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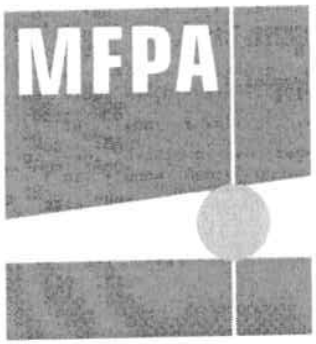

Unit III – Structural fire prevention
Manager of unit: Dipl.-Phys. Ingolf Kotthoff

WG fire behavior of building materials

Expert opinion

GU III/B-06-033

of 20/07/2006 1st copy

Object: Expert opinion to test certificate No. 3003/9939-CR- dated 15/05/2000 of MPA Brunswick, issued for Münchner Entwicklungsgesellschaft für Brandschutz im Ausbau GmbH Baierbrunn, in terms of application in the Arab Emirates

Principal: UGA System-Technik GmbH & Co.
Heidenheimer Str. 80-82

89542 Herbrechtingen

Order dated: 03/07/2006

Prepared by: Dr. Nause

This expert opinion consists of 2 sheets.

Gesellschaft für Materialforschung und Prüfungsanstalt für das Bauwesen Leipzig mbH
Geschäftsführer: Univ.-Prof. Dr.-Ing. Stefan Winter, Dr.-Ing. Frank Dehn
Sitz: Hans-Weigel-Straße 2b · D - 04319 Leipzig
Telefon: +49 (0) 341/65 82-113
Fax: +49 (0) 341/65 82-197
E-Mail: nause@mfpa-leipzig.de

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MEBA GmbH · Heidenheimer Str. 80-82 · 89542 Herbrechtingen

UGA SYSTEM-TECHNIK
GmbH & Co.
Heidenheimer Str. 80 – 82

89542 Herbrechtingen

MEBA GmbH
Münchener Entwicklungsgesellschaft
für Brandschutz im Ausbau

Heidenheimer Straße 80-82
89542 Herbrechtingen
Telefon 0 73 24/98 72 56
Telefax 0 73 24/98 72 58
meba-brandschutz@t-online.de
info@meba-systeme.de
www.meba-systeme.de

Herbrechtingen, 23.06.2006

Licence for UGA SYSTEM-TECHNIK for the use of MEBA test certificates

Dear sirs,

we, the company MEBA GmbH, confirm with this document, that the company UGA SYSTEM-TECHNIK is allowed to use the test certificate no. 3003/9939-CR of the MPA Materialprüfanstalt für Bauwesen in Braunschweig in their and in our name.

This is serving for the approval of the "FEP Rund-Kabelschott S 90" and for the "FEP Rechteck-Kabelschott S 90".

Best regards

Werner Thomas
General Manager

MEBA GmbH
Münchener Entwicklungsgesellschaft für Brandschutz im Ausbau
Heidenheimer Str. 80-82 · 89542 Herbrechtingen
Tel. 0 73 24 / 98 72 56 · Fax 0 73 24 / 98 72 58

MATERIALPRÜFANSTALT FÜR DAS BAUWESEN

INSTITUT FÜR BAUSTOFFE, MASSIVBAU UND BRANDSCHUTZ

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MPA BRAUNSCHWEIG

Test Certificate

submitted for application of a Type Approval

- Translation -

Nr.: 3003/9939 -CR-
(2000-05-15)

1st official copy

Client: Münchener Entwicklungsgesellschaft für Brandschutz im Ausbau GmbH (MEBA GmbH)

M E B A GmbH
Münchener Entwicklungsgesellschaft für Brandschutz im Ausbau
Heidenheimer Str. 80-82 · 89542 Herbrechtingen
Tel. 07324/98 72 56 · Fax 07324/98 72 58

Order date: 06-07-1999 Ref.: verbal Received: 06-07-1999

Subject:

Circular and rectangular cable penetration seals "FEP Rund-Kabelschott S 90" and "FEP Rechteck-Kabelschott S 90", respectively, of different thicknesses, mounted in a 150-mm and 200-mm thick floor made from aerated-concrete slabs, in a 100-mm thick non-loadbearing flexible wall construction, and in a 100-mm thick aerated-concrete wall, to be tested for their reaction to fire in compliance with DIN 4102-09 : 1990-05 to determine their fire resistance time when having one face exposed to the fire.

Test material received:	Week 31 and week 47, 1999; and week 2, 2000
Sampling:	The Testing House does not have any information indicating official sampling.
Marking:	None

The Test Certificate covers 31 pages and 103 annexes.

The validity of the Test Certificate will expire on 15-05-2002.

Materialprüfanstalt f. d. Bauwesen MPA BS 3 Braunschweig

Materialprüfanstalt für das Bauwesen
Technische Universität Braunschweig
Beethovenstraße 52
D-38106 Braunschweig

Tel +49-(0)531-391-5431
Fax +49-(0)531-391-4573
E-Mail mpa@tu-bs.de
http://www.mpa.tu-bs.de

Norddeutsche Landesbank Hannover
Kto. 106 020 050 (BLZ 250 500 00)
Swift-Code: NOLADE 2H
USt.-ID-Nr. MPA-DE 183500654

1 Structural design of specimen

1.1 Description of floor and wall systems

1.1.1 Description of floor systems

Floor system D1 (test 1)

The floor system with the dimensions 2,250 mm long by 1,250 mm wide consisted of 150-mm thick aerated concrete slabs and was provided with an opening 1,000 mm long by 500 mm wide to accommodate the rectangular cable penetration seal "FEP Rechteck-Kabelschott S 90".

Floor system D2 (test 3)

The floor system with the dimensions 2,400 mm long by 1,250 mm wide consisted of 200-mm thick aerated concrete slabs and was provided with an opening 700 mm long by 500 mm wide to accommodate the rectangular cable penetration seal "FEP Rechteck-Kabelschott S 90".

In addition, both floor systems were provided with two bore holes each, d = 210 mm in diameter, which were to accommodate the circular cable penetration seals "FEP Rund-Kabelschott S 90", and one bore hole d = 105 mm in diameter each.

1.1.2 Description of wall systems (test 2)

Flexible wall construction

The flexible wall construction with the dimensions 1,500 mm wide by 3,000 mm high consisted of a 100-mm thick non-loadbearing separating partition. The flexible wall construction was made from CW 50 x 50 x 06 and UW 50 x 40 x 06 sheet-metal channel sections and 2 x 12.5-mm thick fire-resistant gypsum plasterboards ("GKF") in compliance with DIN 18180, and a 40-mm thick mineral-fibre insulation layer (melting point ≥ 1000 °C, building material class A1 in compliance with DIN 4102, apparent density approx. 100 kg/m^3). It was thus in conformity with DIN 4102-4 : 1994-03, section 4.10, table 48 ("F 90-A").
The flexible wall construction was provided with an opening with the inside dimensions 1,050 mm wide by 550 mm high to accommodate the rectangular cable penetration seal "FEP Rechteck-Kabelschott S 90".

Aerated-concrete wall

The wall system with the dimensions 1,500 mm wide by 3,000 mm high was provided with an opening with the inside dimensions 1,000 mm wide by 500 mm high to accommodate the rectangular cable penetration seal "FEP Rechteck-Kabelschott S 90". In the region of the openings and the bore holes the wall was made from 100-mm thick aerated-concrete stones.

The bottom-end wall section, about 1,000 mm high, consisted of 200-mm thick aerated-concrete stones. On the fire-exposed face, these stones rested flush against the layer of 100-mm thick aerated-concrete stones above them.
In addition, both wall systems were provided with two bore holes each, d = 210 mm in diameter, which were to accommodate the circular cable penetration seals "FEP Rund-Kabelschott S 90",and one bore hole d = 105 mm in diameter each.

1.2 Cable support systems

1.2.1 Floor systems

On the face not exposed to the fire, two studs ZST3-3000/ FT, about 1,000 mm / 500 mm long each, were provided on the sides of the openings and the bore holes. These studs were connected to the aerated concrete slabs. Steel brackets ZA 500/ FS were bolted to the studs with two M12 x 25 construction bolts each. These carried one CP 30 L/ FS channel section each (30 mm high and 1,200 mm / 1,000 mm long), which were bolted in place at a clearance of a = 130 mm and a = 500 mm from the seal surface. For the rectangular cable penetration seals "FEP Rechteck-Kabelschott S 90", these support structures were fitted with wide-span cable racks and cable trays of different widths, as well as control pipes and non-combustible pipes of different sizes. For the circular cable penetration seals "FEP Rund-Kabelschott S 90", the above support structures were fitted with different types of cables and control pipes. On the fire-exposed face, the wide-span cable racks and trays were about 550 mm long; on the non-exposed face they had a length of about 500 mm. All elements used for the support structure (studs, brackets, carriage bolts, channel sections) and the wide-span cable racks and cable trays were supplied by Hermann Wilden GmbH & Co. KG, Köln/Germany.

Details of the different wide-span cable racks, cable trays, cables, control pipes and non-combustible pipes, the clearance between these parts and the distance from the seal reveal, are described in connection with the structural design of the different seals and are illustrated in annexes 1.1, 1.2, 1.6 and 1.7.

1.2.2 Wall systems

On the fire-exposed face, one stud ZST3-3000/ FT, about 3,000 mm long each, was provided on the sides of the openings and the bore holes. This stud was fitted to the test frame at its top and bottom ends. On the non-exposed face, one stud ZST3-3000/ FT, about 3,000 mm long (flexible wall construction) and 2,000 mm long (aerated-concrete wall) each, was provided on the sides of the openings and the bore holes, which was fitted to the test frame at its top and bottom ends (flexible wall construction) or at its top only.

The stud on the non-exposed face of the aerated-concrete wall rested with its bottom end on the bottom-end projecting aerated-concrete stones of the 200-mm thick wall section. It was connected with the aerated-concrete stones with steel angles and bolts. An additional stud ZST3-3000/ FT, about 3,000 mm long, was provided on the fire-exposed and the non-exposed face in the transition region between flexible wall construction and aerated-concrete wall, which was fitted to the test frame at its top and bottom ends. Steel brackets ZA 500/ FS, about 585 mm long, were bolted to the studs with two M12 x 25 construction bolts each. The spacing between the steel brackets was about 1,400 mm. To carry the wide-span cable racks and cable trays, the cables, the control pipes, and the non-combustible pipes, one CP 30 L/ FS channel section, 30 mm high and l ≅ 1,500 mm long, was fitted with M6 threaded bolts to the steel brackets on the non-exposed face at a distance of a = 500 mm from the wall surface; on the fire-exposed face, one round bar ∅ 18, l ≅ 1,500 mm, each was welded in place. This support structure carried wide-span cable racks and cable trays of different widths, cables of different sizes, control pipes, and non-combustible pipes of different sizes. On the fire-exposed face, the wide-span cable racks, cable trays, cables, control pipes, and non-combustible pipes were about 600 mm long; on the non-exposed face, their length was about 520 mm.

Details of the different wide-span cable racks, cable trays, cables, control pipes and non-combustible pipes, the clearance between these parts and the distance from the seal reveal, are described in connection with the structural design of the different seals and are illustrated in annexes 1.11 to 1.13.

1.3 Cable penetration seals

1.3.1 Cable penetration seals in the floor systems

Floor system D1

Rectangular cable penetration seal "FEP Rechteck-Kabelschott S 90"

On the non-exposed face, an 100 mm wide and 50 mm high layer, made from PROMATECT®-H boards, was provided around the opening with the inside dimensions 1,000 mm long by 500 mm wide. This layer was bolted to the aerated-concrete floor, and it ended flush with the member reveal such that in the region that was to accommodate the rectangular cable penetration seal "FEP Rechteck-Kabelschott S 90" the floor was 200 mm thick.

Four cable racks and one steel and three copper pipes were passed through the above opening. The pipes were not insulated.

1st rack unit:

The 1st rack unit was fitted with a 500-mm wide perforated cable tray KWL 500/60/FS (side wall h = 60 mm high, plate t = 1.50 mm thick) and three copper pipes. The minimum clearance between the cable tray side wall and the 500-mm long seal reveal was $a_{\parallel}$ = 0 mm, and between the cable tray side wall and the 1,000-mm long seal reveal $a_{\perp}$ = 50 mm.

The minimum clearance between the copper pipes (pipe outside diameter d = 18 mm; pipe wall s = 1.0 mm thick) was a = 20 mm. The minimum clearance between these pipes and the seal reveal was a = 50 mm.

The minimum clearance between the copper pipe with outside diameter d = 28 mm (pipe wall s = 1.0 mm thick) and the copper pipes with d = 18 mm outside diameter was a = 50 mm; and between the copper pipe and the seal reveal it was a = 60 mm.

The minimum clearance between the copper pipe with outside diameter d = 28 mm (pipe wall s = 1.0 mm) and the cable tray was a = 306 mm.

2nd rack unit:

The 2nd rack unit was fitted with a 300-mm wide wide-span cable rack WSK 80/300/FS (side wall h = 80 mm high) as well as one steel pipe. The minimum clearance between the side wall of the wide-span cable rack and the 500-mm long seal reveal was $a_{\parallel}$ = 150 mm, and between the side wall and the 1,000-mm long seal reveal $a_{\perp}$ = 60 mm. The minimum clearance between the wide-span cable rack and the side walls of the wide-span cable racks of the 3rd rack unit was a = 0 mm.

The minimum clearance between the steel pipe and the seal reveal was a = 50 mm.

The minimum clearance between the steel pipe and the wide-span cable rack was a = 302 mm.

3rd rack unit:

The 3rd rack unit was fitted with two 300-mm wide wide-span cable racks (side wall h = 80 mm high). The minimum clearance between the side wall of the wide-span cable rack and the 500-mm long seal reveal and the 1,000-mm long seal reveal was $a_{\perp}$ = 0 mm. The minimum clearance between the wide-span cable racks was also a = 0 mm.

Circular cable penetration seal "FEP Rund-Kabelschott S 90"

The minimum clearance between the circular cable penetration seals "FEP Rund-Kabelschott S 90" was a = 50 mm.

The minimum clearance between the circular cable penetration seals "FEP Rund-Kabelschott S 90" and the rectangular cable penetration seals "FEP Rechteck-Kabelschott S 90" was a = 205 mm.

Floor system D2

Rectangular cable penetration seal "FEP Rechteck-Kabelschott S 90"

Two rack units and a copper pipe insulated on both sides of the cable penetration seal were passed through the opening.

1st rack unit:

The 1st rack unit was fitted with a 500-mm wide wide-span cable rack WSK 80/500/FS (side wall h = 80 mm high). The minimum clearance between the wide-span cable rack and the seal reveals was a = 0 mm.

2nd rack unit:

The 2nd rack unit was fitted with a 300-mm wide perforated cable tray KWL 300/60/FS (side wall h = 60 mm high, plate t = 0.75 mm thick) and a copper pipe. The minimum clearance between the cable tray side wall and the 500-mm long seal reveal was $a_{\parallel}$ = 0 mm; and between the cable tray side wall and the 1,000-mm long seal reveal it was $a_{\perp}$ = 210 mm. The minimum clearance between the cable tray and the side walls of the cable racks of the 1st rack unit was a = 190 mm.
Outside the cable penetration seal, the additionally installed copper pipe (outer pipe diameter d = 28 mm, pipe wall s = 1.0 mm thick) was protected on the fire-exposed and the non-exposed face by insulating material 400 mm long, made from "FEP Schaum Plus" foam, d = 20 mm. The minimum clearance between the copper pipe insulation and the seal reveal was a = 50 mm.
The minimum clearance between the copper pipe insulation and the cable tray was a = 282 mm.

Circular cable penetration seal "FEP Rund-Kabelschott S 90"

The minimum clearance between the circular cable penetration seals "FEP Rund-Kabelschott S 90" was a = 50 mm.
The minimum clearance between the circular cable seals "FEP Rund-Kabelschott S 90" and the rectangular cable penetration seals "FEP Rechteck-Kabelschott S 90" was a = 190 mm.

1.3.2 Cable penetration seals in the wall systems

Flexible wall construction

Rectangular cable penetration seal "FEP Rechteck-Kabelschott S 90"

On one side of the opening with the inside dimensions 1,050 mm wide by 550 mm high, the rectangular cable penetration seal "FEP Rechteck-Kabelschott S 90" was delimited by the stud section CW 50 x 50 x 06, and on the opposite side by an additional steel channel section CW 50 x 50 x 06, l ≅ 650 mm. Part of the above opening was delimited by a cross channel section UW 50 x 40 x 06, which was arranged at right angles with the above steel channel section and which ended flush with the member reveal.

The steel channel section CW 50 x 50 x 06 and the cross channel section UW 50 x 40 x 06 were fitted to the fire-resistant gypsum plasterboards of the flexible wall construction with dry-wall screws 3.9 x 35, a ≤ 200 mm

A box, 200 mm deep, made from 25-mm thick PROMATECT®-H boards which were not fixed to each other, was centrally positioned in the opening, and the joints of the PROMATECT®-H boards were closed with filler material along the entire depth of the box. The PROMATECT®-H boards were not fixed in the flexible wall construction. One extra insulation layer, 50 mm wide by 1,050 mm long by 25 mm deep each, was provided below the above box to both sides of the flexible wall construction. Dry wall screws 3.5 x 35 mm, a ≤ 300 mm, were used to bolt the insulation layer into the fire-resistant gypsum plaster boards.

Four cable racks and two steel and three copper pipes were passed through the above opening.

1st rack unit:

The first rack unit was fitted with one 300-mm wide wide-span cable rack WSK 80/300/FS (side wall h = 80 mm high). The minimum clearance between the wide-span cable rack and the lateral and top seal reveal was $a_{||}$ = 150 mm and $a_{\perp}$ = 0 mm, respectively.

2nd rack unit

The 2nd rack unit was fitted with two 300-mm wide perforated cable trays KWL 300/60/FS (side wall h = 60 mm high, plate t = 0.75 mm thick), and three copper pipes. The minimum clearance between the cable trays and the lateral seal reveal was $a_{||}$ = 0 mm, between the cable trays a = 0mm, and between the cable top edge and the top seal reveal a = 200 mm.

The minimum clearance between the copper pipes without insulation outside the cable seal (outer pipe diameter d = 18.0 mm, pipe wall s = 1.0 mm thick) was a = 20 mm. The minimum clearance between the above pipes and the seal reveal was a = 30 mm.

The additionally installed copper pipe (outer pipe diameter d = 28.0 mm, pipe wall s = 1.0 mm thick) was protected on the fire-exposed and the non-exposed face by insulating material 230 mm long, made from "FEP Schaum Plus" foam, d = 20 mm. The minimum clearance between the non-insulated copper pipes and the insulation layer of the above copper pipe was a = 20 mm. The minimum clearance between the insulation of the above copper pipe and the seal reveal was a ≅ 200 mm.

The minimum clearance between the insulation of the copper pipe and the cable tray was a = 216 mm.

3rd rack unit:

The 3rd rack unit was fitted with a 500-mm wide wide-span cable rack WSK 80/500/FS (side wall h = 80 mm high) and two steel pipes. The minimum clearance between the wide-span cable rack and the lateral and bottom-end penetration seal reveal was $a_{||}$ = 0 mm and a = 25 mm, respectively. The minimum clearance between the wide-span cable rack and the cable trays above was a = 130 mm.

Two steel pipes (outer pipe diameter d = 54.0 mm, pipe wall s = 1.5 mm thick) were installed in addition. One steel pipe was protected on the fire-exposed and the non-exposed face by insulating material 240 mm long, made from "FEP Schaum Plus" foam, d = 20 mm. The other steel pipe was not insulated. The minimum clearance between the insulation layer of the steel pipe and the non-insulated steel pipe was a = 30 mm, and between the non-insulated steel pipe and the seal reveal a = 40 mm.

The minimum clearance between the insulation layer of the above steel pipe and the wide-span cable rack was a = 282 mm.

Circular cable penetration seal "FEP Rund-Kabelschott S 90"

The circular cable seals "FEP Rund-Kabelschott S 90" consisted of 200-mm long, connected half-round Vermiculite sections, d = 25 mm. These were placed into the flexible wall construction in a central position such that they projected by p = 50 mm beyond each side of the flexible wall construction. The joint between the half-round Vermiculite sections was filled with gypsum filler material along the entire length of the half-round sections. The outer diameter of the Vermiculite sections was d = 150 mm and d = 250 mm.

The minimum clearance between the circular cable penetration seals "FEP Rund-Kabelschott S 90" was a = 50 mm. The minimum clearance between the circular cable penetration seals "FEP Rund-Kabelschott S 90" and the rectangular cable penetration seal "FEP Rechteck-Kabelschott S 90" was also a = 50 mm.

Aerated-concrete wall

Rectangular cable penetration seal "FEP Rechteck-Kabelschott S 90"

On the fire-exposed face, an extra insulation layer 100mm wide and 100 mm thick, made from PROMATECT®-H boards, was provided around the above opening. It was fitted with steel bolts, a ≤ 250 mm, and it ended flush with the member reveal such that in the region that was to accommodate the rectangular cable penetration seal "FEP Rechteck-Kabelschott S 90" the wall was 200 mm thick.

Three cable racks and two steel and three copper pipes were passed through this opening.

1st rack unit:

The 1st rack unit was fitted with a 300-mm wide wide-span cable racks 80/300/FS (side wall h = 80 mm high) and three copper pipes. The minimum clearance between the wide-span cable rack and the lateral penetration reveal was $a_{||}$ = 0 mm, between the wide-span cable racks a = 0 mm, and between the cable top edge and the top seal reveal a = 200 mm.

The minimum clearance between the non-insulated copper pipes (outer pipe diameter d = 18.0 mm, pipe wall s = 1.0 mm thick) was a = 20 mm. The minimum clearance between the above pipes and the seal reveal was a = 45 mm.

Outside the cable penetration seal, the additionally installed copper pipe (outer pipe diameter d = 28.0 mm, pipe wall s = 1.0 mm thick) was protected on the fire-exposed and the non-exposed face by insulating material 230 mm long, made from "FEP Schaum Plus" foam, d = 20 mm. The minimum clearance between the non-insulated copper pipes and the insulation layer of the above copper pipe was a = 20 mm. The minimum clearance between the insulation layer of the above copper pipe and the seal reveal was a ≅ 200 mm.

The minimum clearance between the insulation layer of the copper pipe and the wide-span cable rack was a = 216 mm.

2nd rack unit:

The 2nd rack unit was fitted with one 500-mm wide perforated cable tray KWL 500/60/FS (side wall h = 60 mm high, plate t = 1.50 mm thick) and two steel pipes. The minimum clearance between the cable tray and lateral and bottom-end reveal was $a_{||}$ = 0 mm. The minimum clearance between the cable tray and the wide-span cable racks above was a = 130 mm.

Two steel pipe (outer pipe diameter d = 54.0 mm, pipe wall s = 1.5 mm thick) were installed in addition. Outside the cable penetration seal, one steel pipe was protected on the fire-exposed and the non-exposed face by insulating material 240 mm long, made from "FEP Schaum Plus" foam, d = 20 mm. The other steel pipe was not insulated. The minimum clearance between the insulation layer of the steel pipe and the non-insulated steel pipe was a = 30 mm, and between the non-insulated steel pipe and the seal reveal a = 40 mm.

The minimum clearance between the insulation layer of the above steel pipe and the cable tray was a = 302 mm.

Circular cable penetration seal „FEP Rund-Kabelschott S 90"

On the fire-exposed face, an extra insulation layer, 50 mm thick, made from PROMATECT®-H boards, was provided around the bore holes. This layer ended flush with the member reveal such that in the region that was to accommodate the circular cable penetration seals "FEP Rund-Kabelschott S 90" the wall was 150 mm thick.

The minimum clearance between the circular cable penetration seals "FEP Rund-Kabelschott S 90" was a = 50 mm. The minimum clearance between the circular cable penetration seals "FEP Rund-Kabelschott S 90" and the rectangular cable penetration seal "FEP Rechteck-Kabelschott S 90" was also a = 50 mm.

1.4 Cable and pipe assignment

1.4.1 General

Rectangular cable penetration seal "FEP Rechteck-Kabelschott S 90"

The wide-span cable racks and the cable trays of the rectangular cable penetration seals "FEP Rechteck-Kabelschott S 90" of floor system D1, and those of the flexible wall construction and the aerated-concrete wall were fitted with cables as specified in DIN 4102-09 : 1990-05. The floor system D2 was fitted with cables which had achieved a fire resistance time < 90 minutes in the floor system D1 fire test (secondary test made for floor system D1). The wide-span cable racks and cable trays were subjected to additional loads as specified in draft DIN EN 1366-03 : 1994-04 (wall penetration seals).

Circular cable penetration seal "FEP Rund-Kabelschott S 90"

No cable routes were passed through the circular cable penetration seals "FEP Rund-Kabelschott S 90".

Tie wire was used to fix the individual cables, the cable bundles, the control pipes, and the non-combustible pipes at or on the wide-span cable racks, cable trays, channel sections CP 30 L/ FS and the round bars ∅ 18 used in connection with the rectangular cable penetration seals "FEP Rechteck-Kabelschott S 90" and the circular cable penetration seals "FEP Rund-Kabelschott S 90". The cables, the control pipes, and the non-combustible pipes were about 525 mm and 600 mm long each on the fire-exposed and the non-exposed face. On the non-exposed face, the cut faces of the cables were sealed with fire-resistant compound "FEP Masse". On the fire-exposed face, a steel or copper plate was welded / soldered to the open ends of the steel and copper pipes.

The rectangular cable penetration seals "FEP Rechteck-Kabelschott S 90" and circular cable penetration seals "FEP Rund-Kabelschott S 90" were fitted with the following cables, control pipes, and non-combustible pipes :

1.4.2 Floor system D1

Rectangular cable penetration seal "FEP Rechteck-Kabelschott S 90"

1st rack unit, 500-mm wide cable tray and copper pipes:

- d = 20 each NYY-O 4 x 10 mm^2 — Cu cable up to 1 kV with PVC sheath, outer diameter d = 16 mm
- e = 20 each NYY-O 5 x 1.5 mm^2 — Cu cable up to 1 kV with PVC sheath, outer diameter d = 14 mm
- Tied cable bundle with : — telecommunications cables S-Y(St)Y 56 x 3 x 0.6 mm^2 outer diameter cable bundle approx. 100 mm
- 2 copper pipes : — outer pipe diameter d = 18 mm, pipe wall s = 1.0 mm thick, outside seal not insulated
- 1 copper pipe : — outer pipe diameter d = 28 mm, pipe wall s = 1.0 mm thick, outside seal not insulated

2nd rack unit, 300-mm wide wide-span cable rack, and steel pipes

- Wide-span cable rack not occupied
- 1 steel pipe — outer pipe diameter d = 54 mm, pipe wall s = 1.5 mm thick, outside seal not insulated
- 1 steel pipe : — outer pipe diameter d = 54 mm, pipe wall s = 1.5 mm thick, additionally insulated with "FEP Schaum Plus" foam, d = 20 mm, each l = 400 mm on both sides of seal

3rd rack unit, two 300-mm wide wide-span cable racks

- a = 1 each NYSEY 3 x 185 mm^2 — Cu cable up to 1 kV with PVC sheath, outer diameter d = 68 mm
- b = 3 each NYY-I 3 x 185/95 mm^2 — Cu cable up to 1 kV with PVC sheath outer diameter d = 53 mm
- c = 3 each N2XSY 1 x 150 mm^2 — Cu cable up to 10 kV with PVC sheath outer diameter d = 30 mm
- g= 2 each NAYY-I 4 x 185 mm^2 — Al cable up to 1 kV with PVC sheath outer diameter d = 50 mm
- 3 each control pipes made from plastics ∅ 15 mm
- 3 each control pipes made from steel ∅ 15 mm

Circular cable penetration seal "FEP Rund-Kabelschott S 90"

Circular penetration seal ∅ 105

- c = 3 each N2XSY 1 x 150 mm^2 — Cu cable up to 10 kV with PVC sheath, outer diameter d = 30 mm

Circular penetration seal ∅ 210

- Tied cable bundle with : — telecommunications cables S-Y(St)Y 56 x 3 x 0.6 mm^2, outer diameter cable bundle approx. 100 mm
- 3 each control pipes made from plastics ∅ 15 mm
- 3 each control pipes made from steel ∅ 15 mm

Circular penetration seal ∅ 210

- b = 2 each NYY-I 3 x 185/95 mm^2 — Cu cable up to 1 kV with PVC sheath, outer diameter d = 53 mm
- g= 1 each NAYY-I 4 x 185 mm^2 — Al cable up to 1 kV with PVC sheath, outer diameter d = 50 mm

1.4.3 Floor system D2

Rectangular cable penetration seal "FEP Rechteck-Kabelschott S 90"

1st rack unit, 500-mm wide wide-span cable racks:

- b = 1 each NYY-I 3 x 185/95 mm^2 — Cu cable up to 1 kV with PVC sheath, outer diameter d = 53 mm
- c = 3 each N2XSY 1 x 150 mm^2 — Cu cable up to 10 kV with PVC sheath, outer diameter d = 30 mm
- Tied cable bundle with : — telecommunications cables S-Y(St)Y 56 x 3 x 0.6 mm^2, outer diameter cable bundle approx. 100 mm

2nd rack unit, 300-mm wide cable tray and one copper pipe

- Cable tray not occupied
- 1 copper pipe : — outer pipe diameter d = 28 mm, pipe wall s = 1.0 mm thick, additionally insulated with "FEP Schaum Plus" foam, d = 20 mm, l = 400 mm each on both sides of seal

Circular cable penetration seal "FEP Rund-Kabelschott S 90"

Circular penetration seal ∅ 105

- c = 3 each N2XSY 1 x 150 mm^2 — Cu cable up to 10 kV with PVC sheath, outer diameter d = 30 mm

Circular penetration seal ∅ 210

- Tied cable bundle with : telecommunications cables S-Y(St)Y 56 x 3 x 0.6 mm^2
  outer diameter cable bundle approx. 100 mm

Circular penetration seal ∅ 210

- b = 2 each NYY-I 3 x 185/95 mm^2 Cu cable up to 1 kV with PVC sheath
  outer diameter d = 53 mm
- g= 1 each NAYY-I 4 x 185 mm^2 Al cable up to 1 kV with PVC sheath
  outer diameter d = 50 mm

1.4.4 Flexible wall construction

Rectangular cable penetration seal "FEP Rechteck-Kabelschott S 90"

1st rack unit, 300-mm wide wide-span cable racks

- Cable tray not occupied

2nd rack unit, two 300-mm wide cable trays and copper pipes:

- a = 1 each NYSEY 3 x 185 mm^2 Cu cable up to 1 kV with PVC sheath,
  outer diameter d = 68 mm
- b = 3 each NYY-I 3 x 185/95 mm^2 Cu cable up to 1 kV with PVC sheath
  outer diameter d = 53 mm
- c = 3 each N2XSY 1 x 150 mm^2 Cu cable up to 10 kV with PVC sheath
  outer diameter d = 30 mm
- g= 2 each NAYY-I 4 x 185 mm^2 Al cable up to 1 kV with PVC sheath
  outer diameter d = 50 mm
- 3 each control pipes made from plastics ∅ 15 mm
- 3 each control pipes made from steel ∅ 15 mm
- 2 copper pipes : outer pipe diameter d = 18 mm,
  pipe wall s = 1.0 mm thick,
  outside seal not insulated
- 1 copper pipe : outer pipe diameter d = 28 mm,
  pipe wall s = 1.0 mm thick,
  additionally insulated with "FEP Schaum Plus" foam",
  d = 20 mm, l = 230 mm each on both sides of seal

3rd rack unit, 500-mm wide wide-span cable rack and steel pipes

- d = 20 each NYY-O 4 x 10 mm^2 Cu cable up to 1 kV with PVC sheath,
  outer diameter d = 16 mm
- e = 20 each NYY-O 5 x 1,5 mm^2 Cu cable up to 1 kV with PVC sheath,
  outer diameter d = 14 mm

- Tied cable bundle with : telecommunications cables S-Y(St)Y 56 x 3 x 0.6 mm^2 outer diameter cable bundle approx. 100 mm
- 1 steel pipe : outer pipe diameter d = 54 mm, pipe wall s = 1.5 mm thick, outside seal not insulated
- 1 steel pipe : outer pipe diameter d = 54 mm, pipe wall s = 1.5 mm thick, additionally insulated with "FEP Schaum Plus" foam" d = 20 mm, l = 240 mm each on both sides of seal

Circular cable seal "FEP Rund-Kabelschott S 90"

Circular penetration seal ∅ 105

- c = 3 each N2XSY 1 x 150 mm^2 Cu cable up to 10 kV with PVC sheath outer diameter d = 30 mm

Circular seal ∅ 210

- b = 2 each NYY-I 3 x 185/95 mm^2 Cu cable up to 1 kV with PVC sheath outer diameter d = 53 mm
- g= 1 each NAYY-I 4 x 185 mm^2 Al cable up to 1 kV with PVC sheath outer diameter d = 50 mm
- 3 each control pipes made from plastics ∅ 15 mm
- 3 each control pipes made from steel ∅ 15 mm

Circular seal ∅ 210

- Tied cable bundle with : telecommunications cables S-Y(St)Y 56 x 3 x 0.6 mm^2 outer diameter cable bundle approx. 100 mm

1.4.5 Aerated-concrete wall

Rectangular cable penetration seal "FEP Rechteck-Kabelschott S 90"

1st rack unit, two 300-mm wide wide-span cable racks and copper pipes:

- a = 1 each NYSEY 3 x 185 mm^2 Cu cable up to 1 kV with PVC sheath, outer diameter d = 68 mm
- b = 3 each NYY-I 3 x 185/95 mm^2 Cu cable up to 1 kV with PVC sheath outer diameter d = 53 mm
- c = 3 each N2XSY 1 x 150 mm^2 Cu cable up to 10 kV with PVC sheath outer diameter d = 30 mm
- g= 2 each NAYY-I 4 x 185 mm^2 Al cable up to 1 kV with PVC sheath outer diameter d = 50 mm
- 3 each control pipes made from plastics ∅ 15 mm

- 3 each control pipes made from steel ∅ 15 mm

- 2 copper pipes : outer pipe diameter d = 18 mm,
  pipe wall s = 1.0 mm thick,
  outside seal not insulated

- 1 copper pipe : outer pipe diameter d = 28 mm,
  pipe wall s = 1.0 mm thick,
  additionally insulated with "FEP Schaum Plus" foam,
  d = 20 mm, l = 230 mm each on both sides of seal

2nd rack unit, 500-mm wide cable tray and steel pipes

- d = 20 each NYY-O 4 x 10 mm^2 Cu cable up to 1 kV with PVC sheath,
  outer diameter d = 16 mm

- e = 20 each NYY-O 5 x 1,5 mm^2 Cu cable up to 1 kV with PVC sheath,
  outer diameter d = 14 mm

- Tied cable bundle with : telecommunications cables S-Y(St)Y 56 x 3 x 0.6 mm^2
  outer diameter cable bundle approx. 100 mm

- 1 steel pipe outer pipe diameter d = 54 mm,
  pipe wall s = 1.5 mm thick,
  outside seal not insulated

- 1 steel pipe : outer pipe diameter d = 54 mm,
  pipe wall s = 1.5 mm thick,
  additionally insulated with "FEP Schaum Plus" foam
  d = 20 mm, l = 240 mm each on both sides of seal

Circular cable penetration seal "FEP Rund-Kabelschott S 90"

Circular penetration seal ∅ 105

- c = 3 each N2XSY 1 x 150 mm^2 Cu cable up to 10 kV with PVC sheath
  outer diameter d = 30 mm

Circular penetration seal ∅ 210

- b = 2 each NYY-I 3 x 185/95 mm^2 Cu cable up to 1 kV with PVC sheath
  outer diameter d = 53 mm

- g= 1 each NAYY-I 4 x 185 mm^2 Al cable up to 1 kV with PVC sheath
  outer diameter d = 50 mm

- 3 each control pipes made from plastics ∅ 15 mm
- 3 each control pipes made from steel ∅ 15 mm

Circular penetration seal ∅ 210

- Tied cable bundle with : telecommunications cables S-Y(St)Y 56 x 3 x 0.6 mm^2
  outer diameter cable bundle approx. 100 mm

Because previous experience with testing this kind of cable penetration seals was not sufficient, cable removing and addition was not dispensed with. In the circular/rectangular cable penetration seal "FEP Rund- Rechteck-Kabelschott S 90" of floor system D 1 and of the flexible wall construction, one 'c' cable each (N2XSY 1 x 150 mm², Cu cable up to 1 kV with PVC sheath, outer diameter d = 53 mm) was removed and added.

1.5 Structural design of cable penetration seal

Before producing the rectangular and circular cable penetration seals "FEP Rechteck-Kabelschott S 90" and "FEP Rund-Kabelschott S 90", respectively, the reveals of the openings that had been prepared in the members beforehand (aerated-concrete wall, floor, box made from PROMATECT®-H boards and Vermiculite sections) and the wide-span cable racks, cable trays, cables, control pipes, and the non-combustible pipes were cleaned and freed from dust. The member opening remaining between the cables, control pipes and cable support structures was (in the case of the rectangular cable penetration seals "FEP Rechteck-Kabelschott S 90") completely filled with square moulded parts (name used by client : block), which were made from "FEP Schaum Plus" foam. The prefabricated moulded parts were fitted, with their long sides in parallel with the cables and with staggered joints, in such a way that the seal opening was closed tightly. In the region of the cables, control pipes, cable support structures and seal reveals, the moulded parts were cut with a suitable cutting tool to produce tightly fitting pieces. Once the member opening had been closed completely, one copper pipe each was passed through the joints between the moulded parts, and the remaining void was tightly closed with "FEP Masse" compound which produces an intumescent effect in fires. To fit the steel pipes, a recess was cut around the joint between two moulded parts, through which the steel pipe was passed. The remaining void was tightly closed with matching moulded parts and with the "FEP Masse" compound. After that, some of the non-combustible pipes were additionally protected by 20-mm thick mats of different lengths, made from "FEP Schaum Plus" foam. The ends of the mats were glued together.

The prefabricated moulded parts for the circular cable penetration seals "FEP Rundschott-Kabelschott S 90" were also made from "FEP Schaum Plus" foam. They had the shape of a circular truncated cone ("round plugs") and differed in their diameters. Before fitting the round plugs, recesses exactly matching the cables that were to be passed through them were cut into the moulded parts with a suitable cutting tool. Their conical shape allowed the round plugs to be fitted tightly into the member reveal. The round plugs ended flush with the floor top and underside, with the Vermiculite sections (flexible wall construction), and with the aerated-concrete wall and the extra insulation layer. The round plugs were always 70 mm thick. Depending on the thickness of the seal, this created an air gap 10 mm or 50 mm deep between the plugs.

. . .

While installing the rectangular and circular cable penetration seals "FEP Rechteck-Kabelschott S 90" and "FEP Rund-Kabelschott S 90", respectively, all joints and interstices between the cables / the non-combustible pipes and the moulded parts were filled with "FEP Masse" compound throughout the entire seal thickness. The interstices within the cable bundles were not filled with "FEP Masse" compound. As a final measure, all visible, near-surface joints between the moulded parts were carefully filled with spray-applied "FEP Masse" compound.
For further details of the structural design of the specimen, reference is made to annexes 1.1 to 1.21.

1.6 Specimens and material characteristics

The construction materials used for the cable penetration seal tested are in compliance with the details specified in annexes 1.22 to 1.24 respecting material classification, weight per unit area, apparent density, and moisture content.

2 Test set-up and testing

The client's own expert staff installed the cable penetration seals into the floor and wall systems described in section 1.1 above. For the structural design of the specimen, reference is made to annexes 1.1 to 1.21.

The fire test was made in compliance with DIN 4102-09 : 1990-05.

The temperatures on the non-exposed face of the specimen were measured by means of 83 each (floor system D1 : test 1), 36 each (floor system D2 : test 3), and 137 each (wall system: test 2) NiCr-Ni thermocouples ∅ 0.5 mm, which were fixed on the non-exposed face of the specimen.

The static gauge pressure in the furnace was 10 ± 2 Pa during the fire test. Furnace flaming was in compliance with the DIN 4102-2 : 1977-09 standard temperature-time curve (ETK).

3 Test results and observations

The temperature rise beyond initial temperatures established during the fire test on the non-exposed face

- on the floor and wall systems,
- on the rectangular cable penetration seal "FEP Rechteck-Kabelschott S 90",
- on the circular cable penetration seal "FEP Rund-Kabelschott S 90",
- on the extra insulation layers made from PROMATECT®-H boards,
- on the box made from PROMATECT®-H boards,
- on the Vermiculite sections,
- on the cable support structures,

. . .

- on the cables and cable bundle,
- on the control pipes, and
- on the non-combustible pipes,

and the temperatures in the furnace are illustrated in the graphs in annexes 2.1 to 2.19, 3.1 to 3.12, and 4.1 to 4.42. For observations made during the fire test, reference is made to annexes 2.20, 3.13, 3.14, 4.43, and 4.44.

Tables 1a and 1b list the most important test results.

For tables 1a and 1b see sheets 19 and 20.

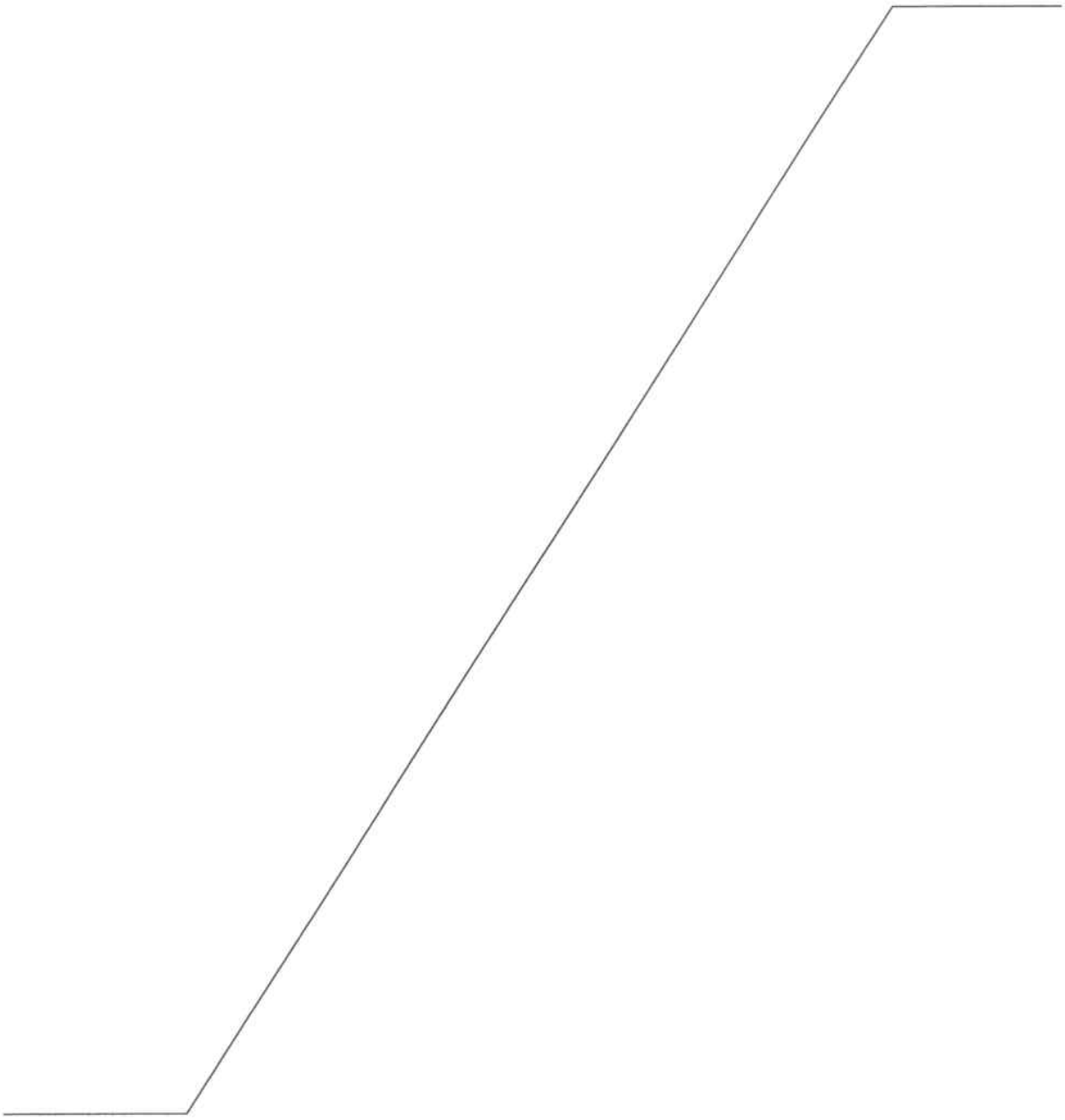


Table 1a: Essential test results summarized (floor tests)

Type of test in	Cable seal	Position of measuring points	Occurrence of Flames on non-exposed face after [min.]	Occurrence of Smoke [1] on non-exposed face after [min.]	Max. temperature rise in K, Test period in minutes: 30	60	90	93	117	Temperature 180 K exceeded: Meas point	[min.]	Verified fire resistance time in minutes
Floor D1 : Aerated-concrete floor, d = 200 mm	"FEP Rechteck-Kabel-schott S 90"	On cables	-	-	56	118	213	220	-	14	81	81
		On cable bundle	-	-	47	87	197	205	-	26	83	83
		On control pipes	-	-	33	88	173	175	-	-	-	>93
		On racks	-	-	56	91	161	168	-	-	-	>93
		On the Cu pipes Ø18	-	-	103	147	174	178	-	-	-	>93
		On the Cu pipe Ø28	-	-	154	209	242	248	-	36	43	43
		On the steel pipe	-	-	83	102	132	133	-	-	-	>93
		On the seal / on the floor system	-	-	15	72	69	70	-	-	-	>93
Floor D1 : Aerated-concrete floor d = 150 mm	"FEP Rund-Kabel-schott S 90"	On the cables (seal Ø 105)	-	-	25	85	200	205	-	52	86	86
		On the cables (seal Ø 210)	-	-	38	163	365	371	-	62	69	69
		On the cable bundle	76	-	67	201	1138	895	-	70	54	54
		On the control pipes	-	-	5	30	35	36	-	-	-	>93
		On the seal / on the floor system	75 (seal Ø 210 : fitted with cables)	-	24	70	939	905	-	72	79	79
Floor D2 : Aerated-concrete floor, d = 200 mm	"FEP Rechteck-Kabel-Schott S 90"	On the cables	-	-	37	132	172	-	290	3	96	96
		On the cable bundle	-	-	32	89	176	-	227	4	91	91
		On the racks	-	-	8	20	31	-	41	-	-	>117
		On the Cu pipes Ø28	-	-	29	62	91	-	113	-	-	>117
		On the seal / on the floor system	-	-	11	66	72	-	76	-	-	>117
	"FEP Rund-Kabel-schott S 90"	On the cables (seal Ø 105)	-	-	20	87	180	-	208	33	90	90
		On the cables (seal Ø 210)	-	-	22	87	180	-	184	20	116	116
		On the cable bundle	-	-	42	181	336	-	387	28	60	60
		On the seal / on the floor system	-	-	7	59	70	-	157	29	97	97

1) Very low development of smoke is not considered

Table 1b: Essential test results summarized (wall tests)

Type of test in a	Cable seal	Position of measuring points	Occurrence of		Max. temperature rise in K				Temperature 180 K exceeded		Verified-fire resistance time in minutes
			Flames on non-exposed face after [min.]	Smoke [1] on non-exposed face after [min.]	Test period in minutes 30	60	90	97	Meas point	[min.]	
flexible wall, d = 100 mm	"FEP Rechteck-Kabel-schott S 90"	On cables	-	-	100	98	122	128	-	-	>97
		On cable bundle	-	-	39	97	105	118	-	-	>97
		On control pipes	-	-	75	90	108	113	-	-	>97
		On racks	-	-	30	105	144	169	-	-	>97
		On the Cu pipes ∅18	-	-	94	143	180	189	36	90	90
		On the Cu pipe ∅28	-	-	34	67	86	91	-	-	>97
		On the non-insulated steel pipe	-	-	61	64	78	80	-	-	>97
		On the insulated steel pipe	-	-	8	24	49	51	-	-	>97
		On the seal / on the wall system	33	33	23	77	79	75	-	-	33
	"FEP Rund-Kabel-schott S 90"	On the cables (seal ∅ 105)	-	-	31	91	102	100	-	-	>97
		On the cables (seal ∅ 210)	-	-	74	106	131	188	44	97	97
		On the cable bundle	-	-	68	117	124	140	-	-	>97
		On the control pipes	-	-	75	90	107	114	-	-	>97
		On seal / on the wall system	-	-	51	86	118	126	-	-	>97
Aerated-concrete wall d = 100 mm	"FEP Rechteck-Kabel-schott S 90"	On the cables	-	-	62	106	193	208	76	88	88
		On the cable bundle	-	-	35	109	175	188	85	93	93
		On the control pipes	-	-	34	56	80	88	-	-	>97
		On the racks	-	-	31	78	141	165	-	-	>97
		On the Cu pipes ∅18	-	-	94	129	162	170	-	-	>97
		On the Cu pipe ∅28	-	-	39	75	94	97	-	-	>97
		On the non-insulated steel pipe	-	-	77	78	96	99	-	-	>97
		On the insulated steel pipe	-	-	14	31	46	50	-	-	>97
		On the seal / on the wall system	21	21	243	352	718	802	94	27	21
Aerated-concrete wall d = 100 mm	"FEP Rund-Kabel-schott S 90"	On the cables (Schott ∅ 105)	-	-	32	123	224	254	113	69	69
		On the cables (Schott ∅ 210)	-	-	50	142	191	232	109	88	88
		On the cable bundle	-	-	64	188	318	345	114	59	59
		On the control pipes	-	-	34	56	80	90	-	-	>97
		On the seal / on the wall system	-	-	24	104	190	199	124	89	89

1) Very low development of smoke is not considered

4 Test results summarized and conclusions

4.1 Test results summarized

On 6 August 1999 (floor system D 1 : test 1), on 26 November 1999 (wall systems : test 2), and on 14 January 2000 (floor system D 2 : test 3), circular and rectangular cable penetration seals "FEP Rund-Kabelschott S 90" and "FEP Rechteck-Kabelschott S 90", respectively, which were mounted with different thicknesses in a 150-mm and 200-mm thick floor made from aerated-concrete slabs, in a 100-mm thick non-loadbearing, separating flexible wall construction, and in a 100-mm thick aerated-concrete wall, were to be tested for their reaction to fire in compliance with DIN 4102-09 : 1990-05 for determination of the fire resistance time when having one face of the specimen exposed to the fire.

Table 2 to 4 show the most important test results for the cable penetration seals.

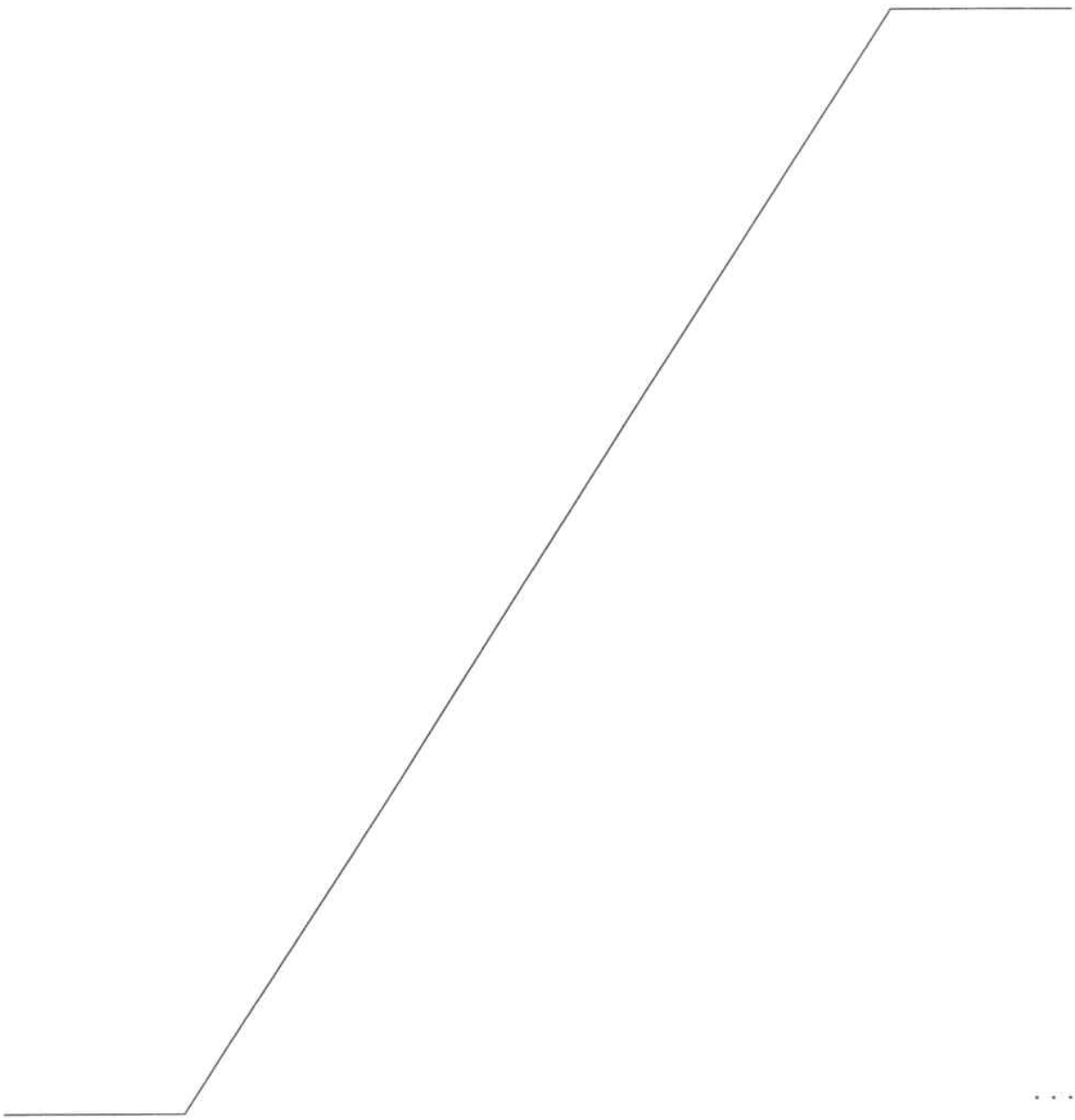


Table 2: Requirements made on cable penetration seals in compliance with DIN 4102-09 : 1990-05.
Most important test results summarized (floor system D 1 and D 2 tests)

Line	Cross reference with Standard details based on DIN4102 Part 9, Section	Requirements 1) For horizontal cable routes, a test wall has to be tested with 2 specimens. If this test produces positive results, only one additional test needs to be made for vertical cable routes, using one test floor (1 specimen). 2) For vertical cable routes, two test floors (2 specimen) have to be tested, unless testing has been made in compliance with item 1) above.			Test results	Assess-ment
1	4.1.2	Openings in walls and floors for electric cables and conduits have to be sealed off in such a way that - irrespective of the amount of cabling installed, and - irrespective of the side of fire attack, a spread of fire to other compartments or floors is prevented. This means that in the fire tests	– the integrity must be maintained, i.e. the following must be prevented:	ignition of cotton swab.	Cotton swab ignited after: - minutes	Fire resistance time reached 90 min.[1)]
2				flames on the non-exposed face.	Flames on non-exposed face occurred after : - min.	
3			– on the non-exposed face, temperatures must not reach ΔT > 180 K as a maximum at any point of the penetration seal, the holders, the cable sheath, and (if provided) the cable support structure		Adm. ΔT was exceeded after 60[1)] min. (see tables 1a and 1b)	
4			– there must be no reason for objections because of secondary fire effects (smoke permeability, production of smoke).		Serious production of smoke: up to - min. Inflammable gasses occurred after - min.	Complied with
5	5.4.2	Cable penetration seals primarily produced from construction materials whose fire-engineered effect does not come to bear unless in the presence of the heat of fire, have to meet the requirements in lines 1 to 4 also in fire tests using a mitigated temperature-time curve (smouldering fire).			Does not apply	Does not apply
6	4.2	Assignment of additional or new cables (standby penetration seal) must be possible. The measures to be taken for this purpose most not affect the protective function of the penetration seal.			Possible; no additional negative effects	by expert committee ("SVA")
7	Other details	The construction materials used in the design and construction of the penetration seal must be insusceptible to aging and corrosion. This equally applies to ambient temperatures of up to 80 °C, to account for possible Joulean heat, and to a relative air humidity of up to 100%.		The penetration seal construction materials were:	moulded parts made from "FEP Schaum Plus" foam, and "FEP Masse" compound with intumescent effect in a fire	by expert committee ("SVA")
8		Construction materials whose suitability as penetration seal materials is based on the granular or powdery consistence and which tend to clot in the presence of moisture, have to be adequately protected against such influence.				Does not apply
9		Solvents, filler and sealing material must at no time (starting with the installation of the penetration seal until its intended service life) have any damaging effect on the cables.			See line 5	by expert committee ("SVA")
10		The cable support structure has to be designed such that the penetration seal will not be subjected to any additional mechanical loads..				by expert committee ("SVA")
11		With floor-mounted penetration seals, the proportionate weight of the cables above and below the floor has to be transmitted in such a way that the effectiveness of the support system used will me maintained for the fire resistance time determined for the penetration seal as a minimum.			Does not apply	Does not apply

1) See section 4.2 - Conclusions

. . .

Table 3: Requirements made on cable penetration seals in compliance with DIN 4102-09 : 1990-05.
Most important test results summarized (flexible wall construction test)

Line	Cross reference with Standard details based on DIN4102 Part 9, Section	Requirements 1) For horizontal cable routes, a test wall has to be tested with 2 specimens. If this test produces positive results, only one additional test needs to be made for vertical cable routes, using one test floor (1 specimen). 2) For vertical cable routes, two test floors (2 specimen) have to be tested, unless testing has been made in compliance with item 1) above.			Test results	Assess-ment
1	4.1.2	Openings in walls and floors for electric cables and conduits have to be sealed off in such a way that - irrespective of the amount of cabling installed, and - irrespective of the side of fire attack, a spread of fire to other compartments or floors is prevented. This means that in the fire tests	– the integrity must be maintained, i.e. the following must be	ignition of cotton swab.	Cotton swab ignited after: - minutes	Fire resistance time reached 90 min.
2				flames on the non-exposed face.	Flames on non-exposed face occurred after: 33 min.[1]	
3			– on the non-exposed face, temperatures must not reach $\Delta T > 180$ K as a maximum at any point of the penetration seal, the holders, the cable sheath, and (if provided) the cable support structure		Adm. ΔT was exceeded after min. (see table 1)	
4			– there must be no reason for objections because of secondary fire effects (smoke permeability, production of smoke).		Serious production of smoke: up to 33 min. Inflammable gasses occurred after - min.	Complied with
5	5.4.2	Cable penetration seals primarily produced from construction materials whose fire-engineered effect does not come to bear unless in the presence of the heat of fire, have to meet the requirements in lines 1 to 4 also in fire tests using a mitigated temperature-time curve (smouldering fire).			Does not apply	Does not apply
6	4.2	Assignment of additional or new cables (standby penetration seal) must be possible. The measures to be taken for this purpose most not affect the protective function of the penetration seal.			Possible; no additional negative effects	by expert committee ("SVA")
7	Other details	The construction materials used in the design and construction of the penetration seal must be insusceptible to aging and corrosion. This equally applies to ambient temperatures of up to 80 °C, to account for possible Joulean heat, and to a relative air humidity of up to 100%.		The penetration seal construction materials were:	moulded parts made from "FEP Schaum Plus" foam, and "FEP Masse" compound with intumescent effect in a fire	by expert committee ("SVA")
8		Construction materials whose suitability as penetration seal materials is based on the granular or powdery consistence and which tend to clot in the presence of moisture, have to be adequately protected against such influence.				Does not apply
9		Solvents, filler and sealing material must at no time (starting with the installation of the penetration seal until its intended service life) have any damaging effect on the cables.			See line 5	by expert committee ("SVA")
10		The cable support structure has to be designed such that the penetration seal will not be subjected to any additional mechanical loads..				by expert committee ("SVA")
11		With floor-mounted penetration seals, the proportionate weight of the cables above and below the floor has to be transmitted in such a way that the effectiveness of the support system used will me maintained for the fire resistance time determined for the penetration seal as a minimum.			Does not apply	Does not apply

[1] See section 4.2 - Conclusions

Table 4: Requirements made on cable penetration seals in compliance with DIN 4102-09 : 1990-05.
Most important test results summarized (aerated-concrete wall test)

Line	Cross reference with Standard details based on DIN4102 Part 9, Section	Requirements 1) For horizontal cable routes, a test wall has to be tested with 2 specimens. If this test produces positive results, only one additional test needs to be made for vertical cable routes, using one test floor (1 specimen). 2) For vertical cable routes, two test floors (2 specimen) have to be tested, unless testing has been made in compliance with item 1) above.			Test results	Assess-ment
1	4.1.2	Openings in walls and floors for electric cables and conduits have to be sealed off in such a way that - irrespective of the amount of cabling installed, and - irrespective of the side of fire attack, a spread of fire to other compartments or floors is prevented. This means that in the fire tests	– the integrity must be maintained, i.e. the following must be prevented:	ignition of cotton swab.	Cotton swab ignited after: - minutes	Fire resistance time reached: 69 min.
2				flames on the non-exposed face.	Flames on non-exposed face occurred after: 21 min.[1]	
3			– on the non-exposed face, temperatures must not reach $\Delta T > 180$ K as a maximum at any point of the penetration seal, the holders, the cable sheath, and (if provided) the cable support structure		Adm. ΔT was exceeded after min. (see table 1)	
4			– there must be no reason for objections because of secondary fire effects (smoke permeability, production of smoke).		Serious production of smoke: until 21min.[1] Inflammable gasses occurred after - min.	Complied with
5	5.4.2	Cable penetration seals primarily produced from construction materials whose fire-engineered effect does not come to bear unless in the presence of the heat of fire, have to meet the requirements in lines 1 to 4 also in fire tests using a mitigated temperature-time curve (smouldering fire).			Does not apply	Does not apply
6	4.2	Assignment of additional or new cables (standby penetration seal) must be possible. The measures to be taken for this purpose most not affect the protective function of the penetration seal.			Possible; no additional negative effects	by expert committee ("SVA")
7	Other details	The construction materials used in the design and construction of the penetration seal must be insusceptible to aging and corrosion. This equally applies to ambient temperatures of up to 80 °C, to account for possible Joulean heat, and to a relative air humidity of up to 100%.		The penetration seal construction materials were:	"FEP Schaum Plus" foam and moulded parts made from "FEP Masse Formteile BDS-90" mass, with intumescent effect in a fire	by expert committee ("SVA")
8		Construction materials whose suitability as penetration seal materials is based on the granular or powdery consistence and which tend to clot in the presence of moisture, have to be adequately protected against such influence.				Does not apply
9		Solvents, filler and sealing material must at no time (starting with the installation of the penetration seal until its intended service life) have any damaging effect on the cables.			See line 5	by expert committee ("SVA")
10		The cable support structure has to be designed such that the penetration seal will not be subjected to any additional mechanical loads..				by expert committee ("SVA")
11		With floor-mounted penetration seals, the proportionate weight of the cables above and below the floor has to be transmitted in such a way that the effectiveness of the support system used will me maintained for the fire resistance time determined for the penetration seal as a minimum.			Does not apply	Does not apply

[1] See section 4.2 - Conclusions

4.2 Conclusions

Starting from the results achieved in the tests, the cable penetration seals tested can be classified into fire resistance class "S 90", provided with following boundary conditions are complied with :

4.2.1 Conclusions for rectangular and circular cable penetration seals "FEP Rechteck-Kabelschott S 90" and "FEP Rund-Kabelschott S 90", respectively, mounted in floors

The cable penetration seal may be mounted in floors, 200 mm thick as a minimum, made from concrete / reinforced concrete or aerated-concrete designed for compliance with fire resistance class F 90 as a minimum (code designation F 90-AB). Should the floor which is to accommodate the cable penetration seal be less than 200 mm thick, an extra all-around insulation layer made from calcium silicate or gypsum plasterboard strips or made from KERAGUSS board strips (types N,L and S as defined in General Building Code Test Certificate No. P-3184/1784-MPA BS), 100 mm wide as a minimum, has to be anchored in the region of the unfinished opening on the upper side of the floor in such a way that the overall floor thickness is 200 mm as a minimum. The extra insulation layer may be up to 50 mm thick.

Rectangular cable penetration seal "FEP Rechteck-Kabelschott S 90"

The square moulded parts, up to 1,000 mm wide and 20 mm to 100 mm high, made from "FEP Schaum Plus" foam have to be 220 mm thick as a minimum. The width of the cable penetration seal (corresponding to the inside width of the member opening in the unfinished state) must not exceed 500 mm; its length is unlimited.

The cable penetration seal may accommodate

- pipes made from copper, outer pipe diameter up to 18 mm, pipe wall ≥ 1.0 mm thick, and
- pipes made from steel, outer pipe diameter up to 54 mm, pipe wall ≥ 1.5 mm thick,

in addition to the cables, cable bundles, control pipes and cable support systems (wide-span cable racks, cable trays, cable racks).

It is evident from the observations listed in annex 3.13 for the floor system D2 test that in test minute 43 the insulation protecting the copper pipes (outer pipe diameter d = 28 mm, pipe wall s = 1.0 mm thick) cracked on the fire-exposed face at the glued mat ends along a length of 400 mm. As a result, the copper pipe was completely exposed to the fire. On the non-exposed face, the glued mat ends came apart along a length of 200 mm in test minute 53. After that only the bottom section of the copper pipe, 200 mm high, remained insulated. After test minute 117, the temperature rise recorded as a maximum by the temperature measuring points that had been fixed to the copper pipe was 113 K.

. . .

After test minute 117, the temperature rise recorded on the copper pipe as a maximum value by the roving element at a distance of 200 mm from the seal surface was 160°C (see annexes 3.13 and 3.14). In view of these test results, and in view of the temperature rise recorded on the above copper pipe in the wall systems, there are no reservations from a fire engineering point of view against issuing a type approval for copper pipes of an outer pipe diameter up to d = 28 mm and a pipe wall s ≥ 1.0 mm thick, provided these copper pipes are protected with "FEP Schaum Plus" foam insulation d ≥ 20 mm and 300 mm long as a minimum outside the seal.

Circular penetration seal "FEP Rund-Kabelschott S 90"

The cable penetration seal has to consist of two moulded elements ("round plugs") placed above each other, which have the shape of a circular truncated cone and are made from "FEP Schaum Plus" foam, and which – for cable penetration seals up to 210 mm in diameter (corresponding to the inside width of the member opening in the unfinished state) – are each 70 mm thick as a minimum and end flush with the upper and lower edge of the floor. In view of the results achieved in the test, there are no reservations from a fire engineering point of view against using – for cable penetration seals between 211 mm and 310 mm in diameter – round plugs which are each 110 mm thick as a minimum. The diameter of the cable penetration seal (corresponding to the inside width of the member opening in the unfinished state) must thus not exceed 310 mm.

It is evident from the observations listed for the floor system D1 test that in test minute 52, the temperature measuring points fixed on the cable bundle sheaths forced themselves into the softened cable sheaths. Because of this temperatures were after that measured directly on the bare cables. This is why a fire resistance time of only 54 minutes was reached (see table 1a). For the same reason, any subsequent temperature rise on the cable sheaths was determined with the roving element. The temperature rise thus recorded in test minute 74 was 166 K. In test minute 76, the cable penetration seal was closed with filler material (see annex 2.20).

In the floor system D2 test (see annex 3.13), the temperature measuring points fixed on the cable bundle sheaths forced themselves into the softened cable sheaths in test minute 55, which is why a fire resistance time of only 60 minutes was reached (see table 1a). The temperature rise measured in test minute 86 with the roving element was 180 K plus.

In view of the results achieved in the floor system D1 and D2 tests, there are no reservations from a fire engineering point of view against extrapolating the test results (see annex 4.45), and against classifying the circular cable penetration seal "FEP Rund-Kabelschott S 90" accommodating cable bundles, diameter D ≤ 100 mm, into fire resistance class "S 90" in compliance with DIN 4102-09 : 1990-05, provided the seal is 250 mm thick as a minimum.

Cable support structures must not be passed through the cable penetration seal.

4.2.2 Conclusions for rectangular and circular cable penetration seals "FEP Rechteck-Kabelschott S 90"and "FEP Rund-Kabelschott S 90", respectively, mounted in flexible wall constructions and rigid walls

The cable penetration seals may be mounted in flexible wall constructions with steel strapping, 100 mm thick as a minimum and provided with fire-resistant gypsum plaster boarding on both sides, in compliance with DIN 18180, and they may be mounted in aerated-concrete walls, 100 mm thick as a minimum. In all other respects, the flexible wall construction must comply with the specifications in DIN 4102-4 : 1994-03 for walls made from fire-resistant gypsum plasterboard, which are designed to fire resistance class F 90.

Rectangular cable penetration seals "FEP Rechteck-Kabelschott S 90"

It is evident from the observations listed in annex 4.43 that the cable penetration seals tested failed because of the deformations of the cable support structure. As a result of these deformations, a gap was created above the wide-span cable racks at the top-end seal reveal, through which flames could leap. In view of the other results achieved in this test, and in view of the test results achieved in the floor system D1 and D2 tests and on the cable seal and the floor / the extra insulation layer, there are no reservations from a fire engineering point of view against classifying the rectangular cable seal "FEP Rechteck-Kabelschott S 90" into fire resistance class "S 90" in compliance with DIN 4102-09 : 1990-05, provided the first holders for the cable support structures are arranged at distances ≤ 100 mm on both sides of the wall, and, provided further, the following boundary conditions are complied with :

The square moulded parts made from "FEP Schaum Plus" foam have to be 220 mm thick as a minimum. The dimensions of the cable seal (corresponding to the inside width of the member opening in the unfinished state) must not exceed a width of 1,000 mm and a height of 500 mm. Apart from that there are no reservations from a fire engineering point of view against reducing the height of the seal, while at the same time increasing its width, provided the total area of the cable seal does not exceed 0.50 m^2, and, provided further, the width of the seal is bridged by adequate lintels or adequate load transmitting members for compliance with structural boundary conditions.

Should the rigid wall which is to accommodate the cable seal be less than 200 mm thick, an extra all-around insulation layer made from calcium silicate or gypsum plasterboard strips or made from KERAGUSS board strips (types N,L and S as defined in General Building Code Test Certificate No. P-3184/1784-MPA BS), 100 mm wide as a minimum, has to be anchored in the region of the unfinished opening on both sides of the wall in such a way that the overall thickness of the cable seal is 200 mm as a minimum and the extra insulation layer has the same thickness on both sides of the wall.

With rigid walls d ≥ 150 mm thick it is also acceptable to provide an extra insulation layer on one side only, provided the overall thickness of the cable seal is 200 mm as a minimum.
The cable penetration seal mounted in the flexible wall construction must be delimited on both sides by the studs of the flexible wall construction or by the wall rods provided in addition. Horizontal members may be dispensed with, if the size of the seal opening is ≤ 550 mm x 550 mm and if a spacing ≤ 625 mm is complied with between the studs. In all other respects, the expert committee resolution shall apply (seal ≤ 300 mm x 300 mm). The reveal of the opening in the flexible wall construction always has to be provided with an all-around 25-mm / 2 x 12.5 mm thick and 200-mm wide strip made from calcium silicate or gypsum plasterboard or from KERAGUSS boards (type N,L and S as defined in General Building Code Test Certificate No. P-3184/1784-MPA BS).

Below the seal opening, an extra insulation layer, 50 mm wide and 25 mm thick as a minimum, made from building board material specified above, has to be fitted to both sides of the flexible wall construction with dry wall screws 3.5 x 35 mm, a ≤ 300 mm, which will be bolted into the fire-resistant gypsum plaster boards of the flexible wall construction. The length of the extra insulation layer has to correspond to the cable penetration seal (corresponding to the inside width of the member opening in the unfinished state).

The cable penetration seal may accommodate

- pipes made from copper, outer pipe diameter up to 18 mm, pipe wall ≥ 1.0 mm thick,
- pipes made from copper, outer pipe diameter up to 28 mm, pipe wall ≥ 1.0 mm thick, which are insulated on both sides of the seal with "FEP Schaum Plus" foam, d = 20 mm, 230 mm long as a minimum, and
- pipes made from steel, outer pipe diameter up to 54 mm, pipe wall ≥ 1.5 mm thick,

in addition to the cables, cable bundles, control pipes and cable support systems (wide-span cable racks, cable trays, cable racks).

Circular cable penetration seals "FEP Rund-Kabelschott S 90"

The circular cable penetration seal „FEP Rund-Kabelschott S 90" mounted in the flexible wall construction must be delimited by non-combustible pipe insulation made from calcium-silicate, gypsum fibre material or KERAGUSS (type N,L and S), d ≥ 25 mm, 200 mm long as a minimum, which shall be placed in the middle of the flexible wall construction.
The cable penetration seal mounted in the rigid wall has to be 200 mm thick as a minimum. Should the rigid wall which is to accommodate the cable penetration seal be less than 200 mm thick, an extra all-around insulation layer made from calcium silicate or gypsum plasterboard strips or made from KERAGUSS board strips (types N,L and S), 100 mm wide as a minimum,

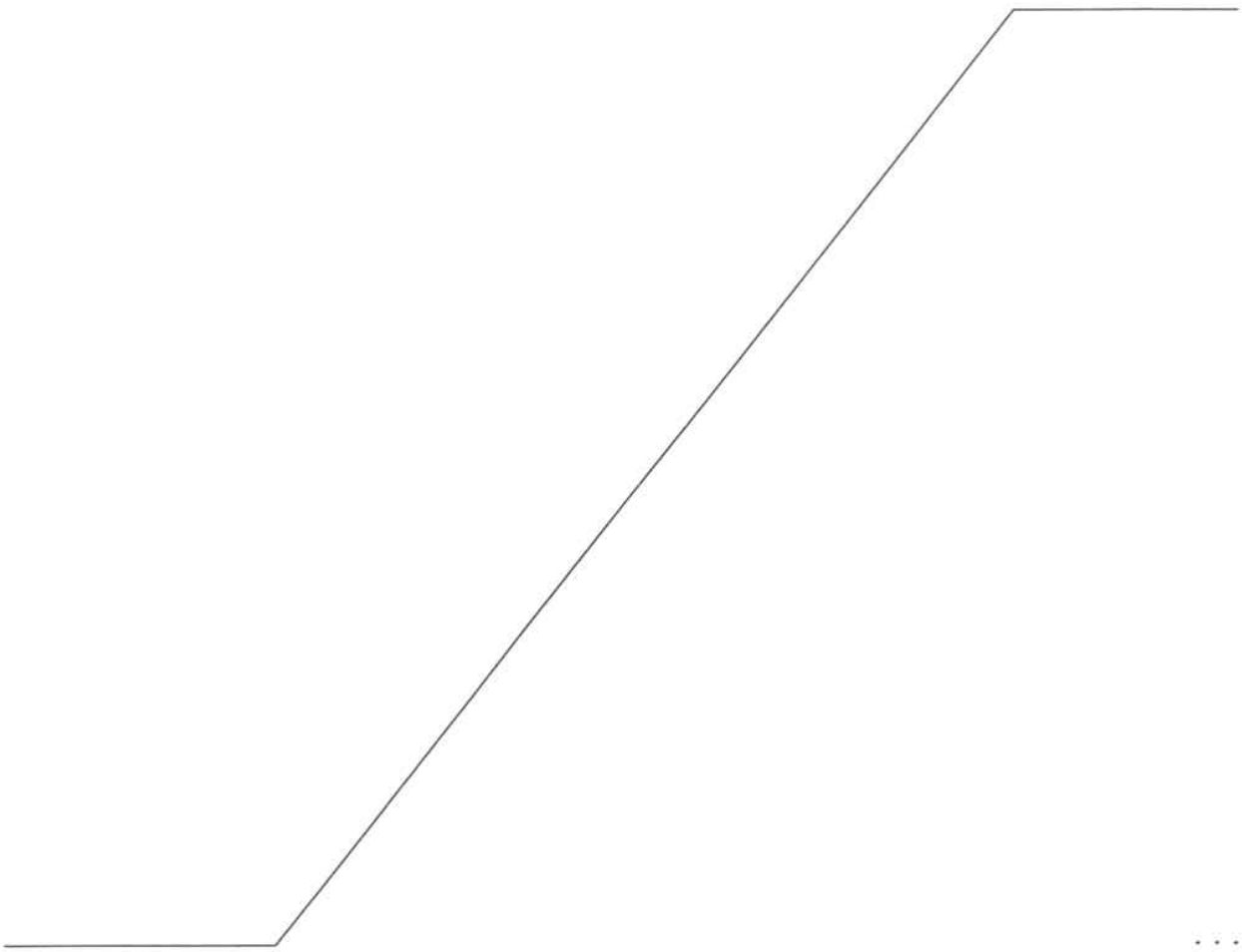
. . .

has to be anchored in the region of the unfinished opening in such a way that the overall wall thickness is 200 mm as a minimum and the extra insulation layer has the same thickness on both sides of the wall. The extra insulation layer may be 50 mm as a maximum.

The cable penetration seal has to consist of two moulded elements ("round plugs") which have the shape of a circular truncated cone and are made from "FEP Schaum Plus" foam, and which – for cable penetration seals up to 210 mm in diameter (corresponding to the inside width of the member opening in the unfinished state) – are each 70 mm thick as a minimum and end flush with the pipe insulation on both sides of the wall. In view of the results achieved in the tests, there are no reservations from a fire engineering point of view against using – for cable penetration seals between 211 mm and 310 mm in diameter – round plugs which are each 110 mm thick as a minimum. The diameter of the cable penetration seal (corresponding to the inside width of the member opening in the unfinished state) must thus not exceed 310 mm.
Cable support structures must not be passed through the cable penetration seal.

Any additional details have to be coordinated with the German approval authority Deutsches Institut für Bautechnik in Berlin, and the Civil Engineering Materials Testing Institute (MPA) in Braunschweig.

A final assessment will be made by Deutsches Institut für Bautechnik, Berlin.



5 Special notes

5.1 The statements made in section 4.2 above and the fire resistance times established in the tests shall apply only to seals mounted in walls made from aerated-concrete in compliance with DIN 4166; masonry walls in compliance with DIN 1053; RC walls in compliance with DIN 1045; or mounted in flexible wall constructions in compliance with DIN 4102-4 : 1994-03, section 4.10, table 48, or in compliance with a General Building Code Test Certificate, $d \geq 100$ mm thick; or to seals mounted in floors made from aerated-concrete slabs or RC floors in compliance with DIN 1045, $d \geq 150$ mm thick, the opening and the seal itself having to comply in respect of their type, thickness, design, etc. to the specifications made in section 1 above and annexes 1.1, 1.2, 1.6, 1.7, 1.11, 1.12, 1.13, 1.20 and 1.21 of this test certificate. The test results cannot be transferred to walls or floors of a lower thickness or walls and floors of different designs (e.g. ceiling membranes or shaft walls).

5.2 The fire resistance times established in the tests shall apply only if the first holder for the cable support structure is provided at a distance a = 100 mm from the surface of the cable penetration seal.

5.3 Test Certificate No. 3003/9939 -CR- serves as a basis for the type approval application procedure and may without the approval of the Testing House only be submitted to the German approval authority Deutsches Institut für Bautechnik, Berlin.

5.4 The validity of Test Certificate No. 3003/9939 will expire on 15-05-2002.

The Director
i.A.

Materialprüfanstalt f. d. Bauwesen MPA BS 3 Braunschweig

Engineer in charge

RR Dr.-Ing. Rohling

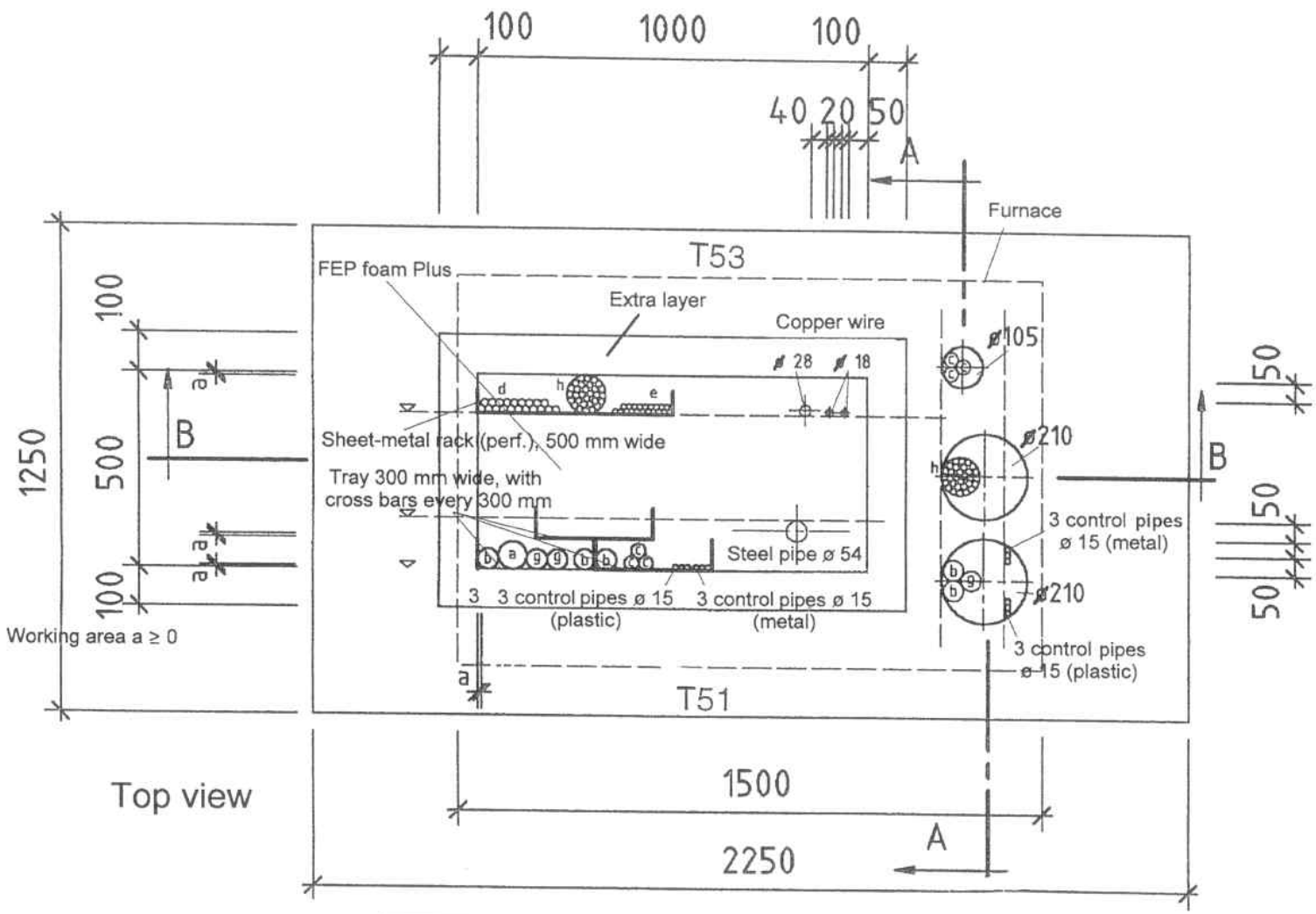
Dipl.-Ing. Rabbe

Braunschweig, dated 15 May 2000

For a list of annexes see next page

List of annexes

Annexes	1.1 and 1.2	:	Structural design of specimen : Floor system D1
Annexes	1.3 to 1.5	:	Position of measuring points : Floor system D1
Annexes	1.6 and 1.7	:	Structural design of specimen : Floor system D2
Annexes	1.8 to 1.10	:	Position of measuring points : Floor system D2
Annexes	1.11 to 1.13	:	Structural design of specimen : Wall systems
Annexes	1.14 to 1.16	:	Position of measuring points : Flexible wall construction
Annexes	1.17 to 1.19	:	Position of measuring points : Aerated-concrete wall
Annex	1.20	:	Rectangular seal "FEP Rechteckschott S 90" – Design of moulded parts (block)
Annex	1.21	:	Circular seal "FEP Rundschott S 90" – Design of moulded parts (plug)
Annexes	1.22 to 1.24	:	Material characteristics
Annex	2.1	:	Furnace temperatures : Floor system D1 (test 1)
Annexes	2.2 to 2.19	:	Specimen temperatures : Floor system D1 (test 1)
Annex	2.20	:	Observations during the fire test : Floor system D1 (test 1)
Annex	3.1	:	Furnace temperatures : Floor system D2 (test 3)
Annexes	3.2 to 3.12	:	Specimen temperatures : Floor system D2 (test 3)
Annexes	3.13 and 3.14	:	Observations during the fire test : Floor system D2 (test 3)
Annex	4.1	:	Furnace temperatures : Wall test (test 2)
Annexes	4.2 to 4.22	:	Specimen temperatures : Flexible wall construction (test 2)
Annexes	4.23 to 4.42	:	Specimen temperatures : Aerated-concrete wall (test 2)
Annexes	4.43 and 4.44	:	Observations during the fire test : Wall systems (test 2)
Annex	4.45	:	Extrapolation of test results for floors : Circular cable penetration seal "FEP Rund-Kabelschott S 90" : Cable bundle



T 51 and T 52 :
Furnace temperature measuring points
NiCr-Ni sheathed thermocouples ∅ 3.2 mm

Dimensions in mm

Structural design of specimen
Floor system D1 :
Top view

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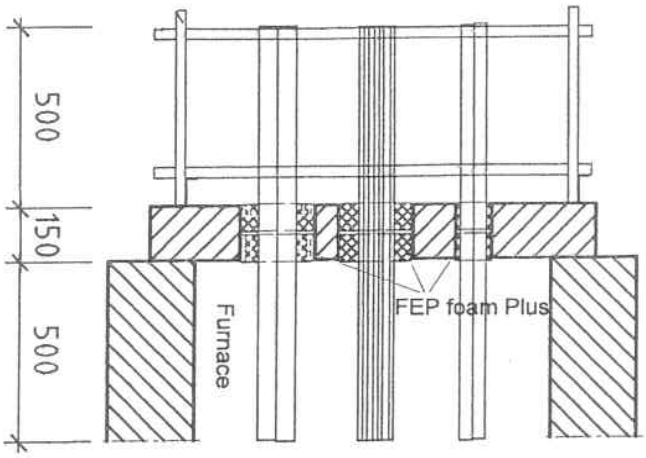
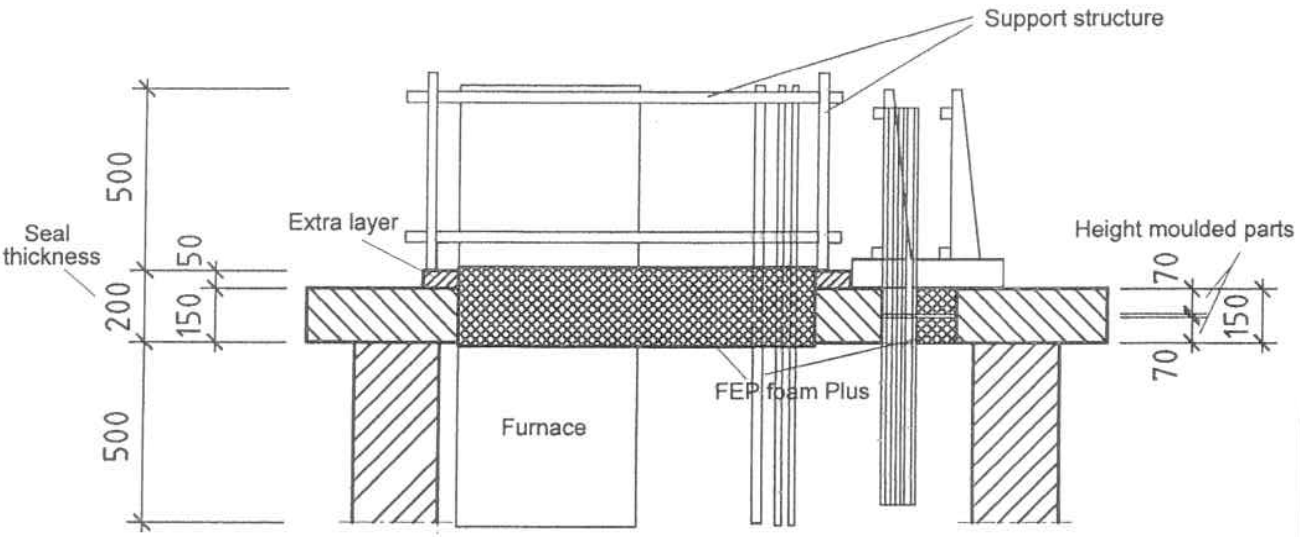
Annex 1.1
of
Test Certificate
No. 3003/9939

Section A-A



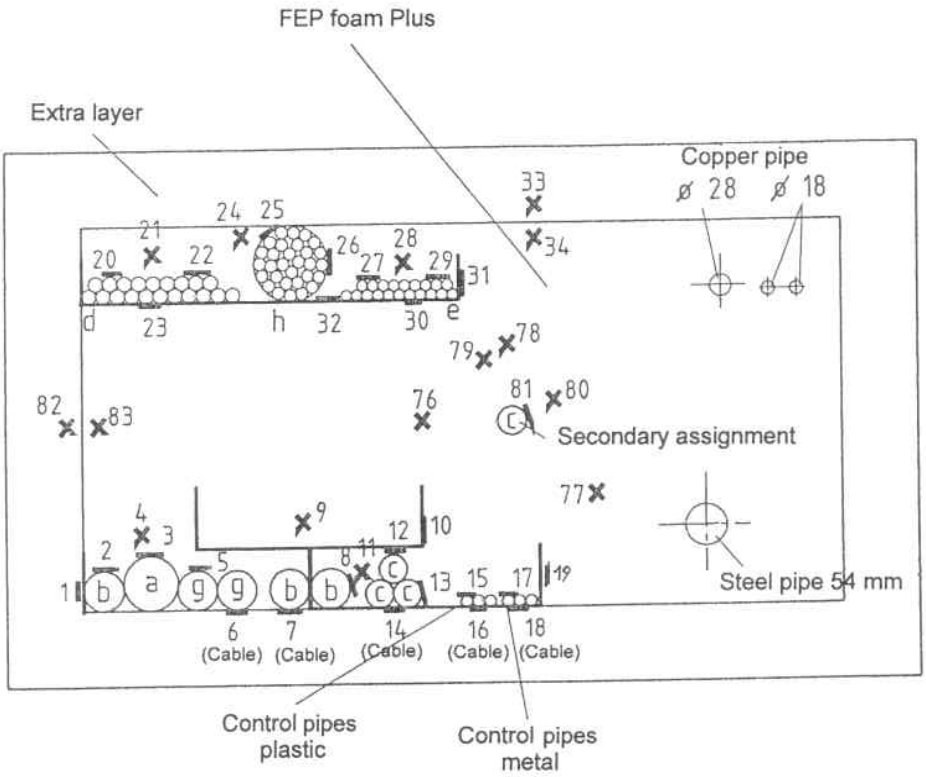
Section B-B



Dimensions in mm

Structural design of specimen **Floor system D1** : Section A-A and section B-B	Annex 1.2 of Test Certificate No. 3003/9939
Materialprüfanstalt für das Bauwesen Institut für Baustoffe, Massivbau und Brandschutz der Technischen Universität Braunschweig	

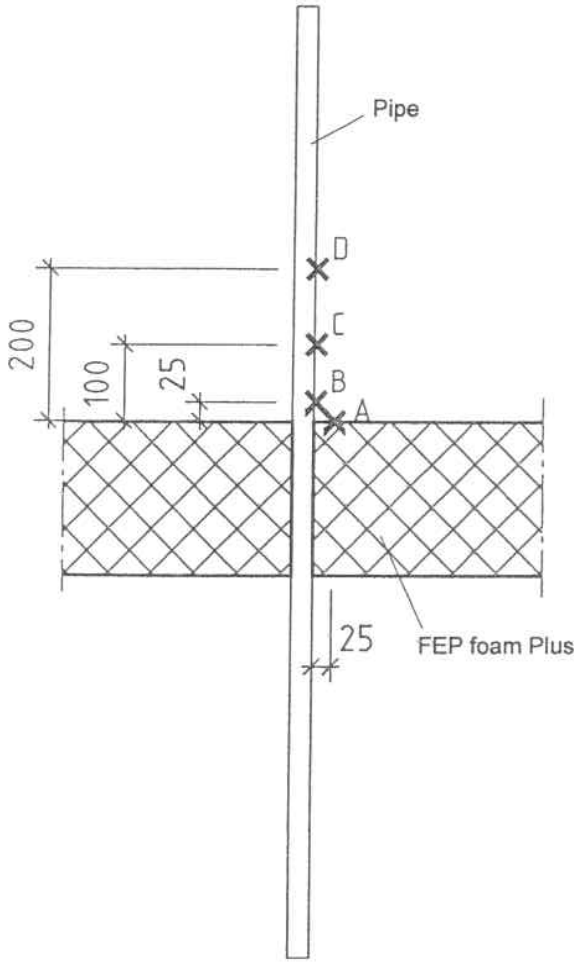
Rectangular seal



Dimensions in mm

Structural design of specimen **Floor system D1 :** Position of measuring points – rectangular seal	Annex 1.3 of Test Certificate No. 3003/9939
Materialprüfanstalt für das Bauwesen Institut für Baustoffe, Massivbau und Brandschutz der Technischen Universität Braunschweig	

Rectangular seal
Pipes



	Copper pipe			Steel pipe
	Ø 28	Ø 18	Ø 18	Ø 54
A	35	41	45	47
B	36	39	44	48
C	37	40	43	49
D	38	42	46	50

Dimensions in mm

Structural design of specimen

Floor system D1 :

Position of measuring points – pipes, rectangular seal

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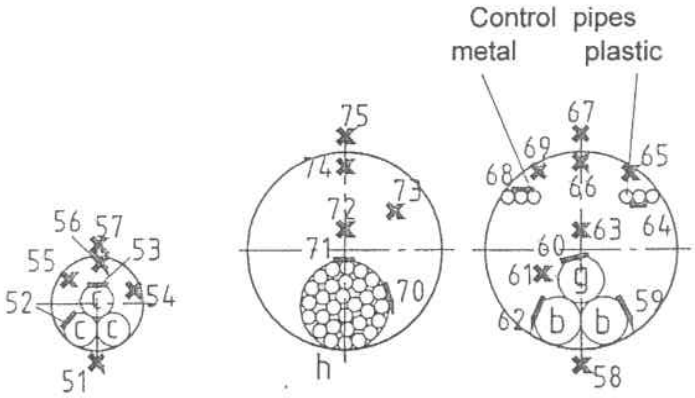
Annex 1.4

of

Test Certificate

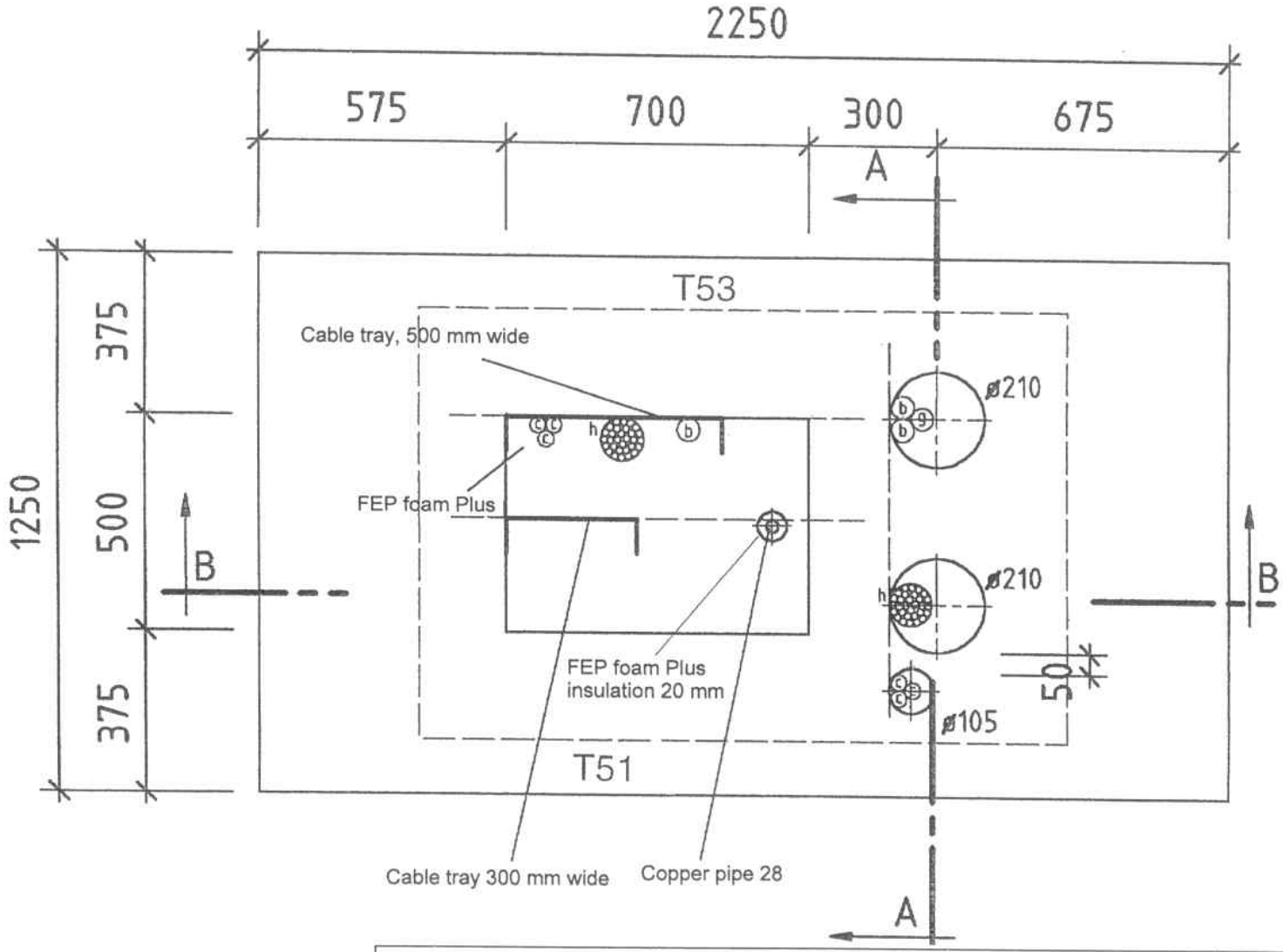
No. 3003/9939

Circular seal



Dimensions in mm

Structural design of specimen **Floor system D1** : Position of measuring points – circular seal	Annex 1.5 of Test Certificate No. 3003/9939
Materialprüfanstalt für das Bauwesen Institut für Baustoffe, Massivbau und Brandschutz der Technischen Universität Braunschweig	



T 51 and T 52 :
Furnace temperature measuring points
NiCr-Ni sheathed thermocouples ∅ 3.2 mm

Dimensions in mm

Structural design of specimen

Floor system D2 :

Top view

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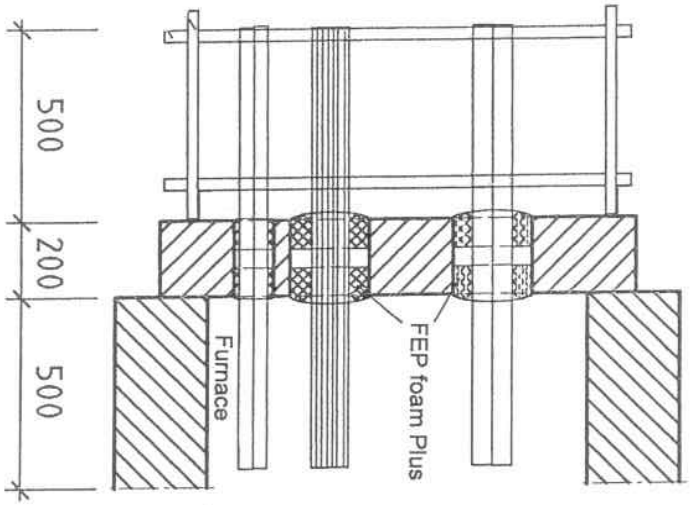
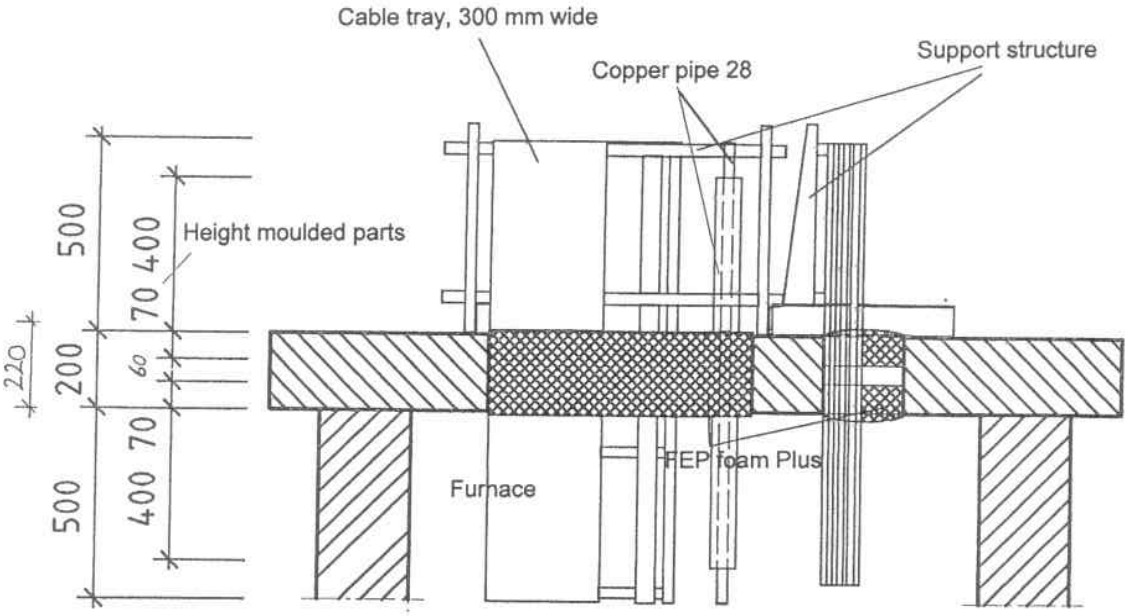
Annex 1.6
of
Test Certificate
No. 3003/9939

Section A-A



Section B-B



Dimensions in mm

Structural design of specimen **Floor system D2** : Section A-A and section B-B	Annex 1.7 of Test Certificate No. 3003/9939
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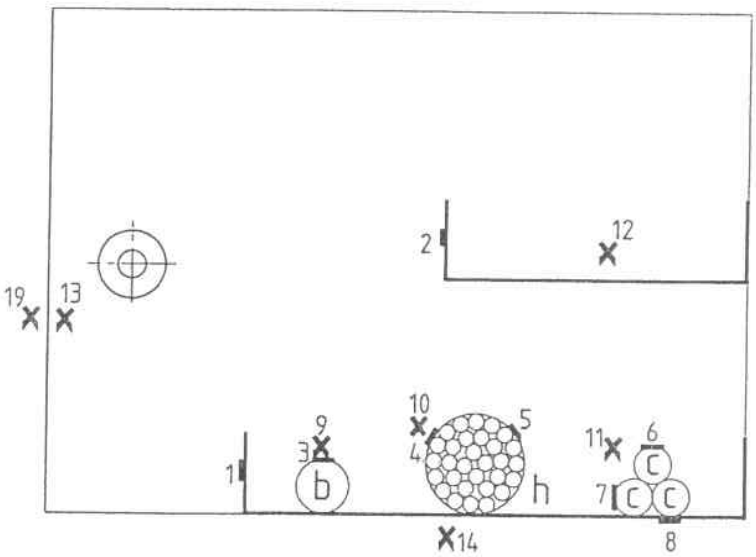
Rectangular seal



Structural design of specimen

Floor system D2 :

Position of measuring points – rectangular seal

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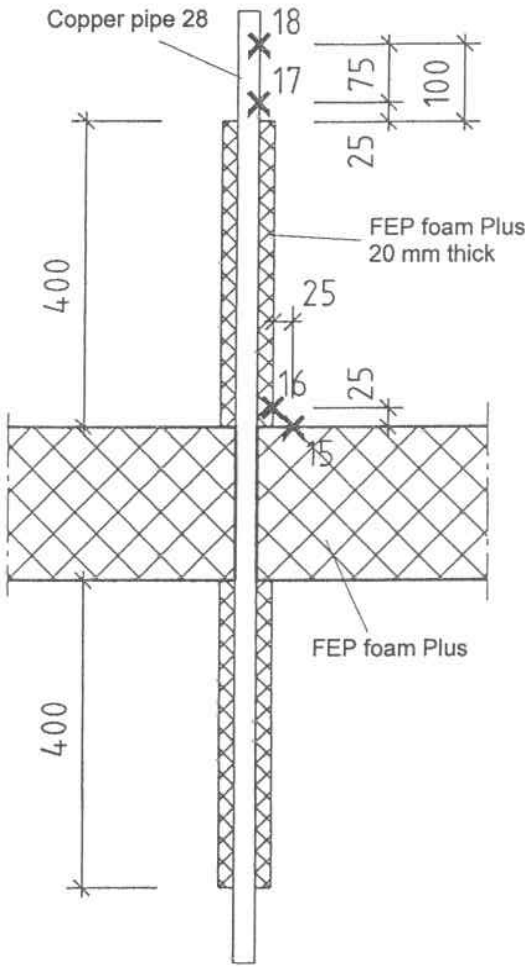
Annex 1.8

of

Test Certificate

No. 3003/9939

Rectangular seal
Pipe



Dimensions in mm

Structural design of specimen **Floor system D2** : Position of measuring points – pipe, rectangular seal	Annex 1.9 of Test Certificate No. 3003/9939
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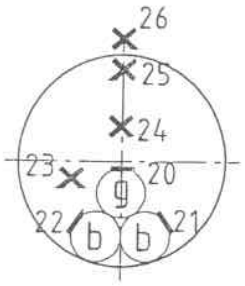
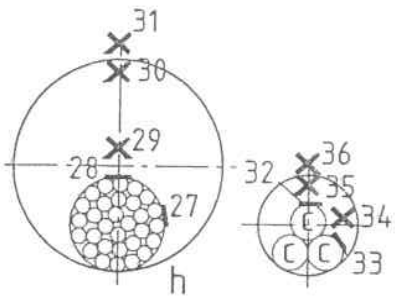
Circular seal



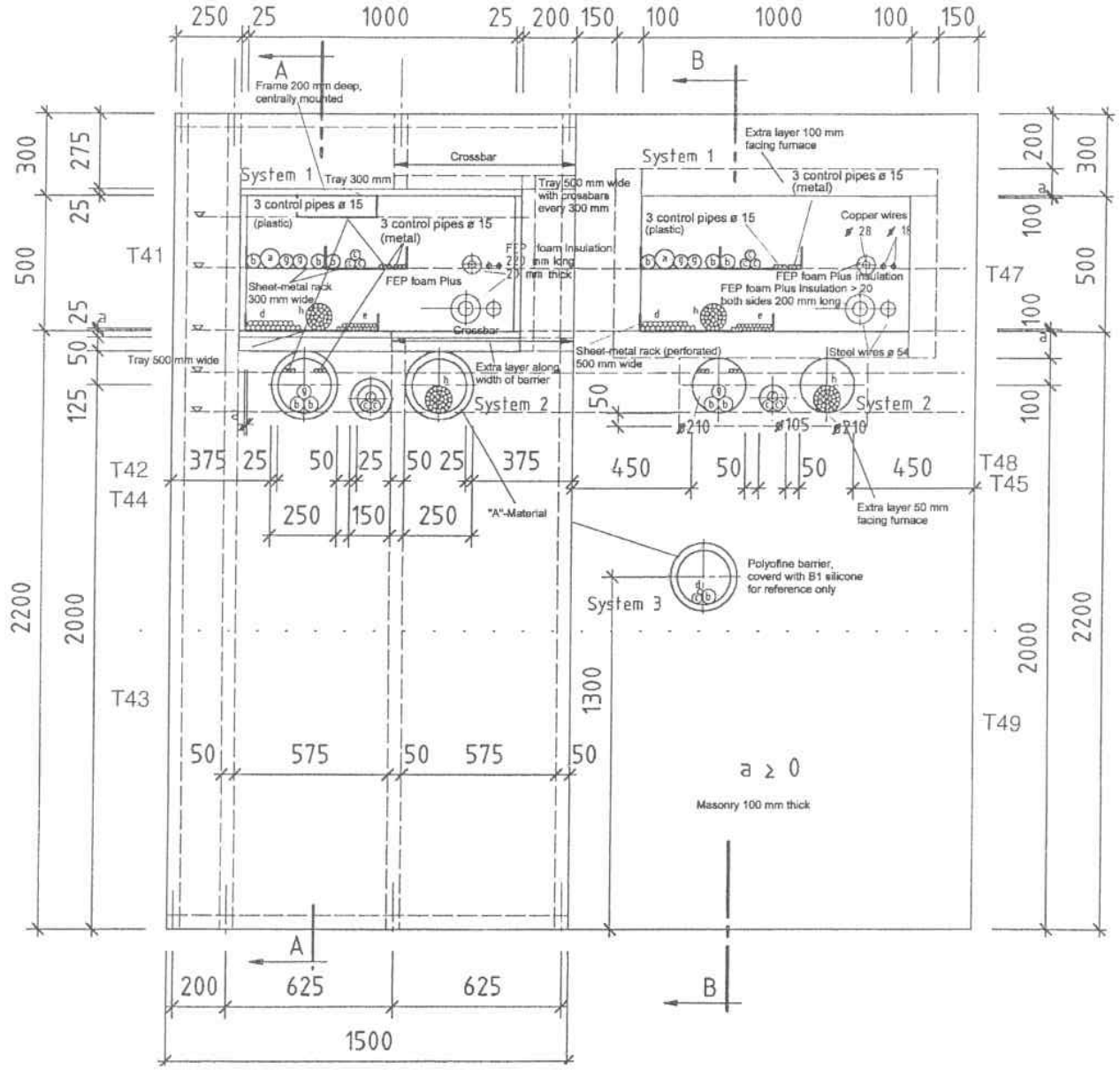
ø210



ø210 ø105

Dimensions in mm

Structural design of specimen **Floor system D2** : Position of measuring points – circular seal	Annex 1.10 of Test Certificate No. 3003/9939
Materialprüfanstalt für das Bauwesen Institut für Baustoffe, Massivbau und Brandschutz der Technischen Universität Braunschweig	

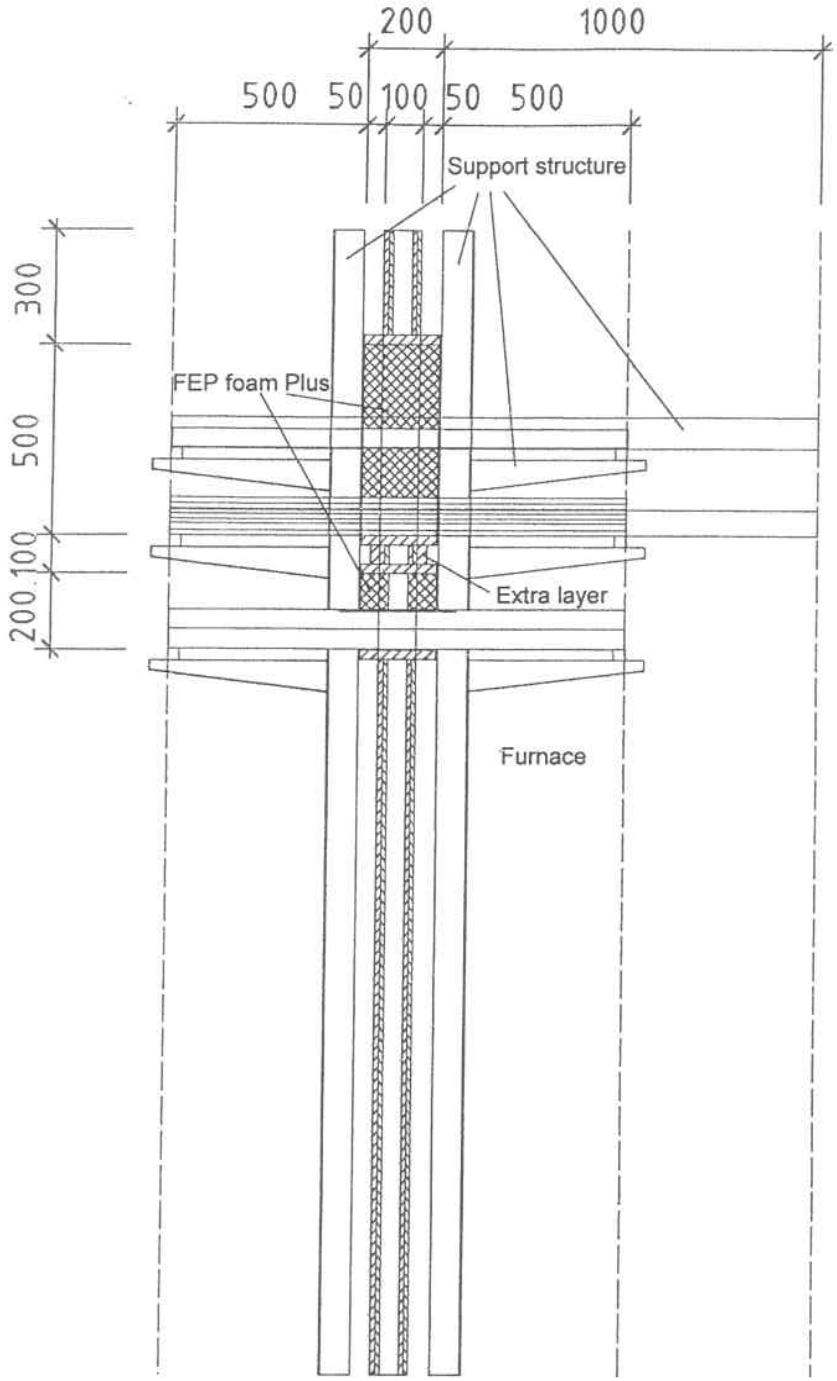


The flexible wall construction is a non-loadbearing separating wall element as specified in DIN 4102-04: 1994-03, table 48 : F90-A

T 41 – T 45 and T 47 – T 49 : furnace temperature meas. points NiCr-Ni sheathed thermocouples ∅ 3.2 mm

Dimensions in mm

Structural design of specimen **Wall systems**: Top view	Annex 1.11 of Test Certificate No. 3003/9939
Materialprüfanstalt für das Bauwesen Institut für Baustoffe, Massivbau und Brandschutz der Technischen Universität Braunschweig	



Gypsum plasterboard wall
Section A-A

Dimensions in mm

Structural design of specimen

Wall systems:

Section A-A : flexible wall construction

Materialprüfanstalt für das Bauwesen

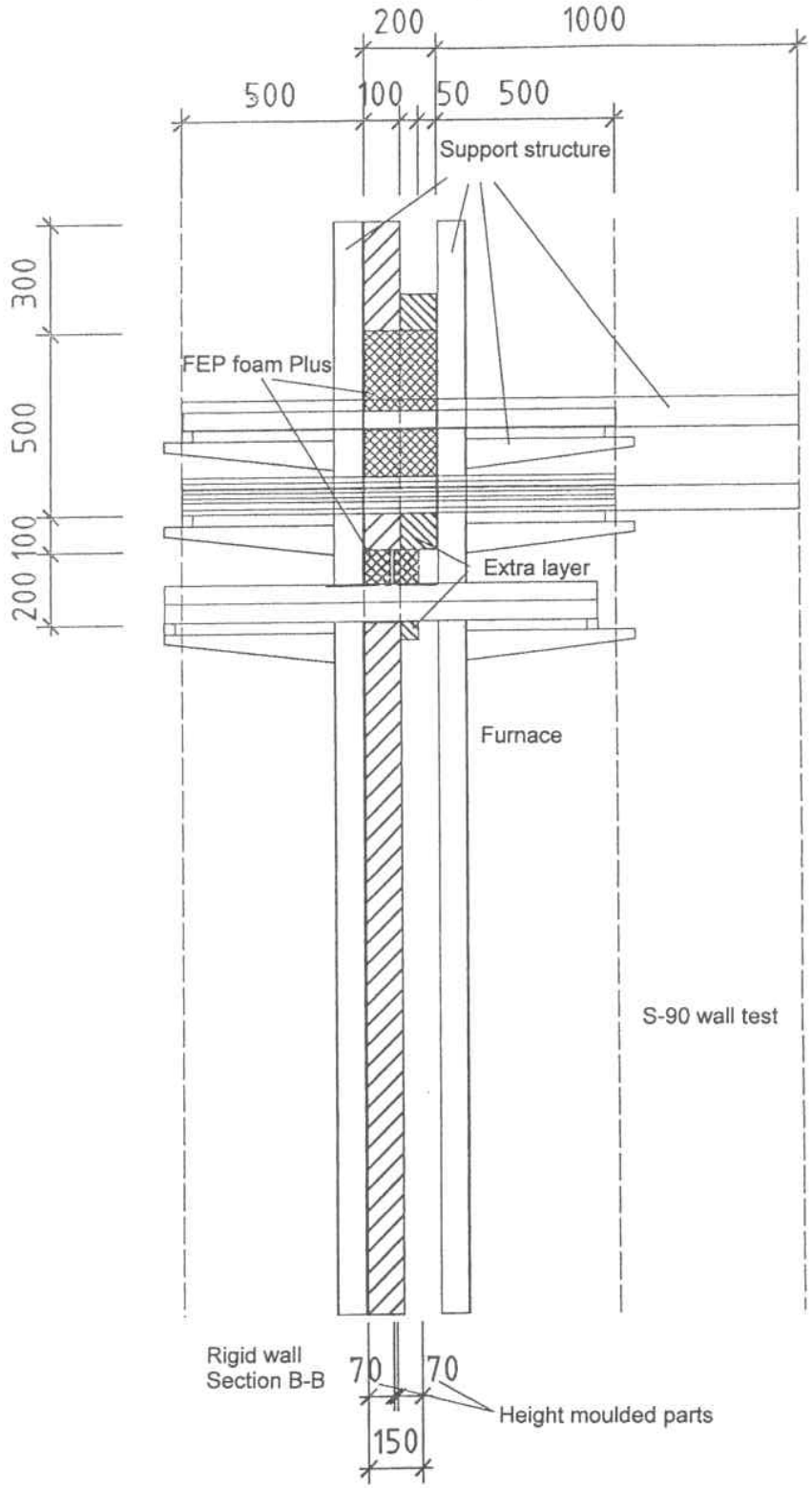
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 1.12

of

Test Certificate

No. 3003/9939



Dimensions in mm

Structural design of specimen

Wall systems:

Section B-B : aerated-concrete wall

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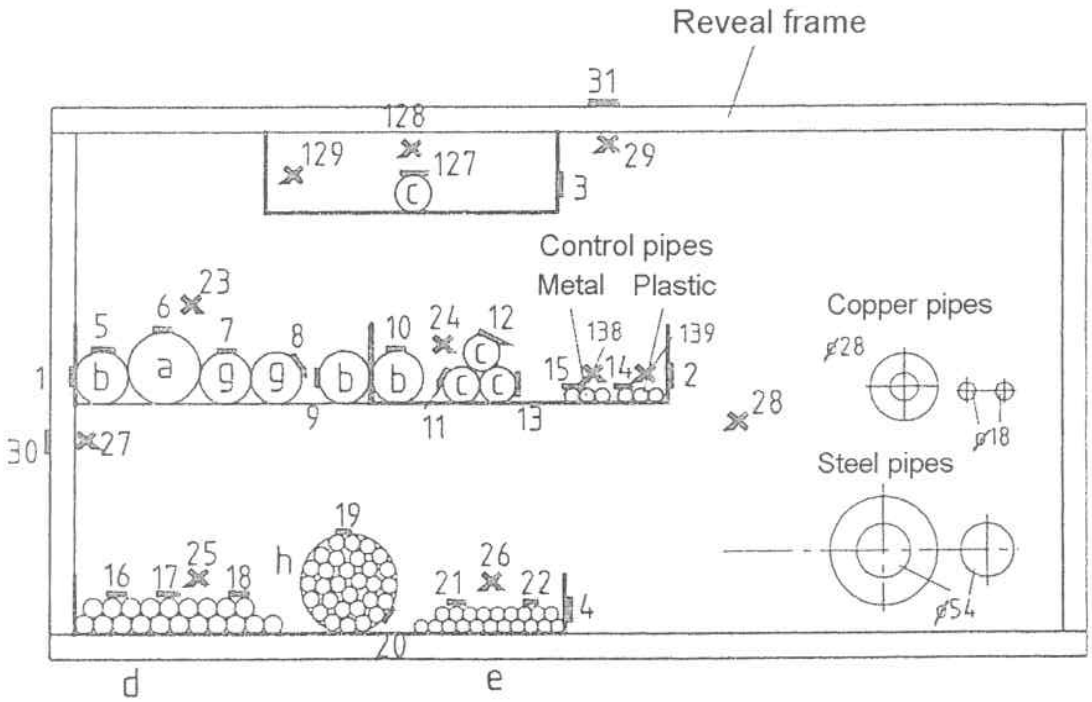
Annex 1.13

of

Test Certificate

No. 3003/9939

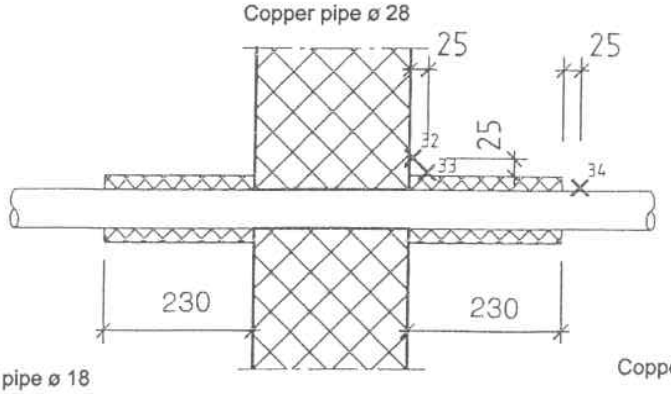
Rectangular seal "flexible wall construction"



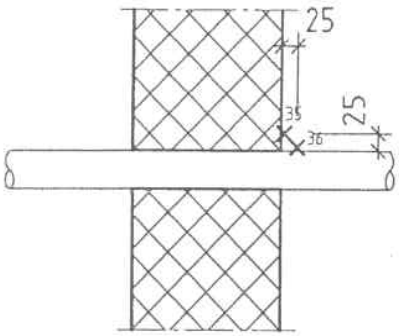
Structural design of specimen **Partition system:** Position of measuring points – rectangular seal	Annex 1.14 of Test Certificate No. 3003/9939
Materialprüfanstalt für das Bauwesen Institut für Baustoffe, Massivbau und Brandschutz der Technischen Universität Braunschweig	

Rectangular seal "flexible wall construction"
Pipes

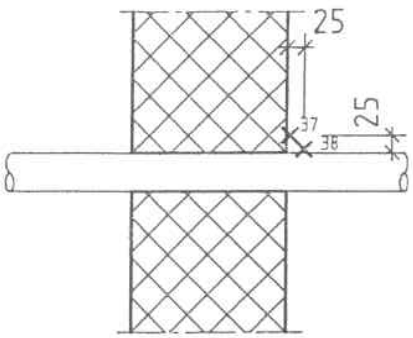
Copper pipe ø 28



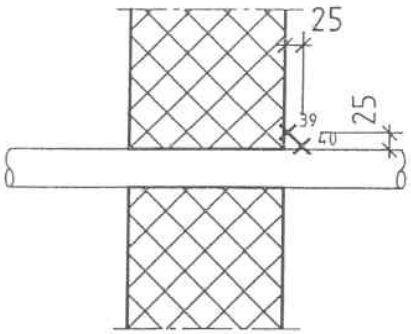
Copper pipe ø 18



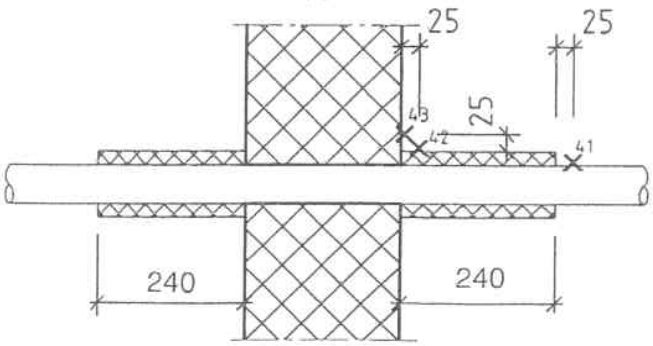
Copper pipe ø 18



Steel pipe ø 54



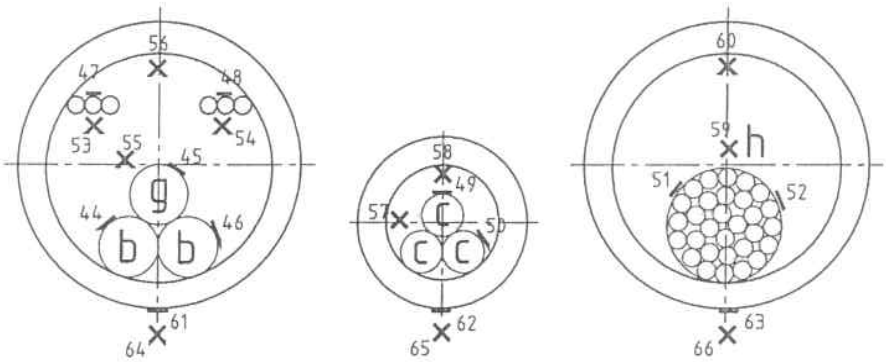
Steel pipe ø 54



Dimensions in mm

Structural design of specimen **Partition system**: Position of measuring points – pipes, rectangular seal	Annex 1.15 of Test Certificate No. 3003/9939
Materialprüfanstalt für das Bauwesen Institut für Baustoffe, Massivbau und Brandschutz der Technischen Universität Braunschweig	

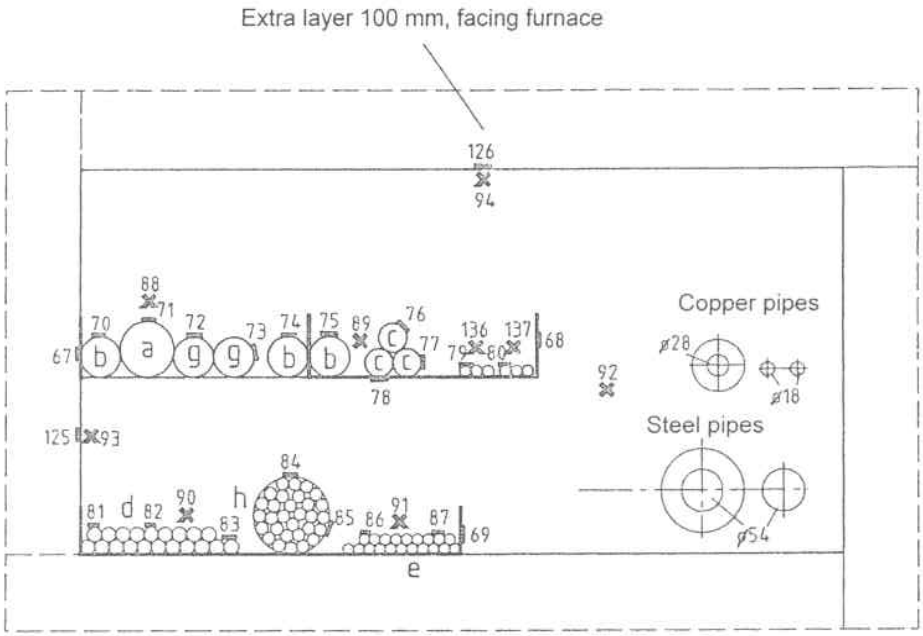
Rectangular seal "flexible wall construction"



∅ 210 ∅ 105 ∅ 210

Structural design of specimen **Partition system**: Position of measuring points – circular seal	Annex 1.16 of Test Certificate No. 3003/9939
Materialprüfanstalt für das Bauwesen Institut für Baustoffe, Massivbau und Brandschutz der Technischen Universität Braunschweig	

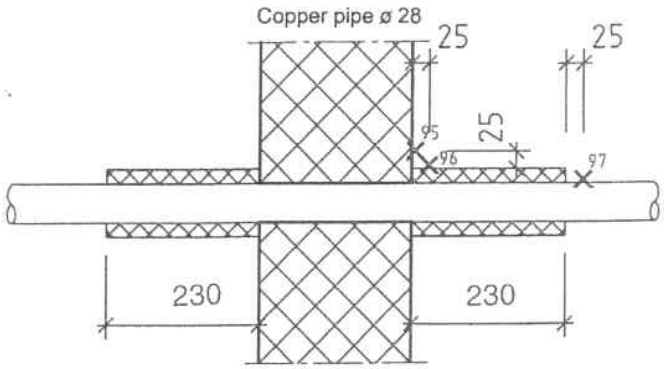
Rectangular barrier "rigid wall"

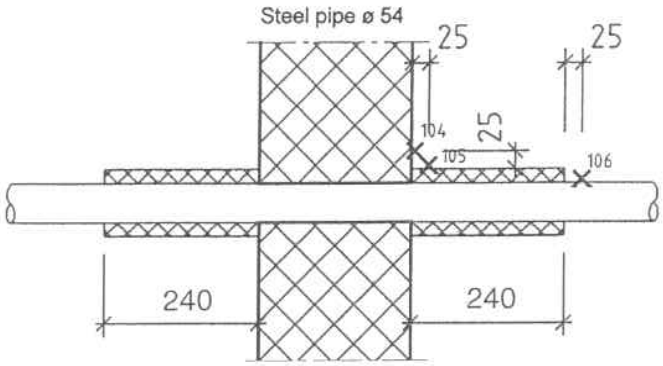


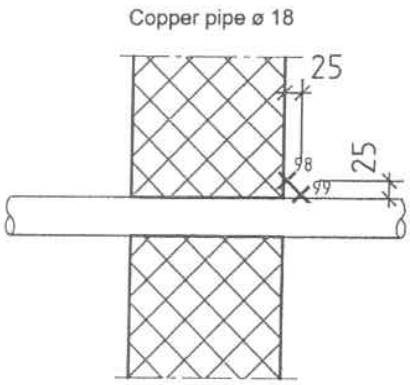
Dimensions in mm

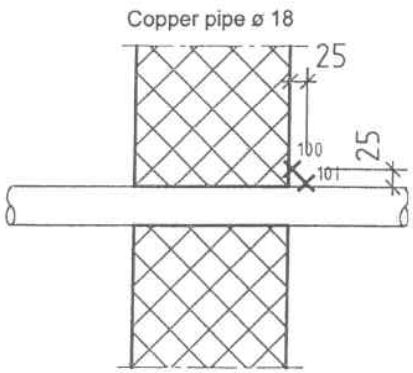
Structural design of specimen **Aerated-concrete wall**: Position of measuring points – rectangular seal	Annex 1.17 of Test Certificate No. 3003/9939
Materialprüfanstalt für das Bauwesen Institut für Baustoffe, Massivbau und Brandschutz der Technischen Universität Braunschweig	

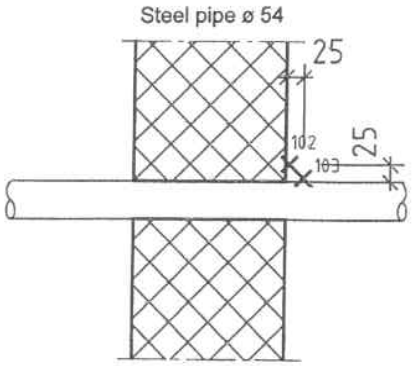
Rectangular barrier "rigid wall"
Pipes











Dimensions in mm

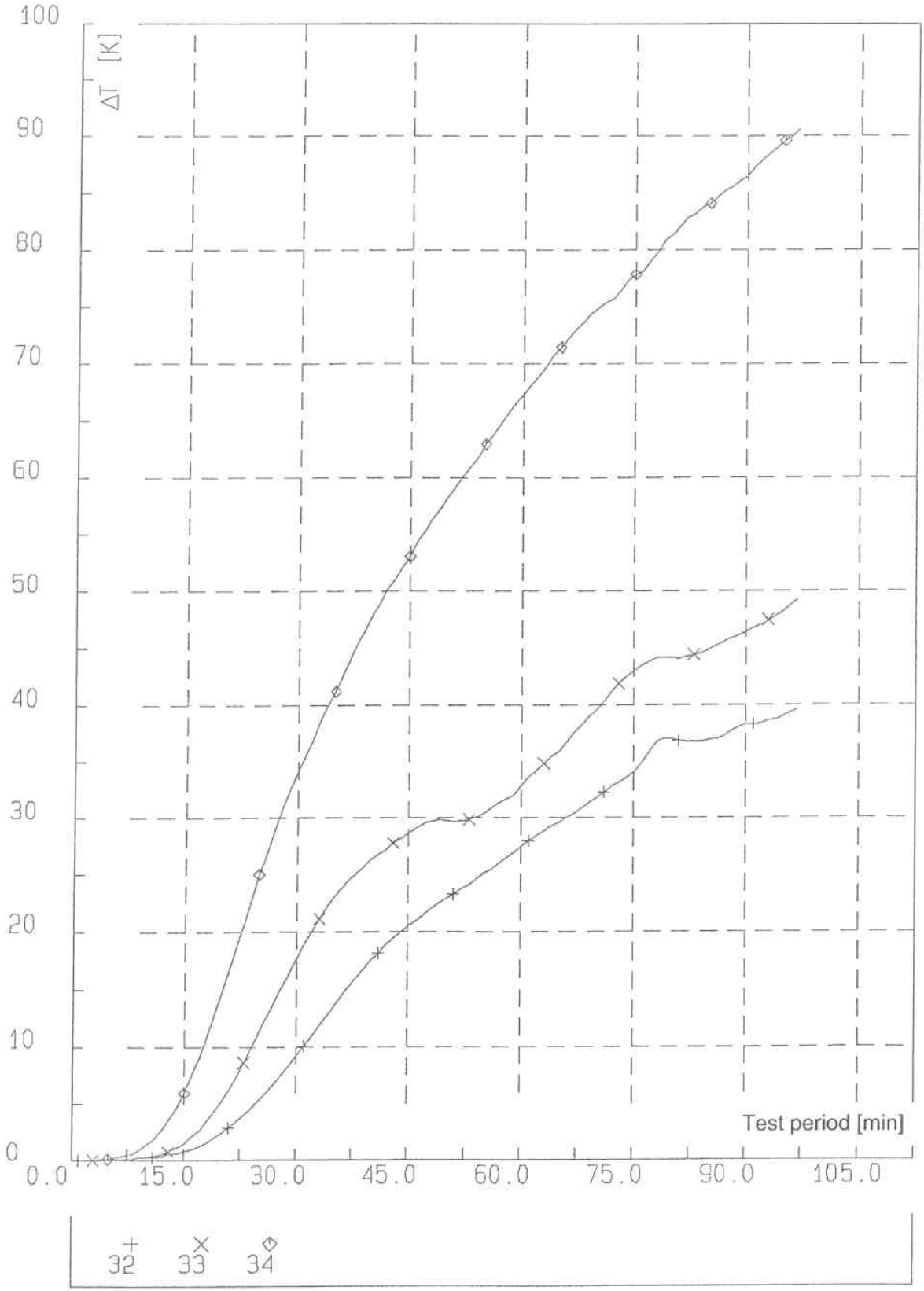
Structural design of specimen

Aerated-concrete wall:
Position of measuring points – pipes, rectangular seal

Annex 1.18
of
Test Certificate
No. 3003/9939

Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Copper pipe, outside diameter d = 28 mm, pipe wall s = 1.0 mm thick (insulated)



Specimen temperatures

Flexible wall construction : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

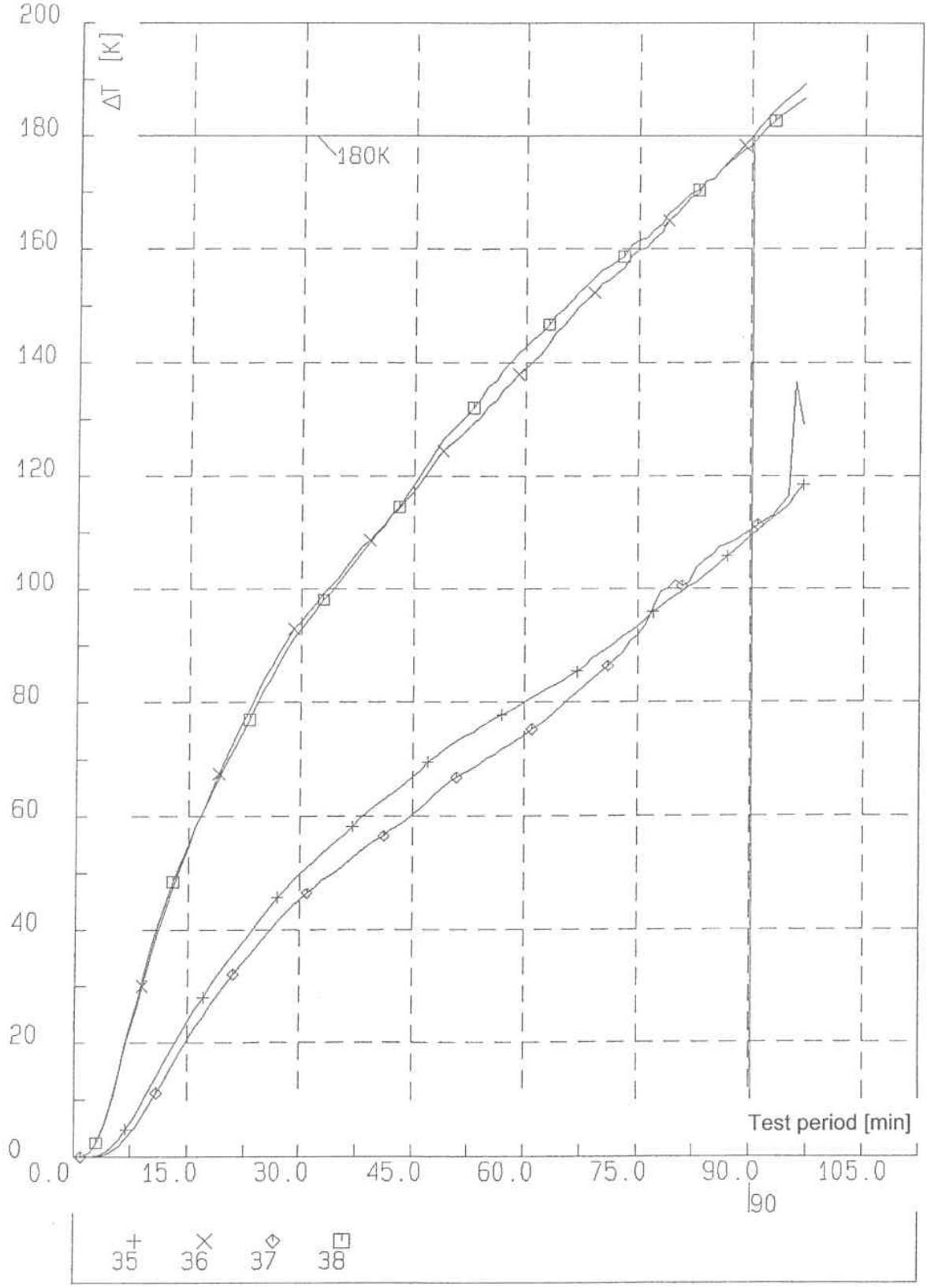
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.11 of

Test Certificate

No. 3003/9939

Copper pipes, outside diameter d = 18 mm, pipe wall s = 1.0 mm thick (not insulated)



Specimen temperatures

Flexible wall construction : "FEP Rechteckschott S 90"

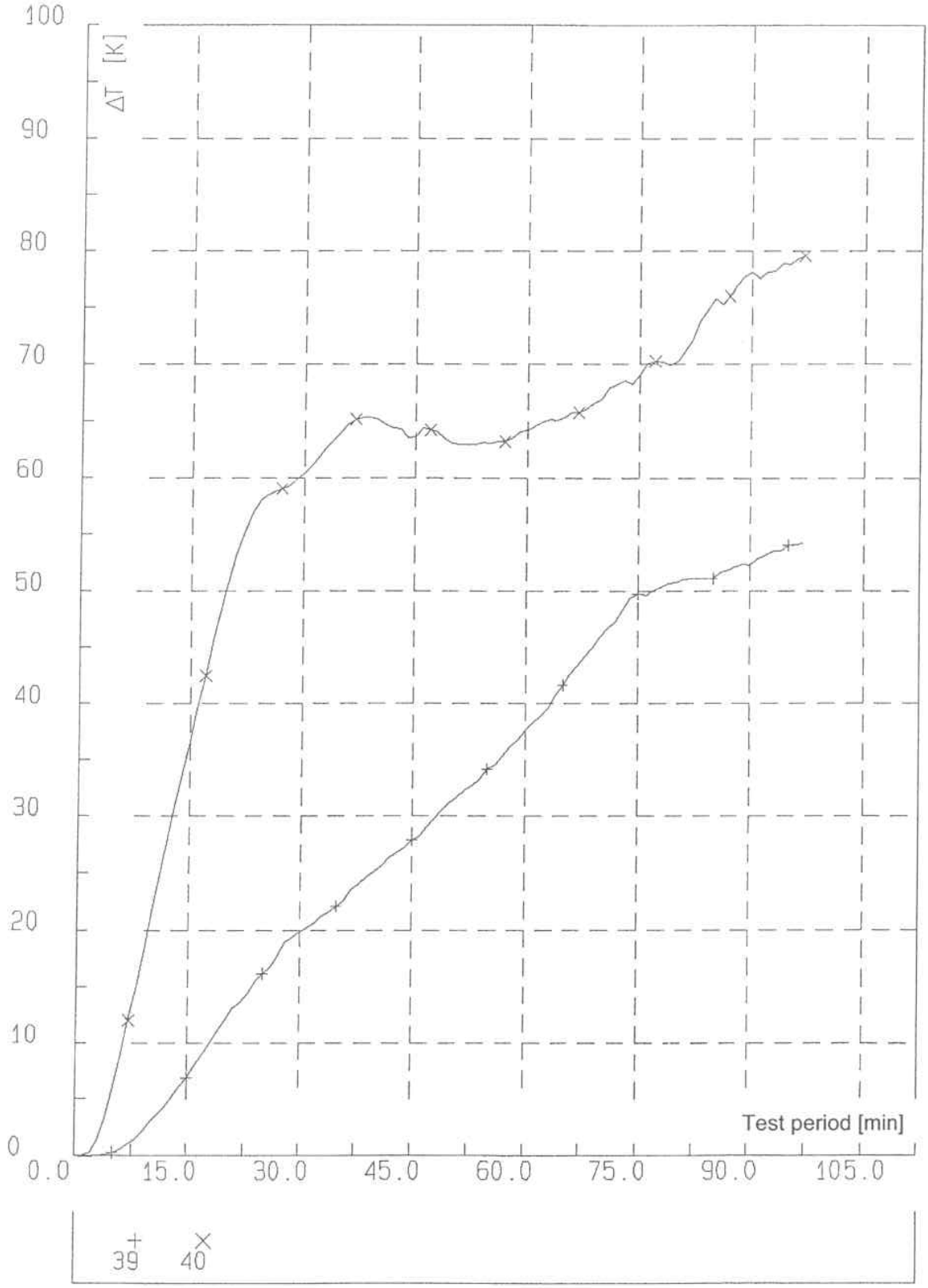
Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.12 of

Test Certificate

No. 3003/9939

Steel pipe, outside diameter d = 54 mm, pipe wall s = 1.5 mm thick (not insulated)



Specimen temperatures

Flexible wall construction : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

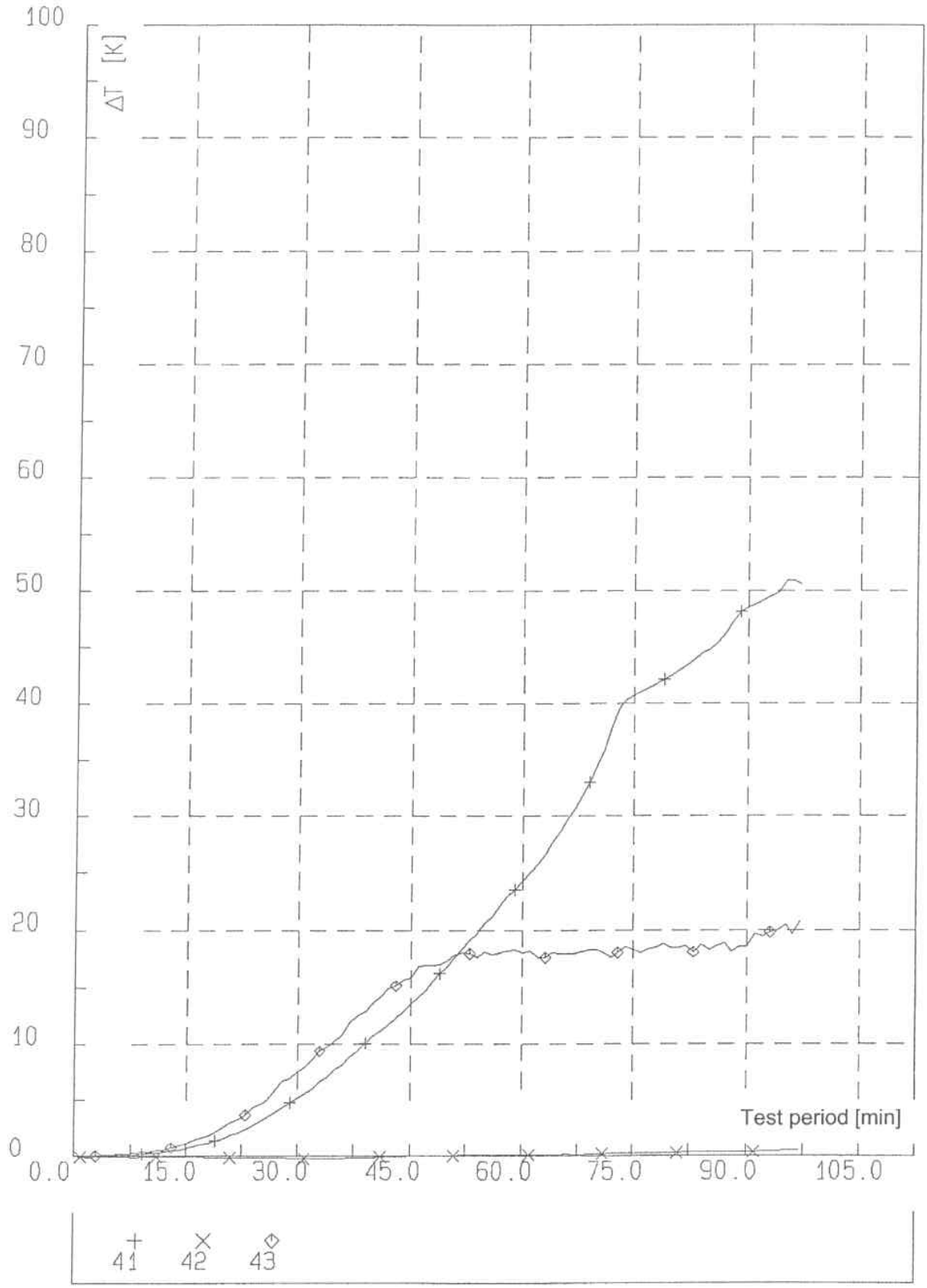
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.13 of

Test Certificate

No. 3003/9939

Steel pipe, outside diameter d = 54 mm, pipe wall s = 1.5 mm thick (insulated)



Specimen temperatures

Flexible wall construction : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

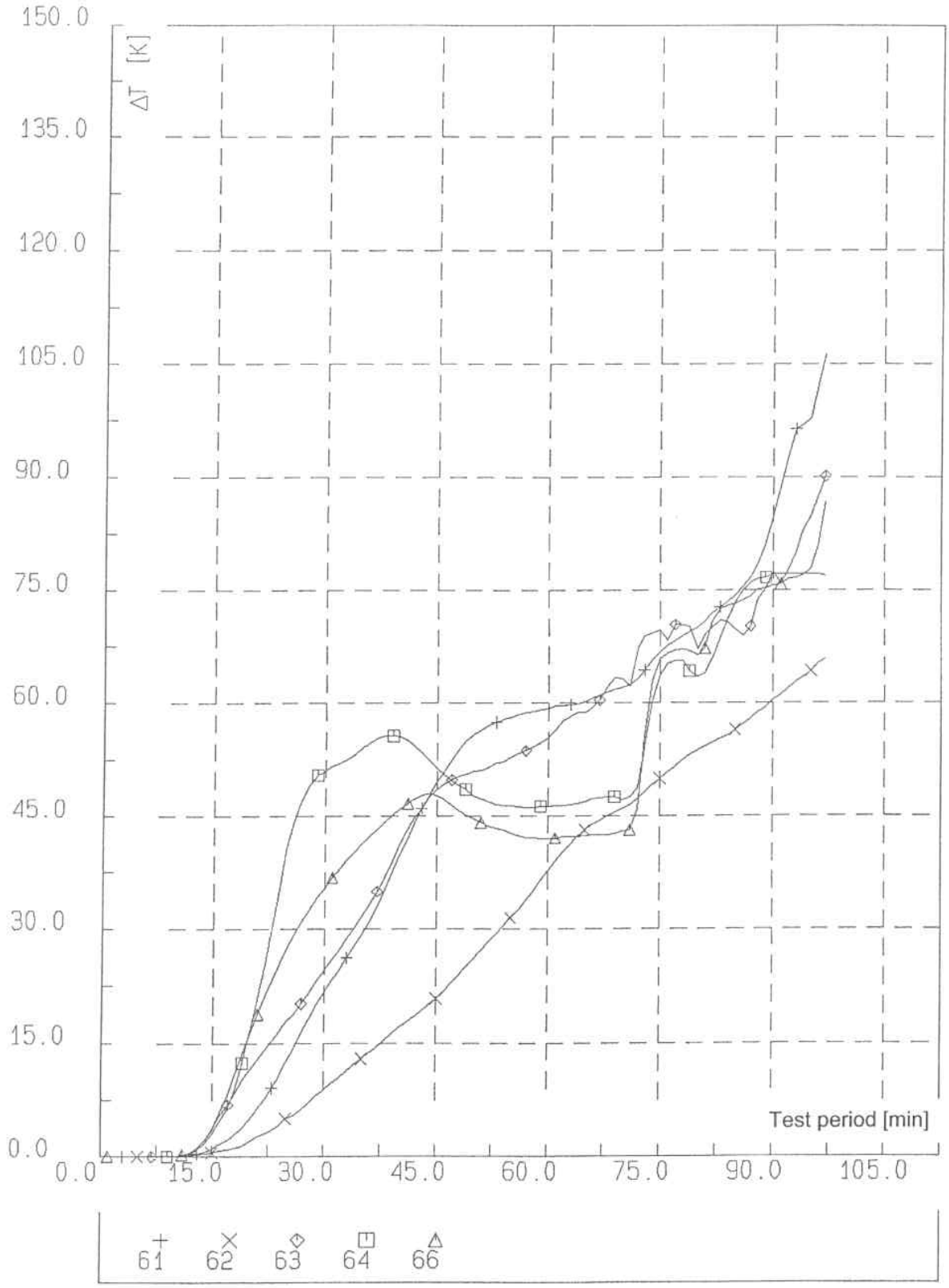
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.14 of

Test Certificate

No. 3003/9939

On the Vermiculite pipes and the flexible wall construction



Specimen temperatures

Flexible wall construction "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen

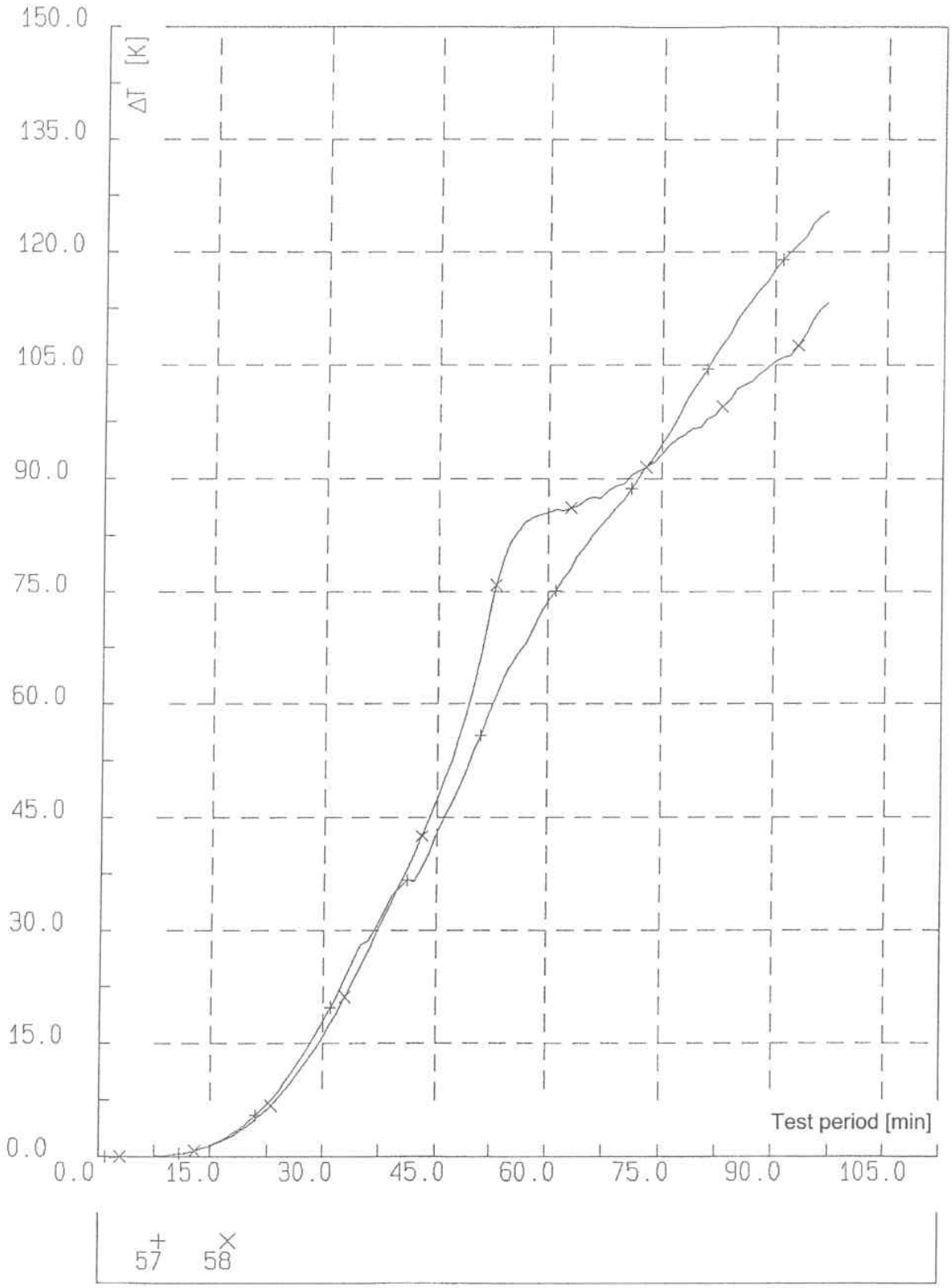
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.15 of

Test Certificate

No. 3003/9939

On the circular seal ∅ 105



Specimen temperatures

Flexible wall construction : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen

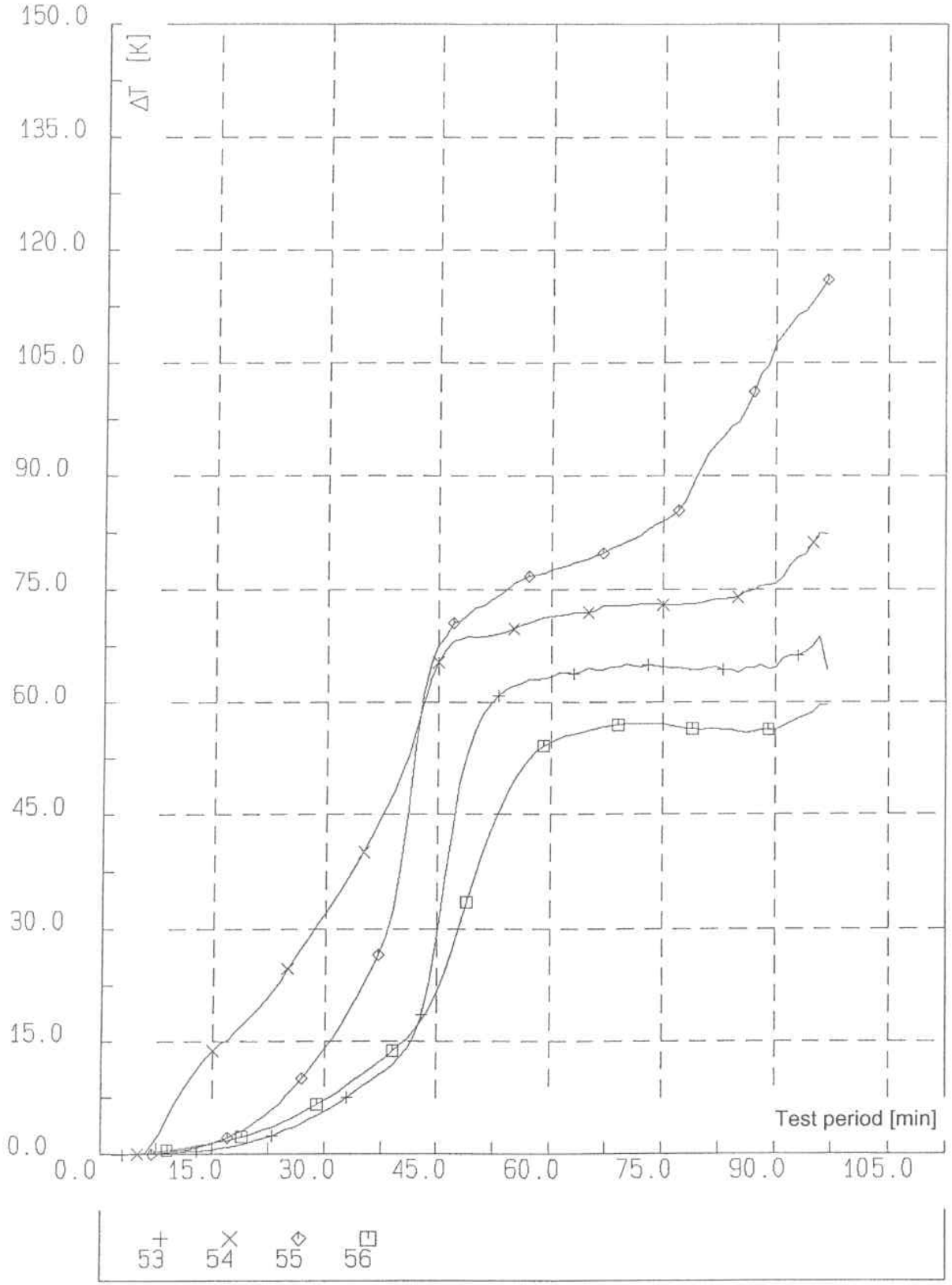
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.16 of

Test Certificate

No. 3003/9939

On the circular seal ∅ 210 (circular seal with cables and control pipes)



Specimen temperatures

Flexible wall construction : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen

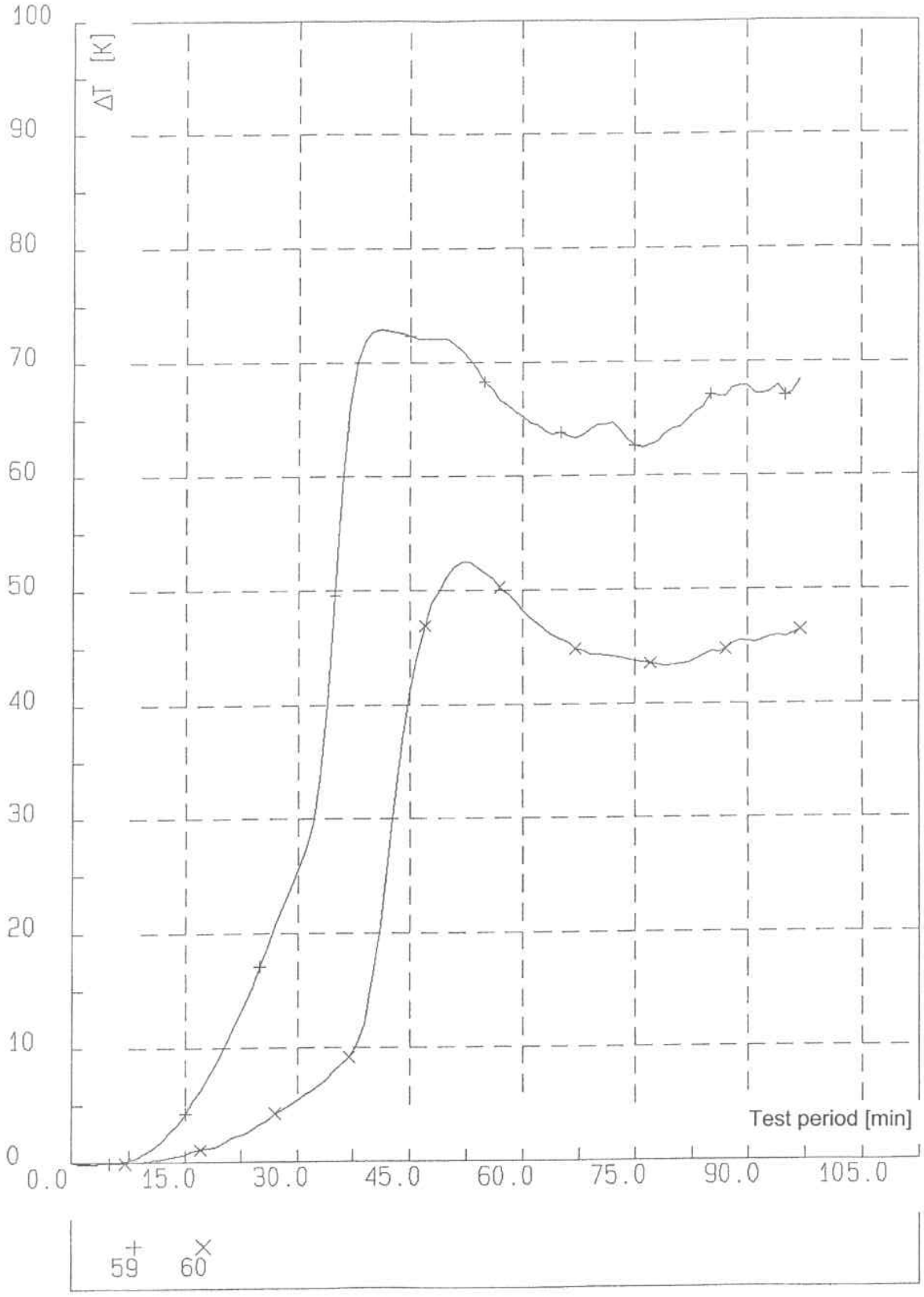
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.17 of

Test Certificate

No. 3003/9939

On the circular seal ∅ 210 (circular seal with cable bundle)



Specimen temperatures

Flexible wall construction : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen

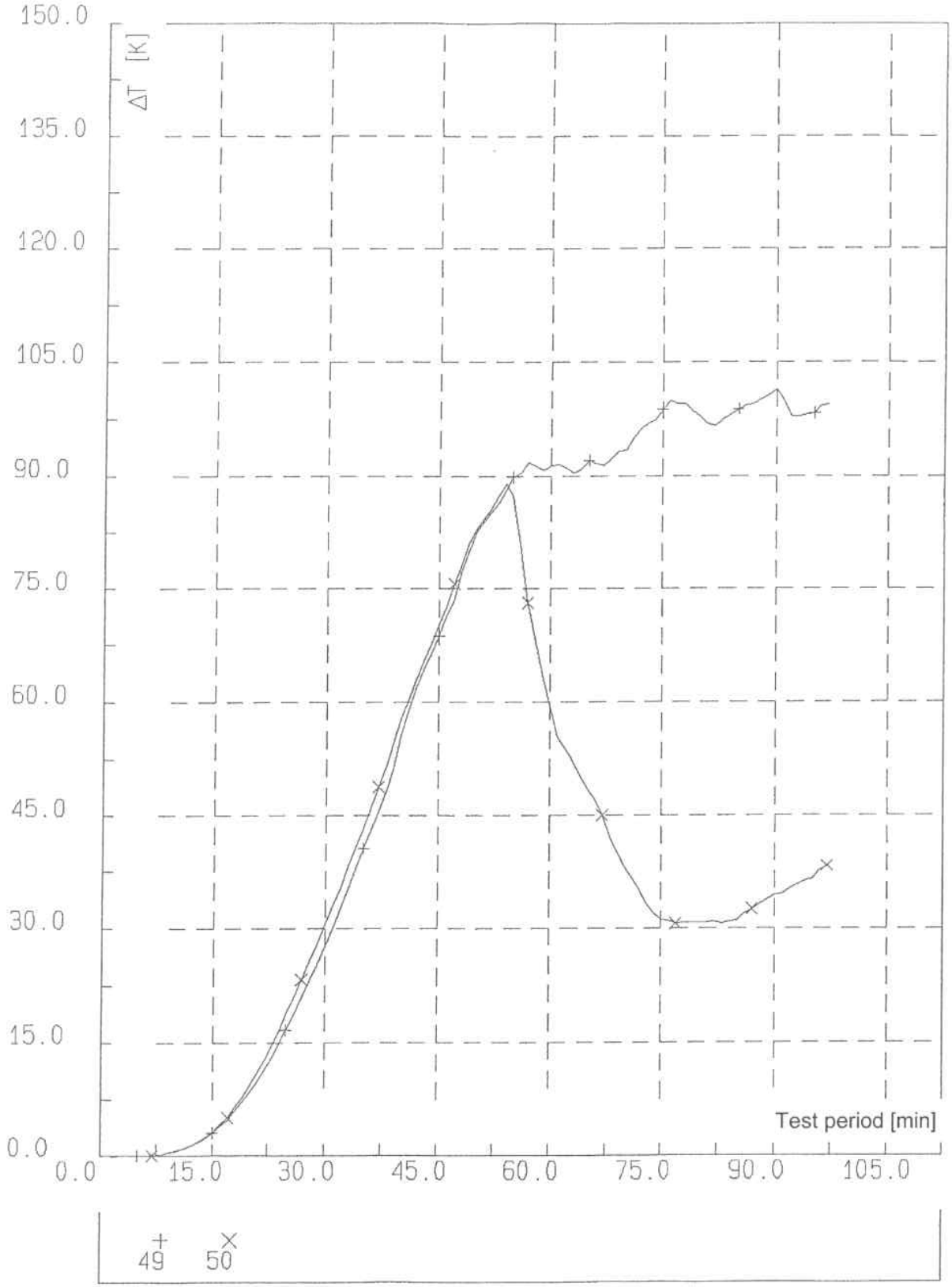
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.18 of

Test Certificate

No. 3003/9939

On the cables of circular seal ∅ 105



Specimen temperatures

Flexible wall construction : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen

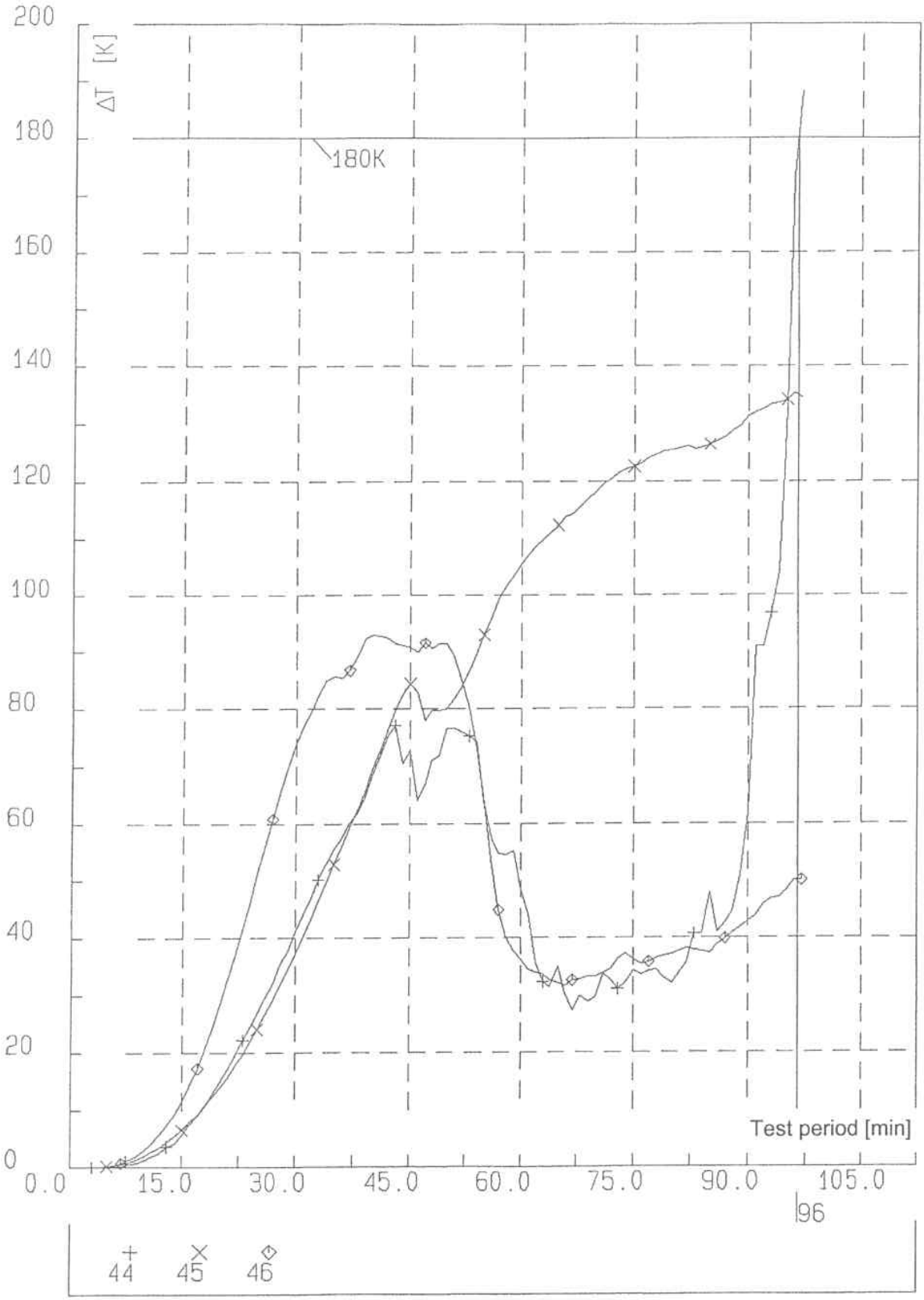
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.19 of

Test Certificate

No. 3003/9939

On the cables of circular seal ∅ 210



Specimen temperatures

Flexible wall construction : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen

Institut für Baustoffe, Massivbau und Brandschutz

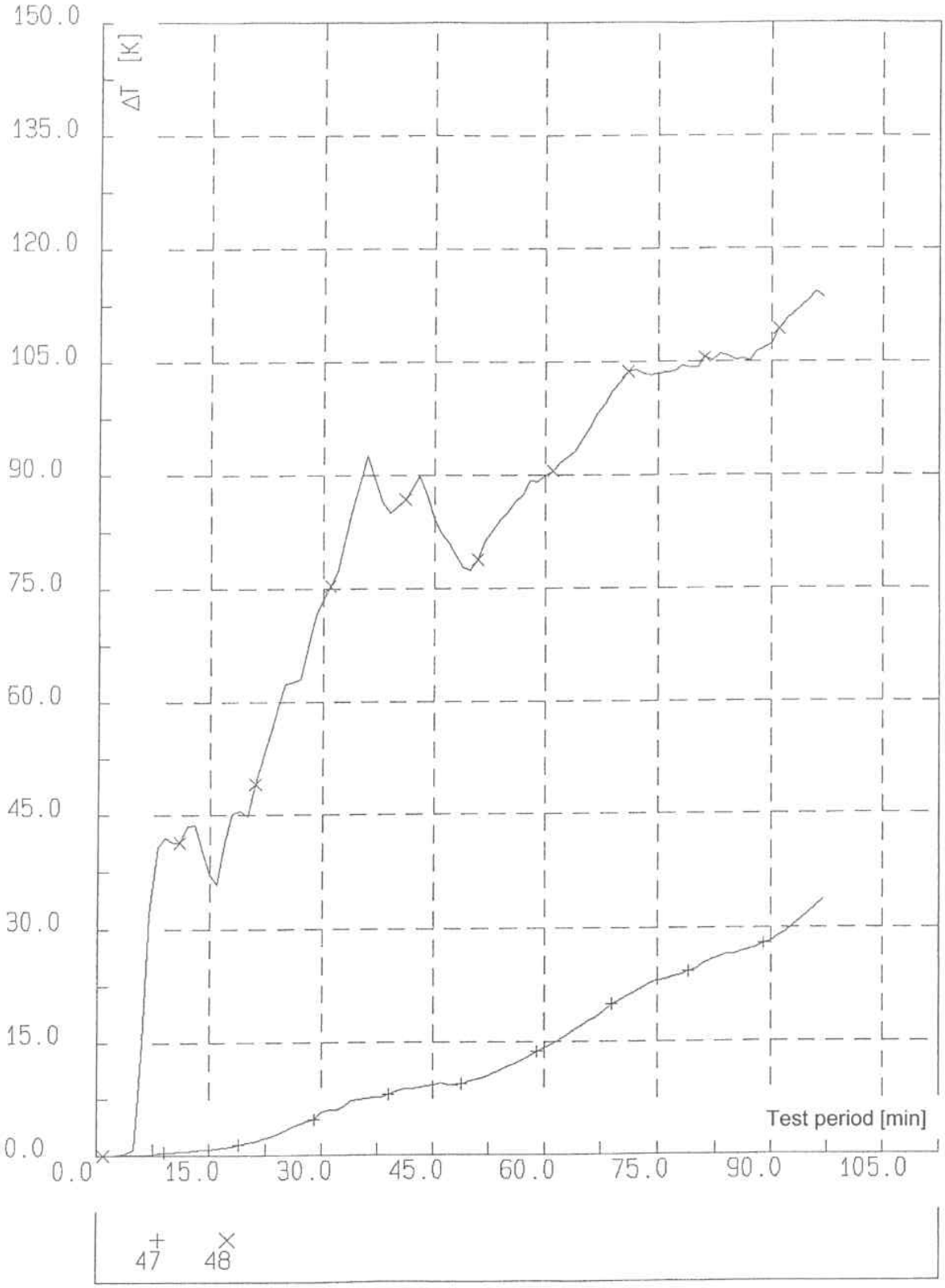
der Technischen Universität Braunschweig

Annex 4.20 of

Test Certificate

No. 3003/9939

On the control wires of circular seal ∅ 210



Specimen temperatures

Flexible wall construction : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen

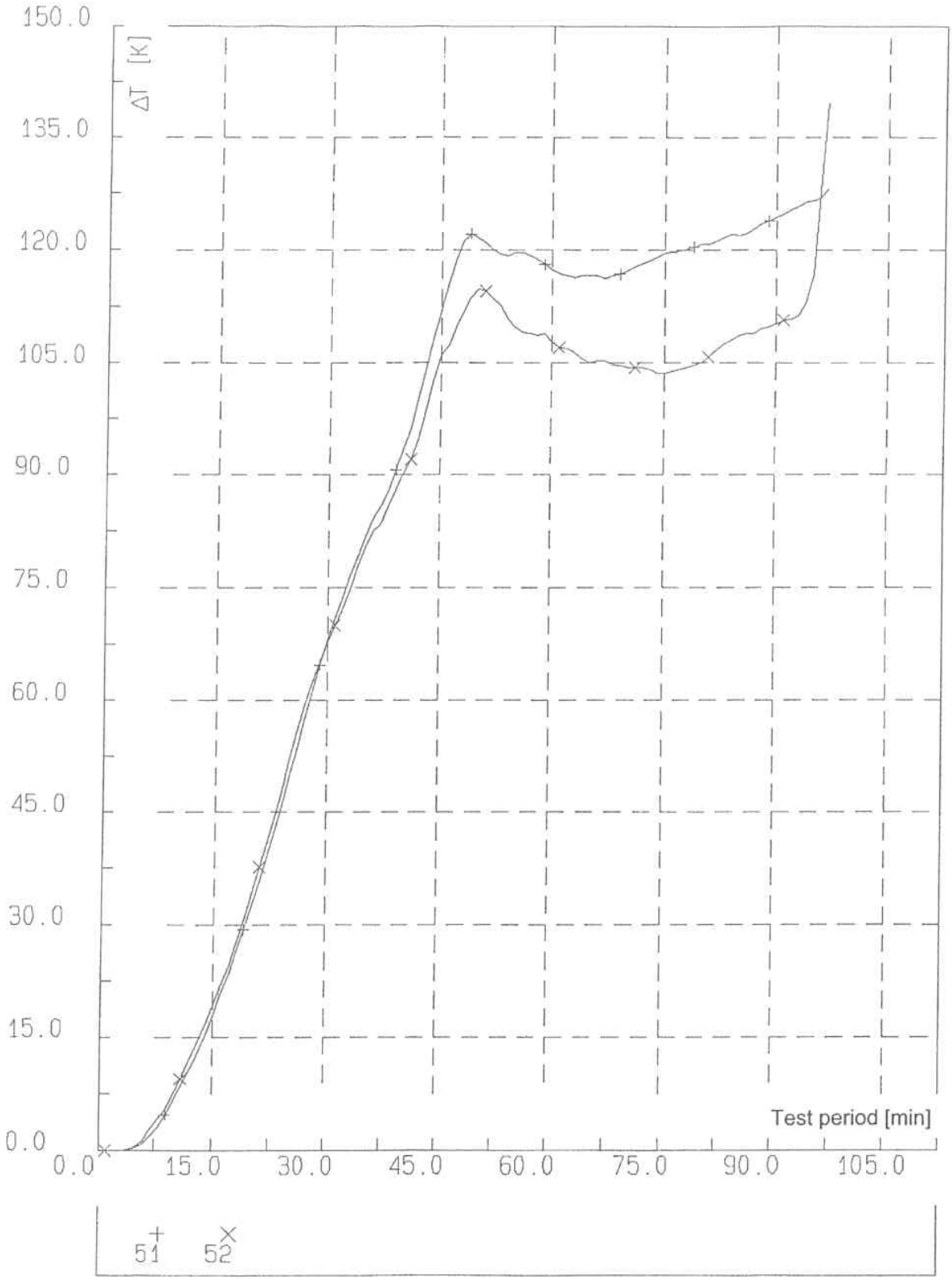
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.21 of

Test Certificate

No. 3003/9939

On the cable bundle of circular seal ∅ 210



Specimen temperatures

Flexible wall construction : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen

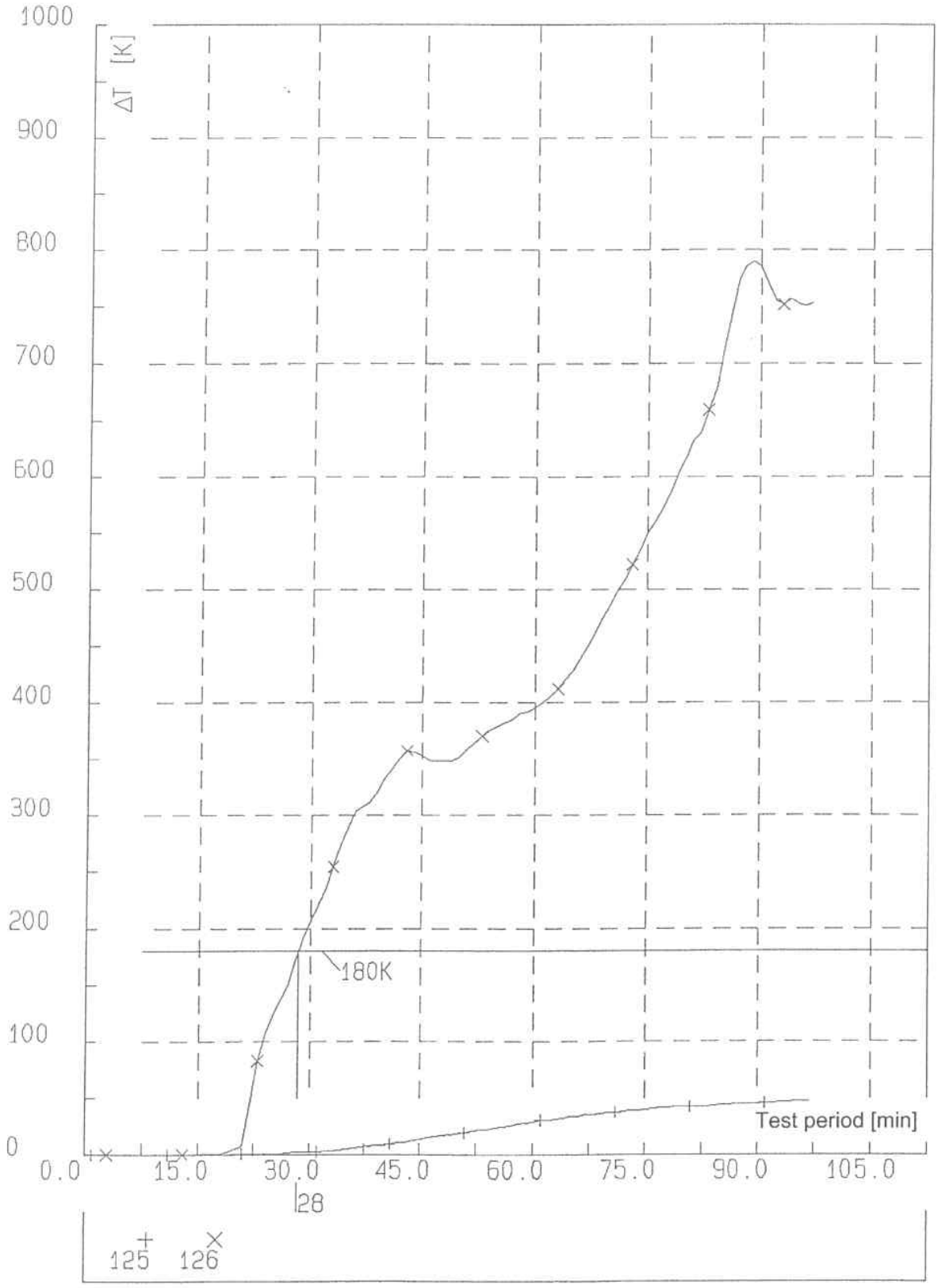
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.22 of

Test Certificate

No. 3003/9939

On the extra layer



Specimen temperatures

Aerated-concrete wall : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

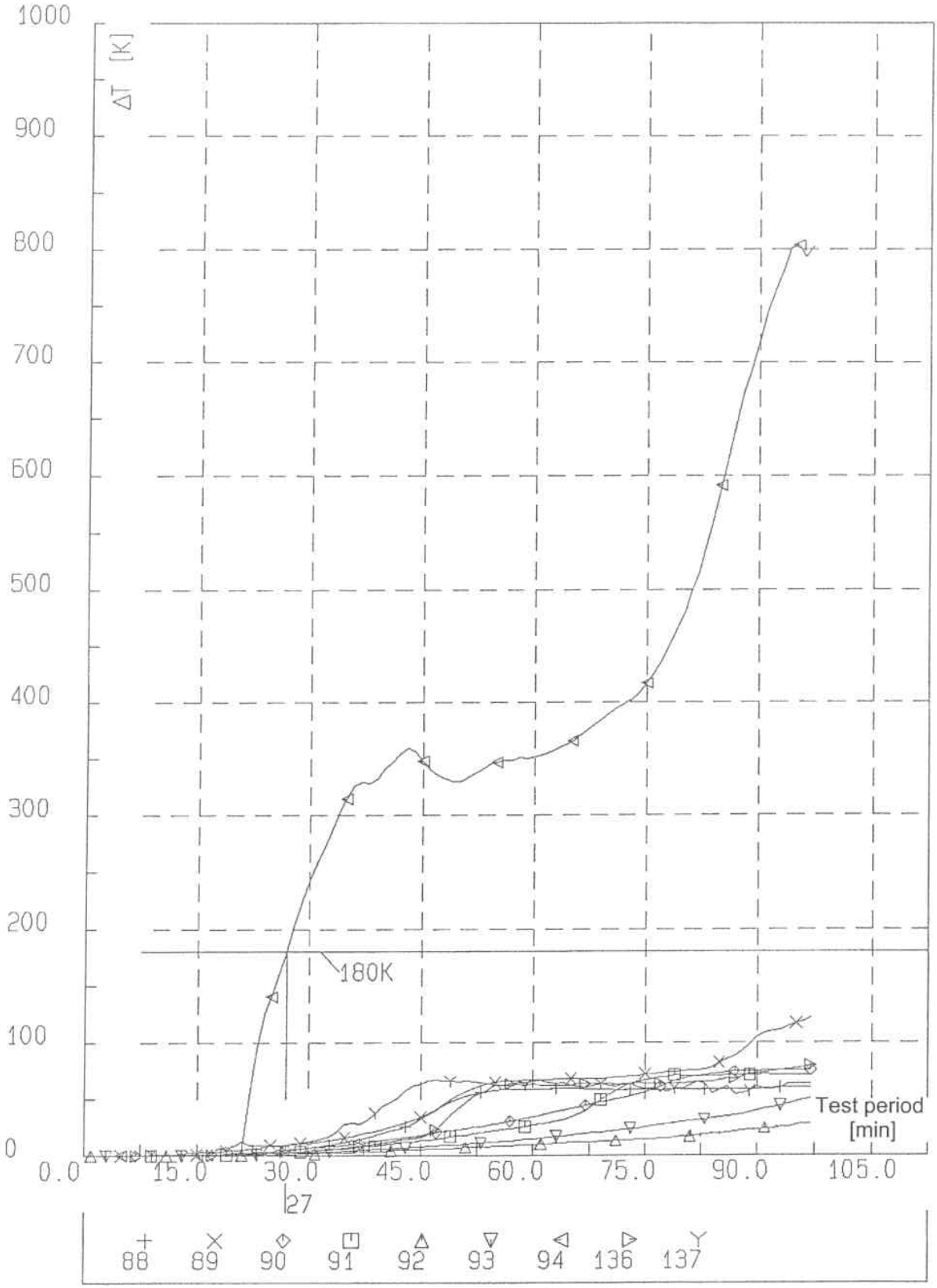
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.23 of

Test Certificate

No. 3003/9939

On the seal



Specimen temperatures

Aerated-concrete wall : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

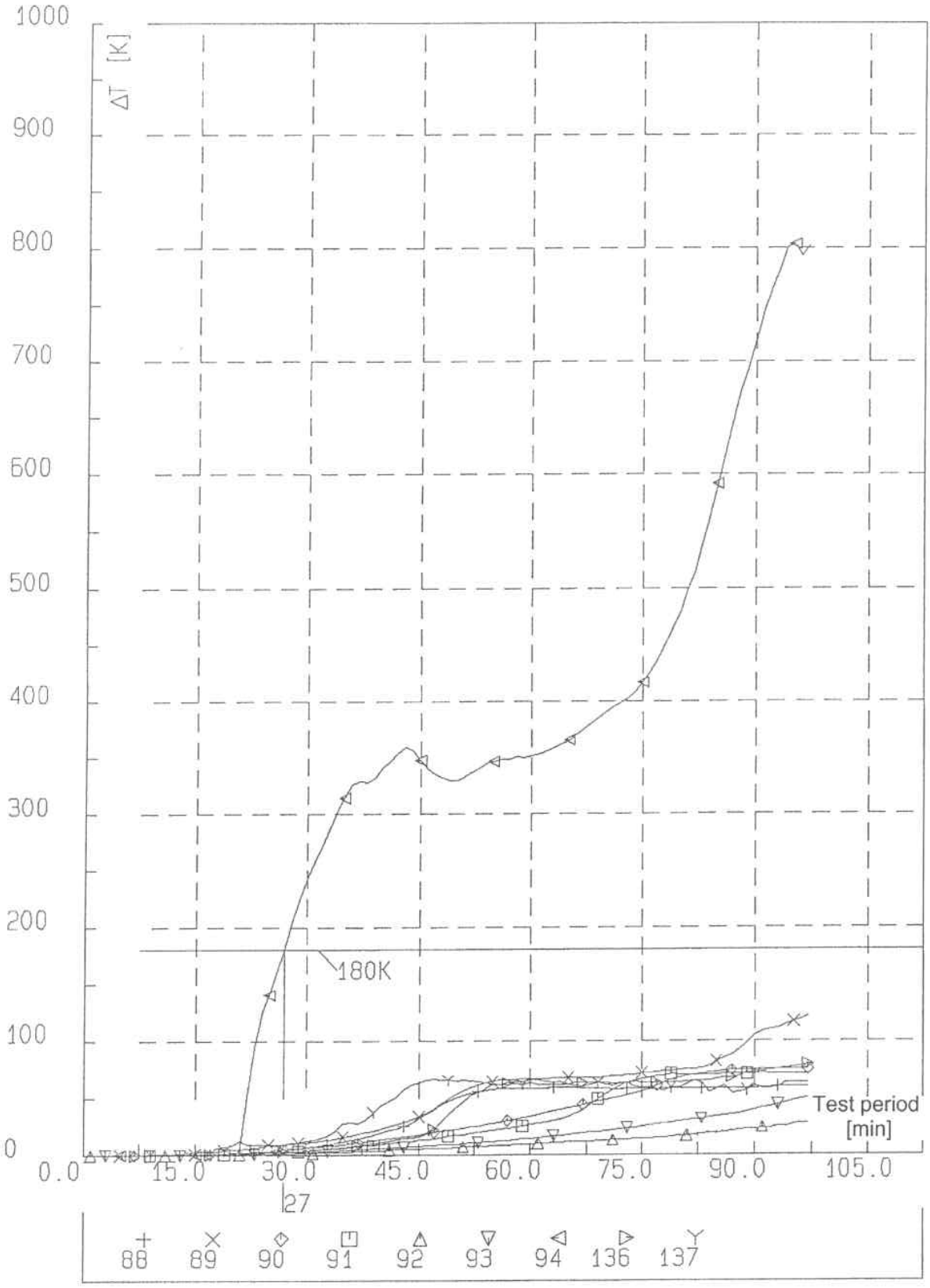
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.24 of

Test Certificate

No. 3003/9939

On the cables of the wide-span cable trays 80/300/FS



Specimen temperatures

Aerated-concrete wall : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

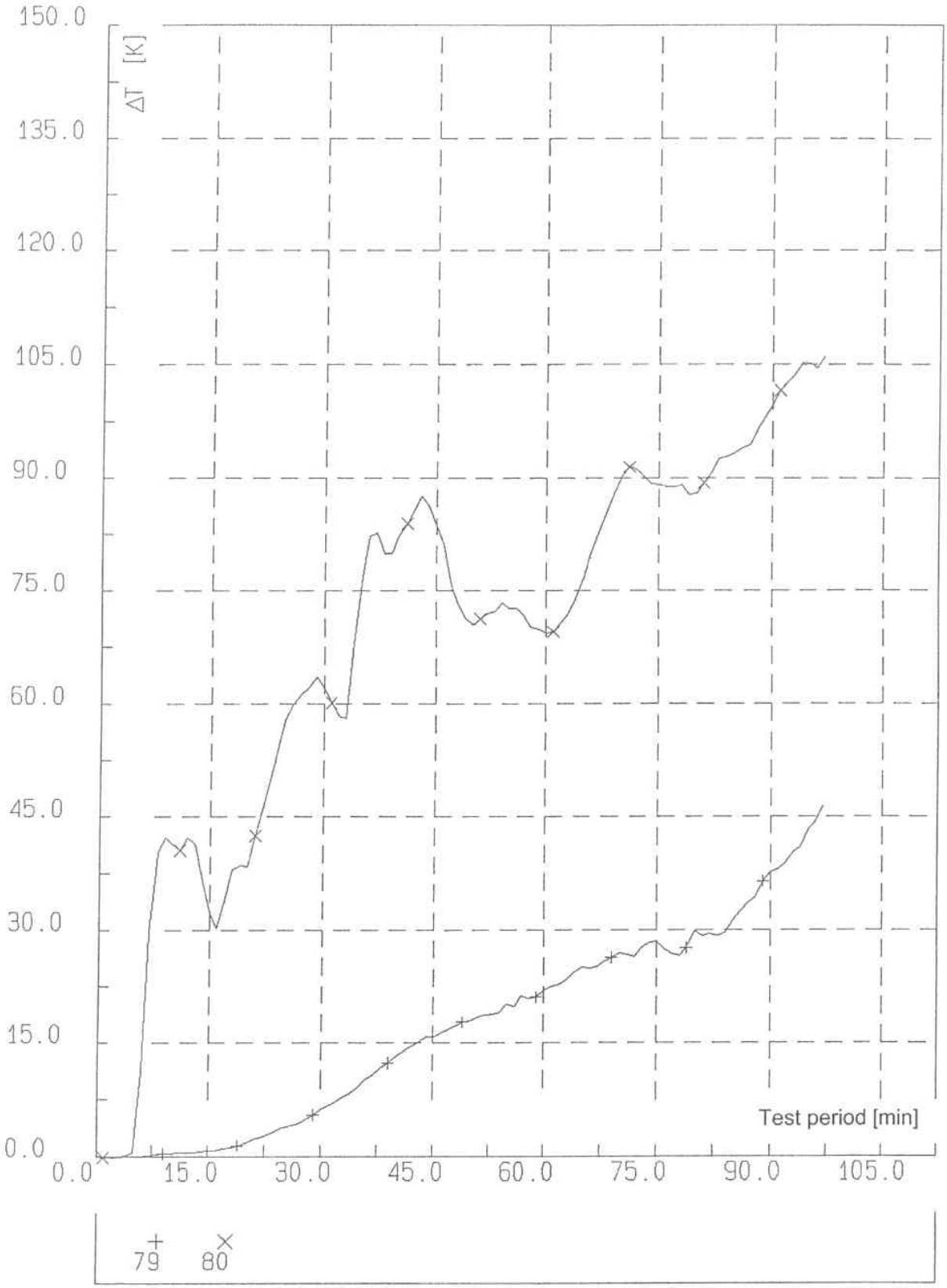
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.25 of

Test Certificate

No. 3003/9939

On the control pipes of the wide-span cable rack 80/300/FS



Specimen temperatures

Aerated-concrete wall : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

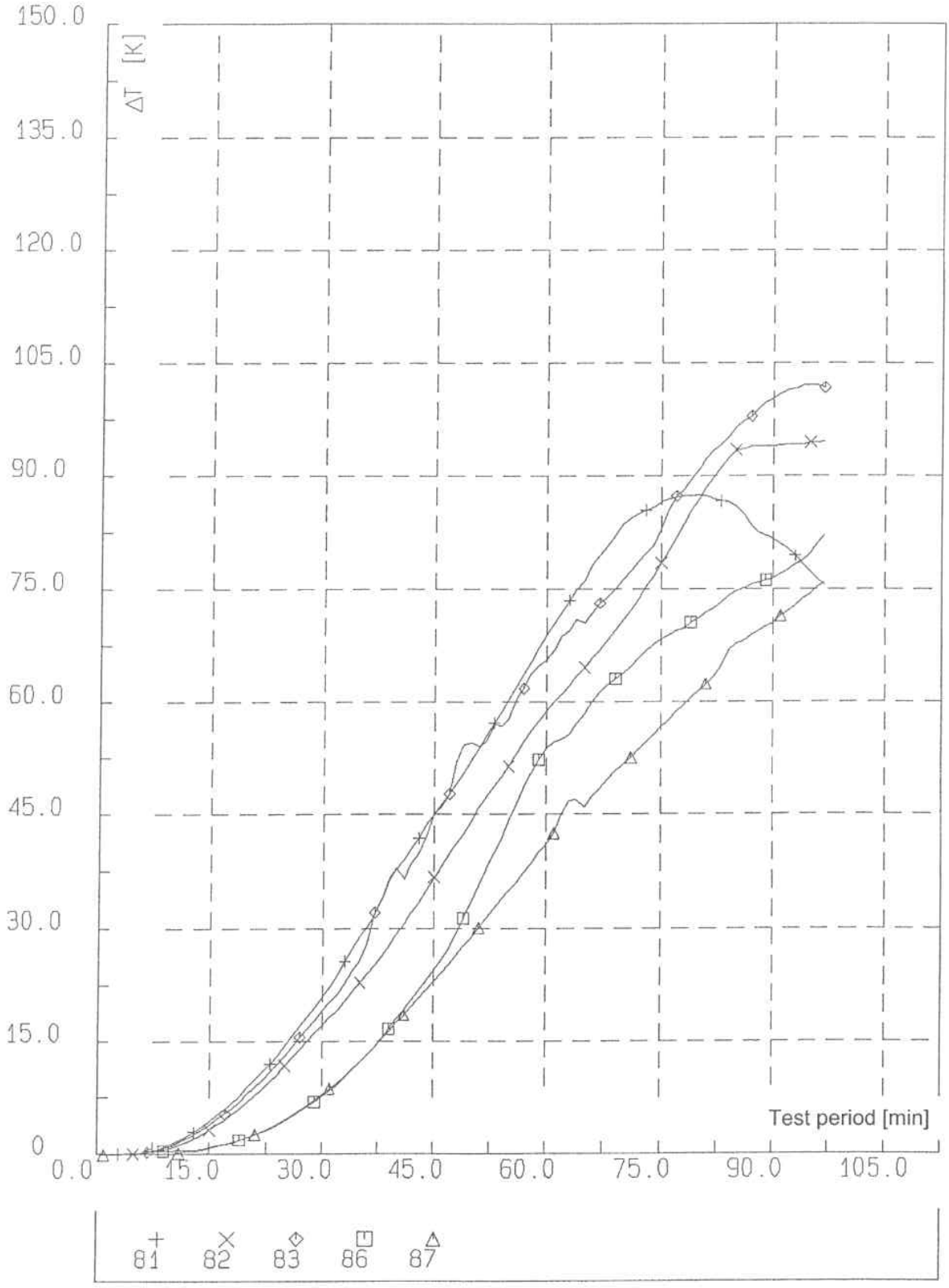
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.26 of

Test Certificate

No. 3003/9939

On the cables of cable tray KWL 500/60/FS



Specimen temperatures

Aerated-concrete wall : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

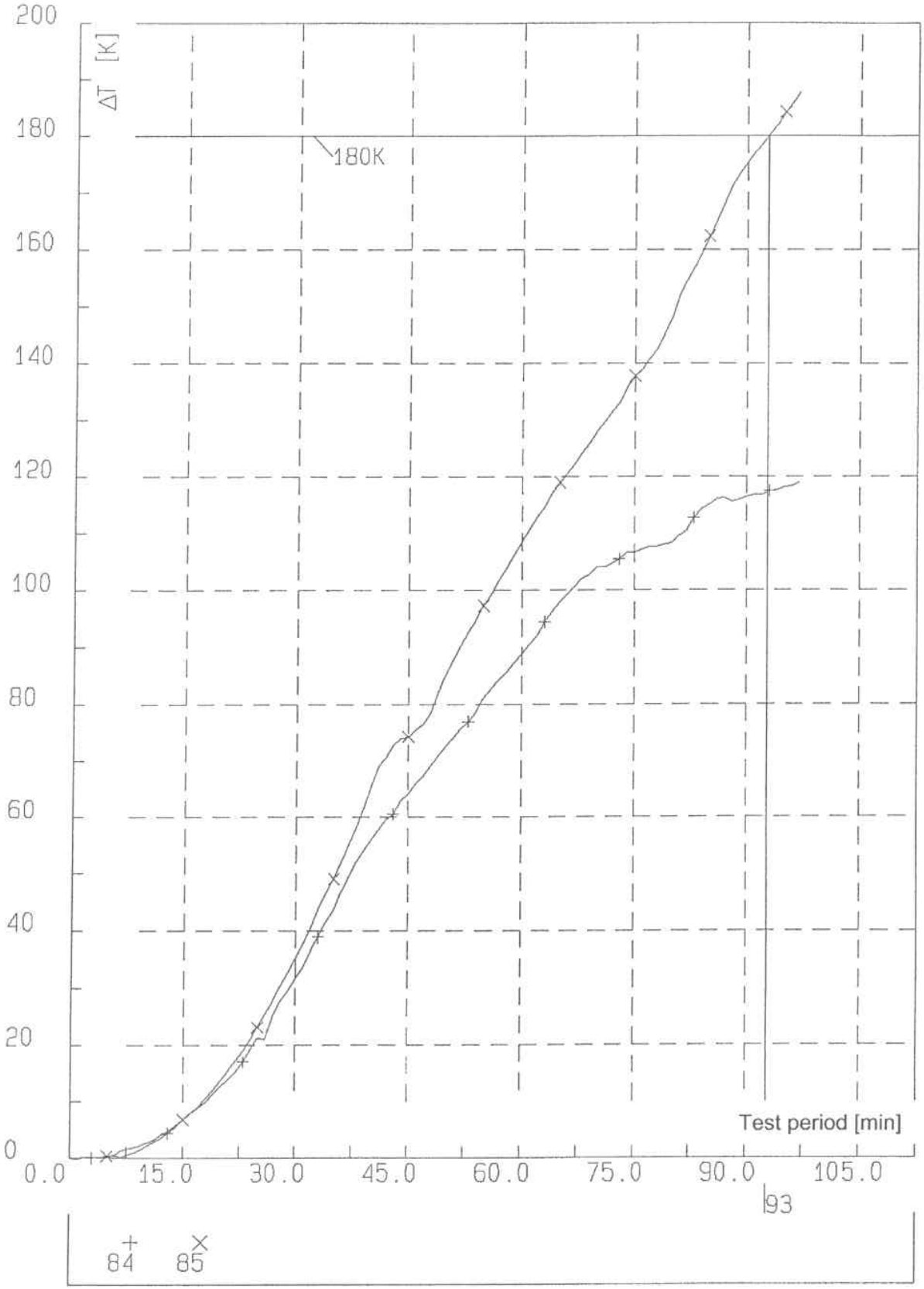
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.27 of

Test Certificate

No. 3003/9939

On the cable bundle of cable tray KWL 500/60/FS



Specimen temperatures

Aerated-concrete wall : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

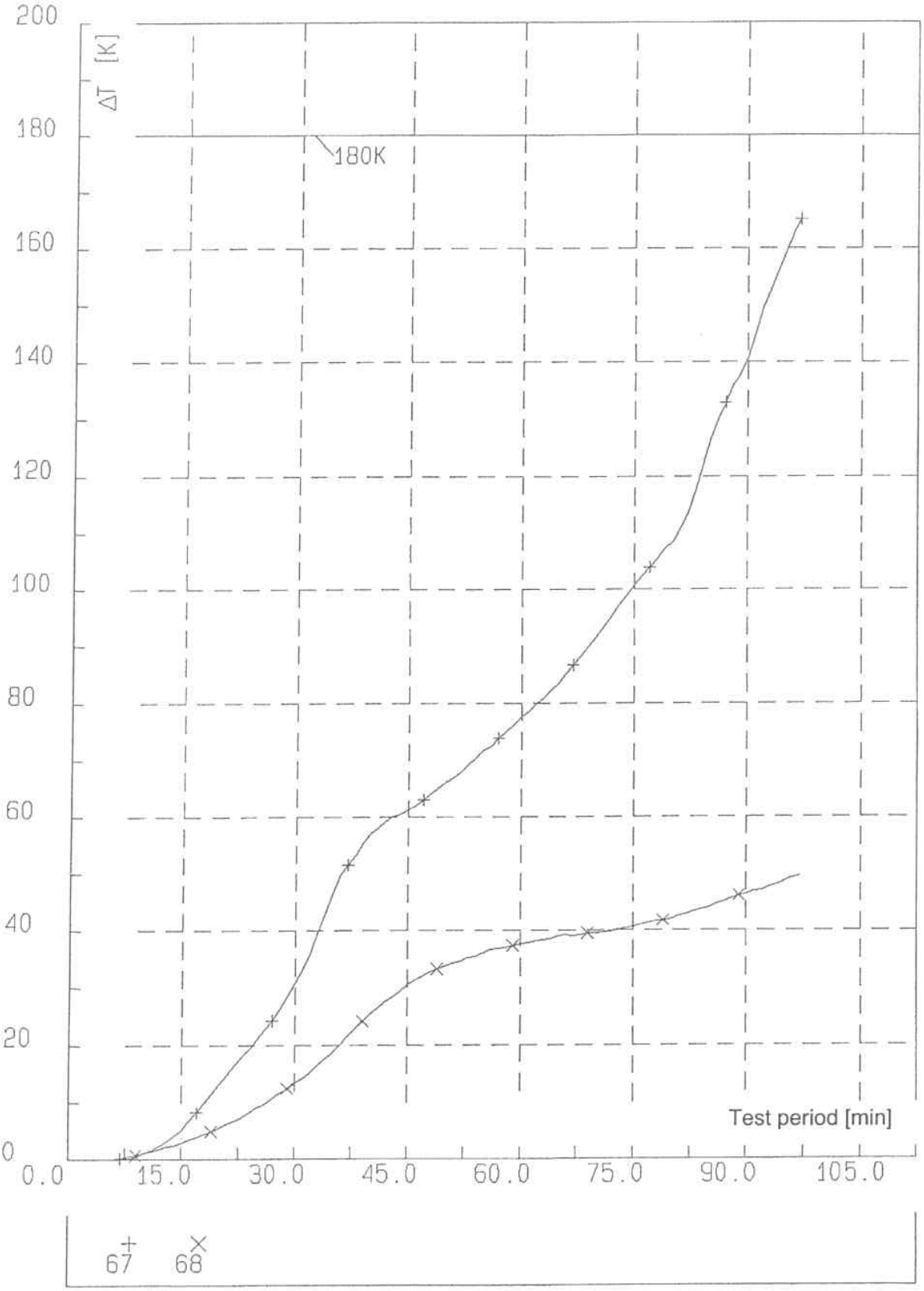
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.28 of

Test Certificate

No. 3003/9939

On the wide-span cable racks 80/300/FS



Specimen temperatures

Aerated-concrete wall : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

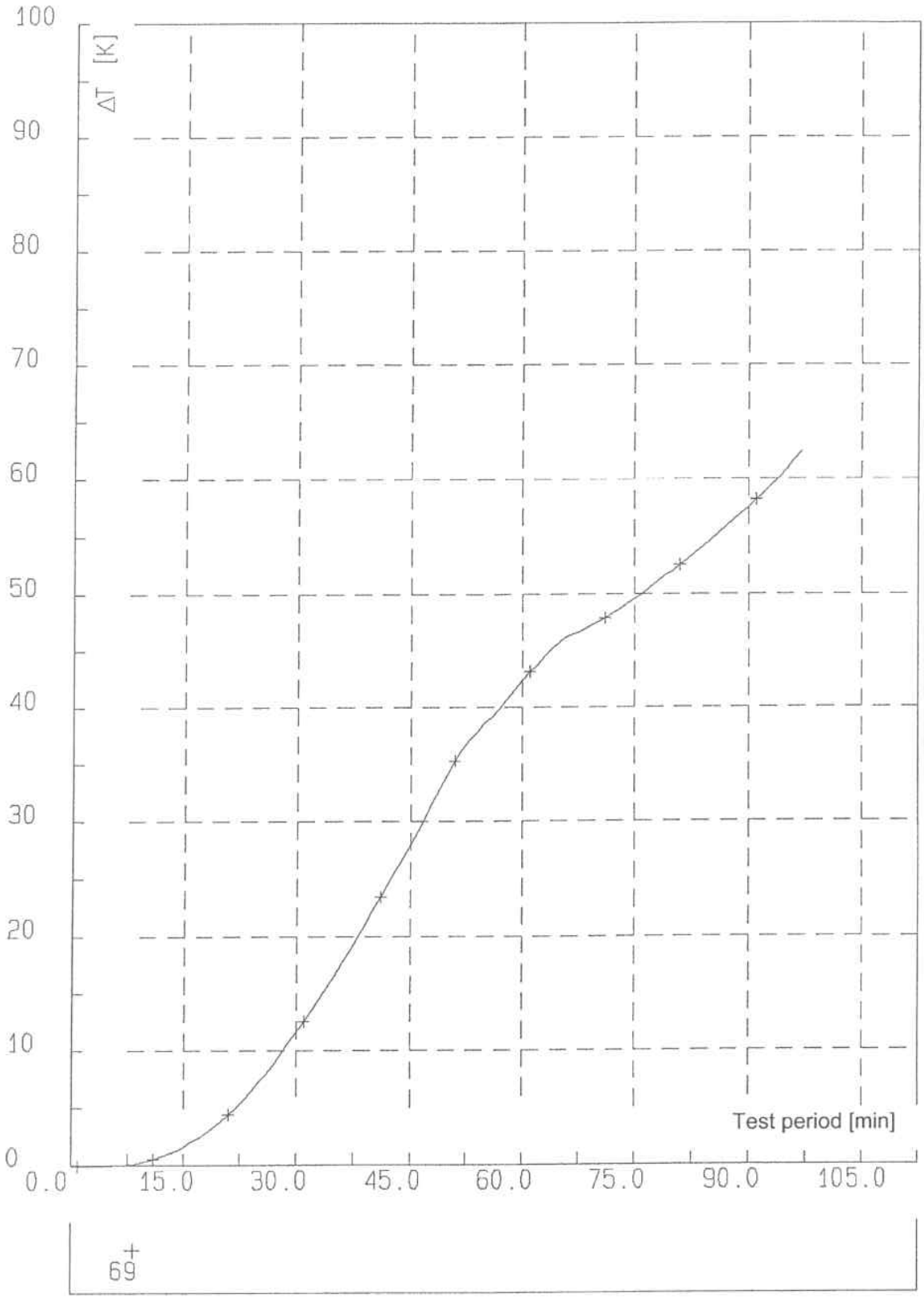
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.29 of

Test Certificate

No. 3003/9939

On cable tray KWL 500/60/FS



Specimen temperatures

Aerated-concrete wall : "FEP Rechteckschott S 90"

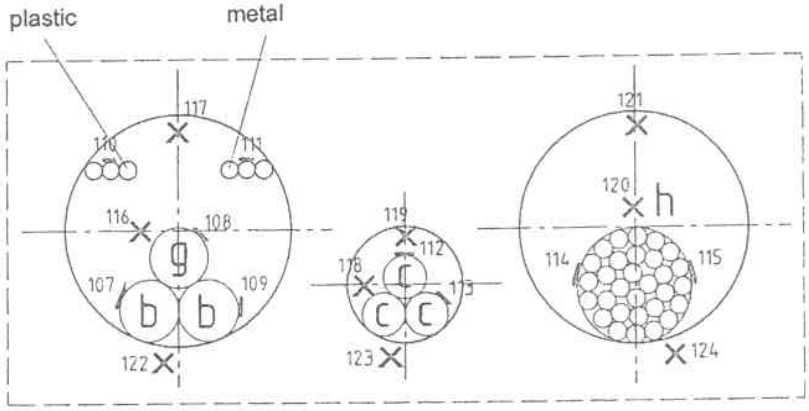
Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.30 of

Test Certificate

No. 3003/9939

Circular seal "rigid wall"



Structural design of specimen

Aerated-concrete wall

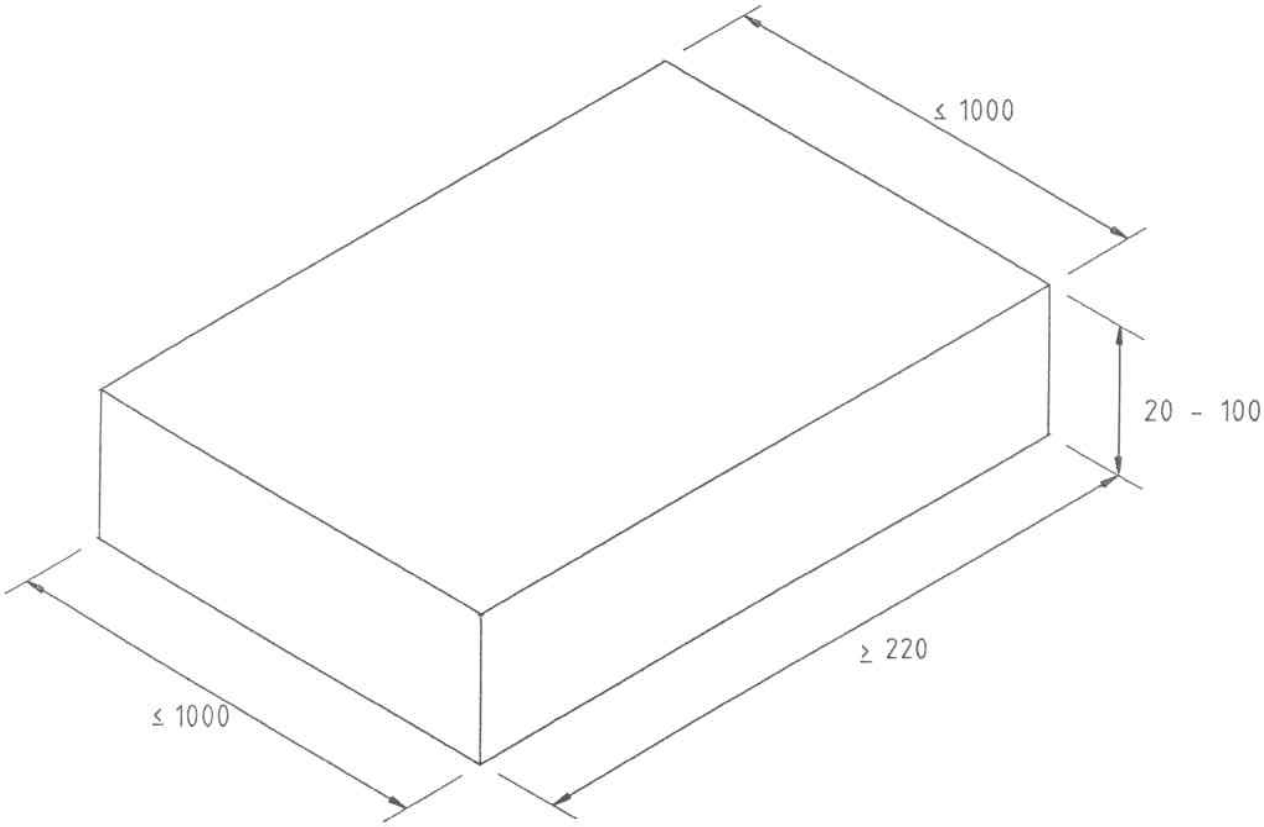
Position of measuring points – circular seal

Materialprüfanstalt für das Bauwesen

Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 1.19
of
Test Certificate
No. 3003/9939

Block for system *"FEP corner seal S 90"* made from *"FEP foam Plus"*



Type	Length [mm]	Width [mm]	Height [mm]
FEP ES 90	≥ 220	≤ 1000	20 - 100

Dimensions in mm

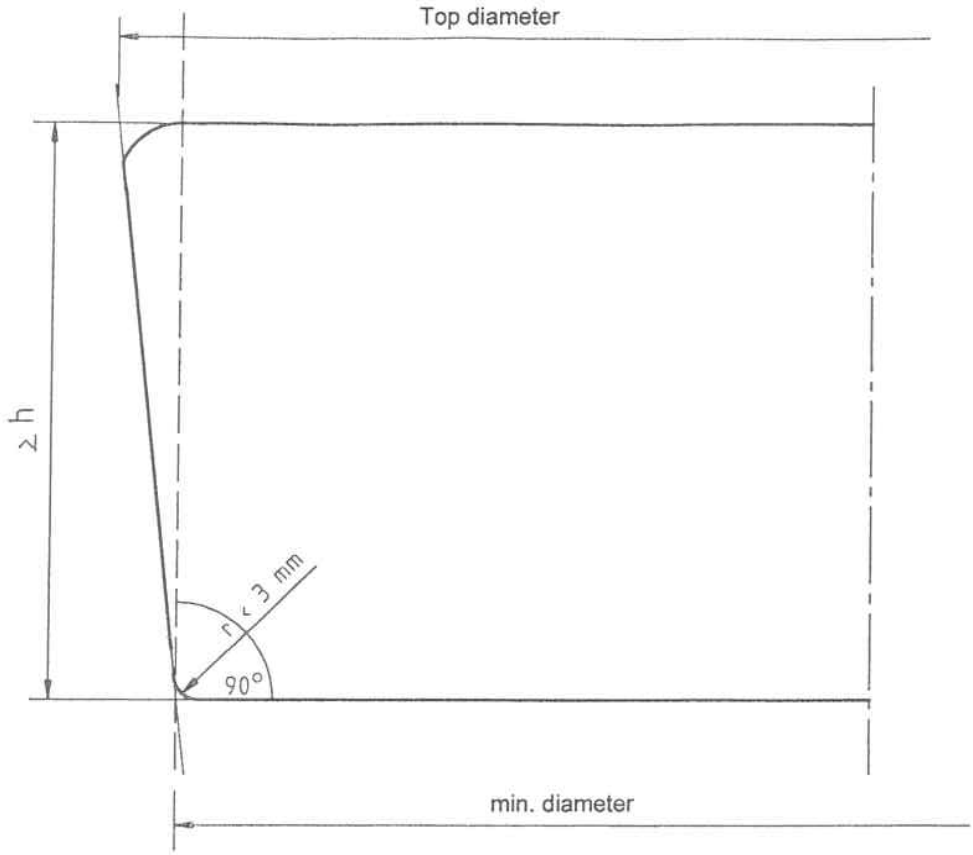
Structural design of specimen

"FEP Rechteckschott S 90" – design of moulded parts (block)

Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 1.20 of
Test Certificate
No. 3003/9939

Moulded part for system *"FEP circular seal S 90"* made from *"FEP foam Plus"*



Type	Coring Ø [mm]	min. dia. Ø [mm]	Top dia. Ø [mm]	Height h [mm]
FEP RS 52	52	55	61	70
FEP RS 77	77	80	86	70
FEP RS 107	107	110	116	70
FEP RS 132	132	136	142	70
FEP RS 158	158	162	168	70
FEP RS 202	202	206	212	70
FEP RS 250	250	254	263	110
FEP RS 300	300	304	313	110

Dimensions in mm

Structural design of specimen

"FEP Rundschott S 90" – design of moulded parts

Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 1.21 of
Test Certificate
No. 3003/9939

Material	Supplier	Thick-ness	Weight per unit area	Apparent density	Moistu re conten t	Material classification
			as built			Test marks
		mm	kg/m²	kg/m³	% by wt.	
Intumescent-material "FEP Schaum Plus" foam	Münchener Entwicklungs-gesellschaft für Brandschutz im Ausbau GmbH (MEBA), Baierbrunn	55.0[1] and 70.0[2]	11.10[1] and. 16.32[2]	221.5[1] and. 233.2[2]	2.0[1] and. 2.1[2]	-[3]
Intumescent-material "FEP Masse" compound		-[4]	-[4]	-[4]	-[4]	-[3]
PROMATECT®-H	Promat GmbH, Ratingen	25	28.5	1141.5	4.4	A1: acc. to type approval No. Z-PA-III 4.770

1) relates to the square moulded parts (name used by client: "Block")

2) relates to the moulded parts shaped like a circular truncated cone ("round plugs")

3) fitness-for-use attestation not available to Testing House; type approval has been applied for with the German approval body Deutsche Institut für Bautechnik, Berlin

4) not determined

Material	Supplier	Thick-ness	Weight per unit area	Apparent density	Moisture content	Material classification
			as built			Test marks
		mm	kg/m^2	kg/m^3	% by wt.	
Intumescent-material "FEP Schaum Plus" foam"	Münchener Entwicklungs-gesellschaft für Brandschutz im Ausbau GmbH (MEBA), Baierbrunn	55.0[1] and 70.0[2]	12.61[1] and 15.91[2]	229.2[1] and 227.3[2]	2.2[1] and 2.0[2]	-[3]
Intumescent-material "FEP Masse" compound		-[4]	-[4]	-[4]	-[4]	-[3]

1) relates to the square moulded parts (name used by client: "Block")

2) relates to the moulded parts shaped like a circular truncated cone ("round plugs")

3) fitness-for-use attestation not available to Testing House; type approval has been applied for with the German approval body Deutsche Institut für Bautechnik, Berlin

4) not determined

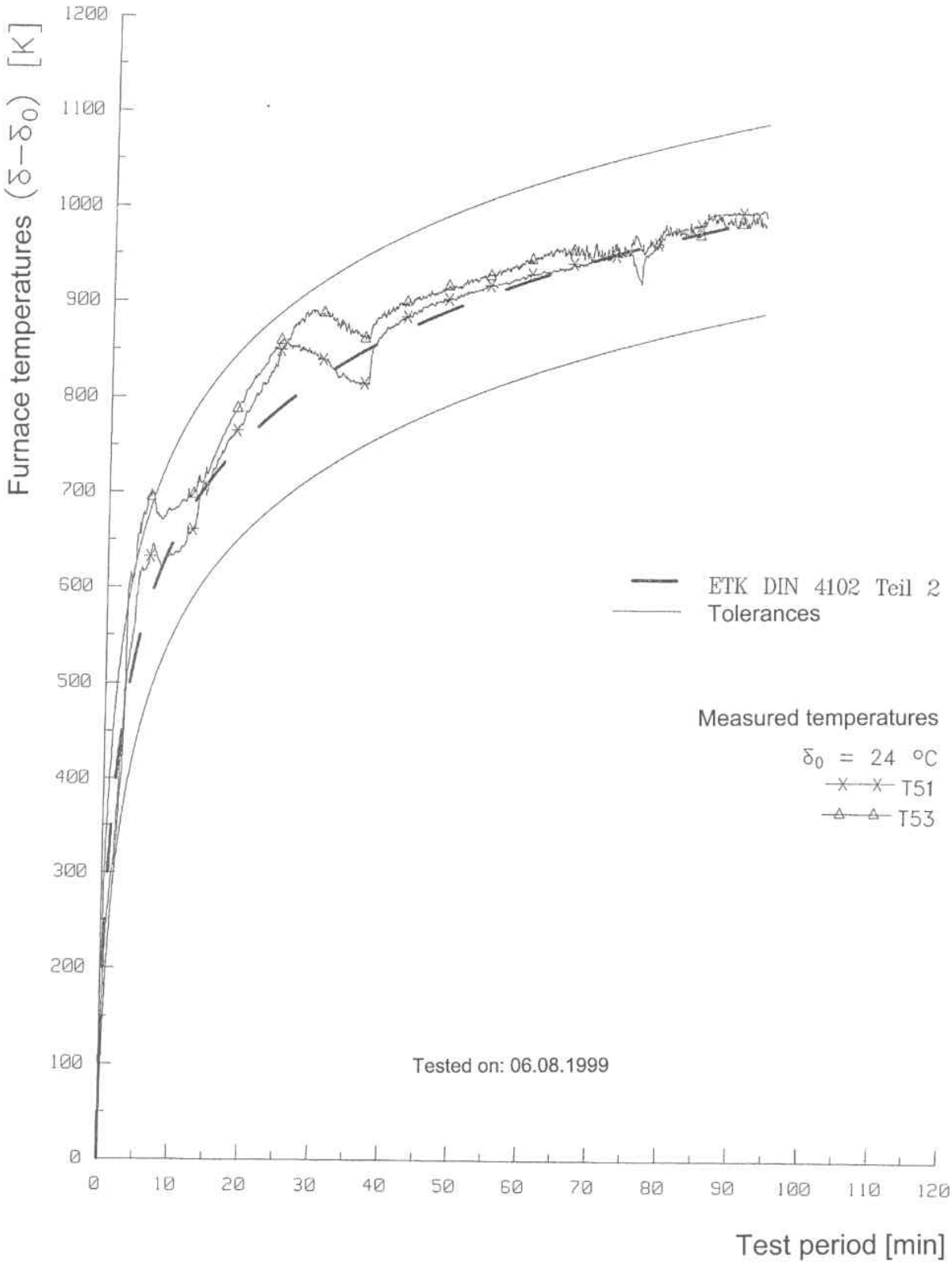
Material	Supplier	Thick-ness	Weight per unit area	Apparent density	Moisture content	Material classification
			as built			Test marks
		mm	kg/m²	kg/m³	% by wt.	
Intumescent-material "FEP Schaum Plus" foam	Münchener Entwicklungs-gesellschaft für Brandschutz im Ausbau GmbH (MEBA), Baierbrunn	55.0[1] and 70.0[2]	13.00[1] and 16.58[2]	235.6[1] and 236.8[2]	2.2[1] and 2.3[2]	-[3]
Intumescent-material "FEPMasse" compound		-[4]	-[4]	-[4]	-[4]	-[3]
PROMATECT®-H	Promat GmbH, Ratingen	25,0	24,5	980,5	3,5	A1: acc. to type approval No. Z-PA-III 4.770
Vermiculite	-	25	-[4]	-[4]	-[4]	A1: acc. to DIN 4102-4 1994-03

1) relates to the square moulded parts (name used by client: "Block")

2) relates to the moulded parts shaped like a circular truncated cone ("round plugs")

3) fitness-for-use attestation not available to Testing House; type approval has been applied for with the German approval body Deutsche Institut für Bautechnik, Berlin

4) not determined



Furnace temperatures
Floor system D 1 (Test 1)

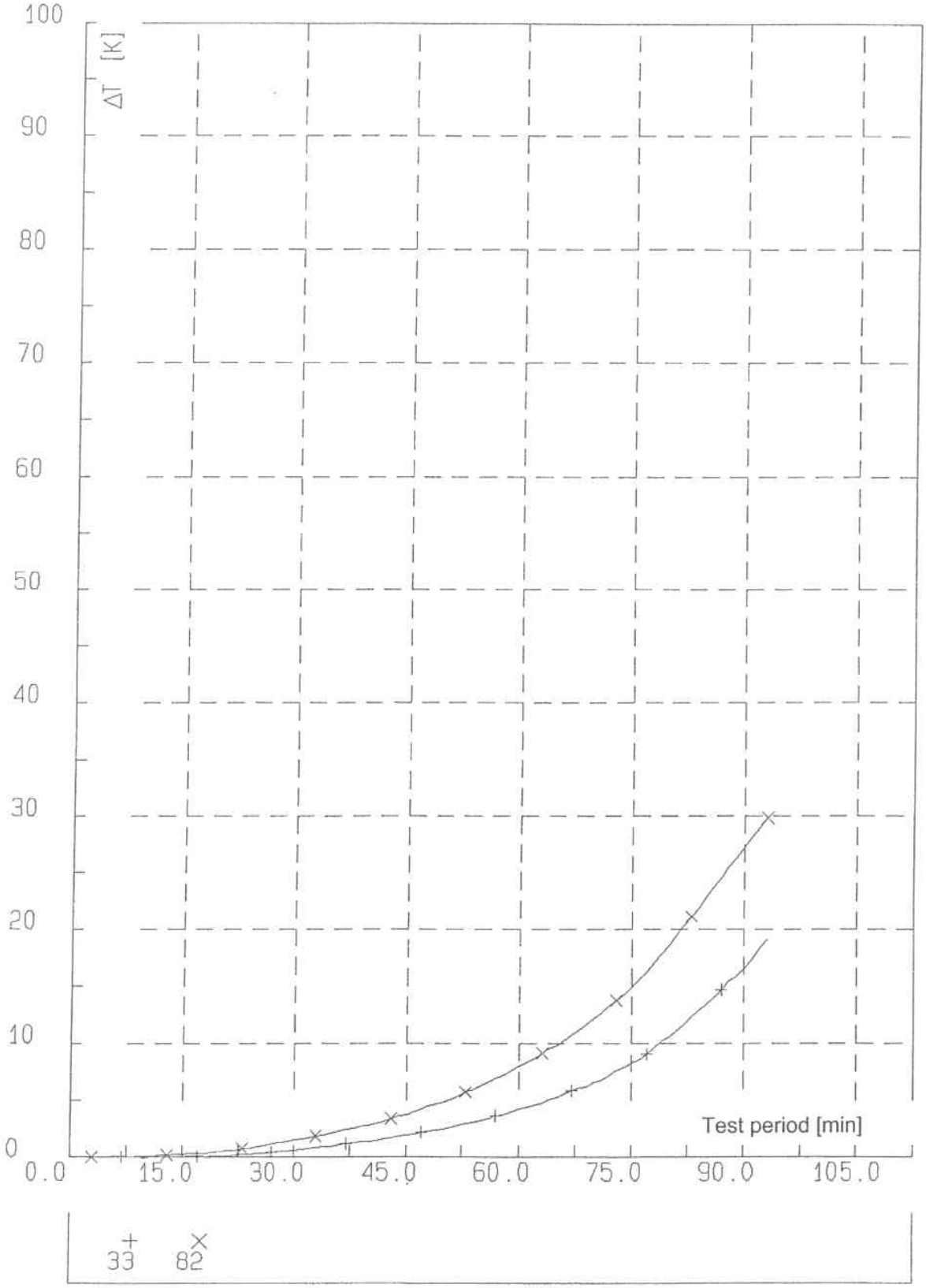
Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 2.1 of

Test Certificate

No. 3003/9939

On the extra layer



Specimen temperatures

Floor system D1 : "FEP Rechteckschott S 90"

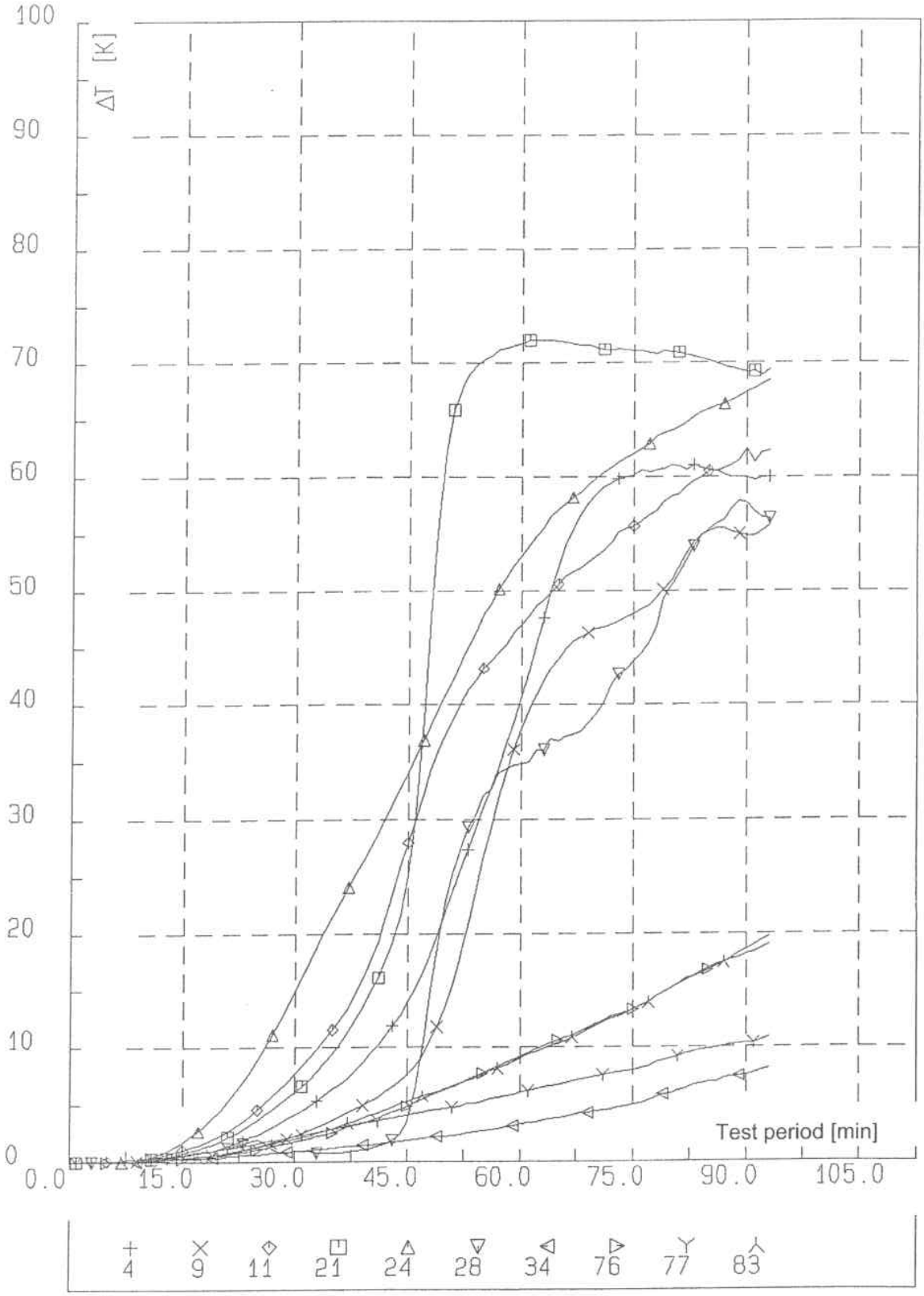
Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 2.2 of

Test Certificate

No. 3003/9939

On the seal



Specimen temperatures

Floor system D1 : "FEP Rechteckschott S 90"

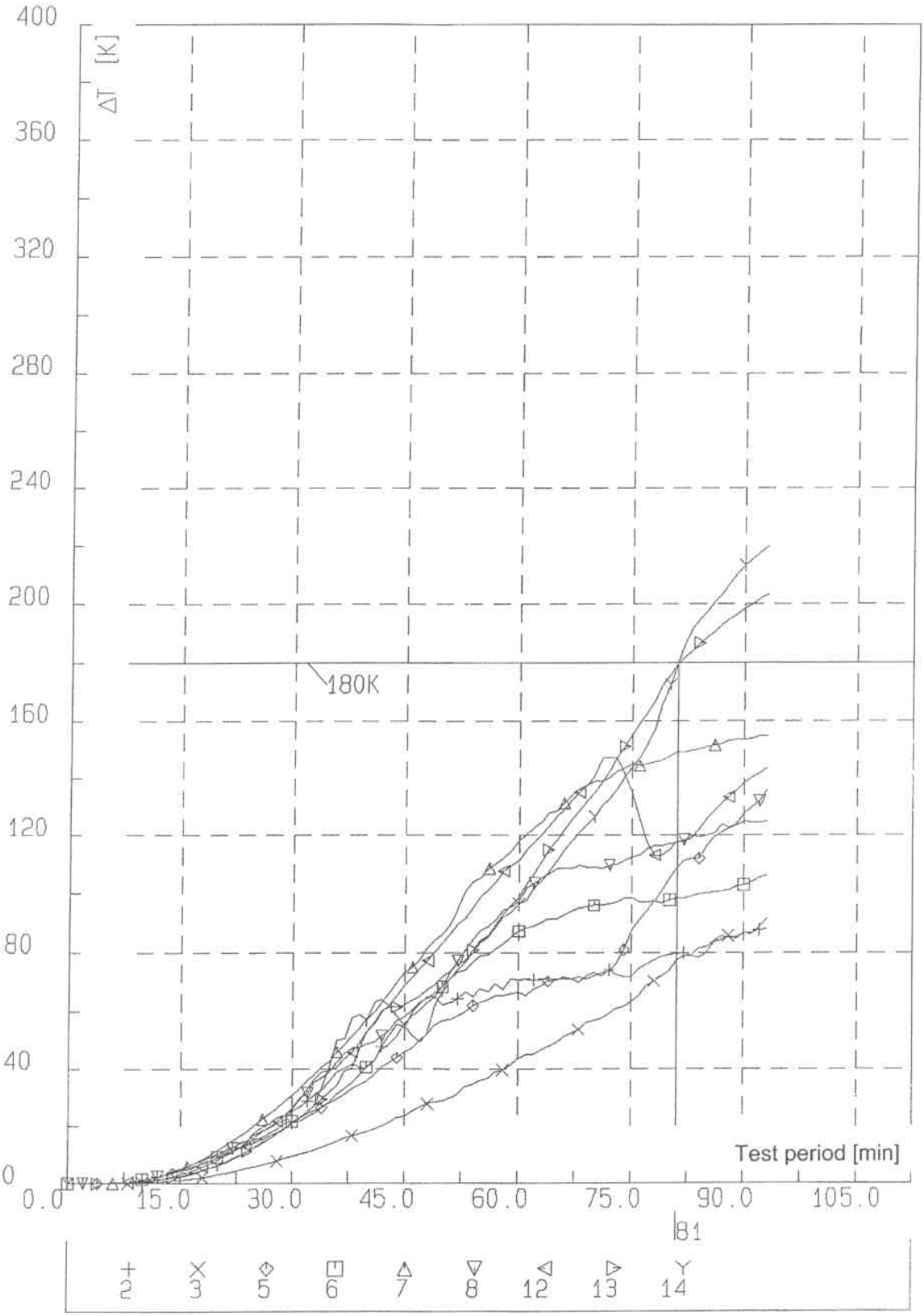
Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 2.3 of

Test Certificate

No. 3003/9939

On the cables of the wide-span cable racks 80/300/FS



Specimen temperatures

Floor system D1 : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

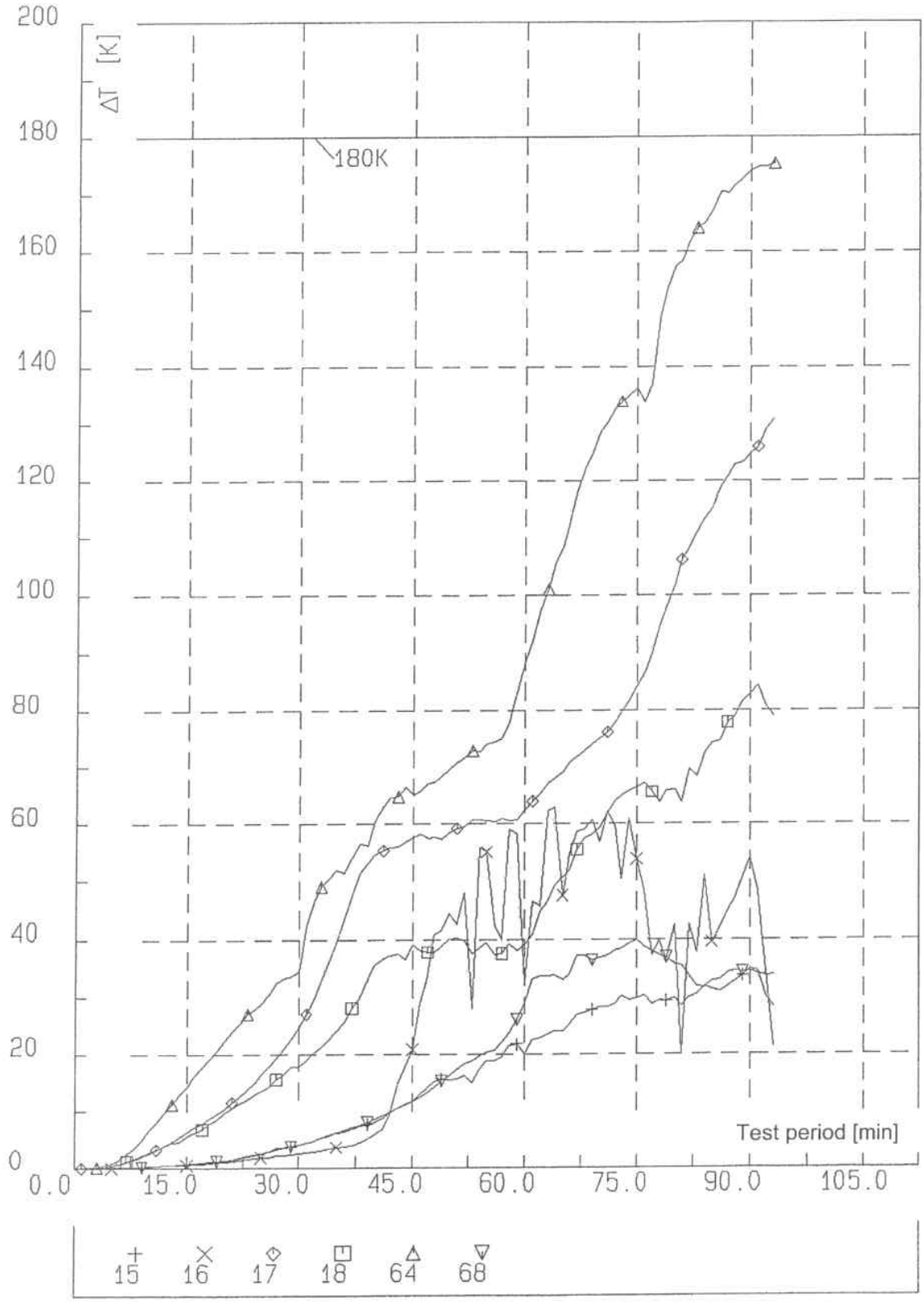
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 2.4 of

Test Certificate

No. 3003/9939

On the control pipes of the wide-span cable rack 80/300/FS (in addition: measuring points Nos. 64 and 68 of the control pipes of the "FEP Rundschott S 90"-∅ 210, additionally shown for comparison)



Specimen temperatures

Floor system D1 : "FEP Rechteckschott S 90"

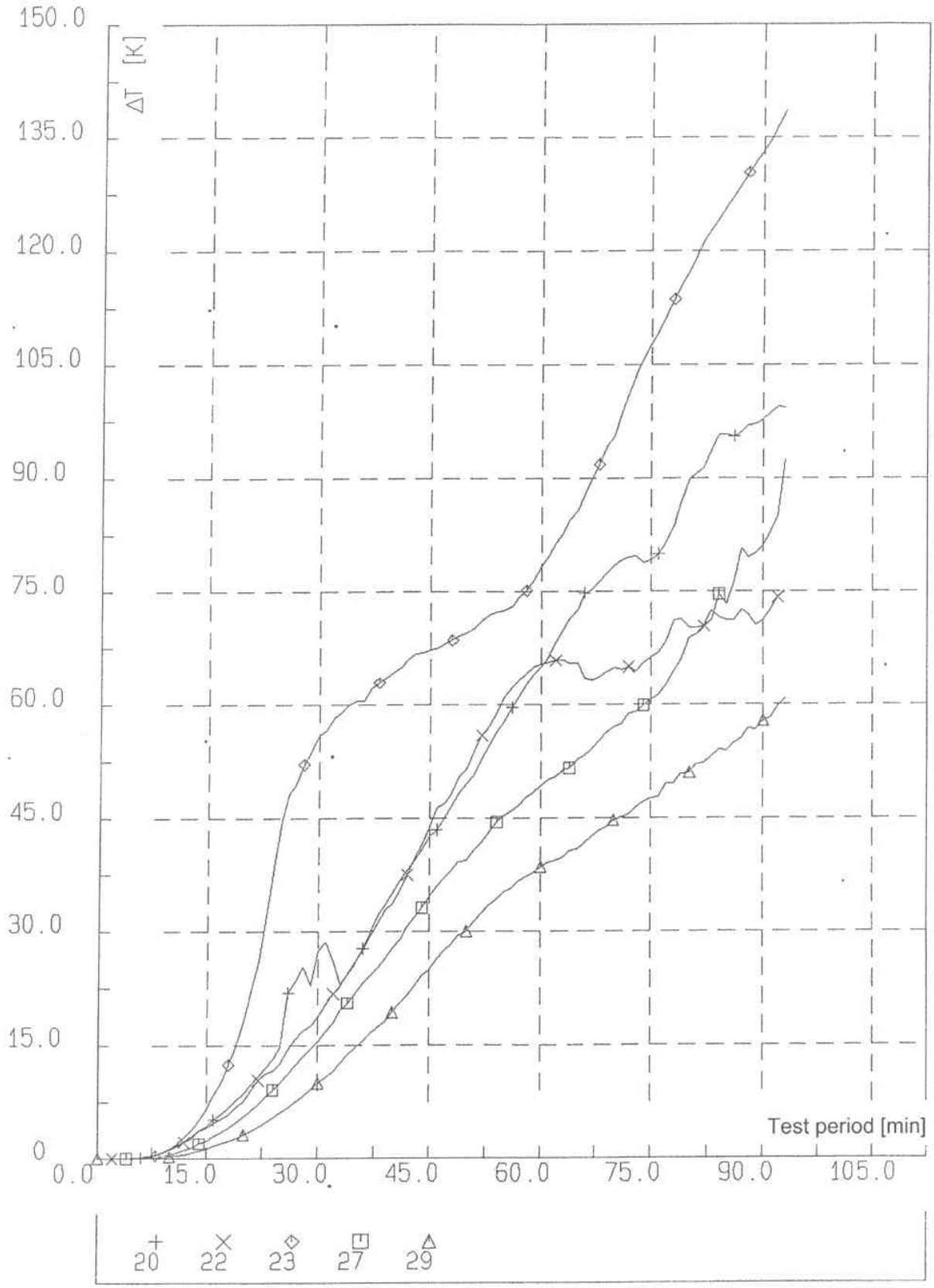
Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 2.5 of

Test Certificate

No. 3003/9939

On the cables of cable tray KWL 500/60/FS



Specimen temperatures

Floor system D1 : "FEP Rechteckschott S 90"

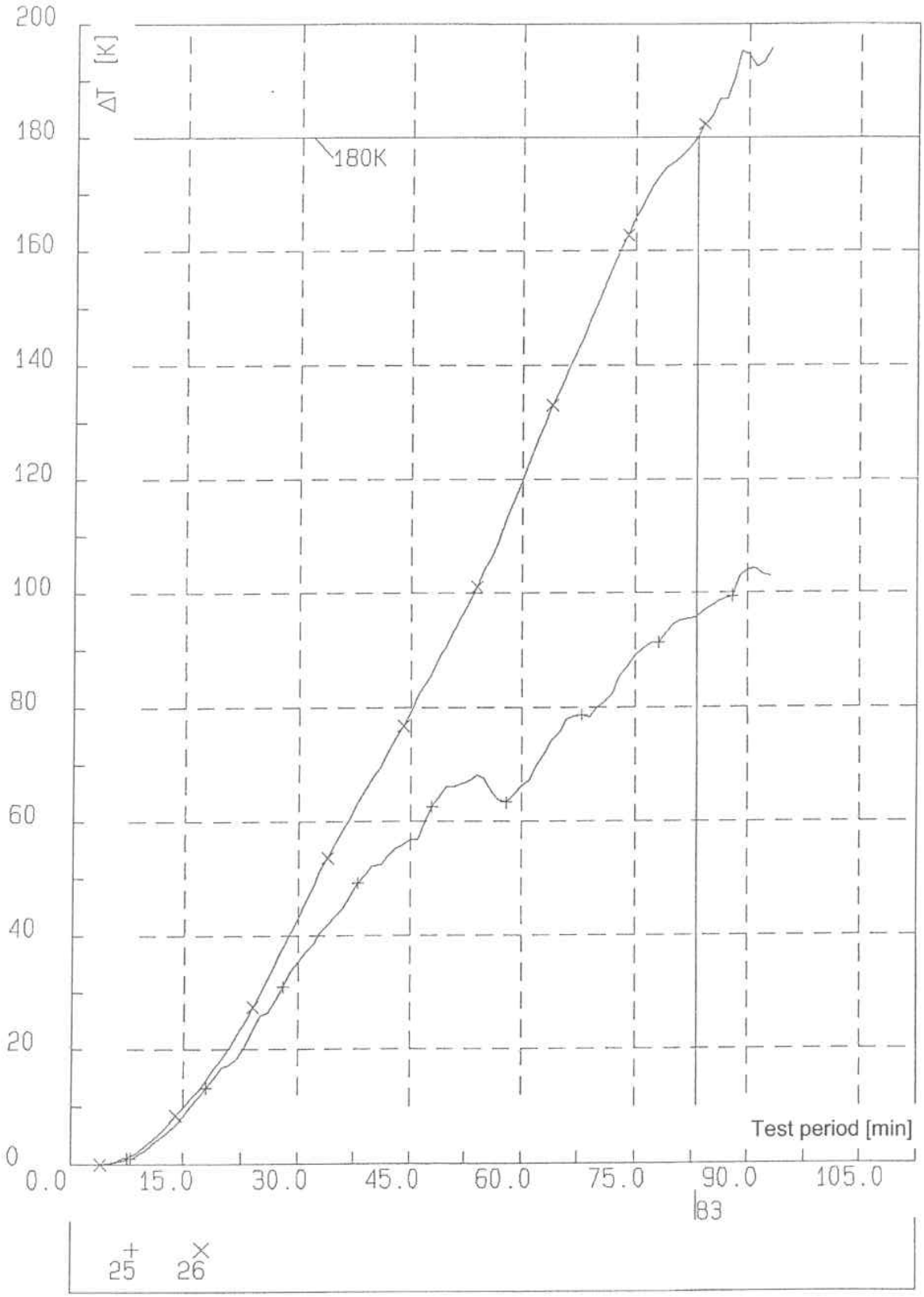
Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 2.6 of

Test Certificate

No. 3003/9939

On the cable bundle of cable tray KWL 500/60/FS



Specimen temperatures

Floor system D1 : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

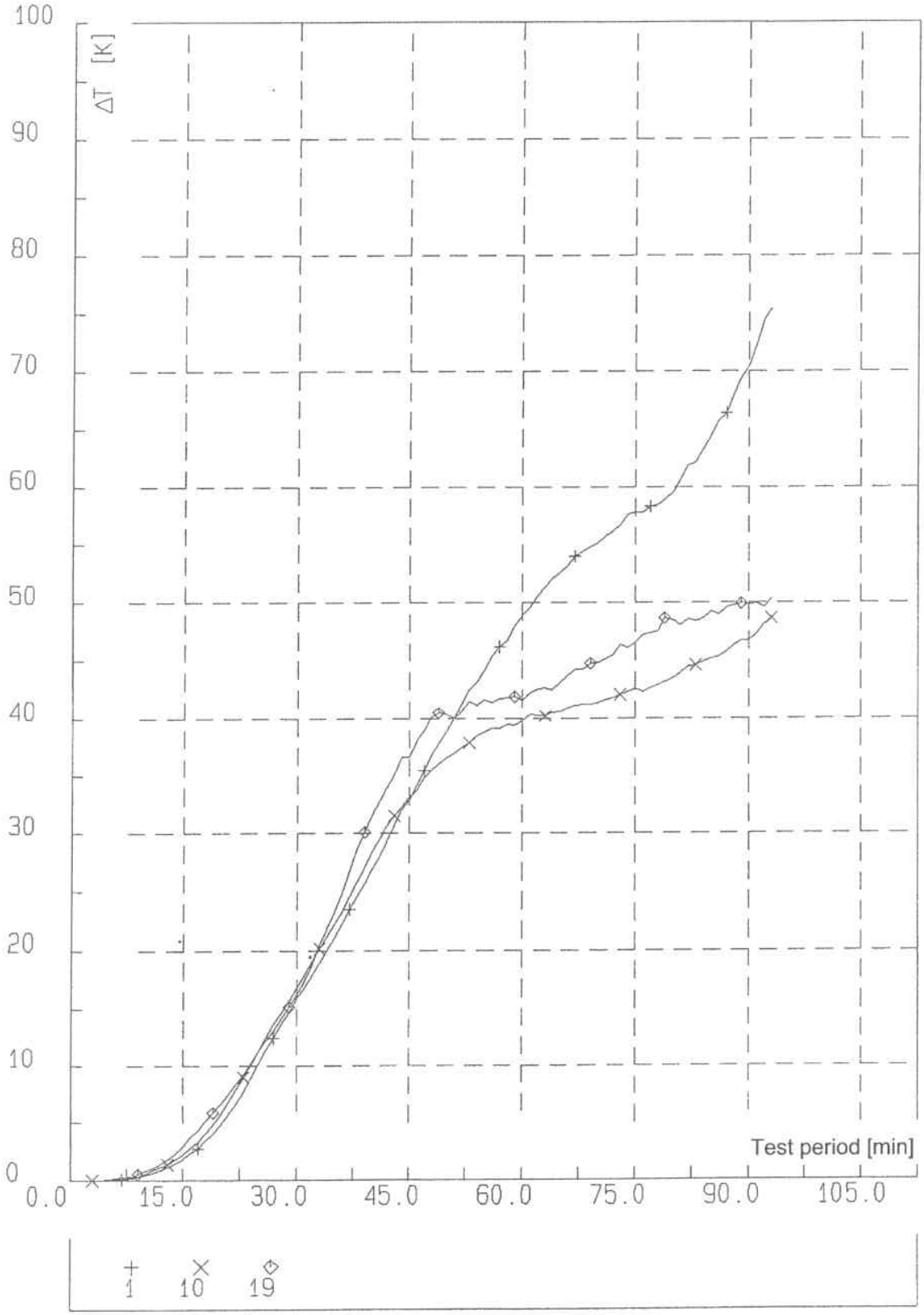
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 2.7 of

Test Certificate

No. 3003/9939

On the wide-span cable racks 80/300/FS



Specimen temperatures

Floor system D1 : "FEP Rechteckschott S 90"

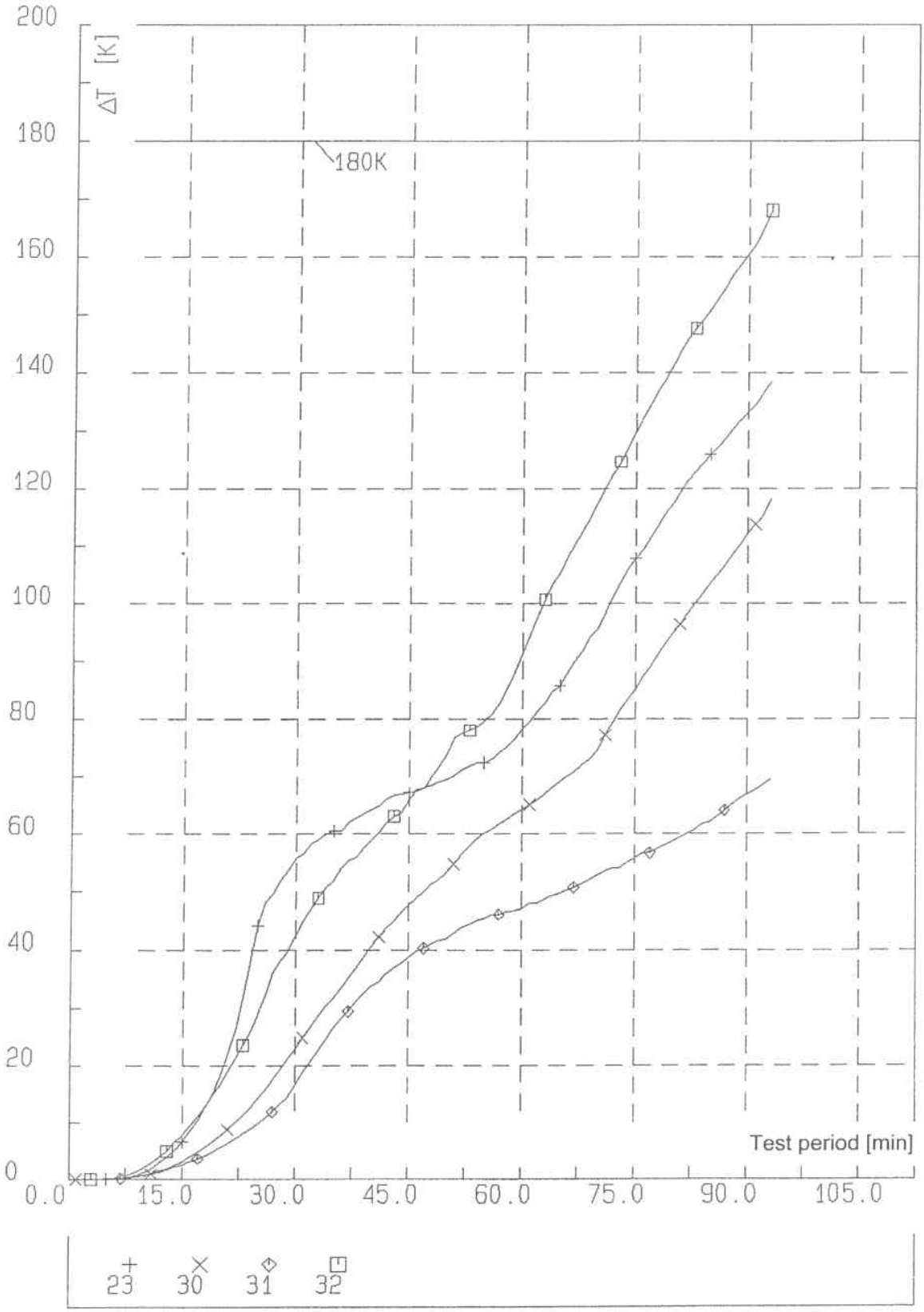
Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 2.8 of

Test Certificate

No. 3003/9939

On cable tray KWL 500/60/FS



Specimen temperatures

Floor system D1 : "FEP Rechteckschott S 90"

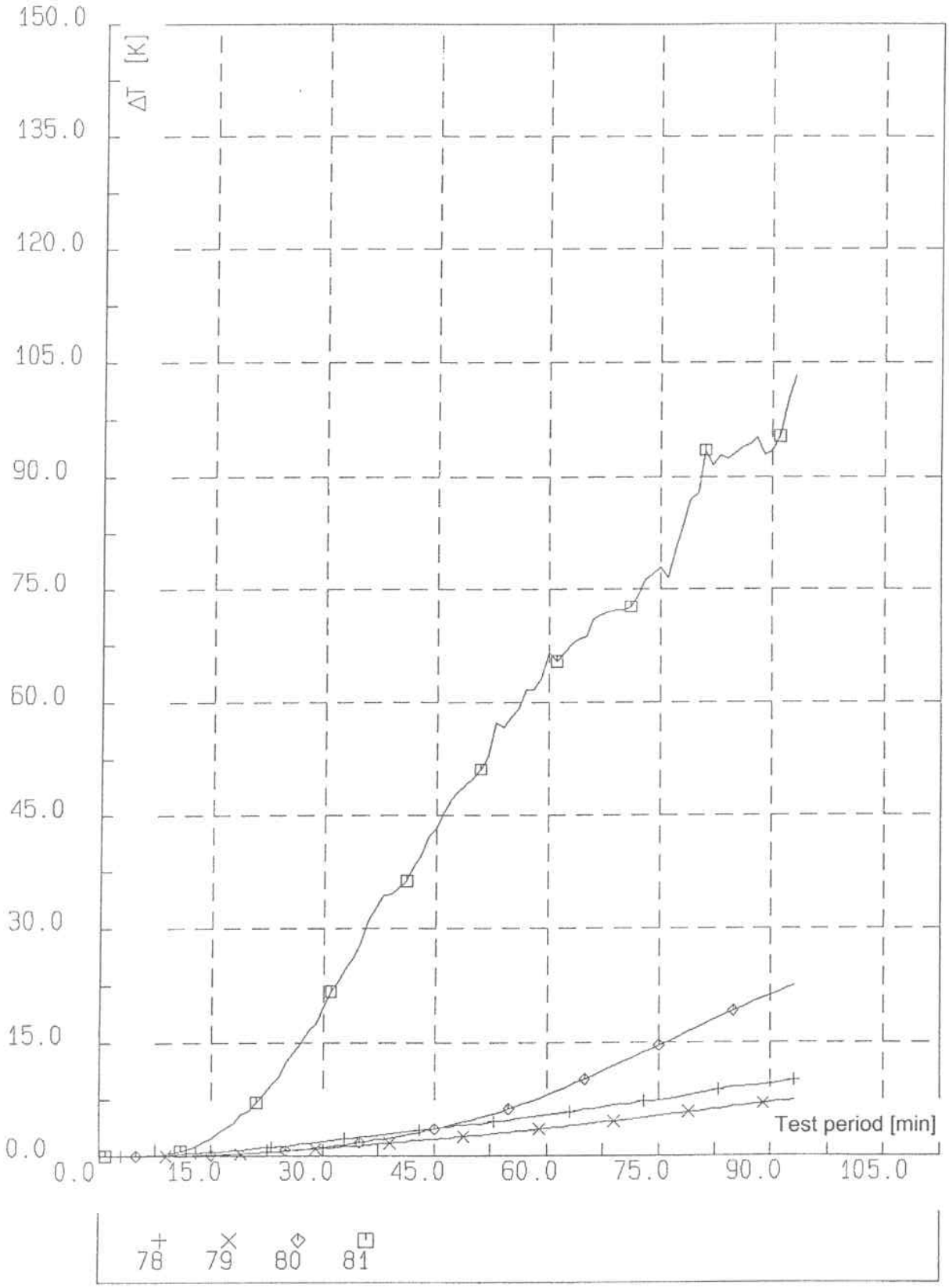
Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 2.9 of

Test Certificate

No. 3003/9939

Cable pulling/secondary assignment : on seal and “c” cable



Specimen temperatures

Floor system D1 : “FEP Rechteckschott S 90“

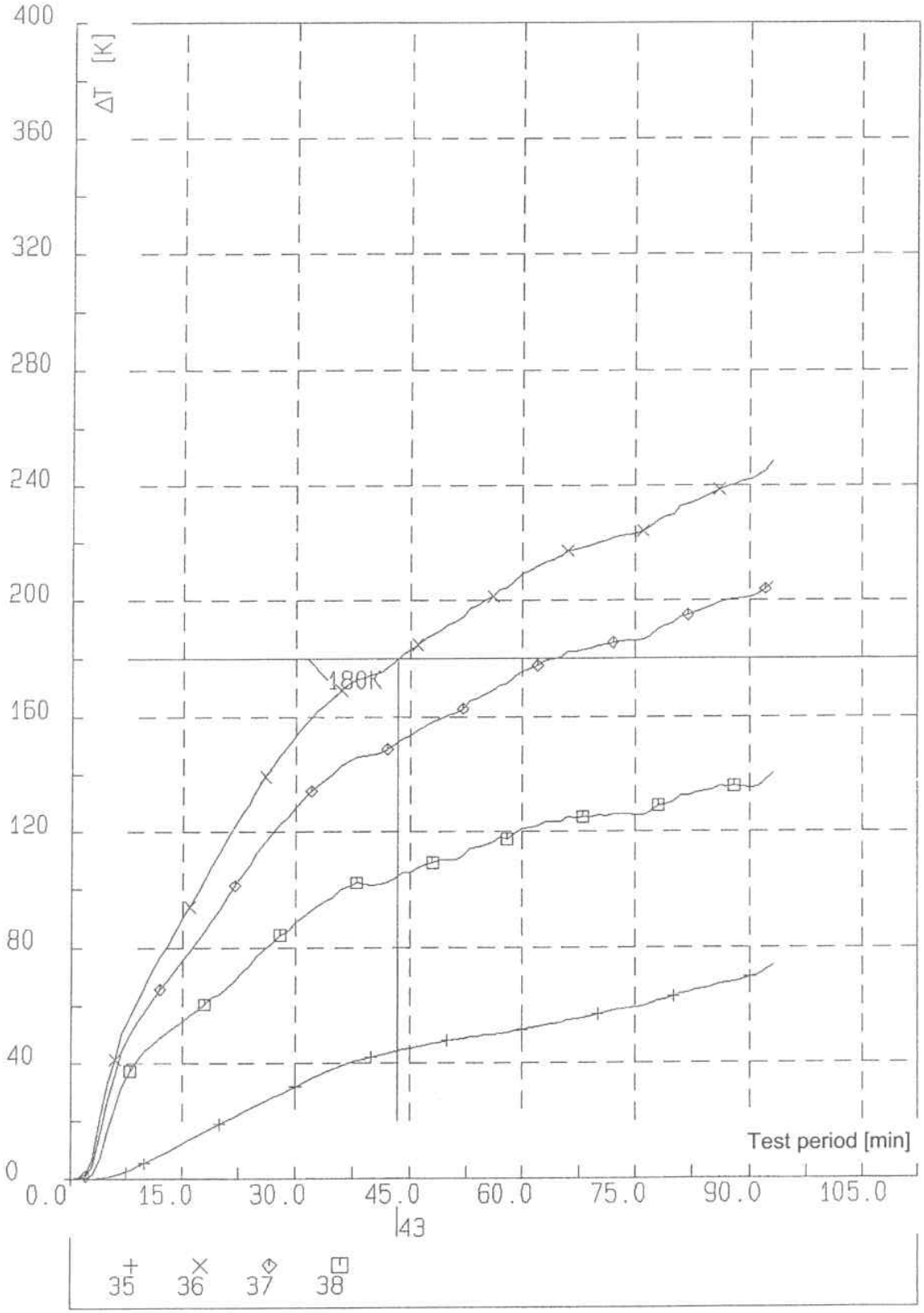
Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 2.10 of

Test Certificate

No. 3003/9939

Copper pipe, outside diameter d = 28 mm, pipe wall s = 1.0 mm thick



Specimen temperatures

Floor system D1 : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

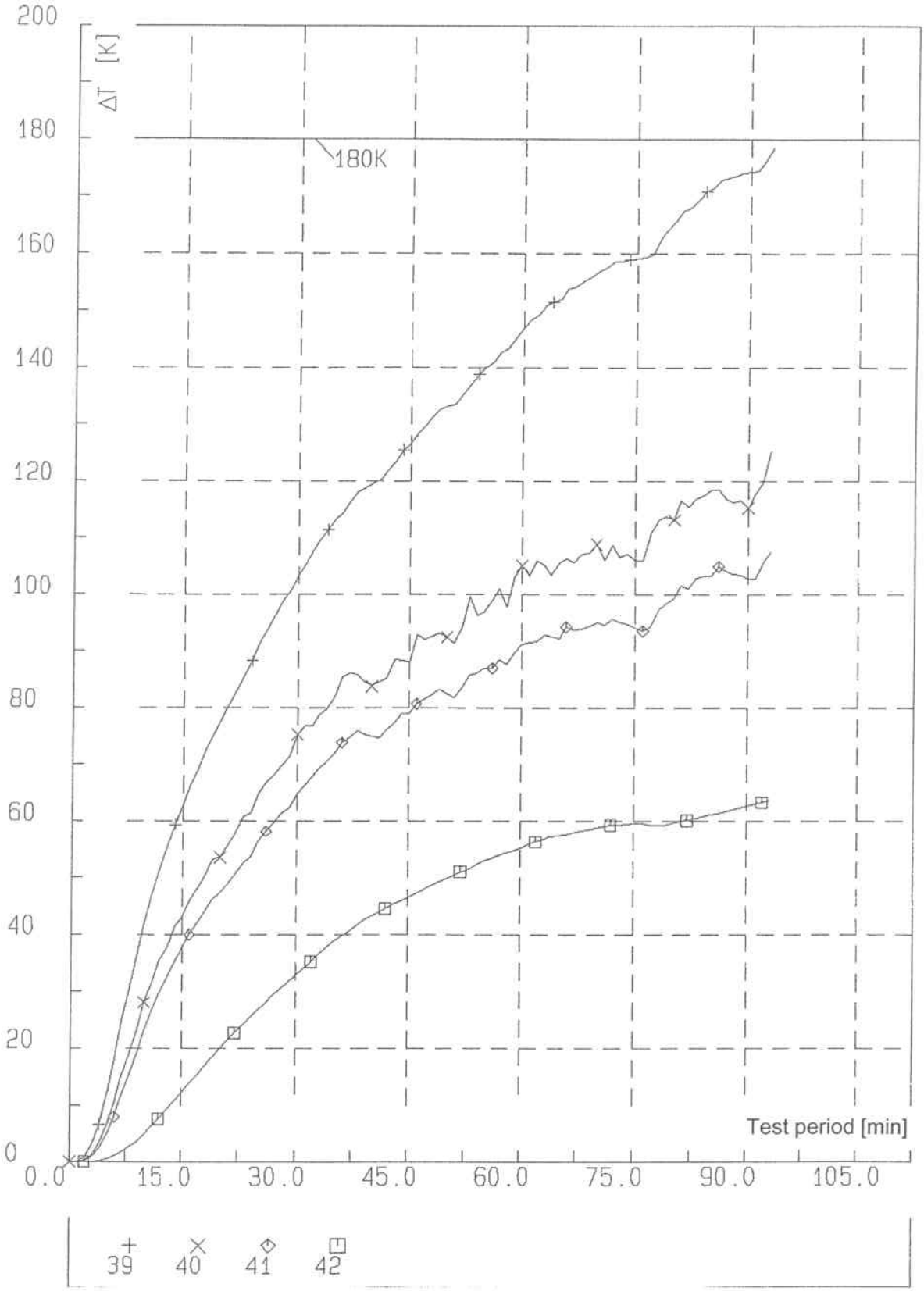
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 2.11 of

Test Certificate

No. 3003/9939

Copper pipe, outside diameter d = 18 mm, pipe wall s = 1.0 mm thick



Specimen temperatures

Floor system D1 : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

Institut für Baustoffe, Massivbau und Brandschutz

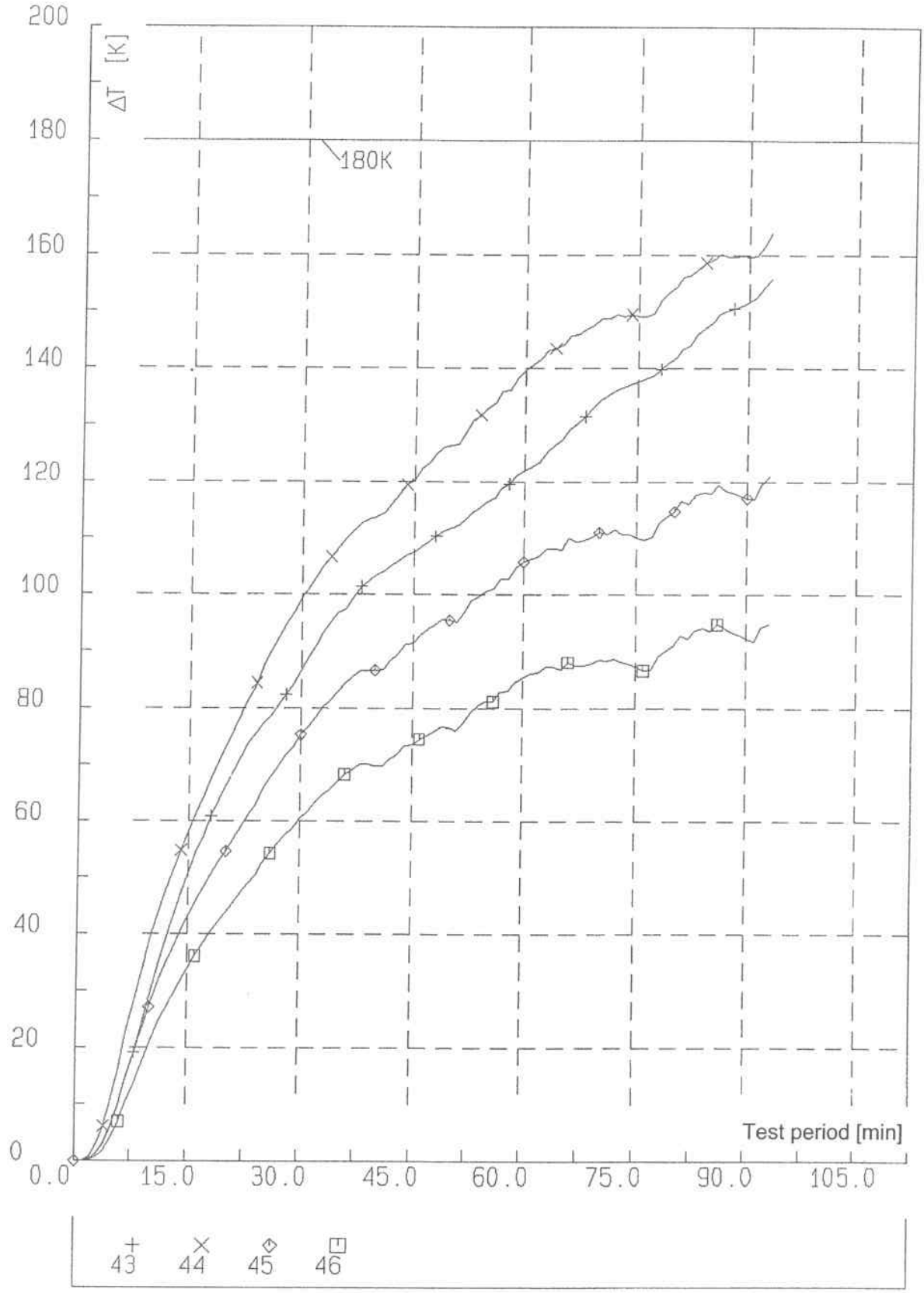
der Technischen Universität Braunschweig

Annex 2.12 of

Test Certificate

No. 3003/9939

Copper pipe, outside diameter d = 18 mm, pipe wall s = 1.0 mm thick



Specimen temperatures

Floor system D1 : "FEP Rechteckschott S 90"

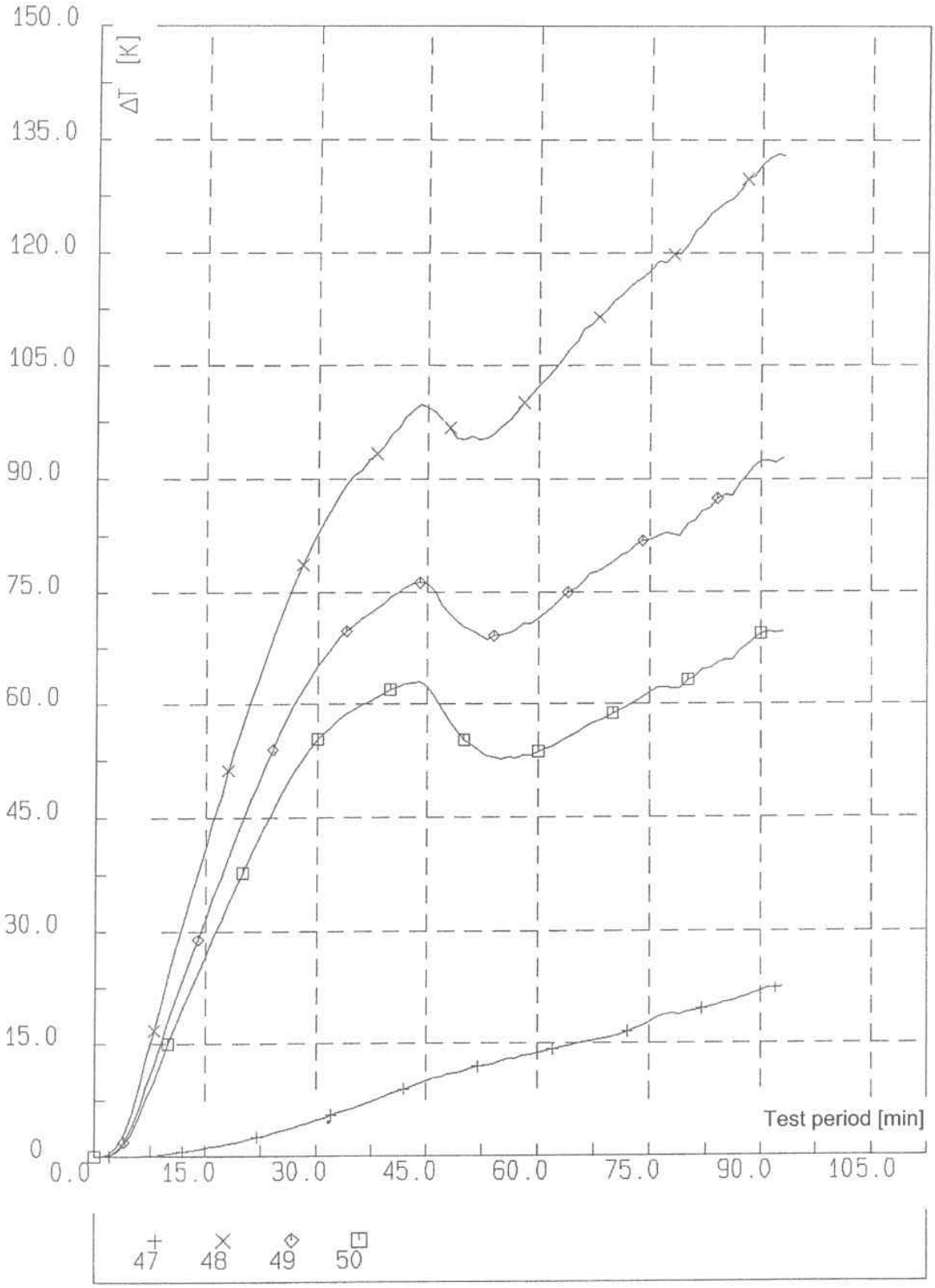
Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 2.13 of

Test Certificate

No. 3003/9939

Steel pipe, outside diameter d = 54 mm, pipe wall s = 1.5 mm thick



Specimen temperatures

Floor system D1 : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

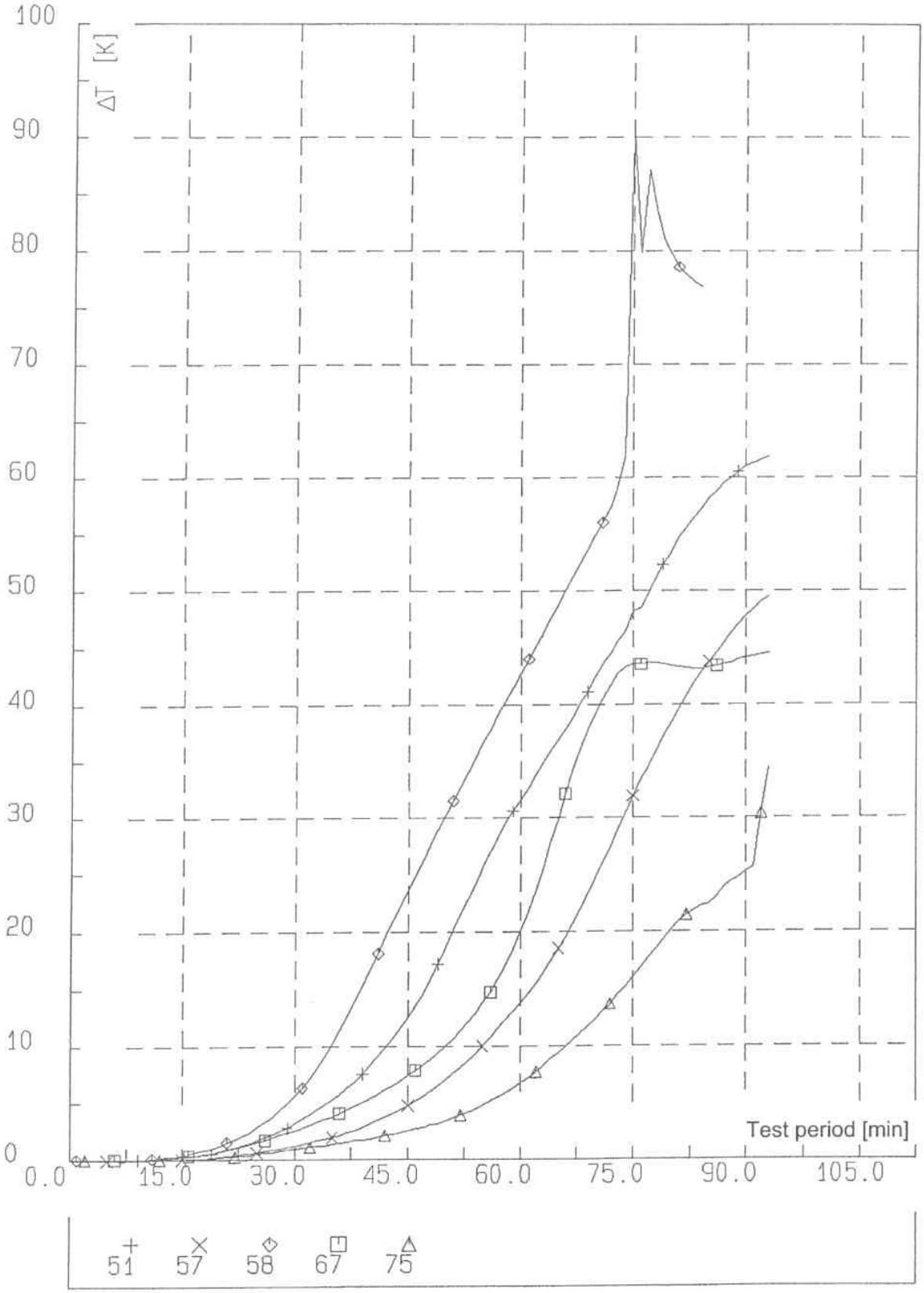
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 2.14 of

Test Certificate

No. 3003/9939

On the aerated-concrete floor



Specimen temperatures

Floor system D1 : "FEP Rundschott S 90"

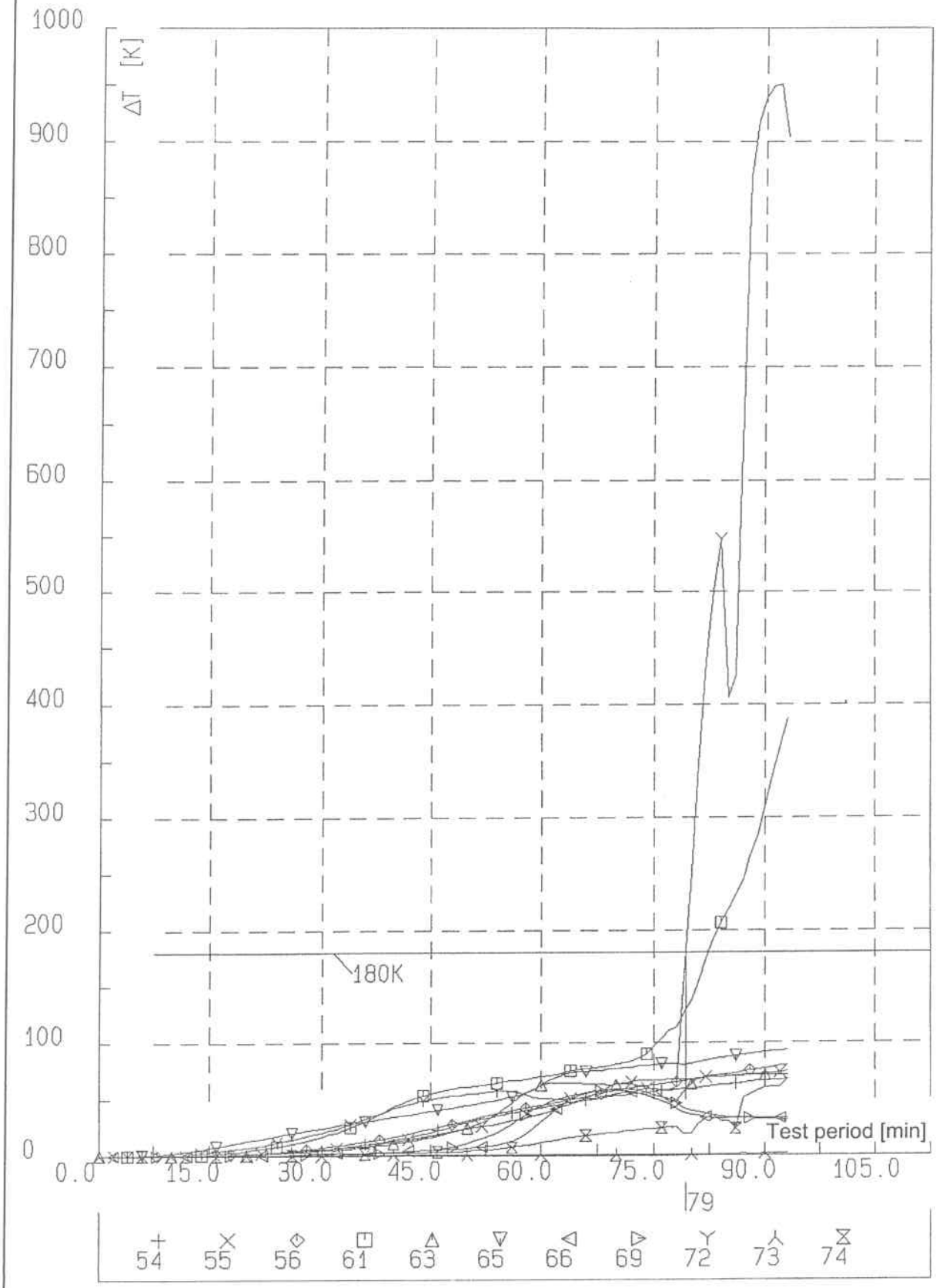
Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 2.15 of

Test Certificate

No. 3003/9939

On the seal



Specimen temperatures

Floor system D1 "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen

Institut für Baustoffe, Massivbau und Brandschutz

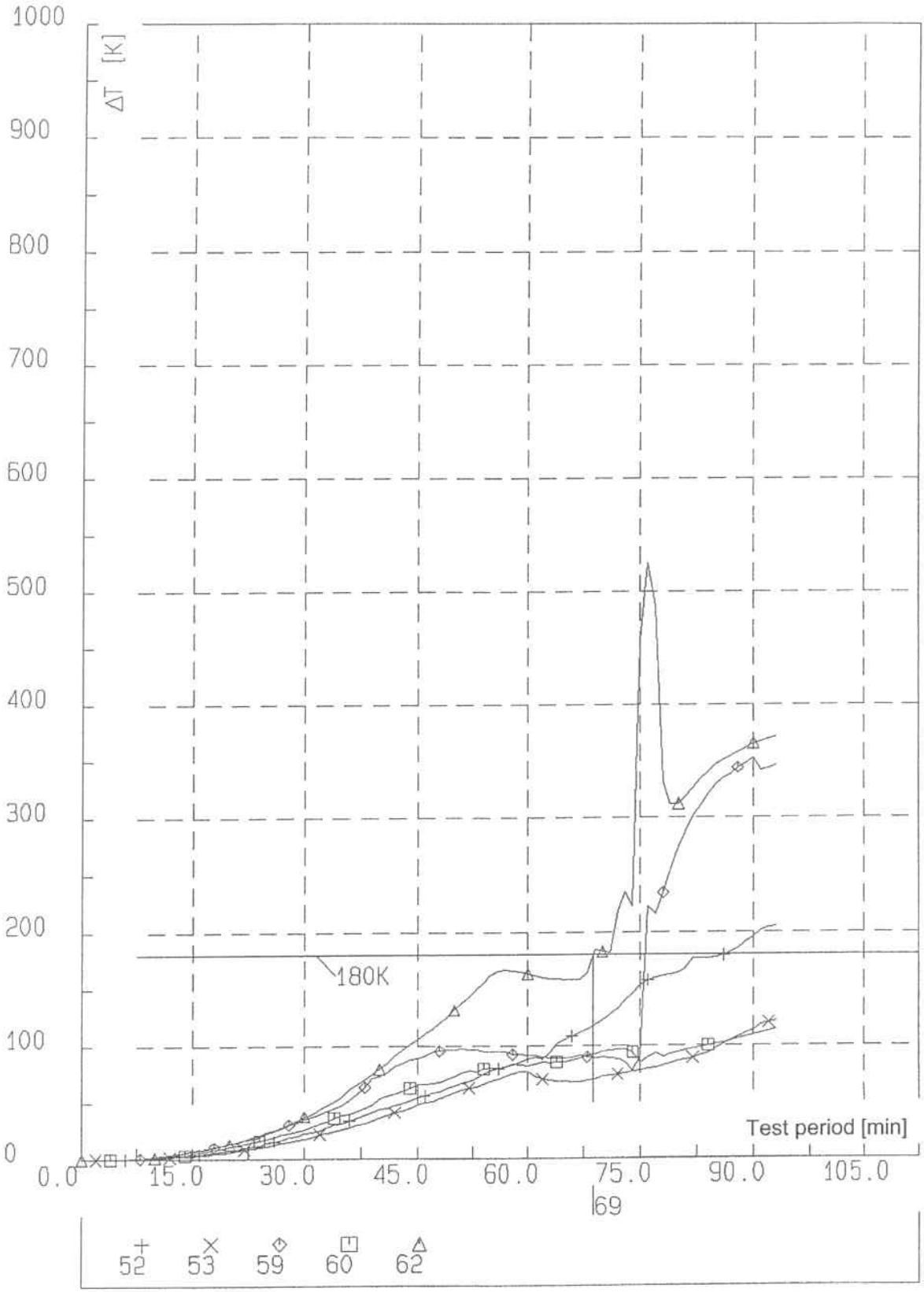
der Technischen Universität Braunschweig

Annex 2.16 of

Test Certificate

No. 3003/9939

On the cables



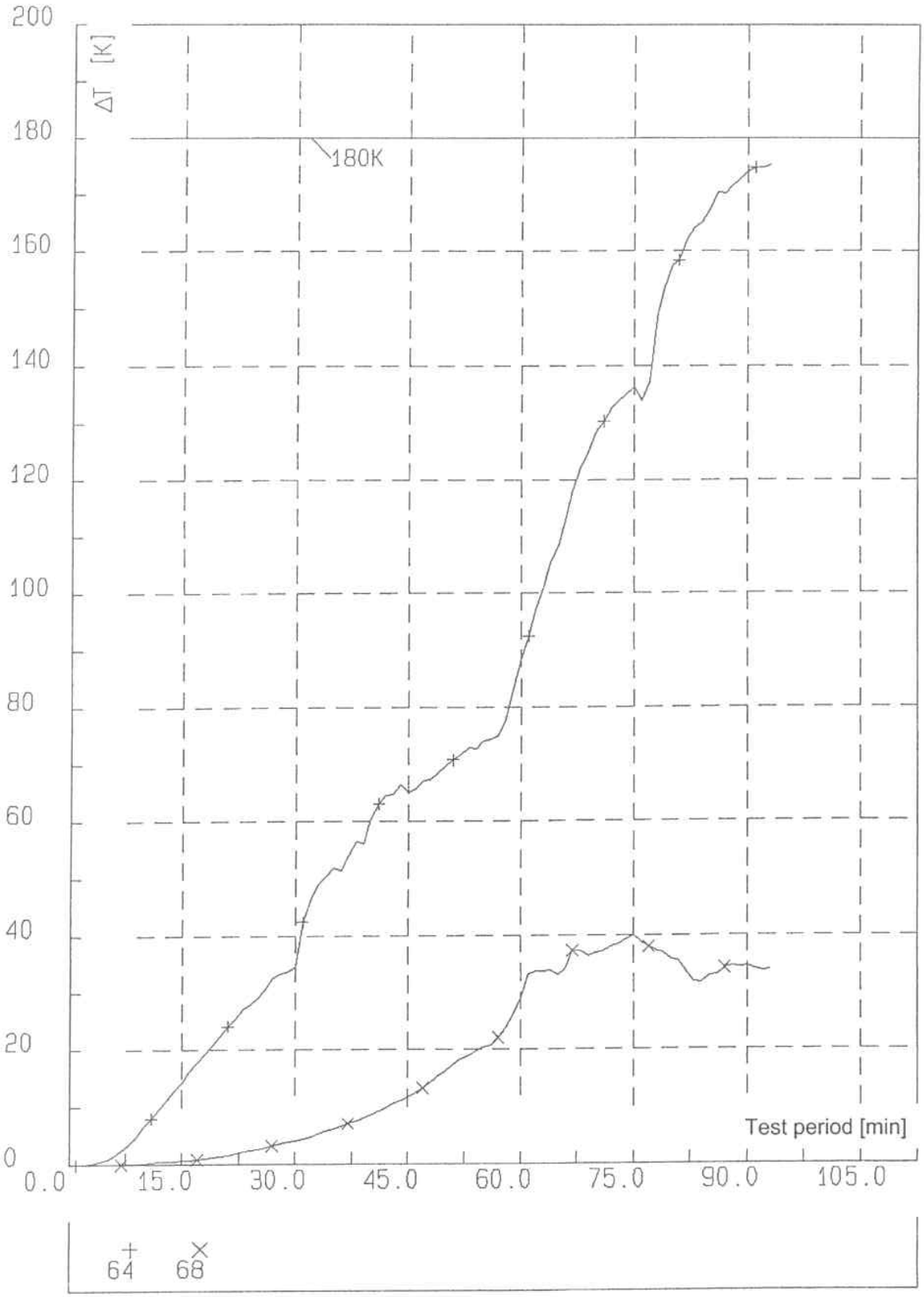
Specimen temperatures

Floor system D1 : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 2.17 of
Test Certificate
No. 3003/9939

On the control pipes



Specimen temperatures

Floor system D1 : "FEP Rundschott S 90"

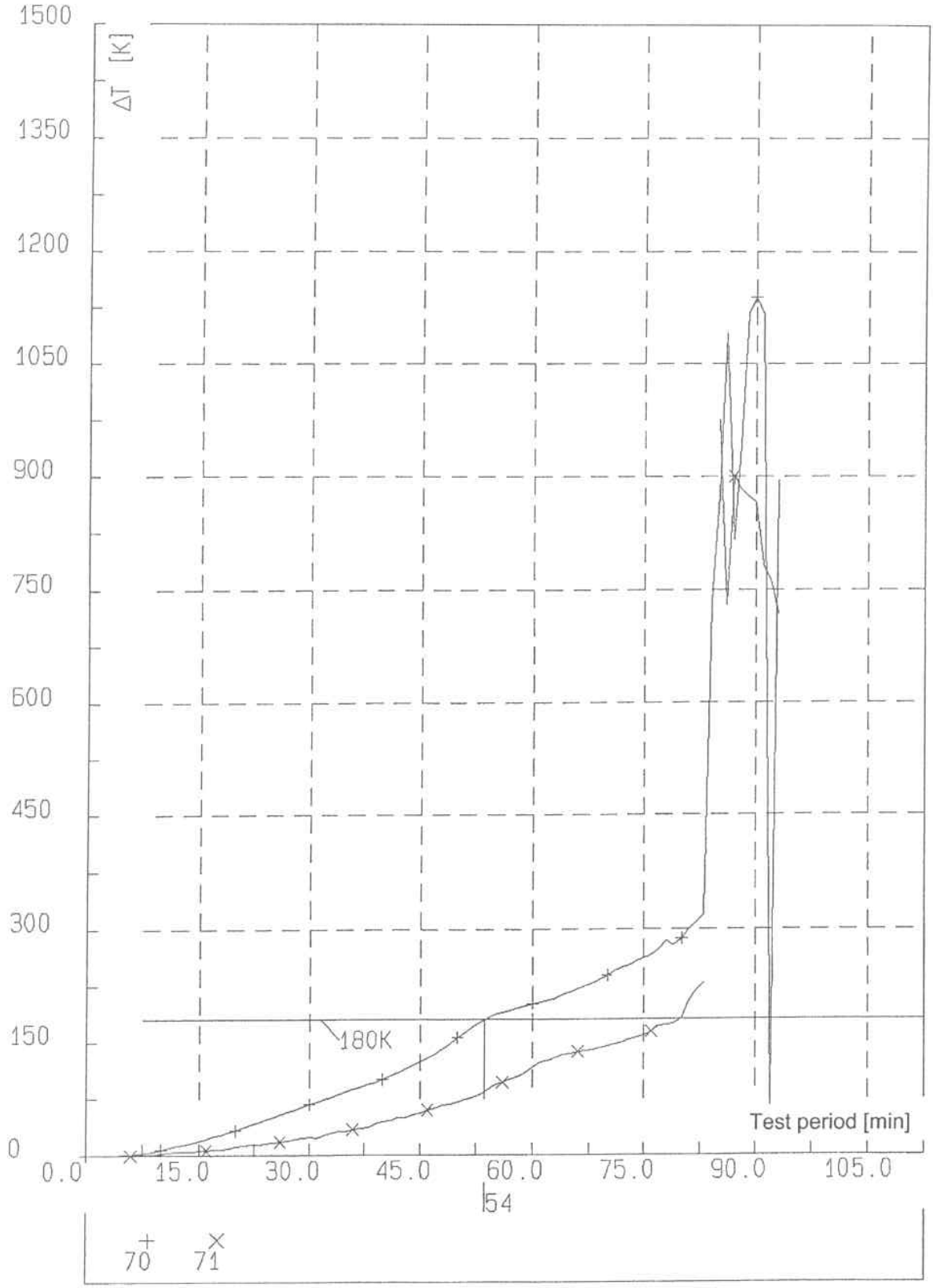
Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 2.18 of

Test Certificate

No. 3003/9939

On the cable bundle



Specimen temperatures

Floor system D1 : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen

Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

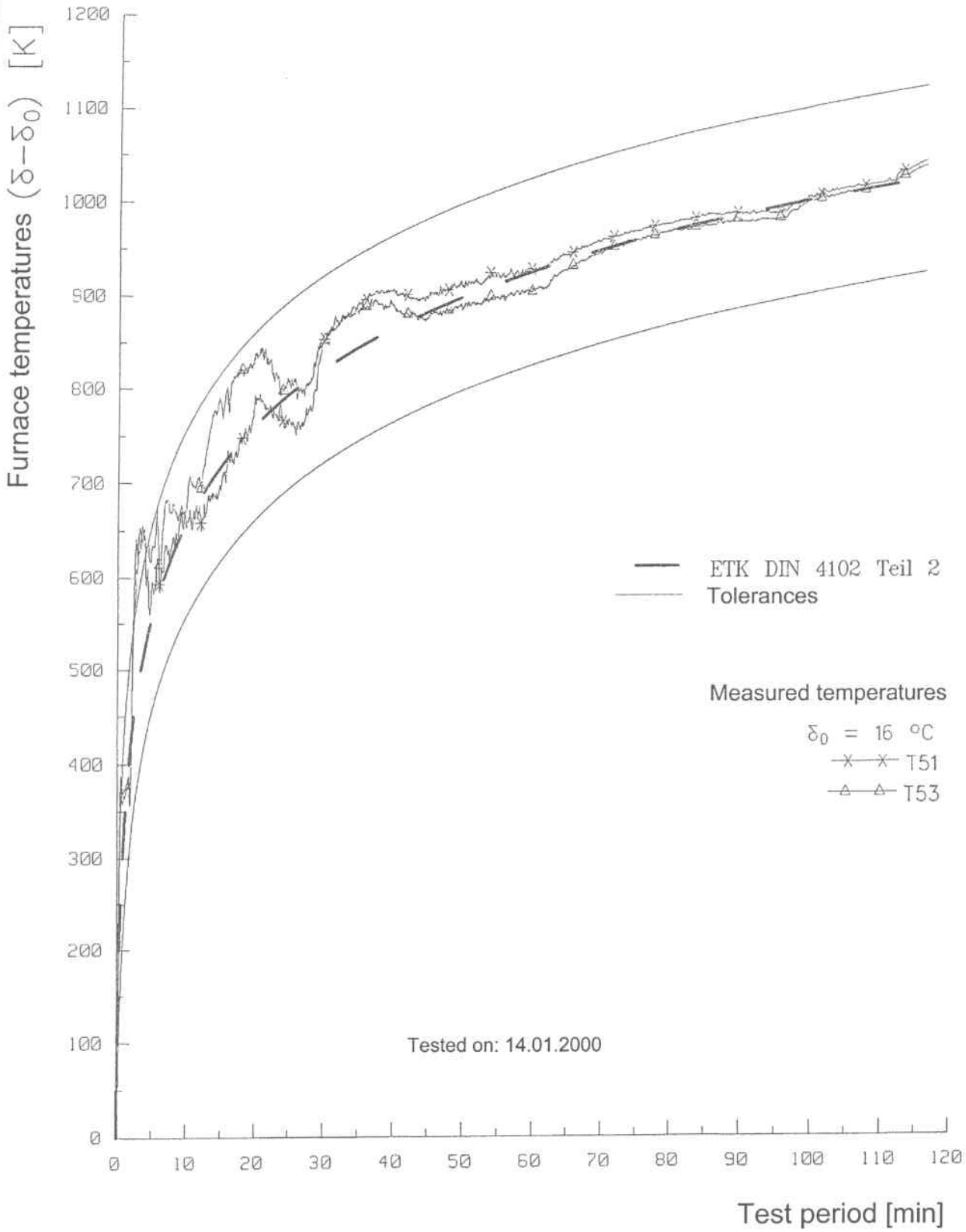
Annex 2.19 of

Test Certificate

No. 3003/9939

Test period (min)	Face *)	Observations during the fire test on 06-08-1999
2	F	Cable sheathes are softening; starting to burn.
3-18	F	The combustion products thus products are obstructing the view into the furnace.
23	A	Rectangular seal "FEP Rechteck-Kabelschott S 90" : Some water is emerging on the seal surface in the region of cable tray KWL 500/60/FS.
30	A	Rectangular seal "FEP Rechteck-Kabelschott S 90" : Maximum temperature measured with the roving element on the copper pipe (outer pipe diameter d = 28 mm) is 150°C.
35	A	Rectangular seal "FEP Rechteck-Kabelschott S 90" : Some water is emerging on the seal surface at three points in the region of the cable bundle of cable tray KWL 500/60/FS.
40	A	Rectangular seal "FEP Rechteck-Kabelschott S 90" : The water emerged on the seal surface in the region of cable tray KWL 500/60/FS has evaporated.
41	A	Rectangular seal "FEP Rechteck-Kabelschott S 90" : The maximum temperature measured with the roving element on the copper pipe (outer pipe diameter d = 28 mm) is 175°C.
52	A	Circular seal "FEP Rund-Kabelschott S 90" ∅ 210 : The cable sheaths are bulging in the cable-bundle to seal-surface region. The fixed measuring points have forced their way into the cable sheaths.
56	A	Rectangular seal "FEP Rechteck-Kabelschott S 90" - cable tray KWL 500/60/FS : The cable sheaths are bulging in the cable-bundle to seal-surface region.
60	A	Circular seal "FEP Rund-Kabelschott S 90" ∅ 210 : The cable sheaths of the "b" and "g" cables are bulging in the cable to seal-surface region.
61	A	Circular seal "FEP Rund-Kabelschott S 90" ∅ 105 : The cable sheaths of the "c" cables are softening in the cable to seal-surface region.
63	A	Rectangular seal "FEP Rechteck-Kabelschott S 90" – wide-span cable trays 80/300/FS : The cable sheaths of the "a", "b" and "g" cables are softening in the cable to seal-surface region.
74	A	Circular seal "FEP Rund-Kabelschott S 90" ∅ 210 : The temperature measured with the roving element on the cable sheaths of the cable bundle is 191°C.
75	A	Circular seal "FEP Rund-Kabelschott S 90" ∅ 210 : Fire is emerging in the region of the "b" and "g" cables ⇒ The circular seal is closed.
76	A	Circular seal "FEP Rund-Kabelschott S 90" ∅ 210 : Fire is emerging in the region of the cable bundle ⇒ The circular seal is closed.
93	A	End of fire exposure.

*) F = fire-exposed face
A = non-exposed face



Furnace temperatures
Floor system D 2 (Test 3)

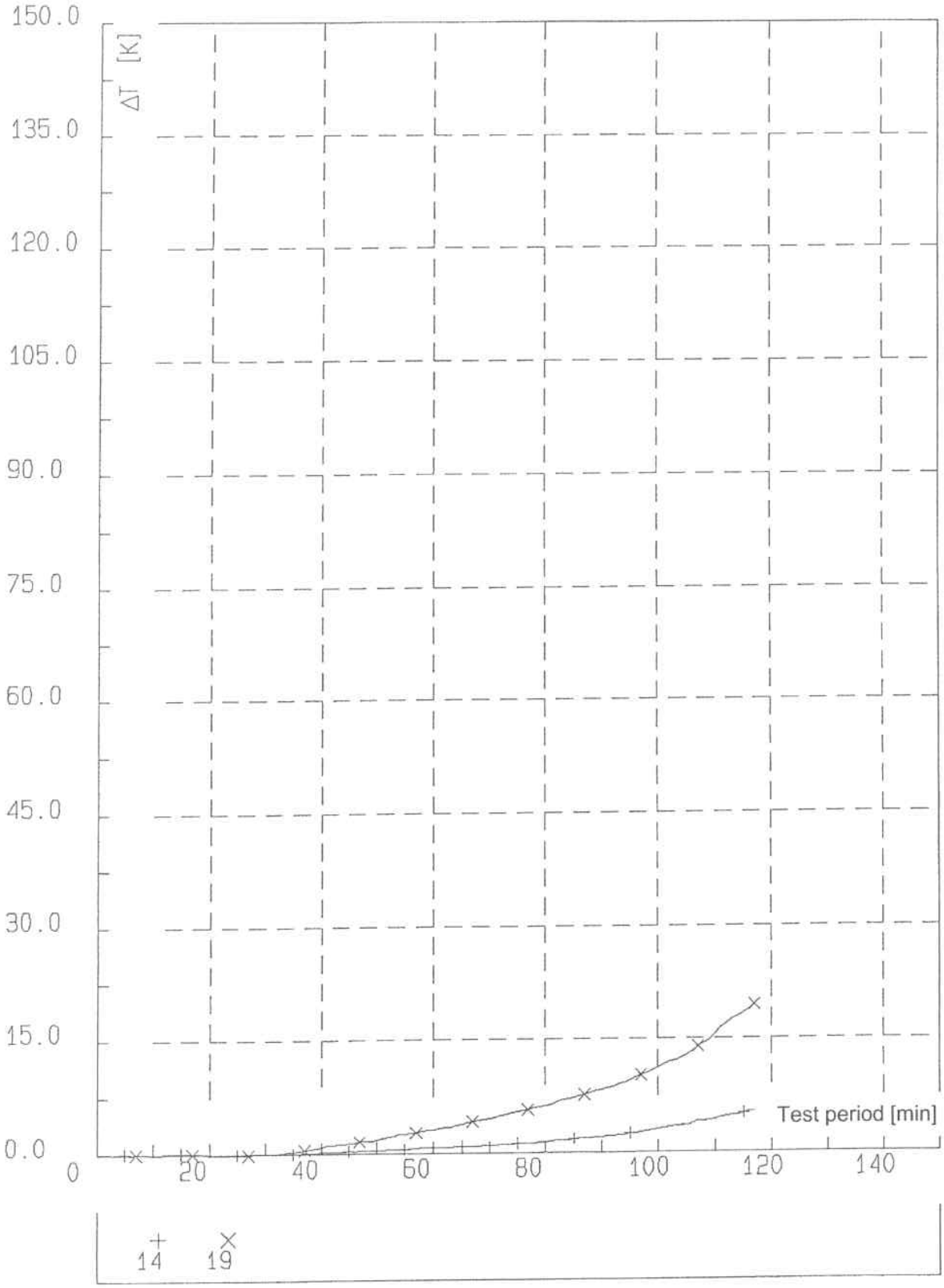
Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 3.1 of

Test Certificate

No. 3003/9939

On the aerated-concrete floor



Specimen temperatures

Floor system D2 : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

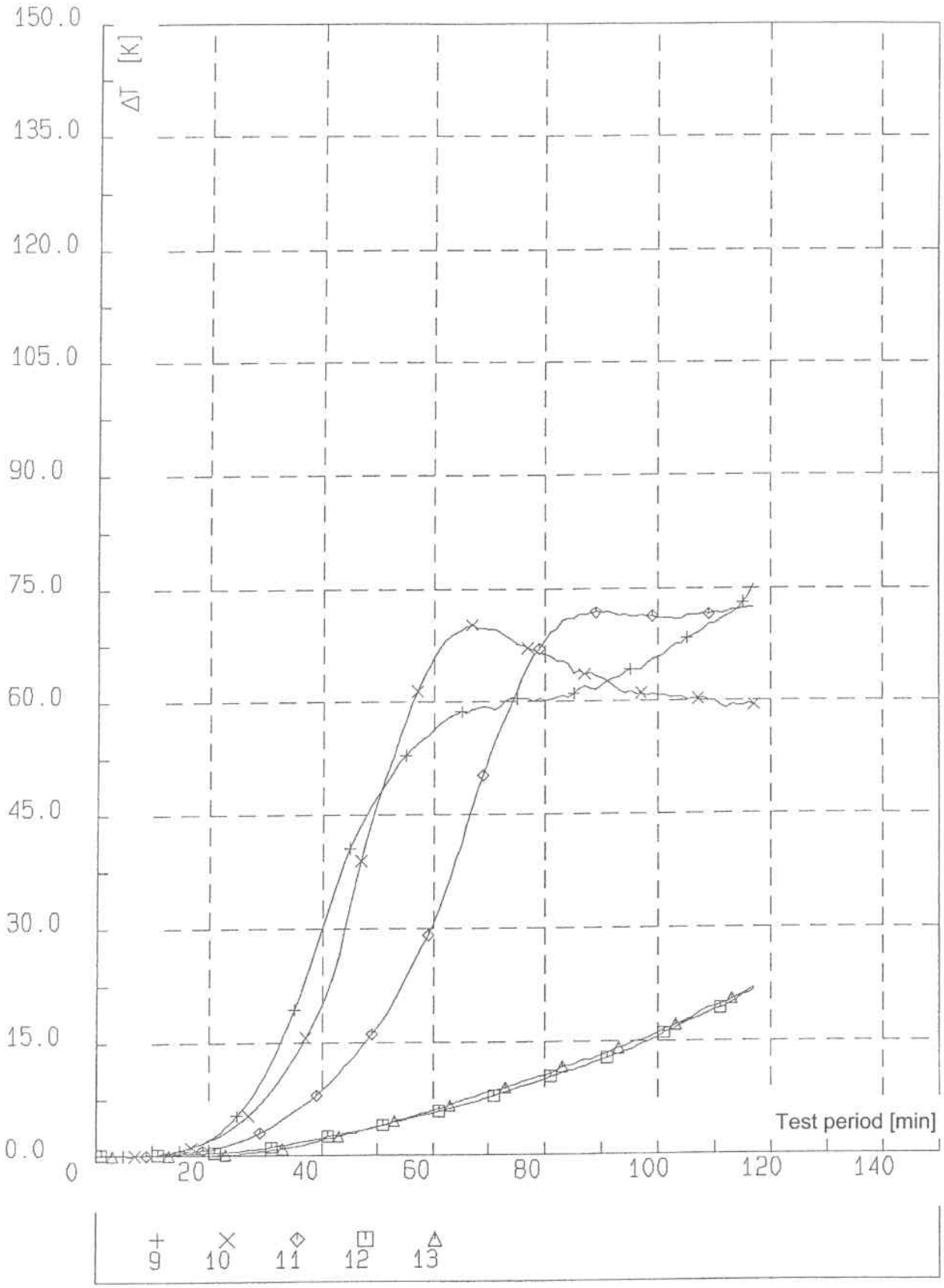
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 3.2 of

Test Certificate

No. 3003/9939

On the seal



Specimen temperatures

Floor system D2 : "FEP Rechteckschott S 90"

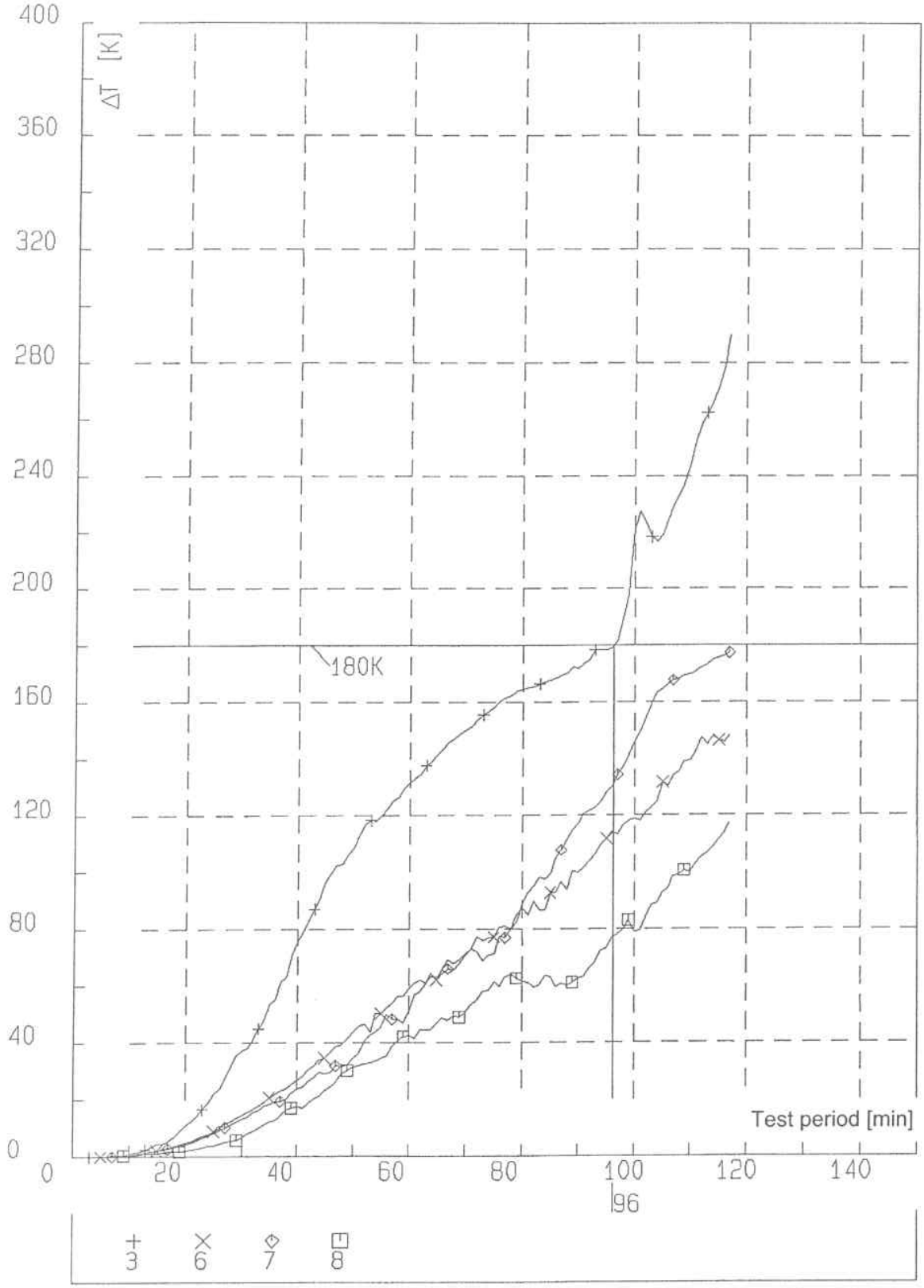
Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 3.3 of

Test Certificate

No. 3003/9939

On the cables of the wide-span cable rack 80/500/FS



Specimen temperatures

Floor system D2 : "FEP Rechteckschott S 90"

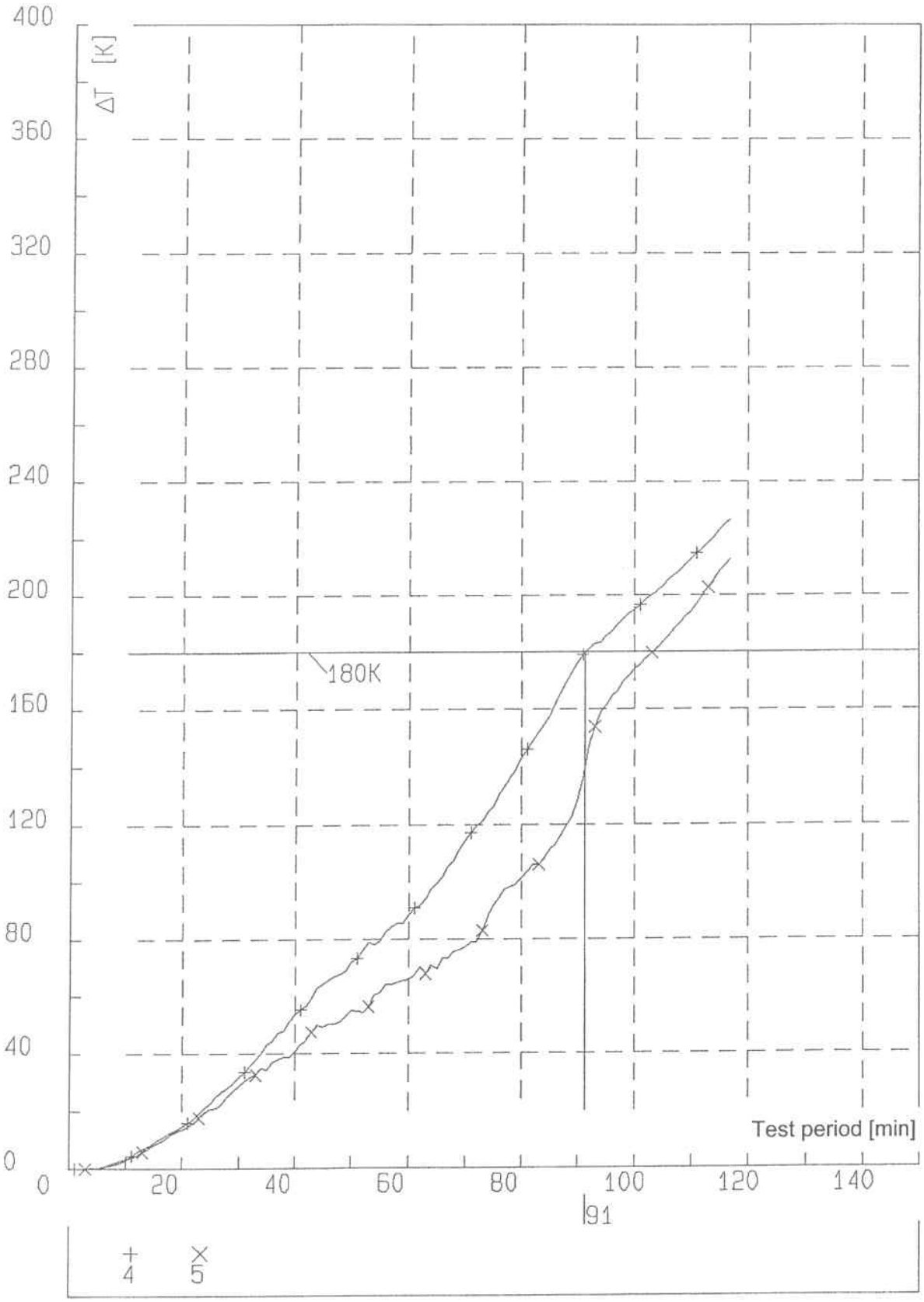
Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 3.4 of

Test Certificate

No. 3003/9939

On the cable bundle of the wide-span cable rack 80/300/FS



Specimen temperatures

Floor system D2 : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

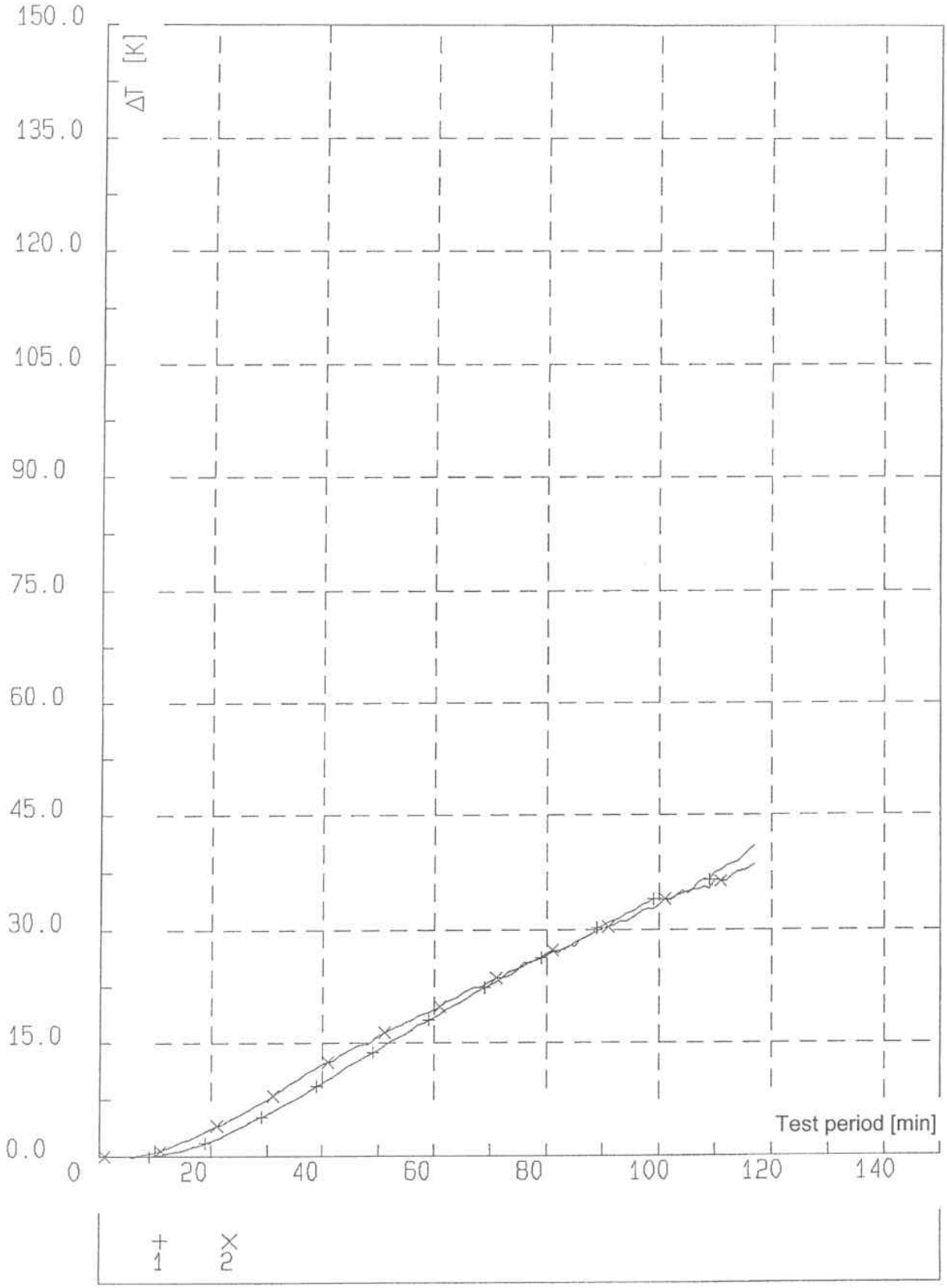
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 3.5 of

Test Certificate

No. 3003/9939

On the wide-span cable rack 80/500/FS and cable tray KWL 300/60/FS



Specimen temperatures

Floor system D2 : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

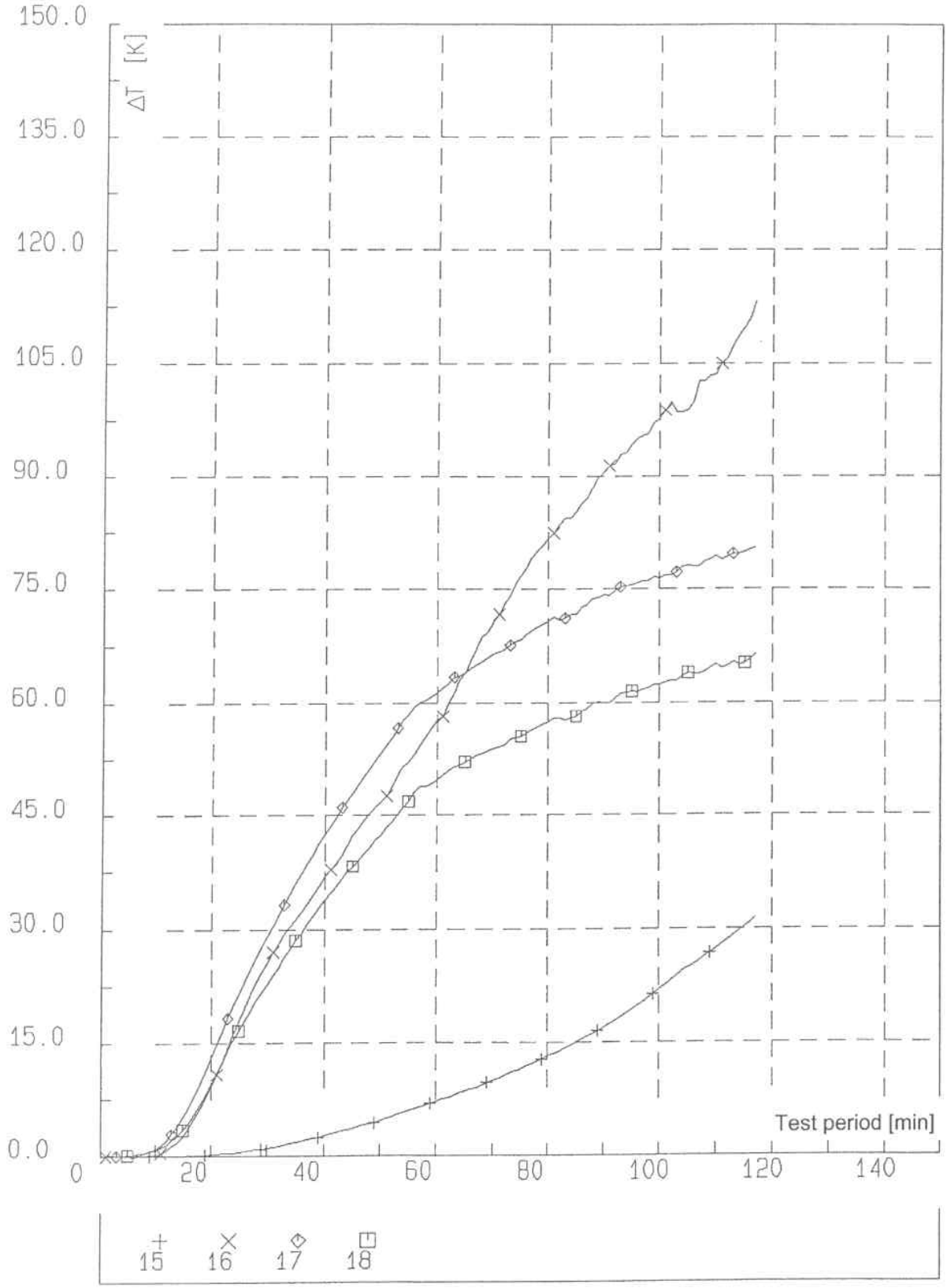
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 3.6 of

Test Certificate

No. 3003/9939

Copper pipe, outside diameter d = 28 mm, pipe wall s = 1.0 mm thick



Specimen temperatures

Floor system D2 : "FEP Rechteckschott S 90"

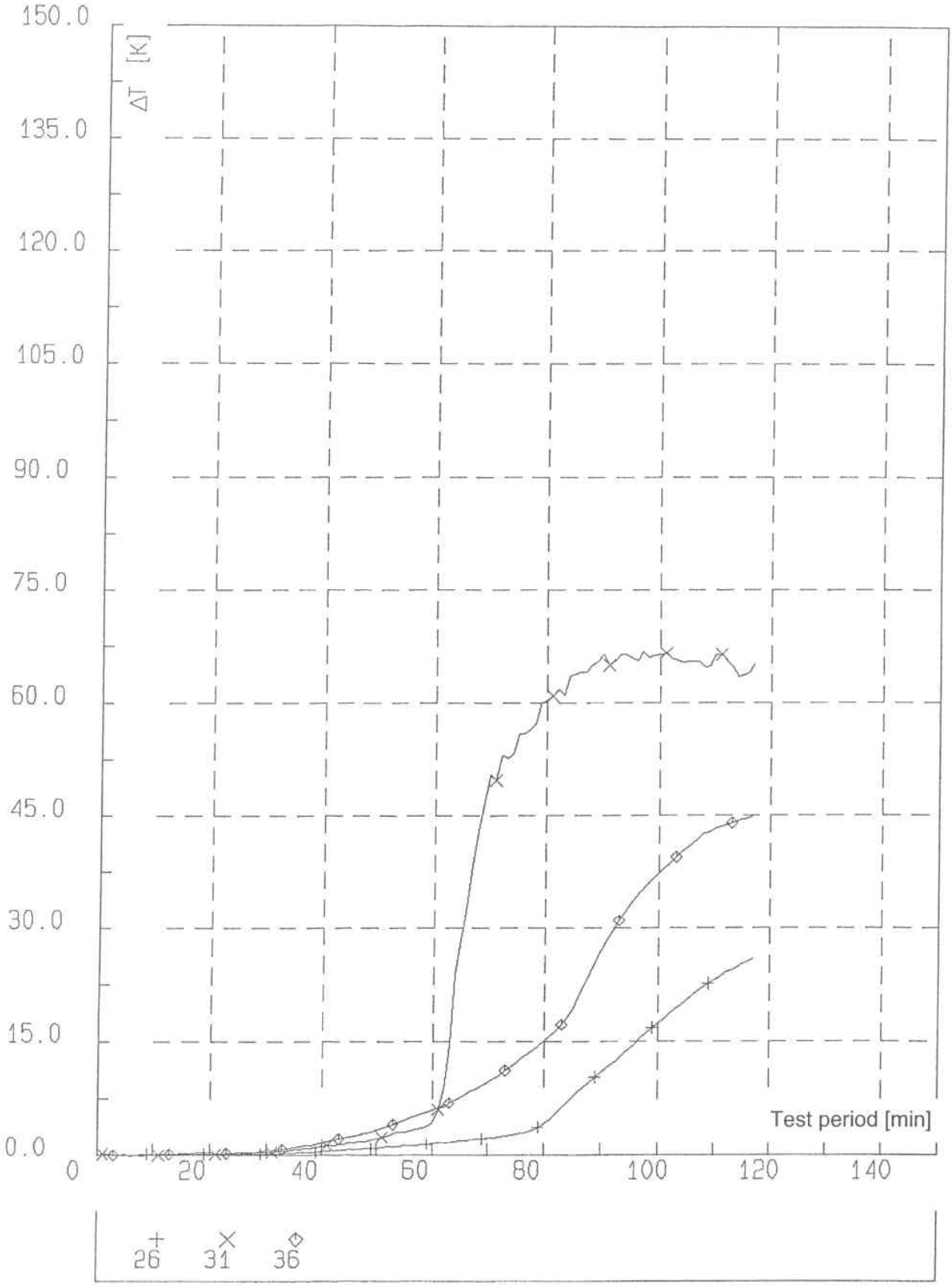
Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 3.7 of

Test Certificate

No. 3003/9939

On the aerated-concrete floor



Specimen temperatures

Floor system D2 : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen

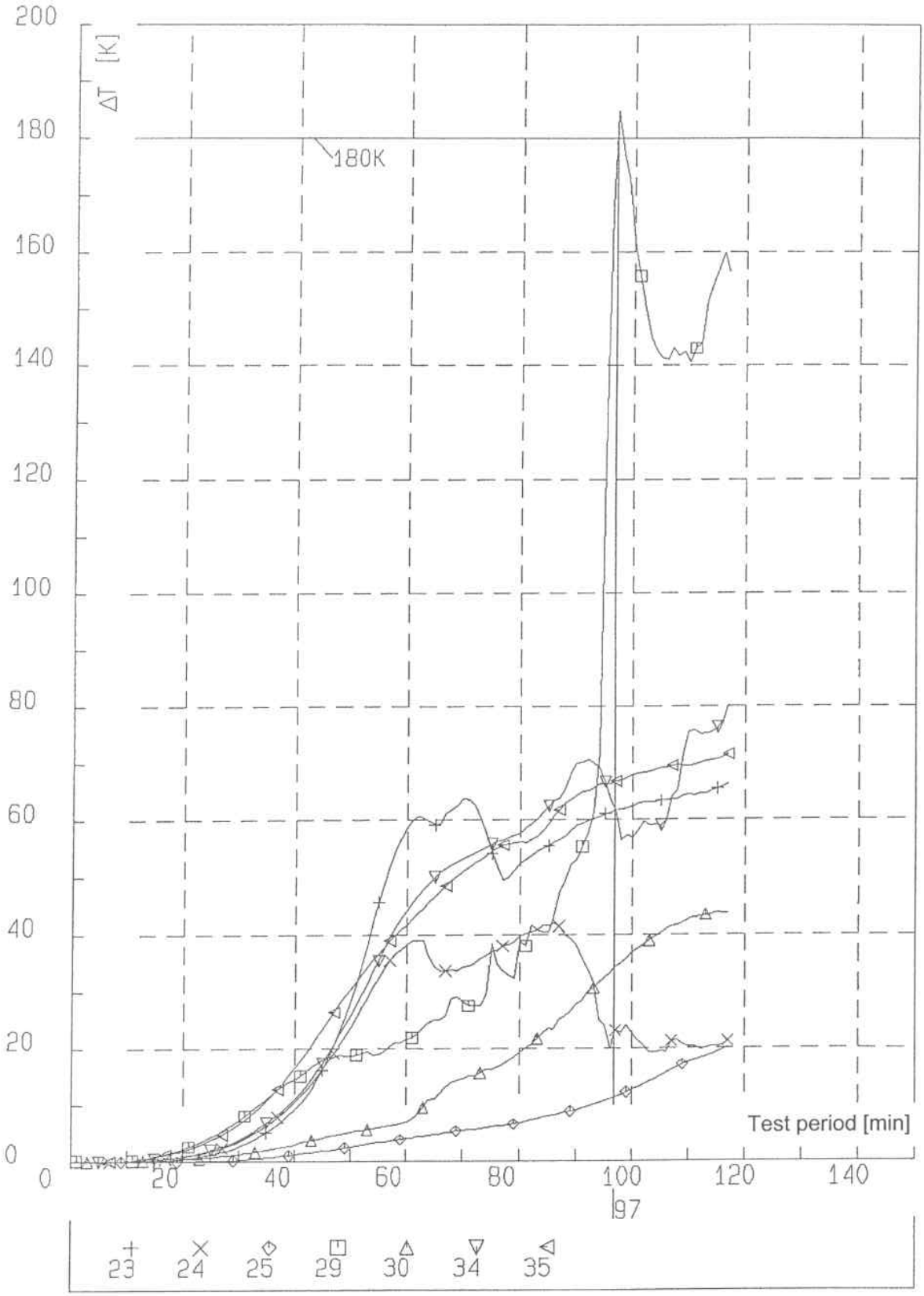
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 3.8 of

Test Certificate

No. 3003/9939

On the seal



Specimen temperatures

Floor system D2 : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen

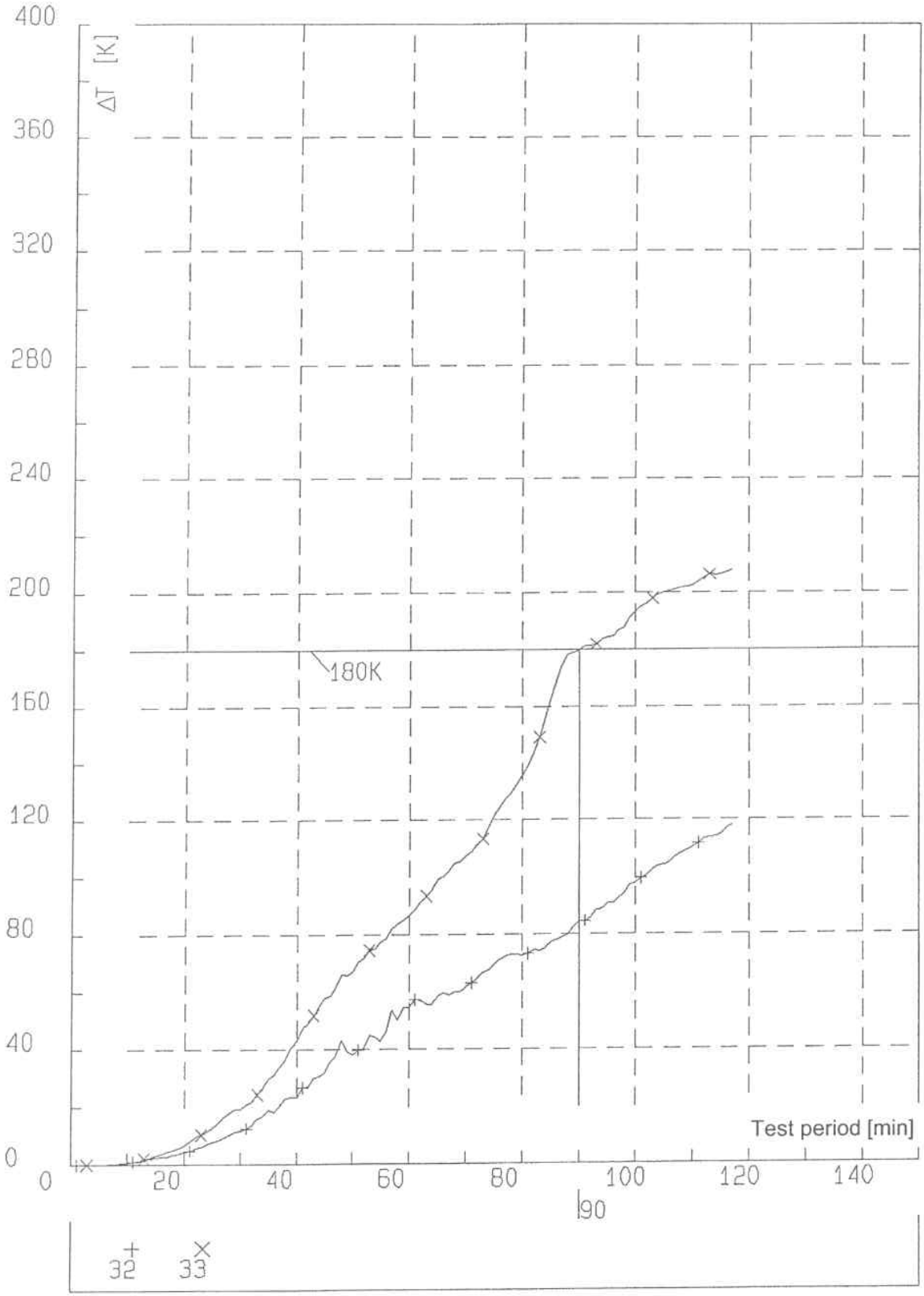
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 3.9 of

Test Certificate

No. 3003/9939

On the cables of circular seal ∅ 105



Specimen temperatures

Floor system D2 : "FEP Rundschott S 90"

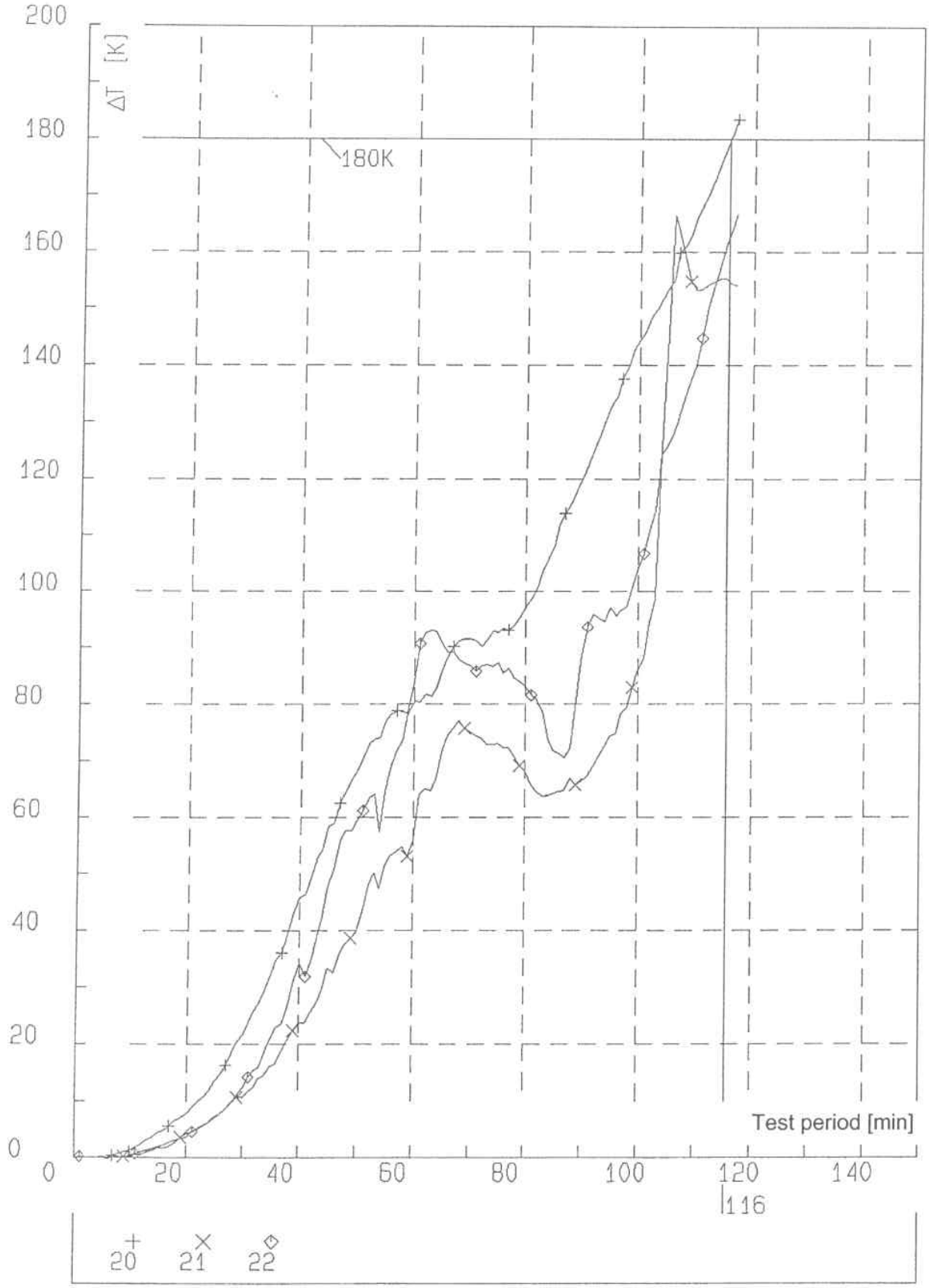
Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 3.10 of

Test Certificate

No. 3003/9939

On the cables of circular seal ∅ 210



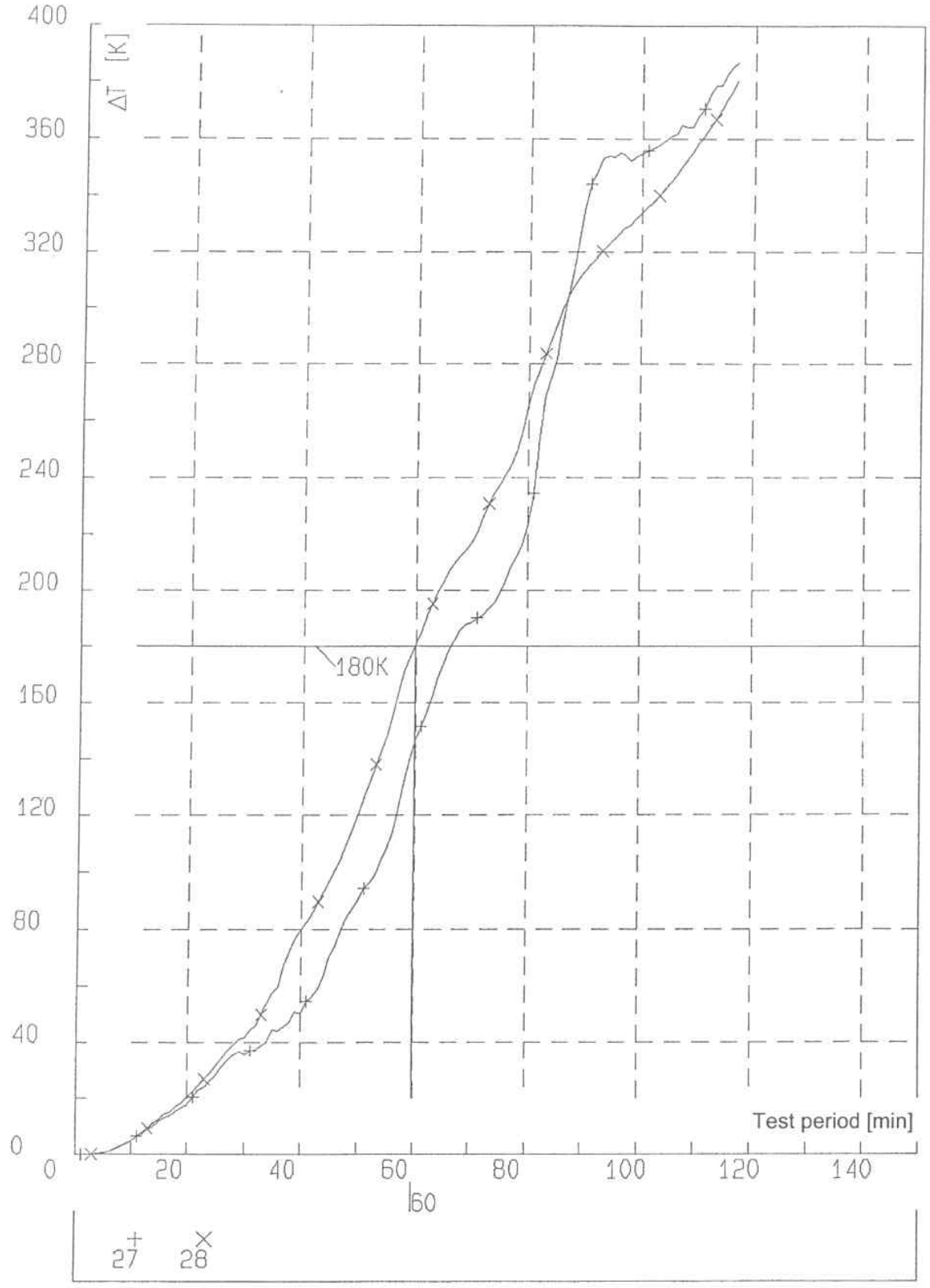
Specimen temperatures

Floor system D2 : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 3.11 of
Test Certificate
No. 3003/9939

On the cable bundle of circular seal ∅ 210



Specimen temperatures

Floor system D2 : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 3.12 of

Test Certificate

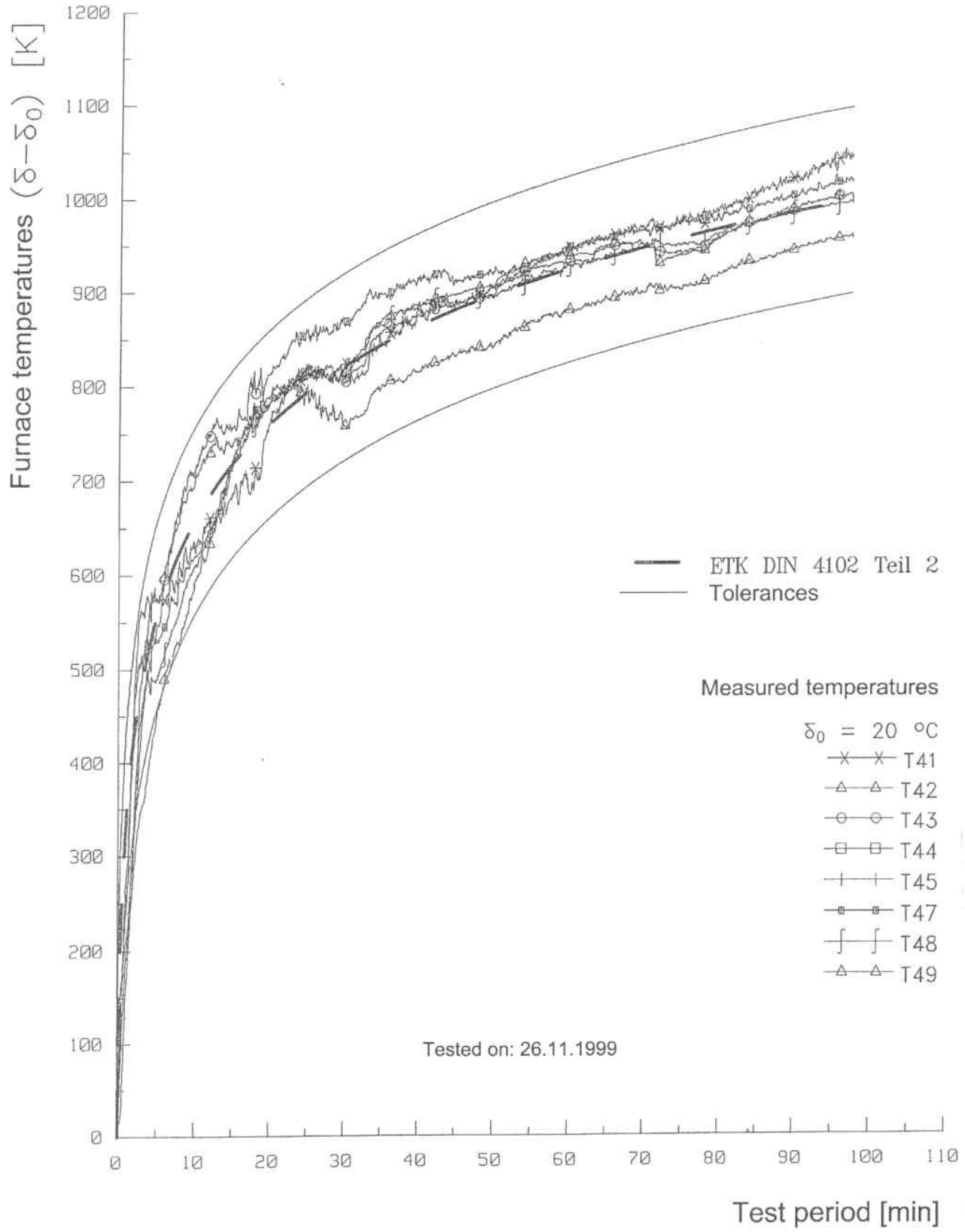
No. 3003/9939

Test period (min)	Face *)	Observations during the fire test on 14-01-2000
2	F	Cable sheathes are softening; starting to burn.
3	F	Rectangular seal "FEP Rechteck-Kabelschott S 90" : The intumescent insulation of the copper pipe has expanded and has turned black.
5-13	F	The combustion products thus products are obstructing the view into the furnace.
15	A	Rectangular seal "FEP Rechteck-Kabelschott S 90" : At some points, the galvanized coat of the cable trays is turning slightly white.
43	F	Rectangular seal "FEP Rechteck-Kabelschott S 90" : In the region of its glued ends, the insulation layer of the copper pipe has torn apart completely, i.e. along the entire length of 400 mm.
46	F	Circular seal "FEP Rund-Kabelschott S 90" : The cable sheaths of all cables have burnt.
53	A	Rectangular seal "FEP Rechteck-Kabelschott S 90" : In the region of its glued ends, the insulation layer of the 200-mm copper pipe has torn apart above the seal surface; only the bottom half of the insulation (200mm long) is still intact.
55	A	Circular seal "FEP Rund-Kabelschott S 90" ∅ 210 : The cable sheaths are bulging in the cable-bundle to seal-surface region. The fixed measuring points have forced their way into the cable sheaths.
60	A	Circular seal "FEP Rund-Kabelschott S 90" ∅ 210 : Some smoke is emerging in the cable-bundle to seal-surface region.
65	A	Circular seal "FEP Rund-Kabelschott S 90" ∅ 210 : The maximum temperature measured with the roving element on the cable sheaths is 80°C.
70	A	Rectangular seal "FEP Rechteck-Kabelschott S 90" : The cable sheaths of the "b" and "c" cables and of the cable bundle are bulging in the cable to seal-surface and in the cable-bundle to seal-surface regions.
75	A	Rectangular seal "FEP Rechteck-Kabelschott S 90" : The maximum temperature measured with the roving element on the unprotected pipe at a distance of 200 mm from the seal surface is 110°C.
77	A	Circular seal "FEP Rund-Kabelschott S 90"-Rundschott ∅ 210 : The cable sheaths of some of the cable bundle cables have torn open for about 1-2 mm.
80	A	Circular seal "FEP Rund-Kabelschott S 90"-Rundschott ∅ 210 : The maximum temperature measured with the roving element on the cable sheaths is 100°C.

*) F = fire-exposed face
A = non-exposed face

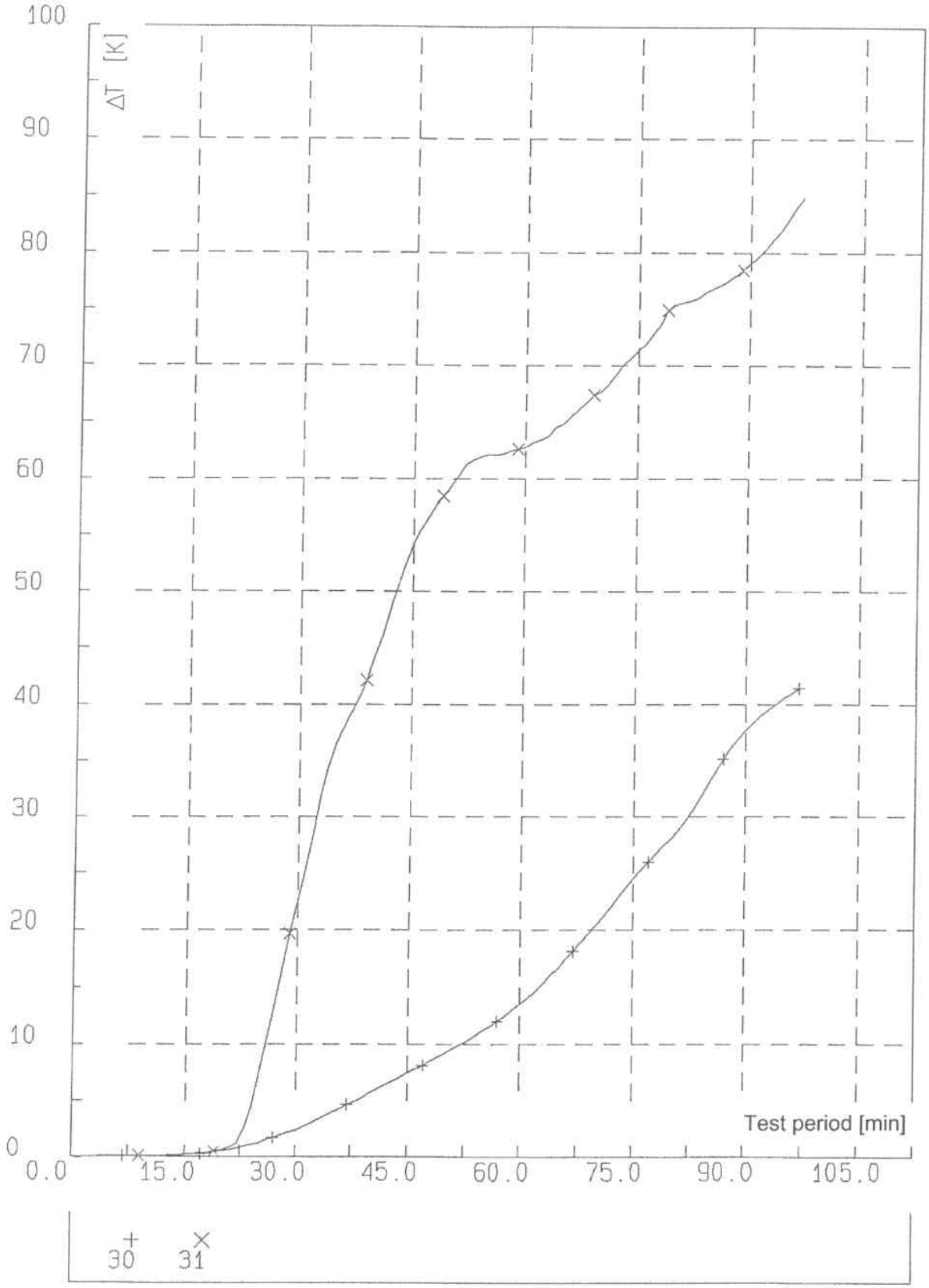
Test period (min)	Face *)	Observations during the fire test on 14-01-2000 (continued)
83	A	Rectangular seal "FEP Rechteck-Kabelschott S 90" : The maximum temperature measured with the roving element on the unprotected pipe at a distance of 200 mm from the seal surface is 120°C.
85	A	Circular seal "FEP Rund-Kabelschott S 90" ∅ 210 : The maximum temperature measured with the roving element on the cable sheaths is 180°C.
86	A	Circular seal "FEP Rund-Kabelschott S 90" ∅ 210 : The maximum temperature measured with the roving element on the cable sheaths is 230°C.
90	A	Rectangular seal "FEP Rechteck-Kabelschott S 90" : The maximum temperature measured with the roving element on the unprotected pipe at a distance of 200 mm from the seal surface is 140°C.
100	A	Rectangular seal "FEP Rechteck-Kabelschott S 90" : The maximum temperature measured with the roving element on the unprotected pipe at a distance of 200 mm from the seal surface is 158°C.
110	A	Rectangular seal "FEP Rechteck-Kabelschott S 90" : The maximum temperature measured with the roving element on the unprotected pipe at a distance of 200 mm from the seal surface is 165°C.
116	A	Rectangular seal "FEP Rechteck-Kabelschott S 90" : The maximum temperature measured with the roving element on the unprotected pipe at a distance of 200 mm from the seal surface is 175°C.
117	A	End of fire exposure.

*) F = fire-exposed face
A = non-exposed face



Furnace temperatures **Wall test (Test 2)**	Annex 4.1 of Test Certificate No. 3003/9939
Materialprüfanstalt für das Bauwesen Institut für Baustoffe, Massivbau und Brandschutz der Technischen Universität Braunschweig	

On the extra layer



Specimen temperatures

Flexible wall construction : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

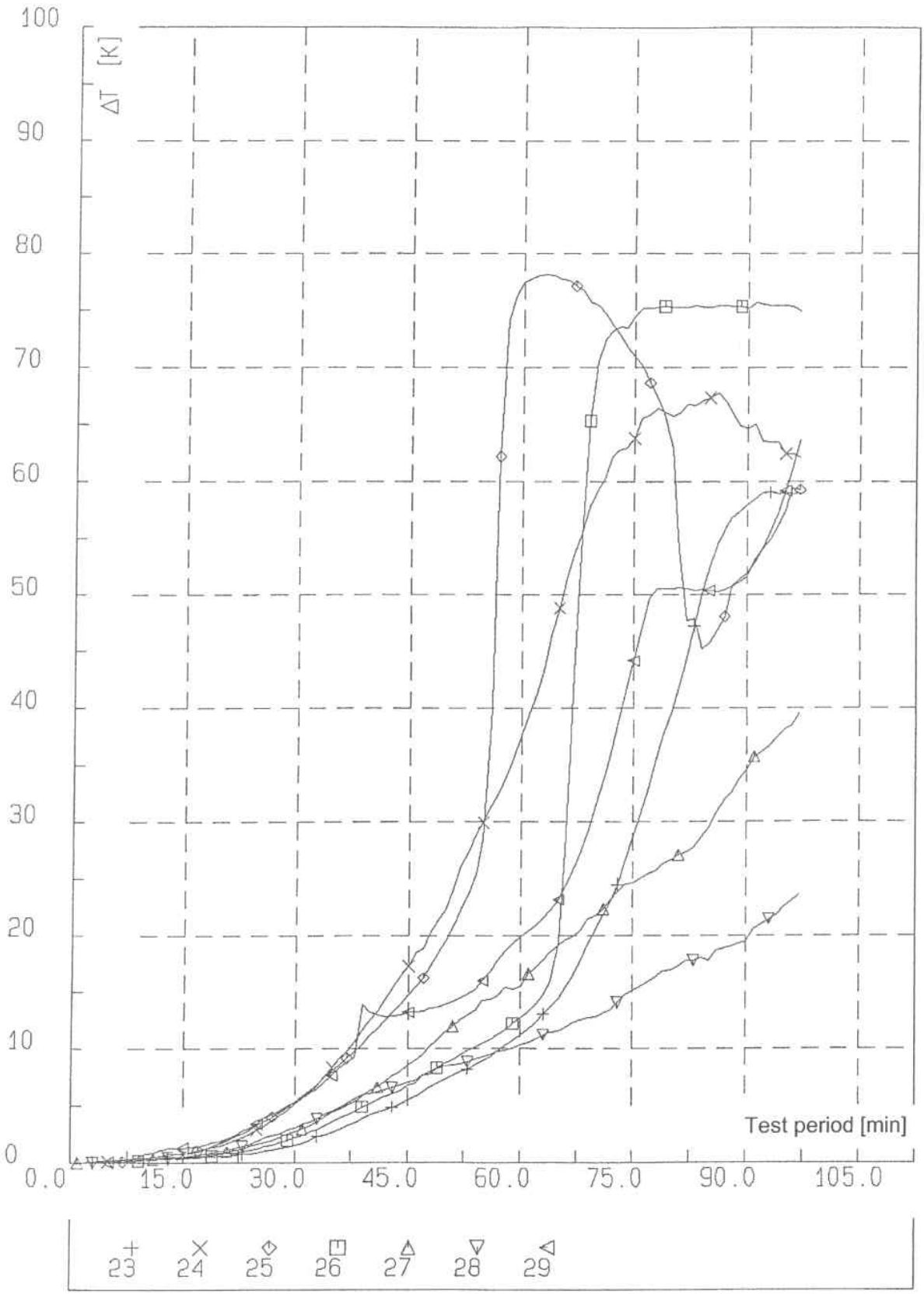
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.2 of

Test Certificate

No. 3003/9939

On the seal



Specimen temperatures

Flexible wall construction : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen

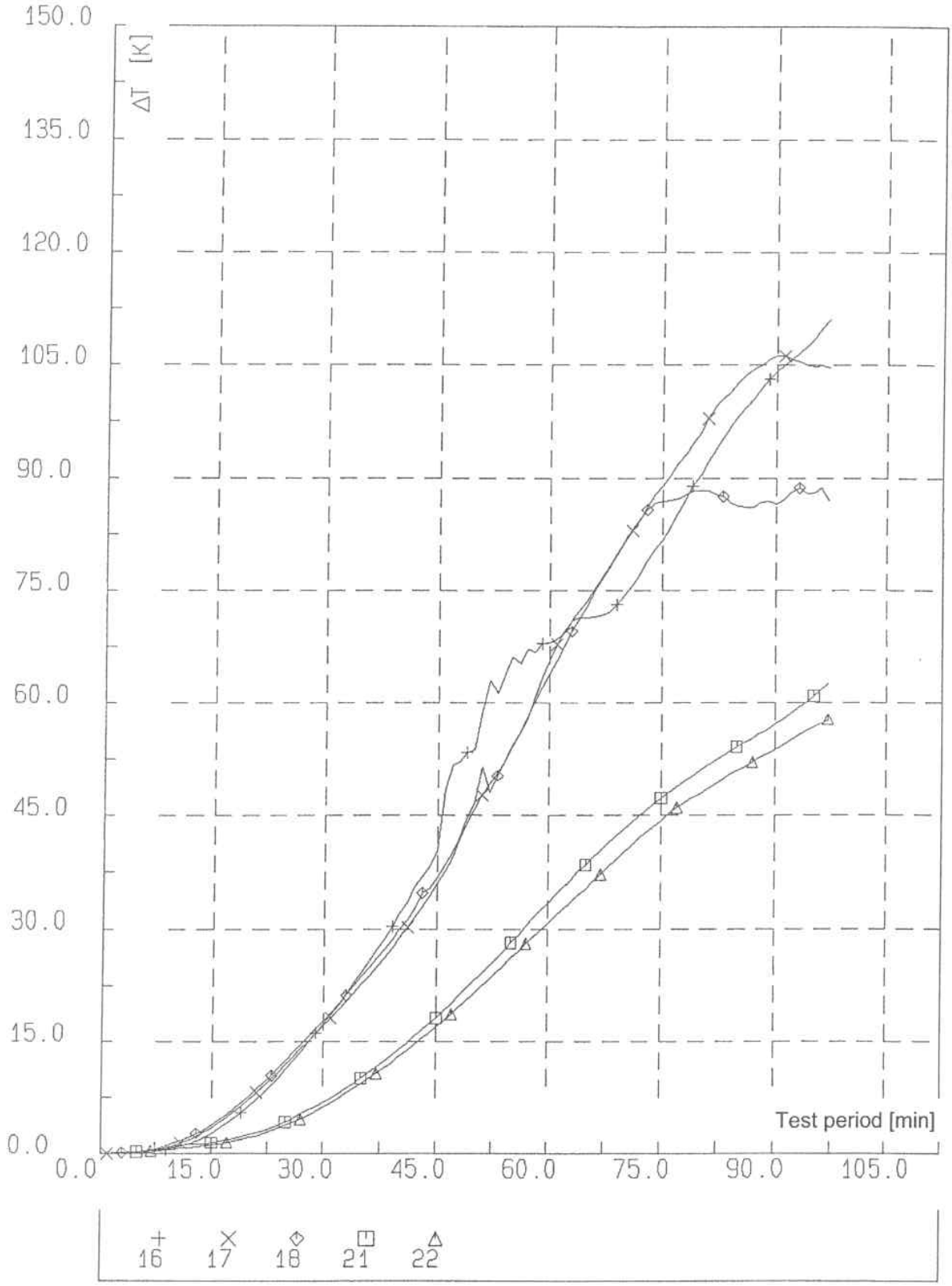
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.3 of

Test Certificate

No. 3003/9939

On the cables of the wide-span cable rack 80/500/FS



Specimen temperatures

Flexible wall construction : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

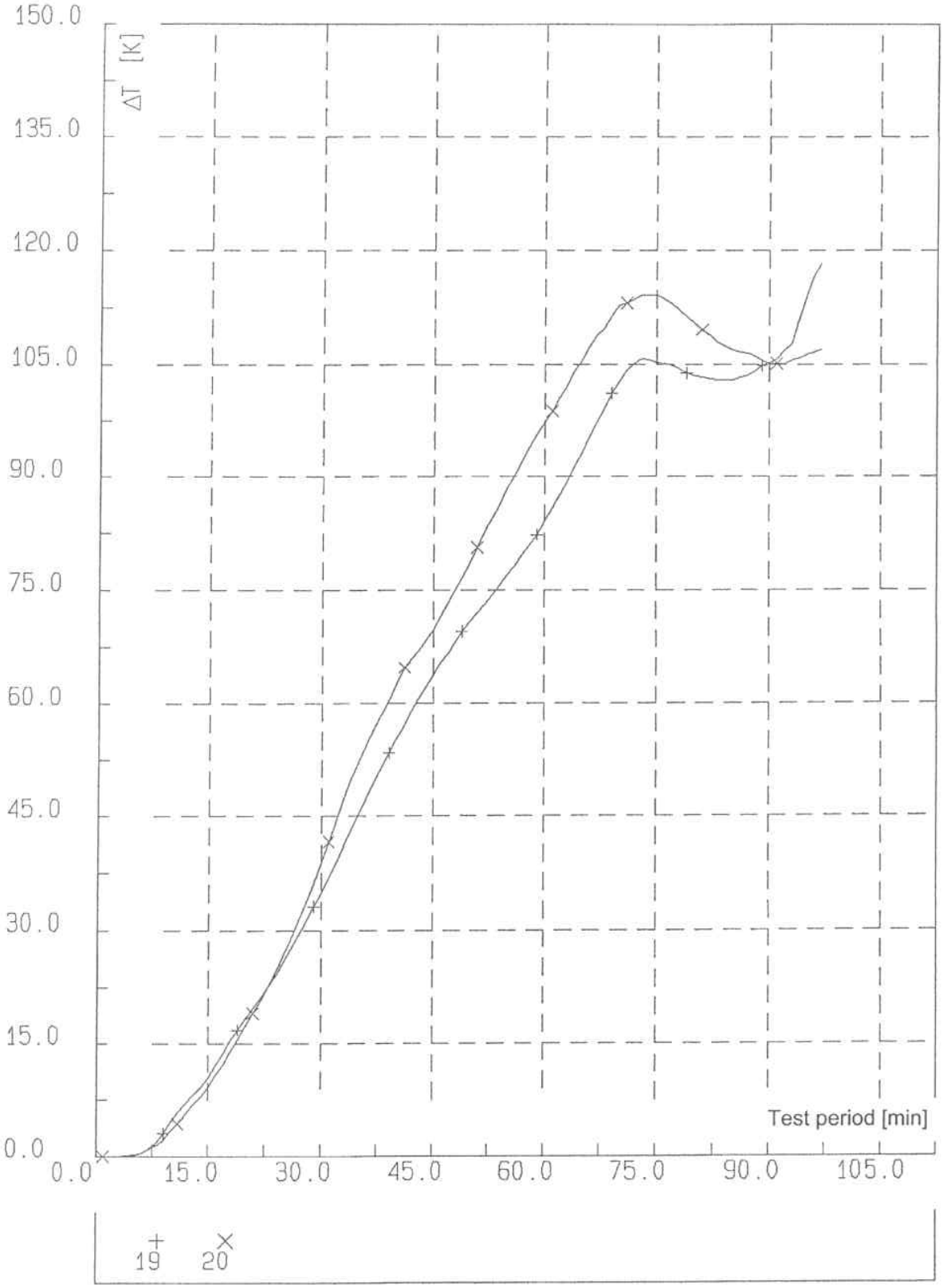
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.4 of

Test Certificate

No. 3003/9939

On the cable bundle of the wide-span cable rack 80/500/FS



Specimen temperatures

Flexible wall construction : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

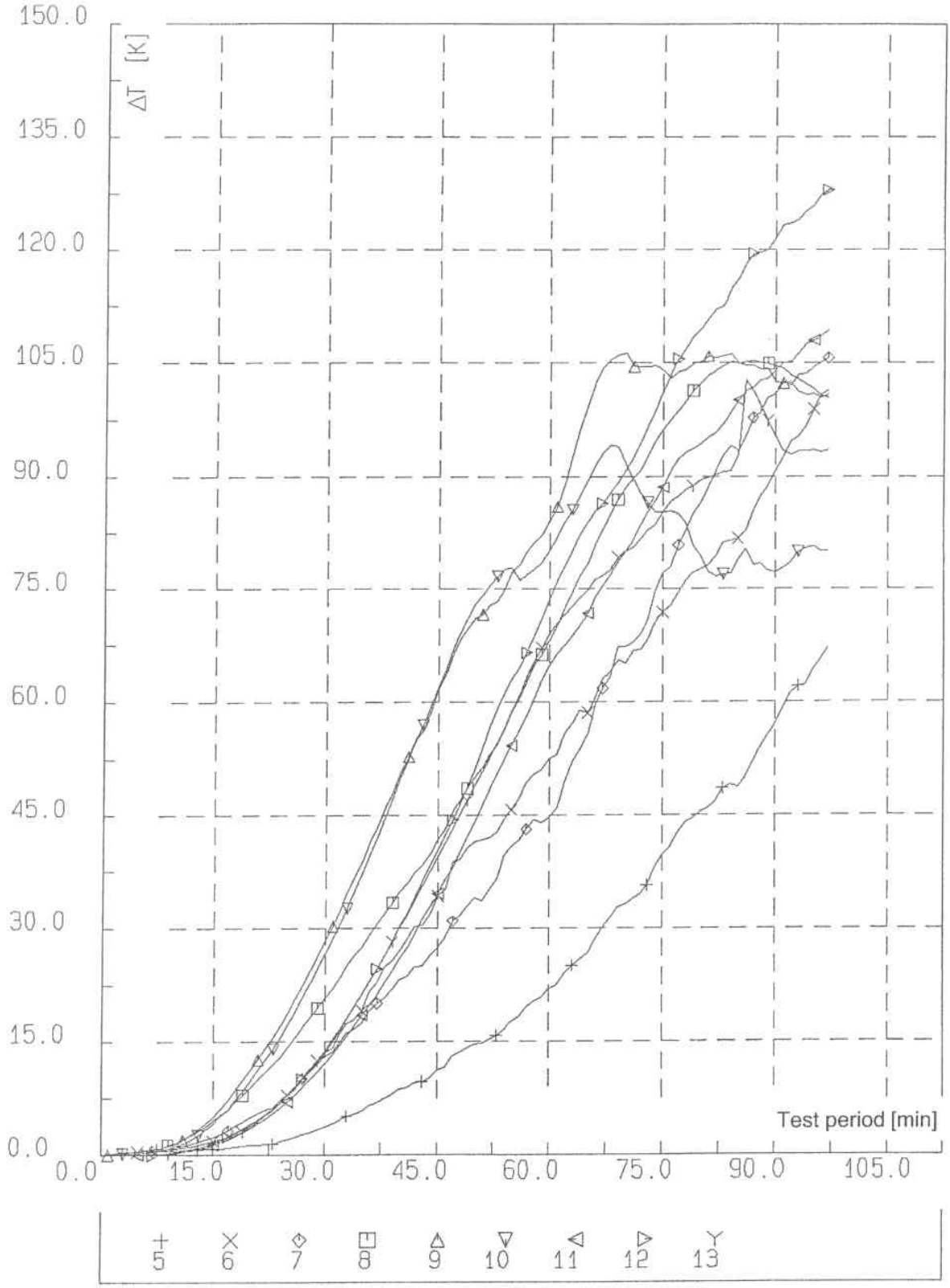
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.5 of

Test Certificate

No. 3003/9939

On the cables of cable trays KWL 300/60/FS



Specimen temperatures

Flexible wall construction : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

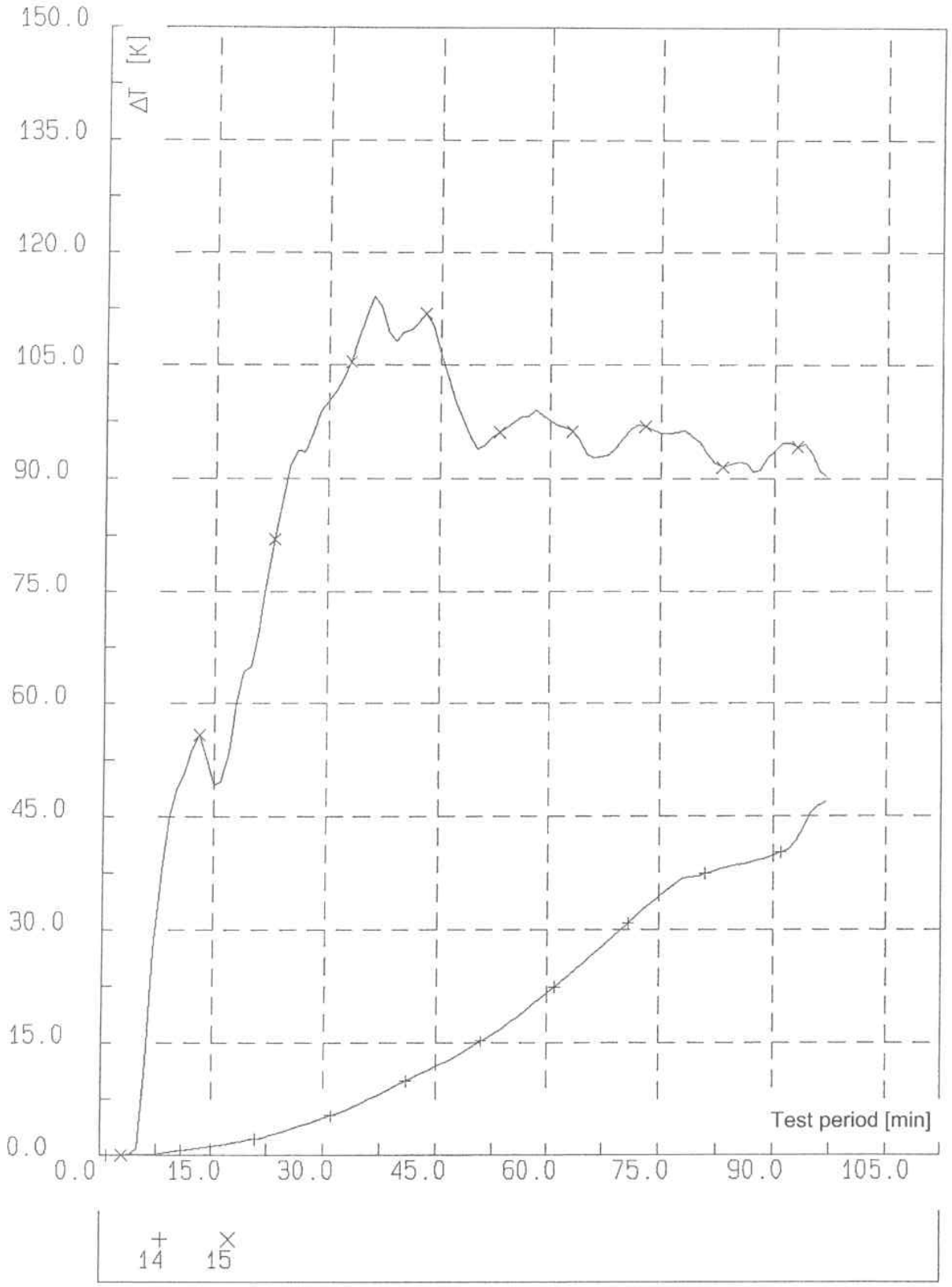
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.6 of

Test Certificate

No. 3003/9939

On the control pipes of cable tray KWL 300/60/FS



Specimen temperatures

Flexible wall construction : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

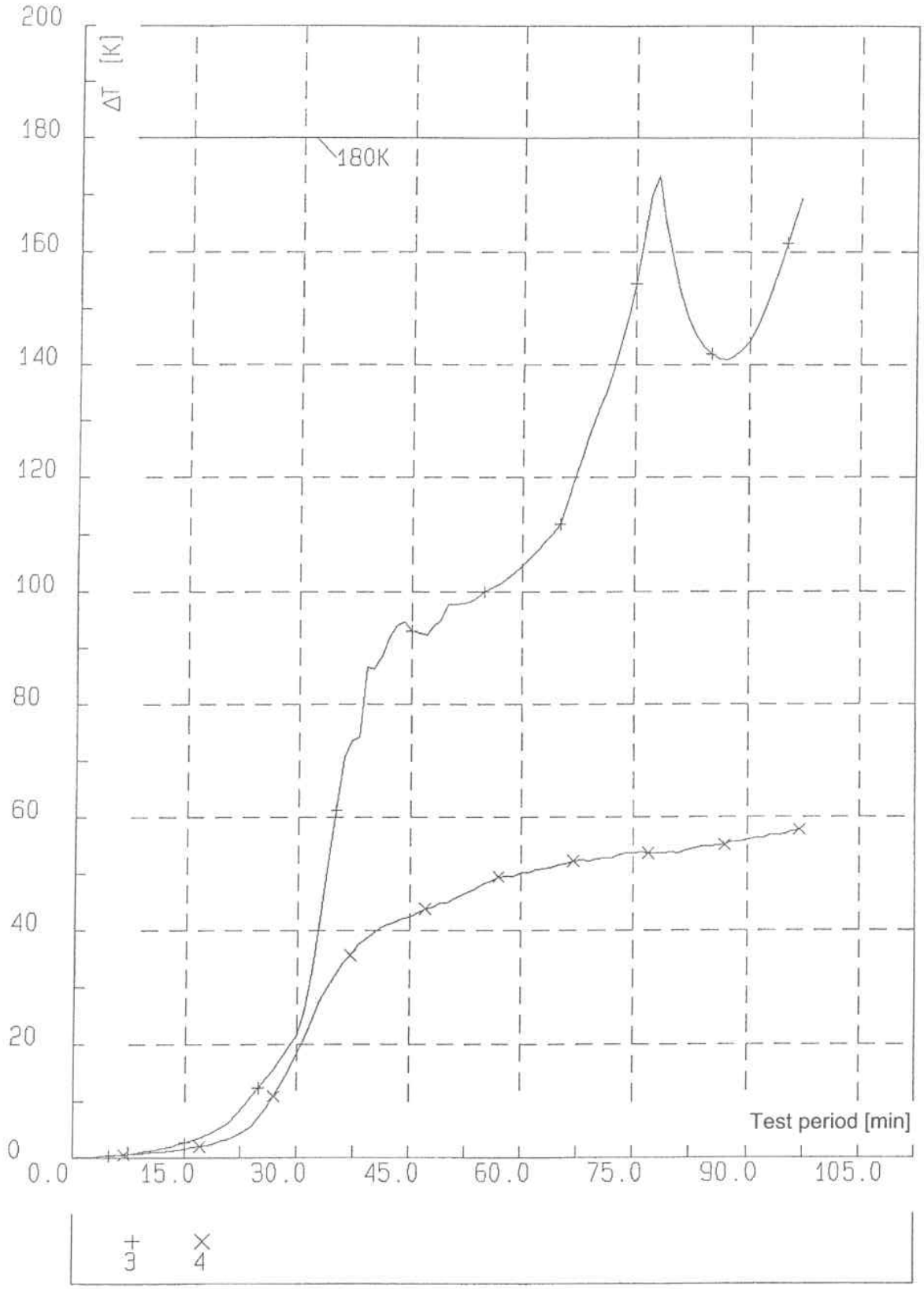
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.7 of

Test Certificate

No. 3003/9939

On the wide-span cable racks 80/300/FS and 80/500/FS



Specimen temperatures

Flexible wall construction : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

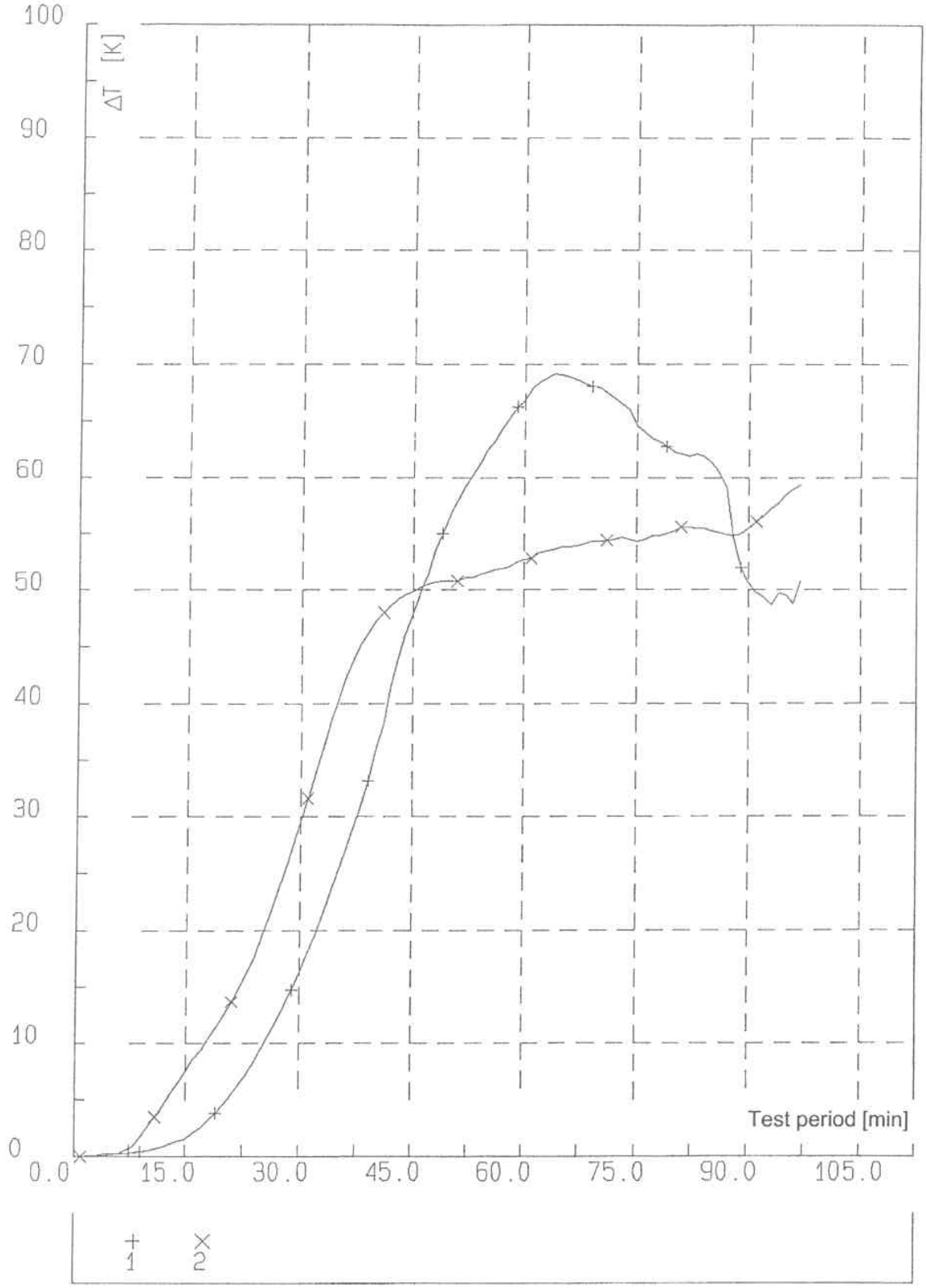
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.8 of

Test Certificate

No. 3003/9939

On cable trays KWL 300/60/FS



Specimen temperatures

Flexible wall construction : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

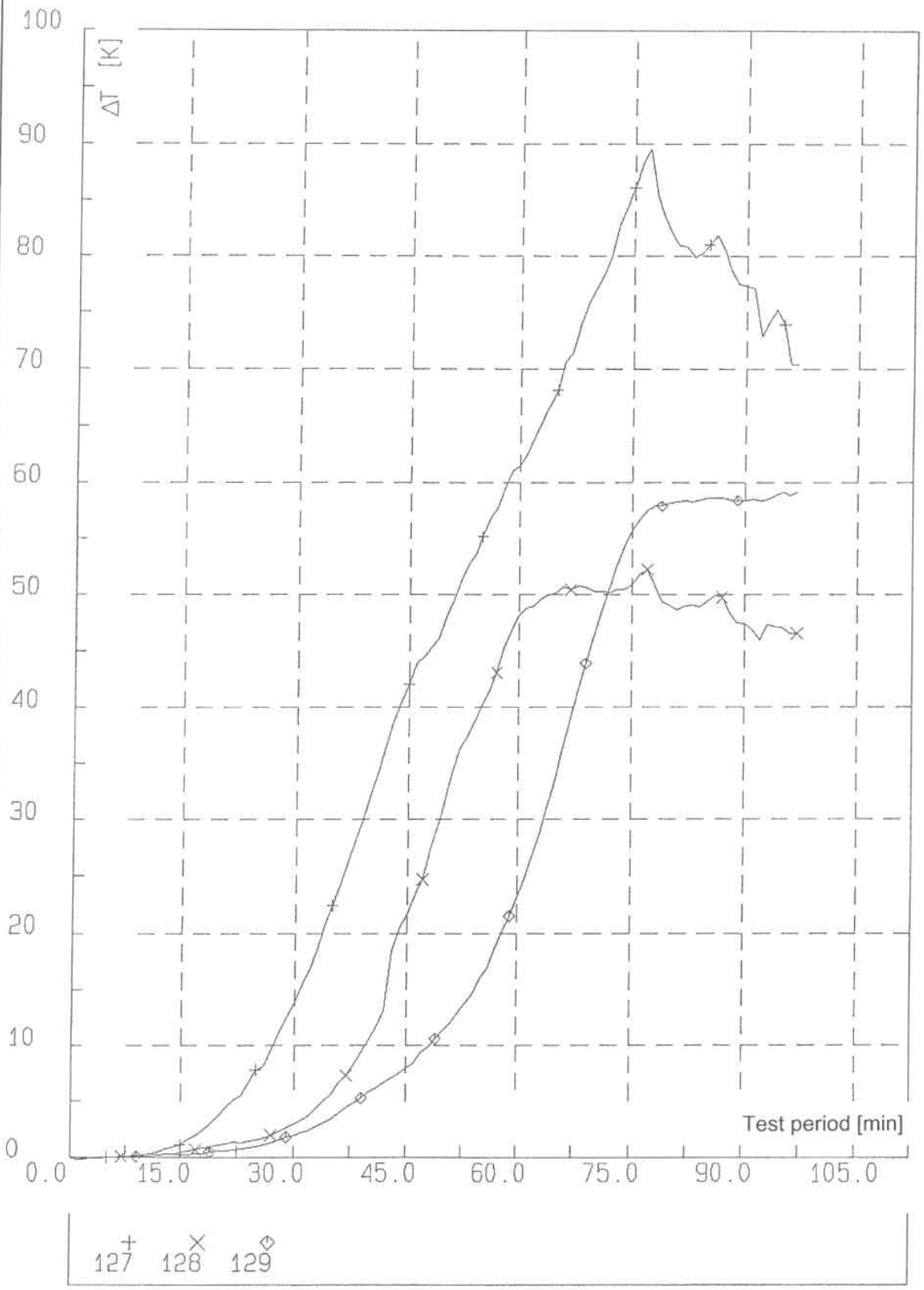
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.9 of

Test Certificate

No. 3003/9939

Cable pulling/secondary assignment : on the seal and the "c" cable



Specimen temperatures

Flexible wall construction : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

Institut für Baustoffe, Massivbau und Brandschutz

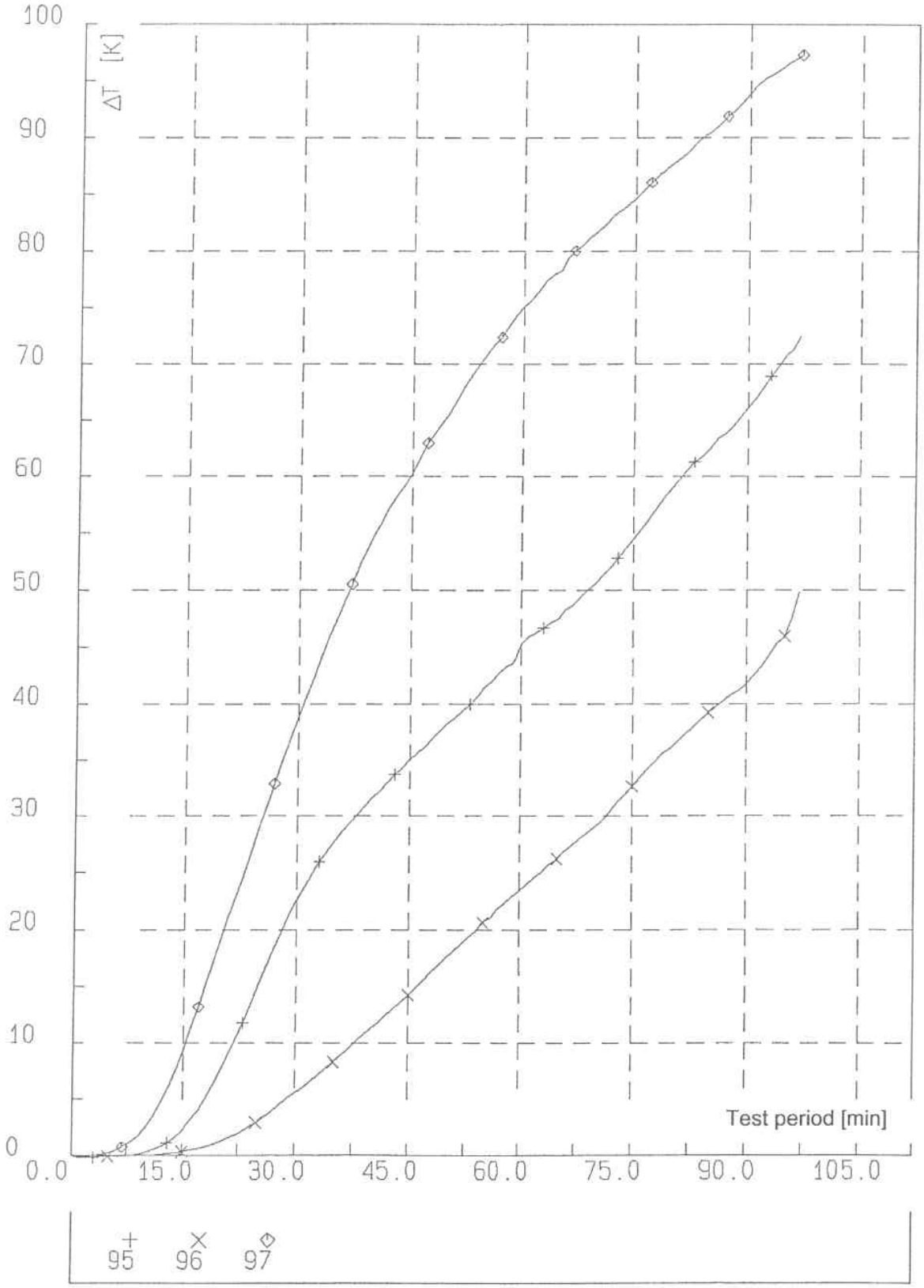
der Technischen Universität Braunschweig

Annex 4.10 of

Test Certificate

No. 3003/9939

Copper pipe, outside diameter d = 28 mm, pipe wall s = 1.0 mm thick (insulated)



Specimen temperatures

Aerated-concrete wall : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

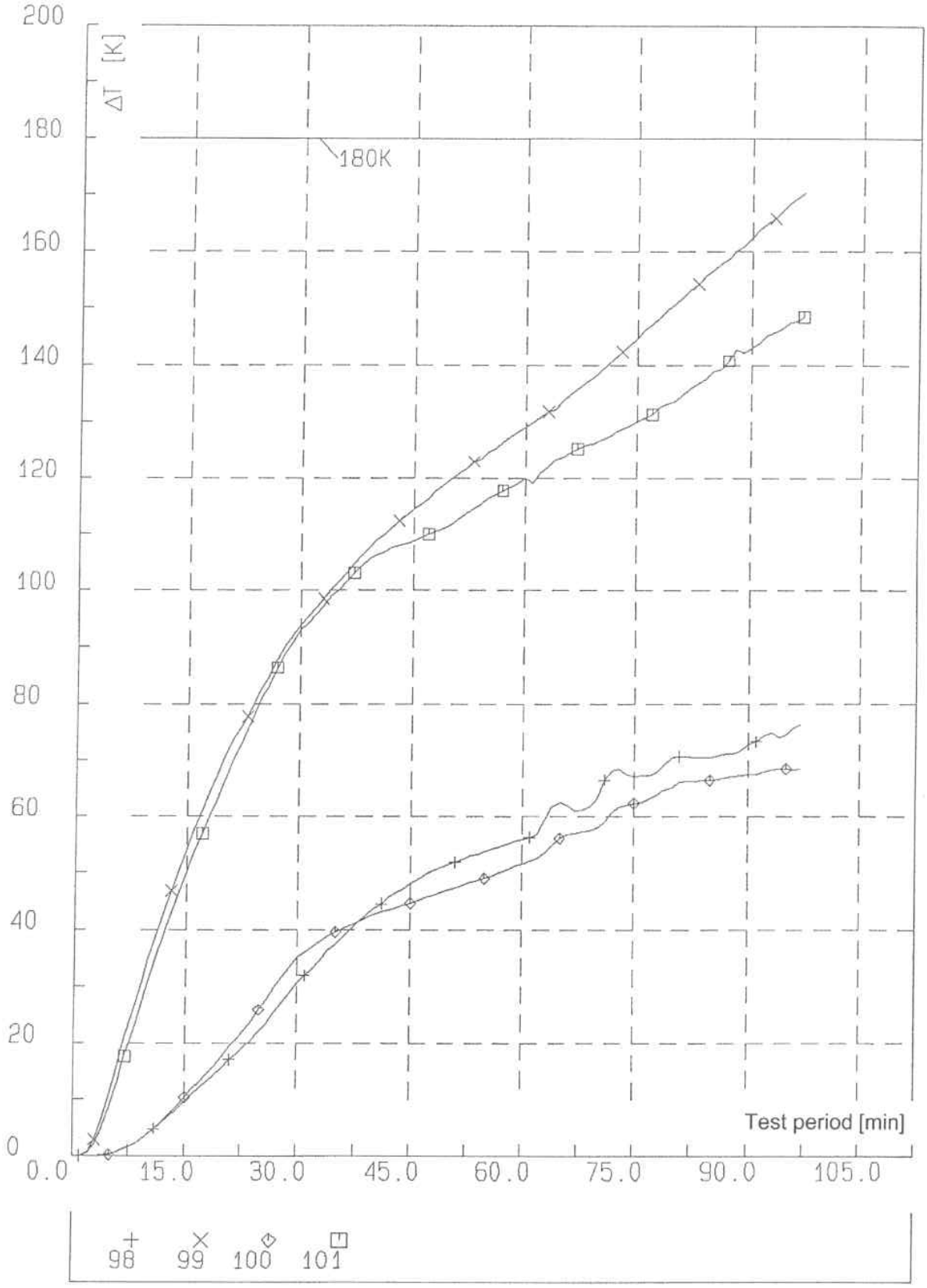
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.31 of

Test Certificate

No. 3003/9939

Copper pipe, outside diameter d = 18 mm, pipe wall s = 1.0 mm thick (not insulated)



Specimen temperatures

Aerated-concrete wall : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

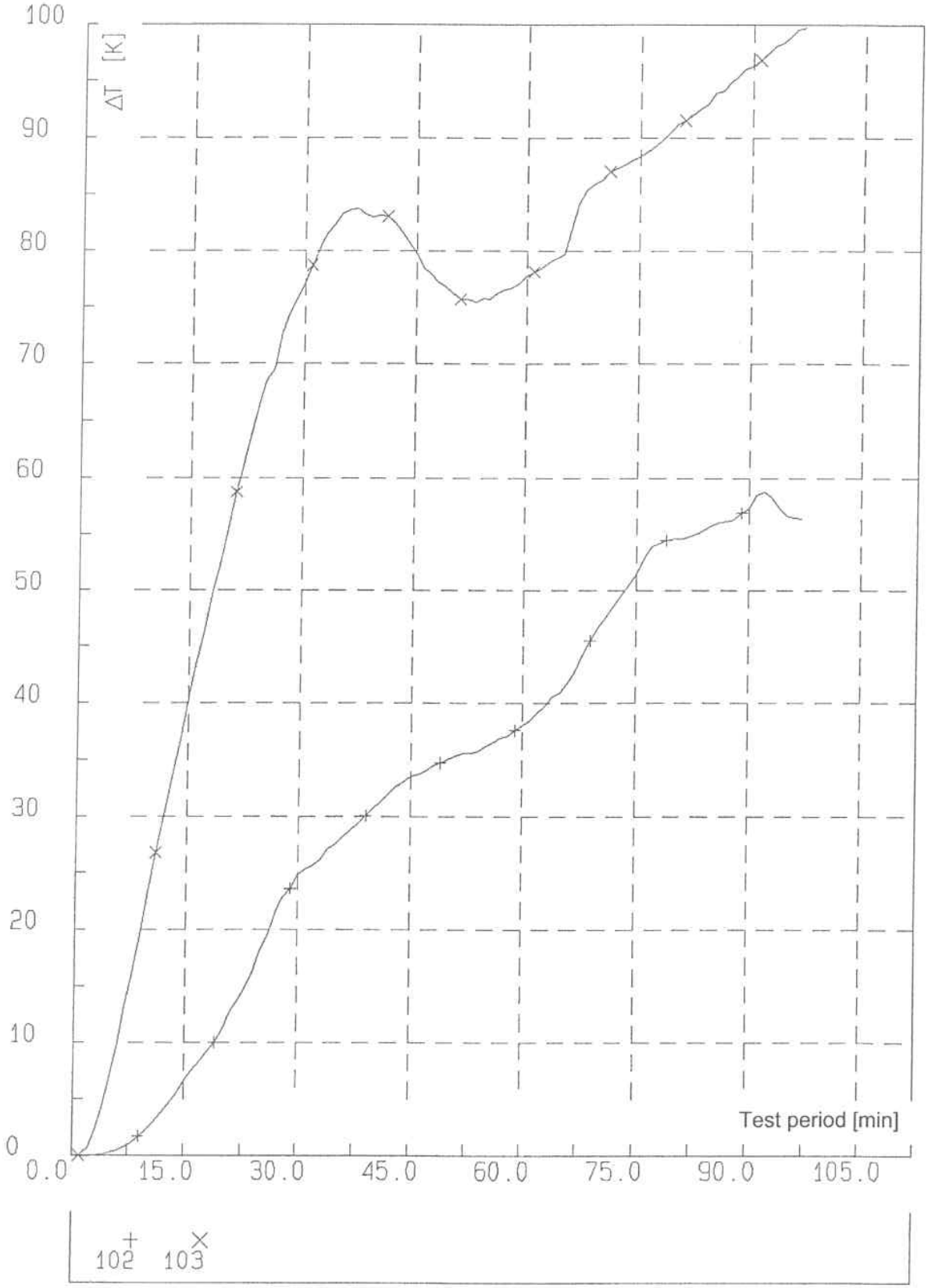
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.32 of

Test Certificate

No. 3003/9939

Steel pipe, outside diameter d = 54 mm, pipe wall s = 1.5 mm thick (not insulated)



Specimen temperatures

Aerated-concrete wall : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

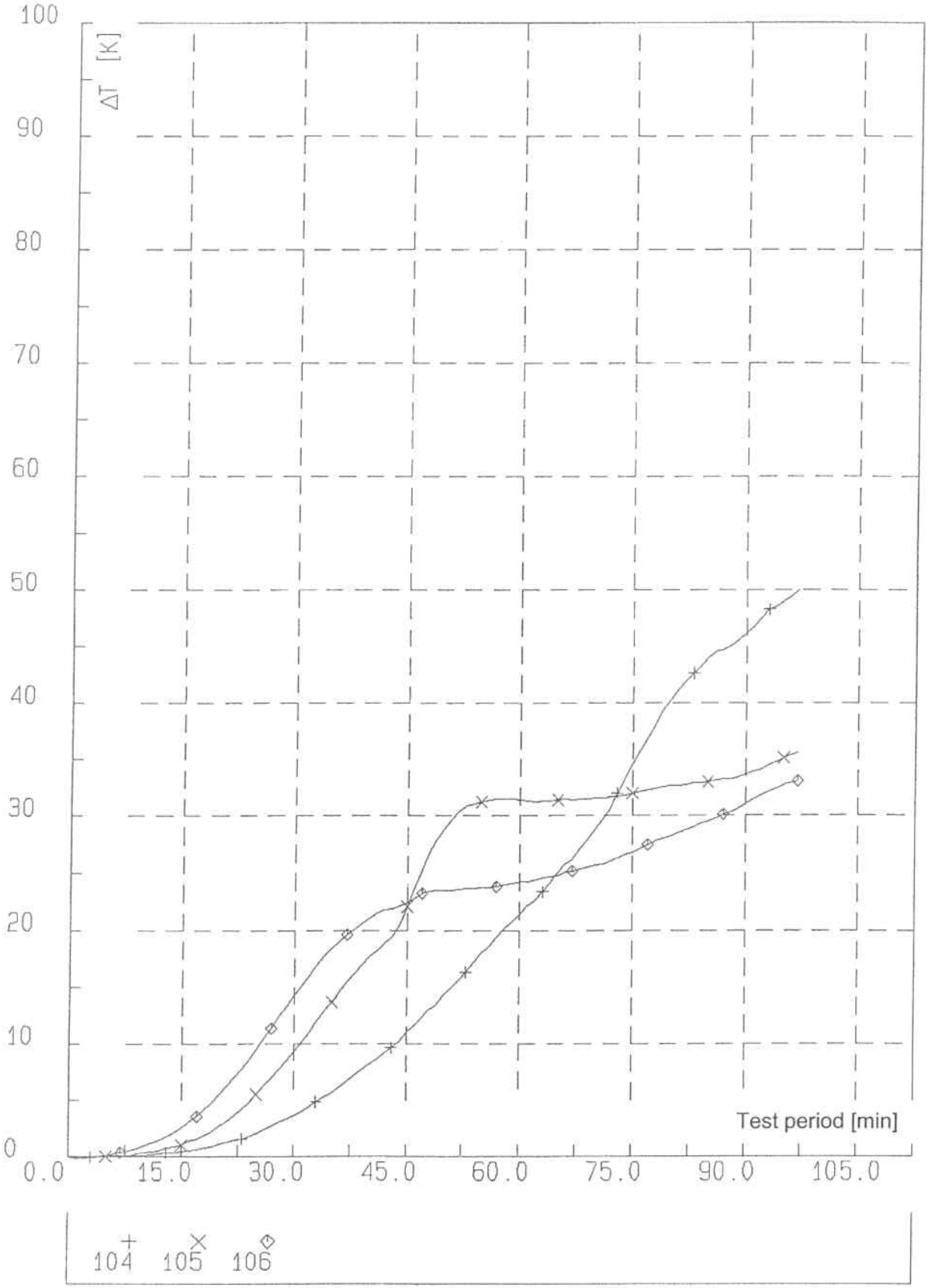
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.33 of

Test Certificate

No. 3003/9939

Steel pipe, outside diameter d = 54 mm, pipe wall s = 1.5 mm thick (insulated)



Specimen temperatures

Aerated-concrete wall : "FEP Rechteckschott S 90"

Materialprüfanstalt für das Bauwesen

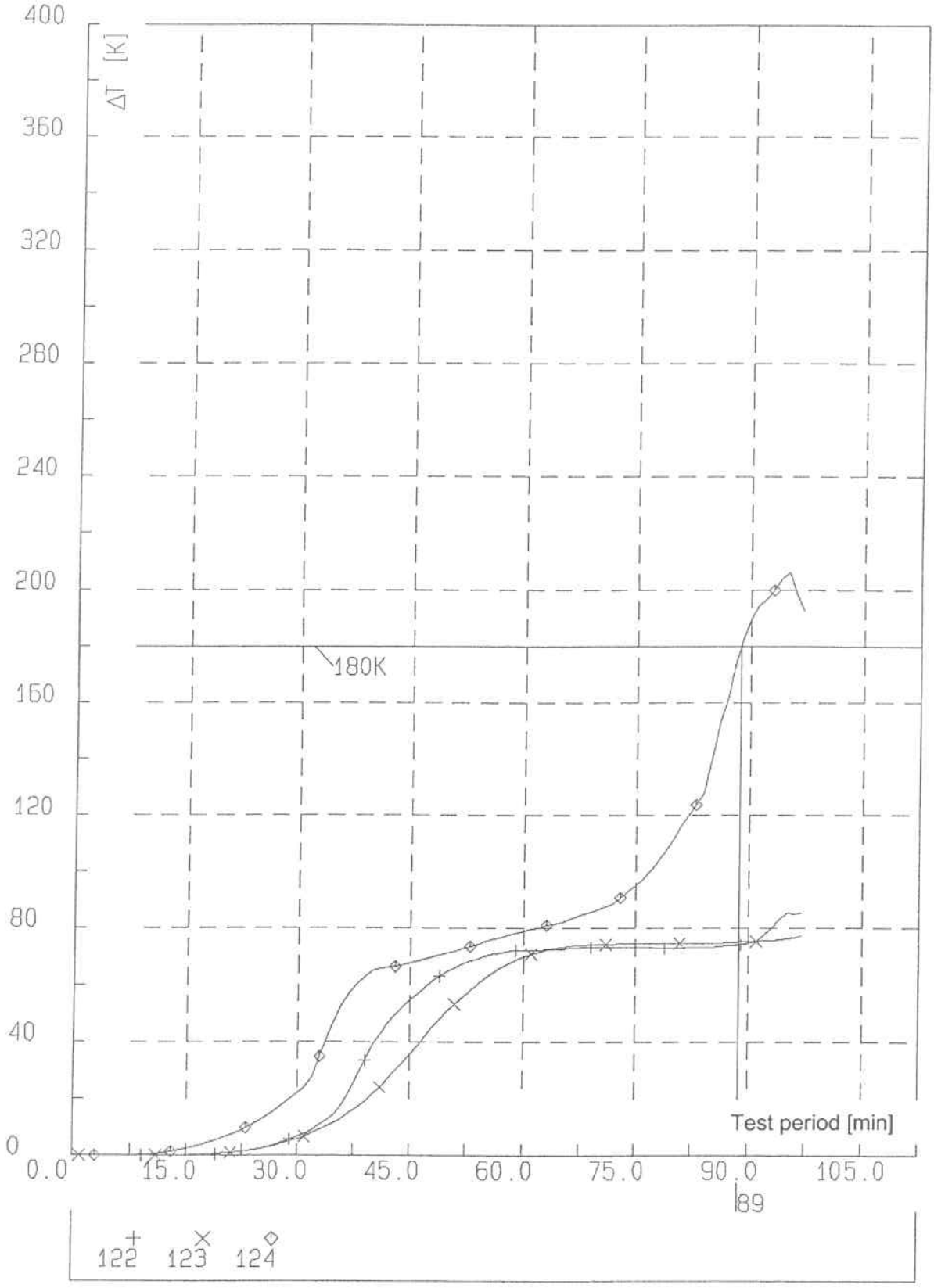
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.34 of

Test Certificate

No. 3003/9939

On the extra layer



Specimen temperatures

Aerated-concrete wall : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen

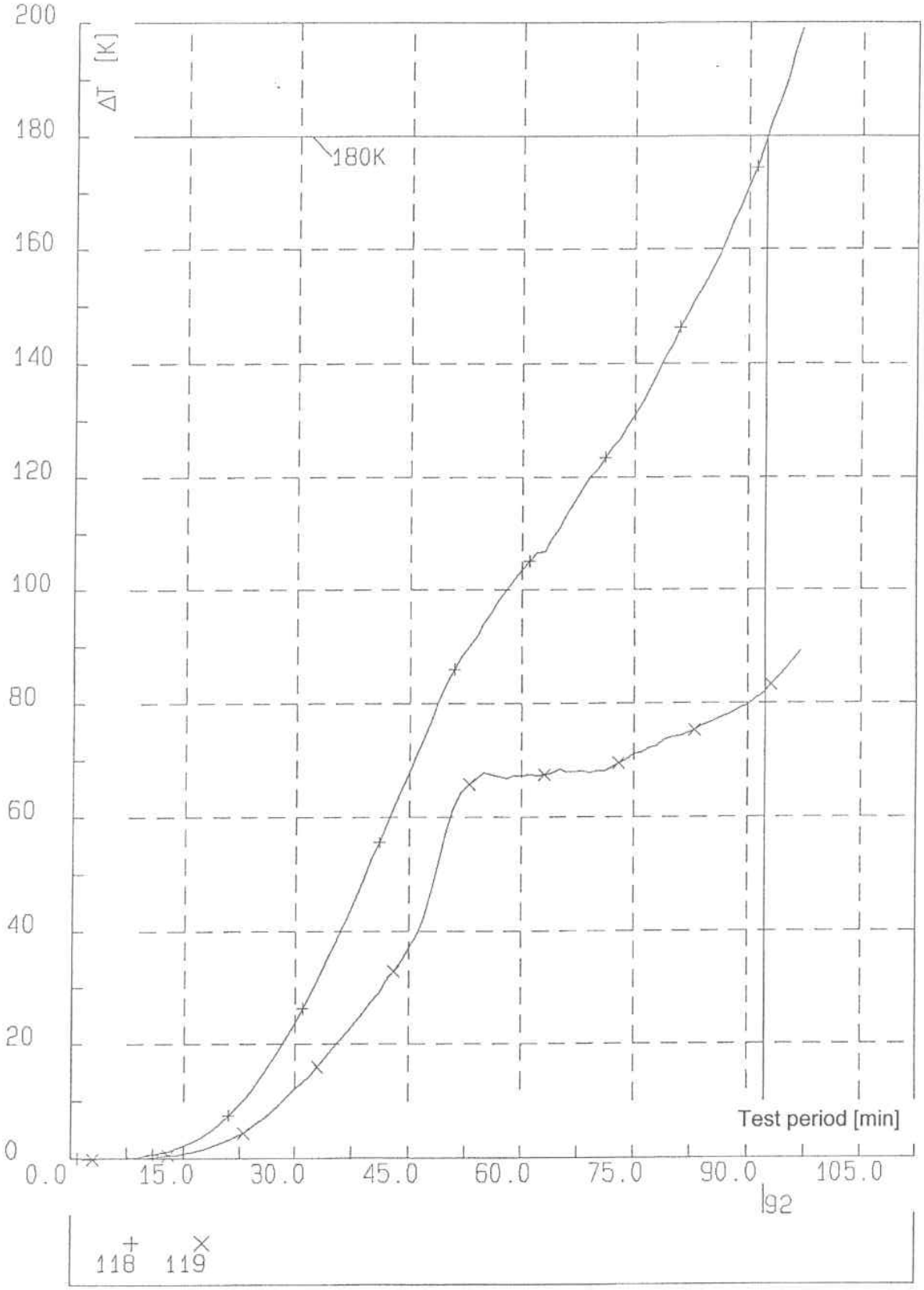
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.35 of

Test Certificate

No. 3003/9939

On the seal ∅ 105



Specimen temperatures

Aerated-concrete wall : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen

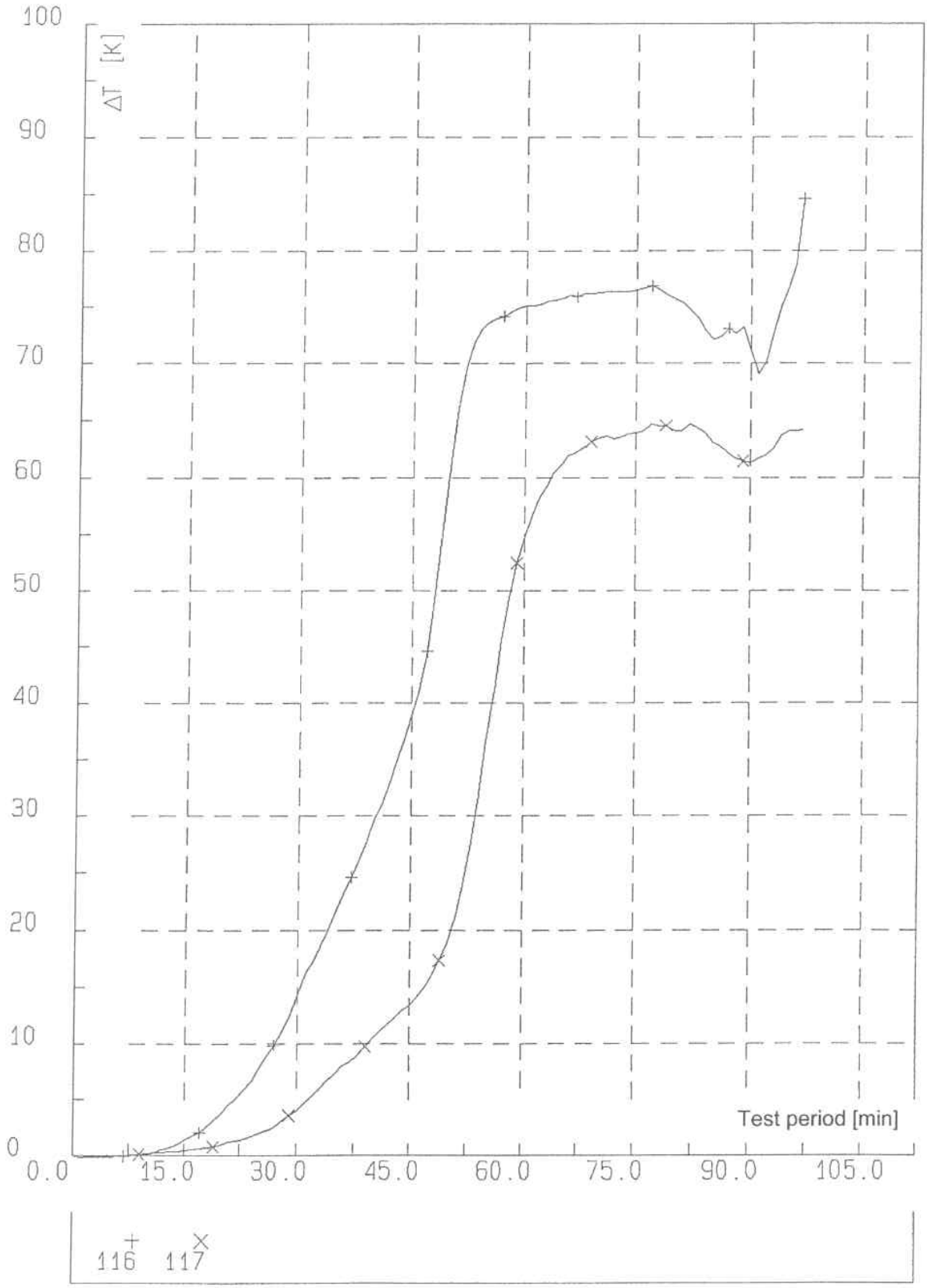
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.36 of

Test Certificate

No. 3003/9939

On the circular seal ∅ 210 (circular seal with cables and control pipes)



Specimen temperatures

Aerated-concrete wall : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen

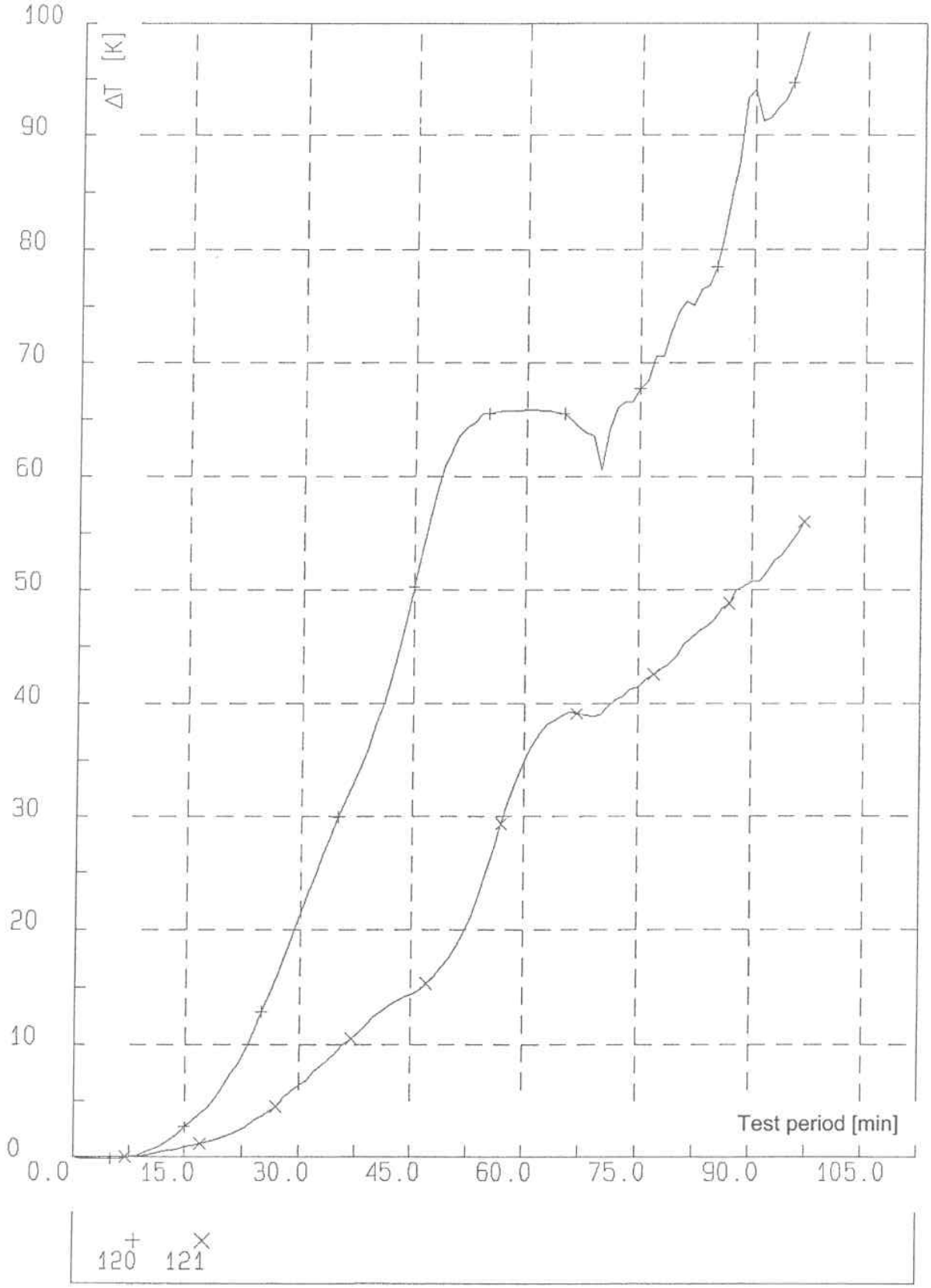
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.37 of

Test Certificate

No. 3003/9939

On the circular seal ∅ 210 (circular seal with cable bundle)



Specimen temperatures

Aerated-concrete wall : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen

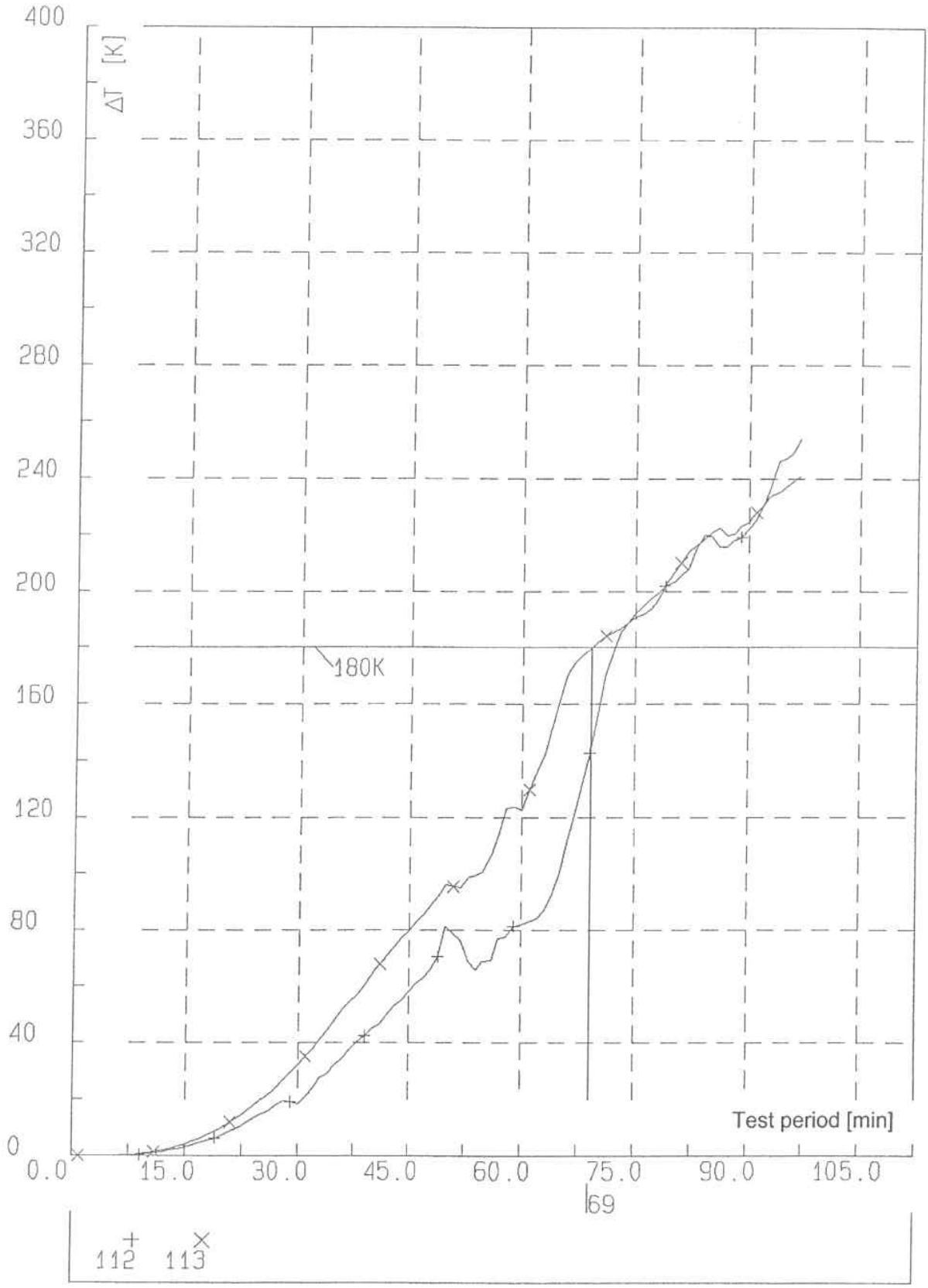
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.38 of

Test Certificate

No. 3003/9939

On the cables of circular seal ∅ 105



Specimen temperatures

Aerated-concrete wall : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen

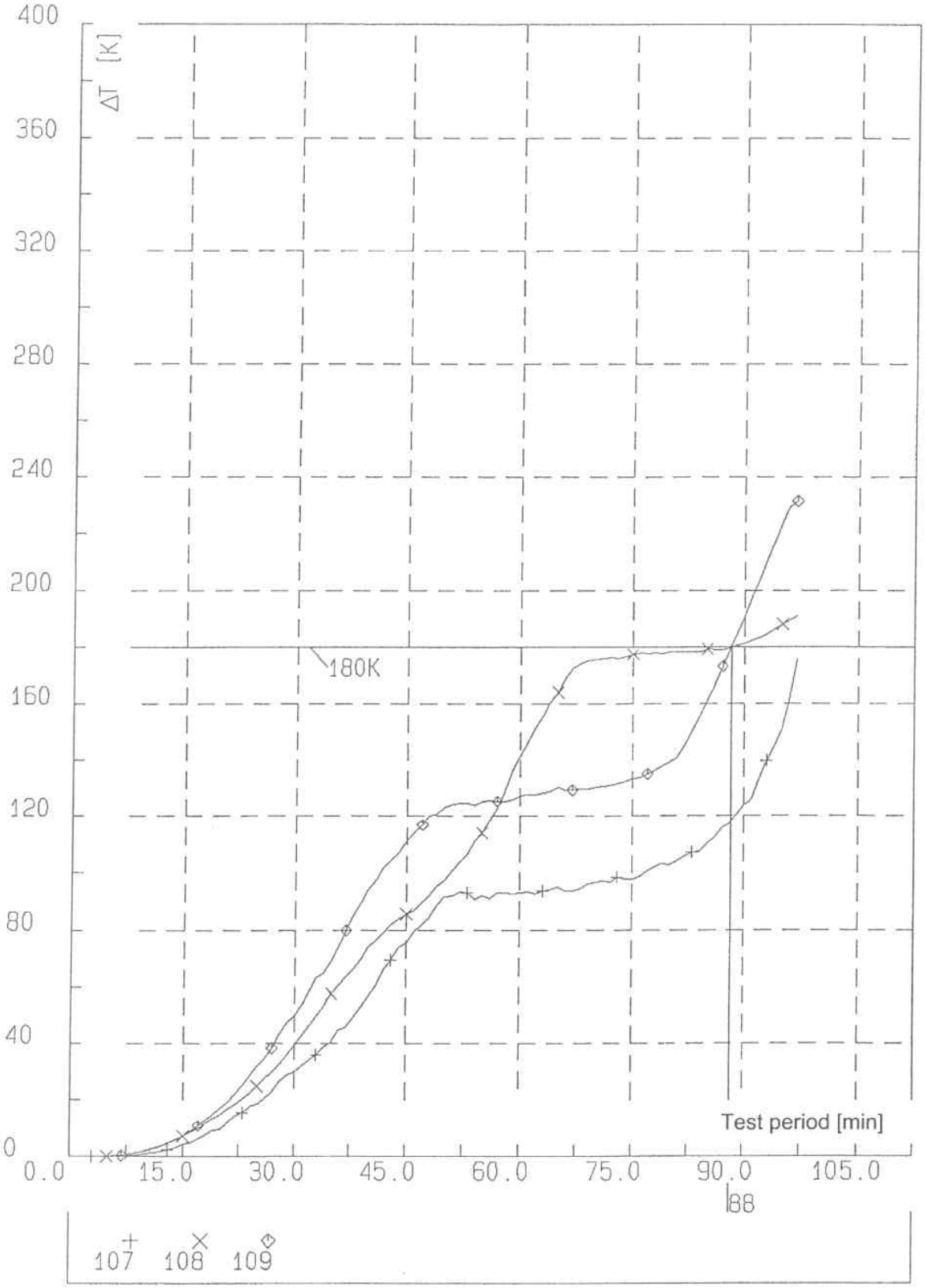
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.39 of

Test Certificate

No. 3003/9939

On the cables of circular seal ∅ 210



Specimen temperatures

Aerated-concrete wall : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen

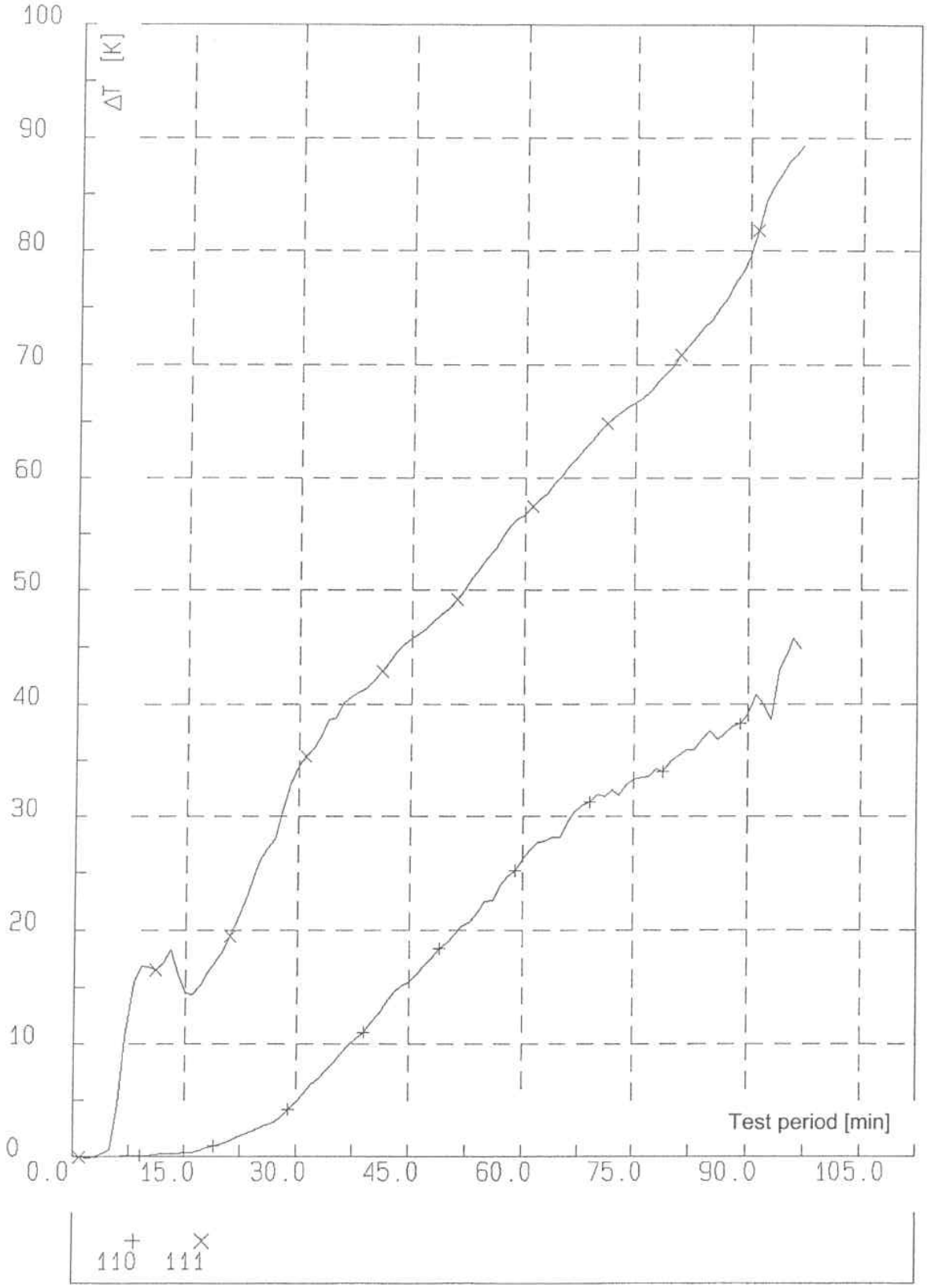
Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.40 of

Test Certificate

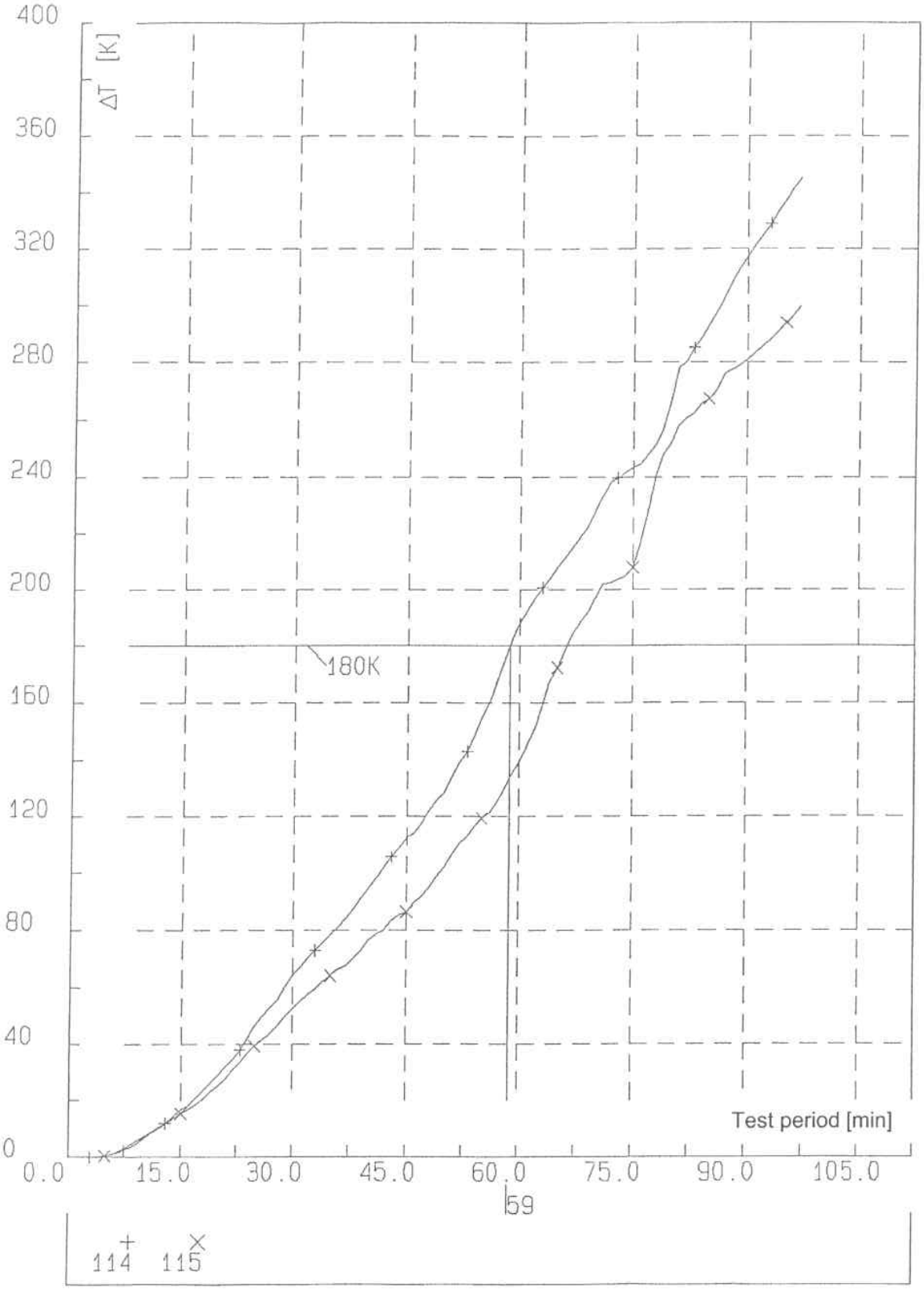
No. 3003/9939

On the control wires of circular seal ∅ 210



Specimen temperatures Aerated-concrete wall : "FEP Rundschott S 90"	Annex 4.41 of Test Certificate No. 3003/9939
Materialprüfanstalt für das Bauwesen Institut für Baustoffe, Massivbau und Brandschutz der Technischen Universität Braunschweig	

On the cable bundle of circular seal ∅ 210



Specimen temperatures

Aerated-concrete wall : "FEP Rundschott S 90"

Materialprüfanstalt für das Bauwesen

Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.42 of

Test Certificate

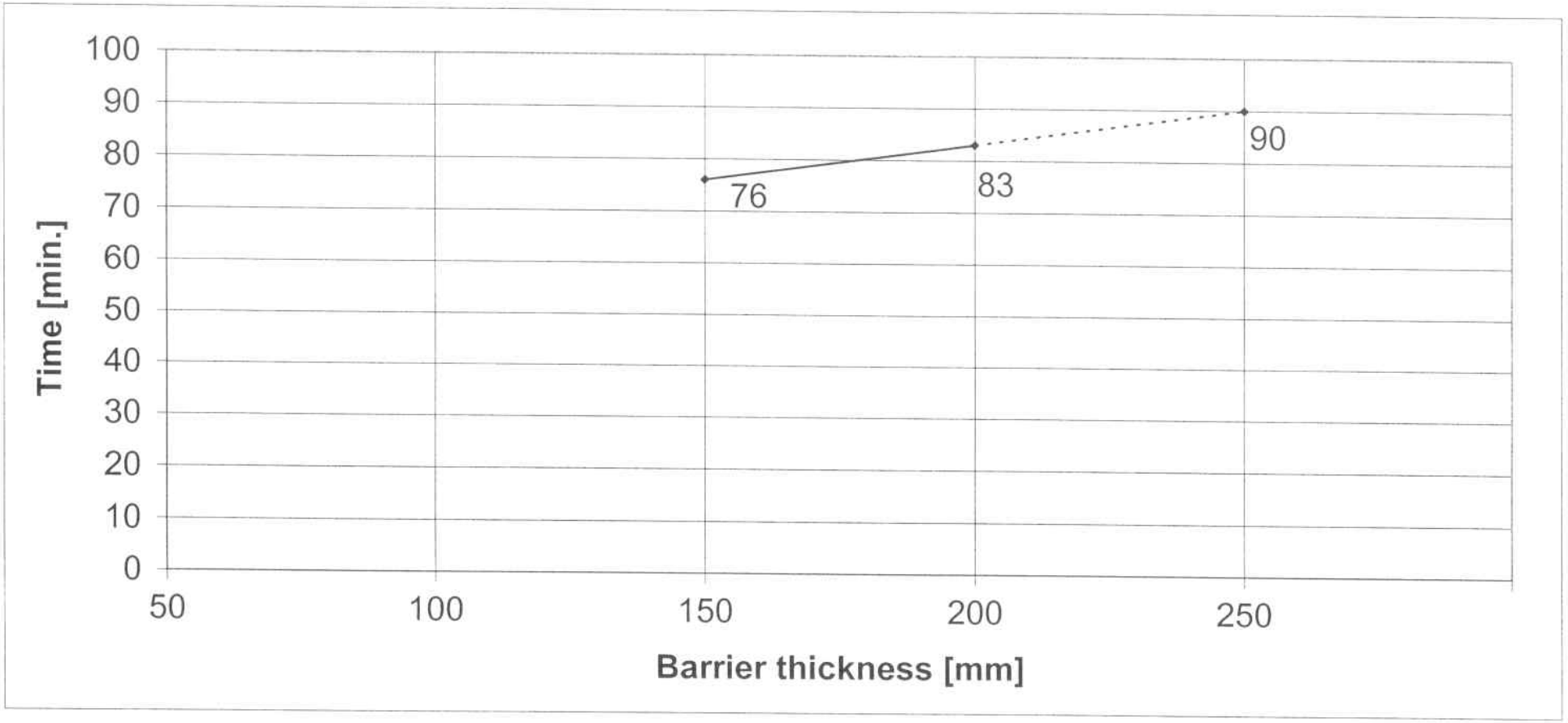
No. 3003/9939

Test period (min)	Face *)	Observations during the fire test on 26-11-1999	
		Flexible wall construction	Aerated-concrete wall
1	F	All control pipes made from plastics have burnt.	
3	F	Cable sheaths are softening and starting to burn.	
7	A	Circular seal "FEP Rund-Kabelschott S 90" : Some smoke is emerging in the cable bundle region.	
	F	Rectangular seal "FEP Rechteck-Kabelschott S 90" : The threaded rods ∅ 18 welded to the arms, the wide-span cable racks and the cable trays are deflecting.	
7-28	F	The combustion products thus products are obstructing the view into the furnace.	
10	A	Rectangular seal "FEP Rechteckschott S 90" : Some smoke is emerging between horizontal seal/PROMATECT®-H box in the region of the uppermost wide-span cable rack 80/300/FS.	Rectangular seal "FEP Rechteckschott S 90" : Some smoke is emerging from the horizontal seal/extra PROMATECT®-H insulation transition above the two wide-span cable rack 80/300/FS.
17	A	-	Rectangular seal "FEP Rechteckschott S 90" : Larger amounts of smoke emerging from the top horizontal seal / extra PROMATECT®-H insulation transition; the smoke has turned to a sulphur-yellow.
21	A	-	Rectangular seal "FEP Rechteckschott S 90" : Gaping joint in the top horizontal seal / extra PROMATECT®-H insulation transition region; flames leaping through this joint ⇒ the joint is closed.
28	F	Rectangular seal " FEP Rechteck-Kabelschott S 90" : Intensified deflection of threaded rod ∅ 18, wide-span cable racks and cable trays.	
29	F	Rectangular seal "FEP Rechteckschott S 90" : Lager amounts of smoke emerging in the top horizontal seal/PROMATECT®-H box transition region; the smoke has turned to a sulphur-yellow.	-

*) F = fire-exposed face
A = non-exposed face

Test period (min)	Face *)	Observations during the fire test on 26-11-1999 (continued)	
		Flexible wall construction	Aerated-concrete wall
33	A	Rectangular seal "FEP Rechteckschott S 90" : Gaping joint in the top horizontal seal / PROMATECT®-H box transition region ⇒ the joint is closed.	-
79	A	-	Circular seal "FEP Rundschott S 90" - ∅ 210 : Some smoke is emerging from the circular seal in the cable / cable bundle region.
84	A	-	Circular seal "FEP Rund-Kabelschott S 90" - ∅ 105 : Cable sheaths of the "c" cables are bulging in the cable / seal surface transition region.
85	A	Circular seal "FEP Rund-Kabelschott S 90" - ∅ 210 : The Vermiculite pipe has turned black in the Vermiculite pipe / partition transition region.	-
97	-	End of fire exposure	

*) F = fire-exposed face
A = non-exposed face



Extrapolation of test results for floors

"FEP Rundschott S 90" : Cable bundle

Materialprüfanstalt für das Bauwesen

Institut für Baustoffe, Massivbau und Brandschutz
der Technischen Universität Braunschweig

Annex 4.45 of

Test Certificate

No. 3003/9939