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REPORT

Summary report – fire resistance according to NEN 6069:2011 and NEN-EN 1366-3 of penetrations, sealed with the FP Sealing System, applied for 30 minutes fire resistance

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1. INTRODUCTION

Efectis Nederland has been commissioned by Den Braven located at Oosterhout to summarise the test results and assessments for penetrations where the FP Sealing System has been applied for 30 minutes fire resistance. The current assessment is given on the basis of the Dutch standard NEN 6069:2011.

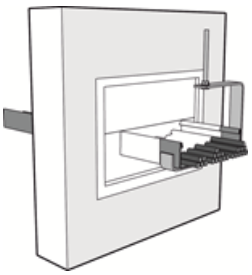

Figure 1.1 FP Sealing System

The assessment is based on the following test reports:

- TNO Centre for Fire Research test report 2003-CVB-R0276
- TNO Centre for Fire Research test report 2005-CVB-R0151
- TNO Centre for Fire Research test report 2005-CVB-R0156
- Efectis Nederland BV test report 2007-Efectis-R0191
- Efectis Nederland BV test report 2007-Efectis-R0192[Rev.1]
- Efectis Nederland BV test report 2007-Efectis-R0383
- Efectis Nederland BV test report 2008-Efectis-R0381[Rev.1]
- Efectis Nederland BV test report 2008-Efectis-R0451
- Efectis Nederland BV test report 2008-Efectis-R0452
- Efectis Nederland BV test report 2008-Efectis-R0456[Rev.1]
- Efectis Nederland BV test report 2008-Efectis-R0457[Rev.2]
- Efectis Nederland BV test report 2008-Efectis-R0458[Rev.2]
- Efectis Nederland BV test report 2008-Efectis-R0461[Rev.1]
- Efectis Nederland BV test report 2008-Efectis-R0462[Rev.1]
- Efectis Nederland BV test report 2011-Efectis-R0299
- Peutz test report Y.1432.RA.001

A summary of the reports is given in Chapter 2. In Chapter 3 the conclusion is presented. Additional documentation for the purpose of supporting and clarifying the conclusions in Chapter 3 is provided in the appendix of this report. The documentation has been provided by Den Braven. Efectis Nederland has checked and confirmed the accuracy of the contents.

1.1 INFORMATION REGARDING REVISIONS

Version 0, April 2015

2. TEST AND ASSESSMENT REPORTS

2.1 TNO CENTRE FOR FIRE RESEARCH TEST REPORT 2003-CVB-R0276

This report describes the results of a fire test according to NEN6069:2001 for a cable penetration through a wall with a cable tray and three cable bundles, sealed with the FP Sealing System. For details see Appendix A, Figure A.1.

The test specimen had the following characteristics:

- Aerated concrete wall, thickness 100 mm, installation opening 800 x 400 mm (b x h);
- The installation opening is sealed with a FP Fire Board, thickness 60 mm and density 141 kg/m^3. Both sides are coated with FP Intumescent Coating.
- Penetration: one steel perforated cable tray (60 x 600 x 60 mm) with three cable bundles: A to C.
- FP Intumescent Acrylic is applied between the individual cables, between the cables and installation openings as well as between the cables and the board;
- The cables are provided with FP Intumescent Coating on both sides of the FP Fire Board over a length of 50 mm. The layer thickness was a few millimetres;
- The cable tray was supported at 80 mm and 465 mm from both sides of the wall.
- The cable bundles had the following characteristics:

	Number of cables per bundle	External diameter	Cross-sectional area copper core	Type Code
A	6	19.5 mm	5 x 10 mm^2	YVVK-8mb
B	3	28 mm	4 x 35 mm^2	IKFY mvK mb/1000
	1	20 mm	5 x 10 mm^2	YVVK-8mb
	1	22 mm	5 x 16 mm^2	YmvK
C	5	11.5 mm	-	YMVK mb 4G 2.5 ALCAIEL AKB-B

A summary of the results according to NEN 6069:2001 is given in the report:

Criterion	Time duration calculated from the start of heating during which the criterion according to NEN 6069:2001 was fulfilled.
	NEN 6069:2001
a) Integrity (E)	84 minutes
b) Thermal Insulation (I)	46 minutes

The determined fire resistance according to Appendix A of van NEN 6069:2001, with respect to the separating function of the investigated cable penetration in a wall, is 46 minutes.

2.2 TNO CENTRE FOR FIRE RESEARCH TEST REPORT 2005-CVB-R0151

This report describes the results of a fire test according to NEN6069:2001 in conjunction with prEN1366-3:2003 for a FP Fire Board in an aerated concrete wall, 100 mm thick. Pipe penetrations were also present in the test frame (reported separately). For details see Appendix A, Figure A.2.

The test specimen, type I, had the following characteristics:

- Built into an aerated concrete wall, thickness 100 mm, installation opening 100 x 1000 mm;
- The FP Fire Board, treated with 1 layer of FP Intumescent Coating beforehand, had the following characteristics:
  - Dimensions: 100 x 1000 x 60 mm (b x h x d);
  - Density: 155 kg/m³;
- Mounting: wedged into the wall;
- Finishing: penetration on both sides provided with FP Intumescent Coating, two layers, minimum 600 g/m^2.

A summary of the results according to NEN 6069:2001 in conjunction with prEN 1366-3:2003 is given in the report:

Criterion	Time duration calculated from the start of heating during which the criterion according to NEN 6069:2001 and prEN 1366-3:2003 was fulfilled.	
	NEN 6069:2001	prEN 1366-3:2003
a) Integrity (E)	120 minutes	>120 minutes
b) Thermal Insulation (I)	120 minutes	>120 minutes

The determined fire resistance according to Appendix A of van NEN 6069:2001, with respect to the separating function of the investigated FP Fire Board, is 120 minutes.

2.3 TNO CENTRE FOR FIRE RESEARCH TEST REPORT 2005-CVB-R0156

This report describes the results of a fire test according to NEN6069:2001 in conjunction with prEN1366-3:2003 for a PVC Ø40 mm pipe penetration in an aerated concrete wall of thickness 100 mm. For details see Appendix A, Figure A.3.

The test specimen, type N, had the following characteristics:

- Built into an aerated concrete wall, thickness 100 mm, installation opening Ø40 mm;
- PVC pipe, Ø40 mm / t = 4.1mm;
- Mounting: wedged into the installation opening;
- The end of the pipe, on the not directly heated side, was sealed with a stone wool sleeve;
- Finishing: 200 mm FP Intumescent Coating, min. 600 g/m², was applied to the pipe at both sides of the wall. Around the pipe, the aerated concrete wall was treated with FP Intumescent Coating over a distance of 25 mm.
- The pipe was supported at 250 mm and 750 mm from the not directly heated side of the wall.

A summary of the results according to NEN 6069:2001 in conjunction with prEN 1366-3:2003 is given in the report:

Criterion	Time duration calculated from the start of heating during which the criterion according to NEN 6069:2001 and prEN 1366-3:2003 was fulfilled.	
	NEN 6069:2001	prEN 1366-3:2003
a) Integrity (E)	120 minutes	>120 minutes
b) Thermal Insulation (I)	120 minutes	>120 minutes

The determined fire resistance according to Appendix A of van NEN 6069:2001, with respect to the separating function of the investigated pipe penetration, is 120 minutes.

2.4 EFECTIS NEDERLAND TEST REPORT 2007-EFECTIS-R0191

This report describes the results of a fire test according to NEN-EN 1366-3:2005 in conjunction with NEN6069:2005 for a combination of 5 steel pipe penetration in an aerated concrete floor of thickness 200 mm. This summary concerns pipe penetrations of type M,O and P. For details see Appendix A, Figures A.4, A.5 and A.6.

The test specimens had the following characteristics:

- Built into an aerated concrete floor, thickness 200 mm;
- The pipes were supported at 280 mm and 590 mm from the not directly heated side of the wall.

The pipe penetrations had the following characteristics:

	Test specimen M	Test specimen O	Test specimen P
Pipe	Steel Ø 76 mm / t= 2.9 mm End sealed by means of a steel plate on the directly heated side	Steel Ø 38 mm / t= 2.6 mm End sealed by means of a steel plate on the directly heated side	Copper Ø 54 mm / t= 1.5 mm End sealed by means of a copper board on the directly heated side
Insulation	n/a	n/a	Armaflex 1500 x 20 mm (l x d) 56 kg/m^3
FP Intumescent Coating	1 layer, min. 600 g/m², 200 mm at both sides of the floor	1 layer, min. 600 g/m², 200 mm at both sides of the floor	2 layers, min. 600 g/m², 250 mm at both sides of the floor

A summary of the results according to NEN-EN 1366-3:2005 in conjunction with NEN 6069:2005 is given in the report:

Criterion	Time duration calculated from the start of heating during which the criterion according to NEN-EN 1366-3:2005 and NEN 6069:2005 was fulfilled.	
	NEN-EN 1366-3:2005	NEN 6069:2005
Test specimen M, O and P		
a) Integrity (E)	>127 minutes	127 minutes
b) Thermal Insulation (I)	>127 minutes	127 minutes

The classification according to EN 13501-2:2003 of the fire resistance of the FP Intumescent Coating with steel pipework, as described in the classification report 2007-Efectis-R0207, is E120-C/U and EI120-C/U.

The classification according to EN 13501-2:2003 of the fire resistance of the FP Intumescent Coating with copper pipework with Armaflex insulation, as described in the classification report 2007-Efectis-R0209, is E120-C/U and EI120-C/U.

2.5 EFECTIS NEDERLAND TEST REPORT 2007-EFECTIS-R0192[REV.1]

This report describes the results of two fire tests according to NEN-EN 1366-3:2005 in conjunction with NEN 6069:2005 of a FP Fire Board and 14 pipe penetrations treated with FP Intumescent Coating, FP Pipe Wrap or FP Pipe Collar, in an aerated concrete floor. The FP Pipe Wrap and FP Pipe Collar are reported separately. This summary concerns test specimens of type D and a FP Fire Board. For details see Appendix A, Figures A.7 and A.8.

The test specimen, type D, had the following characteristics:

- Aerated concrete floor, thickness 200 mm, with an installation opening of Ø41 mm;
- PVC pipe, Ø40 mm, pipe wall thickness 3.0 mm;
- The end of the penetration, on the not directly heated side, was sealed with rock wool;
- 1 layer of FP Intumescent Coating was applied to the pipe over a length of 200 mm on both sides of the floor, minimum 600 g/m^2.
- The pipes were supported at 280 mm and 590 mm above the upper side of the floor on the not directly heated side.

The test specimen with a FP Fire Board had the following characteristics:

- Aerated concrete floor, thickness 200 mm, with an installation opening of 1000 x 600 mm;
- FP Fire Board, 1000 x 600 x 60 mm (l x b x d), density 150 kg/m^3.
- The FP Fire Board was placed in the aerated floor without penetration. The upper face of the board was positioned at 10 mm underneath the upper side of the floor.
- The FP Fire Board is treated on both sides with FP Intumescent Coating. Before the Board was placed, this had already been treated with FP Intumescent Coating.

A summary of the results according to NEN-EN 1366-3:2005 in conjunction with NEN 6069:2005 is given in the report:

Criterion	Time duration calculated from the start of heating during which the criterion according to NEN-EN 1366-3:2005 and NEN 6069:2005 was fulfilled.	
	NEN-EN 1366-3:2005	NEN 6069:2005
Test specimen D (pipe penetration)		
a) Integrity (E)	96 minutes	96 minutes
b) Thermal Insulation (I)	96 minutes	96 minutes
Test specimen with FP Fire Board		
a) Integrity (E)	>108 minutes	108 minutes
b) Thermal Insulation (I)	>108 minutes	108 minutes

The classification according to EN 13501-2:2007 of the fire resistance of the FP Fire Board with aforementioned penetration (D), as described in the classification report 2009-Efectis-R0204, is E90 U/C and EI90 U/C.

2.6 EFECTIS NEDERLAND TEST REPORT 2007-EFECTIS-R0383

This report describes the results of a fire test according to NEN-EN 1366-3:2005 in conjunction with NEN 6069:2005 of electric cables with cable ladder and cable tray through a FP Fire Board according to standard configuration. Pipe penetrations were also present in the test frame. The cable ladder and cable tray are reported separately. For details see Appendix A, pipe penetrations Figures A.9 to A.13, cable penetrations Figures A.14 to A.17.

The test specimens with pipe penetrations had the following characteristics:

- Built into an aerated concrete floor, thickness 200 mm;
- An installation opening was made in the floor that was sealed with an FP Fire Board;
- The pipes were supported at 280 mm and 590 mm above the not directly heated side of the floor.
- The end of the pipes, on the directly heated side, was sealed by means of a steel plate.

The pipe penetrations had the following characteristics:

	Test specimen S	Test specimen W	Test specimen X	Test specimen Y	Test specimen A1
Pipe	Steel Ø 89 mm t = 3.2 mm	Steel Ø 89 mm t = 3.2 mm	Steel Ø 114 mm t = 3.6 mm	Steel Ø 89 mm t = 3.2 mm	Steel Ø 76 mm t = 2.9 mm
Stone wool sleeve					
- dimensions	n/a	1000x30 mm (l x d)	1000x40 mm (l x d)	1000x25 mm (l x d)	1000x40 mm (l x d)
- distance from board on the not directly heated side		300 mm	300 mm	300 mm	360 mm
- general		Stone wool sleeve is provided with aluminium foil applied around the steel pipe, density 75 kg/m^3			
FP Intumescent Coating	One layer over a distance of 200 mm from the FP Fire Board	Stone wool sleeve on the exterior, both sides of the wall, treated with two layers of FP Intumescent Coating over a distance of 200 mm from the FP Fire Board			

The test specimens with the cable penetrations had the following characteristics:

- The standard cable ladders and trays according to EN 1366-3:2005 are applied:
  - Test specimen A6, cable ladder 200 x 60 x 1.0 mm (b x h x t);
  - Test specimen A7, cable ladder 300 x 60 x 1.25 mm (b x h x t);
  - Test specimen A8, smooth cable tray 500 x 60 x 1.5 mm (b x h x t);
  - Test specimen A9, perforated cable tray 500 x 60 x 1.5 mm (b x h x t), no cables were placed on test specimen A9.
  - Aerated concrete floor, 200 mm thick.
  - Cables were fixed in place using a steel clamp and two threaded rods M6 on the steel cable ladder at 250 and 450 mm from the upper face of the FP Fire Board (only on the not directly heated side).
  - Cables, cable tray and cable ladder on both sides of the FP Fire Board are treated with FP Intumescent Coating over a length of 200 mm.
  - Diverse cables were placed on the cable ladders and trays. See the table below for details:

	Number cables	Cable type	Dimensions	Further details	Type Code
Cable ladder A6	1	D2	4 x 185 mm^2	Electric cable with EPR insulation	H07RN-F 4G185
	1	E	1 x 185 mm^2	Electric cable with PVC insulation	XVB 1x185(BE)
Cable ladder A7	20	F	20 x (5 x 1.5 mm^2)	Telecommunications cables with PE insulation	Diameter 15-17 mm
	1	B	1 x 95 mm^2	Electric cable with PVC insulation	XVB 1x95(BE)
	1	C1	4 x 95 mm^2	Electric cable with PVC insulation	H0RN-F 4G95
Cable tray A8	1	G1	1 x 95 mm^2	Electric cable with PVC insulation	H07V-R
	10	A2	10 x (5 x 1.5 mm^2)	Electric cable with EPR insulation	H07RN-F 5G1.5

A summary of the results according to NEN-EN 1366-3:2005 in conjunction with NEN 6069:2005 is given in the report:

Criterion	Time duration calculated from the start of heating during which the criterion according to NEN-EN 1366-3:2005 and NEN 6069:2005 was fulfilled.	
	NEN-EN 1366-3:2005	NEN 6069:2005
Pipe penetration, type S		
a) Integrity (E)	>127 minutes	127 minutes
b) Thermal Insulation (I)	46 minutes	46 minutes
Pipe penetration, type W		
a) Integrity (E)	>127 minutes	127 minutes
b) Thermal Insulation (I)	118 minutes	118 minutes
Pipe penetration, type X		
a) Integrity (E)	>127 minutes	127 minutes
b) Thermal Insulation (I)	100 minutes	100 minutes

Pipe penetration, type Y		
a) Integrity (E)	>127 minutes	127 minutes
b) Thermal Insulation (I)	99 minutes	99 minutes
Pipe penetration, type A1		
a) Integrity (E)	>127 minutes	127 minutes
b) Thermal Insulation (I)	>127 minutes	127 minutes

Criterion	Time duration calculated from the start of heating during which the criterion according to NEN-EN 1366-3:2005 and NEN 6069:2005 was fulfilled.	
	NEN-EN 1366-3:2005	NEN 6069:2005

Electric cable D2 and E (on cable ladder A6)		
a) Integrity (E)	>127 minutes	127 minutes
b) Thermal Insulation(I)	>127 minutes	127 minutes
Electric cable F, B and C1 (on cable ladder A7)		
a) Integrity (E)	>127 minutes	127 minutes
b) Thermal Insulation(I)	>127 minutes	127 minutes
Electric cable A2 (on cable tray A8)		
a) Integrity (E)	>127 minutes	127 minutes
b) Thermal Insulation(I)	65 minutes	65 minutes
Electric cable G (on cable tray A8)		
a) Integrity (E)	>127 minutes	127 minutes
b) Thermal Insulation(I)	>127 minutes	127 minutes

Cable ladder A6		
a) Integrity (E)	>127 minutes	127 minutes
b) Thermal Insulation(I)	103 minutes	103 minutes
cable ladder A7		
a) Integrity (E)	>127 minutes	127 minutes
b) Thermal Insulation(I)	109 minutes	109 minutes
Cable tray A8		
a) Integrity (E)	>127 minutes	127 minutes
b) Thermal Insulation(I)	107 minutes	107 minutes
Cable tray A9		
a) Integrity (E)	>127 minutes	127 minutes
b) Thermal Insulation(I)	90 minutes	90 minutes

2.7 EFECTIS NEDERLAND TEST REPORT 2008-EFECTIS-R0381[REV.1]

This report describes the results of a fire test according to EN 1366-3:2004 in conjunction with prEN 1366-3:2007 for two penetrations in a flexible wall construction. The test specimens are a copper pipe, Ø 15mm, with Armaflex AF 8mm, tested on 29-02-2008 and a PE-Xb/Al/PE pipe, Ø 20 mm, with Armaflex AF 8mm, tested on 27-03-2008. For details see Appendix A, Figures A.18 and A.19.

The test specimens had the following characteristics:
- Built into a flexible wall construction according to EN 1366-3:2004;
- The space between the pipe and wall was sealed with 2 mm FP Intumescent Acrylic, length 25 mm;
- The pipe was supported on both sides of the wall at a distance of 500 mm;

The pipe penetrations had the following characteristics:

	Test specimen V date 29-02-2008	Test specimen V date 27-03-2008
Installation opening	Ø 37 mm	Ø 38 mm
Pipe	Copper, length 1500 mm Ø 15 mm / t= 1 mm End of the heated side squeezed closed	Pe-Xb/Al/PE, length 1500 mm Ø 20 mm / t= 2.5 mm End of the not directly heated side closed off with mineral wool
Insulation	Armaflex AF 8 mm around the pipe for a length of 1100 mm also through the wall, insulation over 500 mm from both sides of the wall	
FP Intumescent Coating	1 layer, min. 600 g/m², 200 mm on both sides of the wall applied over the Armaflex AF	

A summary of the results according to NEN-EN 1366-3:2004 is given in the report:

Criterion	Time duration calculated from the start of heating during which the criterion according to NEN-EN 1366-3:2004 and NEN 6069:2005 was fulfilled.
	NEN-EN 1366-3:2004
Test specimen V date 29-02-2008	
a) Integrity (E)	120 minutes
b) Thermal Insulation (I)	100 minutes
Test specimen V date 27-03-2008	
a) Integrity (E)	125 minutes
b) Thermal Insulation (I)	125 minutes

The classification according to EN 13501-2:2007 of the fire resistance of the FP Intumescent Coating and FP Intumescent Acrylic with PE-Xb/Al/PE, Ø 20 mm, with Armaflex AF 8mm, as described in the classification report 2009-Efectis-R0291, is E120-C/U and EI120-C/U.

The classification according to EN 13501-2:2007 of the fire resistance of the FP Intumescent Coating and FP Intumescent Acrylic with copper pipe, Ø 15 mm, with Armaflex AF 8mm, as described in the classification report 2009-Efectis-R0290, is E120-C/U and EI90-C/U.

2.8 EFECTIS NEDERLAND TEST REPORT 2008-EFECTIS-R0451

This report describes the results of two fire tests according to NEN-EN 1366-3:2005 in conjunction with prEN 1366-3:2007 for a cable penetration in a flexible wall construction. It concerns two fire tests dated 27 March, 2008 and 6 June, 2008. The two test specimens consisted of two cable trays and two ladders, A, B, C and D, in which were placed a number of cables. The cable trays and cable ladders were lined with an FP Fire Board. For details see Appendix A, Figures A.20 to A.27.

The test specimens had the following characteristics:

- The test specimens were built into a flexible wall according to NEN-EN 1366-3:2005, with an installation opening of 600 x 600 mm.
- A FP Fire Board was installed, the position of the board in the wall varied between the tests on 27 March and 6 June:
  - 27 March, 2008: FP Fire Board positioned at the directly heated side;
  - 6 June, 2008: FP Fire Board positioned at the non-directly heated side;
- On both sides of the FP Fire Board, FP Intumescent Coating was applied to the cables, cable ladders and cable trays over a distance of 200 mm.
- The penetration was supported on both sides of the wall at a distance of 500 mm by a steel frame according to NEN-EN1366-3:2005.

The cable ladders and trays had the following characteristics:

	Type		Dimensions	Load (heated side)
A	Cable ladder	-	300 x 60 x 1.0 mm	7.1 kg
B	Cable tray	Perforated	500 x 60 x 1.6 mm	11.4 kg
C	Cable tray	Not perforated	500 x 60 x 1.3 mm	13.8 kg
D	Cable ladder	-	200 x 60 x 1.0 mm	4.4 kg

	Number cables	Cable type	Dimensions	Further details	Type code
A	1	D1 group 3	4 x 185 mm^2	Large protected cable	NYCWY 4x185SM/95
	2	E group 2	1 x 185 mm^2	Medium protected cable	NYY-J 1x185RM
	1	D2 group 3	4 x 185 mm^2	Large protected cable	H07RN-F 4G185
B	10	A1 group 1	5 x 1.5 mm^2	Small protected cable	NYY-J 5x1.5RE
	10	A2 group 1	5 x 1.5 mm^2	Small protected cable	H07RN-F 5G1.5
	10	A3 group 1	5 x 1.5 mm^2	Small protected cable	N2XH-J 5x1
	2	B group 1	1 x 95 mm^2	Small protected cable	NYY-J 1x95RM
	1	C1 group 2	4 x 95 mm^2	Medium protected cable	NYCWY 4x95SM/50
	1	C2 group 2	4 x 95 mm^2	Medium protected cable	H07RN-F 4G95
	1	C3 group 2	4 x 95 mm^2	Medium protected cable	N2XH-J 4x95 SM
C	1	G1 group 5	1 x 95 mm^2	Not protected (cable)	H07V-R
	1	G2 group 5	1 x 185 mm^2	Not protected (cable)	H07V-R
	20	F group 4	2 x 0.6 mm^2	Telecommunications cable	
D	1	D2 group 3	4 x 185 mm^2	Large protected cable	H07RN-F 4G185

A summary of the results according to NEN-EN 1366-3:2005 is given in the report:

Criterion	Time duration calculated from the start of heating during which the criterion according to NEN-EN 1366-3:2005 was fulfilled.
	NEN-EN 1366-3:2005

Results fire test 27-03-2008

Test specimen A	
a) Integrity (E)	125 minutes
b) Thermal insulation (I)	103 minutes
Test specimen B	
a) Integrity (E)	125 minutes
b) Thermal insulation (I)	125 minutes
Test specimen C	
a) Integrity (E)	125 minutes
b) Thermal insulation (I)	104 minutes
Test specimen D	
a) Integrity (E)	125 minutes
b) Thermal insulation (I)	125 minutes

Results fire test 06-06-2008

Test specimen A	
a) Integrity (E)	123 minutes
b) Thermal insulation (I)	67 minutes
Test specimen B	
a) Integrity (E)	123 minutes
b) Thermal insulation (I)	109 minutes
Test specimen C	
a) Integrity (E)	123 minutes
b) Thermal insulation (I)	94 minutes

Test specimen D	
a) Integrity (E)	123 minutes
b) Thermal insulation (I)	123 minutes

The classification according to EN 13501-2:2007 of the fire resistance of the FP Sealing System with aforementioned penetration, as described in the classification report 2009-Efectis-R0316, is E120 and EI60.

2.9 EFECTIS NEDERLAND TEST REPORT 2008-EFECTIS-R0452

This report describes the results of two fire tests according to NEN-EN 1366-3:2005 in conjunction with prEN 1366-3:2007 for a cable penetration in a flexible wall construction. It concerns two fire tests dated 29 February, 2008 and 27 March, 2008. The two test specimens consisted of two penetrations, according to the "standard configuration for small cable penetration seals" in a flexible wall. For details see Appendix A, Figures A.28 to A.31.

The test specimens had the following characteristics:

- The test specimens were built into a flexible wall construction according to NEN-EN 1366-3:2005, with an installation opening of 200 mm.
- The position of the electric cables through the FP Fire Board was different for test specimen G and H:
  - Test specimen G: the electric cables were placed at the bottom;
  - Test specimen H: the electric cables were placed centrally.
- A FP Fire Board was installed in the installation opening, the position of the board in the wall varied between the tests on 29 February and 27 March:
  - 29 February, 2008: FP Fire Board positioned at the non-directly heated side;
  - 27 March, 2008: FP Fire Board positioned at the directly heated side;
- On both sides of the FP Fire Board, FP Intumescent Coating was applied to the cables over a distance of 200 mm.
- The cables were supported on both sides of the wall at a distance of 500 mm by a steel frame according to NEN-EN1366-3:2005.

The following cables were used in both tests:

Number cables	Cable type	Dimensions	Further details	Type code
3	A3 group 1	5 x 1.5 mm^2	Small protected cable	N2XH-J 5x1.5 RE
3	A2	5 x 1.5 mm^2	Small protected cable	H07RN-F 5G1.5
3	A1	5 x 1.5 mm^2	Small protected cable	NYY-J 5x1.5 RE
1	B	1 x 95 mm^2	Small protected cable	NYY-J 1x95 RM

A summary of the results according to NEN-EN 1366-3:2005 is given in the report:

Results fire test 29-02-2008

Criterion	Time duration calculated from the start of heating during which the criterion according to NEN-EN 1366-3:2005 was fulfilled.
	NEN-EN 1366-3:2005
Test specimen G	
a) Integrity (E)	120 minutes
b) Thermal Insulation (I)	97 minutes
Test specimen H	
a) Integrity (E)	120 minutes
b) Thermal Insulation (I)	109 minutes

Results fire test 27-03-2008

Criterion	Time duration calculated from the start of heating during which the criterion according to NEN-EN 1366-3:2005 was fulfilled.
	NEN-EN 1366-3:2005
Test specimen G	
a) Integrity (E)	125 minutes
b) Thermal Insulation (I)	94 minutes
Test specimen H	
a) Integrity (E)	125 minutes
b) Thermal Insulation (I)	125 minutes

The classification according to EN 13501-2:2007 of the fire resistance of the FP Sealing System with the aforementioned penetration, as described in the classification report 2009-Efectis-R0292, is E120 and EI90.

2.10 EFECTIS NEDERLAND TEST REPORT 2008-EFECTIS-R0456[REV.1]

This report describes the results of a fire test according to NEN-EN 1366-3:2005 in conjunction with prEN 1366-3:2007 for three steel pipe penetrations with fire blanket through a flexible wall construction. For details see Appendix A, Figures A.32 to A.34.

The test specimens had the following characteristics:

- Built into a flexible wall construction, wall thickness 100 mm.
- On both sides of the wall a fire blanket was placed on the pipe over a length of 500 mm from the wall, thickness 60 mm, density 100 kg/m^3.
- The fire blanket was treated on the outside with FP Intumescent Coating on both sides of the wall over a length of 500 mm.
- Over 25 mm from the installation opening the wall was treated with FP Intumescent Coating.
- The steel pipe was treated with FP Intumescent Coating over a length of 55 mm on the non-heated side.
- The pipes were supported on both sides of the wall at a distance of 500 mm from the wall.
- On the not directly heated side, the end of the pipe was sealed using a steel plate.

The pipe penetrations had the following characteristics:

	Penetration Q	Penetration R	Penetration S
Installation opening	Ø 174 mm	Ø 174 mm	Ø 39 mm
Pipe	Steel Ø 168.3 mm Wall thickness = 4.5 mm	Steel Ø 168.3 mm Wall thickness = 10 mm	Steel Ø 33.7 mm Wall thickness = 2.6 mm

A summary of the results according to NEN-EN 1366-3:2005 is given in the report:

Criterion	Time duration calculated from the start of heating during which the criterion according to NEN-EN 1366-3:2005 was fulfilled.
	NEN-EN 1366-3:2005
Test specimen Q, R and S	
a) Integrity (E)	125 minutes
b) Thermal Insulation (I)	125 minutes

2.11 EFECTIS NEDERLAND TEST REPORT 2008-EFECTIS-R0457[REV.2]

This report describes the results of a fire test according to NEN-EN 1366-3:2005 in conjunction with prEN 1366-3:2007 for two copper pipe penetrations with FP Intumescent Coating or Armaflex insulation with FP Intumescent Coating in a flexible wall. For details see Appendix A, Figure A.35 and A.36.

The test specimens had the following characteristics:

- Built into a flexible wall construction according to NEN-EN 1366-3:2005.
- The space between the pipe and the wall, at the location of the gypsum boards, was closed with 3 mm FP Intumescent Acrylic (length 25 mm, on both sides).
- The pipes were supported on both sides of the wall at a distance of 500 mm from the wall with a steel frame according to NEN-EN 1366-3:2005.
- The end of the penetration on the directly heated side was squeezed closed.

The pipe penetrations had the following characteristics:

	Test specimen E	Test specimen V
Installation opening	Ø 21 mm	Ø 37 mm
Pipe	Copper, Ø 15 mm, wall thickness 1 mm The end at the directly heated side was squeezed closed	
Insulation	n/a	Armaflex AF 8 mm length 1100 mm 500 mm from the wall
FP Intumescent Coating	Over a length of 200 mm over the penetration On both sides of the wall	

The results according to NEN-EN 1366-3:2005 are summarised in the report:

Criterion	Time duration calculated from the start of heating during which the criterion according to NEN-EN 1366-3:2005 was fulfilled.
	NEN-EN 1366-3:2005
Test specimen E	
a) Integrity (E)	120 minutes
b) Thermal Insulation (I)	65 minutes
Test specimen V	
a) Integrity (E)	120 minutes
b) Thermal Insulation (I)	100 minutes

The classification according to EN 13501-2:2007 of the fire resistance of the FP Sealing System with the aforementioned penetrations E and V, as described in the classification report 2009-Efectis-R0292, is E120 C/U and EI60 C/U.

2.12 EFECTIS NEDERLAND TEST REPORT 2008-EFECTIS-R0458[REV.2]

This report describes the results of a fire test according to NEN-EN 1366-3:2005 in conjunction with prEN 1366-3:2007 for a wall socket and two PVC pipe penetrations in a flexible wall. Results for the wall socket in a flexible wall are reported separately. For details see Appendix A, Figure A.37 and A.38.

The test specimens had the following characteristics:

- Built into a flexible wall construction according to NEN-EN 1366-3:2005.
- The space between the pipe and the wall, at the location of the gypsum boards, was closed with FP Intumescent Acrylic (on both sides).
- FP Intumescent Coating was applied to the wall at 55 mm from the installation opening
- The pipe was supported on both sides of the wall at a distance of 500 mm from the wall with a steel frame according to NEN-EN 1366-3:2005.
- The end of the pipe on the not directly heated side was closed off with mineral wool.

The pipe penetrations had the following characteristics:

	Test specimen T	Test specimen U
Installation opening	Ø 20 mm	Ø 16 mm
Pipe	PVC Ø19.1 mm, wall thickness 1.2 mm	PVC Ø 15.9 mm, wall thickness 1.1 mm
Cables in pipe	3 not protected electric cables 2 x 2.5 mm^2 and 1 x 1.5 mm^2 type H07V-U	
FP Intumescent Coating	Over a length of 200 mm over the penetration On both sides of the wall	

The results according to NEN-EN 1366-3:2005 are summarised in the report:

Criterion	Time duration calculated from the start of heating during which the criterion according to NEN-EN 1366-3:2005 was fulfilled.
	NEN-EN 1366-3:2005
Test specimen T and U	
a) Integrity (E)	120 minutes
b) Thermal Insulation (I)	120 minutes

The classification according to EN 13501-2:2007 of the fire resistance of the FP Sealing System with the aforementioned penetrations, as described in the classification report 2009-Efectis-R0299, is E120 and EI120.

2.13 EFECTIS NEDERLAND TEST REPORT 2008-EFECTIS-R0461[REV.1]

This report describes the results of a fire test according to NEN-EN 1366-3:2005 in conjunction with prEN 1366-3:2007 for four PE/Al/PE pipe penetrations with FP Intumescent Coating, in a flexible wall. For details see Appendix A, Figures A.39 to A.42.

The test specimens had the following characteristics:

- Built into a flexible wall construction according to NEN-EN 1366-3:2005.
- The space between the pipe and the wall, at the location of the gypsum boards, was closed with FP Intumescent Acrylic (on both sides).
- FP Intumescent Coating was applied to the wall at 25 mm from the installation opening
- The pipe was supported on both sides of the wall at a distance of 500 mm from the wall with a steel frame according to NEN-EN 1366-3:2005.
- The end of the penetration on the not directly heated side was closed off with mineral wool.

The pipe penetrations had the following characteristics:

	Test specimen T	Test specimen U	Test specimen V	Test specimen W
Installation opening	Ø 18 mm	Ø 22 mm	Ø 38 mm	Ø 41 mm
Pipe	PEx/Al/PE Ø 16 mm t = 2 mm	PE-XB/Al/PE Ø 20 mm t = 2.5 mm	PE-XB/Al/PE Ø 20 mm t = 2.5 mm	PE-XB/Al/PE Ø 40 mm t = 3.5 mm
Insulation	n/a	n/a	Armaflex AF 8 mm length 1100 mm 500 mm from wall	n/a
FP Intumescent Coating	Over a length of 200 mm over the penetration On both sides of the wall			

The results according to NEN-EN 1366-3:2005 are summarised in the report:

Criterion	Time duration calculated from the start of heating during which the criterion according to NEN-EN 1366-3:2005 was fulfilled.
	NEN-EN 1366-3:2005
Test specimen T and V	
a) Integrity (E)	125 minutes
b) Thermal Insulation(I)	125 minutes
Test specimen U	
a) Integrity (E)	125 minutes
b) Thermal Insulation(I)	120 minutes
Test specimen W	
a) Integrity (E)	125 minutes
b) Thermal Insulation(I)	74 minutes

The classification according to EN 13501-2:2007 of the fire resistance of the FP Sealing System with the aforementioned penetrations T, U and V, as described in the classification report 2009-Efectis-R0303, is E120 and EI120.

The classification according to EN 13501-2:2007 of the fire resistance of the FP Sealing System with the aforementioned penetration W, as described in the classification report 2009-Efectis-R0304, is E120 and EI60.

2.14 EFECTIS NEDERLAND TEST REPORT 2008-EFECTIS-R0462[REV.1]

This report describes the results of a fire test according to NEN-EN 1366-3:2005 in conjunction with prEN 1366-3:2007 for a PVC pipe penetration with FP Intumescent Coating, in a flexible wall. For details see Appendix A, Figure A.43.

The test specimen, type W, had the following characteristics:

- Built into a flexible wall construction according to NEN-EN 1366-3:2005, installation opening Ø 41 mm.
- PVC pipe, Ø 40 mm, wall thickness 3 mm.
- FP Intumescent Coating was applied over the penetration on both sides of the wall over a length of 210 mm
- The space between the pipe and the wall, at the location of the gypsum boards, was closed with FP Intumescent Acrylic (on both sides).
- FP Intumescent Coating was applied to the wall at 25 mm from the installation opening
- The pipe was supported on both sides of the wall at a distance of 500 mm from the wall with a steel frame according to NEN-EN 1366-3:2005.
- The end of the penetration on the not directly heated side was closed off with a PVC cap.

The results according to NEN-EN 1366-3:2005 are summarised in the report:

Criterion	Time duration calculated from the start of heating during which the criterion according to NEN-EN 1366-3:2005 was fulfilled.
	NEN-EN 1366-3:2005
a) Integrity (E)	120 minutes
b) Thermal Insulation (I)	120 minutes

The classification according to EN 13501-2:2007 of the fire resistance of the FP Sealing System with the aforementioned penetration, as described in the classification report 2009-Efectis-R0305, is E120 and EI120.

2.15 EFECTIS NEDERLAND TEST REPORT 2011-EFECTIS-R0299

This report describes the results of a fire test according to NEN-EN 1366-3:2009 for three copper pipe penetrations with various FP Sealing Systems, in an aerated concrete wall. Penetration 2 is reported separately. For details see Appendix A, Figures A.44 and A.45.

The test specimens had the following characteristics:

- Built into an aerated concrete wall construction, wall thickness 150 mm, according to NEN-EN 1366-3:2009, installation opening 800 x 800 mm.
- Installation opening was sealed with an FP Fire Board.
- The pipe was supported on both sides of the wall at a distance of 400 mm from the wall with a steel frame according to NEN-EN 1366-3:2009.
- The end of the pipe on the directly heated side was closed off.

The pipe penetrations had the following characteristics:

	Test specimen 1	Test specimen 3
Pipe	Copper, Ø 54 mm, wall thickness 1.5 mm	Copper, Ø 35 mm, wall thickness 1.5 mm
Insulation	Armaflex AF 13 mm + insulation sleeve with aluminium foil, length 200 mm from the Board	Armaflex SH 9 mm
FP Fire Board	Single FP Fire Board	Double FP Fire Board 400 x 400 mm
FP Intumescent Coating	The insulation sleeve was treated over the whole length	Over a length of 200mm, on the outside of the Armaflex on both sides of the FP Fire Board

The results according to NEN-EN 1366-3:2009 are summarised in the report:

Criterion	Time duration calculated from the start of heating during which the criterion according to NEN-EN 1366-3:2009 was fulfilled.
	NEN-EN 1366-3:2009
Test specimen 1	
a) Integrity (E)	120 minutes
b) Thermal Insulation (I)	65 minutes
Test specimen 3	
a) Integrity (E)	120 minutes
b) Thermal Insulation (I)	85 minutes

The classification according to EN 13501-2:2007 of the fire resistance of the FP Sealing System with the aforementioned penetrations, as described in the classification report 2011-Efectis-R0300, is E120 and EI60.

2.16 PEUTZ TEST REPORT Y.1432.RA.001

This report describes the results of a fire test according to NEN-EN 1366-3:2009 for various penetrations with FP Intumescent Coating, in a flexible wall. For details see Appendix A, bus bar penetrations Figures A.46 to A.49 and FP Fire Board Figure A.50.

The test specimens had the following characteristics:

- Built into a flexible wall construction, wall thickness 95 mm, according to NEN-EN 1366-3:2009
- Test specimen H was a FP Fire Board, 250 x 250 mm, thickness 60 mm, surface parallel to the directly heated side, provided with FP Intumescent Coating on both sides. The FP Fire Board was pre-treated with 1 layer FP Intumescent Coating.
- The bus bar penetration was supported at 625 mm (directly heated side) and 525 mm (not directly heated side) from the wall.
- The bus bars were closed on the directly heated side with a calcium silicate board.

The bus bar penetrations had the following characteristics:

	D1	D2	E1	E2
Installation opening	195x195 mm	195x195 mm	195x195 mm	195x195 mm
Rooster	Bus bar BKS Stromschienen ag. Type SC-R SB 060-04 AL N, L1,L2,L3 (90x90 mm)	Bus bar BKS Stromschienen ag. Type SC-R SB 120 A N, L1,L2,L3 PE (150x120 mm)	Bus bar BKS Stromschienen ag. Type SC-R SB 120 A N, L1,L2,L3 PE (120x150 mm)	Bus bar BKS Stromschienen ag. Type SC-R SB 060-04 AL N, L1,L2,L3 (90x90 mm)
	length 1500 mm			
Orientation of bus bar strips	Aluminium strips horizontally orientated		Aluminium strips vertically orientated	
FP Sealing System	A double FP Fire Board (total thickness 120 mm) both sides provided with one layer FP Intumescent Coating (The FP Fire Board was pre-treated with 1 layer FP Intumescent Coating)			
FP Intumescent Coating	FP Intumescent Coating was applied to the penetration on both sides of the FP Fire Board over a length of 200 mm			

The results according to NEN-EN 1366-3:2009 are summarised in the report:

Criterion	Time duration calculated from the start of heating during which the criterion according to NEN-EN 1366-3:2009 was fulfilled.
	NEN-EN 1366-3:2009
Test specimen D1, D2, E1 en E2	
a) Integrity (E)	127 minutes
b) Thermal Insulation (I)	127 minutes
Test specimen H	
a) Integrity (E)	123 minutes
b) Thermal Insulation (I)	98 minutes

3. CONCLUSION

This report, reference 2015-Efectis-R000383(E), has been compiled by Efectis Nederland and was commissioned by Den Braven. The report concerns a collection of the test results and assessments, as determined for penetrations where the FP Sealing System has been applied. The current assessment is given on the grounds of the Dutch norm NEN 6069:2011.

The assessment is based on the following test reports:

- TNO Centre for Fire Safety test report 2003-CVB-R0276
- TNO Centre for Fire Safety test report 2005-CVB-R0151
- TNO Centre for Fire Safety test report 2005-CVB-R0156
- Efectis Nederland BV test report 2007-Efectis-R0191
- Efectis Nederland BV test report 2007-Efectis-R0192[Rev.1]
- Efectis Nederland BV test report 2007-Efectis-R0383
- Efectis Nederland BV test report 2008-Efectis-R0381[Rev.1]
- Efectis Nederland BV test report 2008-Efectis-R0451
- Efectis Nederland BV test report 2008-Efectis-R0452
- Efectis Nederland BV test report 2008-Efectis-R0456[Rev.1]
- Efectis Nederland BV test report 2008-Efectis-R0457[Rev.2]
- Efectis Nederland BV test report 2008-Efectis-R0458[Rev.2]
- Efectis Nederland BV test report 2008-Efectis-R0461[Rev.1]
- Efectis Nederland BV test report 2008-Efectis-R0462[Rev.1]
- Efectis Nederland BV test report 2011-Efectis-R0299
- Peutz test report Y.1432.RA.001

Efectis Nederland has controlled the test and assessment results on the basis of the Dutch standard NEN 6069:2011. The conclusions based on these test results are given in the next paragraph.

The documents have been provided by Den Braven. Efectis has checked and confirmed the documents.

According to the conditions presented below, the fire resistance according to Appendix A of NEN 6069:2011, with respect to the separating function, is 30 minutes, on the basis of the EI-criteria, for the following penetrations with the FP Sealing System.

3.1 PENETRATIONS IN A FLOOR CONSTRUCTION

1) An installation opening is made in the floor construction in order to accommodate the penetration;
   - For a pipe penetration, the pipe is wedged into the floor construction or in the FP Fire Board, where:
     - The diameter of the installation opening is equal to:
       - The pipe diameter, or
       - The sum of the pipe diameter and the thickness of the insulation.
   - For a cable penetration, the cable tray is placed through a FP Fire Board, where:
     - The maximum dimensions of the installation opening are 1200 x 1000 (b x h);
     - The FP Fire Board has a minimum thickness of 60 mm;

   - For a "blank" penetration, an FP Fire Board is placed in the installation opening, where:
     - The maximum dimensions of the installation opening and the FP Fire Board are 1000 x 600 mm (b x h);
     - The FP Fire Board has a thickness of ≥ 60 mm and a density ≥ 150 kg/m^3;
     - The upper side of the FP Fire Board is positioned 10 mm under the upper side of the floor;

2) The following pipes are allowed:
   - Steel pipe, wedged into a floor construction:
     - The minimum diameter of the pipe is 38 mm with a wall thickness of ≥ 2.6 mm;
     - The maximum diameter of the pipe is 76 mm with a wall thickness of 2.9 mm;
     - The maximum wall thickness of the pipe is 2.9 mm;
     - Interpolation between the aforementioned values is permitted.

   - Steel pipe, wedged into an FP Fire Board:
     - The minimum diameter of the pipe is 76 mm with a wall thickness ≥ 2.9 mm;
     - The maximum diameter of the pipe is 114 mm with a wall thickness 3.6 mm.
     - The maximum wall thickness of the pipe is 3.6 mm.
     - Interpolation between the aforementioned values is permitted.

   - Copper pipe Ø 54 mm and with a wall thickness 1.5 mm.
   - PVC pipe Ø 40 mm and with a wall thickness 3.0 mm.

3) The following cables are allowed:
   - In combination with a cable tray / cable ladder:

Cable tray/ladder	Cables	Maximum cross-sectional area cables	Maximum surface area cables
Cable ladder 200 mm, t=1.0 mm	type D2 and E	4 x 185 mm^2	925 mm^2
Cable ladder 300 mm, t=1.25 mm	type F, B and C1	4 x 95 mm^2	625 mm^2
Smooth cable tray 500 mm, t=1.5 mm	type G1 and A2	1 x 95 mm^2	170 mm^2

   - In addition, a standard perforated cable tray 500 mm with wall thickness 1.5 mm may be used without cables.
   - When applying a cable penetration the following minimum distances apply:

- Distance between the cable tray / ladder and installation opening,
  - In the width ≥ 60 mm;
  - In the length ≥ 23 mm;
- Distance between the cable tray and cable ladder,
  - In the width ≥ 40 mm;
  - In the length ≥ 170 mm.

4) A pipe shall be provided with insulation in the following situations:
   - For a copper pipe, the pipe is provided with Armaflex insulation, minimum 1500 x 20 mm (l x d), density ≥ 76 kg/m^3.
   - For a steel pipe in an FP Fire Board, the pipe shall be provided with a stone wool sleeve in the following situations:
     - Diameter ≥ 76 and < 89 mm: minimum thickness insulation 40 mm, over minimum 360 mm from the FP Fire Board on the not directly heated side.
     - Diameter ≥ 89 and ≤ 114 mm:
       - Minimum thickness insulation 25 mm for diameter 89 mm;
       - Minimum thickness insulation 40 mm for diameter 114 mm;
       - Interpolation between the aforementioned values is permitted.
       - Insulation over minimum 360 mm from FP Fire Board on the not directly heated side.
     - The total length of the insulation is minimum 1000 mm.
   - Optionally, a steel pipe Ø 89 mm may be provided with insulation.

5) The penetration shall be provided with FP Intumescent Coating at the following locations:
   - When it concerns a pipe penetration:
     - For an uninsulated pipe, a minimum of 1 layer of FP Intumescent Coating is applied to the pipe on both sides of the floor over a minimum length of 200 mm.
     - If insulation is used:
       - The FP Intumescent Coating is applied to the outside of the insulation, over a length of 200 mm,
       - For a steel pipe in an FP Fire Board, a minimum of 2 layers of FP Intumescent Coating is applied to the outside of the stone wool sleeve.
   - For a cable penetration, a minimum of 1 layer of FP Intumescent Coating is applied to the cables on both sides of the FP Fire Board over a minimum length of 200 mm.
   - For an FP Fire Board, the FP Fire Board shall be treated at least once with FP Intumescent Coating before mounting. After mounting, a minimum of 1 layer of FP Intumescent Coating is applied to the FP Fire Board.

6) The penetration shall be supported at various locations, where:
   - For a pipe penetration, the pipe is supported on the not directly heated side of the floor at ≤ 280 and ≤ 590 mm.
   - For a cable penetration, the cable tray / ladder is supported on the not directly heated side at of the floor at ≤ 250 and ≤ 450 mm.

7) The pipes may be used in non-ventilated systems, gas, drinking water and heating systems.

8) The supporting construction is a stone-like floor with a thickness and density of minimum 200 mm and 600 kg/m^3, respectively.

3.2 PENETRATIONS IN A RIGID WALL CONSTRUCTION

1) An installation opening is made in the wall construction in order to accommodate the penetration;
   - For a PVC pipe penetration, the pipe is wedged into the wall construction, where:
     - The diameter of the installation opening is 40 mm.

   - For a copper pipe penetration, the pipe is wedged into an FP Fire Board, where:
     - The maximum dimensions of the installation opening are 800 x 800 (b x h).
     - For a copper pipe provided with Armaflex AF 13 a single FP Fire Board is placed in the installation opening.
     - For a copper pipe provided with Armaflex SH 9 a double FP Fire Board, minimum dimensions 400 x 400 mm (b x h), is placed in in the installation opening.

   - For a cable penetration, the cable tray is placed in a FP Fire Board, where:
     - The maximum dimensions of the installation opening are 800 x 400 mm (b x h);
     - The minimum dimensions of the FP Fire Board are 400 x 400 mm (b x h);
     - The FP Fire Board has a thickness of ≥ 60 mm and a density ≥ 141 kg/m^3;
     - The upper side of the FP Fire Board is positioned 10 mm under the upper side of the floor;

   - For a "blank" penetration, an FP Fire Board is placed in the installation opening, where:
     - The maximum dimensions of the installation opening and the FP Fire Board are 100 x 1000 mm (b x h);
     - The FP Fire Board has a thickness of ≥ 60 mm.

2) The following pipes are allowed:
   - PVC pipe, Ø40 mm with a wall thickness 4.1 mm;
   - Copper pipe, Ø 35 mm with a wall thickness 1.5 mm

3) A perforated cable tray is permitted, maximum dimensions 600 x 60 mm (b x h), with electric and data cables, where
   - Maximum diameter cable ≤ 28 mm;
   - Maximum surface cables ≤ 185 mm^2.
   - The following minimum distances apply for cable penetrations:
     - Distance between cable tray / ladder and installation opening ≥ 100 mm;
     - Distance between cable tray an cable ladder ≥ 170 mm;

4) A pipe shall be provided with insulation in the following situations:
   - For a copper pipe, the pipe is provided with insulation over a minimum length of 200 mm on both sides of the wall, where:
     - If the copper pipe is placed through a single FP Fire Board, the pipe is provided with Armaflex AF 13 insulation.
     - If the copper pipe is placed through a double FP Fire Board, the pipe is provided with Armaflex SH 9 insulation.

5) The penetration shall be provided with FP Intumescent Coating at the following locations:
   - For an uninsulated pipe, a minimum of 1 layer of FP Intumescent Coating is applied at the following locations:
     - On the pipe, over a minimum length of 200 mm, on both sides of the wall;
     - On the wall, around the installation opening, treated area is minimum 90 x 90 mm, on both sides of the wall.

- For an insulated pipe, a minimum of 1 layer of FP Intumescent Coating is applied to the outside of the insulation over a minimum length of 200 mm, on both sides of the wall;

- For a cable penetration, the cables are provided with FP Intumescent Coating over a minimum length of 50 mm , on both sides of the wall.

- For an FP Fire Board, the FP Fire Board shall be treated at least once with FP Intumescent Coating before mounting. After mounting, a minimum of 1 layer of FP Intumescent Coating is applied to the FP Fire Board.

For a cable penetration, FP Intumescent Acrylic is applied between the cables, and between the cables, cable tray and installation opening.

6) The penetration shall be supported at various locations, where:
   - For a PVC pipe, the pipe is supported on the not directly heated side of the wall at ≤ 280 and ≤ 750 mm.
   - For a copper pipe, the pipe is supported on both sides of the wall at ≤ 400 mm.
   - For a cable penetration, the cable tray / ladder is supported on both sides of the wall at ≤ 80 and ≤ 465 mm.

7) The pipe may be used in non-ventilated systems, gas, drinking water and heating systems.

8) The supporting construction is a stone-like wall with a thickness and density of minimum 100 mm and 600 kg/m^3, respectively.

3.3 PENETRATIONS IN A FLEXIBLE WALL CONSTRUCTION

1) An installation opening is made in the wall construction in order to accommodate the penetration;
   - For a pipe penetration, the pipe is wedged into the wall construction, where:
     - The diameter of the installation opening is equal to:
       - The pipe diameter, or
       - The sum of the pipe diameter and the thickness of the insulation.
     - An increase in the diameter ≤ 6 mm is permitted.

   - For a cable penetration, the cable tray is placed in an FP Fire Board, where:
     - The maximum dimensions of the installation opening are 600 x 600 (b x h);
     - The FP Fire Board has a thickness ≥ 60 mm;
     - The FP Fire Board can be placed at the directly, or not directly heated side.

   - For a bus bar, the maximum dimensions of the installation opening are 195 x 195 mm. A double FP Fire Board is placed in the installation opening.

   - For a “blank” penetration, an FP Fire Board is placed in the installation opening, where:
     - The maximum dimensions of the installation opening and the FP Fire Board are 250 x 250 (b x h);
     - The minimum thickness of the FP Fire Board is 60 mm;
     - The surface of the FP Fire Board is parallel to the directly heated side.

2) The following pipes are allowed:
   - Steel, PVC or PE-Xb/Al/PE pipe with the following dimensions:

	Steel pipe	PVC pipe	PE-Xb/Al/PE pipe
minimum diameter	33.7 mm	15.9 mm	16 mm
- associated wall thickness	2.6 mm	1.1 mm	2.0 mm
maximum diameter	168.3 mm	40 mm	40 mm
- associated wall thickness	4.5 mm	3.0 mm	3.5 mm
maximum wall thickness	10.0 mm	3.0 mm	3.5 mm

     - Interpolation between the values above is permitted.
   - Copper pipe, Ø 15 mm with wall thickness 1 mm.
   - In addition, unprotected cables with a maximum area of 6.5 mm^2 can be placed in a PVC pipe with diameter ≥15.9 mm and ≤19.1 mm

3) The following cables are allowed:
   - In combination with a cable tray / ladder:

Cable tray /-ladder	Cables	Maximum X-sectional area cables	Maximum surface area cables
cable ladder 300 x 60 x 1.0 mm	large & medium protected cables	4 x 185 mm^2	1850 mm^2
Perforated cable tray 500 x 60 x 1.6 mm	medium & small protected cables	4 x 95 mm^2	1555 mm^2
Smooth cable tray 500 x 60 x 1.3 mm	Unprotected and telecommunications cables	1 x 185 mm^2	304 mm^2
Cable ladder 200 x 60 x 1.0 mm	Large protected cable	1 x 95 mm^2	740 mm^2

   - In addition, small protected cables, maximum cross-sectional area 1 x 95 mm^2 with maximum surface area 162.5 mm^2, without cable tray / ladder, shall be passed through an FP Fire Board, where:
     - The FP Fire Board is parallel to the directly or not directly heated side.
     - The cables can be placed in the centre or at the bottom of the FP Fire Board.
     - The FP Fire Board has a minimum width and length of 200 x 200 mm.
   - The following minimum distances apply when a cable penetration is used:
     - Distance between cable tray / ladder and installation opening,
       - In the width ≥ 32 mm;
       - In the height ≥ 139 mm;
     - Distance between cable tray and cable ladder,
       - In the width ≥ 40 mm;
       - In the height ≥ 139 mm.

4) A bus bar can be used in the wall construction, where:
   - The bus bar is one of the following two types:
     - Bus bar BKS Stromschienen ag. Type SC-R SB 060-04 AL N, L1, L2, L3, maximum dimensions 90 x 90 mm.
     - Bus bar BKS Stromschienen ag. Type SC-R SB 120 A N, L1, L2, L3 PE, maximum dimensions 120 x 150 mm.
   - The bus bars can be mounted with vertical and horizontal strips.

5) A pipe shall be provided with insulation in the following situations:
   - For a steel pipe, the pipe is provided with a fire blanket over a length of minimum 500 mm on both sides of the wall, with a thickness ≥ 60 mm and density ≥ 100 kg/m^3.

   - Optionally, a copper pipe or a PE-Xb/Al/PE pipe Ø 20 mm shall be provided with Armaflex AF 8 insulation, minimum length 1100 mm, minimum thickness 8 mm. Insulation over a length of 500 mm from the wall, on both sides.

6) The penetration shall be provided with FP Intumescent Coating at the following locations:

   - When it concerns a pipe penetration:
     - For an uninsulated pipe, a minimum of 1 layer of FP Intumescent Coating is applied to the pipe on both sides of the wall over a minimum length of 200 mm.
     - For an uninsulated PVC pipe, a minimum of 1 layer of FP Intumescent Coating is applied to the pipe on both sides of the wall over a minimum length of 210 mm.
     - For a PVC or PE-Xb/Al/PE pipe, the wall surrounding the installation opening is also treated with a minimum of 1 layer of FP Intumescent Coating. The minimum dimensions of the wall surface to be treated are:

	PVC pipe	PE-Xb/Al/PE pipe
Minimum installation opening	16 mm	18 mm
- minimum dimensions treated wall surface	130 x 130 mm	68 x 68 mm
Maximum installation opening	40 mm	40 mm
- minimum dimensions treated wall surface	91x91 mm	91 x 91 mm

       - Interpolation of the values above is allowed.

     - For an insulated copper or PE-Xb/Al/PE pipe, a minimum of 1 layer of FP Intumescent Coating is applied to the outside of the insulation over a length of 200 mm, on both sides of the wall;

     - For a steel pipe, a minimum of 1 layer of FP Intumescent Coating is applied to the outside of the fire blanket over a length of 500 mm, on both sides of the wall. Also, the steel pipe on the non-heated side is treated with a minimum of 1 layer of FP Intumescent Coating over a length of 55 mm from the end of the fire blanket.

   - For a cable penetration, the cables are provided with a minimum of 1 layer of FP Intumescent Coating, on both sides of the FP Fire Board over a minimum length of 200 mm.
   - For a bus bar, a minimum of 1 layer of FP Intumescent Coating is applied to the bus bar on both sides of the FP Fire Board, over a minimum length of 200 mm.
   - For an FP Fire Board, the FP Fire Board shall be treated at least once with FP Intumescent Coating before mounting. After mounting, a minimum of 1 layer of FP Intumescent Coating is applied to the FP Fire Board.

7) The penetration shall be provided with FP Intumescent Acrylic at the following locations:
   - When it concerns a pipe penetration: in the installation opening, between the pipe and the wall, at the location of the gypsum board.
   - When it concerns a cable penetration: between the cables, and between the cables and the FP Fire Board.

8) The penetration shall be supported at various locations, where:
   - A pipe penetration or cable penetration is supported on both sides of the wall at ≤ 500 mm from the wall.
   - A bus bar is supported at ≤ 625 mm (directly heated side) and ≤ 525 mm (not directly heated side) of the wall.

9) The pipes may be used in non-ventilated systems, gas, drinking water and heating systems.

10) The penetrations can be used in the following supporting constructions:

    - A flexible wall construction according to EN 1363-1:2012;
      - The wall thickness can be increased, and more gypsum plates can be applied.
      - The flexible supporting construction can also be built from a wooden framework (width/depth ≥ 50 x 75 mm) with the same number of gypsum plates (2 x 12.5 mm).
    - A concrete or brick wall with a minimum thickness of 100 mm.

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APPENDIX A: FIGURES

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Figure A.4 Detail specimen M, based on 2007-Efectis-R0191
Figure A.5 Detail specimen O, based on 2007-Efectis-R0191
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Figure A.49 Detail specimen E2, based on Peutz Y.1432.RA.001
Figure A.50 Detail specimen H, based on Peutz Y.1432.RA.001

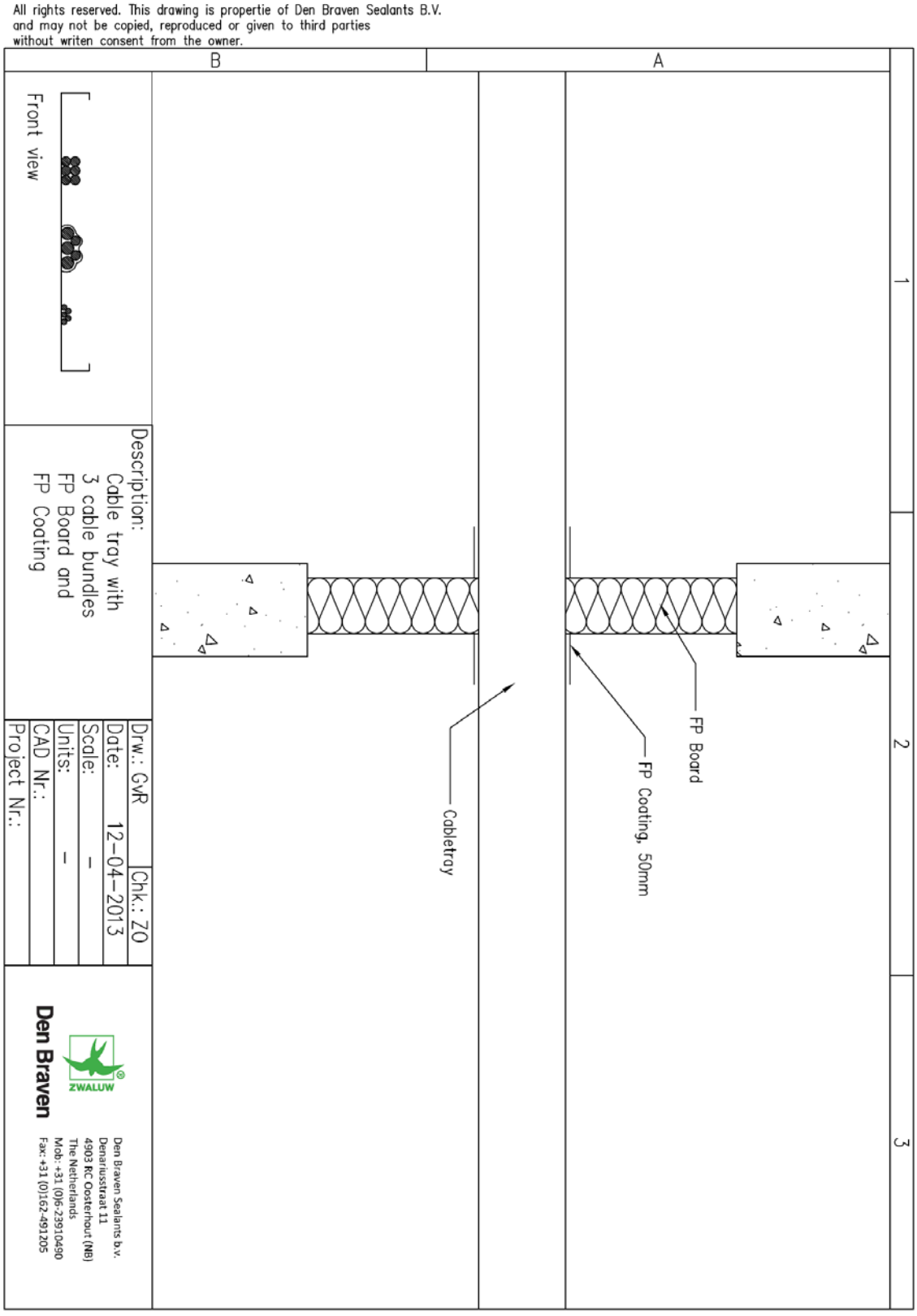

Figure A.1 Detail cable penetration, based on 2003-CVB-R0276

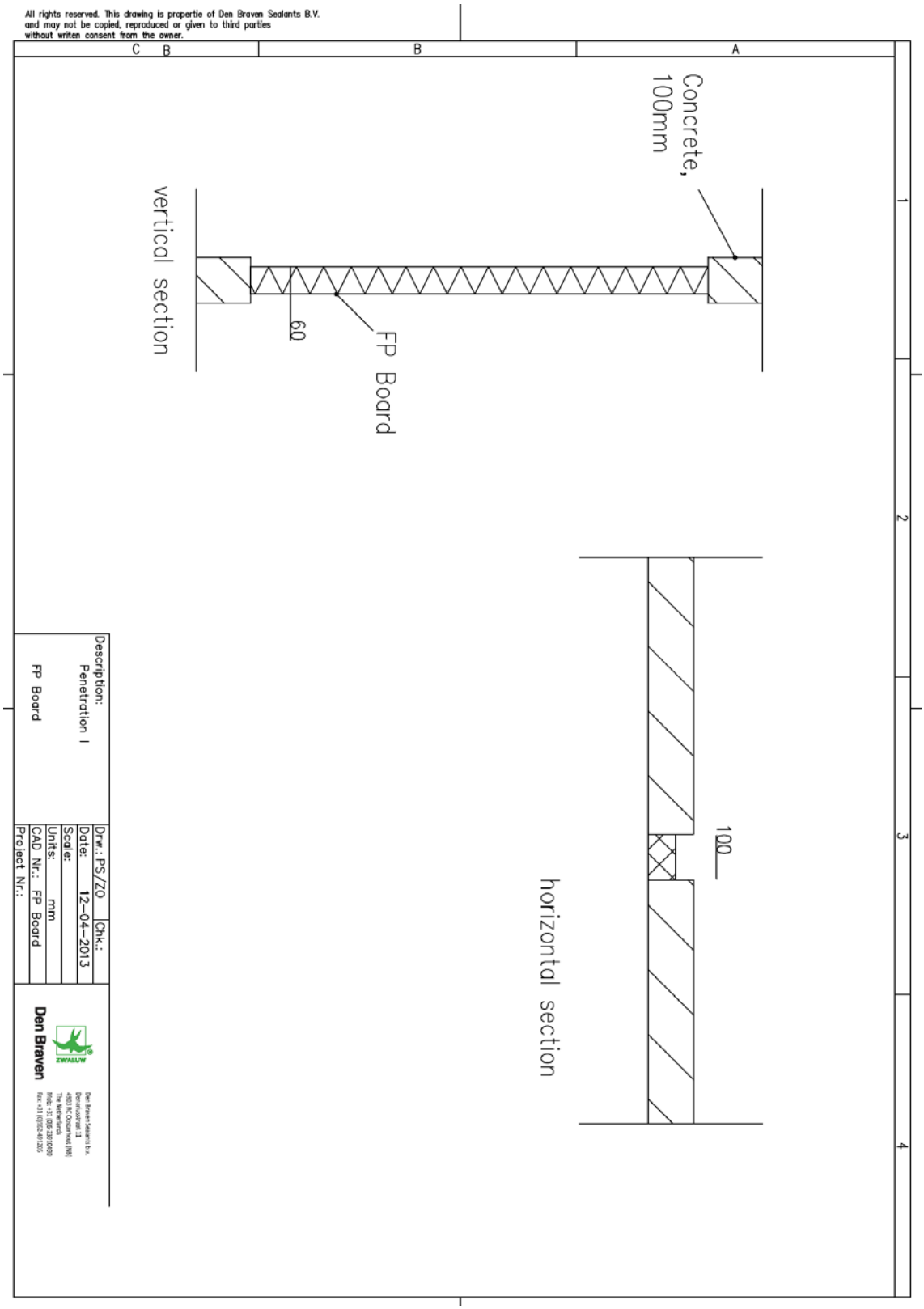

Figure A.2 Detail test specimen I, based on 2005-CVB-R0151

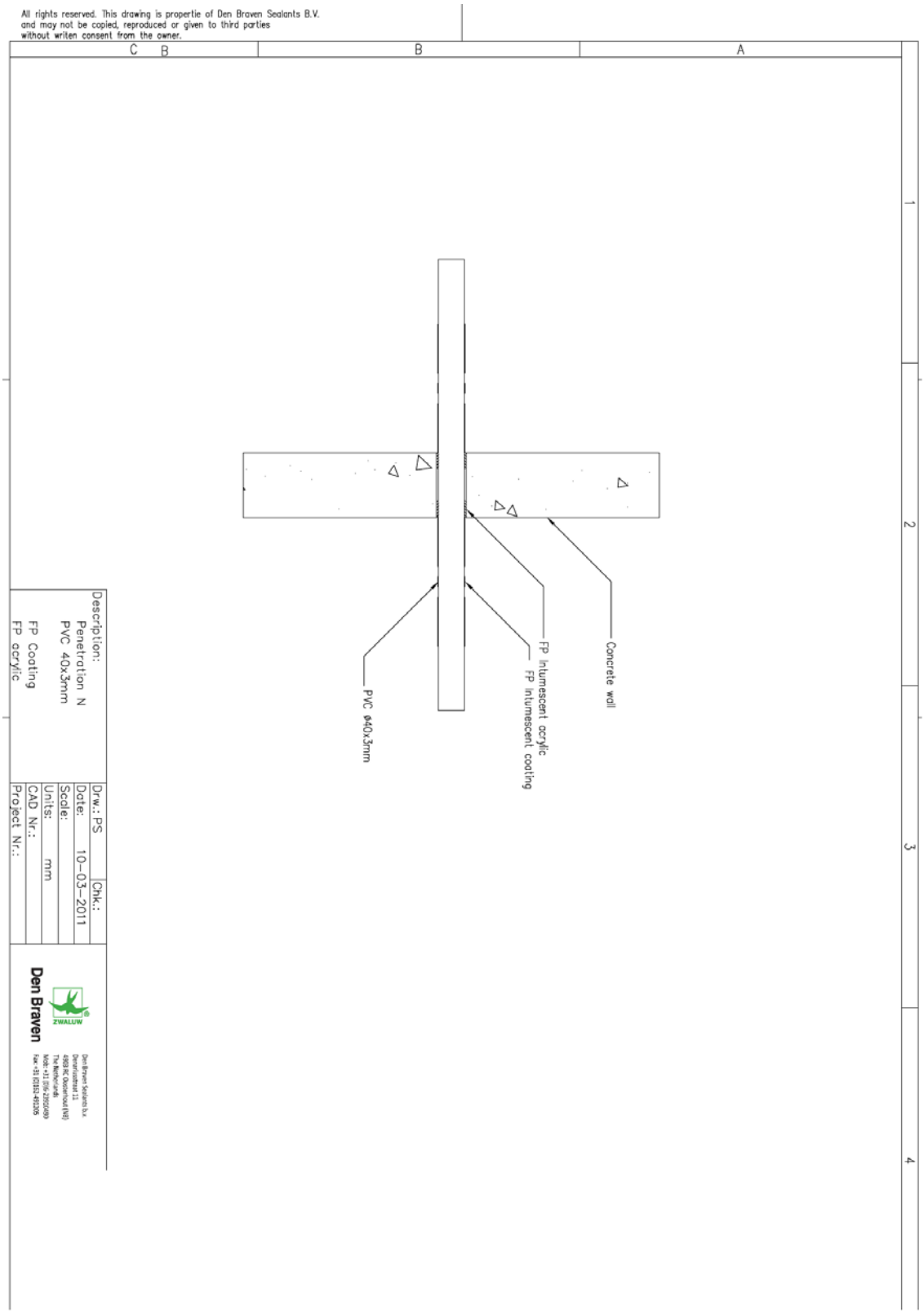

Figure A.3 Detail test specimen N, based on 2005-CVB-R0156

Figure A.4 Detail test specimen M, based on 2007-Efectis-R0191

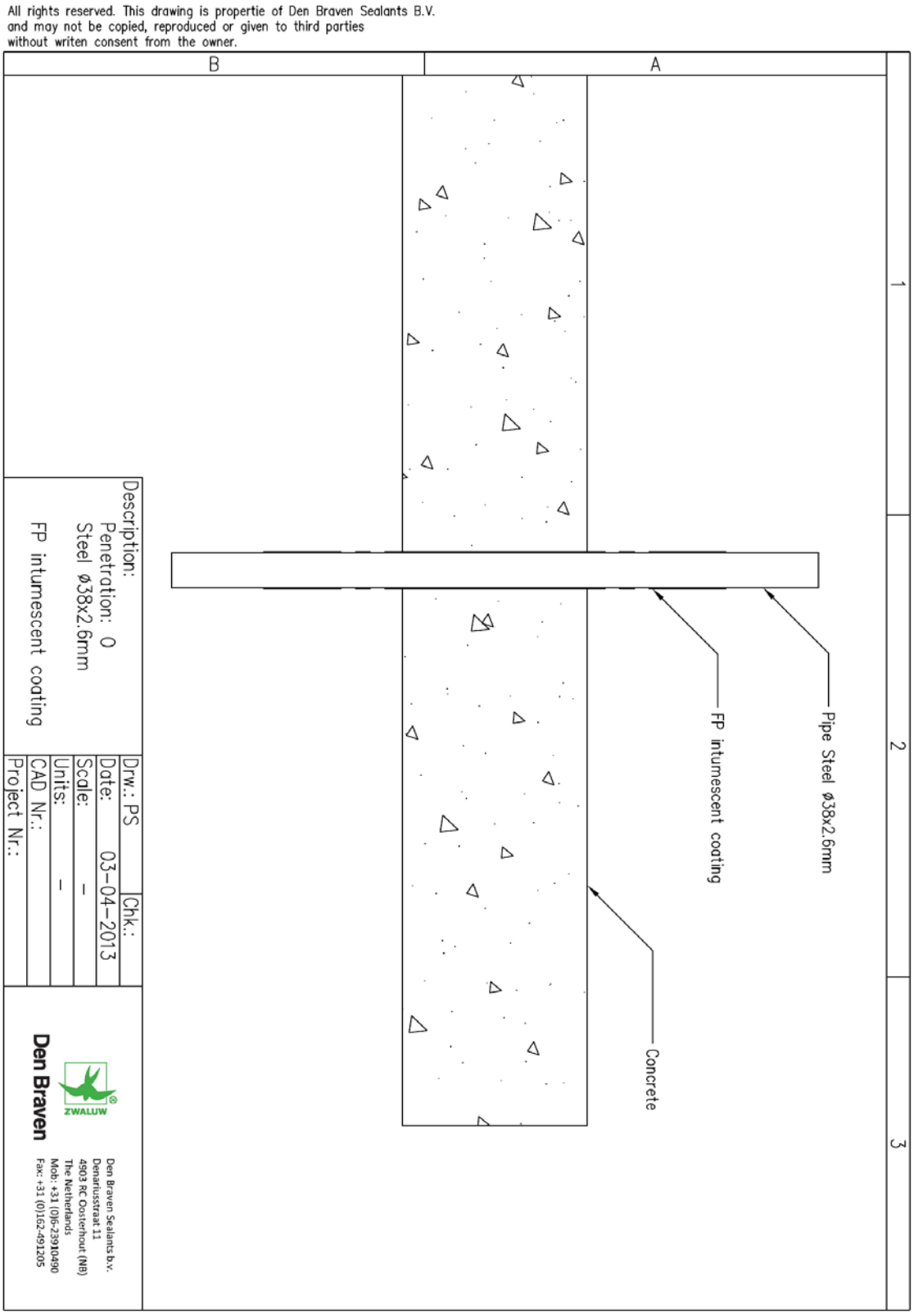

Figure A.5 Detail test specimen O, based on 2007-Efectis-R0191

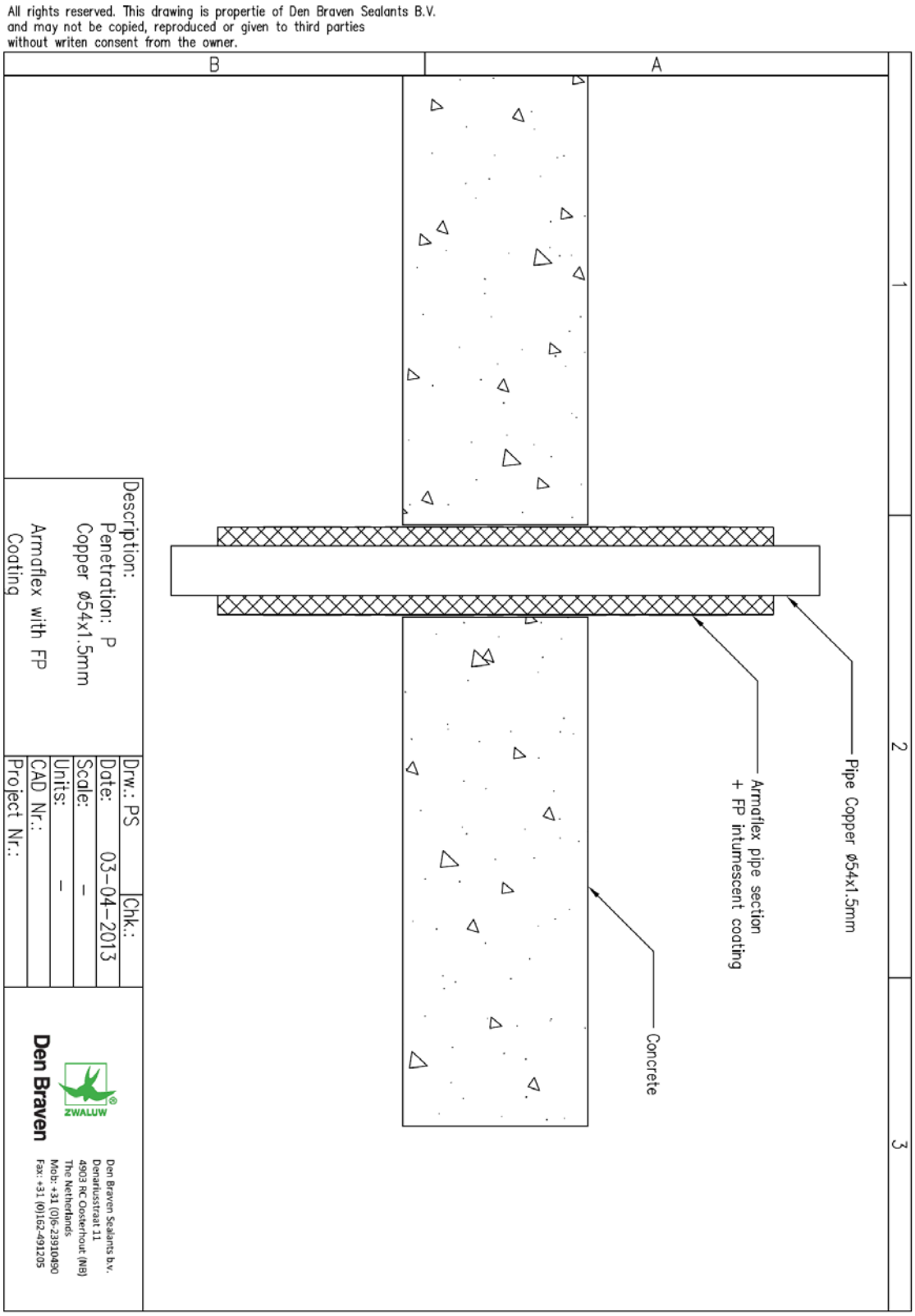

Figure A.6 Detail test specimen P, based on 2007-Efectis-R0191

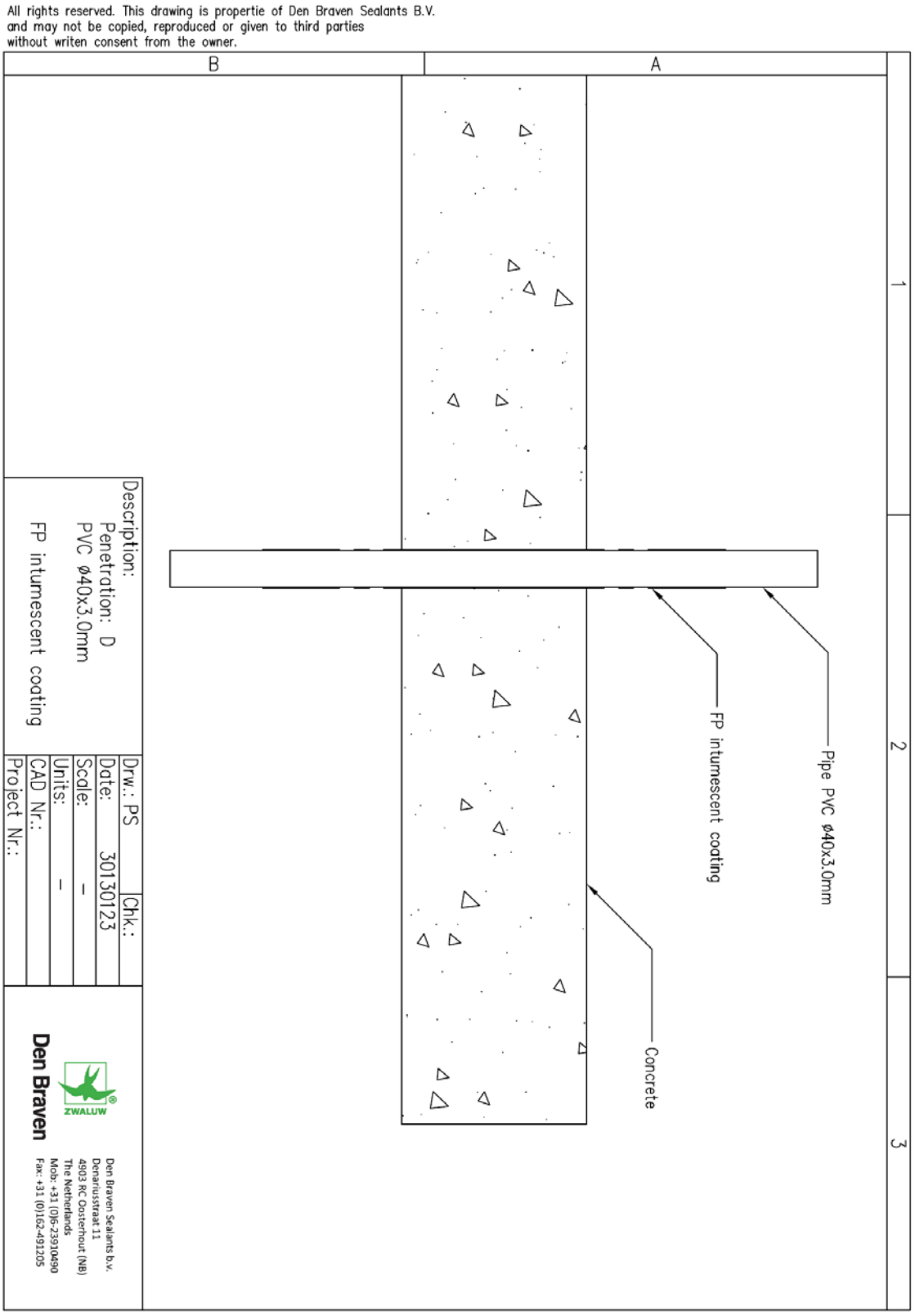

Figure A.7 Detail test specimen D, based on 2007-Efectis-R0192[Rev.1]

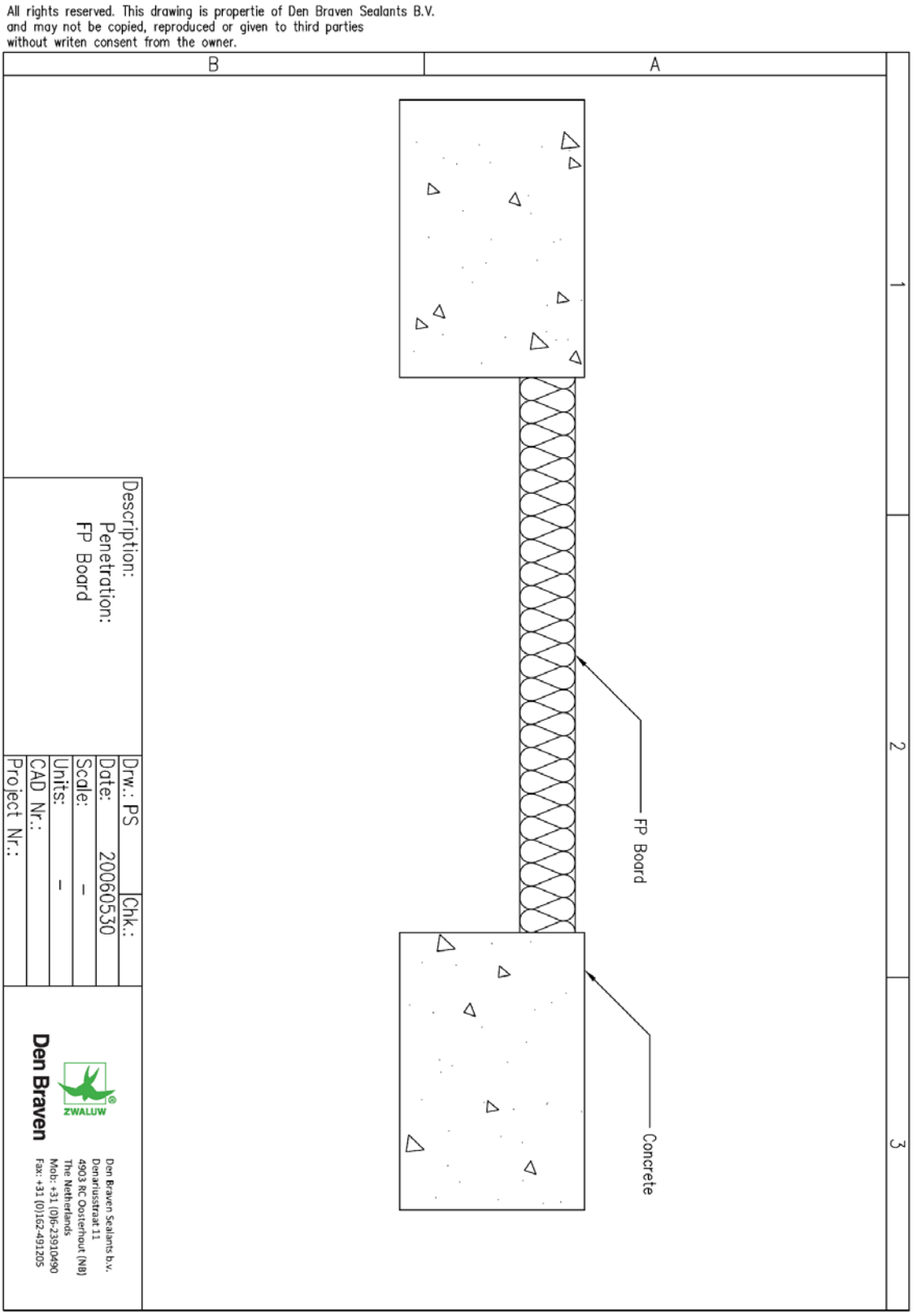

Figure A.8 Detail “blank” penetration, based on 2007-Efectis-R0192[Rev.1]

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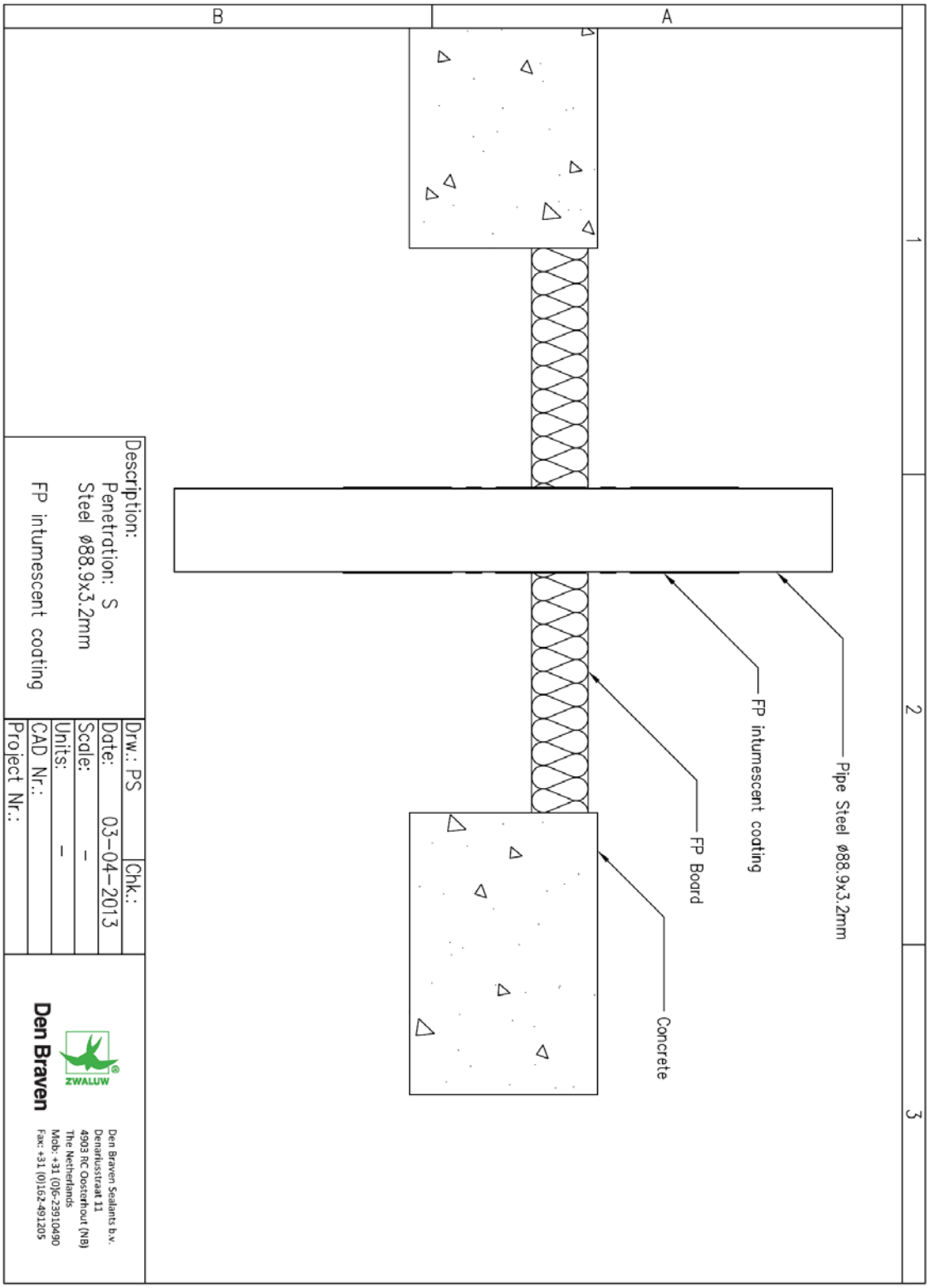

Figure A..9 Detail test specimen S, based on 2007-Efectis-R0383

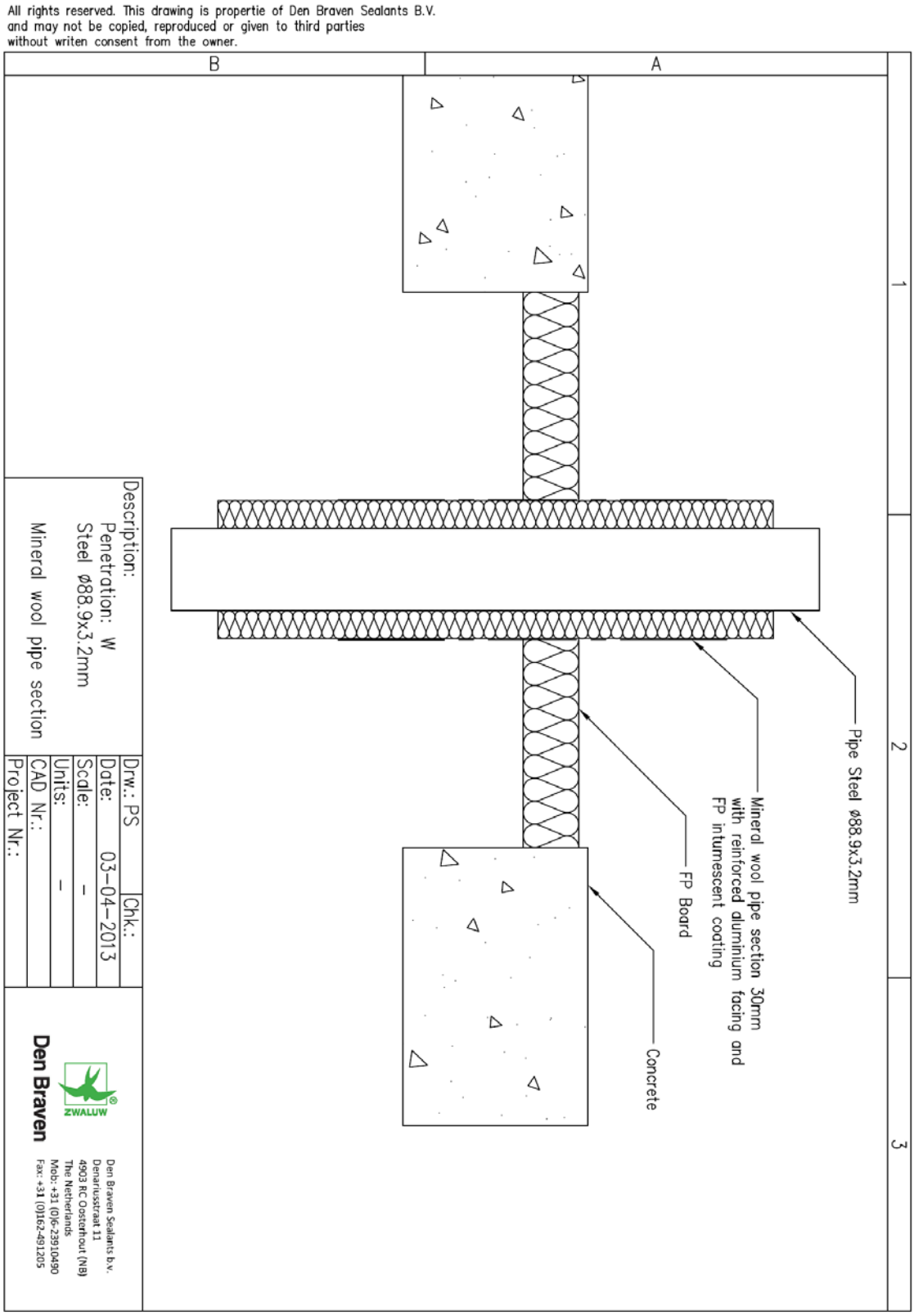

Figure A.10 Detail test specimen W, based on 2007-Efectis-R0383

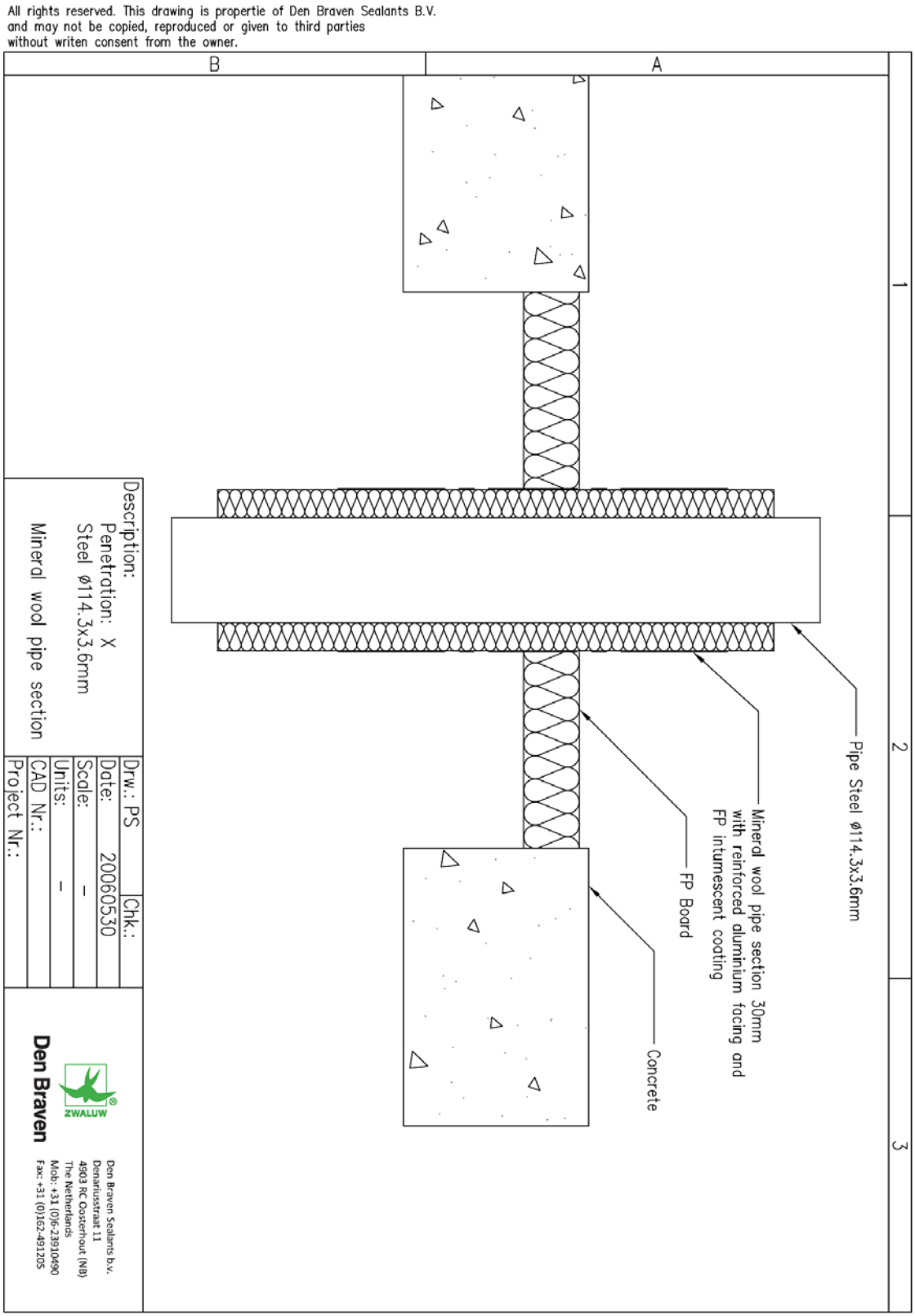

Figure A.11 Detail test specimen X, based on 2007-Efectis-R0383

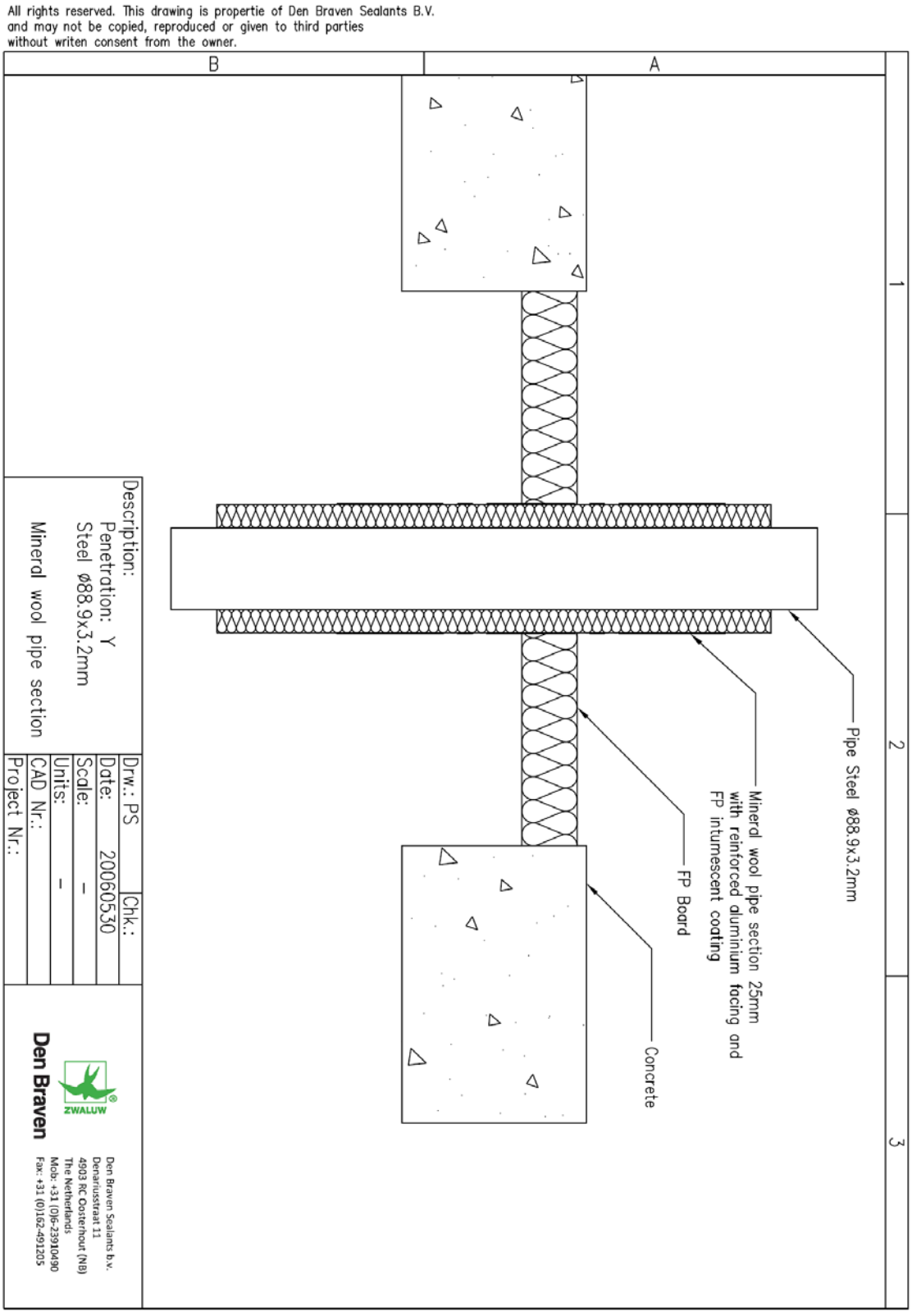

Figure A.12 Detail test specimen Y, based on 2007-Efectis-R0383

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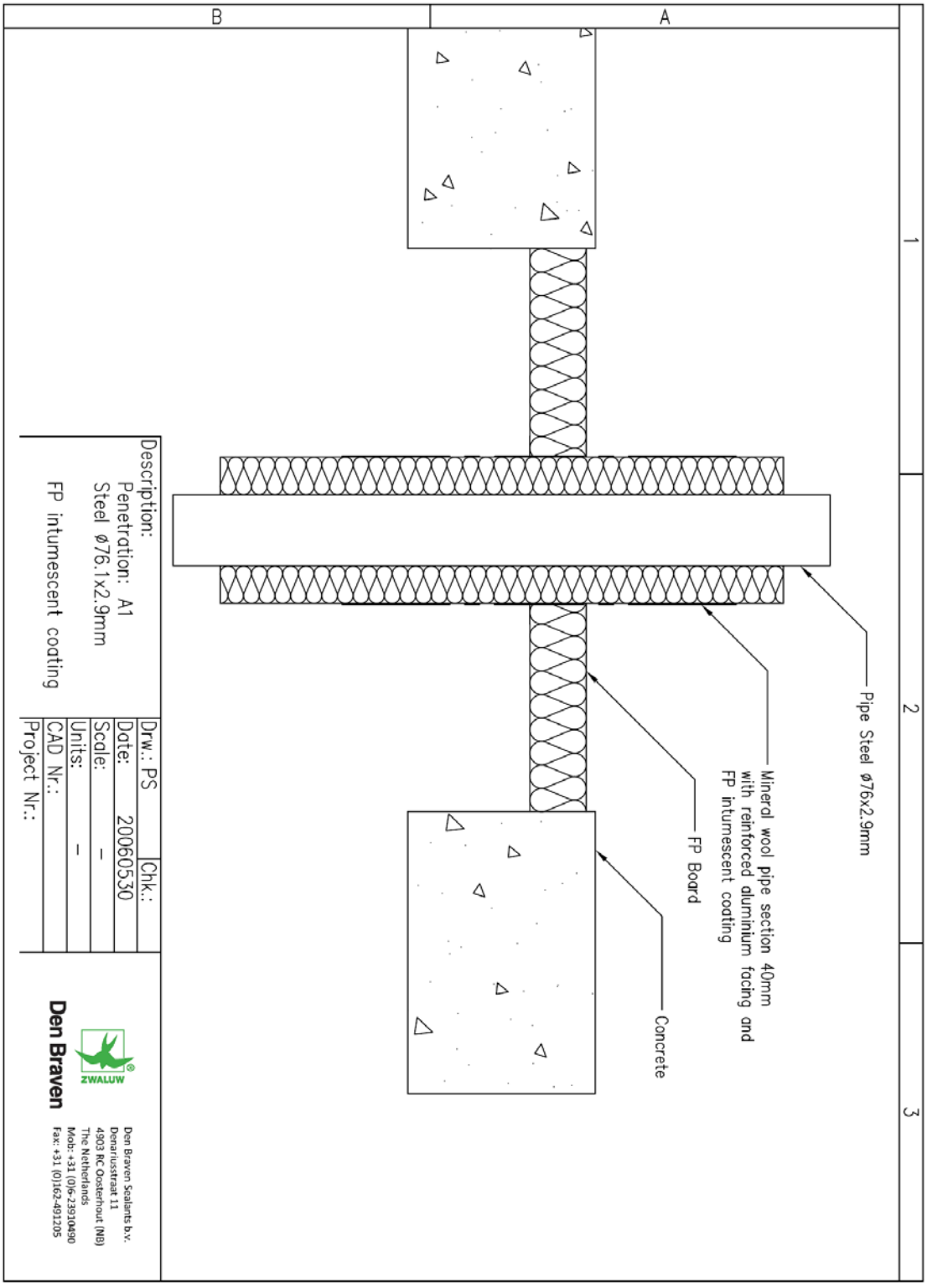

Figure A.13 Detail test specimen A1, based on 2007-Efectis-R0383

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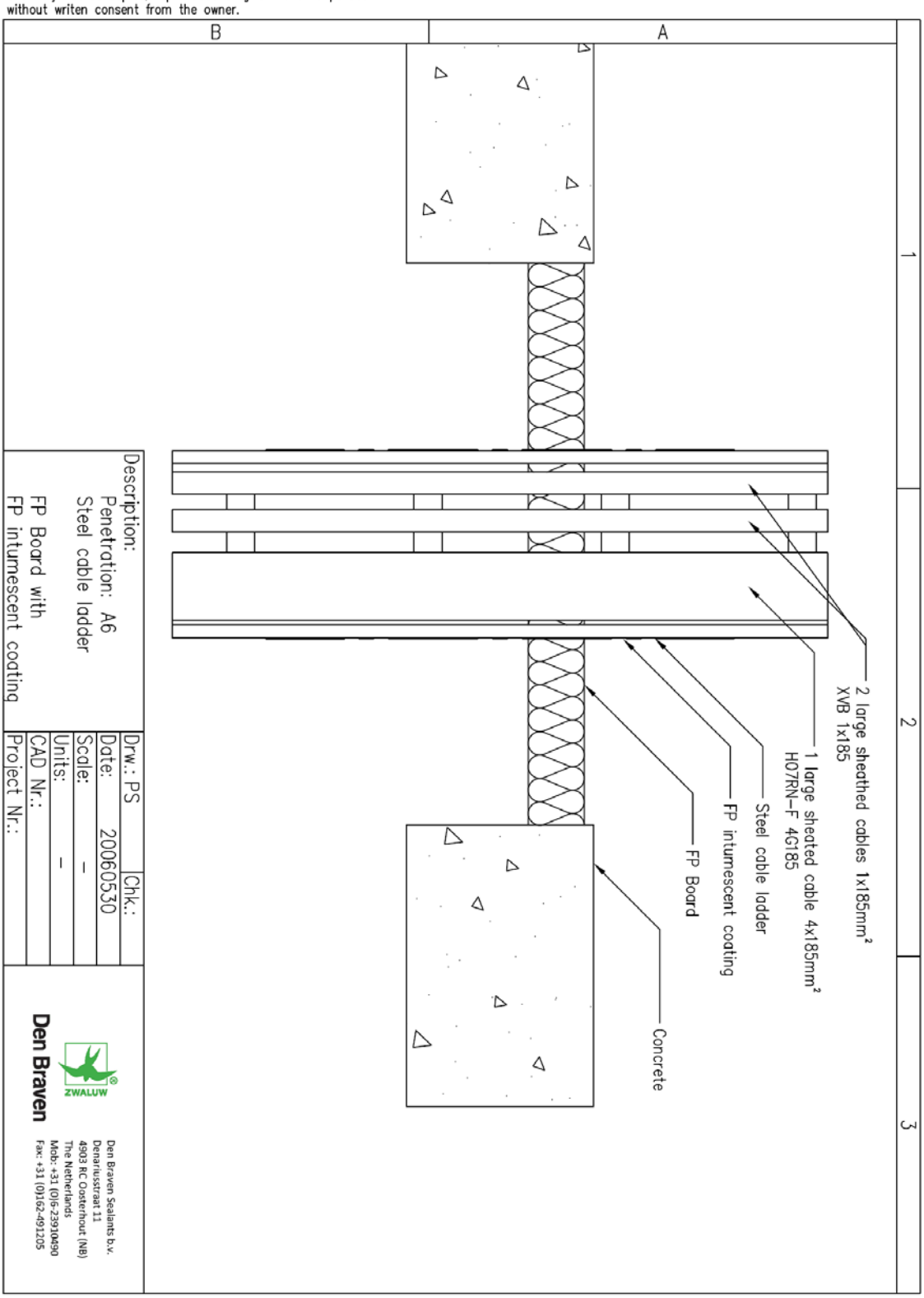

Figure A.14 Detail test specimen A6, based on 2007-Efectis-R0383

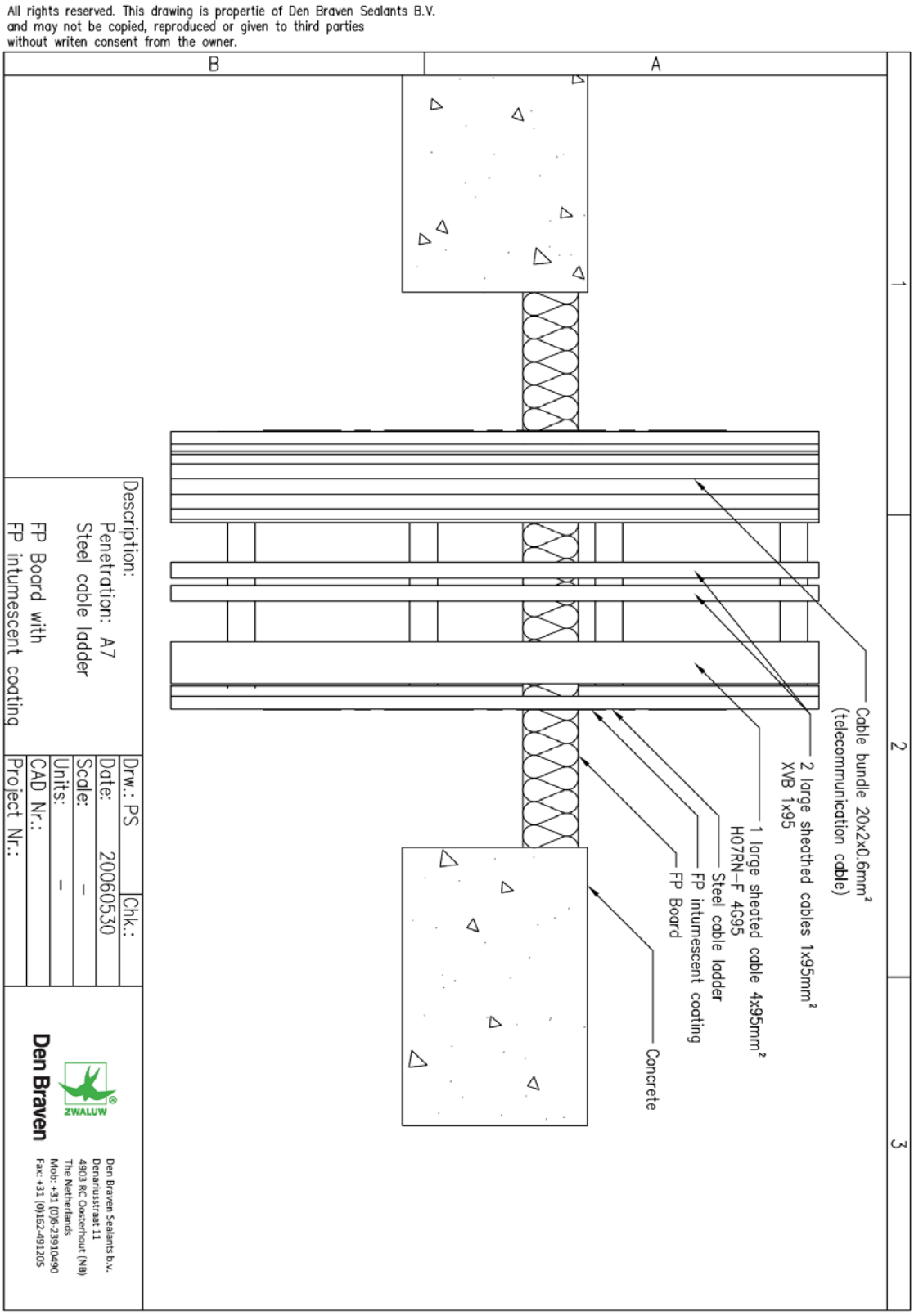

Figure A.15 Detail test specimen A7, based on 2007-Efectis-R0383

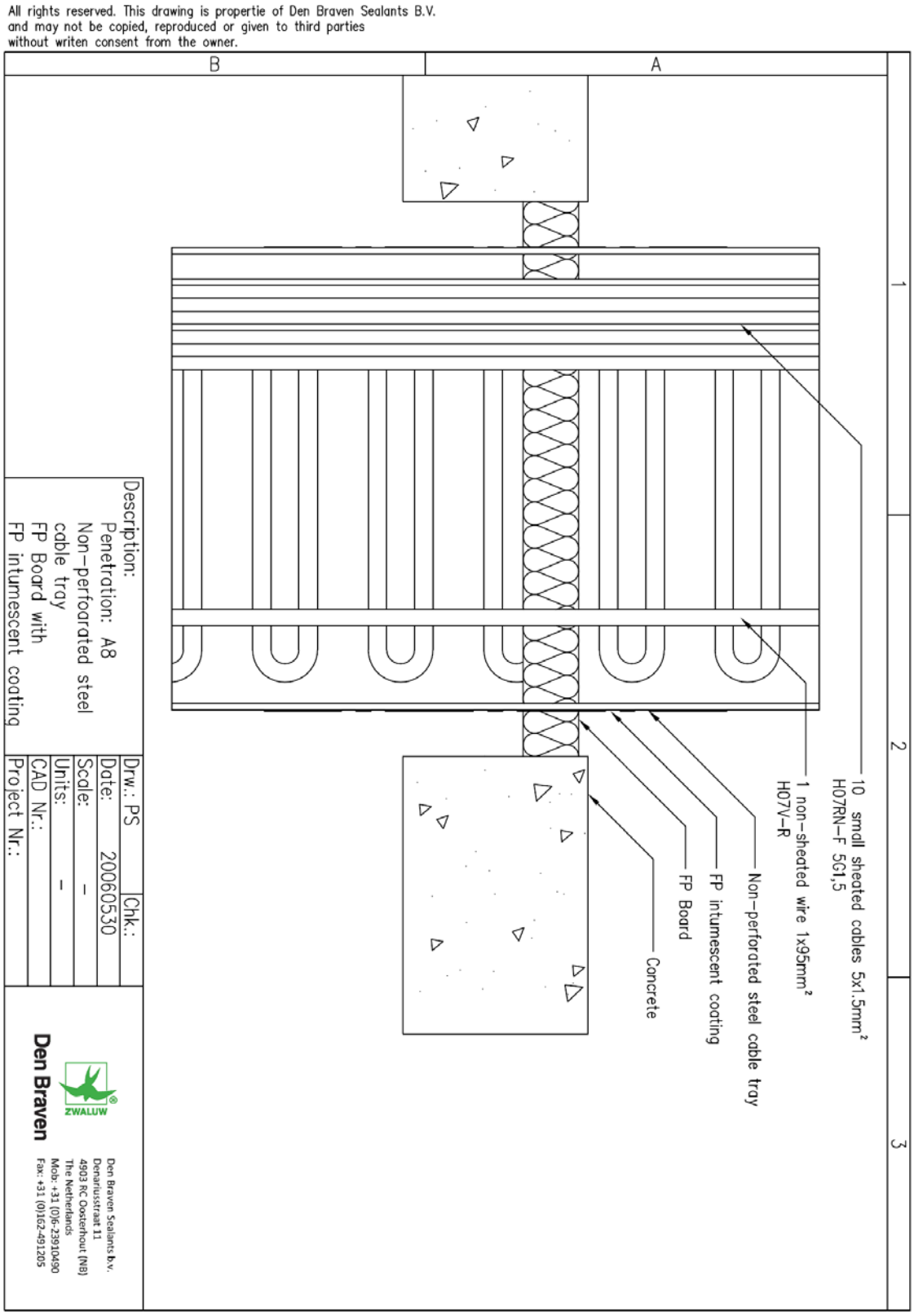

Figure A.16 Detail test specimen A8, based on 2007-Efectis-R0383

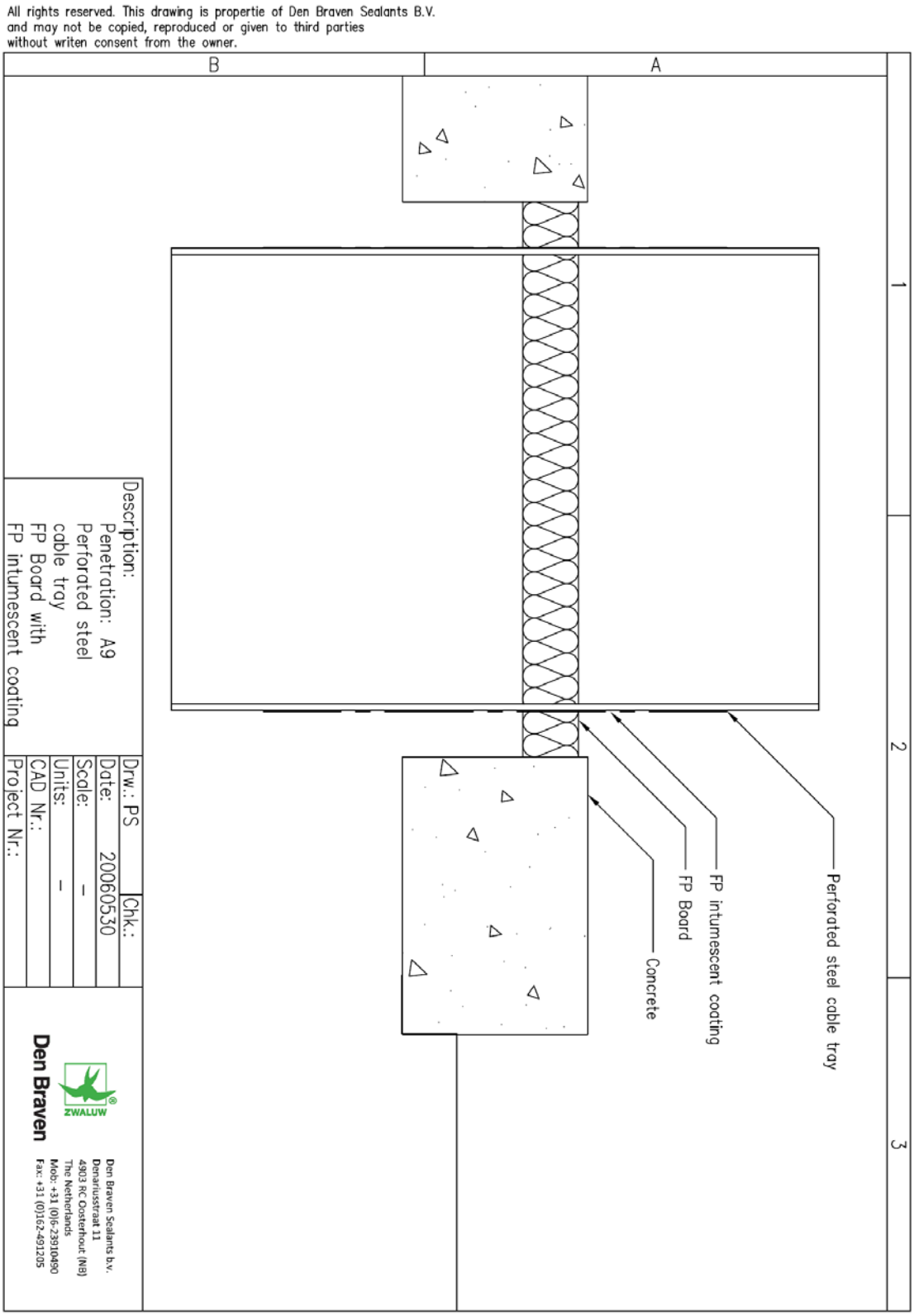

Figure A.17 Detail test specimen A9, based on 2007-Efectis-R0383

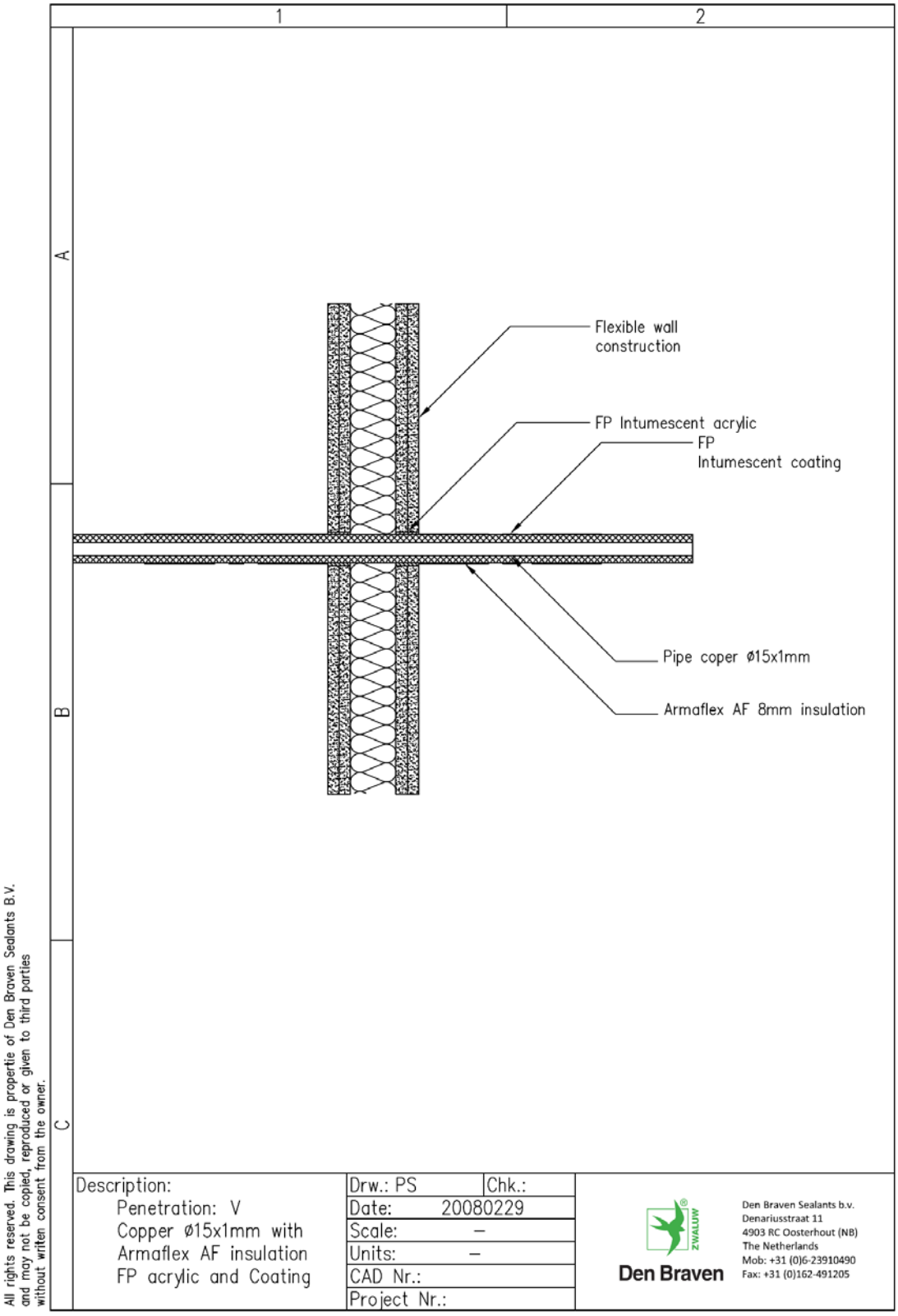

Figure A.18 Detail test specimen V dated 29-02-2008, based on 2008-Efectis-R0381[Rev.1]

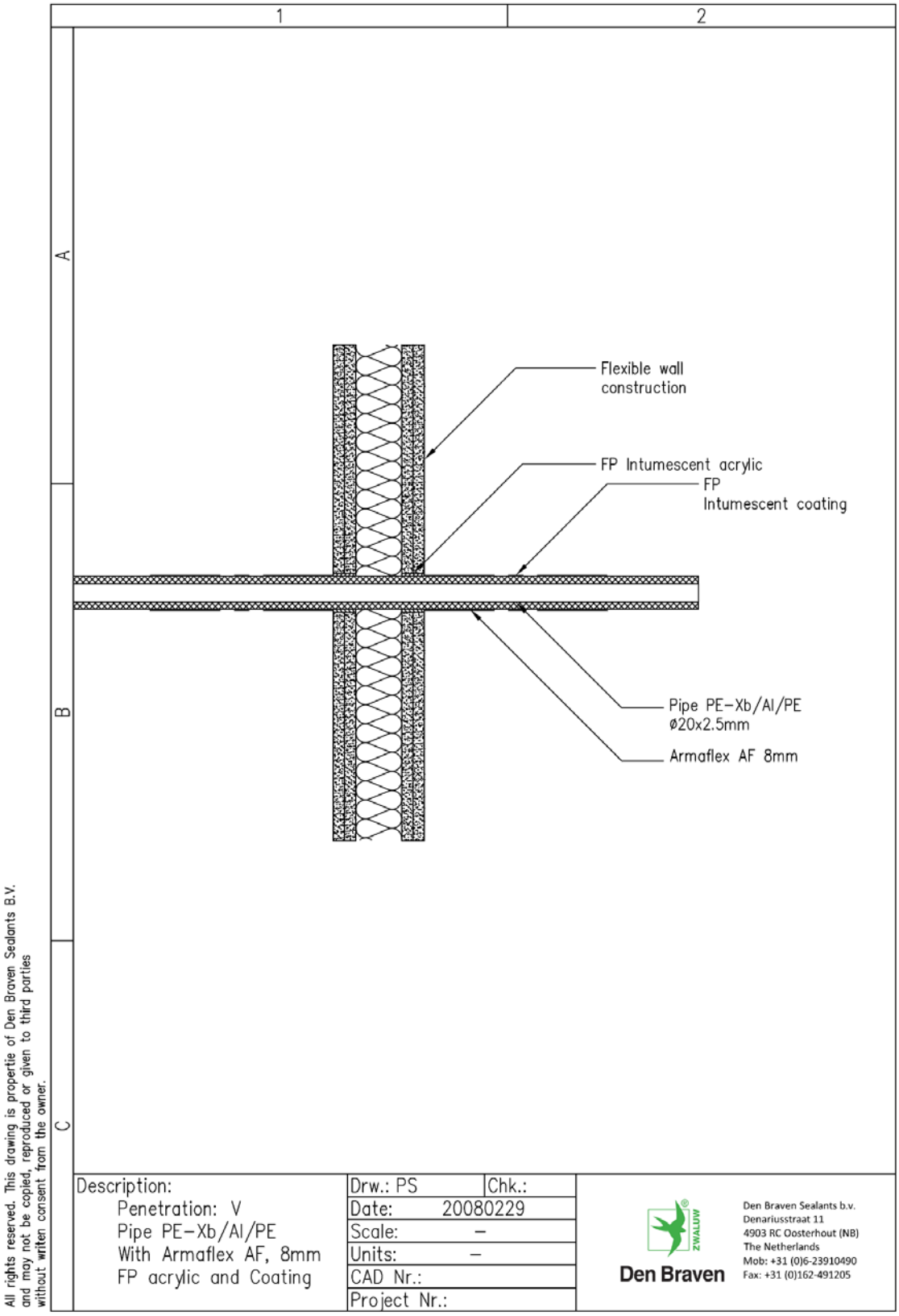

Figure A.19 Detail test specimen V dated 27-03-2008, based on 2008-Efectis-R0381[Rev.1]

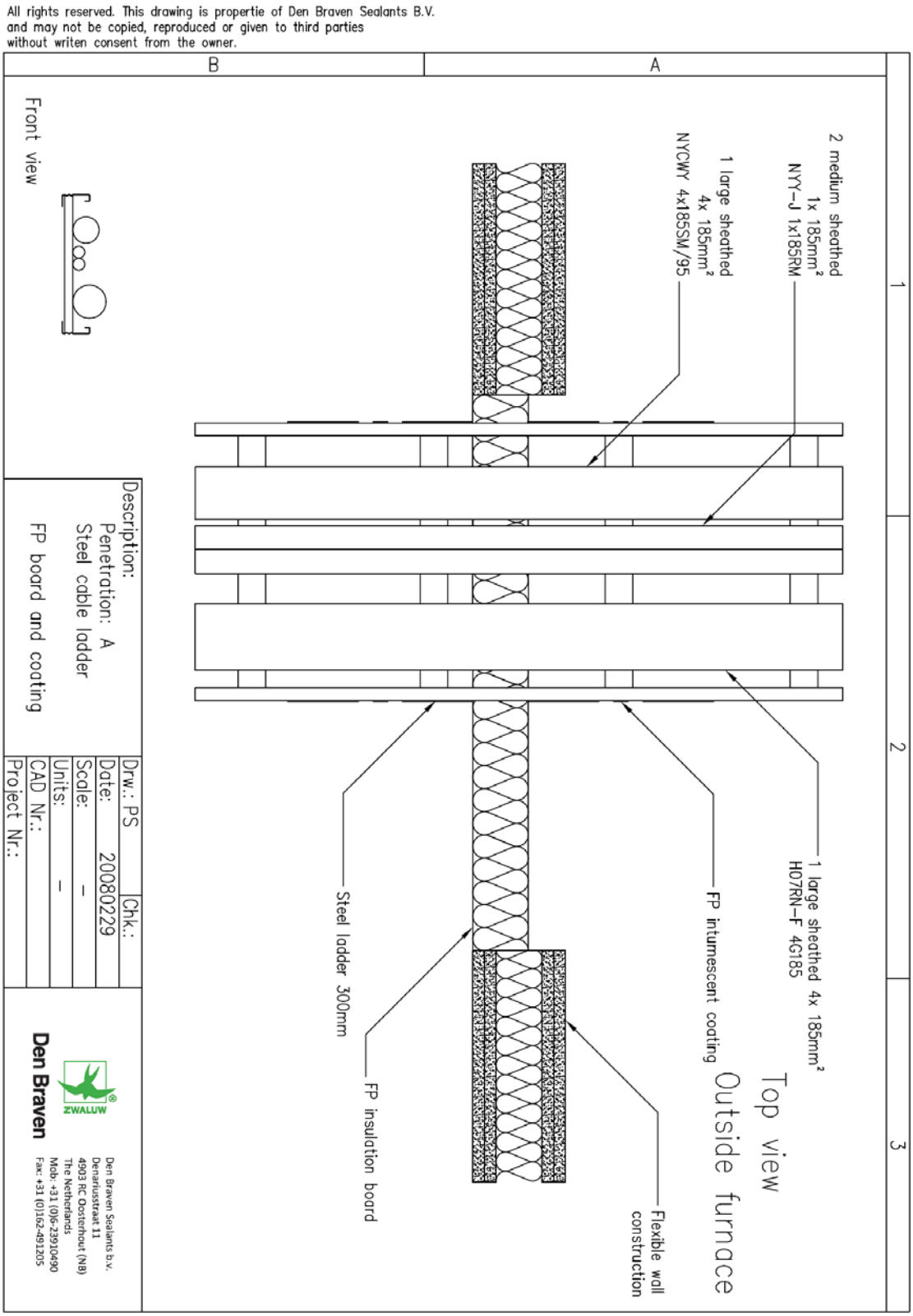

Figure A.20 Detail test specimen A dated 27-03-2008, based on 2008-Efectis-R0451

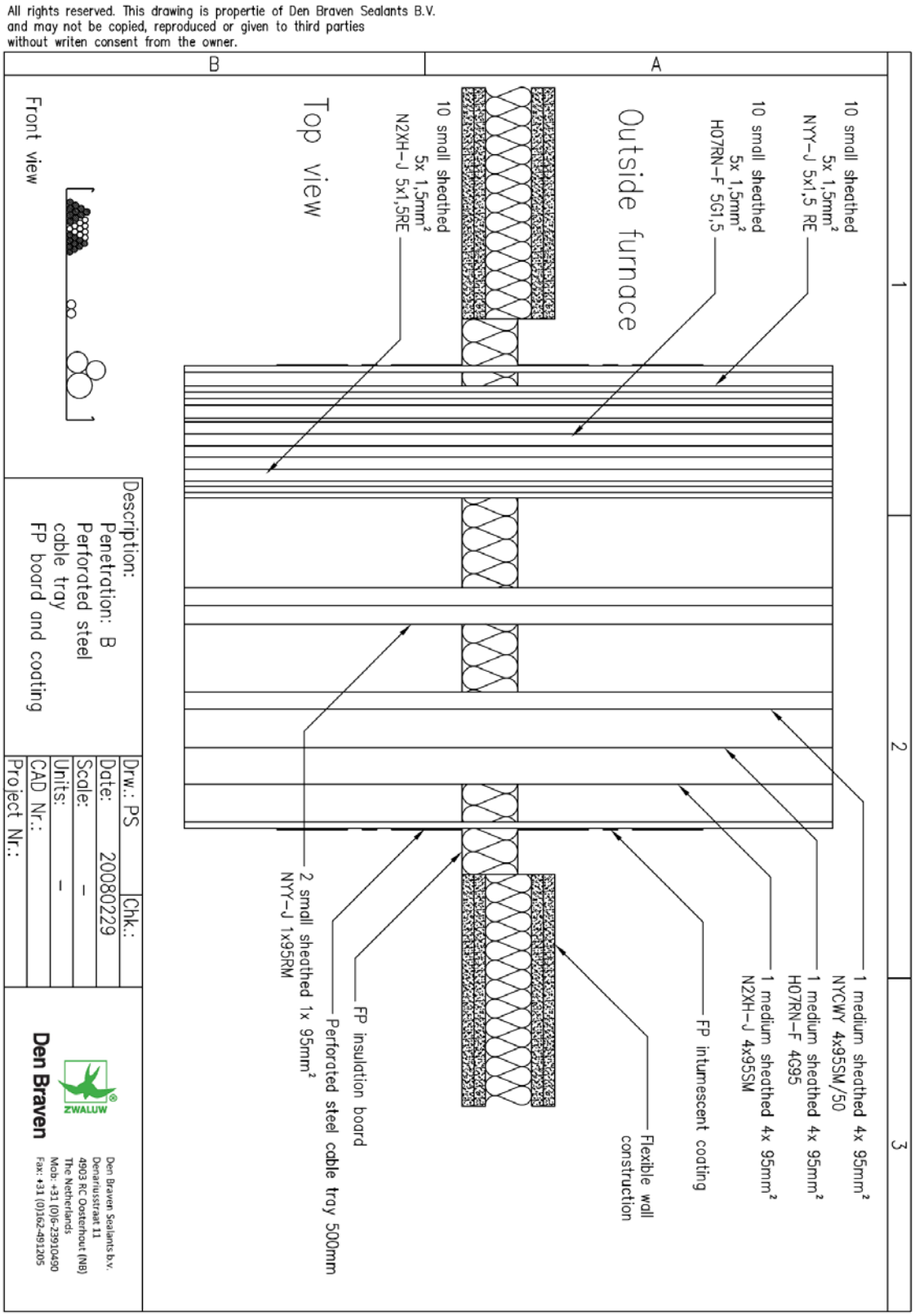

Figure A.21 Detail test specimen B dated 27-03-2008, based on 2008-Efectis-R0451

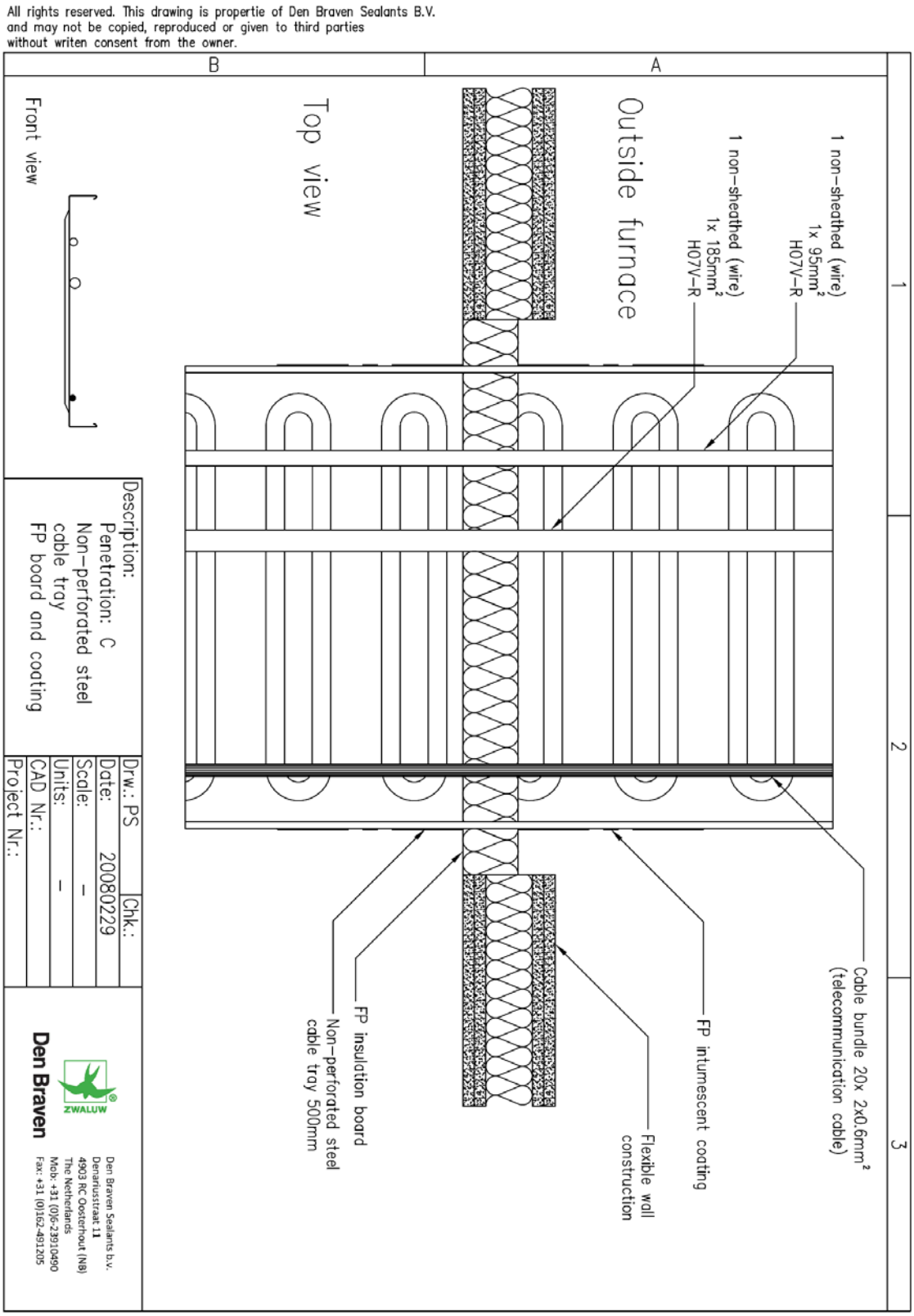

Figure A.22 Detail test specimen C dated 27-03-2008, based on 2008-Efectis-R0451

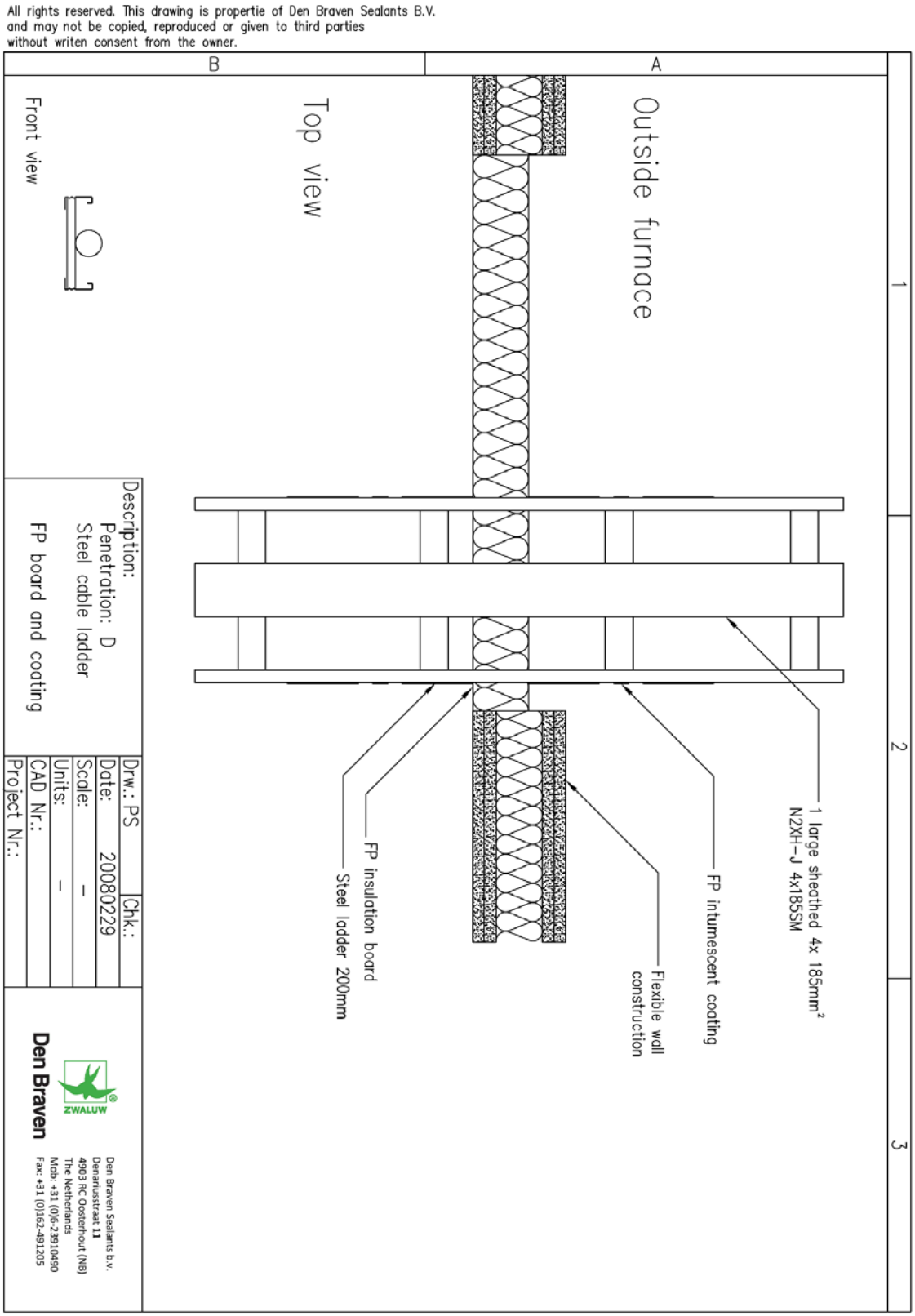

Figure A.23 Detail test specimen D dated 27-03-2008, based on 2008-Efectis-R0451

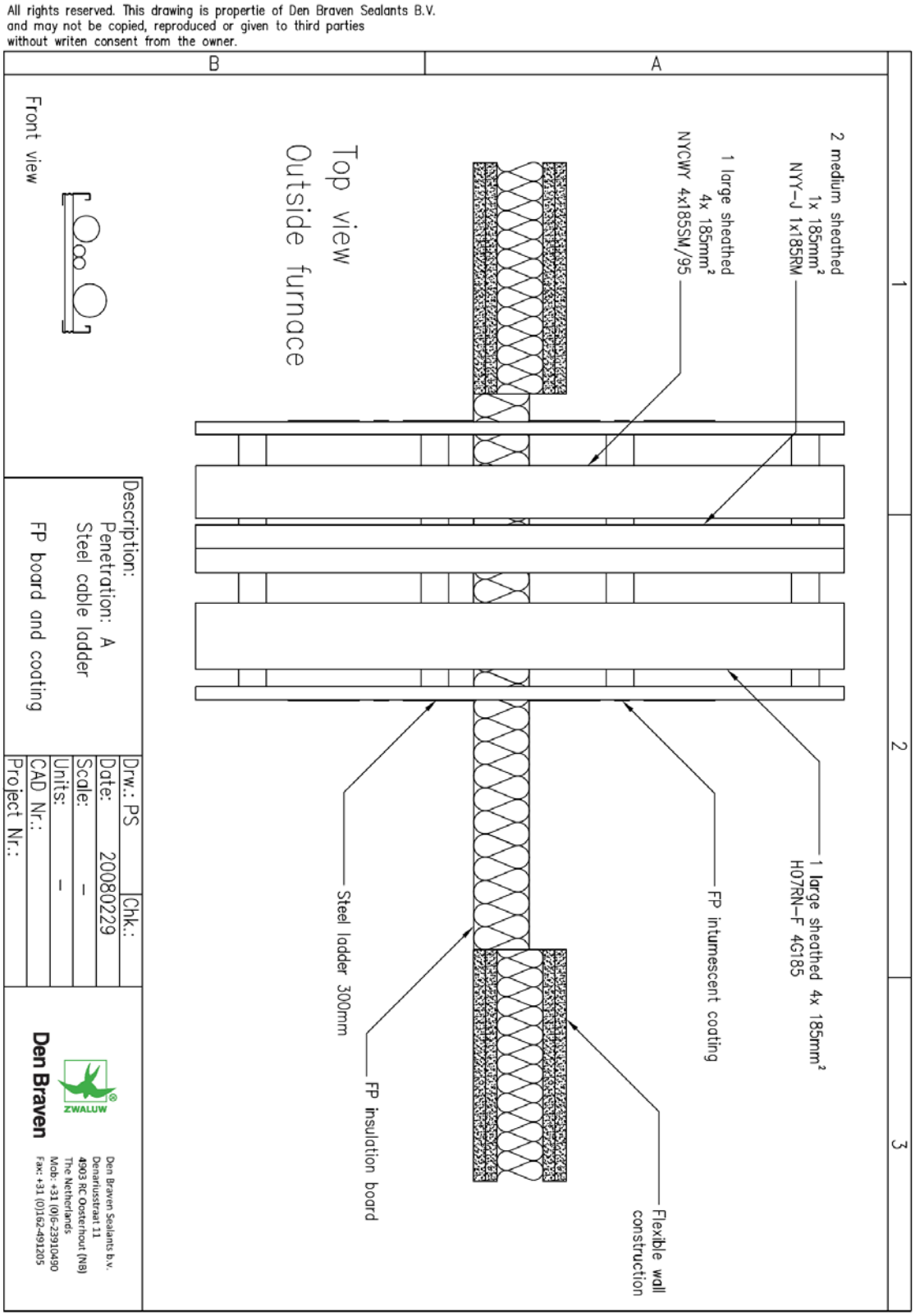

Figure A.24 Detail test specimen A dated 06-06-2008, based on 2008-Efectis-R0451

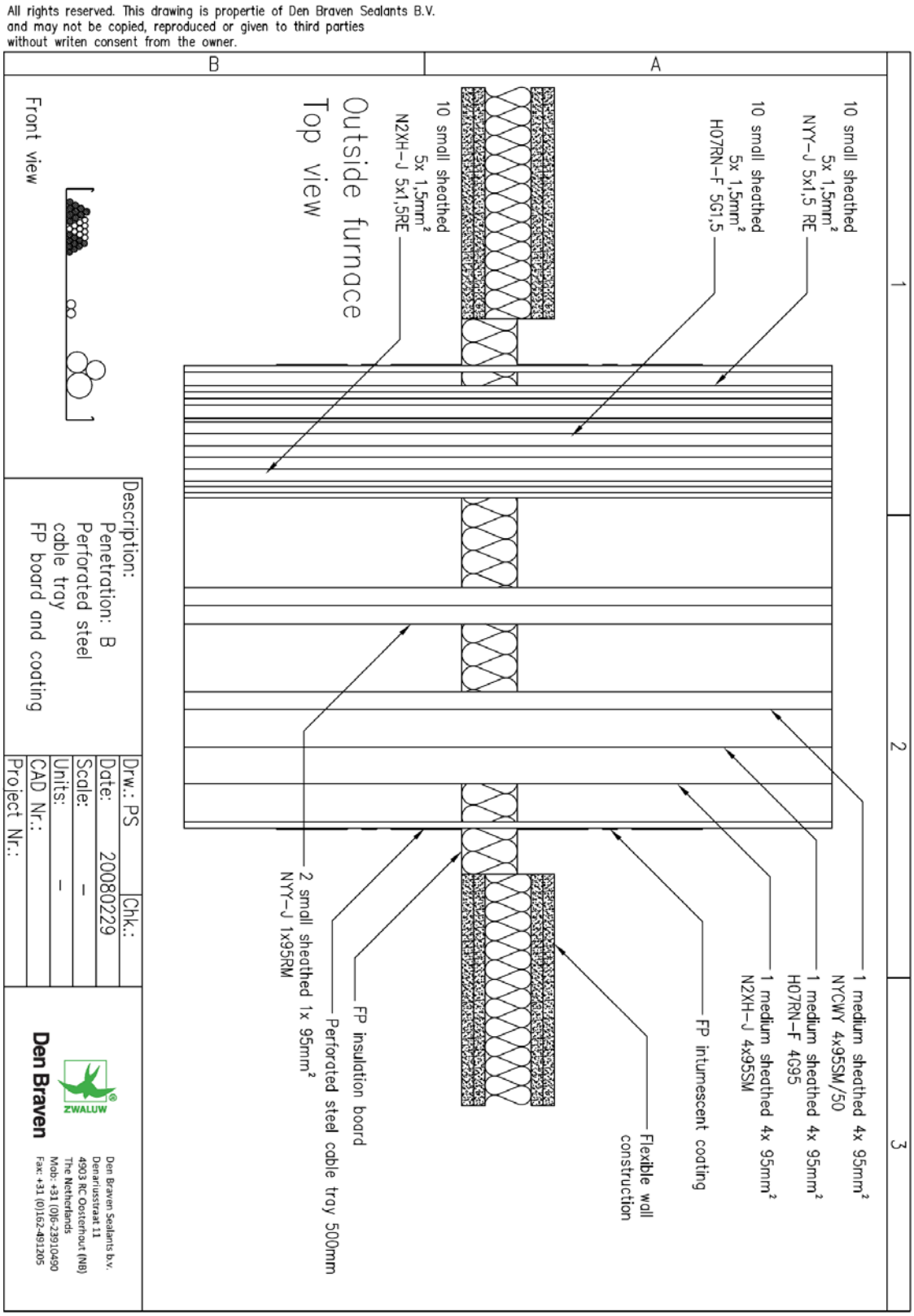

Figure A.25 Detail test specimen B dated 06-06-2008, based on 2008-Efectis-R0451

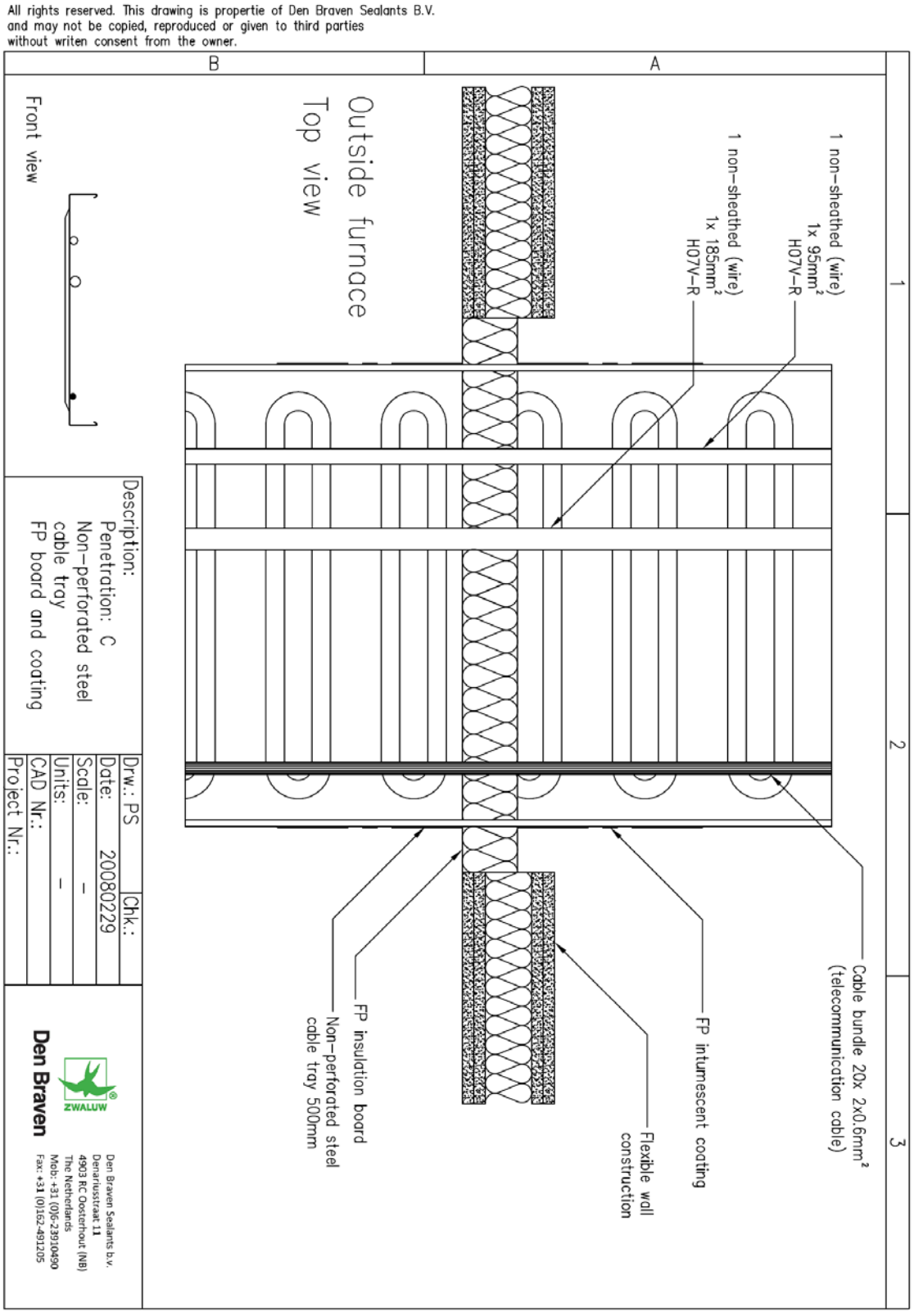

Figure A.26 Detail test specimen C dated 06-06-2008, based on 2008-Efectis-R0451

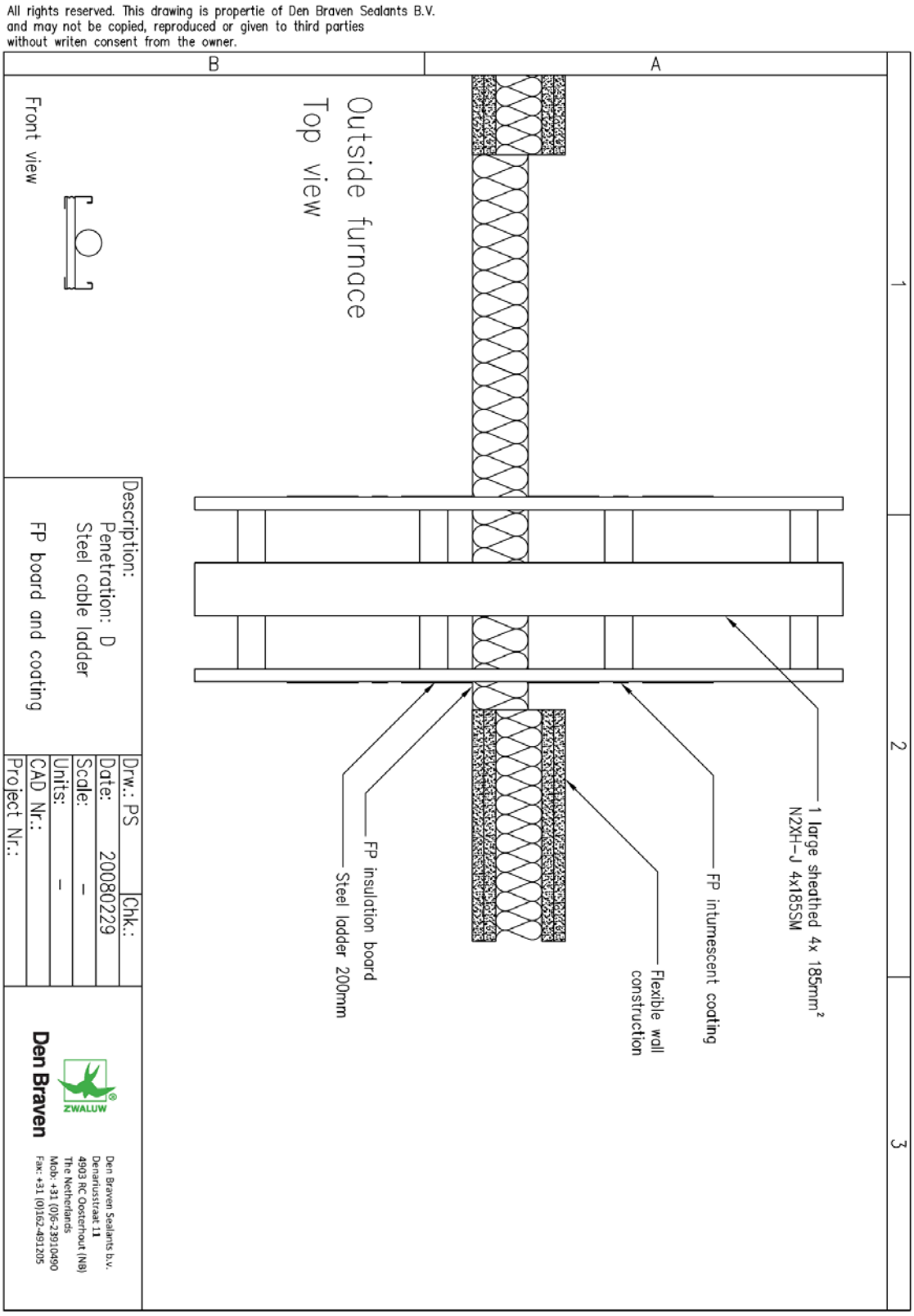

Figure A.27 Detail test specimen D dated 06-06-2008, based on 2008-Efectis-R0451

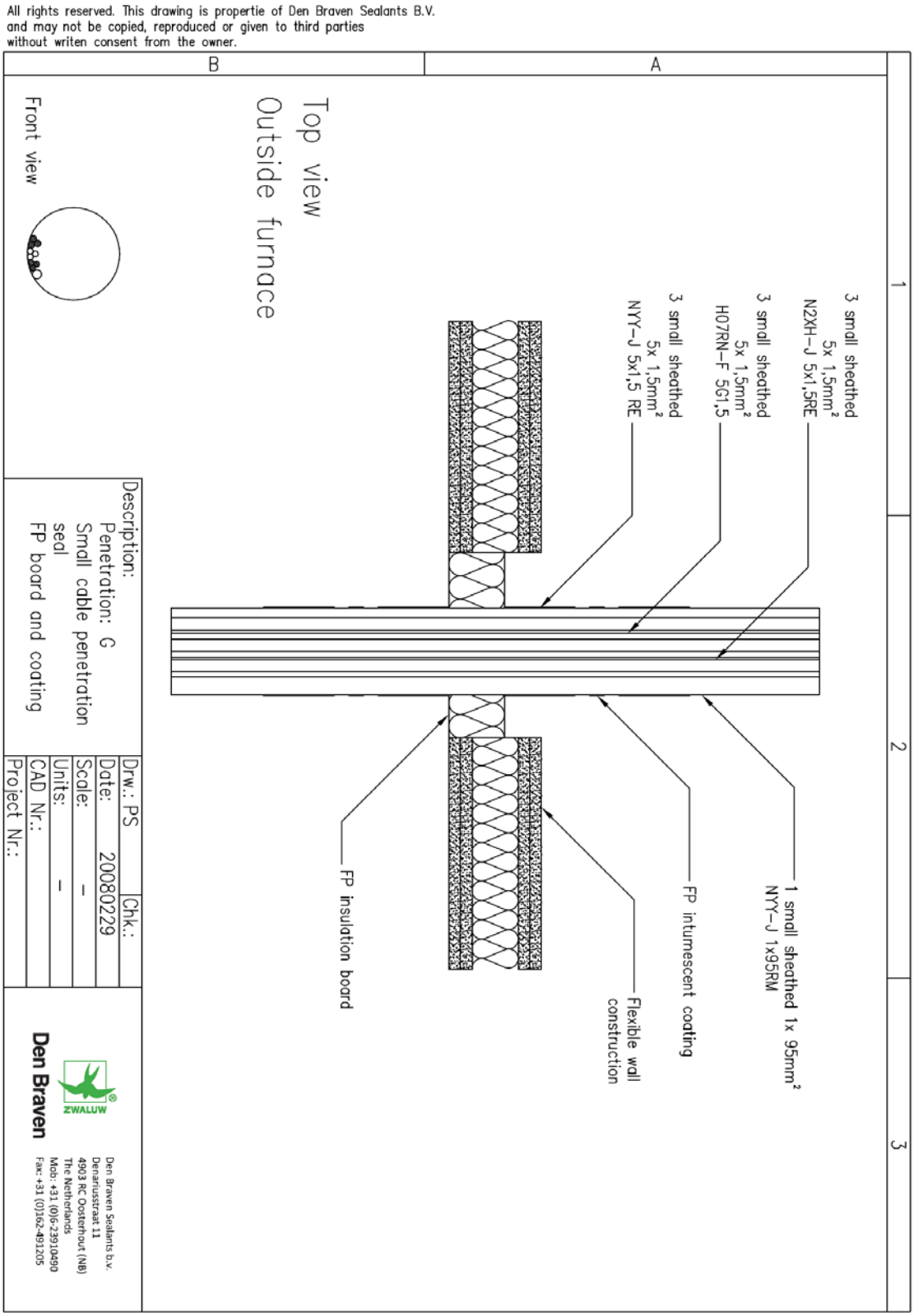

Figure A.28 Detail test specimen G dated 29-02-2008, based on 2008-Efectis-R0452

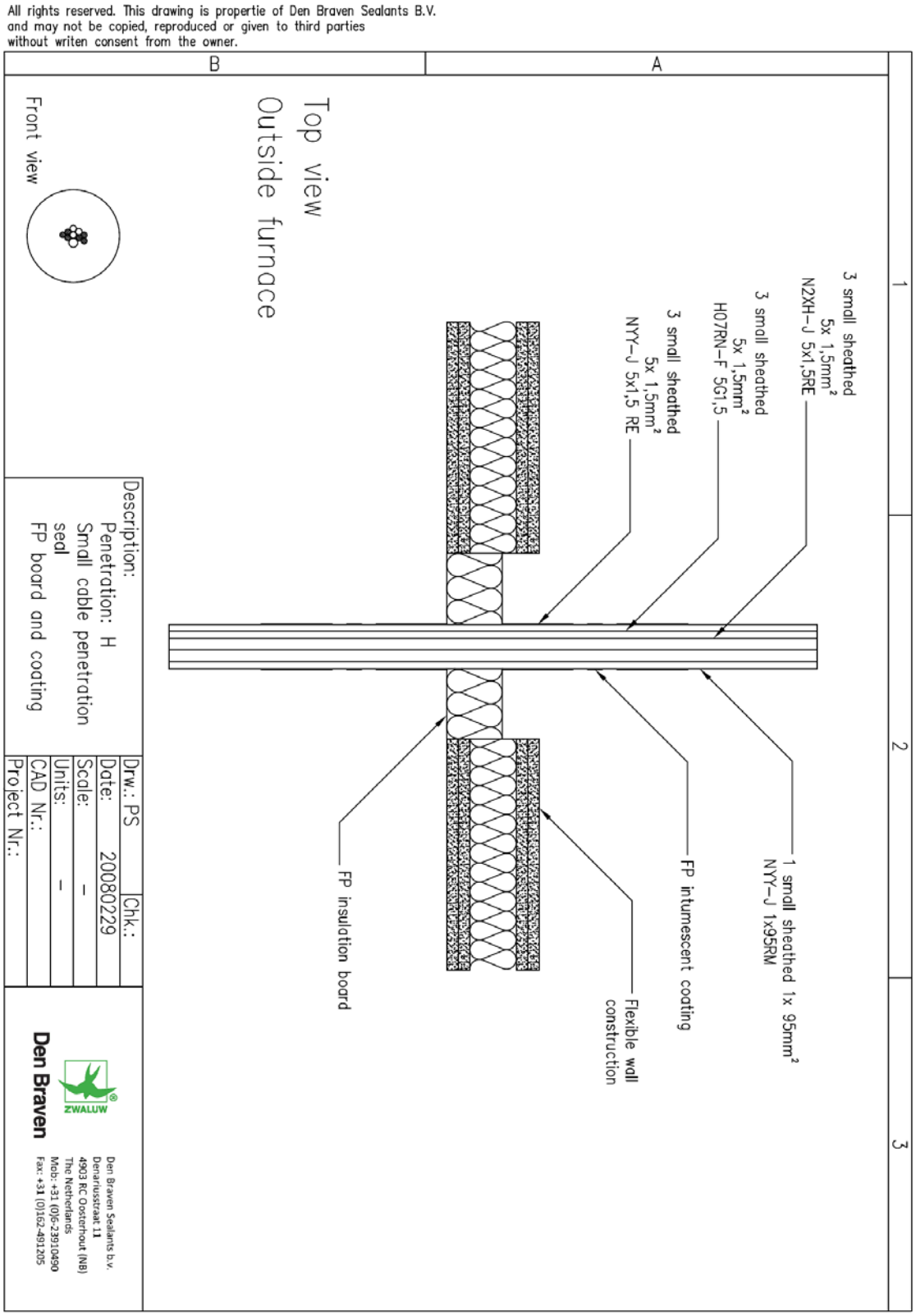

Figure A.29 Detail test specimen H dated. 29-02-2008, based on 2008-Efectis-R0452

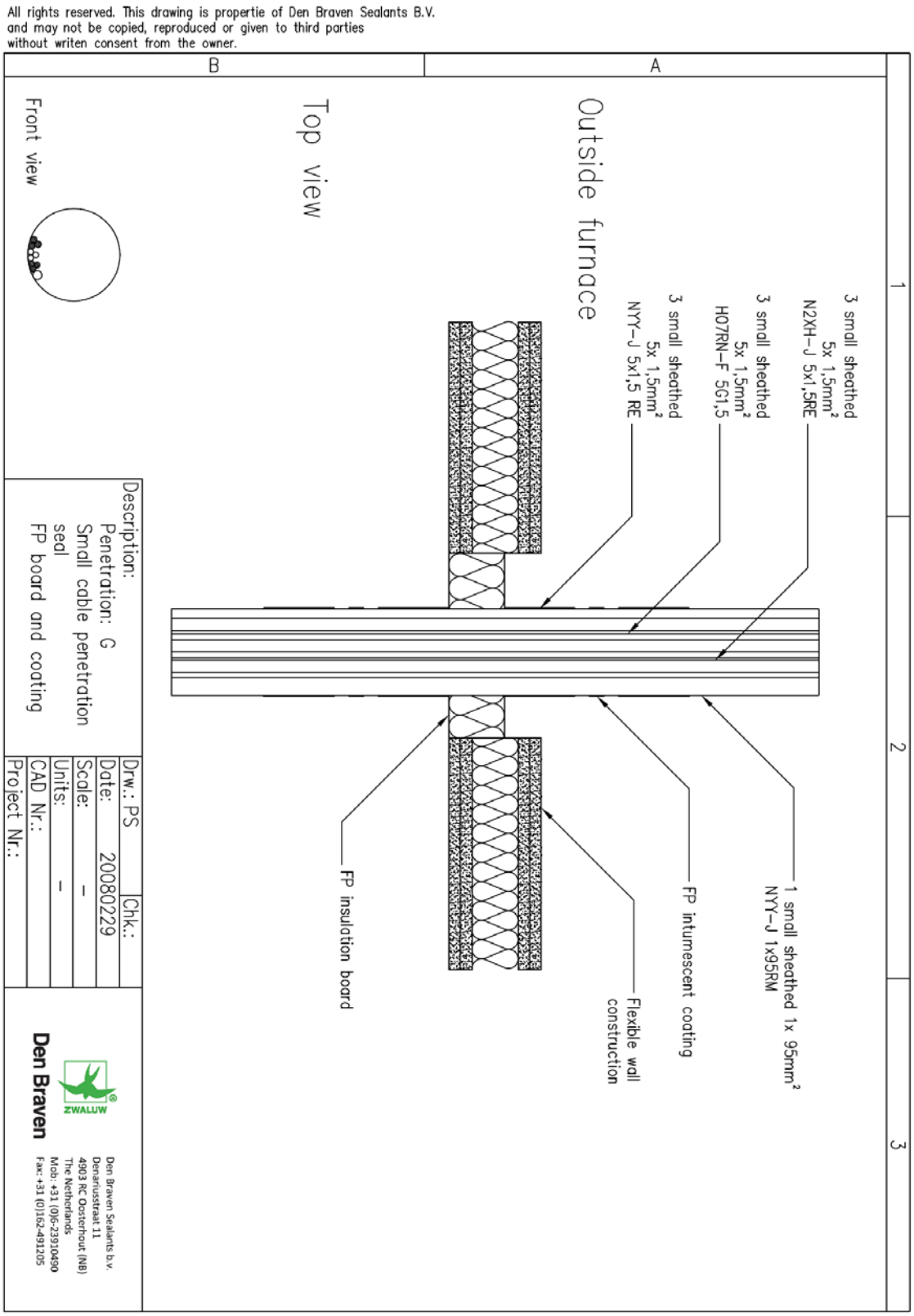

Figure A.30 Detail test specimen G dated 27-03-2008, based on 2008-Efectis-R0452

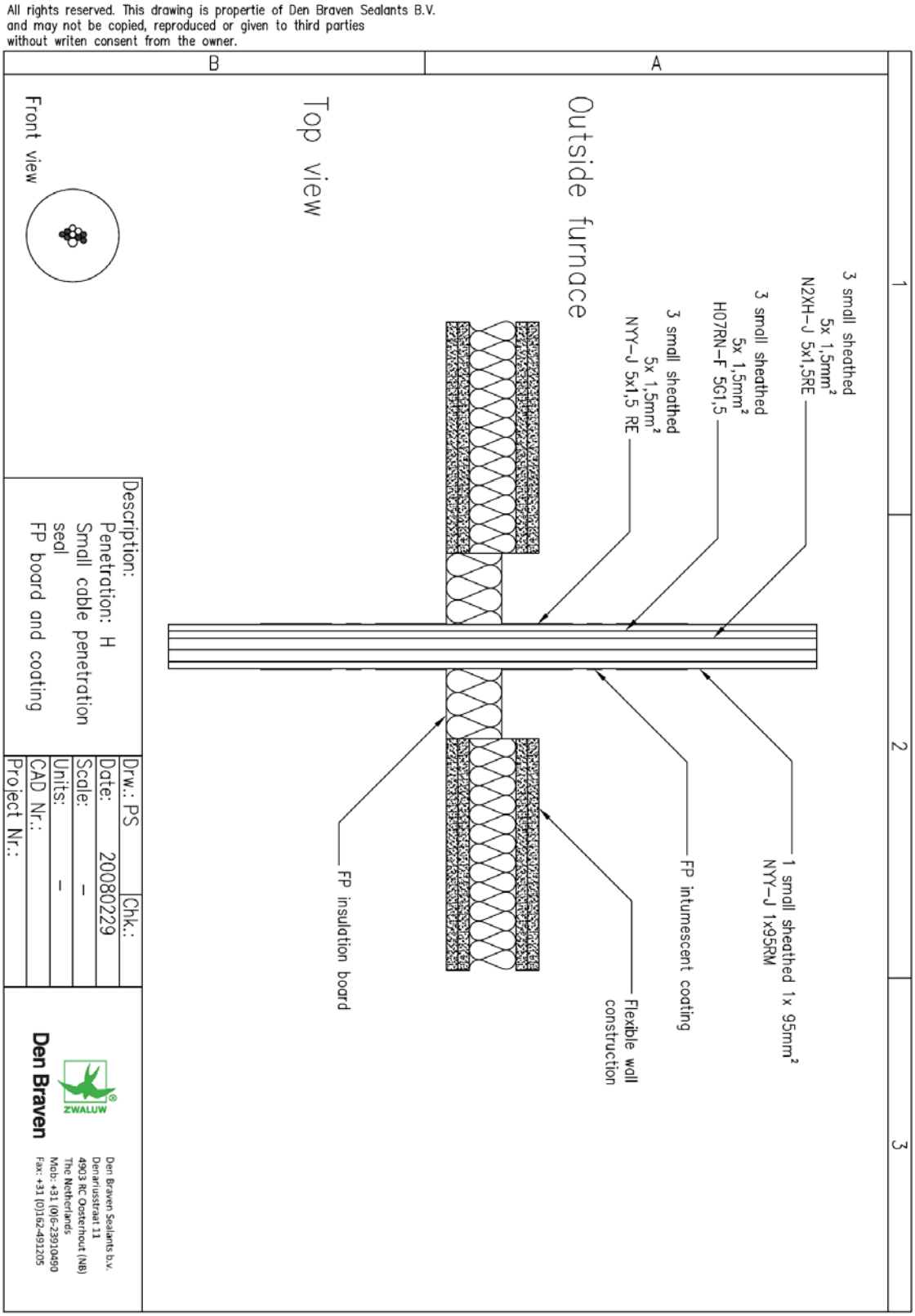

Figure A.31 Detail test specimen H dated 27-03-2008, based on 2008-Efectis-R0452

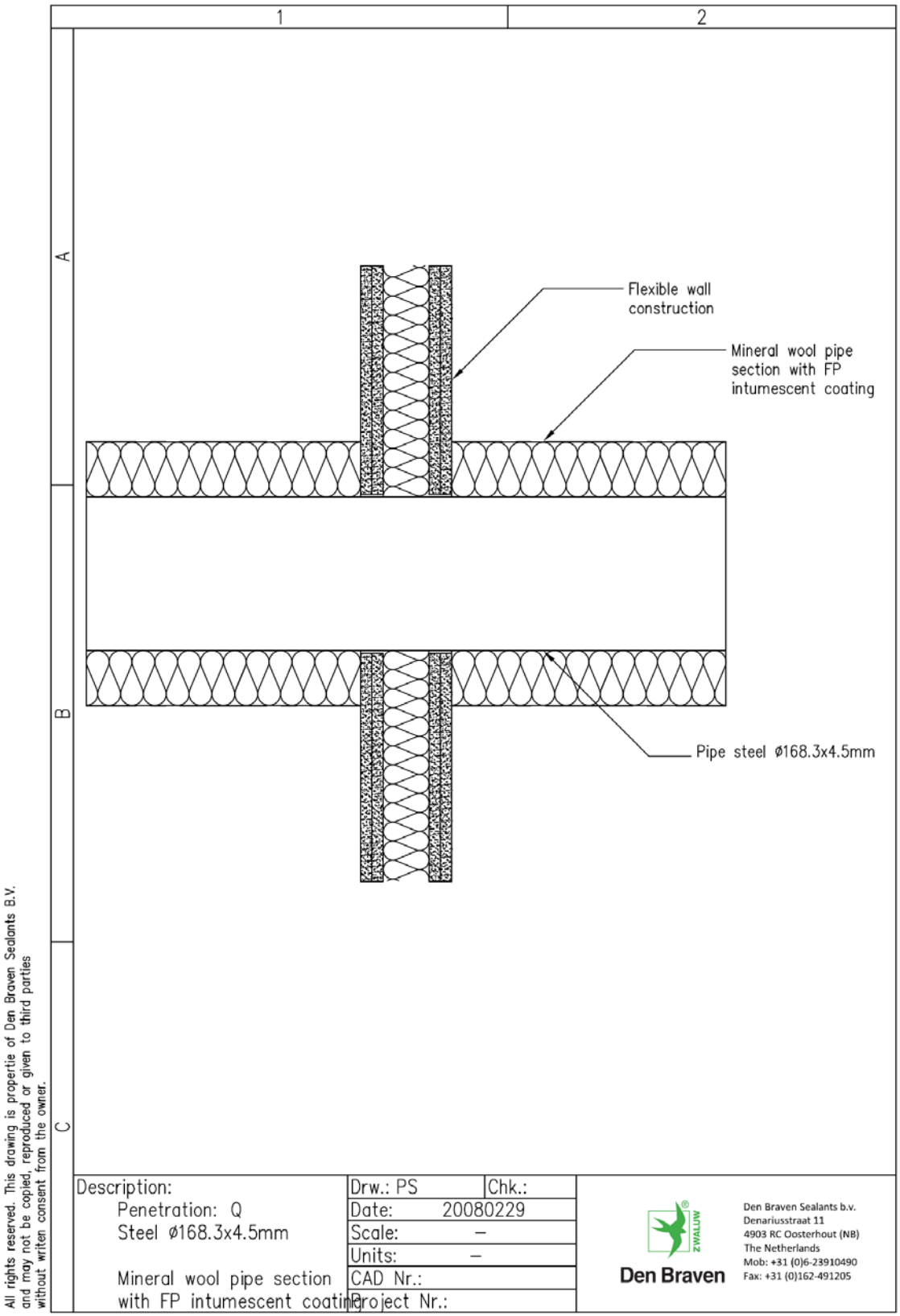

Figure A.32 Detail test specimen Q, based on 2008-Efectis-R0456[Rev.1]

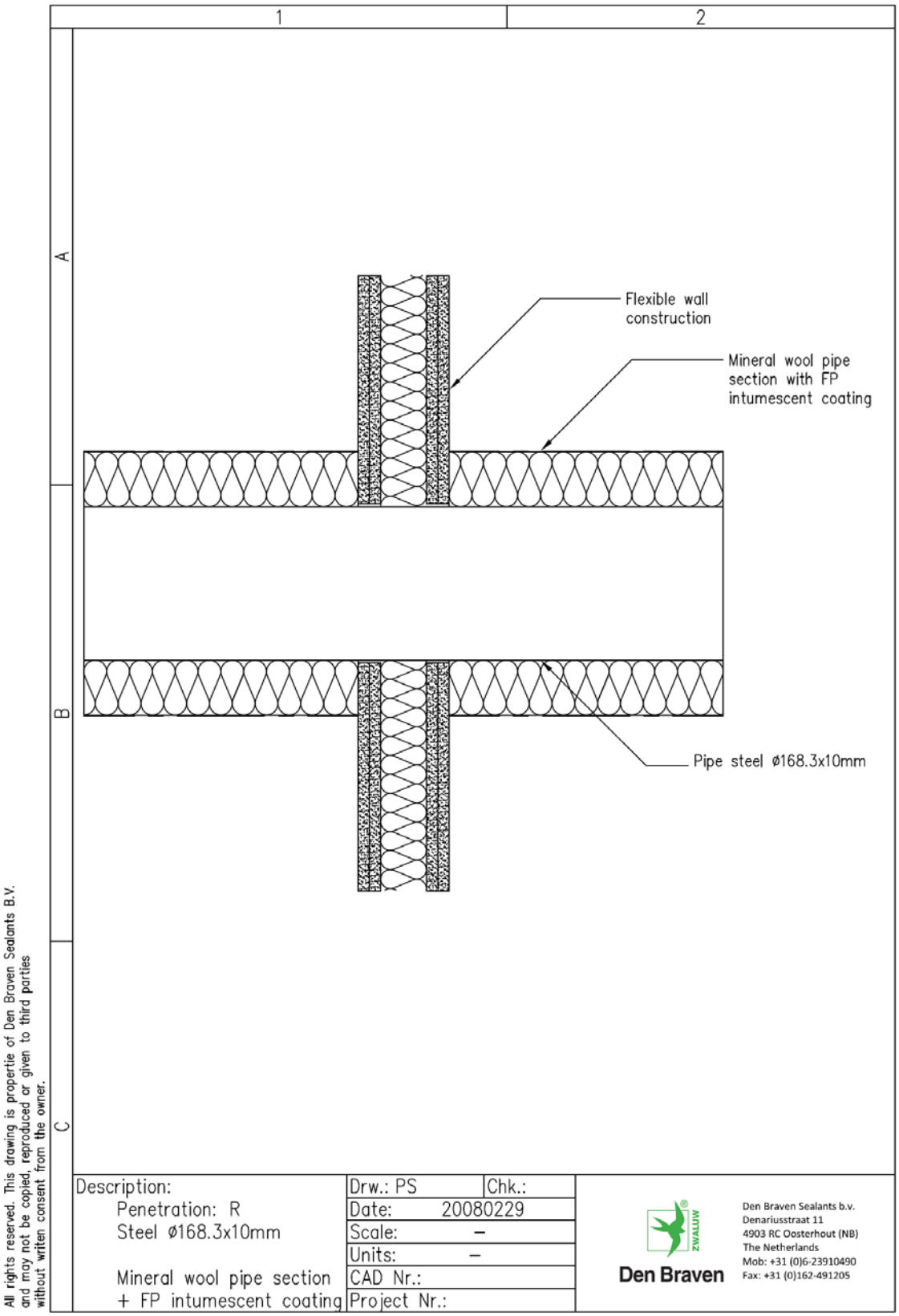

Figure A.33 Detail test specimen R, based on 2008-Efectis-R0456[Rev.1]

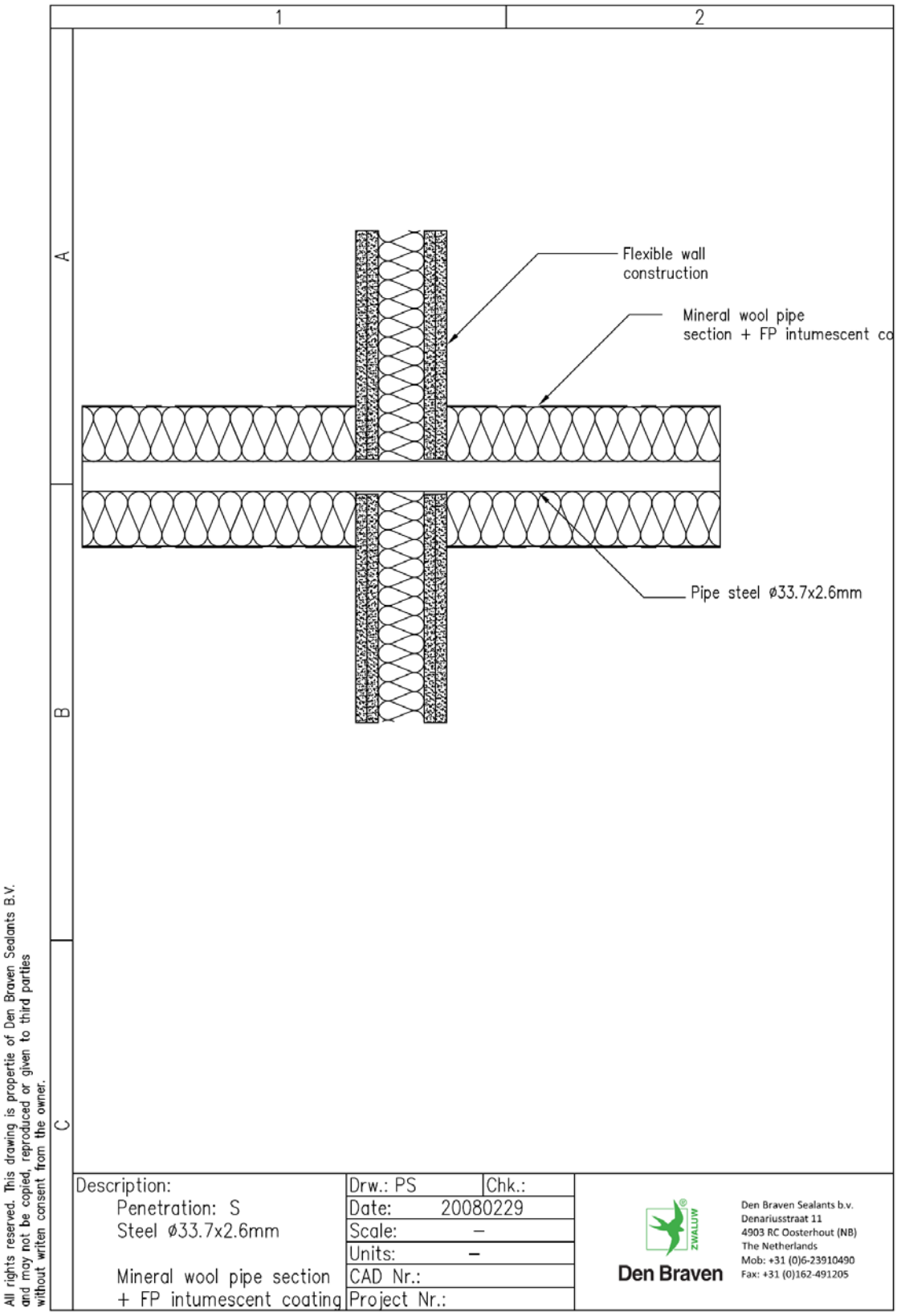

Figure A.34 Detail test specimen S, based on 2008-Efectis-R0456[Rev.1]

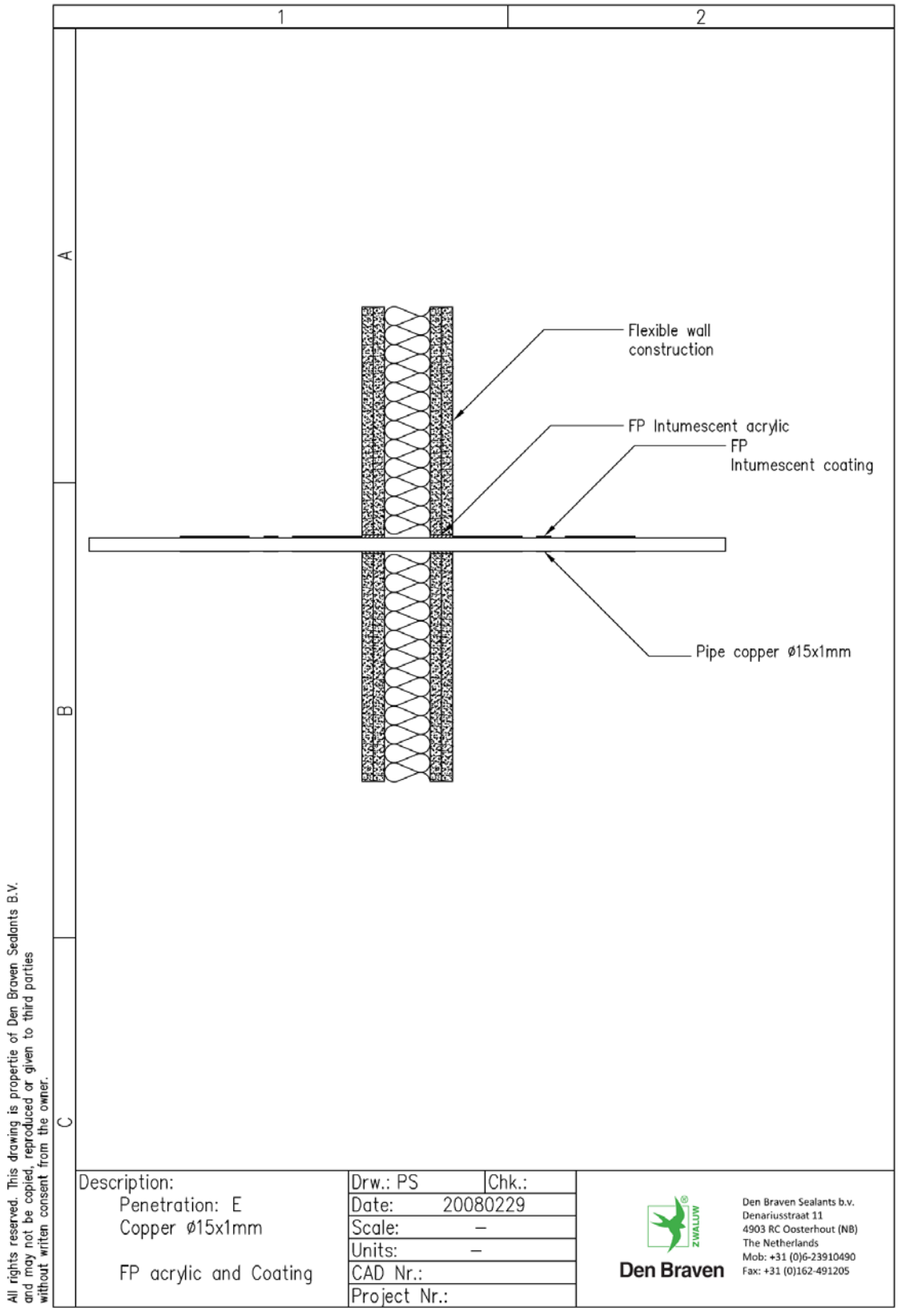

Figure A.35 Detail test specimen E, based on 2008-Efectis-R0457[Rev.2]

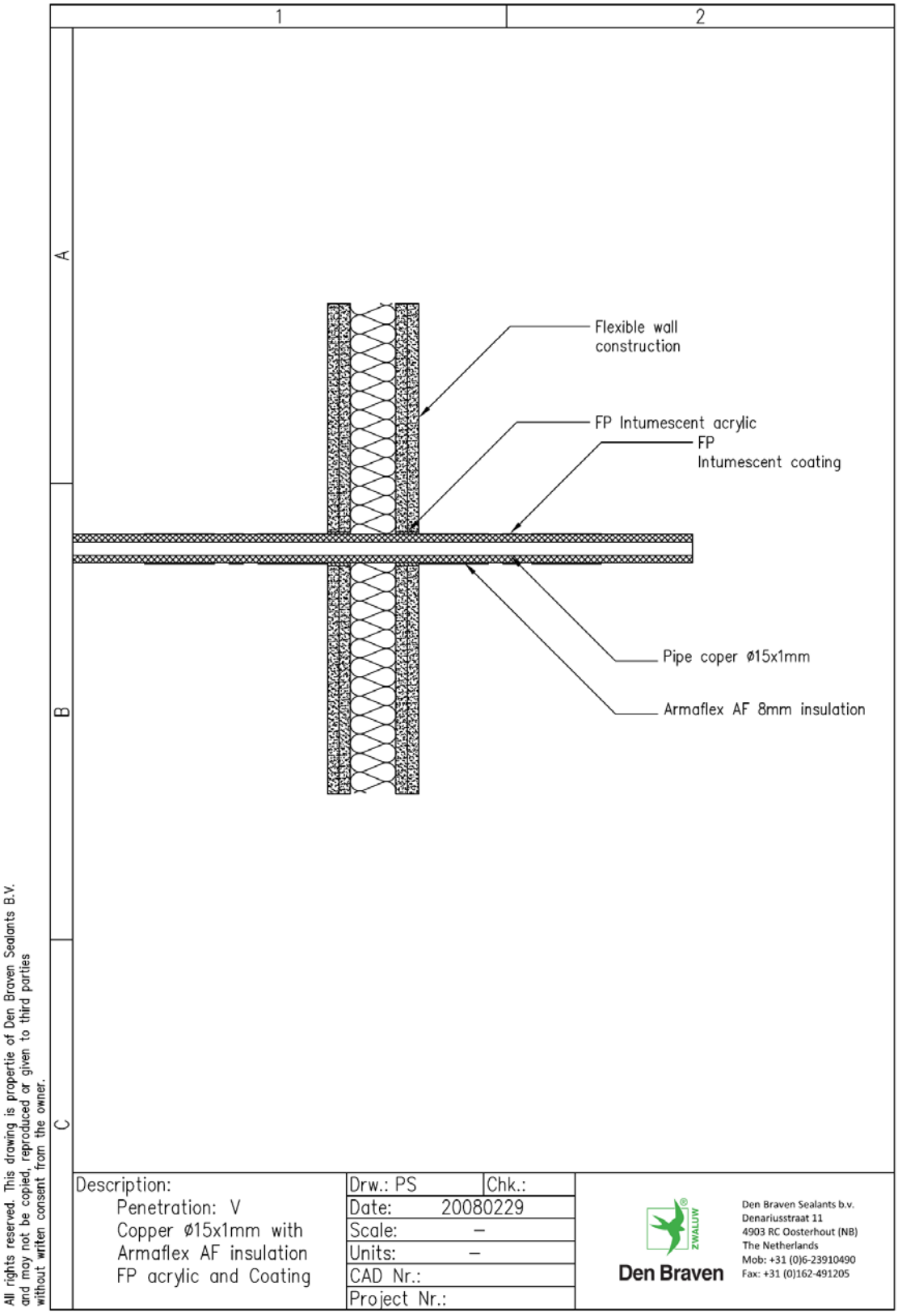

Figure A.36 Detail test specimen V, based on 2008-Efectis-R0457[Rev.2]

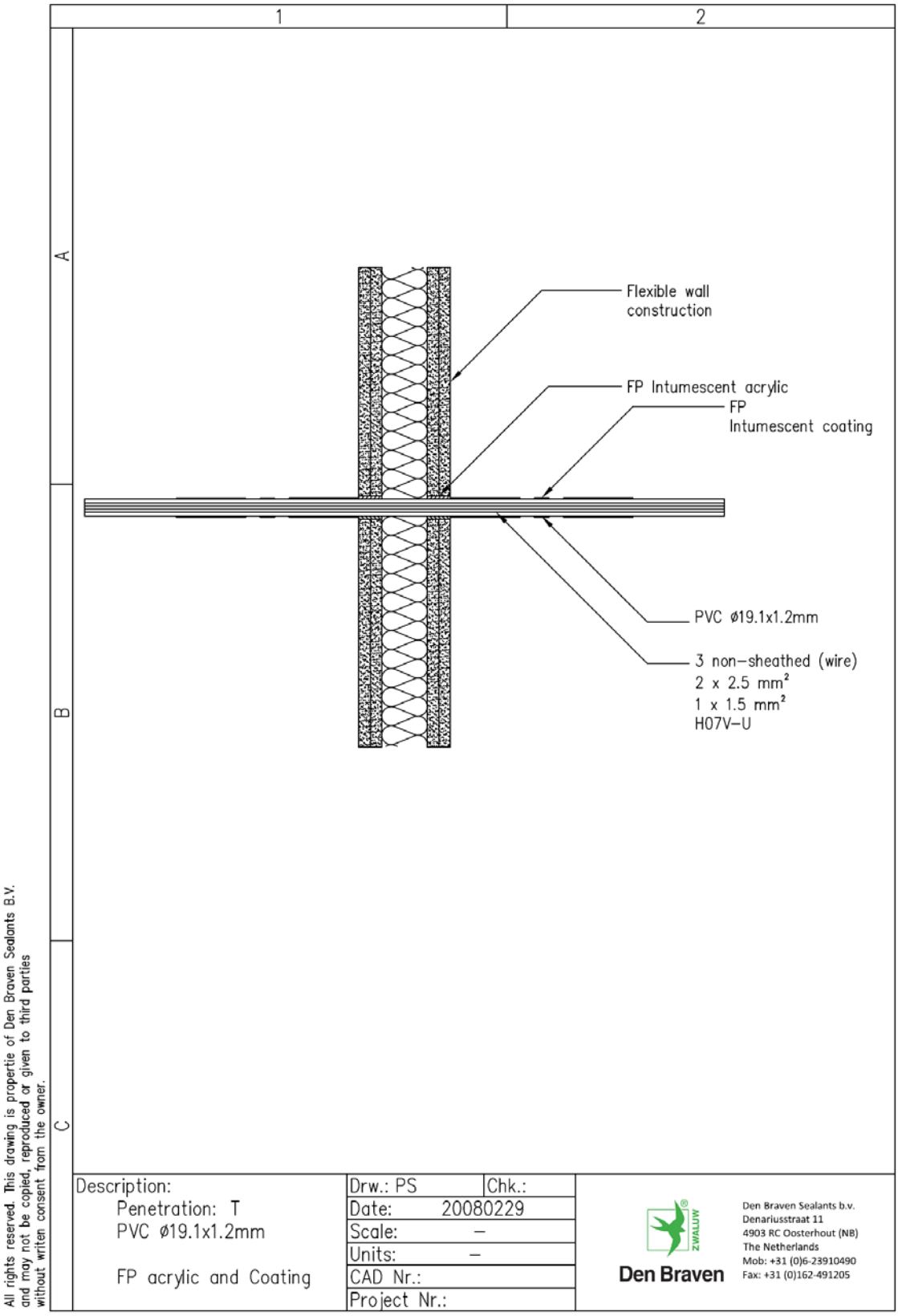

Figure A.37 Detail test specimen T, based on 2008-Efectis-R0458[Rev.2]

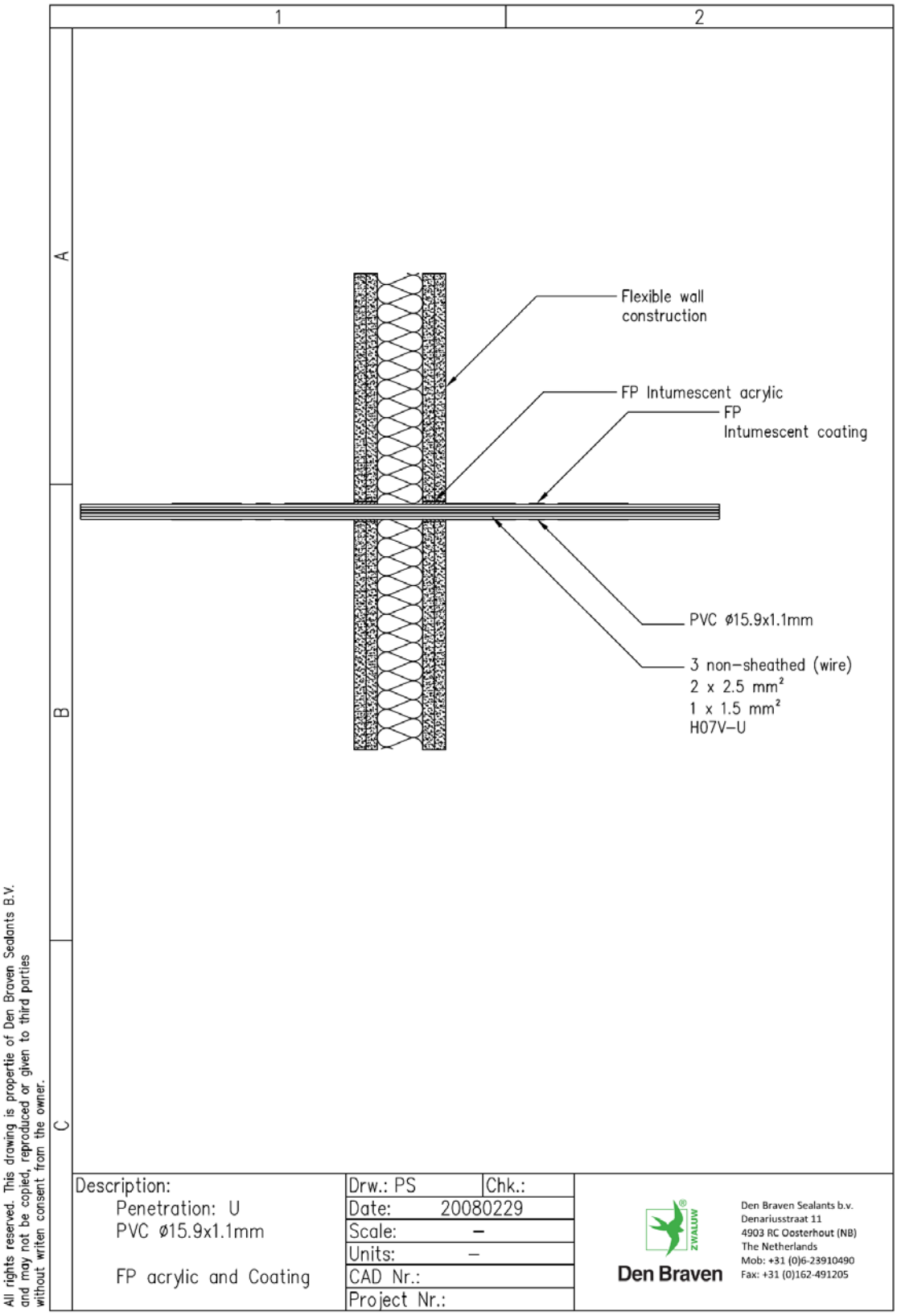

Figure A.38 Detail test specimen U, based on 2008-Efectis-R0458[Rev.2]

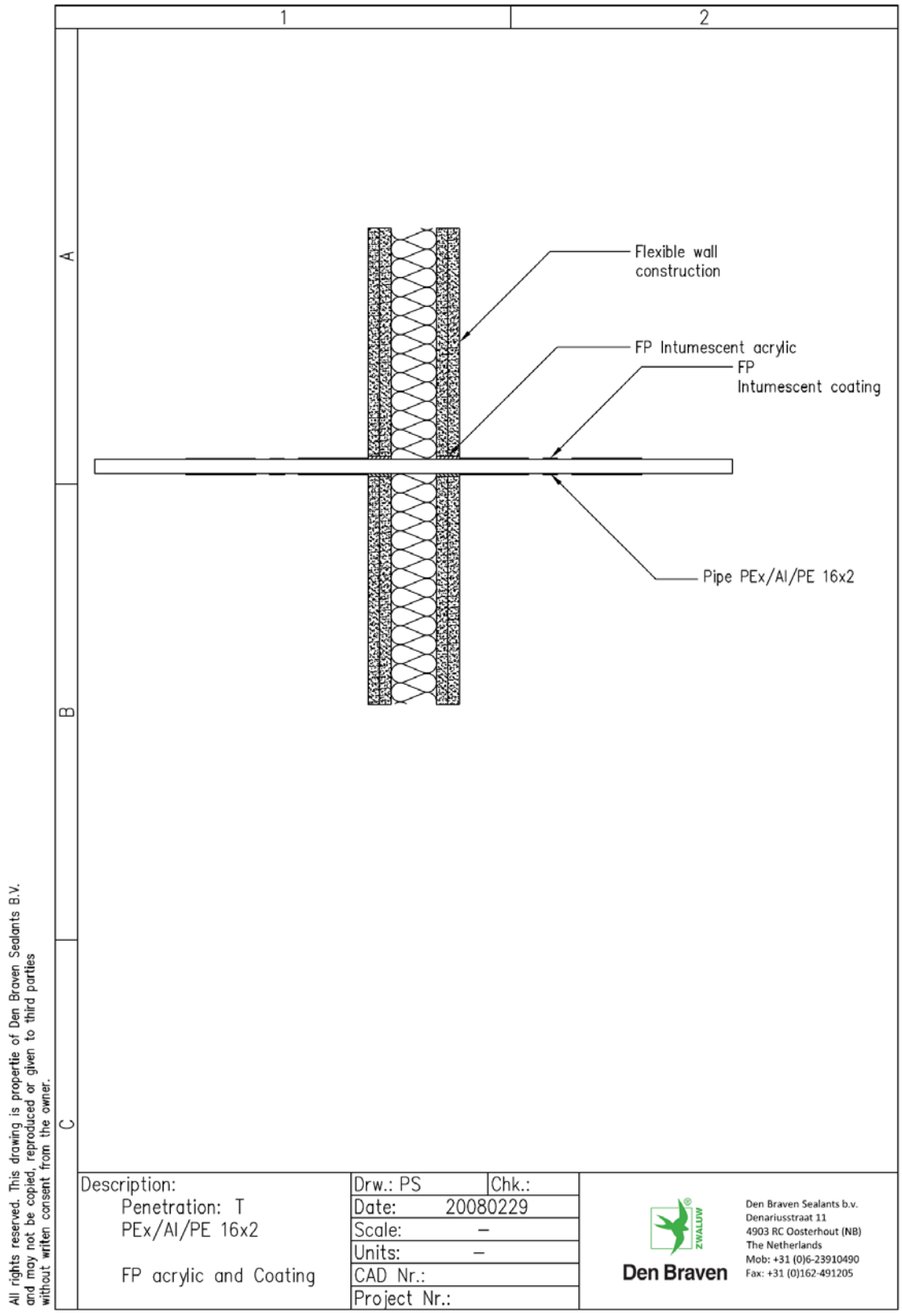

Figure A.39 Detail test specimen T, based on 2008-Efectis-R0461[Rev.1]

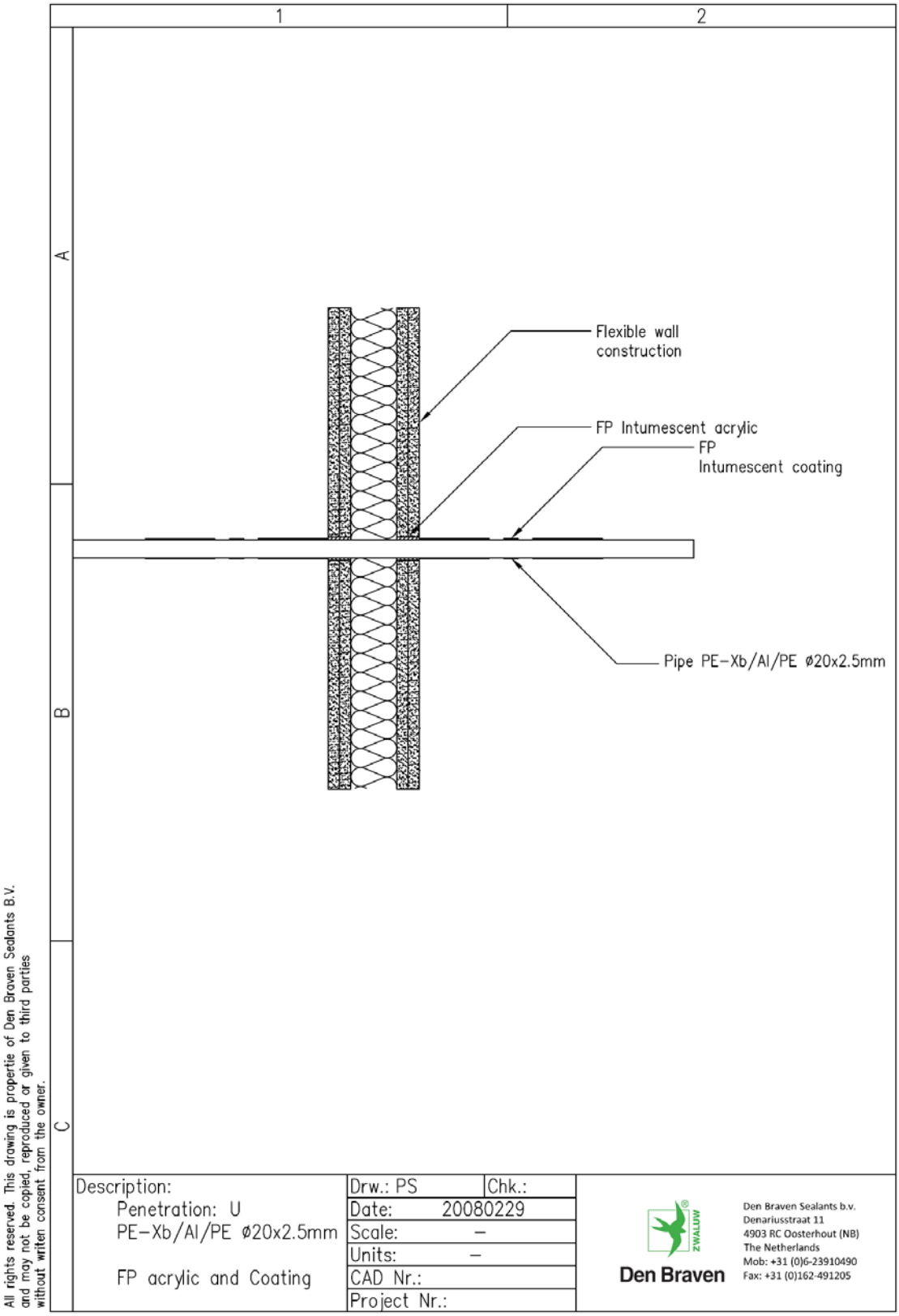

Figure A.40 Detail test specimen U, based on 2008-Efectis-R0461[Rev.1]

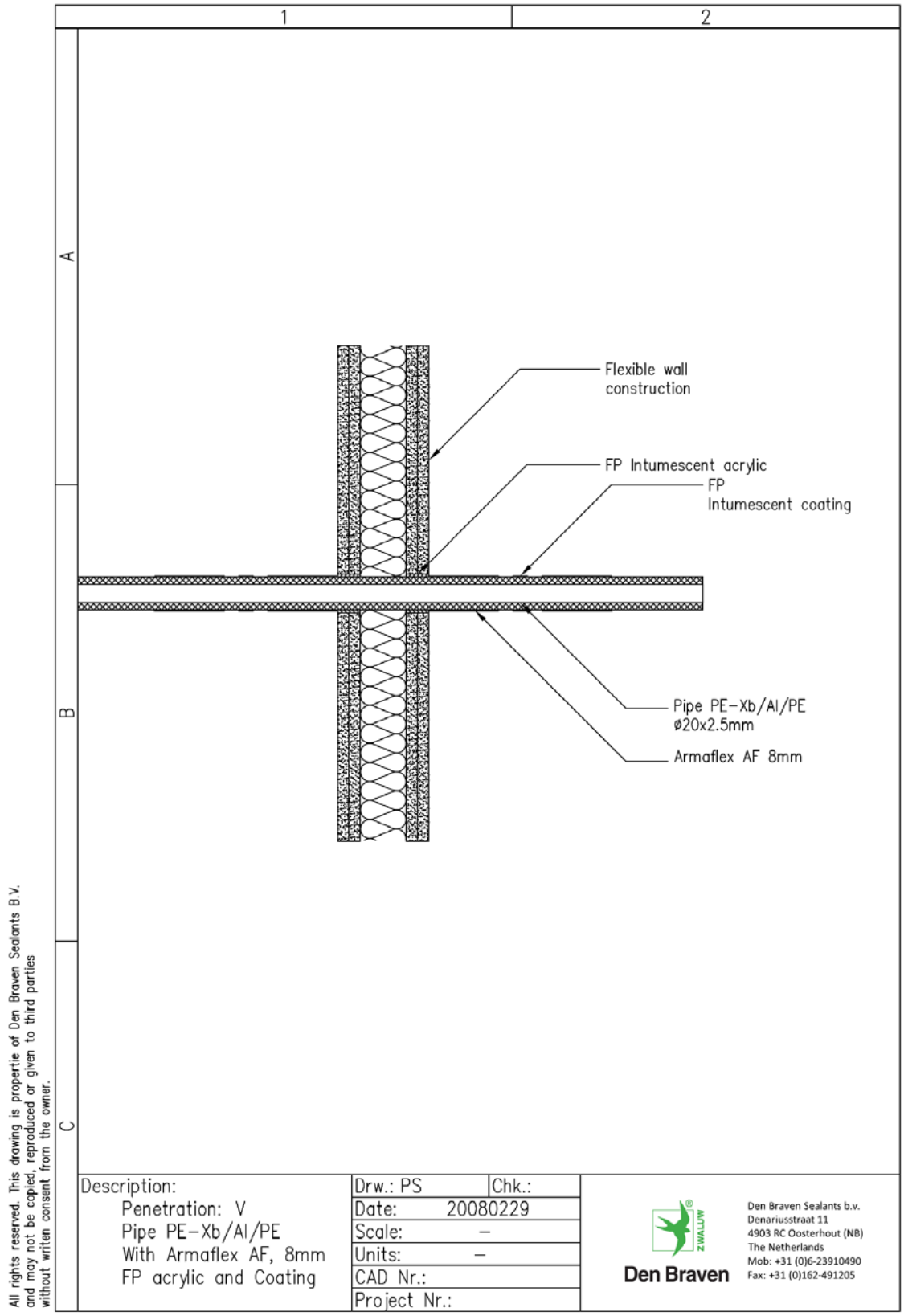

Figure A.41 Detail test specimen V, based on 2008-Efectis-R0461[Rev.1]

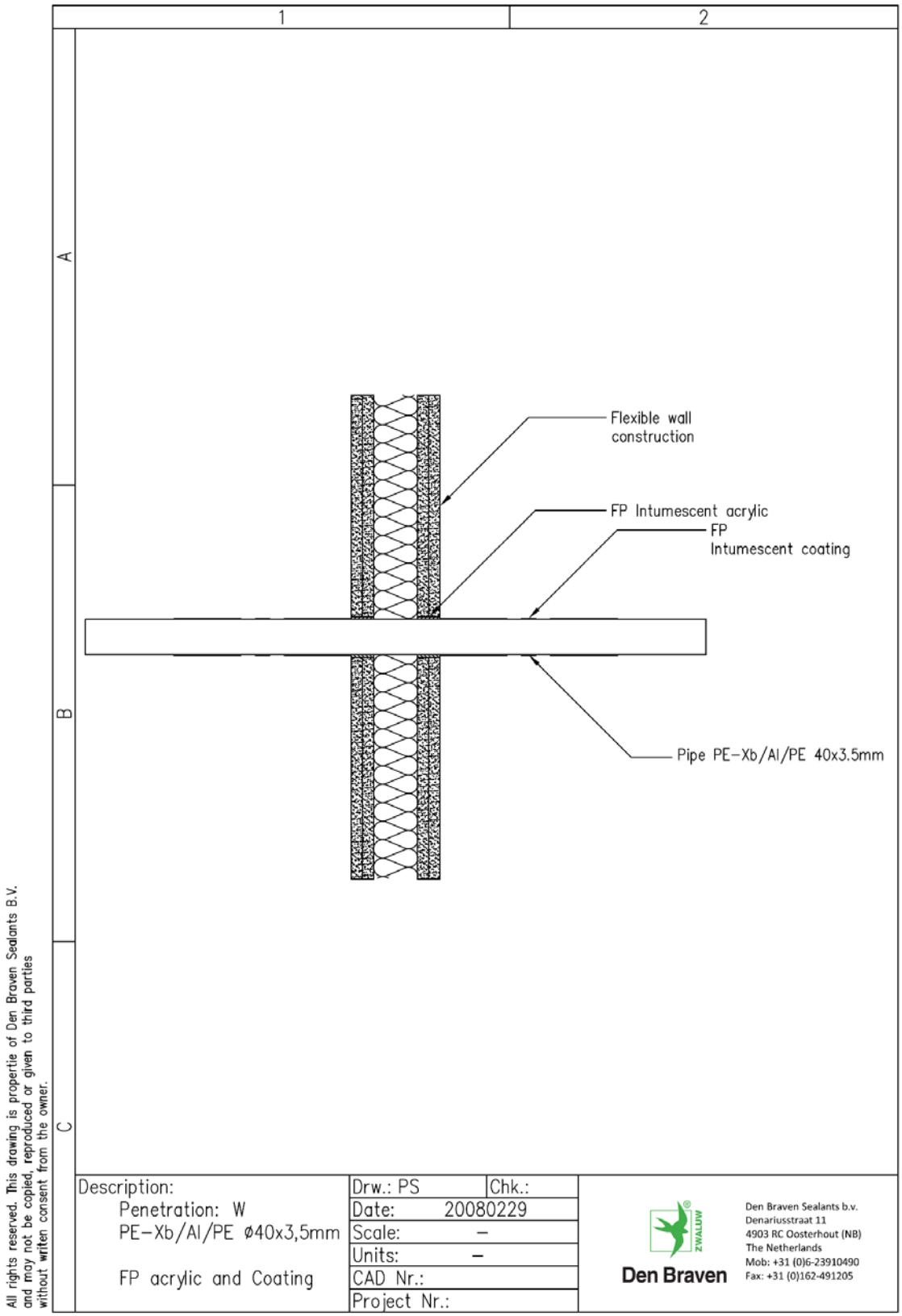

Figure A.42 Detail test specimen W, based on 2008-Efectis-R0461[Rev.1]

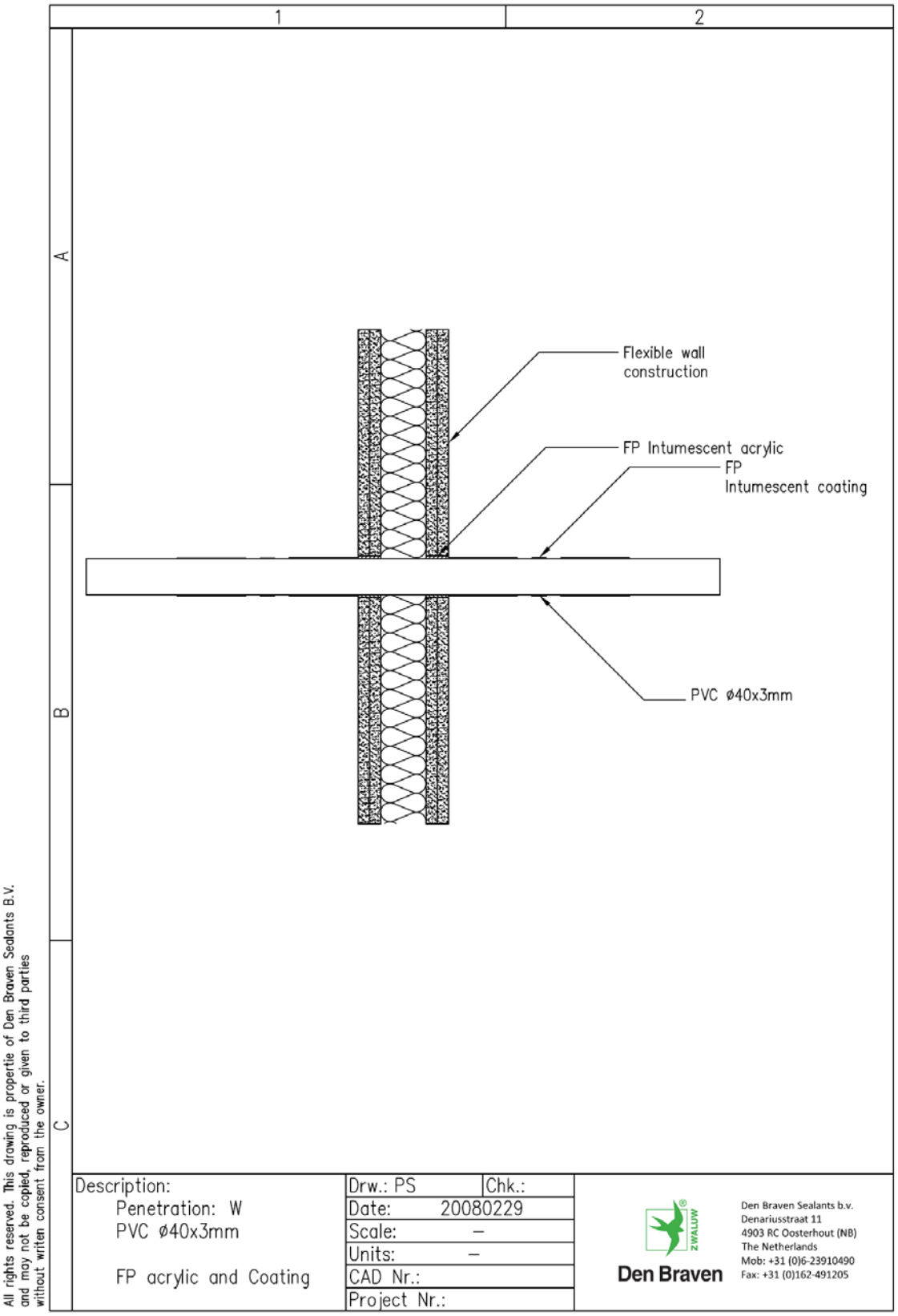

Figure A.43 Detail test specimen W, based on 2008-Efectis-R0462[Rev.1]

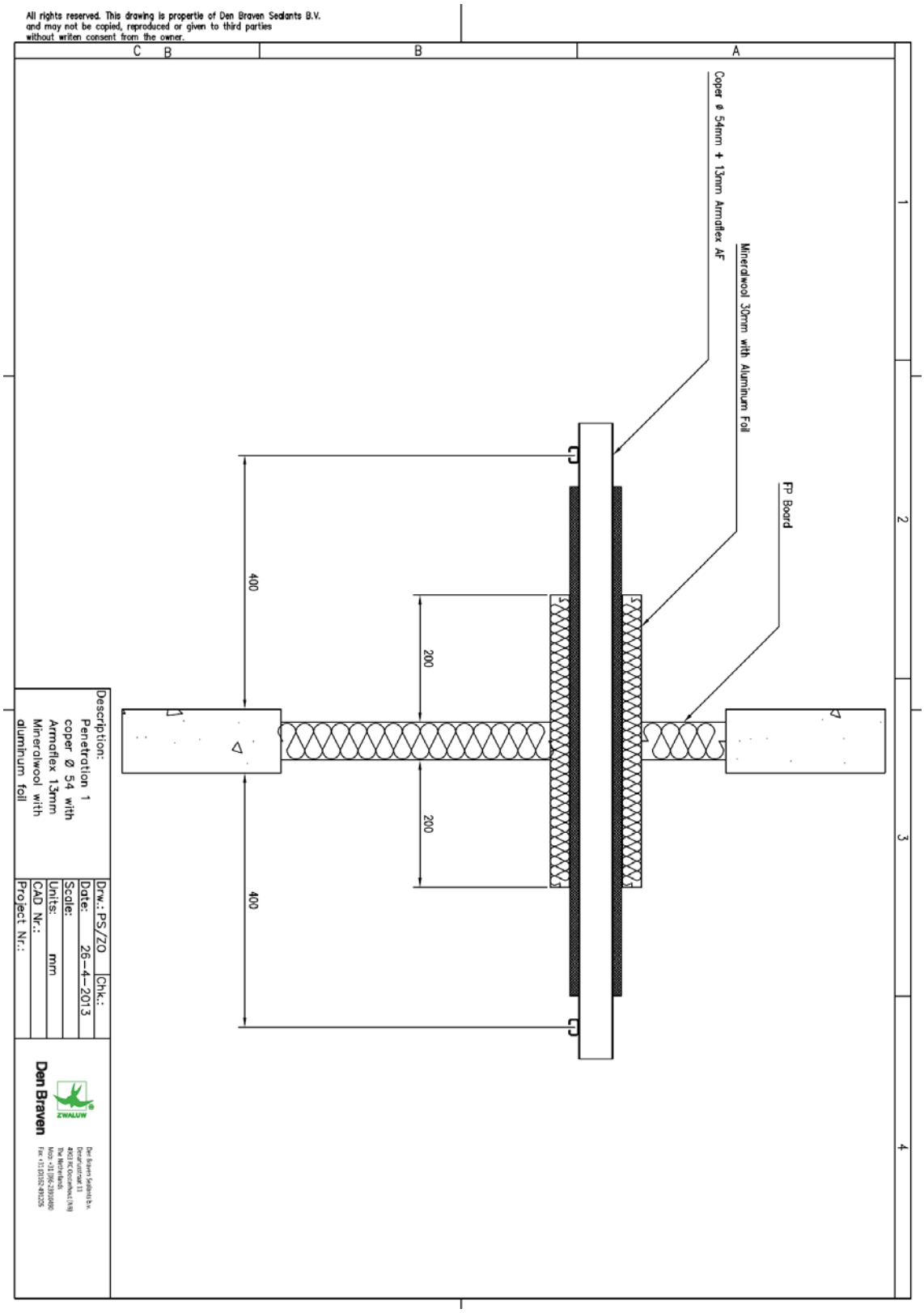

Figure A.44 Detail test specimen 1, based on 2011-Efectis-R0299

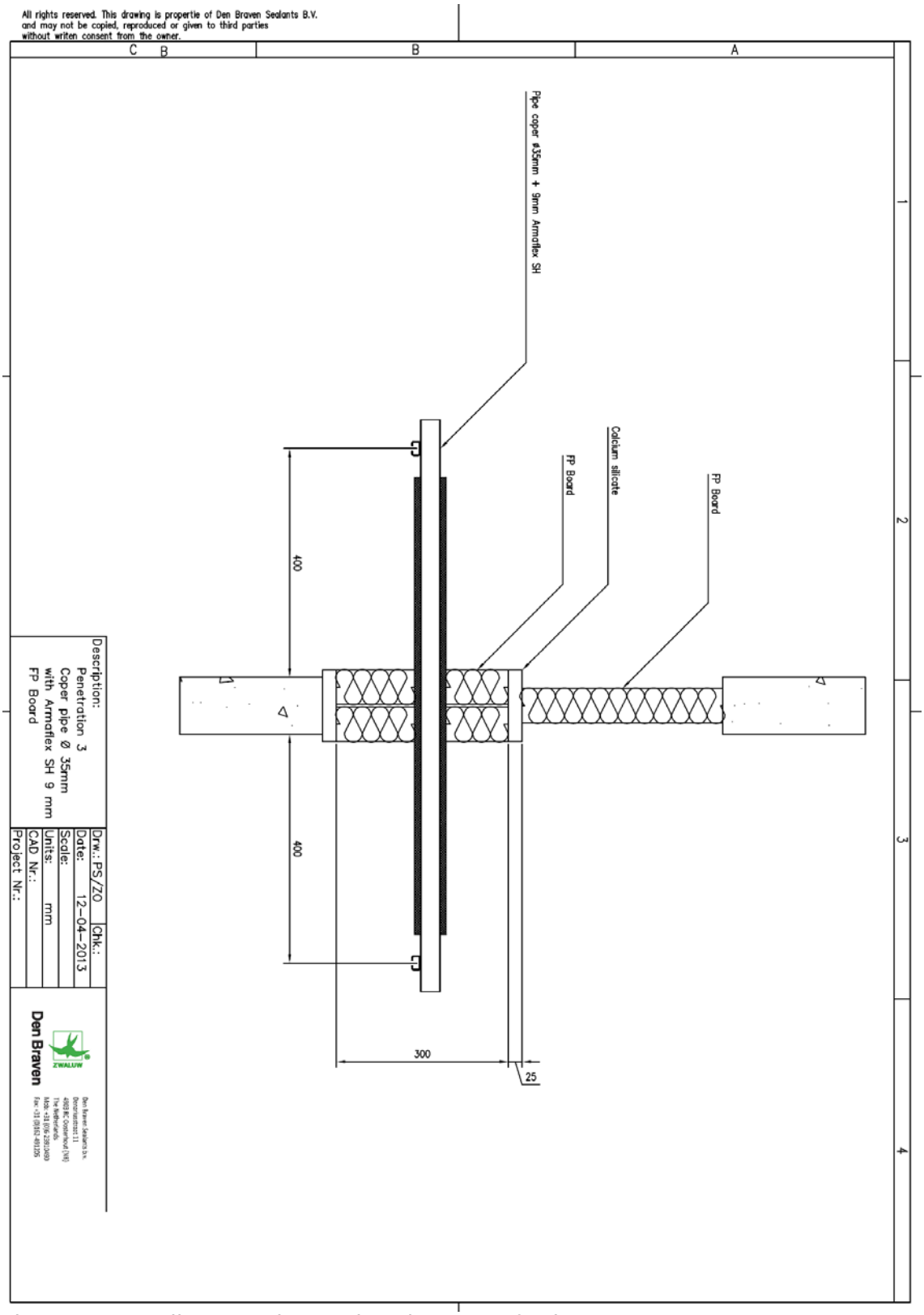

Figure A.45 Detail test specimen 3, based on 2011-Efectis-R0299

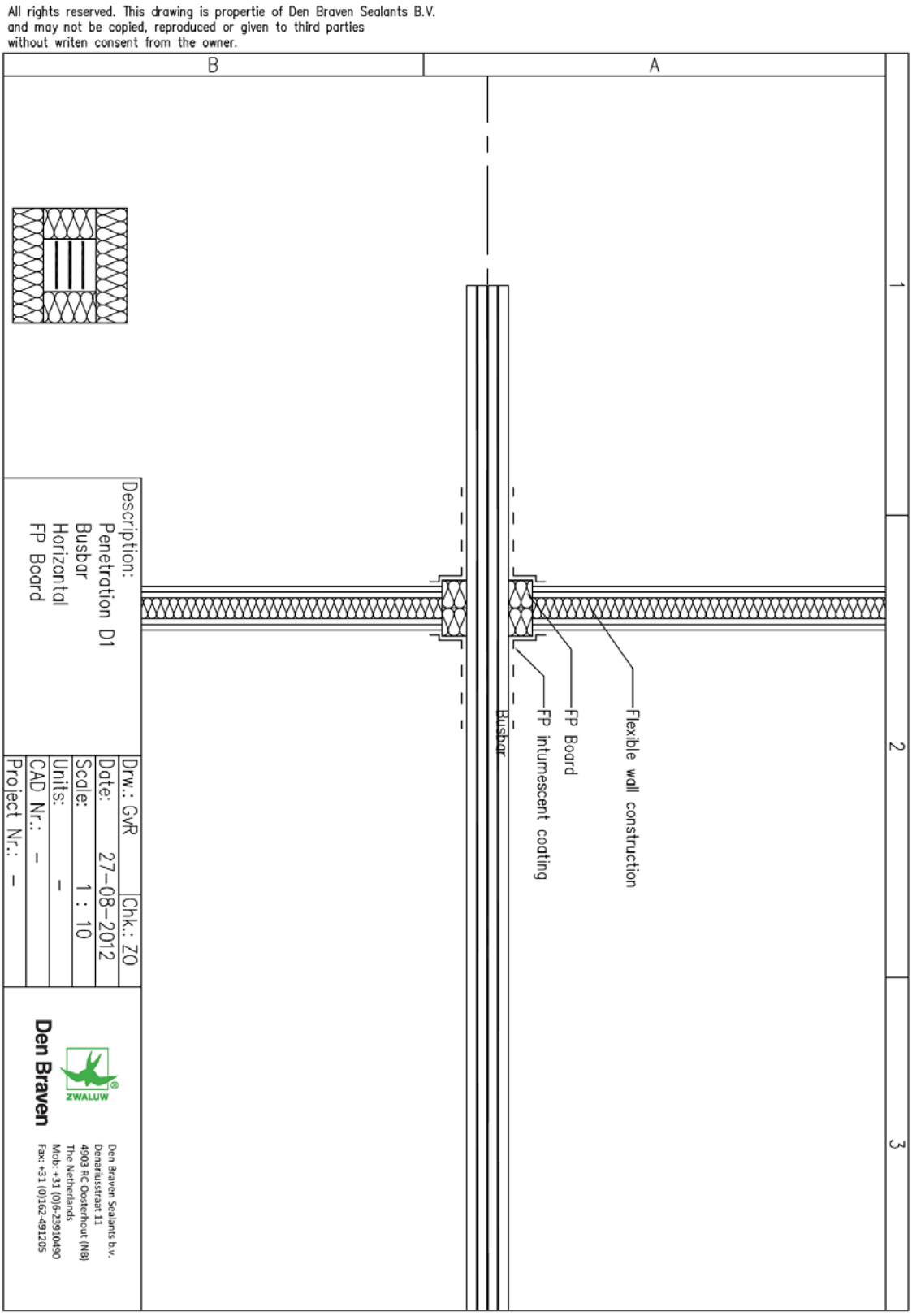

Figure A.46 Detail test specimen D1, based on op Peutz Y.1432.RA.001

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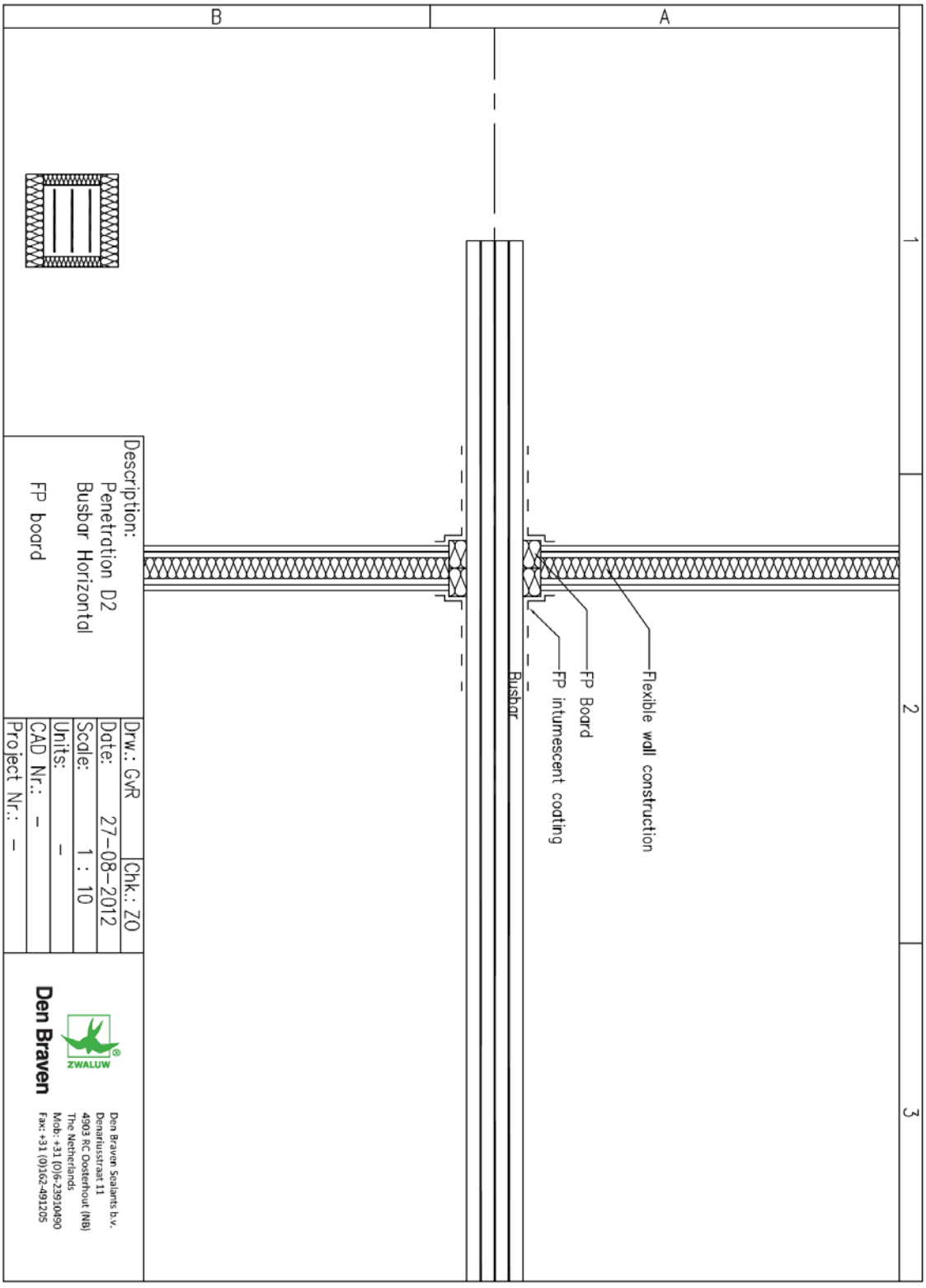

Figure A.47 Detail test specimen D2, based on Peutz Y.1432.RA.001

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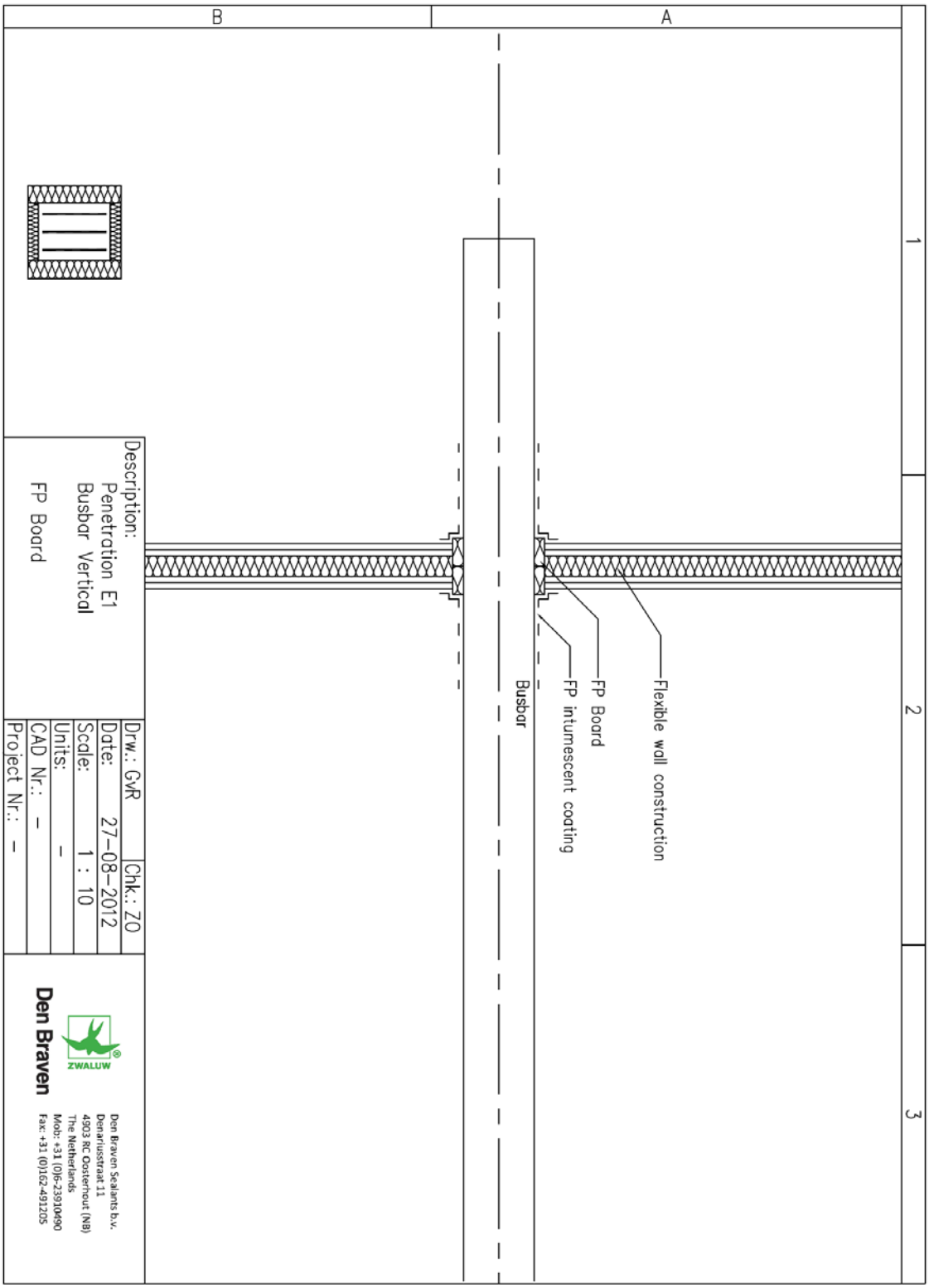

Figure A.48 Detail test specimen E1, based on Peutz Y.1432.RA.001

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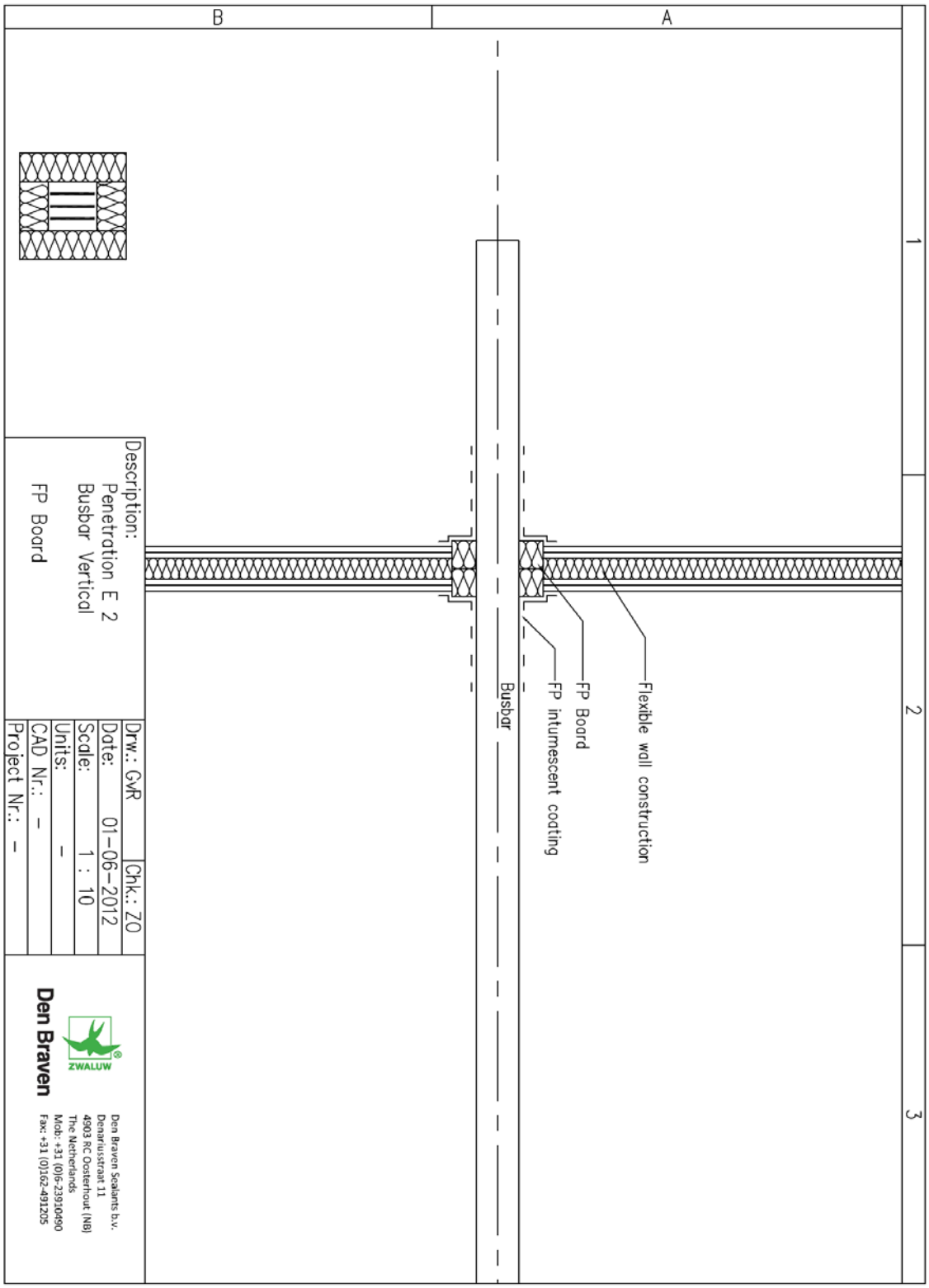

Figure A.49 Detail test specimen E2, based on Peutz Y.1432.RA.001

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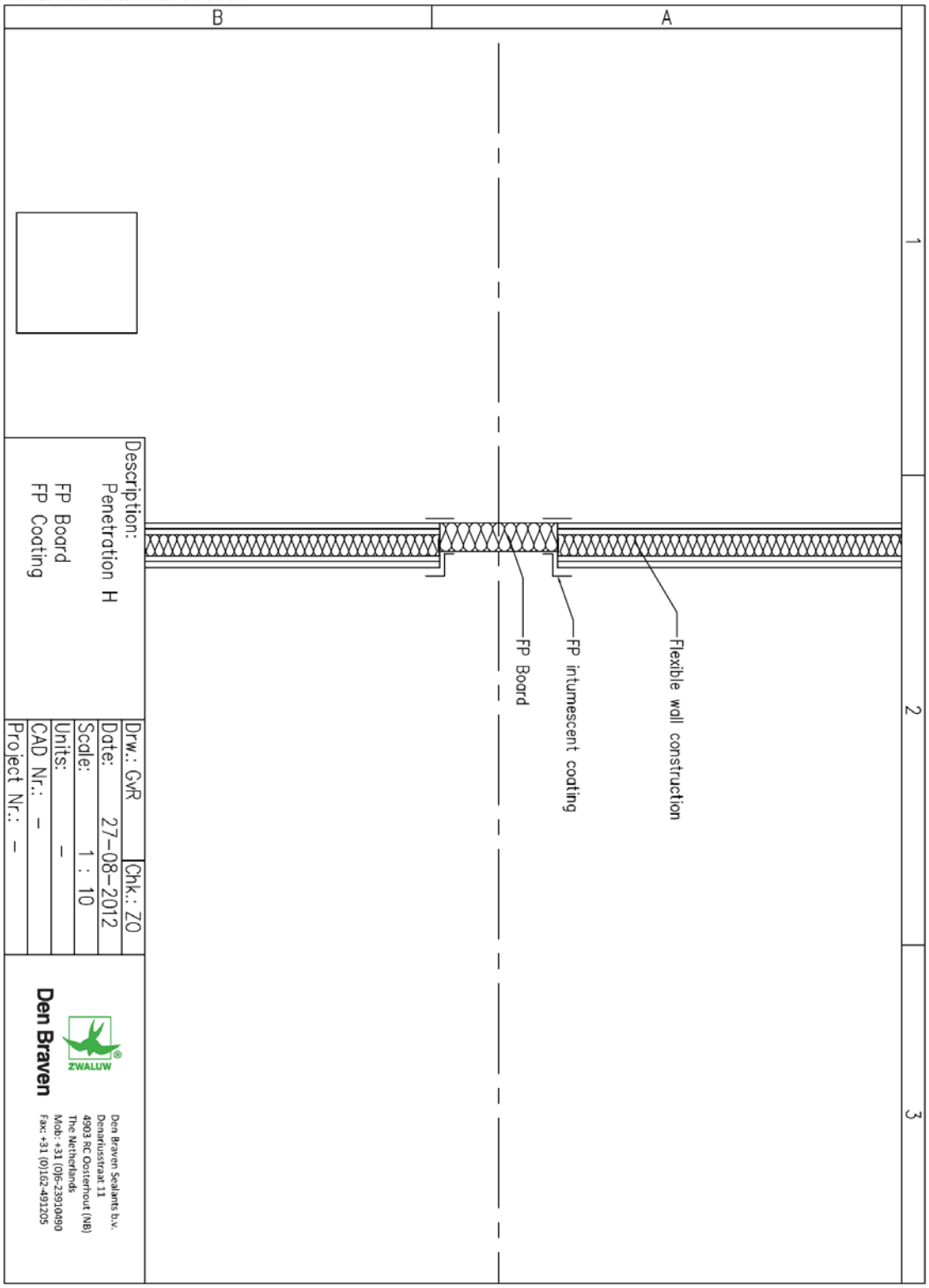

Figure A.50 Detail test specimen H, based on Peutz Y.1432.RA.001