



Fire resistance test report

Penetration systems tested in accordance with AS 1530.4:2014

Test sponsor: Snap Fire Systems

Job number: FRT190069

Test date: 31 May 2019 Revision: R2.0

Amendment schedule

Version	Date	Information relating to report			
R1.0	28/06/2019	Description	Initial issue		
			Prepared by	Reviewed by	Authorised by
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		Signature			
R2.0	08/08/2019	Description	Amendment to schedule of components and drawings		
			Prepared by	Reviewed by	Authorised by
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Executive summary

This report documents the findings of the fire resistance test of penetration systems undertaken on 31 May 2019 in accordance with Section 2 and 10 of AS 1530.4:2014. Warringtonfire Australia did the test at the request of Snap Fire Systems.

The test specimen consisted of 1900mm long × 1900mm wide × 150mm thick concrete slab with a 600mm wide × 560mm high concrete beam located 350mm from the south edge of the slab. The concrete beam & slab was penetrated by three varying penetration systems. A summary of the penetration systems is provided in Table 1.

Table 1 Test summary

Penetration system	Service	Local fire-stopping protection	Fire resistance level (FRL)
A	Ø50mm uPVC pipe	Snap L50S low-top stack collar	-/240/240
B	Ø100mm uPVC pipe	Combat collar clean 100 CC100	-/240/240
C	Ø150mm uPVC pipe	Snap H150S – RR high top collar	-/240/240

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1. Introduction

This report documents the findings of the fire resistance test of penetration systems undertaken on 31 May 2019 in accordance with section 2 and 10 of AS 1530.4:2014. Warringtonfire Australia did the test at the request of Snap Fire Systems.

Table 2 Test sponsor details

Test Sponsor	Address
Snap Fire Systems	1343 Wynnum Road Tingalpa 4173 QLD Australia

2. Construction details

Table 3 provides details of the test assembly. Table 4 provides a summary of the test specimen. A full description of the specimen is provided in Appendix A and section 3. Table 5 shows the installation method and orientation of the test specimen.

Table 3 Test assembly

Item	Detail
Separating element	150mm thick concrete slab & beam floor system
Nominal separating element size	Width (w): 1900mm Length (h): 1900mm Thickness (t): 150mm
Number of penetration systems	Three
Restraint conditions	Restrained along all 4 edges

Table 4 Test specimen

Penetration system	Service	Local fire-stopping protection	Fire resistance level (FRL)
A	Ø50mm uPVC pipe	Snap L50S low-top stack collar	-/240/240
B	Ø100mm uPVC pipe	Combat collar clean 100 CC100	-/240/240
C	Ø150mm uPVC pipe	Snap H150S – RR high top collar	-/240/240

Table 5 Installation method and orientation

Item	Detail
Start date of separating element construction	24 April 2019
Start date of penetration systems	24 April 2019
Completion date of test specimen construction and installation	31 May 2019
Penetration system installed by	Representatives of Warringtonfire Melbourne.
Orientation	Asymmetrical, due to service penetrations being supported on the unexposed side. The collars were fixed, and the services capped only on the exposed side.

3. Schedule of components

Table 6 lists the schedule of components for the test specimen which was surveyed by Warringtonfire Australia.

Table 6 Schedule of components

Item	Description		
Separating element			
1.	Item name	150mm Concrete floor slab	
	Size	1900mm wide × 1900mm long × 150mm thick	
	Material	40MPa, 14mm aggregate concrete	
	Installation	<ul style="list-style-type: none"> 1 layer of SL81 reinforcement bar was placed on top of 75mm high bar chairs. 	
2.	Item name	Concrete beam	
	Size	600mm wide × 560mm high × 1900mm long	
	Material	40MPa, 14mm aggregate concrete	
	Location	The beam was located 350mm from the south edge of the floor slab (item 1) and extended to a width of 600mm.	
	Installation	<ul style="list-style-type: none"> 1 layer of SL81 reinforcement bar was positioned 75mm from the three sides of the beam. The test specimen services were mounted to the formwork through apertures cut into the metal reinforcement prior to pouring the concrete. 	
Blanking wall			
3.	Item name	Fire-rated plasterboard	
	Product name	CSR Fyrchek plasterboard	
	Size	1350mm wide × 3000mm long × 16mm thick (cut to size)	
	Density	786 kg/m ³ (measured)	
4.	Item name	Steel frame	
	Product name	Rondo 92mm × 0.5 BMT studs Rondo 92mm × 0.5 BMT tracks	
	Installation	2 layers of 16mm Fyrchek fixed to 92mm steel studs and tracks at 400mm centres. The exposed side of the plasterboard was lined with 25mm thick ceramic fibre wool.	
Fire collar			
5.	Item name	Cast-in fire collar	
	Product name	Snap H150S – RR high top cast-in fire collar	
	Collar details	Outer diameter (OD)	200mm
		Inner diameter (ID)	187.4mm
		Height (h)	250mm
		Outer shell thickness (t)	2.1mm
	Intumescent details	Number of layers	1
Length (L)		650mm (measured)	
Width (w)		110mm (measured)	
Thickness (t)		5.5mm (measured)	
Density	1118 kg/m ³ (measured)		

Item	Description		
	Installation	The collar was installed perpendicular to the beam so that the bottom end of the outer shell was 75mm above the underside of the beam. The collar was temporarily secured to the unexposed side of the formwork.	
6.	Item name	Cast-in fire collar	
	Product name	Snap L50S low-top, cast-in fire collar	
	Collar details	Outer diameter (OD)	80.4mm(measured)
		Inner diameter (ID)	68.9mm(measured)
		Height (h)	76.6mm(measured)
Outer shell thickness (t)		2mm	
Intumescent details	Number of layers	1	
	Length (L)	250mm (measured)	
	Width (w)	54.9mm (measured)	
	Thickness (t)	5.2mm (measured)	
Density	619 kg/m ³ (measured)		
Installation	The collar was installed perpendicular to the beam so that the bottom end of the outer shell was 75mm above the underside of the beam. The collar was temporarily secured to the unexposed side of the formwork.		
7.	Item name	Cast-in fire collar	
	Product name	Combat Collar Clean 100 CC100	
	Collar details	Outer diameter (OD)	158.2mm (measured)
		Inner diameter (ID)	126.7mm (measured)
		Height (h)	77.5mm (measured)
Outer shell thickness (t)		2.4mm (measured)	
Intumescent details	Number of layers	1	
	Length (L)	443mm (measured)	
	Width (w)	49mm (measured)	
	Thickness (t)	13.8mm (measured)	
Density	1015 kg/m ³ (measured)		
Installation	The collar was installed perpendicular to the beam so that the bottom end of the outer shell was 75mm above the underside of the beam. The collar was temporarily secured to the unexposed side of the formwork.		
Services			
8.	Item name	Ø50mm uPVC Pipe	
	Product name	20260 Vinidex Quality BEP PVC DWV 50 PVCU LIC No. 1010 AS/NZS 1260 SL17 [0]17.04.07 10.56 <S1>	
	Size	Outer diameter (OD)	55.8mm (measured)
Inner diameter (ID)		51.3mm (measured)	
Thickness (t)		2.3mm (measured)	
9.	Item name	Ø100mm uPVC Pipe	
	Product name	Pipe King BEP PVC 100 DWV PVCU SN6SC 19/05/01 Syd AS/NZS 1260 LIC 2157 W	
	Size	Outer diameter (OD)	110mm (measured)
Inner diameter (ID)		101mm (measured)	
Thickness (t)		4.5mm (measured)	
10.	Item name	Ø150mm uPVC Pipe	
	Product name	19070 Vinidex BEP PVC DWV 150 PVC-U SN 4 SC W LIC. No.1079 AS/NZS 1260 UL03 [9] 16.55 <FDWV>	

Item	Description		
	Size	Outer diameter (OD)	160mm (measured)
		Inner diameter (ID)	149mm (measured)
		Thickness (t)	5.5mm (measured)
11.	Item name	Ø150mm uPVC 90° female to female elbow	
	Installation	Used in conjunction with the pipe cement (item 17) to join the vertical and horizontal sections of pipe (item 10).	
12.	Item name	Ø100mm uPVC 90° female to female elbow	
	Installation	Used in conjunction with the pipe cement (item 17) to join the vertical and horizontal sections of pipe (item 9).	
13.	Item name	Ø50mm uPVC 90° female to female elbow	
	Installation	Used in conjunction with the pipe cement (item 17) to join the vertical and horizontal sections of pipe (item 8).	
14.	Item name	Ø150mm uPVC straight coupling	
	Installation	Used in conjunction with the pipe cement (item 17) to join a 500mm length and a 240mm length of pipe together horizontally (item 10).	
15.	Item name	Ø100mm uPVC straight coupling	
	Installation	Used in conjunction with the pipe cement (item 17) to join a 500mm length and a 280mm length of pipe together horizontally (item 9)	
16.	Item name	Ø50mm uPVC straight coupling	
	Installation	Used in conjunction with the pipe cement (item 17) to join a 500mm length and a 445mm length of pipe together horizontally (item 8)	
Adhesives			
17.	Item name	uPVC pipe cement	
	Specification	Type N solvent cement	
	Installation	Used to secure all the joints between the uPVC pipes, 90° elbows and couplings.	
Penetration system A			
A	Service	Ø50mm uPVC Pipe (item 8)	
	Service detail	<p>A short section of Ø50mm uPVC pipe (item 8) was inserted into the unexposed side of the fire collar (item 6) which finished flush with both sides of the fire collar. A 90° uPVC elbow (item 13) was then attached to the unexposed side of the pipe with the flared section of the elbow located within the fire collar (item 6). A vertical section of pipe was then inserted into the unexposed side of the elbow and extended 2000mm beyond the top of the floor slab (item 1). After the formwork was removed, a Ø50mm uPVC coupler (item 16) was inserted into the exposed side of the collar (item 6) and used to extend a 500mm length section of pipe (item 8) horizontally beyond the face of the beam.</p> <p>All pipe joints were secured using the pipe cement (item 17).</p> <p>The pipe protruded nominally 500mm from the exposed side of the beam and nominally 2000mm beyond the unexposed side of the floor slab. The pipe was capped with a PVC end cap on the exposed side only.</p>	
	Service support	The pipe was supported on the unexposed side at 500mm and 1500mm from the slab using pipe clamps.	
	Local fire-stopping protection		
	Protection	Snap L50S low-top cast-in fire collar (item 6). See Figure 1 and Figure 3 in Appendix A for more details.	

Item	Description	
Penetration system B		
B	Service	Ø100mm uPVC Pipe (item 9)
	Service detail	<p>A short section of Ø100mm uPVC pipe (item 9) was inserted into the unexposed side of the fire collar (item 7) which extended 150mm beyond the unexposed side of the fire collar and finished flush with the exposed side of the fire collar. A 90° uPVC elbow (item 12) was then attached to the unexposed side of the pipe. A vertical section of pipe was then inserted into the unexposed side of the elbow and extended 2000mm beyond the top of the floor slab (item 1). After the formwork was removed, a Ø100mm uPVC coupler (item 15) was inserted into the exposed side of the collar (item 7) and used to extend a 500mm length section of pipe (item 9) horizontally beyond the face of the beam.</p> <p>All pipe joints were secured using the pipe cement (item 17).</p> <p>The pipe protruded nominally 500mm from the exposed side of the beam and nominally 2000mm beyond the unexposed side of the floor slab. The pipe was capped with a PVC end cap on the exposed side only.</p>
	Service support	The pipe was supported on the unexposed side at 500mm and 1500mm from the slab using pipe clamps.
	Local fire-stopping protection	
	Protection	Combat Collar Clean 100 (item 7). See Figure 1 and Figure 4 in Appendix A for more details.
Penetration system C		
C	Service	Ø150mm uPVC Pipe (item 10)
	Service detail	<p>A short section of Ø150mm uPVC pipe (item 10) was inserted into the unexposed side of the fire collar (item 5) which finished flush with both sides of the fire collar. A 90° uPVC elbow (item 11) was then attached to the unexposed side of the pipe with the flared section of the elbow located within the fire collar (item 5). A vertical section of pipe was then inserted into the unexposed side of the elbow and extended 2000mm beyond the top of the floor slab (item 1). After the formwork was removed, a Ø150mm uPVC coupler (item 14) was inserted into the exposed side of the collar (item 5) and used to extend a 500mm length section of pipe (item 10) horizontally beyond the face of the beam.</p> <p>All pipe joints were secured using the pipe cement (item 17).</p> <p>The pipe protruded nominally 500mm from the exposed side of the beam and nominally 2000mm beyond the unexposed side of the floor slab. The pipe was capped with a PVC end cap on the exposed side only.</p>
	Service support	The pipe was supported on the unexposed side at 500mm and 1500mm from the slab using pipe clamps.
	Local fire-stopping protection	
	Protection	Snap H150S – RR high top cast-in fire collar (item 5). See Figure 1 and Figure 5 in Appendix A for more details.

4. Test procedure

Table 7 details the test procedure for this fire resistance test.

Table 7 Test procedure

Item	Detail	
Statement of compliance	The test was performed in accordance with the requirements of section 2 and 10 of AS 1530.4:2014 appropriate for service penetrations.	
Variations	<ul style="list-style-type: none"> None 	
Pre-test conditioning	The construction and installation of the test specimen was completed on 31 May 2019. The test specimen was subjected to normal laboratory temperatures and conditions between the completion of construction of the test specimen and the start of the test.	
Sampling / specimen selection	The laboratory was not involved in sampling or selecting the test specimen for the fire resistance test.	
Ambient laboratory temperature	Start of the test	14°C
	Minimum temperature	14°C
	Maximum temperature	17°C
Test duration	241 minutes	
Instrumentation and equipment	<p>The instrumentation was provided in accordance with AS 1530.4:2014 as follow:</p> <ul style="list-style-type: none"> The furnace temperature was measured by four mineral insulated metal sheathed Type K thermocouples – with wire diameters not greater than 1mm, an overall diameter of 3mm, and the measuring junction insulated from the sheath. The thermocouples protruded a minimum of 25mm from steel supporting tubes. The non-fire side specimen temperatures were measured by Type K thermocouples with wire diameters less than 0.5mm soldered to 12mm diameter x 0.2mm thick copper discs covered by 30mm x 30mm x 2.0mm inorganic insulating pads. The thermocouple positions are shown in Table 10 and Figure 6 to Figure 8 in Appendix D. A roving thermocouple was available to measure temperatures at positions that appeared hotter than the positions monitored by the fixed thermocouples. The furnace pressure was measured at 900mm below the slab. Cotton pads were available during the test to assess the performance of the specimen under the criteria for integrity. 	

5. Test measurements and results

The measurements taken for the pressure and temperature of the furnace and test specimen are included in Appendix E. Table 9 in Appendix B includes observations of any significant behaviour of the specimen and details of the occurrence of the various performance criteria specified in AS 1530.4:2014. Photographs of the specimen are included in Appendix F.

Table 8 summarises the results the specimen achieved against the performance criteria listed in sections 2 and 10 of AS 1530.4:2014, subject to the variations listed in Section 4.

Table 8 Test results

Penetration system	Criteria	Results	Fire resistance level (FRL)
A	Structural adequacy	Not applicable	-/240/240
	Integrity	No failure at 241 minutes	
	Insulation	No failure at 241 minutes	
B	Structural adequacy	Not applicable	-/240/240
	Integrity	No failure at 241 minutes	
	Insulation	No failure at 241 minutes	
C	Structural adequacy	Not applicable	-/240/240
	Integrity	No failure at 241 minutes	
	Insulation	No failure at 241 minutes	

6. Application of test results

6.1 Test limitations

The results of these fire tests may be used to directly assess fire hazard, but it should be recognised that a single test method will not provide a full assessment of fire hazard under all fire conditions.

These results only relate to the behaviour of the specimen of the element of the construction under the particular conditions of the test. They are not intended to be the sole criteria for assessing the potential fire performance of the element in use, and they do not necessarily reflect the actual behaviour in fires.

6.2 Variations from the tested specimen

This report details methods of construction, the test conditions and the results obtained when the specific element of construction described herein was tested following the procedure outlined in AS 1530.4:2014. Any significant variation with respect to size, construction details, loads, stresses, edge or end conditions, other than that allowed under the field of direct application in the relevant test method, is not covered by this report.

It is recommended that any proposed variation to the tested configuration – other than as permitted under the field of direct application specified in Appendix C – should be referred to the test sponsor. They should then obtain appropriate documentary evidence of compliance from Warringtonfire Australia Pty Ltd or another registered testing authority.

6.3 Uncertainty of measurements

It is not possible to provide a stated degree of accuracy for the results, because of the nature of fire resistance testing and the consequent difficulty in quantifying the uncertainty of measurement of fire resistance.

Appendix A Drawings of test assembly

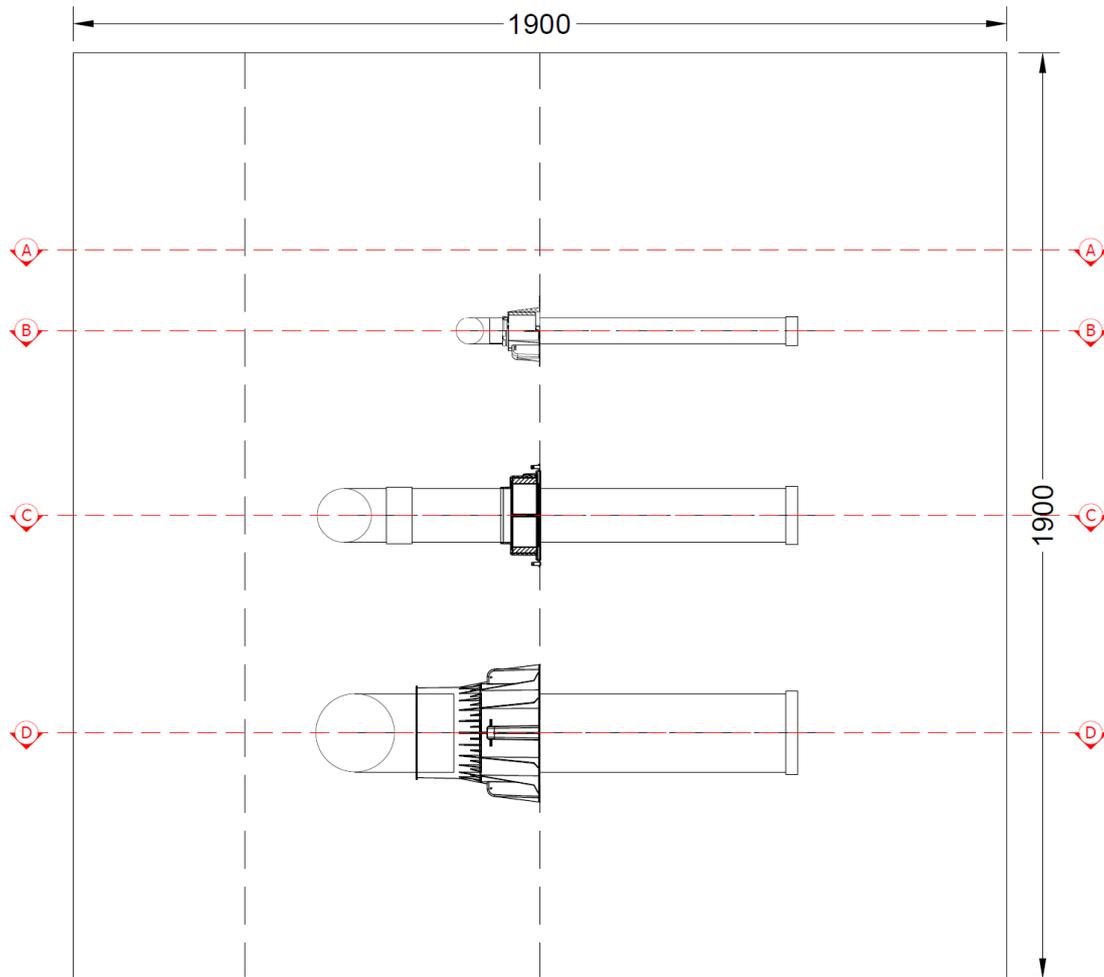


Figure 1 Plan view of the test specimen (unexposed side)

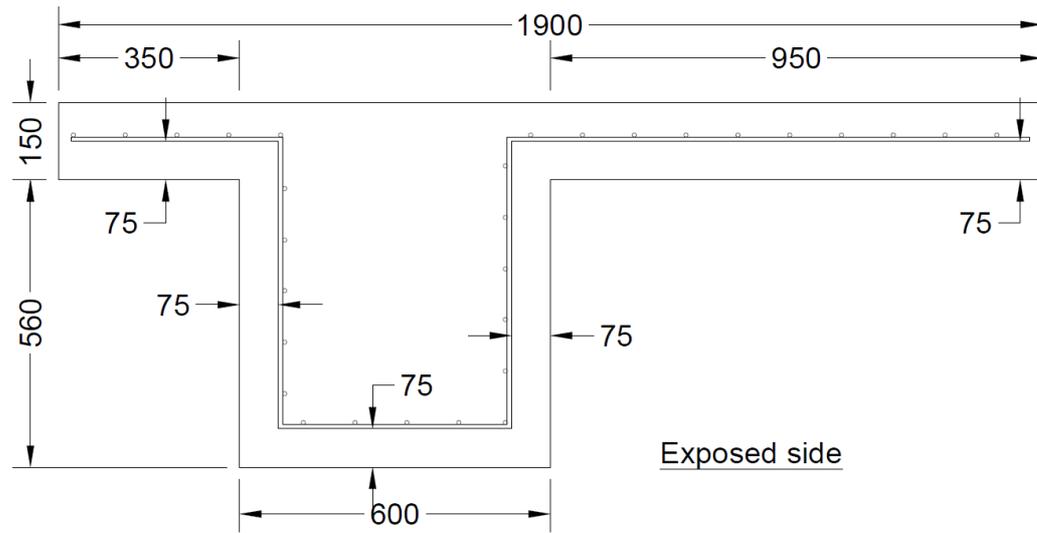


Figure 2 Cross-section of the test specimen (A-A)

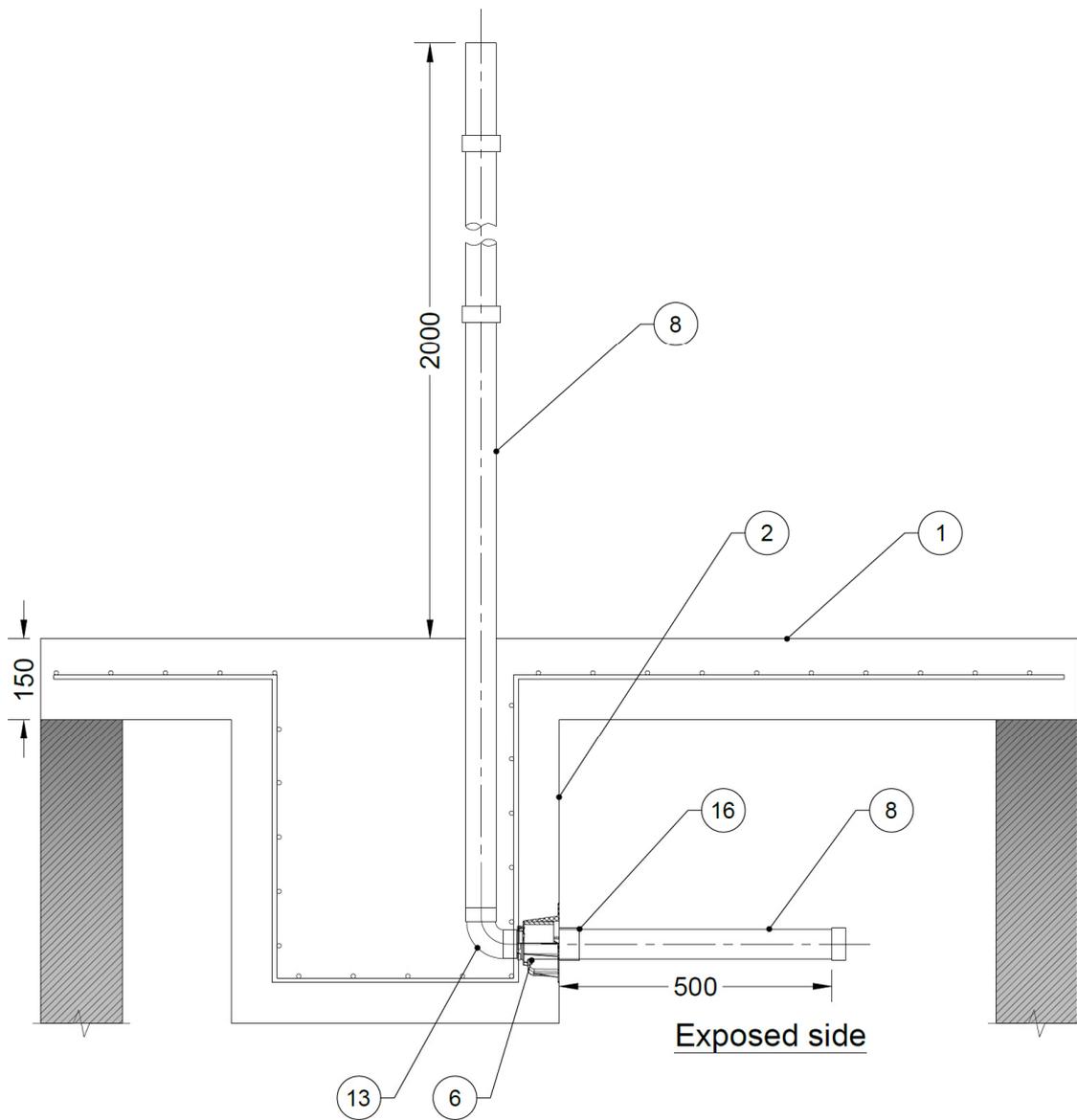


Figure 3 Cross-section B-B

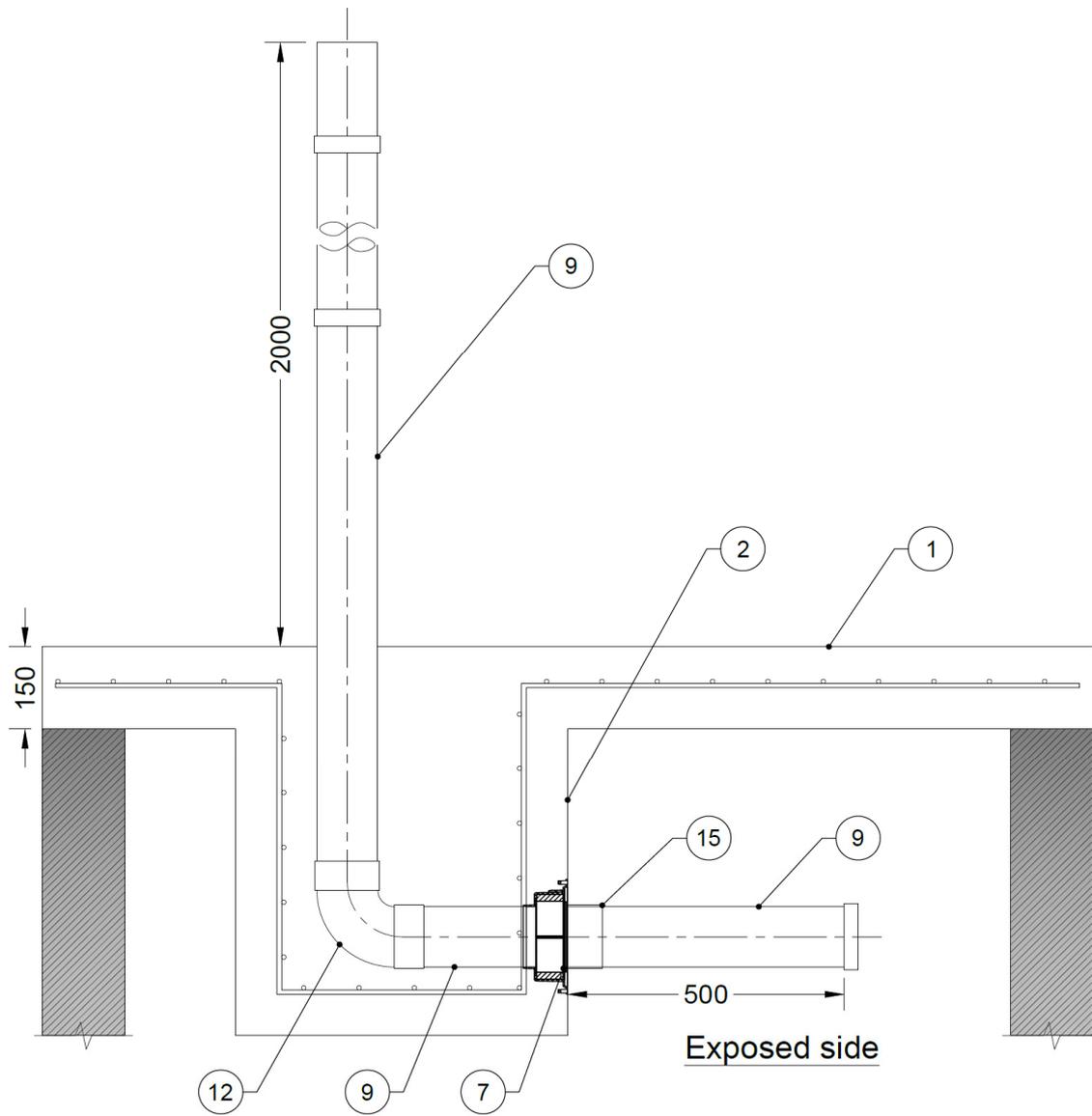


Figure 4 Cross-section C-C

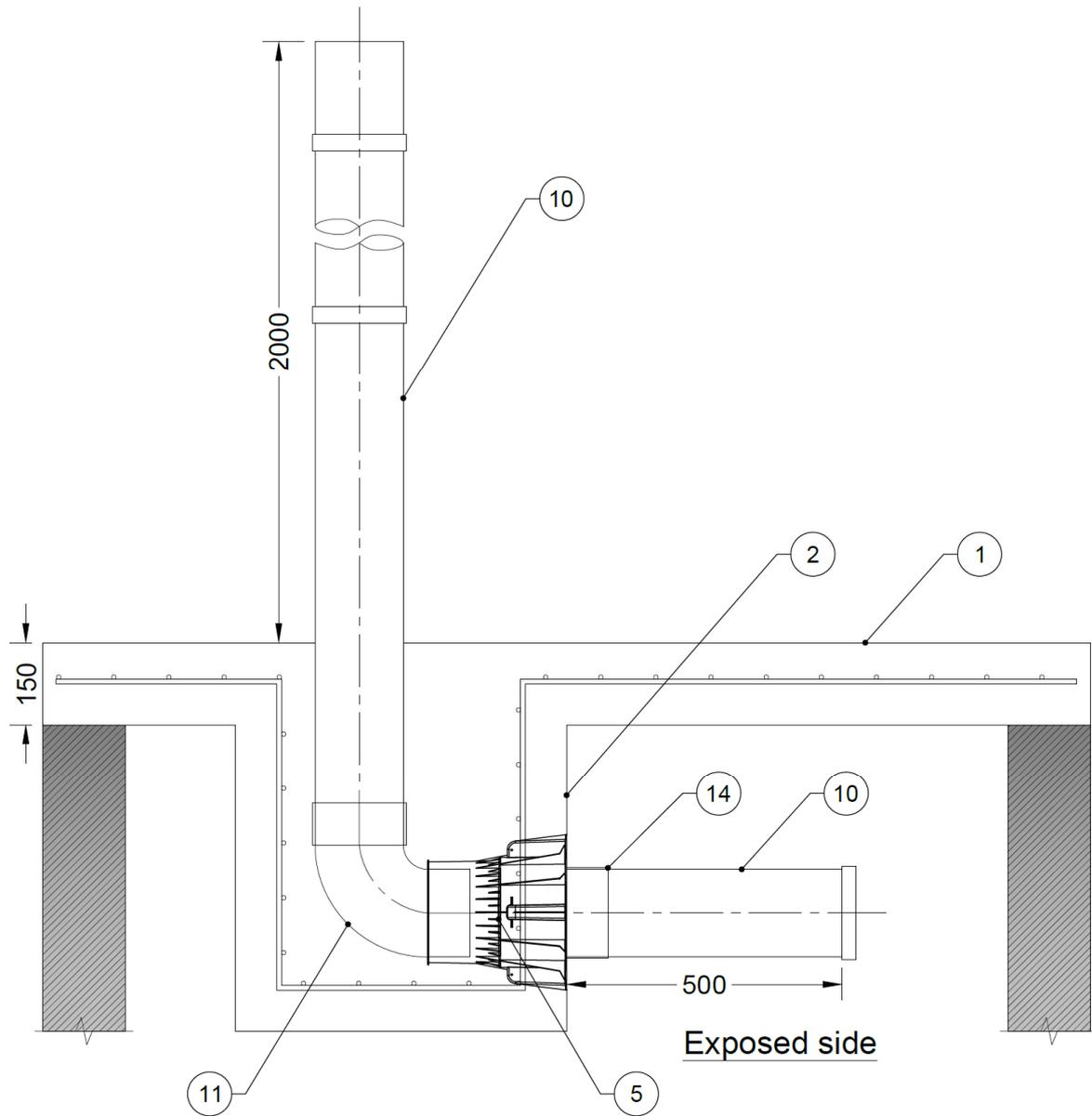


Figure 5 Cross-section D-D

Appendix B Test observations

Table 9 shows observations of any significant behaviour of the specimen during the test.

Table 9 Test observations

Time		Observation
Min	Sec	
Penetration system A		
00	00	Fire resistance test commenced, and the initial temperature of the specimen was approximately 14°C.
1	50	Grey smoke venting from the open end service.
2	50	Smoke venting stopped from the service.
12	00	Concrete had started spalling in the furnace.
30	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
40	00	Concrete had stopped spalling in the furnace.
60	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
90	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
94	55	Slight smoke venting from the end of the pipe.
100	60	Smoke venting stopped from the service.
120	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
180	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
240	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
241	00	Fire resistance test terminated.
Penetration system B		
00	00	Fire resistance test commenced, and the initial temperature of the specimen was approximately 14°C.
1	50	Grey smoke venting from the open end service.
3	05	Dark black smoke venting from the service.
4	20	Pipe melted off above the socket.
4	50	Pipe had collapsed on the slab.
4	55	Smoke venting stopped from the service.
12	00	Concrete had started spalling in the furnace.
30	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
40	00	Concrete had stopped spalling in the furnace.
60	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
90	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
120	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
180	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
240	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
241	00	Fire resistance test terminated.

Time		Observation
Min	Sec	
Penetration system C		
00	00	Fire resistance test commenced, and the initial temperature of the specimen was approximately 14°C.
2	35	Smoke venting at the open end of the service.
5	50	Dark black smoke venting from the service.
7	50	Smoke venting reduced significantly from the service.
12	00	Concrete had started spalling in the furnace.
30	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
37	00	Smoke venting stopped from the service.
40	00	Concrete had stopped spalling in the furnace.
60	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
81	25	Smoke venting from the end of the service.
90	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
94	55	Slight smoke venting from the end of the service.
109	35	Smoke venting from the end of the service had increased.
120	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
180	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
240	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
241	00	Fire resistance test terminated.

Appendix C Direct field of application

The text, figures and tables in this appendix have been taken from section 10 of AS 1530.4:2014.

C.1 General

The results of the fire test contained in the test report are directly applicable without reference to the testing authority to similar constructions where one or more of the changes set out in clauses 10.12.2 to 10.12.6 of AS 1530.4:2014 have been made.

C.2 Separating elements

Results obtained for sealing systems in various types of masonry and concrete construction may be applied as follows:

- for elements manufactured from similar types of concrete or masonry, the results of the prototype test may be applied to materials of density within $\pm 15\%$ of the tested specimen. For greater variations, the opinion of a registered testing authority shall be obtained.

C.3 Plastic pipes

C.3.1 General

In addition to the requirements of clause 10.12.2 of AS 1530.4:2014, test results may be directly applied to masonry and concrete elements thicker than the tested prototype when installed in accordance with Figure 10.12.5.1 of AS 1530.4:2014.

Results obtained from a particular test shall not be applied to plastics pipes of different diameters, wall thicknesses or material types.

Results obtained from tests on penetrations through vertical separating elements shall not be used to assess performance in horizontal elements, and vice versa.

As penetration seals for plastic pipes are dependent for activation upon exposure to fire conditions, they shall always be installed with the same orientation and fire exposure as was established in the fire resistance test.

C.3.2 Services not perpendicular to the fire separation

Penetrations not perpendicular to the plane of the element are acceptable, provided the fire-stopping system has similar exposure and dimensions to the tested prototype.

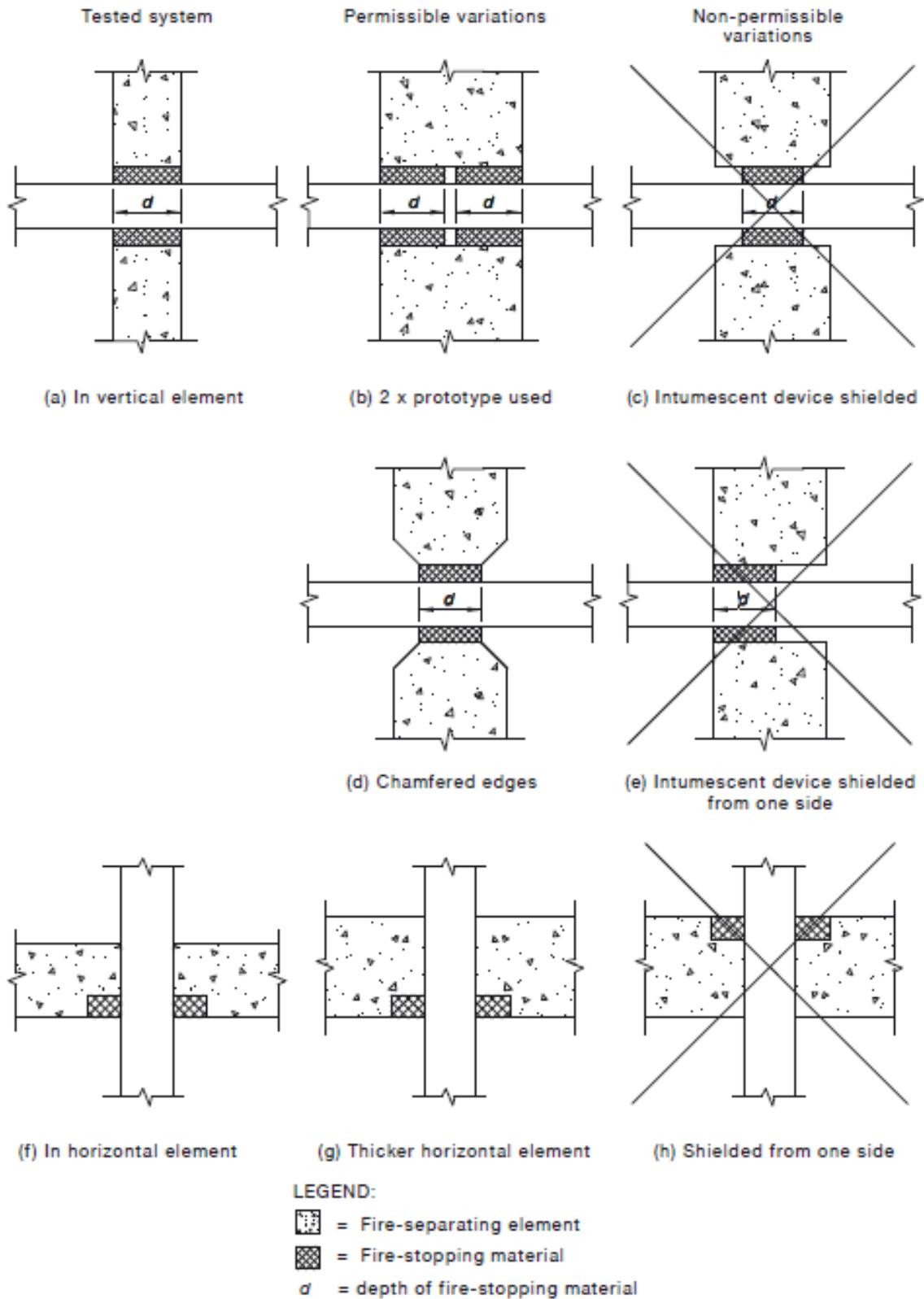


FIGURE 10.12.5.1 EQUIVALENT EXPOSURE OF UPVC PIPE FIRE-STOPPING SYSTEMS

Appendix D Instrumentation locations

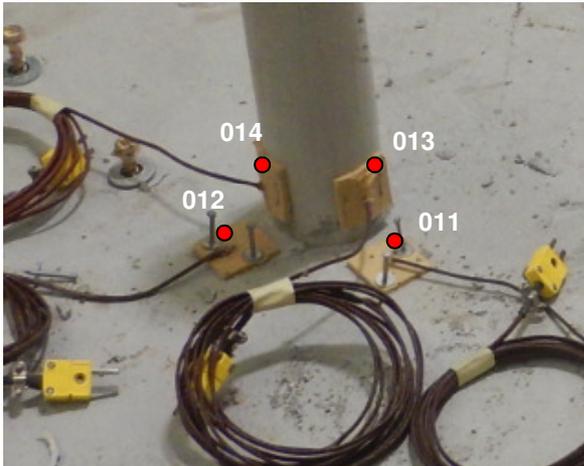


Figure 6 Penetration system A

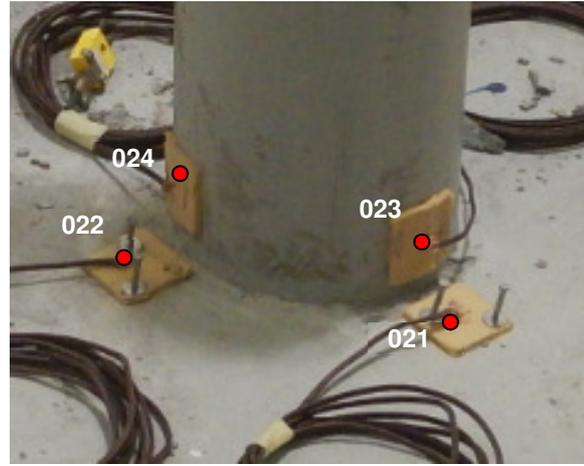


Figure 7 Penetration system B



Figure 8 Penetration system C

Table 10 Thermocouple locations

Penetration system	T/C no.	Description
A	011	On the separating element, 25mm from the pipe.
	012	On the separating element, 25mm from the pipe.
	013	On the service, 25mm from the separating element.
	014	On the service, 25mm from the separating element.
B	021	On the separating element, 25mm from the pipe.
	022	On the separating element, 25mm from the pipe.
	023	On the service, 25mm from the separating element.
	024	On the service, 25mm from the separating element.
C	031	On the separating element, 25mm from the pipe.
	032	On the separating element, 25mm from the pipe.
	033	On the service, 25mm from the separating element.
	034	On the service, 25mm from the separating element.

Appendix E Test data

E.1 Furnace temperature

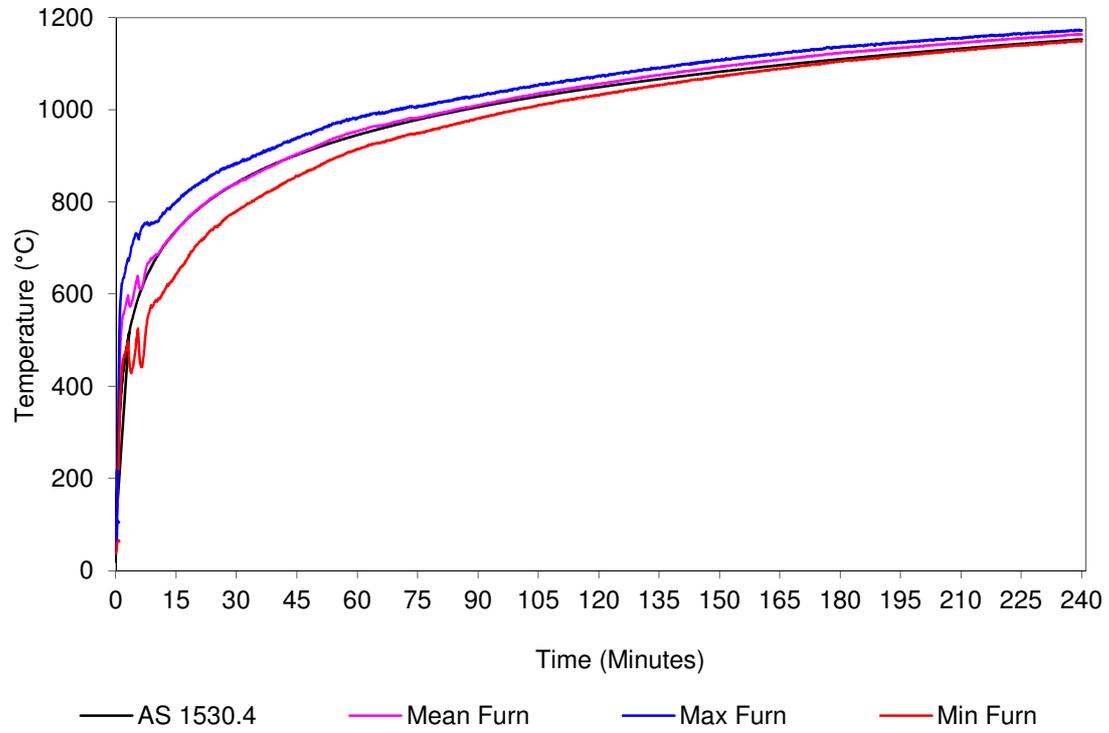


Figure 9 Furnace thermocouple temperature vs time

E.2 Furnace pressure

The furnace pressure was measured at 900mm below the slab.

Table 11 Furnace pressure

Time (minutes)	Pressure (Pa) average	Time (minutes)	Pressure (Pa) average	Time (minutes)	Pressure (Pa) average
5-10	22	85-90	20	165-170	19
10-15	20	90-95	20	170-175	19
15-20	20	95-100	20	175-180	19
20-25	19	100-105	21	180-185	20
25-30	21	105-110	21	185-190	19
30-35	19	110-115	19	190-195	19
35-40	19	115-120	18	195-200	19
40-45	20	120-125	18	200-205	19
45-50	21	125-130	19	205-210	19
50-55	22	130-135	19	210-215	20
55-60	20	135-140	19	215-220	21
60-65	19	140-145	19	220-225	20
65-70	19	145-150	20	225-230	18
70-75	19	150-155	20	230-235	18
75-80	20	155-160	20	235-240	19
80-85	20	160-165	20		

E.3 Specimen temperatures

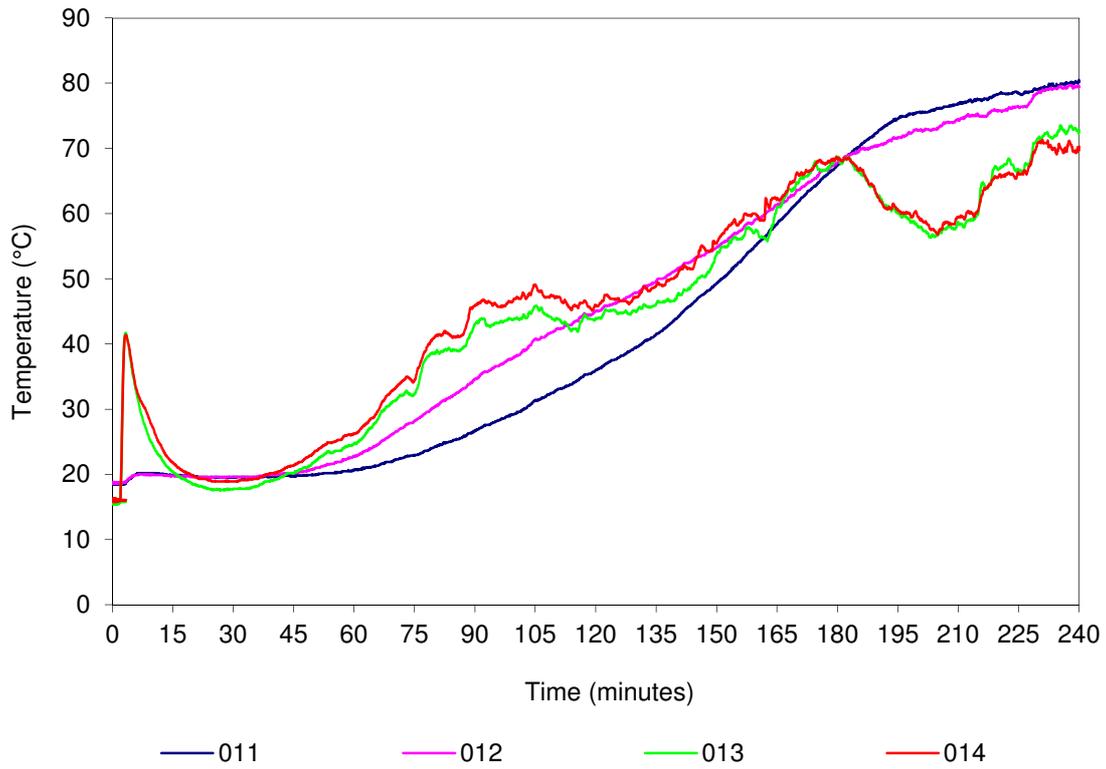


Figure 10 Penetration system A – temperature vs time

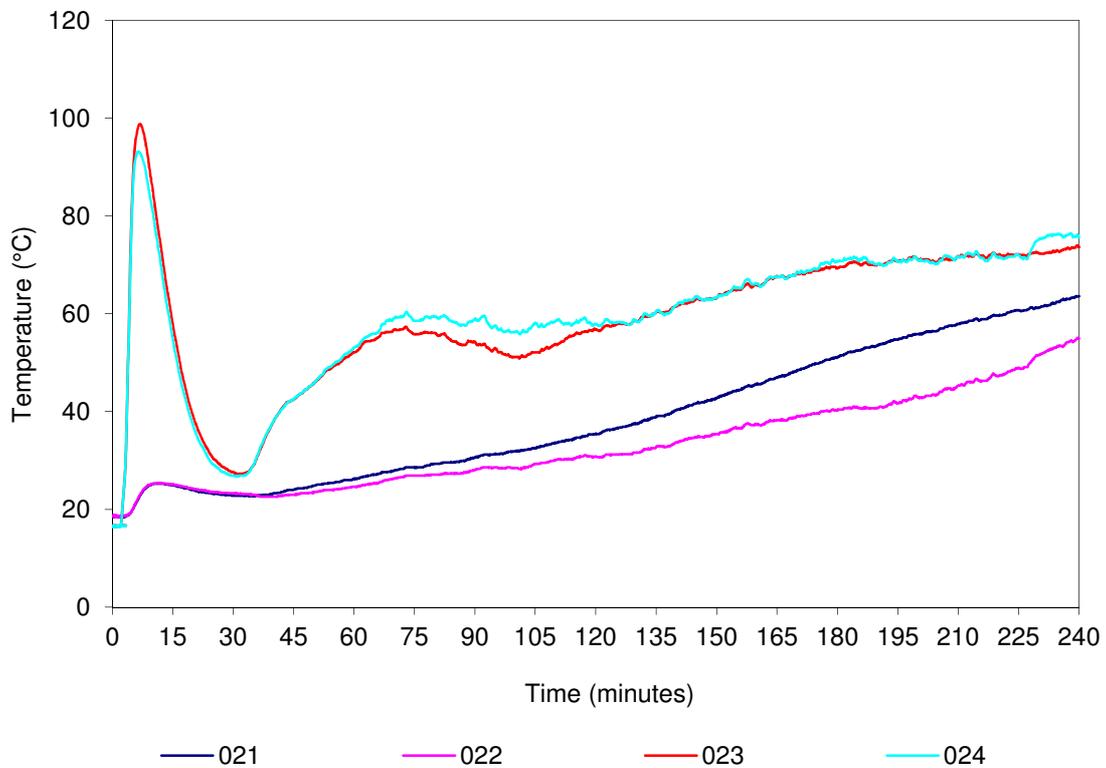


Figure 11 Penetration system B – temperature vs time

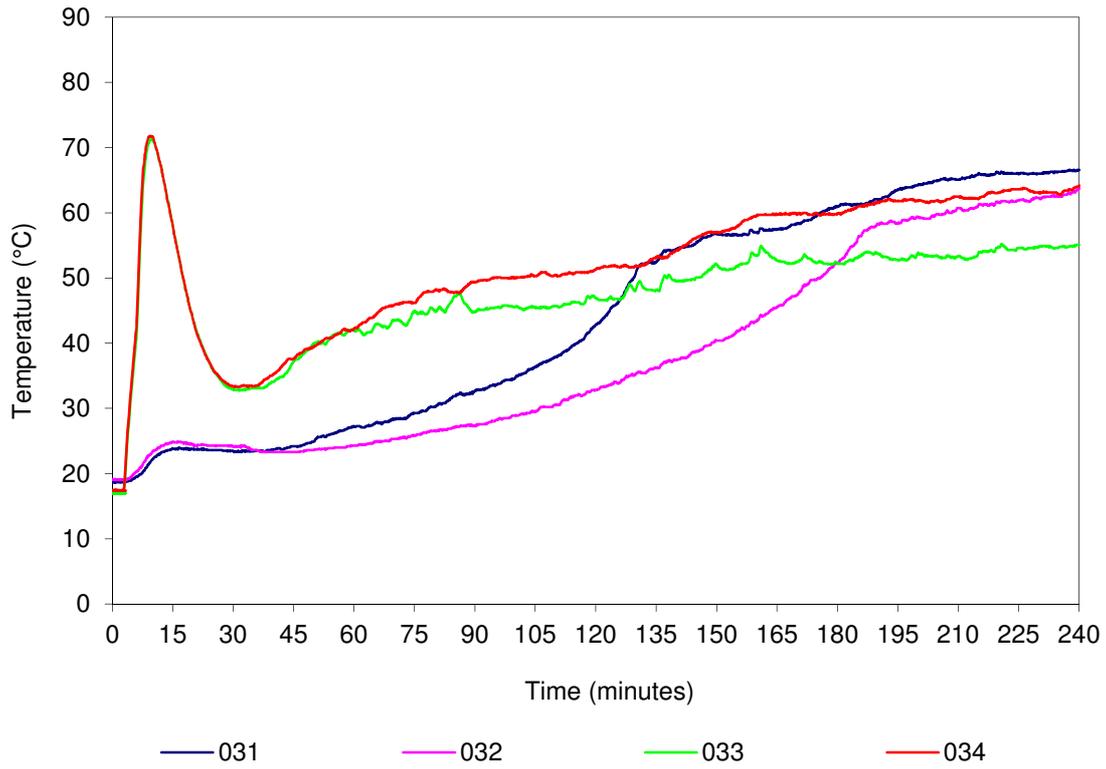


Figure 12 Penetration system C – temperature vs time

Table 12 Test specimen temperatures

Penetration system	T/C no.	Description ²	Temp (°C) at t (minutes)					Limit ¹ (minutes)
			t=0	t=60	t=120	t=180	t=240	
A	011	On the separating element.	19	21	36	68	80	-
	012	On the separating element.	19	23	45	68	80	-
	013	On the service.	16	25	44	69	73	-
	014	On the service.	16	26	46	69	70	-
B	021	On the separating element.	19	26	35	51	64	-
	022	On the separating element.	19	25	31	40	55	-
	023	On the service.	17	52	57	69	74	-
	024	On the service.	17	53	58	71	76	-
C	031	On the separating element.	19	27	43	61	67	-
	032	On the separating element.	19	24	33	52	64	-
	033	On the service.	17	42	47	52	55	-
	034	On the service.	18	42	52	60	64	-

Notes

- ¹ Limit time is the time to the nearest whole minute, rounded down to the nearest minute, at which the temperature recorded by the thermocouple does not rise by more than 180K above the initial temperature.
- ² Refer to Appendix D for locations of thermocouples as only a generic description is included in the table.
- ³ No insulation failure before thermocouple failure.
- # Thermocouple failure.
- * Integrity failure of the penetration system.
- ⌋ Under limit column indicates the temperature limit was not exceeded during the test period or up until the time of integrity failure if a failure occurred.

Appendix F Photographs

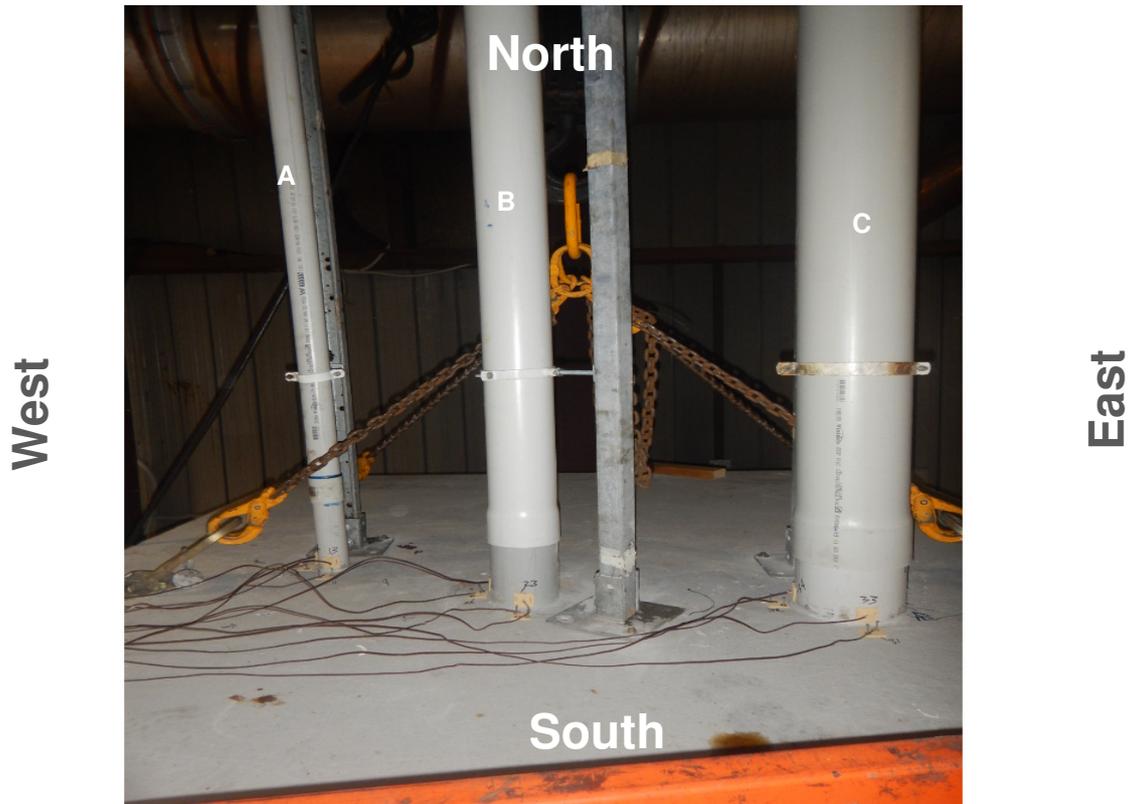


Figure 13 Unexposed face of specimen before the start of test



Figure 14 Exposed face of the specimen before the start of test



Figure 15 Unexposed face of specimen at the end of test

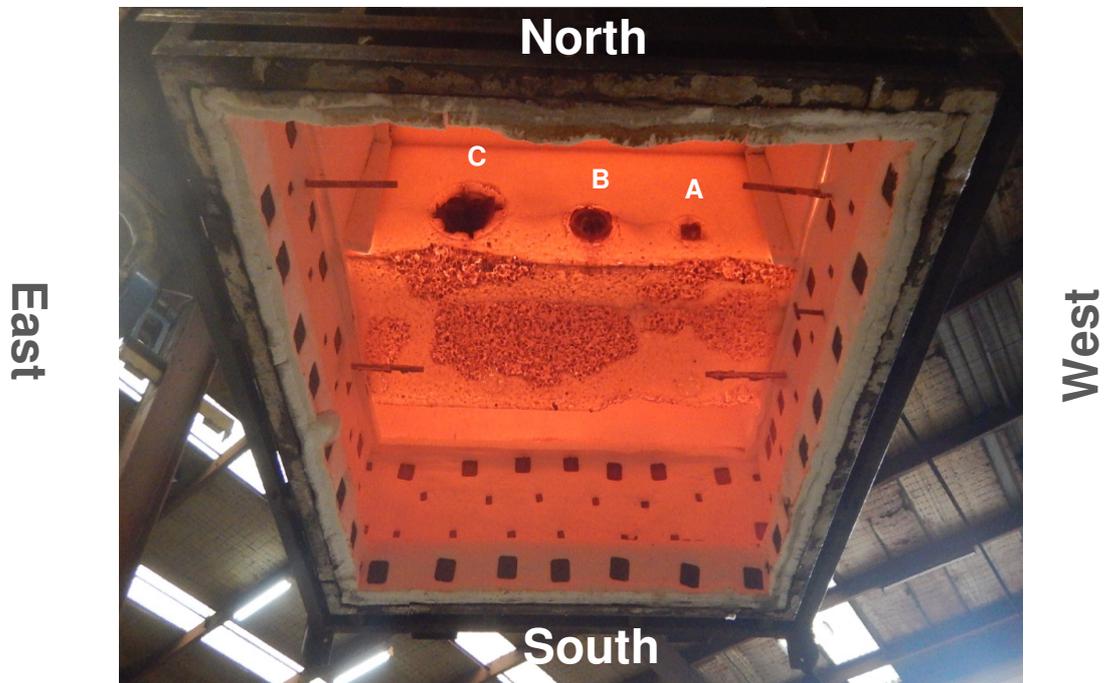


Figure 16 Exposed face of the specimen at the end of test