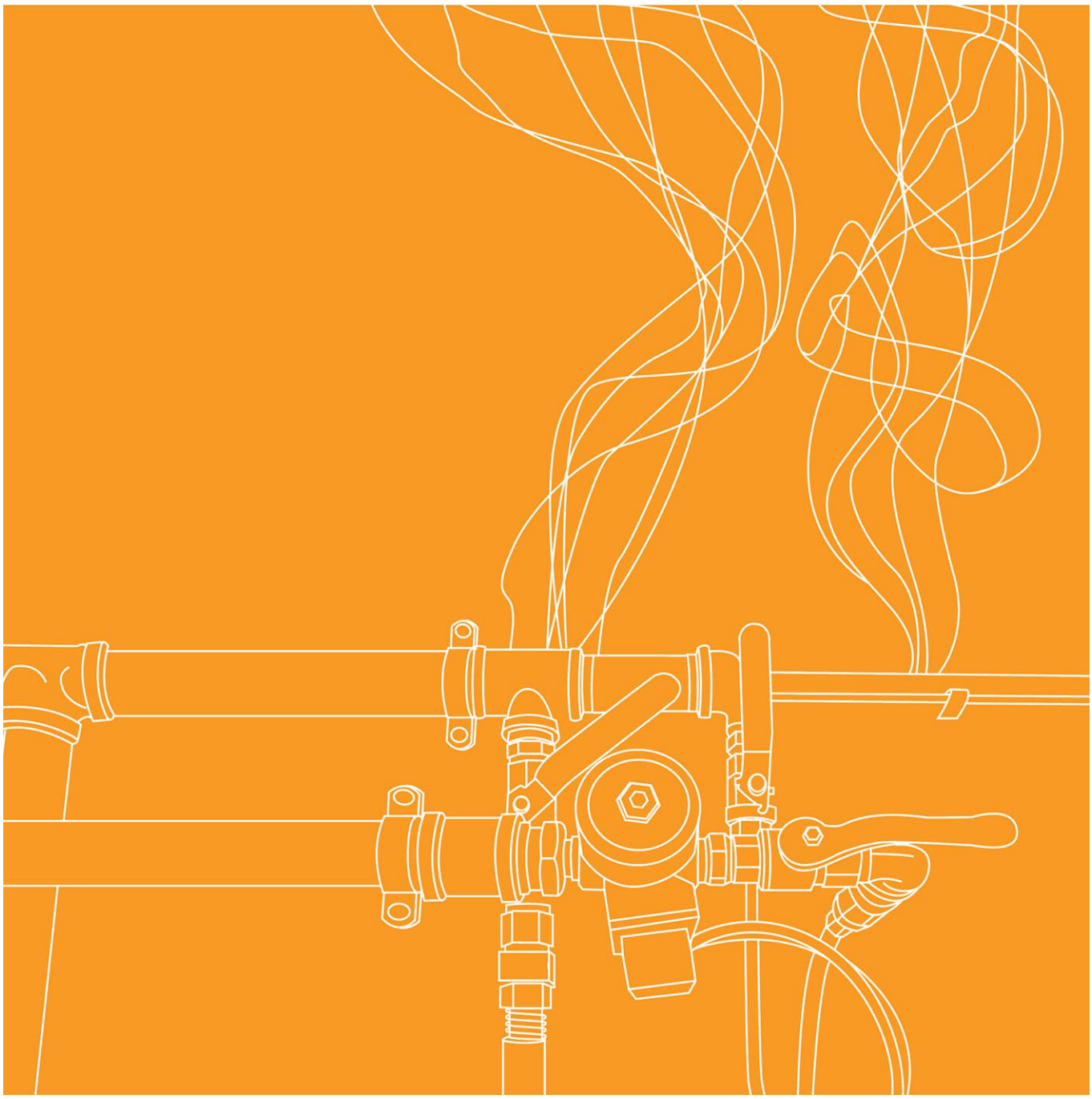

BOSS Products Pty Ltd

Unit 1, 16 Atkinson Rd, Taren Point NSW 2229

Test Report 148693

120 mm slab with MaxiCollar™

AS 1530.4:2014

Holmes Solutions LP, 7 Canterbury Street, Christchurch

DISCLAIMER

Holmes Solutions

Revision: 2.3
14 November 2024
Project: 148693.00

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Revision No:	Date	Revision
1.0	21/08/2024	Draft
1.1	11/09/2024	Draft – Updates to pressure comment and test duration.
2.0	20/09/2024	Final – Minor formatting and comment on 160 mm Valsir TriPlus removal
2.1	07/11/2024	Final – removed 160mm TriPlus results.
2.2	16/10/2024	Final – updates to removal of 160mm TriPlus result.
2.3	14/11/2024	Final – removal of 160mm TriPlus mention section B-2

1 TESTING, RESULTS, AND USE OF REPORTS

1.1 Test Standard

This test report evaluates the performance of products and materials in accordance with AS 1530, Methods for fire tests on building materials, components and structures, Part 4–2014: Fire-resistance test for elements of construction (AS 1530.4:2014), Section 2: General Requirements, and Section 10: Service penetrations and control joints.

This test report also meets the requirements of AS 4072, Components for the protection of openings in fire-resistant separating elements, Part 1–2005, Service penetrations and control joints.

1.2 Test specimen and separating element summary

The fire stopped specimens which are covered within this report are:

- uPVC DWV pipes (32 mm, 40 mm, 50 mm, 65 mm, 80 mm, 100 mm, 150 mm)
- uPVC conduit bundles (a mix of 20 mm, 25 mm, 32 mm – specimen dependent)
- Valsir TriPlus pipes (40 mm, 110 mm)

The specimens were fire stopped using the following products (the exact application was penetration dependent):

- BOSS™ FireMastic-300™
- BOSS™ FireMastic-HPE™
- BOSS™ MaxiCollar™ (40 mm, 50 mm, 80 mm, 100 mm, 125 mm, 150 mm)

The separating element was a 120 mm thick reinforced concrete floor slab.

Further information on the tested systems and Fire Resistance Level (FRL) achieved are detailed herein.

1.3 Test result

Table 1-1 lists the results each specimen achieved in accordance with the performance criteria detailed in AS 1530.4:2014, Section 2 and Section 10. All failure times are noted in elapsed whole minutes between the commencement of heating and the time of failure with respect to the relevant criteria. The test duration was 245 minutes.

Table 1-1: Summary of the fire resistance for all specimen

#	Specimen	Structural Adequacy [min]	Integrity [min]	Insulation [min]	FRL [min]
1	32 mm uPVC DWV	N/A	245	206	-/240/180
2	40 mm uPVC DWV		245	188	-/240/180
3	50 mm uPVC DWV		245	188	-/240/180
4	65 mm uPVC DWV		245	189	-/240/180
5	80 mm uPVC DWV		245	194	-/240/180
6	100 mm uPVC DWV		245	205	-/240/180
7	150 mm uPVC DWV		245	198	-/240/180
8	uPVC conduit bundle with 2 x 20 mm and 1 x 25 mm		245	181	-/240/180
9	uPVC conduit bundle with 1 x 20 mm, 1 x 25 mm and 1 x 32 mm		245	212	-/240/210
10	uPVC conduit bundle with 2 x 20 mm, 2 x 25 mm and 2 x 32 mm		245	152	-/240/150
11	40 mm Valsir TriPlus pipe		245	161	-/240/150
13	110 mm Valsir TriPlus pipe		245	209	-/240/180

1.4 Use of reports and validity

Testing was undertaken on the 23rd of July 2024 at the HSLP, 7 Canterbury Street, Christchurch test facility. Sample (separating element and specimens) construction undertaken in the weeks prior. Test results contained herein are applicable at the time of testing for a specific product installation only. This report is subject to the contractual obligations under which it was prepared. The report must not be used as a means of endorsement.

In particular, the report may only be used for the following purposes:

- The information in the report may be used by the party that commissioned the report for its internal business operations (but not licensing to third parties);
- The report may be copied for distribution within the organisation that commissioned the report;

Copies of this report can only be distributed to external parties by the client who commissioned the testing. Copies may be distributed around an organisation for internal use only.

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 the fire hazard under all fire conditions.

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

Because of the nature of fire resistance testing and the consequent difficulty in quantifying the uncertainty of measurement of fire resistance, it is not possible to provide a stated degree of accuracy of the result.

The name, trademark or logo of Holmes Solutions must not be used without the prior written consent of HSLP.

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APPENDIX TABLES

2 CONSTRUCTION/ PRODUCT INSTALLATION DETAILS

The sample construction and tested systems are detailed within the following sections.

2.1 Schedule of Components

Table 2-1: Schedule of components

Item	Description	
Separating element		
SE	Size (nominal)	Width (w): 1200 mm Height (h): 2400 mm Thickness (t): 120 mm
	Construction	The separating element (floor) was constructed as a single concrete slab, reinforced at mid slab.
1.	**Component**	**Concrete floor**
	Density (kg/m^3)	2400 (nominal)
	Thickness (mm)	120
2.	**Component**	**Reinforcement**
	Product Name	SE820
	Size Ø (mm)	8.0
	Mesh size (mm)	200
	Installation	Mid slab
Penetration Service		
3.	**Component**	**Pipe**
	Type	uPVC DWV
	Sizes	▪ DN 32 mm ○ Outer Diameter: 36.5 mm (nominal) ○ Pipe wall thickness: 2.0 mm (nominal) ▪ DN 40 mm ○ Outer Diameter: 42.9 mm (nominal) ○ Pipe wall thickness: 2.1 mm (nominal) ▪ DN 50 mm ○ Outer Diameter: 55.7 mm (nominal) ○ Pipe wall thickness: 2.2 mm (nominal) ▪ DN 65 mm ○ Outer Diameter: 68.1 mm (nominal) ○ Pipe wall thickness: 3.0 mm (nominal) ▪ DN 80 mm ○ Outer Diameter: 82.6 mm (nominal) ○ Pipe wall thickness: 3.1 mm (nominal)

		▪ DN 100 mm ○ Outer Diameter: 111.6 mm (nominal) ○ Pipe wall thickness: 3.0 mm (nominal) ▪ DN 150 mm ○ Outer Diameter: 159.5 mm (nominal) ○ Pipe wall thickness: 4.0 mm (nominal)
4.	**Component**	**Conduit**
	Type	uPVC Conduit
	Sizes	▪ DN 20 mm ○ Outer Diameter: 20.1 mm (nominal) ○ Pipe wall thickness: 2.2 mm (nominal) ▪ DN 25 mm ○ Outer Diameter: 25.5 mm (nominal) ○ Pipe wall thickness: 2.0 mm (nominal) ▪ DN 32 mm ○ Outer Diameter: 32.8 mm (nominal) ○ Pipe wall thickness: 2.2 mm (nominal) Note: Bundle configuration was specimen dependent.
5.	**Component**	**Pipe**
	Type	Valsir TriPlus
	Sizes	▪ DN 40 mm ○ Outer Diameter: 40.1 mm (nominal) ○ Pipe wall thickness: 2.2 mm (nominal) ▪ DN 110 mm ○ Outer Diameter: 112 mm (nominal) ○ Pipe wall thickness: 3.7 mm (nominal) ▪ DN 160 mm ○ Outer Diameter: 162 mm (nominal) ○ Pipe wall thickness: 5.5 mm (nominal)
Fire Stopping Product / System		
6.	**Component**	**Sealant**
	Product Name	BOSS FireMastic-300™
	Material	Water-based, one-part acrylic emulsion sealant
	Density	Nominal 1560 kg / m^3 (provided by test sponsor)
	Installation	Installed in the annular gap between services and separating element (both sides), to a depth of 5 mm.
7.	**Component**	**Sealant**
	Product Name	BOSS FireMastic-HPE™

	Material	Graphite-based, thixotropic, one-part acrylic emulsion sealant
	Density	Nominal 1230 – 1330 kg / m^3 (provided by test sponsor)
	Installation	Installed in the annular gap between services and separating element (both sides), to a depth of 25 mm on the exposed side and 10 mm on the unexposed side.
8.	**Component**	**Fire collar**
	Product Name	BOSS MaxiCollar™
	Size	▪ 32 mm, 40 mm pipes: 40 mm MaxiCollar™ ▪ 50 mm pipe: 50 mm MaxiCollar™ ▪ 65 mm, 80 mm pipes: 80 mm MaxiCollar™ ▪ 100 mm pipe: 100 mm MaxiCollar™ ▪ 150 mm, 160 mm pipes: 150 mm MaxiCollar™
	Installation	Fire collar was installed around the pipes on the exposed side and fixed into the concrete slab.
9.	**Component**	**Fixings**
	Product type	Masonry Anchors
	Size	6 mm x 40 mm
	Installation	Fixed through the fire collar tabs, directly into the concrete.

2.2 Specimen summary and layout

Tested specimens and fire stopping systems are listed within Table 2-2. Specimens installed through the separating element are illustrated in Figure 2-1.

Table 2-2: Fire stopping and service penetrations summary

#	Specimen	Fire Stopping
1	32 mm uPVC DWV	BOSS FireMastic-300™ & 40 mm BOSS MaxiCollar™
2	40 mm uPVC DWV	BOSS FireMastic-300™ & 40 mm BOSS MaxiCollar™
3	50 mm uPVC DWV	BOSS FireMastic-300™ & 50 mm BOSS MaxiCollar™
4	65 mm uPVC DWV	BOSS FireMastic-300™ & 80 mm BOSS MaxiCollar™
5	80 mm uPVC DWV	BOSS FireMastic-300™ & 80 mm BOSS MaxiCollar™
6	100 mm uPVC DWV	BOSS FireMastic-300™ & 100 mm BOSS MaxiCollar™
7	150 mm uPVC DWV	BOSS FireMastic-300™ & 150 mm BOSS MaxiCollar™
8	uPVC conduit bundle with 2 x 20 mm and 1 x 25 mm	BOSS FireMastic-HPE™
9	uPVC conduit bundle with 1 x 20 mm, 1 x 25 mm and 1 x 32 mm	BOSS FireMastic-HPE™
10	uPVC conduit bundle with 2 x 20 mm, 2 x 25 mm and 2 x 32 mm	BOSS FireMastic-HPE™
11	40 mm Valsir TriPlus pipe	BOSS FireMastic-300™ & 40 mm BOSS MaxiCollar™
13	110 mm Valsir TriPlus pipe	BOSS FireMastic-300™ & 100 mm BOSS MaxiCollar™

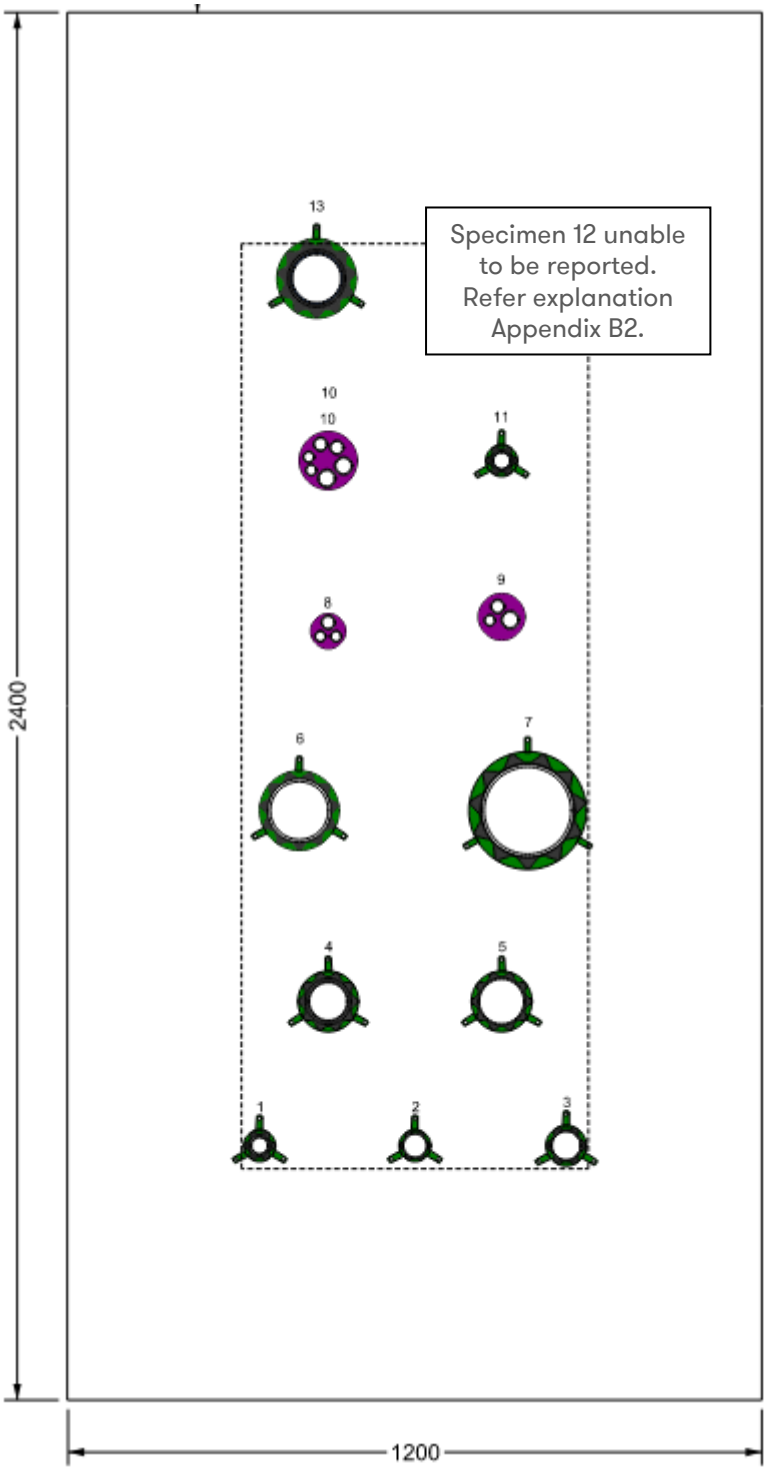


Figure 2-1: Specimen layout

2.3 Specimen installation details

Details for each tested Specimen are presented within this section.

Table 2-3: Specimen 1 - 32 mm uPVC DWV pipe

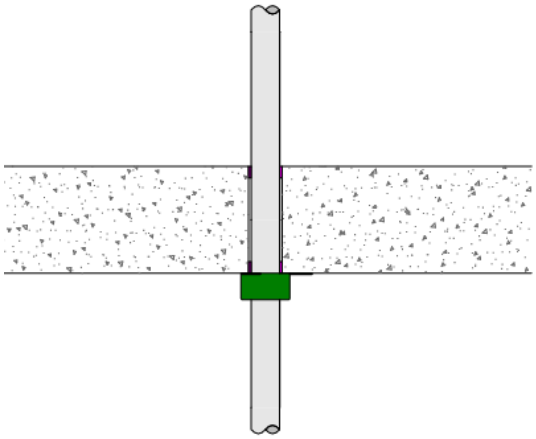
Specimen 1 – 32 mm uPVC DWV pipe	
A Ø32 mm uPVC DWV pipe was installed through a Ø37 mm core hole in the separating element. BOSS FireMastic-300™ was applied to fill the annular gap between the pipe and separating element to a depth of approximately 5 mm on both the exposed and unexposed side. A 40 mm BOSS MaxiCollar™ was installed around the pipe and fixed directly onto the concrete slab using 6 mm x 40 mm masonry anchors.	
	uPVC 32mm DWV 37mm core hole 40mm MaxiCollar sealed with FireMastic-300 to annular gap 5mm deep
Test result: FRL -/240/180	

Table 2-4: Specimen 2 - 40 mm uPVC DWV pipe

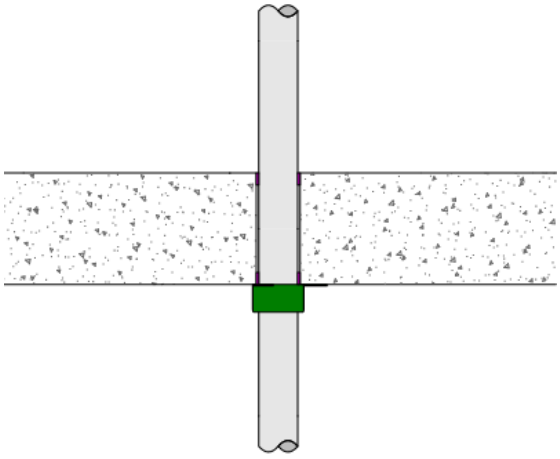
Specimen 2 – 40 mm uPVC DWV pipe	
A Ø40 mm uPVC DWV pipe was installed through a Ø47 mm core hole in the separating element. BOSS FireMastic-300™ was applied to fill the annular gap between the pipe and separating element to a depth of approximately 5 mm on both the exposed and unexposed side. A 40 mm BOSS MaxiCollar™ was installed around the pipe and fixed directly onto the concrete slab using 6 mm x 40 mm masonry anchors.	
	uPVC 40mm DWV 47mm core hole 40mm MaxiCollar sealed with FireMastic-300 to annular gap 5mm deep
Test result: FRL -/240/180	

Table 2-5: Specimen 3 - 50 mm uPVC DWV pipe

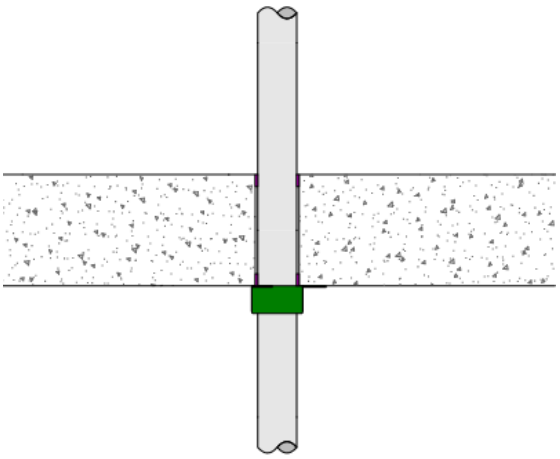
Specimen 3 – 50 mm uPVC DWV pipe	
A Ø50 mm uPVC DWV pipe was installed through a Ø62 mm core hole in the separating element. BOSS FireMastic-300™ was applied to fill the annular gap between the pipe and separating element to a depth of approximately 5 mm on both the exposed and unexposed side. A 50 mm BOSS MaxiCollar™ was installed around the pipe and fixed directly onto the concrete slab using 6 mm x 40 mm masonry anchors.	
	uPVC 50mm DWV 62mm core hole 50mm MaxiCollar sealed with FireMastic-300 to annular gap 5mm deep
Test result: FRL -/240/180	

Table 2-6: Specimen 4 - 65 mm uPVC DWV pipe

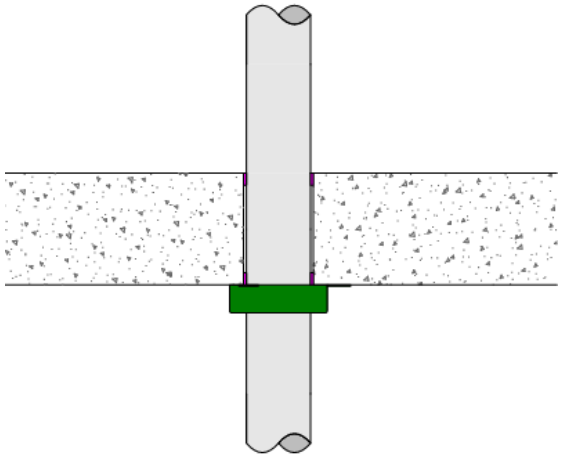
Specimen 4 – 65 mm uPVC DWV pipe	
A Ø65 mm uPVC DWV pipe was installed through a Ø77 mm core hole in the separating element. BOSS FireMastic-300™ was applied to fill the annular gap between the pipe and separating element to a depth of approximately 5 mm on both the exposed and unexposed side. An 80 mm BOSS MaxiCollar™ was installed around the pipe and fixed directly onto the concrete slab using 6 mm x 40 mm masonry anchors.	
	uPVC 65mm DWV 77mm core hole 80mm MaxiCollar sealed with FireMastic-300 to annular gap 5mm deep
Test result: FRL -/240/180	

Table 2-7: Specimen 5 - 80 mm uPVC DWV pipe

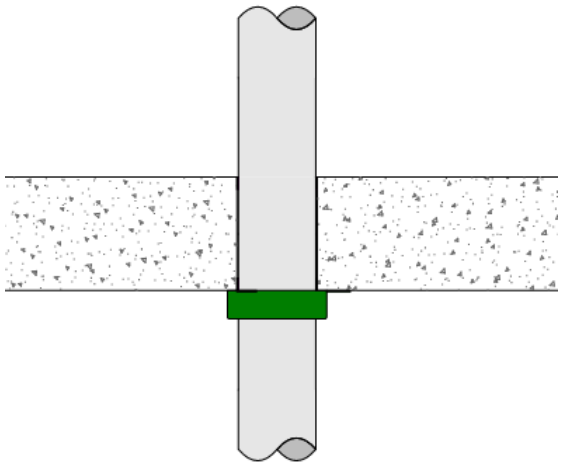
Specimen 5 – 80 mm uPVC DWV pipe	
A Ø80 mm uPVC DWV pipe was installed through a Ø84 mm core hole in the separating element. BOSS FireMastic-300™ was applied to fill the annular gap between the pipe and separating element to a depth of approximately 5 mm on both the exposed and unexposed side. An 80 mm BOSS MaxiCollar™ was installed around the pipe and fixed directly onto the concrete slab using 6 mm x 40 mm masonry anchors.	
	uPVC 80mm DWV 84mm core hole 80mm MaxiCollar sealed with FireMastic-300 to annular gap 5mm deep
Test result: FRL -/240/180	

Table 2-8: Specimen 6 - 100 mm uPVC DWV pipe

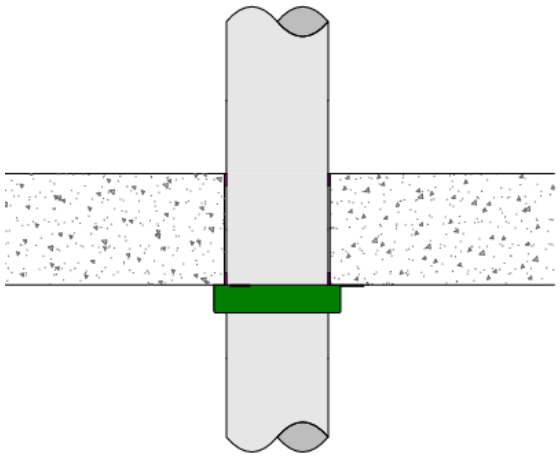
Specimen 6 – 100 mm uPVC DWV pipe	
A Ø100 mm uPVC DWV pipe was installed through a Ø120 mm core hole in the separating element. BOSS FireMastic-300™ was applied to fill the annular gap between the pipe and separating element to a depth of approximately 5 mm on both the exposed and unexposed side. A 100 mm BOSS MaxiCollar™ was installed around the pipe and fixed directly onto the concrete slab using 6 mm x 40 mm masonry anchors.	
	uPVC 100mm DWV 120mm core hole 100mm MaxiCollar sealed with FireMastic-300 to annular gap 5mm deep
Test result: FRL -/240/180	

Table 2-9: Specimen 7 - 150 mm uPVC DWV pipe

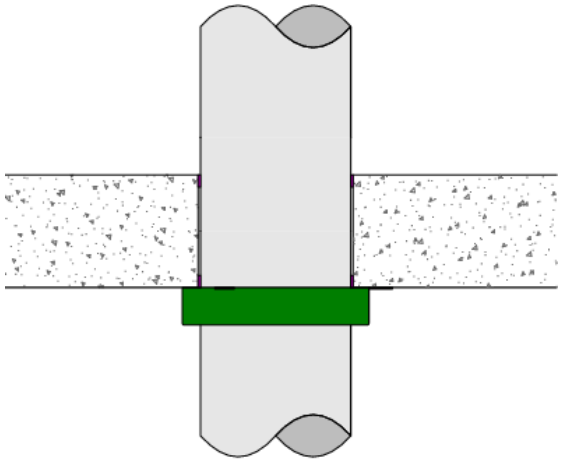
Specimen 7 – 150 mm uPVC DWV pipe	
A Ø150 mm uPVC DWV pipe was installed through a Ø172 mm core hole in the separating element. BOSS FireMastic-300™ was applied to fill the annular gap between the pipe and separating element to a depth of approximately 5 mm on both the exposed and unexposed side. A 150 mm BOSS MaxiCollar™ was installed around the pipe and fixed directly onto the concrete slab using 6 mm x 40 mm masonry anchors.	
	uPVC 150mm DWV 172mm core hole 150mm MaxiCollar sealed with FireMastic-300 to annular gap 5mm deep
Test result: FRL -/240/180	

Table 2-10: Specimen 8 - uPVC conduit bundle with 2 x 20mm and 1 x 25mm

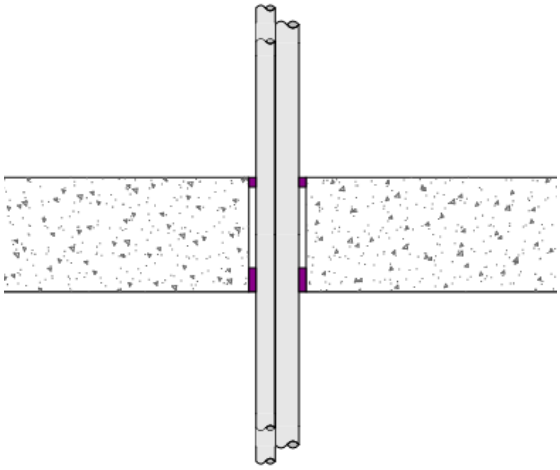
Specimen 8 – uPVC conduit bundle with 2 x 20 mm and 1 x 25 mm	
A uPVC conduit bundle with 2 x 20 mm and 1 x 25 mm was installed through a Ø60 mm core hole in the separating element. BOSS FireMastic-HPE™ was applied to fill the annular gap between the services and separating element to a depth of approximately 25 mm on the exposed, and approximately 10 mm on the unexposed side.	
	uPVC conduits 2 x 20mm + 1 x 25mm 60mm core hole Conduits equally spaced, sealed with HPE 25mm deep in annular below, 10mm deep in annular above.
Test result: FRL -/240/180	

Table 2-11: Specimen 9 - uPVC conduit bundle with 1 x 20mm, 1 x 25mm and 1 x 32mm

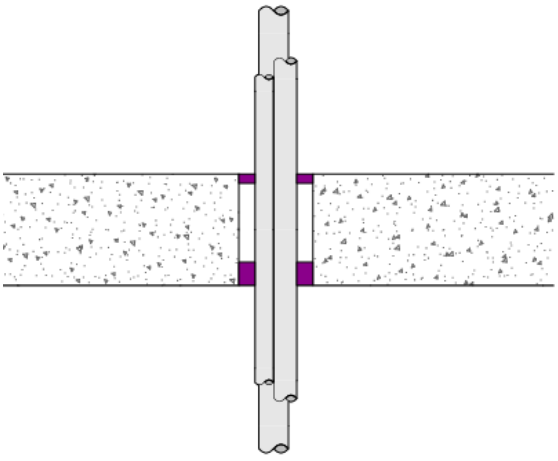
Specimen 9 – uPVC conduit bundle with 1 x 20 mm, 1 x 25 mm and 1 x 32 mm	
A uPVC conduit bundle with 1 x 20 mm, 1 x 25 mm and 1 x 32 mm was installed through a Ø80 mm core hole in the separating element. BOSS FireMastic-HPE™ was applied to fill the annular gap between the services and separating element to a depth of approximately 25 mm on the exposed, and approximately 10 mm on the unexposed side.	
	uPVC conduits 1 x 20mm + 1 x 25mm + 1 x 32mm 80mm core hole Conduits equally spaced, sealed with HPE 25mm deep in annular below, 10mm deep in annular above.
Test result: FRL -/240/210	

Table 2-12: Specimen 10 - uPVC conduit bundle with 2 x 20mm, 2 x 25mm and 2 x 32mm

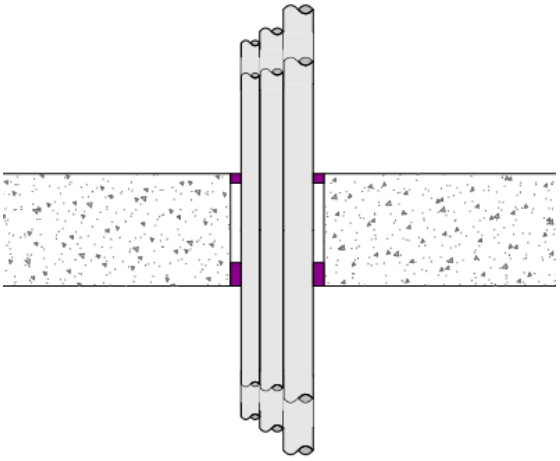
Specimen 10 – uPVC conduit bundle with 2 x 20 mm, 2 x 25 mm and 2 x 32 mm	
A uPVC conduit bundle with 2 x 20 mm, 2 x 25 mm and 2 x 32 mm was installed through a Ø100 mm core hole in the separating element. BOSS FireMastic-HPE™ was applied to fill the annular gap between the services and separating element to a depth of approximately 25 mm on the exposed, and approximately 10 mm on the unexposed side.	
	uPVC conduits 2 x 20mm + 2 x 25mm + 2 x 32mm 100mm core hole Conduits equally spaced, sealed with HPE 25mm deep in annular below, 10mm deep in annular above.
Test result: FRL -/240/150	

Table 2-13: Specimen 11 - 40 mm Valsir TriPlus pipe

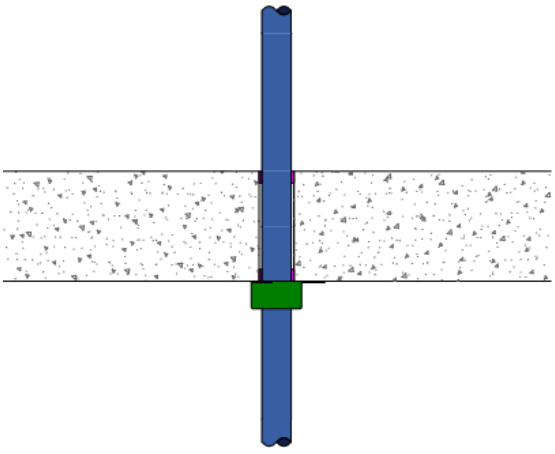
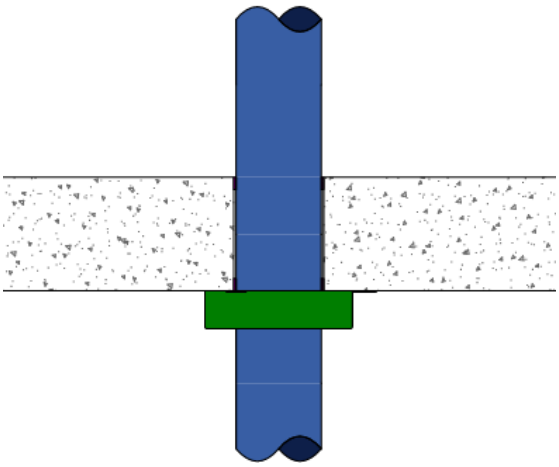
Specimen 11 – 40 mm Valsir TriPlus pipe	
A Ø40 mm Valsir TriPlus pipe was installed through a Ø47 mm core hole in the separating element. BOSS FireMastic-300™ was applied to fill the annular gap between the pipe and separating element to a depth of approximately 5 mm on both the exposed and unexposed side. A 40 mm BOSS MaxiCollar™ was installed around the pipe and fixed directly onto the concrete slab using 6 mm x 40 mm masonry anchors.	
	Valisair TriPlus 40mm 47mm core hole 40mm MaxiCollar sealed with FireMastic-300 to annular gap 5mm deep
Test result: FRL -/240/150	

Table 2-14: Specimen 13 - 110 mm Valsir TriPlus pipe

Specimen 13 – 110 mm Valsir TriPlus pipe	
A Ø110 mm Valsir TriPlus pipe was installed through a Ø112 mm core hole in the separating element. BOSS FireMastic-300™ was applied to fill the annular gap between the pipe and separating element to a depth of approximately 5 mm on both the exposed and unexposed side. A 100 mm BOSS MaxiCollar™ was installed around the pipe and fixed directly onto the concrete slab using 6 mm x 40 mm masonry anchors.	
	Valisair TriPlus 110mm 112mm core hole 100mm MaxiCollar sealed with FireMastic-300 to annular gap 5mm deep
Test result: FRL -/240/180	

2.4 Specimen installation

2.4.1 Exposed side – internal to furnace

The following table details the installation on the exposed side. The pipe and conduit end was capped with either ceramic wool or a uPVC end cap was used, refer Appendix C for specifics.

Table 2-15: Pipe installation details, exposed side

#	Specimen	Projection into Furnace [mm]	Fire Sealant	Fire collar	Sealant Depth [mm]	Service Opening [mm]
1	32 mm uPVC DWV	500	BOSS FireMastic-300™	40 mm BOSS MaxiCollar™	5	37
2	40 mm uPVC DWV					47
3	50 mm uPVC DWV			50 mm BOSS MaxiCollar™		62
4	65 mm uPVC DWV			80 mm BOSS MaxiCollar™		77
5	80 mm uPVC DWV					84
6	100 mm uPVC DWV			100 mm BOSS MaxiCollar™		120
7	150 mm uPVC DWV			150 mm BOSS MaxiCollar™		172
8	uPVC conduit bundle with 2 x 20 mm and 1 x 25 mm		BOSS FireMastic-HPE™	N/A	25	60
9	uPVC conduit bundle with 1 x 20 mm, 1 x 25 mm and 1 x 32 mm					80
10	uPVC conduit bundle with 2 x 20 mm, 2 x 25 mm and 2 x 32 mm					100
11	40 mm Valsir TriPlus pipe		BOSS FireMastic-300™	40 mm BOSS MaxiCollar™	5	47
13	110 mm Valsir TriPlus pipe			150 mm BOSS MaxiCollar™		112

2.4.2 Unexposed side – external to furnace

The following table details the installation on the unexposed side.

Table 2-16: Pipe installation details, unexposed side

#	Specimen	Projection External Furnace [mm]	Fire Sealant	Fire collar	Sealant Depth [mm]	Service Opening [mm]
1	32 mm uPVC DWV	2000	BOSS FireMastic-300™	N/A	5	37
2	40 mm uPVC DWV					47
3	50 mm uPVC DWV					62
4	65 mm uPVC DWV					77
5	80 mm uPVC DWV					84
6	100 mm uPVC DWV					120
7	150 mm uPVC DWV					172
8	uPVC conduit bundle with 2 x 20 mm and 1 x 25 mm		BOSS FireMastic-HPE™		10	60
9	uPVC conduit bundle with 1 x 20 mm, 1 x 25 mm and 1 x 32 mm					80
10	uPVC conduit bundle with 2 x 20 mm, 2 x 25 mm and 2 x 32 mm					100
11	40 mm Valsir TriPlus pipe		BOSS FireMastic-300™		5	47
13	110 mm Valsir TriPlus pipe					112

Notes:

1. The specimen was supported by pipe clamps at approximately 400 mm and 1900 mm from the unexposed side.

2.5 Pre-test Conditioning of Specimen

No specific pre-test conditioning was undertaken or noted on the sample.

2.6 Method of Assembly

2.7 Laboratory Involvement in Selection of Test Specimen

ICS constructed the test separating element. Coring, specimens, and fire stopping systems were selected, constructed, and installed by the Client. Thermocouples were installed in accordance with AS 1530.4:2014.

3 TEST CONDITIONS

3.1 Sample Condition

Prior to the test, the specimen was constructed and stored at ambient laboratory conditions.

3.2 Device Information

Specimen thermocouples were installed to the unexposed face in accordance with AS 1530.4:2014. Locations of thermocouples are detailed in Appendix B.

3.3 Ambient Conditions

The temperature within the laboratory at the commencement of the test was 9˚C, measured in accordance with AS 1530.4:2014.

3.4 Test Duration

The test was terminated at 245 minutes as per client request.

3.5 Variations from the Test Standard

See notes in section B.2 Furnace Pressure for commentary on variation from the Test Standard.

Appendix A Test observations and Results

Throughout the test, observations were made of the test specimens with respect to integrity and insulation, as noted below.

A.1 Structural Adequacy

Structural adequacy is not a performance criterion assessed for service penetrations, as such, no observations have been provided.

A.2 Integrity

In elements that have a separating function, the presence of crack, fissures, other openings, or relevant occurrences, shall be noted. Cotton pads were available to assess the performance of the specimens.

Table A-1 details the relevant observations for each sample from commencement to completion of the test with respect to integrity. Refer Table A-3 for detailed observations.

Table Appendix A-1: Results from the integrity measurement devices during the test

Item	Comment
Cotton Pads	No failure noted.
Sustained Flaming	No failure noted.

Notes:

1. Ignition (glowing or flaming) of a cotton pad is deemed as failure for integrity as per Clause 2.13.2.2 of AS 1530.4:2014.
2. Sustained flaming on the unexposed face for a minimum of 10 seconds is deemed as failure for integrity as per Clause 2.13.2.4 of AS 1530.4:2014.

A.3 Insulation

Temperatures profiles of the fixed thermocouples are provided in Appendix B.

Roving thermocouples were available to measure temperatures at locations that appeared hotter than the locations monitored by the fixed thermocouples. Table A-2 details relevant observations for each sample, from commencement to completion of the test with respect to insulation. Refer Table A-3 for detailed observations.

Table Appendix A-2: Results from the insulation measurement devices during the test

Item	Comment
Roving TC	No failure noted.

Notes:

1. Maximum temperature exceeding the initial specimen temperature by more than 180 K is deemed as failure as per Clause 2.13.3(b) of AS 1530.4:2014.

A.4 Test Observations

Throughout the test, observations have been made on the test specimens with respect to integrity and insulation as noted below.

Table Appendix A-3: Test Observations

Specimen(s)	Time (min)	Observation
-	00	Test start at 10:23am. Ambient temperature is 8°C.
8, 9, 10	01	Smoke at the penetration seal.
1, 2, 3, 6, 10, 11	02	Smoke at the end of the pipe. Yellow smoke for specimen 6, white smoke for the others.
5, 6, 7	03	Dark smoke at the end of the pipe.
8, 10	04	Smoke stopped at the penetration seal.
1, 2, 3	05	Smoke stopped at the end of the pipe.
9	06	Smoke decreasing at the penetration seal.
4, 5, 11	08	Smoke stopped at the end of the pipe.
6, 7, 8, 9, 10	11	Light Smoke at the end of the pipe.
1, 2, 4, 5, 6, 7	15	Pipe lifting through the penetration seal. Sealant cracked at the penetration seal.
8, 10	16	Intumescent sealant at the penetration seal is activating around services.
1, 4, 6, 13	16	Smoke at the penetration seal.
3, 7, 9, 10	19	Light smoke at the end of the pipe. Smoke has stopped at the end of the pipe for all other services.
1, 4	19	Water and smoke are leaking through the penetration seal.
2	20	Smoke at the penetration seal.
3, 11	21	Water and smoke are leaking through the penetration seal.
8, 10	22	Services lifting upward through the core hole, approximately 10 to 20 mm.
8, 9	24	Water and smoke are leaking through the penetration seal.
1, 2, 3, 4, 5, 8, 9, 10, 11, 13	28	Light smoke at the penetration seal.
6, 7, 8, 10, 13	30	Light Smoke at the end of the pipe.
All	**30**	**All remaining specimens maintain integrity and insulation.**
5	32	Water is leaking through the penetration seal.

Specimen(s)	Time (min)	Observation
All	42	Light smoke is leaking through all remaining specimens at the penetration seal.
3, 6, 7, 10	44	Light smoke continued at the end of the pipe.
All	47	All remaining specimens continue to lift through the core hole, now approximately 10 to 25 mm.
2, 3	49	Condensation and light-yellow discoloration on pipe at the penetration seal.
10	52	Roving Thermocouple test on the floor – pass (50°C).
9	53	Roving Thermocouple test on the 25 mm conduit – pass (54°C).
8	58	Light smoke at the end of the pipe.
All	**60**	**All remaining specimens maintain integrity and insulation.**
2, 3, 4	62	Increasing discoloration on services at the penetration seal.
2, 3, 4	79	Increasing discoloration on services at the penetration seal.
All	**90**	**All remaining specimens maintain integrity and insulation.**
2, 3, 4	91	Dark discoloration on services at the penetration seal.
6, 7, 10, 13	92	Continued light smoke the end of the pipe.
7	94	Roving Thermocouple test on the pipe – pass (58°C).
9	96	Roving Thermocouple test on the 25 mm conduit – pass (84°C).
6	111	Roving Thermocouple test on the pipe – pass (51°C).
9	113	Roving Thermocouple test on the 32 mm conduit – pass (89°C).
11	114	Roving Thermocouple test on the pipe – pass (51°C).
9	118	Discoloration on the conduits at the penetration seal.
4, 5, 7	120	Discoloration on pipes at the penetration seal.
All	**120**	**All remaining specimens maintain integrity and insulation.**
6, 7, 10, 13	121	Continued light smoke at the end of the pipe.
All	122	All remaining specimens continue to lift through the core hole, now approximately 10 to 50 mm.
9	140	Roving Thermocouple test on the services – pass (46°C).
10	148	Roving Thermocouple test on the services – pass (72°C).

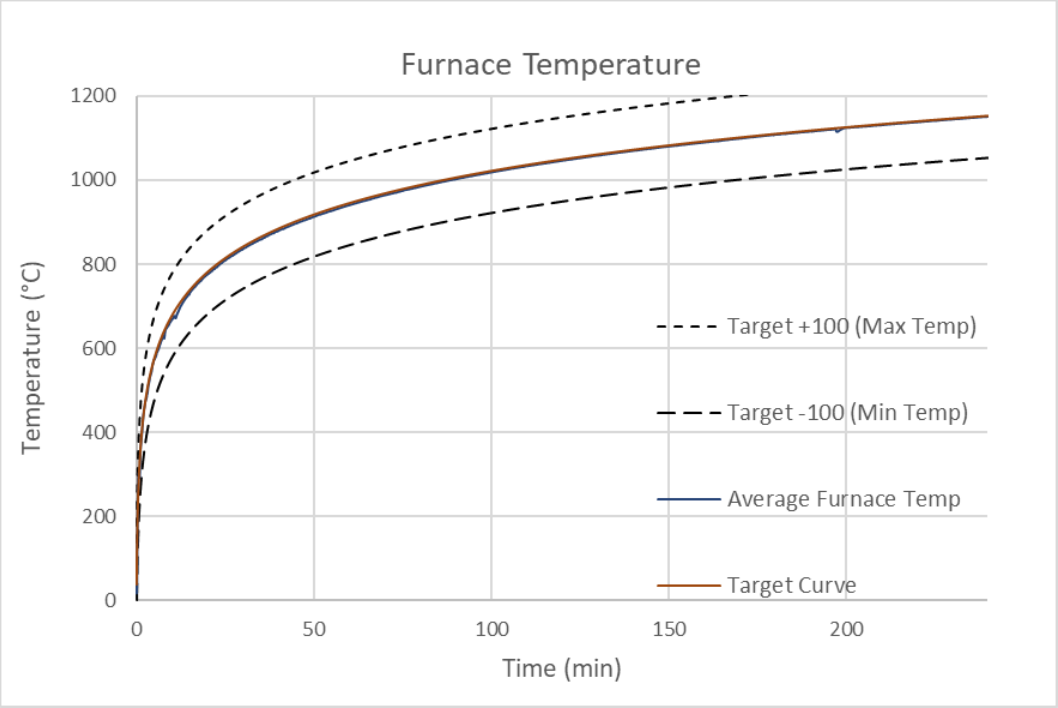
Specimen(s)	Time (min)	Observation
10	148	Smoke stopped the end of the services.
All	**150**	**All remaining specimens maintain integrity and insulation.**
6, 7, 13	150	Continued light smoke at the end of the pipe.
All	151	Continued increasing discoloration on the services at the penetration seal. Continued light smoke at the penetration seal.
6, 7	160	TC 33 and 38 has detached slightly from pipe. Specimen was monitored with roving thermocouple.
6	166	Slight increase in smoke at the end of the pipe.
9	178	Roving Thermocouple test on the services – pass (48°C).
All	**180**	**All remaining specimens maintain integrity and insulation.**
6, 7, 13	180	Continued light smoke at the end of the pipe.
All	180	Continued smoke at the penetration seal.
All	**210**	**All remaining specimens maintain integrity.**
6, 7, 13	210	Continued light smoke at end of pipe.
1, 3, 4, 13	211	Smoke at penetration seal stopped.
2, 5, 6, 7, 8, 9, 10, 11	211	Continued increasing discoloration on services at penetration seal. Continued light smoke at penetration seal.
3	213	Light smoke at end of pipe.
7	214	Light yellow smoke at penetration seal.
8	216	Minor deformation on 20 mm conduit approximately 100 mm from penetration seal.
8, 9, 10	216	Intumescent activating within core hole and pushing up to approximately 25 mm.
7	219	Roving Thermocouple test on services – pass (107°C).
11	221	Smoke at end of pipe.
9	221	Roving Thermocouple test on services – pass (67°C).
10	235	Roving Thermocouple test on services – pass (74°C).
5	236	Very light smoke end of pipe.
7	236	Smoke increasing at end of pipe and through penetration seal.
6	237	Smoke decreasing at end of pipe.
All	**240**	**All remaining specimens maintain integrity.**

Specimen(s)	Time (min)	Observation
6, 7, 11, 13	241	Continued smoke at end of pipe.
2, 4, 5, 6, 7, 8, 9, 10, 11, 13	242	Continued increasing discoloration on services at penetration seal. Continued light smoke at penetration seal.
All	**245**	**Test Ended**

Appendix B Test Conditions

B.1 Furnace Temperature Profile

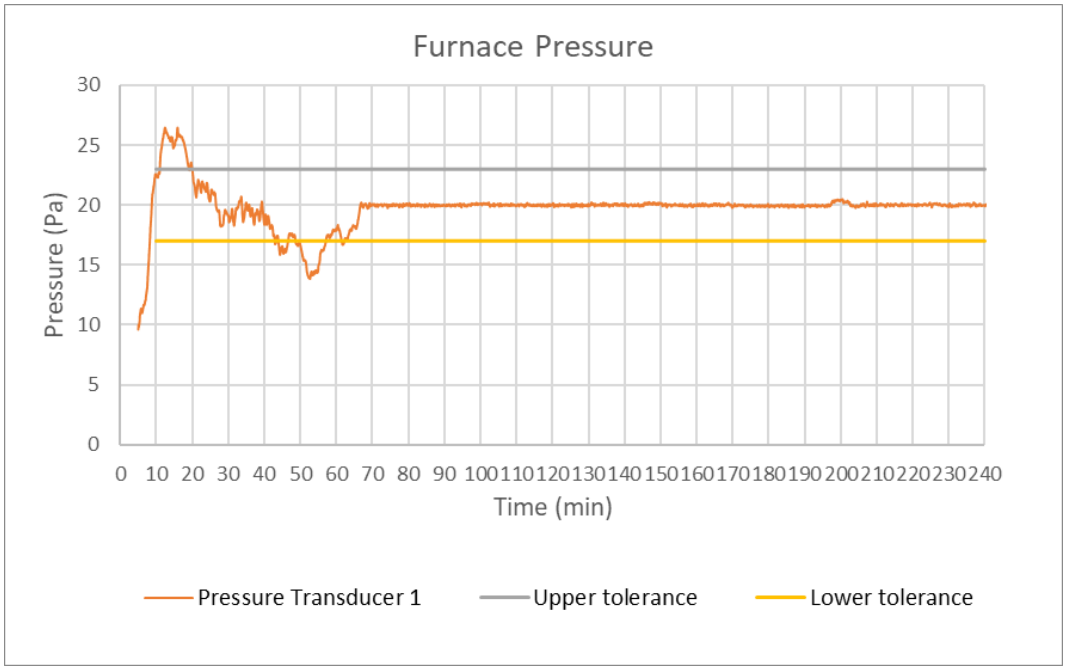
The temperature within the furnace was measured using calibrated thermocouples in accordance with AS 1530.4:2014. The furnace temperature is illustrated in Figure B-1.



Appendix Figure B-1: Furnace temperature profile

B.2 Furnace Pressure

Pressure was measured in accordance with AS 1530.4:2014 using a manometer at a height of 100 mm off the exposed face of the horizontal test separating element. The target pressure is 20 ±3 Pa. The measurement is illustrated in Figure B-2.



Appendix Figure B-2: Furnace pressure

Note: The automated pressure control system experienced a fault which led to the pressure variation shown in Appendix Figure B-2. The fault was identified and remediated through manual intervention. The result of this fault was:

- Exceeding the upper pressure tolerance between 10 minutes and 20 minutes,
- Failing to meet the lower pressure tolerance between 44 minutes and 46 minutes, and between 50 minutes and 57 minutes.
- The fault was to an actuator and the pressure profile recorded during this period remains correct.
- Consequently, the test specimens were subject to over-pressure for 10 minutes, and under-pressure for 9 minutes. Overall, the average recorded pressure for the duration of the test was 20 Pa.

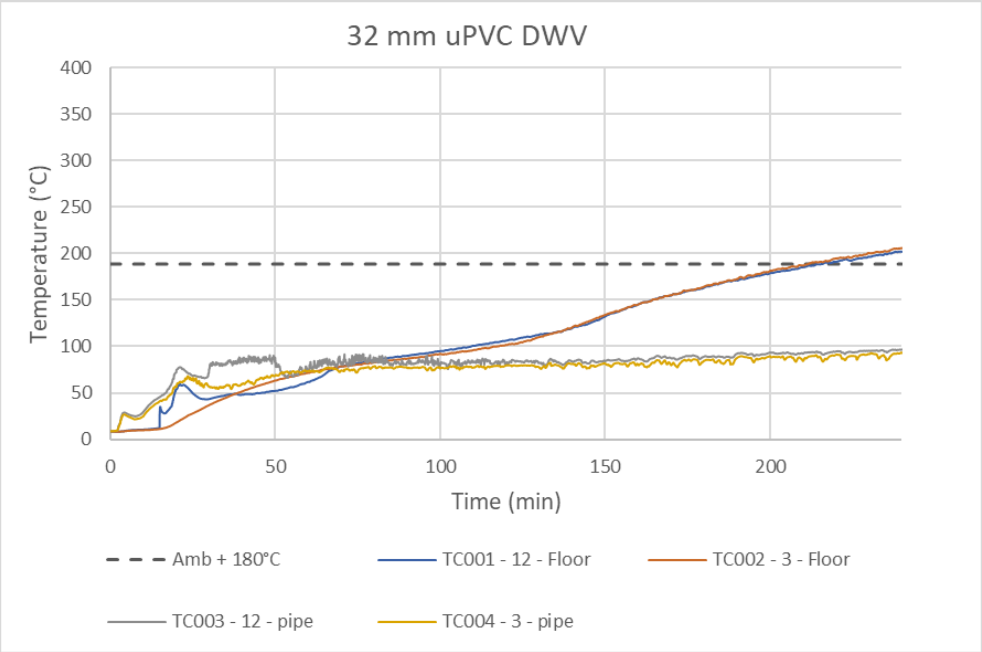
On review of the temperature profiles for the reported specimens, the temperature of each specimen has risen and dropped (as expected) within the first 20minutes/ the period of over pressure. This indicates a successful closing of the intumescent within each specimen. The activation and closure within this time is in line with test observations. This closure and temperature drop has occurred during the period of over pressure and is considered more onerous to the specimen than if the pressure was within tolerance. The two brief periods of low pressure are after the time at which the intumescent has expanded and created a firm seal but still early in the test duration, a slightly reduced pressure at this time and stage is believed to have had minimal impact to the sample following the more onerous start. The pressure was within tolerance for the remainder of the test and the test is deemed compliant.

The period of over pressure during the early stages has resulted in a detrimental outcome to specimen 12. The result for this specimen is therefore unable to be reported, reference to this specimen has been removed from the report.

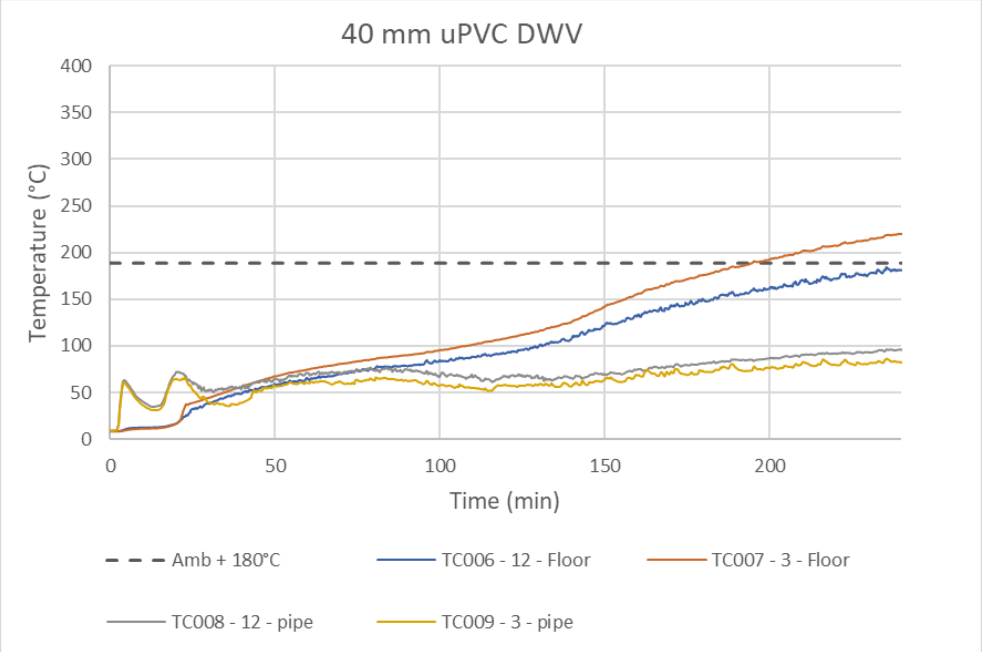
B.3 Specimen Temperature Profiles

B.3.1 Specimen 1 - 12 Temperature Profiles

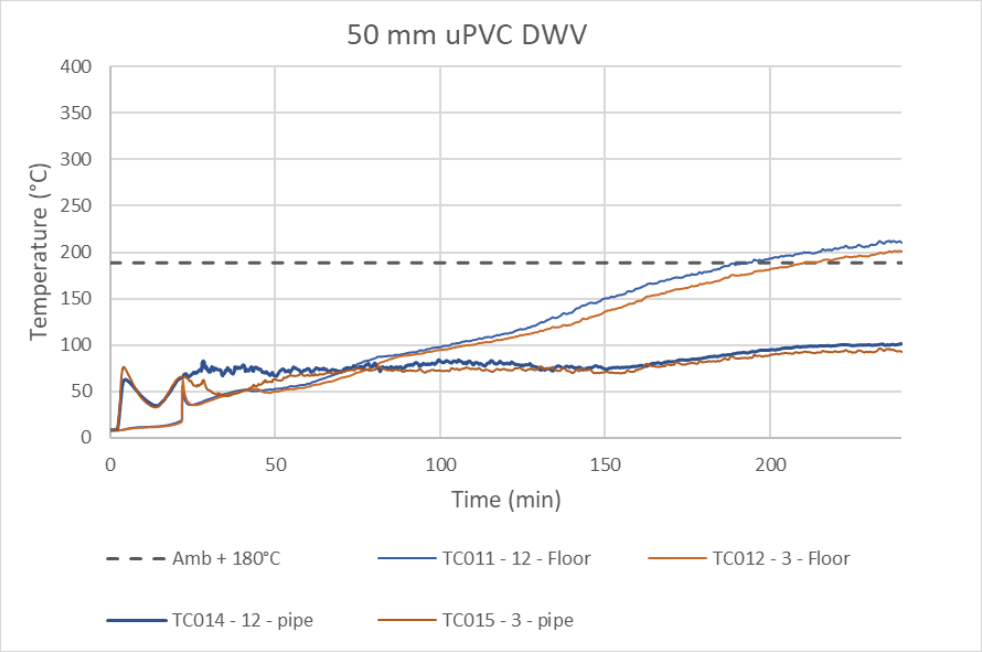
Temperature profiles of fixed thermocouples are graphically presented below for each specimen.



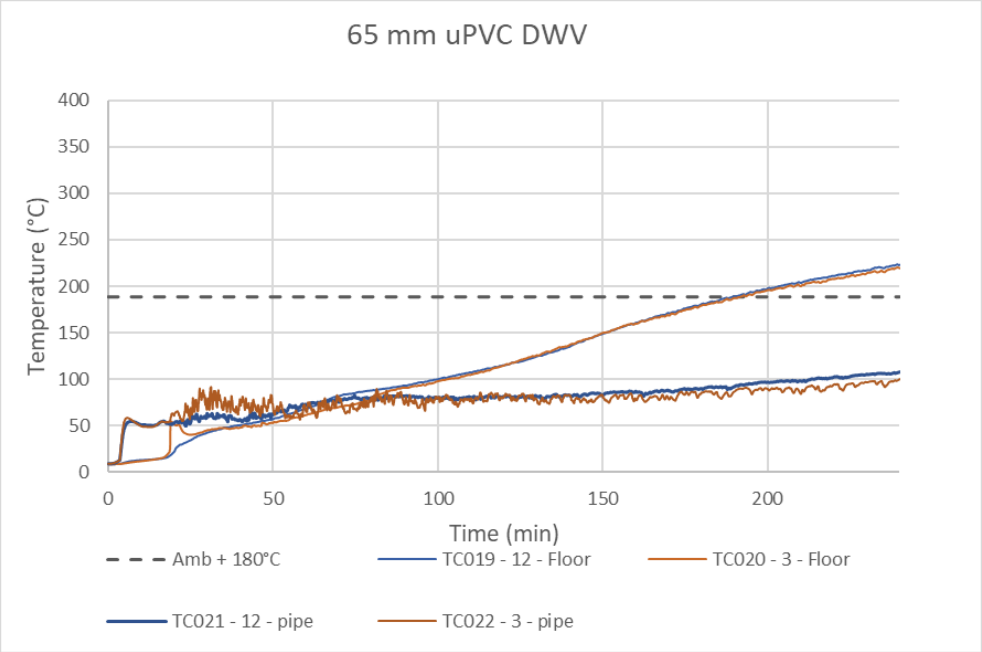
Appendix Figure B-3: Temperature profile Specimen 1 - 32 mm uPVC DWV



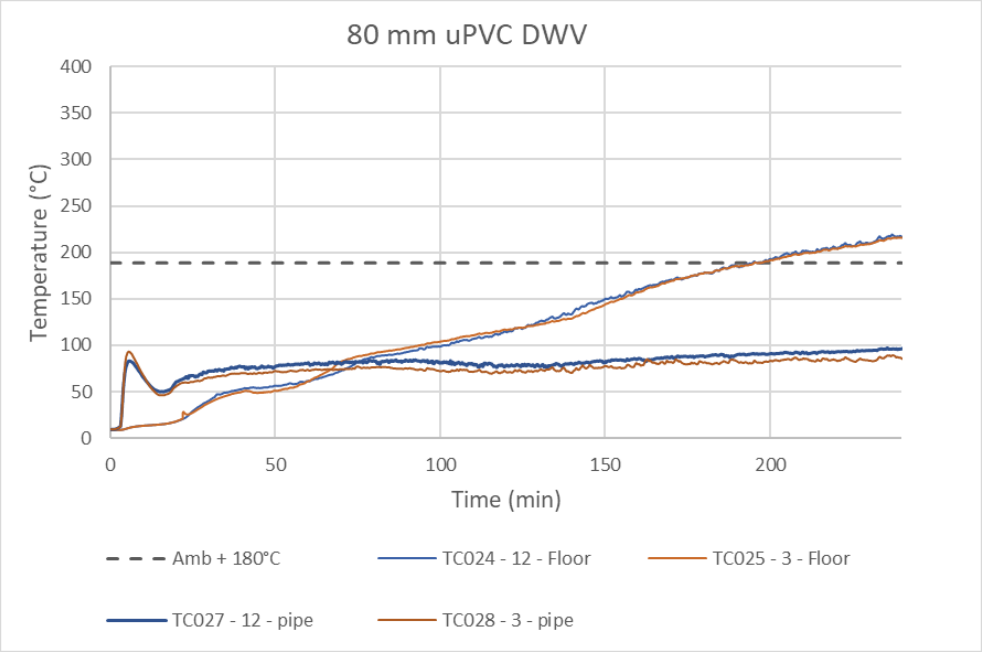
Appendix Figure B-4: Temperature profile Specimen 2 - 40 mm uPVC DWV



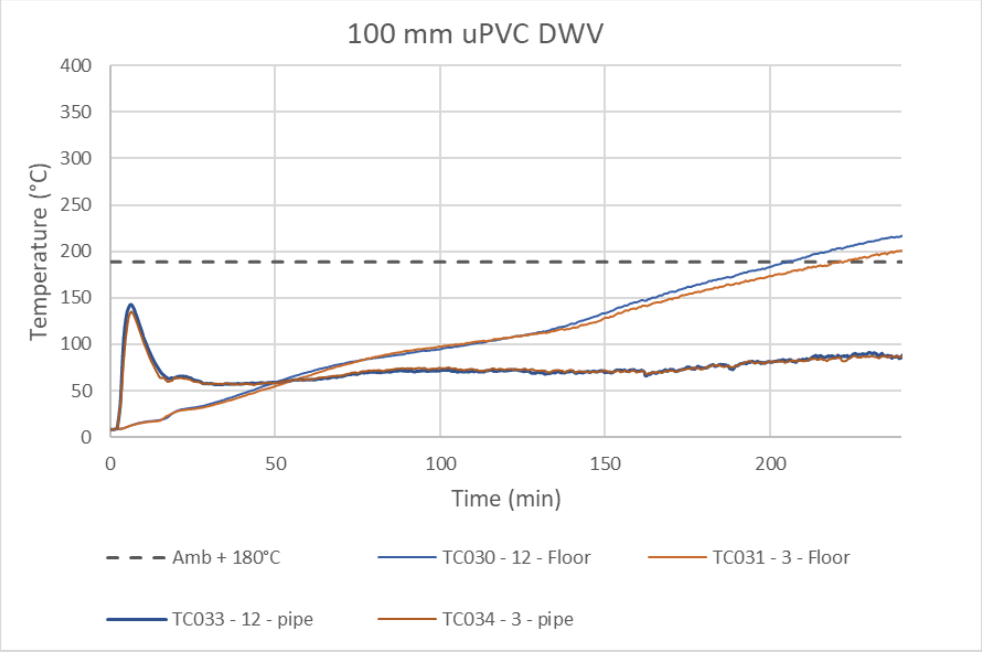
Appendix Figure B-5: Temperature profile Specimen 3 - 50 mm uPVC DWV



Appendix Figure B-6: Temperature profile Specimen 4 - 65 mm uPVC DWV

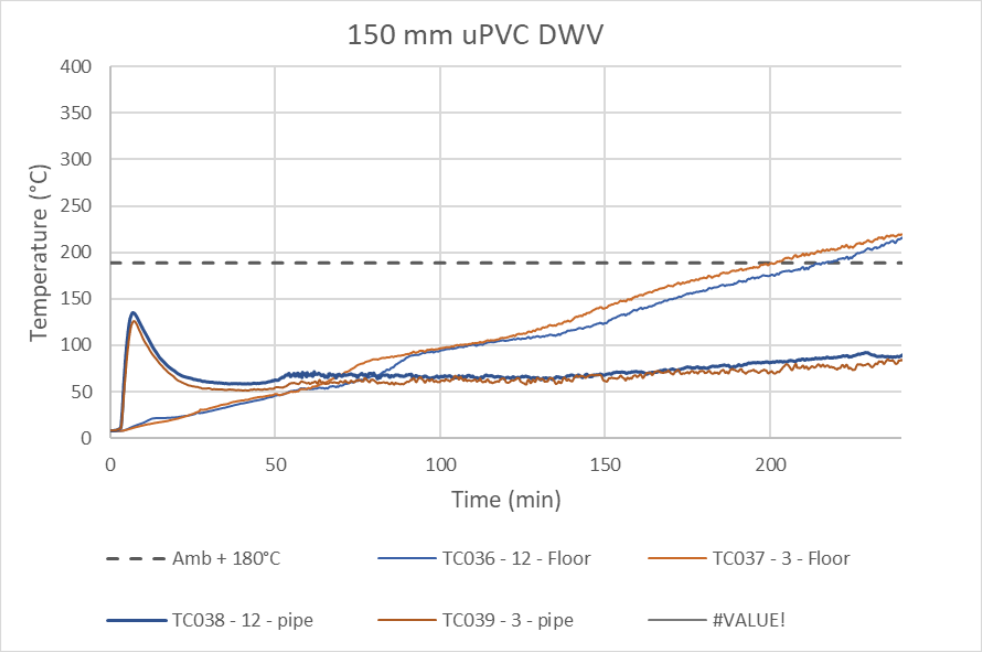


Appendix Figure B-7: Temperature profile Specimen 5 - 80 mm uPVC DWV



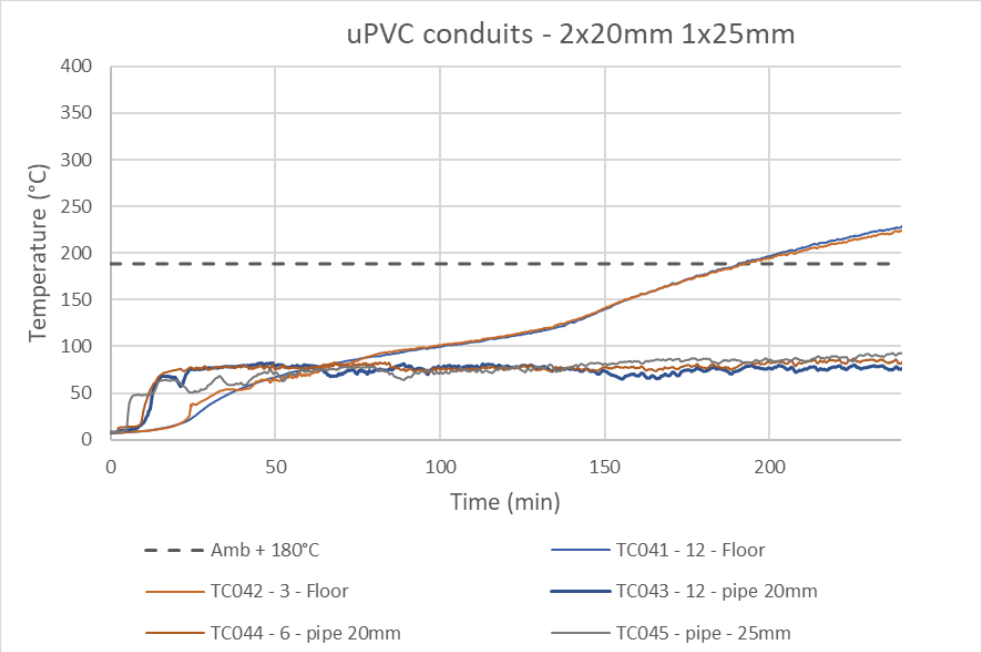
Appendix Figure B-8: Temperature profile Specimen 6 - 100 mm uPVC DWV

Note: As noted in Section B.4, at 160 minutes the TC033 dislodged (slightly). The temperature on the specimen was monitored with a roving thermocouple.

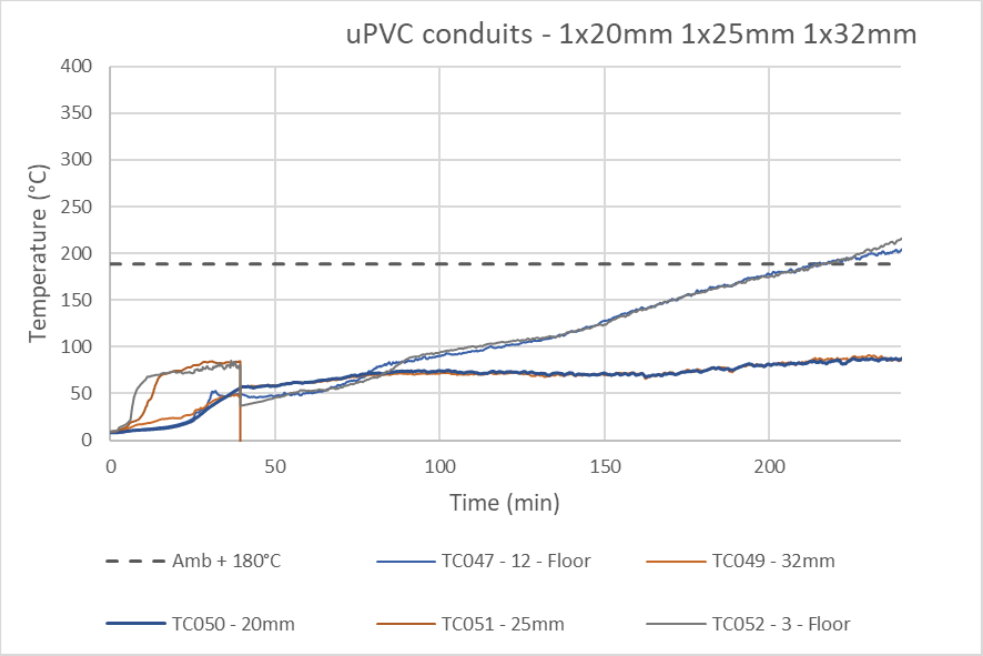


Appendix Figure B-9: Temperature profile Specimen 7 - 150 mm uPVC DWV

Note: As noted in Section B.4, at 160 minutes the TC038 dislodged (slightly). The temperature on the specimen was monitored with a roving thermocouple.

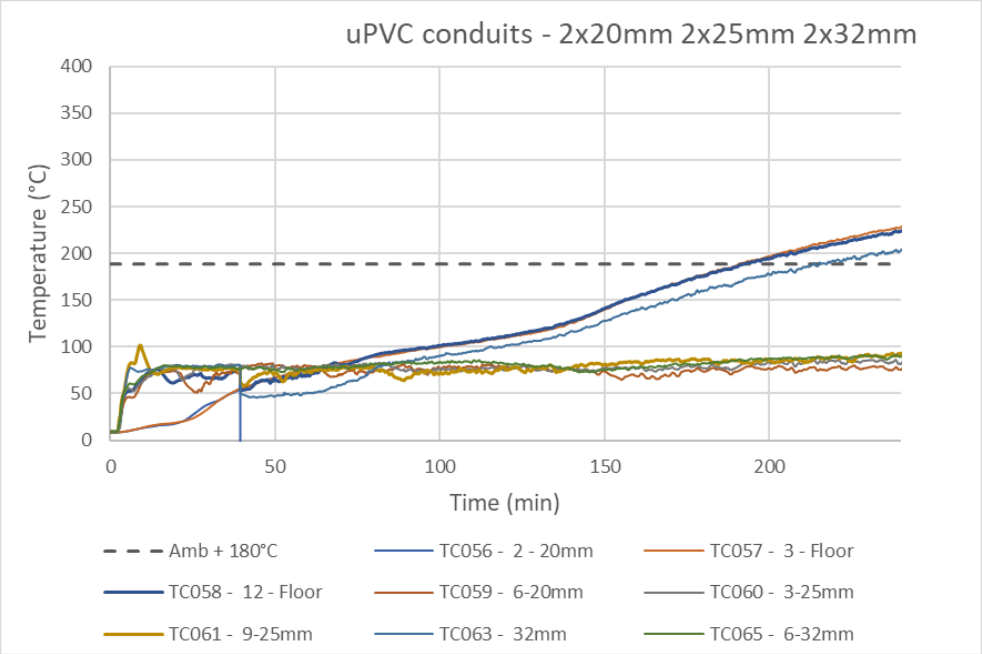


Appendix Figure B-10: Temperature profile Specimen 8 - uPVC conduit bundle with 2 x 20 mm and 1 x 25 mm



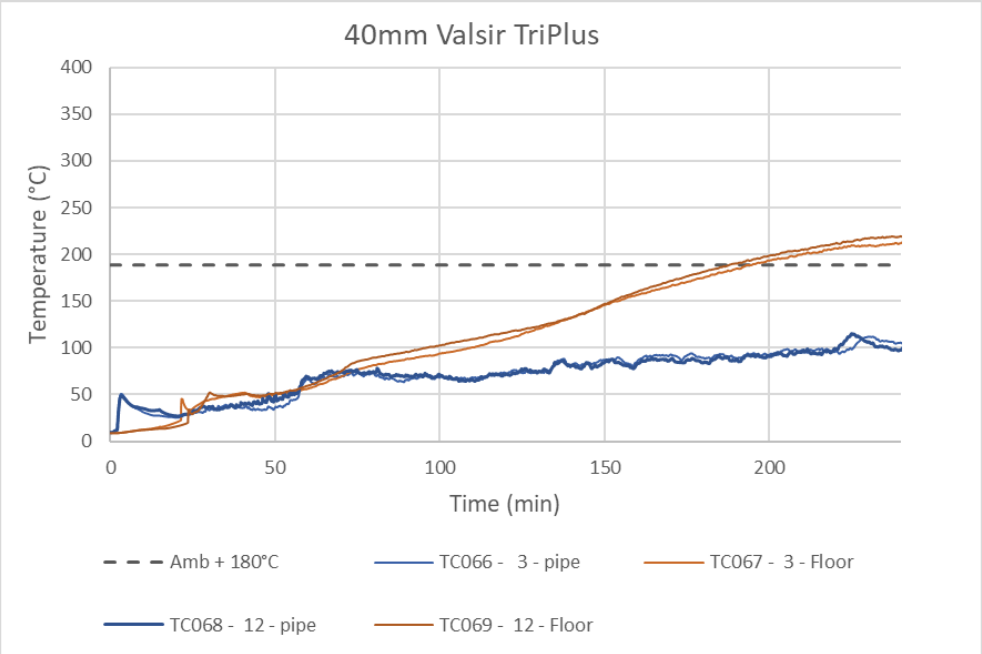
Appendix Figure B-11: Temperature profile Specimen 9 - uPVC conduit bundle with 1 x 20 mm, 1 x 25 mm and 1 x 32 mm

Note: Temperatures for TC051 and TC052 malfunction at approximately 39 minutes and is disregarded. Specimen monitored with roving thermocouple.

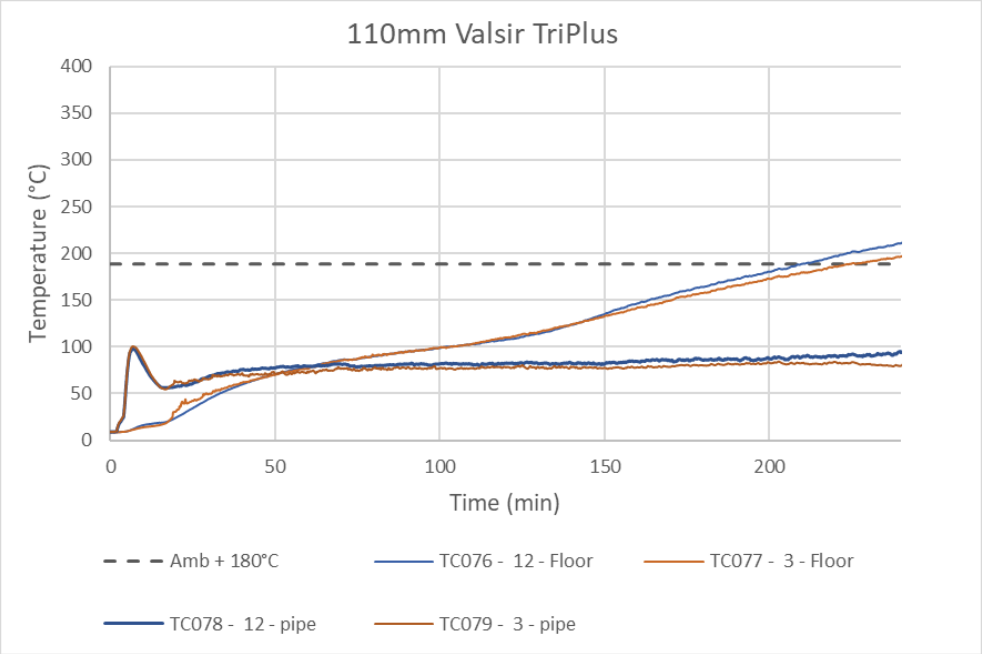


Appendix Figure B-12: Temperature profile Specimen 10 - uPVC conduit bundle with 2 x 20 mm, 2 x 25 mm and 2 x 32 mm

Note: Temperatures for TC056 malfunction at approximately 39 minutes and will be disregarded. Specimen monitored with roving thermocouple.



Appendix Figure B-13: Temperature profile Specimen 11 - 40 mm Valsir TriPlus pipe



Appendix Figure B-14: Temperature profile Specimen 13 - 110 mm Valsir TriPlus pipe

B.4 Thermocouple temperature results at set time intervals

Table B-1 presents the temperature at set time intervals throughout the test for each specimen and thermocouple.

Appendix Table B-1: Thermocouple Results at Set Time Intervals

#	TC ID	Description[1]	Temperature (°C) at t (minutes) [2]								
			t_0	t_{30}	t_{60}	t_{90}	t_{120}	t_{150}	t_{180}	t_{210}	t_{240}
1	TC001	On the separating element (12 o'clock)	8.2	43.4	61.8	90.1	106.2	132.2	163.2	185.0	201.9
	TC002	On the separating element (3 o'clock)	8.2	37.1	71.6	86.8	101.7	134.0	164.3	187.0	205.7
	TC003	On the service (12 o'clock)	8.7	76.2	74.4	83.2	81.9	84.1	89.0	92.2	96.5
	TC004	On the service (3 o'clock)	8.7	56.7	73.5	76.6	79.6	81.3	84.7	84.3	93.2
2	TC006	On the separating element (12 o'clock)	8.3	37.8	64.5	78.1	91.9	122.6	149.0	170.5	181.0
	TC007	On the separating element (3 o'clock)	8.1	44.4	74.6	89.9	107.9	142.3	175.8	202.0	220.0
	TC008	On the service (12 o'clock)	8.9	51.8	70.9	74.5	66.8	69.5	81.1	90.4	96.0
	TC009	On the service (3 o'clock)	8.8	38.9	60.3	62.4	57.9	64.5	72.3	82.4	82.3
3	TC011	On the separating element (12 o'clock)	8.1	42.1	58.6	91.4	112.4	150.2	178.7	199.4	210.5
	TC012	On the separating element (3 o'clock)	8.1	40.0	55.4	88.7	106.8	136.1	166.2	188.1	200.9
	TC014	On the service (12 o'clock)	8.6	71.6	74.5	78.1	80.1	74.4	86.2	98.4	101.3
	TC015	On the service (3 o'clock)	8.8	50.9	67.6	72.5	73.2	71.1	81.6	92.4	92.9
4	TC019	On the separating element (12 o'clock)	8.7	42.7	68.4	93.3	115.1	149.1	181.0	203.6	222.9
	TC020	On the separating element (3 o'clock)	8.7	45.2	61.5	90.7	114.7	149.9	179.3	200.0	219.5
	TC021	On the service (12 o'clock)	9.2	63.2	72.6	82.0	81.5	83.5	90.1	98.4	107.8
	TC022	On the service (3 o'clock)	9.2	67.8	65.3	76.2	81.7	80.3	85.8	84.4	100.1
5	TC024	On the separating element (12 o'clock)	8.7	40.6	61.6	92.8	114.2	150.0	178.0	201.9	216.5
	TC025	On the separating element (3 o'clock)	8.7	38.3	61.3	97.4	116.5	143.9	177.8	199.0	215.6
	TC027	On the service (12 o'clock)	9.2	72.2	81.0	83.2	78.4	82.5	88.2	92.6	96.4
	TC028	On the service (3 o'clock)	9.3	65.1	73.3	74.8	71.2	77.8	81.5	85.5	85.6
6	TC030	On the separating element (12 o'clock)	8.6	35.5	70.2	90.4	106.4	133.3	165.7	193.2	216.7
	TC031	On the separating element (3 o'clock)	8.6	33.6	66.1	93.0	106.8	128.5	157.7	180.0	200.4
	TC033	On the service (12 o'clock)	8.1	57.6	61.9	71.0	71.5	69.7	-	-	-
	TC034	On the service (3 o'clock)	8.2	57.3	61.9	74.0	73.0	71.7	74.2	81.7	87.0
7	TC036	On the separating element (12 o'clock)	7.6	29.0	53.2	87.1	104.9	123.9	158.7	184.2	215.9
	TC037	On the separating element (3 o'clock)	7.7	32.1	54.0	90.6	108.2	140.0	173.0	198.7	219.3
	TC038	On the service (12 o'clock)	7.9	60.3	68.1	67.9	65.0	68.2	-	-	-
	TC039	On the service (3 o'clock)	8.2	53.6	59.7	60.9	60.1	61.6	71.4	78.2	84.2
8	TC041	On the separating element (12 o'clock)	7.5	37.6	76.1	95.3	109.8	140.0	177.2	206.3	228.6
	TC042	On the separating element (3 o'clock)	7.4	46.0	69.8	96.7	111.8	141.2	175.9	202.8	224.0
	TC043	On the service (20mm, 12 o'clock)	8.1	77.4	79.0	78.1	78.9	73.5	73.5	75.0	75.9
	TC044	On the service (20mm, 6 o'clock)	8.1	75.5	75.8	74.5	77.5	77.4	77.3	82.4	82.3
	TC045	On the service (25mm)	8.0	59.0	74.1	66.8	75.5	81.5	86.8	85.0	93.1
9	TC047	On the separating element (12 o'clock)	7.5	43.3	50.5	84.4	101.7	127.9	159.8	184.8	203.9
	TC049	On the service (32mm)	9.2	39.5	61.9	71.0	71.5	69.7	74.6	83.9	87.4

#	TC ID	Description[1]	Temperature (°C) at t (minutes) [2]								
			t_0	t_{30}	t_{60}	t_{90}	t_{120}	t_{150}	t_{180}	t_{210}	t_{240}
	TC050	On the service (20mm)	8.7	35.2	61.9	74.0	73.0	71.7	74.2	81.7	87.0
	TC051	On the service (25mm)	9.2	84.2	-	-	-	-	-	-	-
	TC052	On the separating element (3 o'clock)	9.3	76.3	-	-	-	-	-	-	-
10	TC056	On the service (20mm, 2 o'clock)	8.5	39.1	-	-	-	-	-	-	-
	TC057	On the separating element (3 o'clock)	8.6	34.9	76.1	95.3	109.8	140.0	177.2	206.3	228.6
	TC058	On the separating element (12 o'clock)	9.0	67.0	69.8	96.7	111.8	141.2	175.9	202.8	224.0
	TC059	On the service (20mm, 6 o'clock)	9.0	60.1	79.0	78.1	78.9	73.5	73.5	75.0	75.9
	TC060	On the service (25mm, 3 o'clock)	9.0	79.2	75.8	74.5	77.5	77.4	77.3	82.4	82.3
	TC061	On the service (25mm, 9 o'clock)	9.0	76.1	74.1	66.8	75.5	81.5	86.8	85.0	93.1
	TC063	On the service (32mm, 12 o'clock)	9.0	79.4	50.5	84.4	101.7	127.9	159.8	184.8	203.9
	TC065	On the service (32mm, 6 o'clock)	9.3	77.3	76.8	83.3	81.6	75.8	82.3	87.3	89.9
11	TC066	On the service (3 o'clock)	9.7	33.1	66.9	66.1	72.8	86.9	89.3	96.7	105.4
	TC067	On the separating element (3 o'clock)	8.7	44.4	56.3	88.2	109.5	145.9	175.0	200.2	212.1
	TC068	On the service (12 o'clock)	9.5	36.9	69.0	70.0	71.8	84.7	84.4	96.6	97.9
	TC069	On the separating element (12 o'clock)	8.8	51.9	59.7	95.7	116.3	147.0	181.4	205.2	219.1
13	TC076	On the separating element (12 o'clock)	9	45	79	95	108	135	164	189	211
	TC077	On the separating element (3 o'clock)	9	50	77	95	110	133	158	179	197
	TC078	On the service (12 o'clock)	9	69	79	81	83	82	86	90	94
	TC079	On the service (3 o'clock)	9	66	73	78	78	78	80	83	80

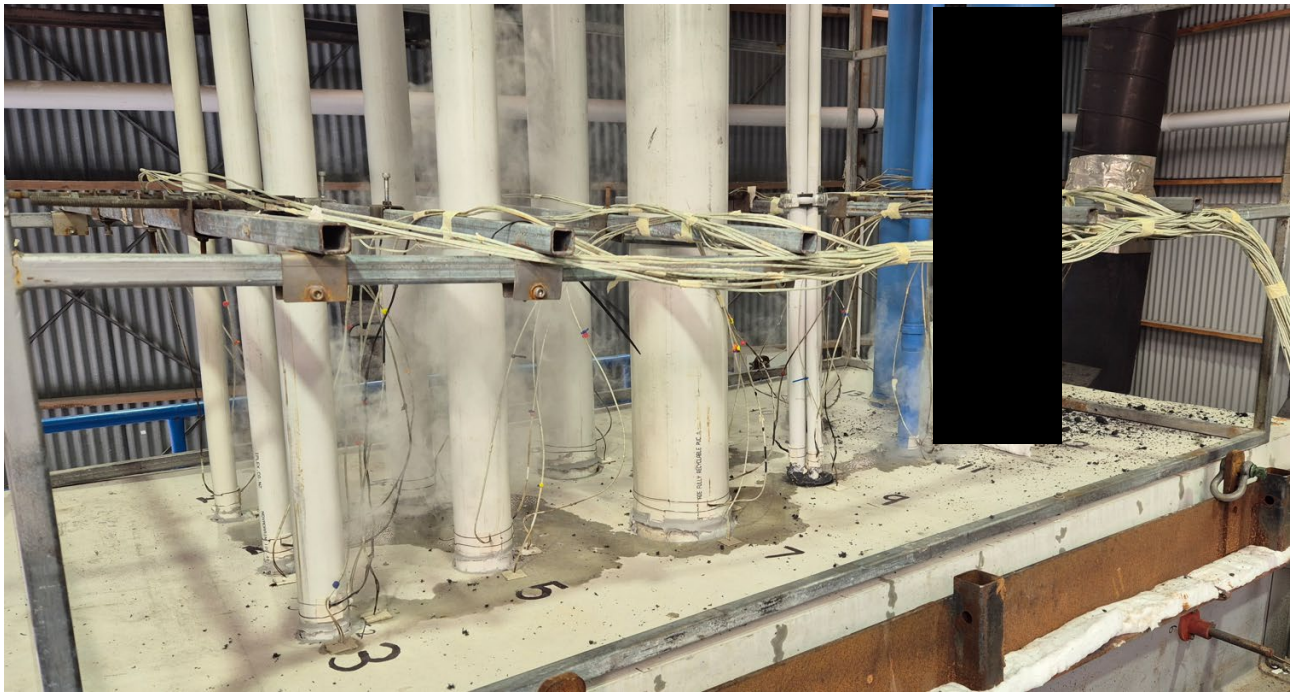
Notes:

1. 12 o'clock is set as the short side closest to Specimens 12 and 13.
2. Temperature measurement not presented for thermocouples that have partially detached or malfunctioned.

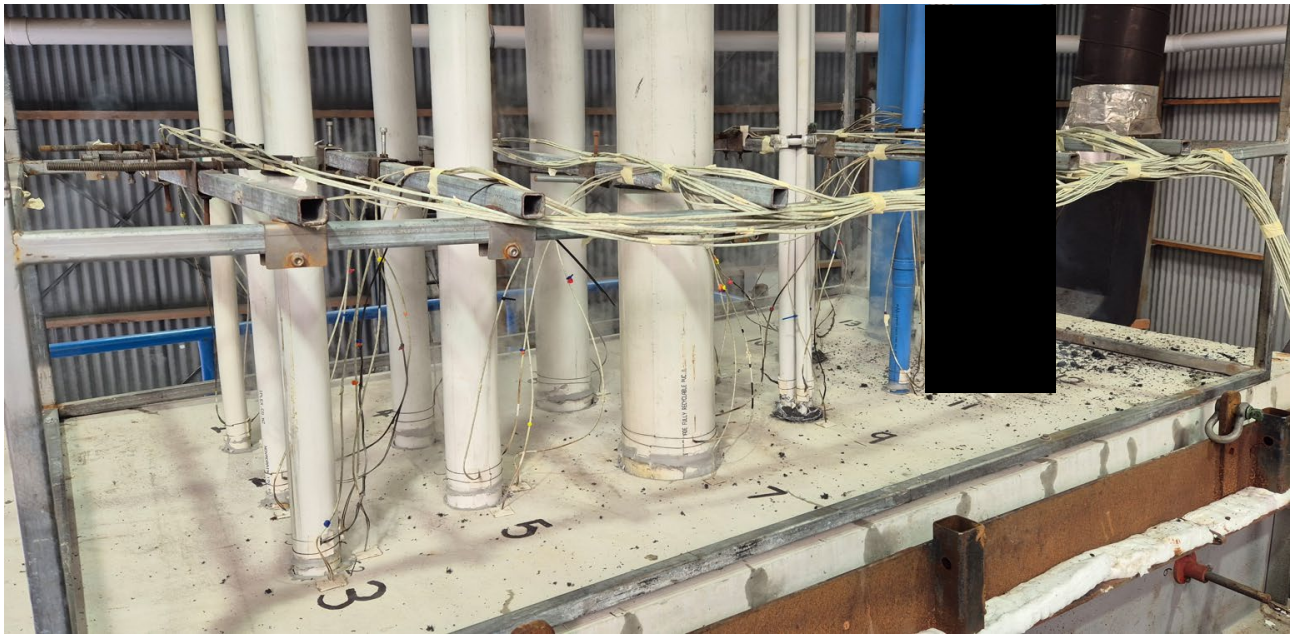
Appendix C Additional Photographs, schematics, and discussion

Appendix Figure C-1: Penetrations 1-13, unexposed side prior to test commencement.

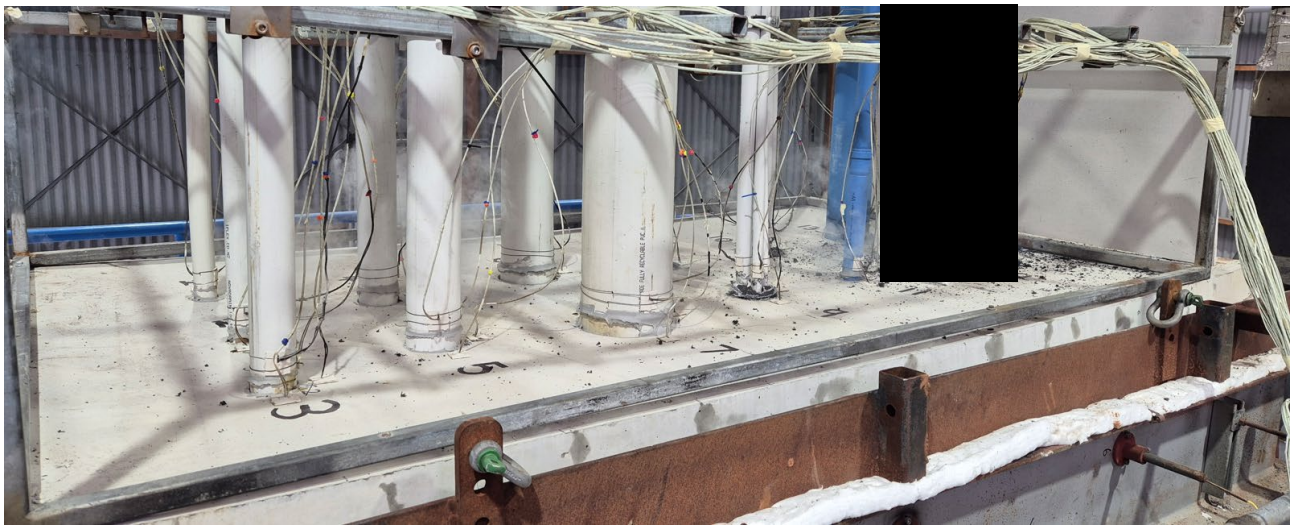
Appendix Figure C-2: Penetrations 1-13, exposed side prior to test commencement.



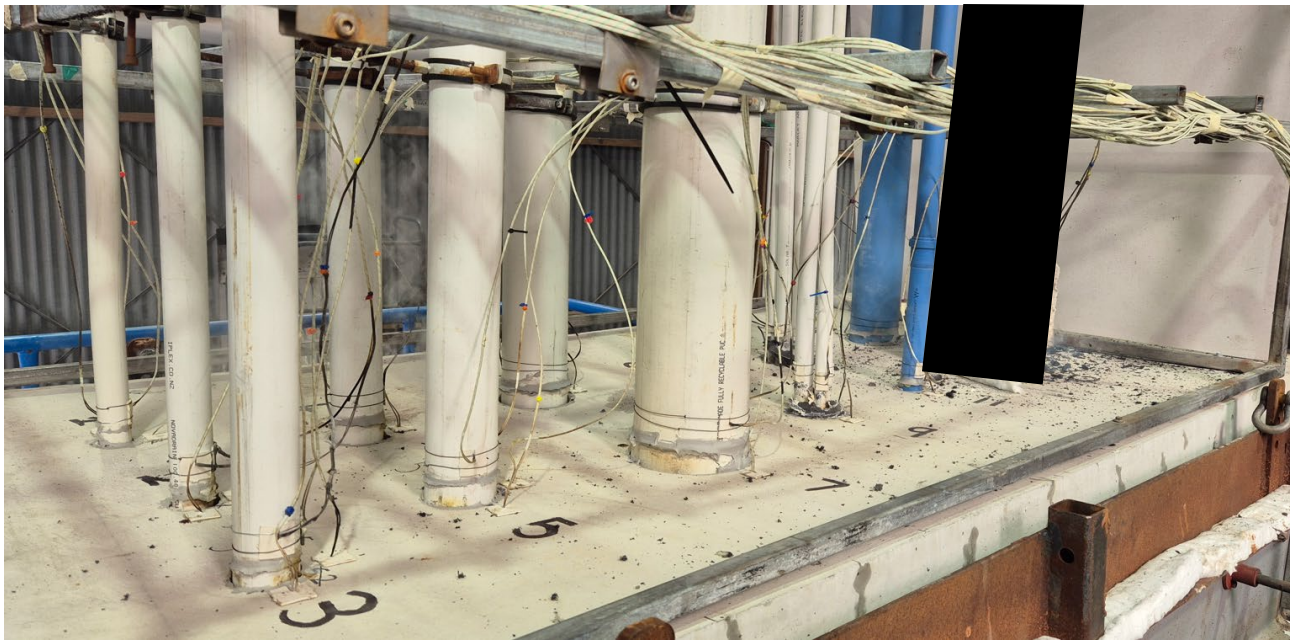
Appendix Figure C-3: Penetrations 1-13, unexposed side at 30 minutes.



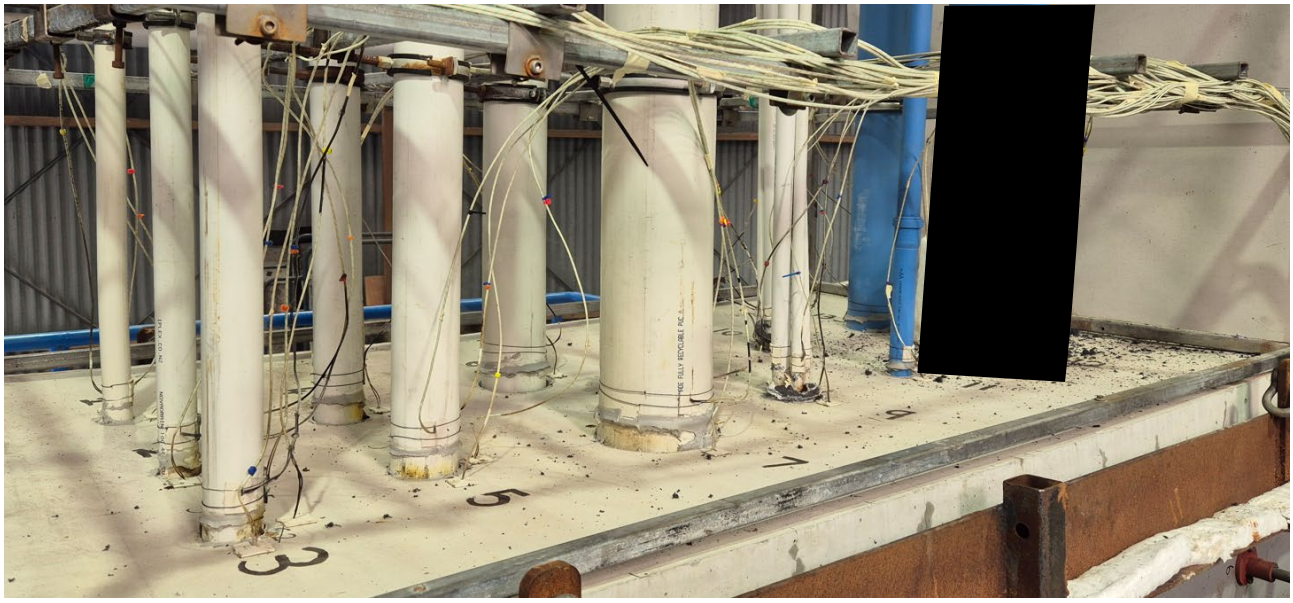
Appendix Figure C-4: Penetrations 1-13, unexposed side at 60 minutes.



Appendix Figure C-5: Penetrations 1-13, unexposed side at 90 minutes.



Appendix Figure C-6: Penetrations 1-13, unexposed side at 120 minutes.



Appendix Figure C-7: Penetrations 1-13, unexposed side at 150 minutes.

Appendix Figure C-8: Penetrations 1-13, unexposed side at 180 minutes.

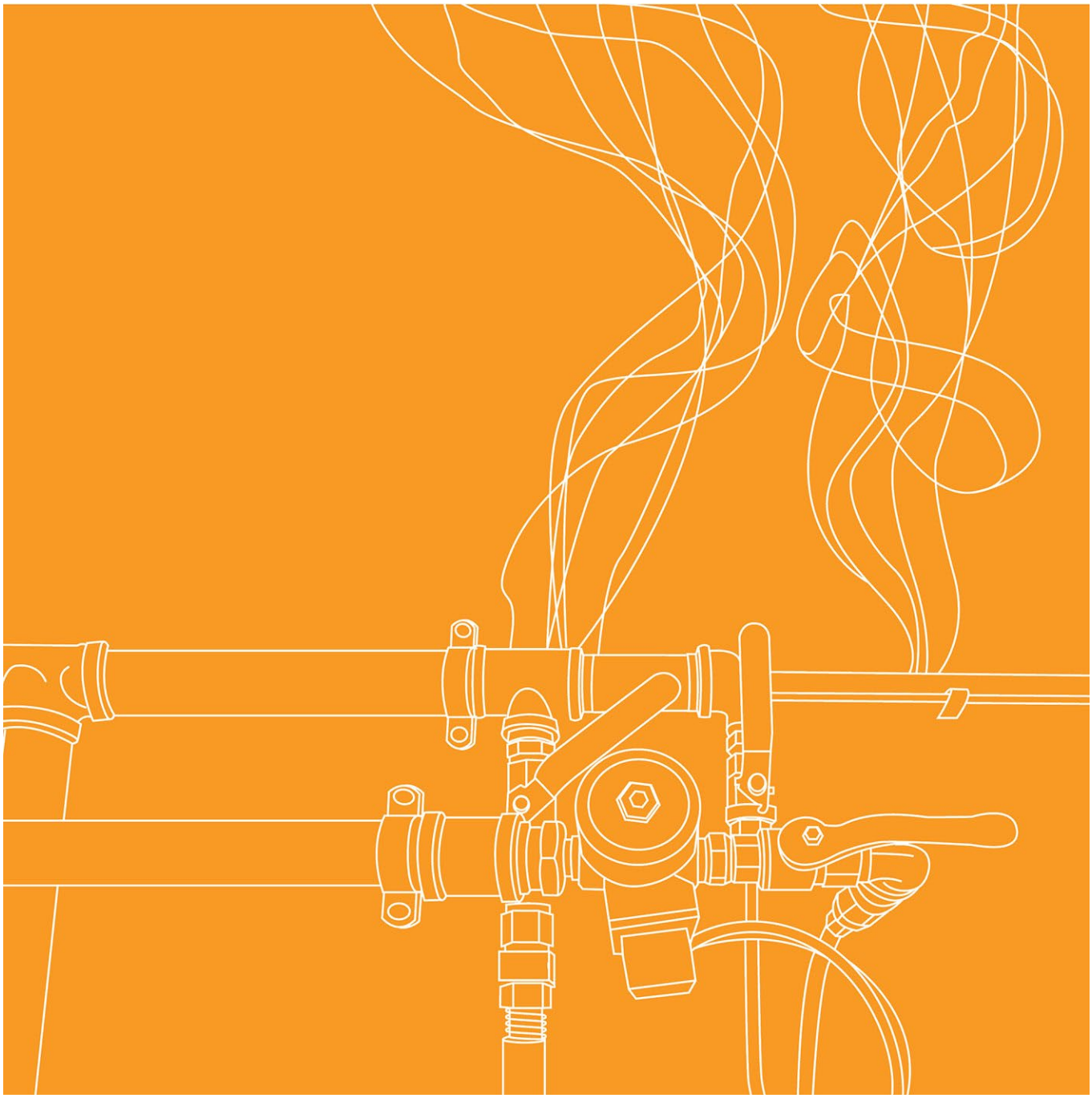
Appendix Figure C-9: Penetrations 1-13, unexposed side at 210 minutes.

Appendix Figure C-10: Penetrations 1-13, unexposed side at 240 minutes.

Appendix Figure C-11: Penetrations 1-13, exposed side at end of test.

Appendix Figure C-12: Penetrations 1-13, unexposed side at end of test.

Appendix Figure C-13: Exposed side following removal from the furnace.



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