Efectis Nederland BV

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The European experts in fire safety

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Efectis Nederland report

2008-Efectis-R0463

Determination of the fire resistance according to EN 1634-1: 2000 of two door-/frame constructions with the purpose to test the functioning of the intumescent components of Environmetal Seals

ISO 9001 DNV REGISTERED

Date	June 2008
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Sponsor	Environmental Seals Ltd. Envirograf House Barfrestone DOVER Kent CT15 7JG United Kingdom
Project name	Fire resistance
Project number	2007417

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Contents

1 Subject

Two door-/frame construction are tested with intumescent components of Environmental Seals.

2 Examination

Determination of the fire resistance according to EN 1634-1: 2000 for the case "doors pivoting towards the fire".

3 Sponsor

Environmental Seals Ltd.
Envirograf House
Barfrestone
DOVER
Kent CT15 7JG
United Kingdom

4 Place and data regarding the examination

The examination was performed at the laboratory of Efectis Nederland BV in Rijswijk, The Netherlands.
The supporting construction was prepared on October 11, 2007.
The specimen was assembled on October 16 and 17 2007.
The fire test was performed on October 19, 2007.

5 Date and number of the report

June 2008; 2008-Efectis-R0463.

6 Test specimen

6.1 General

A fire test was carried out on two wooden single door-/frame constructions of Environmental Seals, consisting of (see figure 1):

- Wooden door leaf;
- Wooden door frame;
- Self closing hinges and letterbox;
- Intumescent components.

For the dimensions and specifications of the materials and components of the examined construction, see figures 1 until 4 in chapter 12. Significant details of the construction are given in the paragraphs below.

6.2 Wooden door leaf

6.2.1 General

Dimensions of the door leaf:
- Height: 1980 mm;
- Width: 760 mm;
- Thickness: 40 mm.

The weight of the doors without hinges, handles and letterbox was:

Door A: 26.9 kg;
Door B: 27.1 kg.

The door leafs were constructed of:
- Mahogany framework;
- STB board with Multigraf
- Fire barrier curtain
- Plywood cladding;
- Meranti beads
- Intumescent strips

6.2.2 Mahogany framework

The timber framework was constructed of Mahogany, dimensions 92 x approx. 37 mm.

6.2.3 STB board with Multigraf

The framework was filled with 2 or 3 STB boards, product no. 91 with on both sides a 2 mm layer of intumescent Multigraf, product no. 84 (see figure 1).

6.2.4 Fire barrier curtain

On both sides of the framework of the doors a fire barrier curtain was applied. The thickness of this barrier, product no. 56 was 0.23 mm (see figure 1).

6.2.5 Plywood cladding

On both sides of the framework/fire barrier curtain a plywood with a thickness of 6 mm was glued and fixed with panel pins, dimensions 20 x 1 mm. The applied adhesive was IA adhesive.

6.2.6 Meranti beads

At the perimeter of the door a Meranti hardwood bead was applied with a thickness of 10 mm. The beads at the edges of the door were fixed with panel pins, dimensions 25 x 1 mm, with a spacing of 250 mm.

6.2.7 Door brush

The door was at both uprights provided with a clip in intumescent fire and smoke seal, with code C15 15/B60, with dimensions 15 x 6 mm (see photo 5 and 6).

6.3 Self closing hinges and letterbox

6.3.1 Self closing hinge

The door was mounted with three black coated self closing hinges, dimensions hinge plate 185 x 40 x 1.5 mm
The positions of hinges 195 mm, 850 mm and 1550 mm, measured from the top of the door. The hinges were fixed to the door leaf with 4 screws per hinge with dimensions 5 x 50 mm. At the back side of the hinge plates intumescent material was applied, product no. 71, with dimensions 25 x 100 x 1 mm. The measured retention force of the door spring was approx. : 13 N.

6.3.2 Letterbox

A solid metal letterbox was provided. The bright chrome finished letterbox case was in the middle encased with one layer of intumescent material, product 49 with a thickness of 3 mm. The letterbox was fixed with two screws with dimensions M5 x 45 mm. The letterbox was also provided with a brush behind the lid (see photo 3).

6.4 Gap width

The gap widths were measured in compliance with EN 1634-1: 2000.
In compliance with article 7.3 of EN 1634: 2000 the gaps applied in practice are specified by the sponsor and are 4 mm (see table of figure 3 and 4)
The determined and given values are shown in figure 11 of chapter 12.

6.5 Wooden door frame

The door frame was constructed of Mahogany and provided with door brushes (where) see figure 3. At the top the transom was at both sides 20 mm wider than the frame.

Exterior dimensions of the wooden door frame:
- Height 2020 mm;
- Width 848 mm.

6.6 Test frame and flexible supporting construction

6.6.1 Test frame

The test frame was constructed of a concrete frame, with internal dimensions of 4000 x 3000 mm (w x h). The thickness of the test frame was 250 mm.
In the frame an aerated concrete wall was erected with a thickness of 150 mm and with 2 openings of 863 x 2036 (w x h).

6.7 Method of assembly

The door-/frame construction is assembled in the following order:

- mounting of wooden door frame in aerated lightweight concrete;
- mounting of door with three hinges;
- adjusting of door and door spring;
- mounting of the letterbox.

7 Sampling and manufacturing of the construction

Efectis Nederland, Centre for Fire Safety:	- Concrete test frame;
Environmental Seals Ltd	- Fabrication of door-/frame construction; - Assembly of the construction.

8 Mode of testing

8.1 Verification of the specimen

The materials and components used were inspected during assembly on the basis of the supplied drawings and data.
Three door constructions were delivered, Efectis Nederland decided which doors were used for the fire test and which one was kept for verification.

8.2 Conditioning

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

- Ambient temperature: 20 ± 5°C.
- Relative humidity: 50 ± 10 %.

8.3 Density and moisture content

Material	Density [kg/m^3]	Moisture [%]
Mahogany	775	8.3
STB board	489	4.2
Plywood	698	8.6
Meranti beads	458	8.0
Mahogany door frame	775	6.3

8.4 Operability test

Prior to the commencement the door construction was checked for operability, to open the door 25 times from fully open to fully closed position (90°) with the help of the door spring.

Test conditions	
Cycles	**25 times manually**
Opening time [s]	4
Closing time [s]	5
Cycle time [s]	9
Period at rest between the cycles [s]	4

8.5 Fire test

8.5.1 Test conditions

The fire test was carried out according to EN 1634-1:2000 for the case "door pivoting towards the fire". This also means that during the fire test, plate thermocouples were used to measure the gas temperatures in the furnace and the overpressure targets in the furnace for 0.5 m and 2.70 m above floor level were 0 and 18 Pa, respectively.

8.5.2 Measurements

During the heating the following data was measured and registered:

Furnace conditions

- Temperatures in the furnace using 8 plate thermocouples (TPL1 to TPL8), equally spread over the heated construction;
- The pressure in the furnace (Press-0 and Press-2.7).

Specimen

- Surface temperatures of door A (TC A1 until TC A15);
- Surface temperatures of door frame A (TC A16 until TC A20);
- Surface temperatures of door B (TC B1 until TC B15);
- Surface temperatures of door frame B (TC B16 until TC B20);
- Radiation at 1.0 m from door A;
- Radiation at 1.0 m from door B;
- Deforming of door A (DefA1, DefA2, DefA3 and DefA4);
- Deforming of door B (DefB1, DefB2, DefB3 and DefB4).

Environment

- The ambient air temperature in the laboratory outside the furnace.

The positions of the thermocouples, radiation and deforming measurement are given in the figures C1a and C1b.

9 Test results

9.1 Observations during heating of door A

After 57 minutes the average temperature of five surface thermocouples on door B was more than 158°C *Thermal insulation exceeded.*
After 58 minutes the temperature of thermocouple TC A3 of door A was more than 197°C: *Thermal insulation exceeded.*
After 58 minutes flames were visible longer than 10 seconds at the right top side of door A: *End of the integrity reached.*

9.2 Observations during heating of door B

After 64 minutes the temperature of thermocouple TC B3 was more than 197°C: *Thermal insulation exceeded.*
After 68 minutes flames were visible for longer than 10 seconds at the left side of door B: *End of the integrity reached.*

The details of the observations are listed in appendix A.
Photographs of details during assembly and the construction before, during and after the test are shown in Appendix D.

9.3 Graphs of the fire test

The test results are shown as graphs in Appendix B and C.
During the heating of the specimen the ambient temperature and air velocity in the laboratory met the requirements of EN 1363-1: 1999.

9.4 Uncertainty of measurement

Due to the nature of fire resistance testing, in which several non-linear effects are present in both the test configuration and the test specimen, which influence each other,

it is at this moment not yet possible to give a stated degree of uncertainty of measurement.

10 Summary

The fire resistance of two wooden door-/frame constructions with intumescent components of Environmental Seals build in aerated light weight concrete was determined. The examination was performed according to EN 1634-1:2000.

Table 2: Summary of test results of door construction A

Criterion	Time measured from the start of the test during which the criterion based on EN 1634-1:2000.	
	EN 1634-1:2000	Criterion reached or not reached
a) Integrity (E)		
– Cotton pad	58 minutes	not reached
– Opening gauges	58 minutes	not reached
– Flames > 10s	58 minutes	reached
b) Thermal insulation (I)		
- Average temperature increase	58 minutes	reached
- Maximum temperature increase (I_1)	58 minutes	reached
- Maximum temperature increase (I_2)	58 minutes	reached
c) Radiation (W)	58 minutes	reached*

*Radiation reached due to end of integrity.

Table 2: Summary of test results of door construction B

Criterion	Time measured from the start of the test during which the criterion based on EN 1634-1:2000.	
	EN 1634-1:2000	Criterion reached or not reached
b) Integrity (E)		
– Cotton pad	68 minutes	not reached
– Opening gauges	68 minutes	not reached
– Flames > 10s	68 minutes	reached
c) Thermal insulation (I)		
- Average temperature increase	57 minutes	reached
- Maximum temperature increase (I_1)	57 minutes	reached
- Maximum temperature increase (I_2)	57 minutes	reached
c) Radiation (W)	68 minutes	reached**

**Radiation reached due to end of integrity.
The heating was terminated after 68 minutes at the request of the sponsor.

11 Field of application and conditions

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 procedure outlined in EN 1363-1, and when appropriate EN 1363-2. Any significant deviation with respect to size, constructional details, load stresses, edge or end conditions other than those allowed under the field of direct application in the relevant test method is not covered by this report.

The results of chapter 10 are only valid for wooden door-/frame constructions provided with Intumescent components of Environmental Seals which are the same in detail as the tested structure and which comply with the following conditions:

a) with dimensions of the door leaf smaller or equal as tested;
b) with a frame work constructed of Mahogany with dimensions 92 x 37 mm;
c) the door frame filled with 2 or 3 STB boards, product no. 91 with on both sides Multigraf intumescent material, product no. 84 with a thickness of 2 mm;
d) At both sides of the framework a fire barrier curtain with product no.56, with a thickness of 0.23 mm;
e) both sides of the frame covered with a plywood cladding, thickness of 6 mm;
f) at the perimeter of the door a Meranti bead with a thickness of 10 mm;
g) the door has at both uprights product 100, clip in intumescent fire and smoke seal with code C15 15/B60;
h) the door is provided with three self closing door hinges, dimensions hinge plate 180 x 40 x 1.5 mm, with intumescent material between door and hinge, type product 71;
i) the number of any movement restrictors such as locks, latches and hinges may be increased but shall not decreased;
j) the distance of the two top hinges from the top of the door shall be equal to or less than that tested;
k) the distance of the bottom hinge from the bottom of the door shall be equal to or less than that tested;
l) the gaps of the door should be not greater than the maximum value specified;
m) constructed from materials with a density equal or higher than tested;
n) the door can provided with a letterbox in the middle encased with intumescent material, product 49, with a thickness of 3 mm;
o) because a paint finish is not expected to contribute to the fire resistance, it is allowed to add a alternative paint at the surface of the wooden door construction.

A.J. Lock P.W.M. Kortekaas

12 Figures

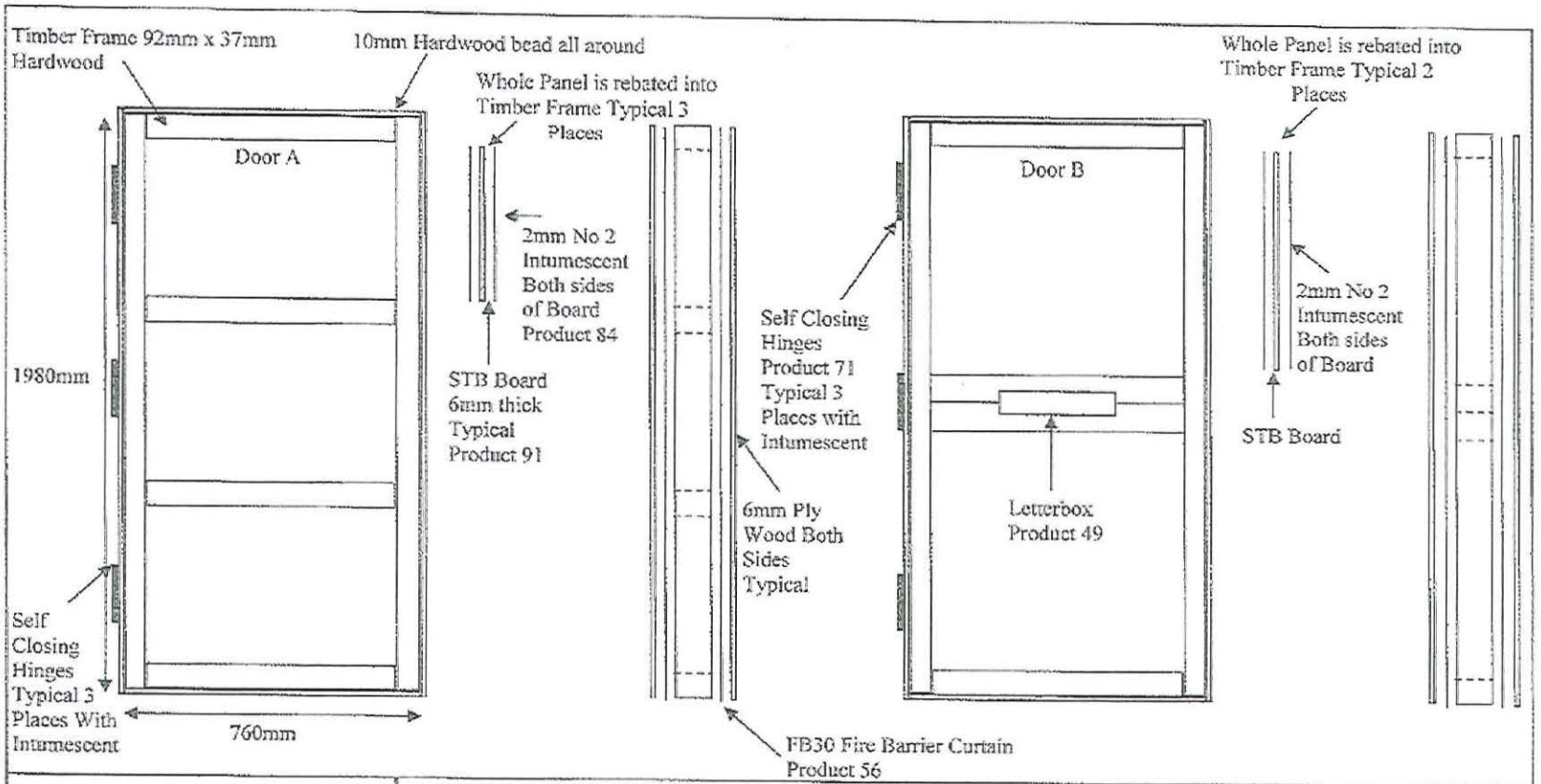


Figure 1: Frame work of both doors

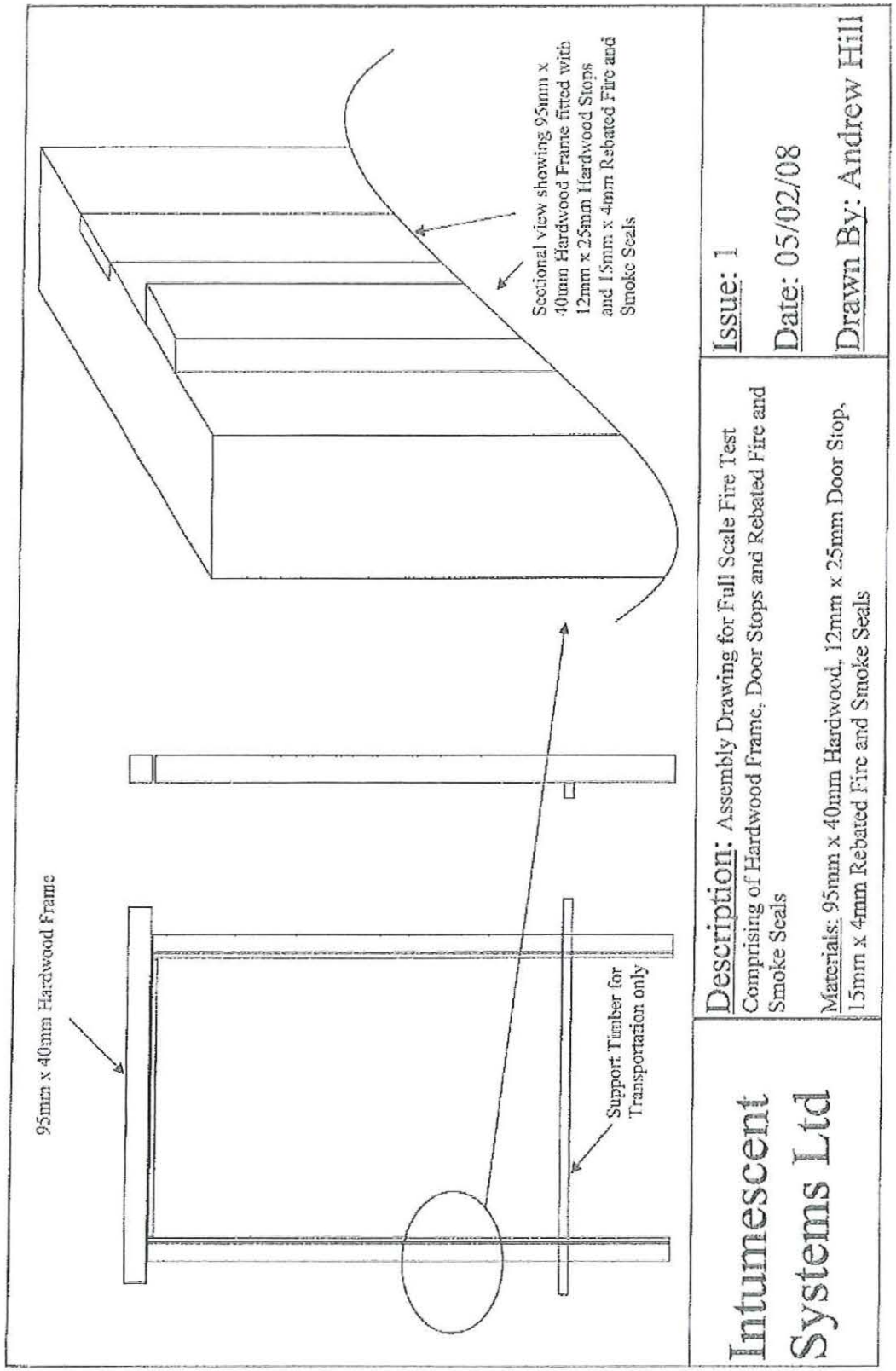


Figure 2: Framework of door frames

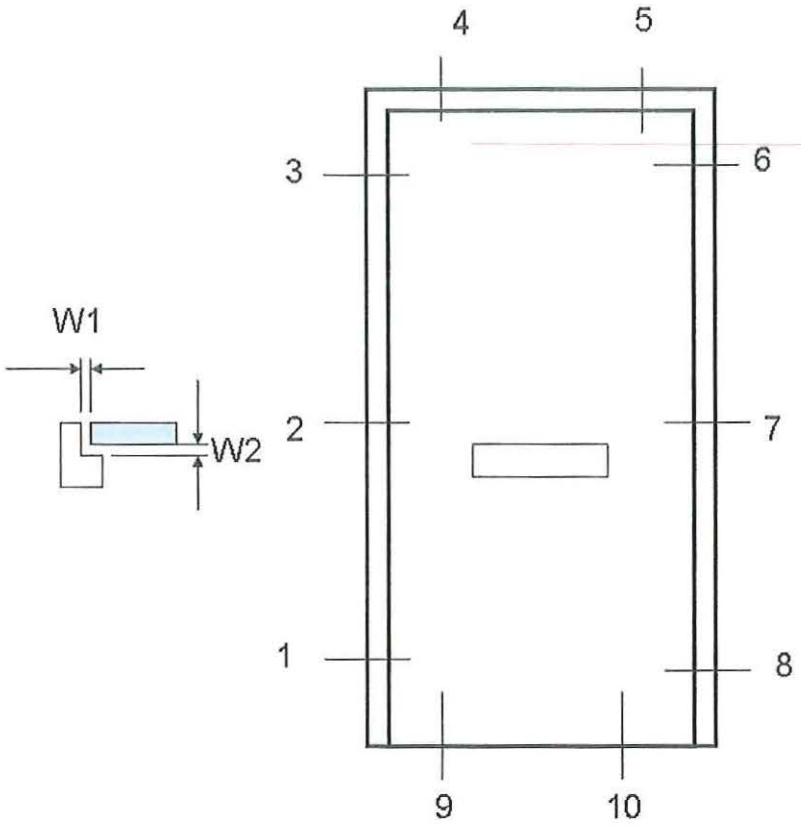


Figure 3: Gap measurements of door A

Position	W1 [mm]	W2 [mm] Non fire side
1	5.6 (4 ±1)	1.3 (0.5±0.5)
2	4.8 (4 ±1)	1.3(0.5±0.5)
3	5.7 (4 ±1)	2.0(0.5±0.5)
4	3.9 (4 ±1)	0.5(0.5±0.5)
5	3.4 (4 ±1)	1.6(0.5±0.5)
6	3.9 (4 ±1)	0.8(0.5±0.5)
7	5.4 (4 ±1)	0.5(0.5±0.5)
8	4.2 (4 ±1)	0.5(0.5±0.5)
9	3.7 (4 ±1)	-
10	4.6 (4 ±1)	-

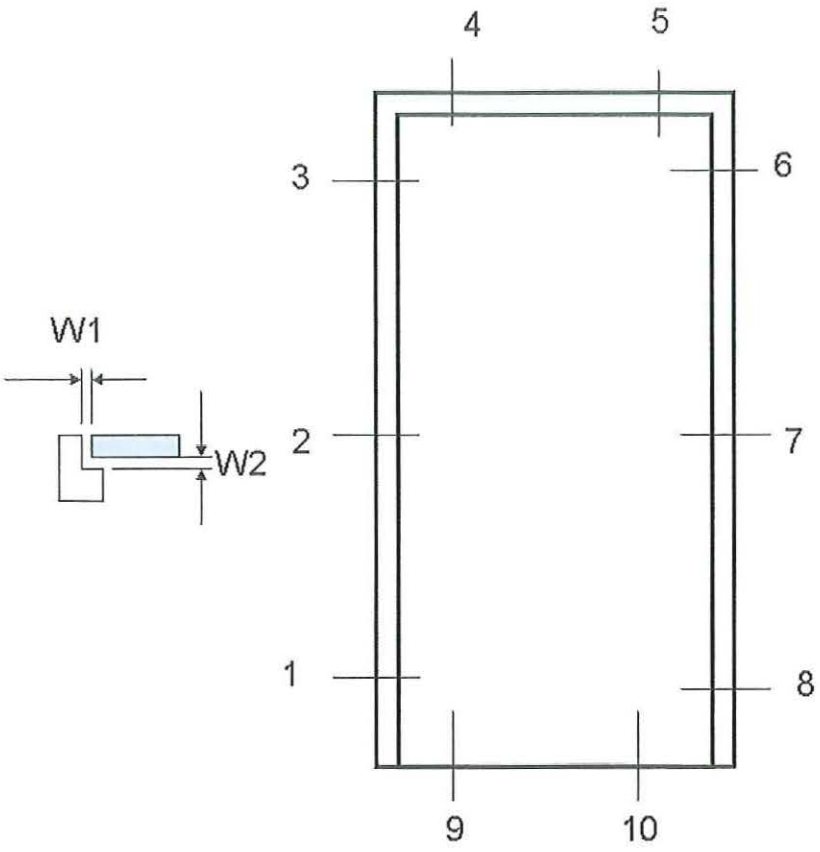


Figure 4: Gap measurements of door B

Position	W1 [mm]	W2 [mm] Non fire side
1	3.5 (4 ±1)	0.5(0.5±0.5)
2	4.1(4 ±1)	0.5(0.5±0.5)
3	3.5(4 ±1)	2.0(0.5±0.5)
4	3.8(4 ±1)	1.1(0.5±0.5)
5	4.1(4 ±1)	1.5(0.5±0.5)
6	3.7(4 ±1)	0.6(0.5±0.5)
7	3.2(4 ±1)	2.9(0.5±0.5)
8	7.5(4 ±1)	3.1(0.5±0.5)
9	6.5(4 ±1)	-
10	6.6(4 ±1)	-

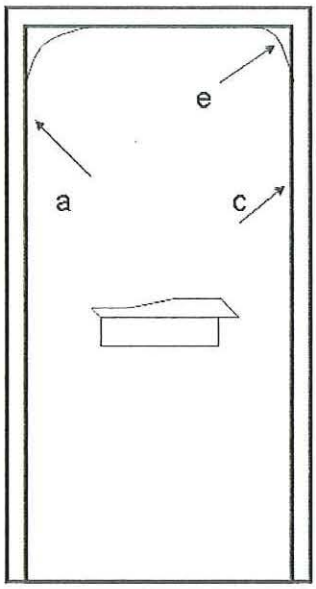
A Observations

A.1 Observations during the test

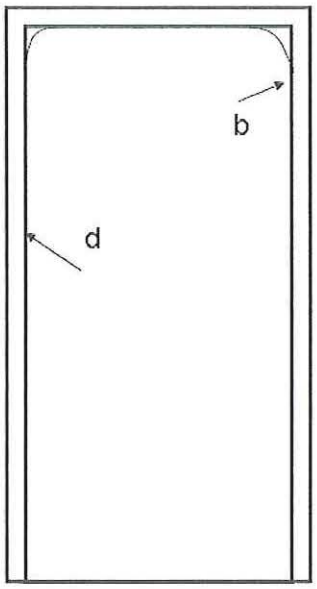
F = Fire side
N = Non fire side

Time [min]	Side	Observation
0		Start heating
30"	N	Smoke along the top side of both doors
2	N	Moist coming out of both doors at positions a, b, c and d
3	N	More smoke coming from both doors at the top
6	N	Burning of wood in the furnace (audible)
6'30"	F	Top layer of both doors burned away
8	N	More moist at the top of door A
8'30"	N	Decreasing of smoke
11	F	Framework of door B is burning
12	N	Glow at the right bottom side of door B and intermittent flames < 1s
13	N	Further decreasing of smoke
15	N	Discolouring of the top corners of both doors
20	N	Temperature measured of letter box lid (87°C)
24	N	Dark spots above letter box
25	N	Temperature above letter box 80°C
28	N	More moist coming out of door B at left bottom side
29	N	Lid of letter box about 10 mm open
34	N	Temperature of letter box lid (110°C)
37	N	Larger dark spot above letter box and in the top corners of both doors
45	N	Temperature of letter box lid (147°C)
50	N	At right top corner of door A position e flames during 2 seconds
51	N	Glow at right top corner door A
55	N	Flames for 6 seconds at the right top side of door A
58	N	Thermal insulation exceeded by thermocouple TC A3 of door A
58	N	Flames visible longer than 10 seconds at the top side of door A
59'30"	N	Door A covered with insulation panel
64	N	Thermal insulation exceeded by thermocouple TC B3 of door B
65	N	Glow at left bottom side of door B
68	N	Flames > 10 seconds at left side of door B
68	N	End of heating

A.2 Position of observations during the test



Door A



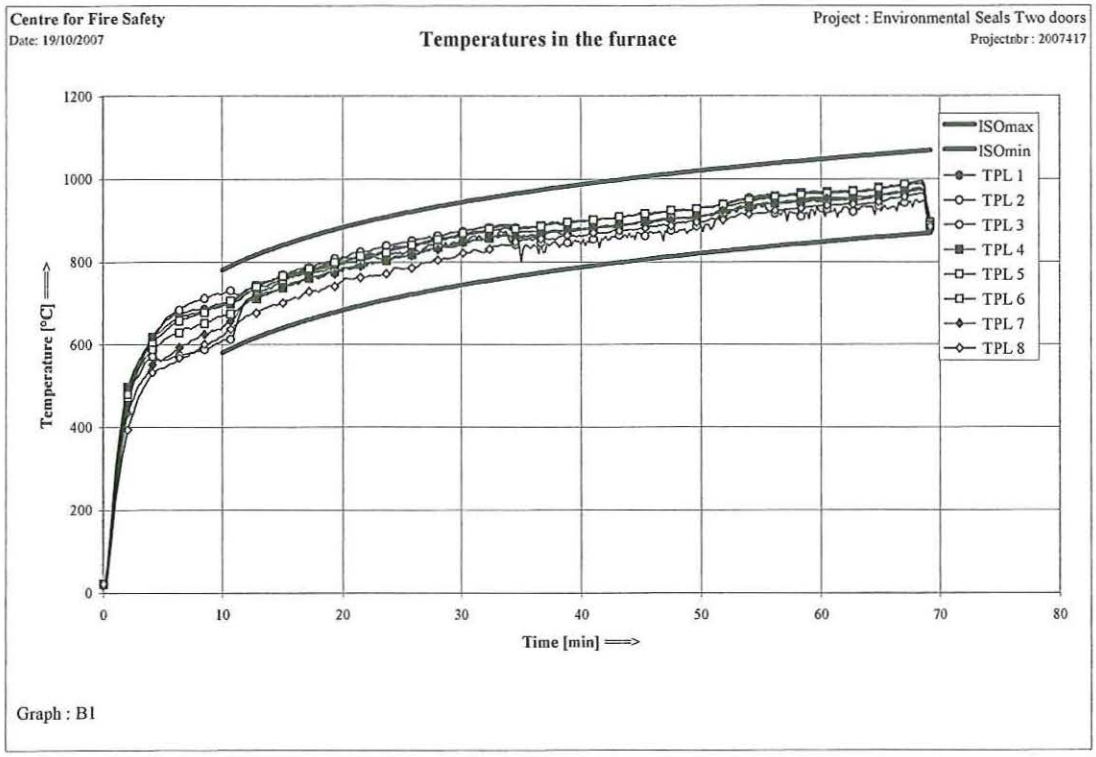
Door B

B Furnace conditions

Graph B1: Furnace temperatures

Graph B2: Deviation of the fire curve

Graph B3: Furnace overpressure



Graph : B1

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Deviation of the fire curve

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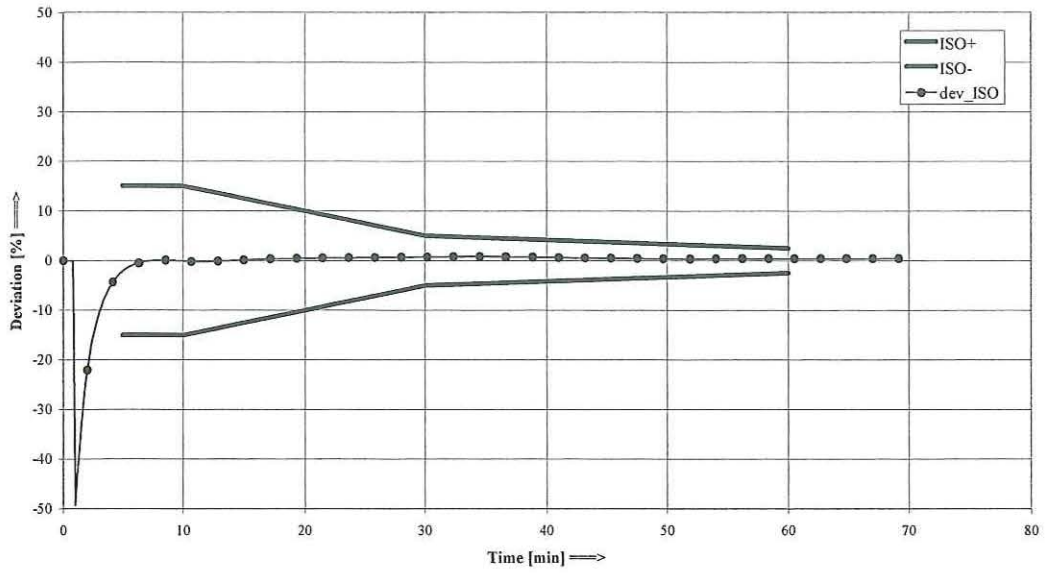

Graph : B2

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Overpressure in the furnace

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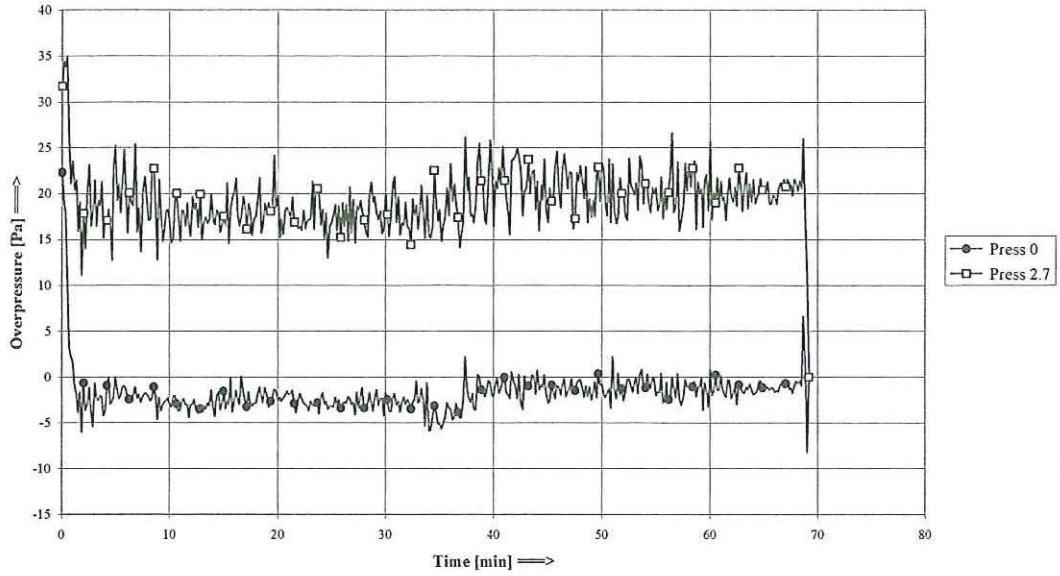


Graph : B3

C Test results

Figure C1a: Positions of thermocouples and radiation

Figure C1b: Positions of deforming measurements

Figure C1c: Positions of deforming measurements

Graph C2: Surface temperatures of door leaf A (average)

Graph C3: Surface temperatures of door leaf A (EI_2 positions)

Graph C4: Surface temperatures of door leaf A (EI_1 positions)

Graph C5: Surface temperatures of door frame A

Graph C6: Surface temperatures of door leaf B (average)

Graph C7: Surface temperatures of door leaf B (EI_2 positions)

Graph C8: Surface temperatures of door leaf B (EI_1 positions)

Graph C9: Surface temperatures of door frame B

Graph C10: Radiation at 1.0 m distance from door A

Graph C11: Radiation at 1.0 m distance from door B

Graph C12: Deforming of door leaf A

Graph C13: Deforming of door leaf B

Graph C14: Ambient air temperature

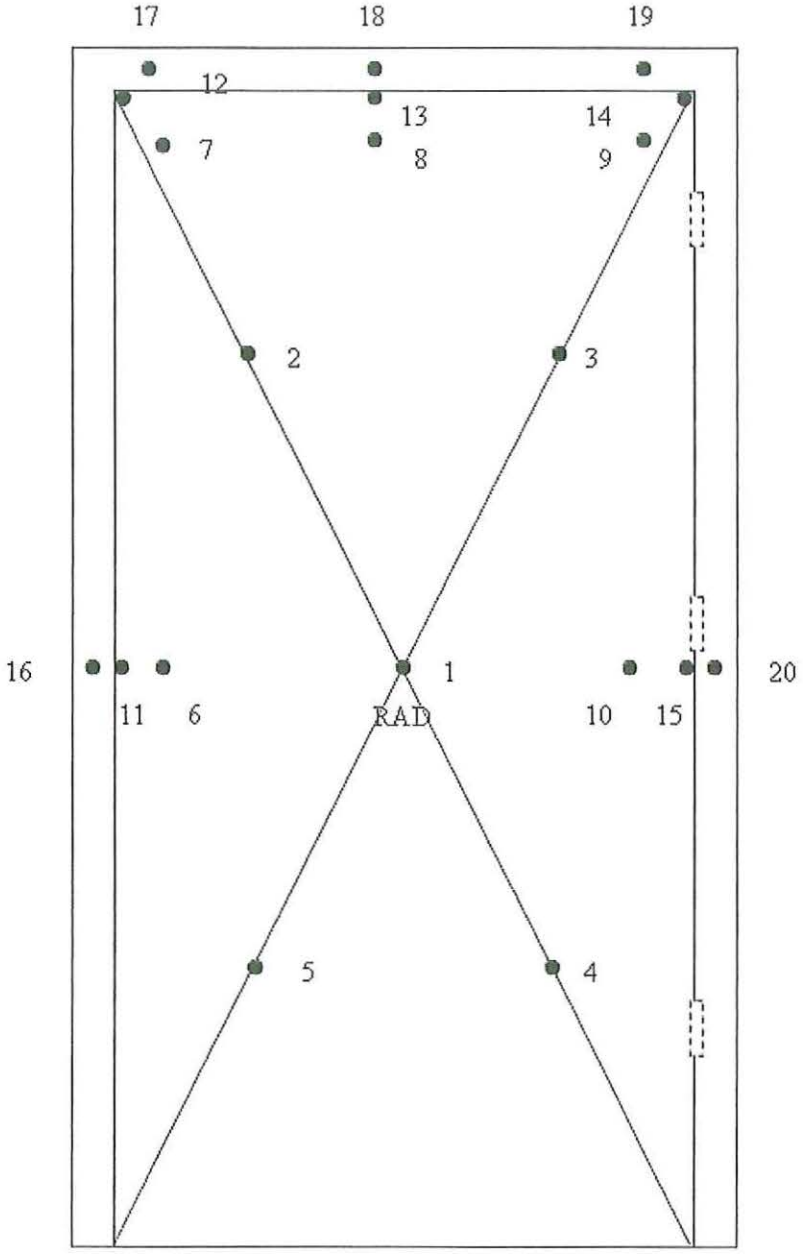


Figure C1a: Positions of thermocouples and radiation

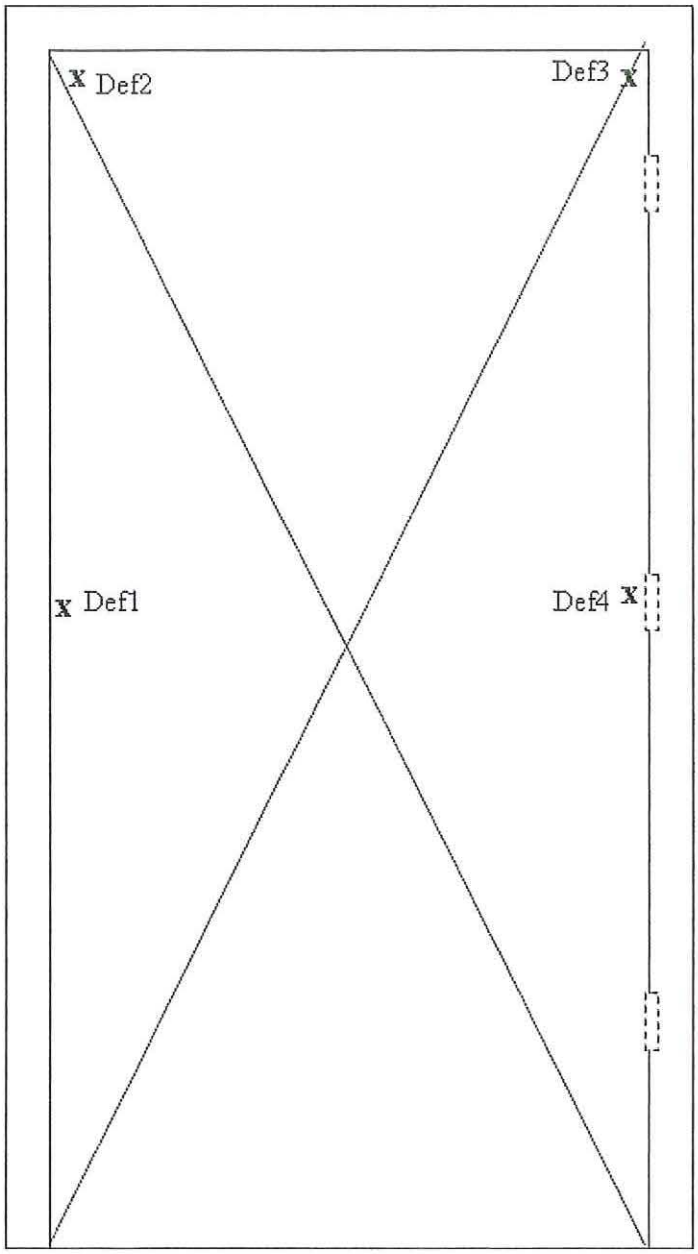
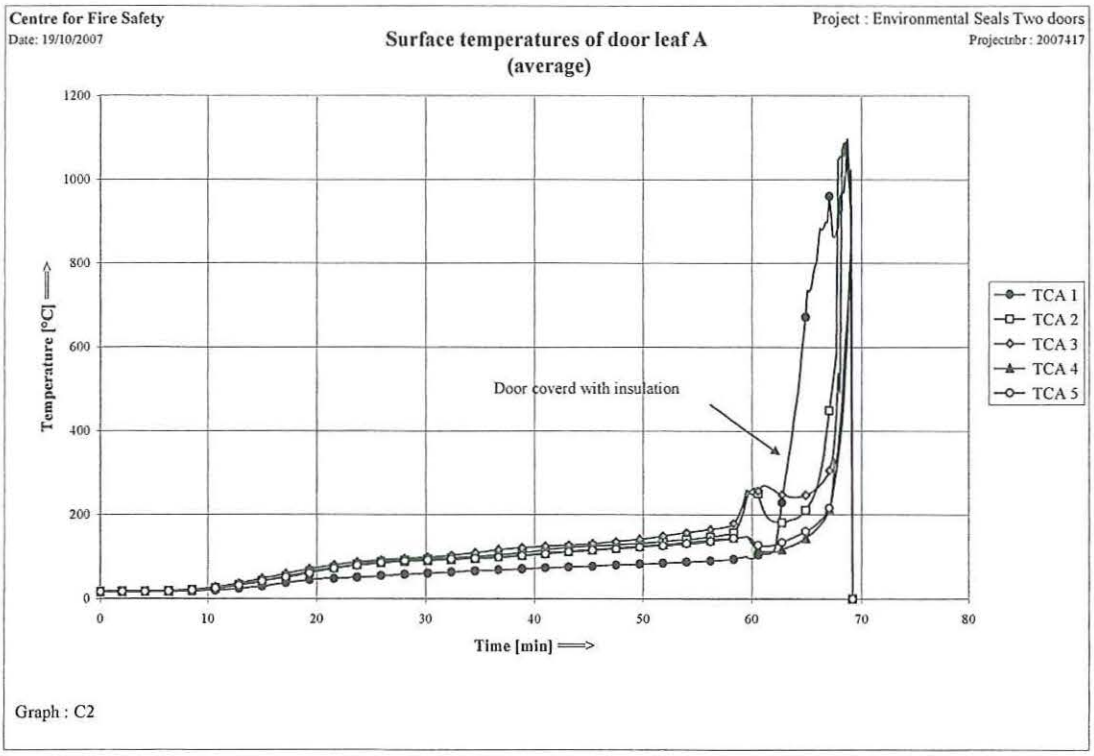
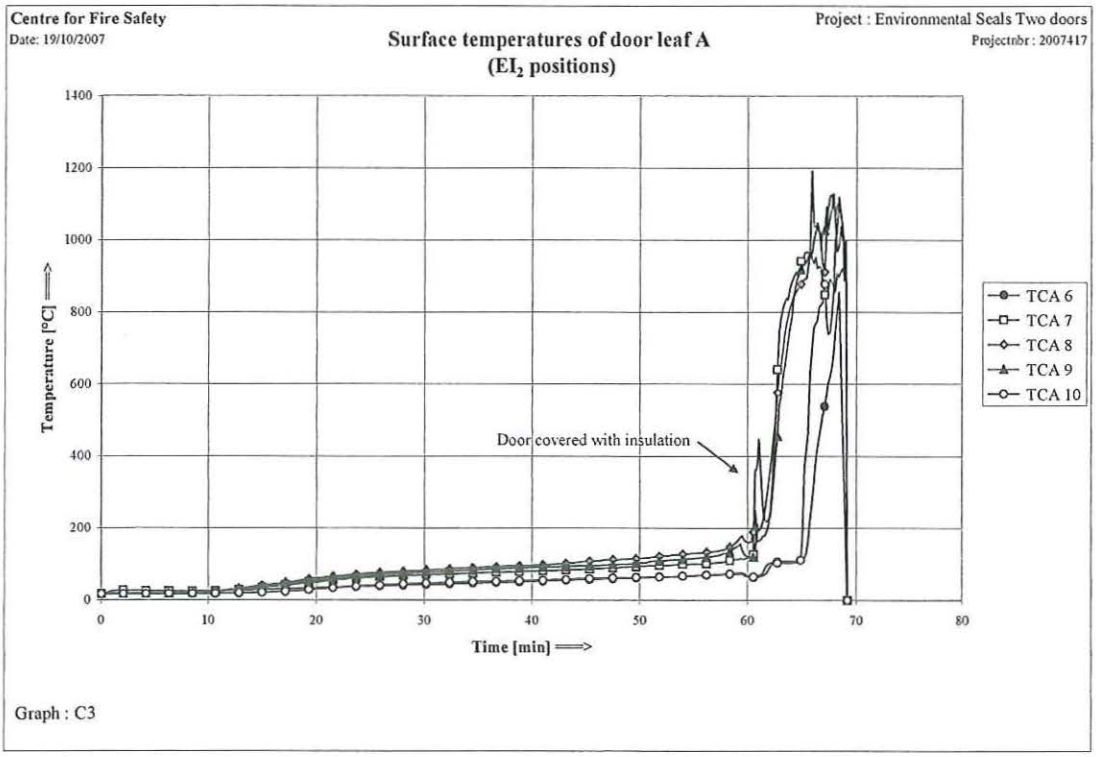


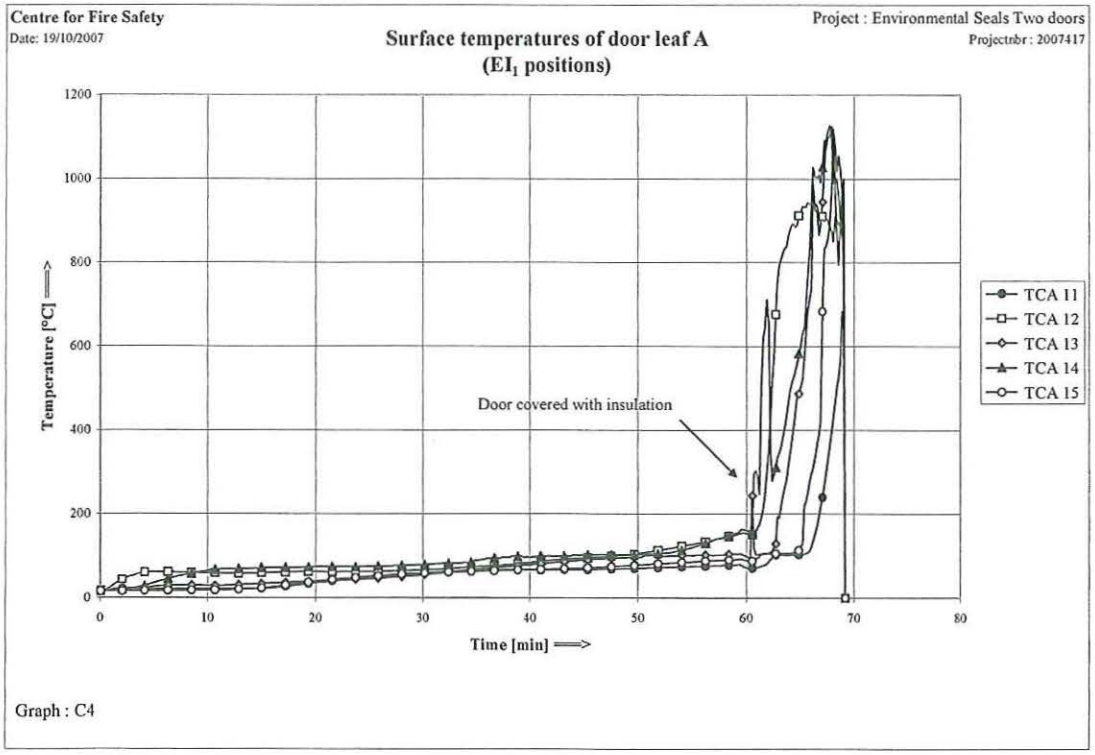
Figure C1c: Positions of deforming measurements



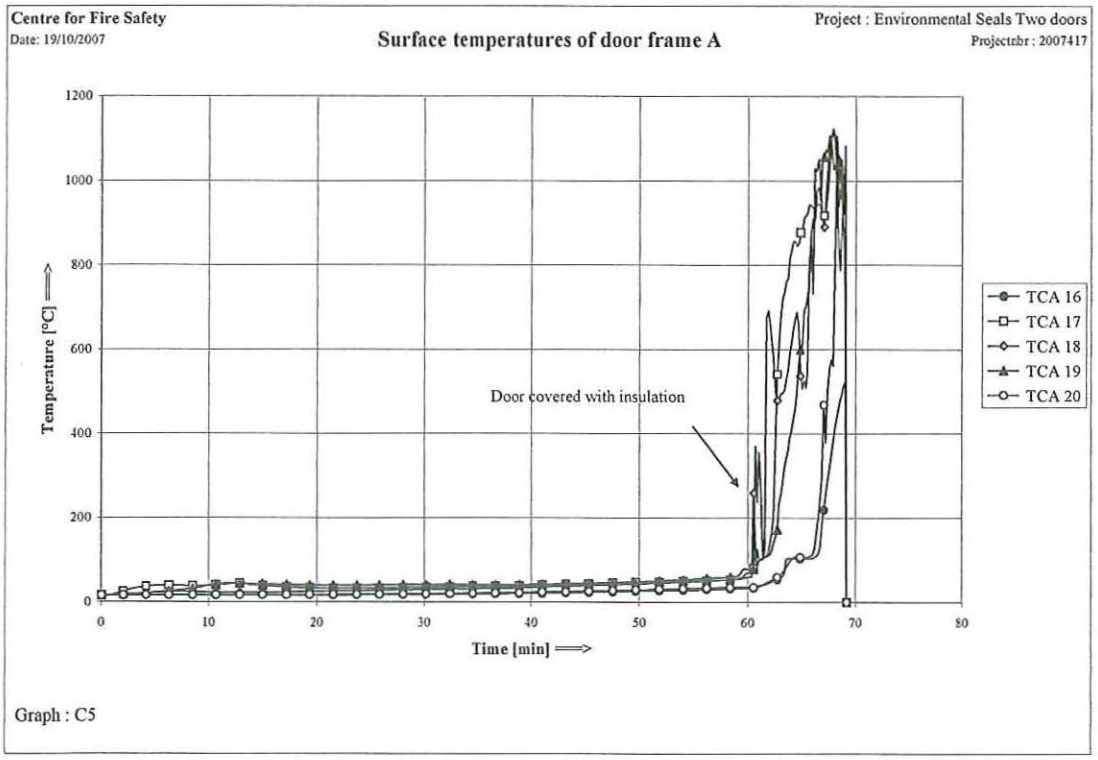
Graph : C2



Graph : C3



Graph : C4



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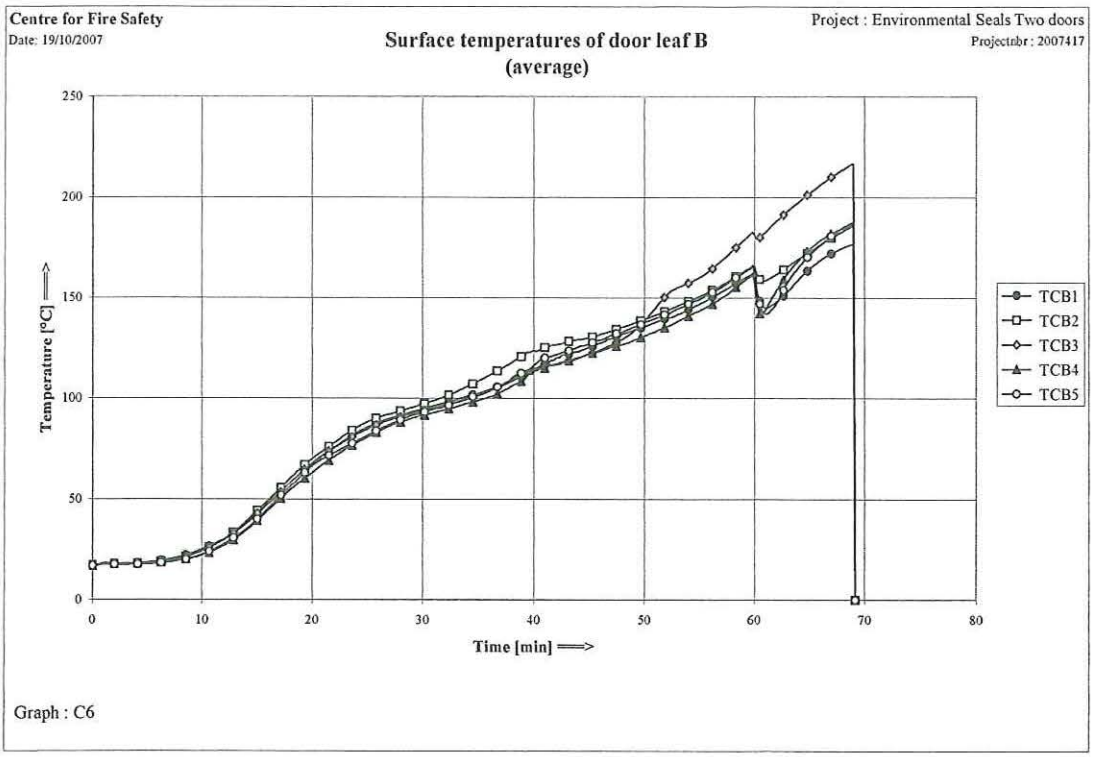

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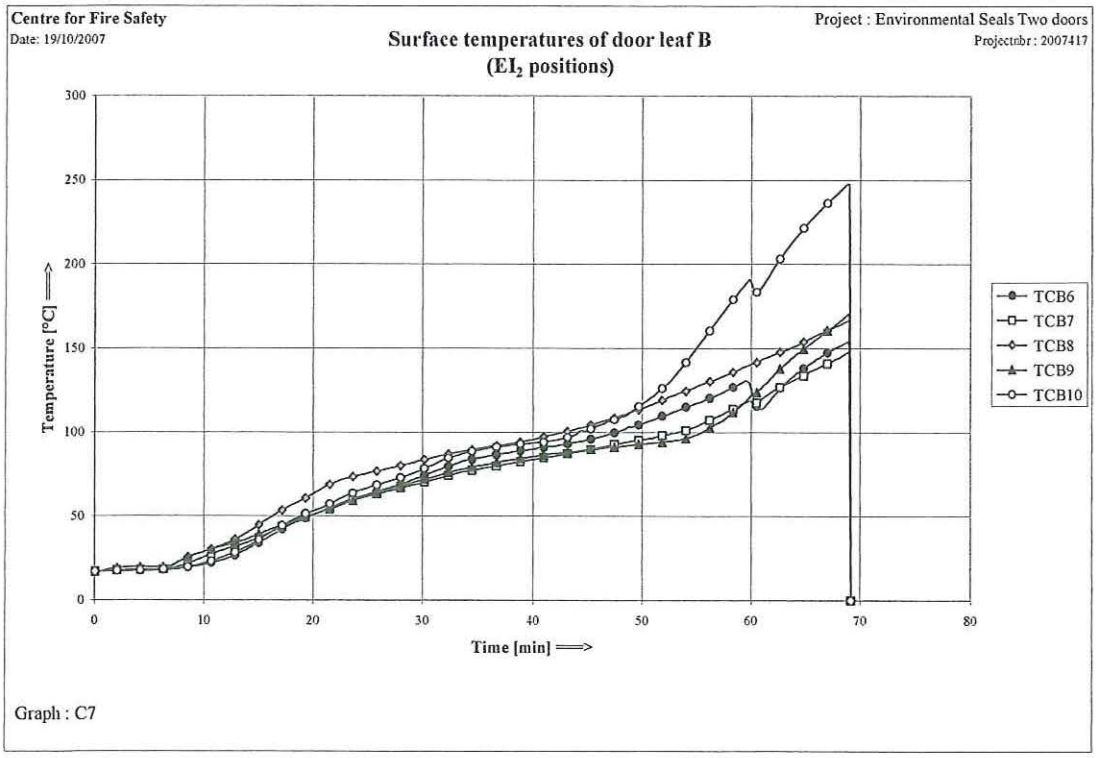

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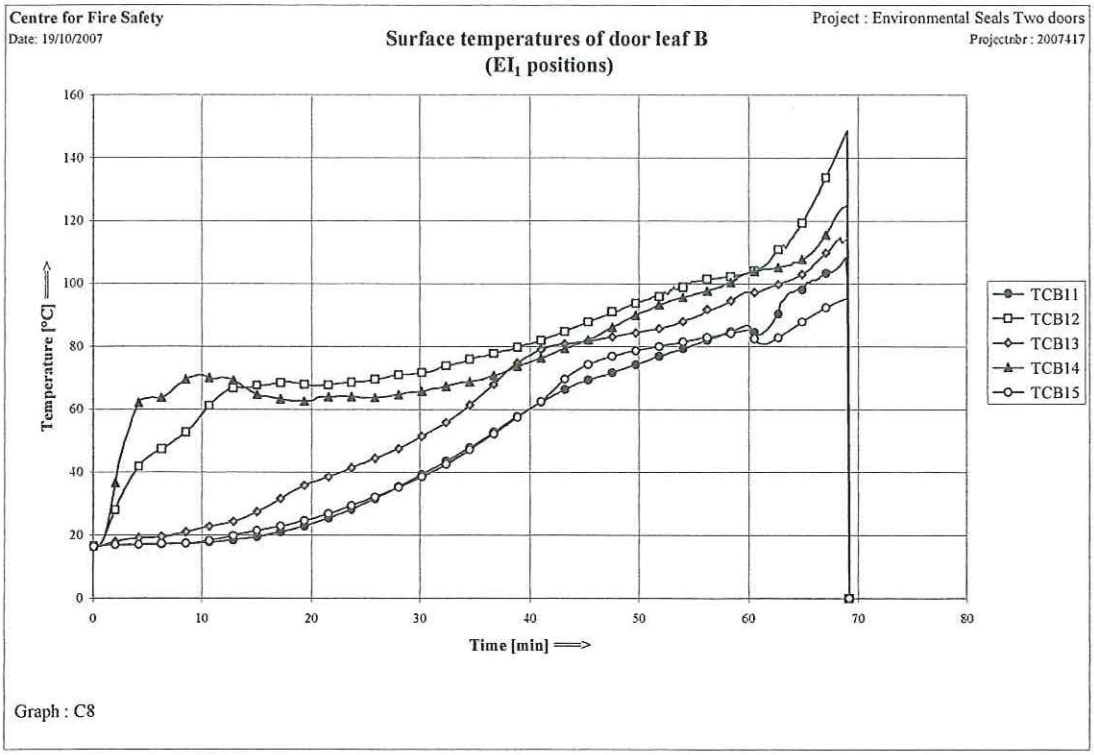

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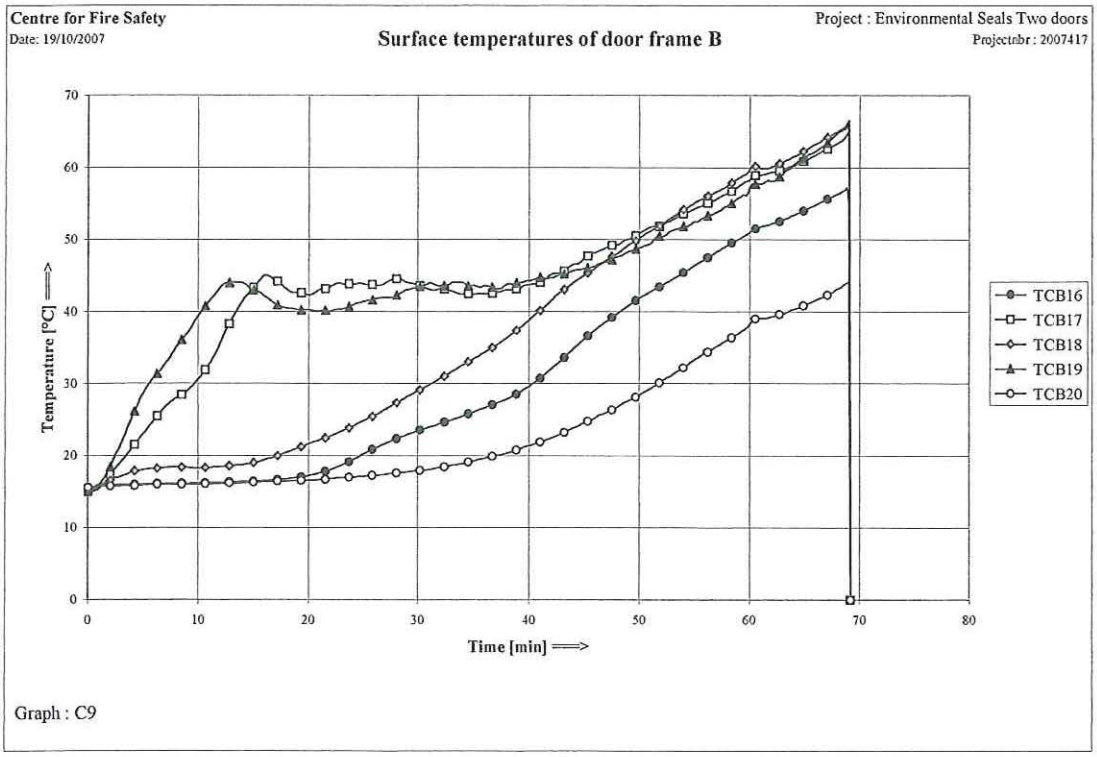

Graph : C9

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Radiation at 1.0 m distance from door A

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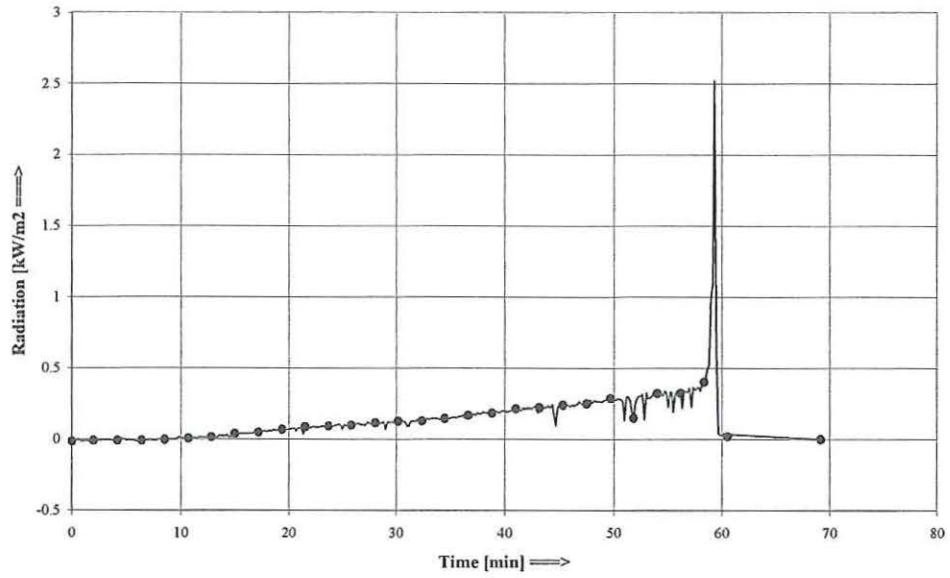
Projectnbr : 2007417



Graph : C10

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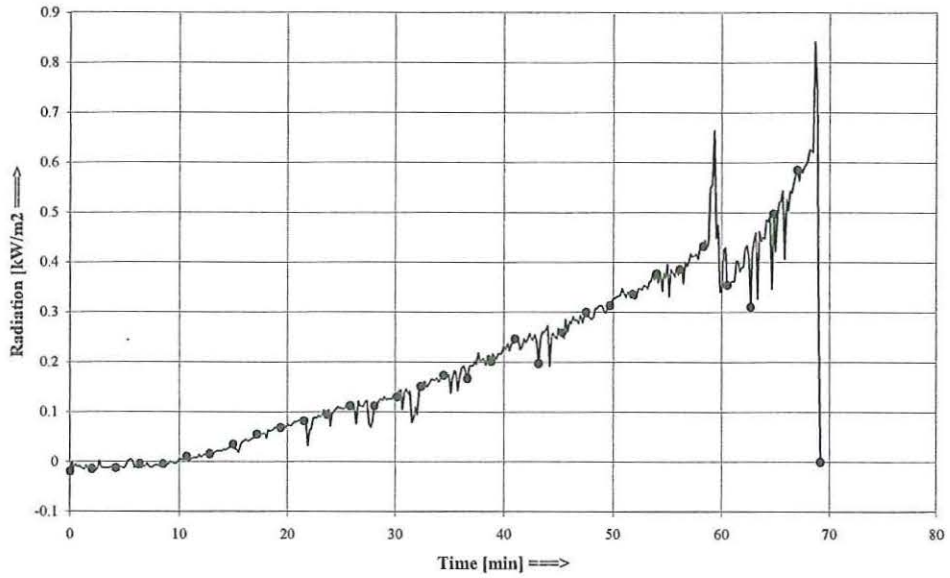
Date: 19/10/2007

Radiation at 1.0 m distance from door B

Project : Environmental Seals Two doors
Projectnbr : 2007417

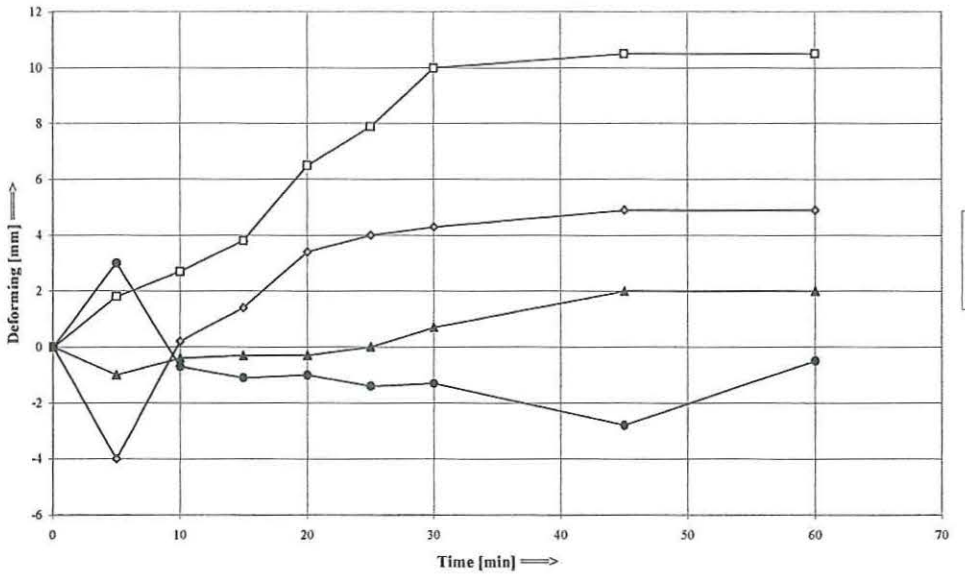


Graph : C11

Centre for Fire Safety
Date: 19/10/2007

Deforming of door leaf A

Project : Environmental Seals Two doors
Projectnbr : 2007417

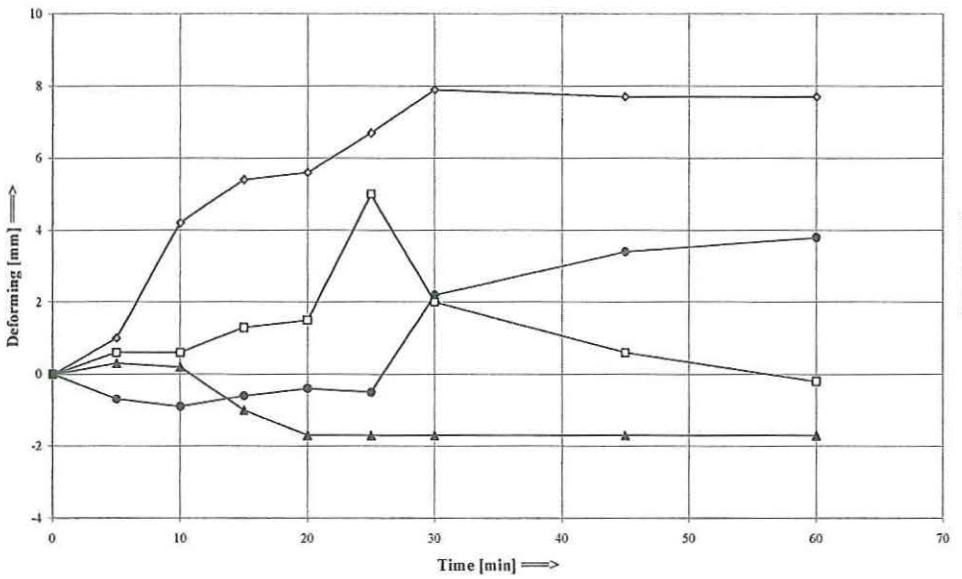


Graph : C12

Centre for Fire Safety
Date: 19/10/2007

Deforming of door leaf B

Project : Environmental Seals Two doors
Projectnbr : 2007417

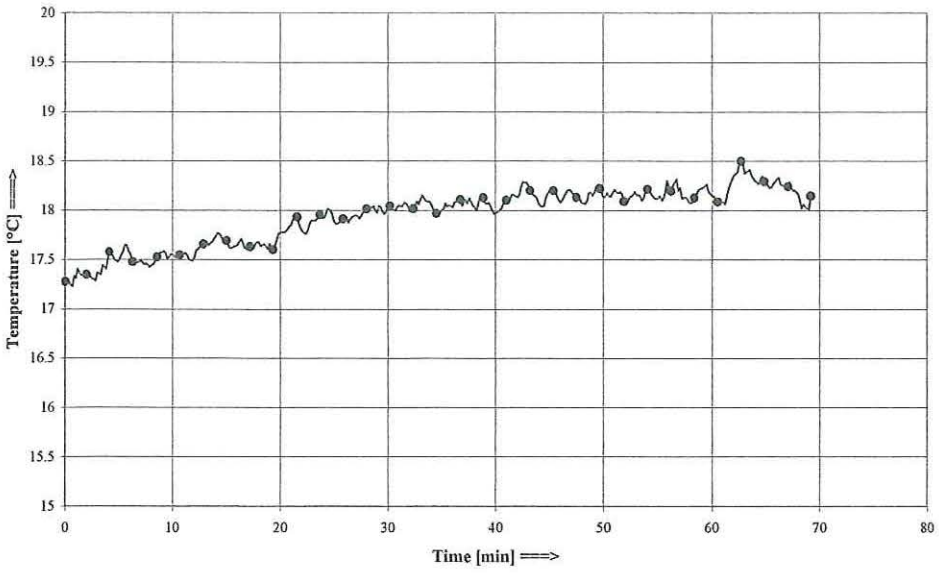


Graph : C13

Centre for Fire Safety
Date: 19/10/2007

Ambient air temperature

Project : Environmental Seals Two doors
Projectnbr : 2007417



Graph : C14

D Photographs

Photo 1: Curtain fabric

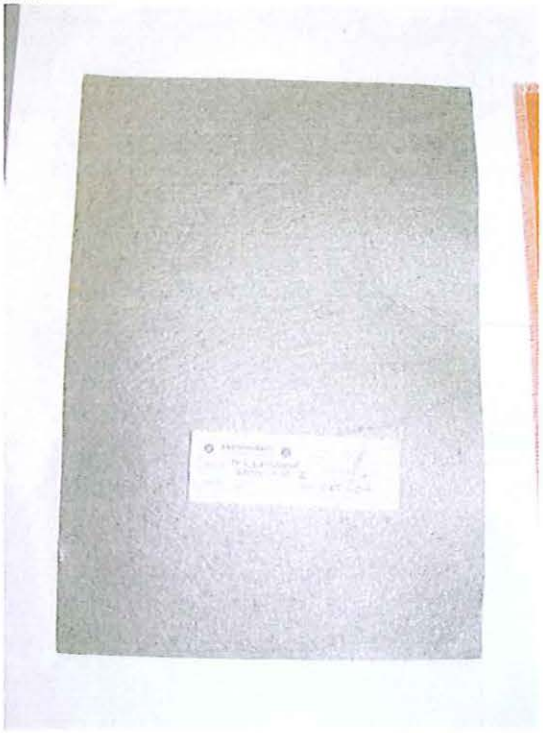


Photo 2: Multigraf Intumescent material which is applied against STB panel

Photo 3: Letterbox with screws

Photo 4: Detail of brush and intumescent material around synthetic middle section

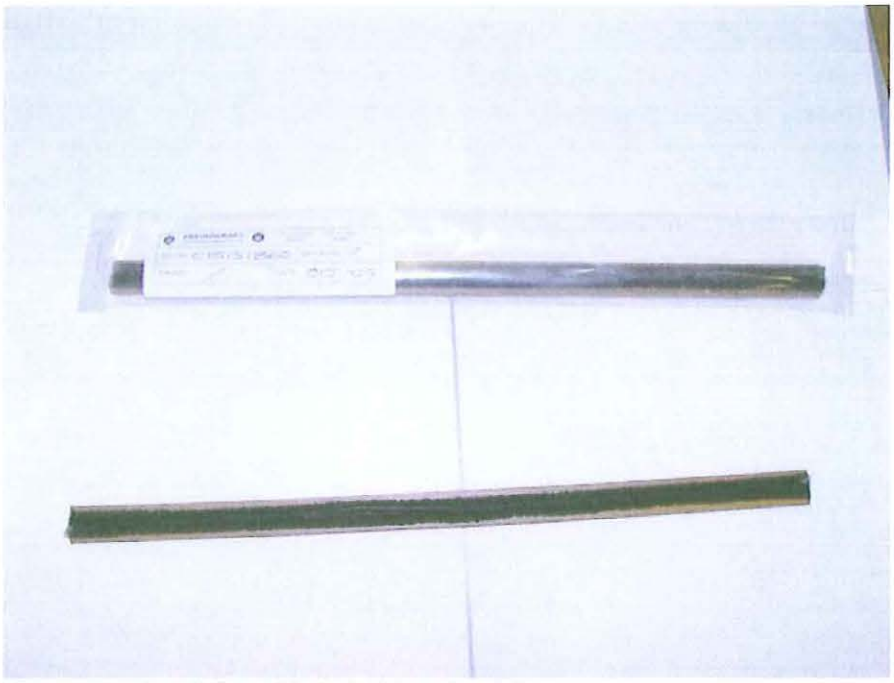


Photo 5: Product 100 used in both sides of uprights

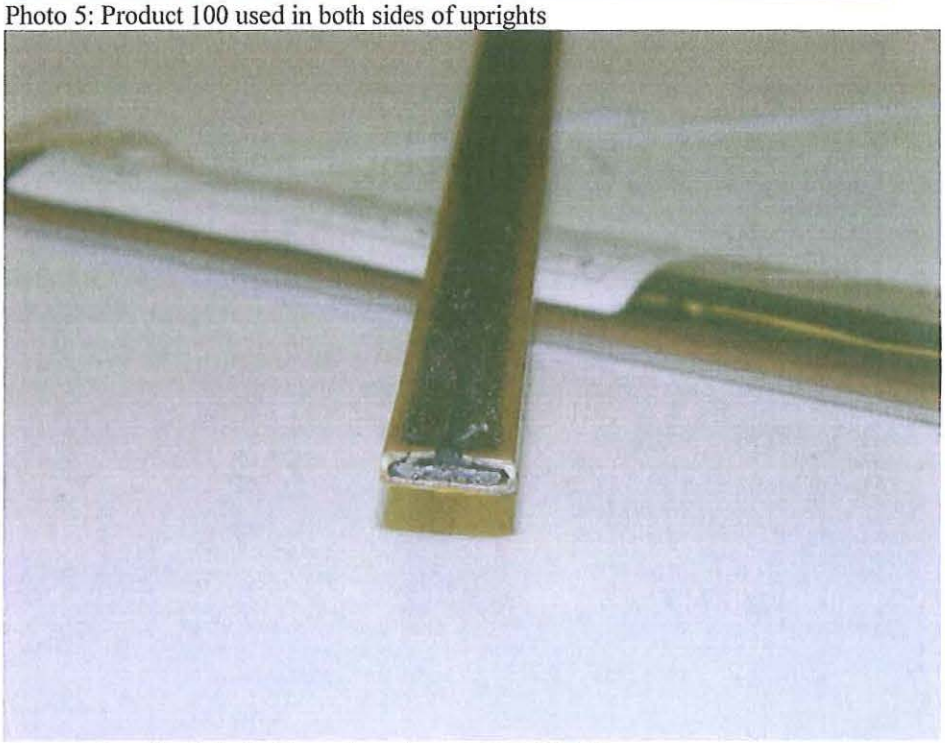


Photo 6: Detail of clip in fire and smokeseal C15 15/B60

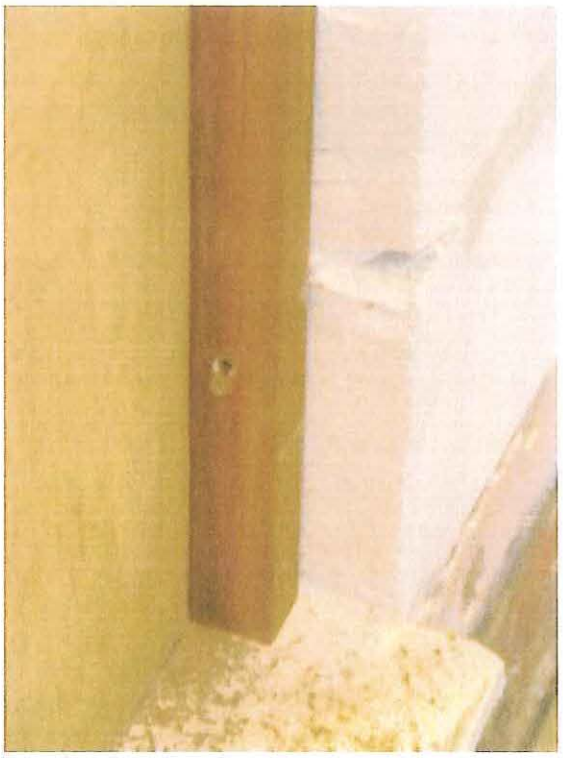


Photo 7: Fixing of wooden door framel

Photo 8: Door A with letterbox during assembly

Photo 9: Both doors in front of furnace

Photo 10: Doors at the beginning of the test

Photo 11: Decreasing of the smoke after 8 minutes

Photo 12: Door A covered with insulation and continued with door B

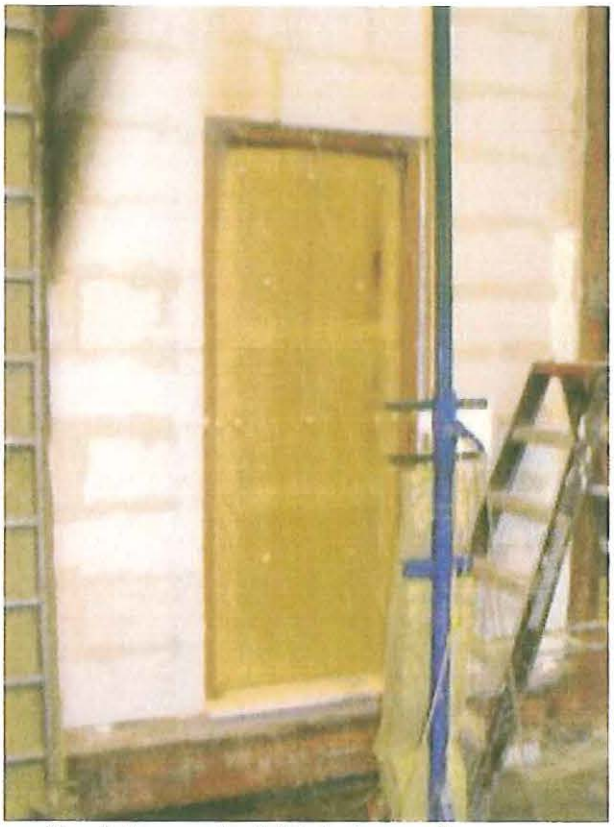


Photo 13: Pattern of insulation panels visible in door surface

Photo 14: Door at end of the test