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REPORT

Determination of the fire resistance according to EN 1366-3:2009 of Flamro pipe closure devices directly mounted in a standard aerated concrete floor

Report no.	2018-Efectis-R000996
Sponsor	Flamepro BV P.O. Box 146 3100 AC SCHIEDAM The Netherlands
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CONTENTS

1. GENERAL

1.1 REPORT

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 where appropriate EN 1363-2. Any significant deviation with respect to size, constructional details, loads, 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.

1.2 SUBJECT

Subject of the investigation were Flamro pipe closure devices mounted directly in a standard aerated concrete floor construction.
In total 10 services with these sealing systems were installed. They were divided over the standard aerated concrete floor. One of the services is not included in this report due to failure.

1.3 INVESTIGATION

Determination of the fire resistance according to the European Standard for service installations – Part 3: Penetration Seals; EN 1366-3.

1.4 SPONSOR AND MANUFACTURER INFORMATION

Sponsor and manufacturer
Flamepro BV P.O. Box 146 3100 AC SCHIEDAM THE NETHERLANDS

1.5 PLACE AND DATA REGARDING THE RESEARCH

The research was conducted at the laboratory of Efectis Nederland BV in Bleiswijk, The Netherlands.	
Mounting of the specimens in the supporting construction	6th to the 9th March 2018
Fire resistance test	14th of March 2018

1.6 NORMATIVE REFERENCES

EN 1363-1:2012	Fire resistance tests - Part 1: General Requirements
EN 1363-2:1999	Fire resistance tests - Part 2: Alternative and additional procedures
EN 1366-3:2009	Fire resistance tests for service installations – Part 3: Penetration seals
EN 13501-2:2016	Fire classification of construction products and building elements - Part 2: Classification using data from fire resistance tests, excluding ventilation services

1.7 REVISION INFORMATION

This is the first version of the test report.

2. TEST SPECIMENS

2.1 GENERAL

A fire test was carried out on penetration seals, installed in a standard aerated concrete floor.

For the dimensions and specifications of the materials and components of the examined construction, also see the figures in chapter 8. Details of the assembly of the construction are given in the paragraphs below.

The density and moisture content of relevant the building materials are defined by the sponsor. No samples were applied, so the density and moisture content of the materials were not determined.

2.2 TEST FRAME

The test frame was constructed of steel beams.

Dimensions	
Aperture	850 mm x 860 mm (w x l)

2.3 SUPPORTING CONSTRUCTION

The penetration seals were built in a standard rigid supporting construction according to EN 1366-3, being an aerated concrete floor with a thickness of 250 mm (density 650 +/- 200 kg/m^3).

2.4 SERVICES

2.4.1 Service one

A steel pipe with diameter 168,3 mm, insulated with a Rockwool 810 shell with a thickness of 25 mm and a density of 70-80 kg/m^3, penetrated the aerated concrete floor construction. Flamro BMA-coating with a thickness of 1 mm was applied to the floor surface and the Rockwool on both sides of the floor to seal the connection of the floor construction with the Rockwool insulation, protruding 150 mm above and below the surface of the floor construction.
The insulation was local sustained (LS).

No.	Material	Pipe diameter (given)	Pipe wall thickness (given)	Pipe diameter (measured)	Pipe wall thickness (measured)	Flamro Variant II	Pipe end configuration
1	Steel	168.3	6.0	169	3.7	-	C/U

2.4.2 Service two

A steel pipe with diameter 42 mm penetrated the aerated concrete floor construction. The remaining opening was filled with stone wool loose fill. Flamro BMA-coating with a thickness of 3 – 4 mm was applied to the floor and pipe surface on both sides of the floor to seal the connection of the floor construction with the pipe, protruding 300 mm above and below the surface of the floor construction.

No.	Material	Pipe diameter (given)	Pipe wall thickness (given)	Pipe diameter (measured)	Pipe wall thickness (measured)	Flamro Variant II	Pipe end configuration
2	Steel	42	3.2	42.4	3.3	-	C/U

2.4.3 Service three

A steel pipe with diameter 114.3 mm, insulated with Armaflex AF with a thickness of 19 mm, penetrated the aerated concrete floor construction. The remaining opening was filled with stone wool loose fill and DSB-W graphite kit (20 x 20 mm (w x t)).
Flamro BMA-coating with a thickness of 1 mm was applied to the Armaflex AF surface on both sides of the floor to seal the connection of the floor construction with the Armaflex AF, protruding 150 mm above and below the surface of the floor construction.
The insulation was local sustained (LS).

No.	Material	Pipe diameter (given)	Pipe wall thickness (given)	Pipe diameter (measured)	Pipe wall thickness (measured)	Flamro Variant II	Pipe end configuration
3	Steel	114.3	3.4	114.8	3.35	-	C/U

2.4.4 Service four

A steel pipe with diameter 114.3 mm, insulated with Insulpir/phen foam insulation with a thickness of 30 mm and a density of 33 kg/m^3, penetrated the aerated concrete floor construction. The insulation was fixed by means of steel wires (1 mm). Between the foam insulation and the floor construction 2 wraps of Flamro Variant II wrap were applied (one was positioned flush on the top of the floor construction and one was positioned flush on the bottom). Both wraps were self-adhesive and consisted of 2 layers.
The remaining opening was filled with stone wool loose fill and Flamro BMK kit. The insulation was local sustained (LS).

No.	Material	Pipe diameter (given)	Pipe wall thickness (given)	Pipe diameter (measured)	Pipe wall thickness (measured)	Flamro Variant II (layers)	Pipe end configuration
4	Steel	114.3	3.4	114.9	3.45	2	C/U

2.4.5 Service 5

A steel pipe with diameter 114.3 mm, insulated with Thermaflex Polyethyleen insulation with a thickness of 19 mm, penetrated the aerated concrete floor construction. The insulation was fixed by means of steel wires (1 mm). Between the insulation and the floor construction 2 wraps of Flamro Variant II wrap were applied (one was positioned flush on the top of the floor construction and one was positioned flush on the bottom). Both wraps were self-adhesive and consisted of 2 layers.
The remaining opening was filled with stone wool loose fill and Flamro BMK kit. Flamro BMA-coating with a thickness of 1 mm and a length of 150 mm, was applied to the Thermaflex insulation surface on both sides of the floor to seal the connection with the floor construction. The insulation was local sustained (LS).

No.	Material	Pipe diameter (given)	Pipe wall thickness (given)	Pipe diameter (measured)	Pipe wall thickness (measured)	Flamro Variant II (layers)	Pipe end configuration
5	Steel	114.3	3.4	114.9	3.3	2	C/U

2.4.6 Service six

A multilayer aluminium pipe with diameter 70 mm penetrated the aerated concrete floor construction. The remaining opening was filled with stone wool loose fill and DSB-W graphite kit (20 x 20 mm (w x t)). Flamro BMA-coating with a thickness of 2 mm was applied to the pipe surface on both sides of the floor to seal the connection of the floor construction with the pipe, protruding 150 mm above and below the surface of the floor construction.

No.	Material	Pipe diameter (given)	Pipe wall thickness (given)	Pipe diameter (measured)	Pipe wall thickness (measured)	Layers Flamro Variant II	Pipe end configuration
6	Henkle Alu/PVC	70	7.5	62.9	-	-	U/U

2.4.7 Service seven

A PVC thimble with diameter 110 mm, provided with cables and conduits penetrated the aerated concrete floor construction. The cables had a maximum diameter of 20 mm and the conduits had a maximum diameter of 16 mm. The pipe was filled with stone wool loose fill and the ends were filled with Flamro BSS foam.

No.	Material	Pipe diameter (given)	Pipe wall thickness (given)	Pipe diameter (measured)	Pipe wall thickness (measured)	Flamro Variant II (layers)	Pipe end configuration
7	PVC pipe		110	3.4	109	-	U/C

2.4.8 Service eight

A Henkle aluminium/PVC pipe with diameter 70 mm, insulated with Armaflex insulation with a thickness of 19 mm, penetrated the aerated concrete floor construction. The remaining opening was filled with stone wool loose fill and DSB-W graphite kit (20 x 20 mm (w x t)). Flamro BMA-coating with a thickness of 1 mm was applied to the Armaflex surface on both sides of the floor to seal the connection of the floor construction with the Armaflex, protruding 150 mm above and below the surface of the floor construction.
The insulation was local sustained (LS).

No.	Material	Pipe diameter (given)	Pipe wall thickness (given)	Pipe diameter (measured)	Pipe wall thickness (measured)	Layers Flamro Variant II	Pipe end configuration
8	Henkle Alu/PVC	70	7.5	67.1	-	-	U/C

2.4.9 Service nine

A steel pipe with diameter 168.3 mm, insulated with Armaflex AF insulation with a thickness of 32 mm, penetrated the aerated concrete floor construction. one was positioned flush on the top of the floor construction and one was positioned flush on the bottom). Both wraps were self-adhesive and consisted of 2 layers.

The remaining opening was filled with stone wool loose fill and Flamro BMK kit. The insulation was local sustained (LS).

No.	Material	Pipe diameter (given)	Pipe wall thickness (given)	Pipe diameter (measured)	Pipe wall thickness (measured)	Flamro Variant II (layers)	Pipe end configuration
9	Steel	168.3	6	167	3.9	2	C/U

2.4.10 Service ten

A steel pipe with diameter 114.3 mm, insulated with Rockwool shell PS960 with a thickness of 25 mm and a density of 70-80 kg/m^3 covered with an aluminium casing with a thickness of 1 mm, penetrated a Flamro BS schot which was mounted in the aerated concrete floor construction.
The joint between the casing and the Flamro BS schot was sealed with Flamro BMS spachtel. Flamro BMA-coating with a thickness of 2 mm was applied to the floor and Rockwool surface on both sides of the floor to seal the connection with the Flamro BMS schot, protruding 300 mm above and below the surface of the floor construction
The insulation was local sustained (LS).

No.	Material	Pipe diameter (given)	Pipe wall thickness (given)	Pipe diameter (measured)	Pipe wall thickness (measured)	Flamro Variant II	Pipe end configuration
10	Steel	168.3	6	114.2	3.4	-	C/U

2.4.11 Pipe end configuration

The pipe end configuration is given in the tables in chapter 2.

2.5 WORKING SPACES

All working spaces are given in figure 1 of chapter 8.

2.6 SERVICE SUPPORT CONSTRUCTION

In the test a standard service support construction in compliance with EN 1366-3 has been used on the unexposed side of the floor (top).

The steel service support construction was made from BIS RapidStrut profiles with a section size of 41 x 41 mm with a thickness of 2,5 mm.
The services were supported by steel rods at 545 mm and 662 mm from the surface of the floor.

2.7 METHOD OF ASSEMBLY

The method of assembly was as follows:

- Placing of the floor slabs and cutting the apertures;
- Placing of the service support construction;
- Placing the services;
- Applying the seals.

3. MANUFACTURING OF THE CONSTRUCTION

Efectis Nederland BV	Supplying test frame with aerated concrete floor
Flamepro BV	Production of penetration seals Installation of seals and services

4. RESEARCH METHOD

4.1 VERIFICATION OF THE SPECIMEN

During construction, the materials and parts used were verified on the basis of the data provided.

4.2 CONDITIONING

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

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

4.3 FIRE TEST

4.3.1 Test conditions

The fire test was carried out according to EN 1366-3. The specimens have been exposed to the standard fire curve according to EN 1363-1. The aimed overpressure in the furnace was max. 20 Pa at max. 100 mm underneath the surface of the supporting floor.

4.3.2 Measurements

During the heating the following data was measured and registered:

Furnace conditions

- The temperatures in the furnace using plate thermocouples, equally spread over the heated surface;
- The pressure in the furnace.

Specimen

- Surface temperatures of the floor;
- Surface temperatures of the services.

Environment

- The temperature in the laboratory.

5. TEST RESULTS

5.1 OBSERVATIONS DURING HEATING

The pictures during assembly, before, during and (when applicable) after the fire test are shown in appendix C.

Observations during test

Time [min]	Service	Observations
0		Commencement of the test.
9	5	End of criterion integrity, flames > 10 sec.
57	4	An opening appeared in the insulation material
70	10	Thermocouple 10Ax is disconnected
101	8	End of criterion integrity, flames > 10 sec.
112		End of heating after consulting the client

5.2 GRAPHS OF THE FIRE TEST

The test results are shown in graphs in appendix A and B.

5.3 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.

6. SUMMARY

The fire resistance was determined of Flamro pipe closure devices, mounted directly in a standard aerated concrete floor construction. In total 10 services with various sealing systems were installed, whereof nine were described in this report. They were divided over the standard aerated concrete floor.

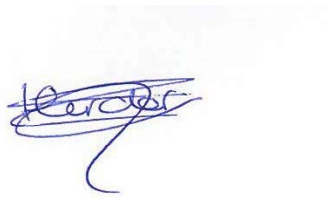
The most important results of the investigation of the specimens are given in the tables below.

Summary of test results

Test results				**Time of reaching a criterion according to EN 1366-3, measured from the start of the test**		
No.	**Material**	**Pipe diameter (given)**	**Pipe wall thickness (given)**	**Integrity 'E' (minutes)**	**Insulation 'I' (minutes)**	**Classification**
1	Steel	168.3	6.0	112	104, A2	E 90-C/U EI 90-C/U
2	Steel	42	3.2	112	102, A1 on coating	E 90-C/U EI 90-C/U
3	Steel	114.3	3.4	112	73, Ax1 on coating	E 90-C/U EI 60-C/U
4	Steel	114.3	3.4	112	100, Ax1 on coating	E 90-C/U EI 90-C/U
5	Steel	114.3	3.4	9	8, Ax2 on coating	-
6	Henkle Alu/PVC	70	7.5	112	33, A1 on coating	E 90-U/C EI 30-U/C
7	PVC pipe		110	112	106, A2 on cable	E 90-U/U EI 90-U/U
8	Henkle Alu/PVC	70	7.5	101	73, Ax1 on coating	E 90-U/C EI 60-U/C
9	Steel	168.3	6	112	102, A2 on bracket	E 90-C/U EI 90-C/U
10	Steel	168.3	6	112	24, Ax1 on coating	E 90-C/U EI 60-C/U
The heating was terminated after 112 minutes after consulting the client.						

7. FIELD OF DIRECT APPLICATION

The field of direct application can be found in the classification reports in relation to this report.



P.G.R. Scholten B.Sc.
Project leader fire resistance

8. FIGURES

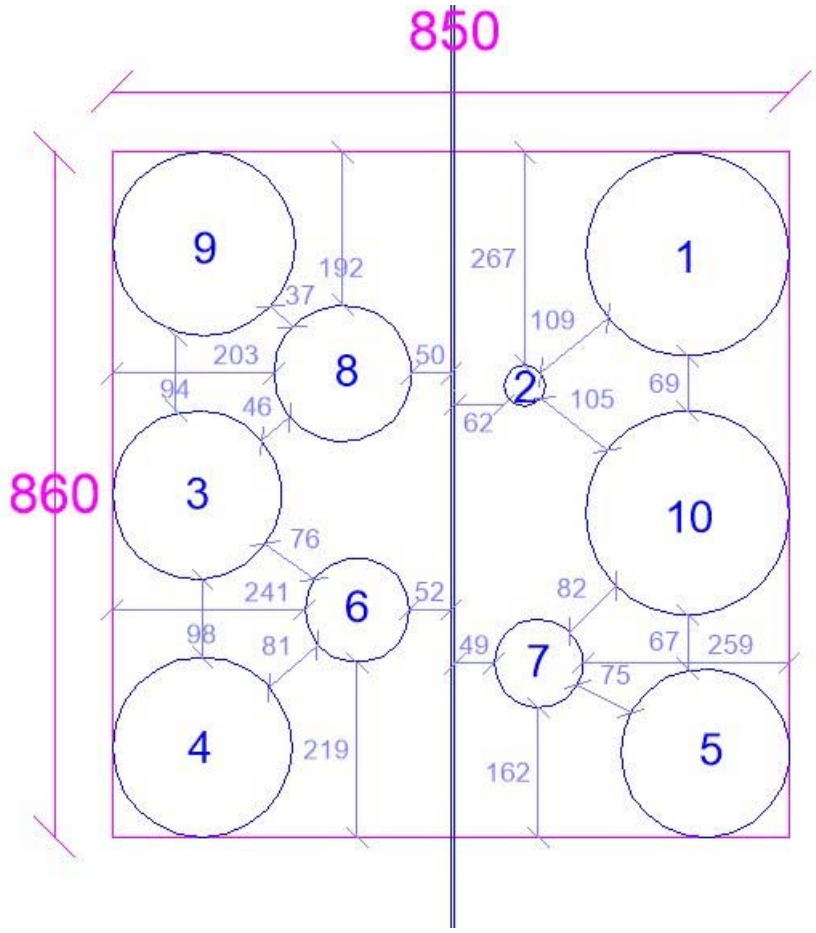


Figure 1 Overview of the specimens

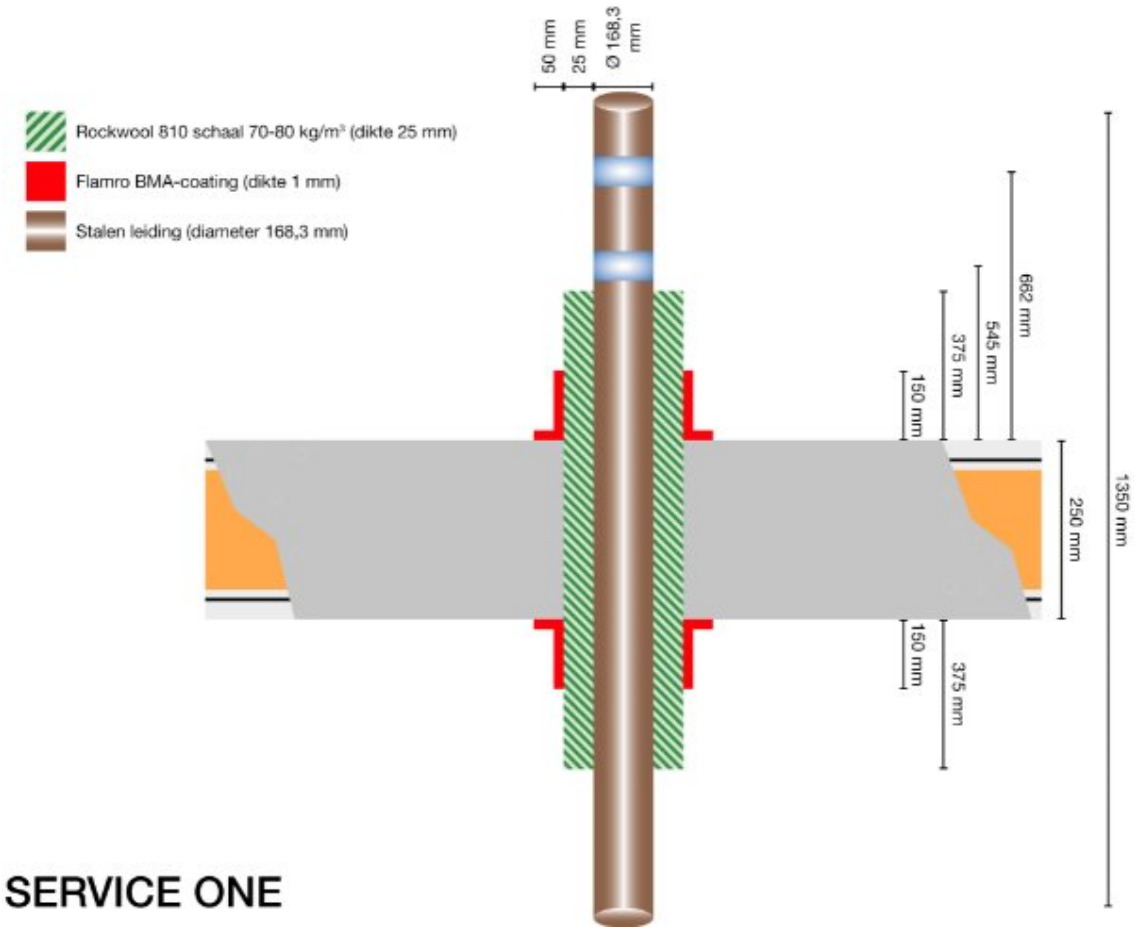


Figure 2 Service no. 1

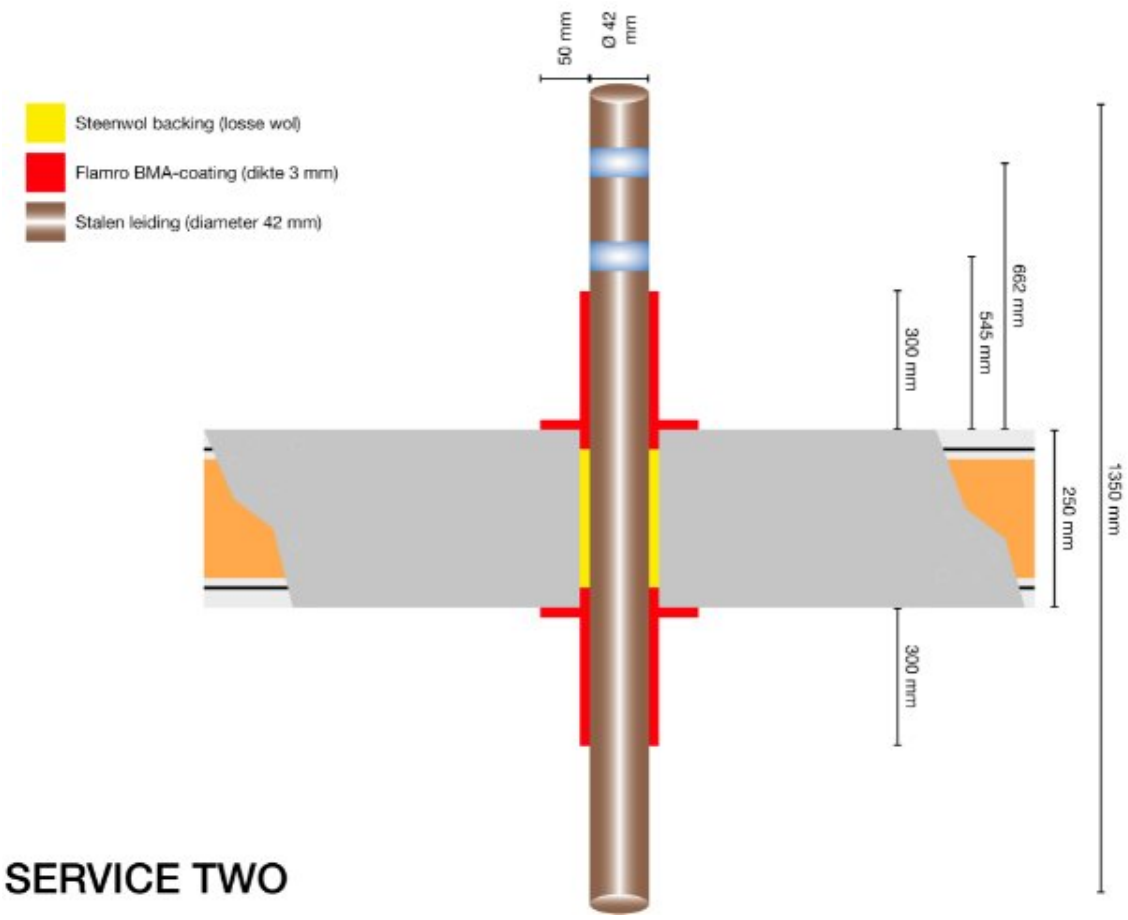


Figure 3 Service no. 2

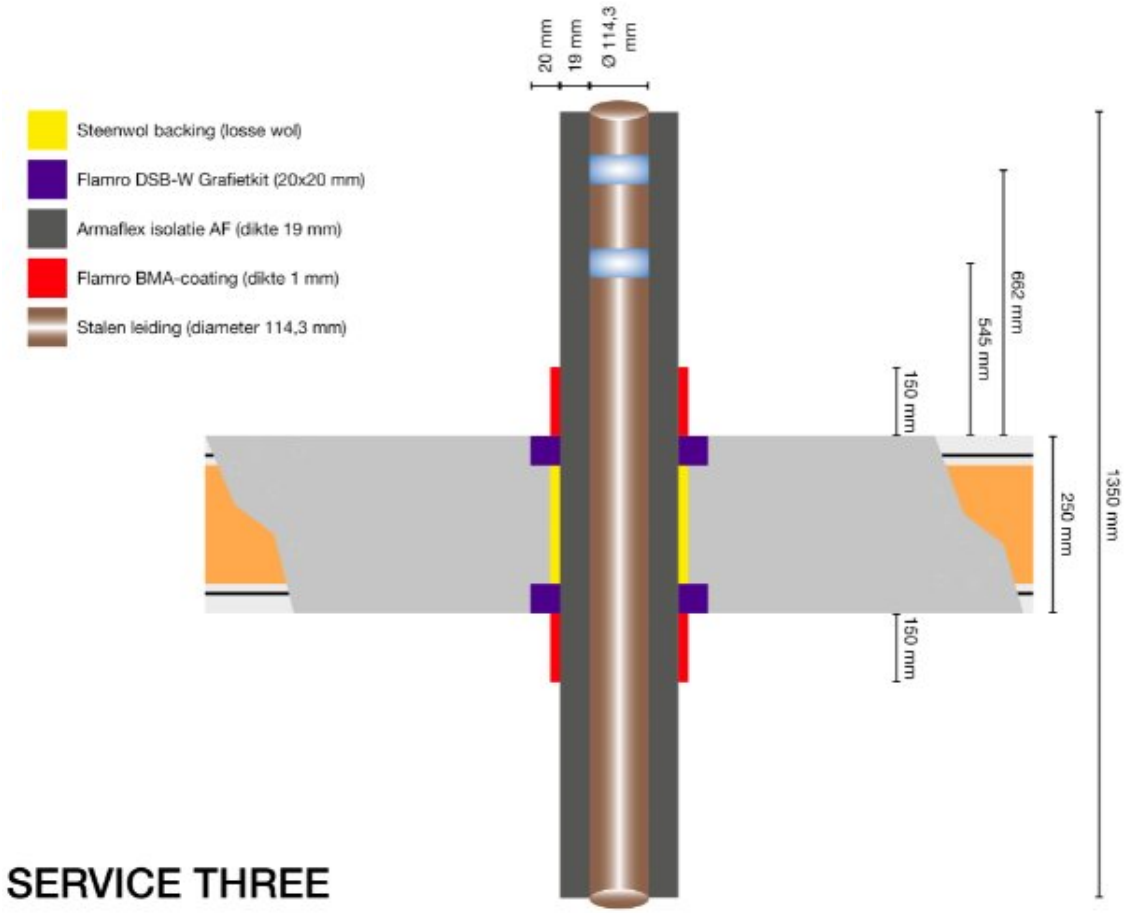


Figure 4 Service no. 3

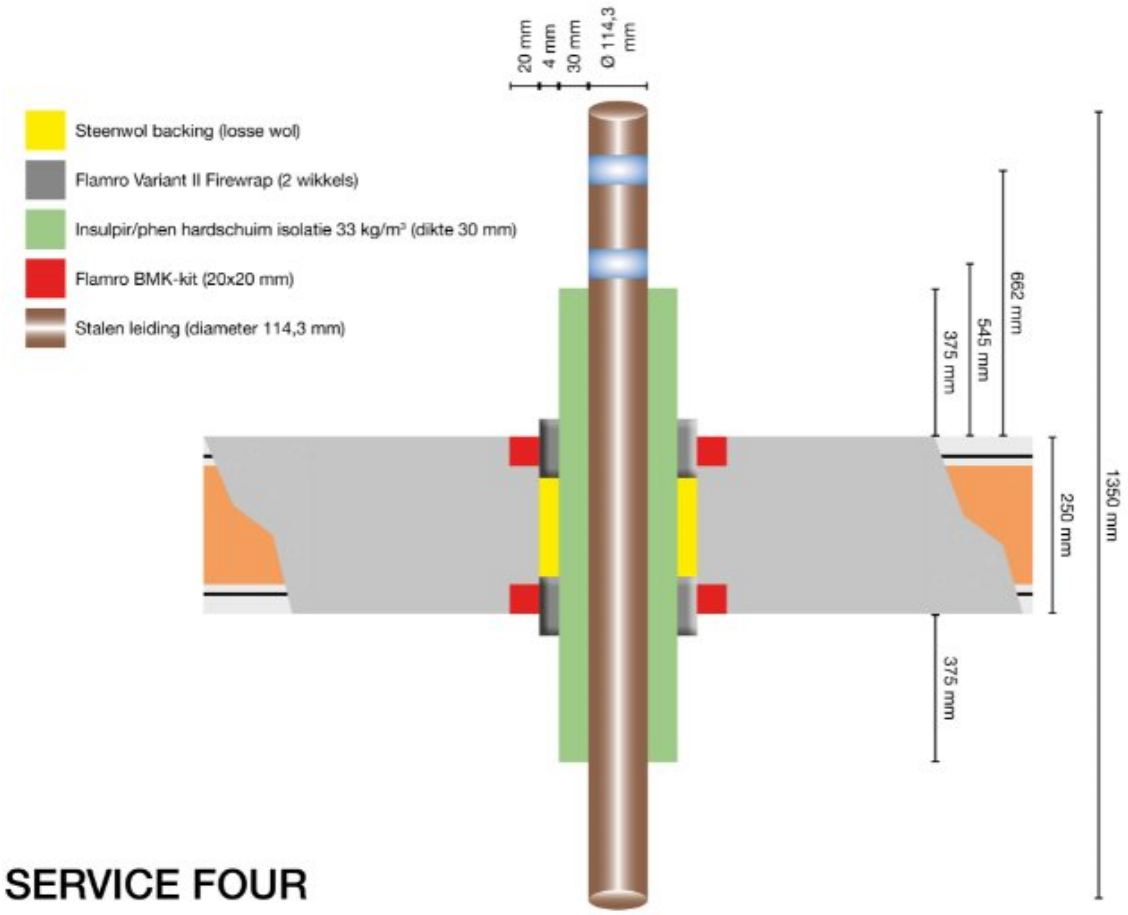


Figure 5 Service no. 4

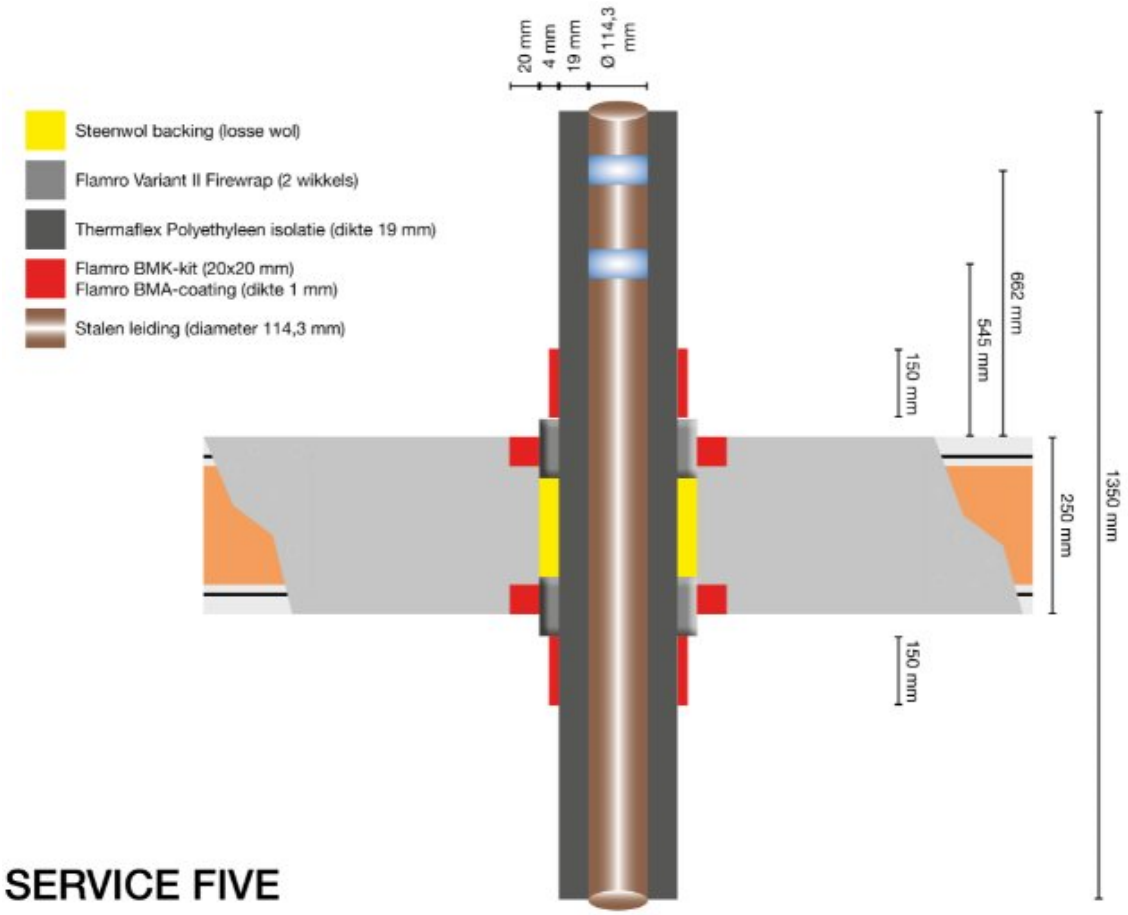


Figure 6 Service no. 5

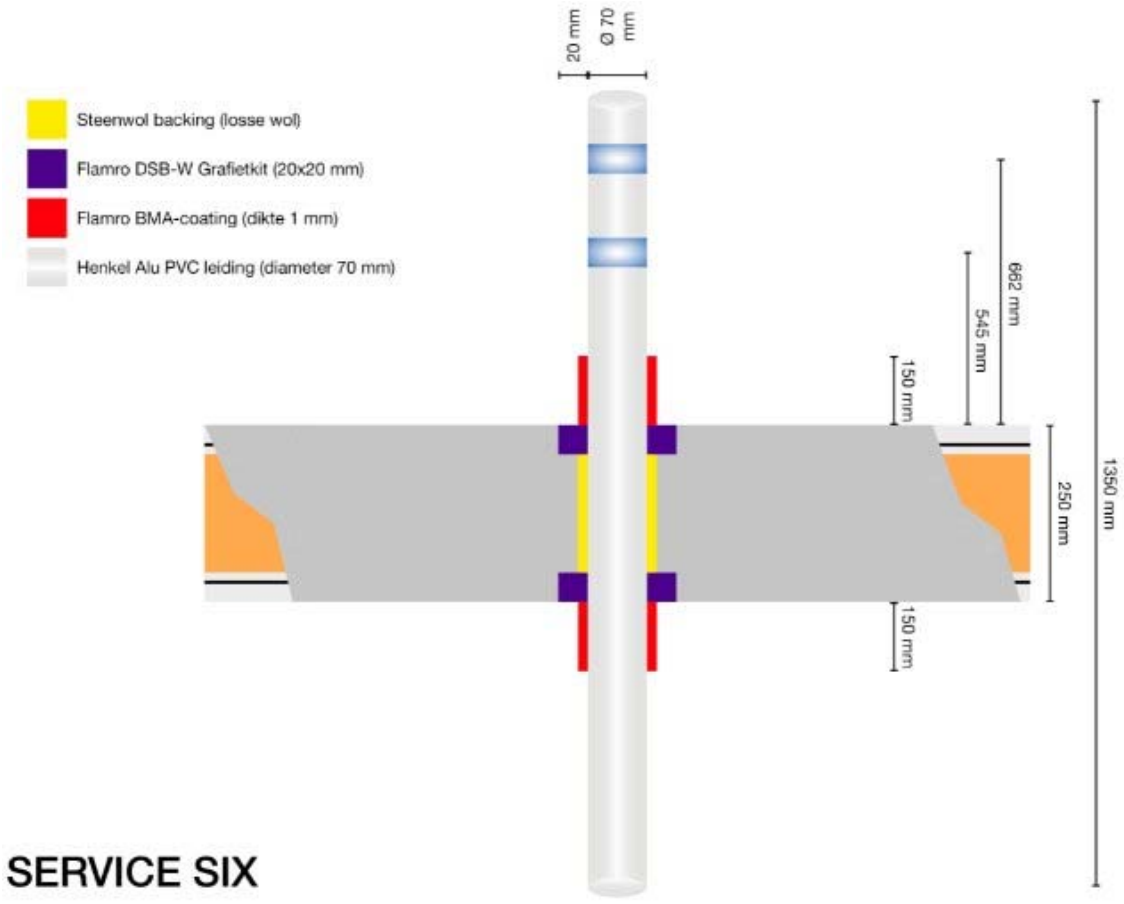
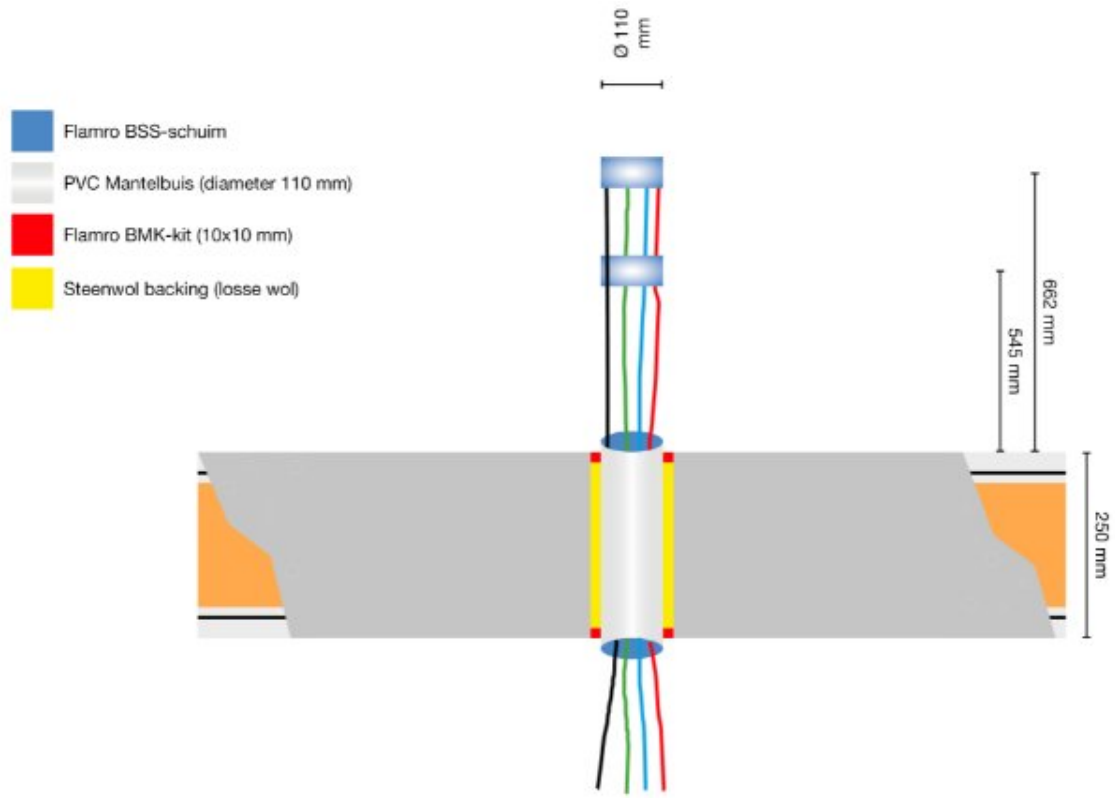


Figure 7 Service no. 6



SERVICE SEVEN

Figure 8 Service no. 7

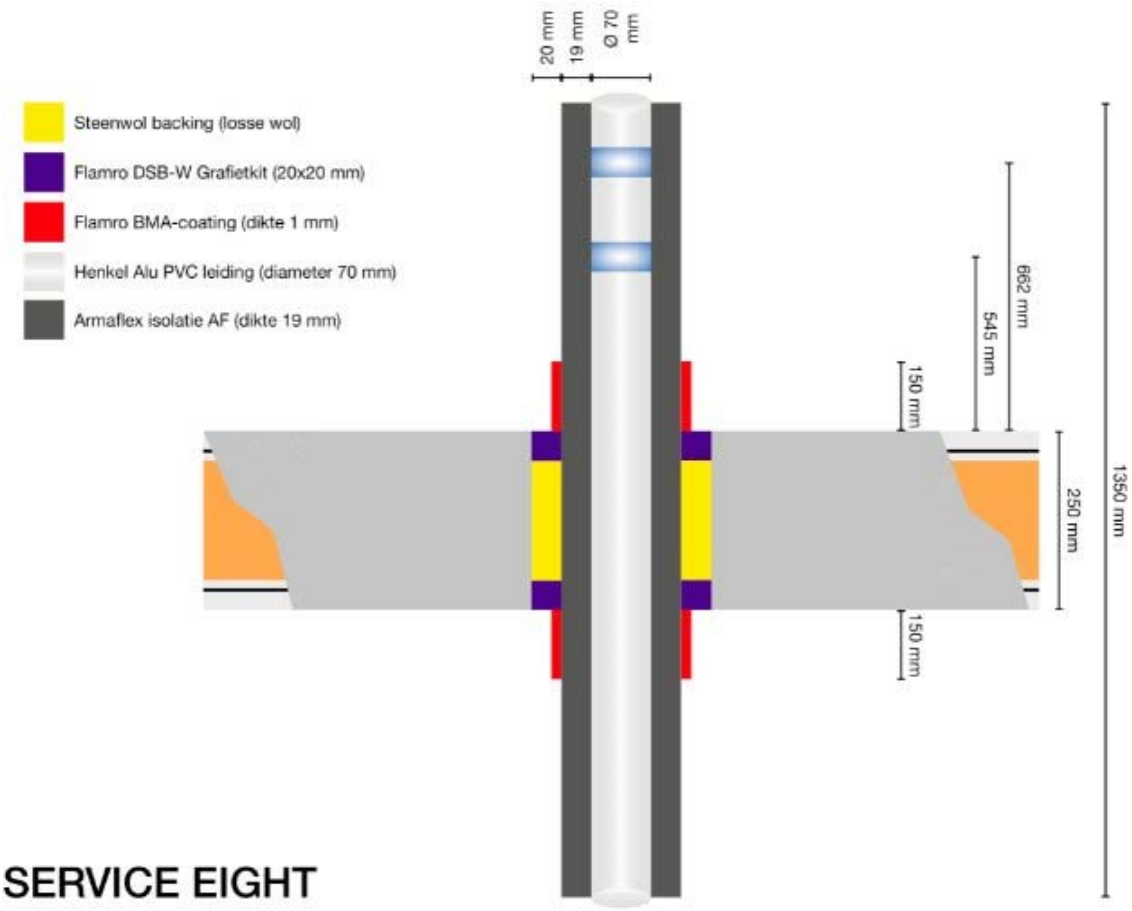


Figure 9 Service no. 8

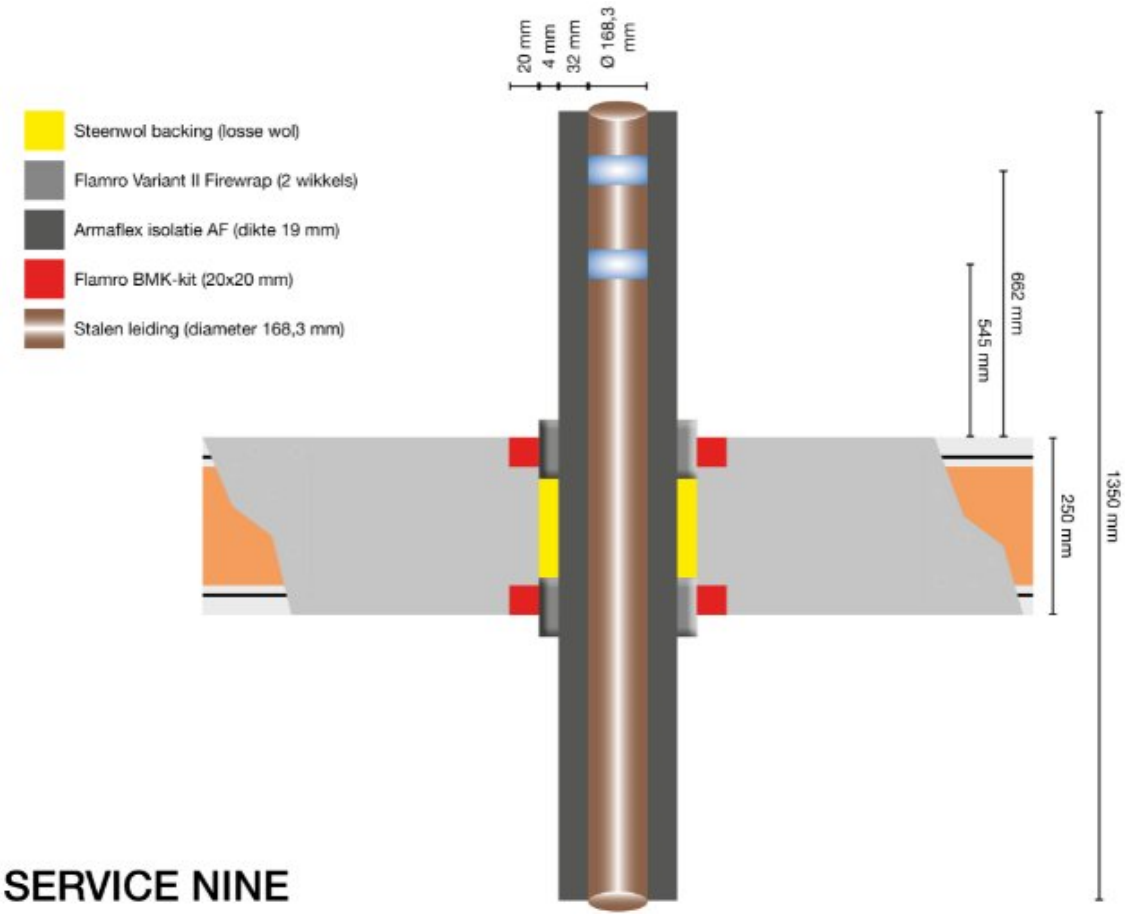


Figure 10 Service no. 9

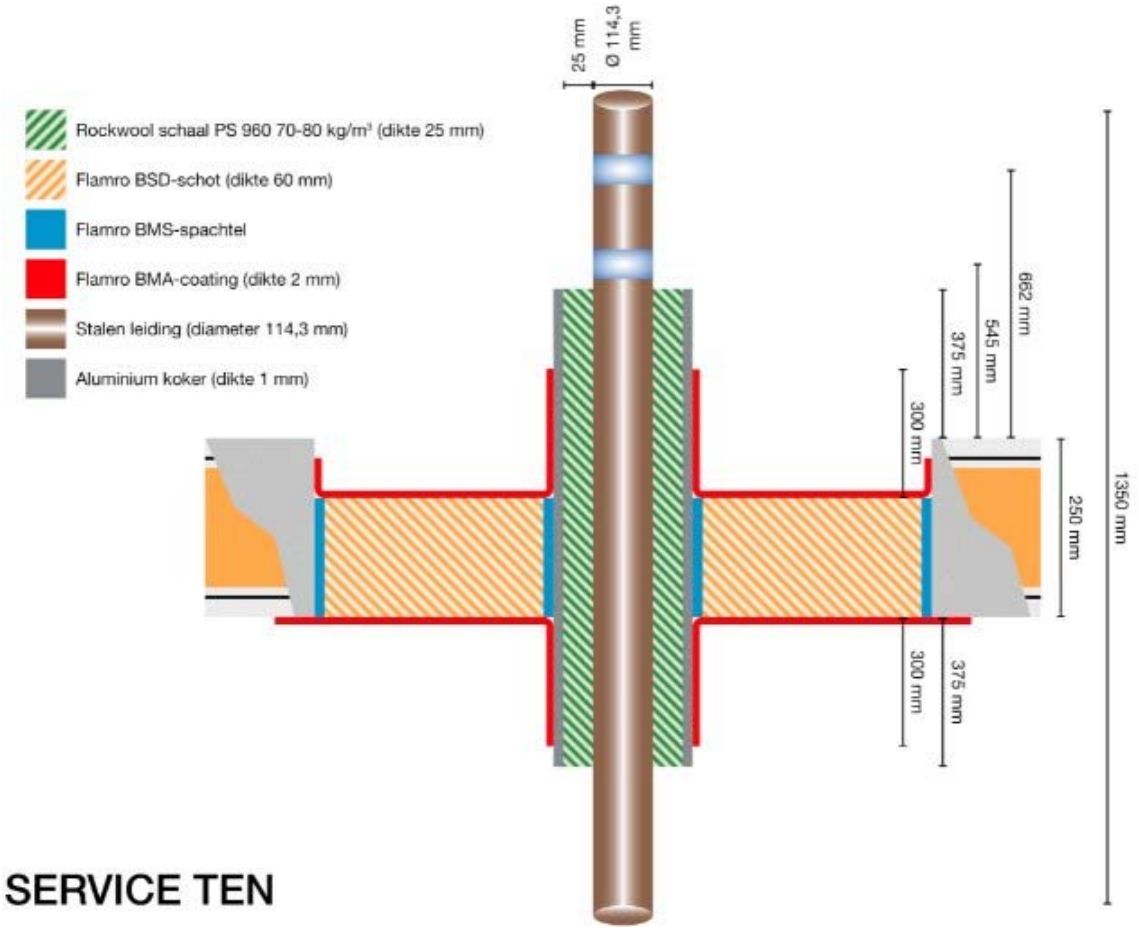


Figure 11 Service no. 10

APPENDIX A: FURNACE CONDITIONS, PRESSURE AND AMBIENT TEMPERATURE

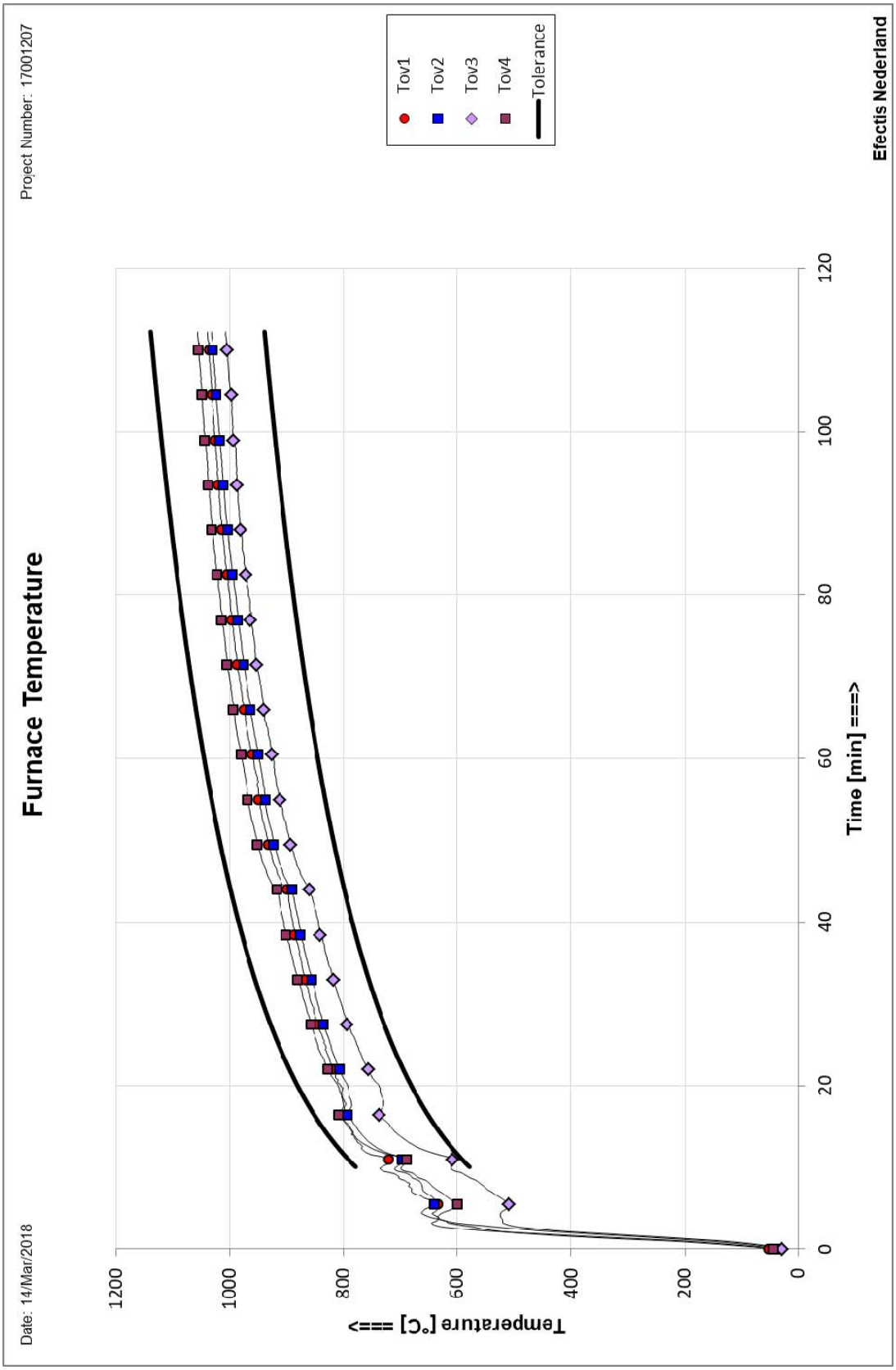


Figure A.1 Furnace temperatures

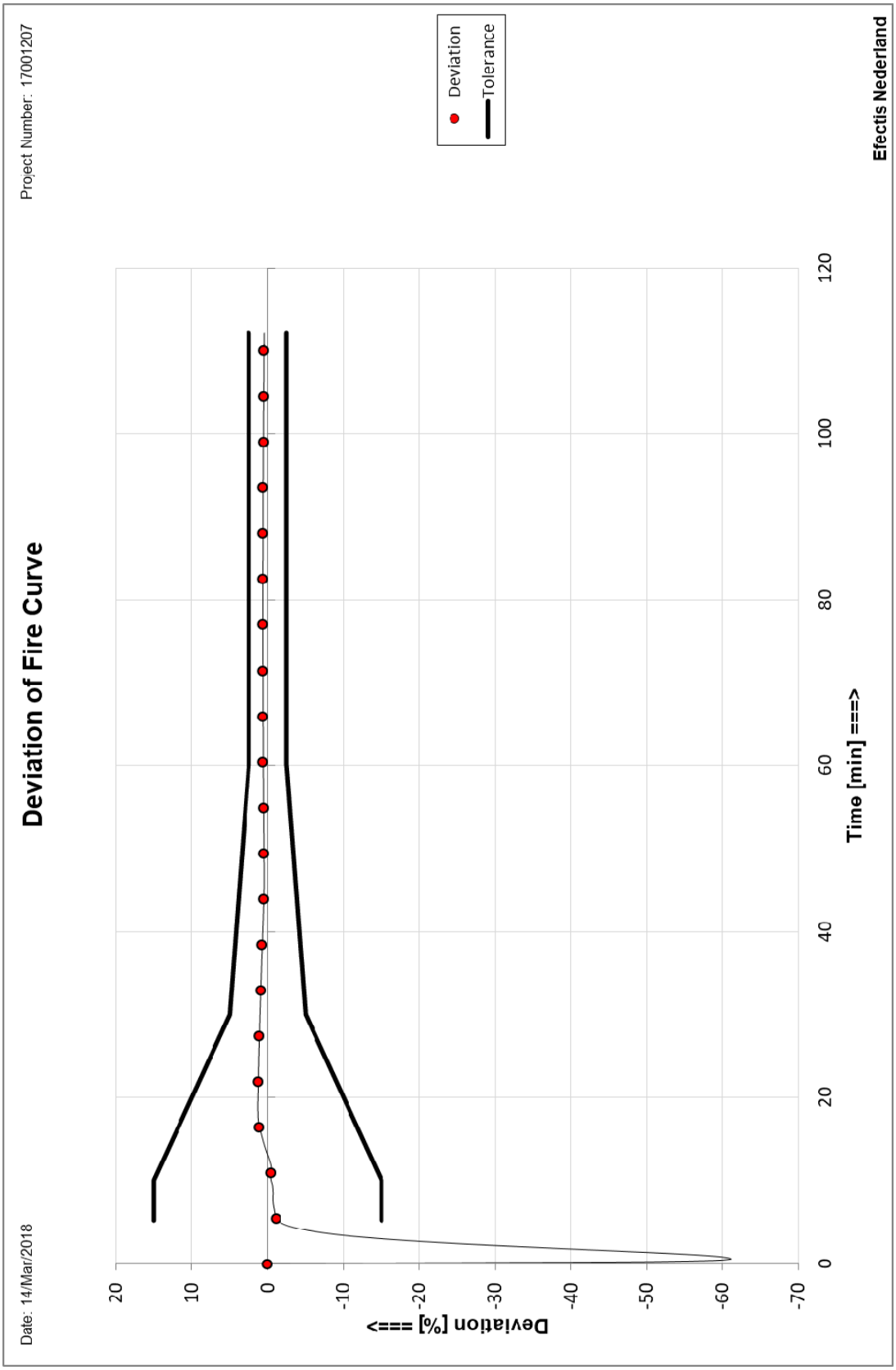


Figure A.2 Deviation fire curve according to EN 1363-1

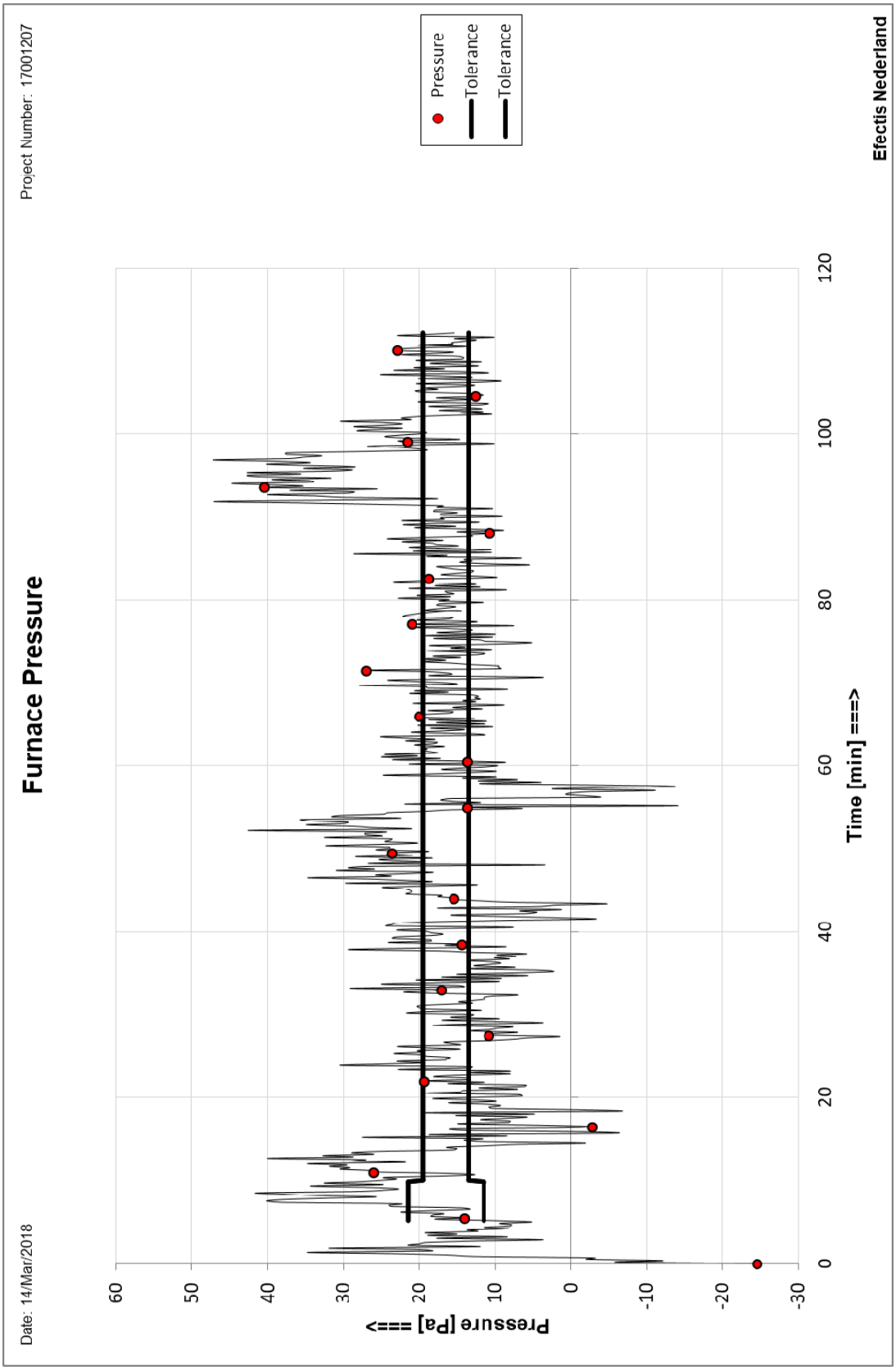


Figure A.3 Furnace pressure

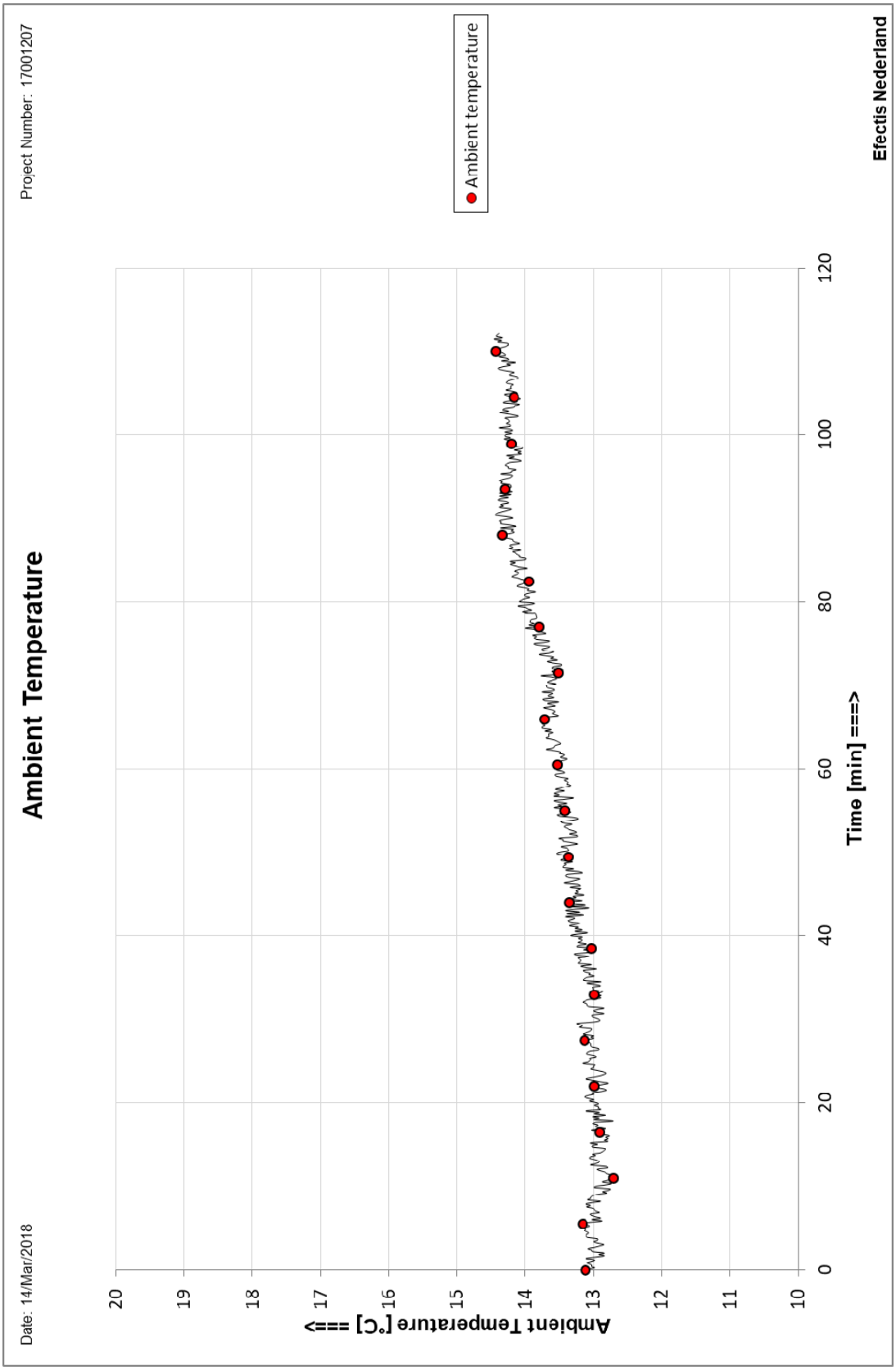
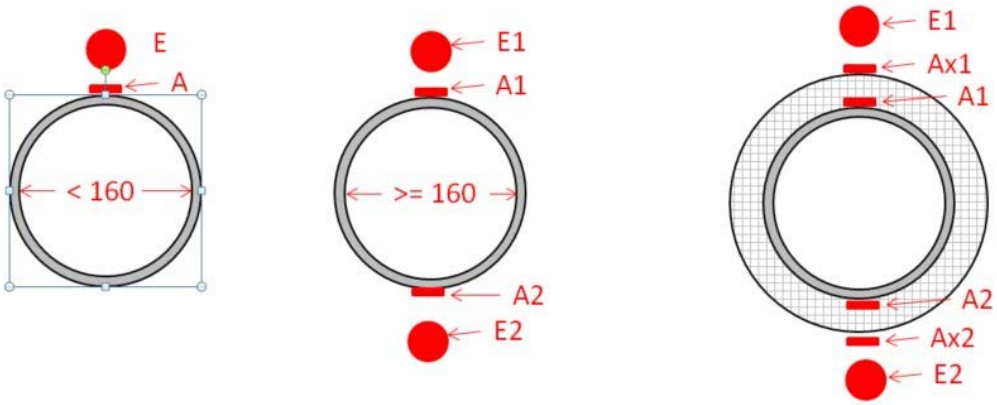


Figure A.4 Ambient temperature

APPENDIX B: POSITION THERMOCOUPLES AND MEASUREMENTS



A thermocouples: Position A according to paragraph 9.1.2.2 in EN 1366-3, on the service, 25 mm from the penetration seal or insulation
Ax thermocouples: Position A according to paragraph 9.1.2.2 in EN 1366-3 on the insulation, 25 mm from the penetration seal
E thermocouples: Position E according to paragraph 9.1.2.6 in EN 1366-3 on the surface of the supporting construction 25 mm from the top edge of the penetration
When there are two, for example, A thermocouples, they are called A1 and A2. A1 being on top of the service, A2 at the bottom.

Figure B.1 Positions of thermocouples

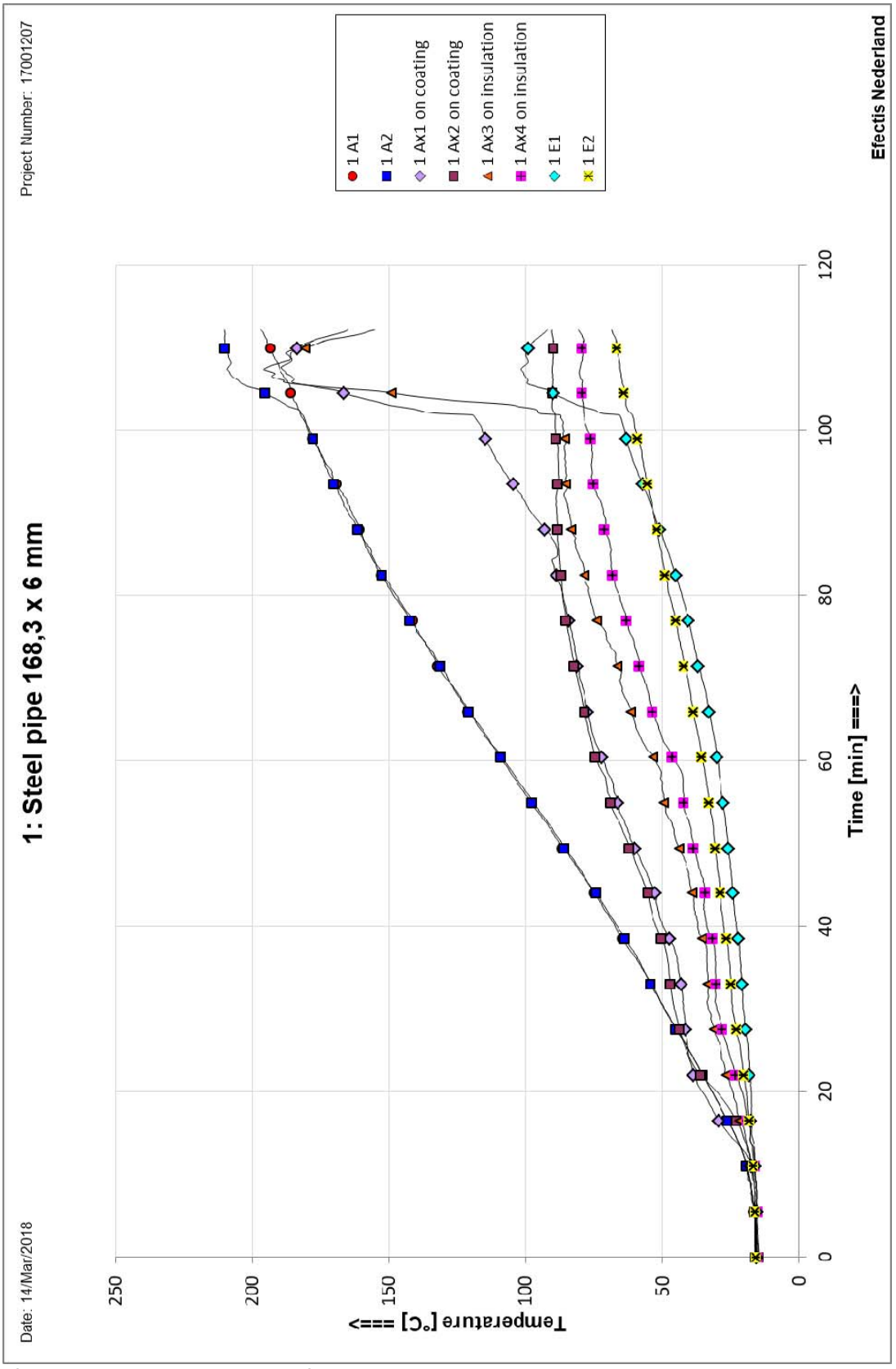


Figure B.2 Temperatures service no. 1

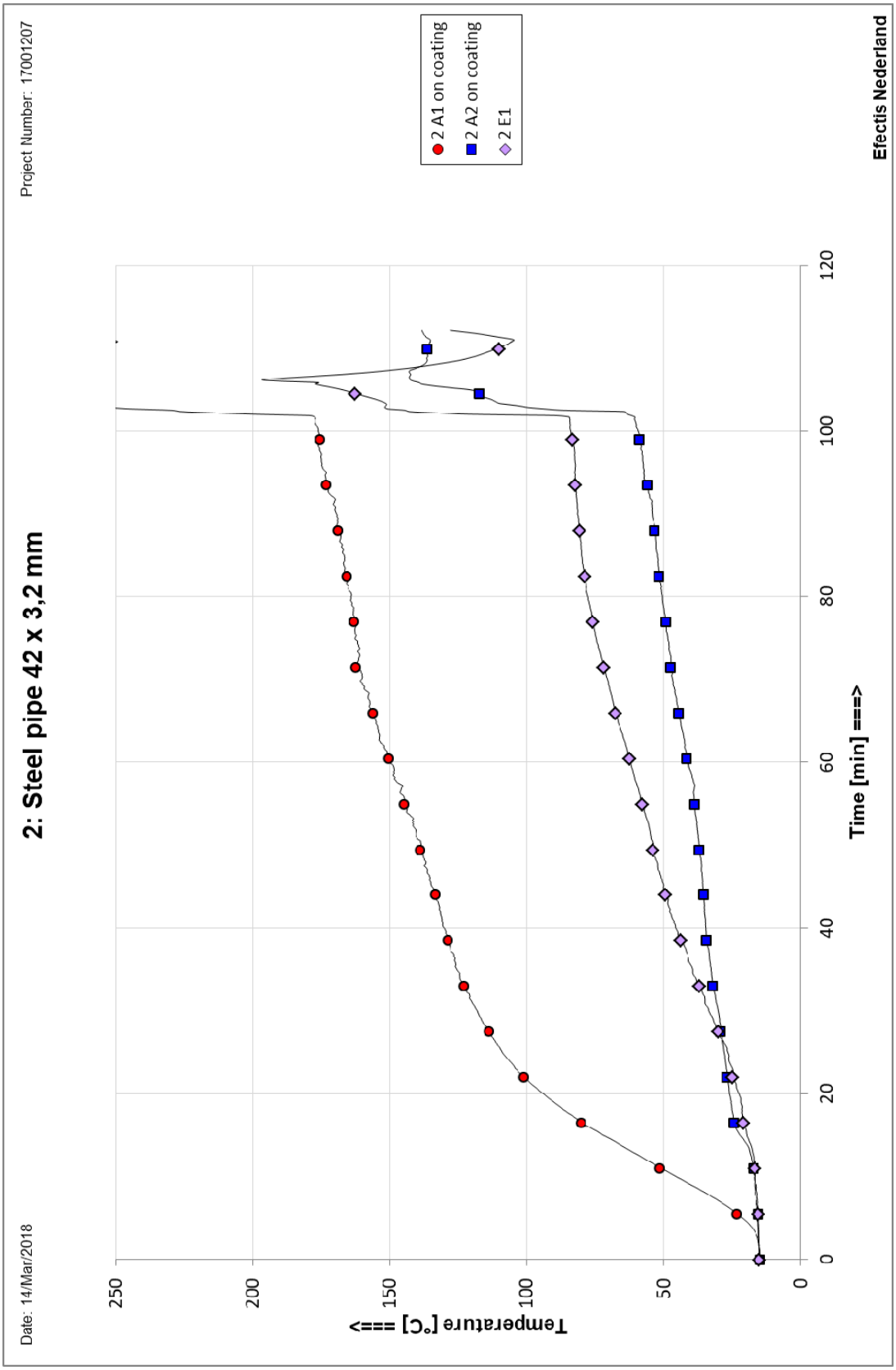


Figure B.3 Temperatures service no. 2

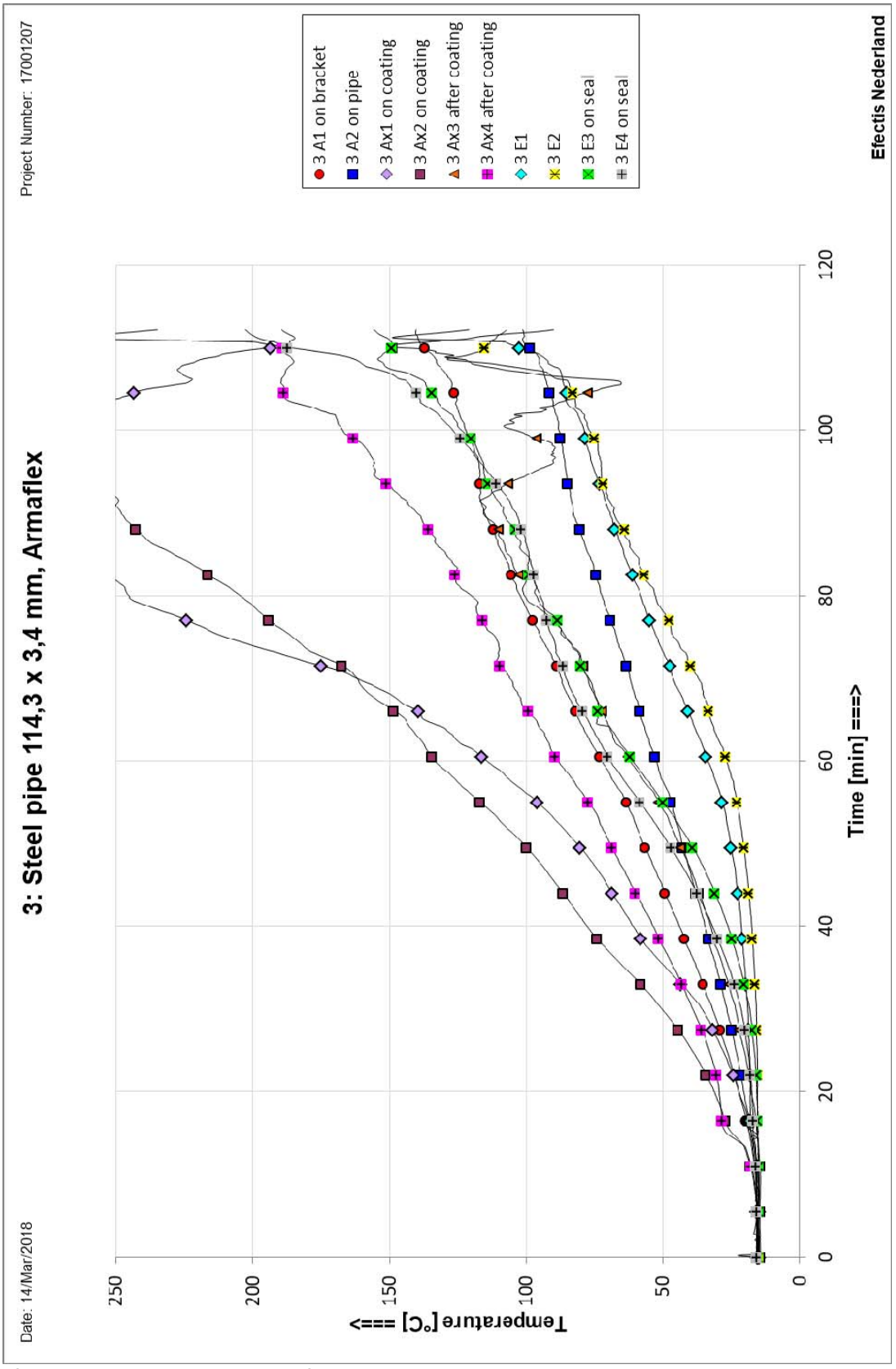


Figure B.4 Temperatures service no. 3

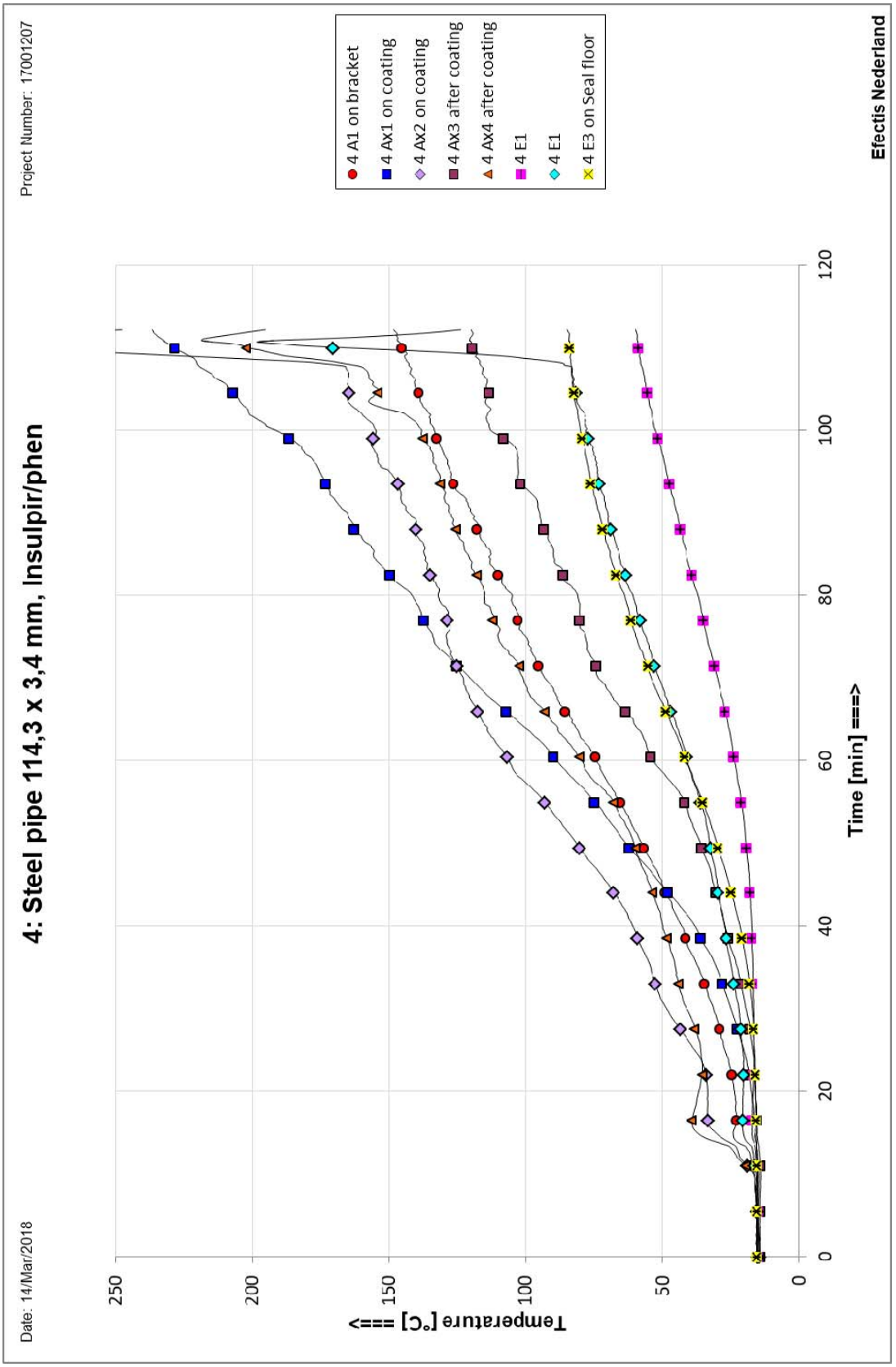


Figure B.5 Temperatures service no. 4

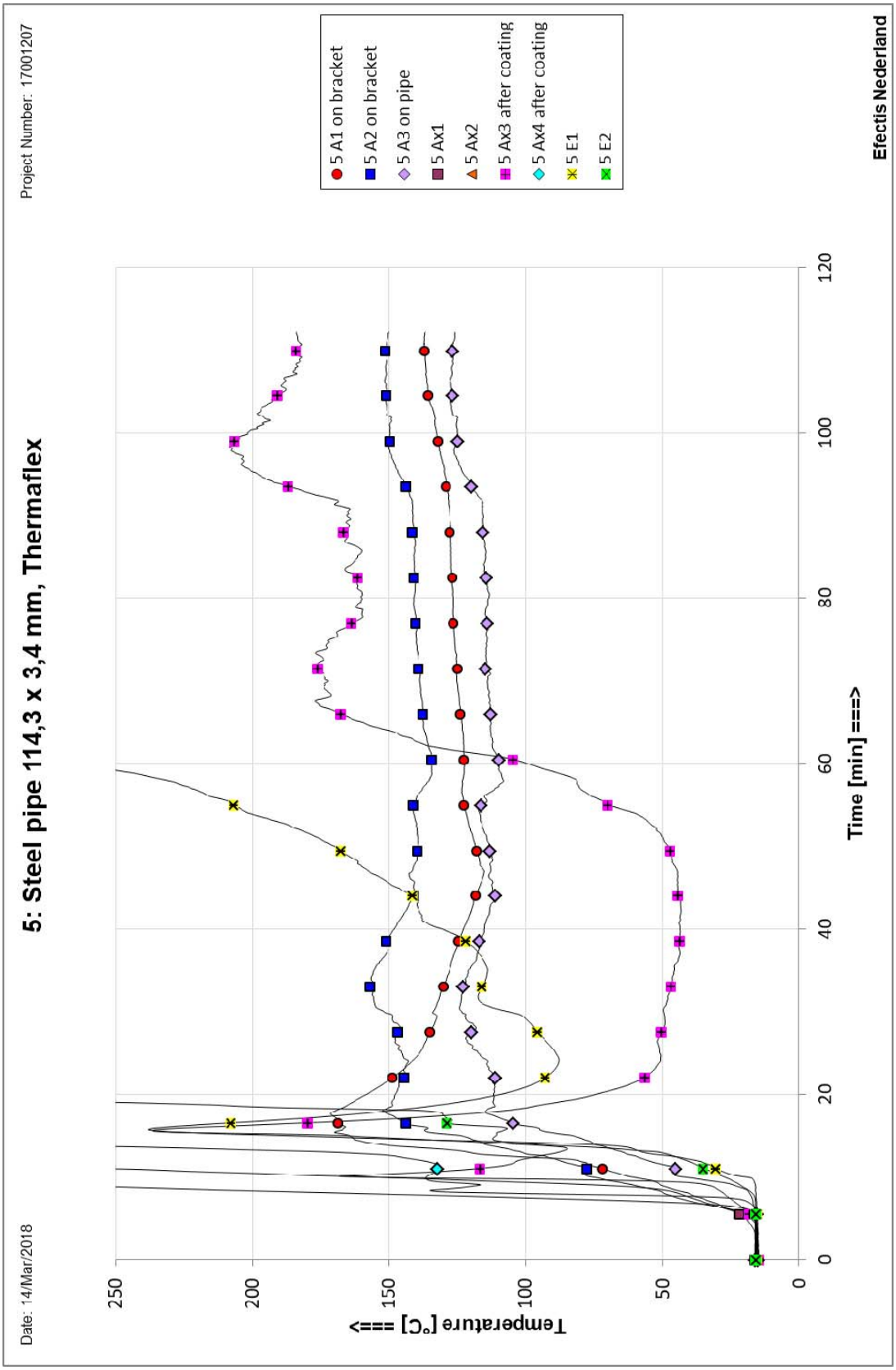


Figure B.6 Temperatures service no. 5

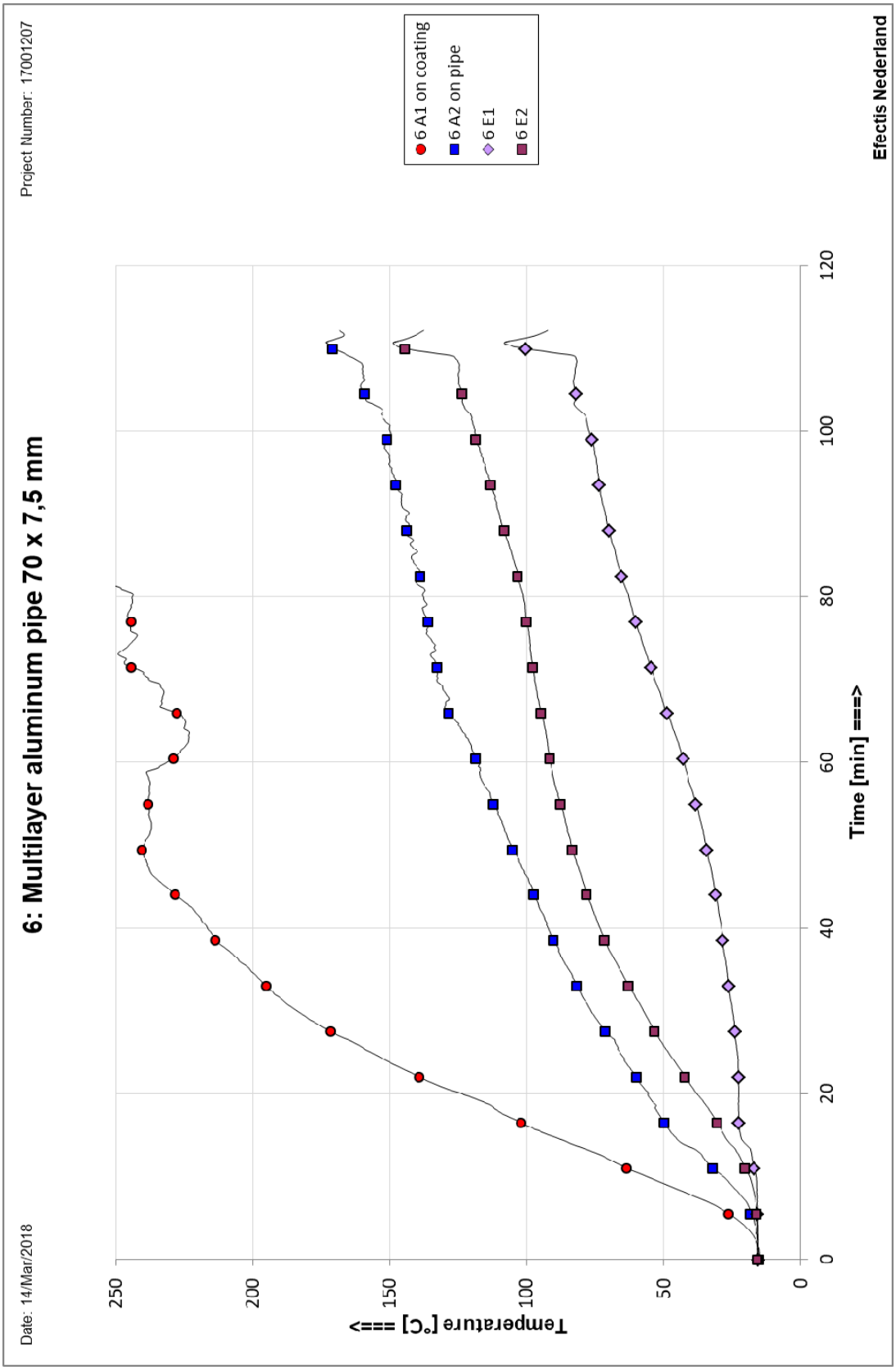


Figure B.7 Temperatures service no. 6

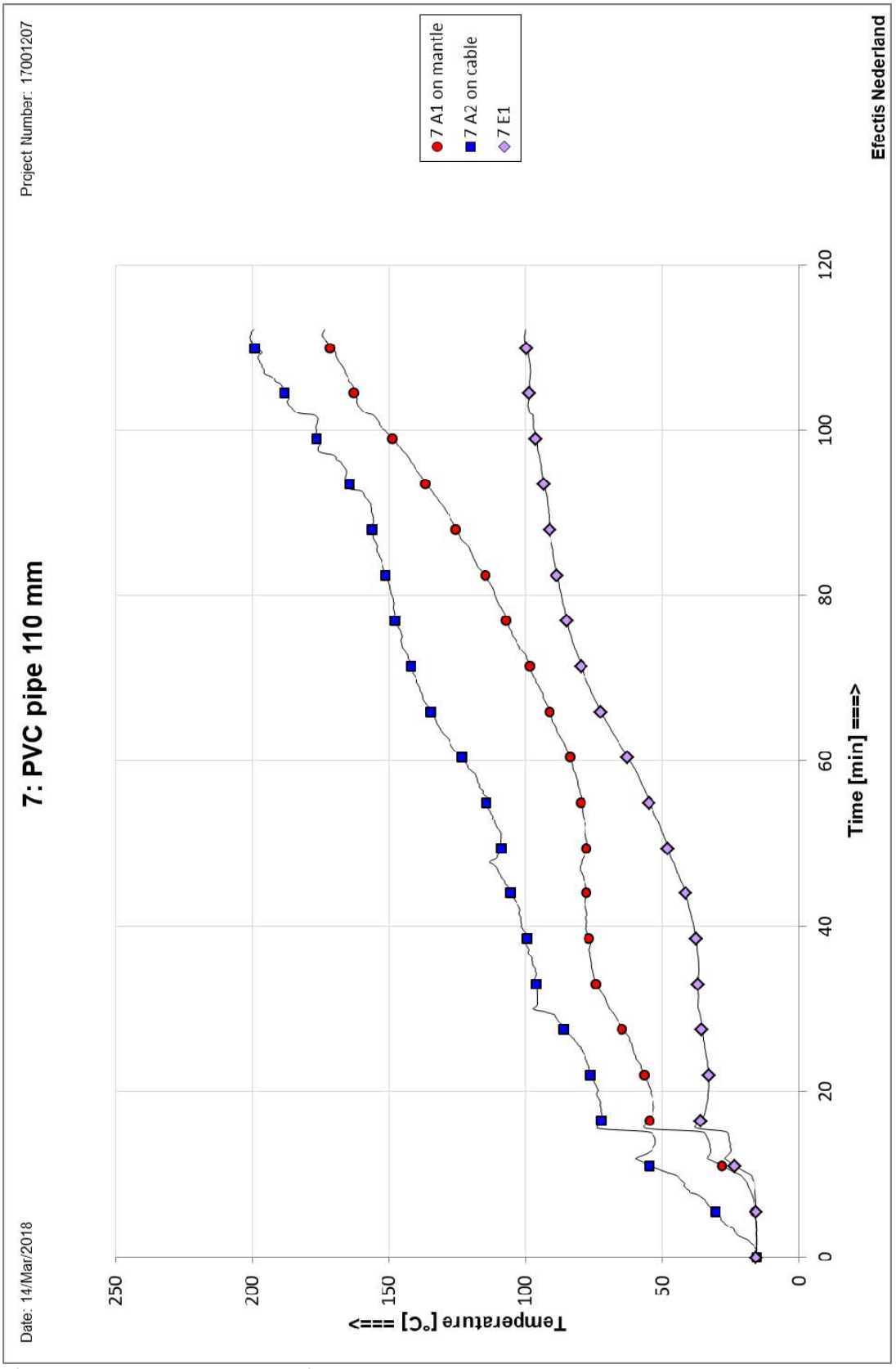


Figure B.8 Temperatures service no. 7

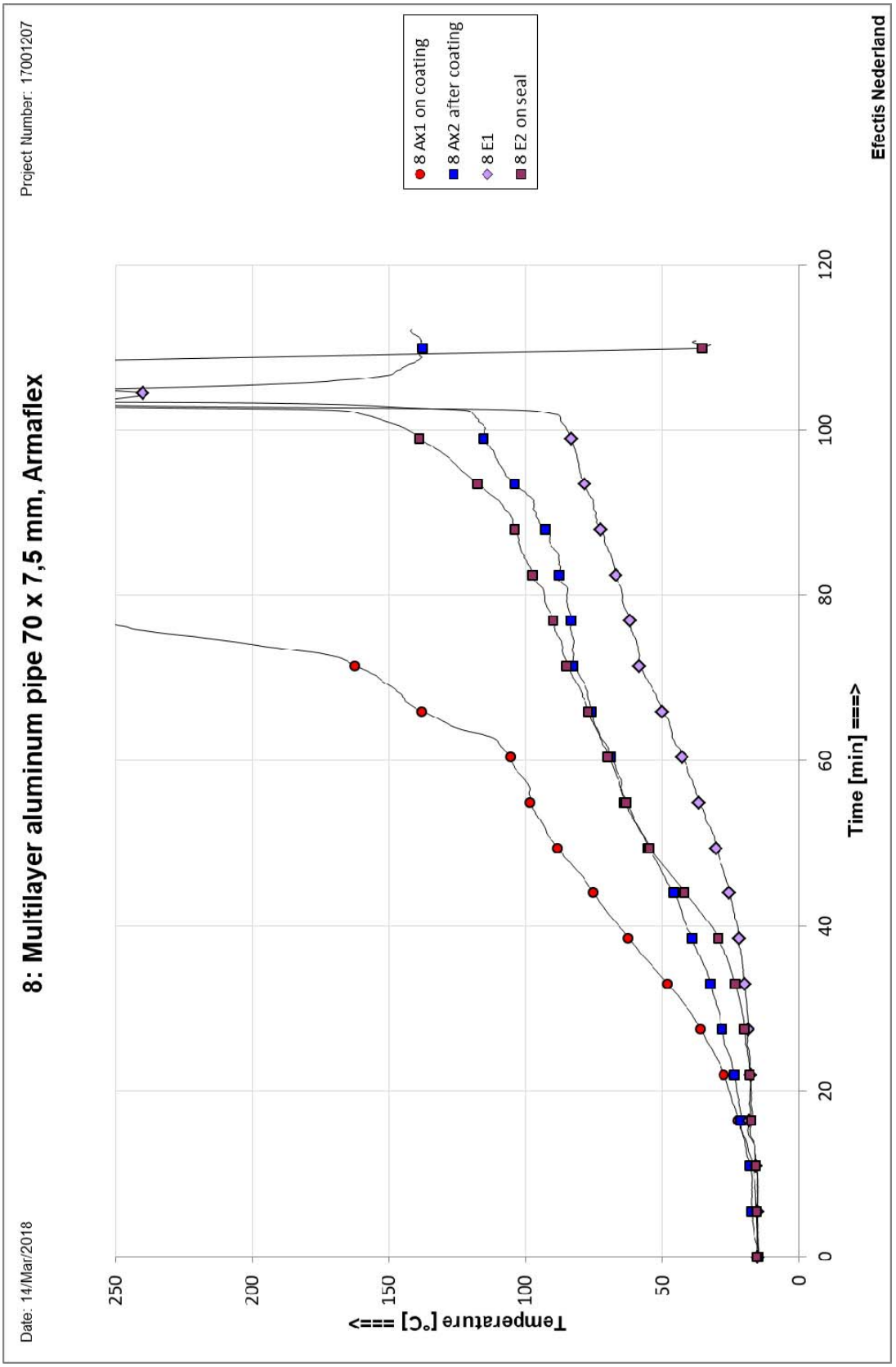


Figure B.9 Temperatures service no. 8

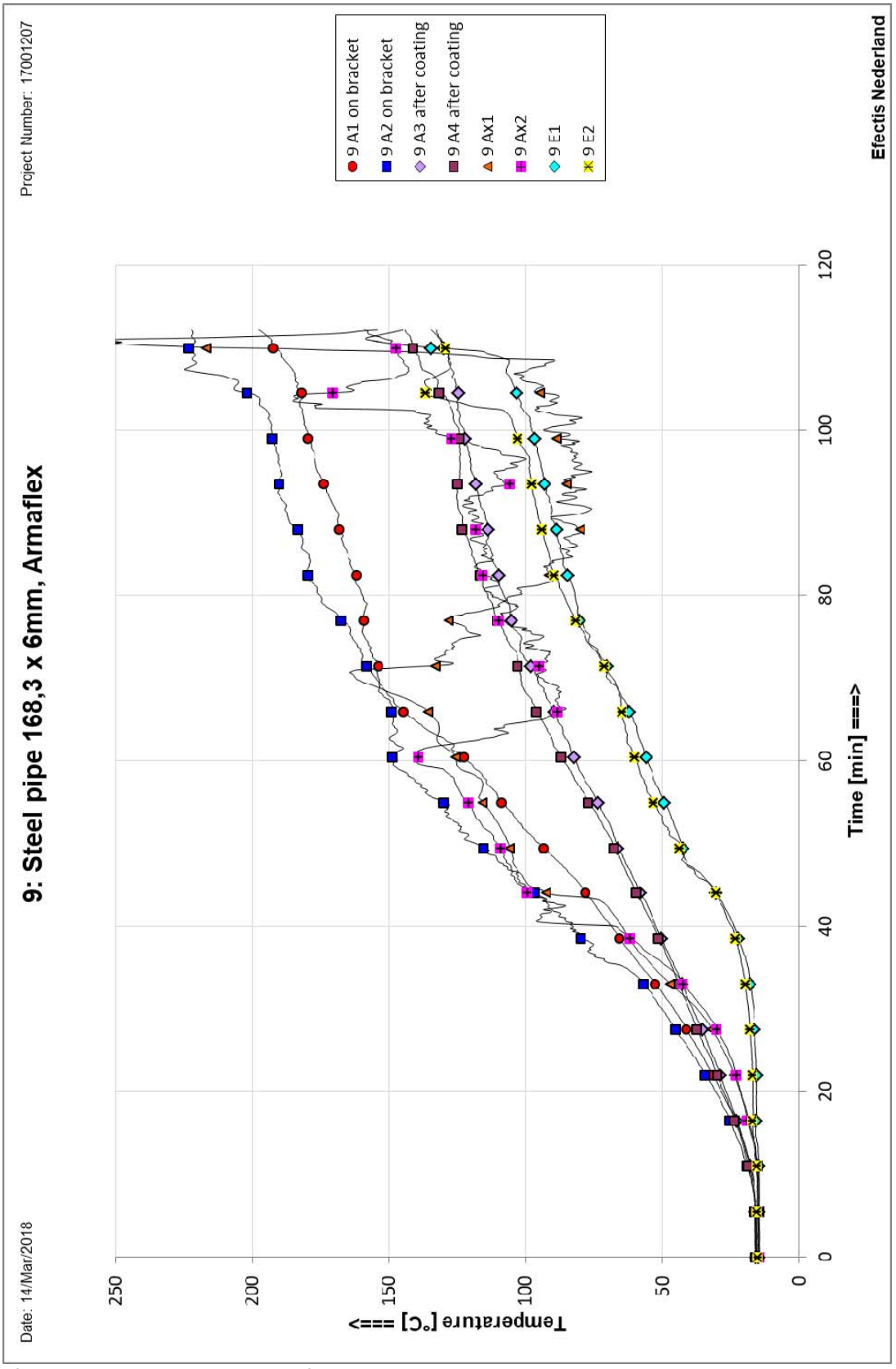


Figure B.10 Temperatures service no. 9

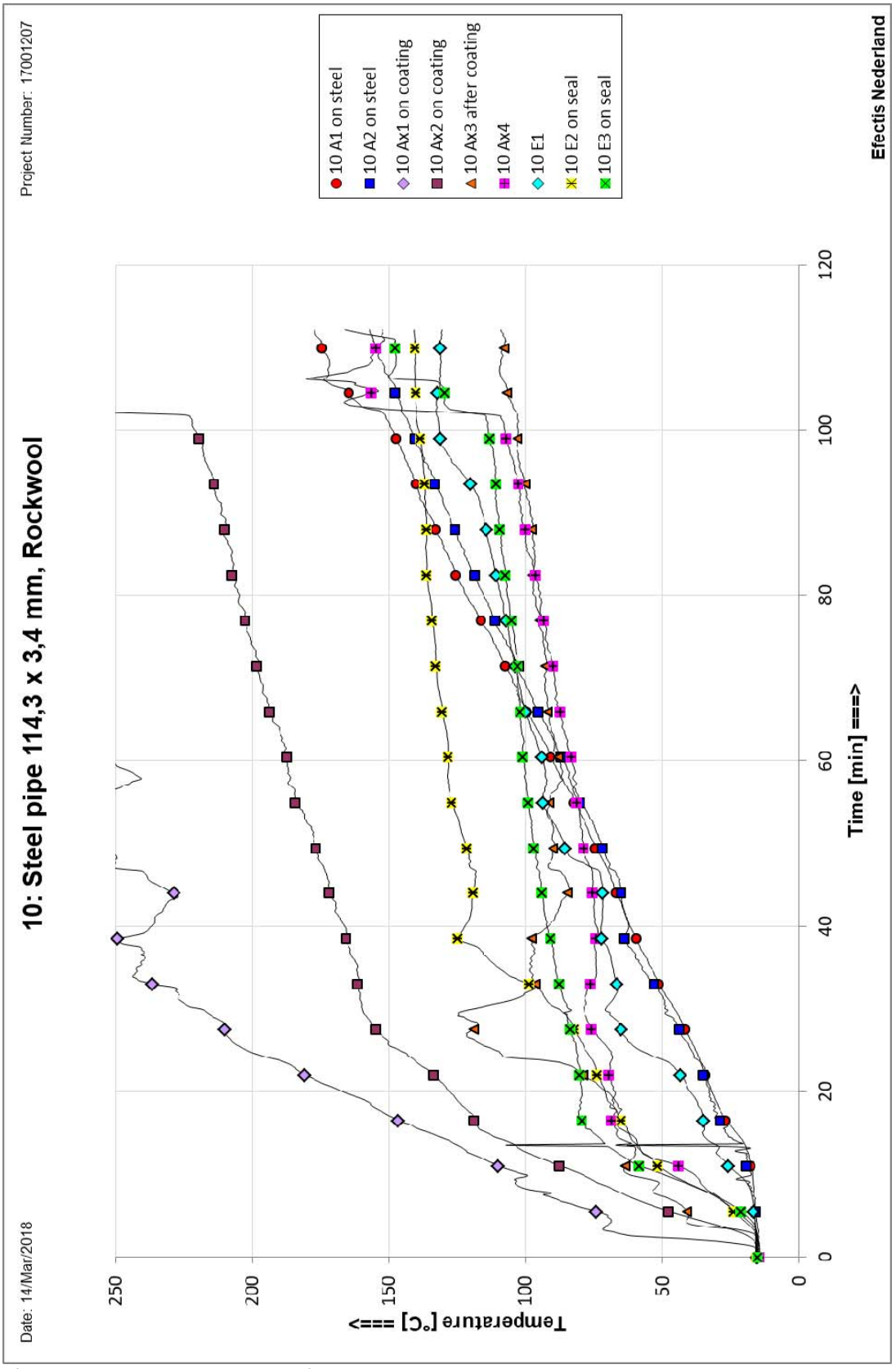
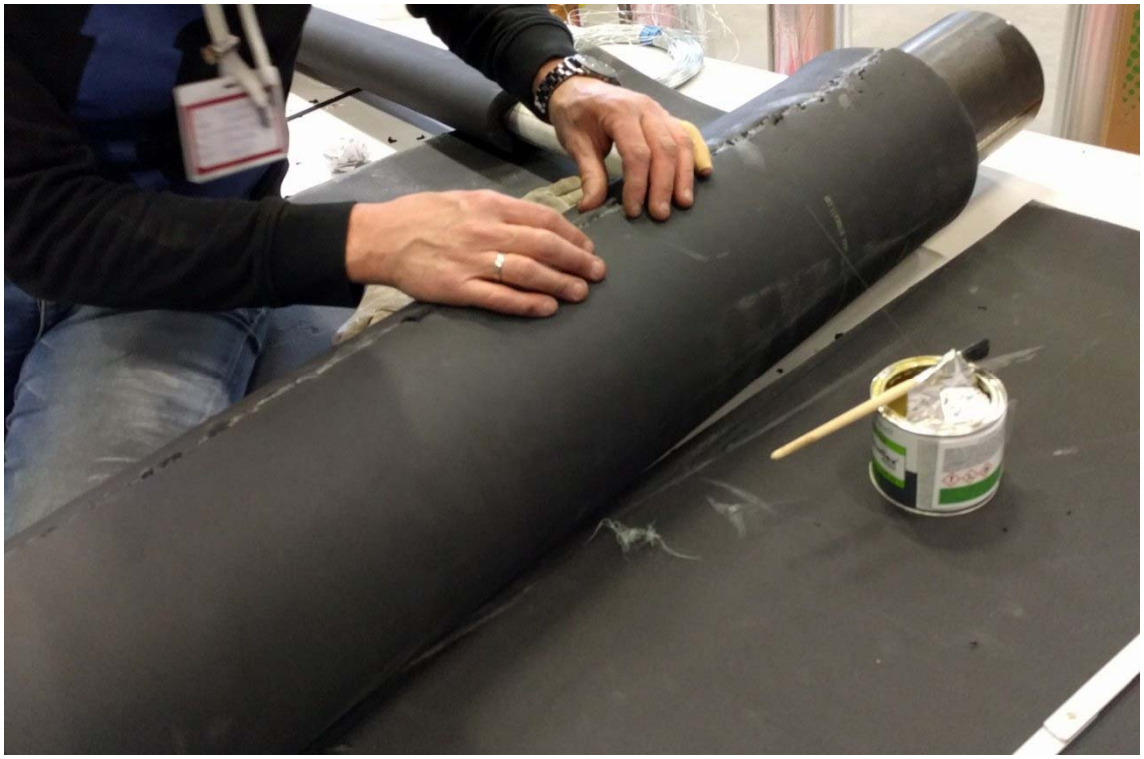
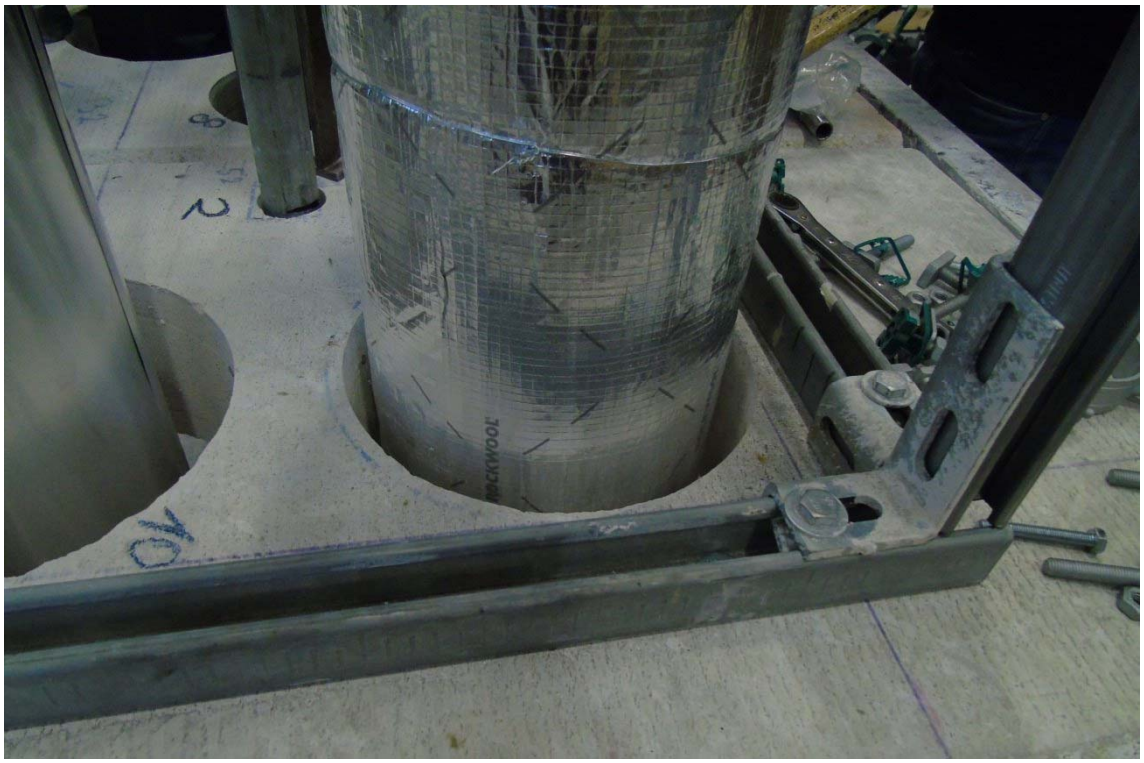


Figure B.11 Temperatures service no. 10

APPENDIX C: PHOTOGRAPHS



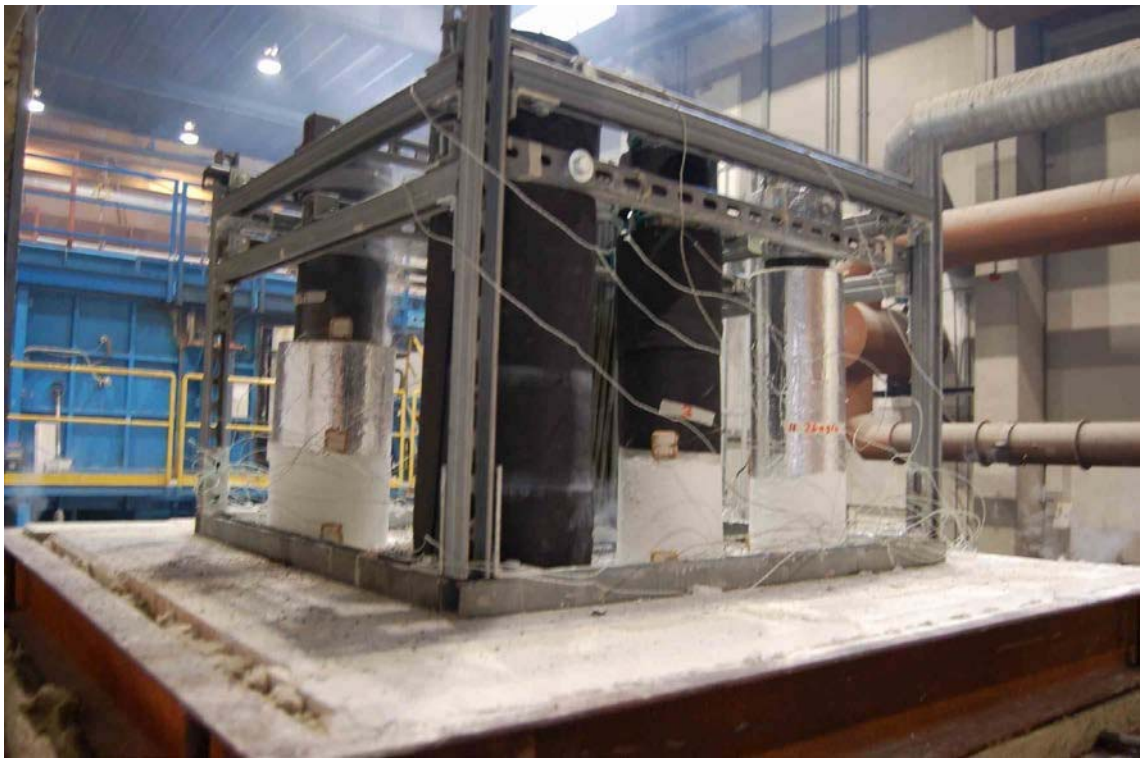
Photograph 1 Installation of the Armaflex



Photograph 2 Service 1 while mounting

Photograph 3 Overview of the exposed side after mounting the services

Photograph 4 Overview of the test specimen, right before heating



Photograph 5 Specimens after 20 min of heating

Photograph 6 Specimens after 28 min of heating

Photograph 7 Specimens after 45 min of heating

Photograph 8 Specimens after 61 min of heating

Photograph 9 Specimens after 91 min of heating

Photograph 10 Specimens after 101 min of heating, flaming on service no. 8

Photograph 11 Specimens after 152 minutes of heating (end of heating after consulting the client)