

Test Report

- Translation -

Document No.: (3683/748/09) – TM of 21/04/2009

Client: Seves S.p.A.
Via Reginaldo Giuliani 360
I 50141 Firenze

Order date: 16/02/2009

Order Ref.: Mr Jedynak

Order received: 16/02/2009

Subject: An about 160-mm thick glass-block wall made from "Seves Glassblock 1919/16 60F" glass blocks to be tested for its resistance to fire in compliance with DIN EN 1364-1 : 1999-10 and DIN EN 1363-1 : 1999-10 to determine its fire resistance time when exposing one side of the specimen to the fire.

Test basis: DIN EN 1364-1 : 1999-10, DIN EN 1363-1 : 1999-10

Test material received: 20/02/2009

Sampling: Samples taken during production; the Testing House does not have any information indicating official sampling.

Test material marking: None

Test date: 02/03/2009

Valid until: Unlimited



This Test Report covers 9 pages, incl. cover sheet, and 15 annexes.

This document is the translated version of 3683/748/09 – TM dated 21/04/2009 . The legally binding text is the aforementioned German Test Report.

This Test Report may not be circulated unless as a complete text without any alterations. Excerpts and abridged versions of the Test Report are subject to a written approval of MPA Braunschweig. Documents that do not carry a signature and the official stamp are invalid. The first sheet of this Test Report as well as the page carrying the signatures bear the official stamp of the MPA. The test material has been fully used. Accreditations are valid for the testing methods specified in the current documents. A list showing fields for which accreditation has been obtained can be made available upon request.

1 General

Under the order placed with the Testing Laboratory, an about 160-mm thick glass-block wall made from “Seves Glassblock 1919/16 60F” glass blocks was to be tested for its resistance to fire in compliance with DIN EN 1364-1 : 1999-10 in conjunction with DIN EN 1363-1 : 1999-10 to determine its fire resistance time when one side of the specimen is exposed to the fire. Essential elements of the glazing system were glass blocks and mortar joints.

This Test Report describes in detail the test conditions and the results achieved for the specific member described in this Test Report, when tested in accordance with the method specified in DIN EN 1364-1 : 1999-10 and DIN EN 1363-1 : 1999-10. Major deviations in terms of size, structural details, boundary conditions except for those accepted under the relevant test procedure for the direct field of application, are not covered by this Test Report.

In view of the special nature of tests conducted to establish the fire resistance time and the difficulties this implies for quantifying any uncertainties in measuring the fire resistance time, a defined degree of accuracy cannot be given for the results established.

The materials testing institute (MPA) in Braunschweig was not involved in selecting the specimen.

2 Description of the element tested

2.1 General

The specimen consisted of a total of 196 glass blocks of type “Seves Glassblock 1919/16 60F“, $d = 160\text{mm}$, on the basis of DIN EN 1051-1 : 2003-04, the mortar joints, and a all-around surround made from heat insulating mortar.

The element had the dimensions $2,960\text{mm} \times 2,960\text{mm}$ (width x height) and a weight of approx. 2,195 kg.

2.2 Structural design of the glass blocks

The glass blocks of type “Seves Glassblock 1919/16 60F“ had the dimensions $190\text{mm} \times 190\text{mm} \times 160\text{mm}$. The wall was 12mm thick, and the all-around fillet was 10mm wide. The fillet was set back with respect to the edges of the wall by 3mm, so that a shallow mortar pocket was produced (see annex 1.3).

2.3 Joints and surround

The mortar used in the joints and the surround was heat insulating “LM 21” mortar.

The joints were approx. 15mm wide. They were set back by about 2mm on both sides with respect to the glass surface.

The surround was 55mm wide and 160mm thick on all sides.

2.4 Reinforcement

The surround was reinforced with three \varnothing 8mm reinforcing bars made from BSt 500 S each side.

Every horizontal joint was reinforced with three \varnothing 6mm reinforcing bars made from BSt 500 S. Every second vertical joint (alternating between inside and outside) was reinforced with two \varnothing 6mm reinforcing bars made from BSt 500 S, which extended to the surround reinforcement (see annex 1.2).

The reinforcing bars were not tied together by wire at crossing points.

2.5 Transport hooks and element mounting

For ease of transport, two threaded M 12 sleeves were welded at the top and laterally to one \varnothing 10mm BSt 500 S reinforcing bar each.

The specimen was connected to the test frame at the top, using 50mm x 8mm x 200mm steel mounting tabs. These were fixed at the top of specimen with two M 10 x 35mm hexagon screws fitted into the threaded M 12 sleeves. At the test frame end, two S 12 Fischer anchors and two \varnothing 10mm x 100mm hexagon screws were used (see annex 1.1).

The joint remaining between test frame and wall element was stuffed with mineral wool (building material classification A1). For mounting into the test frame, the specimen was placed on a 10-mm thick strip of mineral wool (non-flammable; melting point \geq 1000 °C).

For further details of the element, reference is made to annexes 1.1 to 1.3 of this Test Report.

3 Specimen and material characteristics

At the time of testing, the strength and the moisture content of the specimen corresponded by approximation to what can be expected under normal conditions in practice.

The tested system and the construction materials used for the system, are in compliance with the details specified in annex 1.4 regarding building material classification, weight per unit area, apparent density, and moisture content.

4 Test set-up and testing

The client's own expert staff installed the specimen described in section 2 above as a wall supported on two sides in front of the clear opening of a wall test furnace so that it formed a vertical barrier.

The approx. 20-mm wide gap between test frame and specimen on the free vertical lateral ends was filled with mineral wool (non-flammable, melting point ≥ 1000 °C).

The furnace was exposed to the fire in compliance with the standard temperature-time curve (ETK) of DIN EN 1363-1 : 1999-10, section 5.1.1. The temperatures in the furnace were measured with six plate thermometers in compliance with DIN EN 1363-1 : 1999-10, section 4.5.1.1. The position of the measuring points corresponded with the specifications in DIN EN 1364-1 : 1999-10.

The furnace pressure was measured in compliance with the specifications in DIN EN 1363-1 : 1999-10. The furnace pressure graph is shown in annex 2.8.

The temperatures on the face of the specimen not exposed to the fire were measured with thermocouples that complied with DIN EN 1363-1 : 1999-10, section 4.5.1.2.

For the position of measuring points, reference is made to annex 1.1 of this Test Report.

In accordance with DIN EN 1364-1 : 1999-10, section 9.3, the horizontal deflection of the specimen was measured in the middle of the tested wall and 50mm from the free edge. Results are shown in annex 2.6. Another three measuring points were arranged as shown in annex 1.1.

5 Test results and observations

The temperature rise above the initial temperature established during the fire test on the non-exposed face of the specimen, the temperatures in the furnace, the differential pressure, evaluation of the error integral, the ambient temperature, and the deformation of the specimen are shown in the graphs in annexes 2.1 to 2.8.

The observations made during the fire test are listed in annex 2.9.

6 Summary of test results and performance criteria specified in DIN EN 1364-1 : 1999-10 and DIN EN 1363-1 : 1999-10

On 2 March 2009, an about 160-mm thick glass-block wall made from "Seves Glassblock 1919/16 60F" glass blocks was tested to determine its fire resistance time when exposing one side of the specimen to the fire.

For a summary of the test results and performance criteria according to DIN EN 1364-1 : 1999-10 in conjunction with DIN EN 1363-1 : 1999-10 for non-load-bearing, separating, thermally insulating walls that are exposed to a fire on one side, reference is made to table 1 of this Test Report.

(Table 1: see next page)

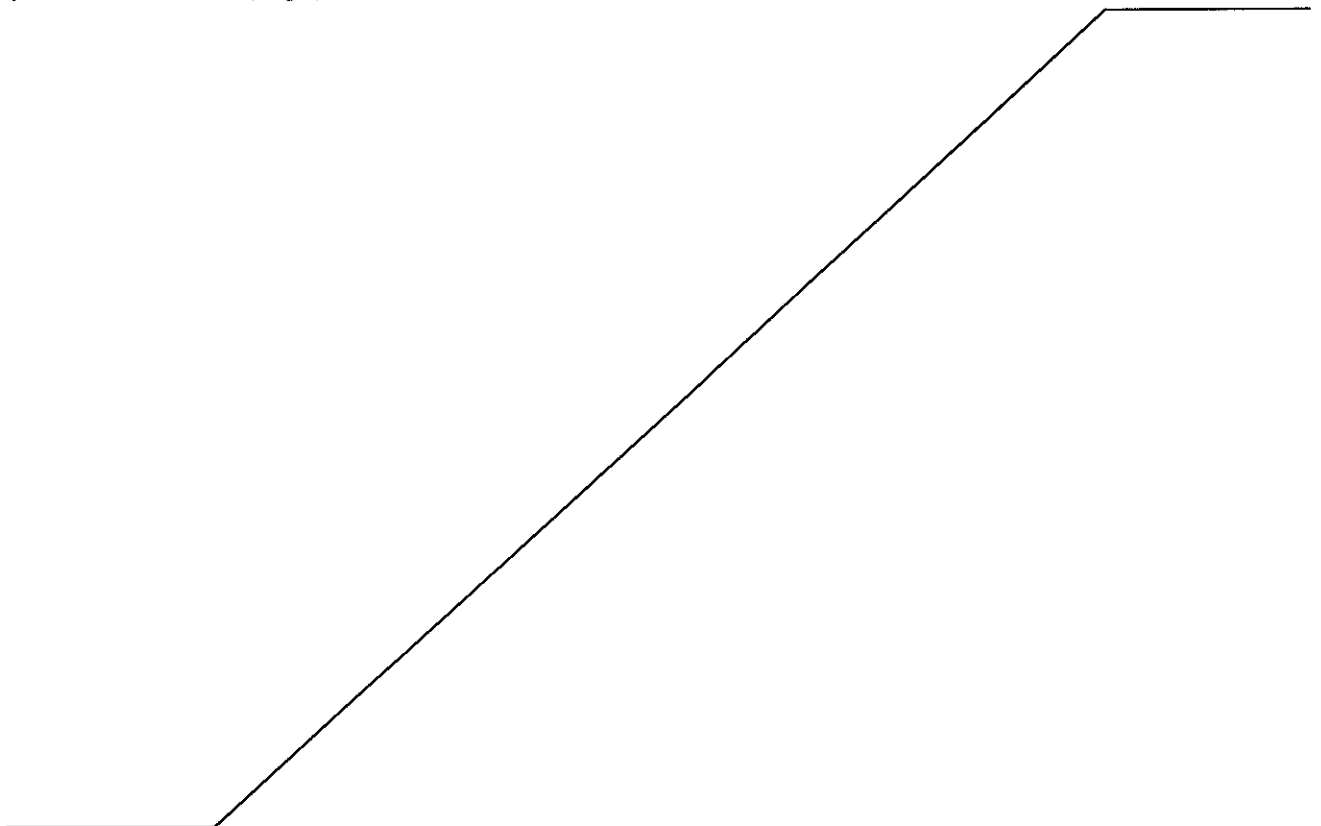


Table 1: Test results and performance criteria according to DIN EN 1364-1 : 1999-10 and DIN EN 1363-1 : 1999-10 for non-loadbearing, separating, thermally insulating walls, when one of their sides is exposed to the fire

Line	Cross reference Details acc. to DIN EN 1363-1 : 1999-10 Section	Requirements		Test results		
				Particulars	Specimen supported on two sides	
1	11.1	<u>Load-bearing capacity</u>	Limit value of vertical compressive strain	Limit value exceeded after:	_2)	
2			Limit value of vertical compression rate	Limit value exceeded after:	_2)	
3	11.2	<u>Integrity</u> to be maintained, i.e.	Ignition of cotton pad to be prevented:	Cotton pad ignited after:	- min. ¹⁾	
4			Cracking to be prevented	Gap gauge could be inserted after:	- min. ¹⁾	
5			Flames on non-exposed face to be prevented	Sustained flaming occurred after:	- min.	
6	11.3	<u>Thermal insulation</u> , i.e. temperature rise on the non-exposed face above initial temperature: Max. adm. mean value $\Delta T = 140$ K Max. adm. Individual value $\Delta T = 180$ K	Test period in minutes:	60	66	
7			Max. temperature rise recorded: mean value in K:	93	125	
8			Max. temperature rise recorded: individual value in K:	128 [2]	164 [2]	
9	5.6	Other particulars	Ambient temperature, when starting the test in the laboratory	18°C		
10			The ambient temperature rose/dropped during the test by max:	1 K		
11	5.2.2.1		Pressure in furnace	see annex 2.8		
12	10.4.4		Test period in minutes:	60	66	
13			Deflection in middle of wall	73 mm	75 mm	
14			Deflection at the free end	15mm	16mm	

- 1) Not tested as there was no need to include this aspect
2) Not subject matter of the test

7 Conclusions based on DIN EN 1364-1 : 1999-10 and DIN EN 1363-1 : 1999-10, and recommendations

The table below lists essential test results with respect to the performance criteria according to DIN EN 1364-1 : 1999-10 in conjunction with DIN EN 1363-1 : 1999-10

Table 2: Test results and performance criteria according to DIN EN 1364-1 : 1999-10 and DIN EN 1363-1 : 1999-10 for non-loadbearing, separating, thermally insulating walls, when one of their sides is exposed to the fire

	Criteria according to standard	Failure after [minutes]:
E	Integrity (sustained flaming, cotton pad, gap gauge)	> 66
I	Thermal insulation	> 66

In view of the results (see tables 1 and 2) produced during the test period between the beginning of fire exposure and the point of failure, the wall system can with respect to its integrity and thermal insulation be recommended to be classified under fire resistance class **EI 60** in accordance with classification standard DIN EN 13501-2 : 2008-01, when one side of the system is exposed to the fire.

8 Direct field of application in accordance with DIN EN 1364-1 : 1999-10, section 13

8.1 General

The results produced in the fire test may be directly transferred to similar designs which are subjected to one or a number of the modifications listed below, and whose design regarding stiffness and strength continues to comply with the requirements of the relevant design standard.

Field of direct application in compliance with the standard		Design is
a)	Reduced glass block dimensions	Acceptable
b)	Variation of the glass block side ratios, provided the largest dimension of the glass blocks and their surface remain unchanged.	Acceptable
c)	Reduced clearance between mullions and transoms (cross members)	Does not apply
d)	Reduced clearance between points of support	Acceptable
e)	Larger frame element dimensions	Does not apply
f)	Bolted glazing supports, if the specimen incorporated click-on glazing support edges	Does not apply

h)	Means for expansion, if the specimen did not incorporate such means	Not acceptable
g)	Modified installation angle of up to 10° from the vertical line	Acceptable
Height increased beyond the height tested		Not acceptable
An identical design may be increased in width, if the specimen was (at a minimum nominal width of 3.0 m) tested with a free vertical edge.		Not acceptable

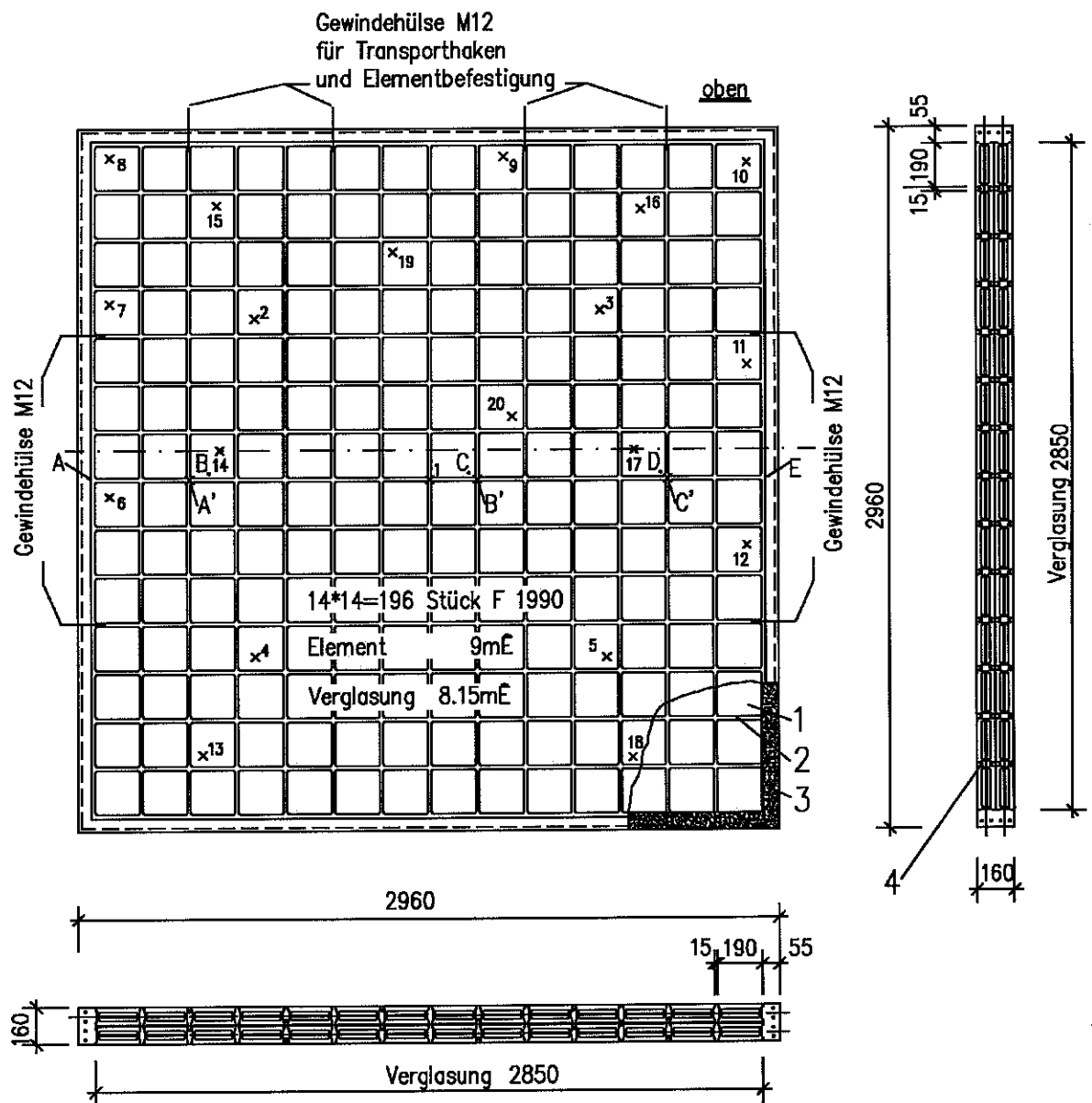
Rohling
ORR Dr. -Ing. A. Rohling
Head of Testing Laboratory



T. Mittmann
i. A.
Dipl.-Ing. T. Mittmann
Engineer/official in charge

List of annexes

- Annexes 1.1 – 1.3 : Structural drawings
- Annex 1.4 : Building material characteristics
- Annex 1.1 : Position of measuring points
- Annex 2.1 : Furnace temperatures
- Annexes 2.2 – 2.4 : Specimen temperatures
- Annex 2.5 : Differential pressure
- Annex 2.6 : Position of furnace thermocouples and pressure measuring points
- Annex 2.7 : Ambient temperature
- Annex 2.8 : Deformations
- Annex 2.9 : Observations during the fire test
- Annexes 3.1 – 3.2 : Photographic documentation



Pos.

- 1 SEVES GLASSBLOCK 1919/16 60F
- 2 Mörtelfuge ca. 15mm
Wärmedämm-Mörtel LM 21
- 3 Randstreifen ca. 55mm
Wärmedämm-Mörtel LM 21
- 4 Bewehrung Bst 500 S gerippt
Randstreifenbewehrung $\varnothing 8\text{mm}$
Horizontalbewehrung $\varnothing 6\text{mm}$
Vertikalbewehrung $\varnothing 6\text{mm}$

1-20, Temperatur-Messstellen auf der dem Feuer abgekehrten Seite, gemäß Abschnitt 4.5.1.2 DIN EN 1363-1

Die Brandraumtemperaturen wurden normgerecht gemäß Abschnitt 4.5.1.1 DIN EN 1363-1 gemessen.

A-F, Verformungsmesspunkte

alle Maße in mm

SEVES GLASSBLOCK 1919/16 60F

Wall element measuring points - deformation measuring points

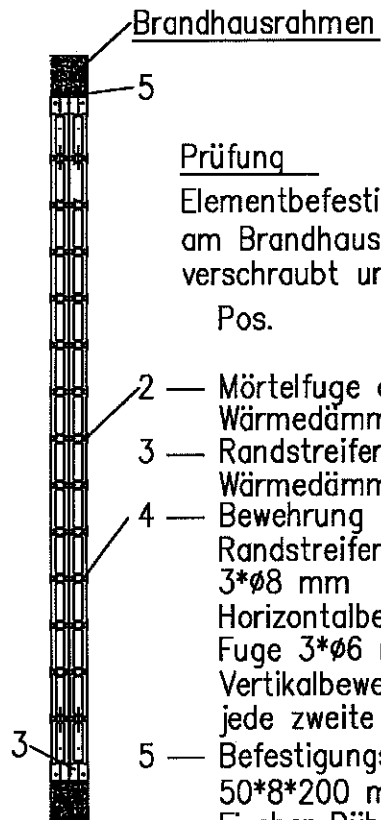
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Annex 1.1 of

Test Report

(3683/748/09) – TM



Brandhausrahmen

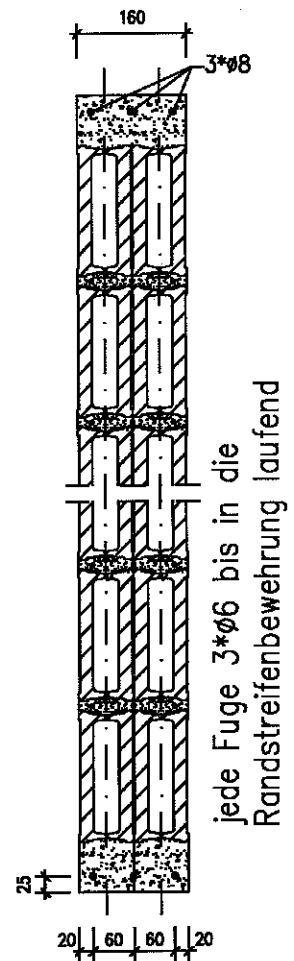
5

Prüfung

Elementbefestigung nur 2 mal oben
am Brandhausrahmen
verschraubt und mit Mineralwolle gestopft

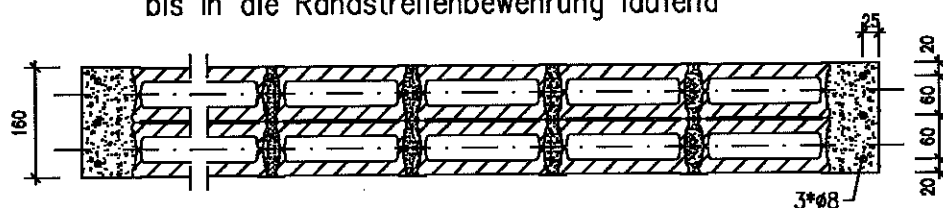
Pos.

- 2 — Mörtelfuge ca. 15mm
Wärmedämm-Mörtel
- 3 — Randstreifen ca. 55mm
Wärmedämm-Mörtel
- 4 — Bewehrung Bst 500 S gerippt
Randstreifenbewehrung
3* ϕ 8 mm
Horizontalbewehrung
Fuge 3* ϕ 6 mm
Vertikalbewehrung
jede zweite Fuge 2* ϕ 6 mm
- 5 — Befestigungsglasche
50*8*200 mit
Fischer Dübel S12 und
Sechskantschraube
DIN 571 10*100mm am
Brandhausrahmen und mit
Sechskantschraube DIN 933 M10*35
am Element befestigt



jede Fuge 3* ϕ 6 bis in die
Randstreifenbewehrung laufend

jede zweite Fuge 2* ϕ 6 im Wechsel innen-aussen
bis in die Randstreifenbewehrung laufend



alle Maße in mm

SEVES GLASSBLOCK 1919/16 60F

Connection with test frame - reinforcement

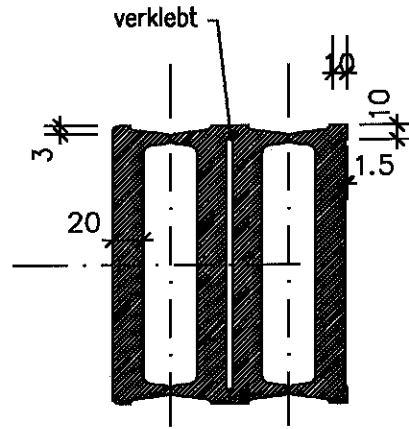
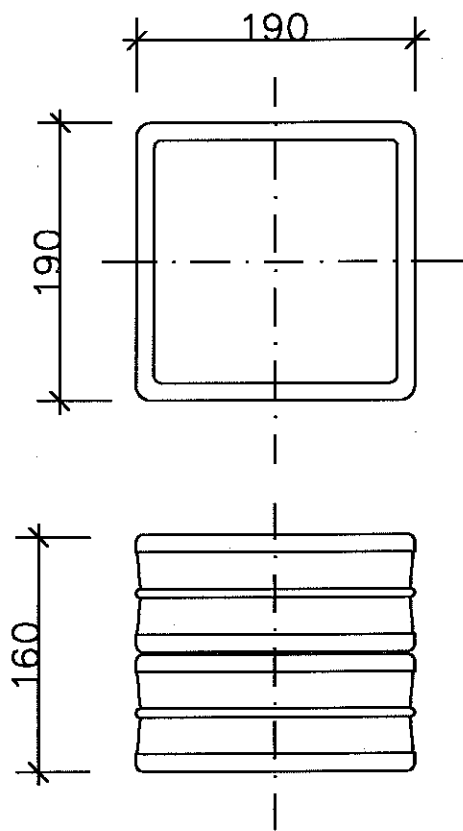
Annex 1.2 of

Test Report

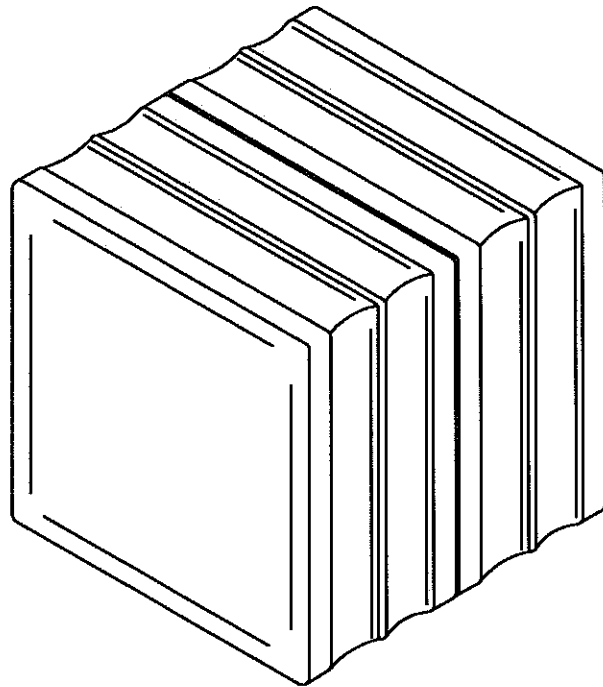
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(3683/748/09) – TM



in Anlehnung an EN 1051 – 1
Maße und Toleranzen nach EN 1051 – 1



alle Maße in mm

SEVES GLASSBLOCK 1919/16 60F

Illustration of glass block

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Annex 1.3 of

Test Report

(3683/748/09) – TM

Material	Supplier	Thickness mm	Material classification Test mark
Mortar LM 21	-	-	A1 acc. to DIN 4102-4 : 1994-03
Seves Glassblock BG 1919/16 60F	Seves Glassblock	160	A1 acc. to DIN 4102-4 : 1994-03

Building material characteristics

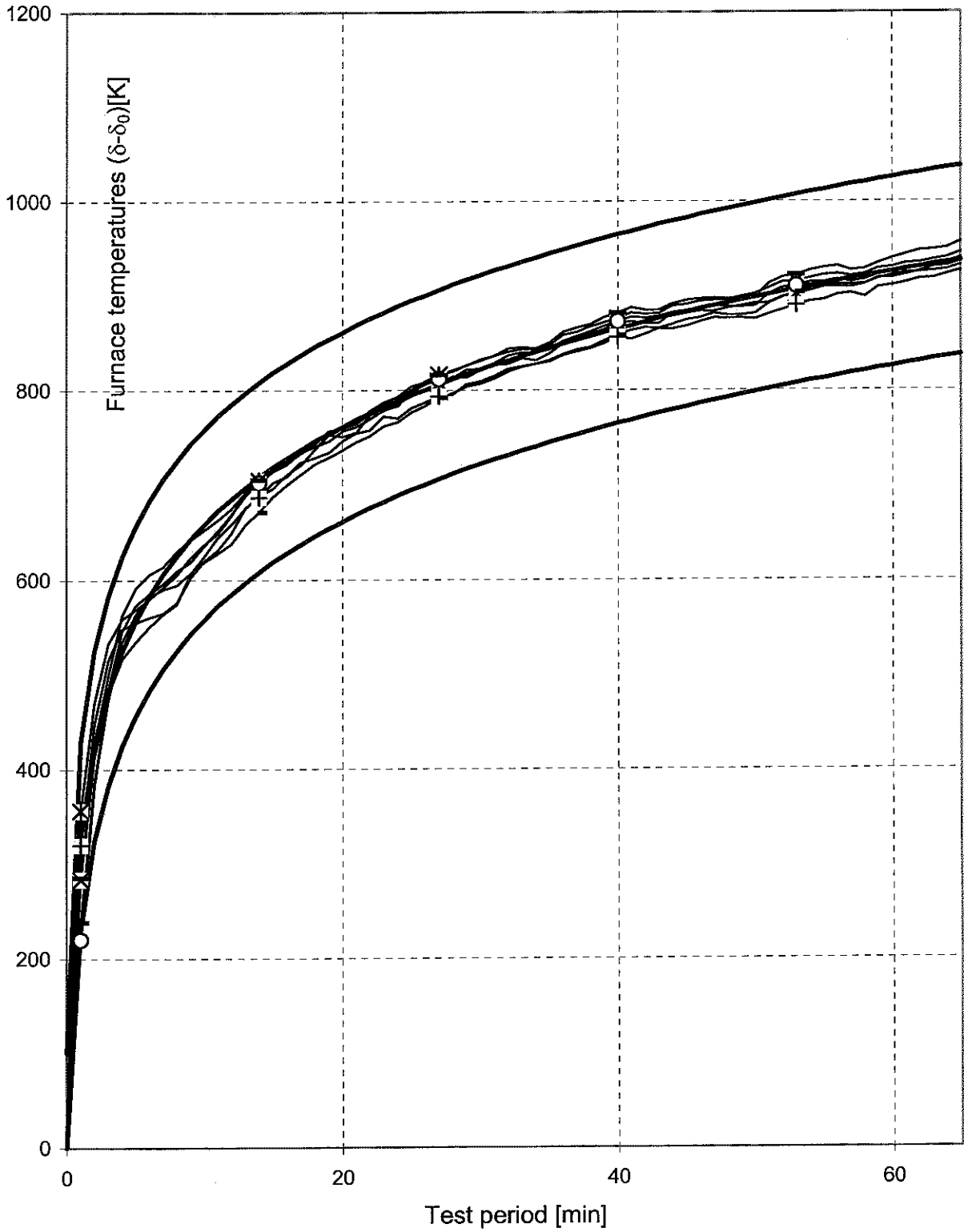
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(3683/748/09) – TM

ETK DIN EN 1363-1: 1999-10



$\delta_0 = 18 \text{ }^\circ\text{C}$

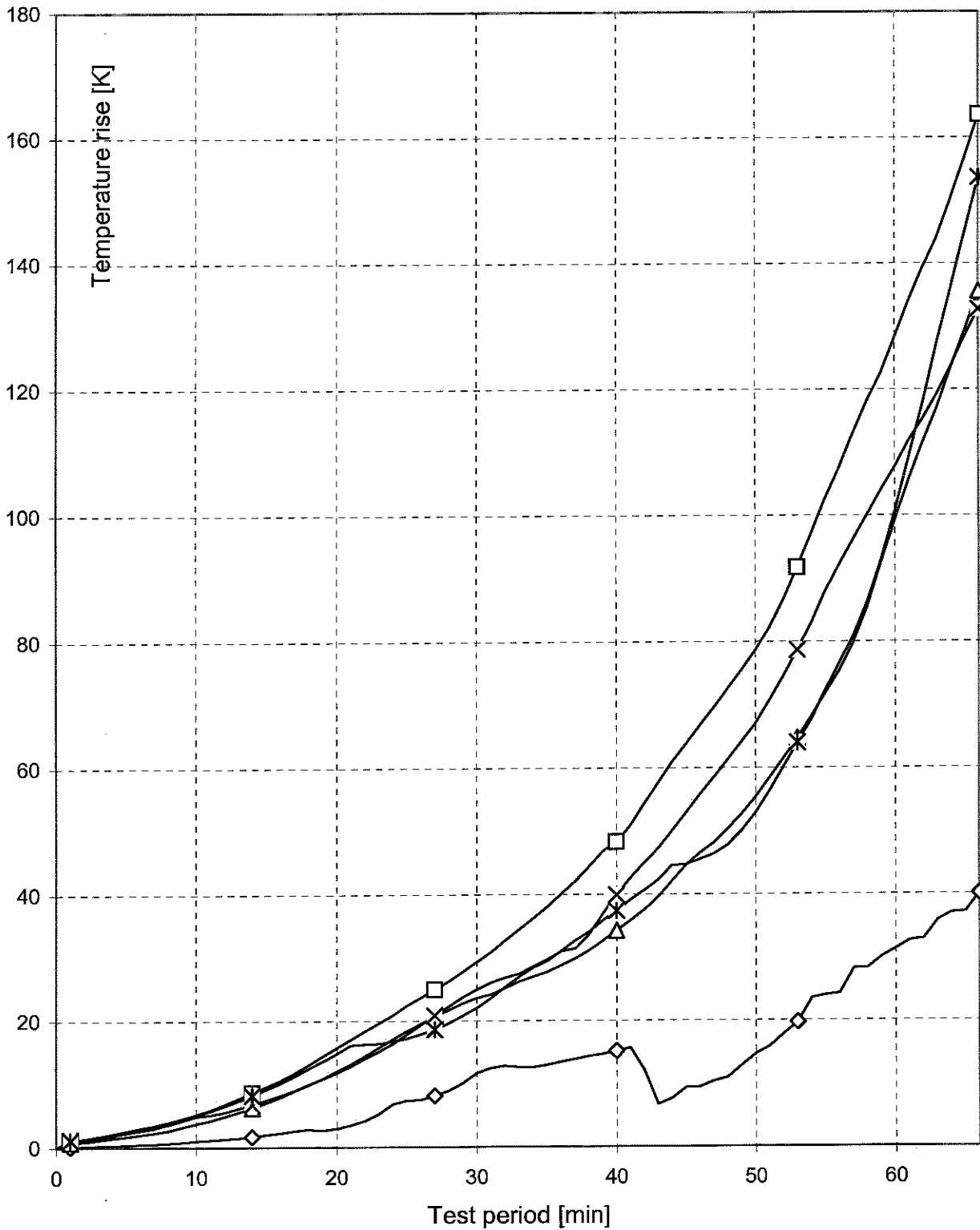
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Furnace temperatures

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Annex 2.1 of
 Test Report
 No. (3683/748/09)-TM

Mean value



◇ MSt.1
 □ MSt.2
 △ MSt.3
 × MSt.4
 ✱ MSt.5

Time [min]	30	60	66	-	-
Mean val.	22 K	93 K	125 K		140 K
Maximum	29 K	128 K	164 K	180 K	
Meas. p.	2	2	2	-	

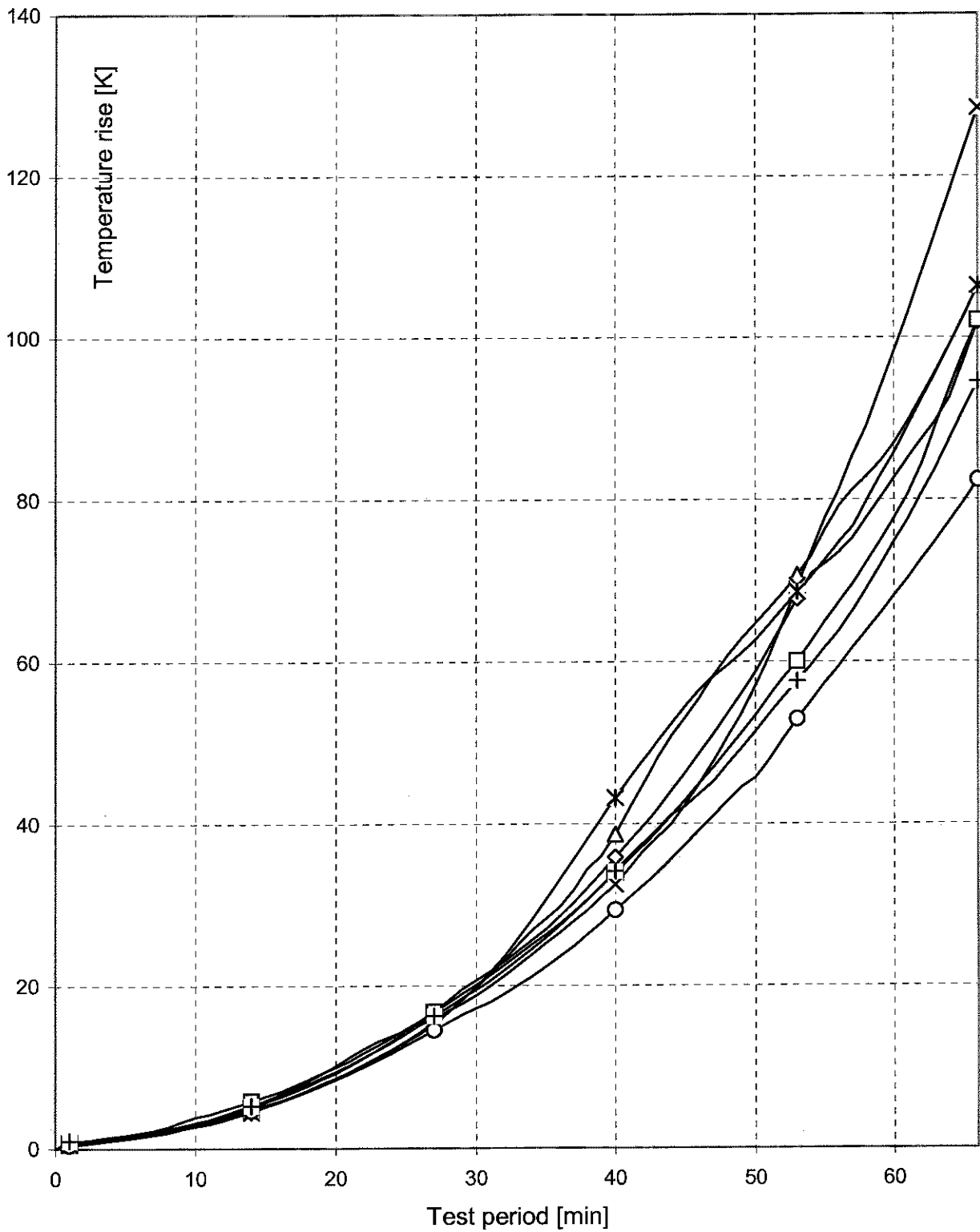
End of fire exposure
after 66 min!

Specimen temperatures

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Annex 2.2 of
 Test Report
 No. (3683/748/09)-TM

Outer wall region



—◇— MSt.6
—□— MSt.7
—△— MSt.8
—X— MSt.9
—*— MSt.10
—○— MSt.11
—+— MSt.12

Time [min]	30	60	66	-
Maximum	21 K	98 K	128 K	180 K
Meas. p.	6	9	9	-

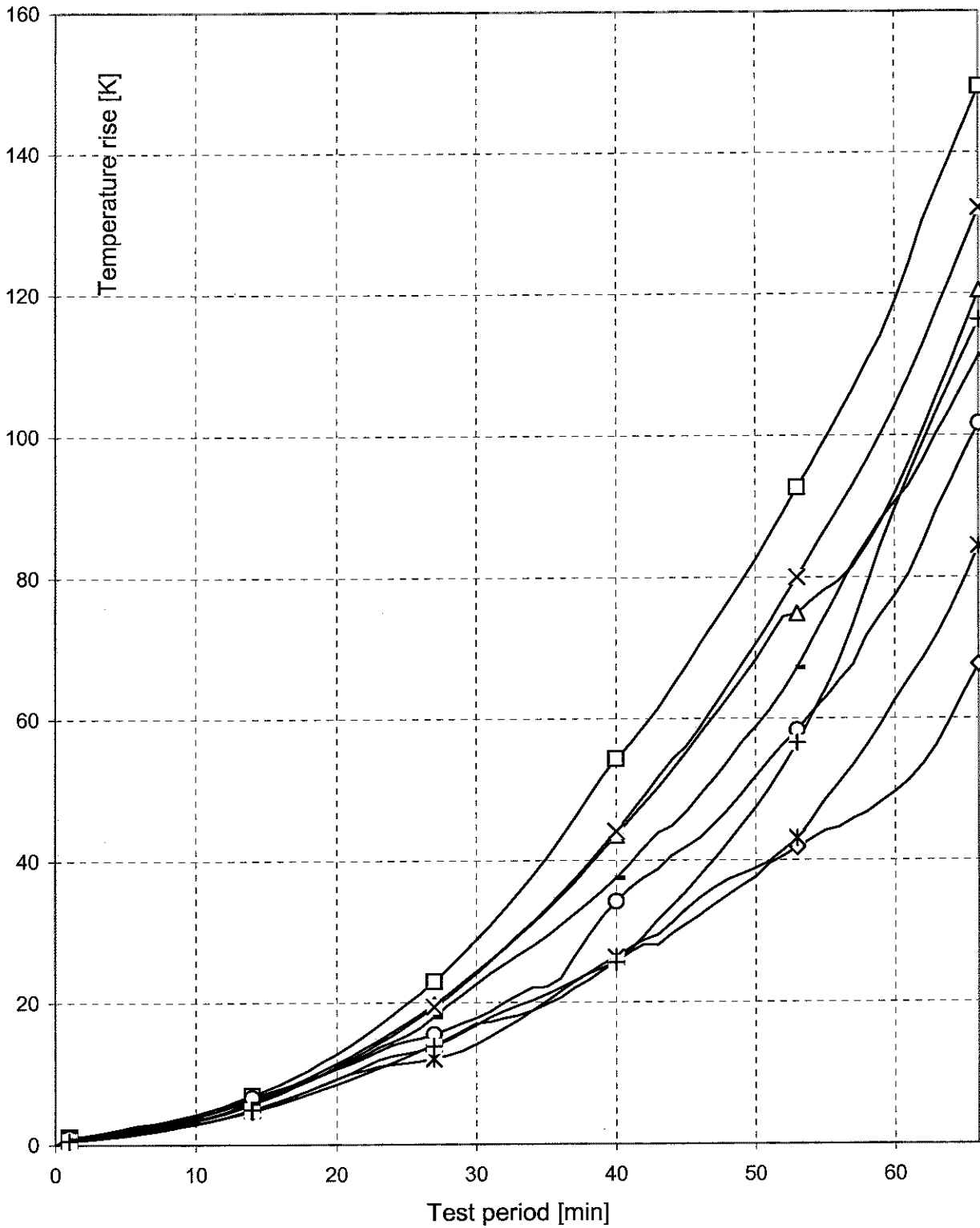
End of fire exposure
after 66 min!

Specimen temperatures

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Annex 2.3 of
 Test Report
 No. (3683/748/09)-TM

Glass blocks, glass block/concrete joint transition



—◇— MSt.13 —□— MSt.14 —△— MSt.15 —×— MSt.16 —*— MSt.17 —○— MSt.18 —+— MSt.19 —■— MSt.20

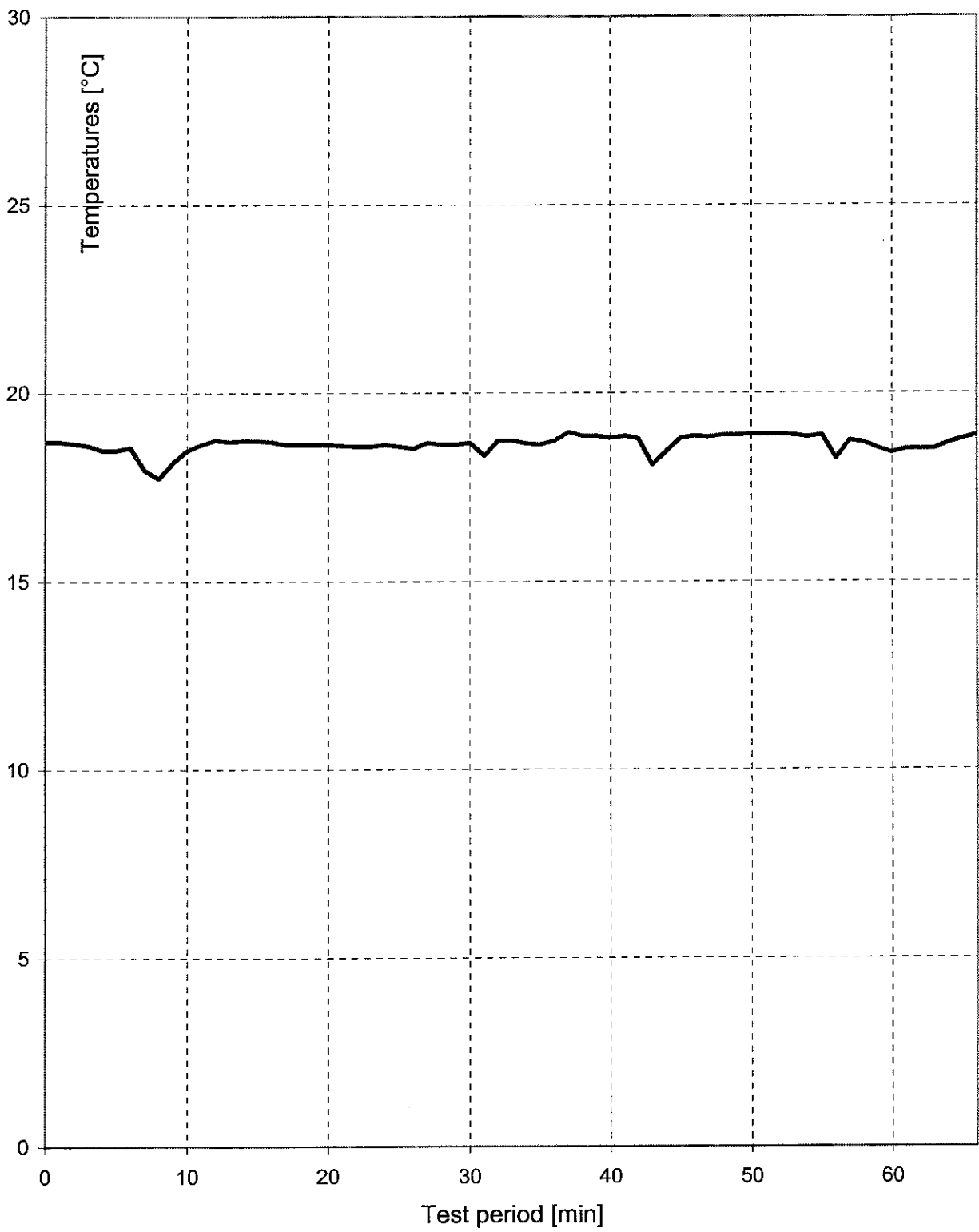
Time [min]	30	60	66	-
Maximum	29 K	119 K	149 K	180 K
Meas. p.	14	14	14	-

End of fire exposure
after 66 min!

Specimen temperatures

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Annex 2.4 of
Test Report
No. (3683/748/09)-TM



— MSt.21

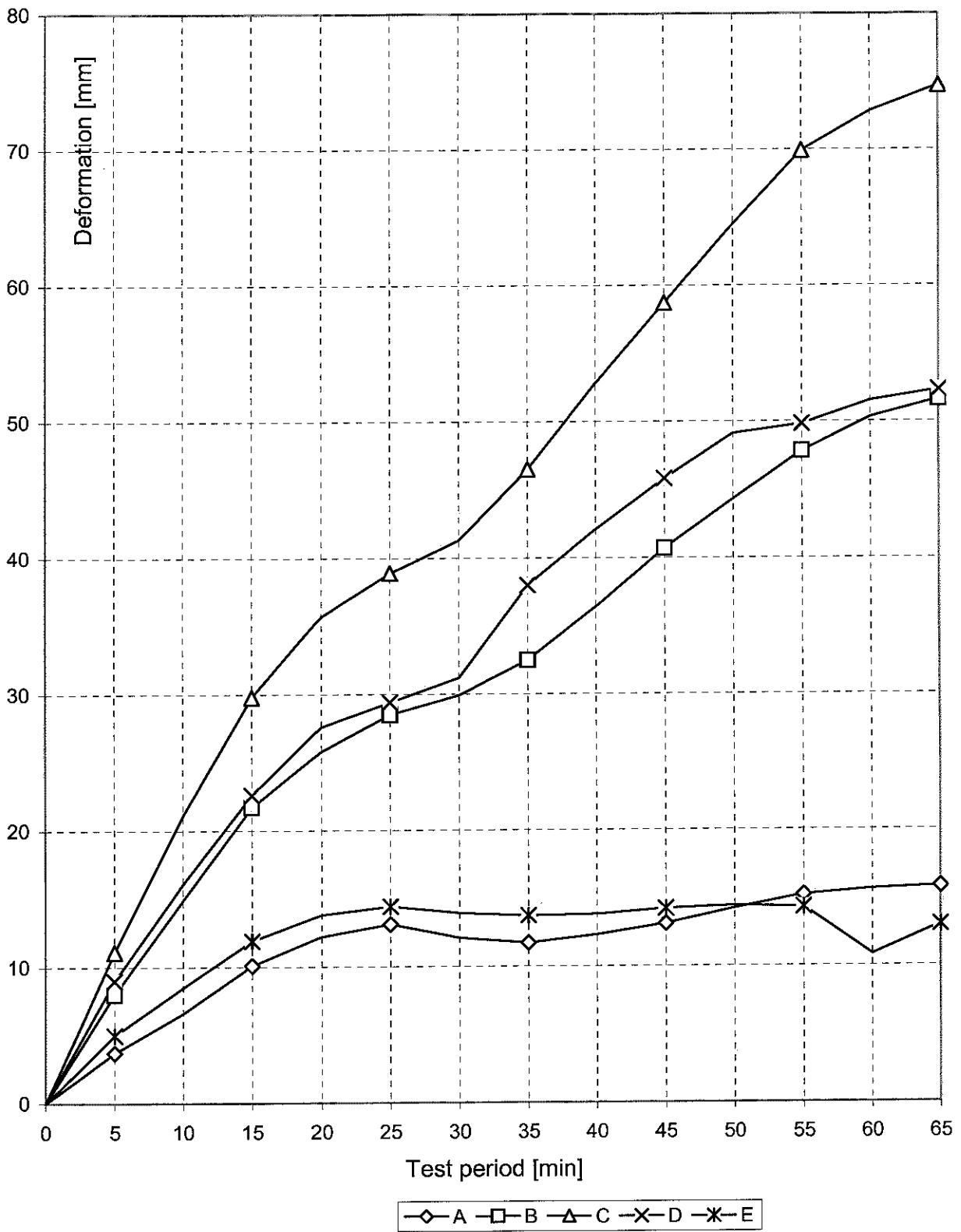
End of fire exposure
after 66 min!

Ambient temperature

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Annex 2.5 of
Test Report
No. (3683/748/09)-TM

Deformation in middle of wall

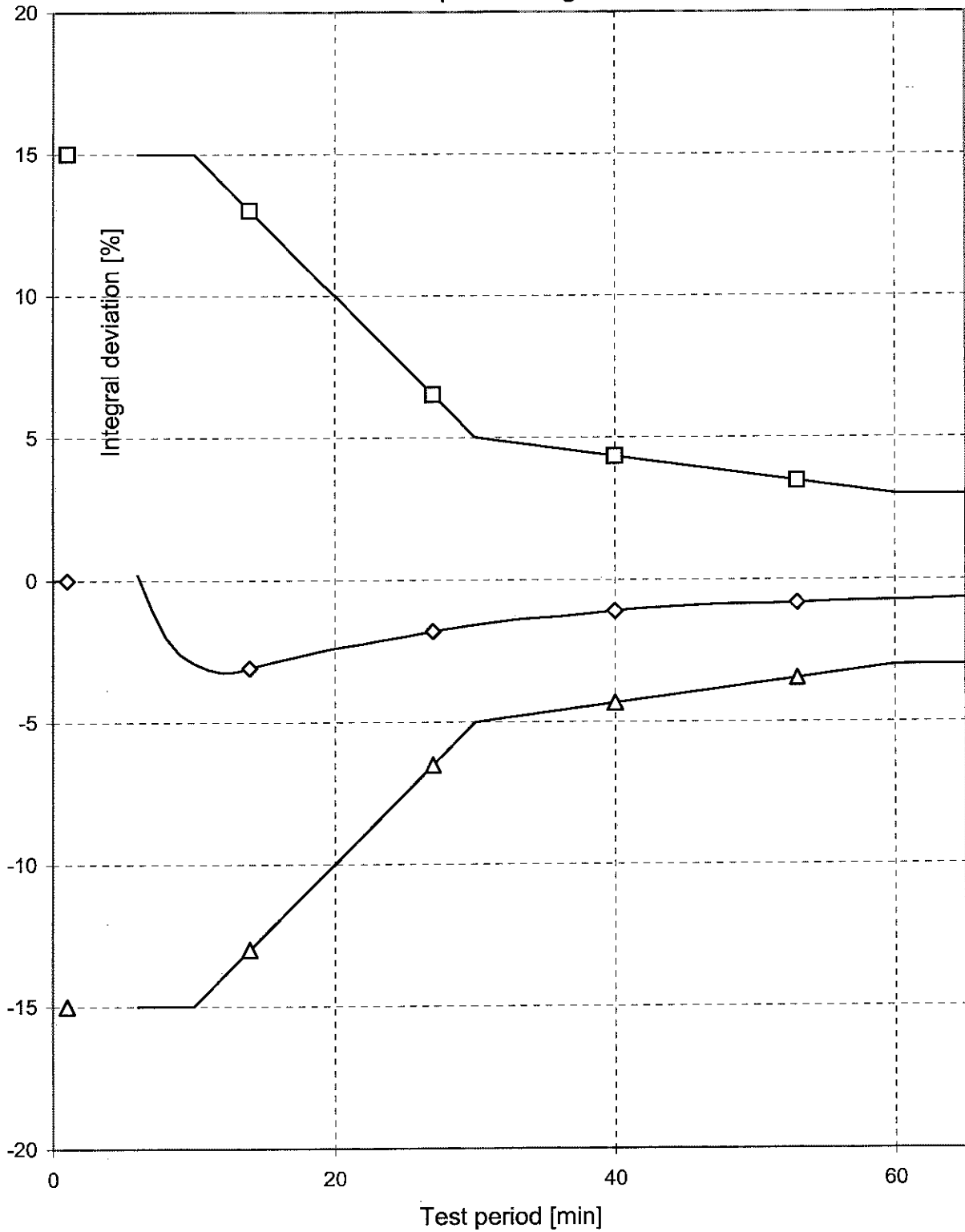


Specimen deformation

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 Test Report
 No. (3683/748/09)-TM

Deviation of furnace temperature integral from the setpoint integral



◆ %-Abw.
 □ Oberes Toleranzband
 ▲ Unteres Toleranzband

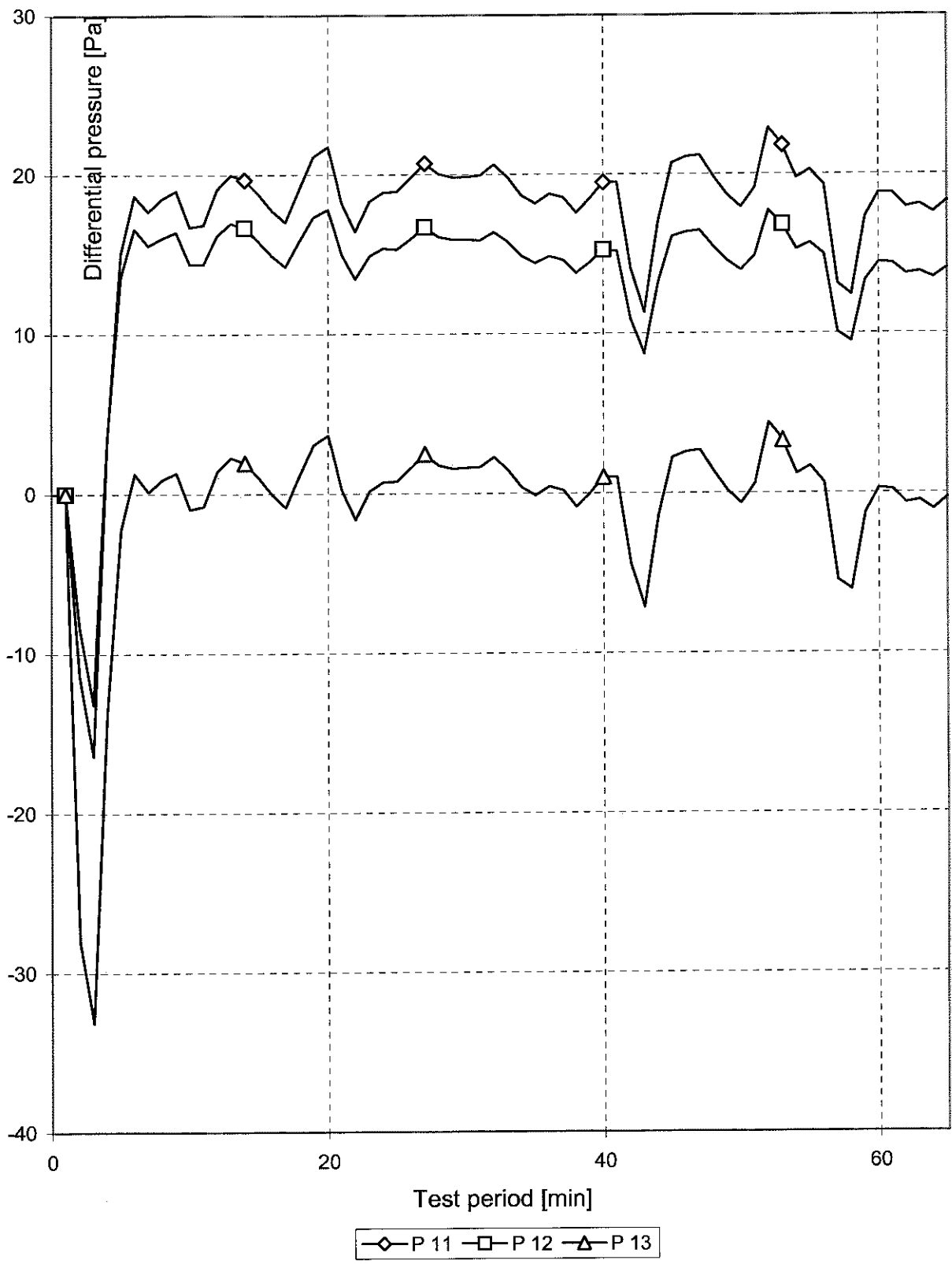
$\delta_0 = 18 \text{ }^\circ\text{C}$

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Evaluation of error integral

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Annex 2.7 of
 Test Report
 No. (3683/748/09)-TM



$\delta_0 = 18 \text{ }^\circ\text{C}$

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Differential pressure in the furnace

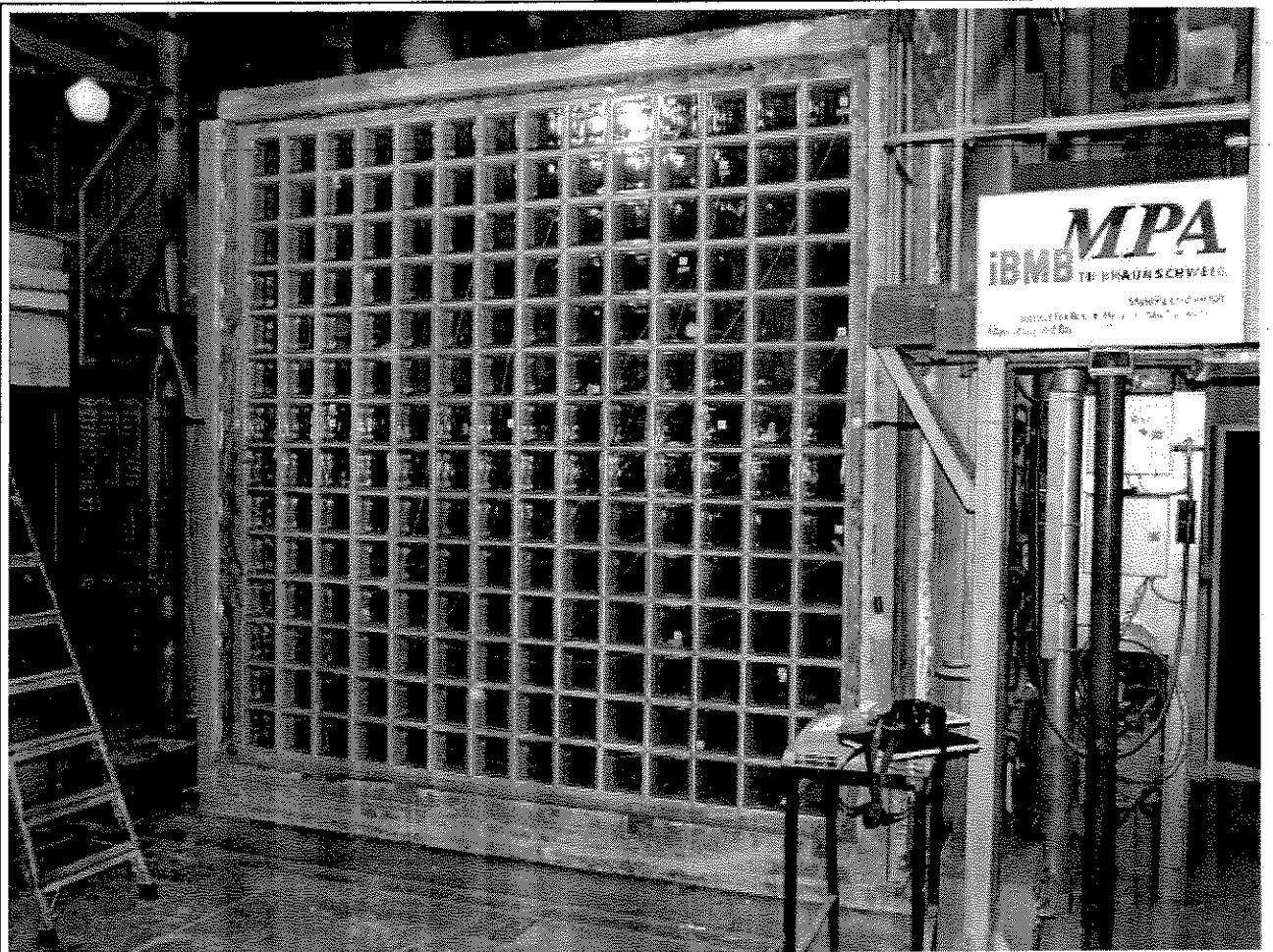
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Annex 2.8 of
 Test Report
 No. (3683/748/09)-TM

Test minute (min.)	Face *)	Observations made for the specimen
1	F	The glass blocks are starting to crack.
22	A	Water vapour escaping through the specimen joints.
37	A	First cracks in the outer shell of the glass blocks.
55	A	Some of the glass blocks are darkening.
57	A	Meas. point 1 has come off; more water vapour is released.
66		End of fire exposure.

*) F = Fire exposed face
A = Non-exposed face

Observations during the fire test	Annex 2.9 of
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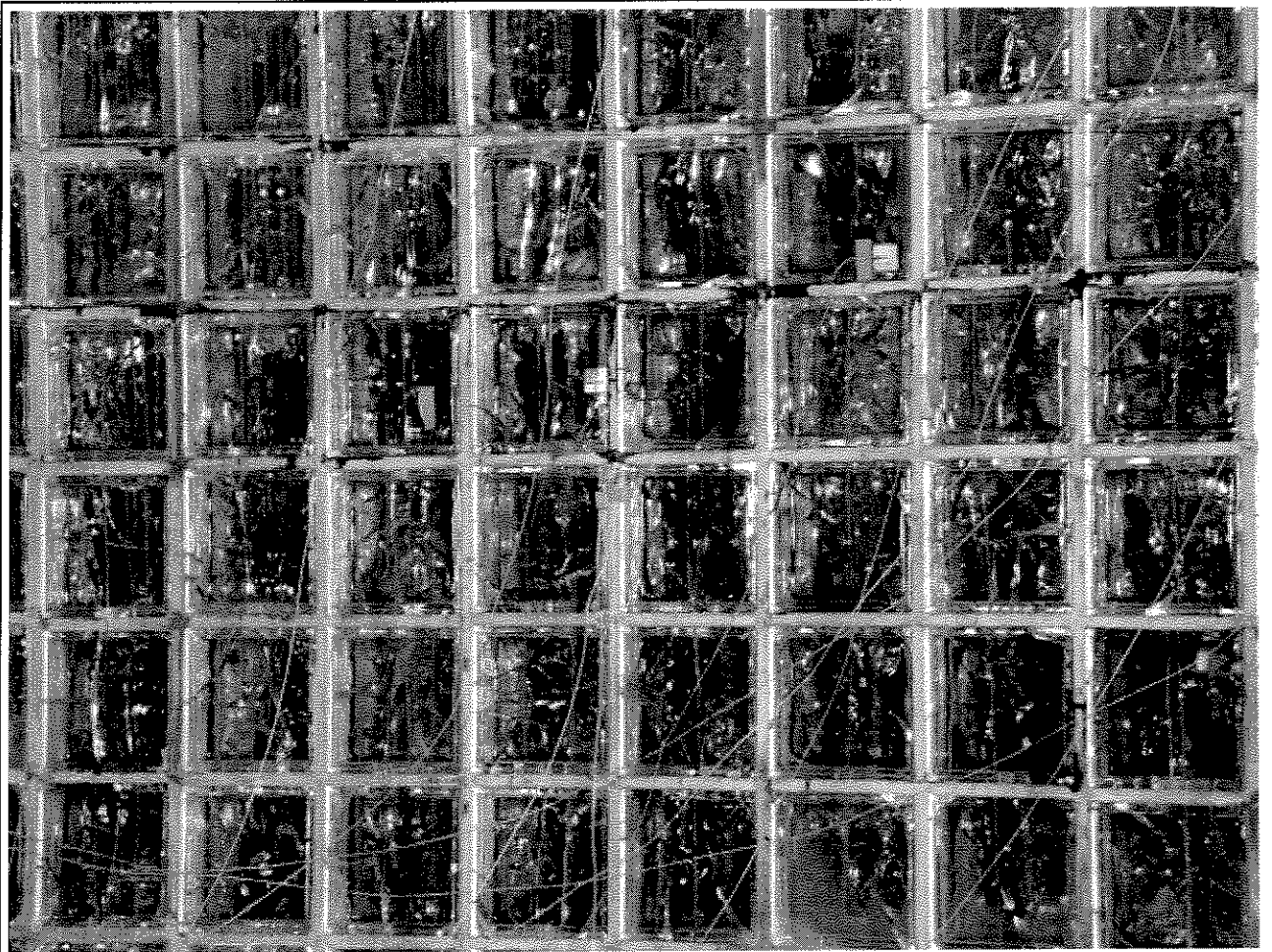


View of wall before the fire test

Photographic documentation

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Annex 3.1 of
Test Report
(3683/748/09) – TM



View of wall after the fire test

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Annex 3.2 of
Test Report
(3683/748/09) – TM