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Efectis Nederland report

2008-Efectis-R0733[Rev.1]

Determination of the fire resistance according to EN 1366-3: 2004 of the standard configuration for testing sealing materials for use with metal pipes

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Sponsor	Flamro Nederland B.V. Algerastraat 28 3125 BS Schiedam Postbus 146 3100 AC Schiedam The Netherlands
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1 Investigation

Determination of the fire resistance according to EN 1366-3: 2004 of the standard configuration for testing sealing materials for use with metal pipes. The sealing materials are produced by Flamro Brandschutz- Systeme GmbH.

2 Sponsor

Flamro Nederland B.V.
Algerastraat 28
3125 BS Schiedam
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3 Location and date of the investigation

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

Installation of the supporting construction:	9th and 10th of May 2008
Installation of the specimen:	13th and 14th of May 2008
Fire test:	30th of May 2008.

4 Investigated construction

4.1 General description and method of assembly

The standard configuration for testing sealing materials for use with metal pipes has been tested in a flexible supporting construction. The following assembly order has been used:
- Erection of the supporting construction with its apertures;
- Installation of the metal pipes;
- Installation of the mineral wool;
- Coating of the mineral wool.

4.2 Supporting construction

The flexible supporting construction was the standard configuration for constructions with an intended fire resistance of 60 to 90 minutes according to EN 1366-3: 2004. It consisted of a frame work of rolled steel C studs and U tracks with a depth of 50 mm. On this frame work two layers paper faced gypsum plasterboard type F according to EN 520 with a thickness of 12.5 mm were installed on both sides. Mineral wool insulation with a

thickness of 60 and a density of 50 kg/m^3 was used. This resulted in a total thickness of the supporting construction of 100 mm.
The supporting construction had two free vertical edges.

4.3 Specimen description

The test set up consisted of five penetrations. Each penetration will be described in the following paragraphs

4.3.1 Specimen 1, blank penetration seal

Specimen 1 is the blank penetration seal with the following dimensions according to annex C 1of the test norm:
Aperture size a_1= 425 mm
Radius R = 190 mm
Therefore the maximum span $X = (a_1 \times 2^{0.5}) - R = 411$ mm.
Therefore the maximum area of an un penetrated area $A = a_1^2 - (\pi R^2/4) = 152.272$ mm^2.

The specimen build up was as follows:
- The aperture in the wall was finished with metal C studs, on the studs one layer of the gypsum plates were screwed on;
- A layer of Flamro BMS trowel on coating was applied on the edges of the aperture;
- The BS-D mineral wool slab was cut to size and inserted in the aperture in the centre of the wall's thickness;
- The surfaces on both sides of the mineral wool slab were coated with Flamro BMA airless spray on coating applied with a brush with a thickness of approximately 1 mm.
- At positions where the BS-D mineral wool slabs cut to shape did not fit closely to the supporting construction the joint was filled with stop wool together with Flamro BMS trowel on coating.

4.3.2 Specimen 2, steel pipe Ø 89.6 mm

Specimen 2 is the medium diameter steel pipe penetrating the seal with the following dimensions according to annex C 1of the test norm:
Aperture size a_6= 230 mm
The specimen build up was as follows:
- The aperture in the wall was finished with metal C studs, on the studs one layer of the gypsum plates were screwed on;
- The steel pipe, with the dimensions[1] Ø 89.6 mm, wall thickness 4.0 mm, was supported, on both sides of the wall, by a steel construction as given in the test norm at 550 mm from the wall;
- A layer of Flamro BMS trowel on coating was applied on the edges of the aperture;
- The BS-D mineral wool slab was cut to size and inserted in the aperture in the centre of the wall's thickness;
- The pipe was insulated on both sides of the wall with a mineral wool shell, Rockwool 850, with a thickness of 30 mm over a distance of 800 mm. The mineral wool shell was discontinued at the mineral wool slab. On both sides of the wall approximately 170 mm of the pipe was not insulated;
- The mineral wool shell was coated with Flamro BMA airless spray applied with a brush with a thickness of approximately 1 mm on both sides of the wall over a distance of 170 mm;

[1] Measured values

- The surfaces on both sides of the mineral wool slab were coated with Flamro BMA airless spray on coating applied with a brush with a thickness of approximately 1 mm.
- At positions where the mineral wool slabs cut to shape did not fit closely to the supporting construction and the pipes the joint was filled with stop wool together with Flamro BMS trowel on coating.

4.3.3 *Specimen 3, copper pipe Ø 107.8 mm*

Specimen 3 is the large copper pipe penetrating the seal with the following dimensions according to annex C 1of the test norm:
Aperture size a_5= 135 mm
Aperture size a_6= 230 mm
The specimen build up was as follows:

- The aperture in the wall was finished with metal C studs, on the studs one layer of the gypsum plates were screwed on;
- The copper pipe, with the dimensions[2] Ø 107.8 mm, wall thickness 2.5 mm, was supported, on both sides of the wall, by a steel construction as given in the test norm at 550 mm from the wall;
- A layer of Flamro BMS trowel on coating was applied on the edges of the aperture;
- The BS-D mineral wool slab was cut to size and inserted in the aperture in the centre of the wall's thickness;
- The pipe was insulated on both sides of the wall with a mineral wool shell, Rockwool 850, with a thickness of 30 mm over a distance of 800 mm. The mineral wool shell was discontinued at the mineral wool slab. On both sides of the wall approximately 170 mm of the pipe was not insulated;
- The mineral wool shell was coated with Flamro BMA airless spray applied with a brush with a thickness of approximately 1 mm on both sides of the wall over a distance of 170 mm;
- The surfaces on both sides of the mineral wool slab were coated with Flamro BMA airless spray on coating applied with a brush with a thickness of approximately 1 mm.
- At positions where the mineral wool slabs cut to shape did not fit closely to the supporting construction and the pipes the joint was filled with stop wool together with Flamro BMS trowel on coating.

4.3.4 *Specimen 4, steel pipe Ø 274 mm*

Specimen 4 is the large steel pipe penetrating the seal with the following dimensions according to annex C 1of the test norm:
Aperture size a_1= 425 mm
Aperture size a_4= 283 mm
The specimen build up was as follows:

- The aperture in the wall was finished with metal C studs, on the studs one layer of the gypsum plates were screwed on;
- The steel pipe, with the dimensions[2] Ø 274 mm, wall thickness 6.1 mm, was supported, on both sides of the wall, by a steel construction as given in the test norm at 550 mm from the wall;
- A layer of Flamro BMS trowel on coating was applied on the edges of the aperture;
- The BS-D mineral wool slab was cut to size and inserted in the aperture in the centre of the wall's thickness;
- The pipe was insulated on both sides of the wall with a mineral wool shell, Rockwool 850, with a thickness of 30 mm over a distance of 800 mm. The mineral wool shell

[2] Measured values

was discontinued at the mineral wool slab. On both sides of the wall approximately 170 mm of the pipe was un insulated;
- The mineral wool shell was coated with Flamro BMA airless spray applied with a brush with a thickness of approximately 1 mm on both sides of the wall over a distance of 170 mm;
- The surfaces on both sides of the mineral wool slab were coated with Flamro BMA airless spray on coating applied with a brush with a thickness of approximately 1 mm.
- At positions where the mineral wool slabs cut to shape did not fit closely to the supporting construction and the pipes the joint was filled with stop wool together with Flamro BMS trowel on coating.

4.3.5 Specimen 5, 2 copper pipes Ø 35.1 mm and 2 steel pipes Ø 33.6 mm

Specimen 5 is the smaller diameters copper and steel pipes penetrating the seal with the following dimensions according to annex C 1of the test norm:
Aperture size a_2= 155 mm
Aperture size a_3= 400 mm
The specimen build up was as follows:
- The aperture in the wall was finished with metal C studs, on the studs one layer of the gypsum plates were screwed on;
- The copper pipes, with the dimensions[3] Ø 35.1 mm, wall thickness 1.7 mm, were supported, on both sides of the wall, by a steel construction as given in the test norm at 550 mm from the wall.
  The steel pipes, with the dimensions[3] Ø 33.6 mm, wall thickness 3.4 mm, were supported, on both sides of the wall, by a steel construction as given in the test norm at 550 mm from the wall. The distances[3] between the pipes were 50 mm;
- A layer of Flamro BMS trowel on coating was applied on the edges of the aperture;
- The mineral wool slab was cut to size and inserted in the aperture in the centre of the wall's thickness;
- The pipes were insulated on both sides of the wall with a mineral wool shell, Rockwool 850, with a thickness of 25 mm over a distance of 800 mm. The mineral wool shell was discontinued at the mineral wool slab. On both sides of the wall approximately 170 mm of the pipe was un insulated;
- The BS-D mineral wool shells were coated with Flamro BMA airless spray applied with a brush with a thickness of approximately 1 mm on both sides of the wall over a distance of 170 mm;
- The surfaces on both sides of the mineral wool slab were coated with Flamro BMA airless spray on coating applied with a brush with a thickness of approximately 1 mm.
- At positions where the mineral wool slabs cut to shape did not fit closely to the supporting construction and the pipes the joint was filled with stop wool together with Flamro BMS trowel on coating.

[3] Measured values

5 Production and installation of the specimen and the supporting construction

Flamro Nederland B.V.	:	Production and installation of the specimen
Demaco B.V. Wouwsestraatweg 4 4621 JA Bergen op Zoom	:	Installation of the supporting construction

6 Method of investigation

6.1 Verification of the test specimen

6.1.1 General

The construction was delivered and installed by the sponsor.
Efectis was not involved in the selection of the materials.

6.2 Conditioning

After delivery the valve was stored in the laboratory of Efectis with ambient conditions 20 ± 5 °C temperature and 50 ± 10 % relative humidity.

6.3 Density and equilibrium moisture content[4]

Paper faced gypsum plasterboard type F according to EN 520
- Density : 1026 kg/m^3
- Moisture content : 0.2 %

Mineral wool shell
- Density : 53 kg/m^3
- Moisture content : 0 %

Mineral wool slab
- Density : 56 kg/m^3
- Moisture content : 0 %

[4] Moisture content determined after drying 24 hrs at 60°C

6.4 Fire test

6.4.1 Conditions and test situation

The investigation was carried out according to EN 1366-3: 2004. During the test the temperature in the laboratory was within the specifications given in EN 1363-1. All metal pipes were capped, C/U, on the fire side. The aimed pressure in the furnace was set at 15 Pa on the centre of penetration 5.

6.4.2 Measurements

During the test the following measurements were made:
- Gas temperatures in the furnace;
- Pressure in the furnace;
- Surface temperatures on the specimen.

7 Observations

Table 7.1 Observations

Time [min]	Observation
0	Start of heating.
4	Some smoke is coming from the inside of pipe 3
11	Smoke coming from the inside of pipe 3 is less. TK3 9 is malfunctioning, will not be reported.
14	No smoke is coming from pipe 3
50	The supporting construction has been deformed substantially and bending away from the furnace. Due to the bending the wall is resting against the steel supporting construction of the pipes
61	On the right side a large crack is forming in the supporting construction. The surface is turning black
77	The end of the heating after consulting the sponsor.
	After the test it was observed that the cap of one of the steel pipes had fallen of. That is probably the reason that TK5 23 had a rapid temperature rise, because the thermocouples TK5 20, TK5 21 and TK5 22 fixed on comparable positions on another steel pipe and on copper pipes as well with nearly the same dimensions showed relatively lower temperature rises during the test.

8 Measurements

8.1 Test results

The test results in a graphical form are given in the figures in appendix A.

In Table 8.1 the results of the investigation are given.

Table 8.1 Test results specimen 1

Criterion	Exceeded
1. Integrity [E] sustained flaming cotton pad 2. Insulation regarding temperature [I]	 77 minutes 77 minutes 77 minutes
The test was discontinued after 77 minutes	

Table 8.2 Test results specimen 2

Criterion	Exceeded
1. Integrity [E] sustained flaming cotton pad 2. Insulation regarding temperature [I]	 77 minutes 77 minutes 77 minutes
The test was discontinued after 77 minutes	

Table 8.3 Test results specimen 3

Criterion	Exceeded
1. Integrity [E] sustained flaming cotton pad 2. Insulation regarding temperature [I]	 77 minutes 77 minutes 77 minutes
The test was discontinued after 77 minutes	

Table 8.4 Test results specimen 4

Criterion	Exceeded
1. Integrity [E] sustained flaming cotton pad 2. Insulation regarding temperature [I]	 77 minutes 77 minutes 77 minutes
The test was discontinued after 77 minutes	

Table 8.5 Test results specimen 5

Criterion	Exceeded
1. Integrity [E] sustained flaming cotton pad	 77 minutes 77 minutes
2. Insulation regarding temperature [I]	51 minutes
The test was discontinued after 77 minutes	

8.2 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.

9 Direct field of application

9.1 General

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.

The results of the fire test are directly applicable to similar constructions where one or more of the changes below are made and the construction continues to comply with the appropriate design codes for its stiffness and stability. Other changes are not permitted.

9.2 Direct field of application

Where the standard configuration was used, the results obtained using steel and copper pipes shall not be applied to metals with a melting point of less than 1000°C, such as brass and aluminium.

For applications where the required integrity performance is lower than the result of the tests, the maximum span X and the maximum area A can be extrapolated by using a multiplication factor $(FR_{test}/FR_{required})^{0.5}$:
$X_{extrapolated} = X_{tested} \times (FR_{test}/FR_{required})^{0.5}$
$A_{extrapolated} = A_{tested} \times (FR_{test}/FR_{required})^{0.5}$

Where,

FR_{test} = Integrity performance of specimen a in the test in minutes
$FR_{required}$ = Integrity performance required by the application in minutes

But only for cases where $FR_{test} > FR_{required}$

9.3 Change from metal stud to timber stud framing

Test results obtained in gypsum standard supporting constructions can be applied to similar flexible constructions as described in paragraph 4.2 with greater wall thickness or systems with more layers of board on each face. These results also apply to flexible constructions with timber studs (breadth/depth ≥ 50 mm × 75 mm) constructed in the same manner with the same number of layers provided that no part of the penetration sealing system is closer than 100 mm to a stud, that the cavity is closed between the penetration sealing system and the stud, and that 100 mm of insulation is provided within the cavity between the penetration seal and the stud.

9.4 Change from flexible supporting construction to stone like materials

Test results obtained with flexible supporting constructions can be applied to concrete or masonry elements of a thickness equal to or greater than that of the element used in the tests.

P.G.R. Scholten, B.Sc. R.D. Scheepe, B. Sc.

10 Drawings

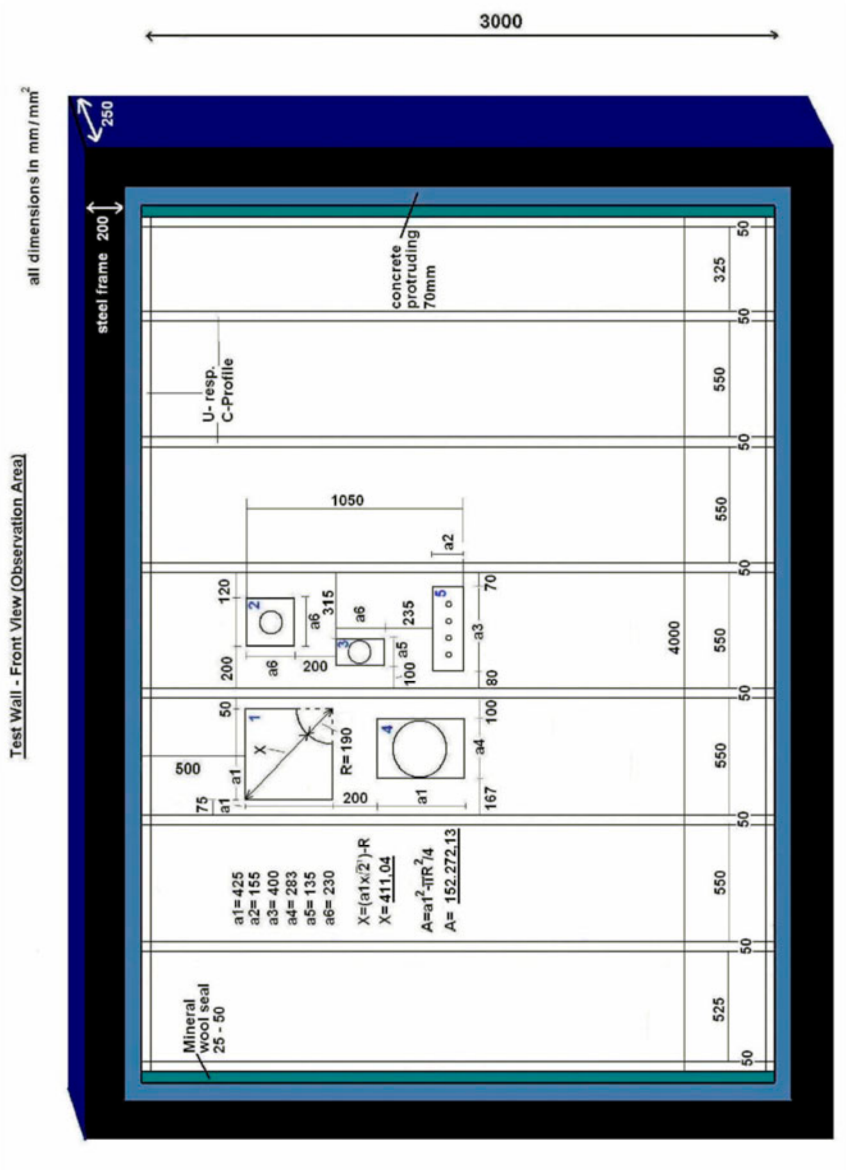


Figure 10.1 General overview of the test specimens in the supporting construction.

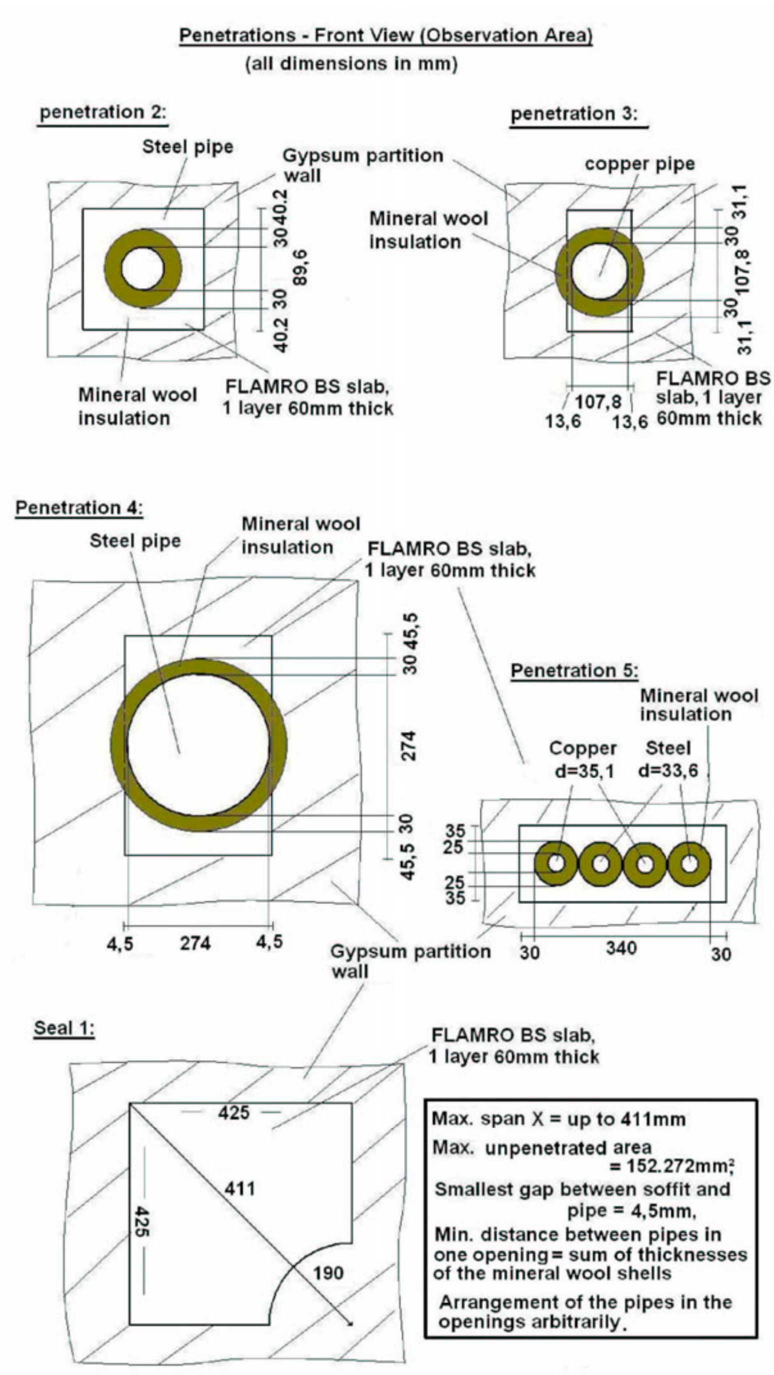


Figure 10.2 Measurements of the specimens

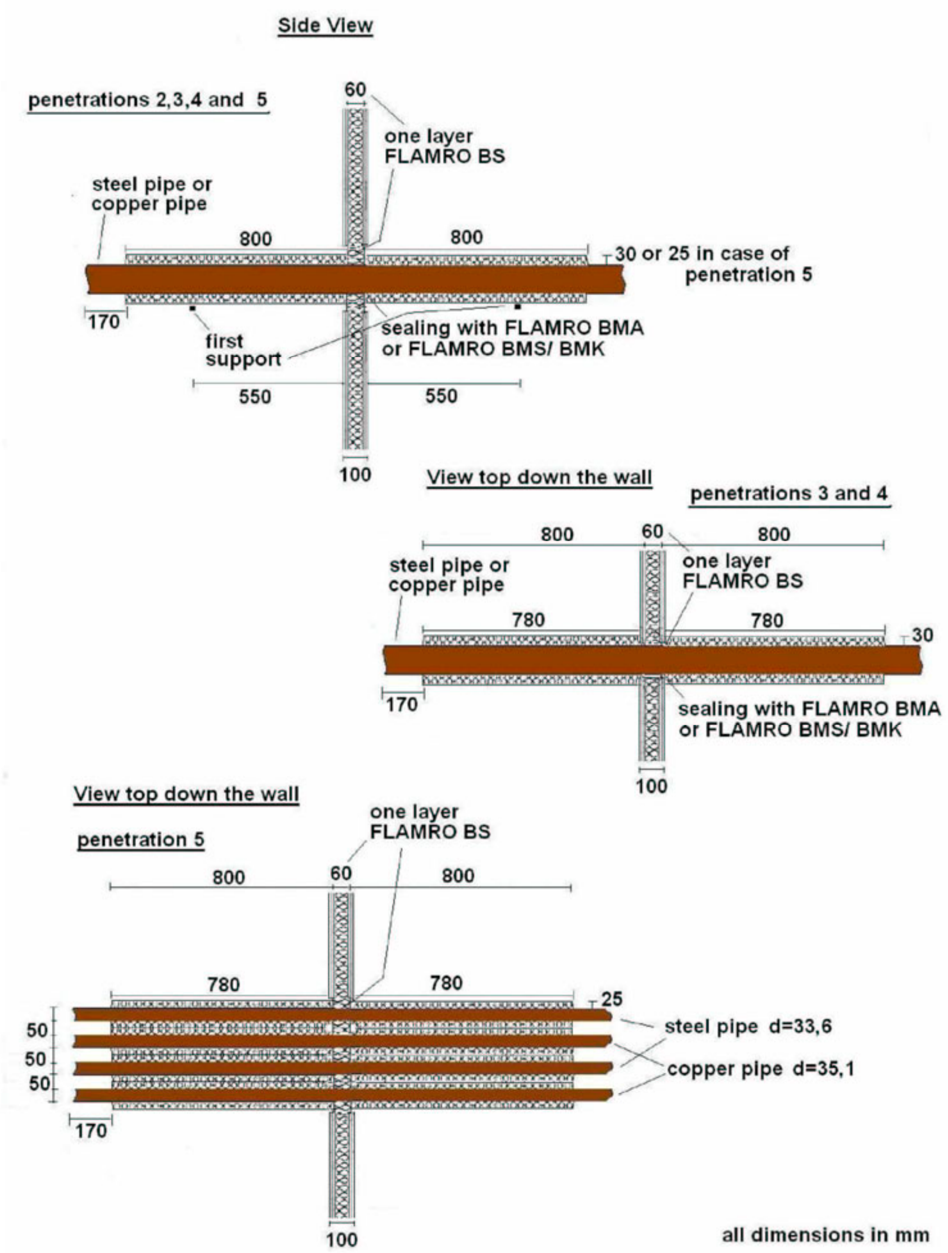


Figure 10.3 Cross sections of the specimens

A Test results

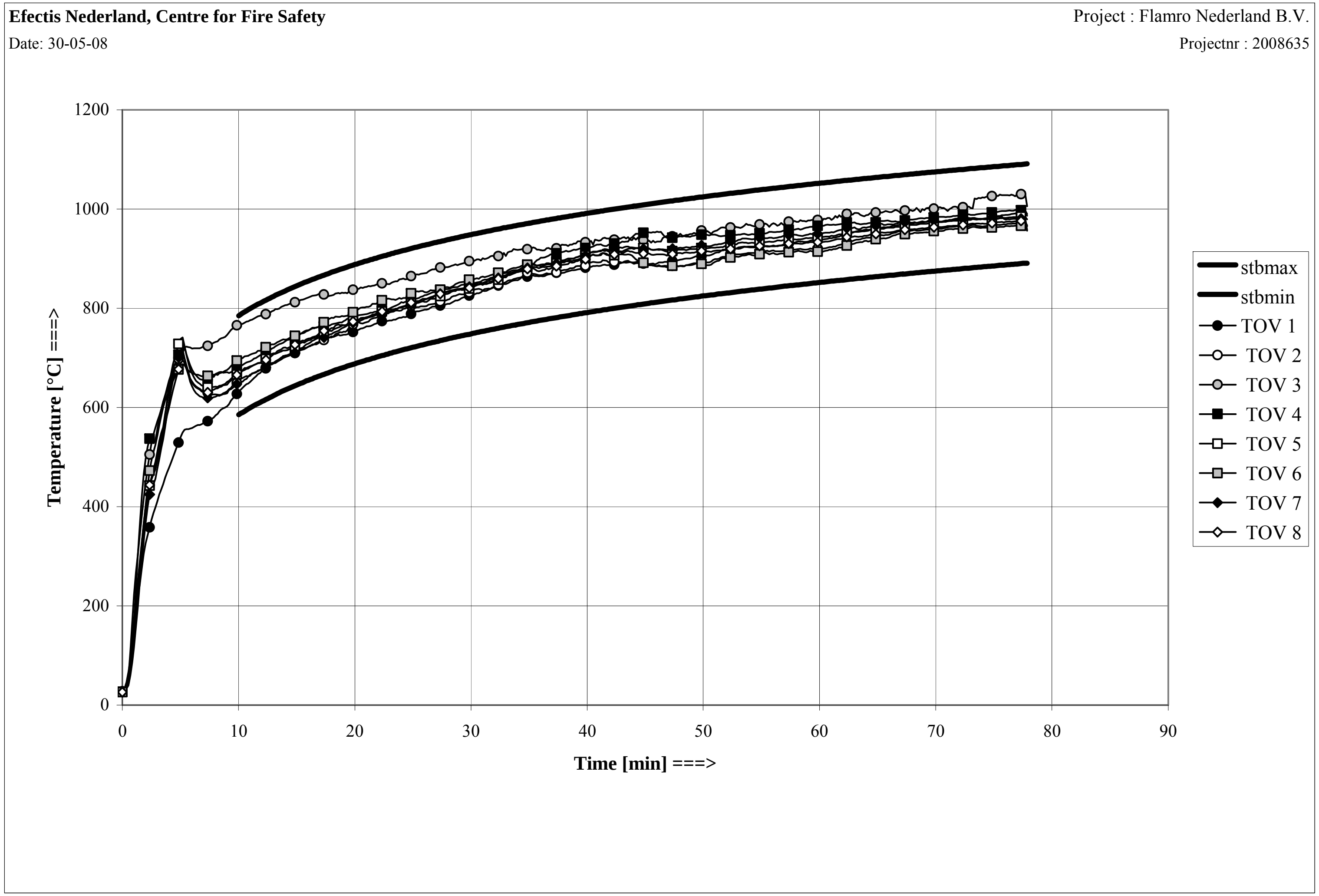


Figure A1 Furnace temperatures

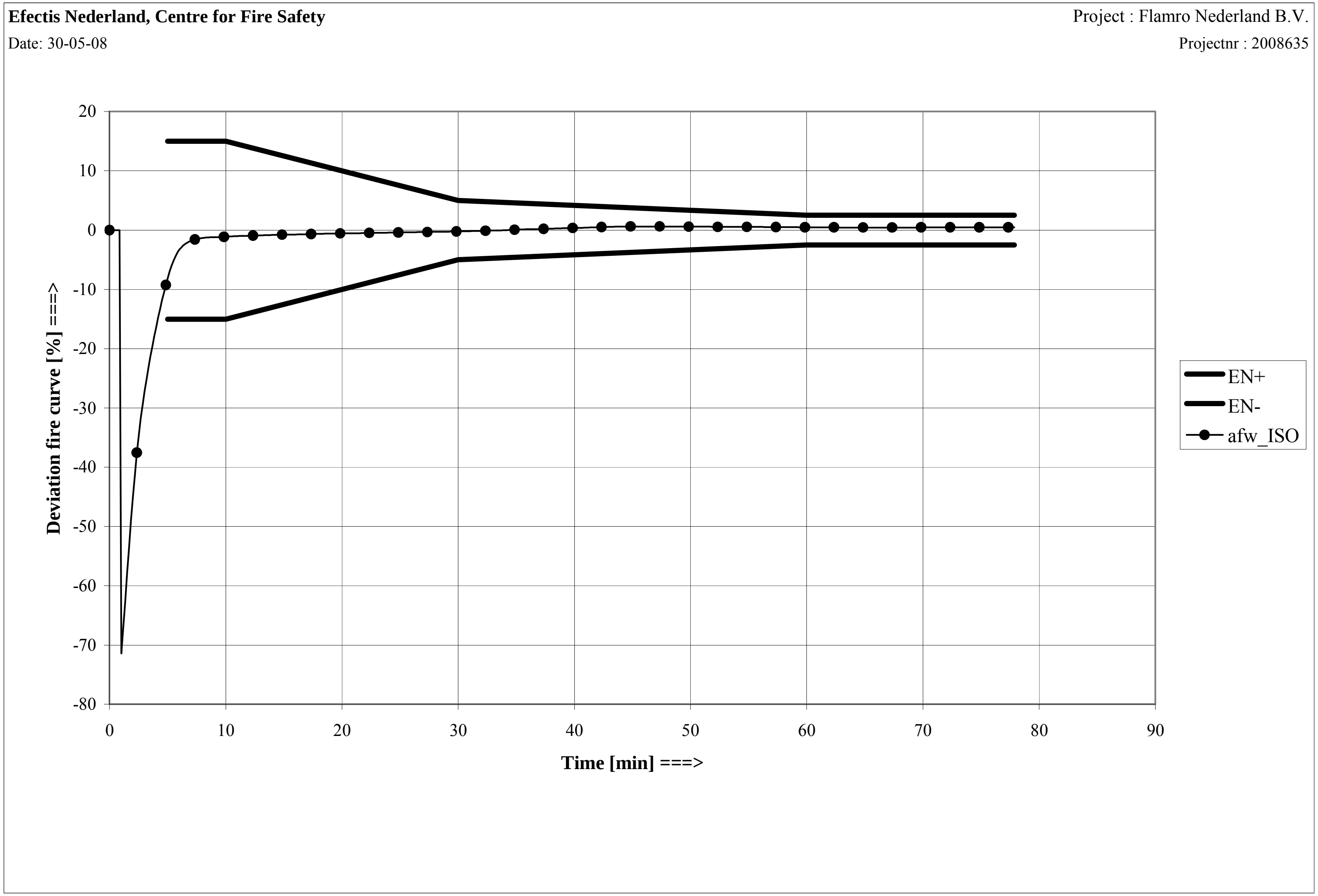


Figure A2 Relative deviation from the standard fire curve according to EN 1363-1

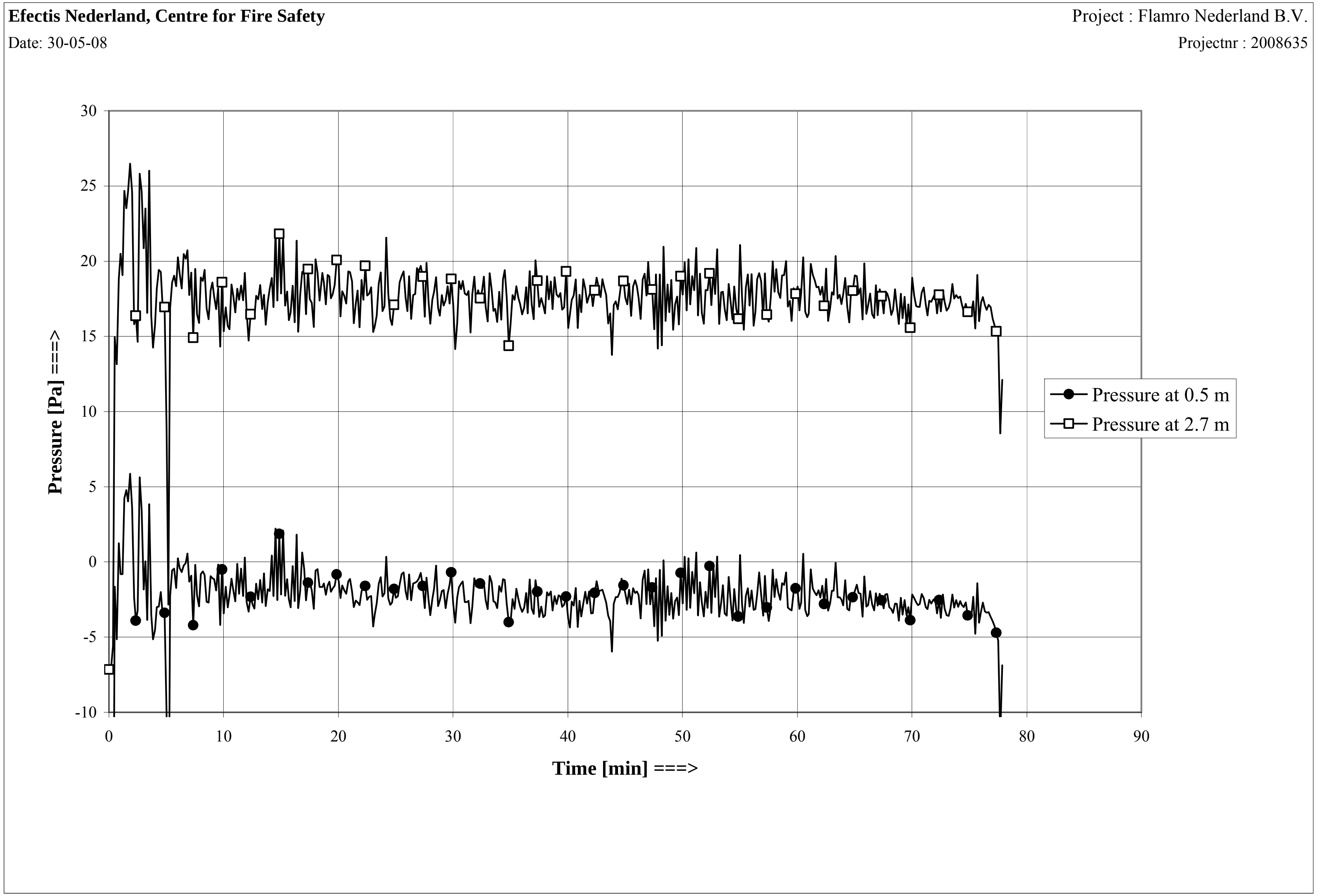


Figure A3 Pressure in the furnace at different heights

Efectis Nederland, Centre for Fire Safety Project : Flamro Nederland B.V.

Date: 30-05-08 Projectnr : 2008635

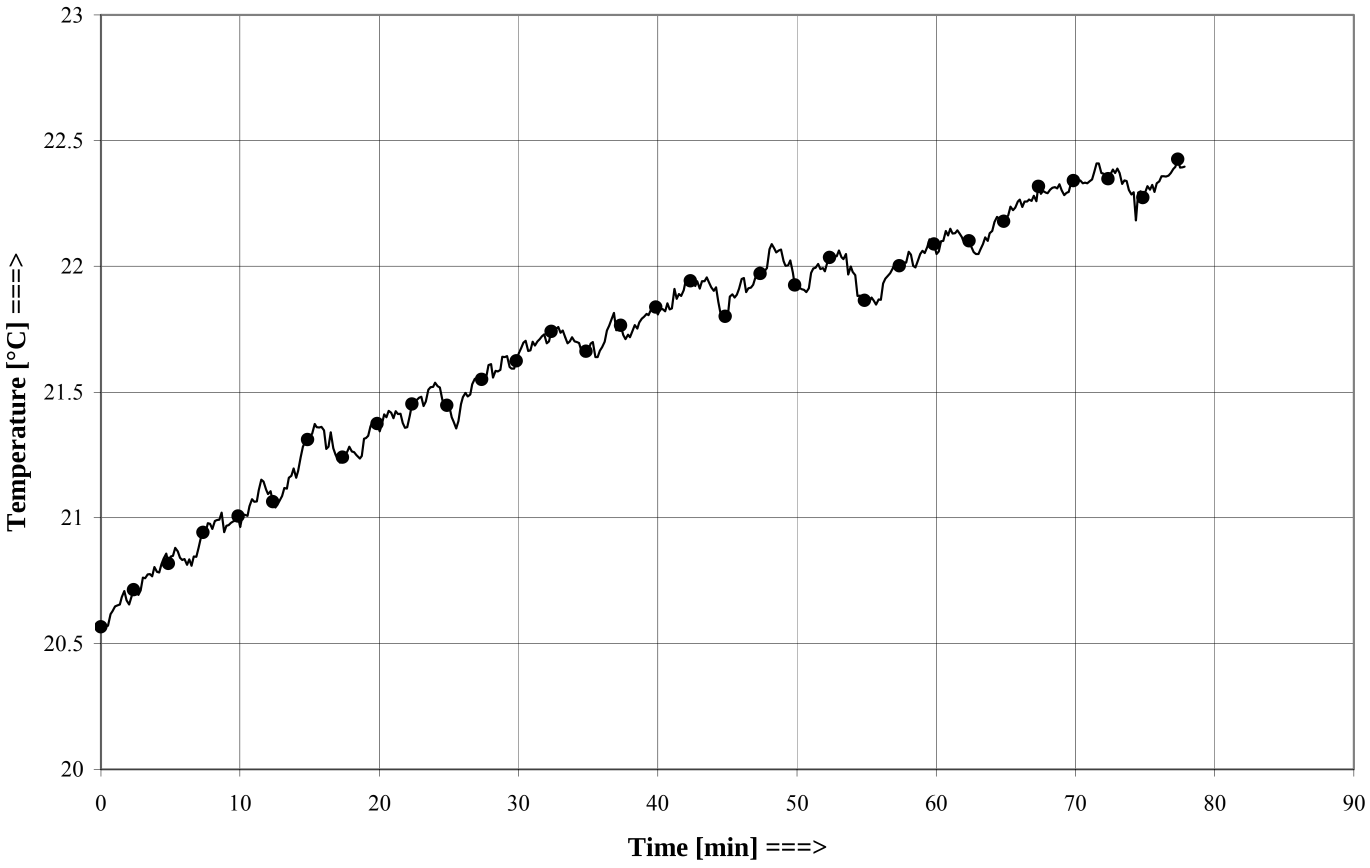


Figure A4 Ambient temperature in the laboratory during the test

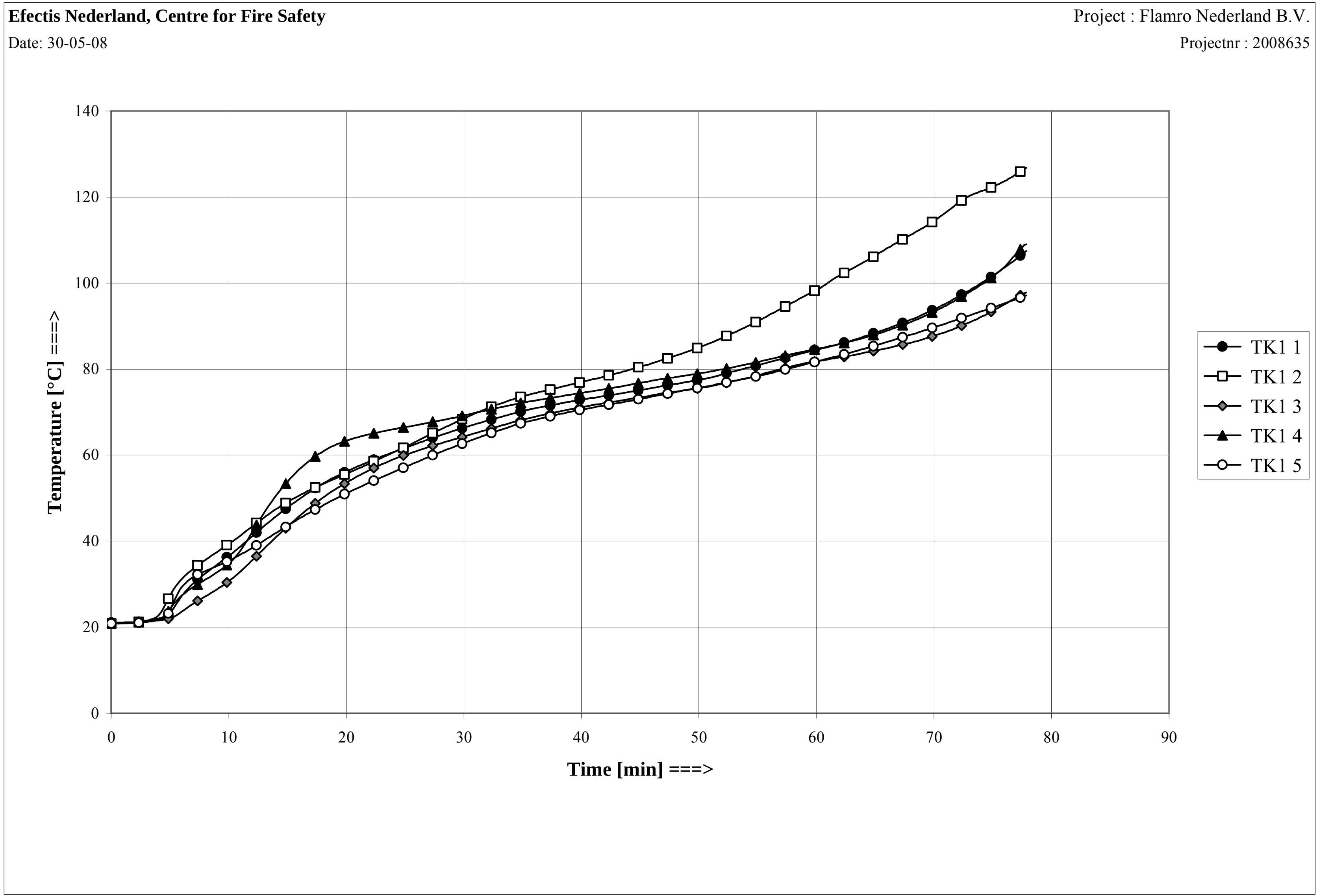


Figure A5 Temperatures on specimen 1

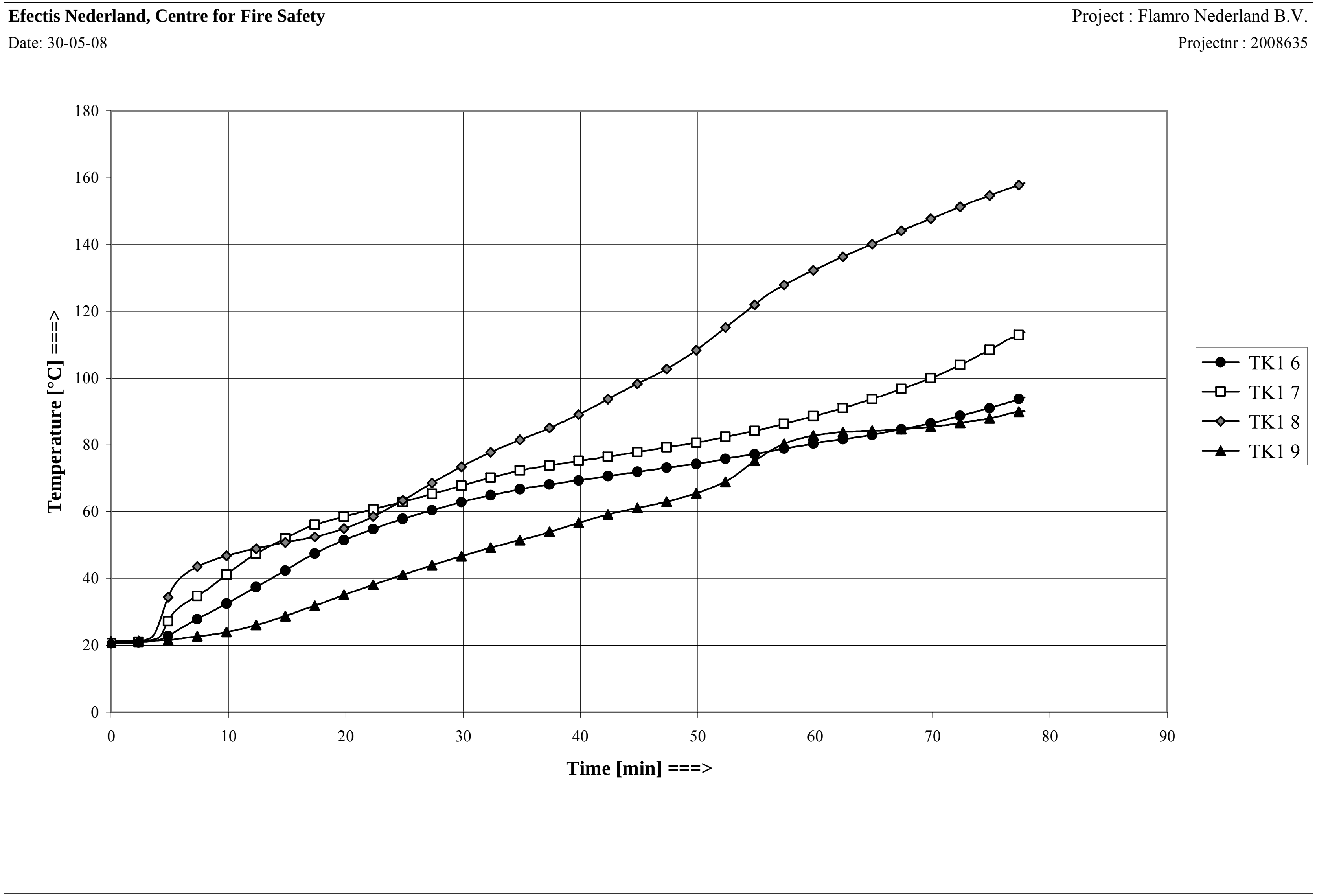


Figure A6 Temperatures on specimen 1

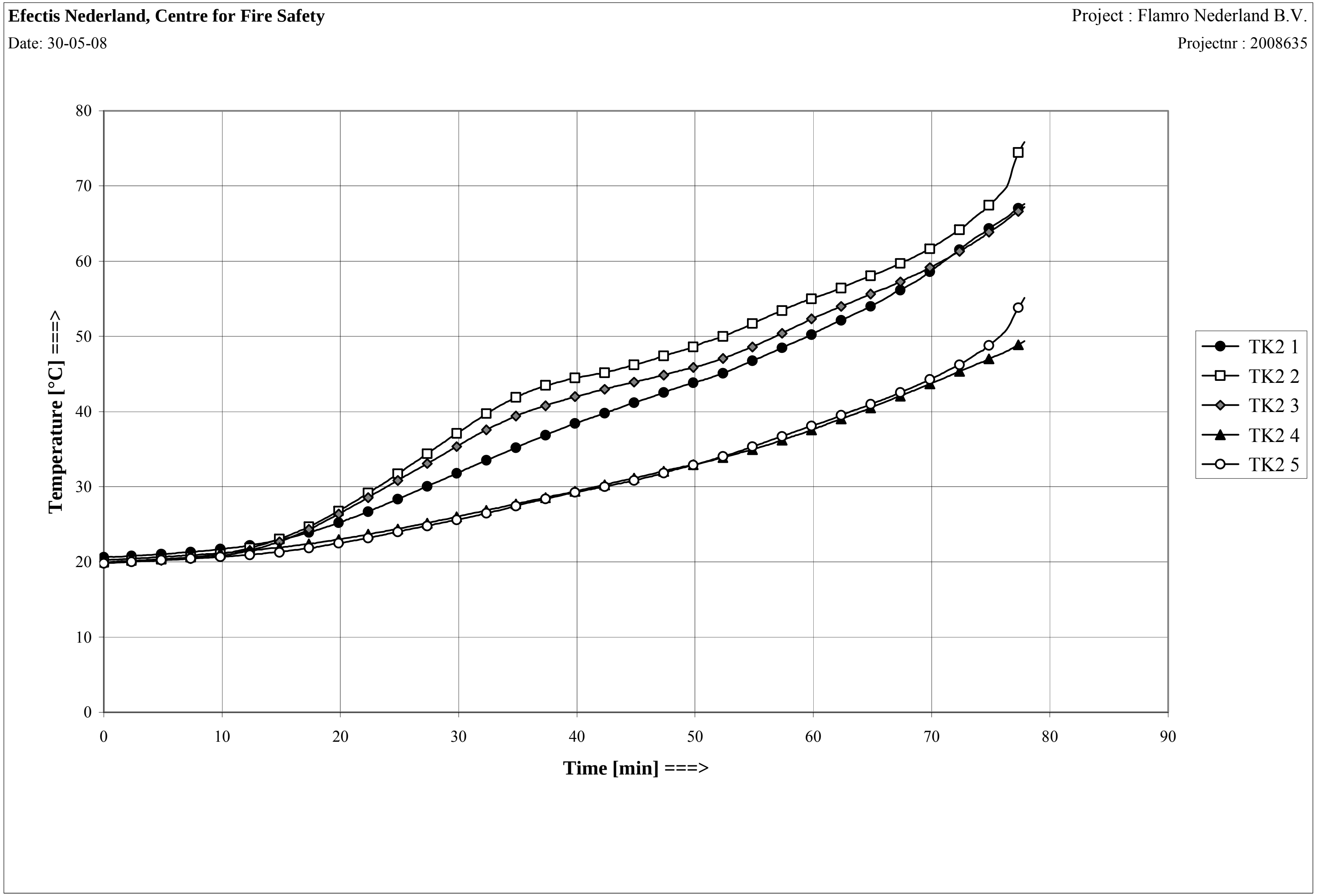


Figure A7 Temperatures on specimen 2

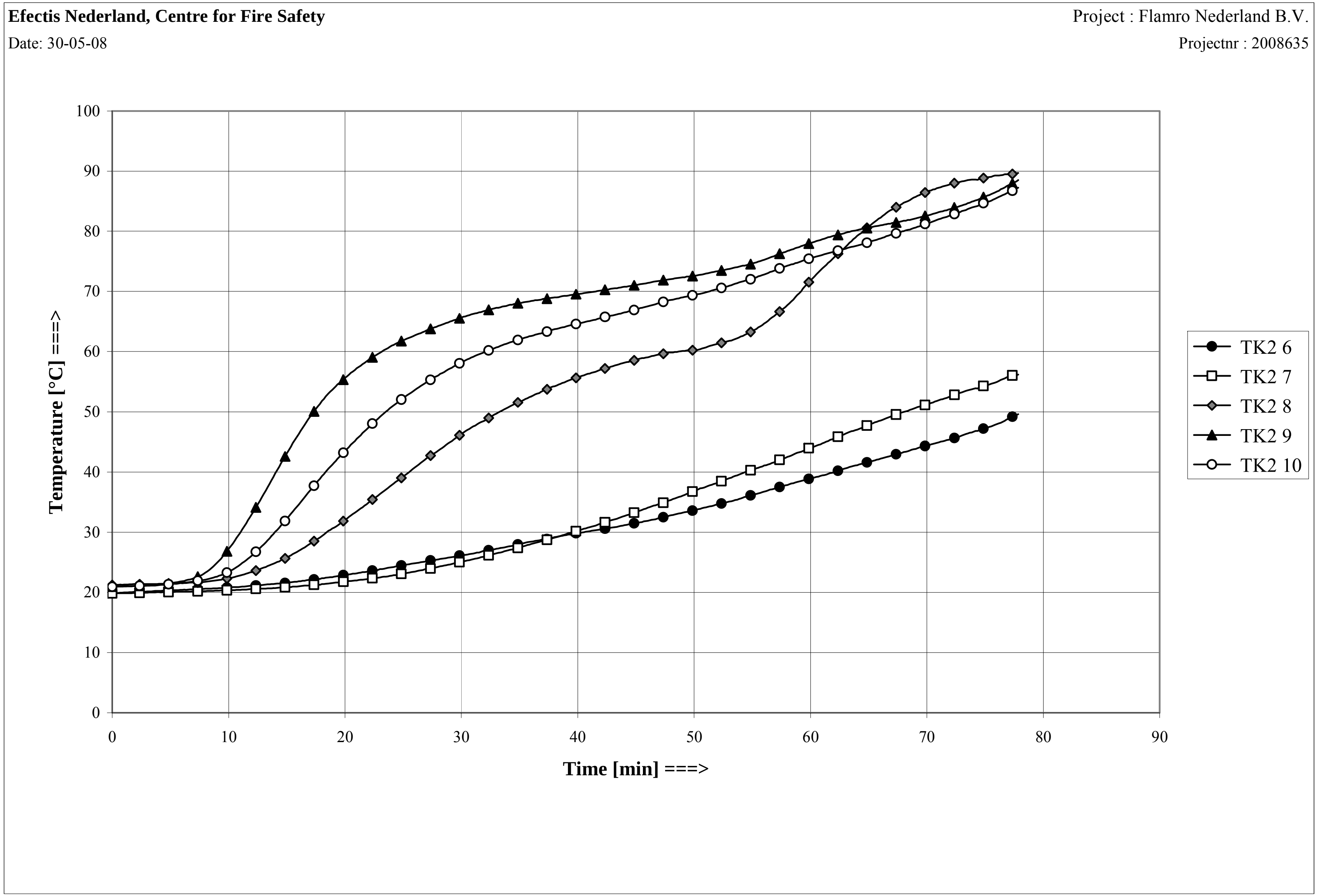


Figure A8 Temperatures on specimen 2

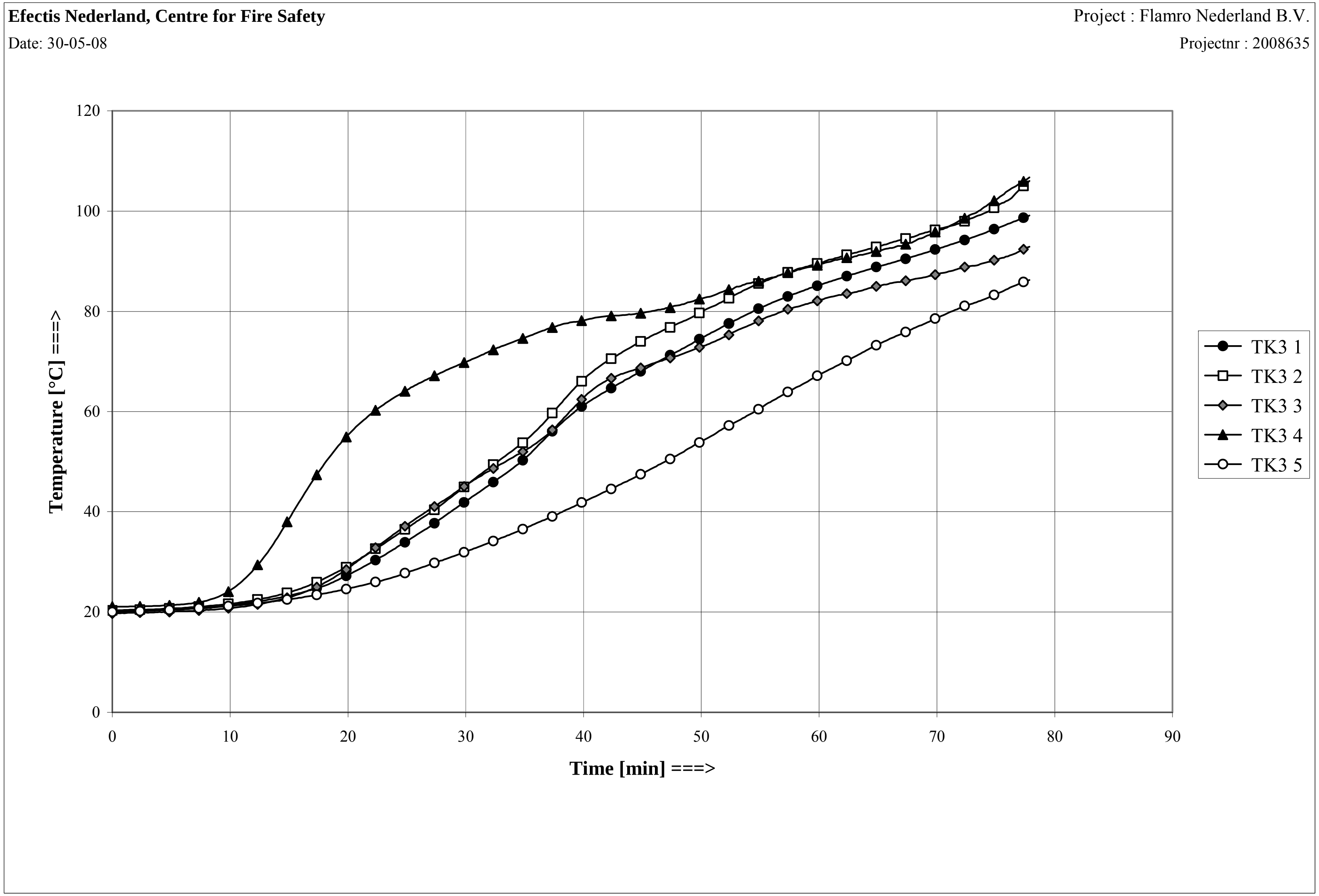


Figure A9 Temperatures on specimen 3

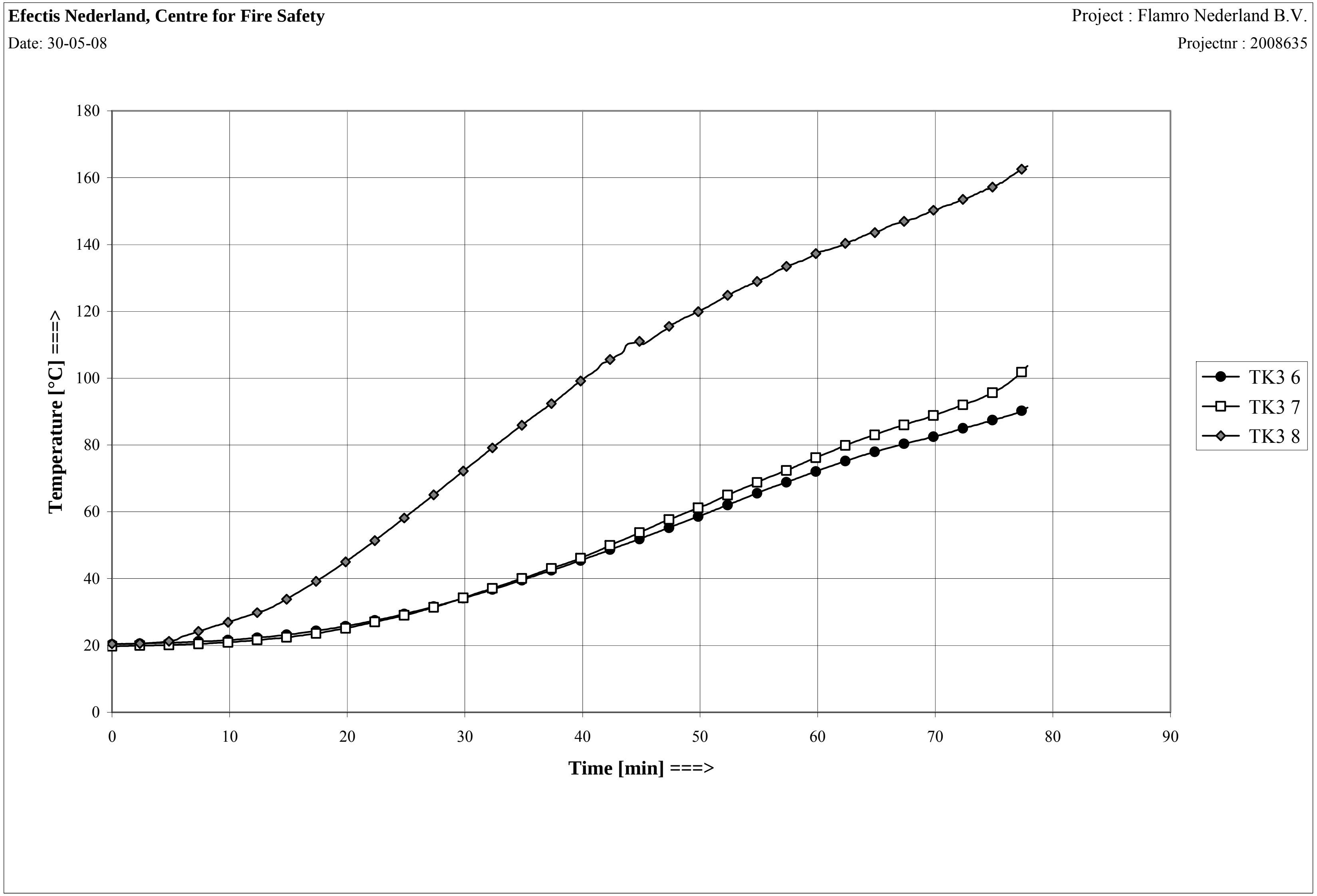


Figure A10 Temperatures on specimen 3

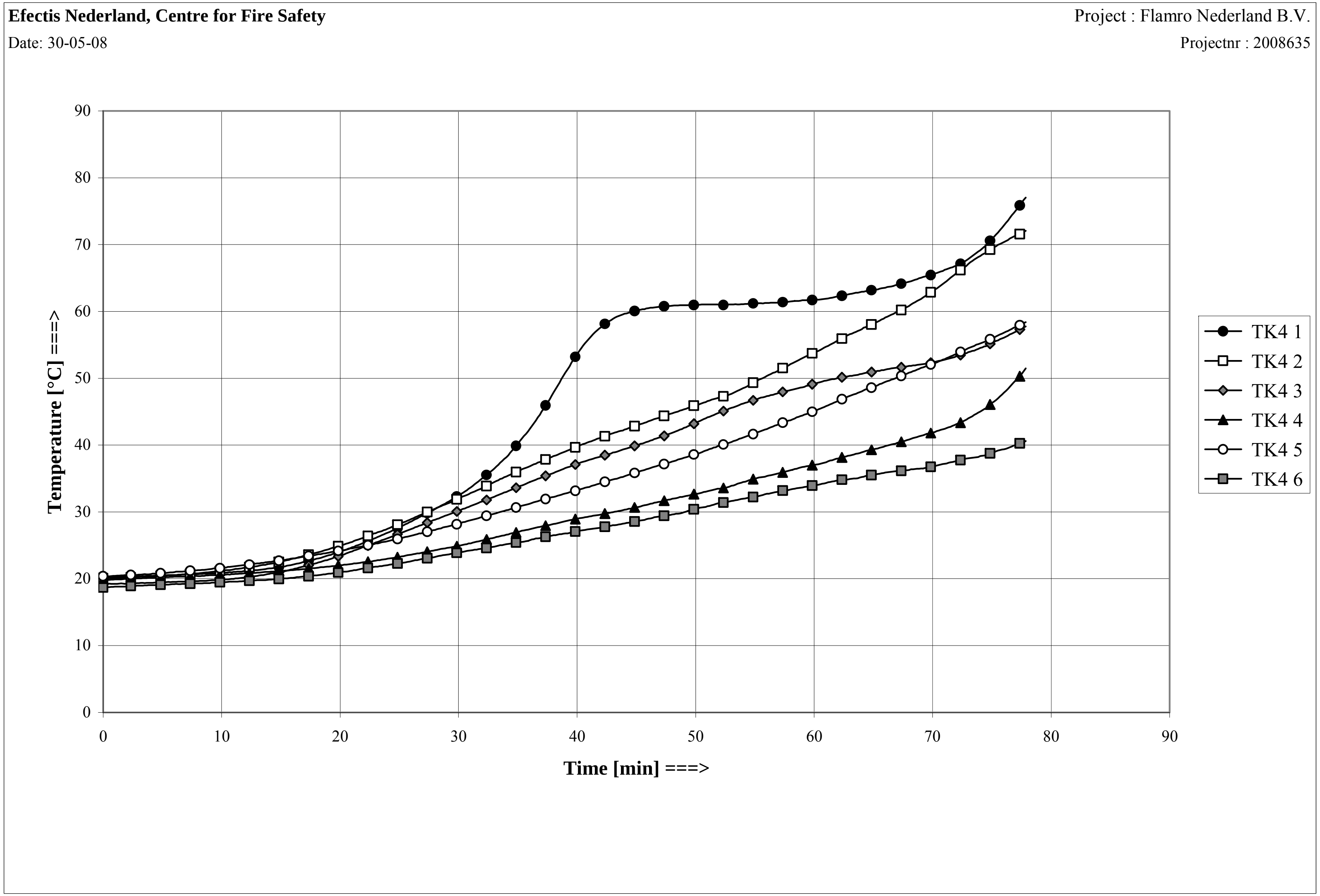


Figure A11 Temperatures on specimen 4

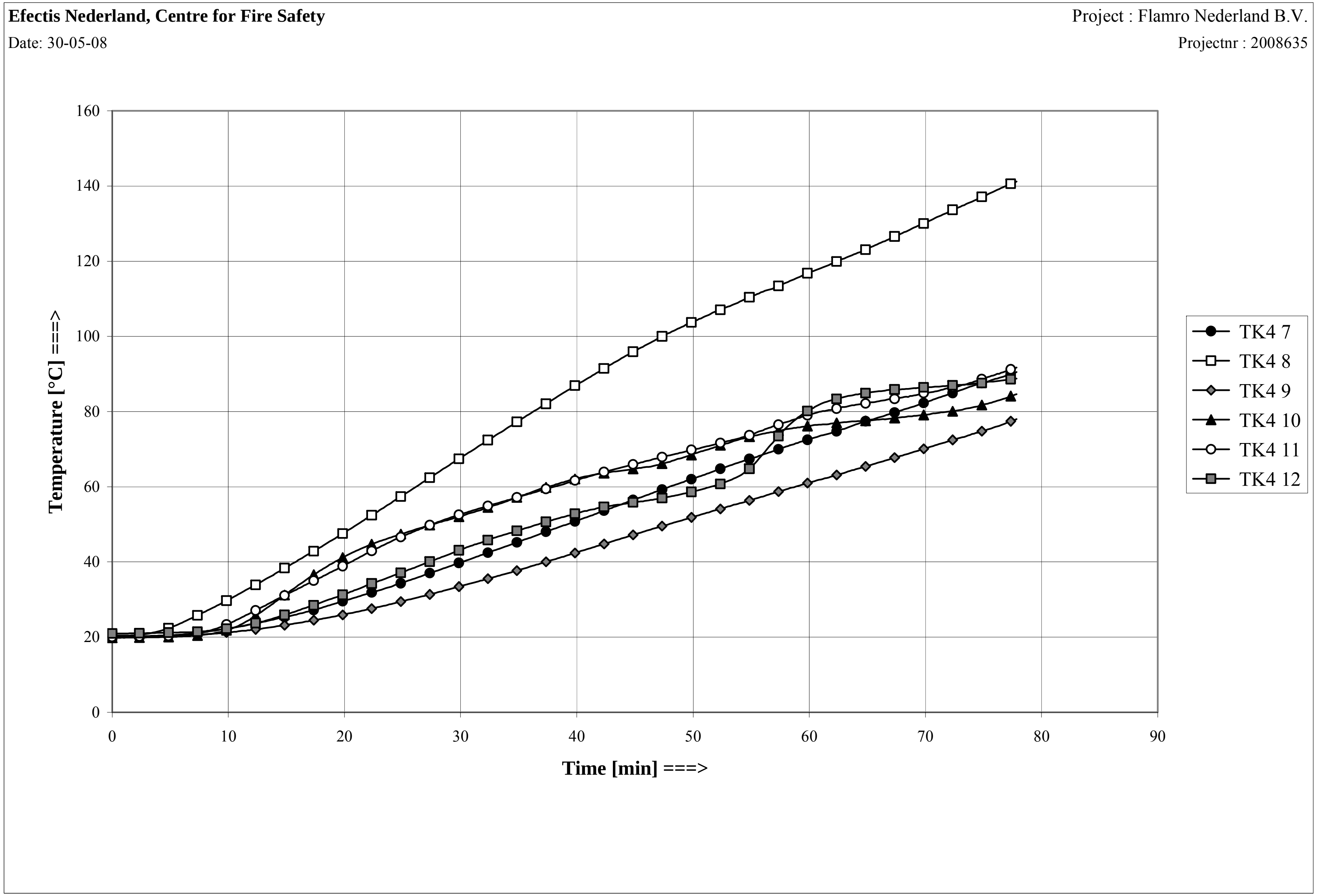


Figure A12 Temperatures on specimen 4

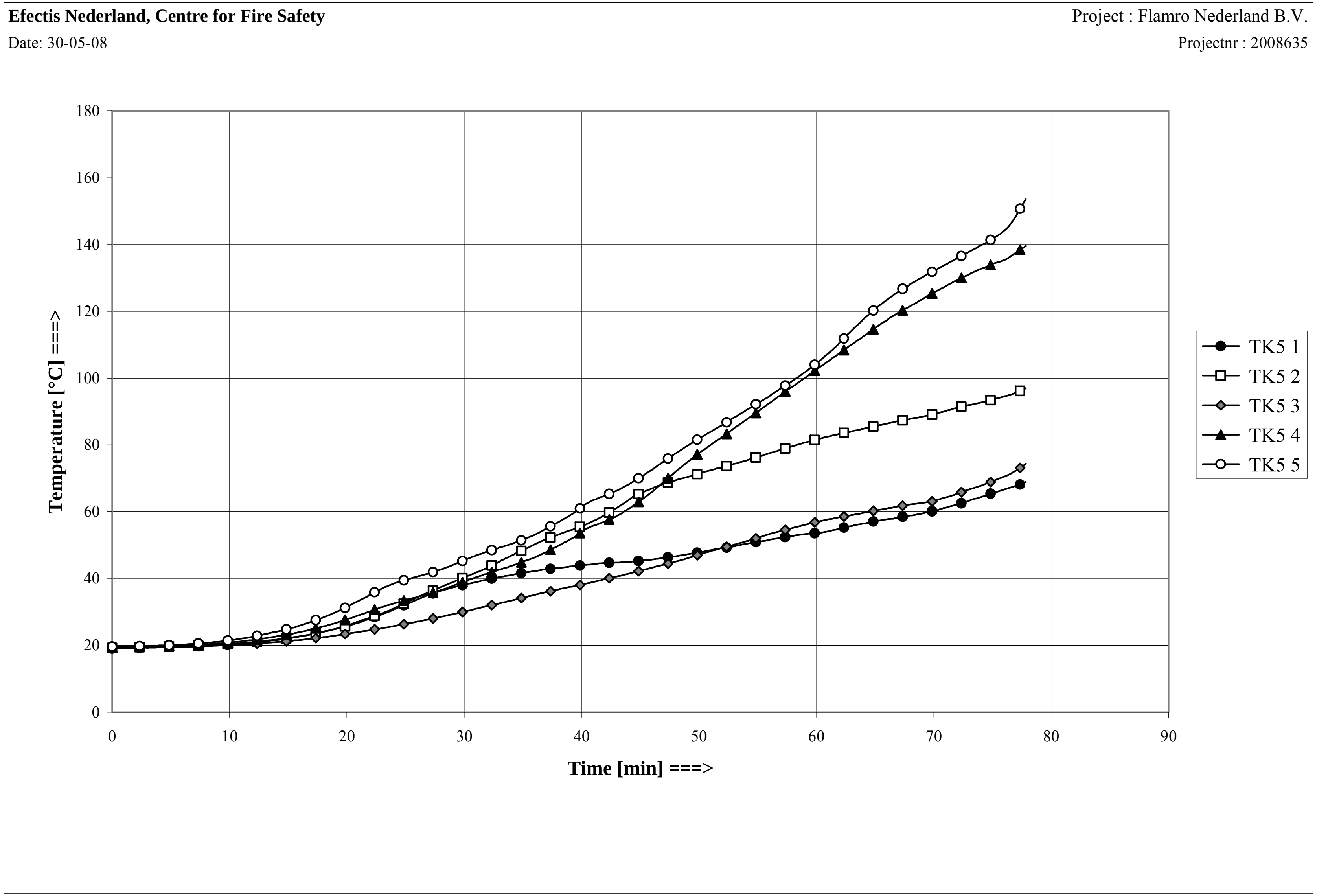


Figure A13 Temperatures on specimen 5

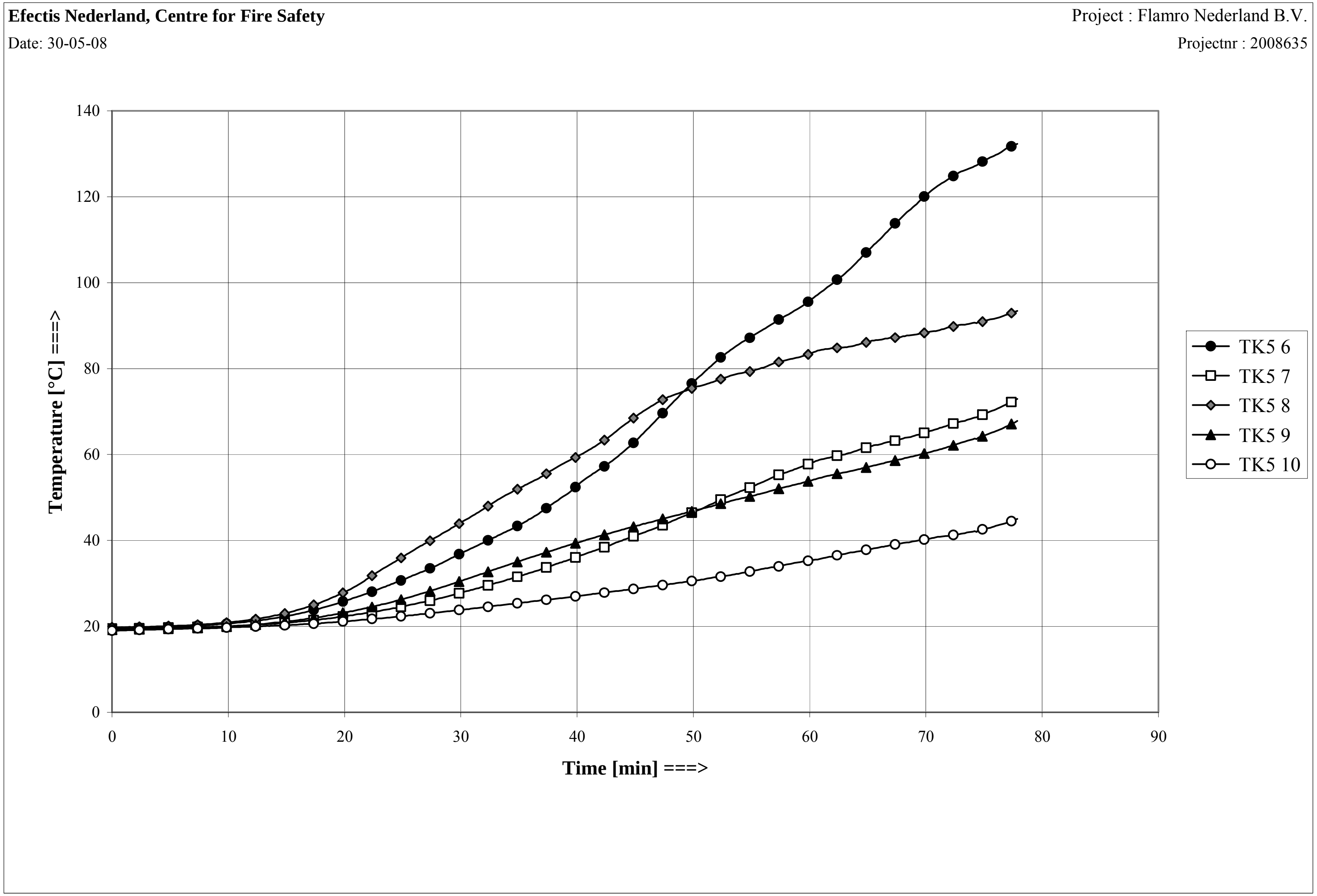


Figure A14 Temperatures on specimen 5

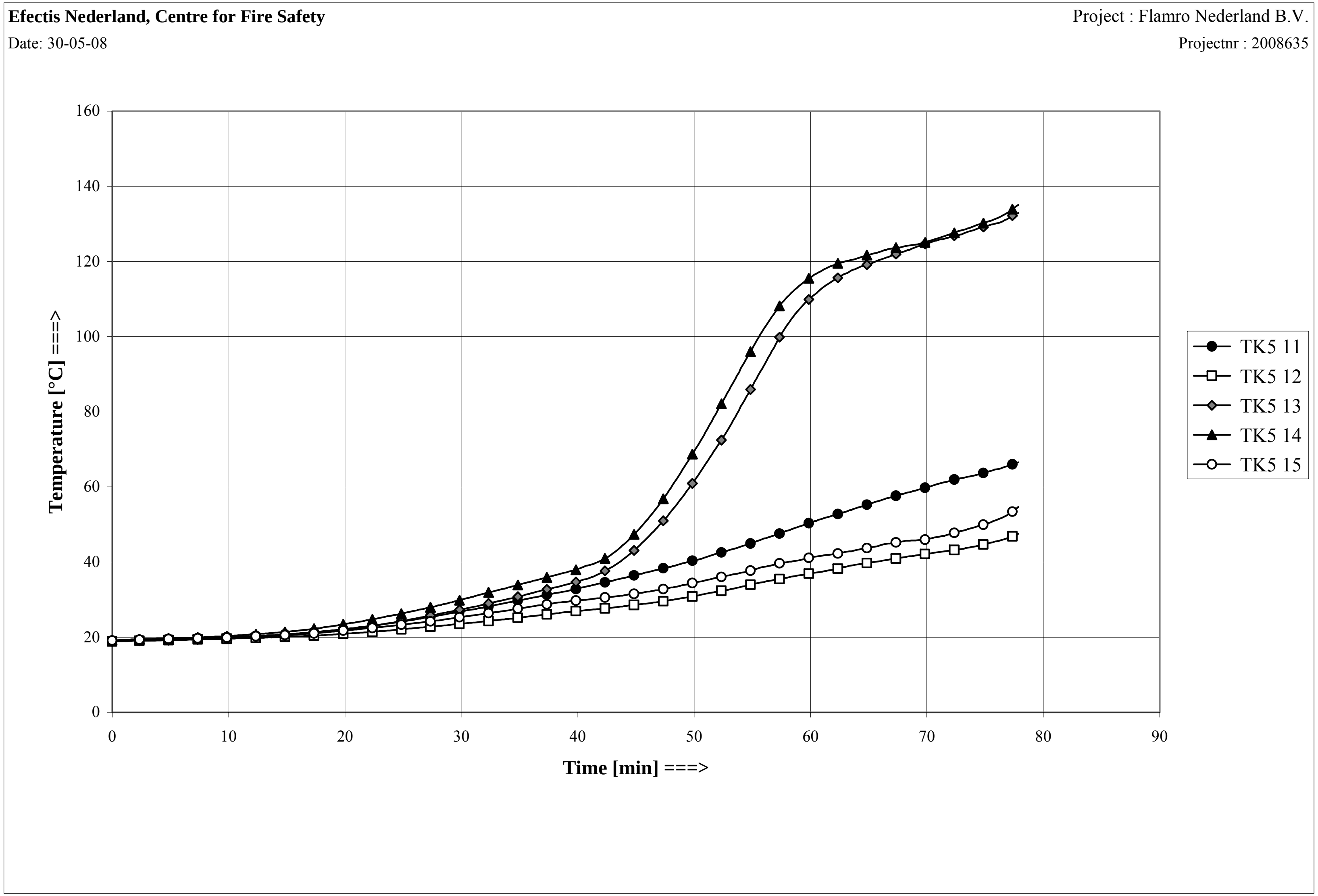


Figure A15 Temperatures on specimen 5

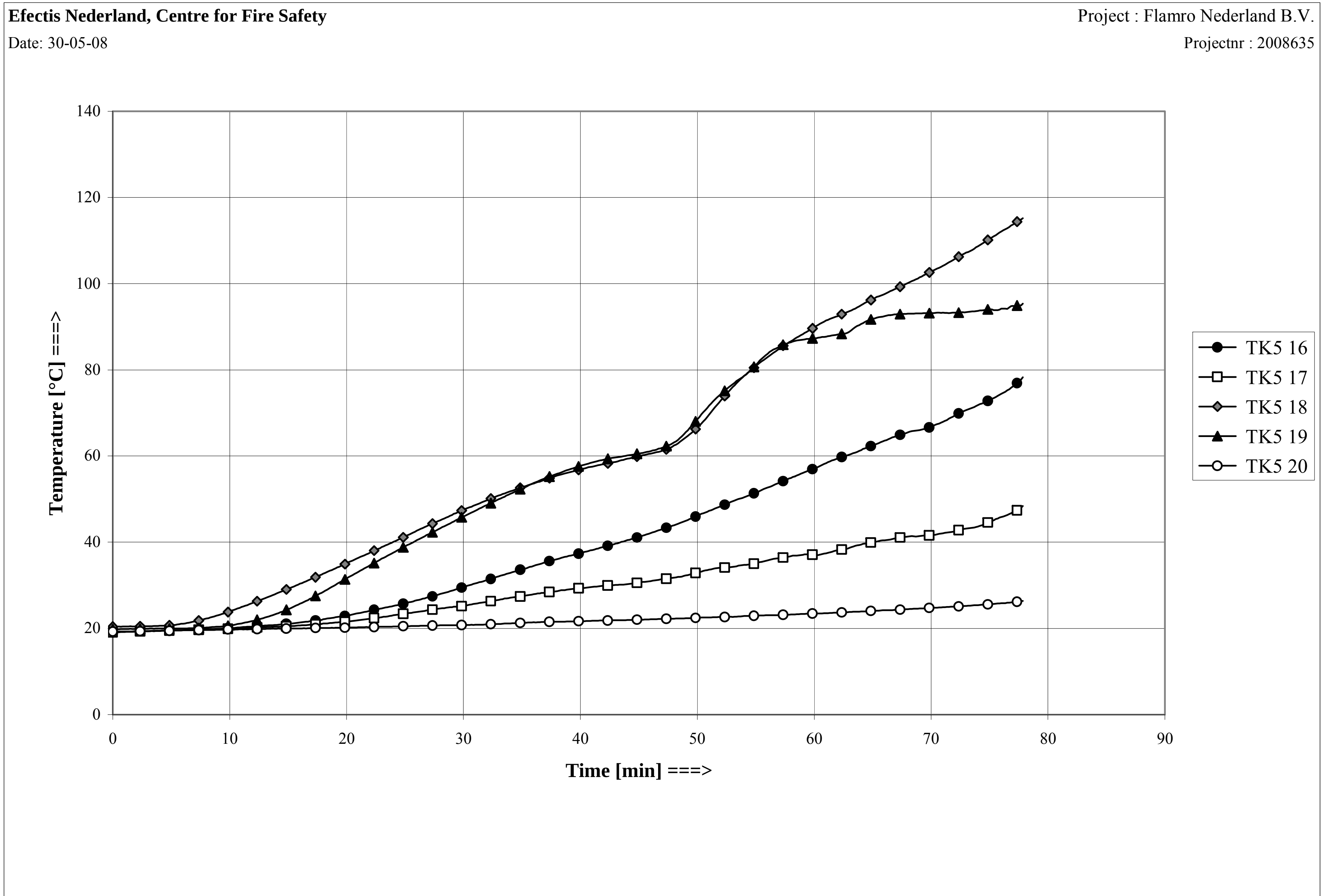


Figure A16 Temperatures on specimen 5

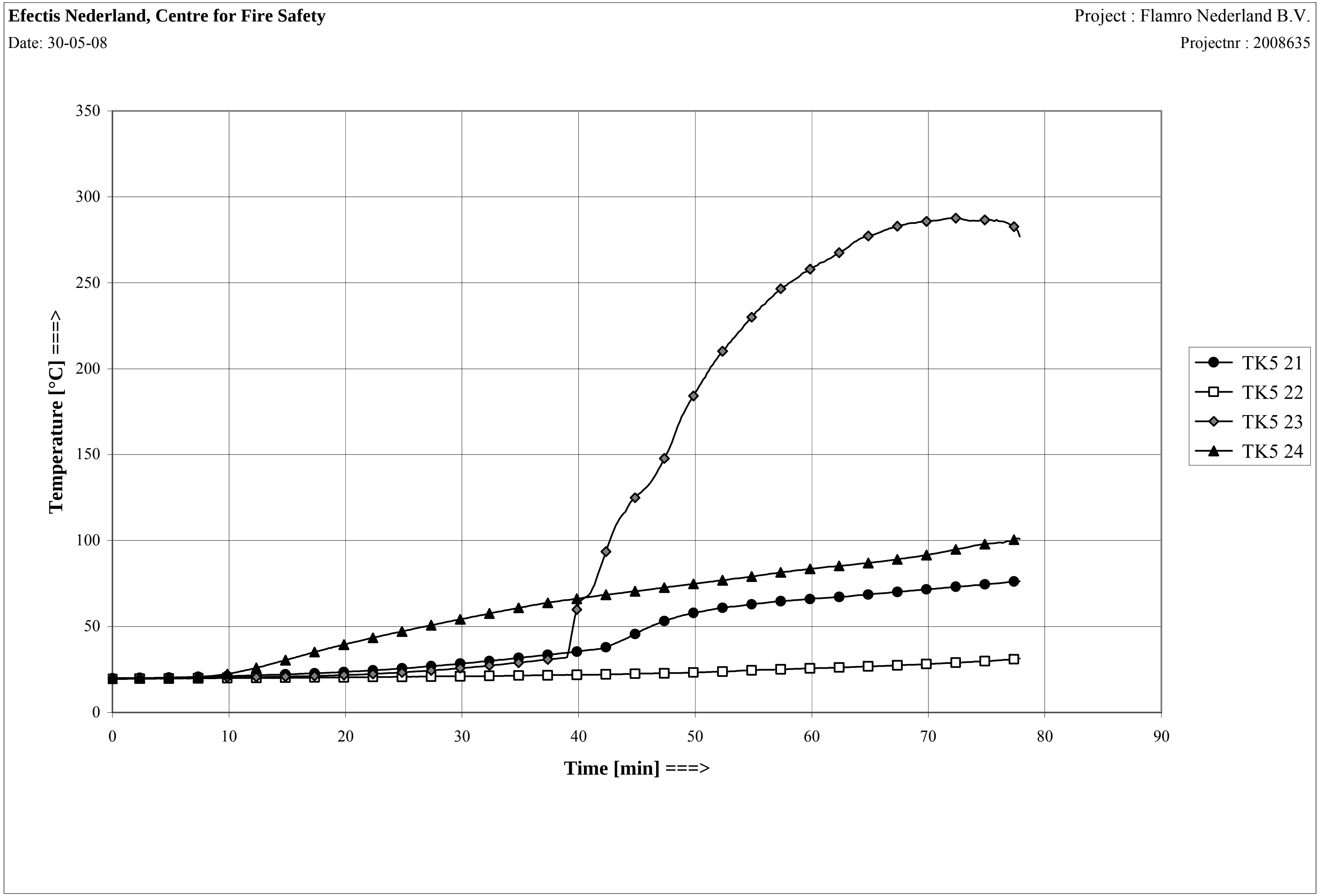


Figure A17 Temperatures on specimen 5

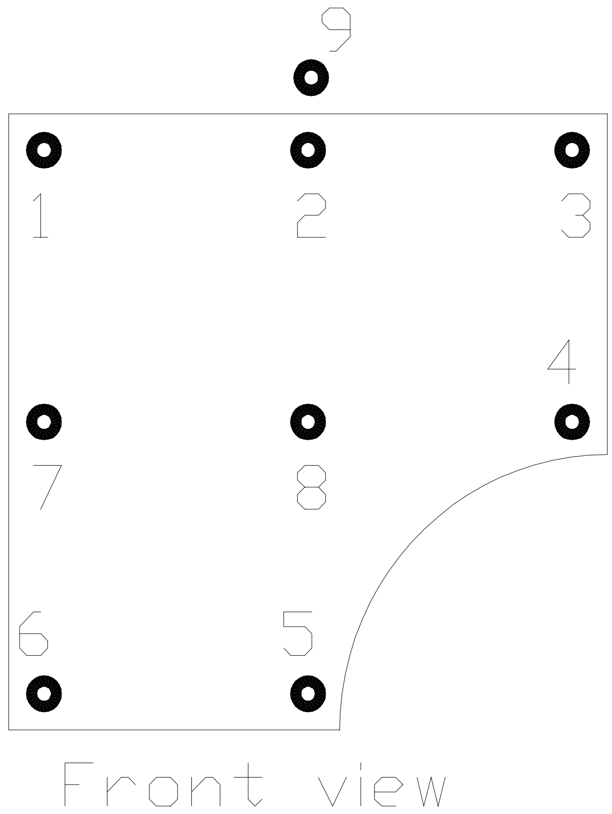


Figure A18 Location of the thermocouples on penetration 1

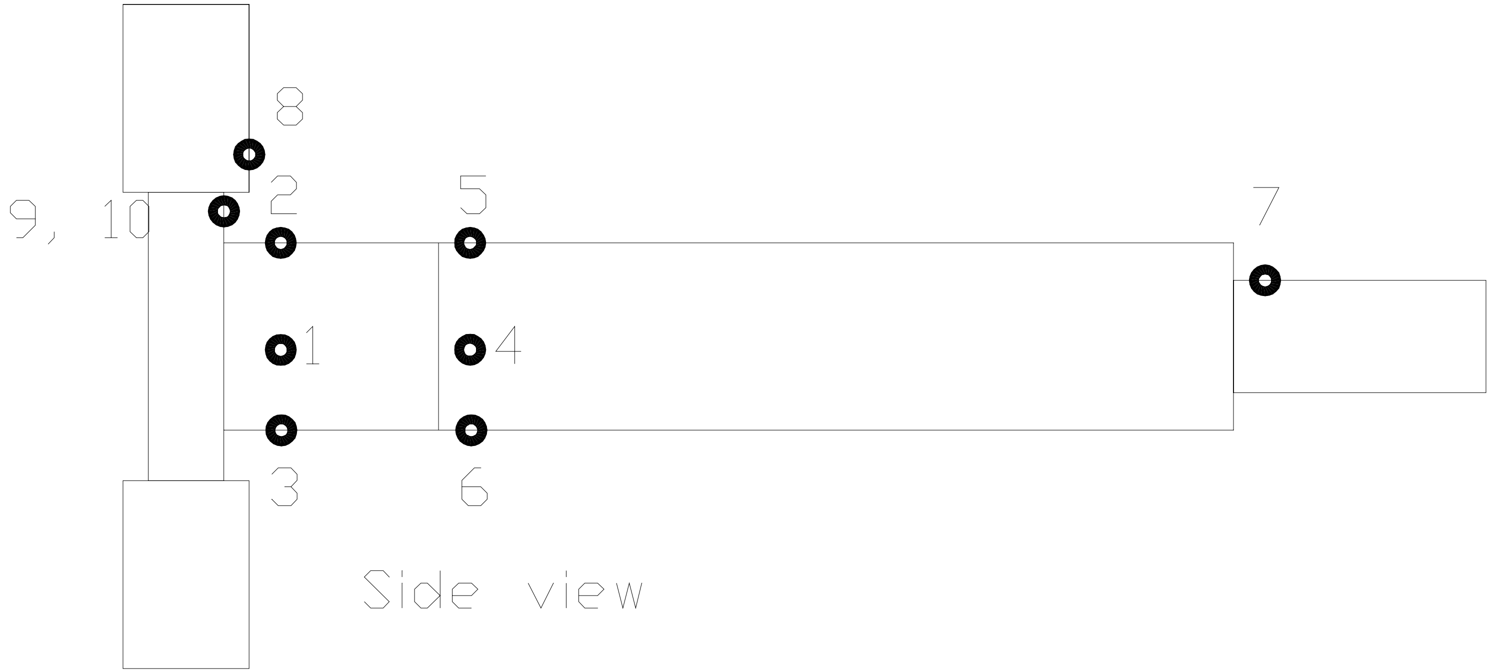


Figure A19 Location of the thermocouples on penetration 2

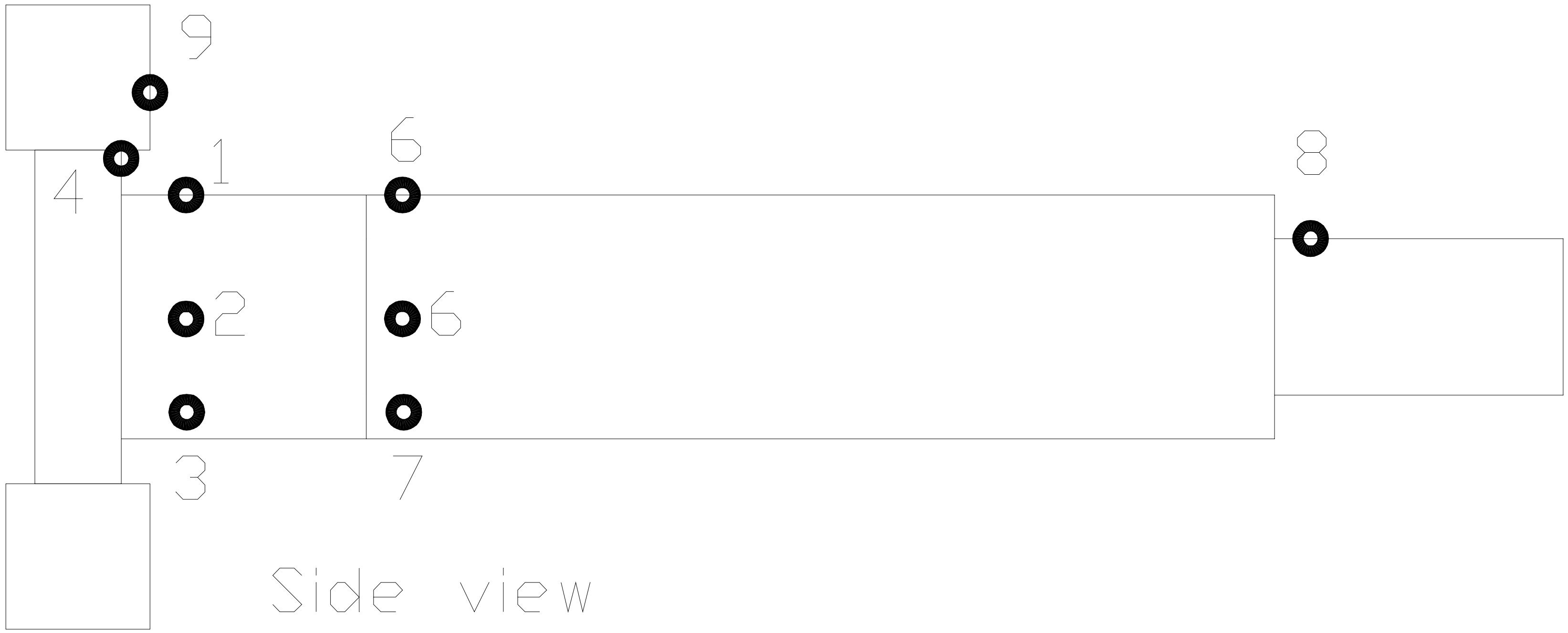


Figure A20 Location of the thermocouples on penetration 3

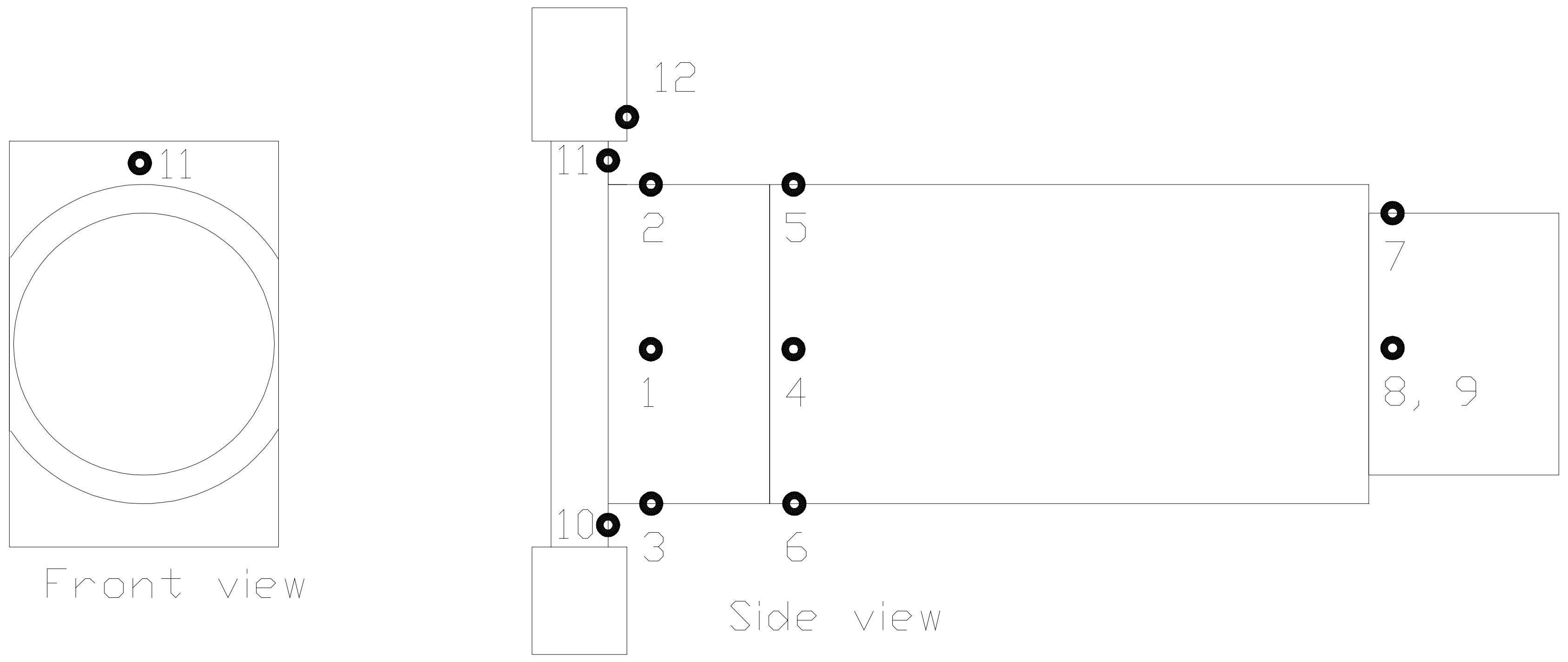


Figure A21 Location of the thermocouples on penetration 4

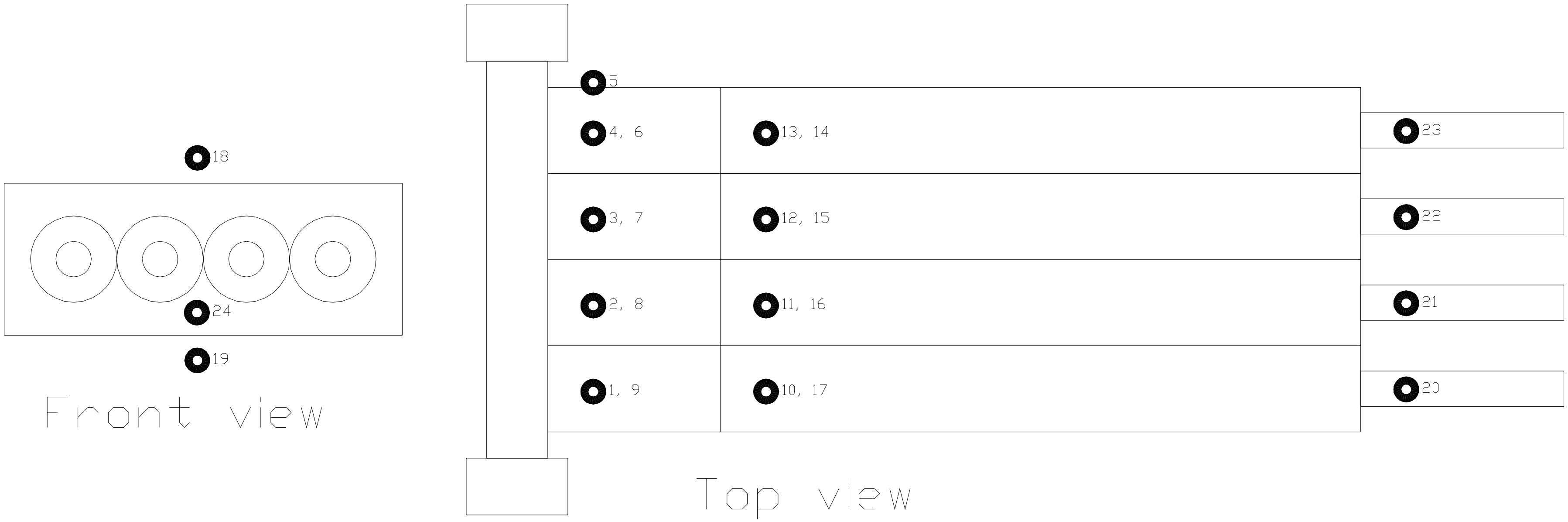
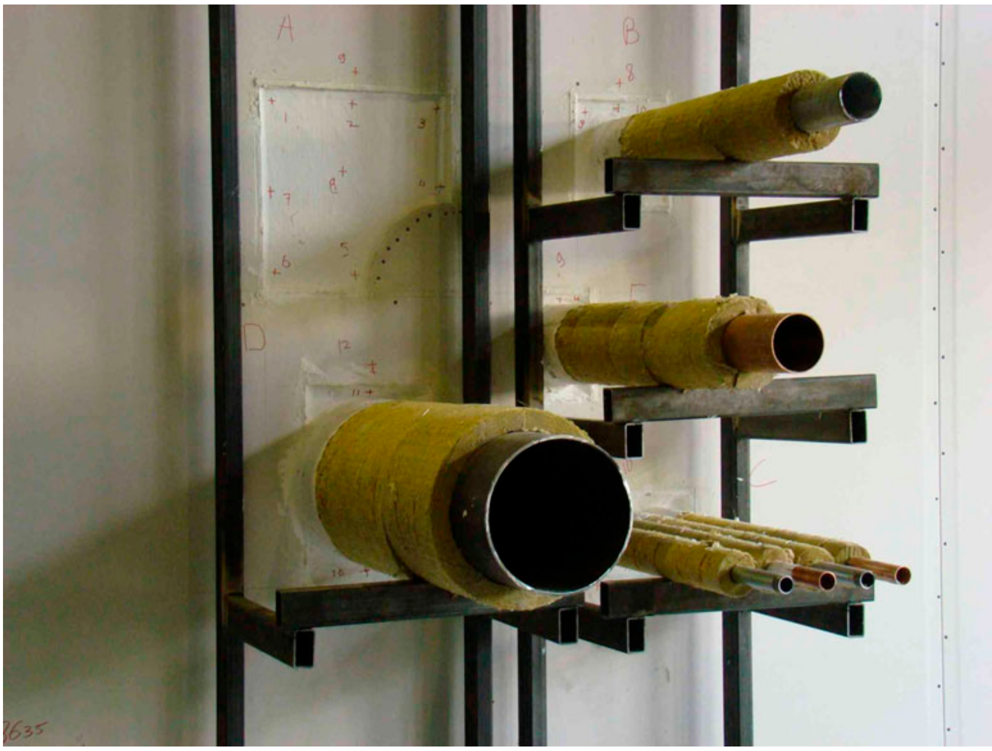


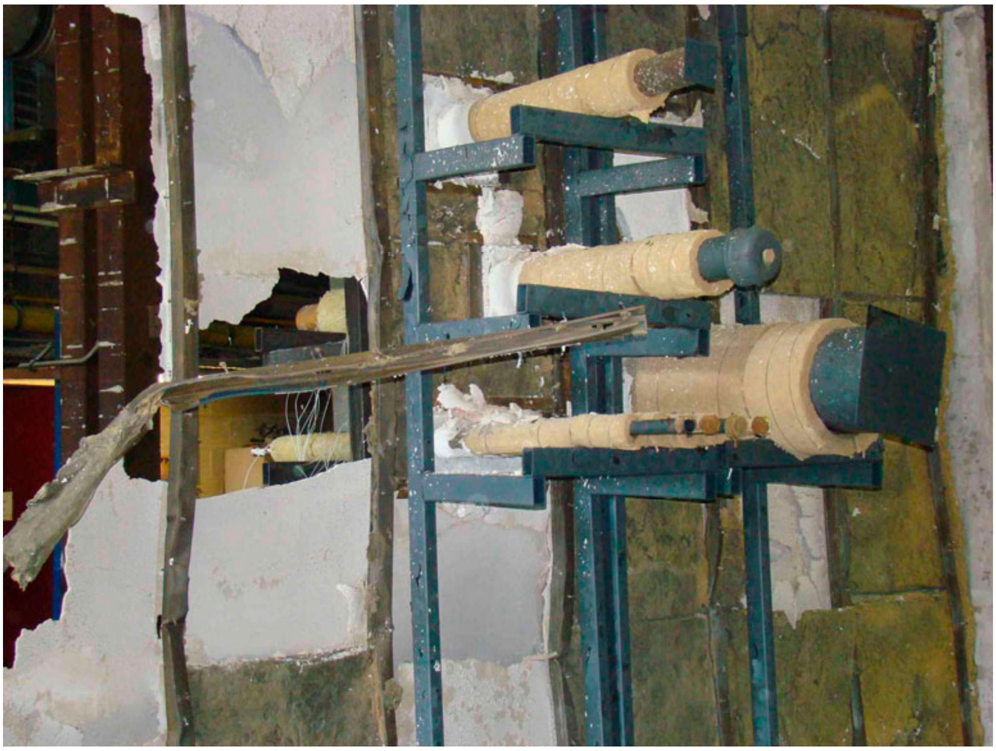
Figure A22 Location of the thermocouples on penetration 5

B Photographs

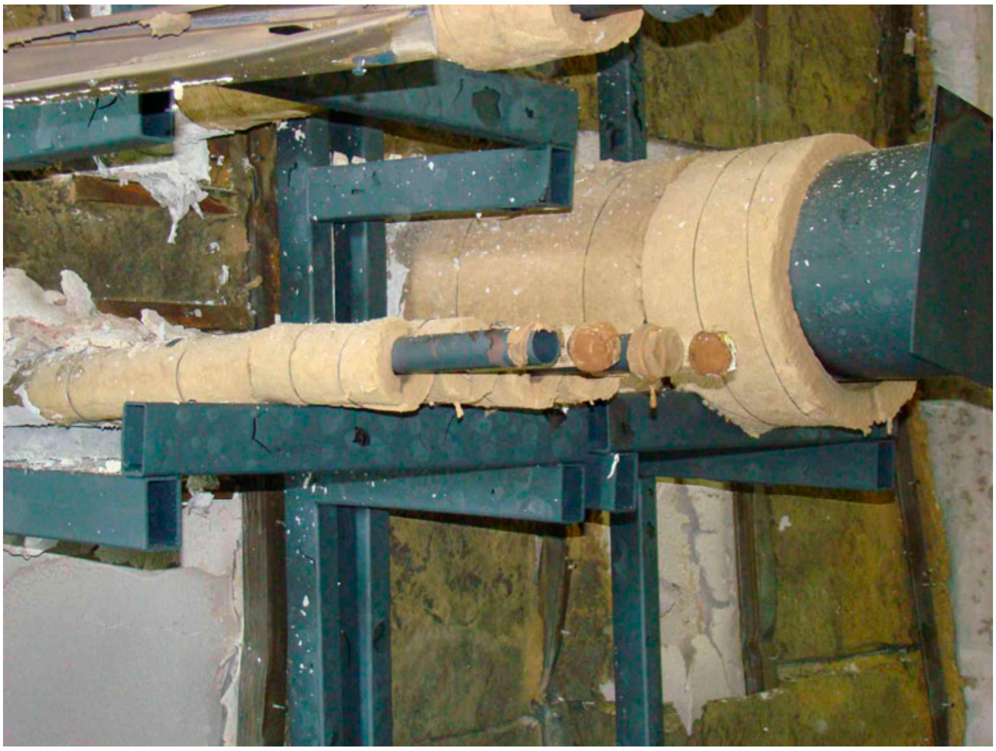


Photograph B1 Specimen before the fire test seen from the non exposed side

Photograph B2 Specimen seen from the non exposed after 76 minutes of heating



Photograph B3 Specimen after the fire test seen from the direct exposed side



Photograph B4 Specimen 5 close up, cap of a steel pipe has fallen off