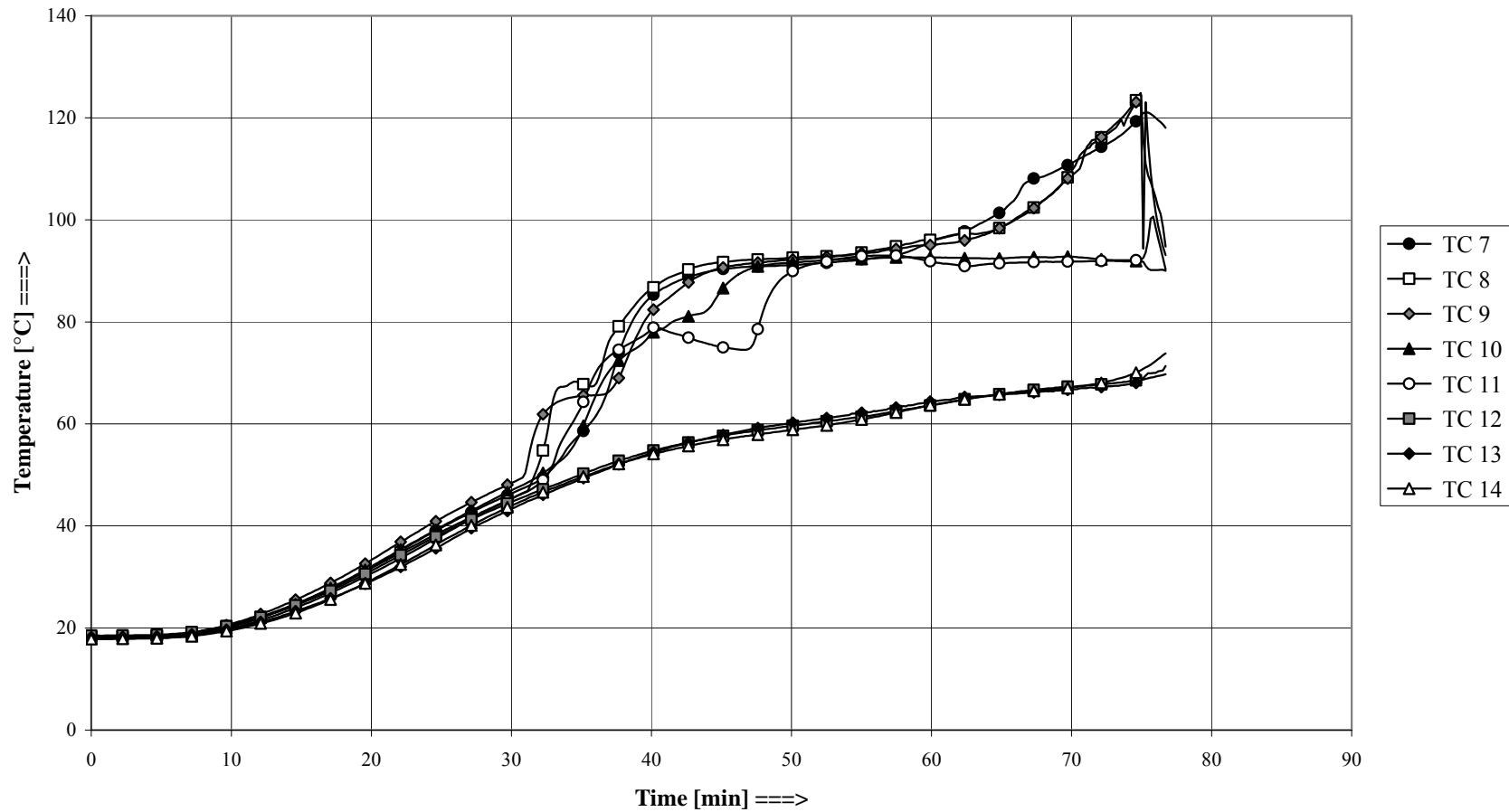
Centre for Fire Safety

Date: 10/2/2007

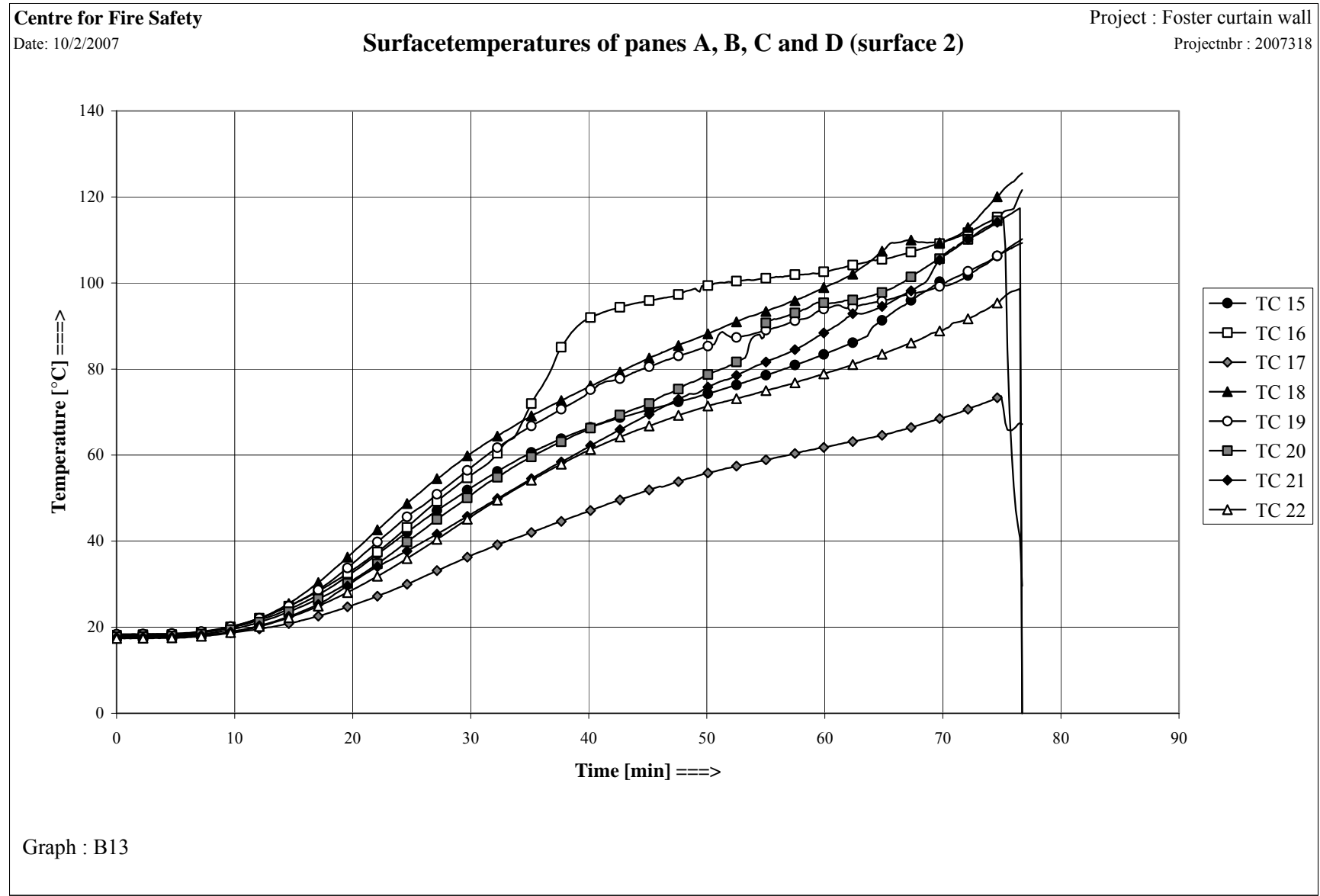
Surfacetemperatures of panes C and D (surface 2)

Project : Foster curtain wall

Projectnbr : 2007318



Graph : B12



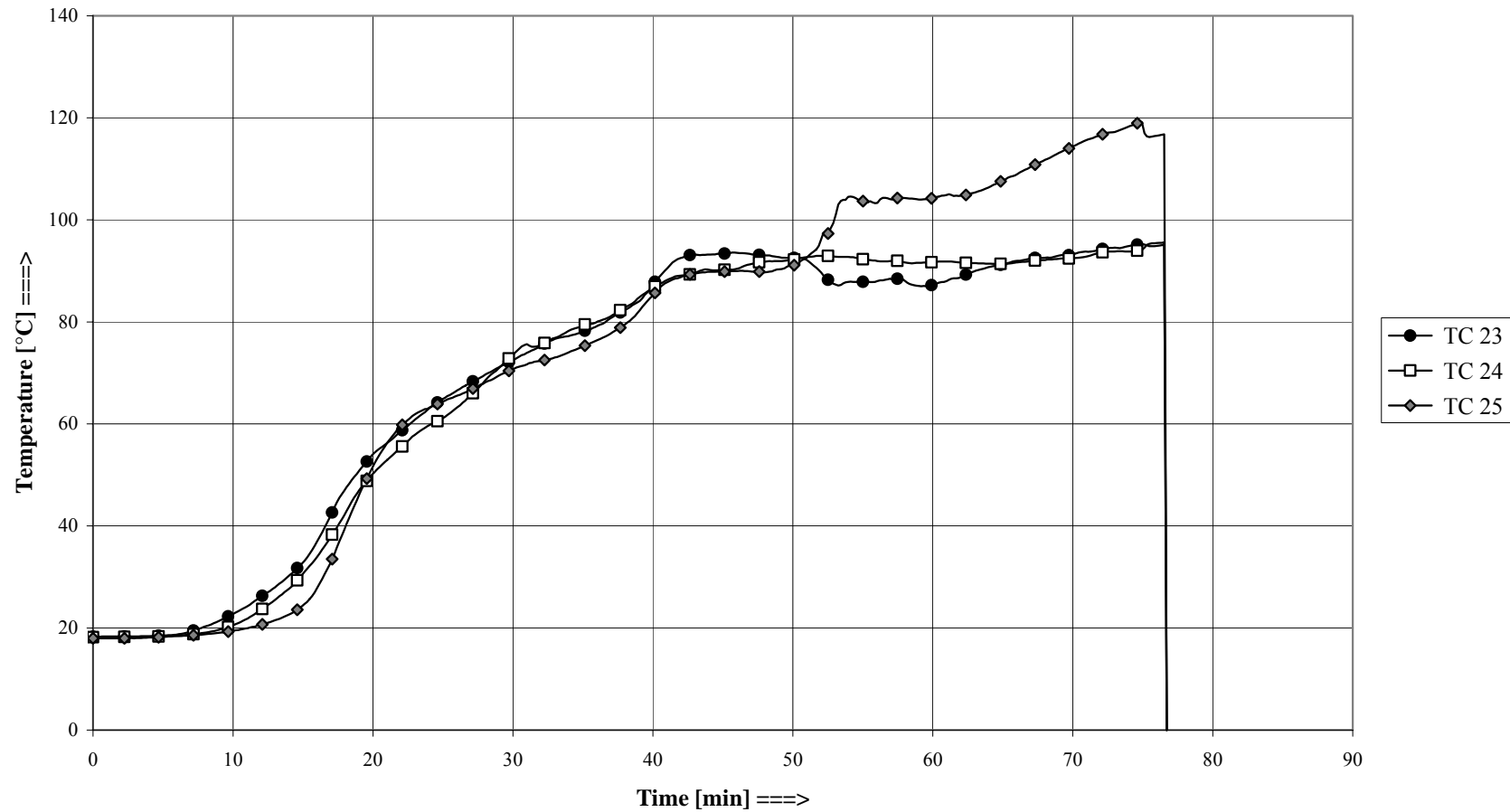
Centre for Fire Safety

Date: 10/2/2007

Surfacetemperatures of profiles (surface 2)

Project : Foster curtain wall

Projectnbr : 2007318



Graph : B14

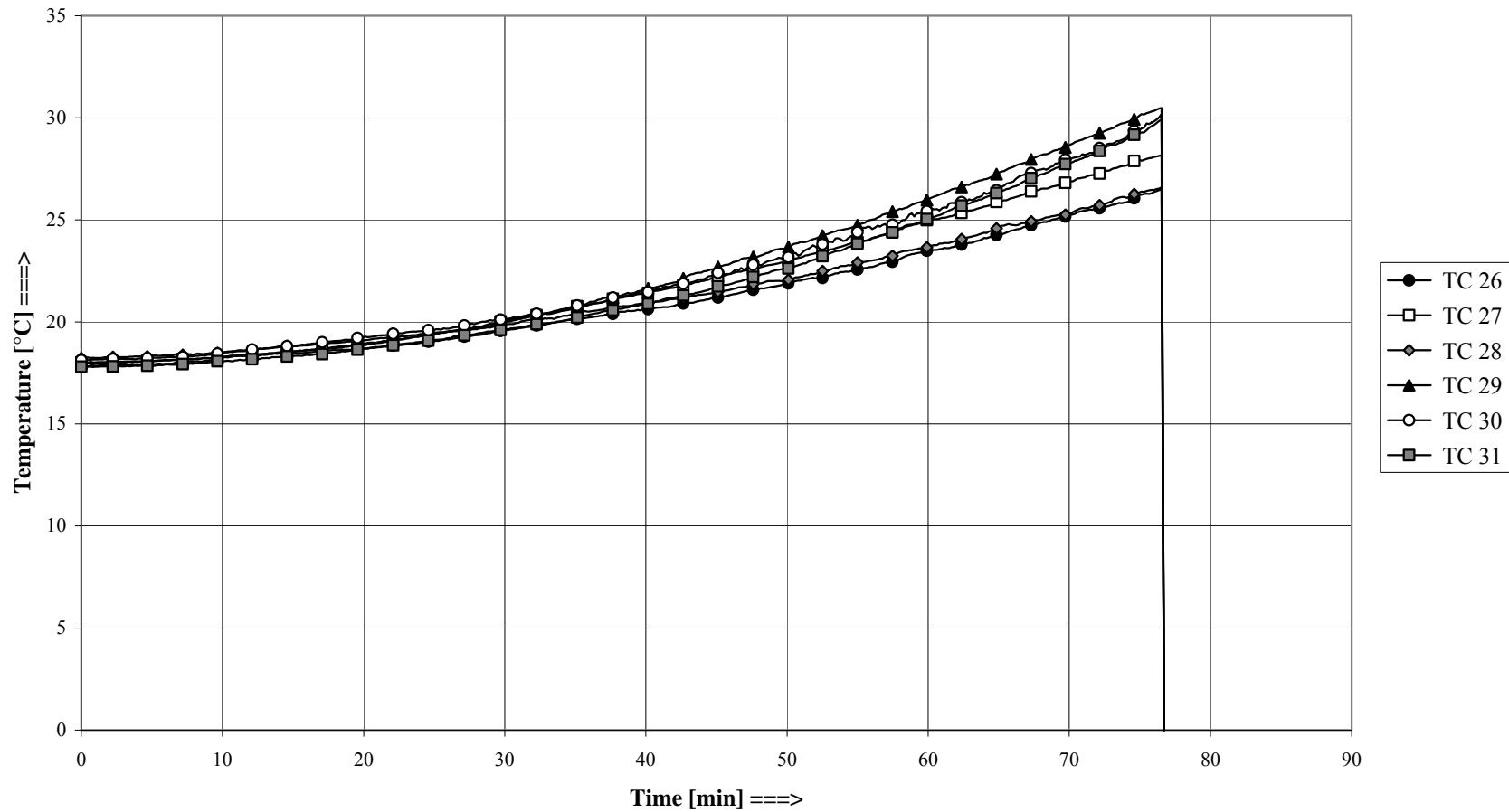
Centre for Fire Safety

Date: 10/2/2007

Surfacetemperatures of panes E, F and G at the backside (surface 3 part 1)

Project : Foster curtain wall

Projectnbr : 2007318



Graph : B15

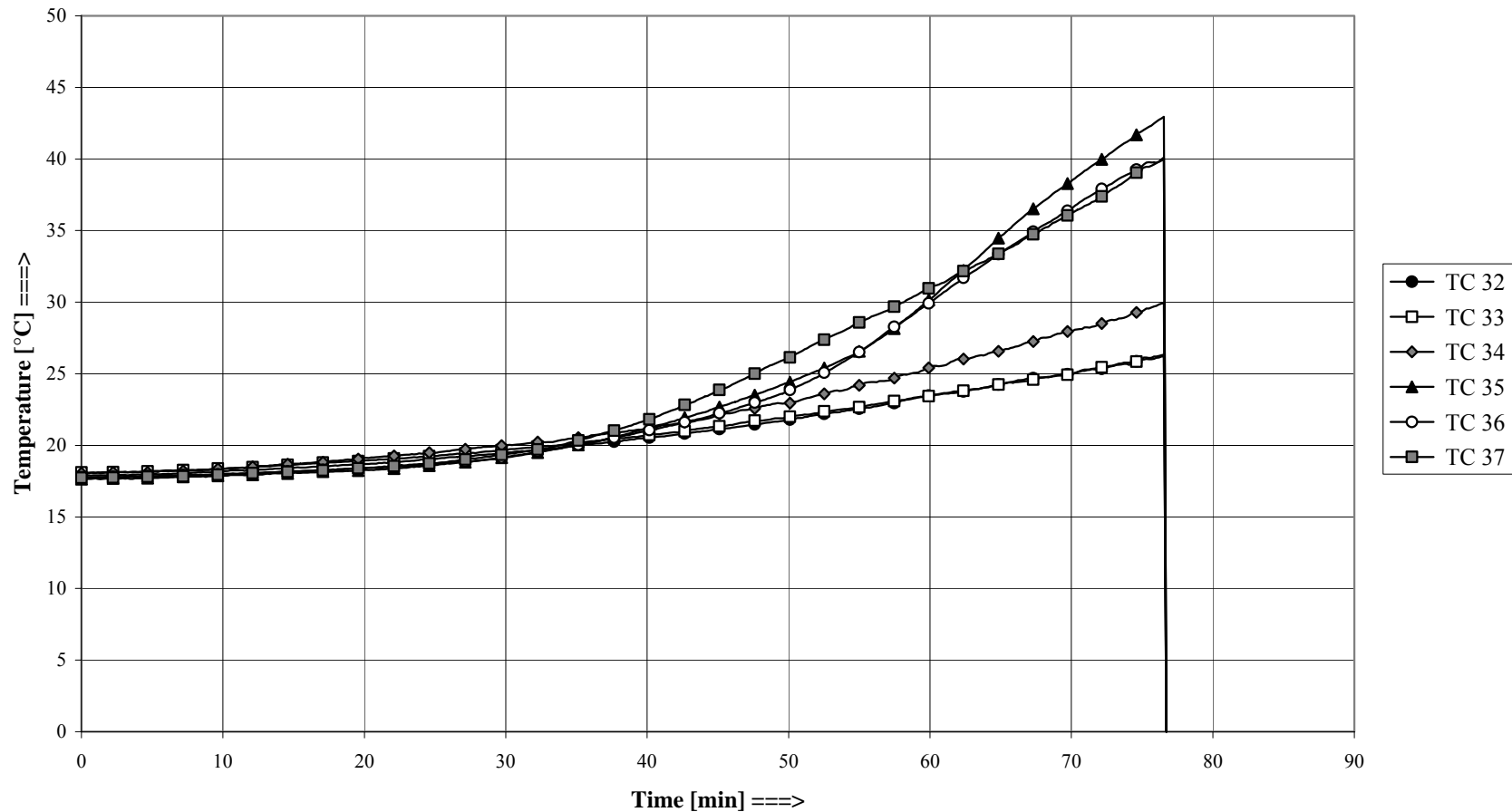
Centre for Fire Safety

Date: 10/2/2007

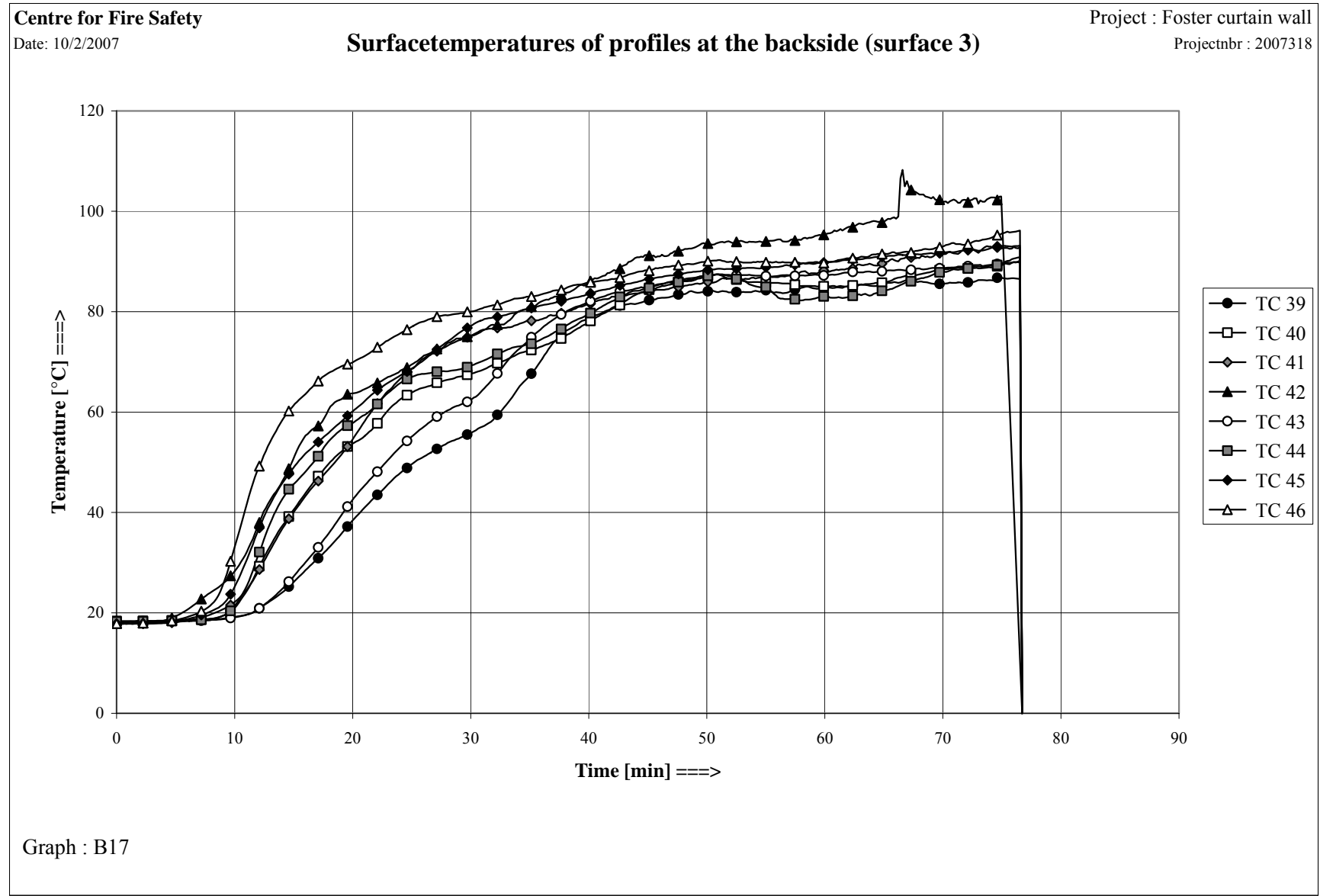
Surfacetemperatures of panes E, F and G at the backside (surface 3 part 2)

Project : Foster curtain wall

Projectnbr : 2007318



Graph : B16



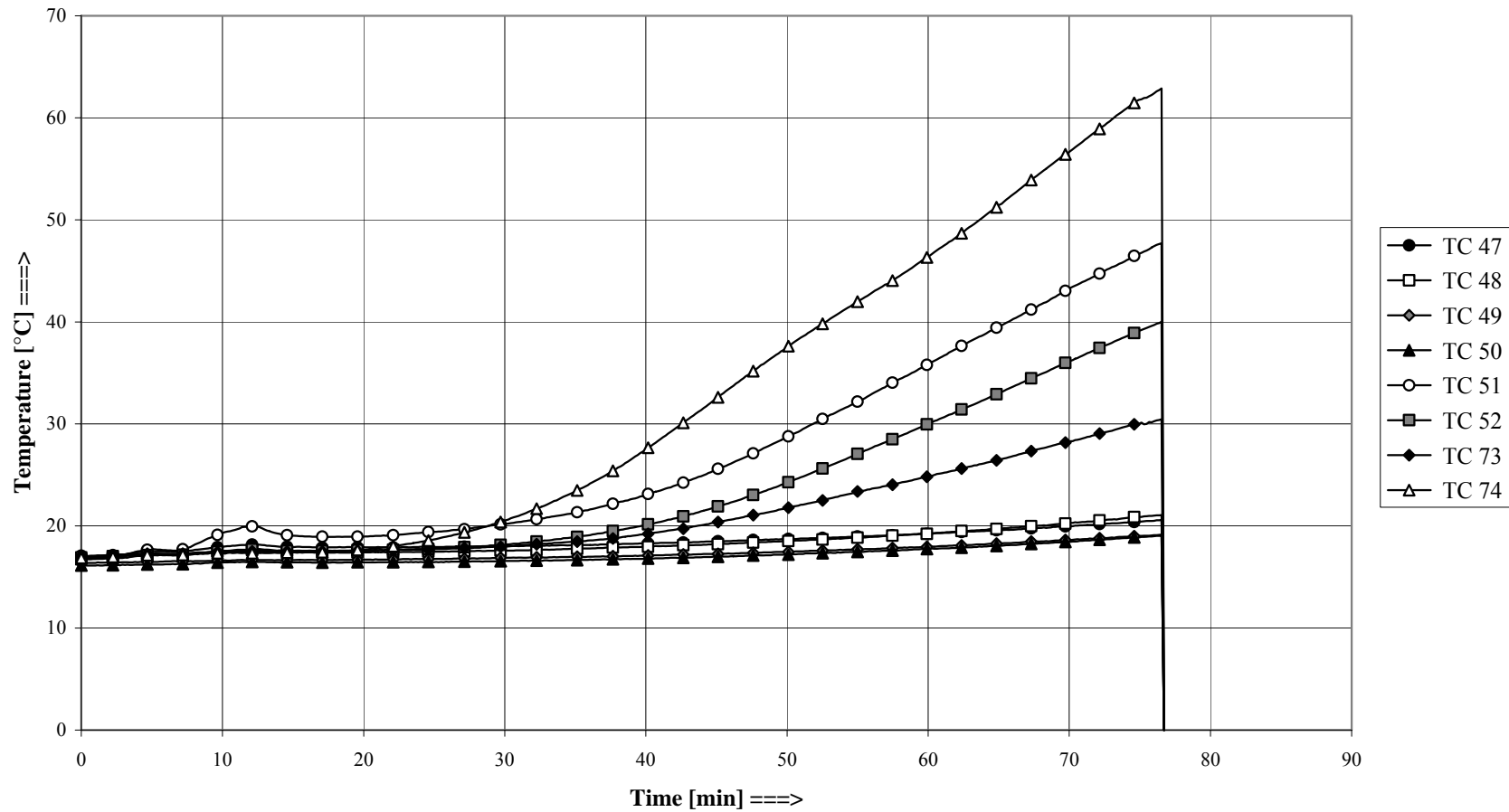
Centre for Fire Safety

Date: 10/2/2007

Surfacetemperatures of panes H and I and profiles at the backside (surface 4)

Project : Foster curtain wall

Projectnbr : 2007318



Graph : B18

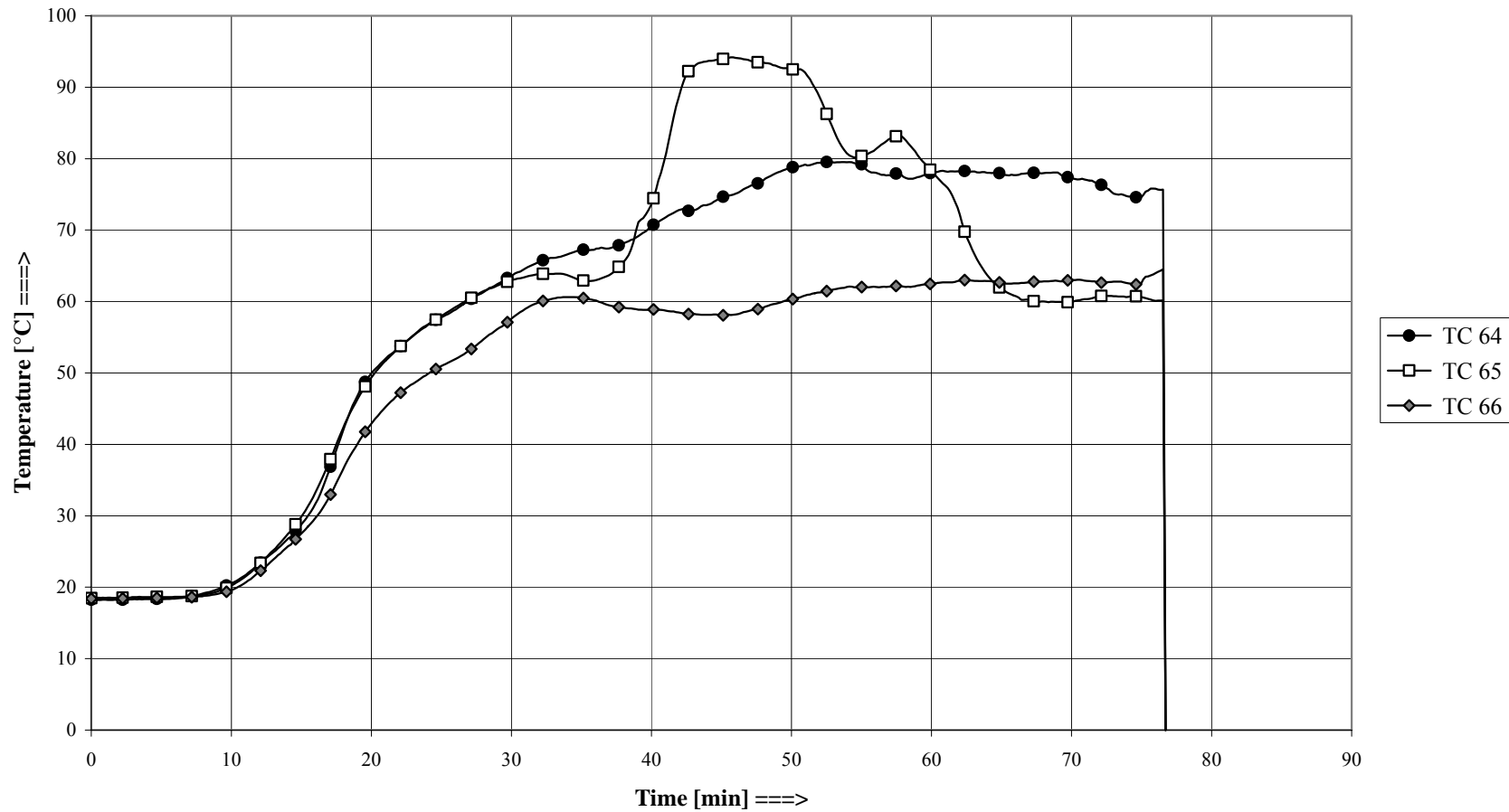
Centre for Fire Safety

Date: 10/2/2007

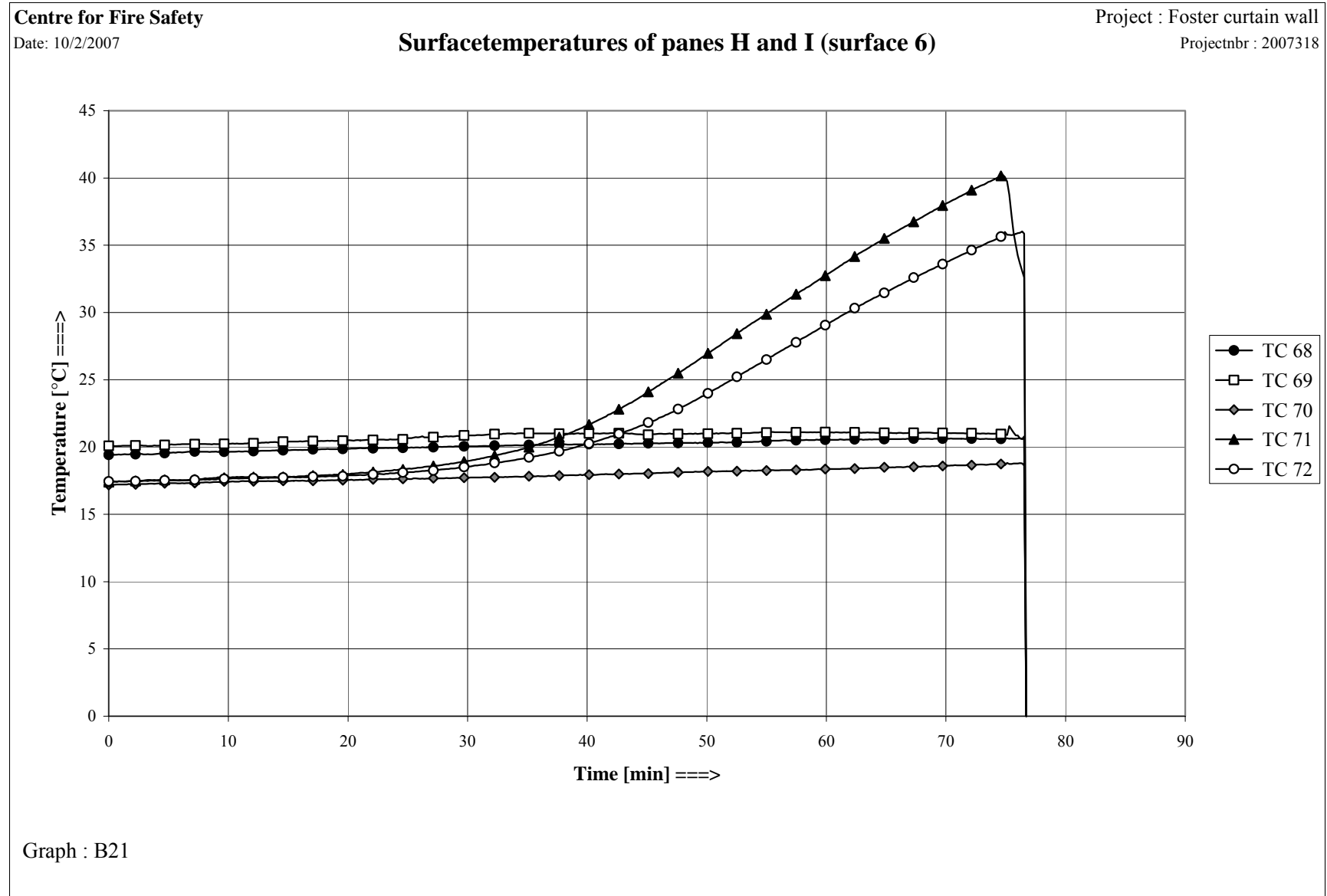
Surfacetemperatures of profiles (surface 5)

Project : Foster curtain wall

Projectnbr : 2007318



Graph : B20



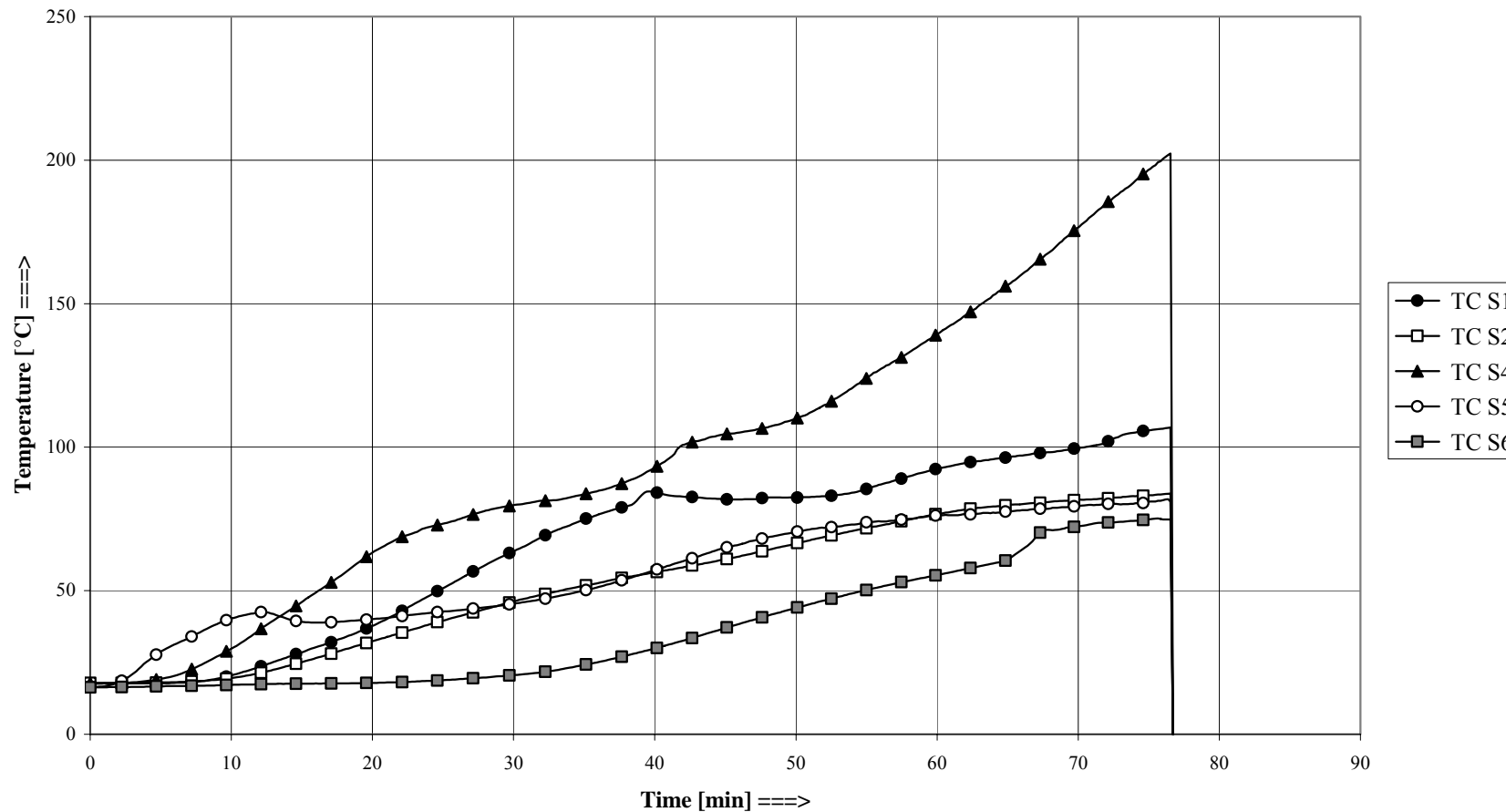
Centre for Fire Safety

Date: 10/2/2007

Surface temperatures of horizontal and vertical gap seals

Project : Foster curtain wall

Projectnbr : 2007318



Graph : B 22

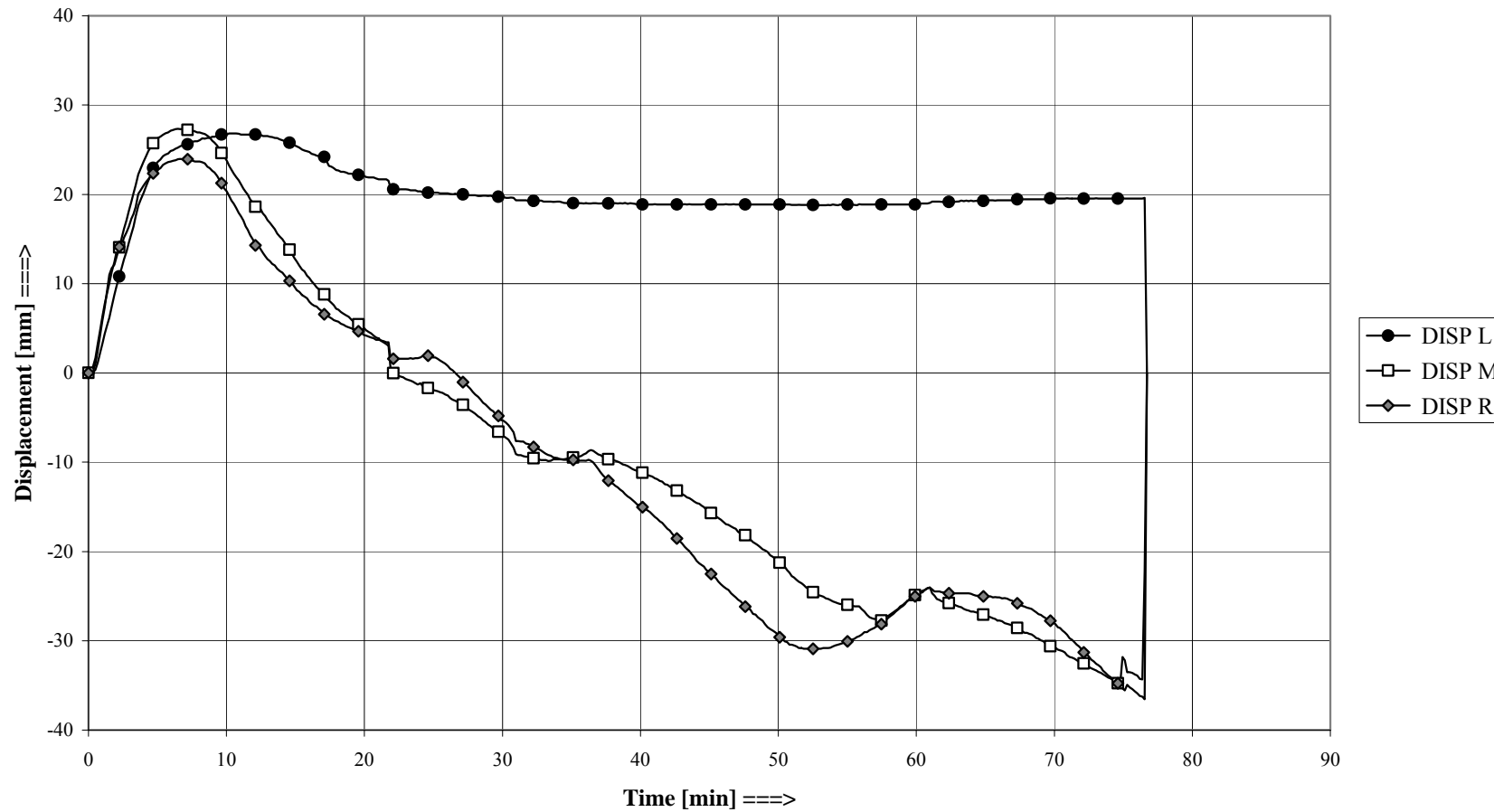
Centre for Fire Safety

Date: 10/2/2007

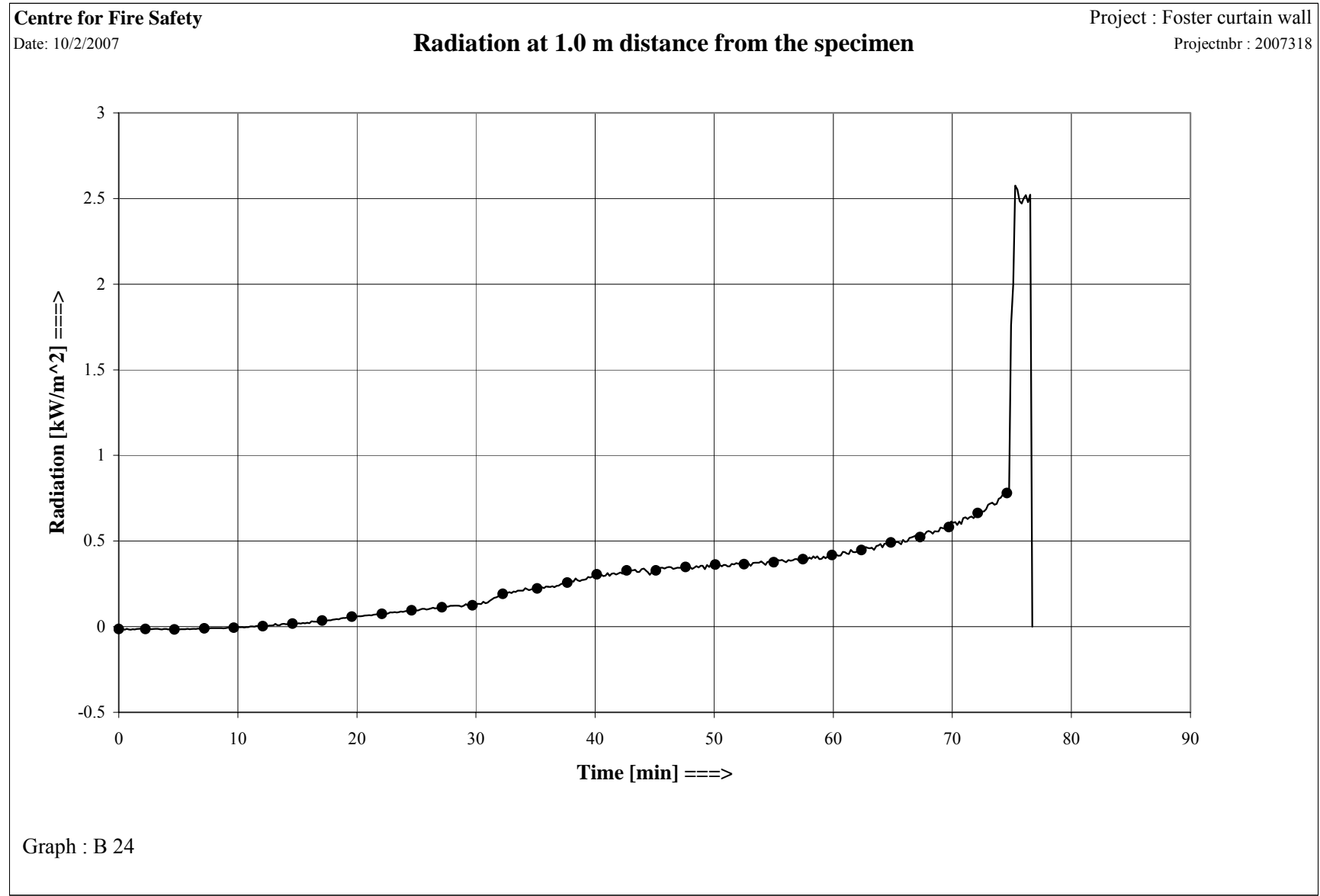
Deforming of the curtain wall

Project : Foster curtain wall

Projectnbr : 2007318



Graph : B23



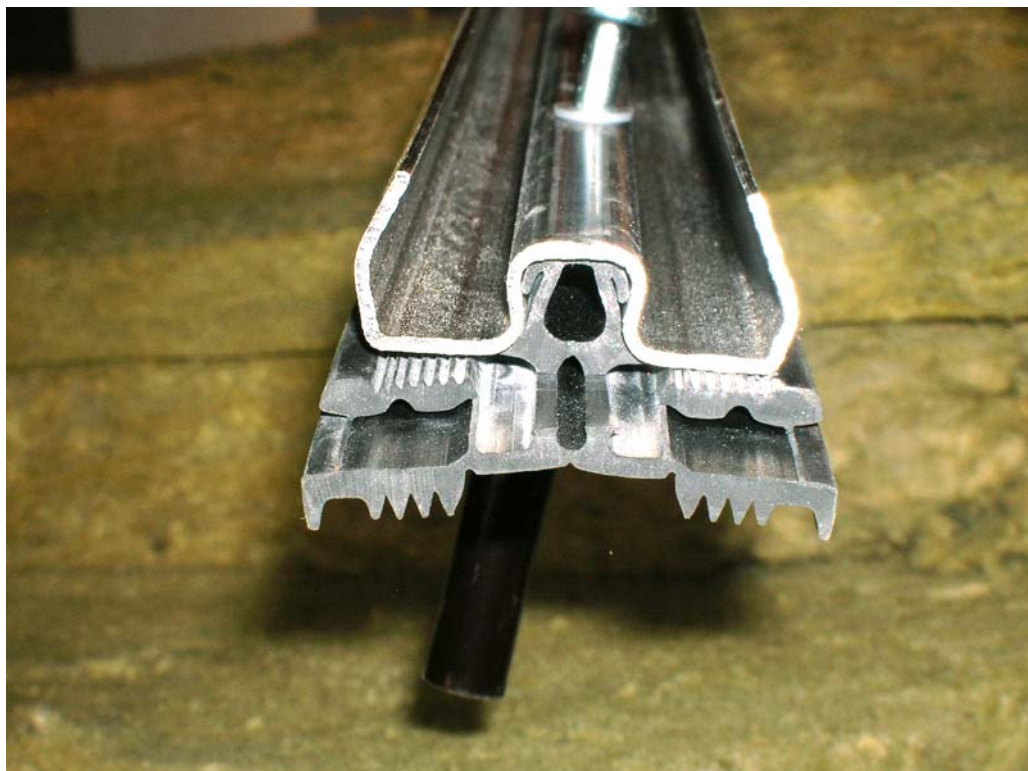
C Photographs



Detail of the fixing of the frame on supporting floors



Cramping profiles equipped with rubber joint strips



Detail of cramping profile and rubber joint strip



Insulation of blind facade panel



Detail of positioning strip for glazed panes



Specimen before the fire test



Specimen after 39 minutes of heating



Specimen after the fire test