

TEST REPORT No. RS00-067

CONCERNING THE FIRE RESISTANCE

OF A BUILDING ELEMENT

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It comprises 10 pages and 20 miscellaneous plates (photos, drawings, graphics)

REQUESTED BY: **SOCIETY SOUDAL**
NV
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Laboratoire pilote agréé du Ministère de l'Intérieur (Arrêtés du 05/02/1972 et du 24/04/1972)
Laboratoire agréé du Ministère chargé de la Marine Marchande
et de l'Assemblée Plénière des Sociétés d'Assurance Dommages

PARIS - MARNE-LA-VALLÉE - GRENOBLE - NANTES - SOPHIA ANTIPOLIS
CENTRE SCIENTIFIQUE ET TECHNIQUE DU BÂTIMENT

PURPOSE

Test of fire resistance of foam seals

REFERENCE TEXT

Thermal Programme of the Decree of August 3, 1999.

NATURE OF THE TEST

Determination of compliance with the criteria of heat insulation, integrity under fire effects, hot gas and flammable gas containment, in the sense of the Decree.

DATE OF THE TEST

May 10, 2000

ORIGIN AND CHARACTERISTICS OF THE TEST SPECIMENS

Material presented by: Société SOUDAL
Trademark: "SOUDAFOAM – FR"
Manufacturer: Société SOUDAL
Origin: TURNHOUT (Belgium)

Made at Marne-la-Vallée, 17 October 2005

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"Fire resistance" Laboratory

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1 - DESCRIPTION OF THE ELEMENT

(The dimensions are given in mm)

1.1 - Configuration

Four vertical seals installed in a vertical concrete wall:

- Height of the apertures: 1600,
- Width of the apertures: 10, 20, 30 and 40.

1.2 - List of components (prepared based on information from the manufacturer)

DESIGNATION	REFERENCE	MATERIAL	CHARACTERISTICS	SUPPLIER
Foam seal	SOUDAFOAM - FR	Polyurethane (also called polyurethane isocyanate)	Density: 32 kg/m ³	SOUDAL (BELGIUM)

1.3 - Description**1.3.1 - Concrete test specimen**

A vertical wall, thickness 200, containing four apertures, for installing the foam seal, height 1600, widths:

- Seal A: 40 mm,
- Seal B: 30 mm,
- Seal C: 20 mm,
- Seal D: 10 mm.

The vertical wall is of traditional concrete, proportioned at 350 kg/m³ and composed of CPJ45 (type of cement), gravel 5/10 and Seine River sand.

The concrete was poured 60 days before the test.

1.3.2 - Seal

Installing the SOUDAFOAM – FR foam seal begins with the dampening of the rims of the apertures.

Packaged in a spray can, the foam seal is then extruded to repletion.

After drying, the foam surplus is removed and the seals trimmed flush.

- See the drawings of the element, Plate no. 1 –

2 - TEST SET-UP

The SOUDAFOAM – FR foam seal was installed by the SOUDAL Company's specialists, in a vertical concrete wall, thickness 200, masonrywork by CSTB.

- See the photos taken during set-up, Plates no. 9 and 10 -

3 - TEST PROCEDURES**3.1 - Fire direction**

Either

3.2 - Thermal programme

The thermal programme followed is represented by the following function:

$$T - T_0 = 345 \log (8t + 1)$$

which gives the oven's temperature rise above ambient in degrees C as a function of time in minutes.

4 - MEASUREMENTS CARRIED OUT DURING THE FIRE RESISTANCE TEST**4.1 - Oven temperature**

The positions and pinpointing markers of the temperature sensors are indicated on Plate no. 2.

The temperatures are measured with the aid of 9 thermocouples (Tcs) and recorded during the test in compliance with Appendix XI of the Decree of August 3, 1999.

- See the recordings, Plate no. 3 -

4.2 - Temperatures of the element

The positions and pinpointing markers of the temperature sensors are indicated on Plate no. 2.

The temperatures are measured with the aid of 16 thermocouples and recorded during the test in compliance with the Decree of August 3, 1999.

- See the recordings, Plates no. 4 to 7 -

4.3 - Pressure in the oven

Over its whole surface, including on its periphery, the test element is subjected to a pressure difference between the inside and the outside of the oven in compliance with Appendix XI of the Decree (10 ± 5 Pa at the upper part of the elements).

- See the recording, Plate no. 8 -

5 - OBSERVATIONS

5.1- During the test

A: seal width 40

B: seal width 30

C: seal width 20

D: seal width 10

TIME	EXPOSED FACE	NON-EXPOSED FACE
0 h 00 min	Test start – Initial temperature 19.5 °C	
0 h 05 min	A, B, C and D: appearance of horizontal cracks over the whole seal.	
0 h 10 min	A, B, C and D: accentuation of the horizontal cracks.	
0 h 18 min	A, B, C and D: separation of the seal from the concrete.	
0 h 21 min	A: start of seal carbonisation.	
0 h 26 min	B, C and D: start of seal carbonisation.	
0 h 30 min		No notable evolution.
1 h 10 min	A, B, C and D: the seal is slightly drawn back from the wall's outside surface.	
1 h 14 min	A, B, C and D: reduction of the seal in its thickness, that is, drawn back from the plane of the exposed face of the concrete frame.	
1 h 20 min	A, B, C and D: reduction of the seal in its thickness, that is, drawn back from the plane of the exposed face of the concrete frame.	
1 h 22 min		Measurements recorded with the aid of the mobile thermocouple at the upper extremity of seals B and C: 25 °C.
1 h 25 min	A, B, C and D: reduction of the seal in its thickness, that is, drawn back from the plane of the exposed face of the concrete frame.	

TIME	EXPOSED FACE	NON-EXPOSED FACE
1 h 50 min	A, B, C and D: the seal is drawn back about about 20 to 30 from the wall's outside surface.	
1 h 57 min		Measurements recorded with the aid of the mobile thermocouple at the upper extremity of seals A, B, C and D: 25 °C
1 h 58 min		
1 h 58 min	A, B, C and D: the seal is drawn back further to about 30 from the wall's outside surface.	
2 h 08 min		A, B, C and D: no change in the appearance, colour and hardness.
2 h 09 min	A, B, C and D: the seal is drawn back further to more than 30 from the wall's outside surface.	
2 h 15		Measurements recorded with the aid of the mobile thermocouple at the upper extremity, seal A: 27 °C, seals B, C and D: 28 °C.
2 h 58 min	A, B, C and D: the seal is drawn back further to about 40 from the wall's outside surface.	
2 h 39 min		Measurements recorded with the aid of the mobile thermocouple at the upper extremity, seals A, B, C and D: 28 °C.
2 h 53 min		Measurements recorded with the aid of the mobile thermocouple at the upper extremity, seals A, B, C and D: 30 °C.
2 h 55 min	A, B, C and D: the seal is drawn back further to about 50 from the wall's outside surface.	
3 h 12 min		Measurements recorded with the aid of the mobile thermocouple at the upper extremity, seals A, B, C and D: 33 °C.
3 h 13 min	A, B, C and D: the seal is drawn back further to more than about 50 from the wall's outside surface. Seals are entirely black colour.	

TIME	EXPOSED FACE	NON-EXPOSED FACE
3 h 26		Measurements recorded with the aid of the mobile thermocouple at the upper extremity, seals A, B, C and D: 33.5 °C.
3 h 30 min	A, B, C and D: the seal is drawn back further to about 55 to 60 from the wall's outside surface.	A: at the bottom part, appearance of a brown stain, at about 35 of the concrete, covering from 80 to 100 high.
3 h 33 min		A: blackening of the stain noted at 3 h 30 minutes of the test.
3 h 37 min		Measurements recorded with the aid of the mobile thermocouple at the brown stain of seal A: 47 °C.
3 h 38 min		A: ignition point at the upper part of the seal, then piercing, appearance of the oven. <u>End of heat insulation of seal A, width 40.</u> Gaseous releases, pilot flame test: no flaming.
3 h 49 min		A: second piercing below the first. Gaseous releases, pilot flame test: no flaming.
3 h 50 min		A: gaseous releases at the piercings. Pilot flame test: no flaming.
3 h 52 min		A: third piercing, the opening surface, letting the oven appear, is larger than 45 cm ² . <u>End of width 40 seal A's flame penetration and hot gas containment.</u>
3 h 58 min		Measurements recorded with the aid of the mobile thermocouple at the upper extremity, seals B, C and D: 36 °C.
3 h 59 min		A: The upper quarter of the seal is entirely destroyed. The seal consumes itself and the destroyed zone is extending downward. The flaming is not considerable (candle).
4 h 06 min		Measurements recorded with the aid of the mobile thermocouple at the upper extremity, seals B, C and D: 36 °C.

TIME	EXPOSED FACE	NON-EXPOSED FACE
4 h 15 min		Measurements recorded with the aid of the mobile thermocouple at the upper extremity, seals C and D: 37 °C.
4 h 20 min		<i>Installation of a wool panel by CSTB employees to seal off the opening of seal A.</i>
4 h 25 min		Measurements recorded with the aid of the mobile thermocouple at the upper extremity, seals C and D: 37 °C.
4 h 30 min		B: at the bottom part, appearance of a slightly brown stain.
4 h 43 min		Measurements recorded with the aid of the mobile thermocouple at the upper extremity, seals B, C and D: 36 °C.
4 h 50 min		B: at the upper part, appearance of a brown stain.
4 h 51 min		B: ignition point at the upper part of the seal, then piercing and flaming. <u>End of the heat insulation and of the flame penetration and hot gas containment of seal B, width 30.</u>
4 h 16 min		Measurements recorded with the aid of the mobile thermocouple at the upper extremity, seals B, C and D: 41 °C.
5 h 20 min		B: destruction of the upper 1/7 of the seal.
5 h 50 min		Measurements recorded with the aid of the mobile thermocouple at the upper extremity, seal C: 48 °C and D: 50 °C.
6 h 00 min	<u>TEST IS STOPPED</u>	

The temperature sensing with the aid of a mobile thermocouple makes it possible to indicate the heat insulation of seals B and C until the end of the test.

- See the photos taken during the test, Plates no. 11 to 18 -

6.1 – After test and cooling**Face exposed to the fire**

- *Seal D, width 10*: the joint aperture is completely reclosed with the concrete deformations.
- *Seal C, width 20*: the two vertical edges are warped toward the inside of the prebuilt aperture. This is reduced to a width of 7 halfway up and to 13 at the extremities. Over the whole surface, there remains a seal thickness of 35 on the exposed face side.
- *Seal B, width 30*: the two vertical edges are warped toward the inside of the prebuilt aperture. This is reduced to a width of 20 halfway up. On the lower half, there remains a seal thickness of 30 on the non-exposed face side.
- *Seal A, width 40*: the two vertical edges are warped toward the inside of the prebuilt aperture. This is reduced to a width of 24 halfway up. Total destruction of the seal.

Face not exposed to the fire

- *Seal D, width 10*: flexible and brown colour.
- *Seal C, width 20*: flexible and brown colour with a black stain at each extremity.
- *Seal B, width 30*: destruction covering 750 at the upper part and at the lower quarter. The remainder is flexible and brown.
- The apertures have widths identical to the initial dimensions.

• See the photos taken after the test, Plates no. 18 to 20 -

7 - CONCLUSIONS**7.1 - Seal A of 40 mm****7.1.1 - Flame penetration and hot or flammable gas containment**

Duration	232 minutes
Cause of limitation	Opening > 45 cm ²

7.1.2 - Heat insulation

Duration	218 minutes
Cause of limitation	Ignition point

7.2 - Seal B of 30 mm**7.2.1 - Flame penetration and hot or flammable gas containment**

Duration	291 minutes
Cause of limitation	Opening > 45 cm ²

7.2.2 - Heat insulation

Duration	291 minutes
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Cause of limitation Ignition point

7.3 - Seal C of 20 mm

7.3.1 - Flame penetration and hot or flammable gas containment

Duration 360 minutes
Cause of limitation Test is stopped

7.3.2 - Heat insulation

Duration 360 minutes
Cause of limitation Test is stopped

7.4 - Seal D of 40 mm

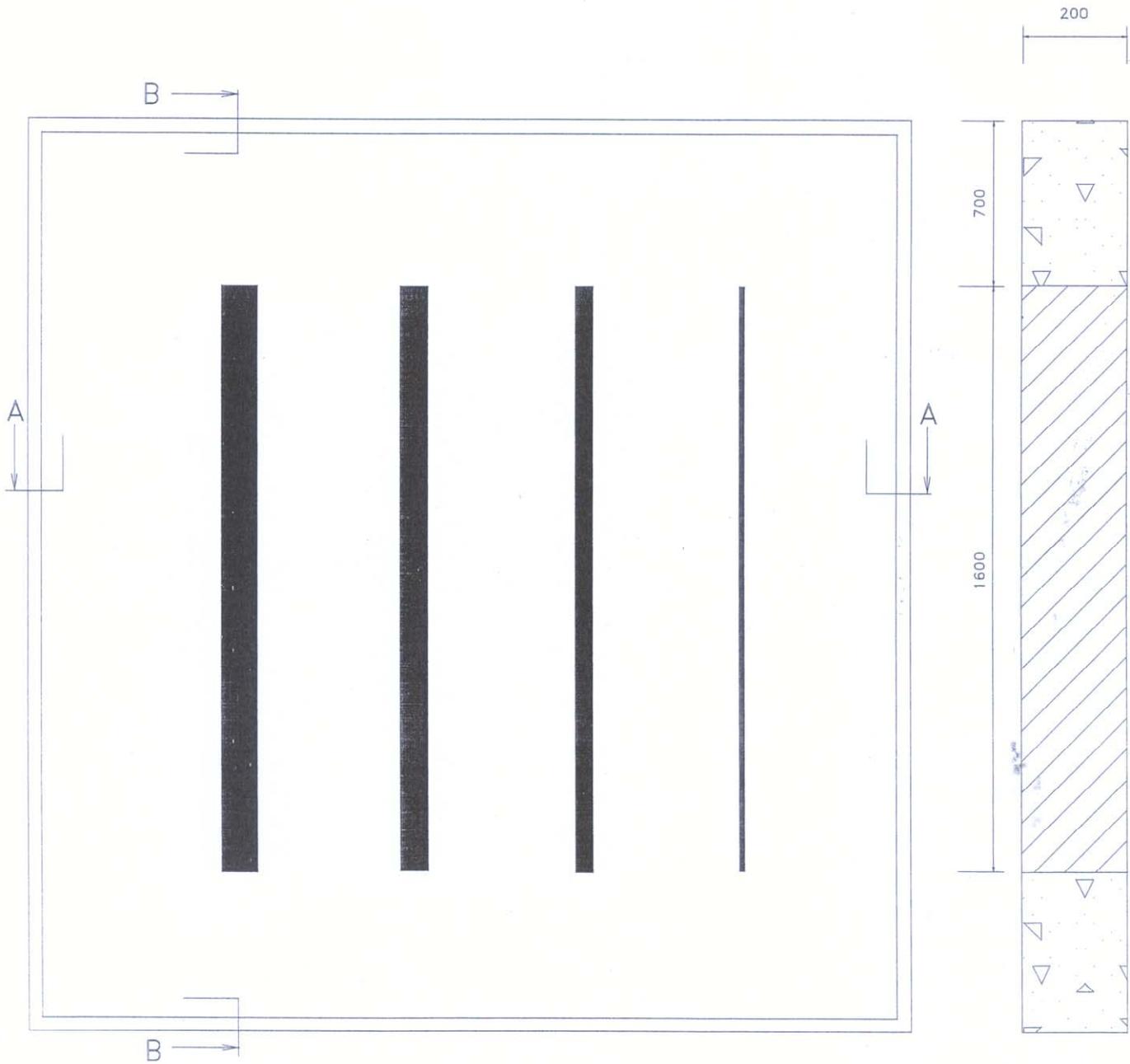
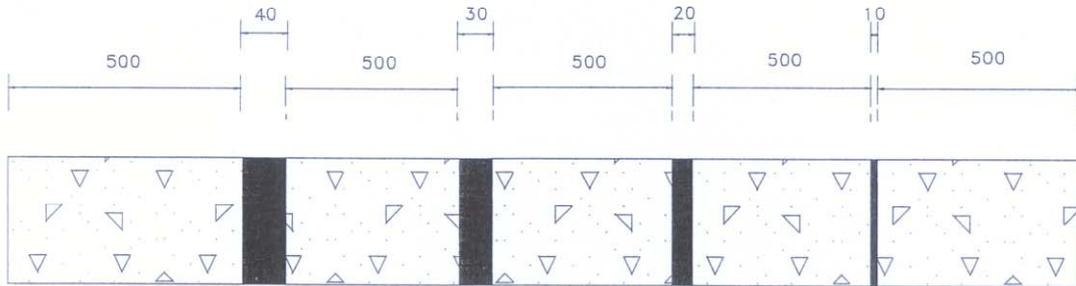
7.4.1 - Flame penetration and hot or flammable gas containment

Duration 360 minutes
Cause of limitation Test is stopped

7.4.2 - Heat insulation

Duration 360 minutes
Cause of limitation Test is stopped

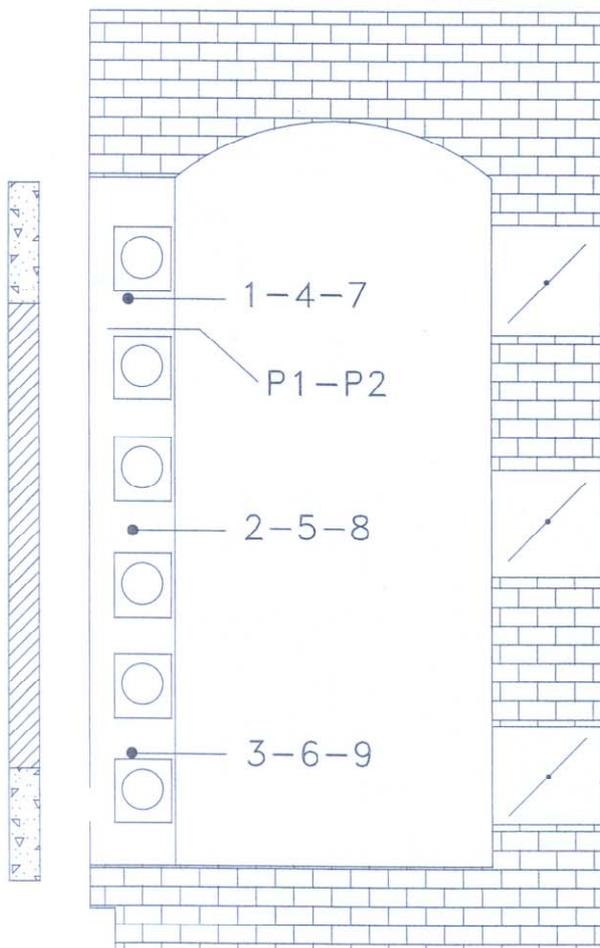
Section A - A



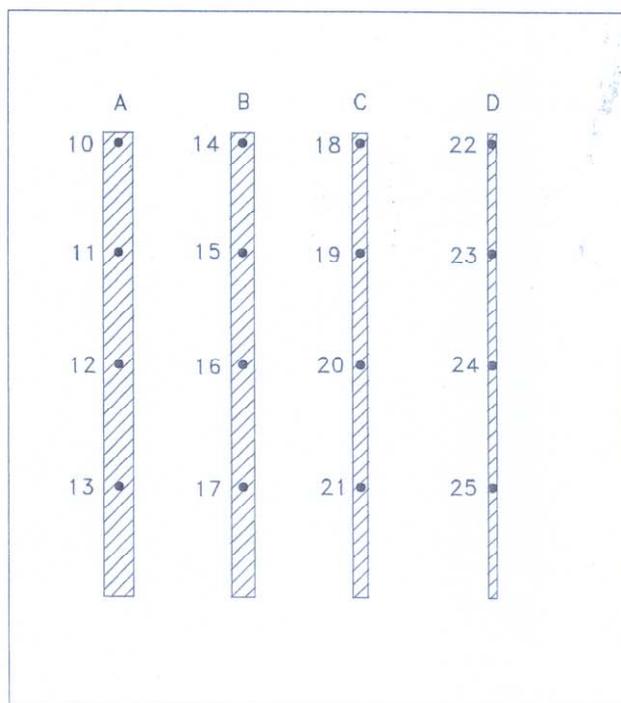
POSITIONS OF THE TEMPERATURE AND PRESSURE SENSORS

- 1 to 9 : Oven temperature, 100 mm from the exposed face
- 10 to 13 : Temperature of the non-exposed face of seal A, 40 mm
- 14 to 17 : Temperature of the non-exposed face of seal B, 30 mm
- 18 to 21 : Temperature of the non-exposed face of seal C, 20 mm
- 22 to 25 : Temperature of the non-exposed face of seal D, 10 mm
- P1 – P2 : Pressure sensors

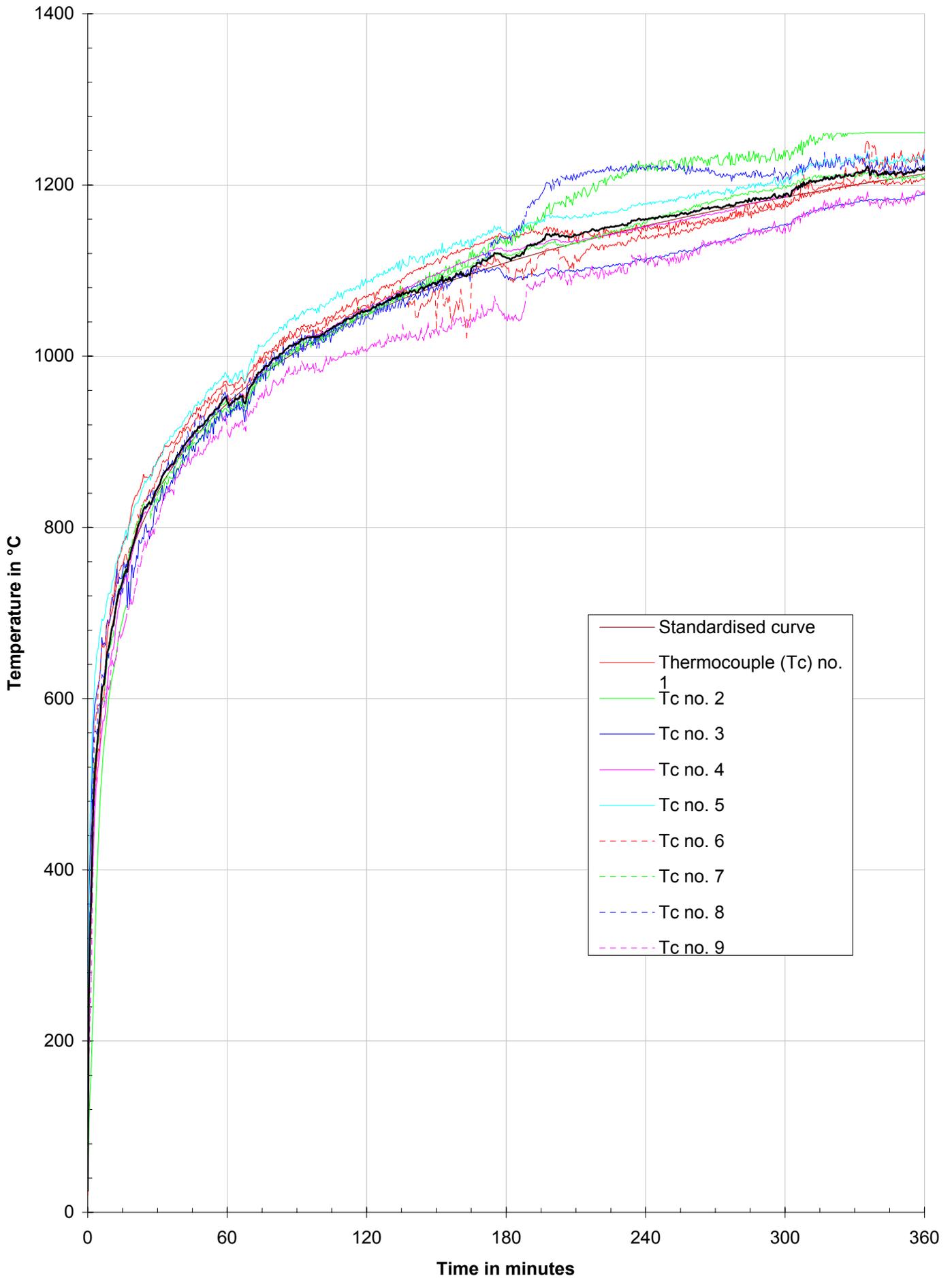
SECTION OF THE OVEN



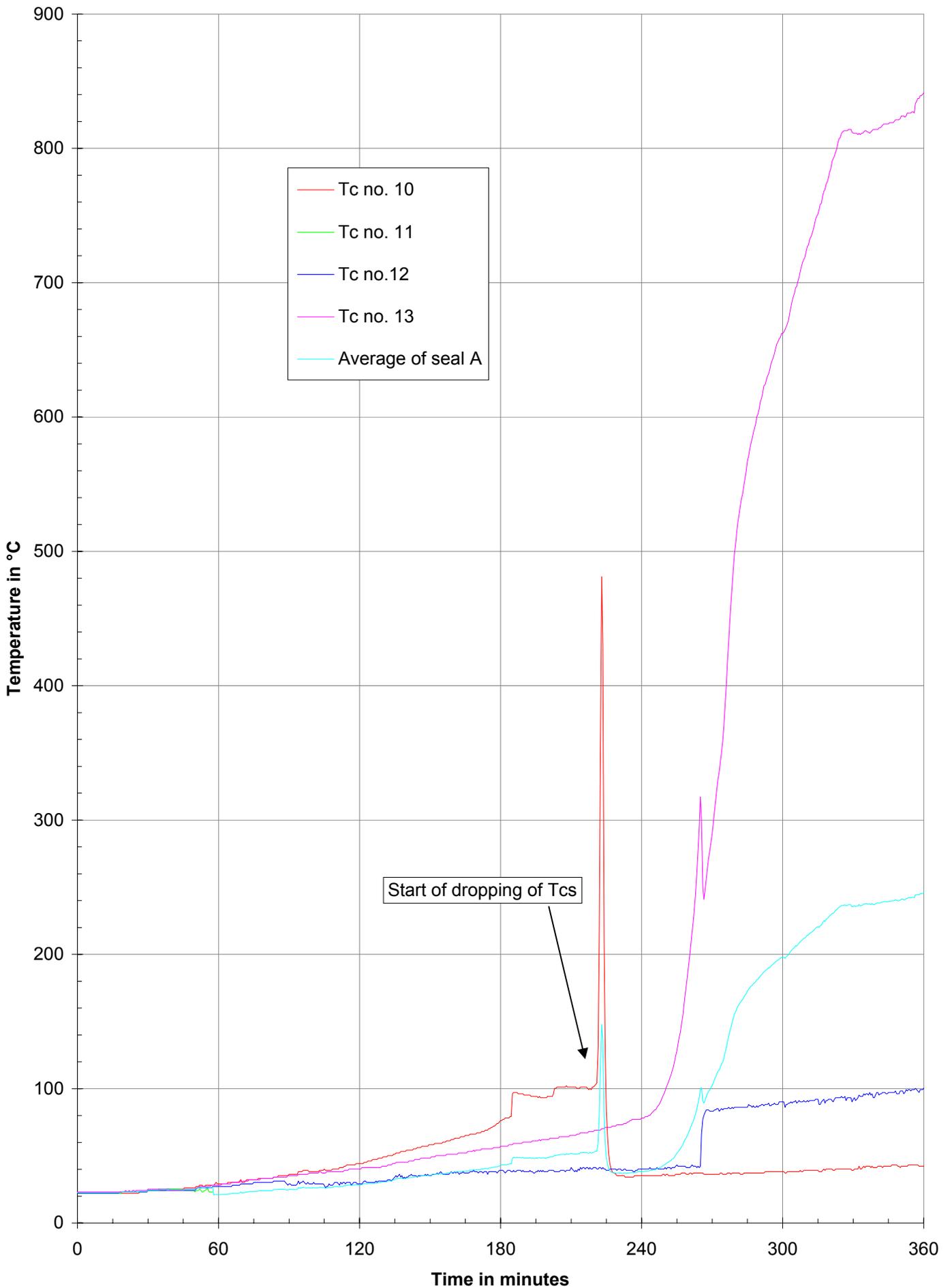
NON-EXPOSED FACE



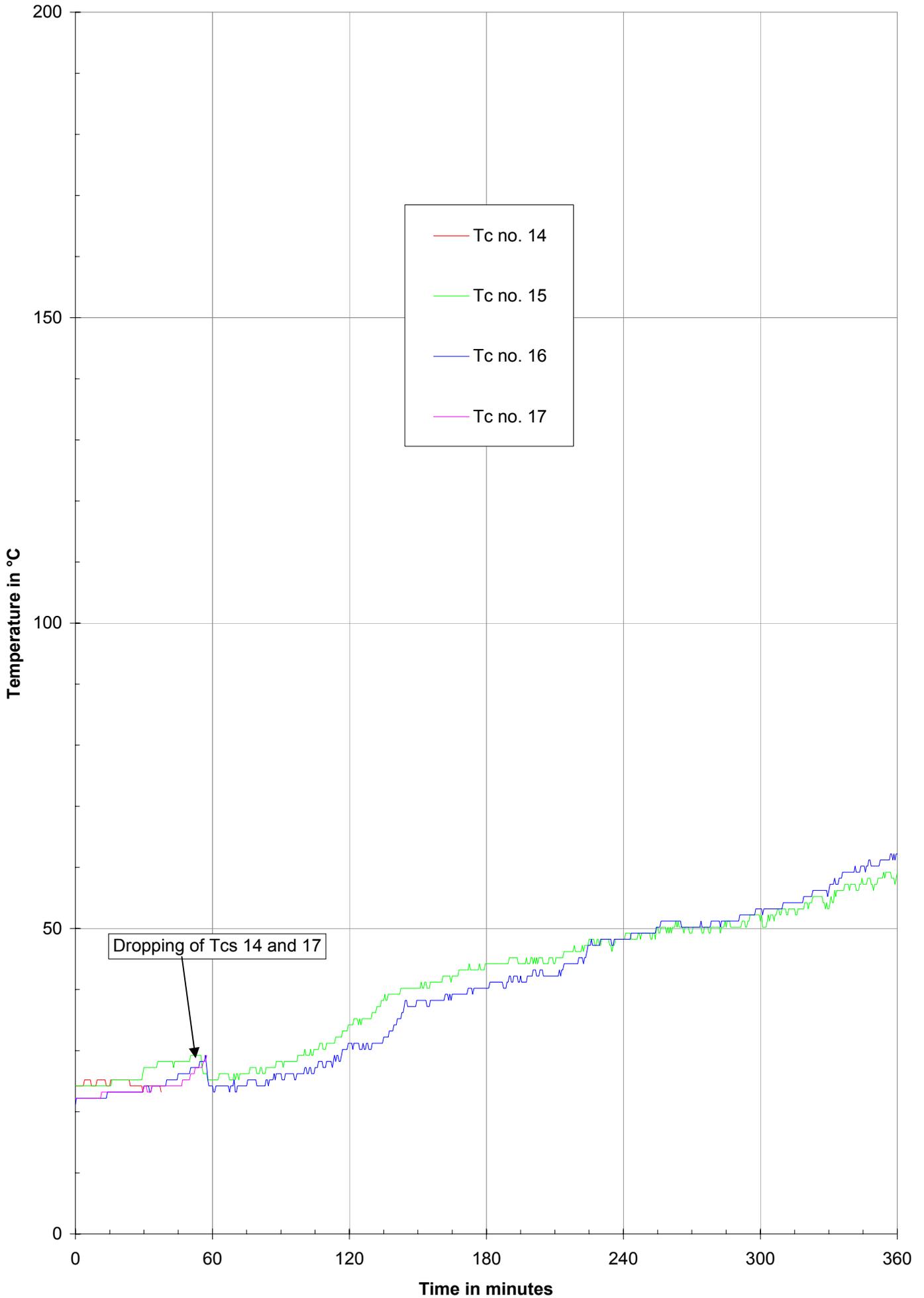
OVEN OPERATION



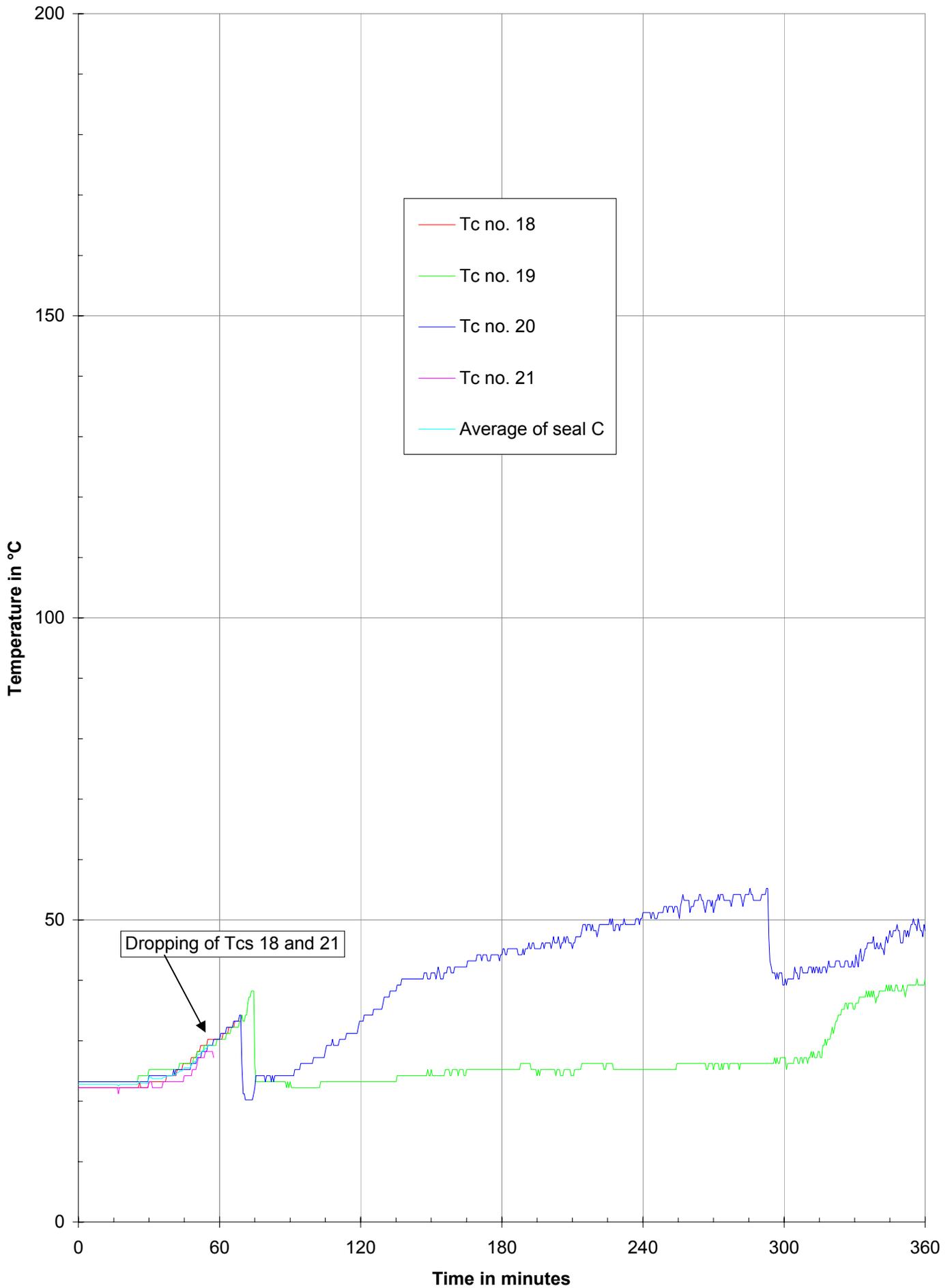
AVERAGE HEATING UP OF SEAL A - 40 mm



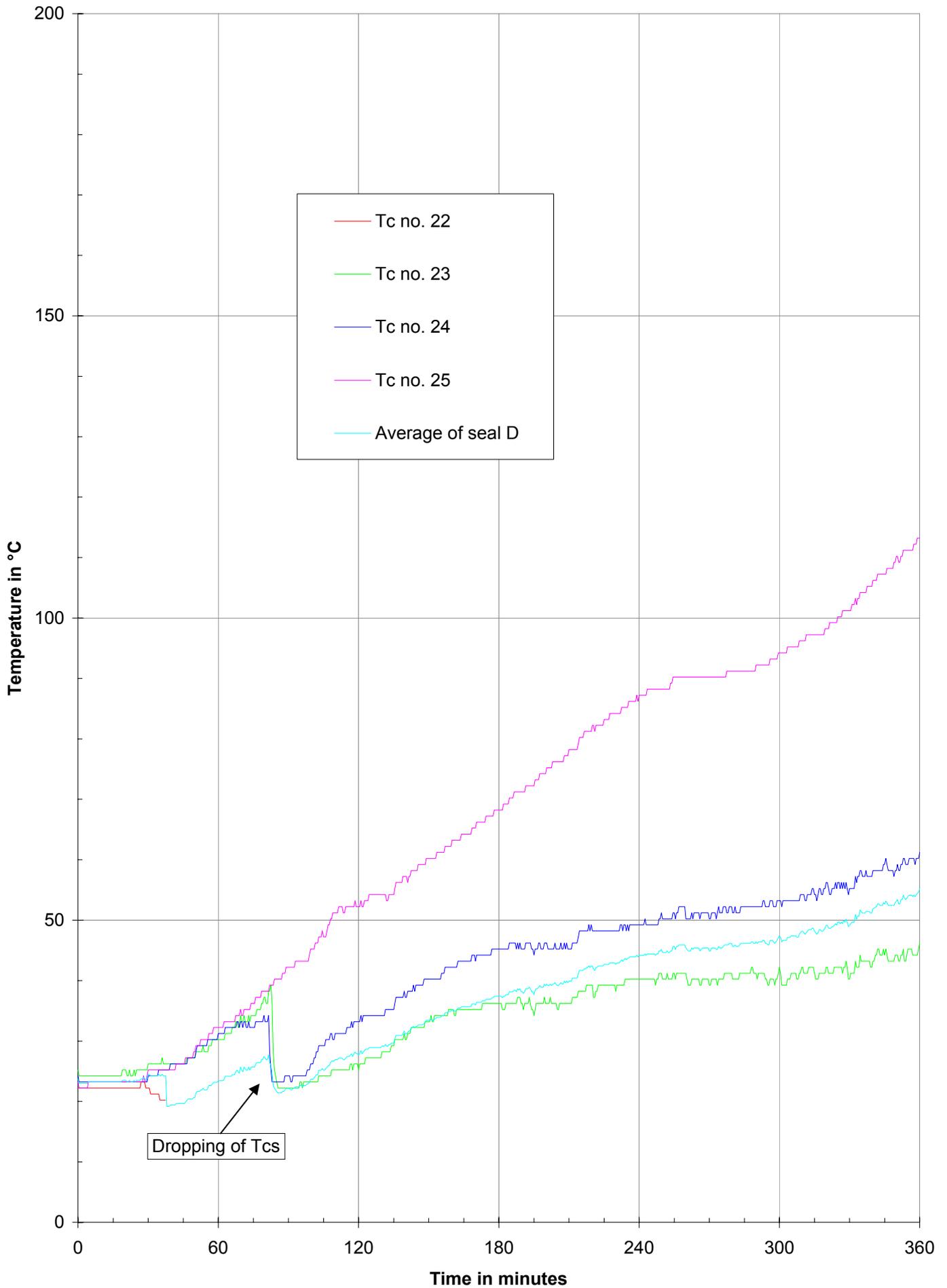
AVERAGE HEATING UP OF SEAL B - 30 mm



AVERAGE HEATING UP OF SEAL C - 20 mm



AVERAGE HEATING UP OF SEAL D - 10 mm



PRESSURE AT THE UPPER PART OF THE ELEMENTS

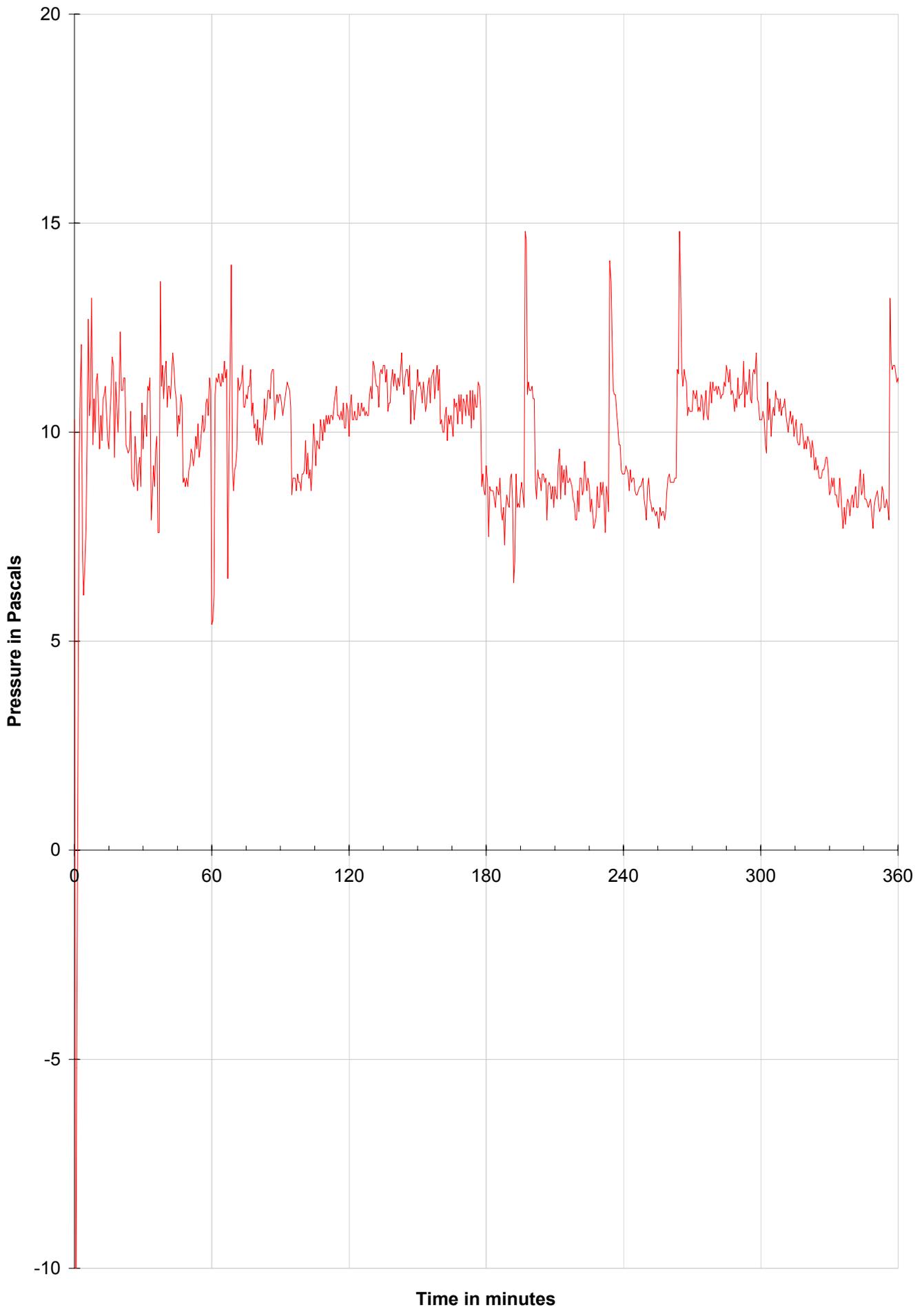




Photo overall of the vertical wall and dampening of the apertures



Photo of the face exposed to fire after elimination of the surplus and bringing the seals flush

PHOTOS TAKEN AFTER TEST



Seal inserted to repletion

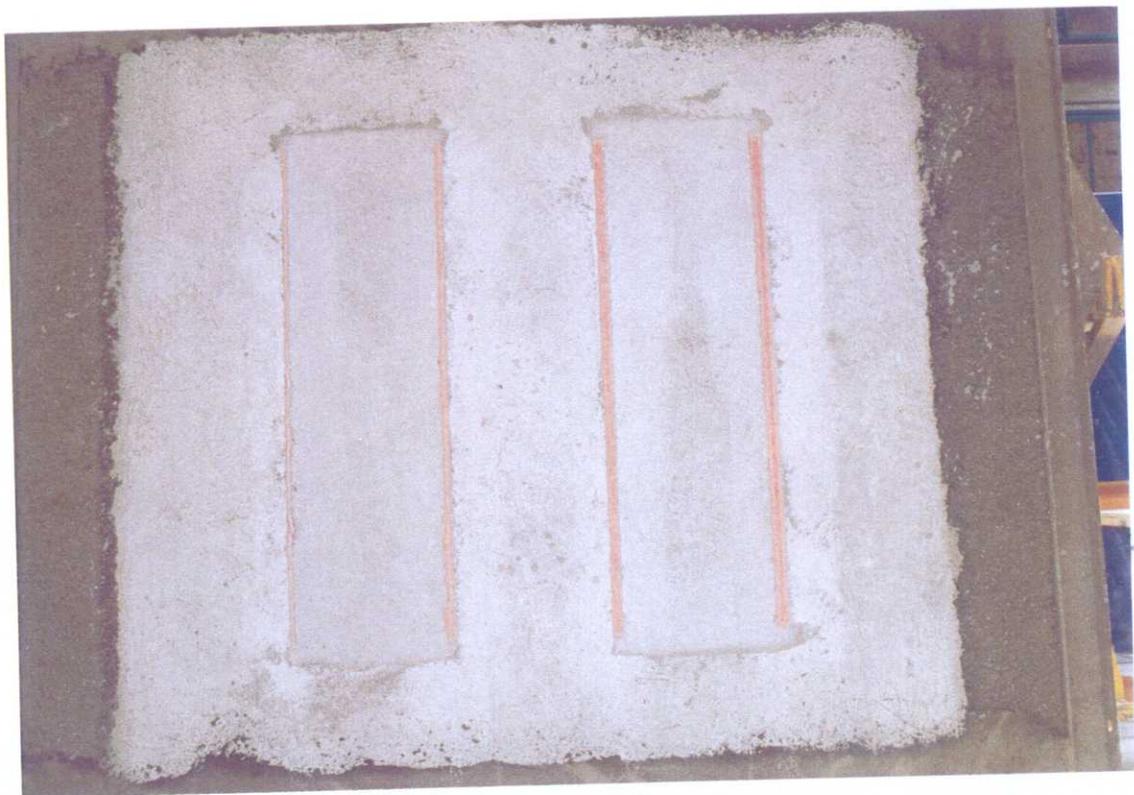


Photo of the face exposed to the fire after elimination of the surplus and bringing the seals flush

PHOTOS TAKEN AFTER TEST



Photo of the face not exposed to the fire at the beginning of the test

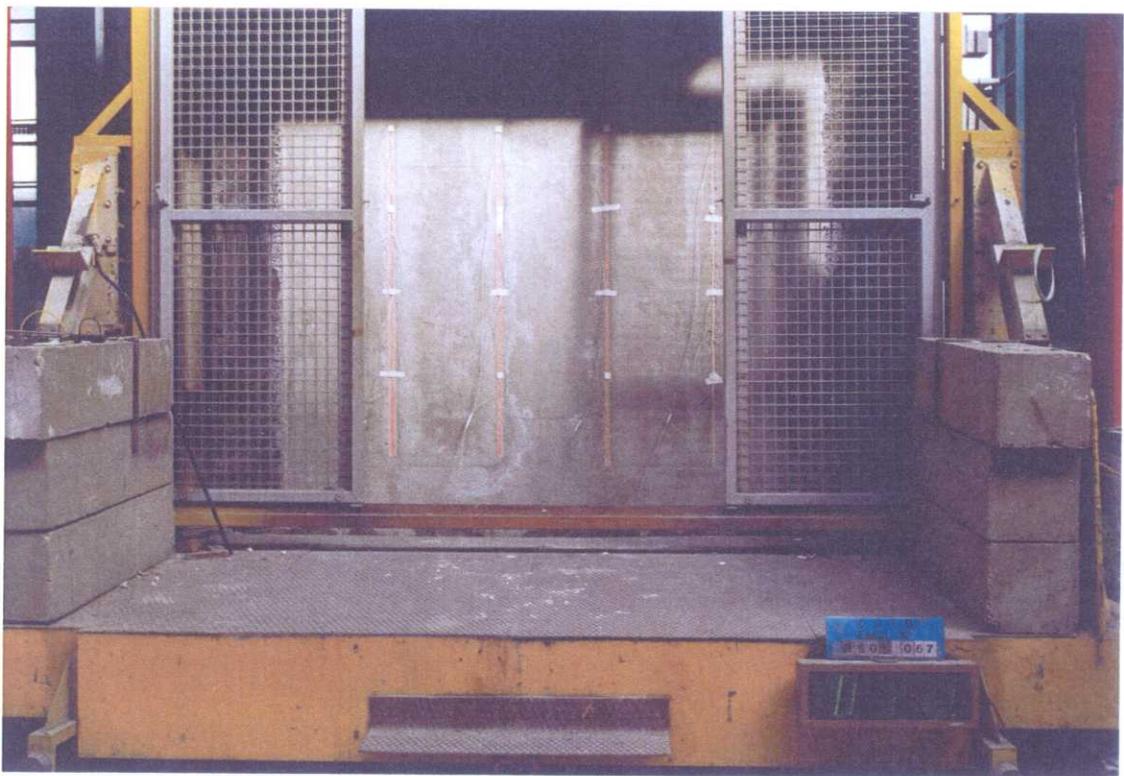


Photo of the face not exposed to the fire at 15 minutes of the test

PHOTOS TAKEN DURING THE TEST



Photo of the face not exposed to the fire at 1 h of the test

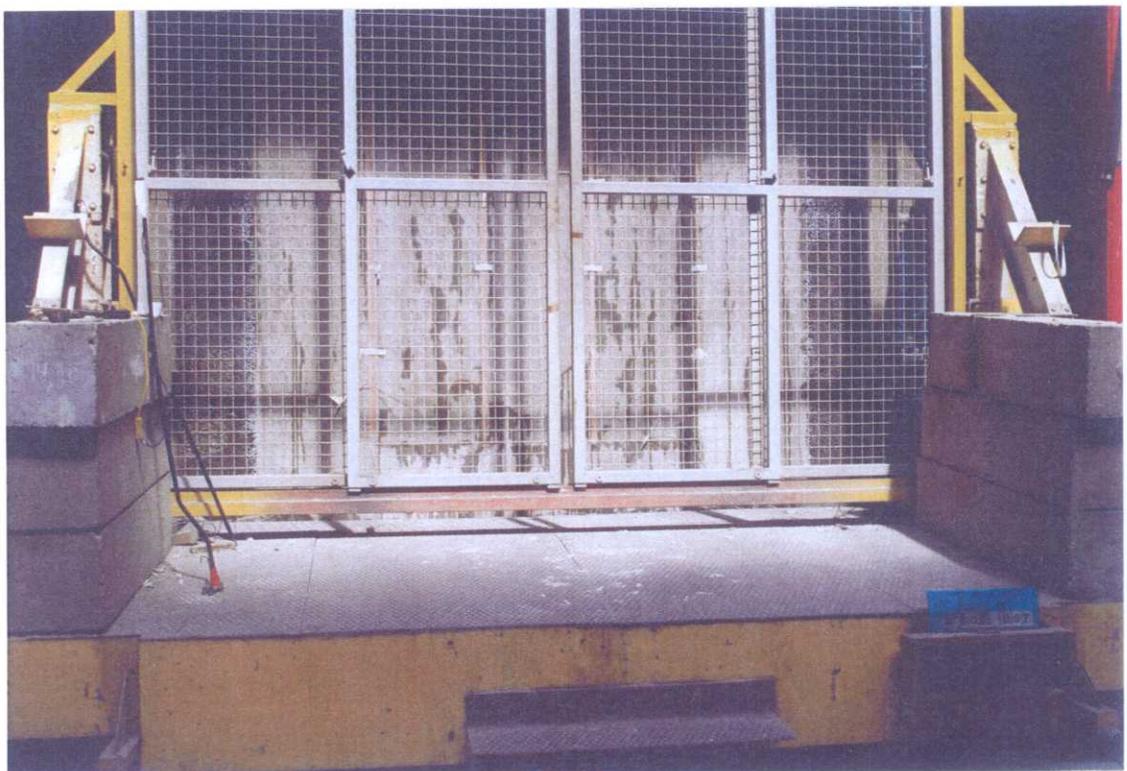


Photo of the face not exposed to the fire at 2 h of the test

PHOTOS TAKEN DURING THE TEST



Detail of seal A, 40 mm, and seal B, 30 mm, at 2 h of test

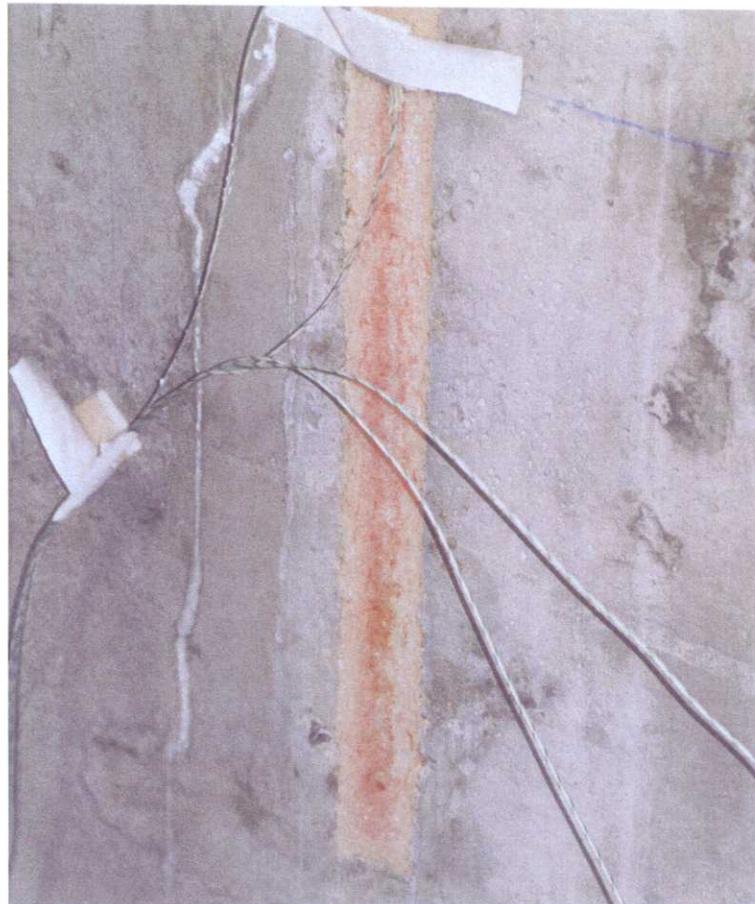


Detail of seal C, 20 mm, and seal D, 10 mm, at 2 h of test

PHOTOS TAKEN DURING THE TEST



Photo of the face not exposed to the fire at 3 h of test



Detail of the brown stain at the lower part of seal A, 40 mm, at 3 h and 30 min. of test

PHOTOS TAKEN DURING THE TEST



Detail of the beginning of piercing at the upper part of seal A, 40 mm, at 3 h and 38 min. of test



Detail of the opening at the upper part of seal A, 40 mm, at 3 h and 43 min. of test

PHOTOS TAKEN DURING THE TEST



Photo of the face not exposed to the fire at 4 h of test



Detail of the beginning of piercing at the upper part of seal B, 30 mm, at 4 h and 51 min. of test

PHOTOS TAKEN DURING THE TEST



Photo of the face not exposed to the fire at 5 h of test



Photo of the face not exposed to fire at 6 h of test

PHOTOS TAKEN DURING THE TEST



Photo of the face not exposed to the fire at 6 h of test; the test is stopped

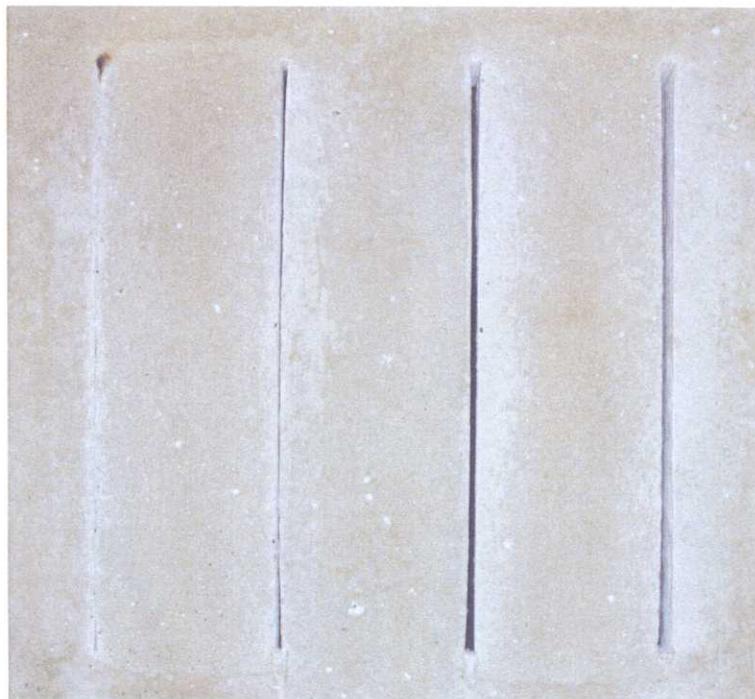


Photo of the face exposed to the fire

PHOTOS TAKEN AT THE END OF TEST AND AFTER TEST

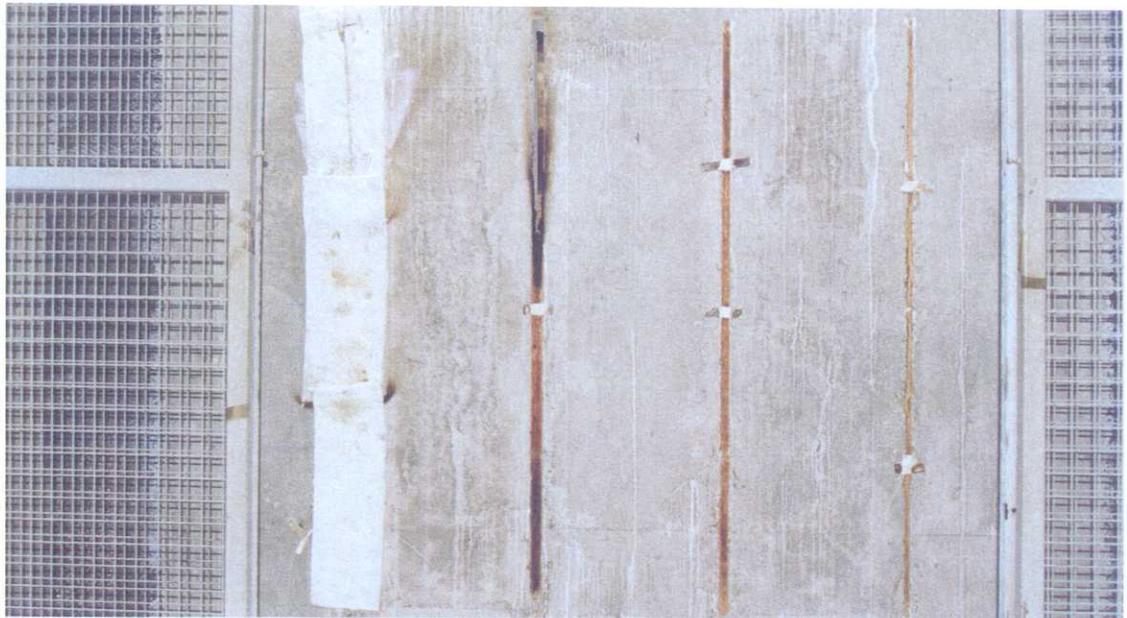
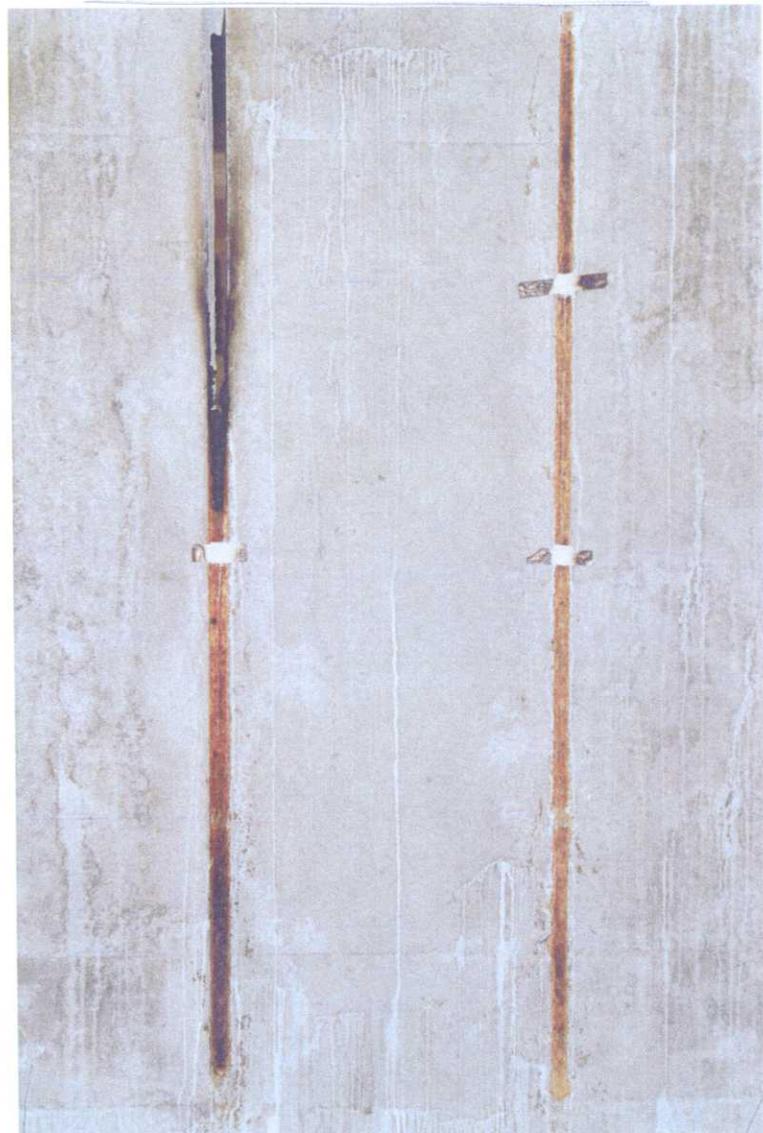
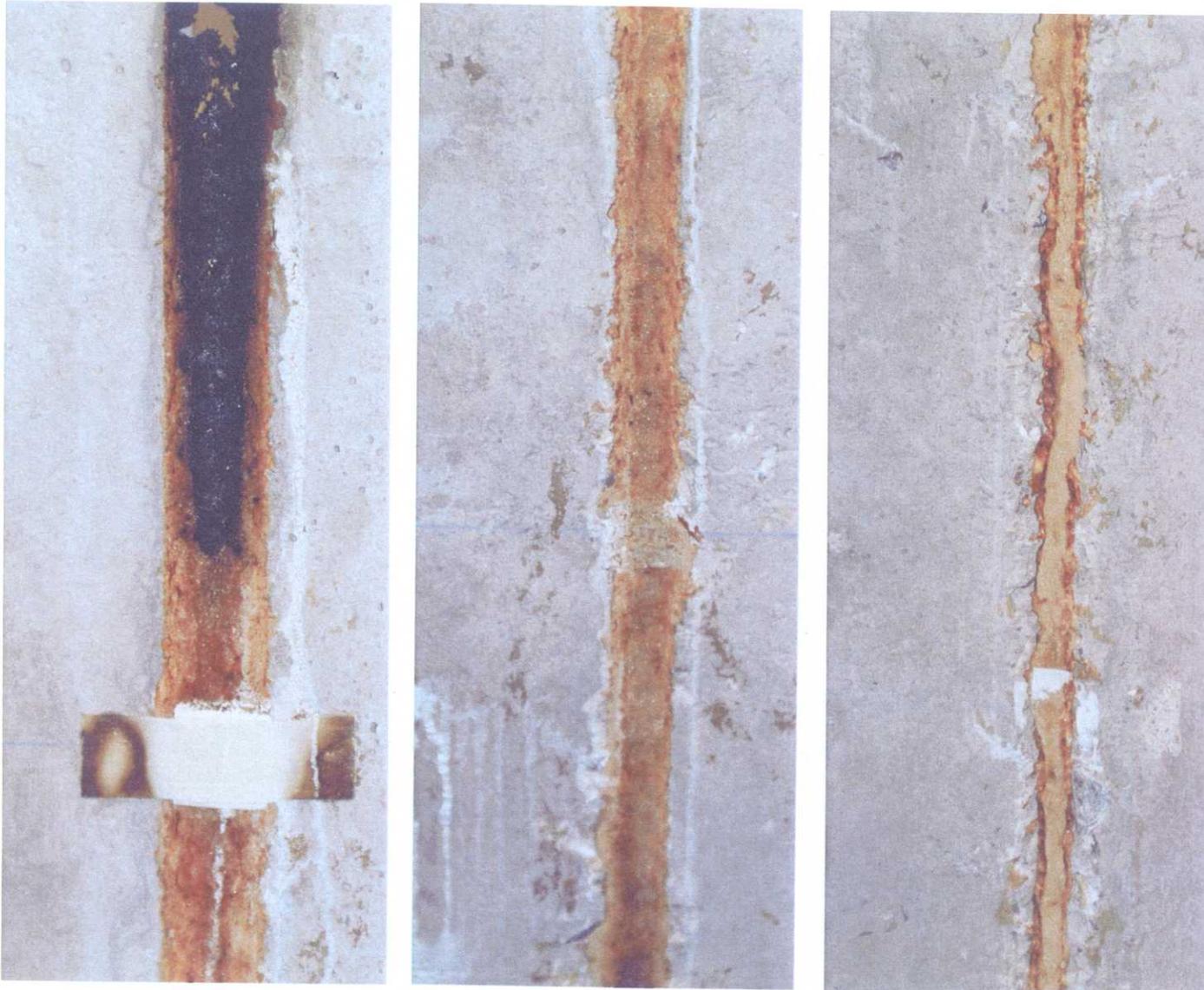


Photo of the face not exposed to the fire



Detail of seals C and D, 20 and 10 mm

PHOTOS TAKEN AFTER TEST



Detail of seals B, C and D, 30, 20 and 10 mm

PHOTOS TAKEN AFTER TEST