

**TEST REPORT No. RS03-007/A**

**CONCERNING THE FIRE RESISTANCE**

**OF A BUILDING ELEMENT**

This Test Report attests only to the characteristics of the items submitted for testing and does not prejudge the characteristics of similar products. So it does not constitute a certification of products in the sense of Article L 115-27 of the Consumer Code and of the Law of June 3, 1994.

Only integral reproduction of this Test Report is authorised.

It comprises 21 pages and 27 miscellaneous plates (photos, drawings, graphics).

**REQUESTER:**

**SOCIETE SOUDAL NV**  
**EVERDONGENLAAN 18-20**  
**B-2300 TURNHOUT**  
**BELGIUM**

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**

**SUBJECT**

Test of fire behaviour of vertical expansion joints and 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 and integrity under the effects of flames and hot or flammable gases in the sense of the Decree.

**TEST DATE**

March 14, 2003.

**SOURCE AND CHARACTERISTICS OF THE TEST PIECES**

Material presented by : Société SOUDAL  
Trademark : « FIRECRYL FR », « FIRESILICONE B1 FR » AND « SOUDASEAL FR »  
Manufacturer : Société SOUDAL  
Source : TURNHOUT factory (Belgium)

Made at Marne-la-Vallée, May 22, 2003

Technician responsible for the test

Head of the  
"Fire Resistance" Laboratory

Karine JACQUEMET

Christophe LEMERLE

**1 - DESCRIPTION OF THE ELEMENT**

(The dimensions are given in mm)

**1.1 - Description of the test structure**

Eleven vertical joints, installed in a vertical concrete wall:

- Height of the joints: 2500,
- Width of the joints: 10, 20 and 30.

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

DESIGNATION	REFERENCE	MATERIAL	CHARACTERISTICS	SUPPLIER
Seals	FIRECRYL FR	With an acrylic dispersion base	Density: 1400 kg/m <sup>3</sup>	SOUDAL (BELGIUM)
	FIRESILICONE B1 FR	With a silicone base	Density: 1170 kg/m <sup>3</sup>	SOUDAL (BELGIUM)
	SOUDASEAL FR	With an MS polymer base	Density: 1450 kg/m <sup>3</sup>	SOUDAL (BELGIUM)
Seal back		Polyurethane	Ø 30, 40, 50	GORINCHEM (THE NETHERLANDS)
Primer	PRIMAIRE 150	With a polyurethane base	Density: 930 kg/m <sup>3</sup> Drying: 60 minutes	SOUDAL (BELGIUM)
	FIRECRYL PRIMAIRE		20% FIRECRYL and 80% water	SOUDAL (BELGIUM)

**1.3 - Description**

**1.3.1 - Concrete test specimen**

The wall contains eleven grooves (representing joints), including six with lengths 10, 20 and 30 with a thickness of 150 and five with lengths 10, 20 and 30 with a thickness of 200, for the installation of the seals in a joint, height 2500.

**1.3.2 - Seals**

Before installation, the grooves are brushed and dusted out.

On the exposed face and on the non-exposed face, seal backings of polyurethane are positioned at the back of the groove:

- Ø 30 for seals with width 10. A clearance of 10 is left between the back of the seal and the surface of the concrete wall.
- Ø 40 for seals with width 20. A clearance of 20 is left between the back of the seal and the surface of the concrete wall.

- Ø 50 for seals with width 30. A clearance of 30 is left between the back of the seal and the surface of the concrete wall.

On the wall of the grooves and on the backs of the seal a primer is applied, which requires one hour of drying before installing the seals:

- PRIMER 150 from SOUDAL for the FIRESILICONE B1 FR and SOUDASEAL FR seals.
- FIRECRYL PRIMER from SOUDAL for the FIRECRYL FR seals.

The seals are then positioned in the following way:

- Seal A, width 30, wall thickness 150: SOUDASEAL FR.
- Seal B, width 10, wall thickness 150: SOUDASEAL FR.
- Seal C, width 30, wall thickness 150: FIRESILICONE B1 FR.
- Seal D, width 10, wall thickness 150: FIRESILICONE B1 FR.
- Seal E, width 20, wall thickness 150: FIRECRYL FR.
- Seal F, width 10, wall thickness 150: FIRECRYL FR.
- Seal G, width 10, wall thickness 200: SOUDASEAL FR.
- Seal H, width 30, wall thickness 200: FIRESILICONE B1 FR.
- Seal I, width 10, wall thickness 200: FIRESILICONE B1 FR.
- Seal J, width 20, wall thickness 200: FIRECRYL FR.
- Seal K, width 10, wall thickness 200: FIRECRYL FR.

The excess is removed and trimmed flush.

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

## **2 - TEST SET-UP**

The seals were installed by specialists from Société SOUDAL, in a vertical concrete wall, thickness 150 and 200, masonry work by CSTB.

- *See the photos taken during the set-up, Plates no. 2 and 3 -*

## **3 - TEST PROCEDURES**

### **3.1 - Direction of the fire**

Either way.

**3.2 - Thermal programme**

The thermal programme followed is represented by the following function:

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

giving the oven's temperature rise above ambient temperature in Celsius degrees, as a function of time in minutes.

**4 - MEASUREMENTS PERFORMED DURING THE FIRE RESISTANCE TEST**

**4.1 - Oven temperatures**

Positions and identification marks of temperature probes are indicated on Plate no. 4.

The temperatures are measured with the aid of nine thermocouples and recorded during the test in compliance with Chapter 2 of Appendix XI of the Decree of August 3, 1999.

- See the records, Plate no. 6 -

**4.2 - Temperatures of the element**

Positions and identification markers of the temperature probes are indicated on Plate no. 5.

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

- See the records, Plates no. 7 to 17 -

**4.3 - Pressure in the oven**

Over its whole surface including its periphery, the test element is subjected to a pressure difference between the inside and the outside of the oven of  $20 \pm 5$  Pa at the top part of the element.

- See the record, Plate no. 18 -

**5 - OBSERVATIONS**

**5.1 - During the test**

**5.1.1 - Seal A of 30 mm: SOUDASEAL FR**

TIME IN H, MIN, S	EXPOSED FACE	NON-EXPOSED FACE
0 h 00 min	Start of the test – Initial temperature: 12° C.	
0 h 06 min	Blackening at the periphery of the seal.	
0 h 29 min 30 s	Brown blotches.	

TIME IN H, MIN, S	EXPOSED FACE	NON-EXPOSED FACE
1 h 48 min	Slight shrinkage of seal from the support wall.	
1 h 51 min		Expansion of the seal through its full height.
2 h 46 min		Releases of smoke half-way up. Test of the pilot flame: no flaming.
3 h 02 min		Melted dribble of the seal at the upper extremity.
3 h 14 min		Release of smoke with colouring of the seal through its full height.
3 h 15 min		Opening on the oven less than 45 cm <sup>2</sup> at the upper end.
3 h 23 min	No notable evolution.	Browning of the seal.
3 h 27 min		Cotton test at the opening on the oven, negative.
3 h 38 min		Melted dribble of the seal at the upper part.
3 h 43 min		Detachment of the excess of the expanded seal, from the concrete at thermocouple no. 11 on 200. Cotton test at the opening on the oven: negative.
3 h 46 min		Pilot flame test at the smoke releases: no flaming.
3 h 52 min		Cotton test at thermocouple no. 11: negative.
4 h 11 min		Cotton test at the opening on the oven: negative.
4 h 23 min		Pilot flame test at the opening: no flaming.
4 h 26 min		Detachment of the excess of the expanded seal from the support wall between thermocouples no. 10 and 11.
4 h 30 min 30 s		Temperature rise greater than 180° C, recorded by thermocouple no. 12. <b>END OF THE THERMAL INSULATION.</b>

TIME IN H, MIN, S	EXPOSED FACE	NON-EXPOSED FACE
4 h 32 min		Releases of smoke at the dislocation detected at 4 h 26 min. Test of pilot flame: no flaming.
4 h 34 min	No notable evolution.	Cotton test at the opening on the oven: negative.
5 h 10 min		Cotton test at the opening on the oven: negative.
5 h 17 min		Cotton test at the opening on the oven: negative.
5 h 22 min		Cotton test at the opening on the oven: negative.
5 h 26 min		Cotton test half-way up: negative.
<b>5 h 32 min</b>		Opening greater than 45 cm <sup>2</sup> half-way up. <b><u>END OF INTEGRITY UNDER THE EFFECTS OF FLAMES.</u></b>
6 h 00 min	<b><u>THE TEST IS STOPPED</u></b>	

### 5.1.2 - Seal B of 10 mm: SOUDASEAL FR

TIME IN H, MIN, S	EXPOSED FACE	NON-EXPOSED FACE
0 h 00 min	Start of the test – Initial temperature: 12° C.	
0 h 06 min	Blackening at the periphery of the seal.	
0 h 32 min	Cracking of the seal all the way up.	
0 h 44 min	Slight shrinkage of the seal from the substrate wall.	
3 h 23 min		Melted dribble of the seal at the upper extremity.
3 h 38 min		Charring of the seal at the upper part.
3 h 43 min		Browning of the seal at thermocouple no. 15.
3 h 46 min		Test of the pilot flame at the smoke releases: no flaming.

TIME IN H, MIN, S	EXPOSED FACE	NON-EXPOSED FACE
3 h 52 min		Charring of the seal over 150 at the upper part.
4 h 06 min		Blackening at the periphery of the seal at thermocouple no. 15.
5 h 10 min	Closing of the groove because of concrete deformation.	
5 h 35 min		Test of the pilot flame at the smoke releases: no flaming.
6 h 00 min	<b><u>THE TEST IS STOPPED.</u></b>	

**5.1.3 - Joint C of 30 mm: FIRESILICONE B1 FR**

TIME IN H, MIN, S	EXPOSED FACE	NON-EXPOSED FACE
0 h 00 min	Start of the test – Initial temperature: 12° C.	
0 h 17 min	Flaming of the seal.	
0 h 29 min 30 s	Complete destruction of the seal.	
1 h 37 min		Measurement recorded with the aid of the mobile thermocouple, half-way up: 75° C.
1 h 45 min		Measurement recorded with the aid of the mobile thermocouple at the upper extremity: 60° C.
1 h 51 min		Measurement recorded with the aid of the mobile thermocouple, half-way up: 86° C.
2 h 10 min		Measurement recorded with the aid of the mobile thermocouple half-way up: 95° C.
2 h 15 min		Measurement recorded with the aid of the mobile thermocouple at the upper extremity: 119° C.
2 h 20 min		Expansion of the seal all the way up.
2 h 28 min		Measurement recorded with the aid of the mobile thermocouple at the upper extremity: 118° C.



TIME IN H, MIN, S	EXPOSED FACE	NON-EXPOSED FACE
3 h 02 min		Measurement recorded with the aid of the mobile thermocouple half-way up: 96° C.
3 h 30 min		Measurement recorded with the aid of the mobile thermocouple at the upper extremity: 151° C.
4 h 32 min	No notable evolution.	Releases of smoke at specific points. Test of the pilot flame: no flaming.
5 h 35 min		Test of the pilot flame at the smoke releases: no flaming.
6 h 00 min	<b><u>THE TEST IS STOPPED.</u></b>	

**5.1.4 - Seal D of 10 mm: FIRESILICONE B1 FR**

TIME IN H, MIN, S	EXPOSED FACE	NON-EXPOSED FACE
0 h 00 min	Start of the test – Initial temperature: 12° C.	
0 h 29 min 30 s	Browning at specific points.	
1 h 48 min	Destruction of the seal half-way up over 50 to 100.	
4 h 11 min 30 s		Temperature rise greater than 180° C detected by thermocouple no. 22. <b><u>END OF THE HEAT INSULATION.</u></b>
5 h 10 min	Closing of the groove because of deformations of the concrete.	
6 h 00 min	<b><u>THE TEST IS STOPPED.</u></b>	

**5.1.5 - Seal E of 20 mm: FIRECRYL FR**

TIME IN H, MIN, S	EXPOSED FACE	NON-EXPOSED FACE
0 h 00 min	Start of the test – Initial temperature: 12° C.	
0 h 29 min 30 s	Browning at specific points.	
0 h 40 min		Cracking half-way up.

TIME IN H, MIN, S	EXPOSED FACE	NON-EXPOSED FACE
0 h 44 min	Slight shrinkage of the seal from the substrate wall.	
1 h 27 min		Cracking at thermocouple at no. 28.
1 h 51 min		Expansion of the joint at the upper extremity with slight colouring of the seal.
2 h 20 min		Expansion of the seal at the upper extremity.
2 h 30 min		Cracking at the upper extremity over 150.
2 h 52 min		Charring at the upper extremity of the seal with releases of smoke.
2 h 58 min		Test of the pilot flame at the upper extremity: no flaming. Cotton test at the upper part: negative.
3 h 05 min		Opening on the lower oven at 45 cm <sup>2</sup> at the upper extremity.
3 h 21 min		Cotton test at the opening on the oven: negative.
3 h 23 min	No notable evolution.	Charring of the seal over 150 at the upper part.
3 h 43 min		Cotton test at the opening on the oven: negative.
3 h 46 min		Test of the pilot flame at the smoke releases: no flaming.
3 h 52 min		Charring of the seal over 250 at the upper part.
4 h 11 min		Cotton test at the opening on the oven: negative. Charring over 300 at the upper part.
4 h 23 min		Test of the pilot flame at the opening on the oven: no flaming. Cotton test at the opening on the oven: negative.
4 h 26 min		Charring of the seal over 350 at the upper part.

TIME IN H, MIN, S	EXPOSED FACE	NON-EXPOSED FACE
4 h 32 min		Smoke releases at specific points. Test of the pilot flame: no flaming.
4 h 38 min		Cotton test at the opening on the oven: negative.
4 h 49 min	No notable evolution.	Charring of the seal up to the height of thermocouple no. 27.
<b>4 h 58 min</b>		Cotton test at the opening on the oven: flaming of the cotton. <b><u>END OF THE INTEGRITY UNDER THE EFFECTS OF HOT GASES.</u></b>
6 h 00 min	<b><u>THE TEST IS STOPPED.</u></b>	

**5.1.6 - Seal F of 10 mm: FIRECRYL FR**

TIME IN H, MIN, S	EXPOSED FACE	NON-EXPOSED FACE
0 h 00 min	Start of the test – Initial temperature: 12° C.	
0 h 15 min		Cracking at thermocouples no. 31 and 33 with releases of smoke. Test of the pilot flame: no flaming.
0 h 28 min 30 s		Stoppage of smoke releases detected at 15 minutes of testing.
0 h 29 min 30 s	Browning at specific points.	
0 h 44 min	Slight shrinkage of the seal from the substrate wall.	
1 h 10 min		Slight colouring of the crack at thermocouple no. 33.
1 h 37 min	Start of the destruction of the seal half- way up.	
1 h 48 min	Destruction of the seal half-way up over 50 to 100.	
2 h 05 min	Destruction of the seal over two thirds of the height.	
2 h 20 min		Expansion of the seal at the upper extremity.

TIME IN H, MIN, S	EXPOSED FACE	NON-EXPOSED FACE
2 h 30 min		Cracking between thermocouples no. 30 and 31 and between thermocouples no. 32 and 33.
4 h 49 min		Melted dribble of seal over 150 at the upper part.
5 h 10 min	Closing of the groove because of deformations of the concrete.	
5 h 29 min		Cotton test at the upper extremity: negative.
5 h 35 min		Test of the pilot flame at the smoke releases: no flaming.
5 h 41 min		A hole has formed at the upper extremity less than 45 cm <sup>2</sup> .
5 h 45 min		Cotton test at the upper extremity of the seal: negative.
5 h 54 min		Cotton test at the hole: negative.
6 h 00 min	<b><u>THE TEST IS STOPPED.</u></b>	

**5.1.7 - Seal G of 10 mm: SOUDASEAL FR**

TIME IN H, MIN, S	EXPOSED FACE	NON-EXPOSED FACE
0 h 00 min	Start of the test – Initial temperature: 12° C.	
0 h 44 min	Slight shrinkage of the seal from the substrate wall.	
2 h 46 min	Closing of the groove half-way up because of the deformations of the concrete.	
6 h 00 min	<b><u>THE TEST IS STOPPED.</u></b>	

**5.1.8 - Seal H of 30 mm: FIRESILICONE B1 FR**

TIME IN H, MIN, S	EXPOSED FACE	NON-EXPOSED FACE
0 h 00 min	Start of the test – Initial temperature: 12° C.	
0 h 17 min	Cracking all the way up.	
0 h 29 min 30 s	Complete destruction of the seal.	
1 h 45 min		Measurement recorded with the aid of the mobile thermocouple half-way up: 64° C.
2 h 00		Measurement recorded with the aid of the mobile thermocouple half-way up: 76° C.
2 h 15 min		Measurement recorded with the aid of the mobile thermocouple at the upper extremity: 68° C.
2 h 28 min		Measurement recorded with the aid of the mobile thermocouple half-way up: 95° C.
5 h 35 min		Test of the pilot flame at the smoke releases: no flaming.
5 h 52 min		Detachment of the expanded seal from the substrate wall at thermocouple no. 39.
6 h 00 min	<b><u>THE TEST IS STOPPED.</u></b>	

**5.1.9 - Seal I of 10 mm: FIRESILICONE B1 FR**

TIME IN H, MIN, S	EXPOSED FACE	NON-EXPOSED FACE
0 h 00 min	Start of the test – Initial temperature: 12° C.	
0 h 17 min	Cracking all the way up.	
0 h 29 min 30 s	Browning at specific points.	
1 h 45 min		Measurement recorded with the aid of the mobile thermocouple half-way up: 60° C.
5 h 10 min	Closing of the groove because of deformations of the concrete.	
6 h 00 min	<b><u>THE TEST IS STOPPED.</u></b>	

**5.1.10 - Seal J of 20 mm: FIRECRYL FR**

TIME IN H, MIN, S	EXPOSED FACE	NON-EXPOSED FACE
0 h 00 min	Start of the test – Initial temperature: 12° C.	
0 h 06 min	Blackening at the periphery of the seal.	
0 h 20 min		Cracking at the upper extremity with releases of smoke. Test of the pilot flame: no flaming.
0 h 24 min		Stoppage of releases of smoke detected at 20 minutes of testing.
0 h 29 min 30 s	Browning at specific points.	
0 h 40 min		Cracking half-way up.
0 h 44 min	Slight shrinkage of the seal from the substrate wall.	
1 h 48 min	Destruction of the seal half-way up over 50 to 100.	
2 h 17 min	Destruction of the seal over one quarter of the height beginning at the centre.	
3 h 51 min	Destruction of the seal over the middle half.	

TIME IN H, MIN, S	EXPOSED FACE	NON-EXPOSED FACE
6 h 00 min	<b><u>THE TEST IS STOPPED.</u></b>	

**5.1.11 - Seal K of 10 mm: FIRECRYL FR**

TIME IN H, MIN, S	EXPOSED FACE	NON-EXPOSED FACE
0 h 00 min	Start of the test – Initial temperature: 12° C.	
0 h 06 min	Blackening at the periphery of the seal.	
0 h 20 min		Cracking at thermocouples no. 51, 52 and 53 with releases of smoke. Test of the pilot flame: no flaming.
0 h 29 min 30 s	Browning at specific points.	
0 h 44 min	Slight shrinkage of the seal from the substrate wall.	
0 h 59 min		Stoppage of releases of smoke detected at 20 minutes of testing.
2 h 30 min		Releases of smoke from the crack at thermocouple no. 51. Test of the pilot flame: no flaming.
3 h 38 min		Releases of smoke from the cracks. Test of the pilot flame: no flaming.
4 h 11 min		Colouring of the cracks at thermocouple no. 52 with releases of smoke. Test of the pilot flame: no flaming.
5 h 10 min	Closing of the groove because of deformations of the concrete.	
5 h 22 min		Slight colouring of the seal at the cracks.
6 h 00 min	<b><u>THE TEST IS STOPPED.</u></b>	

• See the photos taken before and during the tests, Plates no. 19 to 24 -

**5.2 - After testing and cooling**

*Exposed face*

- Seal A: the two vertical edges are bent toward the inside of the joint. This is reduced to a thickness of 25 half-way up. The seal and the seal back are destroyed.
- Seal B: the groove is entirely re-closed with the deformations of the concrete.

- Seal C: the two vertical edges are bent toward the inside of the joint. This is reduced to a width of 10 half-way up and 15 at the extremities. The seal and the back of the seal are destroyed.
- Seal D: the groove is entirely re-closed with the deformations of the concrete.
- Seal E: the two vertical edges are bent toward the inside of the joint. This is reduced to a width of 15 half-way up. The seal and the back of the seal are destroyed.
- Seal F: the groove is entirely re-closed with the deformations of the concrete.
- Seal G: the groove is entirely re-closed with the deformations of the concrete.
- Seal H: the two vertical edges are bent toward the inside of the joint. This is reduced to a width of 15 half-way up and 20 at the extremities. The seal and the back of the seal are destroyed.
- Seal I: the groove is entirely re-closed with the deformations of the concrete.
- Seal J: the groove is entirely re-closed with the deformations of the concrete.
- Seal K: the groove is entirely re-closed with the deformations of the concrete.

#### *Non-exposed face*

- Seal A: the seal is expanded and is brown over the lower half. It is charred over 60 of the upper part and over 350 at thermocouple no. 11.
- Seal B: the seal is brown colour and expanded. Over the upper third, the excess of the seal, due to its expansion, has dropped.
- Seal C: the seal is flexible. Over its whole surface there remains a seal thickness of 15 of which two are sound.
- Seal D: the seal is flexible. Over the whole surface, there remains a seal thickness of 12.
- Seal E: the seal is charred over the upper two thirds. The rest of the seal is expanded. Over the whole remaining surface, there remains a seal thickness of 25 of which five are sound.
- Seal F: the seal is charred over 200 at the upper part. The rest of the seal is expanded and slightly coloured. Over the whole remaining surface, there remains a seal thickness of 3.
- Seal G: the seal is slightly coloured and expanded. Over the whole surface, there remains a seal thickness of 15 of which five are sound.
- Seal H: the seal is flexible. Over the upper half, there remains a seal thickness of 5 and over the lower part; there remains a seal thickness of 25.
- Seal I: the seal is flexible. Over the whole surface, there remains a seal thickness of 12.
- Seal J: the seal is expanded. Over the whole height, there remains a seal thickness of 20.
- Seal K: the seal shows cracks at thermocouples no. 51, 52 and 53. Over the whole height, there remains a seal thickness of 20.
- The width of the joints is the same as the initial dimensions.

• *See the photos taken after the test, Plates 25 and 26 -*



## 6 - INTERPRETING THE RESULTS

### 6.1 - Commentary of seal B of 10 mm: SOUDASEAL FR

The last thermocouple, no.16, for carrying out the measurements of heating up, was detached beginning at 267 minutes, having reached a temperature of 186° C before dropping.

The only dislocation observed during the test was a charring of the seal at the upper part beginning at 218 minutes.

These results preclude declaring heat insulation longer than 240 min.

- See Plate no. 8 and Paragraph 5.1.2 -

### 6.2 - Commentary of seal C of 30 mm: FIRESILICONE B1 FR

All the thermocouples, measuring the heating up, were detached from 60 to 120 minutes of the testing.

The use of the mobile thermocouple made it possible to obtain the following results:

- 96° C at 182 minutes half-way up the seal.
- 151° C at 210 minutes at the upper part of the seal.

Beyond 210 minutes, we have no data concerning the heating up of the seal.

No dislocation was observed during the test.

These results preclude declaring heat insulation longer than 180 minutes.

- See Plate no. 9 and Paragraph 5.1.3 -

### 6.3 - Commentary of seal E of 20 mm: FIRECRYL FR

The thermocouples, carrying out the measurements of heating up, were detached beginning at 192 minutes. Beyond that situation, they could no longer measure the heating up in spite of the use of the mobile thermocouple. It should be noted that there was an opening beginning at 185 minutes of testing (see photo, Plate 21) leading to a slight passing of hot gas.

This finding indicates that the heating up of the non-exposed face exceeded 180° C at that instant.

Furthermore, the trend of the heating up curve of thermocouple no. 26 gave us a temperature of 192° C at 199 minutes, that is, a temperature rise greater than 180° C.

- See Plates no 11, 11 bis and 21 and Paragraph 5.1.5 -

### 6.4 - Commentary of seal F of 10 mm: FIRECRYL FR

The thermocouples, carrying out the measurements of heating up, were detached beginning at 284 minutes, thermocouple no. 31 having reached a temperature of 170° C before dropping.

The only dislocations observed during the test were a melting dribble of the seal over 150 mm at the upper part at 289 minutes of testing, and a hole opening, less than 45 cm<sup>2</sup> at the upper extremity at 341 minutes of testing.

These results preclude declaring heat insulation longer than 240 minutes.

- See Plate no. 12 and Paragraph 5.1.6 -

### **6.5 - Commentary of seal H of 30 mm: FIRESILICONE B1 FR**

All the thermocouples, carrying out measurements of heating up, were detached beginning at 180 minutes, thermocouple no. 39 having reached a temperature of 117° C before dropping.

The use of the mobile thermocouple made it possible to obtain the following temperatures:

- 68° C at 135 minutes at the upper part.
- 95° C at 148 minutes half-way up.

Beyond 180 minutes of testing, we have no data concerning the heating up of the seal.

No dislocation was observed during the test.

The FIRESILICONE B1 FR seal, width 10, tested in a substrate wall, thickness 200, had a better behaviour from the heat insulation point of view than when tested in a substrate wall thickness 150.

The commentary of seal C, width 30, tested in a substrate wall, thickness 150, makes it possible for us to declare a heat insulation up to 180 minutes.

Seal H, the same nature and width, was tested in a substrate wall, thickness 200.

It can be deduced that the heat insulation of seal H will last at least 180 minutes.

- *See Plates no. 9, 10, 14 and 15 and Paragraph 5.1.8 -*

## **7- CONCLUSIONS**

### **7.1 - Seal A of 30 mm: SOUDASEAL FR**

#### **7.1.1 - Integrity under the effects of flames and hot or flammable gases**

Duration	332 minutes
Cause of limitation	opening greater than 45 cm <sup>2</sup>

#### **7.1.2 - Heat insulation**

Duration	270 minutes 30 seconds
Cause of limitation	temperature rise greater than 180° C, detected by thermocouple no. 12

### **7.2 - Seal B of 10 mm: SOUDASEAL FR**

#### **7.2.1 - Integrity under the effects of flames and hot or flammable gases**

Duration	360 minutes
Cause of limitation	the test was stopped

#### **7.2.2 - Heat insulation**

Duration	240 minutes
Cause of limitation	see commentary of seal B ( Paragraph 6.1 )

**7.3 - Seal C of 30 mm: FIRESILICONE B1 FR****7.3.1 - Integrity under the effects of flames and hot or flammable gases**

Duration 360 minutes  
Cause of limitation the test was stopped

**7.3.2 - Heat insulation**

Duration 180 minutes  
Cause of limitation see commentary of seal C ( Paragraph 6.2 )

**7.4 - Seal D of 10 mm: FIRESILICONE B1 FR****7.4.1 - Integrity under the effects of flames and hot or flammable gases**

Duration 360 minutes  
Cause of limitation the test was stopped

**7.4.2 - Heat insulation**

Duration 251 minutes 30 seconds  
Cause of limitation temperature rise greater than 180° C detected by thermocouple no. 22

**7.5 - Seal E of 20 mm: FIRECRYL FR****7.5.1 - Integrity under the effects of flames and hot or flammable gases**

Duration 298 minutes  
Cause of limitation positive cotton test

**7.5.2 - Heat insulation**

Duration 180 minutes  
Cause of limitation see commentary of seal E ( Paragraph 6.3 )

**7.6 - Seal F of 10 mm: FIRECRYL FR****7.6.1 - Integrity under the effects of flames and hot or flammable gases**

Duration 360 minutes  
Cause of limitation the test was stopped

**7.6.2 - Heat insulation**

Duration 240 minutes  
Cause of limitation see commentary of seal F ( Paragraph 6.4 )

**7.7 - Seal G of 10 mm: SOUDASEAL FR****7.7.1 - Integrity under the effects of flames and hot or flammable gases**

Duration 360 minutes  
Cause of limitation the test was stopped

**7.7.2 - Heat insulation**

Duration 360 minutes  
Cause of limitation the test was stopped

**7.8 - Seal H of 30 mm: FIRESILICONE B1 FR****7.8.1 - Integrity under the effects of flames and hot or flammable gases**

Duration 360 minutes  
Cause of limitation the test was stopped

**7.8.2 - Heat insulation**

Duration 180 minutes  
Cause of limitation see commentary of seal H ( Paragraph 6.5 )

**7.9 - Seal I of 10 mm: FIRESILICONE B1 FR****7.9.1 - Integrity under the effects of flames and hot or flammable gases**

Duration 360 minutes  
Cause of limitation the test was stopped

**7.9.2 - Heat insulation**

Duration 360 minutes  
Cause of limitation the test was stopped

**7.10 - Seal J of 20 mm: FIRECRYL FR****7.10.1 - Integrity under the effects of flames and hot or flammable gases**

Duration 360 minutes

Cause of limitation the test was stopped

**7.10.2 - Heat insulation**

Duration 360 minutes

Cause of limitation the test was stopped

**7.11 - Seal K of 10 mm: FIRECRYL FR**

**7.11.1 - Integrity under the effects of flames and hot or flammable gases**

Duration 360 minutes

Cause of limitation the test was stopped

**7.11.2 - Heat insulation**

Duration 360 minutes

Cause of limitation the test was stopped

**END OF REPORT**