



Centre for Fire Research
Lange Kleiweg 5, Rijswijk
P.O. Box 49
2600 AA Delft

TNO report

2004-CVB-R0055

**Fire resistance in the sense of NEN 6069:2001 of
pipe penetrations, manufactured by G+H
Isolierung GmbH**

www.tno.nl

T +31 15 284 20 00
F +31 15 284 39 55

Date April 2004

Author(s) Dr. ir. G. van den Berg

Copy no

No. of copies

Number of pages 16

Number of appendices

Sponsor ISOPOWER B.V.
Arkansadreef 22a
3565 AR Utrecht
The Netherlands

Project name fire resistance - pipe penetrations

Project number 006.45109/01.27.01

All rights reserved.

No part of this publication may be reproduced and/or published by print, photoprint, microfilm or any other means without the previous written consent of TNO.

In case this report was drafted on instructions, the rights and obligations of contracting parties are subject to either the Standard Conditions for Research Instructions given to TNO, or the relevant agreement concluded between the contracting parties. Submitting the report for inspection to parties who have a direct interest is permitted.

© 2004 TNO

1 Introduction

By order of ISOPOWER B.V. at Utrecht, the TNO Centre for Fire Research has carried out an assessment of the applicability of test results obtained by G+H Isolierung GmbH. The assessment has been carried out on the basis of the Dutch standard NEN 6069:2001 in connection with prEN 1366-3:2001.

2 Basis for the assessment

ISOPOWER has delivered the following test reports to TNO:

- IBMB/MPA Prüfbericht Nr. 3204/4482, dated 03-03-2003;
- IBMB/MPA Prüfzeugnis Nr. 3076/8421, dated 26-09-2001;
- IBMB/MPA Prüfzeugnis Nr. 3400/1761, dated 07-11-2001;
- IBMB/MPA Prüfzeugnis Nr. 3214/4872, dated 26-07-2002.

For reasons of verification of the German test results, TNO has carried out a small-scale fire test on 26th January 2004. The results of this fire test are reported in the TNO letter 2004-CVB-B0137 [rev. 1], dated 16th February 2004.

3 Number and date of this TNO report

April 2004; 2004-CVB-R0055.

4 Test results

4.1 IBMB/MPA Prüfbericht Nr. 3204/4482, dated 03-03-2003

A fire test according to the German standard DIN 4102-11 in connection with the European standard pr-EN 1366-3 was carried out on a total of 24 pipe penetrations.

In the tables 1 - 3, the most important features of the test are given. All details of the fire test are provided in the German test report.

4.2 IBMB/MPA Prüfbericht Nr. 3076/8421, dated 26-09-2001

A fire test according to the European standard pr-EN 1366-3 was carried out on a total of 6 pipe penetrations.

In Table 4, the most important features of the test are given. All details of the fire test are provided in the German test report.

4.3 IBMB/MPA Prüfbericht Nr. 3400/1761, dated 11-07-2001

A fire test according to the European standard pr-EN 1366-3 was carried out on a total of 15 pipe penetrations.

In Table 5, the most important features of the test are given. All details of the fire test are provided in the German test report.

4.4 IBMB/MPA Prüfbericht Nr. 3214/4872, dated 26-07-2002

A fire test according to the German standard DIN 4102-11 in connection with the European standard pr-EN 1366-3 was carried out on a total of 26 pipe penetrations.

In the tables 6 and 7, the most important features of the test are given. All details of the fire test are provided in the German test report.

4.5 TNO letter 2004-CVB-B0137 [rev. 1], dated 16-02-2004

A fire test according to the Dutch standard NEN 6069:2001 was carried out on a total of 3 pipe penetrations.

In the Table 8, the most important features of the test are given. All details of the fire test are provided in the TNO test report.

Table 1 – Pipe penetrations in a 150 mm cellular concrete WALL

Nr.	Pipe details ^{*)}			Insulation of the pipe	Sealing system	Test result	
	Material	Outside diameter [mm]	Wall thickness [mm]			Integrity [min]	Thermal insulation [min]
1.1	copper	42.0	1.5	13 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm (through the penetration)	> 122	112
1.2	copper	42.0	1.5	19 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm (through the penetration)	> 122	> 122
1.3	copper	28.0	1.0	13 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm (through the penetration)	> 122	> 122
1.4	stainless steel	108.0	2.0	19 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm (through the penetration)	> 122	103
1.5	stainless steel	108.0	2.0	25 mm KAIFLEX-KK, length 1350 mm	1 x 2.0 mm ROKU strip, length 250 mm (through the penetration)	> 122	> 122 ^{***)}
1.6	stainless steel	108.0	2.0	25 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm (through the penetration)	> 122	> 122
1.7	stainless steel	108.0	2.0	39 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm (through the penetration)	> 122	> 122 ^{***)}
1.8 ^{**)}	steel	159.0	4.0	60 mm G+H ISOVER IS-HF, length 1350 mm	1 x 1.1 mm Pyrostat UNI RM, length 250 mm (through the penetration)	> 122	105 ^{***)}
1.9	steel	159.0	4.0	32 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm (through the penetration)	> 122	> 122 ^{***)}

^{*)} The pipes were supported at 650 mm distance from the wall at both the directly and not-directly exposed side.

^{**)} This specimen was verified in the fire test carried out at TNO.

^{***)} In case the insulation is extended over the full length of the pipe.

Table 2 – Pipe penetrations in a 100 mm light-weight separation WALL (F90 wall according to DIN 4102-4)

Nr.	Pipe details *)				Insulation of the pipe	Sealing system	Test result	
	Material	Outside diameter [mm]	Wall thickness [mm]				Integrity [min]	Thermal insulation [min]
1.10	copper	42.0	1.5		13 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	-	-
1.11	stainless steel	108.0	2.0		39 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	> 122
1.12	copper	42.0	1.5		19 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	> 122 **)
1.13	copper	28.0	1.0		9 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	> 122
1.14	copper	28.0	1.0		13 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	> 122
1.15	steel	114.3	3.2		39 mm Foanglas, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 20 mm G+H ISOVER ML 3, length 300 mm	> 122	> 122
1.16	stainless steel	108.0	2.0		39 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 25 mm KAIFLEX-KK, length 300 mm	> 122	> 122 **)
1.17	stainless steel	204.0	2.0		32 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 25 mm KAIFLEX-KK, length 400 mm	> 122	88 **)
1.18	stainless steel	204.0	2.0		32 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 32 mm KAIFLEX-KK, length 400 mm	> 122	> 122 **)
1.19	copper	42.0	1.5		19 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 20 mm G+H ISOVER ML 3, length 300 mm	> 122	> 122

*) The pipes were supported at 650 mm distance from the wall at both the directly and not-directly exposed side.

**) In case the insulation is extended over the full length of the pipe.

Table 3 – Pipe penetrations in a 100 mm light-weight separation WALL (F90 wall according to DIN 4102-4)

Nr.	Pipe details *)				Insulation of the pipe	Sealing system	Test result	
	Material	Outside diameter [mm]	Wall thickness [mm]				Integrity [min]	Thermal insulation [min]
1.20	steel	219.1	5.6		60 mm G+H ISOVER ML3, length 1350 mm	1 x 1.1 mm Pyrostat UNI RM, length 250 mm 60 mm G+H ISOVER IS-HF, length 250 mm	> 122	103
1.21	steel	219.1	5.6		100 mm G+H ISOVER ML3, length 1350 mm	1 x 1.1 mm Pyrostat UNI RM, length 250 mm 100 mm G+H ISOVER IS-HF, length 250 mm	> 122	> 122
1.22	stainless steel	54.0	1.5		60 mm G+H ISOVER ML3, length 1350 mm	1 x 1.1 mm Pyrostat UNI RM, length 250 mm 60 mm G+H ISOVER IS-HI, length 250 mm	> 122	> 122
1.23	stainless steel	54.0	1.5		60 mm G+H ISOVER ML3, length 1350 mm	1 x 1.1 mm Pyrostat UNI RM, length 250 mm 60 mm G+H ISOVER IS-HI, length 250 mm 20 mm G+H ISOVER ML3, length 300 mm	> 122	> 122
1.24	steel	159.0	4.0		60 mm G+H ISOVER ML3, length 1350 mm	1 x 1.1 mm Pyrostat UNI RM, length 250 mm 60 mm G+H ISOVER IS-HF, length 250 mm	> 122	92

*) The pipes were supported at 650 mm distance from the wall at both the directly and not-directly exposed side.

Table 4 – Pipe penetrations in a 150 mm cellular concrete WALL

Nr.	Pipe details *)				Insulation of the pipe	Sealing system	Test result	
	Material	Outside diameter [mm]	Wall thickness [mm]				Integrity [min]	Thermal insulation [min]
2.1	steel	323.9	5.6		50 mm KAIFLEX-KK, length 1150 mm	2 x 1.5 mm Universalsbandage G+H in 1.0 mm thick steel casing, length 250 mm (at both sides of the penetration)	> 121	121 **)
2.2	steel	159.0	4.0		50 mm KAIFLEX-KK, length 1150 mm	2 x 1.5 mm Universalsbandage G+H in 1.0 mm thick steel casing, length 250 mm (at both sides of the penetration)	> 121	102
2.3	steel	159.0	4.0		25 mm KAIFLEX-KK, length 1150 mm	2 x 1.5 mm Universalsbandage G+H in 1.0 mm thick steel casing, length 150 mm (at both sides of the penetration)	> 121	105
2.4	steel	159.0	4.0		50 mm KAIFLEX-KK, length 1350 mm	2 x 1.5 mm Universalsbandage G+H, length 500 mm (through the penetration)	> 121	116 **)
2.5	steel	159.0	4.0		50 mm AF/ARMAFLEX, length 1350 mm	2 x 1.5 mm Universalsbandage G+H, length 500 mm (through the penetration)	> 121	> 121 **)
2.6	steel	323.9	5.6		25 mm KAIFLEX-KK, length 1150 mm	2 x 1.5 mm Universalsbandage G+H in 1.0 mm thick steel casing, length 150 mm (at both sides of the penetration)	> 121	87

*) The pipes were supported at 650 mm distance from the wall at both the directly and not-directly exposed side.

**) In case the insulation is extended over the full length of the pipe.

Table 5 – Pipe penetrations in a 150 mm cellular concrete WALL

Pipe details *)				Insulation of the pipe	Sealing system	Test result	
Nr.	Material	Outside diameter [mm]	Wall thickness [mm]			Integrity [min]	Thermal insulation [min]
3.1	steel	323.9	5.6	2 x 50 mm KAIFLEX-KK, length 1350 mm	1.5 mm Universalsbandage G+H, length 1150 mm (through the penetration)	> 122	108 **)
3.2	steel	323.9	5.6	50 mm KAIFLEX-KK, length 1350 mm	1.5 mm Universalsbandage G+H, length 1150 mm (through the penetration)	> 122	> 122 ***)
3.3 **)	steel	323.9	5.6	50 mm KAIFLEX-KK, length 1350 mm	1.5 mm Universalsbandage G+H, length 575 mm (at both sides of the penetration)	> 122	87 ***)
3.4	steel	323.9	5.6	6 mm KAIFLEX-KK, length 1350 mm	1.5 mm Universalsbandage G+H, length 575 mm (at both sides of the penetration)	> 122	90 ***)
3.5	steel	323.9	5.6	none	1.5 mm Universalsbandage G+H, length 1150 mm (through the penetration)	> 122	41
3.6	steel	159.0	4.0	50 mm KAIFLEX-KK, length 1350 mm	1.5 mm Universalsbandage G+H, length 575 mm (at both sides of the penetration)	65	65
3.7	steel	159.0	4.0	50 mm KAIFLEX-KK, length 1350 mm	1.5 mm Universalsbandage G+H, length 1150 mm (through the penetration)	> 122	118 ***)
3.8	steel	159.0	4.0	50 mm AF/ARMAFLEX, length 1350 mm	1.5 mm Universalsbandage G+H, length 1150 mm (through the penetration)	> 122	66
3.9	steel	159.0	4.0	50 mm KAIFLEX-KK, length 1350 mm	1.5 mm Universalsbandage G+H, length 250 mm (through the penetration)	> 122	> 122 ***)
3.10	steel	159.0	4.0	none	1.5 mm Universalsbandage G+H, length 1150 mm (through the penetration)	> 122	55
3.11	copper	88.9	2.0	50 mm KAIFLEX-KK, length 1350 mm	1.5 mm Universalsbandage G+H, length 575 mm (at both sides of the penetration)	54	65
3.12 **)	copper	88.9	2.0	50 mm KAIFLEX-KK, length 1350 mm	1.5 mm Universalsbandage G+H, length 1150 mm (through the penetration)	> 122	105 ***)
3.13	copper	88.9	2.0	6 mm KAIFLEX-KK, length 1350 mm	1.5 mm Universalsbandage G+H, length 575 mm (at both sides of the penetration)	> 122	68
3.14	copper	88.9	2.0	None	1.5 mm Universalsbandage G+H, length 1150 mm (through the penetration)	> 122	36
3.15	steel	33.7	2.3	6 mm KAIFLEX-KK, length 1350 mm	1.5 mm Universalsbandage G+H, length 575 mm (at both sides of the penetration)	> 122	> 122

*) The pipes were supported at 650 mm distance from the wall at both the directly and not-directly exposed side.

***) This specimen was verified in the fire test carried out at TNO.

****) In case the insulation is extended over the full length of the pipe.

Table 6 – Pipe penetrations in a 100 mm light-weight separation WALL (F90 wall according to DIN 4102-4)

Pipe details *)				Insulation of the pipe	Sealing system	Test result	
Nr.	Material	Outside diameter [mm]	Wall thickness [mm]			Integrity [min]	Thermal insulation [min]
4.1	copper	54.0	2.0	25 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 300 mm	> 122	70
4.2	copper	88.9	2.0	25 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	86 **)
4.3	copper	88.9	2.0	25 mm KAIFLEX-KK, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	88 **)
4.4	steel	60.3	2.6	13 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	89
4.5	steel	60.3	2.6	19 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	91
4.6	steel	60.3	2.6	25 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 300 mm	> 122	89
4.7	steel	114.3	3.2	19 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	73
4.8	steel	159.0	4.0	25 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	79 **)
4.9	steel	159.0	4.0	32 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	114 **)
4.10	steel	219.1	5.6	32 mm KAIFLEX-KK, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 400 mm	> 122	> 122 **)
4.11	steel	219.1	5.6	32 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 400 mm	> 122	98 **)
4.12	steel	219.1	5.6	32 mm KAIFLEX-MT, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 400 mm	> 122	113 **)
4.13	steel	114.3	3.2	25 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	87

*) The pipes were supported at 650 mm distance from the wall at both the directly and not-directly exposed side.

**) In case the insulation is extended over the full length of the pipe.

Table 7 – Pipe penetrations in a 100 mm light-weight separation WALL (F90 wall according to DIN 4102-4)

Pipe details *)							Test result	
Nr.	Material	Outside diameter [mm]	Wall thickness [mm]	Insulation of the pipe	Sealing system	Integrity [min]	Thermal insulation [min]	
4.14	steel	114.3	3.2	25 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 300 mm	> 122	67	
4.15	steel	114.3	3.2	32 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	111	
4.16	steel	159.0	4.0	50 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	102 **)	
4.17	copper	88.9	2.0	32 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	113 **)	
4.20	copper	54.0	2.0	19 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	82	
4.21	steel	60.3	2.6	25 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	111	
4.22	steel	114.3	3.2	25 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm, in 1.0 mm thick steel casing 19 mm KAIFLEX-KK, length 300 mm	> 122	87	
4.23	VA steel	108.0	2.0	19 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	72 **)	
4.24	VA steel	108.0	2.0	25 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	52 **)	
4.25	VA steel	54.0	1.5	13 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	97	
4.26	VA steel	54.0	1.5	19 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122	89	

*) The pipes were supported at 650 mm distance from the wall at both the directly and not-directly exposed side.

**) In case the insulation is extended over the full length of the pipe.

Table 8 – Pipe penetrations in a 150 mm cellular concrete WALL

Nr.	Pipe details *)				Insulation of the pipe	Sealing system	Test result	
	Material	Outside diameter [mm]	Wall thickness [mm]				Integrity [min]	Thermal insulation [min]
5.1	steel	323.9	5.6		50 mm ISOPIPE-SBI, length 1350 mm	2 x 1.5 mm Universalsbandage G+H, length 250 mm (through the penetration)	> 120	90 **)
5.2	copper	88.9	2.0		50 mm KAIFLEX-KK, length 1350 mm	2 x 1.5 mm Universalsbandage G+H, length 250 mm (through the penetration)	> 120	> 120
5.3	steel	159.0	4.0		60 mm G+H ISOVER IS-HF, length 1350 mm	1.1 mm Pyrostat UNI RM, length 250 mm (through the penetration)	> 120	> 120

*) The pipes were supported at 650 mm distance from the wall at both the directly and not-directly exposed side.

**) In case the insulation is extended over the full length of the pipe.

5 Considerations

In The Netherlands there is no specific standard for determining the fire resistance of pipe penetrations. In the past, the determination has always been based on the general standard NEN 6069. With the introduction of European standards, the rules as given in the preliminary European standard prEN 1366-3 have been adopted.

As outlined in this report, G+H Isolierung GmbH has performed several fire tests on pipe penetrations. In these tests, both the German standard DIN 4102 – Teil 11 as well as the European standard prEN 1366-3 have been adopted. These standards prescribe different levels for the overpressure in the furnace during the fire test and also the control of the gas temperatures inside the furnace is different. The results of these fire tests are assessed on the basis of the Dutch standard NEN 6069. For this purpose, a verification test on some of the pipe penetrations have been performed. From the verification, it is concluded that the results are very well comparable for all three test methods. Therefore, the German test results are also valid for the Dutch situation.

6 Conclusions

On the basis of the German test results, the Dutch verification test and the considerations mentioned above, it is concluded that the fire resistance in the sense of NEN 6069:2001 of the pipe penetrations as mentioned in Tables 9 and 10 are valid.

Table 9 – Pipe penetrations in a 150 mm cellular concrete WALL *)

Pipe specs.	Insulation of the pipe	Sealing system	fire resistance acc. NEN 6069:2001
(1.1) copper, Ø 42.0 x 1.5 mm	13 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm (through the penetration)	112
(1.2) copper, Ø 42.0 x 1.5 mm	19 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm (through the penetration)	> 122
(1.3) copper, Ø 28.0 x 1.0 mm	13 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm (through the penetration)	> 122
(1.4) stainless steel, Ø 108.0 x 2.0 mm	19 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm (through the penetration)	103
(1.5) stainless steel, Ø 108.0 x 2.0 mm	25 mm KAIFLEX-KK, over full length of the pipe	2.0 mm ROKU strip, length 250 mm (through the penetration)	> 122
(1.6) stainless steel, Ø 108.0 x 2.0 mm	25 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm (through the penetration)	> 122
(1.7) stainless steel, Ø 108.0 x 2.0 mm	39 mm KAIFLEX-KK, over full length of the pipe	2 x 1.1 mm Pyrostat UNI RM, length 250 mm (through the penetration)	> 122
(1.8) steel, Ø 159.0 x 4.0 mm	60 mm G+H ISOVER IS-HF, over full length of the pipe	1.1 mm Pyrostat UNI RM, length 250 mm (through the penetration)	105

(Table continued on next page)

(1.9) steel, Ø 159.0 x 4.0 mm	32 mm KAIFLEX-KK, over full length of the pipe	2 x 1.1 mm Pyrostat UNI RM, length 250 mm (through the penetration)	> 122
(2.1) steel, Ø 323.9 x 5.6 mm	50 mm KAIFLEX-KK, over full length of the pipe	2 x 1.5 mm Universalbandage G+H in 1.0 mm thick steel casing, length 250 mm (at both sides of the penetration)	121
(2.2) steel, Ø 159.0 x 4.0 mm	50 mm KAIFLEX-KK, length 1150 mm	2 x 1.5 mm Universalbandage G+H in 1.0 mm thick steel casing, length 250 mm (at both sides of the penetration)	102
(2.3) steel, Ø 159.0 x 4.0 mm	25 mm KAIFLEX-KK, length 1150 mm	2 x 1.5 mm Universalbandage G+H in 1.0 mm thick steel casing, length 250 mm (at both sides of the penetration)	105
(2.4) steel, Ø 159.0 x 4.0 mm	50 mm KAIFLEX-KK, over full length of the pipe	2 x 1.5 mm Universalbandage G+H, length 500 mm (through the penetration)	116
(2.5) steel, Ø 159.0 x 4.0 mm	50 mm AF/ARMAFLEX, over full length of the pipe	2 x 1.5 mm Universalbandage G+H, length 500 mm (through the penetration)	> 121
(2.6) steel, Ø 323.9 x 5.6 mm	25 mm KAIFLEX-KK, length 1150 mm	2 x 1.5 mm Universalbandage G+H in 1.0 mm thick steel casing, length 150 mm (at both sides of the penetration)	87
(3.1) steel, Ø 323.9 x 5.6 mm	2 x 50 mm KAIFLEX-KK, over full length of the pipe	1.5 mm Universalbandage G+H, length 1150 mm (through the penetration)	108
(3.2) steel, Ø 323.9 x 5.6 mm	50 mm KAIFLEX-KK, over full length of the pipe	1.5 mm Universalbandage G+H, length 1150 mm (through the penetration)	> 122
(3.3) steel, Ø 323.9 x 5.6 mm	50 mm KAIFLEX-KK, over full length of the pipe	1.5 mm Universalbandage G+H, length 575 mm (at both sides of the penetration)	87
(3.4) steel, Ø 323.9 x 5.6 mm	6 mm KAIFLEX-KK, over full length of the pipe	1.5 mm Universalbandage G+H, length 575 mm (at both sides of the penetration)	90
(3.5) steel, Ø 323.9 x 5.6 mm	none	1.5 mm Universalbandage G+H, length 1150 mm (through the penetration)	41
(3.6) steel, Ø 159.0 x 4.0 mm	50 mm KAIFLEX-KK, length 1350 mm	1.5 mm Universalbandage G+H, length 575 mm (at both sides of the penetration)	65
(3.7) steel, Ø 159.0 x 4.0 mm	50 mm KAIFLEX-KK, over full length of the pipe	1.5 mm Universalbandage G+H, length 1150 mm (through the penetration)	118
(3.8) steel, Ø 159.0 x 4.0 mm	50 mm AF/ARMAFLEX, length 1350 mm	1.5 mm Universalbandage G+H, length 1150 mm (through the penetration)	66
(3.9) steel, Ø 159.0 x 4.0 mm	50 mm KAIFLEX-KK, over full length of the pipe	1.5 mm Universalbandage G+H, length 250 mm (through the penetration)	> 122
(3.10) steel, Ø 159.0 x 4.0 mm	none	1.5 mm Universalbandage G+H, length 1150 mm (through the penetration)	55
(3.11) copper, Ø 88.9 x 2.0 mm	50 mm KAIFLEX-KK, length 1350 mm	1.5 mm Universalbandage G+H, length 575 mm (at both sides of the penetration)	65
(3.12) copper, Ø 88.9 x 2.0 mm	50 mm KAIFLEX-KK, over full length of the pipe	1.5 mm Universalbandage G+H, length 1150 mm (through the penetration)	105
(3.13) copper, Ø 88.9 x 2.0 mm	6 mm KAIFLEX-KK, length 1350 mm	1.5 mm Universalbandage G+H, length 575 mm (at both sides of the penetration)	68
(3.14) copper, Ø 88.9 x 2.0 mm	none	1.5 mm Universalbandage G+H, length 1150 mm (through the penetration)	36

(Table continued on next page)

(3.15) steel, Ø 33.7 x 2.3 mm	6 mm KAIFLEX-KK, length 1350 mm	1.5 mm Universalbandage G+H, length 575 mm (at both sides of the penetration)	> 122
(5.1) steel, Ø 323.9 x 5.6 mm	50 mm ISOPIPE-SBI, over full length of the pipe	2 x 1.5 mm Universalbandage G+H, length 250 mm (through the penetration)	90
(5.2) copper, Ø 88.9 x 2.0 mm	50 mm KAIFLEX-KK, length 1350 mm	2 x 1.5 mm Universalbandage G+H, length 250 mm (through the penetration)	> 120
(5.3) steel, Ø 159.0 x 4.0 mm	60 mm G+H ISOVER IS-HF, length 1350 mm	1.1 mm Pyrostat UNI RM, length 250 mm (through the penetration)	> 120

*) The mentioned fire resistance is valid for the system as specified, with supports of the pipe at a distance of maximum 650 mm from the wall.

Table 10 – Pipe penetrations in a 100 mm light-weight separation WALL (F90 wall according to DIN 4102-4) *)

Pipe specs.	Insulation of the pipe	Sealing system	fire resistance acc. NEN 6069:2001
(1.11) stainless steel, Ø 108.0 x 2.0 mm	39 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122
(1.12) copper, Ø 42.0 x 1.5 mm	19 mm KAIFLEX-KK, over full length of the pipe	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122
(1.13) copper, Ø 28.0 x 1.0 mm	9 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122
(1.14) copper, Ø 28.0 x 1.0 mm	13 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	> 122
(1.15) steel, Ø 114.3 x 3.2 mm	39 mm Foamglas, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 20 mm G+H ISOVER ML3, length 300 mm	> 122
(1.16) stainless steel, Ø 108.0 x 2.0 mm	39 mm KAIFLEX-KK, over full length of the pipe	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 25 mm KAIFLEX-KK, length 300 mm	> 122
(1.17) stainless steel, Ø 204.0 x 2.0 mm	32 mm KAIFLEX-KK, over full length of the pipe	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 25 mm KAIFLEX-KK, length 400 mm	88
(1.18) stainless steel, Ø 204.0 x 2.0 mm	32 mm KAIFLEX-KK, over full length of the pipe	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 32 mm KAIFLEX-KK, length 400 mm	> 122
(1.19) copper, Ø 42.0 x 1.5 mm	19 mm KAIFLEX-KK, length 1350 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 20 mm G+H ISOVER ML3, length 300 mm	> 122
(1.20) steel, Ø 219.1 x 5.6 mm	60 mm G+H ISOVER ML3, length 1350 mm	1.1 mm Pyrostat UNI RM, length 250 mm 60 mm G+H ISOVER IS-HF, length 250 mm	103
(1.21) steel, Ø 219.1 x 5.6 mm	100 mm G+H ISOVER ML3, length 1350 mm	1.1 mm Pyrostat UNI RM, length 250 mm 100 mm G+H ISOVER IS-HF, length 250 mm	> 122
(1.22) stainless steel, Ø 54.0 x 1.5 mm	60 mm G+H ISOVER ML3, length 1350 mm	1.1 mm Pyrostat UNI RM, length 250 mm 60 mm G+H ISOVER IS-HI, length 250 mm	> 122
(1.23) stainless steel, Ø 54.0 x 1.5 mm	60 mm G+H ISOVER ML3, length 1350 mm	1.1 mm Pyrostat UNI RM, length 250 mm 60 mm G+H ISOVER IS-HI, length 250 mm 20 mm G+H ISOVER ML3, length 300 mm	> 122

(Table continued on next page)

(1.24) steel, Ø 159.0 x 4.0 mm	60 mm G+H ISOVER ML3, length 1350 mm	1.1 mm Pyrostat UNI RM, length 250 mm 60 mm G+H ISOVER IS-HF, length 250 mm	92
(4.1) copper, Ø 54.0 x 2.0 mm	25 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 300 mm	70
(4.2) copper, Ø 88.9 x 2.0 mm	25 mm AF/ARMAFLEX, over full length of the pipe	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	86
(4.3) copper, Ø 88.9 x 2.0 mm	25 mm KAIFLEX-KK, over full length of the pipe	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	88
(4.4) steel, Ø 60.3 x 2.6 mm	13 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	89
(4.5) steel, Ø 60.3 x 2.6 mm	19 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	91
(4.6) steel, Ø 60.3 x 2.6 mm	25 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 300 mm	89
(4.7) steel, Ø 114.3 x 3.2 mm	19 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	73
(4.8) steel, Ø 159.0 x 4.0 mm	25 mm AF/ARMAFLEX, over full length of the pipe	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	79
(4.9) steel, Ø 159.0 x 4.0 mm	32 mm AF/ARMAFLEX, over full length of the pipe	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	114
(4.10) steel, Ø 219.1 x 5.6 mm	32 mm KAIFLEX-KK, over full length of the pipe	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 400 mm	> 122
(4.11) steel, Ø 219.1 x 5.6 mm	32 mm AF/ARMAFLEX, over full length of the pipe	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 400 mm	98
(4.12) steel, Ø 219.1 x 5.6 mm	32 mm KAIFLEX-MT, over full length of the pipe	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 400 mm	113
(4.13) steel, Ø 114.3 x 3.2 mm	25 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	87
(4.14) steel, Ø 114.3 x 3.2 mm	25 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 300 mm	67
(4.15) steel, Ø 114.3 x 3.2 mm	32 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	111
(4.16) steel, Ø 159.0 x 4.0 mm	50 mm AF/ARMAFLEX, over full length of the pipe	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	102
(4.17) copper, Ø 88.9 x 2.0 mm	32 mm AF/ARMAFLEX, over full length of the pipe	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	113
(4.20) copper, Ø 54.0 x 2.0 mm	19 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	82
(4.21) steel, Ø 60.3 x 2.6 mm	25 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	111
(4.22) steel, Ø 114.3 x 3.2 mm	25 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM in 1.0 mm thick steel casing, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	87
(4.23) VA steel, Ø 108.0 x 2.0 mm	19 mm AF/ARMAFLEX, over full length of the pipe	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	72

(Table continued on next page)

(4.24) VA steel, Ø 108.0 x 2.0 mm	25 mm AF/ARMAFLEX, over full length of the pipe	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	52
(4.25) VA steel, Ø 54.0 x 1.5 mm	13 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	97
(4.26) VA steel, Ø 54.0 x 1.5 mm	19 mm AF/ARMAFLEX, length 1300 mm	2 x 1.1 mm Pyrostat UNI RM, length 250 mm 19 mm KAIFLEX-KK, length 300 mm	89

*) The mentioned fire resistance is valid for the system as specified, with supports of the pipe at a distance of maximum 650 mm from the wall.



Dr. Ir. G. van den Berg